



An Oshkosh Corporation Company

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# Service and Maintenance Manual

***Model***  
**800A**  
**800AJ**

**S/N 0300183034 to Present**

**3121628**

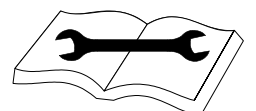
February 08, 2019 - Rev F

**ANSI**

**CE**



**AS/NZS**





## SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

### A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the aerial platform. It is of utmost importance that maintenance personnel pay strict attention to these warnings and precautions to avoid possible injury to themselves or others, or damage to the equipment. A maintenance program must be followed to ensure that the machine is safe to operate.

#### **⚠ WARNING**

**MODIFICATION OR ALTERATION OF AN AERIAL WORK PLATFORM SHALL BE MADE ONLY WITH WRITTEN PERMISSION FROM THE MANUFACTURER.**

The specific precautions to be observed during maintenance are inserted at the appropriate point in the manual. These precautions are, for the most part, those that apply when servicing hydraulic and larger machine component parts.

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

#### **⚠ WARNING**

**SINCE THE MACHINE MANUFACTURER HAS NO DIRECT CONTROL OVER THE FIELD INSPECTION AND MAINTENANCE, SAFETY IN THIS AREA RESPONSIBILITY OF THE OWNER/OPERATOR.**

### B HYDRAULIC SYSTEM SAFETY

It should be noted that the machines hydraulic systems operate at extremely high potentially dangerous pressures. Every effort should be made to relieve any system pressure prior to disconnecting or removing any portion of the system.

Do not use your hand to check for leaks. Use a piece of cardboard or paper to search for leaks. Wear gloves to help protect hands from spraying fluid.



### C MAINTENANCE

#### **⚠ WARNING**

**FAILURE TO COMPLY WITH SAFETY PRECAUTIONS LISTED IN THIS SECTION COULD RESULT IN MACHINE DAMAGE, PERSONNEL INJURY OR DEATH AND IS A SAFETY VIOLATION.**

- ENSURE REPLACEMENT PARTS OR COMPONENTS ARE IDENTICAL OR EQUIVALENT TO ORIGINAL PARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICE MANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTED DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

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## SECTION 1. SPECIFICATIONS

## 1.1 OPERATING SPECIFICATIONS

Table 1-1. Operating Specifications

Travel Speed	3.0 MPH (4.83 Km/hr.)
Gradeability	
2WD	30%
4WD	45%
Turning Radius (Outside)	
2WS	19 ft. 8 in. (6.02 m)
4WS	11 ft. 7 in. (3.53 m)
Turning Radius (Inside)	
2WS	12 ft. 6 in. (3.8 m)
4WS	6 ft. (1.83 m)
Overall Width	8 ft. 1 in. (2.48 m)
Tailswing	8 ft. 4 in. (2.56 m)
Ground Clearance	11 in. (28 cm)
Machine Height Stowed	9 ft. 10 in. (3 m)
Machine Length (Stowed)	
800A	36 ft. 11 in. (11.25 m)
800AJ	36 ft. 6 in. (11.13 m)
Wheel base	10 ft. (3.06 m)
Platform Height - 800A	
Above Grade	+80 ft. (24.38 m)
Below Grade	-15 ft. 7 in. (4.75 m)
Platform Height - 800AJ	
Above Grade	+80 ft. (24.48 m)
Below Grade	-13 ft. 1 in. (3.99 m)
Max. Ground Bearing Pressure	76 psi. (5.3 kg/cm <sup>2</sup> )
Max. Tire Load	17,755 lbs. (8054 kg)
Machine Weight approximately*	35,500 lbs. (16,103 kg)
* Certain options or country standards can increase weight.	

## 1.2 CAPACITIES

Table 1-2. Capacities

Fuel Tank	Approx. 39 Gallons (147.6 L)
Hydraulic Tank	Approx. 40 Gallons (151.4 L)
Hydraulic System (Including Tank)	77 Gallons (291.4 L)
Drive Hub	44 ounces (1.3 L)
Drive Brake	2.7 ounces (80 ml)
Engine Crankcase	
Deutz D2011L04	11 qt (10.5 L)
Deutz TD 2.9L	2.4 Gallons (8.9 L) w/Filter
GM	4.5 qt (4.25 L) w/Filter
Deutz TD 2.9L4 China III	2.11 Gallons (8.0 L)
Ford 2.5 L MSG-425	7 qt (6.6 L)

## 1.3 TIRES

Table 1-3. Tire Specifications

SIZE	TYPE	PLY RATING	LOAD RANGE	PRESSURE
15-625	pneumatic	16	H	95 psi (6.5 bar)
15-625	foam-filled	16	H	N/A
18-625	foam-filled	16	H	N/A

## 1.4 ENGINE DATA

Table 1-4. Deutz D2011L04 Specifications

Type	Liquid Cooled (Oil)
Fuel	Diesel
Oil Capacity	
Cooling System	5 qt (4.5 L)
Crankcase	11 qt (10.5 L) w/Filter
Total Capacity	16 qt (15 L)
Idle RPM	1000
Low RPM	1800
High RPM	2600
Alternator	55 Amp, belt drive
Fuel Consumption	0.88 GPH (3.33 lph)
Battery	1000 Cold Cranking Amps, 210 minutes Reserve Capacity, 12 VDC
Horsepower	61.6 @ 2600 RPM, full load

## SECTION 1 - SPECIFICATIONS

**Table 1-5. Deutz TD 2.9 Specifications**

Fuel	Ultra Low Sulfur Diesel (15 ppm)
Output	67 hp (50 kW)
Torque	173 ft.lbs. (234 Nm) @ 1800rpm
Oil Capacity (Crankcase)	2.4 Gallons (8.9 L) w/Filter
Cooling System	3.3 Gallons (12.5 L)
Low RPM	1200 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	95 Amp
Fuel Consumption	0.65 GPH (2.48 lph)

**Table 1-6. GM 3.0L Specifications**

Fuel	Gasoline or Gasoline/LP Gas
No. of Cylinders	4
BHP	
Gasoline	83 hp @ 3000 rpm
LP	75 hp @ 3000 rpm
Bore	4.0 in. (101.6 mm)
Stroke	3.6 in. (91.44 mm)
Displacement	181 cu.in. (3.0 L, 2966 cc)
Oil Capacity w/filter	4.5 qt (4.25 L)
Minimum Oil Pressure	
at idle	6 psi (0.4 Bar) @ 1000 rpm
Hot	18 psi (1.2 Bar) @ 2000 rpm
Compression Ratio	9.2:1
Firing Order	1-3-4-2
Max. RPM	2800
Fuel Consumption	2.55 GPH (9.65 lph)

**Table 1-7. Deutz TD 2.9 L4 China III Specifications**

Fuel	Low Sulfur Diesel (500 ppm)
No. of Cylinders	4
Output	67 hp (50 kW)
Torque	173 ft.lbs. (234 Nm) @ 1800rpm
Displacement	177 cu.in. (2.9 L, 2900cc)
Oil Capacity (Crankcase)	2.11 Gallons (8.0 L) w/Filter
Cooling System	3.3 Gallons (12.5 L)
Low RPM	1200 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	95 Amp
Fuel Consumption	0.91 GPH (3.44 lph)

**Table 1-8. Ford 2.5L DF, MSG-425**

Fuel	Gasoline/LP Gas
Oil Capacity	7 qt (6.6 L)
Coolant Capacity	0.63 Gallons (2.4 L)
Low RPM	1000 ± 50 rpm
High RPM	3200 ± 50 rpm
Alternator	150 AMP
Starter	64.4A @ 3574 RPM
Fan Ratio	1:3
Fuel Consumption	
Gasoline	0.99 GPH (3.75 LPH)
LP	5.7 lb./h (2.6 Kg/h)
Max Output (Power)	
Gasoline	84HP @ 3200
LP	80HP @ 3200
Max Output (Torque)	
Gasoline	142 ft. lbs. (192Nm) @ 2400 RPM
LP	145 ft. lbs. (197Nm) @ 2400 RPM

## 1.5 COMPONENT DATA

### Drive System

Table 1-9. Drive System Specifications

Drive Motor Displacement	
2WD	2.439 cu. in. max. 1.347 cu. in. min. (40 cc max. 22.09 cc min.)
4WD	2.13 cu. in. max. 0.63 cu. in. min. (35 cc max. 10.3 cc min.)
Drive Hub Ratio	
2WD	87:1
4WD	87:1
Drive Brake	Automatic spring applied, hydraulically released disc brakes.

### Swing System

Table 1-10. Swing System Specifications

Swing Motor Displacement	4.9 cu. in. (80 cm <sup>3</sup> )
Swing Brake	Automatic spring applied hydraulically released disc brakes
Swing Hub Ratio	36.13:1

### Auxiliary Power Pump

Table 1-11. Auxiliary Power Pump Specifications

Pump Output	1.43 GPM (5.6 lpm) @ 1800 psi. (124 bar)
Pump Displacement	0.273 cu. in. (4.48 cm <sup>3</sup> )
Valving	Non-Adj. Unloader Preset to 230 psi Adjustable Relief Set at 1800 psi.
Motor	12 V.D.C. 2T Extended EMC Protected Intermittent Duty
Rotation	Counterclockwise

## 1.6 TORQUE REQUIREMENTS

Table 1-12. Torque Requirements

DESCRIPTION	TORQUE VALUE (DRY)	INTERVAL HOURS
Wheel Bolts	300 ft. lbs. (407 Nm)	150
Support to Rotator Bolts	50 ft. lbs. (68 Nm)	150
Rotator Center Bolt	480 ft. lbs. (651 Nm)	150
Swing Bearing Bolts	190 ft. lbs. (260 Nm)	50/600*
Starter or Aux Pump Solenoid		
Contacts	95 in. lbs. (10.5 Nm)	As required
Coil	40 in. lbs. (4.5 Nm)	
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 3.)		
<b>NOTE:</b> When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.		

1.7 HYDRAULIC OIL

Table 1-13. Hydraulic Oil

HYDRAULIC SYSTEM OPERATING TEMPERATURE RANGE	S.A.E. VISCOSITY GRADE
+0° to +180°F (-18° to +83°C)	10W
+0° to +210°F (-18° to +99°C)	10W-20, 10W-30
+50° to +210°F (+10° to +99°C)	20W-20

**NOTE:** Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Industries recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity index of 152.

**NOTE:** When temperatures remain consistently below 15°F (-9° C.), JLG Industries recommends the use of Mobil DTE10 Excel 32.

**NOTE:** Aside from JLG recommendations, it is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities.

Table 1-14. Mobilfluid 424 Specs

SAE Grade	10W-30
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
VISCOSITY	
Brookfield, cP at -18°C	2700
at 40°C	55 cSt
at 100°C	9.3 cSt
Viscosity Index	152

Table 1-15. Mobil DTE 10 Excel 32 Specs

ISO Viscosity Grade	#32
Pour Point, Max	-65°F (-54°C)
Flash Point, Min.	482°F (250°C)
VISCOSITY	
at 40°C	32.7 cSt
at 100°C	6.63 cSt
at 100°F	32.7 cSt
at 212°F	6.63 cSt
Viscosity Index	164
Density (Kg/l) @ 15°C	0.8468
Density (lb/in <sup>3</sup> ) @ 60°F	0.0305

Table 1-16. Mobil EAL 224H Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	32/46
Specific Gravity	.922
Pour Point, Max	-25°F (-32°C)
Flash Point, Min.	428°F (220°C)
Operating Temp.	0 to 180°F (-17 to 162°C)
VISCOSITY	
at 40°C	37 cSt
at 100°C	8.4 cSt
Viscosity Index	213
<b>NOTE:</b> Must be stored above 32°F (14°C)	

Table 1-17. UCon Hydrolube HP-5046

Type	Synthetic Biodegradable
Specific Gravity	1.082
Pour Point, Max	-58°F (-50°C)
pH	9.1
VISCOSITY	
at 0°C (32°F)	340 cSt (1600SUS)
at 40°C (104°F)	46 cSt (215SUS)
at 65°C (150°F)	22 cSt (106SUS)
Viscosity Index	170

Table 1-18. Exxon Unavis HVI 26 Specs

Specific Gravity	32.1
Pour Point	-76°F (-60°C)
Flash Point	217°F (103°C)
<b>VISCOSITY</b>	
at 40°C	25.8 cSt
at 100°C	9.3 cSt
Viscosity Index	376
<b>NOTE:</b> Mobil/Exxon recommends that this oil be checked on a yearly basis for viscosity.	

## 1.8 MAJOR COMPONENT WEIGHTS

Table 1-19. Major Component Weights

MAJOR COMPONENTS	LBS.	KG.
Platform & Control Console	250	113
Main Boom (Inc. Slave Cylinder Rotator, Support)	3185	1445
Main Lift Cylinder	444.7	202
Main Telescope Cylinder	522	237
Upright	1175	535
Upright Level Cylinder	529.5	240
Tower Boom Complete	3450	1565
Tower Lift Cylinder	625	284
Tower Telescope Cylinder	232.5	105
Turntable Counterweight	4805	2180
Turntable Complete (Including Engine)	10625	4820
Chassis Complete (Pneumatic Tires)	13350	6060
Chassis Complete (Foam Filled Tires)	12220	5545
Machine Complete (GVW) w/ Pneumatic Tires	34200	15513
Machine Complete (GVW) w/ Foam Filled Tires	33100	15014
<b>NOTE:</b> The above components are separate assemblies. Example: "TURNTABLE COMPLETE" does not include booms, upright, lift cylinders or platform. The weights of these components must be added for the total weight.		

**Critical Stability Weights**



**DO NOT REPLACE ITEMS CRITICAL TO STABILITY WITH ITEMS OF DIFFERENT WEIGHT OR SPECIFICATION (FOR EXAMPLE: BATTERIES, FILLED TIRES, COUNTER WEIGHT, ENGINE, AND PLATFORM) DO NOT MODIFY UNIT IN ANY WAY TO EFFECT STABILITY.**

**Table 1-20. Critical Stability Weights**

<b>COMPONENTS</b>		<b>LBS.</b>	<b>KG.</b>
Tire & Wheel Size (Foam Filled Only)	15-625	544	247
	18-625	601	273
Engine	Deutz	534	242
	GMw/pumps	1030	468
	Ford 2.5L MSG-425	358.5	162.6
Counterweight		4805	2180
Wheel Hubs	Rear	218	99
	Front 2WD	210	95
	Front 4WD	218	99
Platform	6 ft. (1.83 m)	205	93
	8 ft. (2.44 m)	230	105

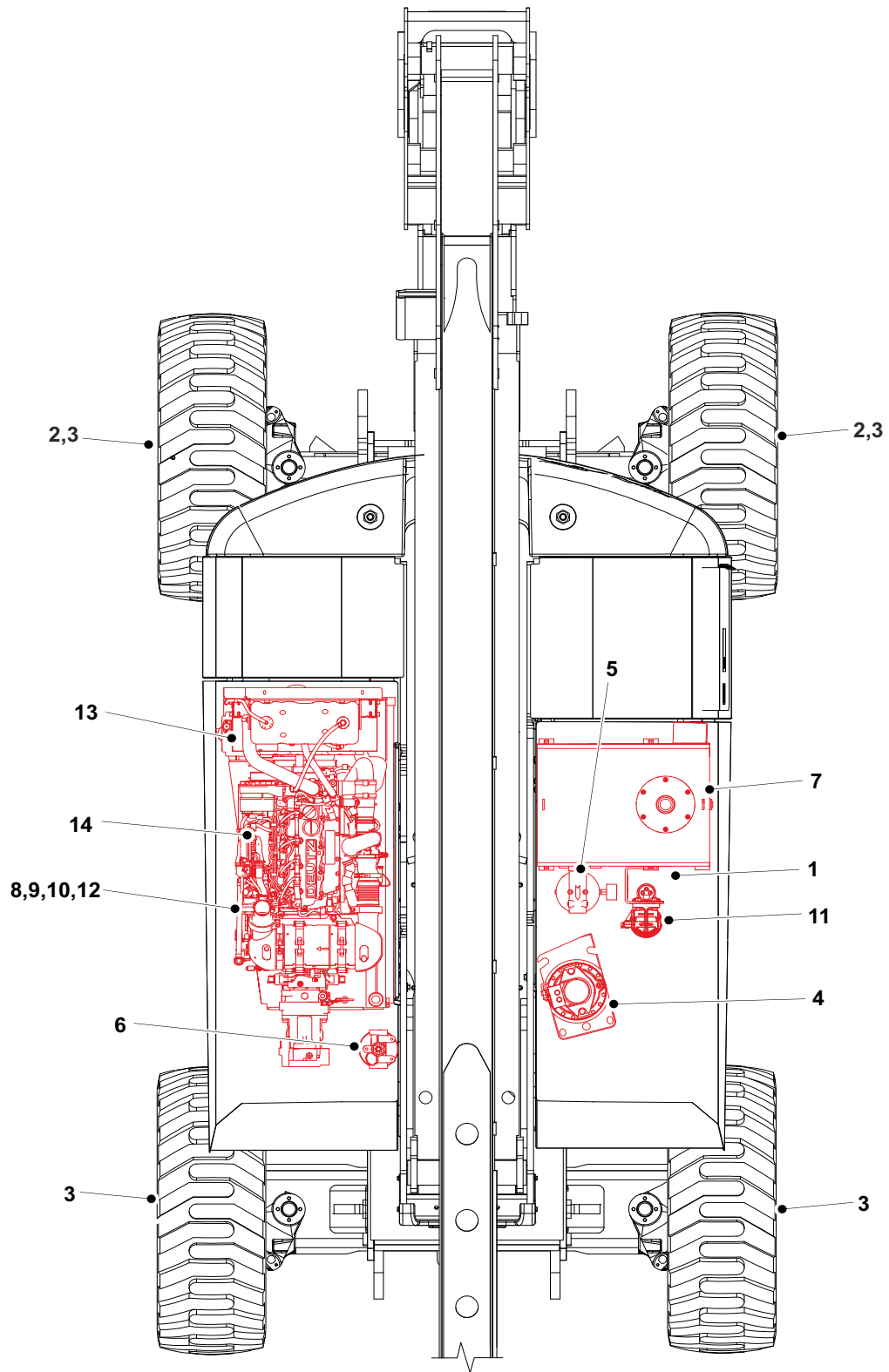


Figure 1-1. Maintenance and Lubrication Diagram

1.9 OPERATOR MAINTENANCE

**NOTE:** The following numbers correspond to those in Figure 1-1., Maintenance and Lubrication Diagram.

**Table 1-21. Lubrication Specifications.**

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350°F (177°C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. Refer Section 1.7, Hydraulic Oil.
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C
Super Lube®	Synthetic-Based Oil, Non-Flammable. Withstands temperatures within -45° to 450°F (-43° to 232°C). JLG P/N 3020042.

**NOTICE**

**LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.**

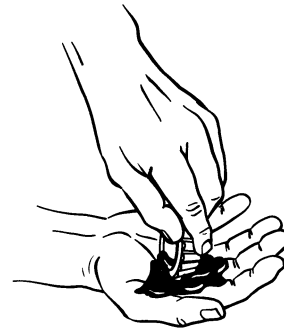
**NOTE:** It is recommended as a good practice to replace all filters at the same time.

1. Swing Bearing - Internal Ball Bearing



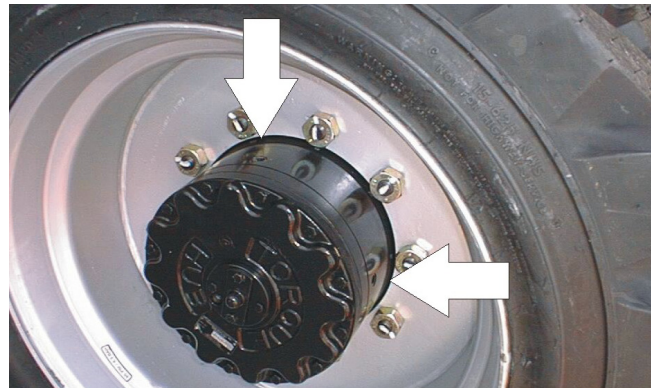
Lube Point(s) - 2 Grease Fittings  
 Capacity - A/R  
 Lube - MPG  
 Interval - Every 3 months or 150 hours of operation  
 Comments - Remote Access

2. Wheel Bearings



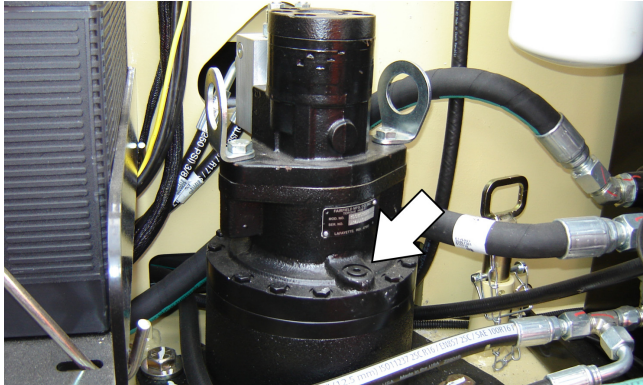
Lube Point(s) - Repack  
 Capacity - A/R  
 Lube - MPG  
 Interval - Every 2 years or 1200 hours of operation

3. Wheel Drive Hub



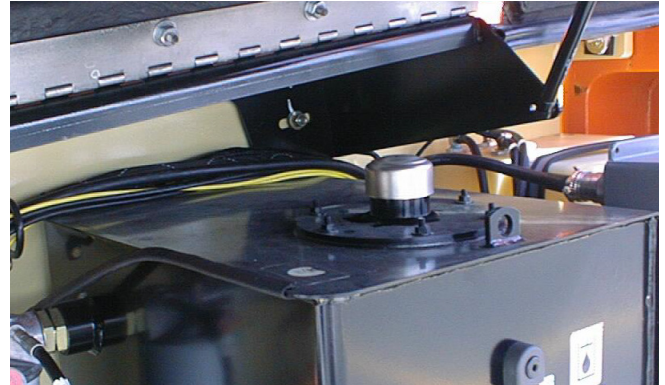
Lube Point(s) - Level/Fill Plug  
 Capacity - 17 oz. (0.5 L) - 1/2 Full  
 Lube - EPGL  
 Interval - Check level every 3 months or 150 hours of operation; change every 2 years or 1200 hours of operation.  
 Comments - Place Fill port at 12 o'clock position and Check port at 3 o'clock position. Pour lubricant into fill port until it just starts to flow out of check port.

**4. Swing Drive Hub**



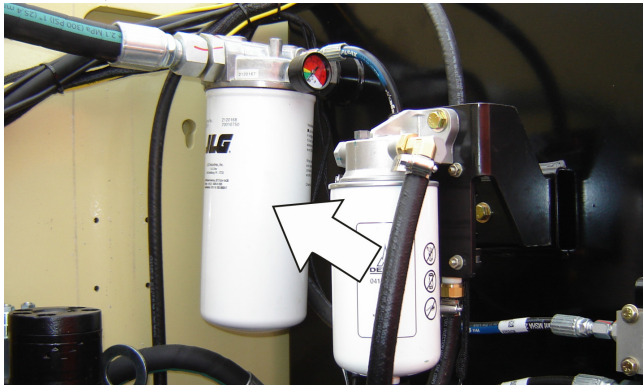
Lube Point(s) - Level/Fill Plug  
 Capacity - 43 oz. (1.3 L)  
 Lube - 90w80 Gear oil  
 Interval - Check level every 3 months or 150 hours of operation; change every 2 years or 1200 hours of operation.

**7. Hydraulic Tank**



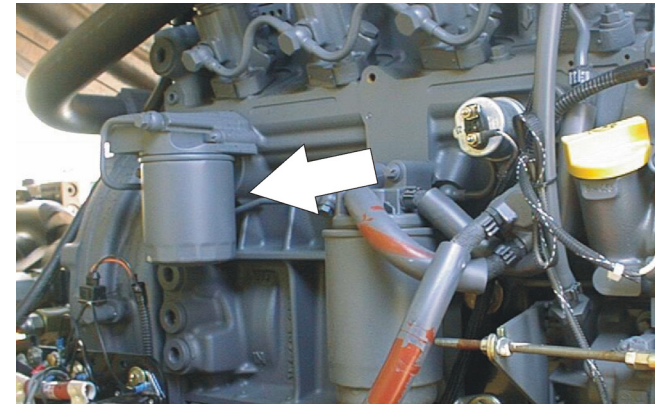
Lube Point(s) - Fill Cap  
 Capacity - 40 gallons (151 L) Tank; 77 gallons (291.4 L) System  
 Lube - HO  
 Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

**5. Hydraulic Return Filter**



Interval - Change after first 50 hours and every 6 months or 300 hours thereafter or as indicated by Condition Indicator.

**8. Oil Change w/Filter - Deutz D2011**



Lube Point(s) - Fill Cap/Spin-on Element  
 Capacity - 11 Quarts (10.5 L) Crankcase  
 Lube - EO  
 Interval - Every Year or 1200 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual. Refer to Figure 1-2., Deutz 2011 Engine Dipstick.

**6. Hydraulic Charge Filter**



Interval - Change after first 50 hours and every 6 months or 300 hours thereafter or as indicated by Condition Indicator.

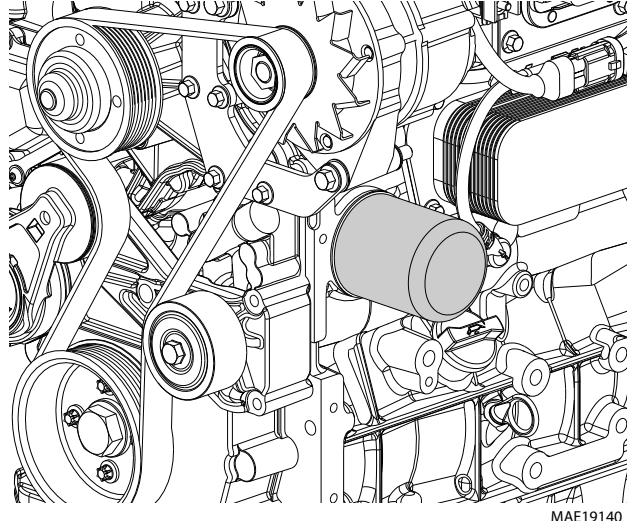
**SECTION 1 - SPECIFICATIONS**

**B. Oil Change w/Filter - Deutz TD2.9**

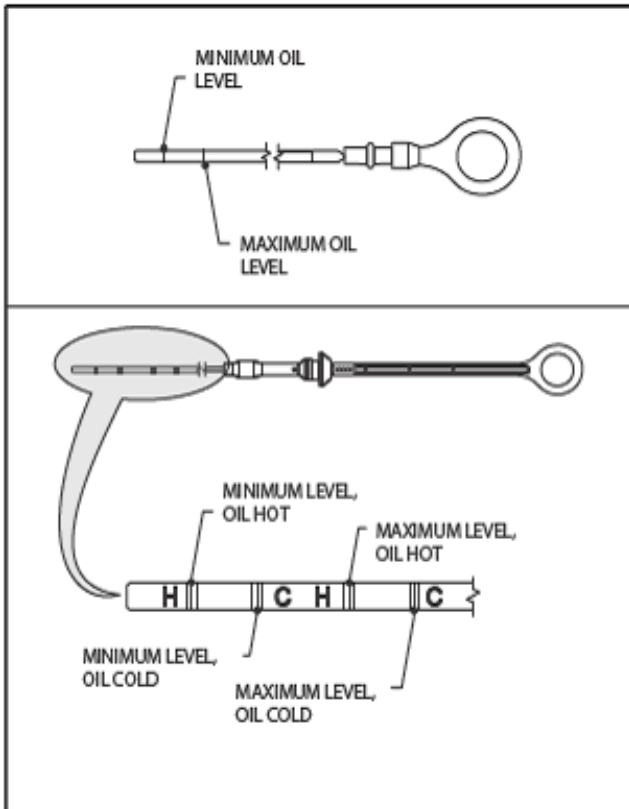


Lube Point(s) - Fill Cap/Spin-on Element  
 Capacity - 9.6 Quarts (9.0 L)  
 Lube - EO  
 Interval - Every Year or 600 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**C. Oil Change w/Filter - Deutz TD 2.9 L4 China III**

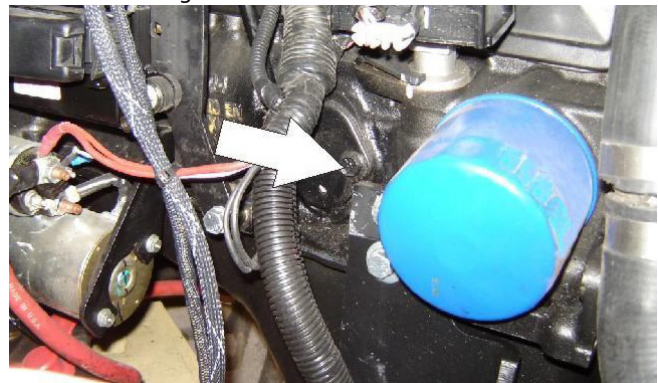


Lube Point(s) - Fill Cap/Spin-on Element  
 Capacity - 8.5 Quarts (8.0 L)  
 Lube - EO  
 Interval - Every Year or 600 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.



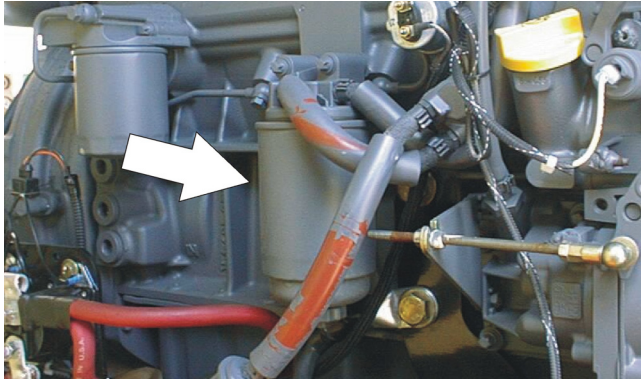
**Figure 1-2. Deutz 2011 Engine Dipstick**

**9. Oil Change w/Filter - GM**



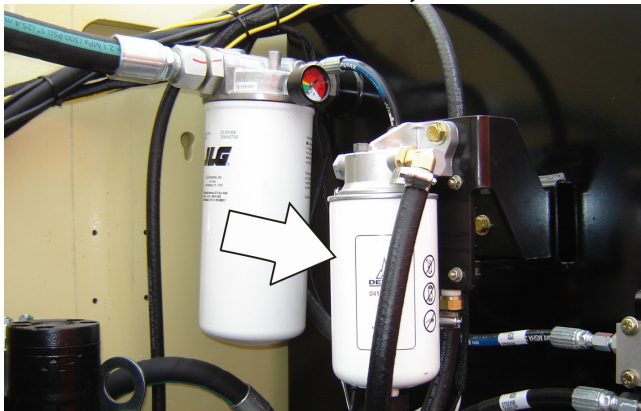
Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7027965)  
 Capacity - 4.5 qt. (4.25 L) w/filter  
 Lube - EO  
 Interval - 3 Months or 150 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**10. A. Fuel Filter - Deutz D2011**



Lube Point(s) - Replaceable Element  
Interval - Every Year or 600 hours of operation

**B. Fuel Filter - Deutz TD2.9 (On Hydraulic Tank)**



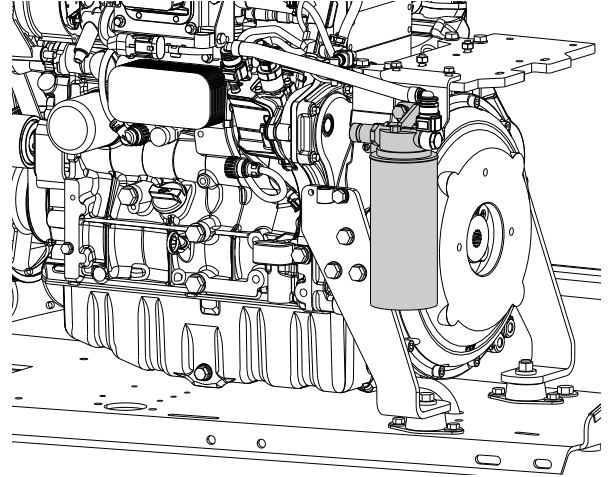
Lube Point(s) - Replaceable Element  
Interval - Change in accordance with engine manual

**C. Fuel Filter - Deutz TD2.9 (On Engine)**



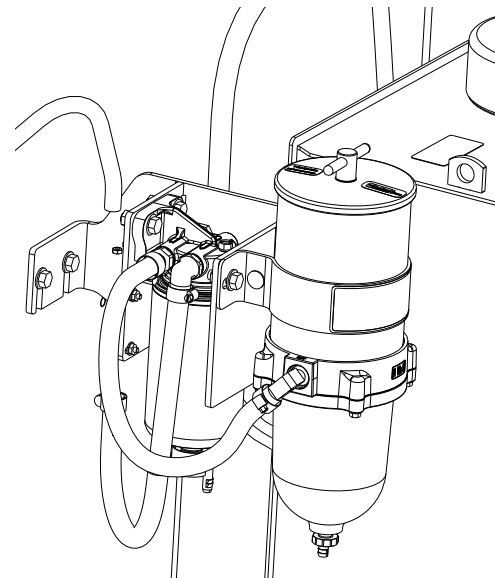
Lube Point(s) - Replaceable Element  
Interval - Change in accordance with engine manual

**D. Fuel Filter - Deutz TD 2.9 L4 China III**



Lube Point(s) - Replaceable Element  
Interval - Change in accordance with engine manual

**11. Fuel/Water Separator - Deutz TD 2.9 L4 China III**



MAE25900

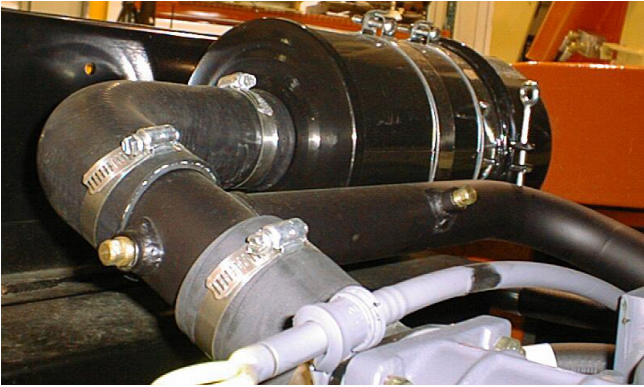
Lube Point(s) - Replaceable Element  
Interval - Drain water daily; Change every year or 600hours of operation.

**12. Fuel Filter (Gasoline) - GM**

Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation

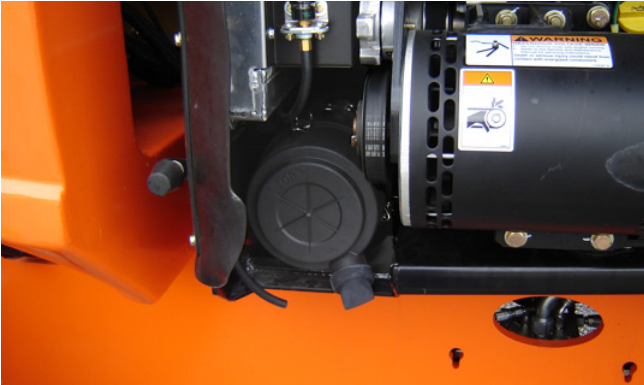
## SECTION 1 - SPECIFICATIONS

### 13. Air Filter



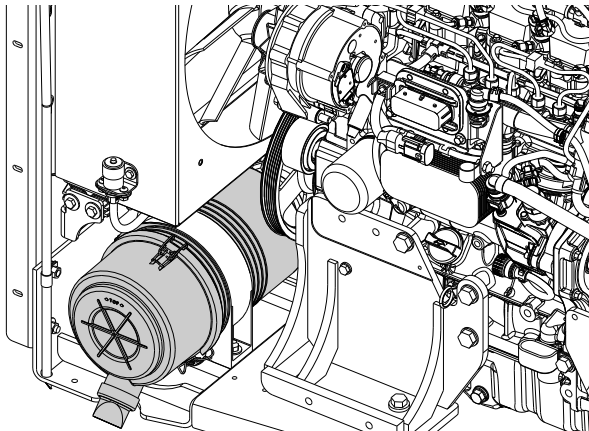
Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation  
or as indicated by the condition indicator

#### B. Air Filter (Deutz TD 2.9)



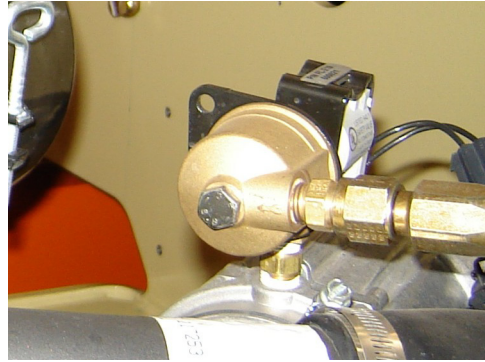
Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation  
or as indicated by the condition indicator

#### C. Air Filter (Deutz TD 2.9 L4 China III)



Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation  
or as indicated by the condition indicator

### 14. Fuel Filter (Propane) - GM Engine



Interval - 3 Months or 150 hours of operation  
Comments - Replace filter. Refer to Propane Fuel Filter  
Replacement.

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)																			
SAE GRADE 5 BOLTS & GRADE 2 NUTS							SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*												
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)		Clamp Load	Torque (Dry or Loctite® 263) K=0.20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
					IN-LB	FT-LB	IN-LB	FT-LB	IN-LB	FT-LB	IN-LB	FT-LB		IN-LB	FT-LB	IN-LB	FT-LB		IN-LB
4	40	0.1120	0.00604	380	8	0.9	6	0.7											
	48	0.1120	0.00661	420	9	1.0	7	0.8											
6	32	0.1380	0.00909	580	16	1.8	12	1.4											
	40	0.1380	0.01015	610	18	2.0	13	1.5											
8	32	0.1640	0.01400	800	30	3.4	22	2.5											
	36	0.1640	0.01474	840	31	3.5	23	2.6					1320						
10	24	0.1900	0.01750	1120	43	4.8	32	3.5					1560						
	32	0.1900	0.02000	1285	49	5.5	36	4					1800						
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12			2860						
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15			3280						
5/16	18	0.3125	0.0654	3340	17	23	13	18	19	26			4720						
	24	0.3125	0.09580	3700	19	26	14	19	21	29			5220						
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48			7000						
	24	0.3750	0.0878	5600	35	47	25	34	40	54			7900						
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75			9550						
	20	0.4375	0.1187	7550	55	75	40	54	60	82			10700						
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116			12750						
	20	0.5000	0.1599	10700	90	122	65	88	100	136			14400						
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163			16400						
	18	0.5625	0.2030	12950	120	163	90	122	135	184			18250						
5/8	11	0.6250	0.2280	14400	150	203	110	149	165	224			20350						
	18	0.6250	0.2560	16300	170	230	130	176	190	258			23000						
3/4	10	0.7500	0.3340	21300	260	353	200	285	388	520			30100						
	16	0.7500	0.3730	23800	300	407	220	298	449	646			33600						
7/8	9	0.8750	0.4620	29400	430	583	320	434	646	925			41600						
	14	0.8750	0.5090	32400	470	637	350	470	707	1045			45800						
1	8	1.0000	0.6060	38600	640	868	480	651	918	1290			51500						
	12	1.0000	0.6630	42200	700	949	530	719	1045	1445			59700						
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	1175	1665			69700						
	12	1.1250	0.8360	47300	880	1193	660	895	1238	1770			77000						
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1598	2270			87200						
	12	1.2500	1.0730	59600	1240	1681	920	1247	1768	2515			96600						
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	2074	2925			104000						
	12	1.3750	1.3150	73000	1680	2278	1260	1708	2380	3310			118100						
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2754	3870			126500						
	12	1.5000	1.5800	87700	2200	2983	1640	2224	3128	4350			142200						

NO. 5000059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 3. \* ASSEMBLY USES HARDENED WASHER

REFERENCE JLG THREAD LOCKING COMPOUND			
JLG P/N	Loctite® P/N	ND Industries P/N	Description
0100011	242™	Vibra-TITE™ 121	Medium Strength (Blue)
0100019	271™	Vibra-TITE™ 140	High Strength (Red)
0100071	262™	Vibra-TITE™ 131	Medium - High Strength (Red)

Figure 1-3. Torque Chart (SAE Fasteners - Sheet 1 of 5)

Values for Magni Coating Fasteners (Ref 4150701)																		
SAE GRADE 5 BOLTS & GRADE 2 NUTS					SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*													
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Locite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Locite® 262™ or VIBRA-TITE™ 131) K=0.15		Torque (Dry or Locite® 263) K=0.17		Torque (Locite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Locite® 262™ or VIBRA-TITE™ 131) K=0.15			
					IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8												
	48	0.1120	0.00661	420	8	0.9												
6	32	0.1380	0.00909	580	14	1.5												
	40	0.1380	0.01015	610	14	1.6												
8	32	0.1640	0.01400	900	25	2.8												
	36	0.1640	0.01474	940	26	2.9												
10	24	0.1900	0.01750	1120	36	4.1												
	32	0.1900	0.02000	1285	42	4.7												
1/4	20	0.2500	0.0318	2020	86	9.7												
	28	0.2500	0.0364	2320	99	11.1												
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20	25	20	25	20	25	20	25	
	24	0.3125	0.0580	3700	15	20	15	21	15	20	25	20	25	20	25	20	25	
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34	35	30	35	30	35	30	35	
	24	0.3750	0.0878	5600	30	40	28	38	25	34	40	35	40	35	40	35	40	
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48	60	55	75	50	70	50	70	
	20	0.4375	0.1187	7550	45	60	44	60	40	54	65	60	80	60	80	60	80	
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75	127	90	120	85	115	80	110	
	20	0.5000	0.1599	10700	75	100	71	97	65	88	144	100	135	95	130	90	120	
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109	164	130	175	125	170	115	155	
	18	0.5625	0.2030	12950	105	145	97	132	90	122	182	145	195	135	185	130	175	
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156	203	180	245	170	230	160	220	
	18	0.6250	0.2560	16300	145	195	136	185	125	170	230	205	280	190	260	180	245	
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272	301	320	435	300	410	280	380	
	16	0.7500	0.3750	23800	255	345	238	324	225	306	336	355	485	335	455	315	430	
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435	416	515	700	485	660	455	620	
	14	0.8750	0.5090	32400	400	545	378	514	355	483	458	570	775	535	730	500	680	
1	8	1.0000	0.6060	38600	545	740	515	700	480	653	515	730	995	685	930	645	875	
	12	1.0000	0.6630	42200	600	815	563	765	530	721	597	845	1150	795	1080	745	1015	
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809	687	1095	1490	1030	1400	965	1310	
	12	1.1250	0.8560	47500	755	1025	713	969	670	911	770	1225	1665	1155	1570	1085	1475	
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142	872	1545	2100	1455	1980	1365	1855	
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265	966	1710	2325	1610	2190	1510	2055	
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496	1040	2025	2755	1905	2590	1785	2430	
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707	1181	2300	3130	2165	2945	2030	2760	
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992	1265	2690	3660	2530	3440	2370	3225	
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237	1422	3020	4105	2845	3870	2665	3625	

NO. 500059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 3. \* ASSEMBLY USES HARDENED WASHER

Figure 1-4. Torque Chart (SAE Fasteners - Sheet 2 of 5)

SOCKET HEAD CAP SCREWS														
Magni Coating (Ref 4150701)*						Zinc Yellow Chromate Fasteners (Ref 4150707)*								
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .17	Torque (Locitite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.16		Torque (Locitite® 262™ or TITE™ 131) K=0.15		Clamp Load See Note 4	Torque (Dry) K = .20	Torque (Locitite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.18		Torque (Locitite® 262™ or TITE™ 131) K=0.15
						IN-LB	[N.m]	IN-LB	[N.m]			IN-LB	[N.m]	
4		In	Sq In	LB										
	40	0.1120	0.00604											
	48	0.1120	0.00661											
	32	0.1380	0.00909											
	40	0.1380	0.01015											
	32	0.1640	0.01400											
	36	0.1640	0.01474											
	24	0.1900	0.01750											
	32	0.1900	0.02000											
	1/4	0.2500	0.0318	2860	122	14	114	13		2860	143	16	129	
	28	0.2500	0.0364	3280	139	16	131	15		3280	164	19	148	17
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	LB	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	4720	25	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	5220	25	35	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	7000	45	40	55	50
	24	0.3750	0.0878	7900	40	55	40	55	35	7900	50	70	45	60
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	9550	70	95	65	90
	20	0.4375	0.1187	10700	65	90	60	80	60	10700	80	110	70	95
1/2	13	0.5000	0.1419	12750	90	120	85	115	110	12750	105	145	95	130
	20	0.5000	0.1599	14400	100	135	95	130	90	14400	120	165	110	150
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	16400	155	210	140	190
	18	0.5625	0.2030	18250	145	195	135	185	130	18250	170	230	155	210
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	20350	210	285	190	260
	18	0.6250	0.2560	23000	205	280	190	260	180	23000	240	325	215	290
3/4	10	0.7500	0.3340	30100	320	435	300	300	280	30100	375	510	340	460
	16	0.7500	0.3730	33600	355	485	335	455	315	33600	420	570	380	515
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	41600	605	825	545	740
	14	0.8750	0.5090	45800	570	775	535	730	500	45800	670	910	600	815
1	8	1.0000	0.6060	51500	730	995	685	930	645	51500	860	1170	775	1055
	12	1.0000	0.6630	59700	845	1150	795	1080	745	59700	995	1355	895	1215
1 1/8	7	1.1250	0.7630	68700	1035	1490	1030	1400	965	68700	1290	1755	1160	1580
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	77000	1445	1965	1300	1770
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	87200	1815	2470	1635	2225
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	96600	2015	2740	1810	2460
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	104000	2385	3245	2145	2915
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	118100	2760	3680	2435	3310
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	126500	3165	4305	2845	3870
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	142200	3555	4835	3200	4350

NO. 500059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-5. Torque Chart (SAE Fasteners - Sheet 3 of 5)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)											
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*						
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™)	Torque (Lub)	Torque (Loctite® 262™ OR VIBRA-TITE™ 131)	Torque (Loctite® 242™ or 271™ OR VIBRA-TITE™ 111 or 140)	Clamp Load	Torque (Dry or Loctite® 263™) K = 0.20	Torque (Lub OR Loctite® 242™ or 271™ OR VIBRA-TITE™ 111 or 140) K = 0.18	Torque (Loctite® 262™ OR VIBRA-TITE™ 131) K = 0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4	3.13			
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3	4.22			
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4	5.47			
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8	8.85			
6	1	20.10	8.74	11	7.9	9.4	12	12.5			
7	1	28.90	12.6	18	13	16	19	18.0	25	23	19
8	1.25	36.60	15.9	26	19	23	28	22.8	37	33	27
10	1.5	58.00	25.2	50	38	45	55	36.1	70	65	55
12	1.75	84.30	36.7	88	66	79	97	52.5	125	115	95
14	2	115	50.0	140	105	126	154	71.6	200	180	150
16	2	157	68.3	219	164	197	241	97.8	315	280	235
18	2.5	192	83.5	301	226	271	331	119.5	430	385	325
20	2.5	245	106.5	426	320	383	469	152.5	610	550	460
22	2.5	303	132.0	581	436	523	639	189.0	830	750	625
24	3	353	153.5	737	553	663	811	222.0	1065	960	800
27	3	459	198.5	1080	810	970	1130	286.0	1545	1390	1160
30	3.5	561	244.0	1460	1100	1320	1530	349.5	2095	1885	1575
33	3.5	694	302.0	1980	1490	1790	2090	432.5	2855	2570	2140
36	4	817	355.5	2560	1920	2300	2690	509.0	3665	3300	2750
42	4.5	1120	487.0	4090	3070	3680	4290	698.0	5865	5275	4395

NO. 5000059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-6. Torque Chart (METRIC Fasteners - Sheet 4 of 5)

Values for Magni Coated Fasteners (Ref 4150701)										
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*					
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™) K=0.17	Torque (Loctite® 262™ OR Vibra-TITE™, 131) K=0.16	Torque (Loctite® 242™, or 271™ OR Vibra-TITE™, 111 or 140) K=0.15	Clamp Load	Torque (Dry or Loctite® 263™) K = 0.17	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K = 0.16	Torque (Loctite® 262™ OR Vibra-TITE™, 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0	3.13			
3.5	0.6	6.78	2.95	1.8	1.7	1.5	4.22			
4	0.7	8.78	3.82	2.6	2.4	2.3	5.47			
5	0.8	14.20	6.18	5.3	4.9	4.6	8.85			
6	1	20.10	8.74	9	8.4	7.9	12.5	13	12	11
7	1	28.90	12.6	15	14	13	18.0	21	20	19
8	1.25	36.60	15.9	22	20	19	22.8	31	29	27
10	1.5	58.00	25.2	43	40	38	36.1	61	58	55
12	1.75	84.30	36.7	75	70	66	52.5	105	100	95
14	2	115	50.0	119	110	105	71.6	170	160	150
16	2	157	68.3	186	175	165	97.8	265	250	235
18	2.5	192	83.5	256	240	225	119.5	365	345	325
20	2.5	245	106.5	362	340	320	152.5	520	490	460
22	2.5	303	132.0	494	465	435	189.0	705	665	625
24	3	353	153.5	627	590	555	222.0	905	850	800
27	3	459	199.5	916	860	810	286.0	1315	1235	1160
30	3.5	561	244.0	1245	1170	1100	349.5	1780	1680	1575
33	3.5	694	302.0	1694	1595	1495	432.5	2425	2285	2140
36	4	817	355.5	2176	2050	1920	509.0	3115	2930	2750
42	4.5	1120	487.0	3477	3275	3070	698.0	4985	4690	4395

NO. 5000059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS  
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%  
 \*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM  
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-7. Torque Chart (METRIC Fasteners - Sheet 5 of 5)



## SECTION 2. GENERAL

### 2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

#### General

This section provides the necessary information needed by those personnel that are responsible to place the machine in operation readiness and maintain its safe operating condition. For maximum service life and safe operation, ensure that all the necessary inspections and maintenance have been completed before placing the machine into service. With proper care, maintenance, and inspections performed per JLG's recommendations, and with any and all discrepancies corrected, this product will be fit for continued use.

#### Preparation, Inspection, and Maintenance

It is important to establish and conform to a comprehensive inspection and preventive maintenance program. The following table outlines the periodic machine inspections and maintenance recommended by JLG Industries, Inc. Consult your national, regional, or local regulations for further requirements for aerial work platforms. The frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

#### Pre-Start Inspection

It is the User's or Operator's primary responsibility to perform a Pre-Start Inspection of the machine prior to use daily or at each change of operator. Reference the Operator's and Safety Manual for completion procedures for the Pre-Start Inspection. The Operator and Safety Manual must be read in its entirety and understood prior to performing the Pre-Start Inspection.

#### Pre-Delivery Inspection and Frequent Inspection

The Pre-Delivery Inspection and Frequent Inspection shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

The Pre-Delivery Inspection and Frequent Inspection procedures are performed in the same manner, but at different times. The Pre-Delivery Inspection shall be performed prior to each sale, lease, or rental delivery. The Frequent Inspection shall be accomplished for each machine in service for 3 months or 150 hours (whichever comes first); out of service for a period of more than 3 months; or when purchased used. The frequency of this inspection must be increased as environment, severity and frequency of usage requires.

Reference the JLG Pre-Delivery and Frequent Inspection Form and the Inspection and Preventive Maintenance Schedule for items requiring inspection during the performance of these inspections. Reference the appropriate areas of this manual for servicing and maintenance procedures.

#### Annual Machine Inspection

The Annual Machine Inspection must be performed on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries recommends this task be performed by a Factory-Trained Service Technician. JLG Industries, Inc. recognizes a Factory-Trained Service Technician as a person who has successfully completed the JLG Service Training School for the subject JLG product model. Reference the machine Service and Maintenance Manual and appropriate JLG inspection form for performance of this inspection.

Reference the JLG Annual Machine Inspection Form and the Inspection and Preventive Maintenance Schedule for items requiring inspection during the performance of this inspection. Reference the appropriate areas of this manual for servicing and maintenance procedures.

For the purpose of receiving safety-related bulletins, it is important that JLG Industries, Inc. has updated ownership information for each machine. When performing each Annual Machine Inspection, notify JLG Industries, Inc. of the current machine ownership.

#### Preventative Maintenance

In conjunction with the specified inspections, maintenance shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

Reference the Preventive Maintenance Schedule and the appropriate areas of this manual for servicing and maintenance procedures. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.

**Table 2-1. Inspection and Maintenance**

Type	Frequency	Primary Responsibility	Service Qualification	Reference
Pre-Start Inspection	Prior to use each day; or At each Operator change.	User or Operator	User or Operator	Operator and Safety Manual
Pre-Delivery Inspection	Prior to each sale, lease, or rental delivery.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Frequent Inspection	In service for 3 months or 150 hours, whichever comes first; or Out of service for a period of more than 3 months; or purchased used.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Annual Machine Inspection	Annually, no later than 13 months from the date of the prior inspection.	Owner, Dealer, or User	Factory-Trained Service Technician (Recommended)	Service and Maintenance Manual and applicable JLG inspection form.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

## 2.2 SERVICE AND GUIDELINES

### General

The following information is provided to assist you in the use and application of servicing and maintenance procedures contained in this book.

### Safety and Workmanship

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

### Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.
2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent entry of foreign matter.
3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be

sure all parts are clean before they are installed. New parts should remain in their containers until they are ready to be used.

### Components Removal and Installation

1. Use adjustable lifting devices, whenever possible, if mechanical assistance is required. All slings (chains, cables, etc.) should be parallel to each other and as near perpendicular as possible to top of part being lifted.
2. Should it be necessary to remove a component on an angle, keep in mind that the capacity of an eyebolt or similar bracket lessens, as the angle between the supporting structure and the component becomes less than 90 degrees.
3. If a part resists removal, check to see whether all nuts, bolts, cables, brackets, wiring, etc., have been removed and that no adjacent parts are interfering.

### Component Disassembly and Reassembly

When disassembling or reassembling a component, complete the procedural steps in sequence. Do not partially disassemble or assemble one part, then start on another. Always recheck your work to assure that nothing has been overlooked. Do not make any adjustments, other than those recommended, without obtaining proper approval.

### Pressure-Fit Parts

When assembling pressure-fit parts, use a molybdenum disulfide base compound or equivalent to lubricate the mating surface.

## Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if the races and balls (or rollers) are pitted, scored, or burned.
3. If bearing is found to be serviceable, apply a light coat of oil and wrap it in clean (waxed) paper. Do not unwrap reusable or new bearings until they are ready to install.
4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

## Gaskets

Check that holes in gaskets align with openings in the mating parts. If it becomes necessary to hand-fabricate a gasket, use gasket material or stock of equivalent material and thickness. Be sure to cut holes in the right location, as blank gaskets can cause serious system damage.

## Bolt Usage and Torque Application

### NOTICE

**SELF LOCKING FASTENERS, SUCH AS NYLON INSERT AND THREAD DEFORMING LOCKNUTS, ARE NOT INTENDED TO BE REINSTALLED AFTER REMOVAL.**

1. Always use new replacement hardware when installing locking fasteners. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.
2. Unless specific torque requirements are given within the text, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart Section 1).

## Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines and electrical wiring, as well as their receptacles, when disconnecting or removing them from the unit. This will assure that they are correctly reinstalled.

## Hydraulic System

1. Keep the system clean. If evidence of metal or rubber particles are found in the hydraulic system, drain and flush the entire system.

2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

## Lubrication

Service applicable components with the amount, type, and grade of lubricant recommended in this manual, at the specified intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

## Battery

Clean battery using a non-metallic brush and a solution of baking soda and water. Rinse with clean water. After cleaning, thoroughly dry battery and coat terminals with an anti corrosion compound.

## Lubrication and Servicing

Components and assemblies requiring lubrication and servicing are shown in the Lubrication Chart in Section 1.

## 2.3 LUBRICATION AND INFORMATION

### Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines..
2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.
3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.

4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

**NOTE:** *Metal particles may appear in the oil or filters of new machines due to the wear-in of meshing components.*

### Hydraulic Oil

1. Refer to Section 1 for recommendations for viscosity ranges.
2. JLG recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity of 10W-30 and a viscosity index of 152.

**NOTE:** *Start-up of hydraulic system with oil temperatures below -15 degrees F (-26 degrees C) is not recommended. If it is necessary to start the system in a sub-zero environment, it will be necessary to heat the oil with a low density, 100VAC heater to a minimum temperature of -15 degrees F (-26 degrees C).*

3. The only exception to the above is to drain and fill the system with Mobil DTE 13 oil or its equivalent. This will allow start up at temperatures down to -20 degrees F (-29 degrees C). However, use of this oil will give poor performance at temperatures above 120 degrees F (49 degrees C). Systems using DTE 13 oil should not be operated at temperatures above 200 degrees F (94 degrees C) under any condition.

### Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils.
2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always clean the mesh element of the filter and replace the cartridge any time the system oil is changed.
3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing the machine back in service.

### Lubrication Specifications

Specified lubricants, as recommended by the component manufacturers, are always the best choice, however, multi-purpose greases usually have the qualities which meet a variety of single purpose grease requirements. Should any question arise, regarding the use of greases in maintenance stock, consult your local supplier for evaluation. Refer to Section 1 for an explanation of the lubricant key designations appearing in the Lubrication Chart.

## 2.4 CYLINDER DRIFT TEST

### Theory

When a hydraulic cylinder is supporting a load, cylinder drift may occur as a result of any of the circumstances below:

- Normal leakage of load holding valves or malfunction of load holding valves. See Cylinder Leakage Test and "Cylinder Drift" below for evaluation.
- Damaged or worn piston seals.
- Normal thermal expansion or contraction of the hydraulic oil within cylinders (See Cylinder Thermal Drift below).

The first two circumstances may result in cylinder movement due to oil leaking out of the cylinder externally or by leaking back to tank or due to oil leaking internally from one cylinder chamber to the other.

Thermal expansion or contraction of oil in hydraulic cylinders is a normal occurrence and does not result in oil leaking out of the cylinder or leaking internally from one cylinder chamber to the other. Thermal expansion or contraction is the tendency for materials to change size in response to a change in temperature.

### Cylinder Leakage Test

**Cylinder oil must be at stabilized ambient temperature before beginning this test.**

Measure drift at cylinder rod with a calibrated dial indicator.

In an area free of obstructions, cylinder must have load applied and appropriately positioned to detect drift.

Cylinder leakage is acceptable if it passes this test.

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13
8	203.2	0.004	0.10
9	228.6	0.003	0.08

**NOTE:** The information is based on 6 drops per minute cylinder leakage.

### Cylinder Thermal Drift

The oil in all hydraulic cylinders will expand or contract due to thermal effects over time and may result in changes to the boom and/or platform position while the machine is stationary. These effects occur as the cylinder oil changes temperature, usually from a higher oil temperature as it cools and approaches the ambient air temperature. Results of these effects are related to several factors including cylinder length and change in temperature over the time the cylinder remains stationary.

## 2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
  - a. Excessive sloppiness in joints.
  - b. Noise originating from the joint during operation.
2. Filament wound bearings should be replaced if any of the following is observed:
  - a. Frayed or separated fibers on the liner surface.
  - b. Cracked or damaged liner backing.
  - c. Bearings that have moved or spun in their housing.
  - d. Debris embedded in liner surface.
3. Pins should be replaced if any of the following is observed (pin should be properly cleaned prior to inspection):
  - a. Detectable wear in the bearing area.
  - b. Flaking, peeling, scoring, or scratches on the pin surface.
  - c. Rusting of the pin in the bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
  - a. Housing should be blown out to remove all dirt and debris... bearings and bearing housings must be free of all contamination.
  - b. Bearing / pins should be cleaned with a solvent to remove all grease and oil...filament wound bearing are a dry joint and should not be lubricated unless otherwise instructed (i.e. sheave pins).
  - c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

## 2.6 WELDING ON JLG EQUIPMENT

**NOTE:** *This instruction applies to repairs, or modifications to the machine and to welding performed from the machine on an external structure, or component.*

### Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Disconnect the moment pin connection (where fitted).
- Ground only to structure being welded.

### Do NOT Do the Following When Welding on JLG Equipment

- Ground on frame and weld on any other area than the chassis.
- Ground on turntable and weld on any other area than the turntable.
- Ground on the platform/support and weld on any other area than the platform/support.
- Ground on a specific boom section and weld on any other area than that specific boom section.
- Allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between the grounding position and the welded area.

### **NOTICE**

**FAILURE TO COMPLY WITH THE ABOVE REQUIREMENTS MAY RESULT IN COMPONENT DAMAGE (I.E. ELECTRONIC MODULES, SWING BEARING, COLLECTOR RING, BOOM WIRE ROPES ETC.).**

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery <sup>1</sup> or Frequent <sup>2</sup> (Quarterly) Inspection	Annual <sup>3</sup> (Yearly) Inspection
<b>Boom Assembly</b>		
Boom Weldments	1,2	1,2
Hose/Cable Carrier Installations	1,2	1,2
Pivot Pins and Pin Retainers	1,2	1,2
Sheaves, Sheave Pins	1,2	1,2
Bearings	1,2	1,2
Wear Pads	1,2	1,2
Covers or Shields	1,2	1,2
Extend/Retract Chain or Cable Systems <sup>4</sup>	1,2	1,2
<b>Platform Assembly</b>		
Railing	2	2
Gate	1,2,3	1,2,3
Floor	2	2
Rotator	1,2,3,4	1,2,3,4
Lanyard Anchorage Point	1,2,6	1,2,6
<b>Turntable Assembly</b>		
Swing Bearing or Worm Gear	1 <sup>50</sup> , 2	1 <sup>50</sup> , 2
Oil Coupling	4	4
Swing Drive System	1,4	1,4
Turntable Lock	1,2,3	1,2,3
Hood, Hood Props, Hood Latches	3	3
<b>Chassis Assembly</b>		
Tires	1,2	1,2
Wheel Nuts/Bolts	1 <sup>50</sup>	1 <sup>50</sup>
Wheel Bearings		1,2,4,5
Oscillating Axle/Lockout Cylinder Systems		1,2,4,5
Extendable Axle Systems	3	3
Steer Components		1,2
Spindle Thrust Bearing/Washers		1,2
Drive Hubs	1,4	1,4

**SECTION 2 - GENERAL**

**Table 2-3. Inspection and Preventive Maintenance Schedule**

AREA	Inspections	
	Pre-Delivery <sup>1</sup> or Frequent <sup>2</sup> (Quarterly) Inspection	Annual <sup>3</sup> (Yearly) Inspection
<b>Functions/Controls</b>		
Platform Controls return to neutral/off when released	1,3,6,9	1,3,6,9
Ground Controls return to neutral/off when released	1,3,6,9	1,3,6,9
Function Control Locks, Guards, or Detents	1,3,9	1,3,9
Footswitch (shuts off function when released)	1,3,9	1,3,9
Emergency Stop Switches (Ground & Platform) arrest all platform movement	1,3,6	1,3,6
Function Limit or Cutout Switch Systems	1,3,9	1,3,9
Capacity Indicator	1,3,9	1,3,9
Drive Brakes	1,3,9	1,3,9
Swing Brakes	1,3,9	1,3,9
Auxiliary Power	1,3,9	1,3,9
<b>Power System</b>		
Engine Idle, Throttle, and RPM	1,3,7	1,3,7
Engine Fluids: Oil	4	4
Engine Fluids: Coolant	1,4,7	1,4,7
Air Filter	1,4	1,4
Fuel Filter(s)	1,5	1,5
Drain Oil Build Up in 2-Stage Vaporizer (LP Only)	1,4	1,4
Exhaust System	1,4	1,4
Batteries	1,4	1,4
Battery Fluid	4	4
Battery Charger	1,3	1,3
Intake System	1,2	1,2
Glow Plug (Diesel Only)	1,2,3	1,2,3
Serpentine Belt, Tensioner, Pulleys	1,2,3	1,2,3
Fuel Reservoir, Cap, and Breather	1,2,4	1,2,4
<b>Hydraulic/Electric System</b>		
Hydraulic Pumps	1,2,4	1,2,4
Hydraulic Cylinders	1,2,4,5	1,2,4,5
Cylinder Attachment Pins and Pin Retainers	1,2	1,2
Hydraulic Hoses, Lines, and Fittings	1,2,4	1,2,3,4
Hydraulic Reservoir, Cap, and Breather	1,2,3,4,5	1,2,3,4,5
Hydraulic Filter(s)	1,4,5	1,4,5
Hydraulic Fluid	4,5	4,5
Electrical Connections	1,2	1,2
Instruments, Gauges, Switches, Lights, Horn		1,3

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery <sup>1</sup> or Frequent <sup>2</sup> (Quarterly) Inspection	Annual <sup>3</sup> (Yearly) Inspection
<b>General</b>		
All Decals/Placards Installed, Secure, Legible	9	9
Annual Machine Inspection Due		9
No Unauthorized Modifications or Additions	9	9
All Relevant Safety Publications Incorporated	9	9
General Structural Condition and Welds	2	2
All Fasteners, Pins, Shields, and Covers	1,2	1,2
Grease and Lubricate to Specifications	9	9
Function Test of All Systems	9	9
Paint and Appearance	5	5
Stamp Inspection Date on Frame		9
Notify JLG of Machine Ownership		9
Footnotes:		
<sup>1</sup> Prior to each sale, lease, or delivery		
<sup>2</sup> In service for 3 months; Out of service for 3 months or more; Purchased used		
<sup>3</sup> Annually, no later than 13 months from the date of the prior inspection, Includes all daily and quarterly inspections, mandated by regulating body		
<sup>4</sup> Replace every 12 years or 7,000 hours		
<sup>50</sup> Indicates a 50 hour interval required to perform task after initial use of machine. This only occurs once in machine life		
<sup>250</sup> Indicates a 250 hour interval required to perform task after initial use of machine. This only occurs once in machine life		
Performance Codes:		
1 - Check for proper and secure: installation, adjustment, or torque		
2 - Visual inspection for damage: (cracks, corrosion, abrasions, distortion, excessive wear, broken welds, gouges, chafing and threads showing)		
3 - Proper operation		
4 - Check for proper sealing, signs of leakage and fluid level		
5 - Clean and free of debris		
6 - Decals installed and legible		
7 - Check for proper tolerances, routing, and lubrication		
8 - Fully Charged		
9 - Verify/Perform		

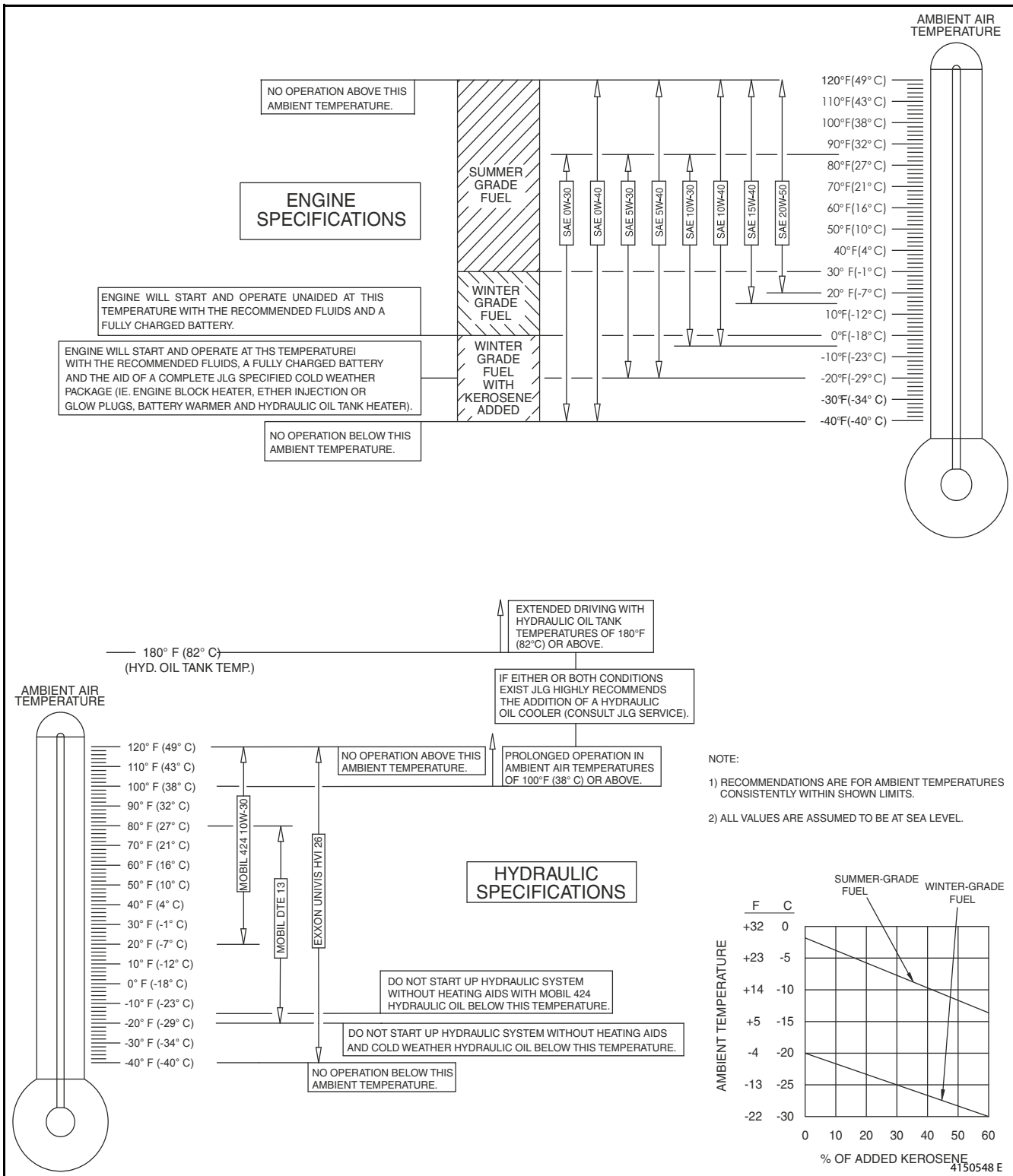


Figure 2-1. Engine and Hydraulic Operating Temperature Specifications - Deutz

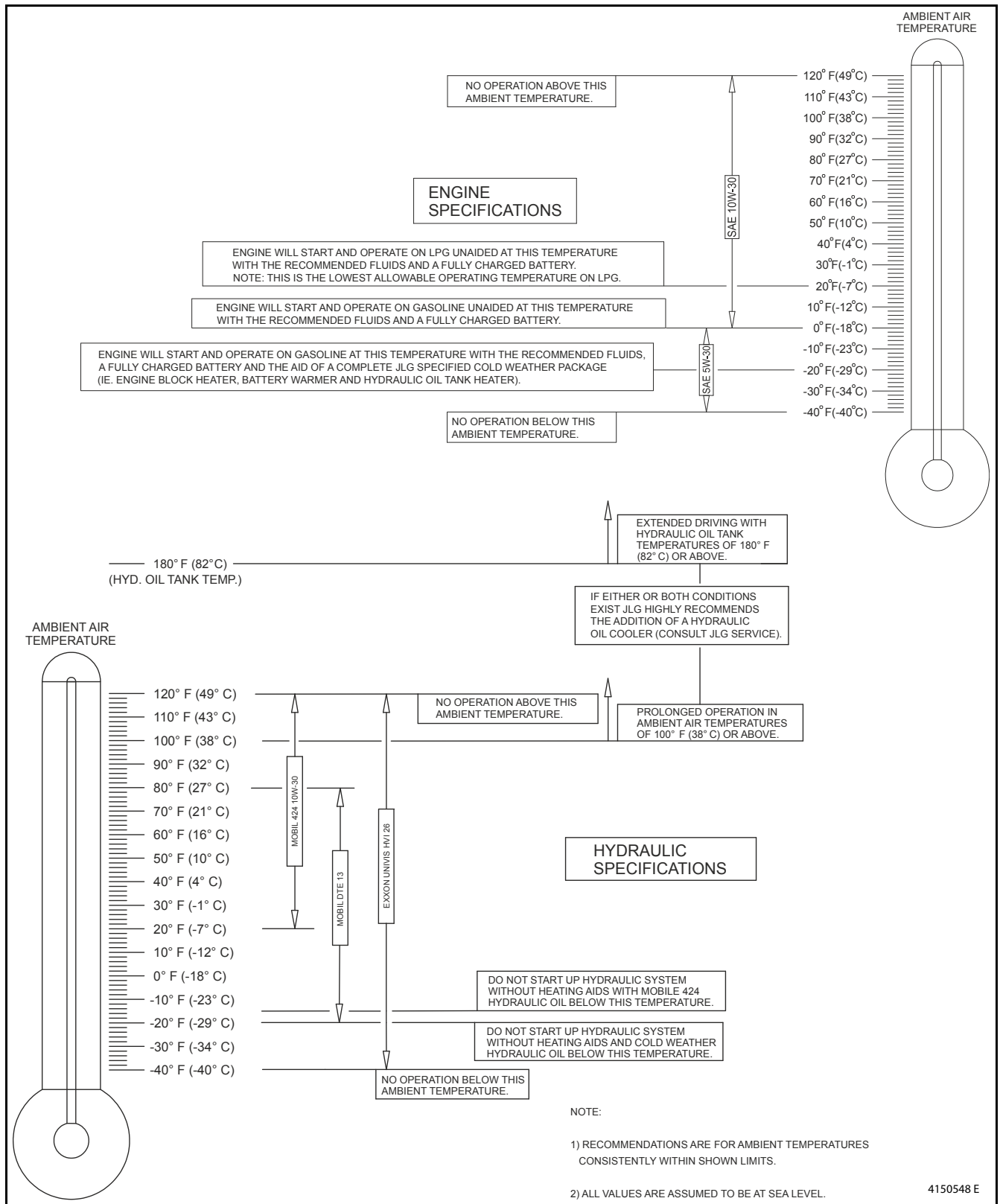
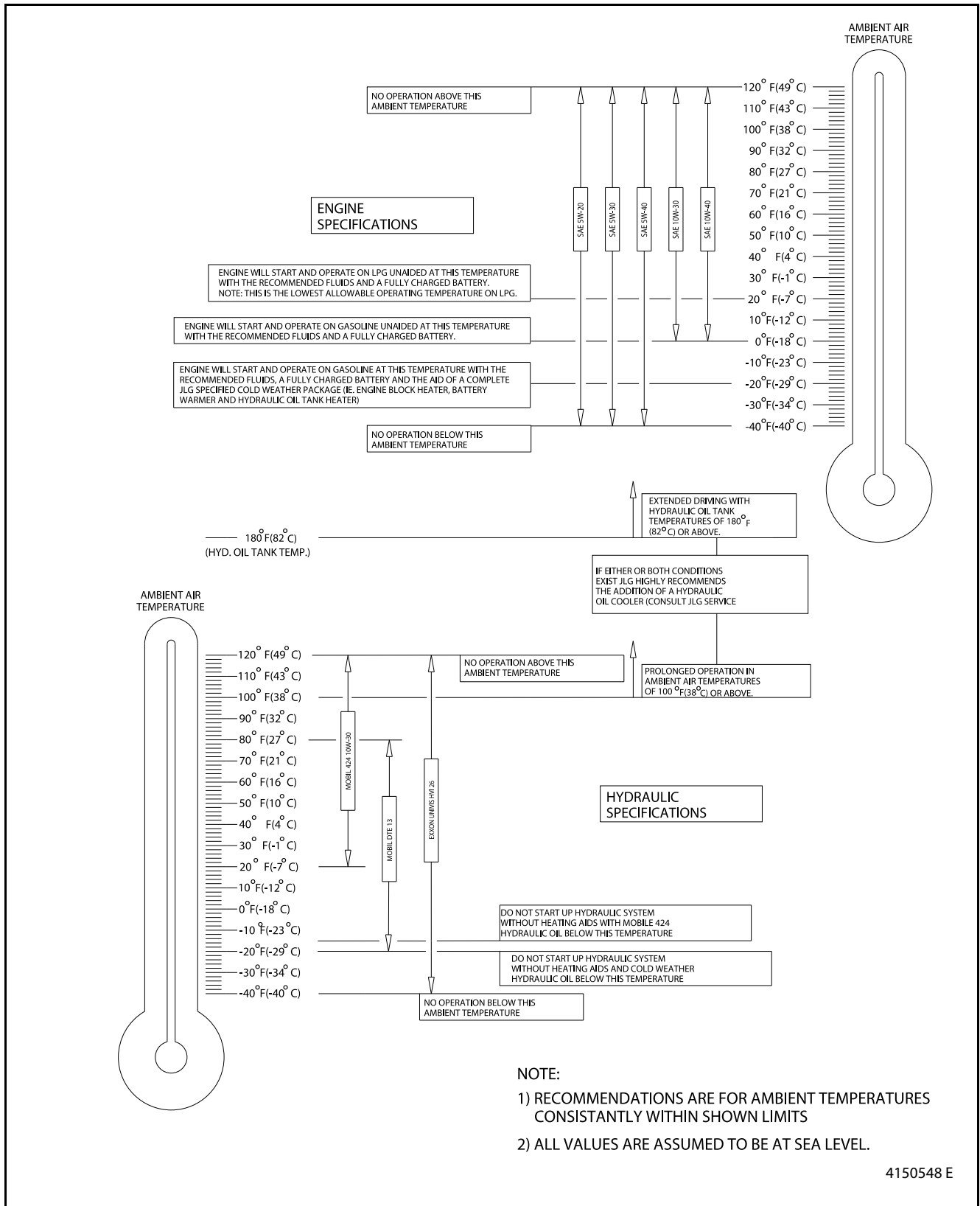


Figure 2-2. Engine and Hydraulic Operating Temperature Specifications - GM

**SECTION 2 - GENERAL**



**Figure 2-3. Engine and Hydraulic Operating Temperature Specifications - Ford MSG 425**

## SECTION 3. CHASSIS & TURNTABLE

### 3.1 TIRES & WHEELS.

#### Tire Inflation

The air pressure for pneumatic tires must be equal to the air pressure that is stenciled on the side of the JLG product or rim decal for safe and proper operational characteristics.

#### Tire Damage

For pneumatic tires, JLG Industries, Inc. recommends that when any cut, rip, or tear is discovered that exposes sidewall or tread area cords in the tire, measures must be taken to remove the JLG product from service immediately. Arrangements must be made for replacement of the tire or tire assembly.

For polyurethane foam filled tires, JLG Industries, Inc. recommends that when any of the following are discovered, measures must be taken to remove the JLG product from service immediately and arrangements must be made for replacement of the tire or tire assembly.

- a smooth, even cut through the cord plies which exceeds 3 in. (7.5 cm) in total length.
- any tears or rips (ragged edges) in the cord plies which exceeds 1 in. (2.5 cm) in any direction.
- any punctures which exceed 1 in. in diameter.
- any damage to the bead area cords of the tire.

If a tire is damaged but is within the above noted criteria, the tire must be inspected on a daily basis to ensure the damage has not propagated beyond the allowable criteria.

Tubes may be installed inside of tires that meet the criteria outlined above for useable tires, only to eliminate small air leaks (i.e., bead leaks, small nail puncture, etc.). Radial nail hole repairs up to 3/8 inch diameter may be made by using an industry approved commercial/industrial tire repair procedure, such as an internally applied plug and liner patch repair system, provided the nail hole is at least one inch inside the shoulder. Do not attempt any section repairs or repairs to the shoulder or sidewall areas.

#### Tire Replacement

JLG recommends a replacement tire be the same size, ply and brand as originally installed on the machine. Please refer to the JLG Parts Manual for the part number of the approved tires for a particular machine model. If not using a JLG approved replacement tire, we recommend that replacement tires have the following characteristics:

- Equal or greater ply/load rating and size of original.
- Tire tread contact width equal or greater than original.

- Wheel diameter, width and offset dimensions equal to the original.
- Approved for the application by the tire manufacturer (including inflation pressure and maximum tire load).

Unless specifically approved by JLG Industries Inc. do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. When selecting and installing a replacement tire, ensure that all tires are inflated to the pressure recommended by JLG. Due to size variations between tire brands, both tires on the same axle should be the same and all four tires should contain the same fill media.

#### Wheel Replacement

The rims installed on each product model have been designed for stability requirements which consist of track width, tire pressure, and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in an unsafe condition regarding stability.

#### Wheel Installation

It is extremely important to apply and maintain proper wheel mounting torque.

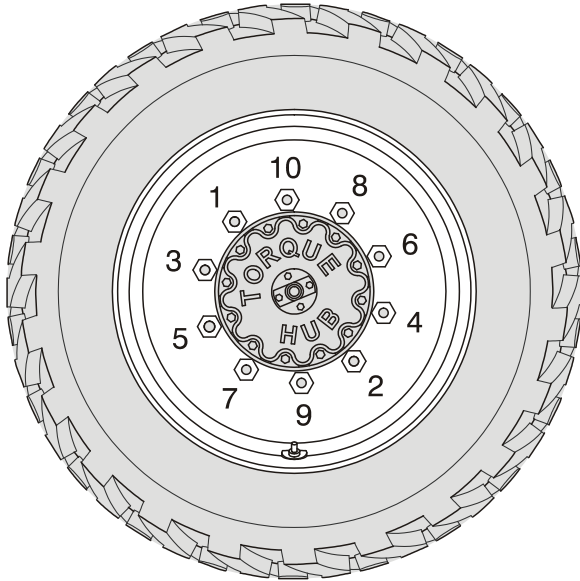
#### WARNING

**WHEEL NUTS MUST BE INSTALLED AND MAINTAINED AT THE PROPER TORQUE TO PREVENT LOOSE WHEELS, BROKEN STUDS, AND POSSIBLE DANGEROUS SEPARATION OF WHEEL FROM THE AXLE. BE SURE TO USE ONLY THE NUTS MATCHED TO THE CONE ANGLE OF THE WHEEL.**

Tighten the lug nuts to the proper torque to prevent wheels from coming loose. Use a torque wrench to tighten the fasteners. If you do not have a torque wrench, tighten the fasteners with a lug wrench, then immediately have a service garage or dealer tighten the lug nuts to the proper torque. Over-tightening will result in breaking the studs or permanently deforming the mounting stud holes in the wheels. The proper procedure for attaching wheels is as follows:

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.

- Tighten nuts in the following sequence:



- The tightening of the nuts should be done in stages. Following the recommended sequence, tighten nuts per wheel torque chart.

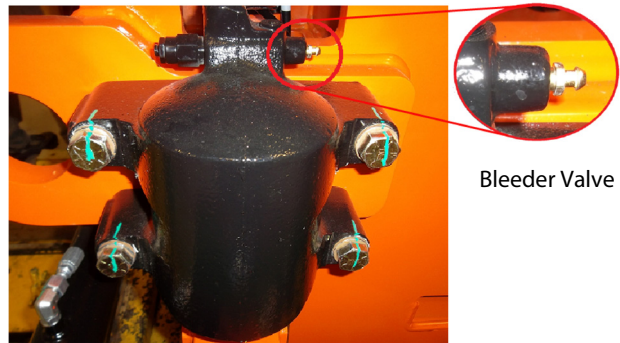
**Table 3-1. Wheel Torque Chart**

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
70 ft. lbs. (95 Nm)	170 ft. lbs. (225 Nm)	300 ft. lbs. (405 Nm)

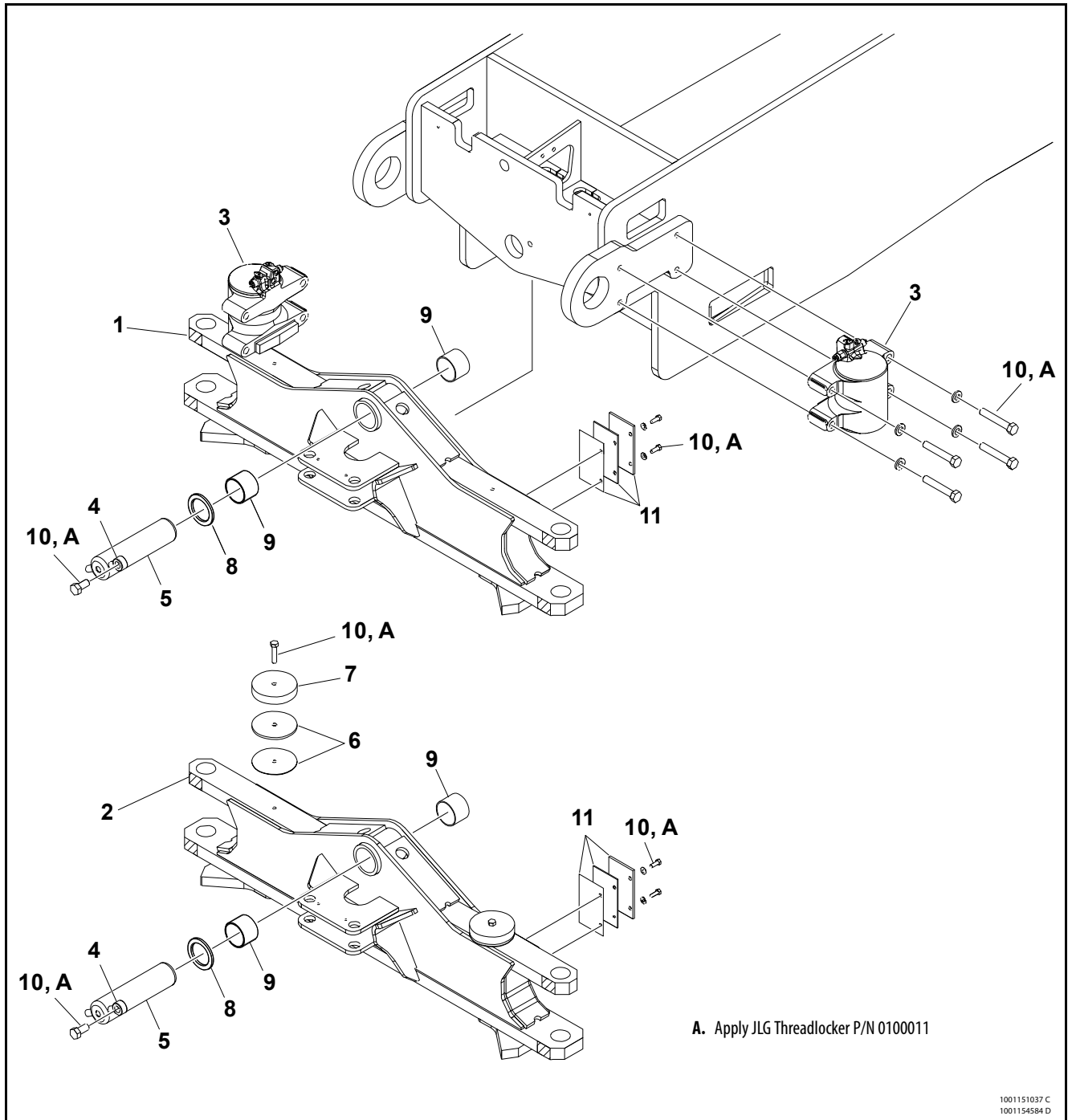
- Wheel nuts should be torqued after first 50 hours of operation and after each wheel removal. Check torque every 3 months or 150 hours of operation.

### 3.2 LOCKOUT CYLINDER BLEEDING

- Start the engine.
- Position the turntable to the normal stowed position.
- Attach clear tubing to bleeder valve nipple.
- Position a small bucket/bottle in front of the lockout cylinder bleeder valve and insert clear tubing.
- Using a 3/8" wrench, loosen the bleeder valve, turning counterclockwise slowly. Bleed air from the top of lockout cylinder. Capture hydraulic oil until a steady unbroken stream of hydraulic oil is viewed. Tighten/close the bleeder valve while stream of hydraulic oil is running.
- Locate the bleeder valve on the opposite side lockout cylinder. Repeat the process.

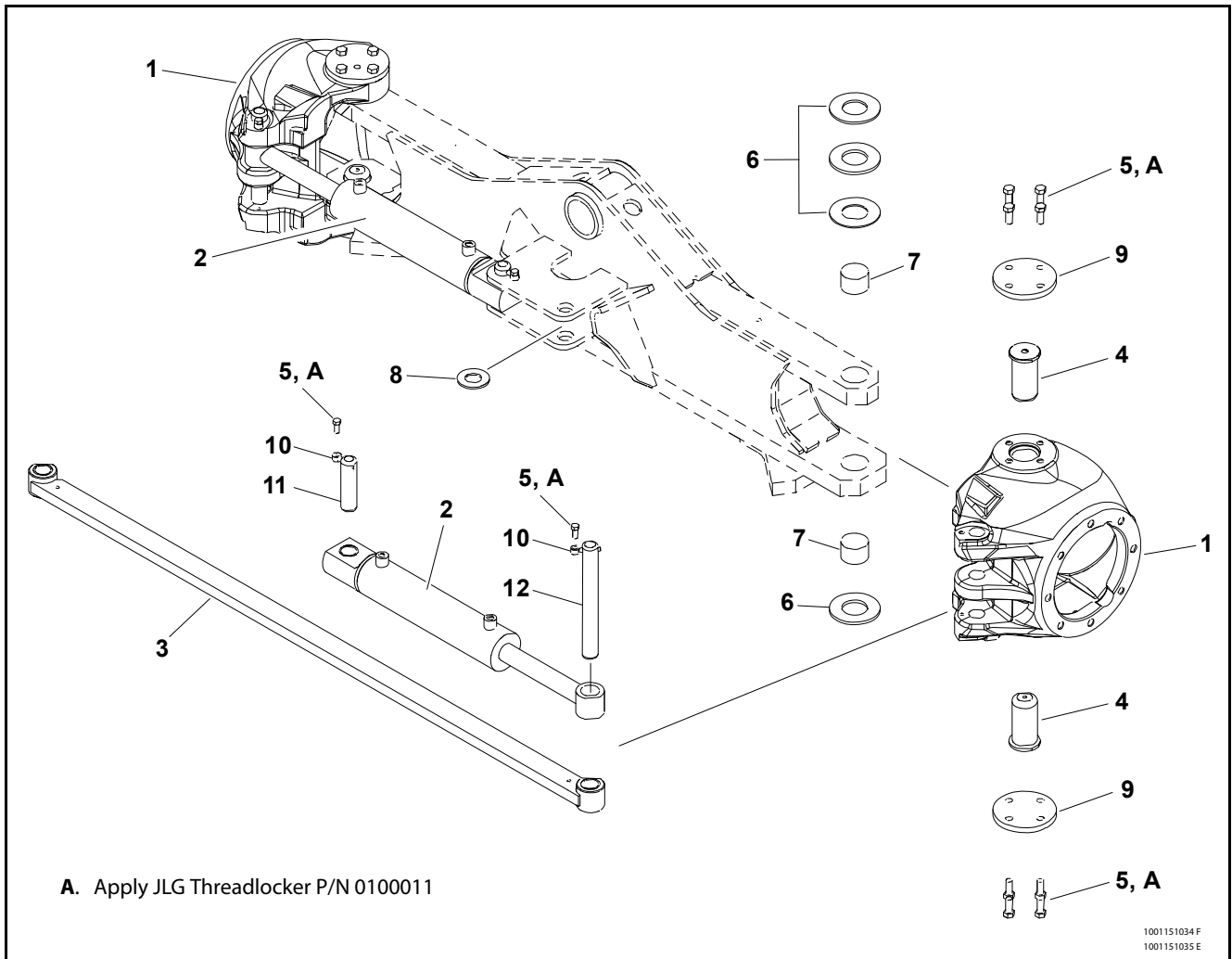


Bleeder Valve



- |                          |                   |               |          |
|--------------------------|-------------------|---------------|----------|
| 1. Oscillating Axle      | 4. Keeper Pin     | 7. Stop Plate | 10. Bolt |
| 2. Fixed Axle            | 5. Axle Pivot Pin | 8. Washer     | 11. Shim |
| 3. Axle Lockout Cylinder | 6. Shim           | 9. Bushing    |          |

Figure 3-1. Axle Installation



- |                   |                  |                      |                        |
|-------------------|------------------|----------------------|------------------------|
| 1. Drive Spindle  | 4. Kingpin       | 7. Composite Bearing | 10. Keeper PIN         |
| 2. Steer Cylinder | 5. Bolt          | 8. Thrust Washer     | 11. Cylinder Pivot Pin |
| 3. Tie Rod        | 6. Thrust Washer | 9. Retaining Plate   | 12. Cylinder Pivot Pin |

**Figure 3-2. Steering Installation**

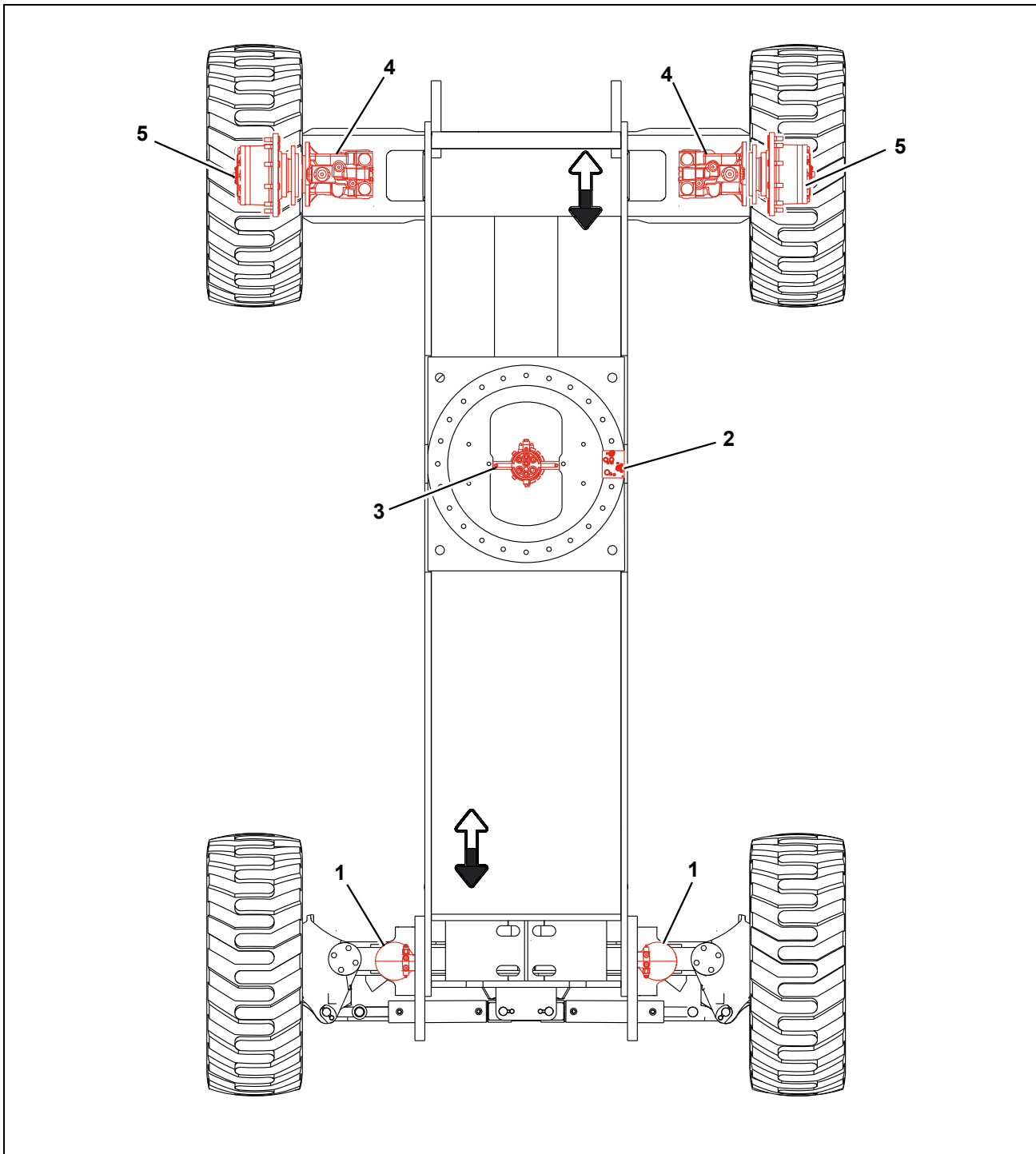
### 3.3 OSCILLATING AXLE LOCKOUT TEST

#### **NOTICE**

**LOCKOUT SYSTEM TEST MUST BE PERFORMED QUARTERLY, ANY TIME A SYSTEM COMPONENT IS REPLACED, OR WHEN IMPROPER SYSTEM OPERATION IS SUSPECTED.**

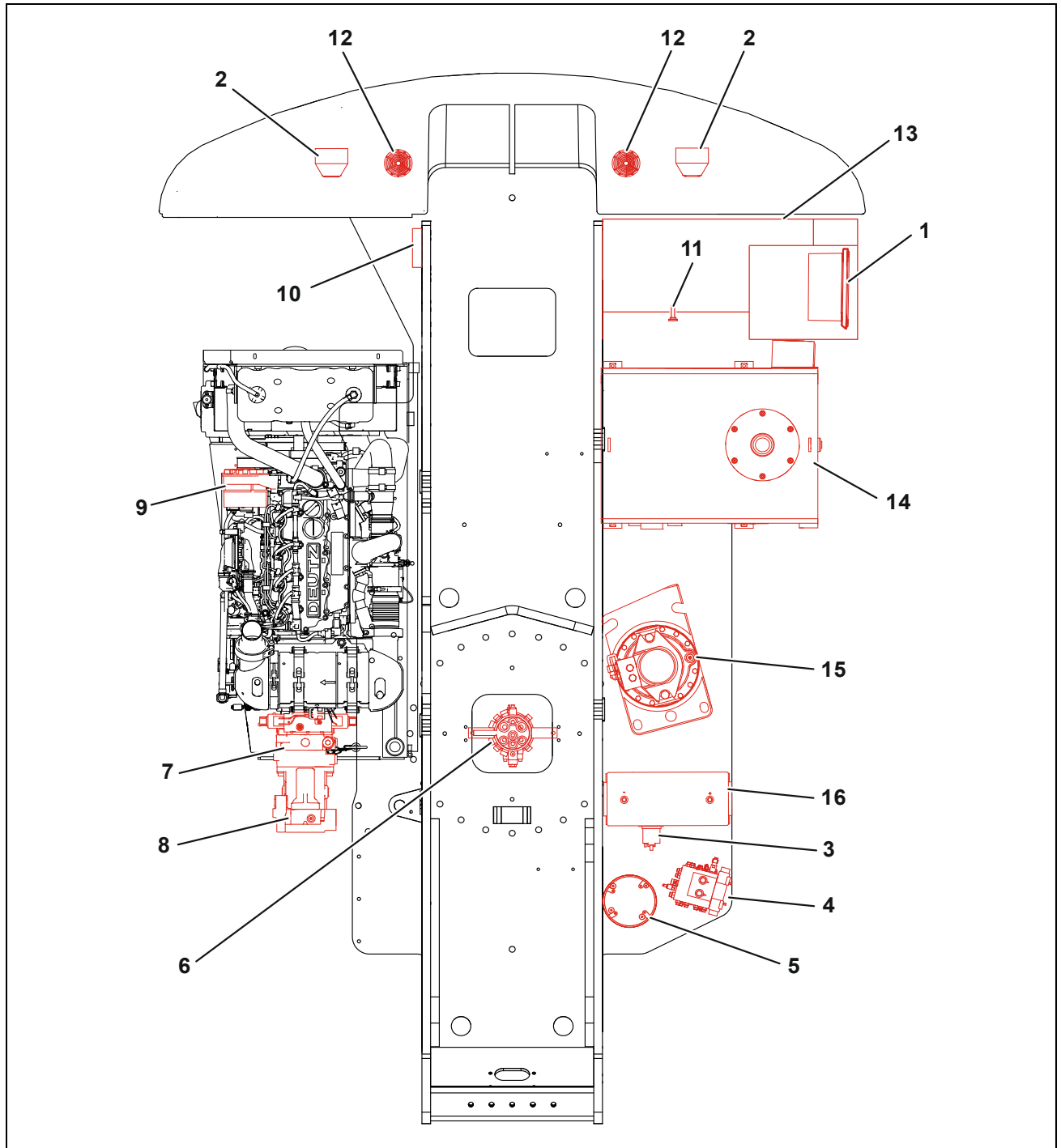
**NOTE:** *Ensure boom is fully retracted, lowered, and centered between drive wheels prior to beginning lockout cylinder test.*

1. Place a 6 inch (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, activate machine hydraulic system.
3. Place FUNCTION SPEED CONTROL and DRIVE SPEED/TORQUE SELECT control switches to their respective LOW positions.
4. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
5. Carefully activate SWING control lever and position boom over right side of machine.
6. With boom over right side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
7. Have an assistant check to see that left front wheel remains locked in position off of ground.
8. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary activate DRIVE to release cylinders.
9. Place the 6 inch (15.2 cm) high block with ascension ramp in front of right front wheel.
10. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
11. Carefully activate SWING control lever and position boom over left side of machine.
12. With boom over left side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.
13. Have an assistant check to see that right front wheel remains locked in position off of ground.
14. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary activate DRIVE to release cylinders.
15. If lockout cylinders do not function properly, have trained personnel correct the malfunction prior to any further operation



- |                          |                |
|--------------------------|----------------|
| 1. Axle Lockout Cylinder | 4. Drive Motor |
| 2. Flow Drive Valve      | 5. Drive Hub   |
| 3. Swivel                |                |

Figure 3-3. Chassis Component Location



- |                          |                         |   |                        |
|--------------------------|-------------------------|---|------------------------|
| 1. Ground Control Box    | 5. Auxiliary Power Pump | 9. Generator                            | 13. Fuel Tank          |
| 2. Headlight             | 6. Swivel               | 10. Deutz Module & Diagnostic Connector | 14. Hydraulic Oil Tank |
| 3. Auxiliary Power Relay | 7. Drive Pumps          | 11. Fuel Level Sensor                   | 15. Swing Drive        |
| 4. Main Control Valve    | 8. Function Pump        | 12. Strobe                              | 16. Battery            |

Figure 3-4. Turntable Component Location

### 3.4 DRIVE HUB (TORQUE)

#### Disassembly

1. Position hub over suitable container and remove drain plugs (10) from unit. Allow oil to completely drain, then replace drain plugs.
2. Remove bolts (41) securing cover assembly to hub (7). Remove cover assembly (23) and discard o-ring seal (22).
3. Lift carrier assembly and top thrust washer and thrust bearing(39, 40) from hub. Thrust washer may stick inside cover.
4. Pry ring gear (21) loose from hub and remove it. Remove o-ring seal (22) from hub counterbore and discard it.
5. Remove input gear (37) and thrust spacer (36) from input shaft assembly and remove input shaft assembly from hub.
6. Lift internal gear (12) and thrust washer and thrust bearing (39, 40) from hub. Thrust washer may stick to bottom of carrier.
7. Remove retaining ring (9) from spindle (1) and discard; lift hub from spindle.

#### **CAUTION**

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL.

8. Remove inside bearing cone (6) and bearing shim (8).
9. If necessary, pry seal (2) out of hub using screwdriver or pry bar. With seal removed, outside bearing cone (4) can be removed.
10. If necessary, remove inner and outer bearing cups (3, 5) using a suitable slide hammer puller or driven out with a punch.
11. To remove the cluster gears from the carrier, drive the anti-roll pin into the planet shaft of the cluster gear. After the planet shaft is removed, the roll pin should be driven out of the planet shaft.

#### **NOTICE**

WHEN REBUILDING TORQUE HUB, REMOVE AND REPLACE ALL O-RINGS AND RETAINING RINGS.

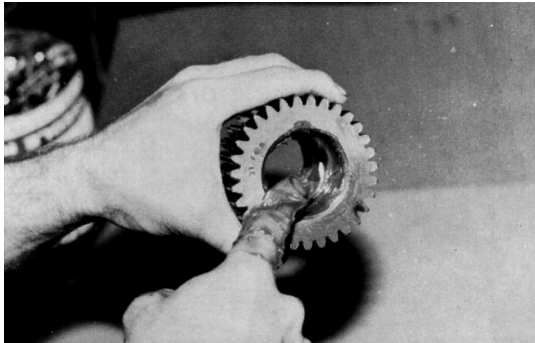
#### Cleaning and Inspection

1. Thoroughly clean all parts in an approved cleaning solvent.
2. Inspect bearing cups and cones for damage, pitting, corrosion, or excessive wear. If necessary, replace bearings as a complete set ensuring that they remain covered until use.
3. Inspect bearing mounting surfaces on spindle, hub, input shaft and carrier. Replace components as necessary.
4. Inspect all geared components for chipped or broken teeth and for excessive or uneven wear patterns.
5. Inspect carrier for damage, especially in anti-roll pin and planet shaft hole areas.
6. Inspect all planet shafts for scoring or other damage.
7. Inspect all threaded components for damage including stretching, thread deformation, or twisting.
8. Inspect seal mounting area in hub for burrs or sharp edges. Dress applicable surfaces or replace components as necessary.
9. Inspect cover for cracks or other damage, and o-ring sealing area for burrs or sharp edges. Dress applicable surfaces or replace cover as necessary.

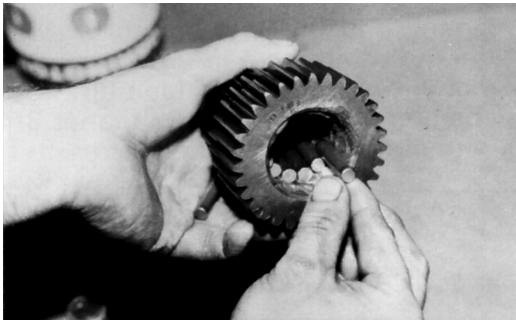
#### Repair

1. Cover Assembly.
  - a. Remove two bolts (25) securing disconnect cap (26) to cover (23) and remove cap.
  - b. Remove two bolts (25) securing cover cap (24) to cover and remove cap.
  - c. Remove disconnect rod (27) from cap and remove o-rings (28, 29) from cover cap. Discard o-rings.
  - d. If necessary, remove pipe plug (30) from cover.
  - e. Clean and inspect parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
  - f. If removed, screw pipe plug into cover.
  - g. Slip o-ring (29) over cover cap and against face.
  - h. Place o-ring (28) into cover cap internal groove. Disconnect rod may be used to push o-ring into groove.
  - i. Place cover cap into cover with large hole located over pipe plug. Secure cover cap to cover with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
  - j. Place disconnect cap over cover cap with nipple facing out and secure with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
  - k. Turn cover over and push disconnect rod into cover cap. Rod will be held in place by friction from o-ring.
2. Carrier Assembly.
  - a. Drive anti-roll pin (19) into planet shaft (17) using a suitable punch.
  - b. Using a suitable press, press planet shaft from carrier (13). After planet shaft is removed, drive anti-roll pin from shaft.
  - c. Remove cluster gear (18) and thrust washers (14) from carriers.

- d. Remove needle rollers (15) from cluster gear bore.
- e. Remove spacer (16) from cluster gear bore and remove second set of needle rollers (15).
- f. Repeat steps (a) through (e) for remaining two cluster gears.
- g. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
- h. Apply a coat of grease or petroleum jelly to cluster gear bore.



- i. Place needle rollers into cluster gear bore.



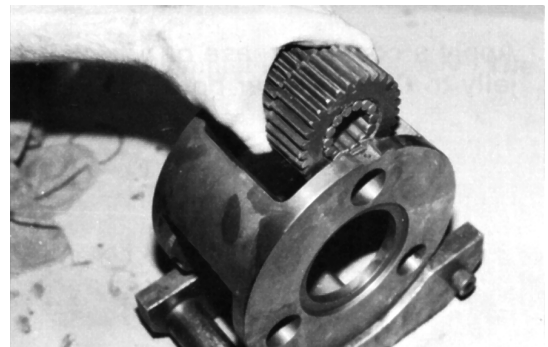
- j. Place spacer into opposite side of cluster gear and against needle rollers.



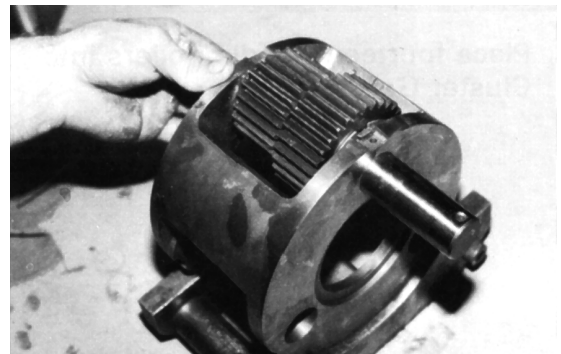
- k. Place second set of needle rollers into cluster gear.
- l. Apply grease or petroleum jelly to tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.



- m. While keeping thrust washers in place, slide cluster gear into carrier with larger gear on side with small pin hole.

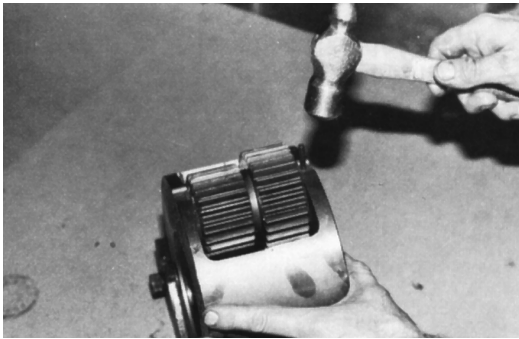


- n. Line up cluster gear and thrust washers with hole in carrier and slide planet shaft through. Ensure chamfered side of hole in planet shaft is lined up with pin hole in carrier.



## SECTION 3 - CHASSIS & TURNTABLE

- o. Drive anti-roll pin flush into carrier hole, locking planet shaft into place.



- p. Repeat steps (h) through (o) for remaining two cluster gears.

### 3. Input Shaft Assembly.

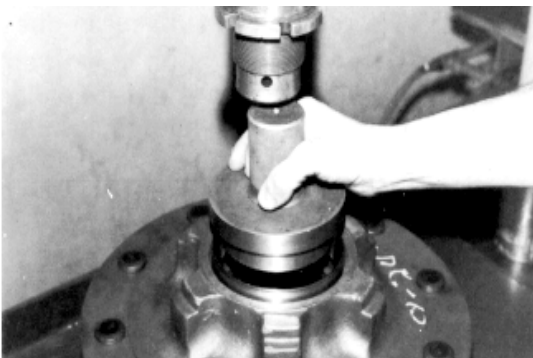
#### **⚠ CAUTION**

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL AND INSTALLATION

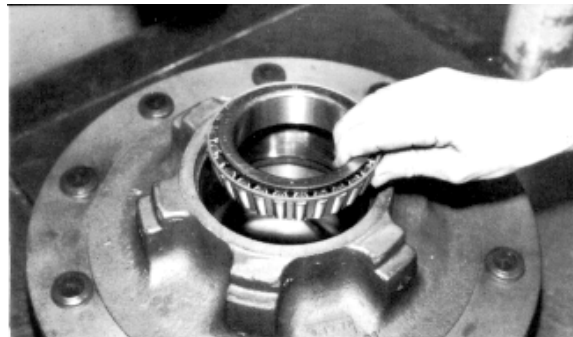
- a. Carefully remove retaining ring (33) from counterbore in the spindle (1) and discard retaining ring.
- b. Remove two washers (31) and spring (32) from input shaft.
- c. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
- d. Place washer (31), spring (32), and washer (31), in that order, onto input shaft.

### Assembly

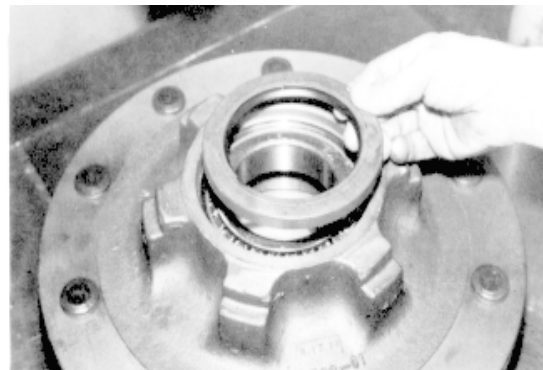
1. Using a suitable press, press new bearing cups (3, 5), with large inside diameters facing out, into hub (7) counterbores.



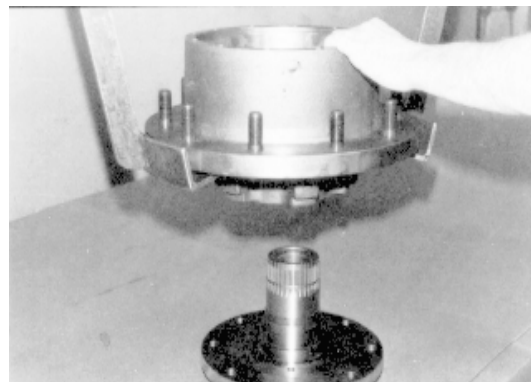
2. Place bearing cone (4) into bearing cup (3) in small end of hub.



3. Press new seal (2) into hub counterbore with flat metal side facing in. Use a flat object to ensure that seal is pressed evenly and is flush with hub face.



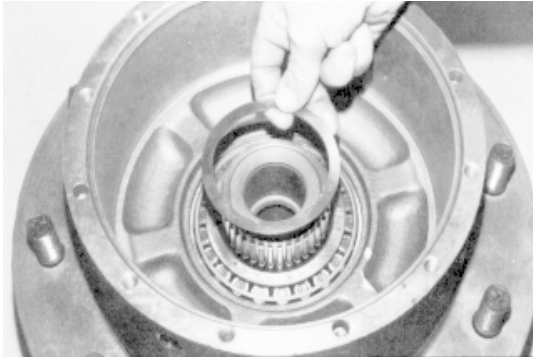
4. Lower hub onto spindle (1) with large open end up.



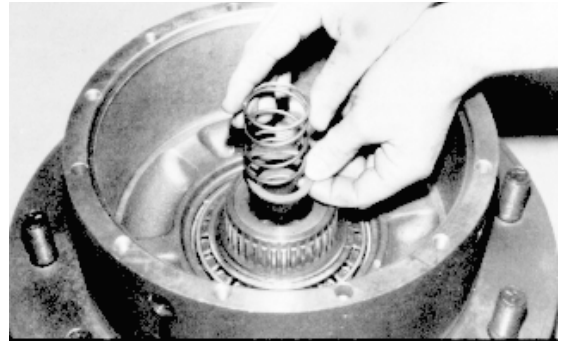
5. Place bearing cone (6) over end of spindle and into bearing cup.



6. Place bearing shim (8) over end of spindle and against bearing cone.



8. The disengage spacer and spring are installed into the counterbore of the spindle.



9. Install retaining ring into input shaft groove to secure spacers and spring to shaft.



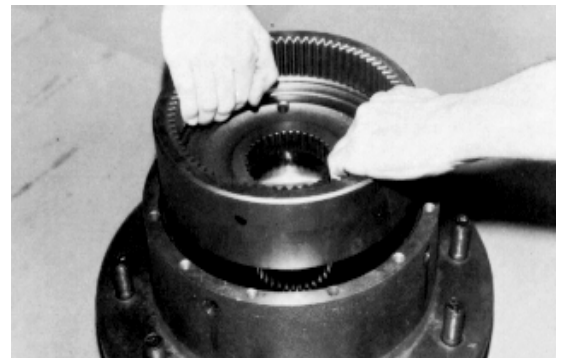
**⚠ CAUTION**

**EYE PROTECTION SHOULD BE WORN DURING RETAINING RING INSTALLATION.**

7. Install retaining ring (9) completely into spindle groove and against bearing shim. Ensure retaining ring is entirely in groove.

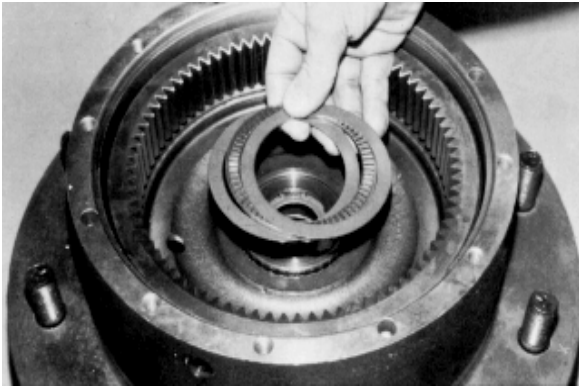


10. Place the internal gear (12) onto end of spindle by matching the bore spline, the spindle spline.

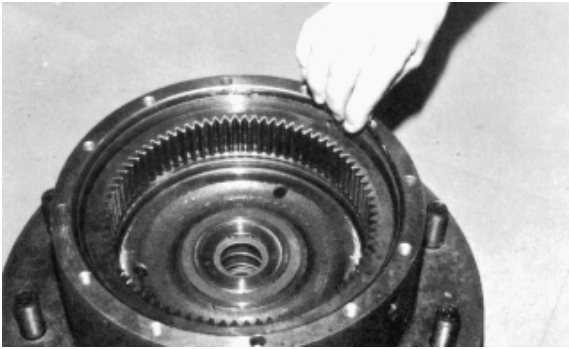


## SECTION 3 - CHASSIS & TURNTABLE

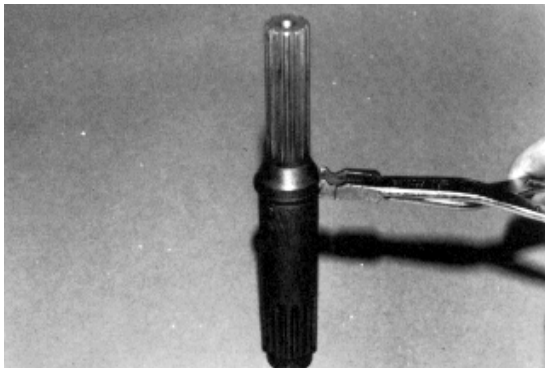
11. Install thrust washers and thrust bearing (39, 40) on the portion of the spindle which extends into the internal gear.



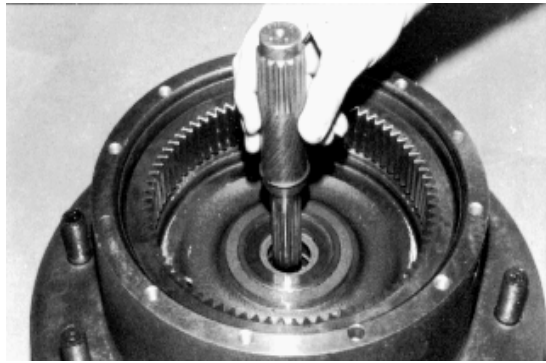
12. The o-ring is placed into the counterbore provided in the hub. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.



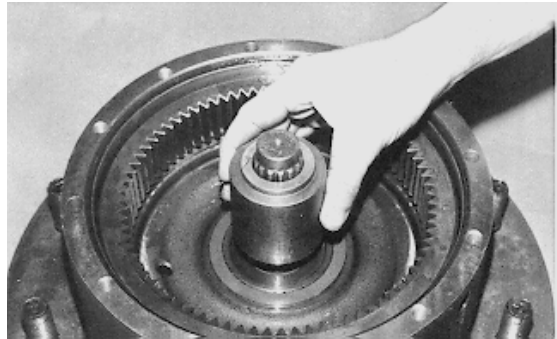
13. Install retaining ring (34) into input shaft retaining ring groove.



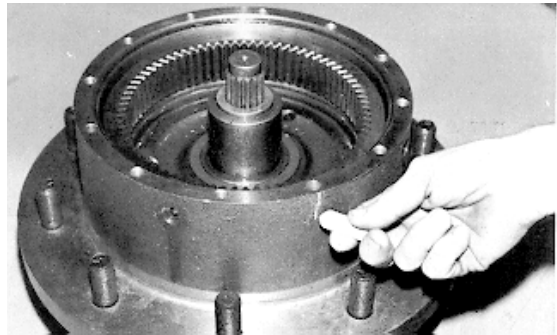
14. Place input shaft assembly (35) into spindle bore with unsplined end facing out. The action of the spring should be checked at this point.



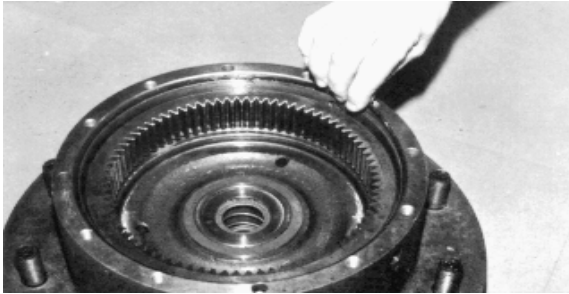
15. Place thrust spacer (36) over input shaft (35) with counterbore side facing spindle.



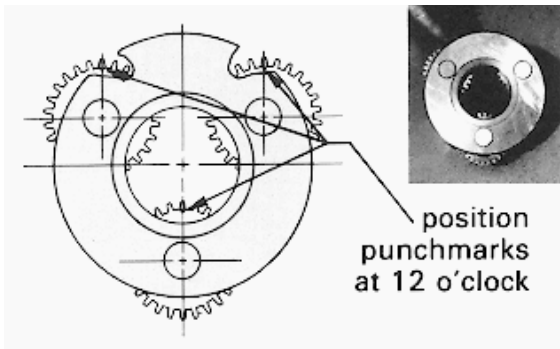
16. Locate the four counter reamed holes in the face of the hub, mark them for later identification.



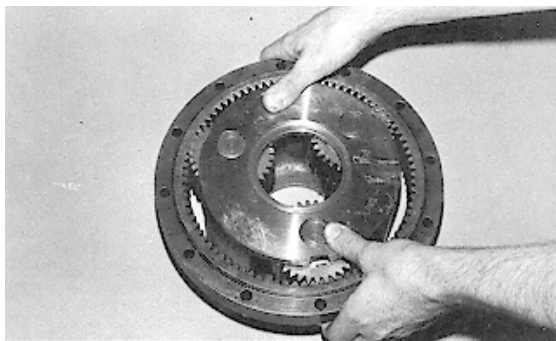
17. Place o-ring (22) into cover assembly counterbore. Use petroleum jelly or grease to hold o-ring in place. Slight stretching of o-ring may be necessary to insure proper seating.



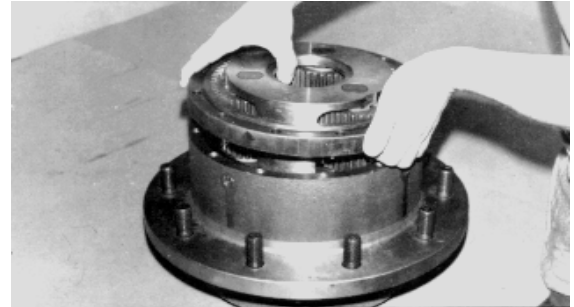
18. Place carrier assembly on a flat surface with large gears up and positioned as shown. Find punch marked tooth on each large gear and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under carrier on upper two gears.



19. With shoulder side of ring gear (21) facing down, place ring gear over (into mesh with) large gears. Ensure punch marks remain in correct location during ring gear installation. The side of the ring gear with 'X' stamped on it should be up.

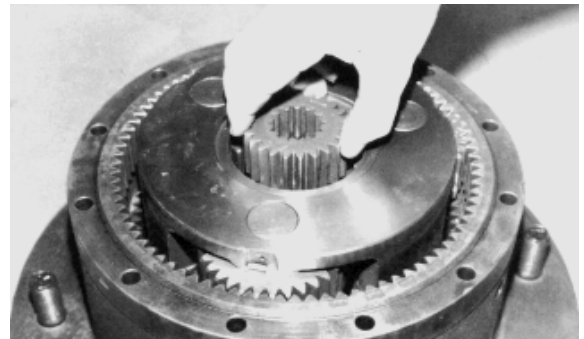


20. While holding ring gear, and cluster gears in mesh, place small side of cluster gears into mesh with internal gear. On ring gear, locate hole marked 'X' over one of the marked counterbored holes in hub.



**NOTE:** If gears do not mesh easily or carrier assembly does not rotate freely, then remove carrier and ring gear and check cluster gear timing.

21. Install input gear (37) into the carrier assembly, meshing with large diameter cluster gears (18). Counterbore in bore of input gear must be to outside of carrier assembly.



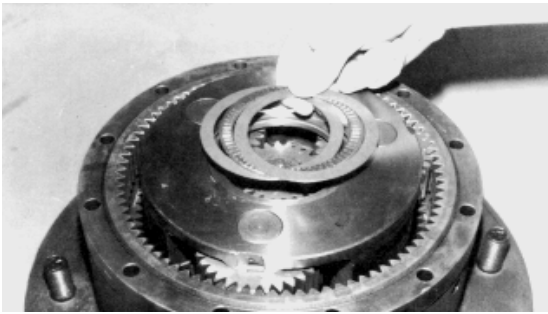
22. After inserting at least one bolt in the proper location, rotate the carrier. Check freedom of rotation and timing.



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23. Install thrust washers and thrust bearing (39, 40) into carrier counterbore.



24. Place o-ring (22) into cover assembly counterbore. Use petroleum jelly or grease to hold o-ring in place.

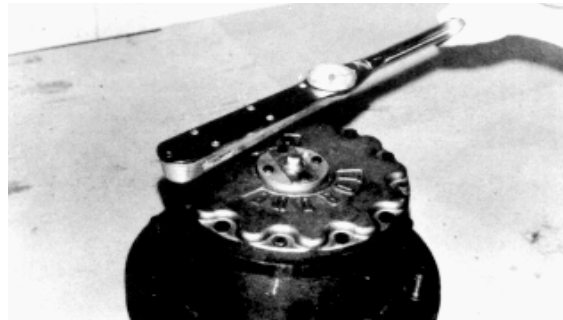


25. Place cover assembly over ring gear with oil level check plug in cover located approximately 90 degrees from oil fill plug in hub.

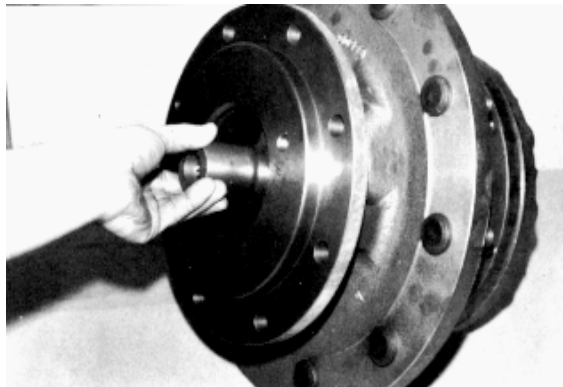
26. Locate four bolts (42), 90 degrees apart into counter-bored holes in hub marked in step (16). Torque bolts to 47 ft. lbs. (64 Nm).



27. Install bolts (41) in remaining holes. Torque bolts to 47 ft. lbs. (64 Nm).



28. Place coupling (1) into spindle and onto input shaft.



29. Fill hub one-half full of EPGL 90 lubricant before operation.

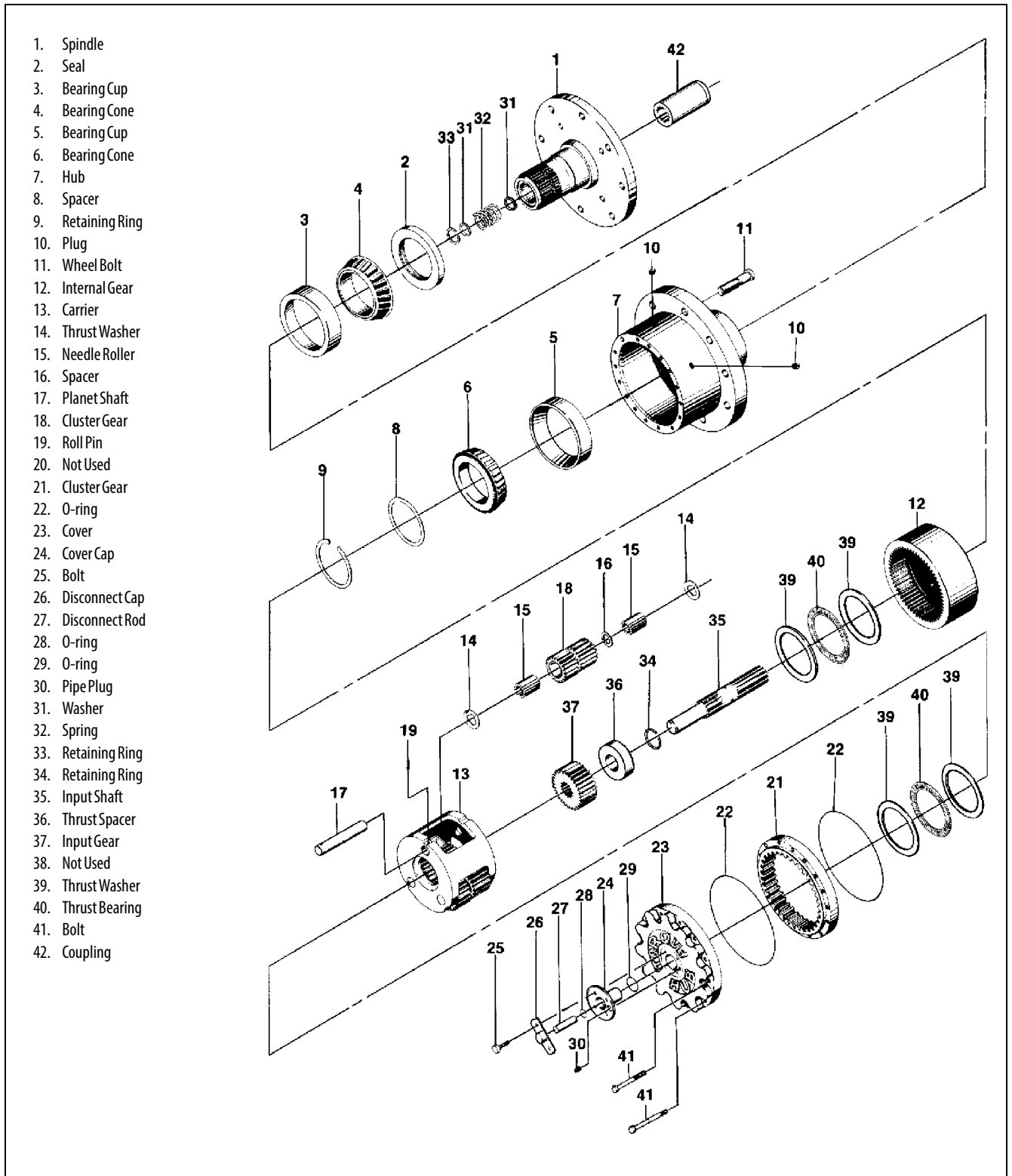


Figure 3-5. Drive Hub (Torque)

### 3.5 DRIVE BRAKE

#### Disassembly

1. Supporting brake; remove the six socket head capscrews and washers (13 & 14) in equal increments to ensure the spring pressure within the brake is reduced gradually and evenly.

If a press is available, the cylinder housing (8) can be restrained while removing the six capscrews and washers (13 & 14).

The brake assembly can now be fully dismantled and the parts examined.

2. Remove cylinder housing (8) and piston (9) subassembly and dismantle if required, removing O-ring seals (15 & 17) and backing rings (16 & 18) as necessary.
3. Remove gasket (7) from housing (2).
4. Remove friction plates (3 & 6) and pressure plate (4).
5. Remove two dowel pins (19).
6. Remove springs (22 & 23).
7. Should it be necessary to replace ball bearing (10) or shaft seal (12), reverse remainder of brake subassembly, supporting on face C of housing (2).
8. Remove internal retaining ring (11).
9. Using arbor press or similar to break Loctite seal, remove brake shaft (1) from housing (2) and lay aside.
10. Reverse housing (2) and press out ball bearing (10). Shaft seal (12) can also be removed if necessary.

#### Inspection

1. Inspect friction plates (3 & 6) and friction surface on pressure plate (4) for wear or damage.
2. Examine friction plates (3) and brake shaft (1) for wear or damage to the splines.
3. Examine input and output splines of brake shaft (1) for wear or damage.
4. Examine compression springs (22 & 23) for damage or fatigue.
5. Check ball bearing (10) for axial float or wear.
6. Examine O-ring seals (15 & 17) and backing rings (16 & 18) for damage.

#### Assembly

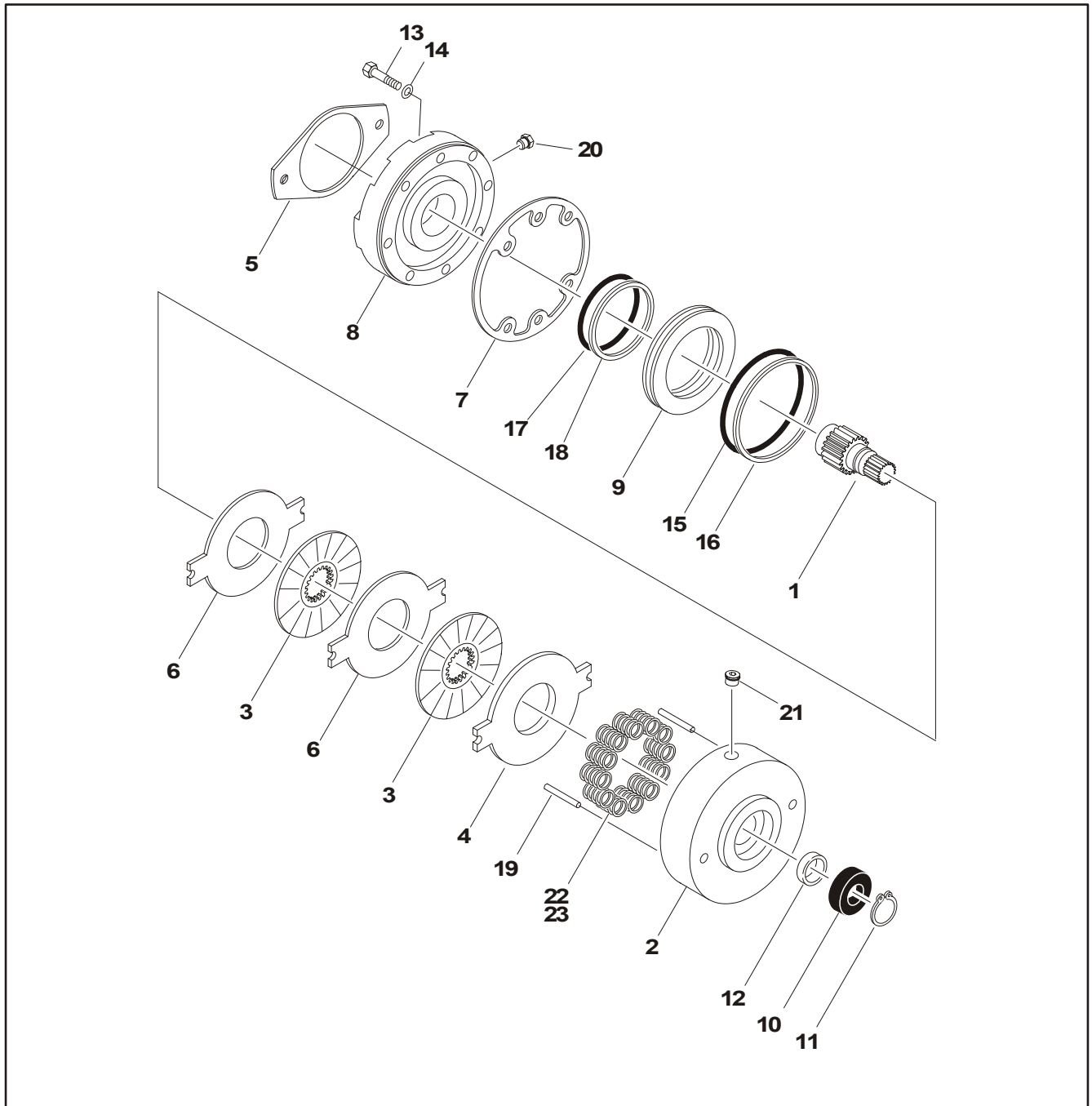
1. Lightly lubricate rotary shaft seal (12) and assemble to housing (2) taking care not to damage seal lip.
2. Apply ring of Loctite 641 or equivalent adhesive to full circumference of housing (2) bearing recess adjacent to shoulder.

Apply complete coverage of Loctite 641 to outside diameter of bearing (10) and assemble fully in housing (2), retaining with internal retaining ring (11). Remove excess adhesive with a clean cloth.

Press shaft (1) through bearing (10), ensuring bearing inner ring is adequately supported.

3. Assemble correct quantity of springs (22 & 23) in orientation required.
4. Lubricate O-ring seals (15 & 17) with Molykote 55M (or equivalent) silicon grease and assemble together with backing rings (16 & 18) to piston (9). To ensure correct brake operation. It is important that the backing rings are assembled opposite to the pressurized side of piston.
5. Correctly orientate piston (9) aligning spaces with the two dowel pin holes and, assemble into cylinder housing (8) taking care not to damage seals and carefully lay aside.
6. Locate 2-off pins (19) in housing (2) followed by pressure plate (4) and friction plates i.e. an inner (3) followed by an outer (6) in correct sequence.
7. Position gasket (7) in correct orientation.
8. Align two holes in cylinder with dowel pins (19) and assemble piston & cylinder sub-assembly to remainder of brake securing with 6 capscrews and washers (13 & 14). Torque to 55 ft.lbs. (75 Nm).

**NOTE:** *The use of a suitable press (hydraulic or arbor) pressing down on cylinder end face B will ease assembly of the capscrews (13).*



- |                   |                  |                    |                 |                      |
|-------------------|------------------|--------------------|-----------------|----------------------|
| 1. Shaft          | 6. Outer Plate   | 11. Retaining Ring | 16. Backup Ring | 21. Plug             |
| 2. Housing        | 7. Gasket        | 12. Shaft Seal     | 17. O-ring      | 22. Spring (Natural) |
| 3. Friction Plate | 8. Cylinder      | 13. Capscrew       | 18. Backup Ring | 23. Spring (Blue)    |
| 4. Pressure Plate | 9. Piston        | 14. Lockwasher     | 19. Dowel Pin   |                      |
| 5. Gasket         | 10. Ball Bearing | 15. O-ring         | 20. Plug        |                      |

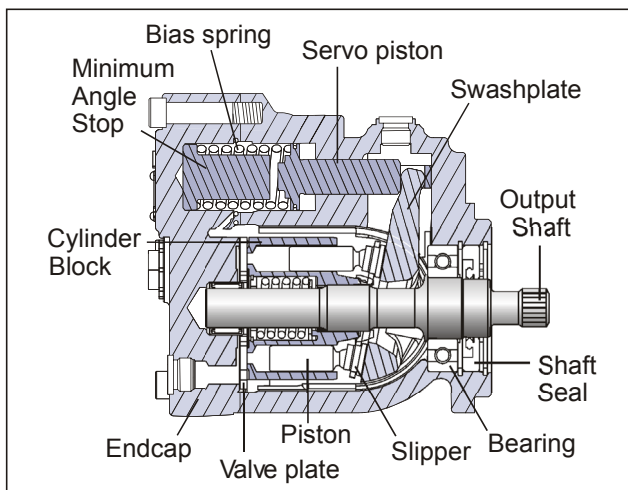
Figure 3-6. Drive Brake

### 3.6 DRIVE MOTOR

#### Description

The drive motors are low to medium power, two-position axial piston motors incorporating an integral servo piston. They are designed for operation in both open and closed circuit applications. The standard control is a direct acting single line hydraulic control. The integral servo piston controls motor displacement.

The motors are spring biased to maximum displacement and hydraulically shifted to minimum displacement. Minimum and maximum displacement can be set with fixed internal stops. The large diameter servo piston allows smooth acceleration and deceleration with relatively large circuit orificing.

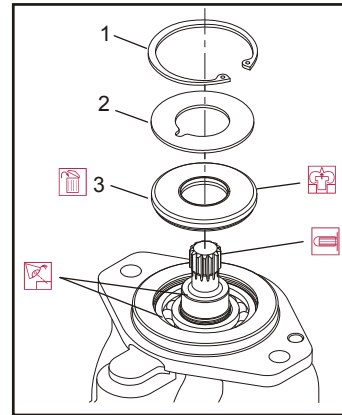


**Figure 3-7. Drive Motor Cross Section**

#### Shaft Seal Replacement

##### REMOVAL

1. Remove the snap ring (1) retaining the shaft seal and support washer.



1. Snap Ring
2. Support Washer
3. Shaft Seal

**Figure 3-8. Removing the Shaft Seal**

2. Remove the support washer (2).
3. Carefully pry out the shaft seal (3).

To avoid damaging the shaft during removal, install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.

4. Discard the seal.

##### INSPECT THE COMPONENTS

Inspect the new seal, the motor housing seal bore, and the sealing area on the shaft for rust, wear, and contamination. Polish the shaft and clean the housing if necessary.

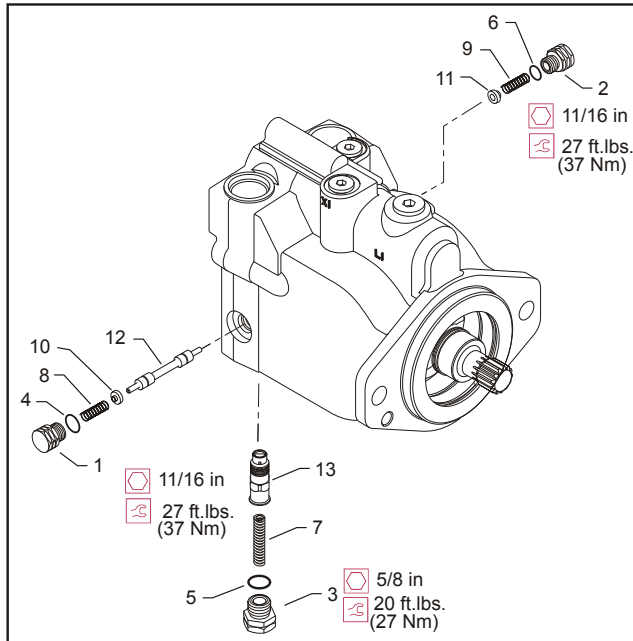
##### INSTALLATION

1. Cover the shaft splines with an installation sleeve to protect the shaft seal during installation.
2. Install a new shaft seal with the cupped side facing the motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal.
3. Install seal support washer.
4. Install snap ring.
5. Remove the installation sleeve.

## Loop Flushing Valve

### REMOVAL

- Using a 11/16 in internal hex wrench remove plug (1) and (2).



- |           |            |                    |
|-----------|------------|--------------------|
| 1. Plug   | 6. O-ring  | 11. Washer         |
| 2. Plug   | 7. Spring  | 12. Shift Spool    |
| 3. Plug   | 8. Spring  | 13. Orifice Poppet |
| 4. O-ring | 9. Spring  |                    |
| 5. O-ring | 10. Washer |                    |

Figure 3-9. Loop Flushing Spool

- Using a 1/4 in hex wrench remove plug (3).
- Remove O-rings (4, 5, and 6).
- Using pliers, remove centering springs (7, 8, and 9).
- Remove spring retaining washers (10 and 11).
- Remove shift spool (12).
- Remove orifice poppet (13).

### INSPECT THE COMPONENTS

Inspect new O-rings and the sealing area for rust, wear, or contamination. Also check springs and poppet for wear.

### INSTALLATION

- Install orifice poppet (13).
- Install shift spool (12).
- Install spring retaining washers onto springs (10 and 11).
- Carefully install centering springs (7, 8, and 9).
- Install new O-rings (6, 4, and 5).
- Using a 1/4 in hex wrench torque plug (3) to 20 ft. lbs. (27 Nm).
- Using a 11/16 in internal hex, torque plugs (2 and 1) to 27 ft.lbs. (37 Nm).

**Troubleshooting**

**Table 3-2. Excessive Noise and/or Vibration**

Item	Description	Action
Check oil level in reservoir and oil supply to the motor.	Insufficient hydraulic fluid could lead to cavitation that would cause system noise.	Fill the reservoir to the proper level and ensure that oil supply to the motor is adequate and the lines are unobstructed.
Check for air in the system.	Air trapped within the system lines, or the motor itself, could result in cavitation that would cause system noise.	Ensure that all of the system lines and components are purged of air.
Inspect the output shaft couplings.	A loose or incorrect shaft coupling will produce vibrations that could result in system noise.	Ensure that the correct coupling is used and that it fits properly onto the shaft.
Inspect the output shaft alignment.	Misaligned shafts create excessive frictional vibration that could result in system noise.	Ensure that the shafts are properly aligned.
Hydraulic oil viscosity above limits.	Viscosity above acceptable limits will result in cavitation that would lead to system noise.	Replace hydraulic oil with appropriate fluid for operating conditions.

**Table 3-3. System Operating Hot**

Item	Description	Action
Check oil level in reservoir and oil supply to the pump.	Insufficient amount of hydraulic fluid will not meet the cooling demands of the system.	Fill the reservoir to the proper level.
Inspect the heat exchanger, (if so equipped).	If the heat exchanger fails, or becomes obstructed, it may not meet the cooling demands of the system.	Ensure that heat exchanger is receiving adequate air flow and that the heat exchanger is in good operating condition. Repair or replace as necessary.
Check the system relief valves.	If a system relief valve becomes unseated for an extended period of time or fails for any other reason, the system could become overheated.	Repair or replace any malfunctioning relief valves as applicable and verify that the loads on the machine are not excessive.

**Table 3-4. Won't Shift or Slow to Start**

Item	Description	Action
Check the signal line to the servo control port.	Obstructed or restricted flow through the servo control signal lines could result in slow shift or no shift conditions within the motor.	Ensure that the signal lines are not obstructed or restricted and that signal pressure is adequate to shift the motor.
Check that the correct supply and drain orifices are properly installed, and are not obstructed.	Supply and drain orifices determine the shift rate of the motor. The smaller the orifice, the longer the time it takes to shift the motor. Obstruction will also increase shift times.	Ensure that the proper control orifices are installed in the motor and verify that they are not obstructed. Clean or replace as necessary.

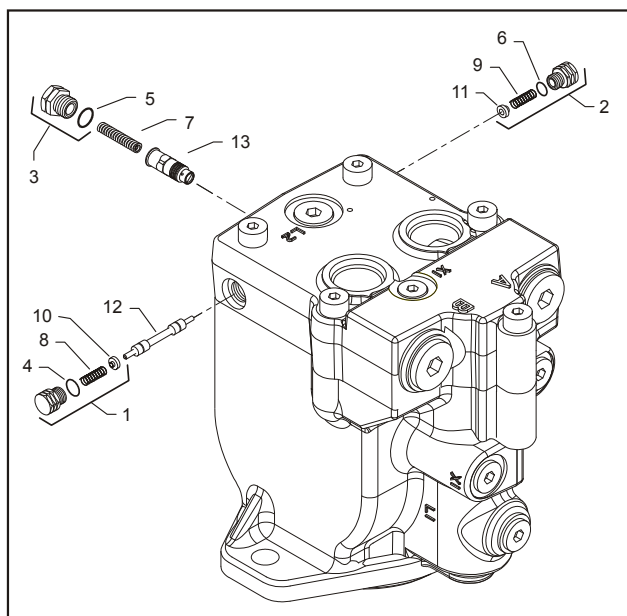
## Disassembly

**NOTE:** Removal of the endcap voids warranty.

During assembly, coat all moving parts with a film of clean hydraulic oil. This assures that these parts will be lubricated during start-up.

Replace all O-Rings and gaskets.

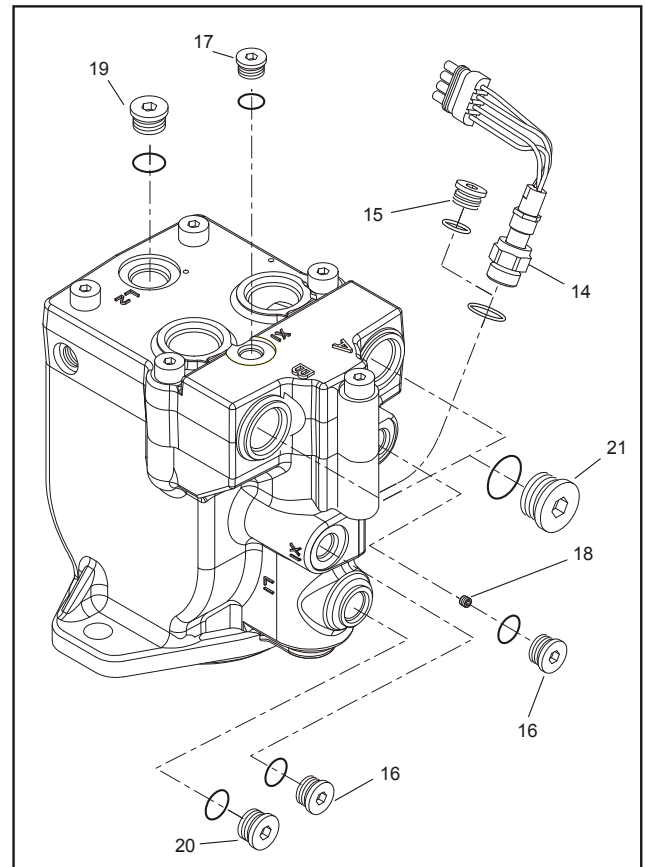
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



- |           |           |            |                    |
|-----------|-----------|------------|--------------------|
| 1. Plug   | 5. O-ring | 9. Spring  | 12. Shift Spool    |
| 2. Plug   | 6. O-ring | 10. Washer | 13. Orifice Poppet |
| 3. Plug   | 7. Spring | 11. Washer |                    |
| 4. O-ring | 8. Spring |            |                    |

**Figure 3-10. Loop Flushing Spool**

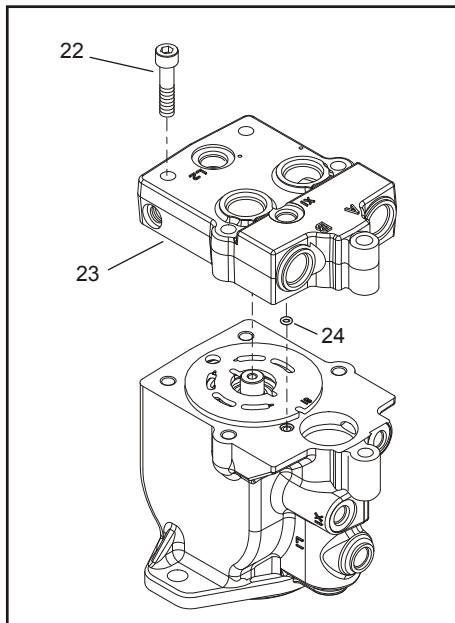
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



- |                       |                    |
|-----------------------|--------------------|
| 14. Lock Nut          | 18. Cavity Plug    |
| 15. O-ring Plug       | 19. Drain Plug     |
| 16. Control Line Plug | 20. Drain Plug     |
| 17. Control Line Plug | 21. Work Port Plug |

**Figure 3-11. Plugs, Fittings, and Speed Sensor**

8. Remove all fittings from the unit. Discard any O-rings on the fittings.
9. Using an 11/16 inch hex wrench, loosen the speed sensor lock nut (14) if equipped. Then remove the speed sensor using a 1/2 inch hex wrench. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a 5/16 inch internal hex wrench.
10. Using a 1/4 inch internal hex wrench, remove control line plugs (16, 17). Discard O-rings. Using a 3 mm hex wrench, remove cavity plug (18, if equipped with two-line control) from X2 cavity.
11. Using a 5/16 inch internal hex wrench, remove drain plugs (19, 20). Discard O-rings.
12. Using a 9/16 inch internal hex wrench, remove work port plugs (21, if equipped with axial ports). Discard O-rings.

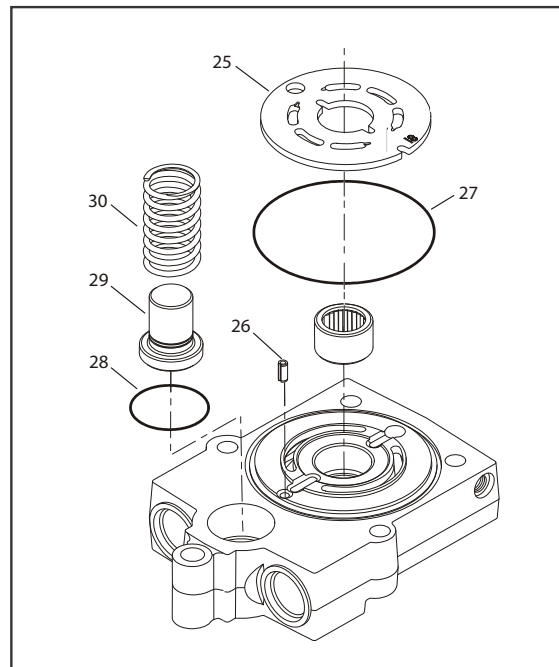


- 22. Screw
- 23. End Cap
- 24. O-ring

**Figure 3-12. End Cap**

13. Using an 8 mm internal hex wrench, remove the endcap screws (22).
14. Remove the endcap (23). Remove O-ring (24) from the housing or endcap.

When the endcap screws are removed, pressure from the servo spring will cause the endcap to bind on the shaft. Press down on the portion of the endcap covering the servo piston and hold the endcap level while removing.



- 25. Valve Plate
- 26. End Cap
- 27. O-ring
- 28. O-ring
- 29. Angle Stop
- 30. Servo Spring

**Figure 3-13. Valve Plate & Rear Shaft Bearing**

**NOTICE**

**TAKE CARE NOT TO SCRATCH THE SURFACE OF THE VALVE PLATE.**

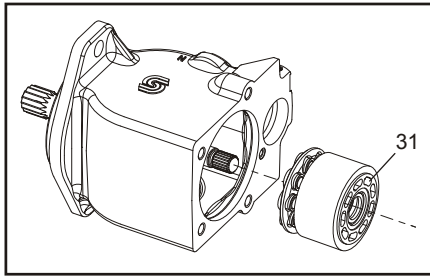
15. Remove the valve plate (25) and timing pin (26) from the endcap.

Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.

16. Remove and discard the O-rings (27 and 28).
17. Remove the rear shaft bearing (29) from the endcap with a bearing puller.

The bearing may be difficult to remove with a puller. Try this as an alternative: Pack the bearing cavity with heavy grease. After the shaft is removed, insert it into the bearing cavity and tap lightly with a soft mallet on the splined end. The grease will force the bearing out. Use caution not to drive the bearing past the rear shaft journal as the bearing may become trapped on the shaft and damaged.

18. Remove minimum angle stop (29) and servo spring (30) from the housing.



31. Cylinder Kit Assembly

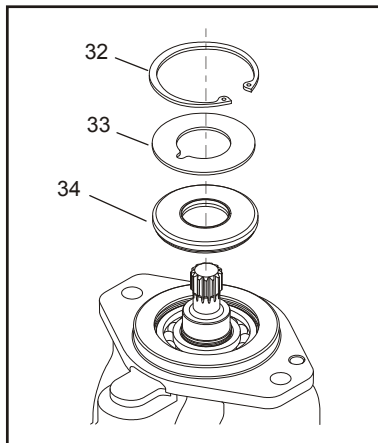
Figure 3-14. Cylinder Kit

19. Turn the housing on its side and remove the cylinder kit assembly (31). Set the assembly aside, being careful not to scratch the running surface.

**NOTE:** Grooves on the surface of the cylinder kit identify its displacement:

Table 3-5. Displacement Identifiers

# of Grooves	Frame L	Frame K
1	25	38
2	30	45
3	35	--

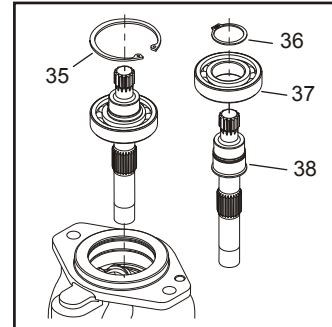


32. Snap Ring  
33. Support Washer  
34. Shaft Seal

Figure 3-15. Shaft Seal

20. Turn the housing over and remove the snap ring (32) retaining the shaft seal and support washer. Remove the support washer (33) and carefully pry out the shaft seal (34). Discard the seal.

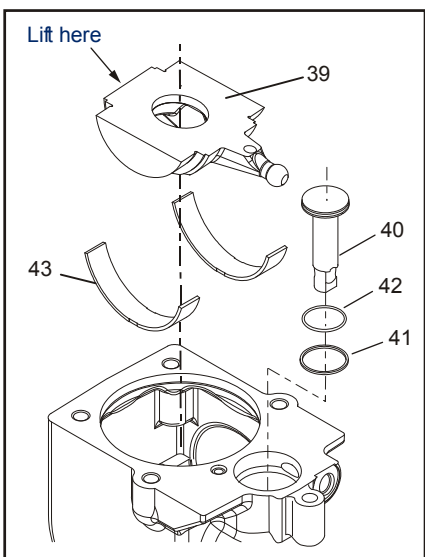
To avoid damaging the shaft during seal removal. Install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.



35. Inner Snap Ring  
36. Snap Ring  
37. Bearing  
38. Shaft

Figure 3-16. Shaft & Front Bearing

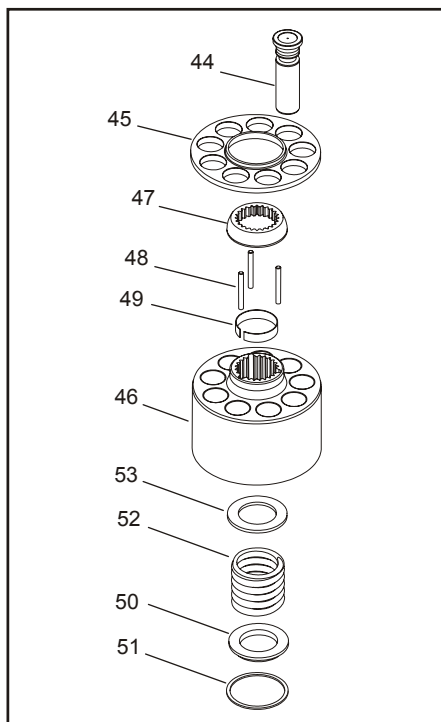
21. Remove the inner snap ring (35) and the shaft / bearing assembly.  
22. Remove the snap-ring (36) retaining the shaft front bearing. Pull the bearing (37) off of the shaft (38).



- 39. Swashplate
- 40. Servo Piston
- 41. Piston Seal
- 42. O-ring
- 43. Journal Bearings

**Figure 3-17. Swash Plate & Servo Piston**

- 23. Turn housing over and remove the swashplate (39) by lifting on the end opposite the servo lever.
- 24. Remove the servo piston (40). Remove the piston seal (41) and O-ring (42) from the servo piston. Discard the seal and O-ring.
- 25. Remove the journal bearings (43) from the housing. If the bearings are to be reused, note the location and orientation of each bearing for reassembly.



- 44. Piston
- 45. Slipper Retainer
- 46. Cylinder Block
- 47. Ball Guide
- 48. Holddown Pins
- 49. Retaining Ring
- 50. Block Spring Washer
- 51. Spiral Retaining Ring
- 52. Block Spring
- 53. Inner Block Spring Washer

**Figure 3-18. Cylinder Kit Disassembly**

- 26. Remove pistons (44) and slipper retainer (45) from the cylinder block (46).  
  
The pistons are not selectively fitted, however units with high hourly usage may develop wear patterns. Number the pistons and bores for reassembly if they are to be reused.
- 27. Remove the ball guide (47), hold-down pins (48), and retaining ring (49) from the cylinder block.

**NOTE:** Most repairs do not require block spring removal. Perform this procedure only if you suspect problems with the block spring.

**⚠ WARNING**

**RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES FORCE OF ABOUT 80 TO 90 LBF (350 TO 400 N). USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS REMOVED.**

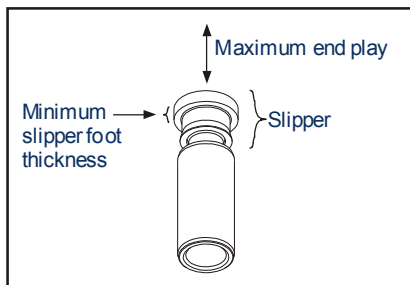
- 28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove the outer block spring washer (50), block spring (52), and inner block spring washer (53) from the cylinder block.

**Inspection**

After disassembly, wash all parts (including the end-cap and housing) thoroughly with clean solvent and allow to air dry. Blow out oil passages in the housing and endcap with compressed air. Conduct inspection in a clean area and keep all parts free from contamination. Clean and dry parts again after any rework or resurfacing.

**PISTON**

Inspect the pistons for damage and discoloration. Discolored pistons may indicate excessive heat; do not reuse.



**SLIPPERS**

Inspect the running surface of the slippers. Replace any piston assemblies with scored or excessively rounded slipper edges. Measure the slipper foot thickness. Replace any piston assemblies with excessively worn slippers. Check the slipper axial end-play. Replace any piston assemblies with excessive end-play.

Minimum slipper foot thickness and maximum axial end-play are given in the table below.

**Table 3-6. Slipper Foot Thickness & End Play**

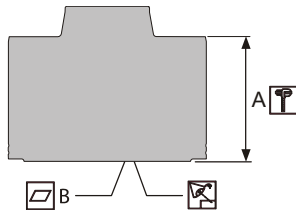
Measurement	L Frame mm (in.)	K Frame mm (in.)
Slipper Foot Thickness	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play	0.15 (0.006)	

**CYLINDER BLOCK**

Measure the cylinder block height. Replace blocks worn beyond the minimum height specification. Inspect the running surface of the cylinder block. Replace or resurface worn or scratched blocks. Blocks may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the block height below the minimum specification. Table 3-7, Cylinder Block Measurements.

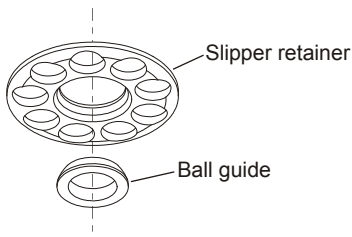
Table 3-7. Cylinder Block Measurements

Measurement	L25 mm (in.)	L30 mm (in.)	L35 mm (in.)	K38 mm (in.)	K45 mm (in.)
Minimum Cylinder Block Height (A)	50.8 (2.00)	50.8 (2.00)	50.8 (2.00)	54.4 (2.14)	54.4 (2.14)
Cylinder Block Surface Flatness	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)



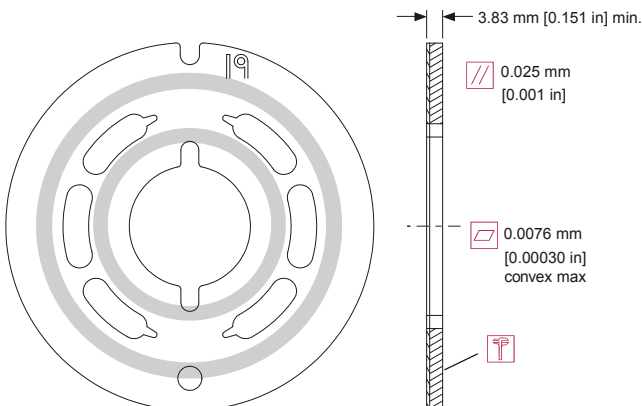
**BALL GUIDE AND SLIPPER RETAINER**

Inspect the ball guide and slipper retainer for damage, discoloration, or excessive wear. A discolored ball guide or slipper retainer indicates excessive heat. Do not reuse.



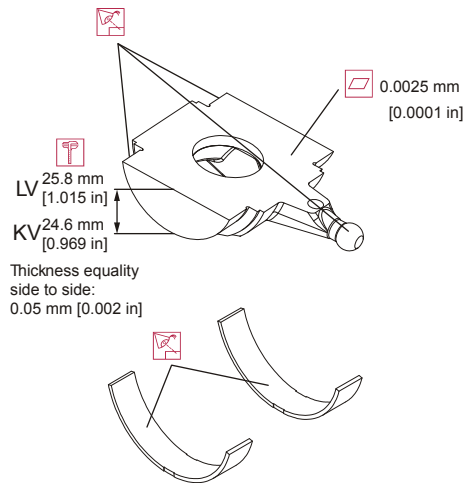
**VALVE PLATE**

The condition of the valve plate is critical to the efficiency of the motor. Inspect the valve plate surfaces carefully for excessive wear, grooves, or scratches. Replace or resurface grooved or scratched valve plates. Measure the valve plate thickness and replace if worn beyond the minimum specification. Valve plates may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the thickness below the minimum specification.



**SWASHPLATE AND JOURNAL BEARINGS**

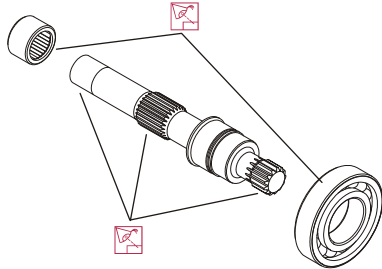
Inspect the running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown. Measure the swashplate thickness from the journals to the running face. Replace swashplate if damaged or worn beyond minimum specification. Replace swashplate if the difference in thickness from one side to the other exceeds specification.



Inspect the journal bearings for damage or excessive wear. Replace journal bearings if scratched, warped, or excessively worn. The polymer wear layer must be smooth and intact.

**SHAFT BEARINGS**

Inspect bearings for excessive wear or contamination. Rotate the bearings while feeling for uneven movement. Bearings should spin smoothly and freely. Replace bearings that appear worn or do not rotate smoothly.

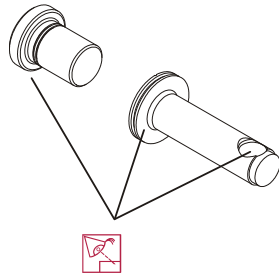


**SHAFT**

Inspect the motor shaft. Look for damage or excessive wear on the output and block splines. Inspect the bearing surfaces and sealing surface. Replace shafts with damaged or excessively worn splines, bearing surfaces, or sealing surfaces.

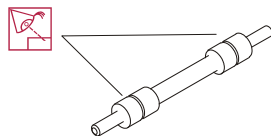
**SERVO PISTON AND MINIMUM ANGLE STOP**

Inspect the minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace if necessary.



**LOOP FLUSHING SPOOL**

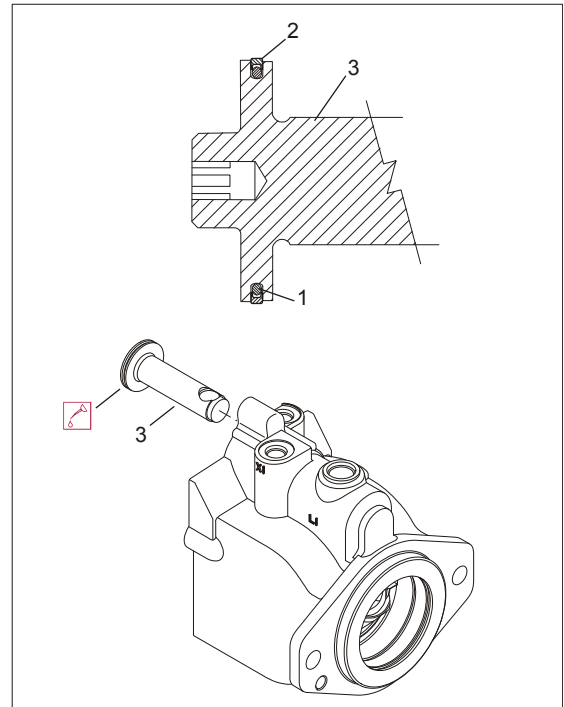
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



**Assembly**

1. Install new O-ring (1) and piston seal (2) to the servo piston (3). Install the piston seal over the O-ring.

Installing the piston seal stretches it, making it difficult to install the servo piston in its bore. Allow 30 minutes for the seal to relax after installation. To speed up seal relaxation, compress the seal by installing the piston head into the servo cavity in the end-cap and let it stand for at least five minutes.



1. O-ring
2. Piston Seal
3. Servo Piston

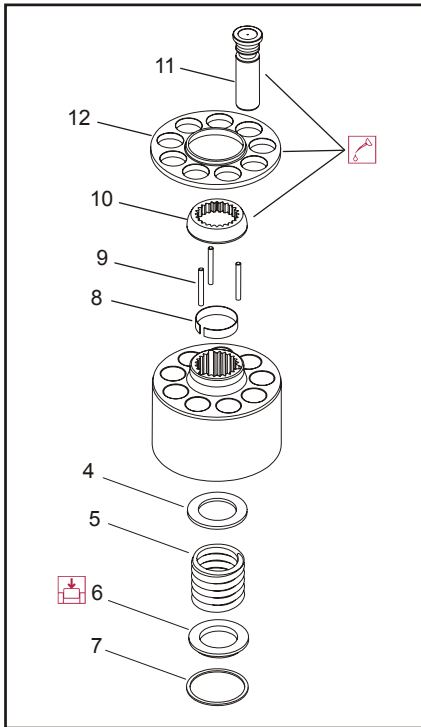
**Figure 3-19. Servo Piston**

2. After piston seal has relaxed, lubricate and install servo piston into the housing bore. Align the piston with the ball socket facing the inside of the housing.

**⚠ WARNING**

**RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 80 TO 90 LBF (350 TO 400 N) OF FORCE. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS INSTALLED.**

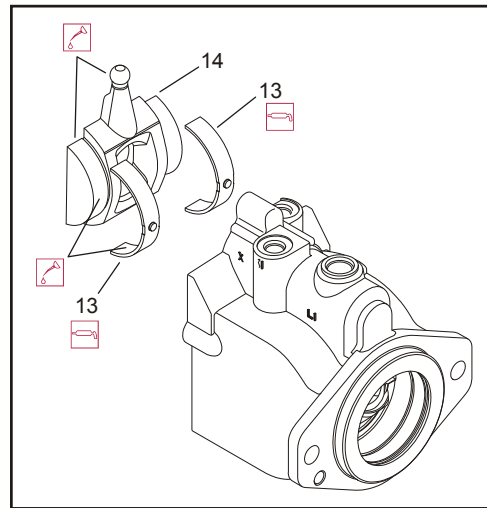
3. Install the inner block spring washer (4), block spring (5), and outer washer (6) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (7) into the groove in the cylinder block.



- |                          |                      |
|--------------------------|----------------------|
| 4. Block Spring Washer   | 9. Holddown Pins     |
| 5. Block Spring          | 10. Ball Guide       |
| 6. Outer Washer          | 11. Piston           |
| 7. Spiral Retaining Ring | 12. Slipper Retainer |
| 8. Retaining Ring        |                      |

**Figure 3-20. Cylinder Kit Assembly**

4. Turn the block over and install the retaining ring (8), hold-down pins (9), and ball guide (10) to the cylinder block.
5. Install the pistons (11) to the slipper retainer (12). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you're reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.
6. Install the journal bearings (13) into the housing seats. Use assembly grease to keep the bearings seated during assembly. Ensure the locating nubs drop into the cavities in the seats. If you're reusing the bearings, install them in the original location and orientation. Lubricate the journal bearings.

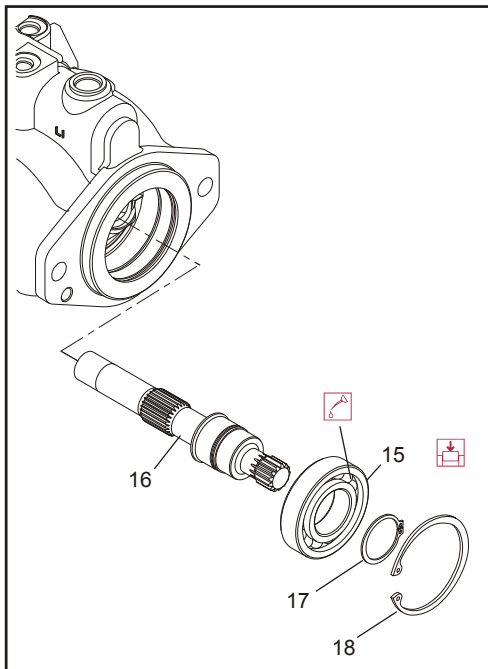


- 13. Journal Bearings
- 14. Swashplate

**Figure 3-21. Swashplate and Journal Bearing**

7. Install the swashplate (14) into the housing. Tilt the swashplate and guide the servo lever ball into its socket in the servo piston rod. Ensure the swashplate seats into the journal bearings and moves freely. Lubricate the running surface of the swashplate.

8. Press front shaft bearing (15) onto shaft (16). Press bearing onto shaft with lettering facing out. Lubricate bearing rollers. Install snap-ring (17) onto shaft.

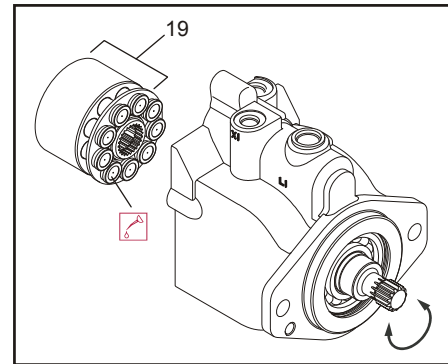


- 15. Front Shaft Bearing
- 16. Shaft
- 17. Snap Ring
- 18. Snap Ring

**Figure 3-22. Shaft and Front Bearing**

9. While holding the swashplate in place, turn the housing on its side. Install the install shaft/bearing assembly into housing from the flange end. Install the snap-ring (18).

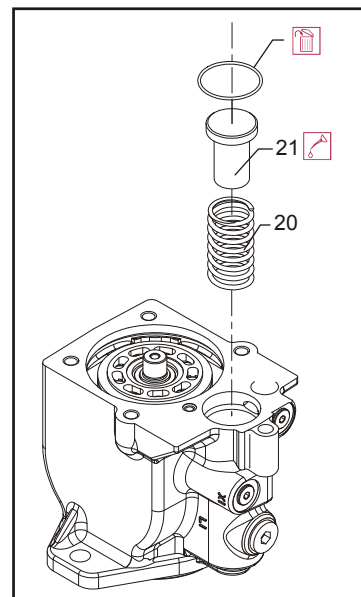
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder kit, swashplate, journal bearings, and servo piston are all secure and properly installed.



19. Cylinder Kit

**Figure 3-23. Cylinder Kit Installation**

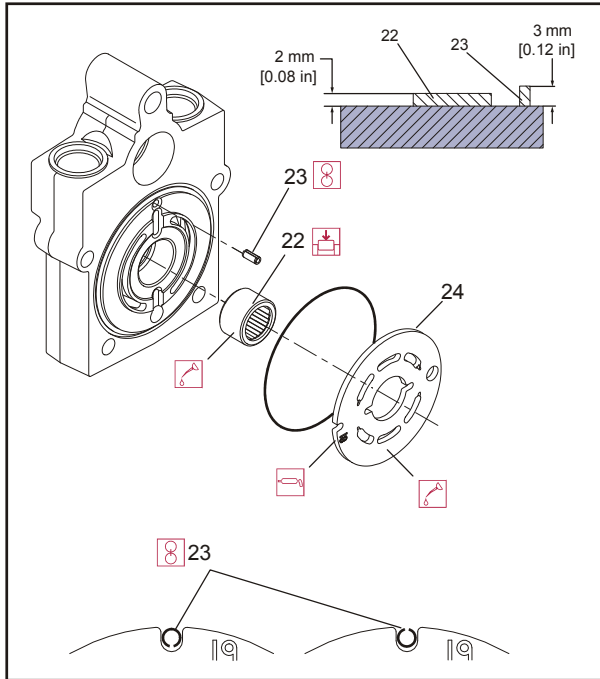
11. Lubricate and install the servo spring (20), and minimum angle stop (21) into the housing bore.



- 20. Servo Spring
- 21. Minimum Angle Stop

**Figure 3-24. Servo Spring and Minimum Angle Stop**

- 12.** Press the rear shaft bearing (22) into the endcap. Install the bearing with letters facing out. Press until bearing surface is  $0.08 \pm 0.01$  in ( $2 \pm 0.25$  mm) above endcap surface.

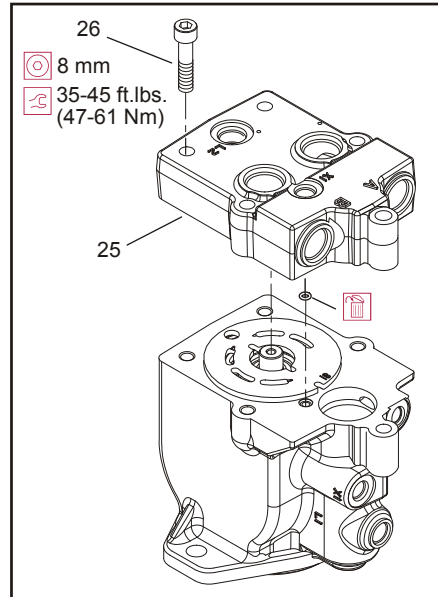


22. Rear Shaft Bearing  
23. Timing Pin  
24. Valve Plate

**Figure 3-25. Valve Plate and Rear Bearing**

- 13.** Install timing pin (23) into its bore in the endcap. Install the pin with its groove facing toward or away from the shaft. Press the pin until the end protrudes  $0.12 \pm 0.01$  in ( $3 \pm 0.25$  mm) above endcap surface.
- 14.** Install the valve plate (24) onto the endcap. Install the valve plate with the yellow surface toward the cylinder block. Align the slot in the valve plate with the timing pin. Apply a liberal coat of assembly grease to the endcap side of the valve plate to keep it in place during installation.

- 15.** Install the endcap (25) onto the housing with the endcap screws (26). Check to ensure the endcap will properly seat onto the housing without interference. Improper assembly of the internal components may prevent the endcap from seating properly. Ensure the O-rings seat properly when installing the endcap.

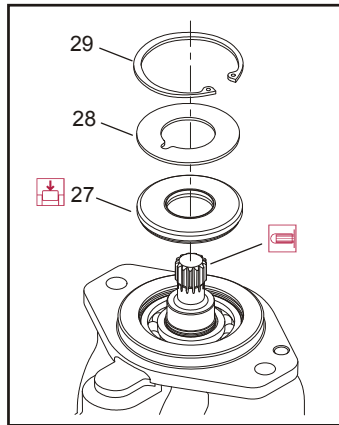


25. End Cap  
26. Screw

**Figure 3-26. End Cap**

- 16.** Using an 8 mm internal hex wrench, tighten the endcap screws. Tighten the screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque endcap screws 35-45 ft.lbs. (47-61 Nm).
- 17.** Before installing the shaft seal, ensure the shaft turns smoothly with less than 120 in.lbs. (13.5 Nm) of force. If the shaft does not turn smoothly within the specified maximum force, disassemble and check the unit.

18. Cover shaft splines with an installation sleeve. Install a new shaft seal (27) with the cup side facing the motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal. Install seal support washer (28) and snap ring (29).



- 27. Shaft Seal
- 28. Seal Support Washer
- 29. Snap Ring

Figure 3-27. Shaft Seal

19. Install remaining plugs and fittings to the housing. Refer to the drawing below for wrench sizes and installation torques.

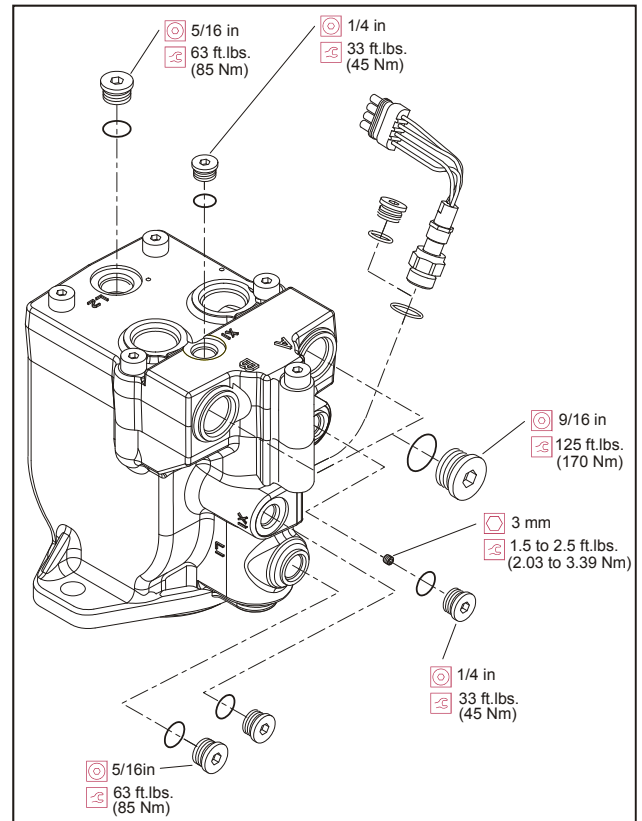
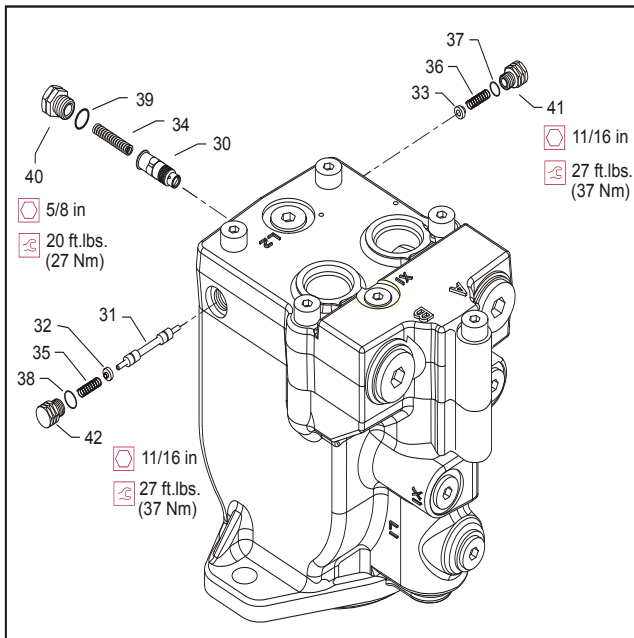


Figure 3-28. Plugs and Fittings Installation

**20.** Install orifice poppet (30).



- |                    |            |            |          |
|--------------------|------------|------------|----------|
| 30. Orifice Poppet | 34. Spring | 37. O-ring | 40. Plug |
| 31. Shift Spool    | 35. Spring | 38. O-ring | 41. Plug |
| 32. Spring         | 36. Spring | 39. O-ring | 42. Plug |
| 33. Spring         |            |            |          |

**Figure 3-29. Loop Flushing Spool**

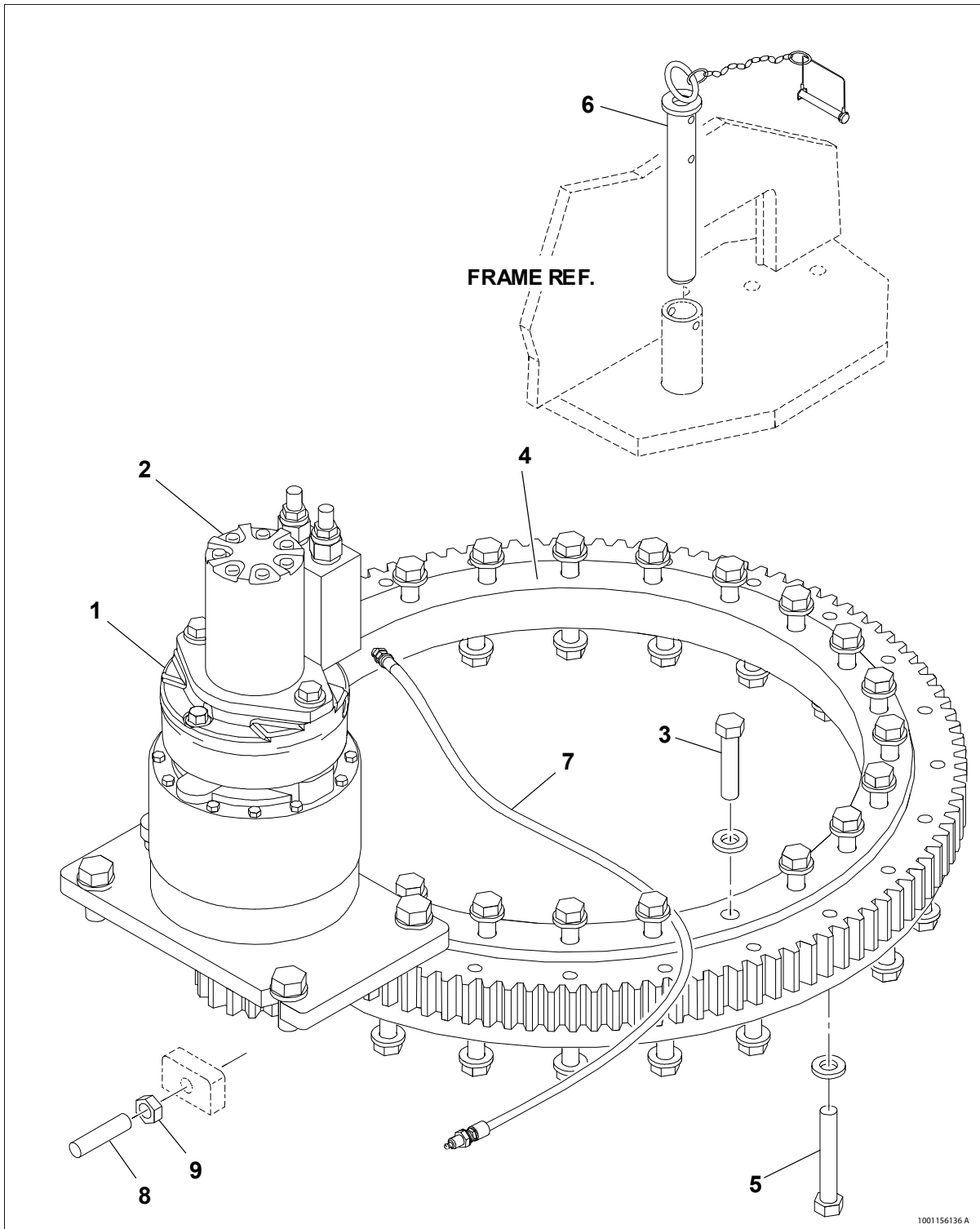
- 21.** Install shift spool (31).
- 22.** Install spring retaining washers onto springs (32 and 33).
- 23.** Carefully install centering springs (34, 35, and 36).
- 24.** Install new O-rings (37, 38, and 39).
- 25.** Using a 5/8 in wrench torque plug (40) to 20 ft.lbs. (27 Nm).
- 26.** Using a 11/16 in wrench, torque plugs (41 and 42) to 27 ft.lbs. (37 Nm).

## Initial Start-up Procedures

Follow this procedure when starting-up a new motor or when installing a motor that has been removed.

Prior to installing the motor, inspect for damage incurred during shipping. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

- 1.** Fill the reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.
- 2.** Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
- 3.** Fill the pump and motor housing with clean hydraulic fluid. Pour filtered oil directly into the upper most case drain port.
- 4.** To ensure the pump and motor stay filled with oil, install case drain lines into the upper most case drain ports.
- 5.** Install a 0 to 500 psi (0 to 35 bar) gauge in the charge pressure gauge port of the pump to monitor system pressure during start up.
- 6.** While watching the pressure gauge, run the engine at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down the prime mover, determine cause, and take corrective action.
- 7.** Operate the hydraulic system for at least fifteen minutes under light load conditions.
- 8.** Check and adjust control settings as necessary after installation.
- 9.** Shut down the prime mover and remove the pressure gauge. Replace plug at the charge pressure gauge port.
- 10.** Check the fluid level in the reservoir; add clean filtered fluid if necessary. The motor is now ready for operation.



- |                            |                            |                |
|----------------------------|----------------------------|----------------|
| 1. Swing Drive             | 4. Swing Bearing           | 7. Grease Line |
| 2. Swing Motor             | 5. Outer Race Bearing Bolt | 8. Bolt        |
| 3. Inner Race Bearing Bolt | 6. Turntable Lock Pin      | 9. Jam Nut     |

Figure 3-30. Swing System

### 3.7 SWING DRIVE

#### Roll, Leak And Brake Testing

Torque-Hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears, bearings and seals are working properly. The following information briefly outlines what to look for when performing these tests.

**NOTE:** *The brake must be released before performing the roll test. This can be accomplished by either pressure testing using the Brake Leak Test procedure below or by tightening the 12 bolts into the piston through the end plate (See Brake Disassembly Procedure).*

**NOTE:** *Bolts must be removed while performing brake release test.*

#### Roll Test

The purpose of the roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for improper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency. Release the pressure at the Brake Housing (6) and remove the test fixtures.

#### Leak Test (Main Unit)

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall after the unit has been pressurized and allowed to equalize. Leaks will most likely occur at the pipe plugs, the main seal or wherever o-rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where the o-rings or gaskets meet on the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring or gasket, the part must be replaced, and the unit rechecked. Leak test at 10 psi (0.7 bar) for 20 minutes.

#### Brake Test

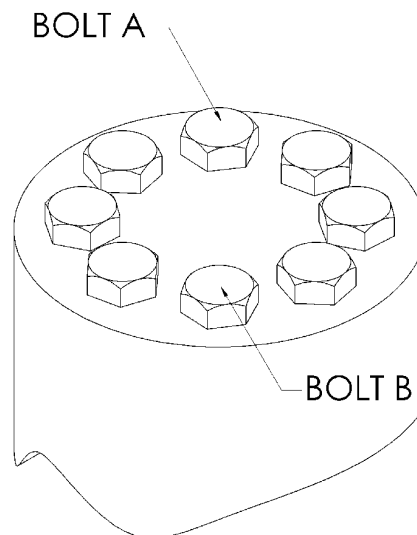
The brake test must be performed with the Motor removed and the Brake Test Plate (T-214404) installed. Install the Hex Bolts through Brake Test Plate and torque to 80 - 100 ft. lbs. (108-135 Nm). Install Roll Checking Tool (T-212731) and apply 210 psi (14 bar) to the o-ring port in the side of the Brake Housing. The roll checking fixture should roll freely. Increase the pressure to 3000 psi (207 bar) and perform the Roll Test.

**NOTE:** *Failure to perform this test may result in damaged or ineffective brake parts.*

#### Tightening and Torquing Bolts

If an air impact wrench is used to tighten bolts, extreme care should be taken to ensure that the bolts are not tightened beyond their specified torque.

The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.

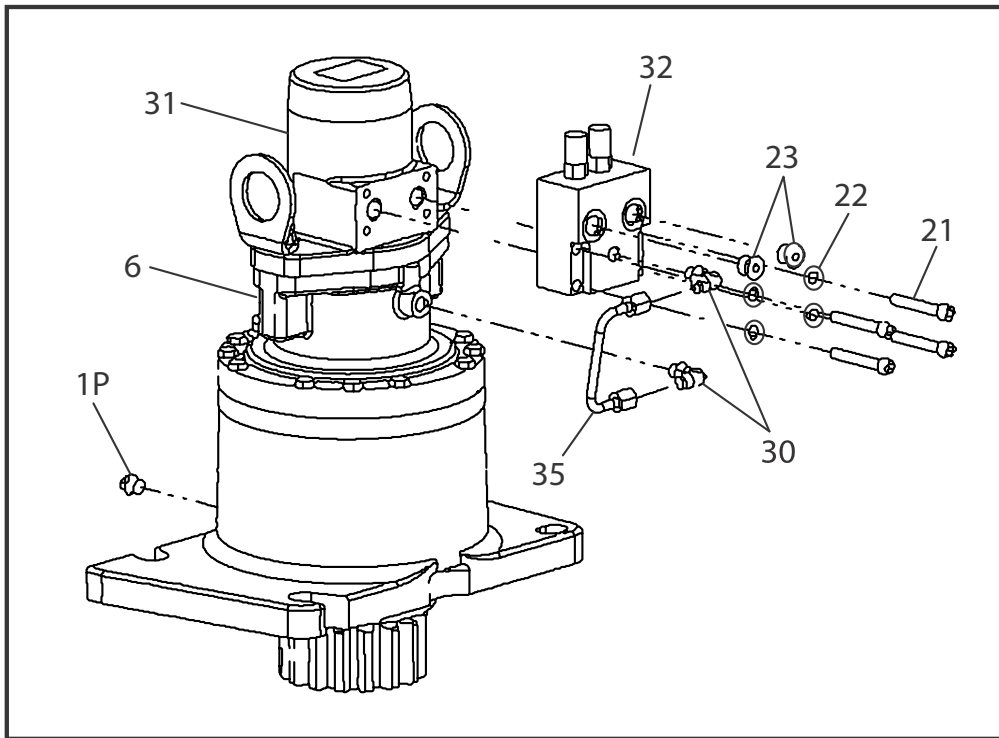


1. Tighten (but do not torque) bolt "A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Using the same sequence, crisscross around the bolt circle and apply an equal torque to the remaining bolts.

### **Motor Control Valve Disassembly**

**NOTE:** Refer to Figure 3-31.

1. Place unit on bench with the motor end up.
2. Remove O-ring Plug (1P) and drain the oil from the gear-box.
3. Remove Hydraulic Tubing Assembly (35) by loosening fittings on both ends of tube with a wrench.
4. Using a wrench, loosen jam nuts on Elbow Fittings (30) and remove fittings from Brake (6) and Motor Control Valve (32).
5. Remove O-ring Plugs (23) from Motor Control Valve (32).
6. Remove Motor Control Valve (32) from Motor (31) by removing the four Bolts (21) and washers (22).



- |                    |                         |
|--------------------|-------------------------|
| 1P. O-ring Plug    | 30. Elbow Fitting       |
| 6. Hydraulic Brake | 31. Hydraulic Motor     |
| 21. Hex Bolt       | 32. Motor Control Valve |
| 22. Lockwasher     | 35. Hydraulic Tubing    |
| 23. Plug           |                         |

**Figure 3-31. Motor Control Valve**

## Motor and Brake Disassembly

**NOTE:** Refer to Figure 3-32.

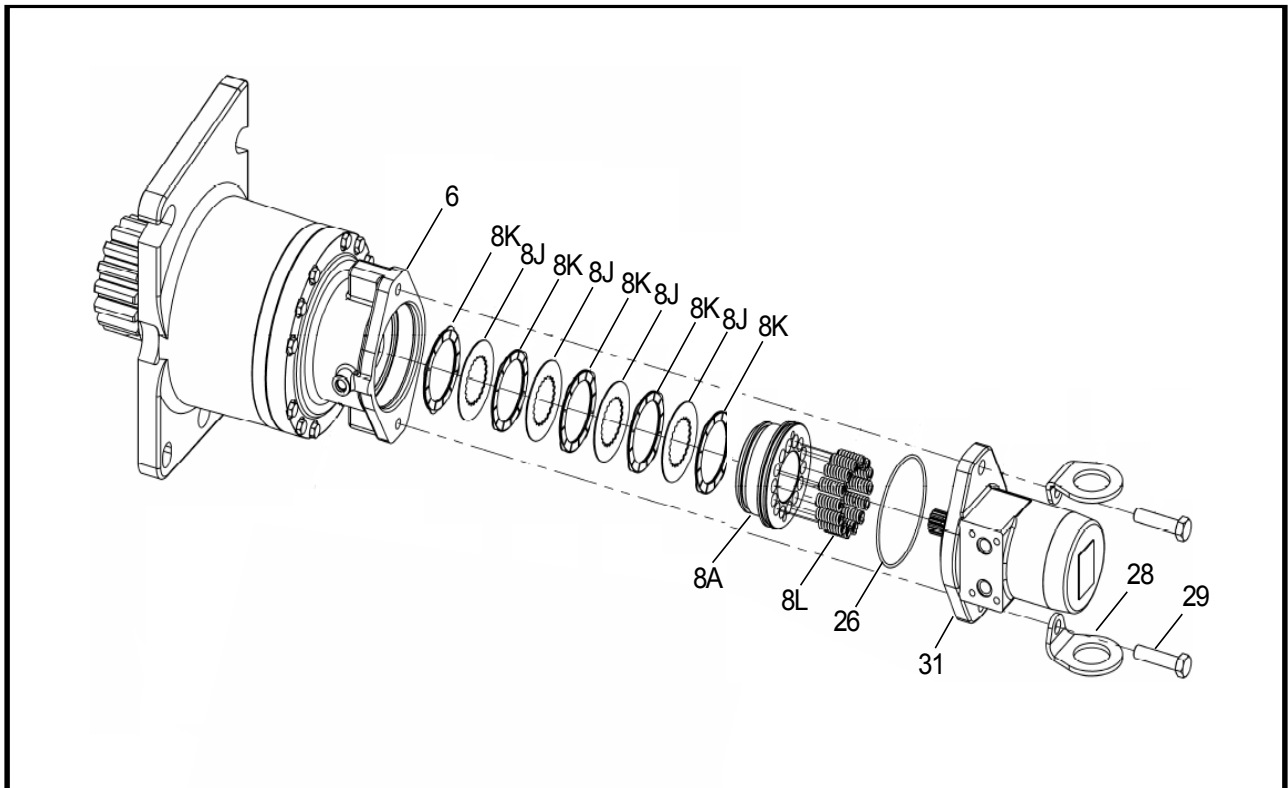
1. With unit resting on bench with Motor (31) end up, loosen Hex Bolts (29) and remove Lift Lugs (28) from the Motor (31).
2. Pull Motor (31) straight up and remove Motor (31) from Brake Housing (6).
3. Remove O-ring (26) from between Motor (31) and Brake Housing (6).

4. Remove the Springs (8L) from the piston.
5. Apply less than 50 psi (3.45 bar) air to the "brake port" to remove Brake Piston (8A).

### **CAUTION**

**THE PISTON MAY MOVE QUICKLY. EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

6. Remove Rotors (8J) and Stators (8K) from Brake Housing (6).



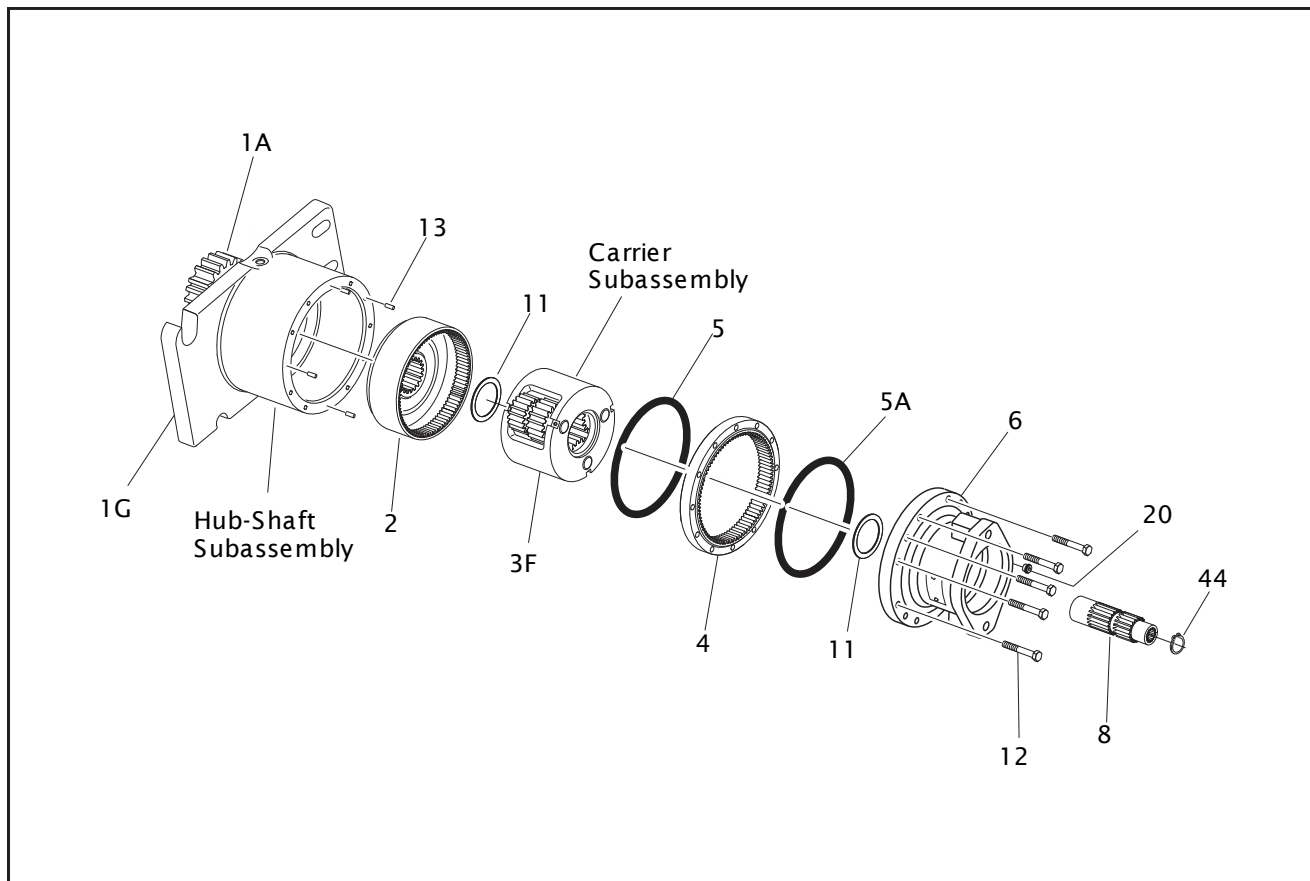
- |                  |              |
|------------------|--------------|
| 6. Brake Housing | 26. O-ring   |
| 8A. Brake Piston | 28. Lift Lug |
| 8L. Spring       | 29. Hex Bolt |
| 8J. Rotors       | 31. Motor    |
| 8K. Stator       |              |

**Figure 3-32. Motor and Brake**

**Main Drive Disassembly**

**NOTE:** Refer to Figure 3-33.

1. Remove Sun Gear (8) with Retaining Ring (44) inside.
2. With the unit resting on the Output Shaft (Pinion) (1A), remove the Bolts (12) from the Brake Housing (6).
3. Remove the Brake Housing (6) from the main assembly.
4. Remove O-ring (5A) from between Brake Housing (6) and Ring Gear (4).
5. Remove Thrust Washer (11) from between Brake Housing (6) and Carrier Subassembly.
6. Remove Ring Gear (4) from Housing (1G).
7. Remove O-ring (5) from between Ring Gear (4) and Housing (1G).
8. Remove Carrier Sub-Assembly.
9. Remove Thrust Washer (11) from between Carrier Sub-Assembly and Internal Gear (2).
10. Remove Internal Gear (2).



- |                           |                   |               |
|---------------------------|-------------------|---------------|
| 1A. Output Shaft (Pinion) | 5. O-ring         | 12. Bolt      |
| 1G. Housing               | 5A. O-ring        | 13. Dowel Pin |
| 2. Internal Gear          | 6. Brake Housing  | 20. Pipe Plug |
| 3F. Carrier subassembly   | 8. Sun Gear       | 44. Ring      |
| 4. Ring Gear              | 11. Thrust Washer |               |

**Figure 3-33. Main Drive Assembly**

## Hub-Shaft Disassembly

**NOTE:** Refer to Figure 3-34.

1. Using retaining ring pliers remove Retaining Ring (1I) from groove in Output Shaft (1A) and discard.

### **CAUTION**

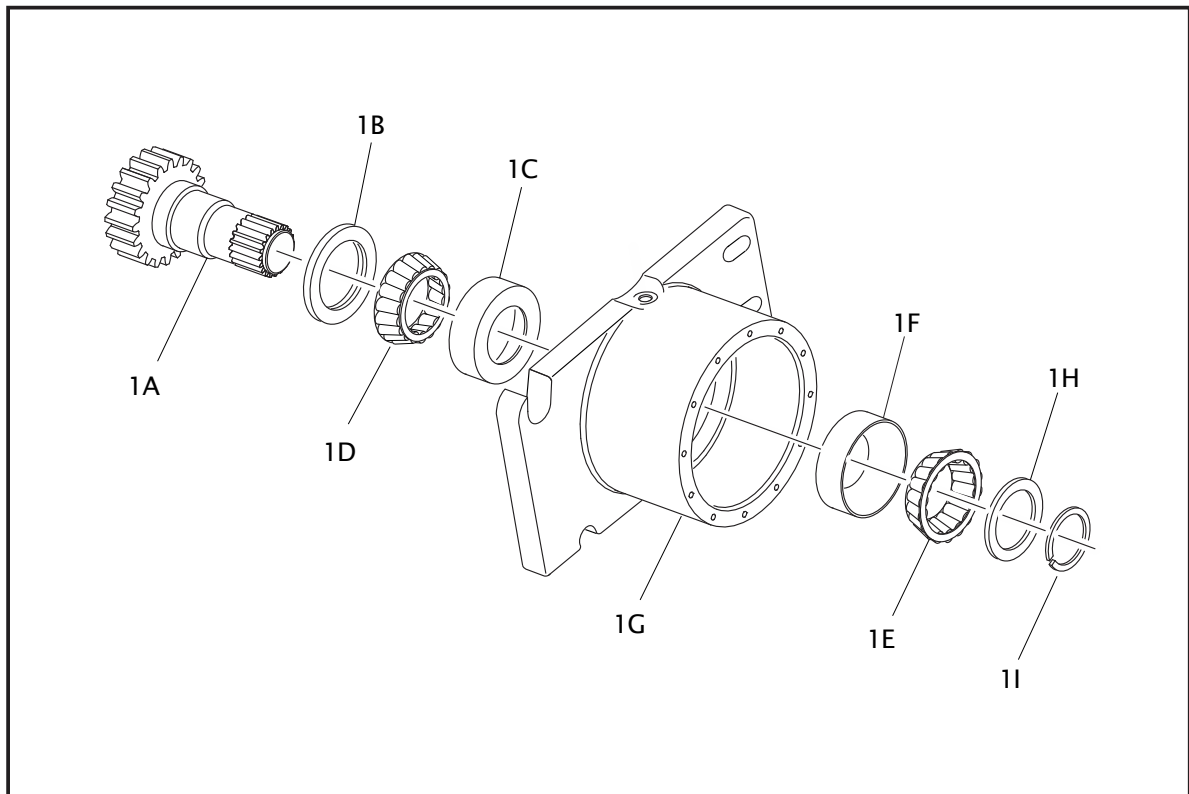
**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

2. Remove Thrust Washer (1H).

3. While supporting the Housing (1G) on the Output Shaft (1A) end, press the Output Shaft (1A) out of the Housing (1G).

**NOTE:** The Lip Seal (1B) will be pressed out of the Housing (1G) by the Bearing Cone (1D) during this step.

4. Remove the Bearing Cone (1E) from the Housing (1G).
5. Use a bearing puller to remove the Bearing Cone (1D) from the Shaft (1A).
6. Bearing Cups (1C & 1F) will remain in Housing (1G).



- |                  |                    |
|------------------|--------------------|
| 1A. Output Shaft | 1F. Bearing Cup    |
| 1B. Lip Seal     | 1G. Housing        |
| 1C. Bearing Cup  | 1H. Thrust Washer  |
| 1D. Bearing Cone | 1I. Retaining Ring |
| 1E. Bearing Cone |                    |

**Figure 3-34. Hub-Shaft**

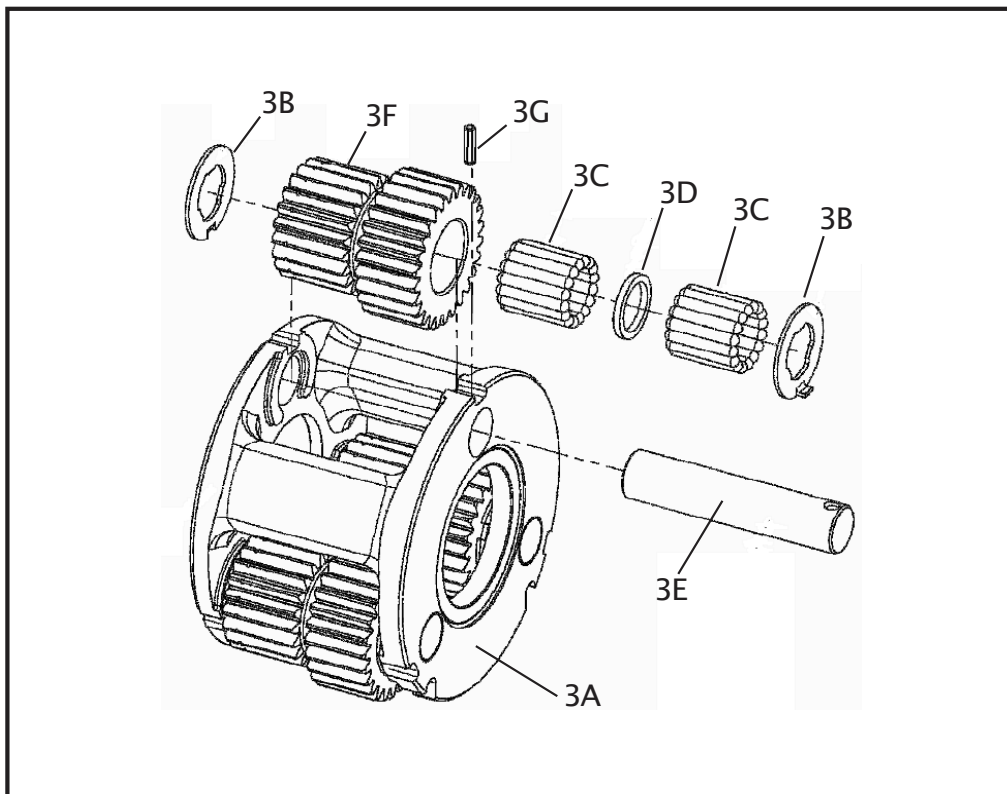
### Carrier Disassembly

**NOTE:** Refer to Figure 3-35.

1. Using a 3/16" punch drive the Roll Pin (3G) which holds the Planet Shaft (3E) in the Carrier (3A) down into the Planet Shaft (3E) until it bottoms.

**NOTE:** Make sure that the Roll Pin has bottomed. Otherwise, damage to the carrier could occur when the Planet Shaft is removed.

2. Remove the Planet Shaft (3E) from the Carrier (3A). Use a small punch to remove the Roll Pin (3D) from the Planet Shaft (3E).
3. Slide the Planet Gear (3F), the two Thrust Washers (3B) out of the Carrier (3A).
4. Remove both rows of Needle Bearings (3C) and the Spacer (3D) from the bore of the Planet Gear (3F).
5. Repeat Steps 1 thru 4 for the remaining two Cluster Gears (3F).



- |                    |                  |
|--------------------|------------------|
| 3A. Carrier        | 3E. Planet Shaft |
| 3B. Thrust Washers | 3F. Cluster Gear |
| 3C. Needle Bearing | 3G. Roll Pin     |
| 3D. Spacer         |                  |

**Figure 3-35. Carrier**

## Hub-Shaft Assembly

**NOTE:** Refer to Figure 3-34.

1. Press Bearing Cup (1C) into Housing (1G) taking care to insure cup starts square with the bore of Hub (1G).
2. Place Bearing Cone (1D) in Bearing Cup (1C) in Housing (1G).
3. Press or tap Seal (1B) Into the counterbore of Housing (1G) to the point where it becomes flush with the Housing (1G) face. Care should be taken to insure Seal (1B) is being correctly installed (smooth face up). Apply grease to the rubber portion of the seal bore.
4. Invert Hub (1G) and press Bearing Cup (1E) into counterbore of Housing (1G).
5. Carefully lower Housing (1G) onto the Output Shaft (1A) until Bearing Cone (1D) contacts the Output Shaft (1A).
6. Press on the small end of the Bearing Cone (1D), being careful not to contact the bearing cage, until the Bearing Cone (1D) seats on the shoulder of the Output Shaft (1A).
7. Start the Bearing Cone (1F) onto the Output Shaft (1A).
8. Press or tap the Bearing Cone (1F) onto the Output Shaft (1A) until it is just seated in the Bearing Cup (1E). while rotating the Housing (G).
9. Install Bearing Spacer (1H) onto Output Shaft (1A) and against Bearing Cone (1F).
10. Install Retaining Ring (1I) into the groove in the Output Shaft (1A). This Retaining Ring (1I) should never be reused in a repair or rebuild.

### **WARNING**

**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

11. Tap the Retaining Ring (1I) with a soft metal punch to ensure that the Retaining Ring (1I) is completely seated in the groove of the Output Shaft (1A).

### **WARNING**

**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

12. Install O-ring Plug (1P) and torque to 23 to 24 ft.lbs. (31 to 32 Nm).

## Carrier Assembly

**NOTE:** Refer to Figure 3-35.

1. Apply a liberal Coat of grease to the bore of Cluster Gear (3F). This will enable the Needle Rollers (3C) to be held in place during assembly.
2. Install the first row of Needle Rollers (3C) into the bore of Cluster Gear (3F).
3. Insert Spacer (3D) into bore of Cluster Gear (3F) on top of the Needle Rollers (3C).
4. Place second row of Needle Rollers (3C) into bore of Cluster Gear (3F) against Spacer (3D).
5. Place Carrier (3A) so that one of the roll pin holes is straight up.
6. Start Planet Shaft (3E) through the hole in Carrier (3A). Using ample grease to hold it in position, slide one Thrust Washer (3B) over the Planet Shaft (3E) with the tang resting in the cast slot of the Carrier (3A).
7. With large end of Cluster Gear (3F) facing the roll pin hole in the Carrier, place the Cluster Gear into position in carrier (3A) and push Planet Shaft (3E) through the Cluster Gear (3F) without going all the way through.
8. Slide the second Thrust Washer (3B) between the Cluster Gear (3F) and the Carrier (3A) with the tang of the washer located in the cast slot of the Carrier (3A). Finish sliding the Planet Shaft (3E) through the Thrust Washer (3B) and into the Carrier (3A).
9. Position the non-chamfered side on the Planet Shaft (3E) roll pin hole so that it is in line with the hole in the Carrier (3A) using a 1/8" (3 mm) diameter punch.
10. After using a 3/16" (5 mm) punch to align the two roll pin holes. Drive the Roll Pin (3G) through Carrier (3A) and into the Planet Shaft (3E) until the Roll Pin (3G) is flush with the bottom of the cast slot in the Carrier (3A) outside diameter at the thrust washer (3B) tang. Use a 1/4" (6 mm) pin punch to make sure the Roll Pin (3G) is flush in the slot.
11. Repeat Steps 1 thru 10 for the remaining two Cluster Gears(3F).

### Main Drive Assembly

**NOTE:** Refer to Figure 3-33.

1. With the Hub Shaft Sub-Assembly resting on the Shaft (1A) install Internal Gear (2). The spline of the Internal Gear (2) bore will mesh with the spline of the Output Shaft (1A). This will be a tight fit.
2. Inspect the location of the Internal Gear (2) on the Output Shaft (1A). The portion of the Output Shaft (1A) should protrude through the Internal Gear (2) bore.
3. Install 4 Dowel Pins (13) into counter bore holes in Hub (1G).
4. Install Thrust Washer (11) in counter bore of Carrier Sub-Assembly (Small Cluster-Gear end) Use grease to hold in place.
5. Place O-ring (5) into Hub counter-bore. Use grease to hold O-ring in place.

#### **⚠ WARNING**

**BEWARE OF SHARP EDGES OF THE COUNTER BORE WHILE SEATING THIS O-RING.**

6. Place Carrier Sub-Assembly on bench with the large end of Cluster Gears (3F) facing up with one at the 12 o'clock position. Find the punch marked tooth on each gear at the large end and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears. Check the timing through the slots in the carrier (See Carrier Sub-Assembly).
7. With large shoulder side of Ring Gear (4) facing down, place Ring Gear (4) over (into mesh with) cluster gears (3F). Be sure that cluster gear timing marks (punch marks) remain in correct location during Ring Gear (4) installation. The side of the Ring Gear (4) with an "X" or punch mark stamped on it should be up.
8. While holding Ring Gear (4) and Cluster Gears (3F) in mesh, place small end of Cluster Gears (3F) into mesh with the Internal Gear (2). On the Ring Gear (4) locate the hole marked "X", or punch marked, over one of the marked counter-bored holes (Step 5) in Hub (1G). Check timing through the slots in the carrier. Rotate carrier in assembly to check for freedom of rotation.

**NOTE:** If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.

9. Install Thrust Washer (11) into the counter-bore on the face of the carrier. Use grease to hold in place.
10. Place O-ring (5A) into counter-bore or Brake Housing (6). Use grease to hold O-Ring in place.

#### **⚠ CAUTION**

**BEWARE OF SHARP EDGES OF THE COUNTER-BORE WHILE SEATING THIS O-RING.**

11. Install the Brake Housing (6), taking care to correctly align Pipe Plug (20) with those in the Hub (1G).
12. Install Bolts (12) through the Brake Housing (6) into the Hub (1G) and torque to 23-27 ft.lbs. (31-37 Nm).
13. With gearbox standing on the pinion end fill gearbox with 43 oz. of ISO VG150/VG220 gear Oil.
14. Install Retaining Ring (44) into the groove in the Sun Gear (8).
15. Install the Sun Gear (8) into mesh with the Planet Gears (3F).
16. Install Pipe Plug (20) into Cover (6) torque to 23 to 24 ft.lbs. (31-32 Nm).

## Motor and Brake Assembly

**NOTE:** Refer to Figure 3-32.

1. Alternate Stators (8K) (O.D. lobes) with Rotors (8J) (I.D. splines) into bore of Brake Housing (6). starting with a Stator (8K) and ending with a Stator (8K).
2. Grease the O-rings (8F) & (8D) and Back-up rings (8H) & (8E). and place them in their respective grooves in the Brake Housing (6) and Piston (8A). Make sure the Back-up rings are correctly positioned.
3. Apply grease sparingly to the Piston O.D. (8A) and the bore of the Brake Housing (6). Insert Piston (8A) into Brake Housing (6) be sure not to damage the O-rings.
4. Install Springs (8L) into the spring pockets of the Piston (8A).
5. Test the brake and perform the roll test. Remove the Brake Test Plate.
6. Install the O-ring (26) onto the pilot of the Motor (31), use grease to keep the O-ring in place.
7. Place Motor (31) into Brake pilot, and line up holes.
8. Assemble Lift Lugs (28) onto Hex Bolts (29). Assemble Hex Bolts (29) with Lift Lugs (28) through the Motor (31) and Brake (6) against Motor flange. Torque to 80-100 ft.lbs. (108-136 Nm).

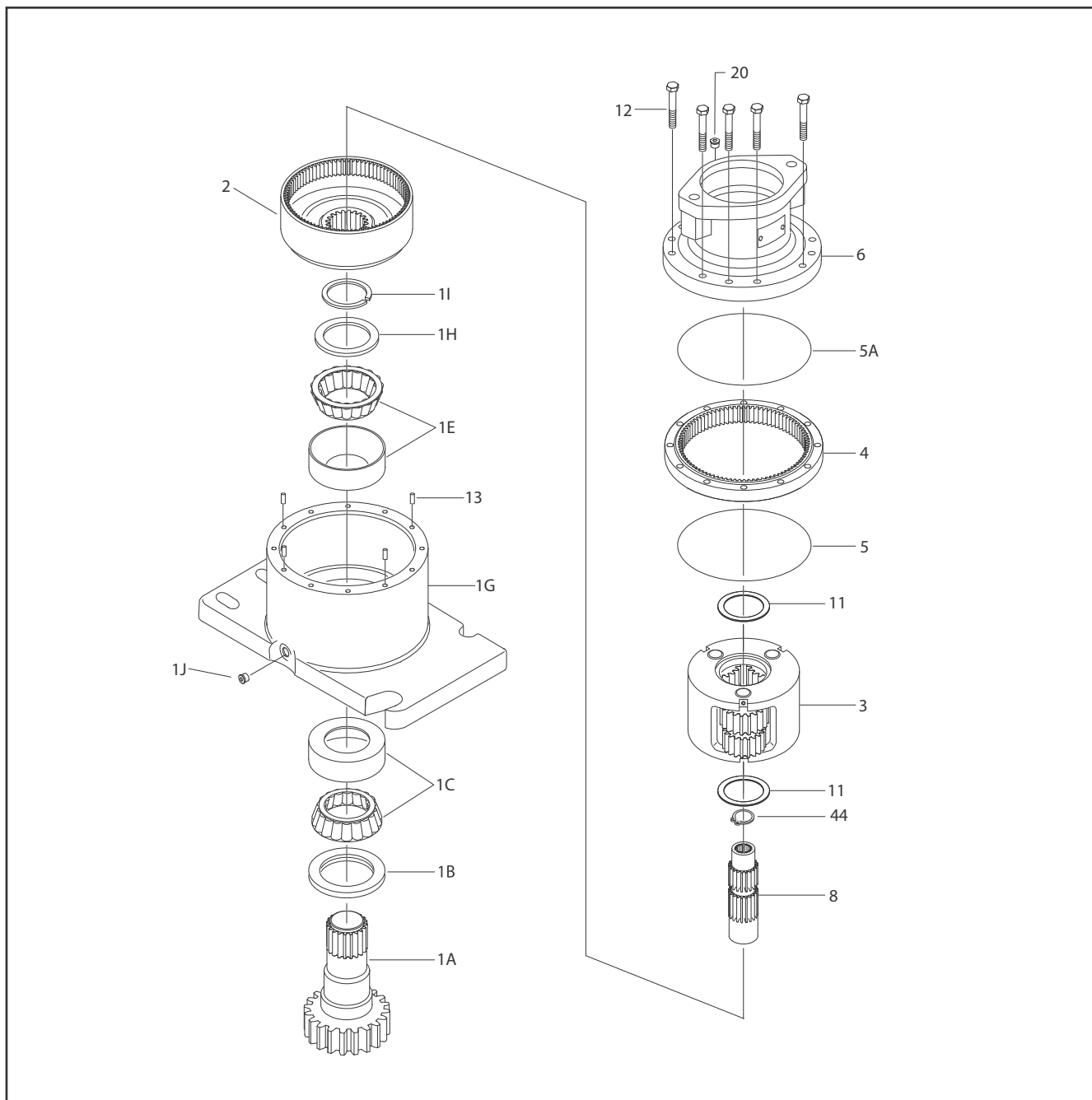
## Motor Control Valve Assembly

**NOTE:** Refer to Figure 3-31.

1. Lay assembly down with motor ports facing up. Remove the two plastic plugs in the motor ports, being careful not to lose the O-ring in each port. Assemble the Motor control Valve (32) onto the Motor (31) with Bolt (21) and Lock Washers (22). Torque Bolts (21) to 23-27 ft.lbs. (31-37 Nm).

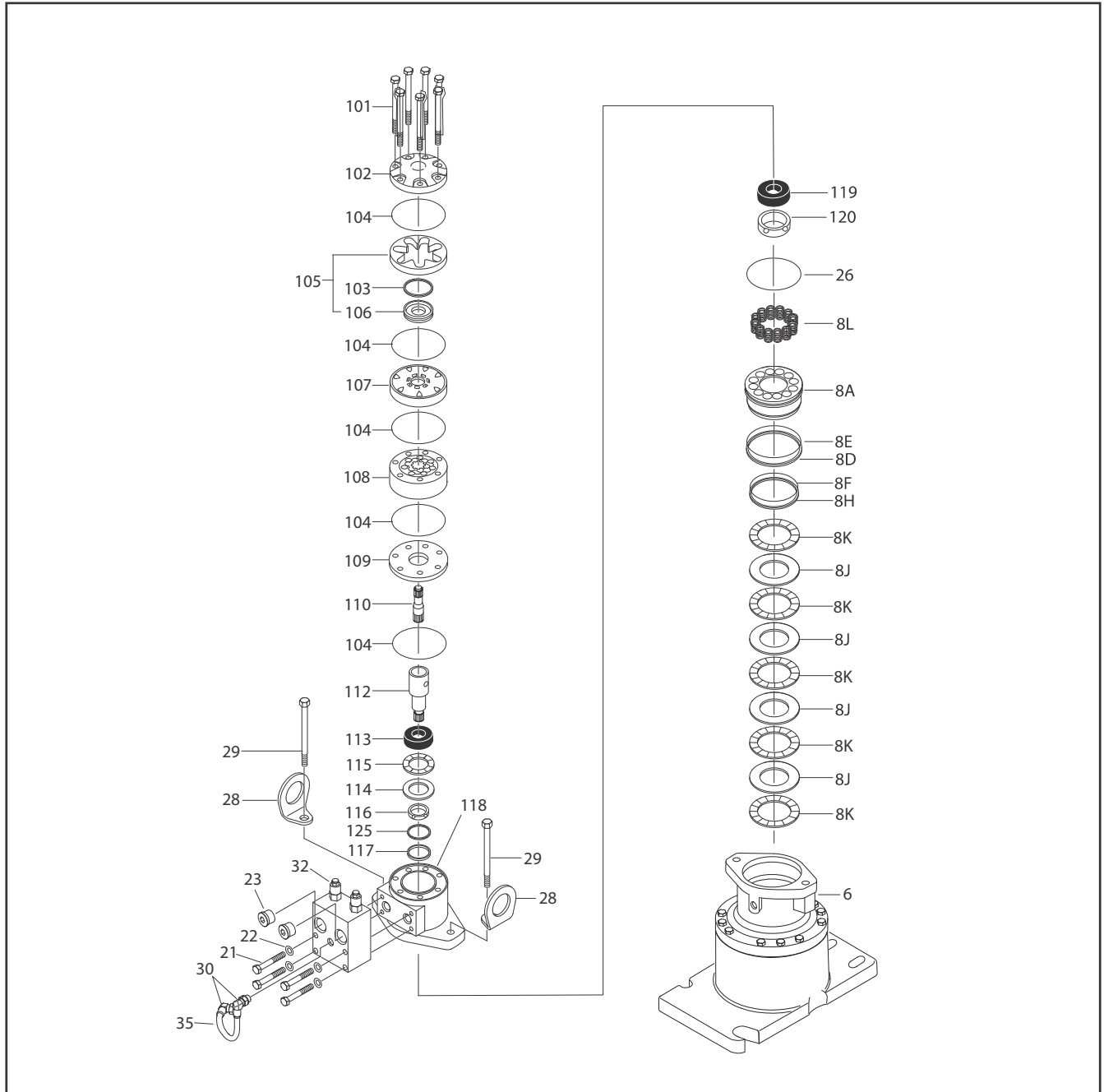
**NOTE:** Be sure to align the holes in the control valve with the motor ports.

2. Install Elbow Fittings (30) into Brake (6). Do not tighten jam nuts.
3. Install Elbow Fittings (30) into Motor Control Valve (32). Do not tighten jam nuts.
4. Assemble Tube (35) into Elbow Fittings (30) and torque to 13-15 ft.lbs (18-20 Nm). Tighten the jam nuts on the Elbow Fittings (30) and torque to 13-15 ft.lbs. (18-20 Nm).
5. Install one O-ring Plug (23) into Motor Control Valve (32) and torque to 30-31 ft.lbs. (41-42 Nm).
6. Pressure test brake, tube and control valve connections by applying 3000 psi (207 bar) pressure to the open port in the Motor Control Valve (32) and holding for 1 minute. Check for leaks at the control-valve-motor interface and the tube connections. Release pressure and install the remaining O-ring Plug (23) into Motor Control Valve (32) and torque to 30-31 ft.lbs. (41-42 Nm).



- |                  |                    |                     |                   |                             |
|------------------|--------------------|---------------------|-------------------|-----------------------------|
| 1A. Output Shaft | 1G. Housing        | 2. Internal Gear    | 5A. O-Ring        | 12. Bolt                    |
| 1B. Lip Seal     | 1H. Thrust Washer  | 3. Carrier Assembly | 6. Brake Housing  | 13. Dowel Pin               |
| 1C. Bearing      | 1I. Retaining Ring | 4. Ring Gear        | 8. Sun Gear       | 20. Pipe Plug               |
| 1D. Bearing      | 1J. Pipe Plug      | 5. O-Ring           | 11. Thrust washer | 44. Internal Retaining Ring |

Figure 3-36. Swing Drive Assembly



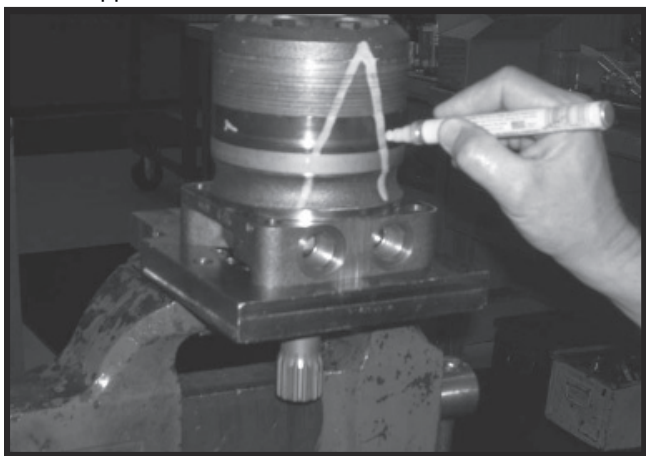
- |                  |                   |                               |                     |                     |
|------------------|-------------------|-------------------------------|---------------------|---------------------|
| 6. Brake Housing | 8L. Spring        | 35. Tube                      | 108. Rotor Set      | 117. Back-up Washer |
| 8A. Piston       | 21. Thrust Washer | 101. Bolt                     | 109. Wear Plate     | 118. Housing        |
| 8D. O-Ring       | 22. Lock washer   | 102. End Cover                | 110. Drive Link     | 119. Outer Bearing  |
| 8E. Back-Up Ring | 23. Pipe Plug     | 103. Commutator Seal          | 112. Coupling Shaft | 120. Seal           |
| 8F. O-Ring       | 26. O-Ring        | 104. Ring Seal                | 113. Inner Bearing  | 125. Back-up Washer |
| 8H. Back-up Ring | 28. Lifting lug   | 105. Commutator and Ring Assy | 114. Thrust Washer  |                     |
| 8J. Rotor Disc   | 29. Bolt          | 106. Ring                     | 115. Thrust Bearing |                     |
| 8K. Stator Disc  | 30. Elbow         | 107. Manifold                 | 116. Inner Seal     |                     |

Figure 3-37. Swing Motor and Brake Assembly

### 3.8 SWING MOTOR

#### Disassembly and inspection

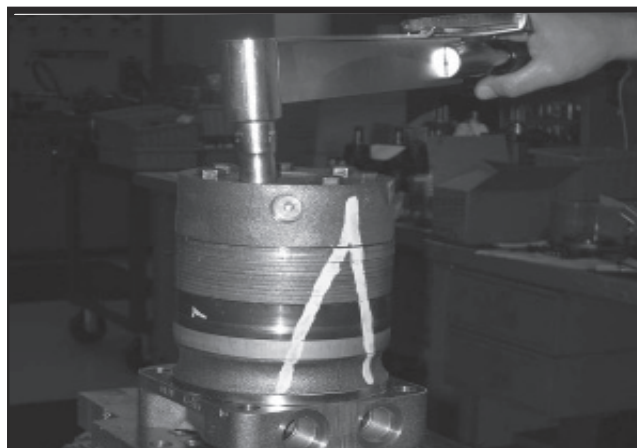
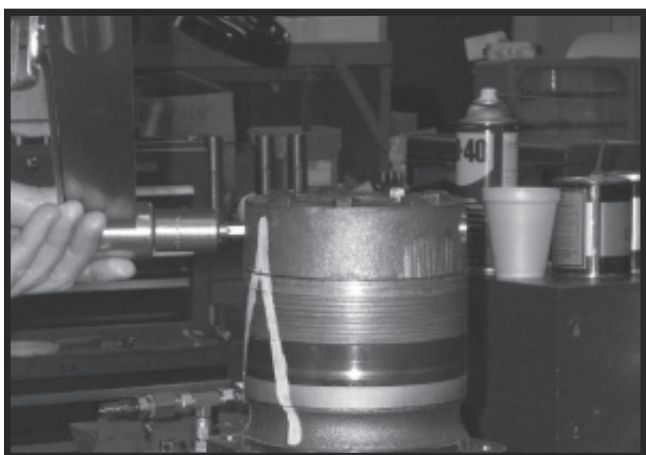
1. Place the Torqmotor™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.



**⚠ WARNING**

IF THE TORQMOTOR™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURING THE SERVICE PROCEDURES, CAUSING INJURY.

2. Scribe an alignment mark down and across the Torqmotor™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch Allen wrench or 1 inch hex socket required.



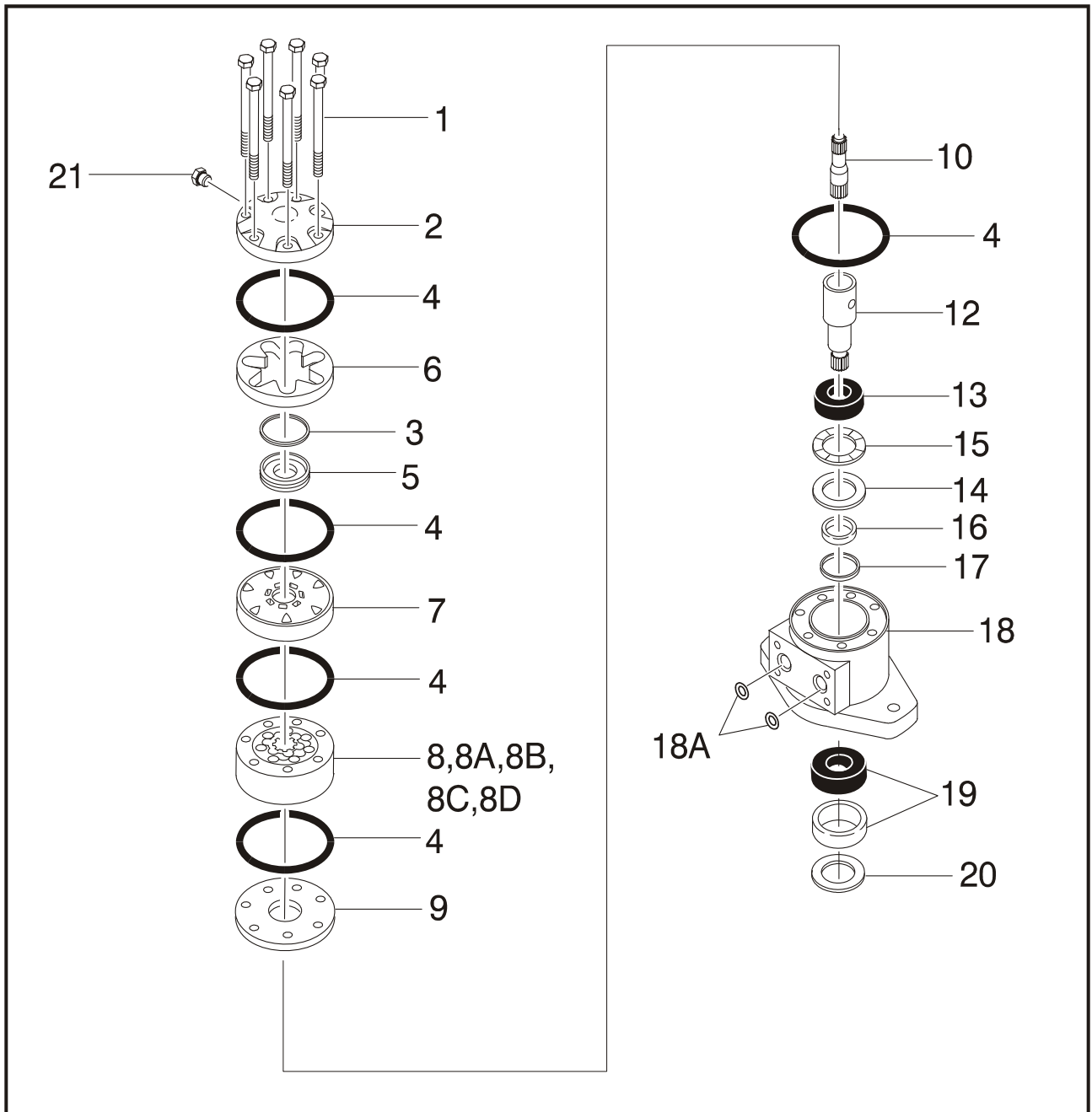
3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 inch size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.



4. Remove end cover assembly (2) and seal ring (4). Discard seal ring.



**NOTE:** Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.

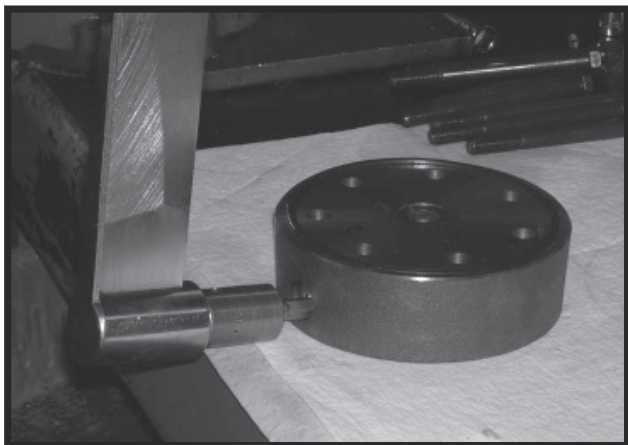


- |                         |                           |                            |                            |
|-------------------------|---------------------------|----------------------------|----------------------------|
| 1. Special Bolts        | 8. Rotor Set              | 12. Coupling Shaft         | 18A. O-Ring                |
| 2. End Cover            | 8A. Rotor                 | 13. Bearing/Bushing, Inner | 19. Bearing/Bushing, Outer |
| 3. Seal Ring-Commutator | 8B. Stator or Stator Vane | 14. Thrust Washer          | 20. Dirt & Water Seal      |
| 4. Seal Ring            | 8D. Stator Half           | 15. Thrust Bearing         | 21. Plug                   |
| 5. Commutator Ring      | 9. Wear Plate             | 16. Seal                   |                            |
| 6. Commutator Ring      | 10. Drive Link            | 17. Back-up Washer         |                            |
| 7. Manifold             | 11. Not Used              | 18. Housing                |                            |

Figure 3-38. Swing Drive Motor

## SECTION 3 - CHASSIS & TURNTABLE

5. If the end cover (2) is equipped with shuttle valve components, remove the two previously loosened plugs (21).



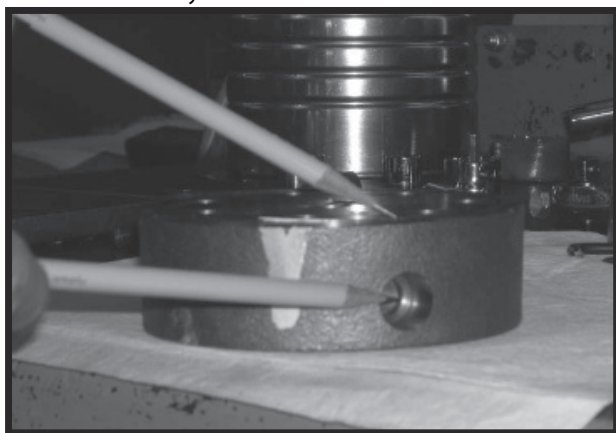
### NOTICE

**BE READY TO CATCH THE SHUTTLE VALVE OR RELIEF VALVE COMPONENTS THAT WILL FALL OUT OF THE END COVER VALVE CAVITY WHEN THE PLUGS ARE REMOVED.**

**NOTE:** O- ring is not included in seal kit but serviced separately, if required.

**NOTE:** The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.

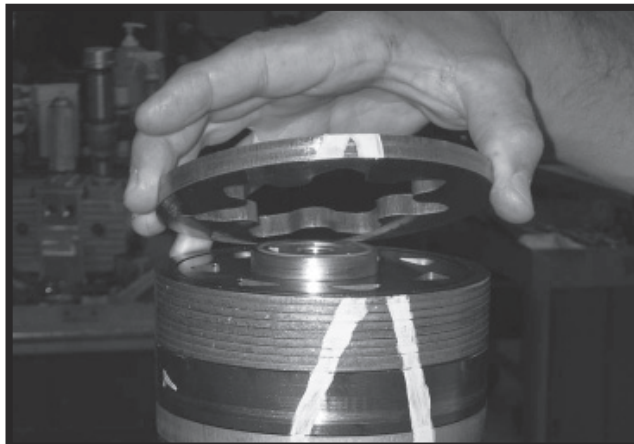
6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary.



**NOTE:** A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close

*inspection of end cover, commutator, manifold, and rotor set.*

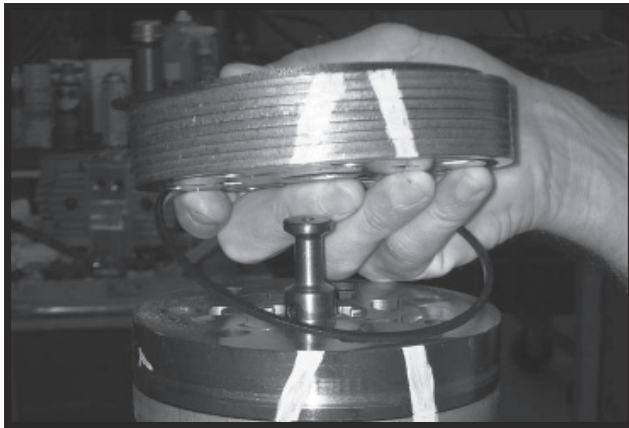
7. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.



8. Remove commutator (5) and seal ring (3) Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator and commutator ring as a matched set.



9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.



**NOTE:** The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of them as if old to ensure that same surface is reassembled against the rotor set.

10. Remove rotor set (8) and warplane (9), together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wear plate. You may have to shift the rotor set on the warplane to work the drive link out of the rotor (8A) and warplane. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the warplane for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wear plate.



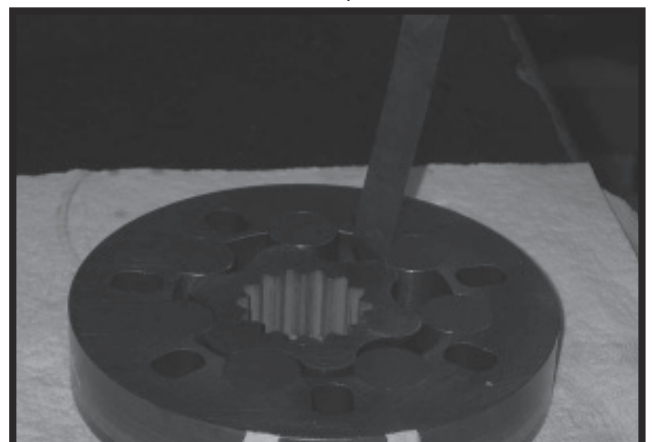
**NOTE:** The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set into Torqmotor™. Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and Torqmotor™.



**NOTE:** Series TG and TH may have a rotor set with two stator halves (8B & 8D) with a seal ring (4) between them and two sets of seven vanes (8C & 8E). Discard seal ring only if stator halves become disassembled during the service procedures.

**NOTE:** A polished pattern on the wear plate from rotor rotation is normal.

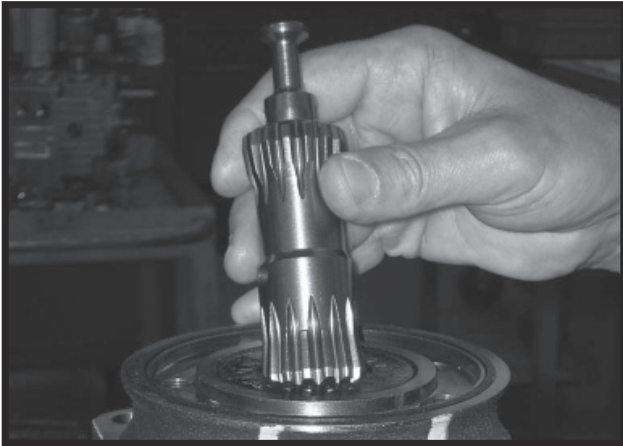
11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than 0.005 inches (0.13 mm) of clearance, replace rotor set.



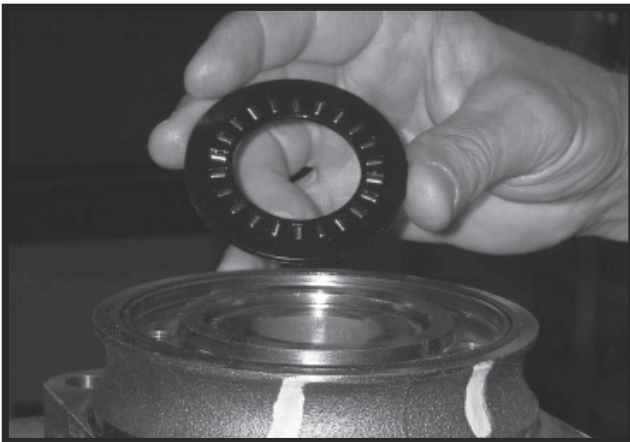
## SECTION 3 - CHASSIS & TURNTABLE

**NOTE:** If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.

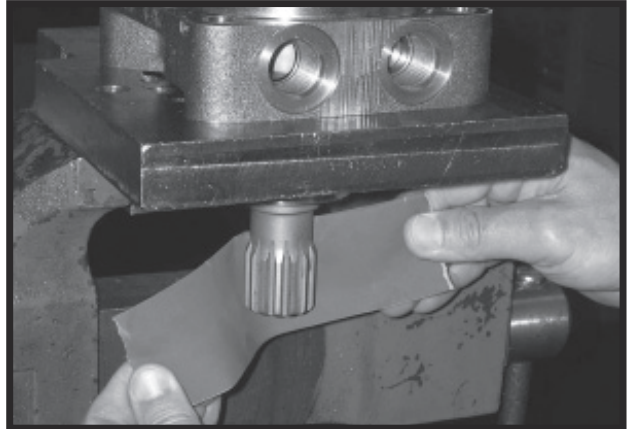
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



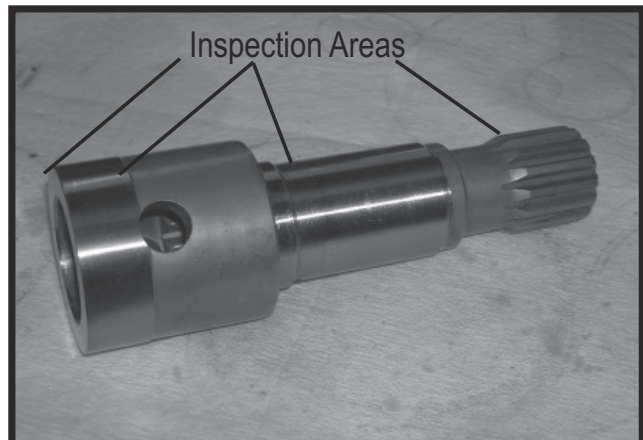
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used. Remove any key (12A), nut (12B), washer (12C), bolt (12D), lock washer (12E), or retaining ring (12F).



15. Remove coupling shaft (12), by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Replace coupling shaft if any of these conditions exist.



**NOTE:** Minor shaft wear in seal area is permissible. If wear exceeds 0.020 inches (0.51 mm) diametrically, replace coupling shaft.

**NOTE:** A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.

- 16. Remove and discard seal ring (4) from housing (18).
- 17. Remove thrust bearing (15) and thrust washer (14) Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



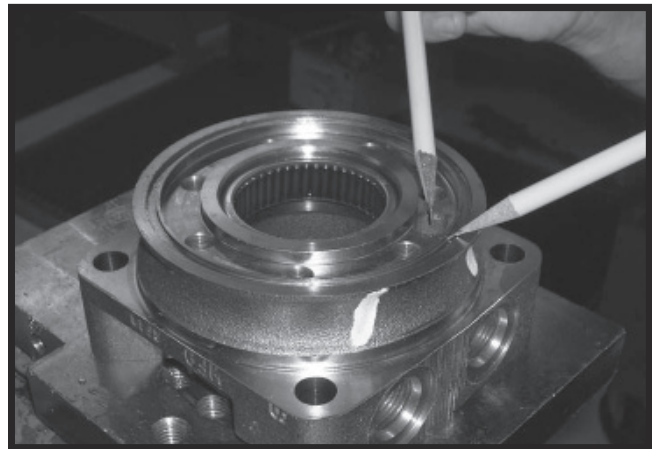
- 18. Remove seal (16) and back up washer (17) from Small Frame, housing (18). Discard both.



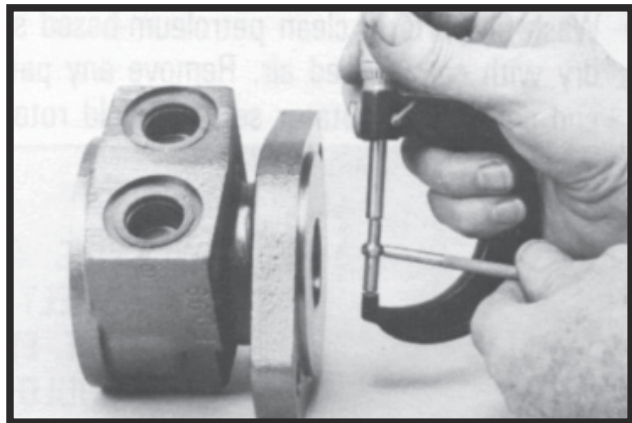
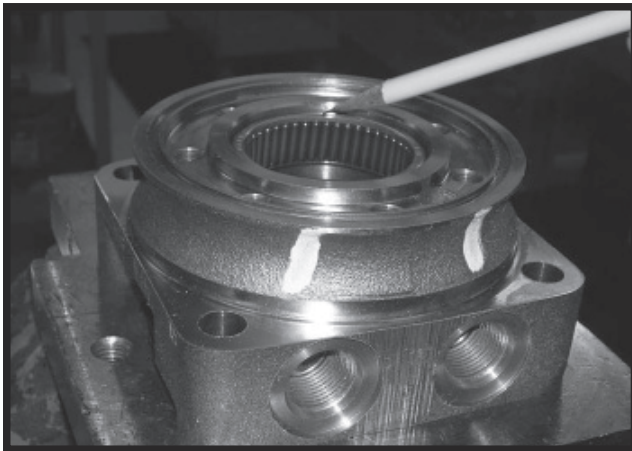
- 19. Remove housing (18) from vise, invert it and remove and discard seal
- 20. A blind hole bearing or seal puller is required.



- 21. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.



22. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. The bushing (19) or (13) to coupling shaft diameter clearance must not exceed 0.010 inch (0.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced. If the housing has passed this inspection the disassembly of the Torqmotor™ is completed.



**NOTE:** The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/ bushings. This will facilitate the correct reassembly of new bearings/bushings.



23. If the bearings, bushing or thrust washers must be replaced use a suitable size bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13).



## Assembly

Replace all seals and seal rings with new ones each time you reassemble the Torqmotor™ unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.

**NOTE:** Individual seals and seal rings as well as a complete seal kit are available. The parts should be available through most OEM parts distributors or Parker approved Torqmotor™ distributors. (Contact your local dealer for availability).

**NOTE:** Unless otherwise indicated, do not oil or grease parts before assembly.

Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing areas.

### **⚠ DANGER**

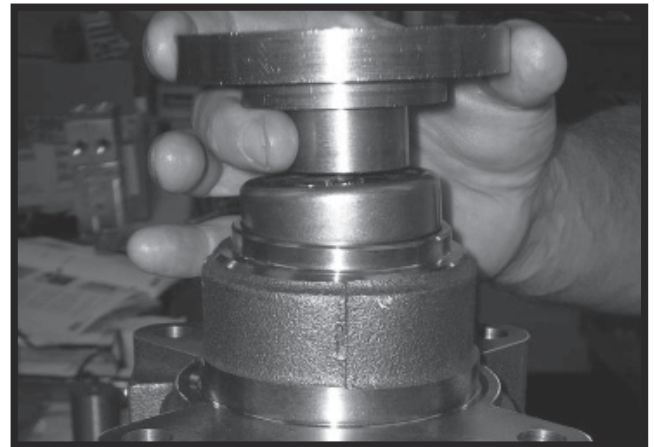
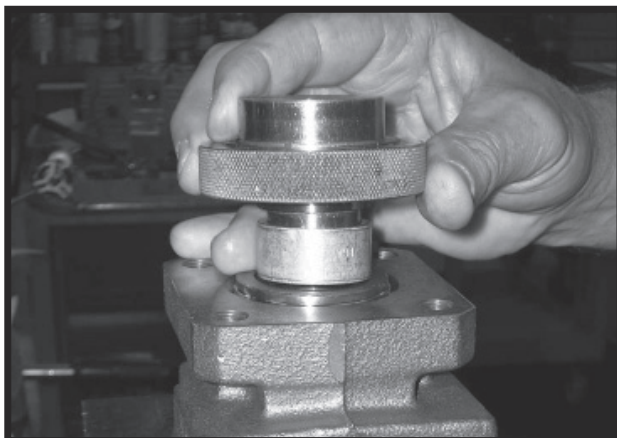
SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

### **⚠ WARNING**

WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a new outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel, which will control the bearing/ bushing depth.

Torqmotor™ housings require the use of bearing mandrel to press bearing/ bushing (19) into the housing to a required depth of 0.151/0.161 inches (3.84/4.09 mm) from the end of the bearing counterbore.



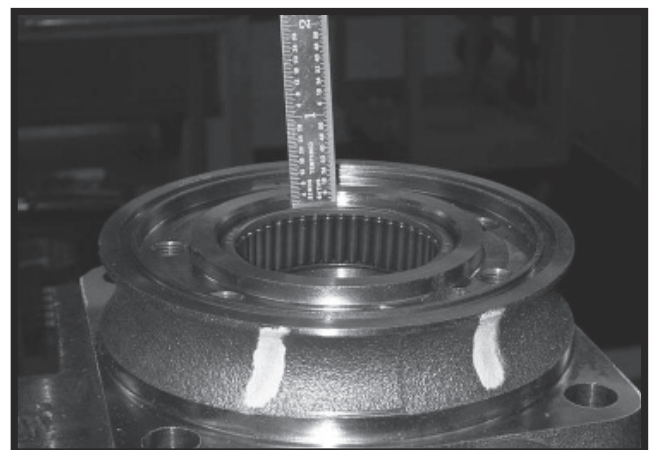
**NOTE:** Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.

### **NOTICE**

IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT COMPONENTS WHEN ASSEMBLED.

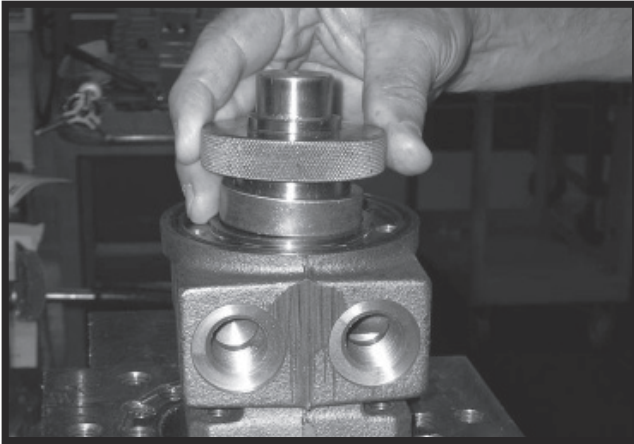
### **NOTICE**

BECAUSE THE BEARING/BUSHINGS (13) AND (19) HAVE A PRESS FIT INTO THE HOUSING THEY MUST BE DISCARDED WHEN REMOVED. THEY MUST NOT BE REUSED.



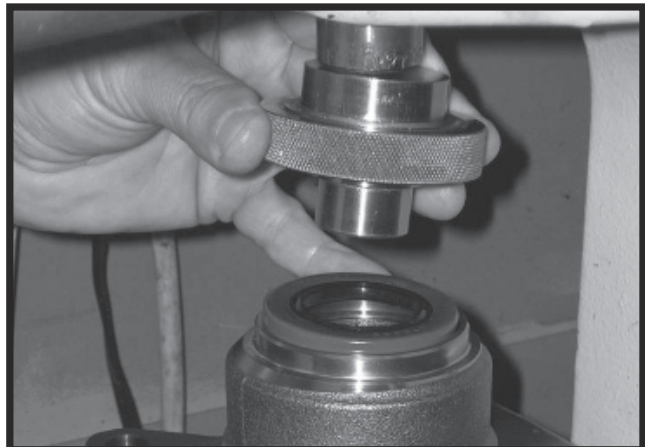
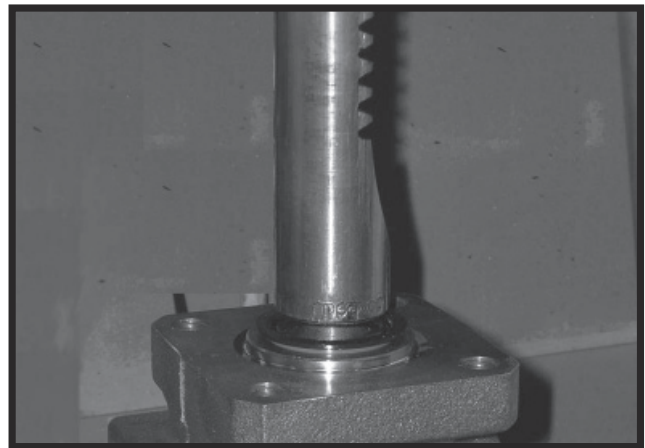
## SECTION 3 - CHASSIS & TURNTABLE

2. The Torqmotor™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/bushing (19).

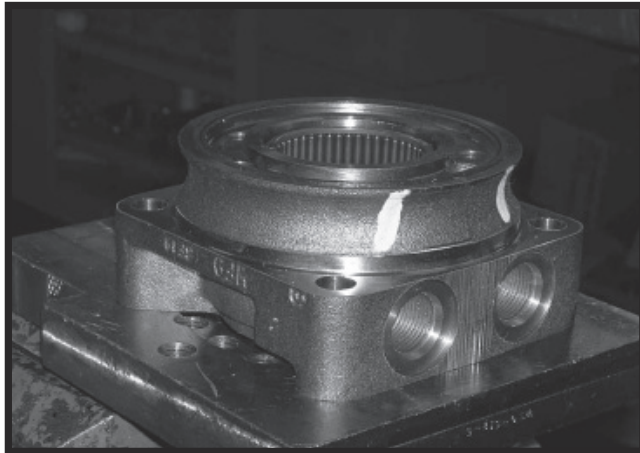


3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

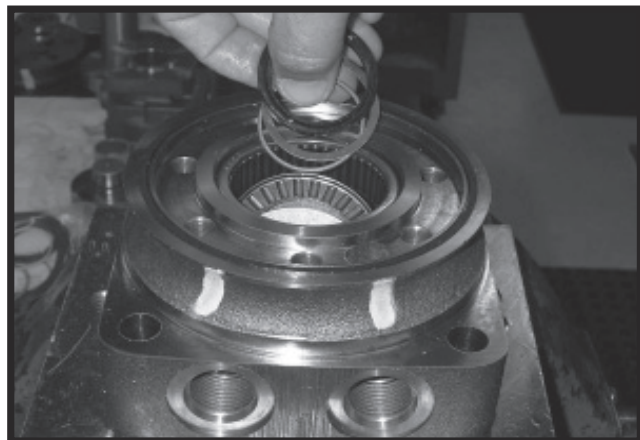
The Torqmotor™ dirt and water seal (20) must be pressed in until its flange is flush against the housing.



- Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



- On the Torqmotor™ assemble a new backup washer (17) and new seal (16) with the seal lip facing toward the inside of Torqmotor™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.



**NOTICE**

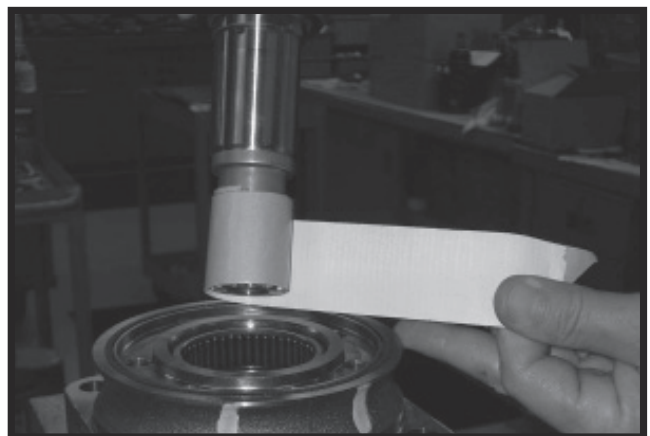
**ORIGINAL DESIGN LARGE FRAME, TF & TG TORQMOTORS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25), AND NEW SEAL (16).**

- Assemble thrust washer (14) then thrust bearing (15) that was removed from the Torqmotor™.



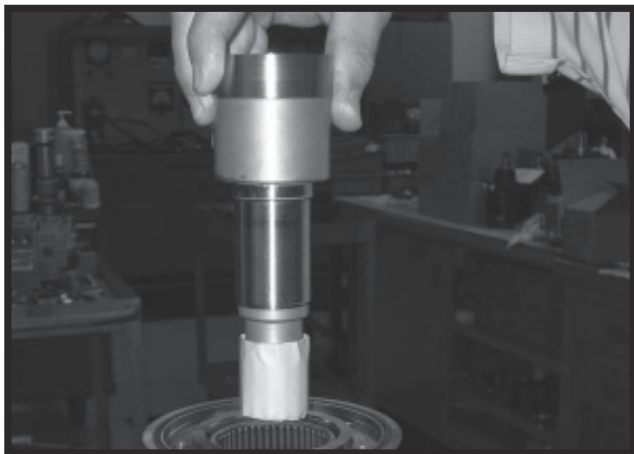
**NOTE:** Torqmotors™ require one thrust washer (14) with thrust bearing (15). The coupling shaft will be seated directly against the thrust.

- Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal.



## SECTION 3 - CHASSIS & TURNTABLE

8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.



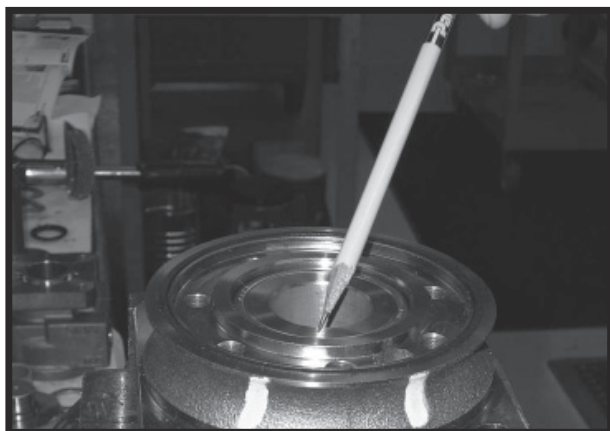
### NOTICE

THE OUTER BEARING (19) IS NOT LUBRICATED BY THE SYSTEM'S HYDRAULIC FLUID. BE SURE IT IS THOROUGHLY PACKED WITH THE RECOMMENDED GREASE, PARKER GEAR GREASE SPECIFICATION #045236, E/M LUBRICANT #K-70M.

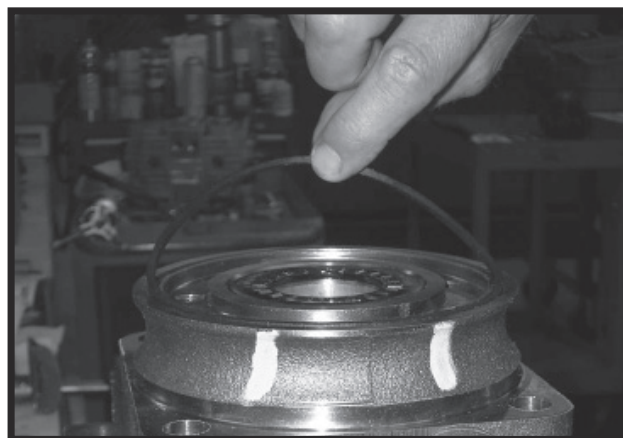
**NOTE:** Mobil Mobilith SHC<sup>®</sup> 460

**NOTE:** A 102Tube (P/N 406010) is included in each seal kit.

**NOTE:** The coupling shaft (12) will be flush or just below the housing wear plate surface on Torqmotors™ when properly seated. The coupling shaft must rotate smoothly on the thrust bearing package.

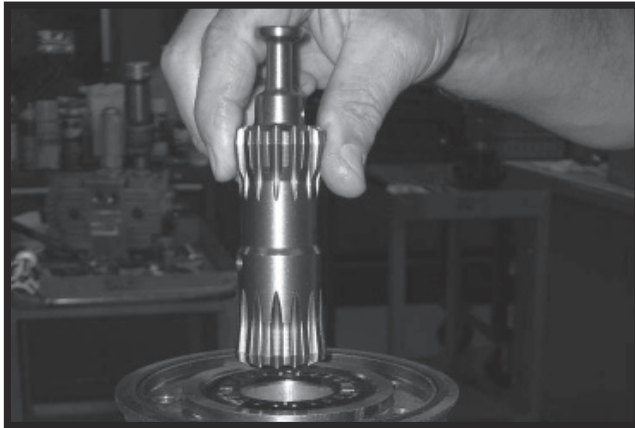


9. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.



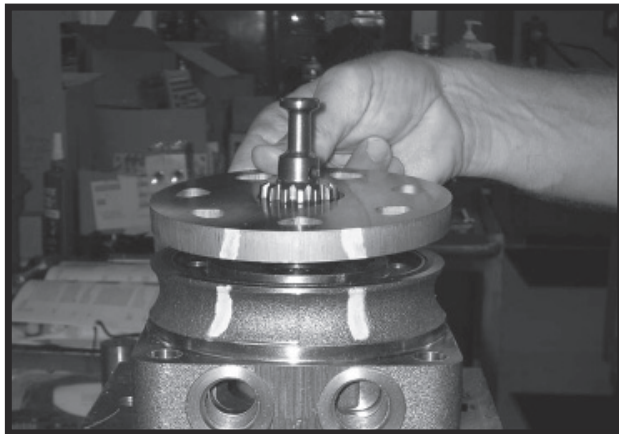
**NOTE:** One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over 0.5 inch (12.7 mm) longer than the bolts (1) used in the Torqmotor™.

- 10.** Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.

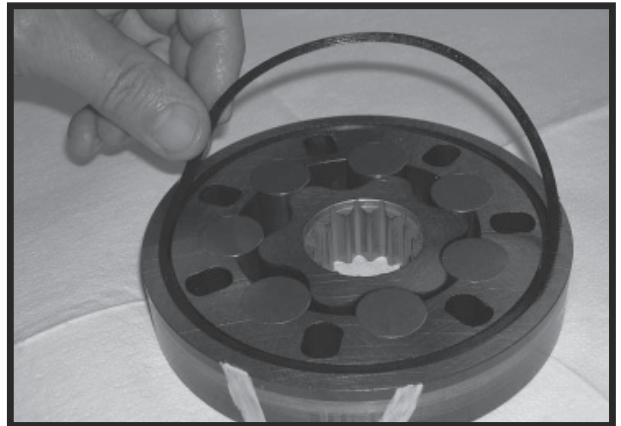


**NOTE:** Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.

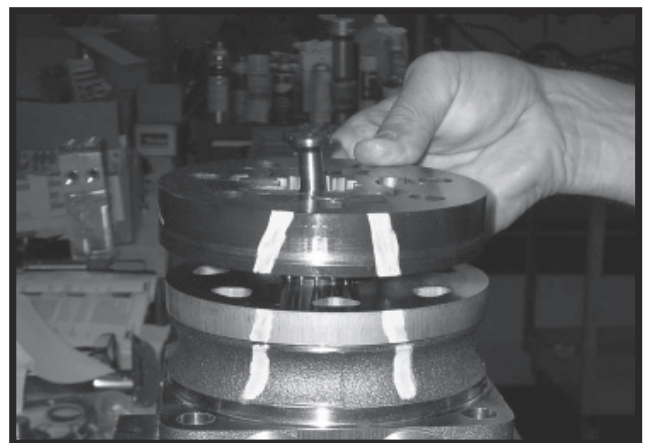
- 11.** Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



- 12.** Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B).



- 13.** Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines.



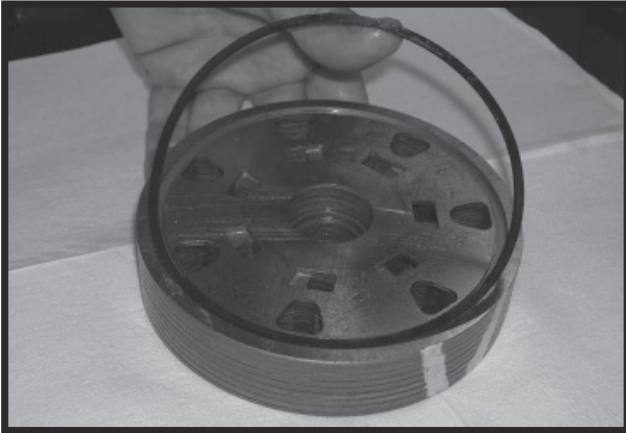
**NOTE:** It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.

**NOTE:** If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure."

**NOTE:** The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down. The rotor set seal ring groove faces toward the wear plate (9).

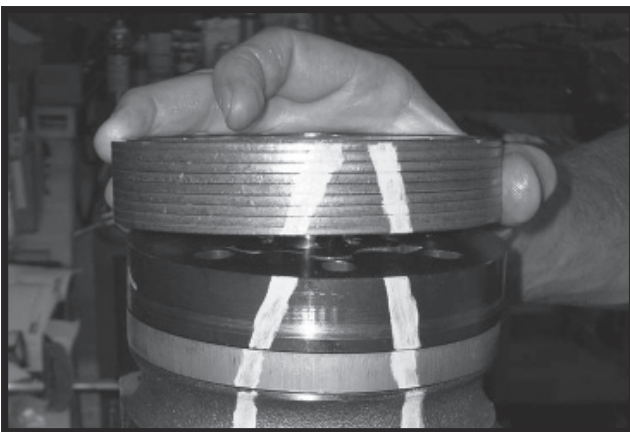
## SECTION 3 - CHASSIS & TURNTABLE

14. Apply clean grease to a new seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7).

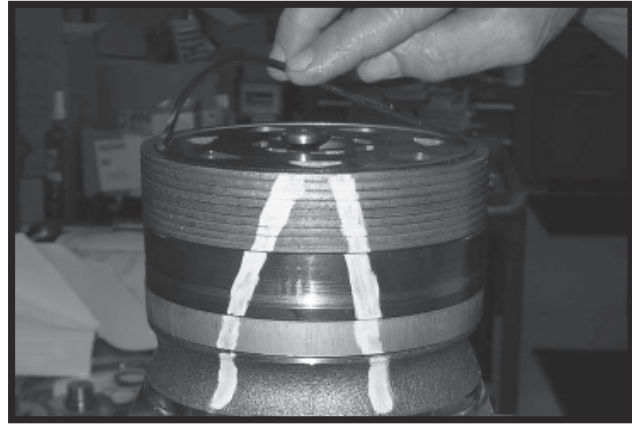


**NOTE:** The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.

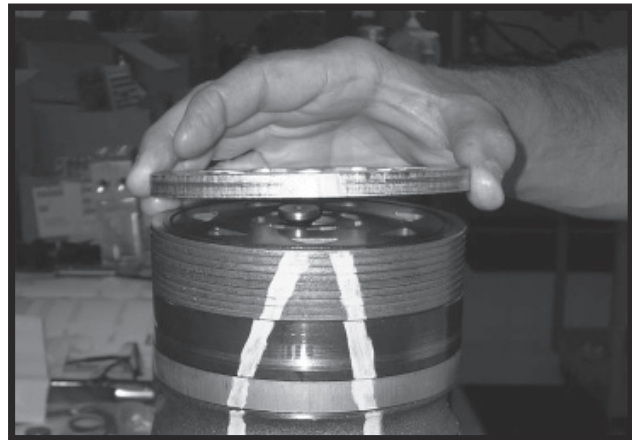
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



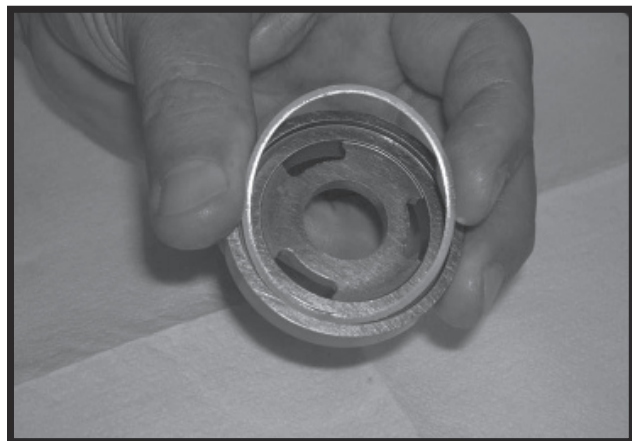
16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.

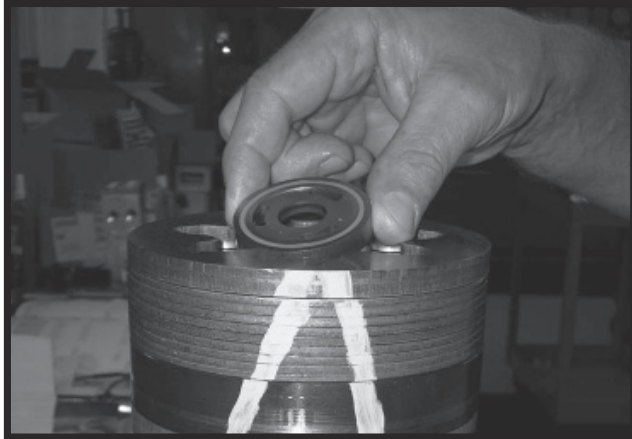


17. Assemble the commutator ring (6) over alignment studs onto the manifold.

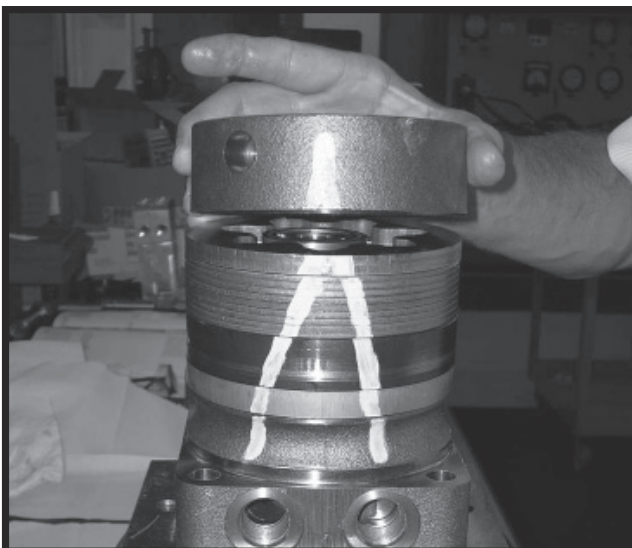
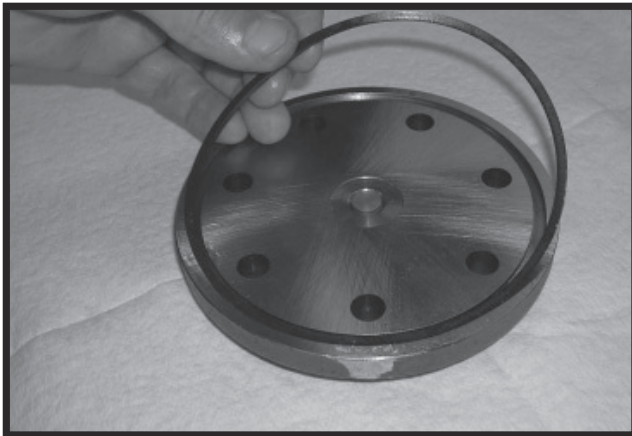
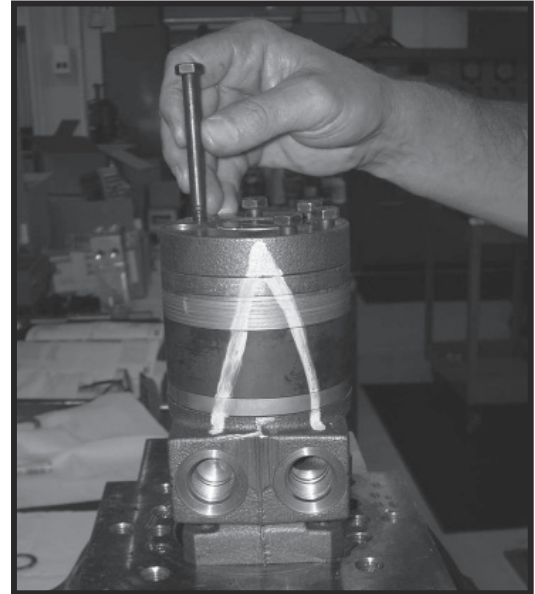


18. Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.



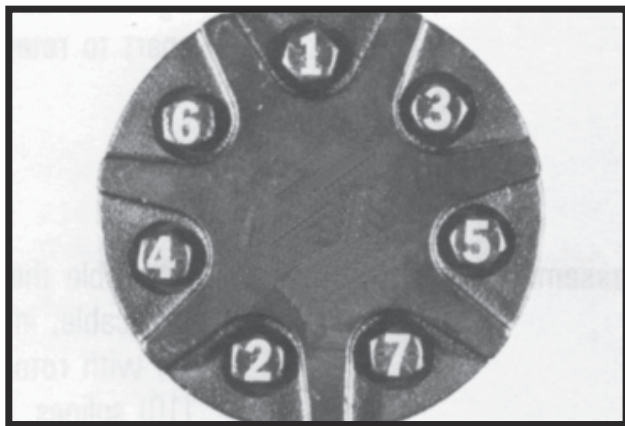
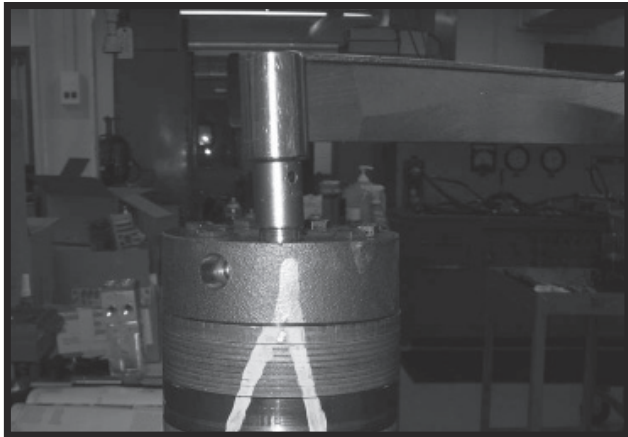
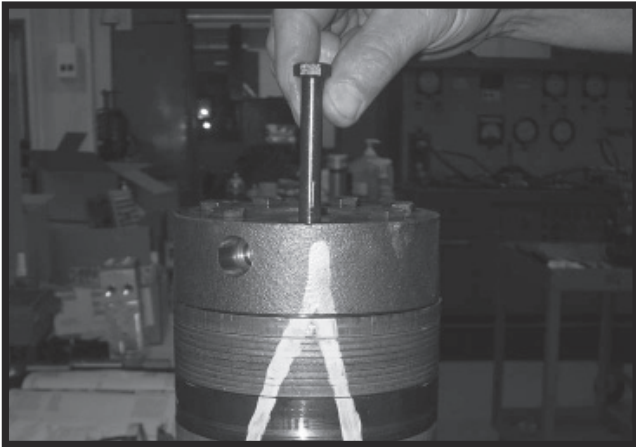


19. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to housing port bosses.



## SECTION 3 - CHASSIS & TURNTABLE

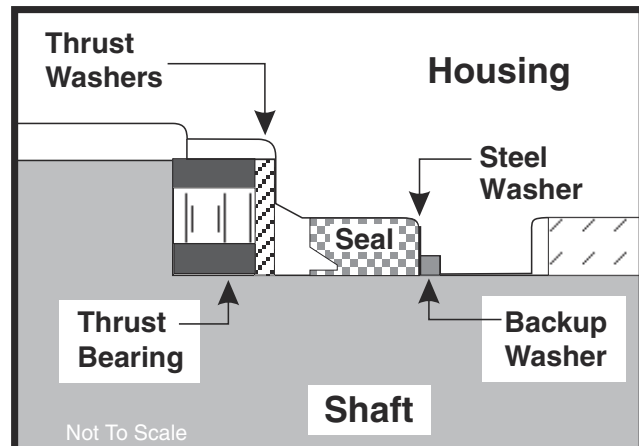
20. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 50-55 ft. lbs.(68-75 N m) for the seven 3/8-24 threaded bolts.



**NOTE:** The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.

21. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 Nm) if cover is so equipped.

Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs.(61-75 Nm) if cover is so equipped.



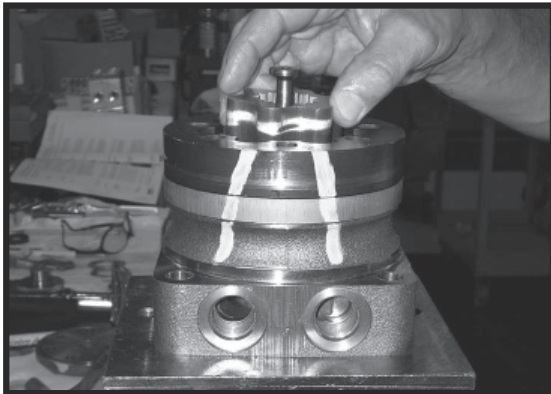
### One Piece Stator Construction

A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqmotor™ assembly procedures 1 through 13. Be sure the seal ring is in place.

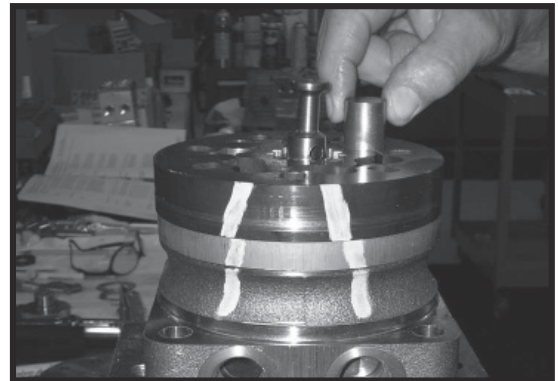


2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.
3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.



**NOTE:** If the manifold side of the rotor was etched during Torqmotor disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.

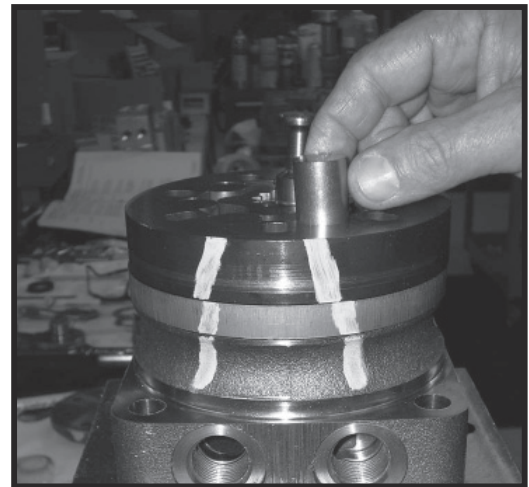
4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



#### NOTICE

**EXCESSIVE FORCE USED TO PUSH THE ROTOR VANES INTO PLACE COULD SHEAR OFF THE COATING APPLIED TO THE STATOR VANE POCKETS.**

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.



6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

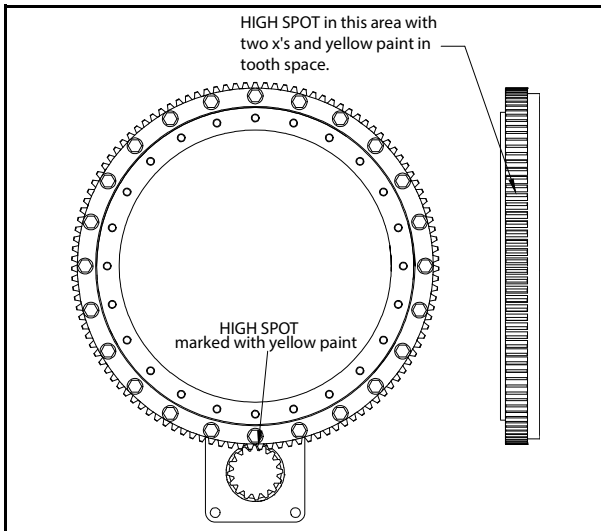
### 3.9 SWING HUB INSTALLATION

Ensure mounting plate and mounting location of the base plate are clean and painted with a uniform coating of minimum thickness (no runs, drips, etc.).

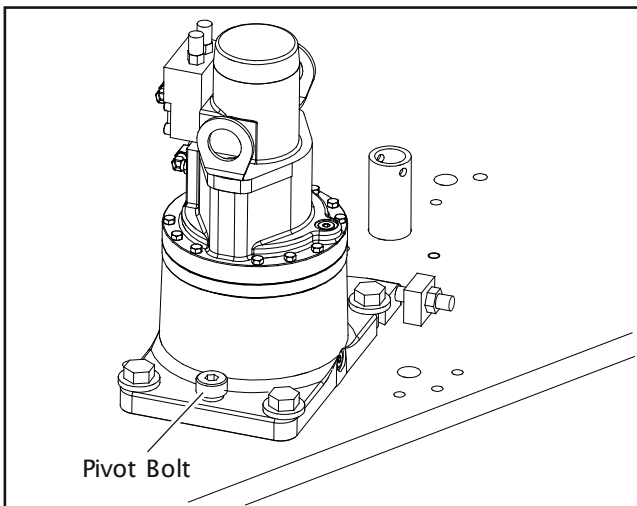
#### Procedure For Setting Swing Gear Backlash

Set backlash to 0.010 in. to 0.015 in. (0.254 mm - 0.381 mm) using the following procedure:

1. Place the machine on firm, level ground.
2. Place shim between pinion and bearing at bearing high spot (shown below).

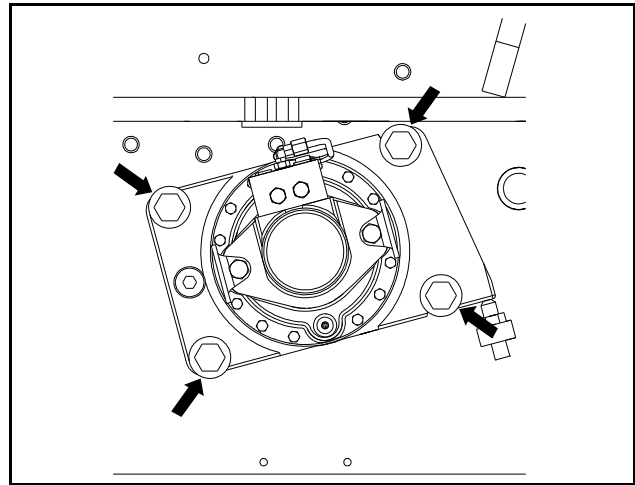


3. Apply JLG Threadlocker P/N 0100019 and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).

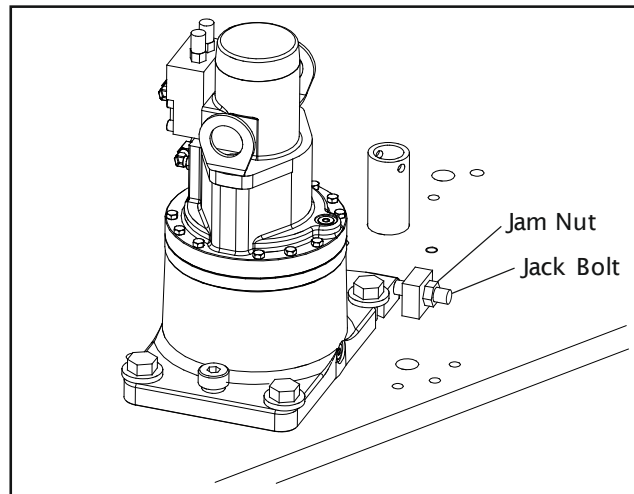


**NOTE:** Make sure the turntable is properly supported during the following step. The turntable can swing a few degrees when the turntable lock is removed if the turntable is not balanced properly.

4. Remove turntable lock pin.
5. Apply JLG Threadlocker P/N 0100019 and pre-torque swing drive mounting bolts to 30 ft. lbs. (40 Nm).

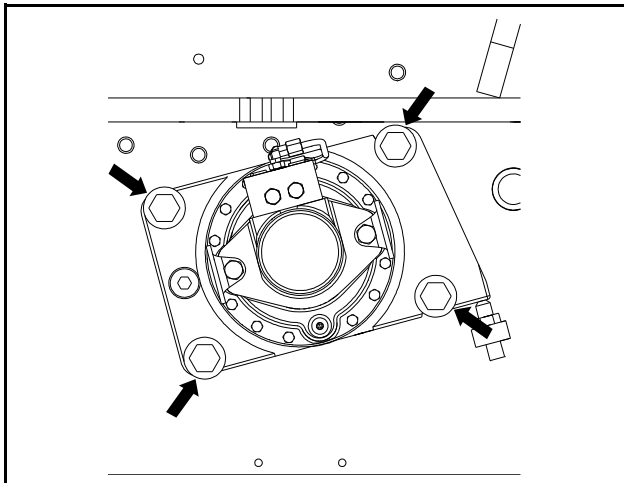


6. Tighten jack bolt until pinion is completely snug against shim and bearing then loosen jack bolt.

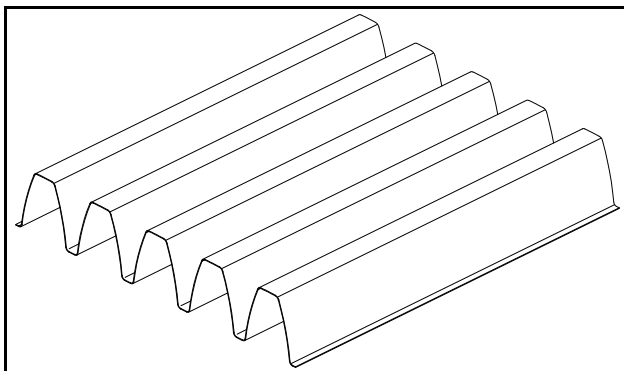


7. Apply JLG Threadlocker P/N 0100019 and torque jack bolt 50 ft. lbs. (68 Nm).
8. Apply JLG Threadlocker P/N 0100019 and tighten jam nut.

9. Torque mounting bolts to 340 ft. lbs. (Nm).

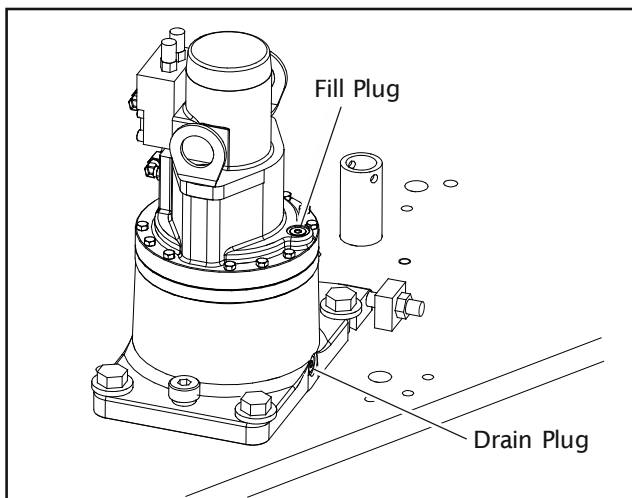


10. Remove shim and discard..



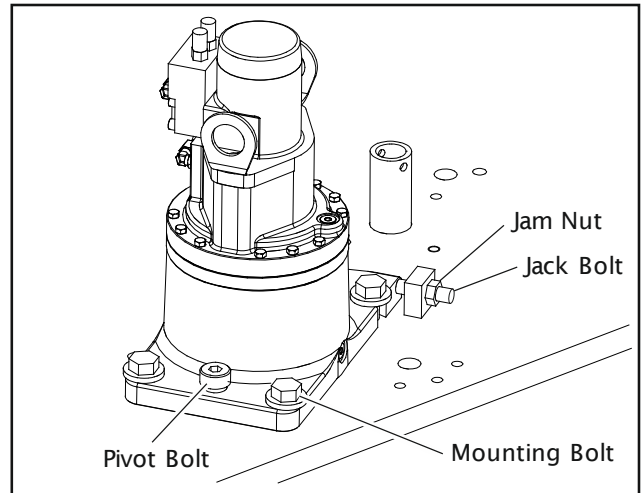
### Swing Drive Lubrication

Fill Swing Drive Gearbox with 43 oz (1.27 L) 90w80gear oil with EP additives. Oil should cover the ring gear. Torque pipe plug to 23-25 ft.lbs (31- 33 Nm).



### 3.10 SWING HUB REMOVAL

1. Disconnect all wiring harness terminals connected to the swing motor.
2. Gently loosen the set screw. Do not remove.
3. Remove the pivot bolt using Allen Wrench.



4. Remove the mounting bolts securing swing drive hub to the turntable.
5. Using the suitable lifting device, remove the swing drive hub from mounting plate without damaging the swing gear.
6. Place swing drive hub in the clean area.
7. Refer to Section 3.7, Swing Drive for swing drive maintenance.

### 3.11 SWING BEARING

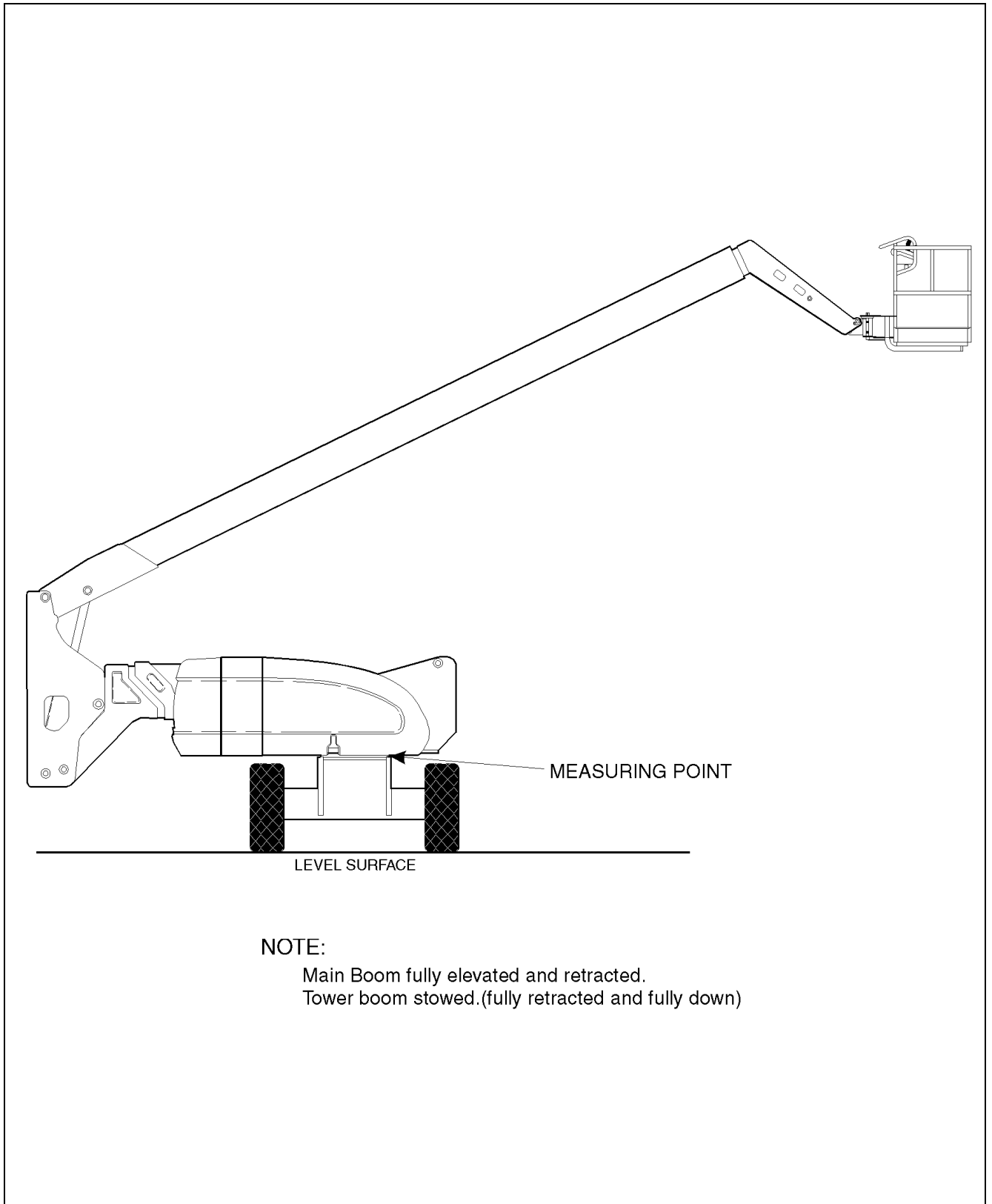
#### Turntable Bearing Mounting Bolt Condition Check

**NOTICE**

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON AN AERIAL LIFT. IT IS HERE THAT THE STRESSES OF LIFTING ARE CONCENTRATED, AT THE CENTER OF ROTATION. BECAUSE OF THIS, PROPER MAINTENANCE OF THE SWING BEARING BOLTS IS A MUST FOR SAFE OPERATION.

**NOTE:** *This check is designed to replace the existing bearing bolt torque checks on JLG Lifts in service. This check must be performed after the first 50 hours of machine operation and every 600 hours of machine operation thereafter. If during this check any bolts are found to be missing or loose, replace missing or loose bolts with new bolts and torque to the value specified in the torque chart, after lubricating the bolt threads with JLG Threadlocker P/N 0100019. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.*

1. Check the frame to bearing attach bolts as follows:
  - a. Elevate the fully extended main boom to horizontal. (See Figure 3-40.)
  - b. At the positions indicated on Figure 3-41. try to insert a.0015 feeler gauge between the bolt and hardened washer at the arrow indicated position.
  - c. Ensure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
  - d. Swing the turntable 90 degrees, and check some selected bolts at the new position.
  - e. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.
2. Check the turntable to bearing Attach bolts as follows:
  - a. Elevate the fully retracted main boom to full elevation.
  - b. At the position indicated on Figure 3-39. try to insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
  - c. Lower the boom to horizontal and fully extend the boom.
  - d. At the position indicated on Figure 3-41., try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.



**NOTE:**

Main Boom fully elevated and retracted.  
Tower boom stowed.(fully retracted and fully down)

**Figure 3-39. Swing Bearing Tolerance Boom Placement (Sheet 1 of 2)**

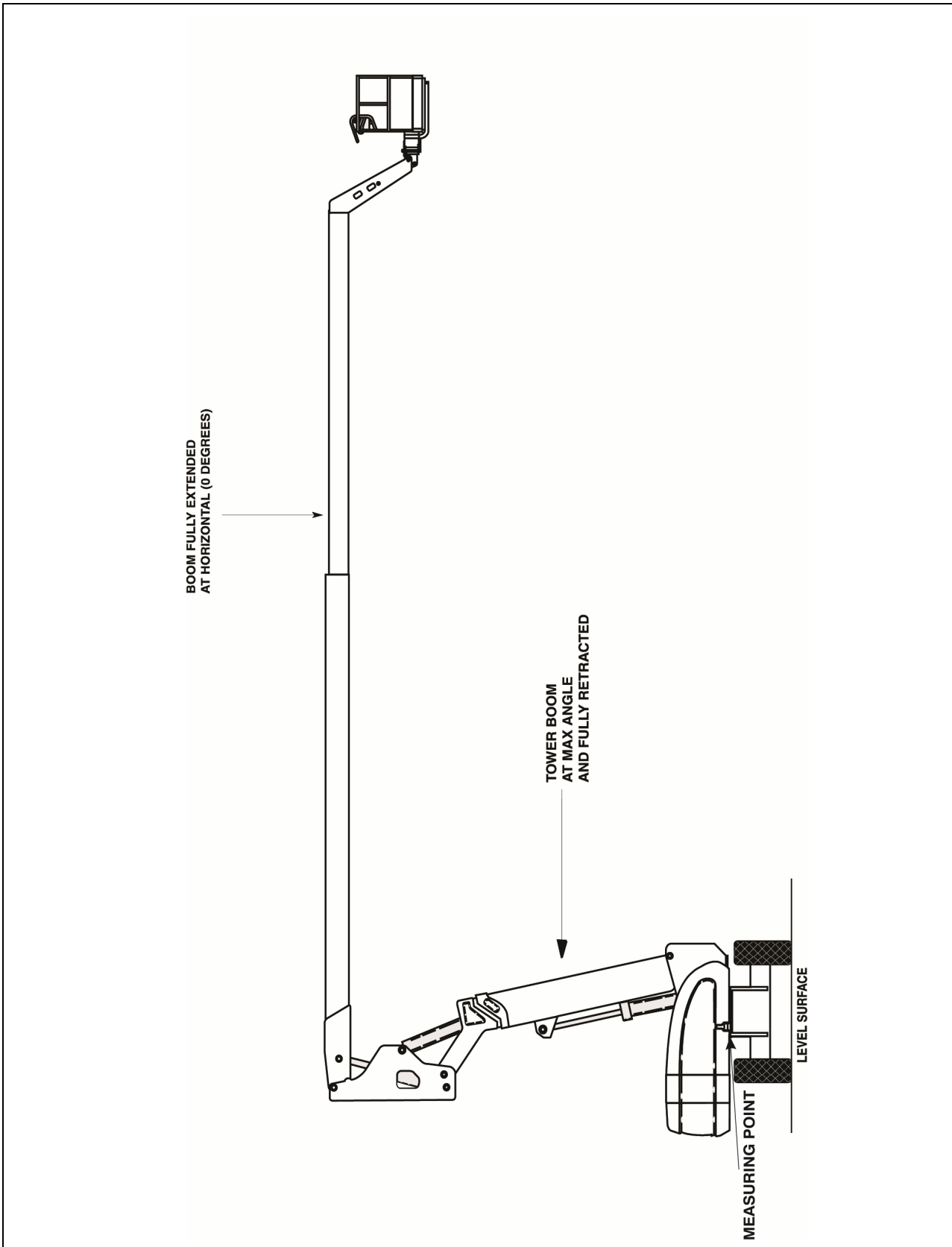


Figure 3-40. Swing Bearing Tolerance Boom Placement (Sheet 2 of 2)

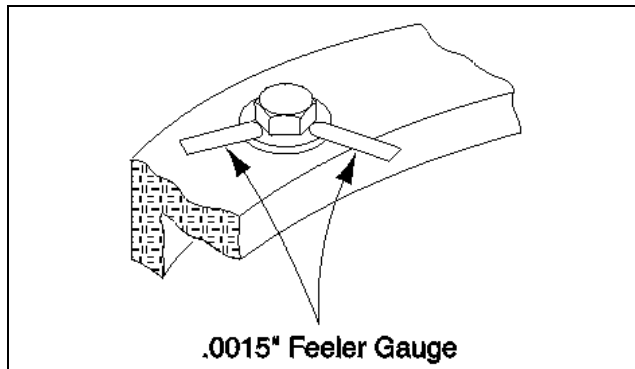


Figure 3-41. Swing Bolt Feeler Gauge Check

## Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted, and tower boom stowed, as shown in Figure 3-39., Swing Bearing Tolerance Boom Placement (Sheet 1 of 2), using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-42., Swing Bearing Tolerance Measuring Point
2. At the same point, with the main boom at horizontal and fully extended, and the tower boom fully elevated and fully retracted as shown in Figure 3-40., Swing Bearing Tolerance Boom Placement (Sheet 2 of 2). Using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-42., Swing Bearing Tolerance Measuring Point
3. If a difference greater than 0.079 in. (2.00 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.079 in. (2.00 mm) is determined, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
  - a. Metal particles in the grease.
  - b. Increased drive power required.
  - c. Noise.
  - d. Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

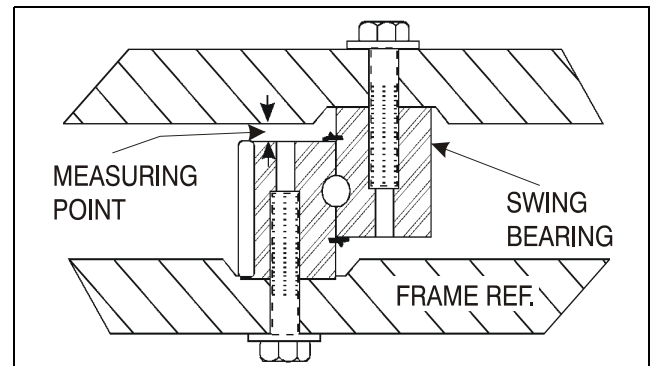


Figure 3-42. Swing Bearing Tolerance Measuring Point

## Swing Bearing Replacement

### REMOVAL

1. From Ground Control station, operate the boom adequately to provide access to frame opening to rotary coupling.

### **⚠ WARNING**

**NEVER WORK BENEATH THE BOOM WITHOUT FIRST ENGAGING BOOM SAFETY PROP OR PROVIDING ADEQUATE OVERHEAD SLING SUPPORT AND/OR BLOCKING.**

2. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
3. From inside turntable, remove mounting hardware which attach rotary coupling retaining yoke brackets to turntable.

### **NOTICE**

**HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID THE ENTRY OF CONTAMINANTS INTO THE SYSTEM.**

4. Tag and disconnect the hydraulic lines from the fittings on the top of the rotary coupling. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.
5. Attach suitable overhead lifting equipment to the base of the turntable weldment.
6. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the turntable to the bearing inner race. Discard the bolts.
7. Use the lifting equipment to carefully lift the complete turntable assembly from the bearing. Ensure that no damage occurs to the turntable, bearing or frame-mounted components.

8. Carefully place the turntable on a suitably supported trestle.
9. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing from the frame, then move the bearing to a clean, suitably supported work area.

### INSTALLATION

1. Using suitable lifting equipment, carefully lower the swing bearing into position on the frame. Ensure the scribed line of the outer race of the bearing aligns with the scribed line on the frame. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the frame.

#### **⚠ CAUTION**

JLG INDUSTRIES RECOMMENDS THAT ALL REMOVED BEARING BOLTS BE DISCARDED AND REPLACED WITH NEW BOLTS. SINCE THE SWING BEARING IS THE ONLY STRUCTURAL LINK BETWEEN THE FRAME AND TURNTABLE, IT IS IMPERATIVE THAT SUCH REPLACEMENT HARDWARE MEETS JLG SPECIFICATIONS. USE OF GENUINE JLG HARDWARE IS HIGHLY RECOMMENDED.

2. Apply a light coating of JLG Threadlocker P/N 0100019 to the new bearing bolts, and loosely install the bolts and washers through the frame and outer race of bearing.

#### **NOTICE**

IF COMPRESSED AIR OR ELECTRICALLY OPERATED IMPACT WRENCH IS USED FOR TIGHTENING THE BEARING ATTACHMENT BOLTS, THE TORQUE SETTING ACCURACY OF THE TOOL SHOULD BE CHECKED PRIOR TO USE.

3. Refer to the Torque Sequence diagram as shown in Figure 3-45., Swing Bearing Torque Sequence. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to an initial torque of 190 Ft. lbs. (260 Nm) w/JLG Threadlocker P/N 0100019.
4. Remove the lifting equipment from the bearing.
5. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.
6. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the turntable.

7. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the turntable and inner race of the bearing.
8. Following the Torque Sequence diagram shown in Figure 3-45., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 ft. lbs. (260 Nm) w/Loctite.
9. Remove the lifting equipment.
10. Install the rotary coupling retaining yoke brackets, apply a light coating of JLG Threadlocker P/N 0100011 to the attaching bolts and secure the yoke to the turntable with the mounting hardware.
11. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.
12. At ground control station, use boom lift control to lower boom to stowed position.
13. Using all applicable safety precautions, activate the hydraulic system and check the swing system for proper and safe operation.

### Swing Bearing Torque Values

1. Outer Race - 190 ft. lbs. (260 Nm) w/JLG Threadlocker P/N 0100019.
2. Inner Race - 190 ft. lbs. (260 Nm) w/JLG Threadlocker P/N 0100019.
3. See Swing Bearing Torquing Sequence.

#### **⚠ WARNING**

CHECK THE INNER AND OUTER SWING BEARING BOLTS FOR MISSING OR LOOSENESS AFTER FIRST 50 HOURS OF OPERATION, AND EVERY 600 HOURS THEREAFTER.

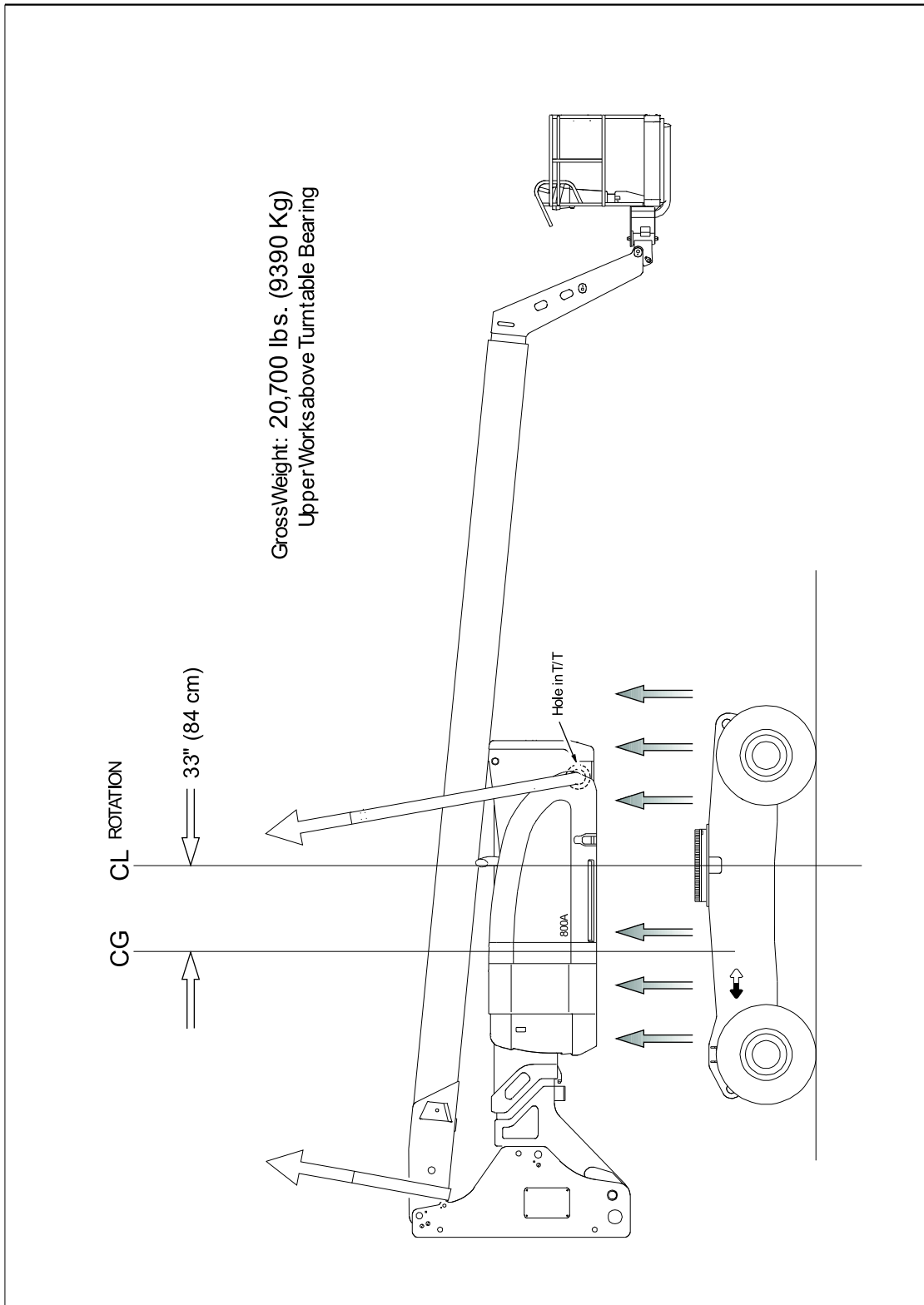


Figure 3-43. Swing Bearing Removal (800A)

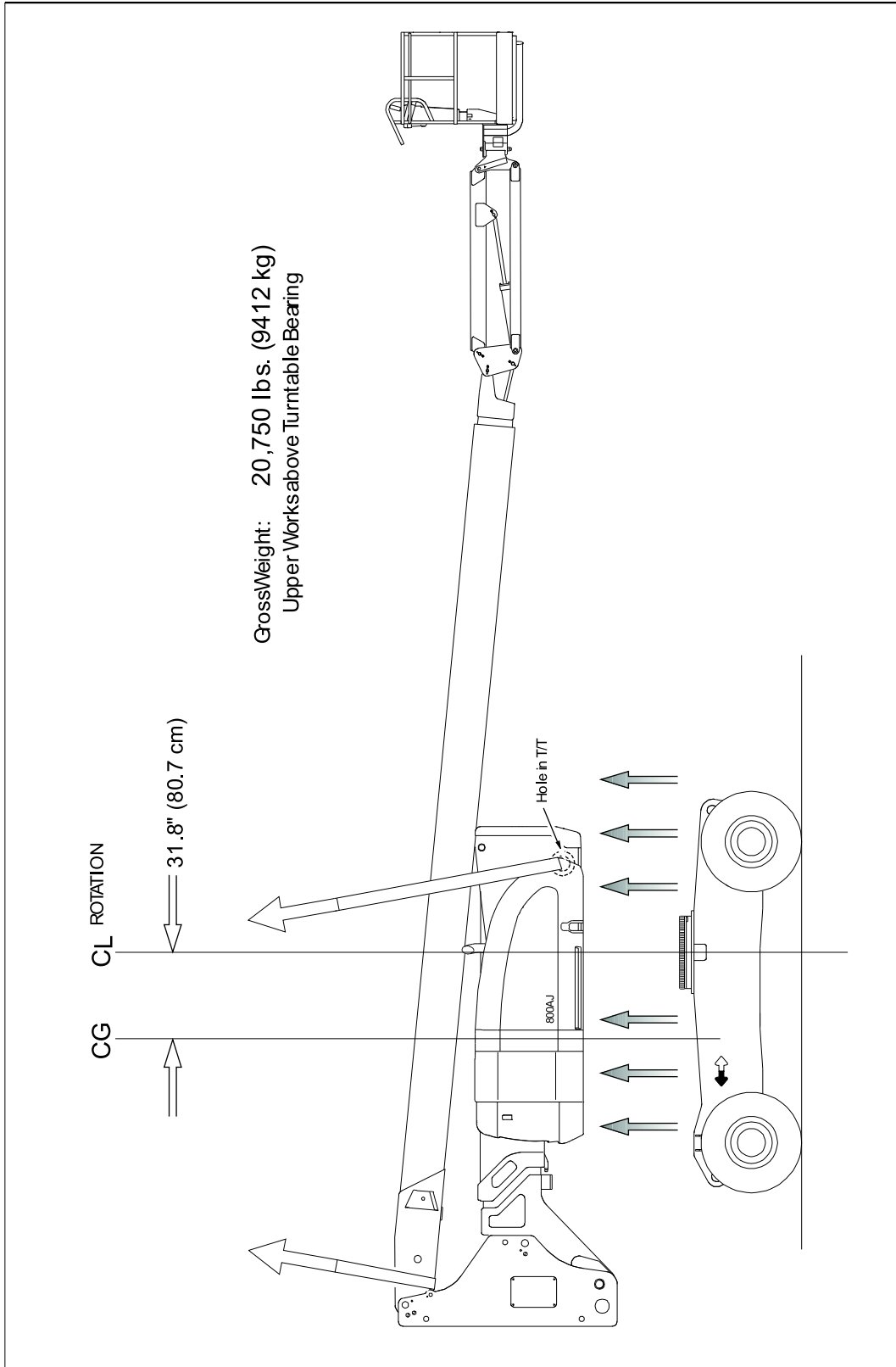
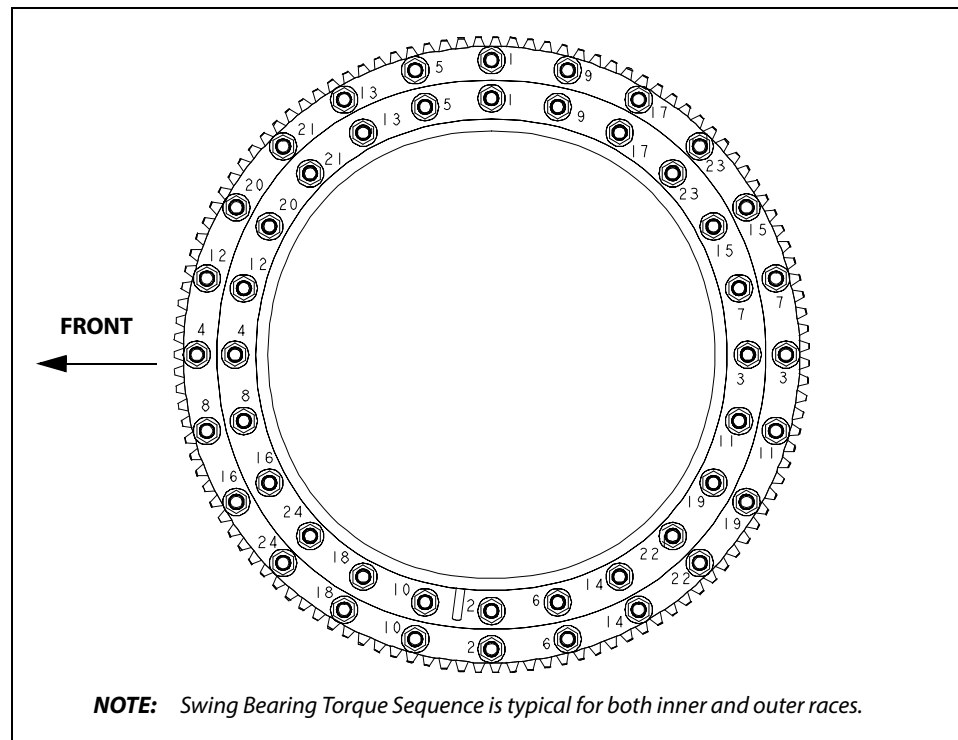


Figure 3-44. Swing Bearing Removal (800AJ)



**Figure 3-45. Swing Bearing Torque Sequence**

### 3.12 TILT INDICATOR SYSTEM

1. The tilt indicator system measures the turntable angle with respect to level ground. The tilt switch itself has two settings; 5 (or 4 degree dependent upon market) and 8.5 degrees. The tilt angle is dependent on market, Refer Table 6-2, Machine Configuration Programming Information (Software Version P6.22).
2. The smaller angle is used for the purpose of warning the operator by means of the tilt light in the platform display panel.
3. Additionally when used in conjunction with the "above elevation cutout system" or the "transport position interlock system", the tilt switch will cause an alarm to sound, and automatically put the machine in the creep speed mode. With the exception of the speed cutback, this is a warning system only.
4. The machine will continue to function. The operator is responsible to prevent the machine from attaining an unstable position. The 8.5 degree angle is used exclusively for the purpose of automatically shifting the drive motors to the maximum displacement position (slow speed).

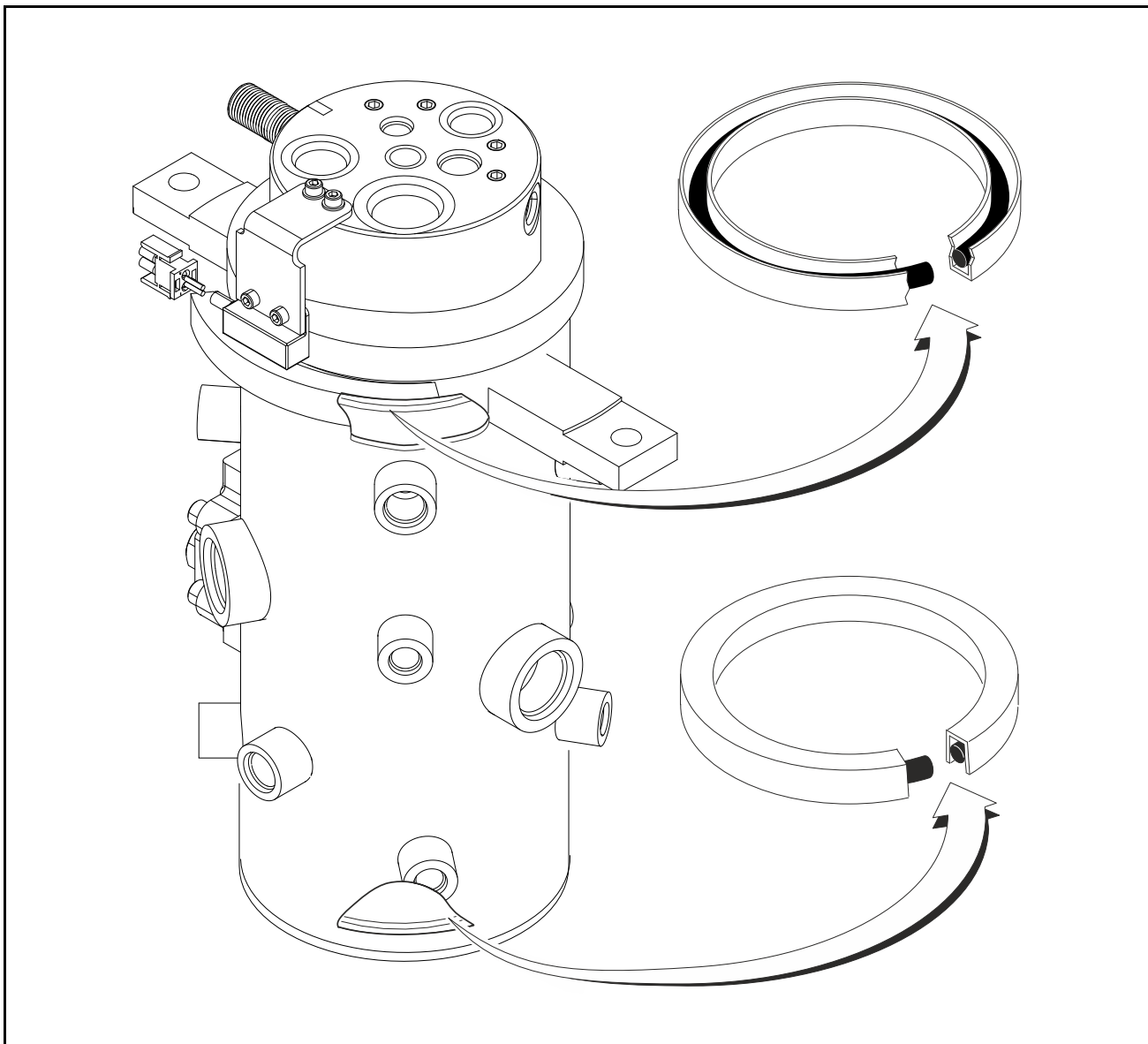
### 3.13 SPARK ARRESTER CLEANING INSTRUCTIONS

1. Remove the cleanout plug in the bottom of spark arrester (muffler).
2. Without causing deformation (or any type of damage to the spark arrester) repeatedly tap on the arrester near the cleanout plug. This may be enough to begin drainage of the spark trap.
3. An industrial vacuum cleaner can do a complete job at this point.
  - a. Or, IN A SAFE AREA, start the engine. Then alternate between low idle and high idle for two to three minutes.
  - b. Or, operate the engine as required by the application for two to three minutes.
  - c. Install the cleanout plug.

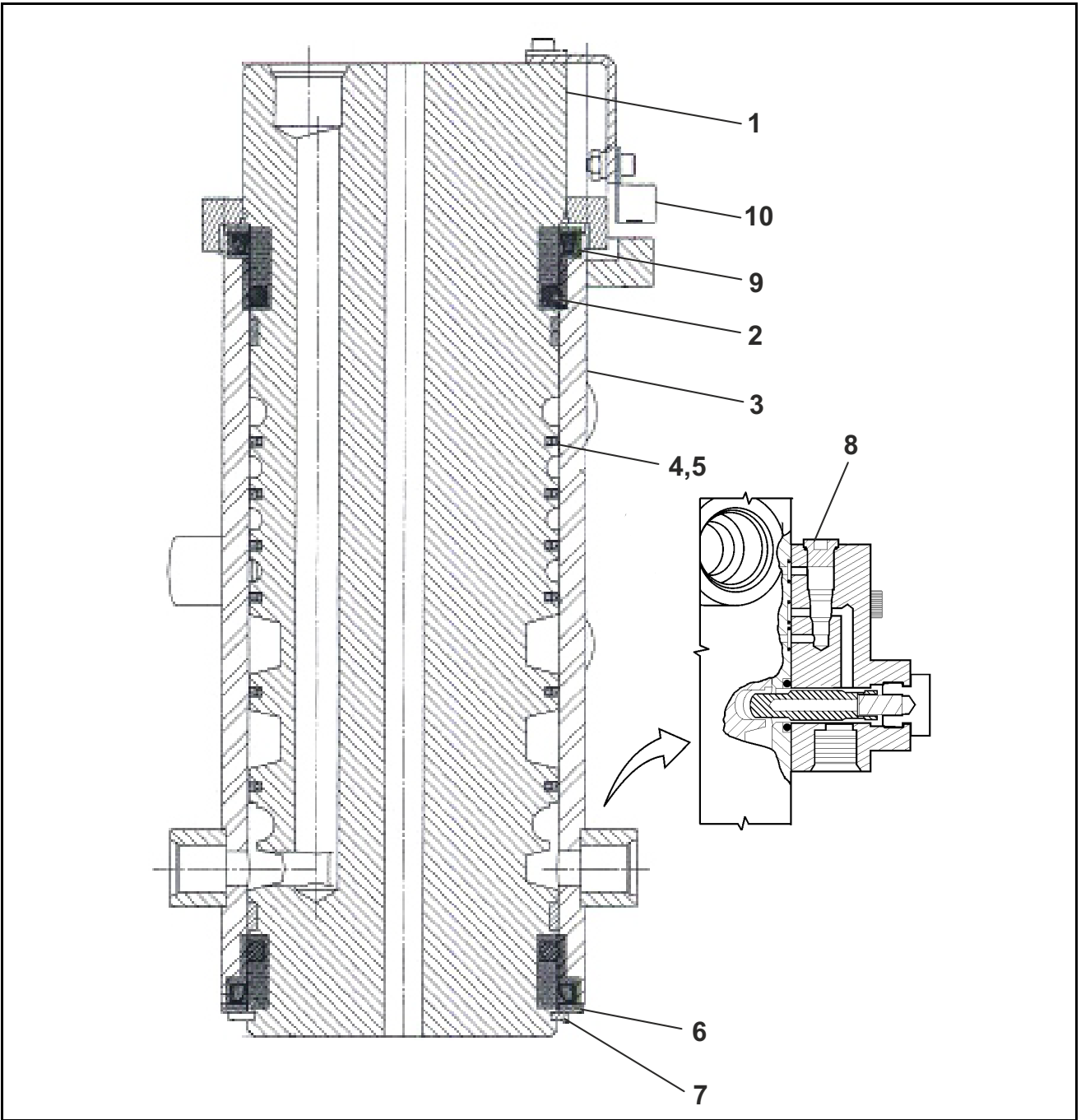
**3.14 ROTARY COUPLING**

Use the following procedure to install the seal kit.

1. If not already removed, remove the axle oscillation valve from the cylinder barrel. The spool of the valve protrudes into the barrel and will damage the spool and seals if left in place.
2. Remove snap ring (7) from end.
3. Remove thrust ring (3) from the same end.
4. Remove center body (1) from housing (3).
5. Cut off old seals (2, 4, 5).
6. Remove proximity switch.
7. Assemble lip seals (2) in direction shown in Figure 3-46., Rotary Coupling Seal Installation.
8. Reassemble O-ring (4).
9. Heat cap seals (5) in hydraulic oil for 5 minutes at 300° F (149° C).
10. Assemble cap seals over O-rings.
11. Reinsert center body into housing (lube with hydraulic oil).
12. Replace thrust ring and snap ring.
13. Install proximity switch as shown in Figure 3-50.



**Figure 3-46. Rotary Coupling Seal Installation**



- |                |                                   |
|----------------|-----------------------------------|
| 1. Center Body | 6. Thrust Ring                    |
| 2. Seal        | 7. Snap Ring                      |
| 3. Housing     | 8. Valve Block (Axle Oscillation) |
| 4. O-ring      | 9. O-ring                         |
| 5. Seal        | 10. Proximity Switch              |

Figure 3-47. Rotary Coupling Cutaway

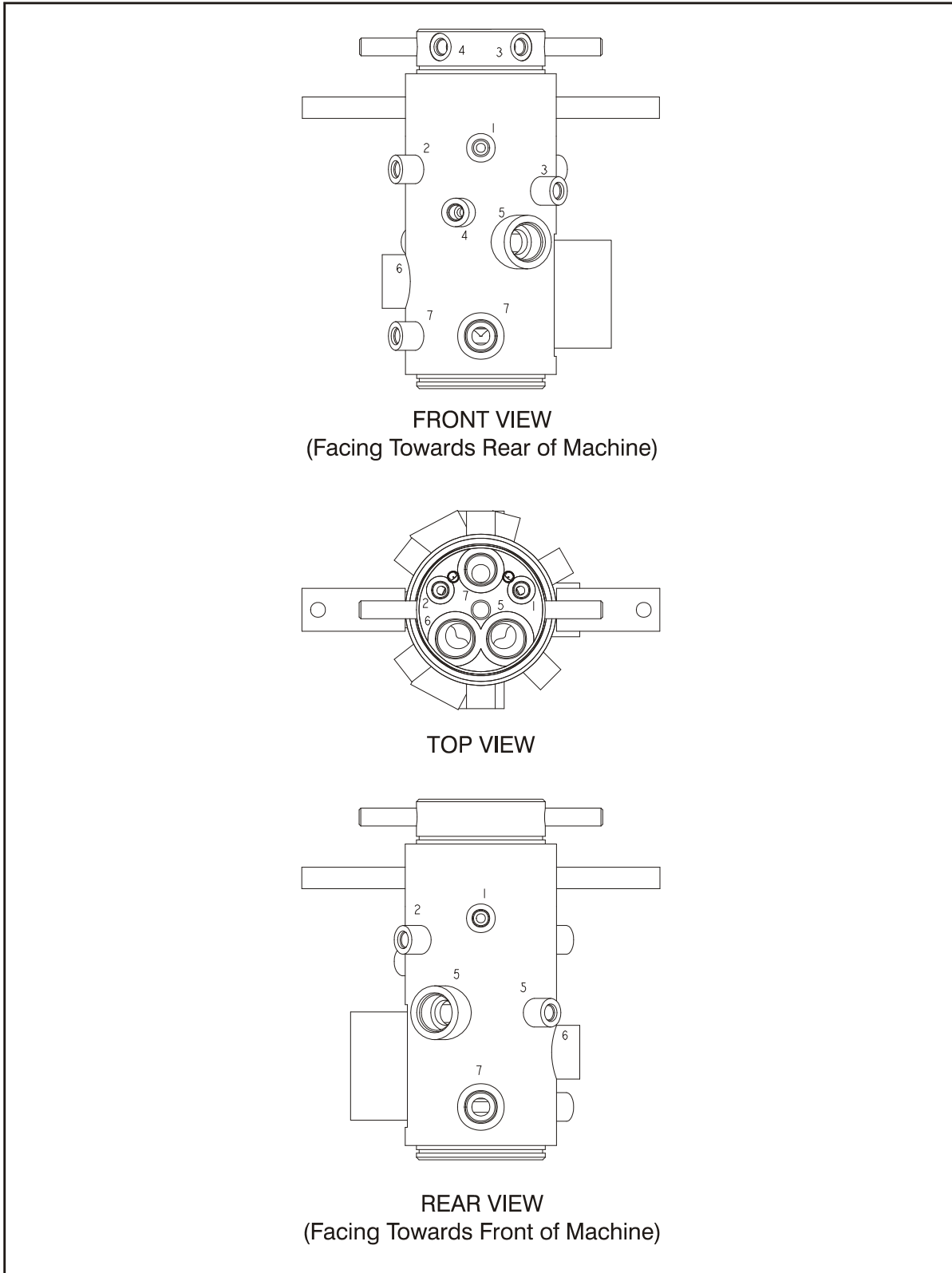


Figure 3-48. Rotary Coupling Port Location (7 Port)

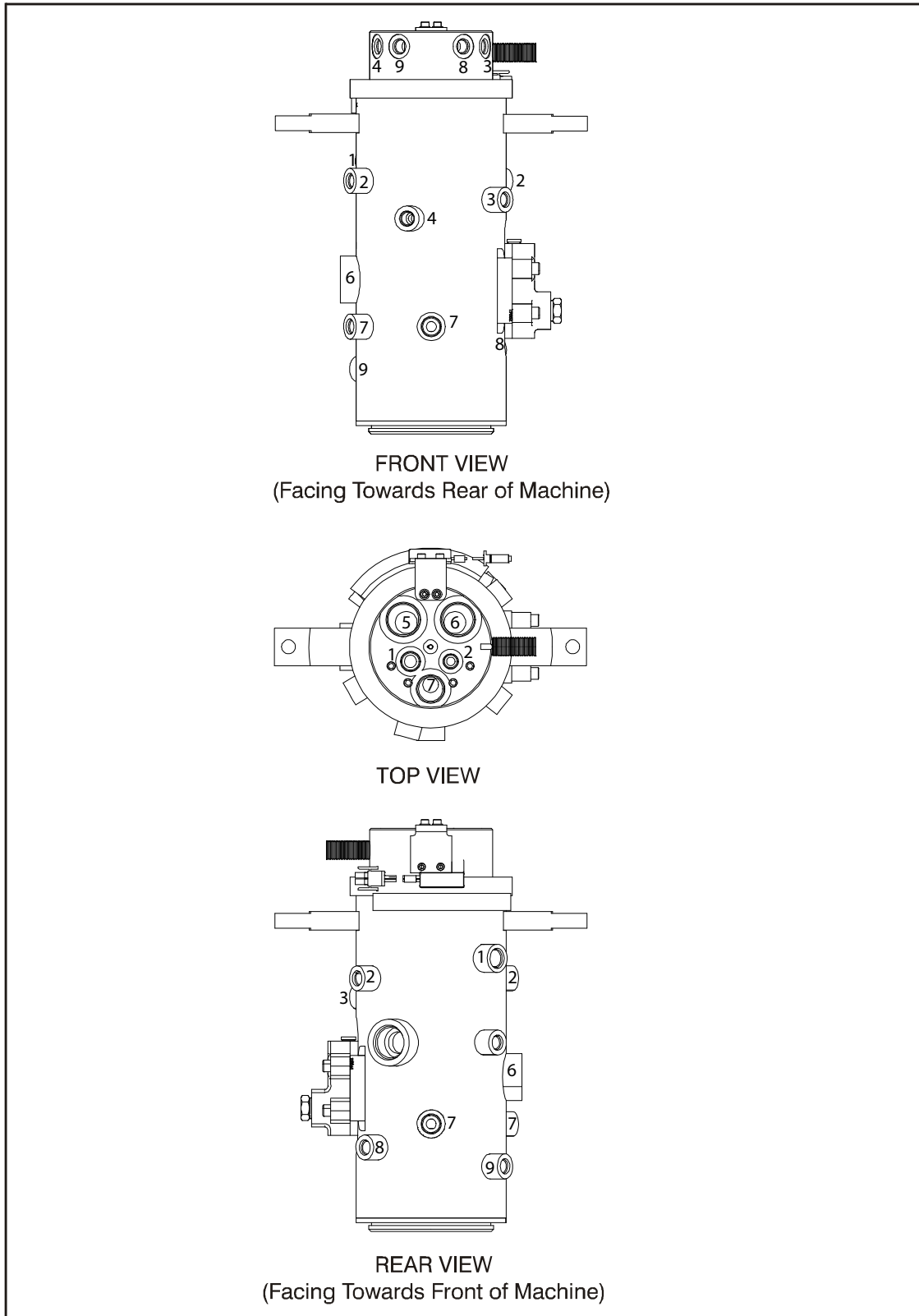
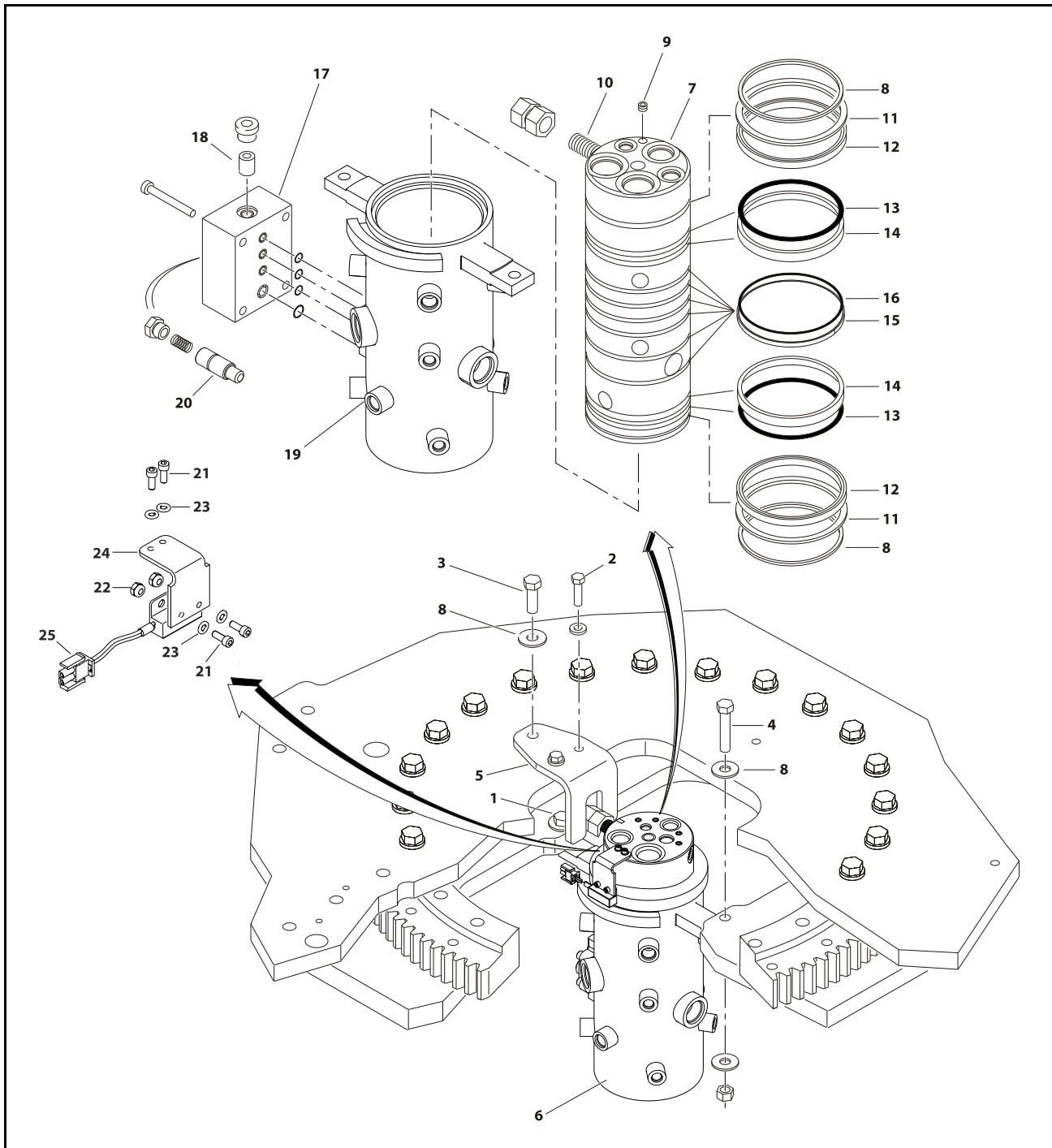


Figure 3-49. Rotary Coupling Port Location (9 Port)



- |                     |                    |              |                   |                      |
|---------------------|--------------------|--------------|-------------------|----------------------|
| 1. JLG Threadlocker | 6. Rotary Coupling | 11. Ring     | 16. O-ring        | 21. Bolt             |
| 2. Bolt             | 7. Spool           | 12. Seal     | 17. Valve         | 22. Nut              |
| 3. Bolt             | 8. Retaining Ring  | 13. O-ring   | 18. Check Valve   | 23. Washer           |
| 4. Bolt             | 9. Plug            | 14. Bearing  | 19. Case          | 24. Bracket          |
| 5. Bracket          | 10. Torque Lug     | 15. Cap Seal | 20. Plunger Valve | 25. Proximity Switch |

Figure 3-50. Rotary Coupling Installation

**Table 3-8. Coupling Port Information Table (7 port)**

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)

**Table 3-9. Coupling Port Information Table (9 port)**

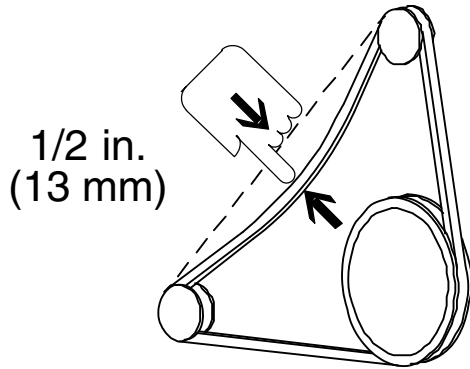
Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)
8	1	-6	Steer	2500 (172)	3750 (258.5)
9	1	-6	Steer	2500 (172)	3750 (258.5)

### 3.15 GENERATOR

#### Maintenance Schedule

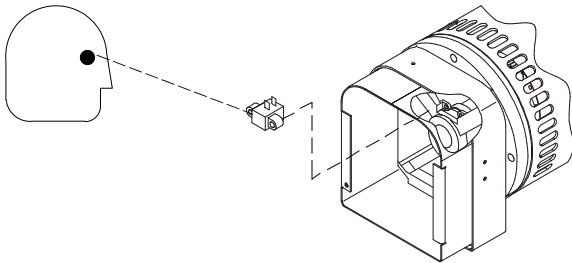
##### EVERY 250 HOURS

Every 250 hours of operation, check the drive belt for proper tension.

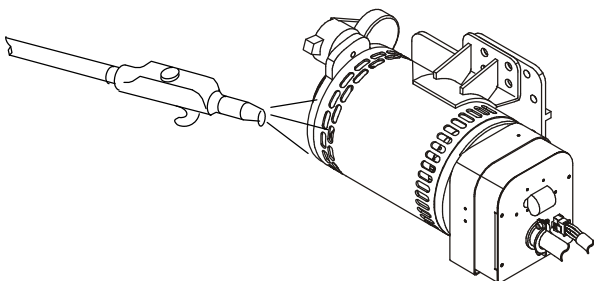


##### EVERY 500 HOURS

Every 500 hours of operation, service the generator brushes and slip rings. Hostile environments may require more frequent service.



Every 500 hours of service, blow out the inside of the generator. If operating in a hostile environment, clean monthly.

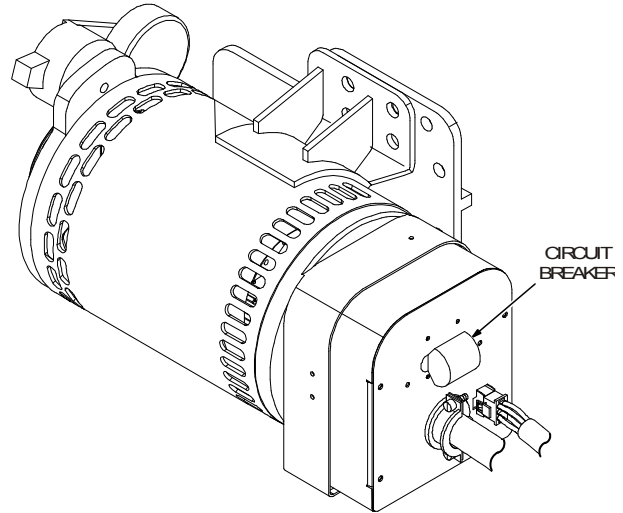


#### Overload Protection

#### **CAUTION**

**STOP THE ENGINE WHENEVER CHECKING OR INSPECTING THE CIRCUIT BREAKER.**

The circuit breaker protects the generator windings from overload. If the circuit breaker opens, generator output stops. If the circuit breaker continues to open, check for faulty equipment connected to the platform receptacles.



#### Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-51., *Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings.*

##### INSPECTING BRUSH POSITION

Inspect brush alignment with slip rings. View alignment through the air vents in the stator barrel. The brushes must ride completely on the slip rings.

##### INSPECTING BRUSHES

Remove the end panel. Inspect the wires. Remove the brush holder assembly. Pull the brushes from the holders.

Replace the brushes if damaged, or if the brush is at or near minimum length.

##### CLEANING SLIP RINGS

Visually inspect the slip rings. Under normal use, the rings turn dark brown.

If the slip rings are corroded or their surface is uneven, remove the belt to turn the shaft by hand for cleaning.

Clean the rings with 220 grit emery paper. Remove as little material as possible. If the rings are deeply pitted and do not clean up, consult generator factory service.

Reinstall the belt, brush holder assembly, and end panel.

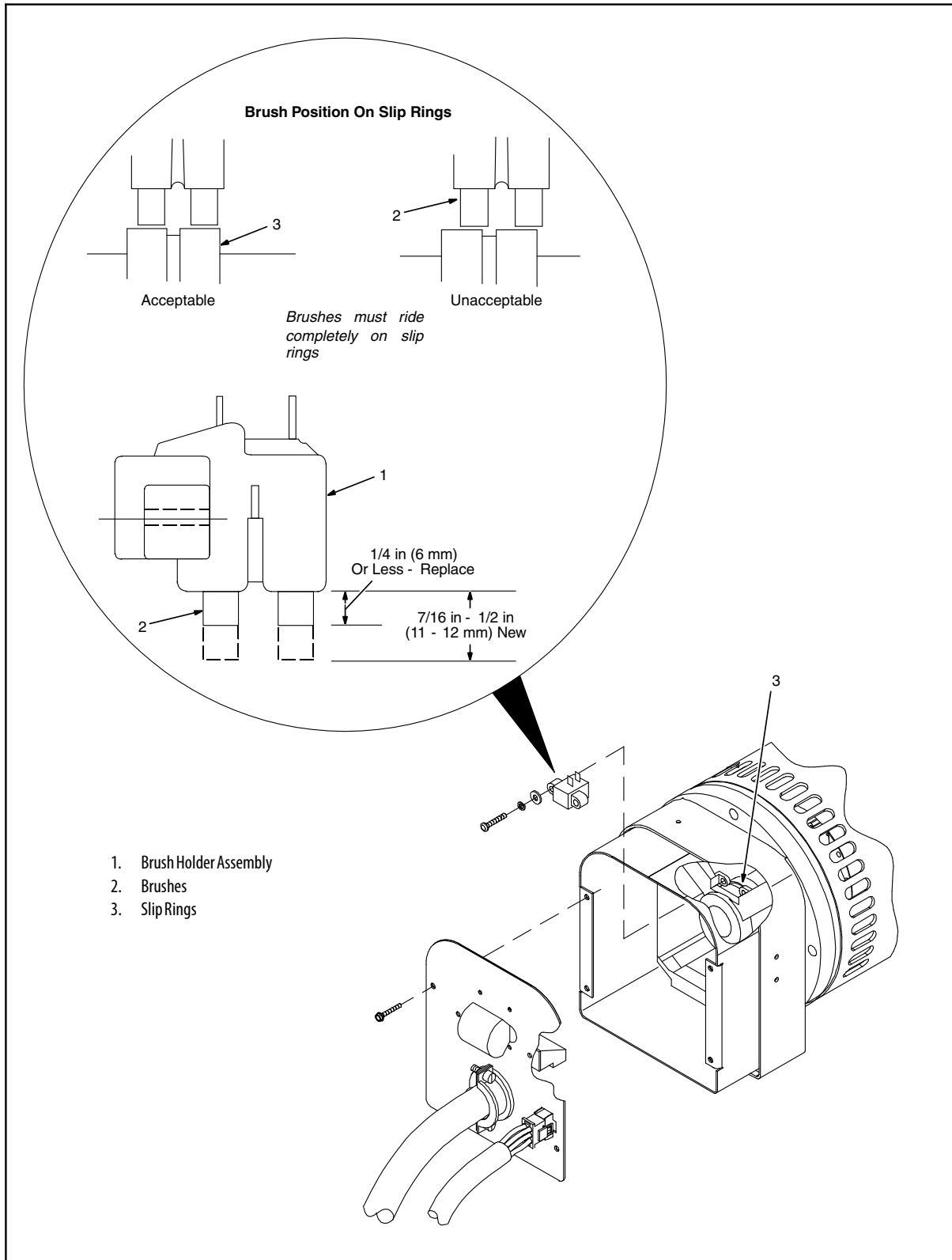


Figure 3-51. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

**Troubleshooting**

**Table 3-10. Troubleshooting**

Trouble	Remedy
No generator output at platform AC receptacles.	Be sure generator control switch is turned on at platform.
	Check and secure electrical connections at platform, generator, and control box.
	Be sure all equipment is turned off when starting unit.
	Reset circuit breaker CB1.
	Check plug PLG3 connection and/or connections at receptacles RC3 and RC5.
	Be sure + 12 volts DC input voltage is being supplied to control box.
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings (nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1, and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Low generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1, and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
High generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Erratic generator output at platform AC receptacles.	Check and secure electrical connections at platform, generator, and control box.
	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.

## Generator Disassembly and Assembly

Refer to Figure 3-53. and Figure 3-54. to determine if trouble is in stator, rotor, control box, or combination of these components.

1. Rotor
2. Stator Assembly

### **⚠ CAUTION**

**DO NOT DAMAGE ROTOR OR STATOR WINDINGS DURING DISASSEMBLY AND ASSEMBLY PROCEDURE.**

#### DISASSEMBLY

1. Mark and disconnect all electrical leads, secure using cable ties.

2. Remove brush holder assembly.
3. Disassemble generator parts shown in Figure 3-52.
4. Clean all parts with approved solvent and dry with compressed air, If applicable.
5. Inspect all part for damage. Replace if necessary.

#### ASSEMBLY

1. Assemble generator parts using torque values in table.
2. Reconnect all leads. Use cable ties to secure leads away from moving or hot parts.

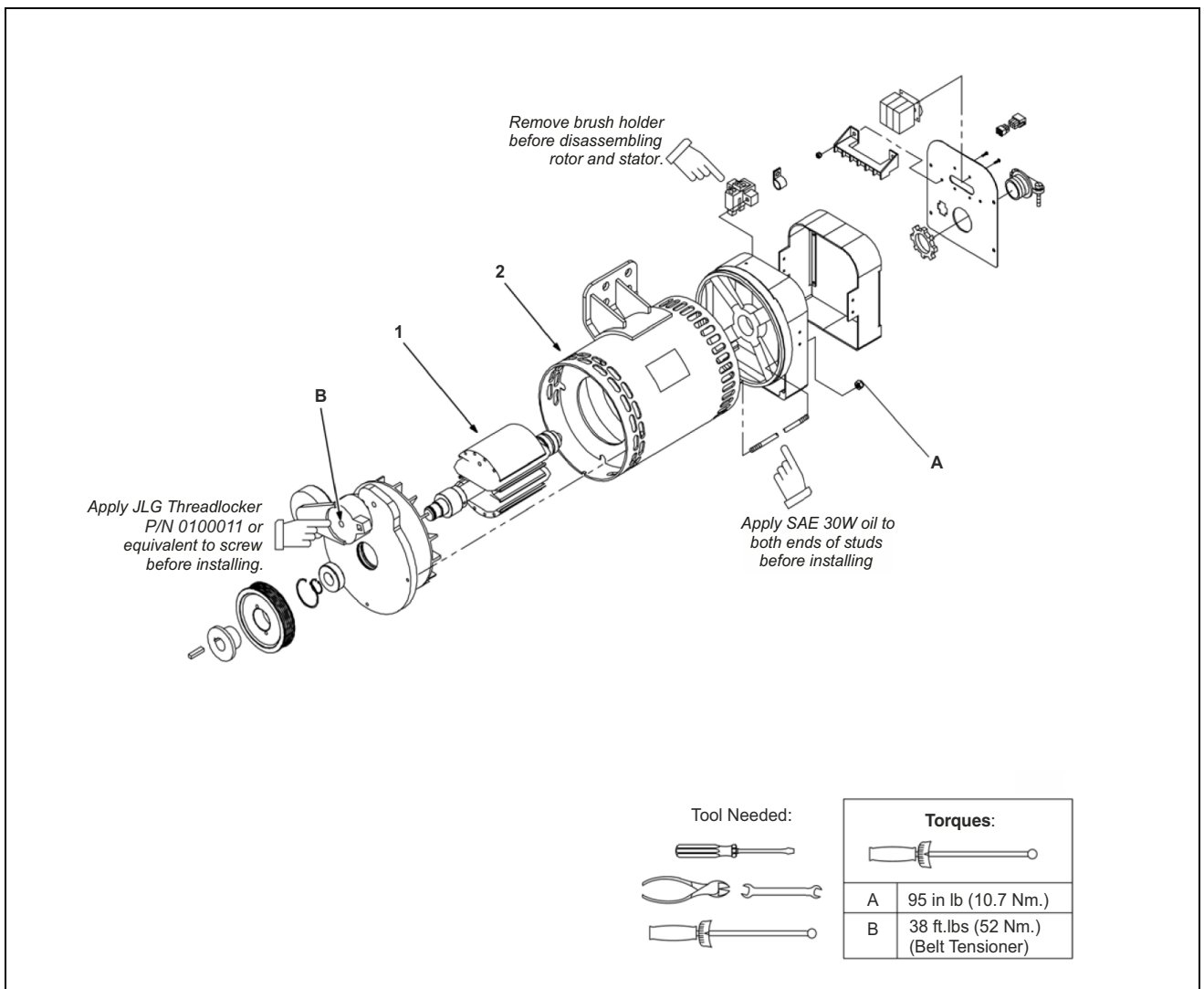


Figure 3-52. Generator Disassembly and Assembly

Resistance Values	
a)	Tolerance - $\pm 10\%$ unless specified
b)	Condition - 70°F (21°C); cold machine (no warm-up)
c)	Wiring Diagram
d)	Stop generator before checking resistance
R1	26 ohms
R2	1 ohm
R3 thru R5	Less than 1 ohm

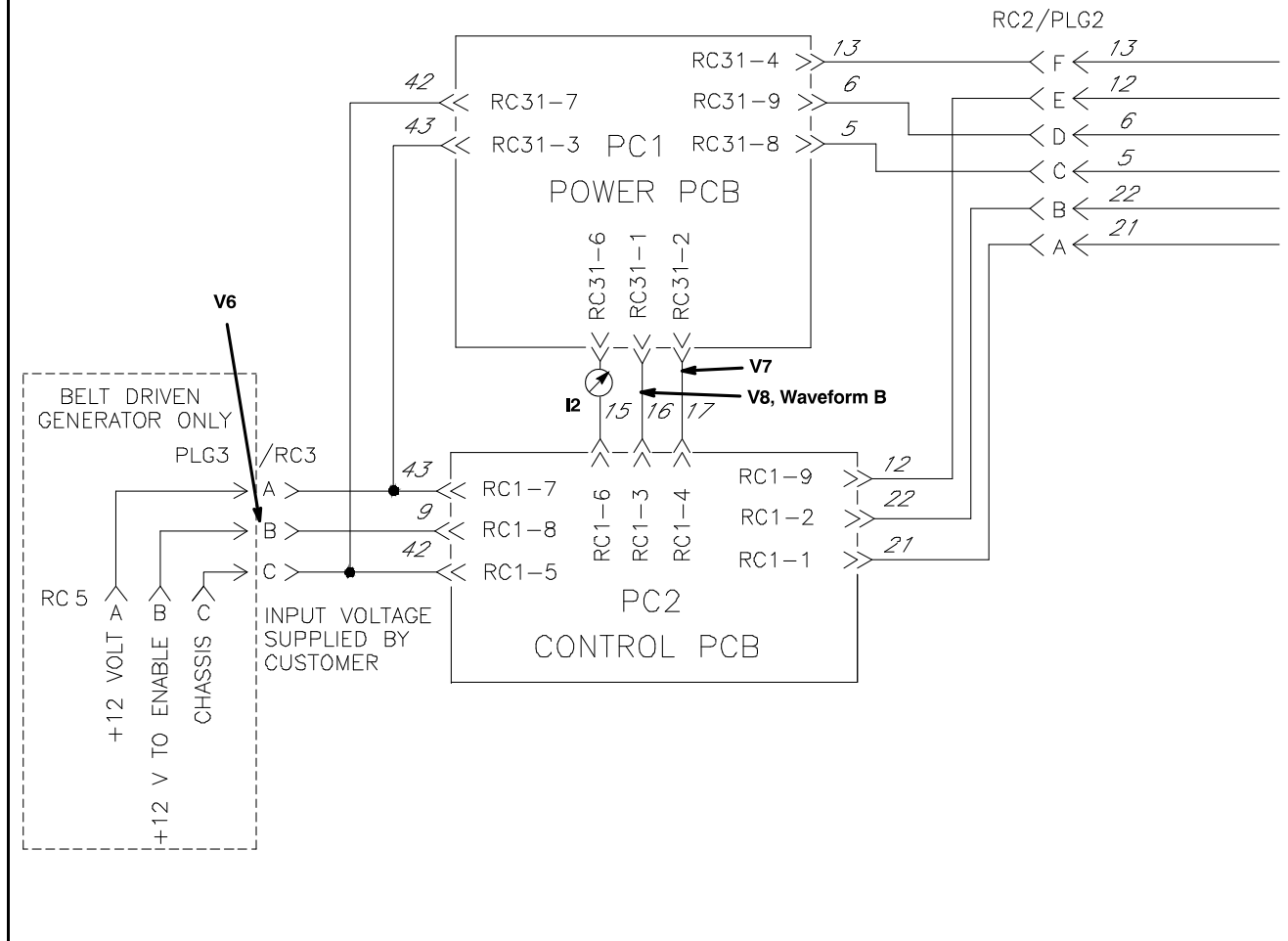


Figure 3-53. Generator Troubleshooting Circuit Diagram (Sheet 1 of 2)

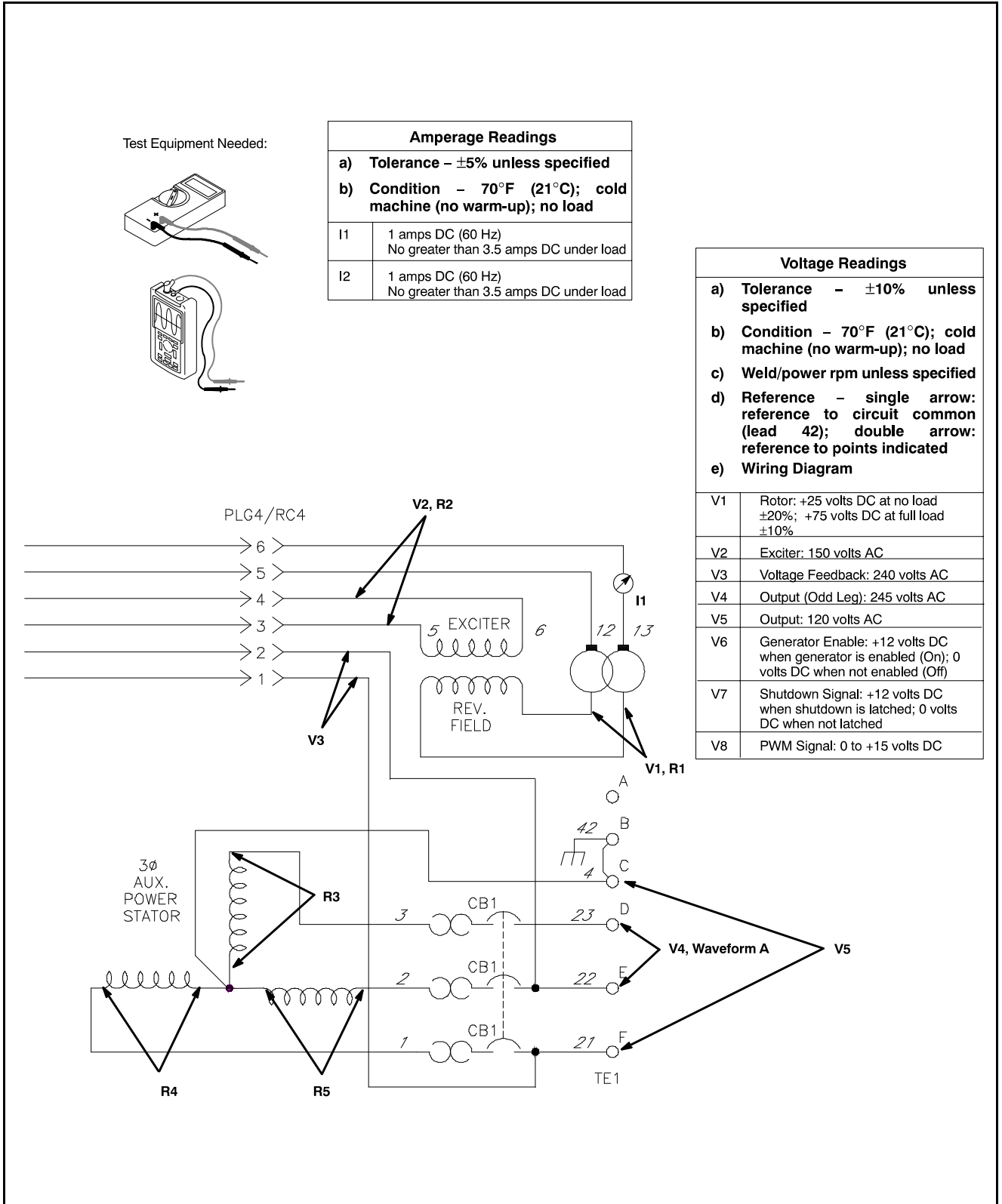


Figure 3-54. Generator Troubleshooting Circuit Diagram (Sheet 2 of 2)

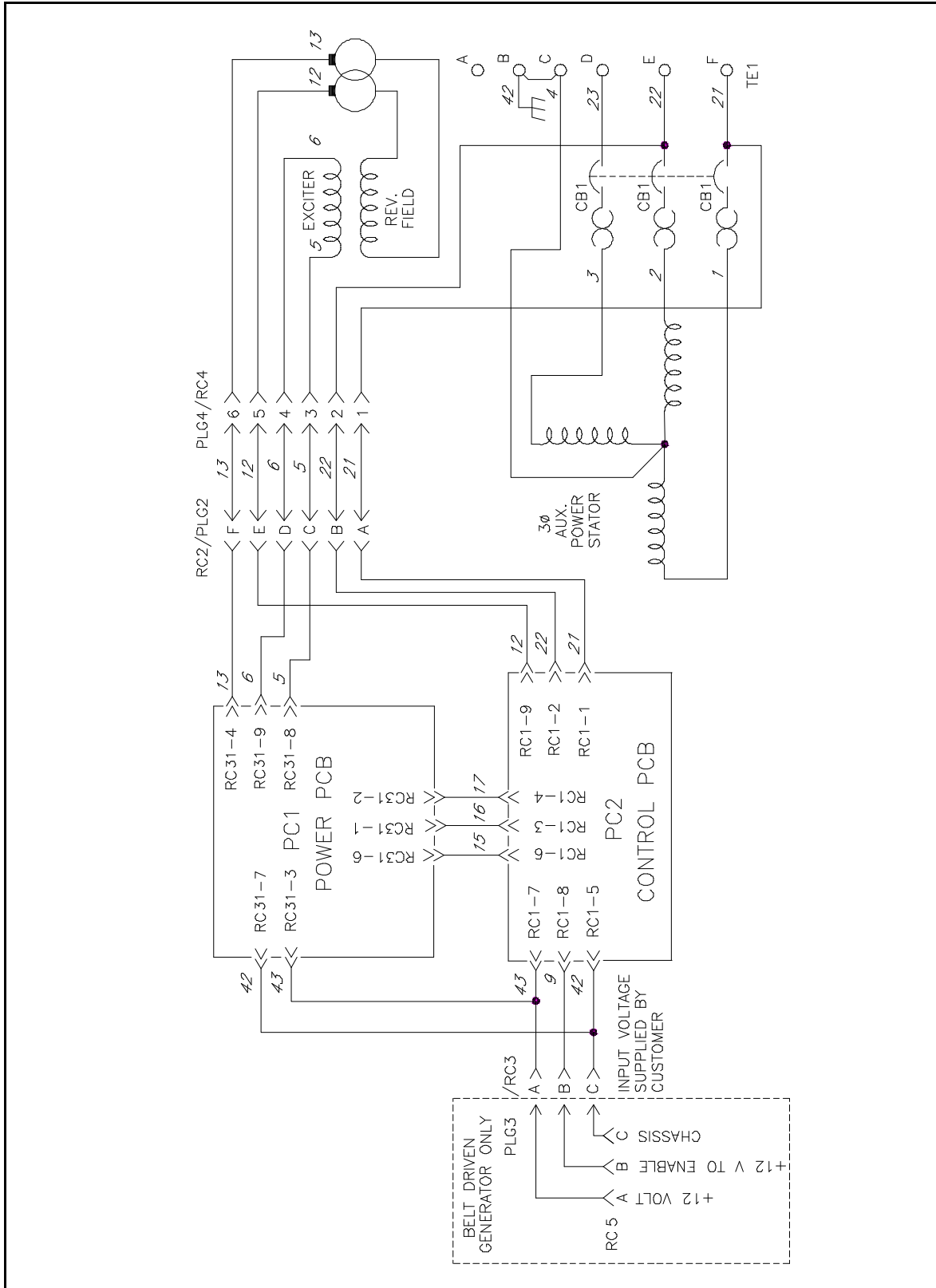


Figure 3-55. Generator Electrical Circuit Diagram

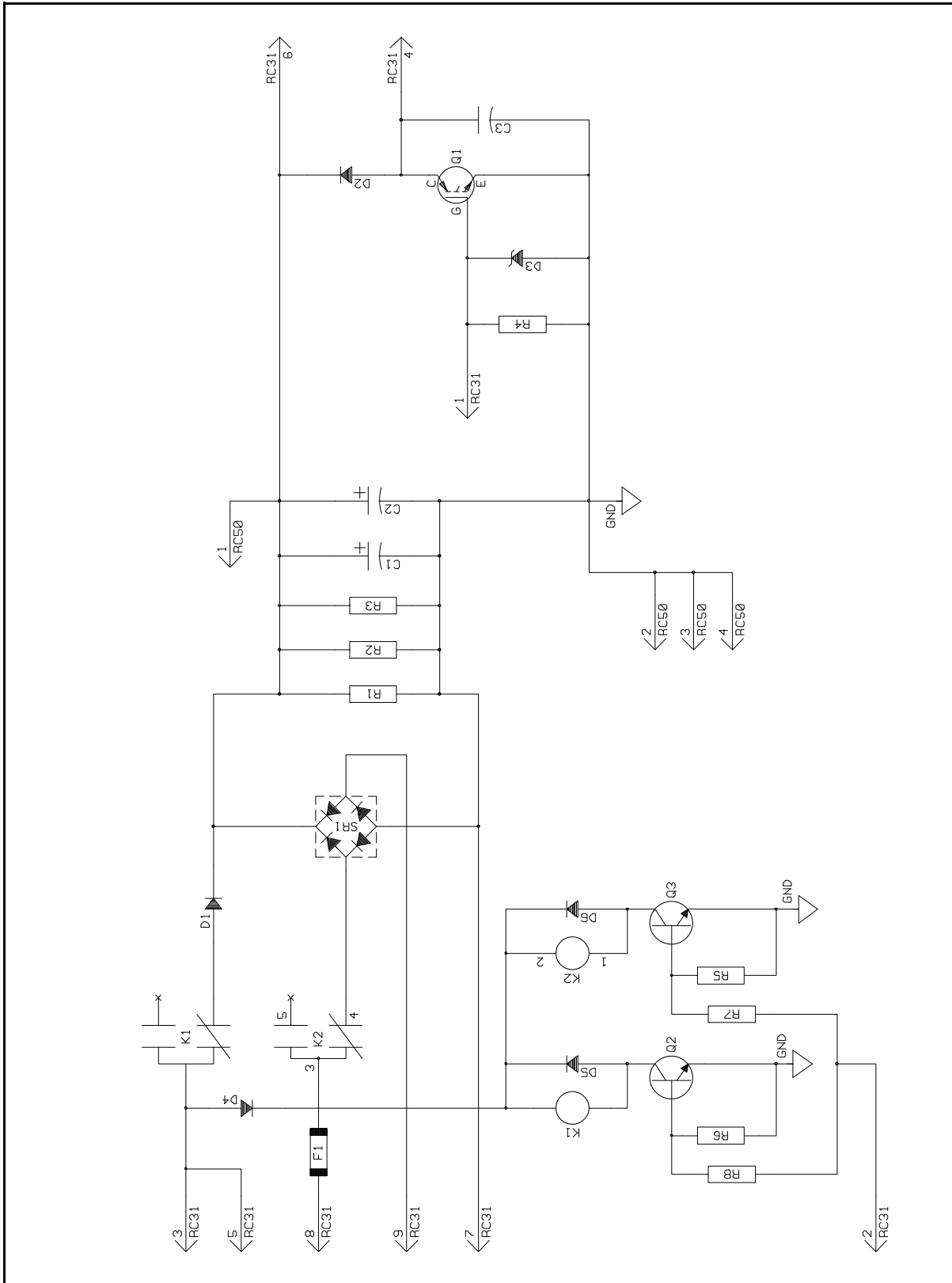
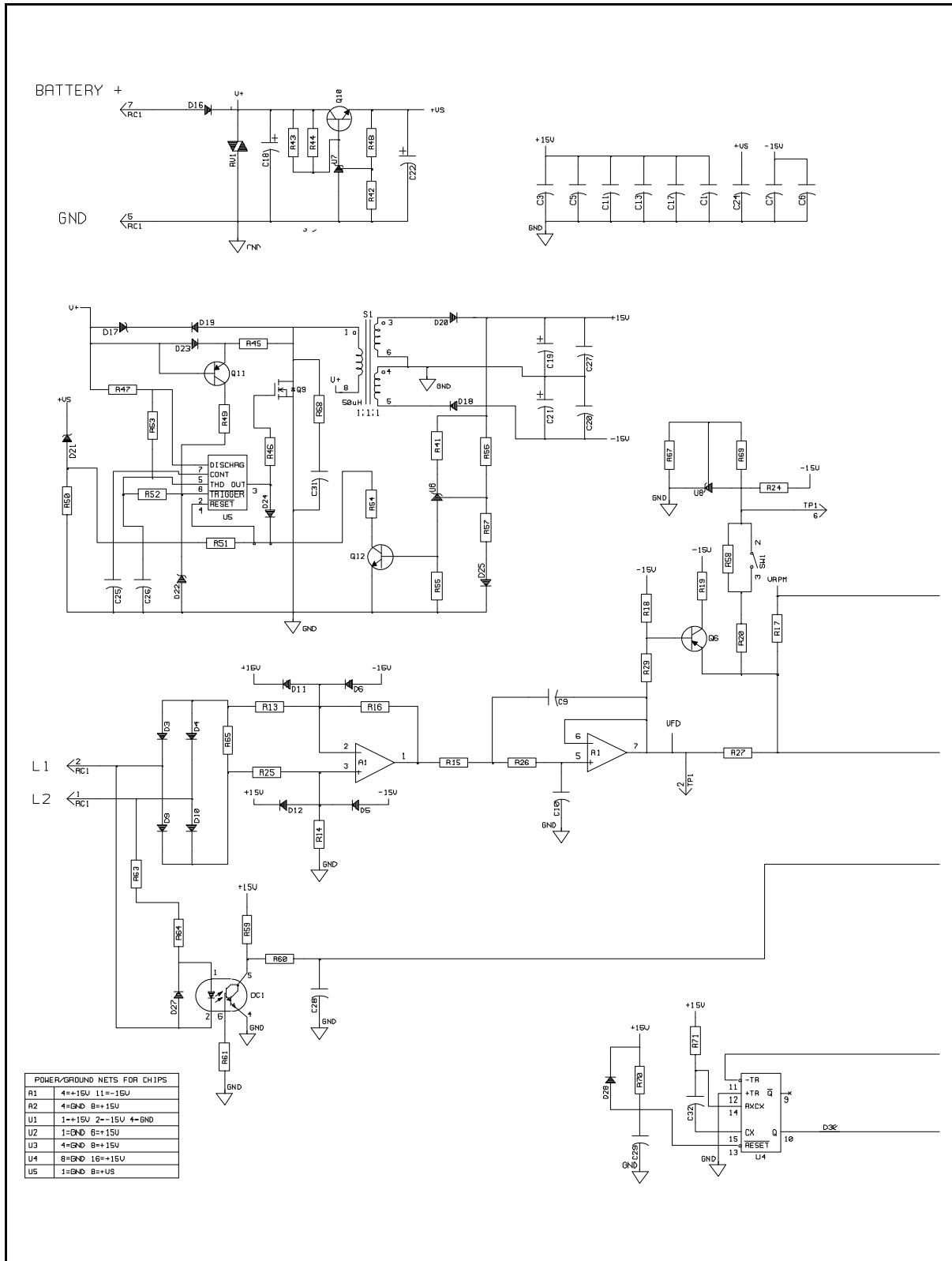


Figure 3-56. Power Board PC1 Electrical Circuit Diagram

**SECTION 3 - CHASSIS & TURNTABLE**



**Figure 3-57. Power Board PC2 Electrical Circuit Diagram (Sheet 1 of 2)**

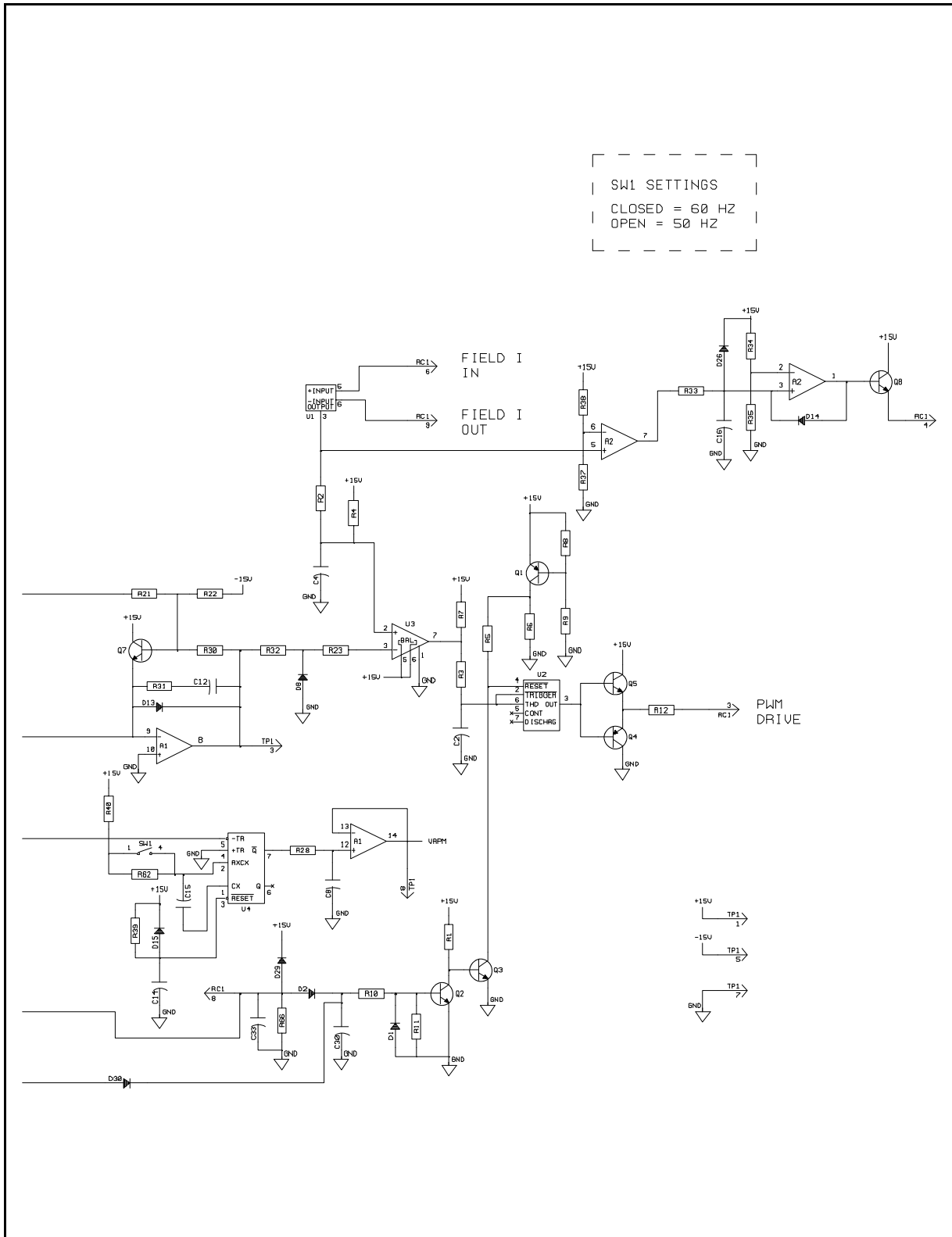


Figure 3-58. Power Board PC2 Electrical Circuit Diagram (Sheet 2 of 2)

**Lead Connection List for Generator**

**NOTE:** Apply small amount of dielectric grade, nonconductive electric grease to connectors where factory-applied grease had been present.

**NOTE:** Table shows physical lead connections and should be used with circuit diagram (table replaces wiring diagram).

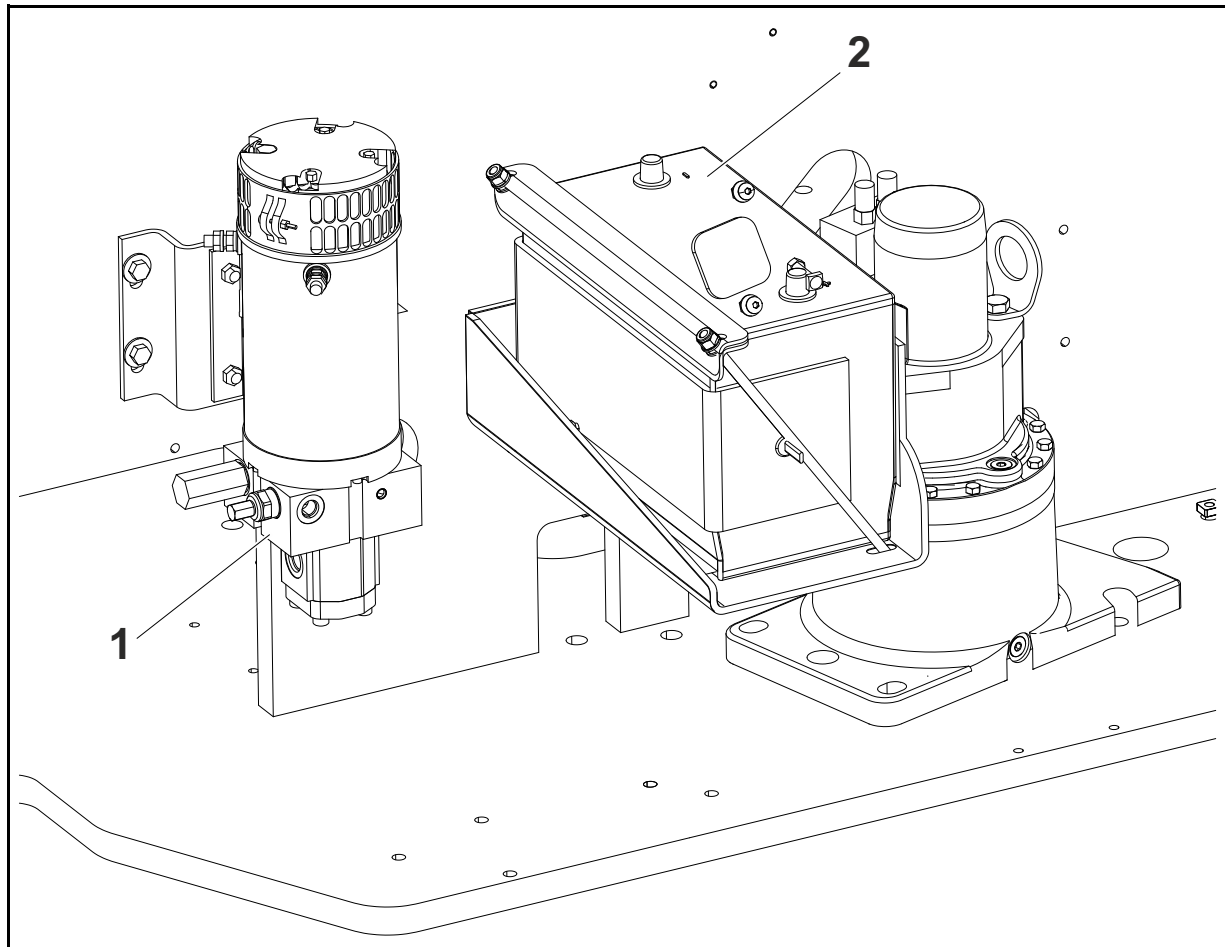
**Table 3-11. Lead Connection List for Generator**

Leads	Connections
1A	STATOR TO CB1
2A	STATOR TO CB1
3A	STATOR TO CB1
4A	STATOR TO TE1 (C)
5A	STATOR TO RC4 (3)
5B	PLG2 (C) TO PLG4 (3)
5C	RC2 (C) PLG31 (8)
6A	STATOR TO RC4 (4)
6B	PLG2 (D) TO PLG4 (4)
6C	RC2 (D) PLG31 (9)
9A	RC5 (B) TO PLG3 (B) (Customer Supplied)
9B	RC3 (B) PLG1 (8)
12A	PLG2 (E) TO PLG4 (5)
12B	RC2 (E) PLG1 (9)
12C	RC4 (5) TO BRUSH
13A	PLG2 (F) TO PLG4 (6)
13B	RC2 (F) PLG31 (4)
13C	RC4 (6) TO BRUSH
15A	PLG1 (6) TO PLG31 (6)
16A	PLG1 (3) TO PLG31 (1)
17A	PLG1 (4) TO PLG31 (2)
21A	CB1 TO TE1 (F)
21B	PLG2 (A) TO PLG4 (1)
21C	PLG1 (1) TO RC2 (A)
21D	RC4 (1) TO CB1
22A	CB1 TO TE1 (E)
22B	PLG2 (B) TO PLG4 (2)
22C	PLG1 (2) TO RC2 (B)
22D	RC4 (2) TO CB1
23A	CB1 TO TE1 (D)
42A	RC5 (C) TO PLG3 (C) (Customer Supplied)
42B	RC3 (C) TO CONNECTION POINT 1
42C	PLG31 (7) TO CONNECTION POINT 1
42D	PLG1 (5) TO CONNECTION POINT 1
42F	END BELL SHROUD TO ENGINE MOUNT
42G	CHASSIS TO TE1 (B)
43A	RC5 (A) TO PLG3 (A) (Customer Supplied)
43B	RC3 (A) TO CONNECTION POINT 2
43C	PLG31 (3) TO CONNECTION POINT 2
43D	PLG1 (7) TO CONNECTION POINT 2

### 3.16 AUXILIARY POWER SYSTEM

The auxiliary power system is intended as a secondary means of moving the boom in the event of primary power loss. This system uses an electric motor/pump unit powered by a 12V (extended upto 24V DC) battery.

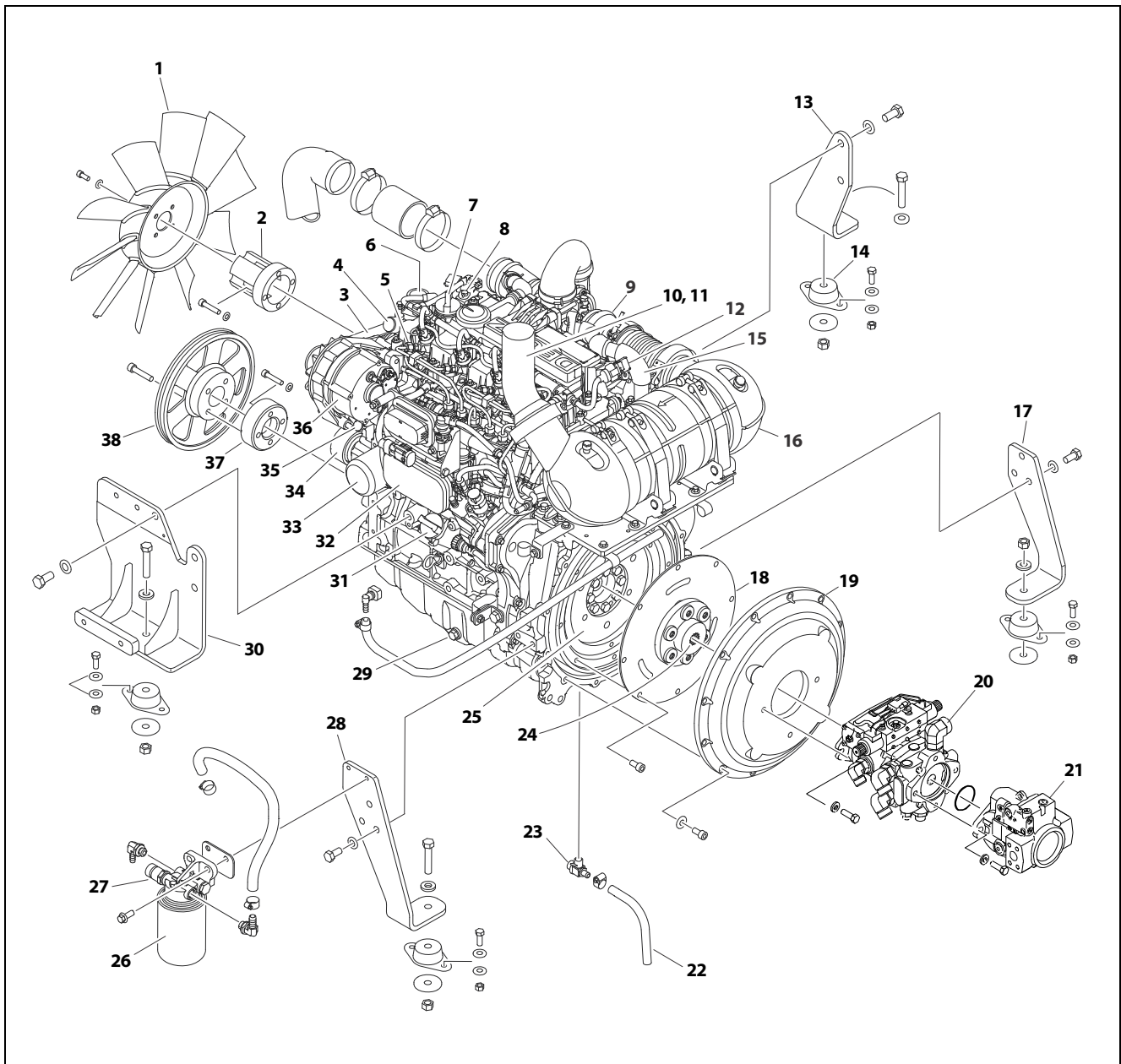
The auxiliary pump functions to provide sufficient oil flow to operate the basic machine functions should the main pump or engine fail. The auxiliary pump will operate tower boom lift, tower telescope, main boom lift, main telescope and swing. The Auxiliary Power control switch energizes the electrically operated hydraulic pump.



1. Auxiliary Pump
2. Battery

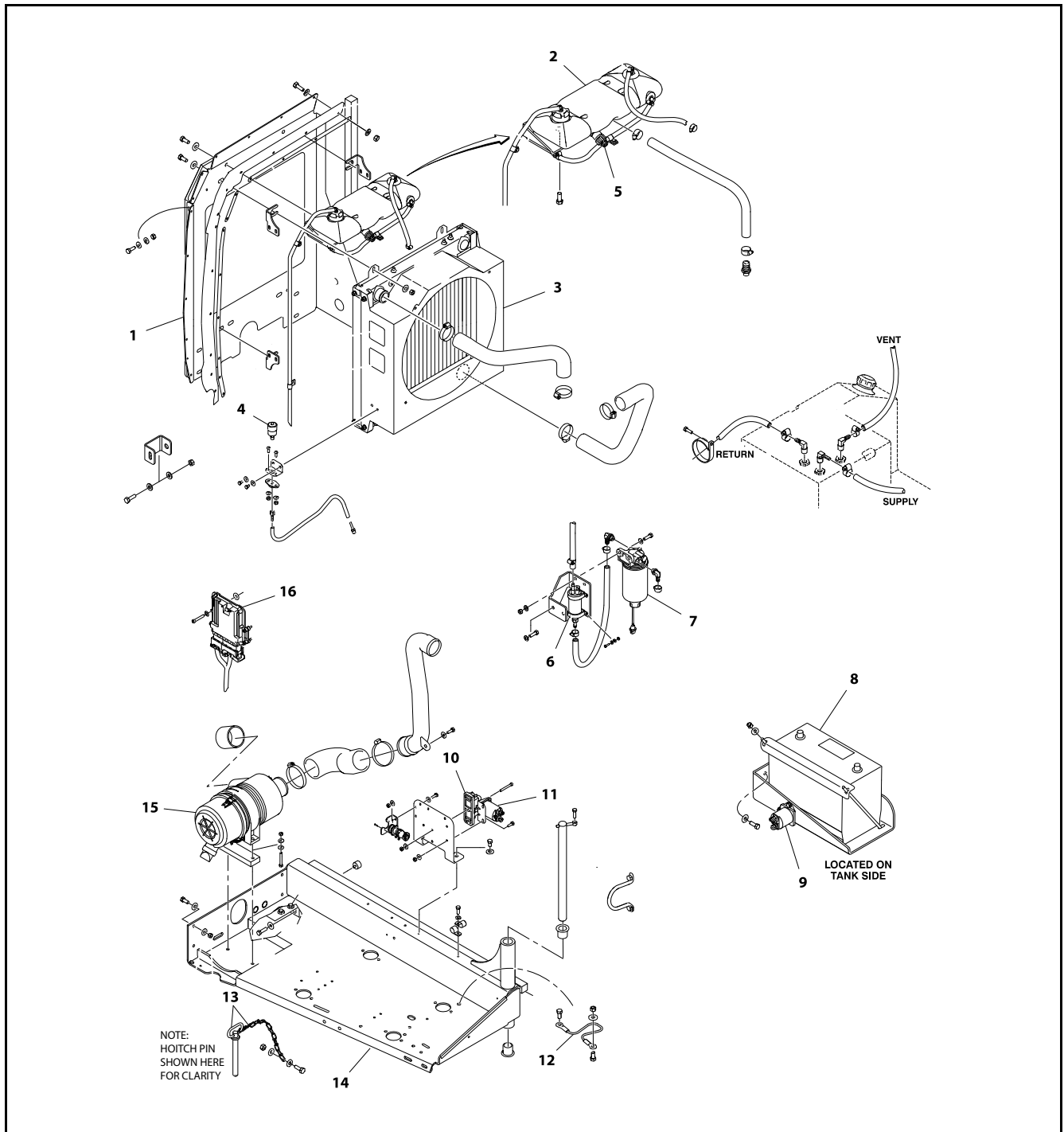
**Figure 3-59. Auxiliary Power System**

3.17 DEUTZ ENGINE



- |                       |                                 |                        |                                  |                    |
|-----------------------|---------------------------------|------------------------|----------------------------------|--------------------|
| 1. Fan                | 9. Turbocharger                 | 17. Rear Engine Mount  | 25. Flywheel                     | 33. Oil Filter     |
| 2. Adapter            | 10. Exhaust Pipe                | 18. Coupling           | 26. Fuel Filter                  | 34. Belt Tensioner |
| 3. Drive Belt         | 11. Spark Arrester              | 19. Pump Adapter Plate | 27. Pressure Sensor              | 35. Plug           |
| 4. Water Pump         | 12. Pressure Sensor             | 20. Pump Assembly      | 28. Rear Engine Mount            | 36. Alternator     |
| 5. Fuel Injector      | 13. Front Engine Mount          | 21. Gear Pump Assembly | 29. Oil Pan Drain Plug           | 37. Adapter        |
| 6. Thermostat         | 14. Motor Mount                 | 22. Oil Drain Hose     | 30. Front Engine/Generator Mount | 38. Pulley         |
| 7. Oil Fill Cap       | 15. Shuttle Valve               | 23. Oil Drain Valve    | 31. Oil Fill Cap                 |                    |
| 8. Temperature Sender | 16. Catalytic Converter/Muffler | 24. Pump Coupler       | 32. Oil Cooler                   |                    |

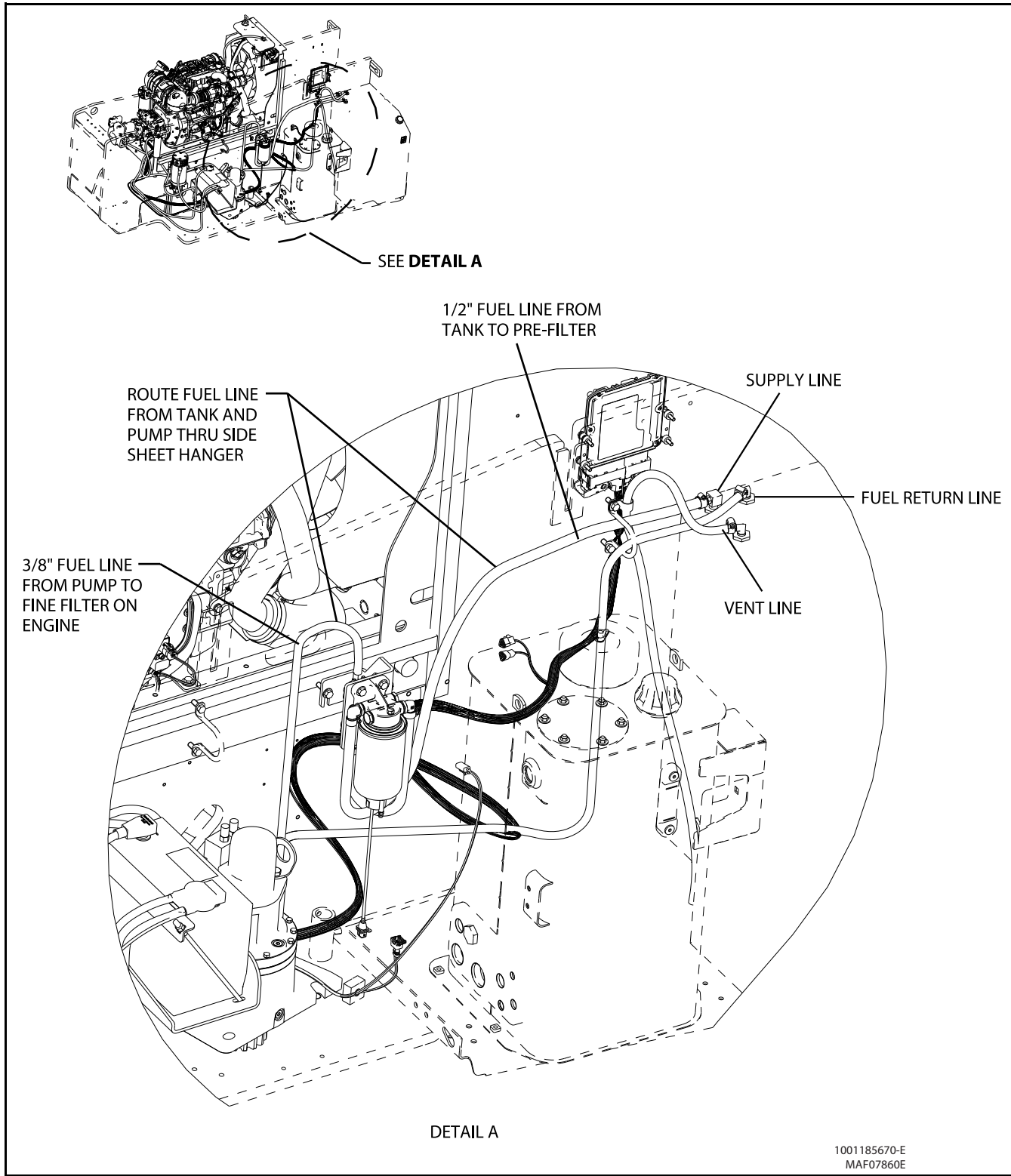
Figure 3-60. Deutz TD2.9L4 Engine Components - Sheet 1 of 2



- |                                 |                         |                        |                               |
|---------------------------------|-------------------------|------------------------|-------------------------------|
| 1. Radiator Assembly            | 5. Coolant Level Sensor | 9. Battery Relay       | 13. Hitch Pin                 |
| 2. Coolant Recovery Tank        | 6. Fuel Pump            | 10. Power Module Relay | 14. Engine Tray               |
| 3. Air Filter Service Indicator | 7. Fuel Pre-Filter      | 11. Relay              | 15. Air Filter Assembly       |
| 4. Coolant Overflow Hose        | 8. Battery              | 12. Lanyard            | 16. Engine Control Unit (ECU) |

Figure 3-61. Deutz TD2.9L4 Engine Components - Sheet 2 of 2

**SECTION 3 - CHASSIS & TURNTABLE**



**Figure 3-62. Deutz TD2.9L4 Engine Installation (800A) - Sheet 1 of 8**

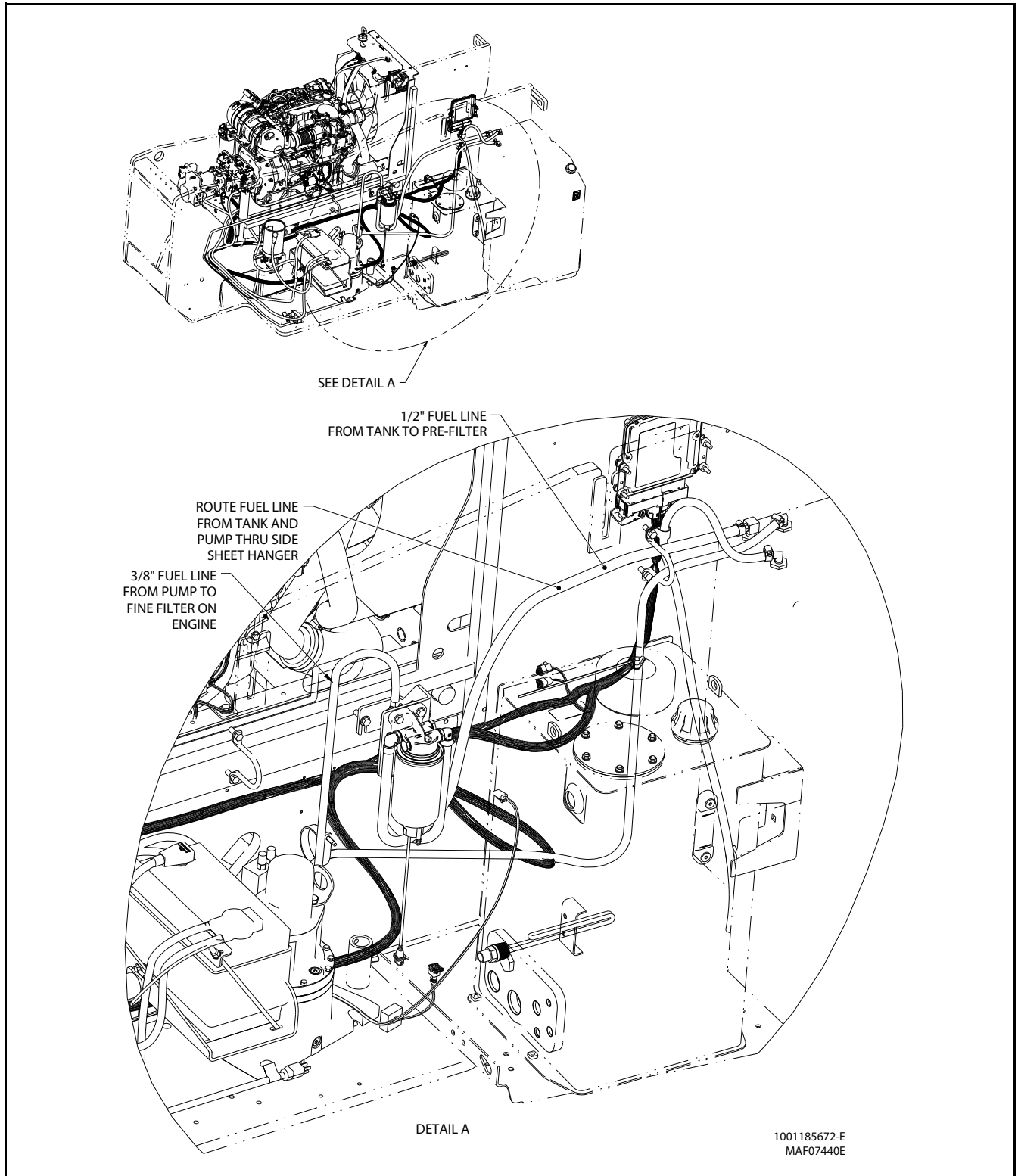


Figure 3-63. Deutz TD2.9L4 Engine Installation (800AJ) - Sheet 2 of 8

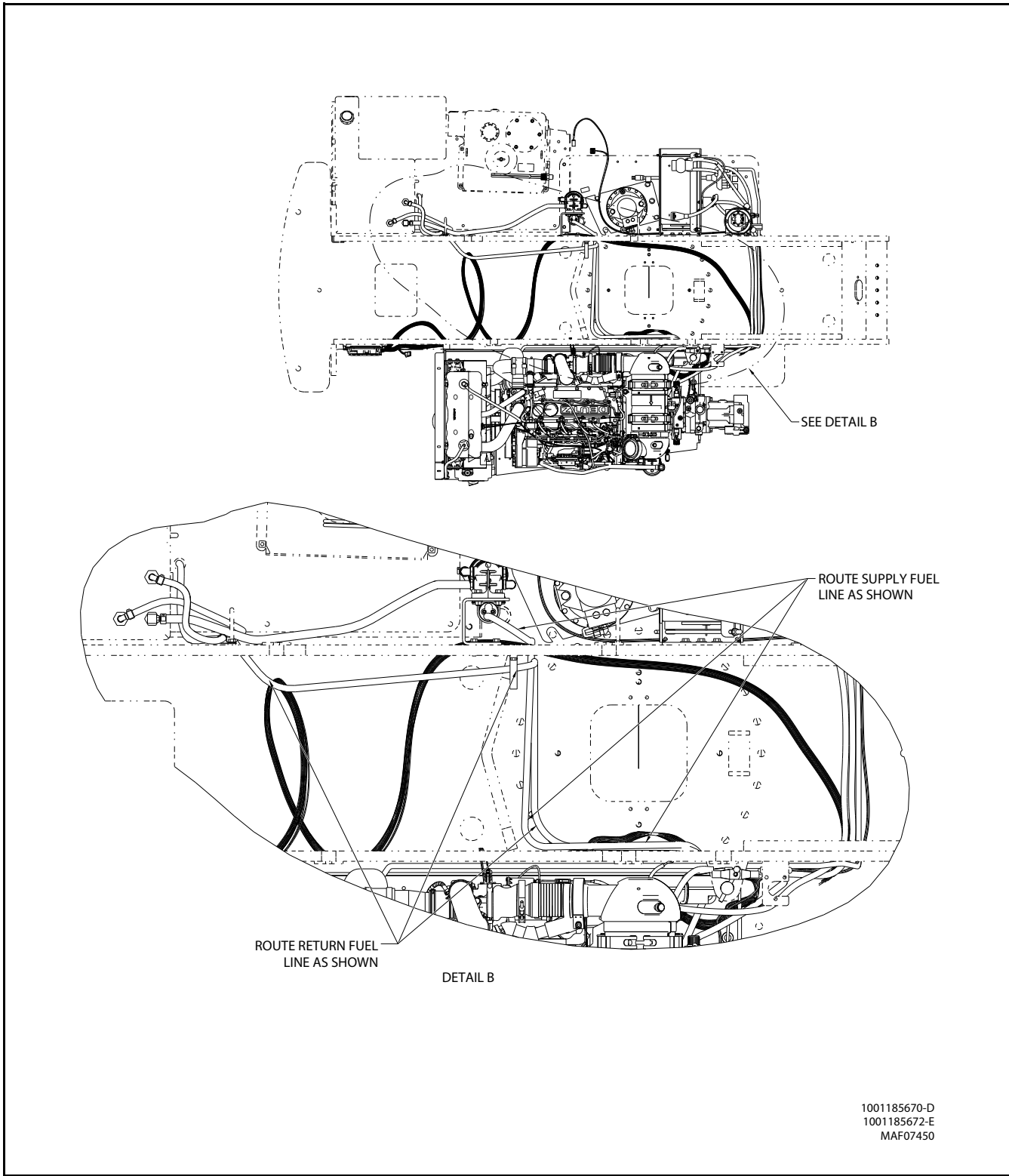


Figure 3-64. Deutz TD2.9L4 Engine Installation - Sheet 3 of 8

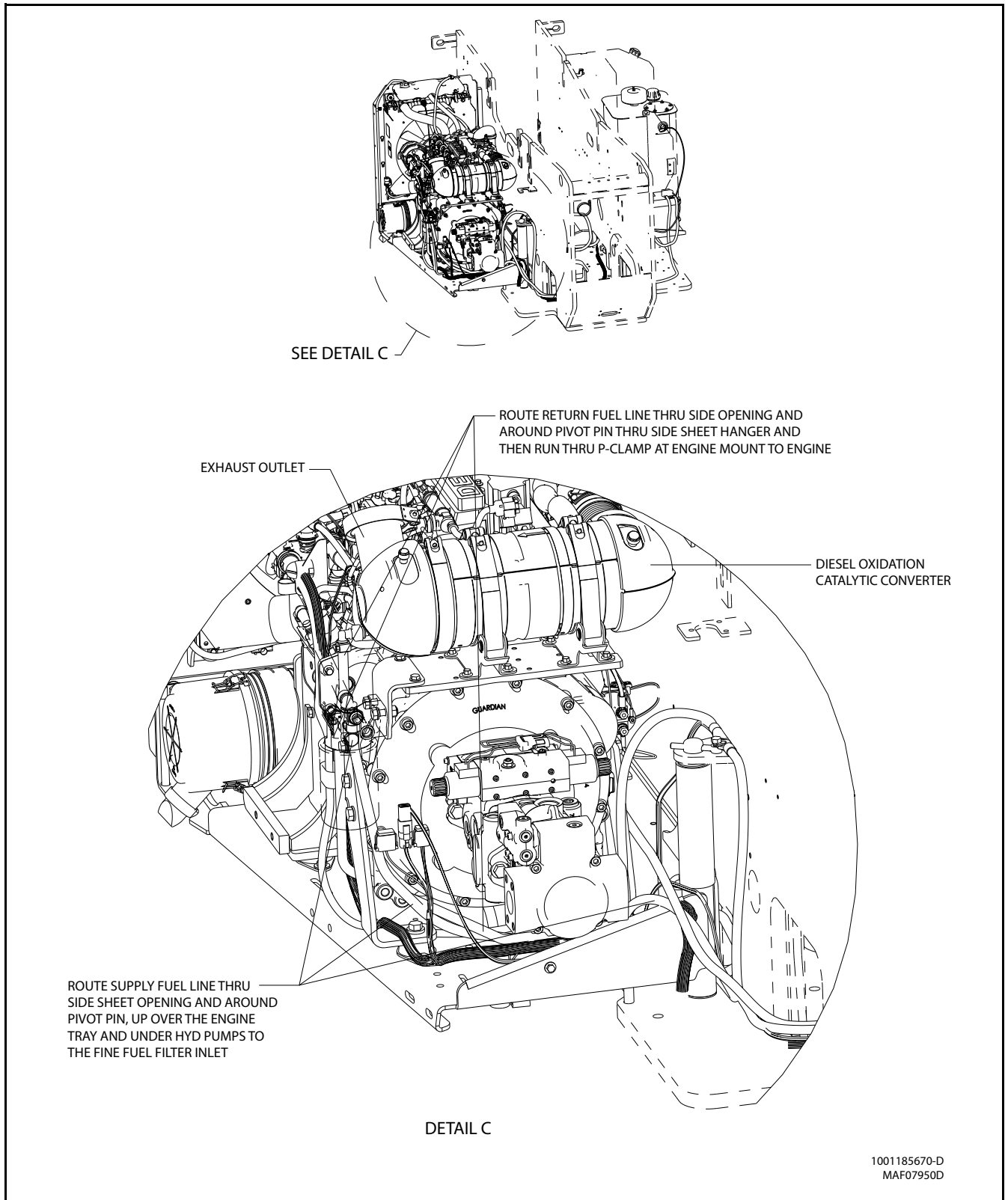


Figure 3-65. Deutz TD2.9L4 Engine Installation (800A) - Sheet 4 of 8

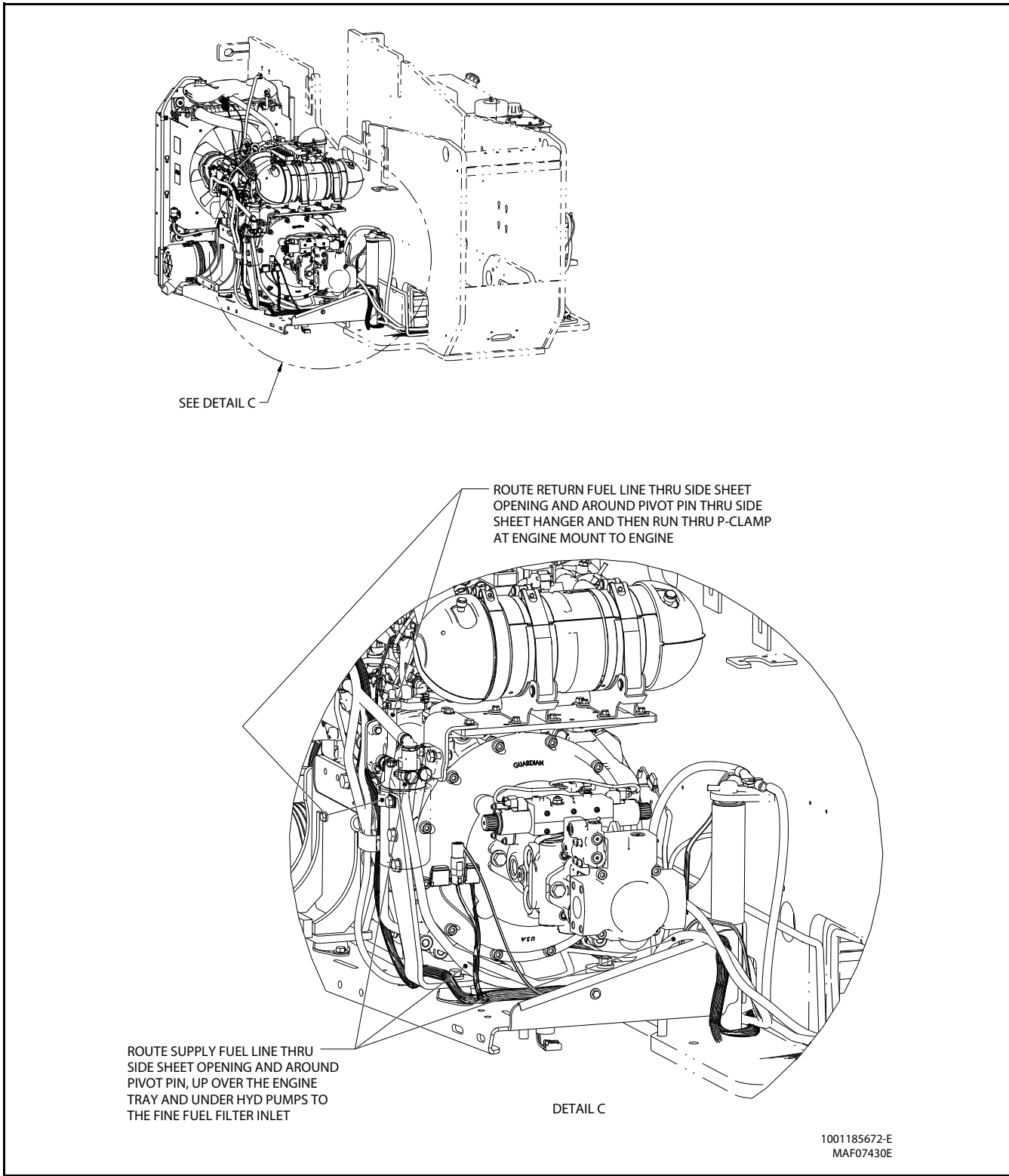


Figure 3-66. Deutz TD2.9L4 Engine Installation (800AJ) - Sheet 5 of 8

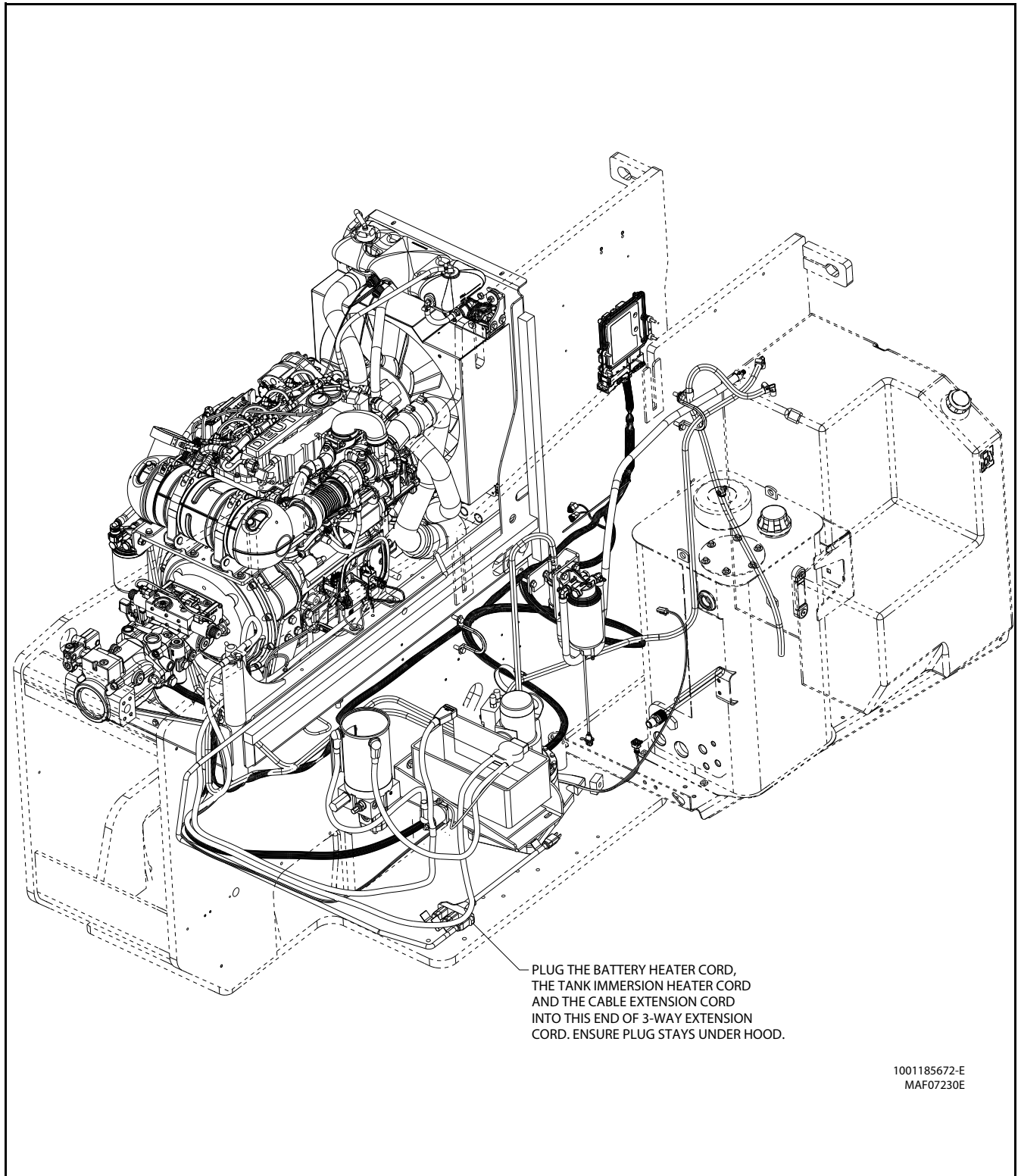
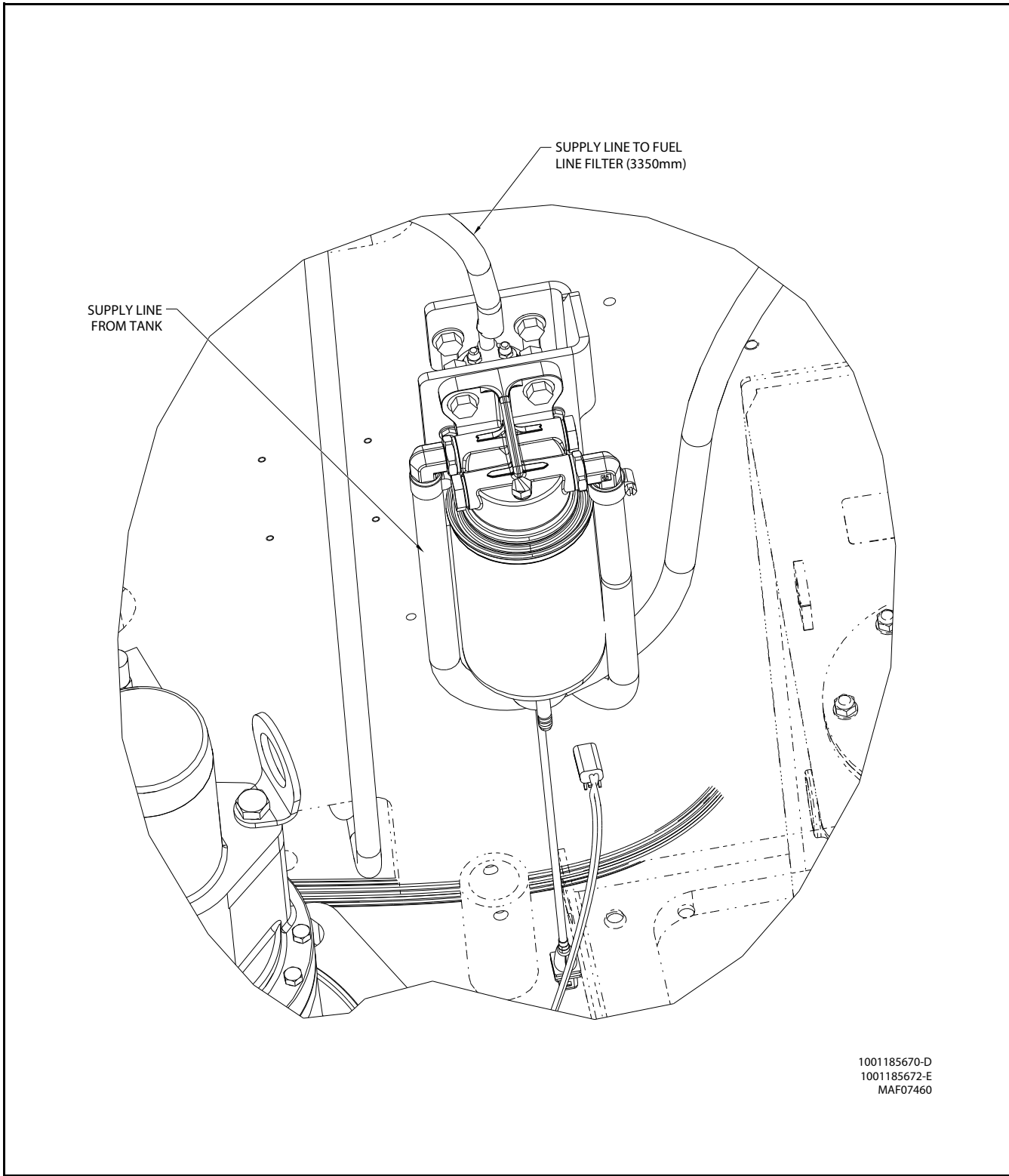
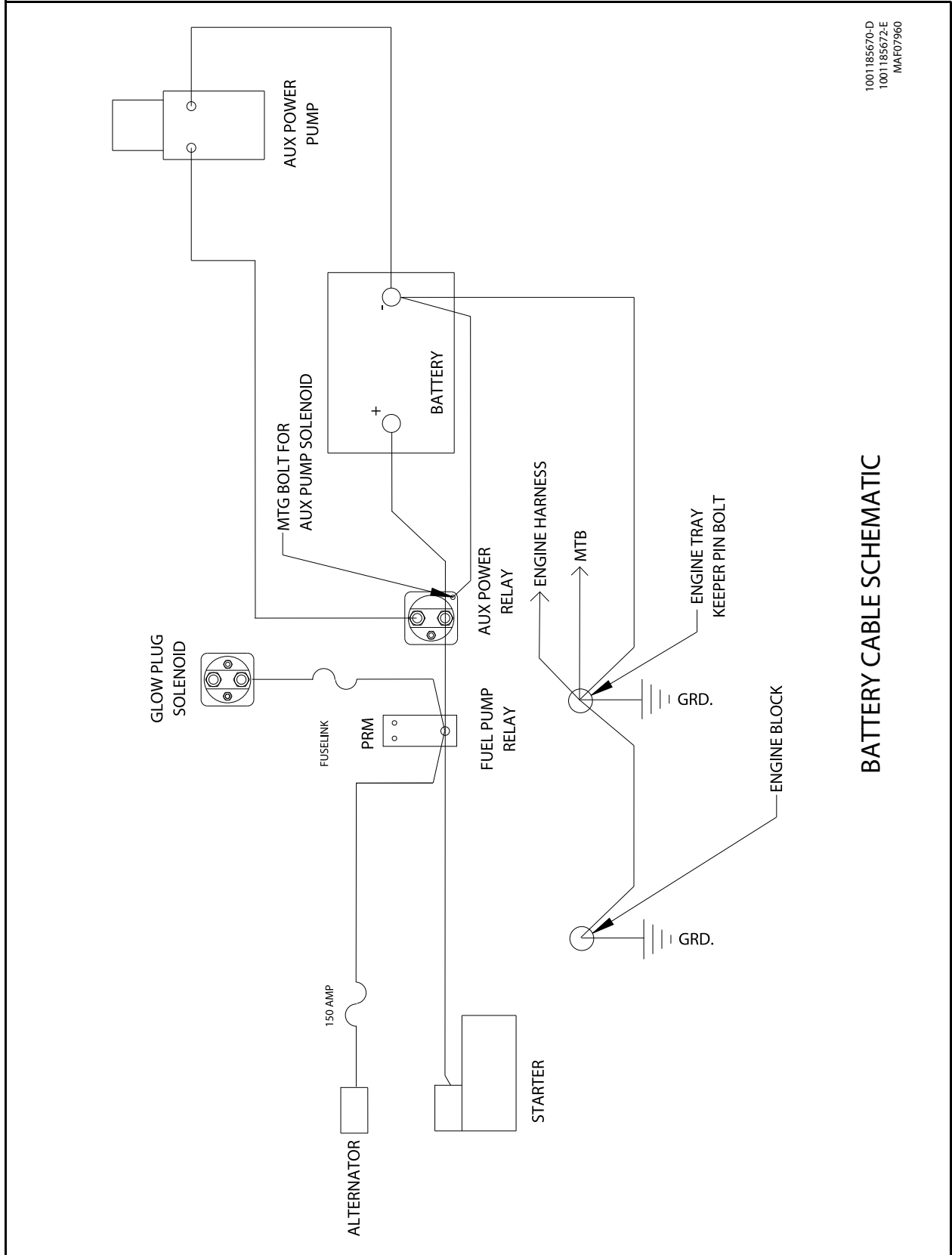


Figure 3-67. Deutz TD2.9L4 Engine Installation (800AJ) - Sheet 6 of 8



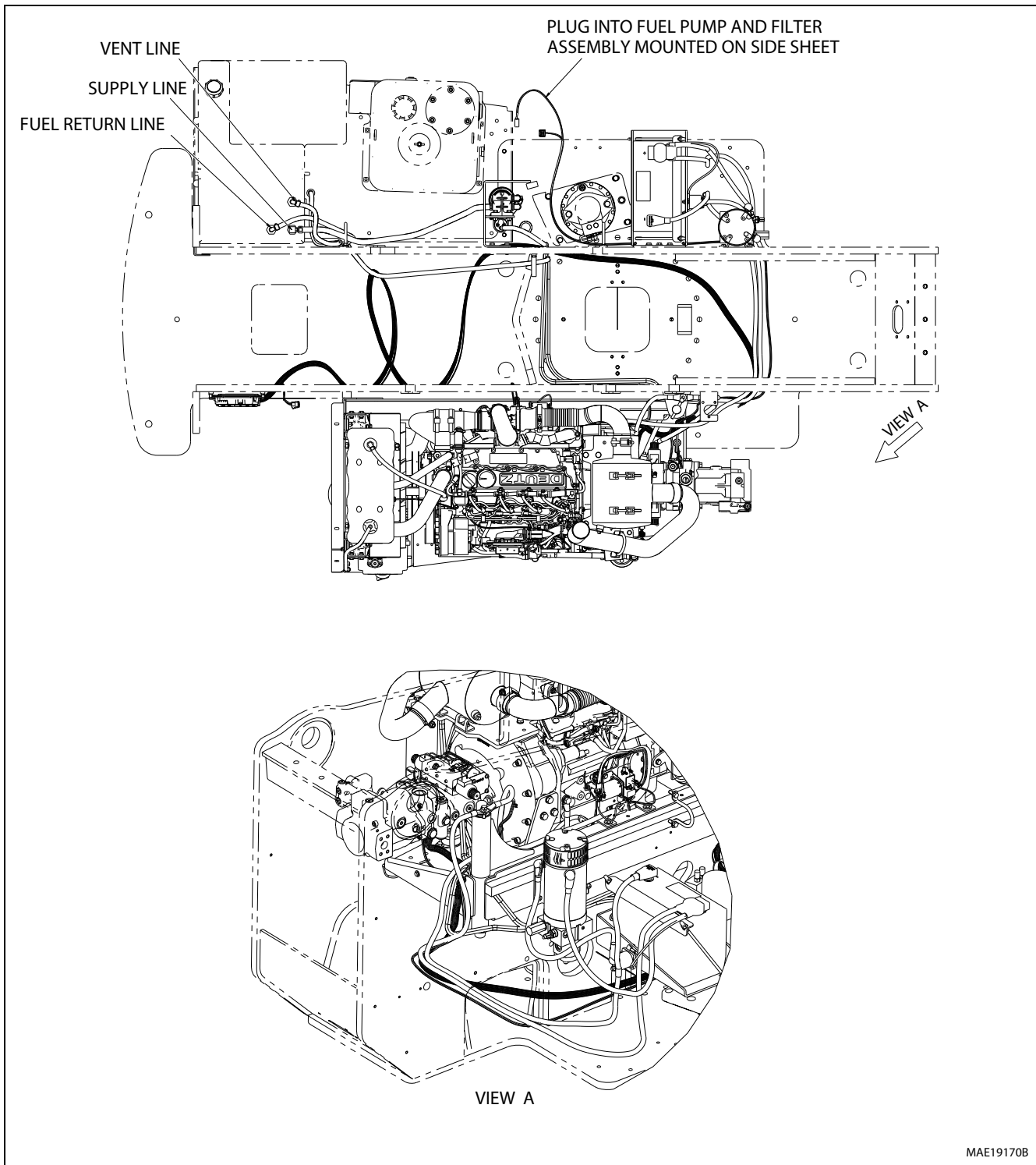
**Figure 3-68. Deutz TD2.9L4 Engine Installation- Sheet 7 of 8**



BATTERY CABLE SCHEMATIC

Figure 3-69. Deutz TD2.9L4 Engine Installation -Sheet 8 of 8

**SECTION 3 - CHASSIS & TURNTABLE**



**Figure 3-70. Deutz TD2.9L4 China III Engine Installation - Sheet 1 of 7**

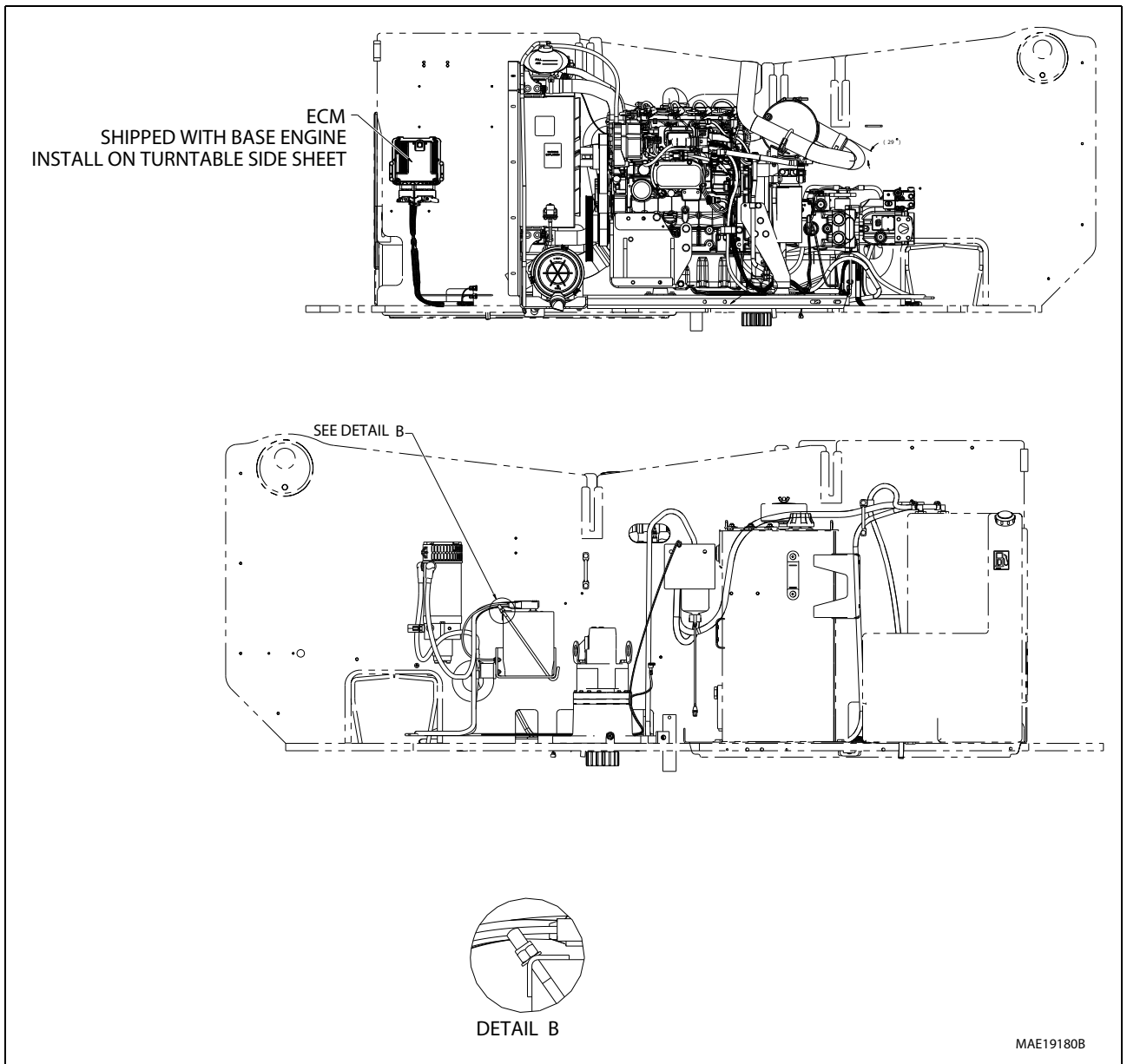


Figure 3-71. Deutz TD2.9L4 China III Engine Installation - Sheet 2 of 7

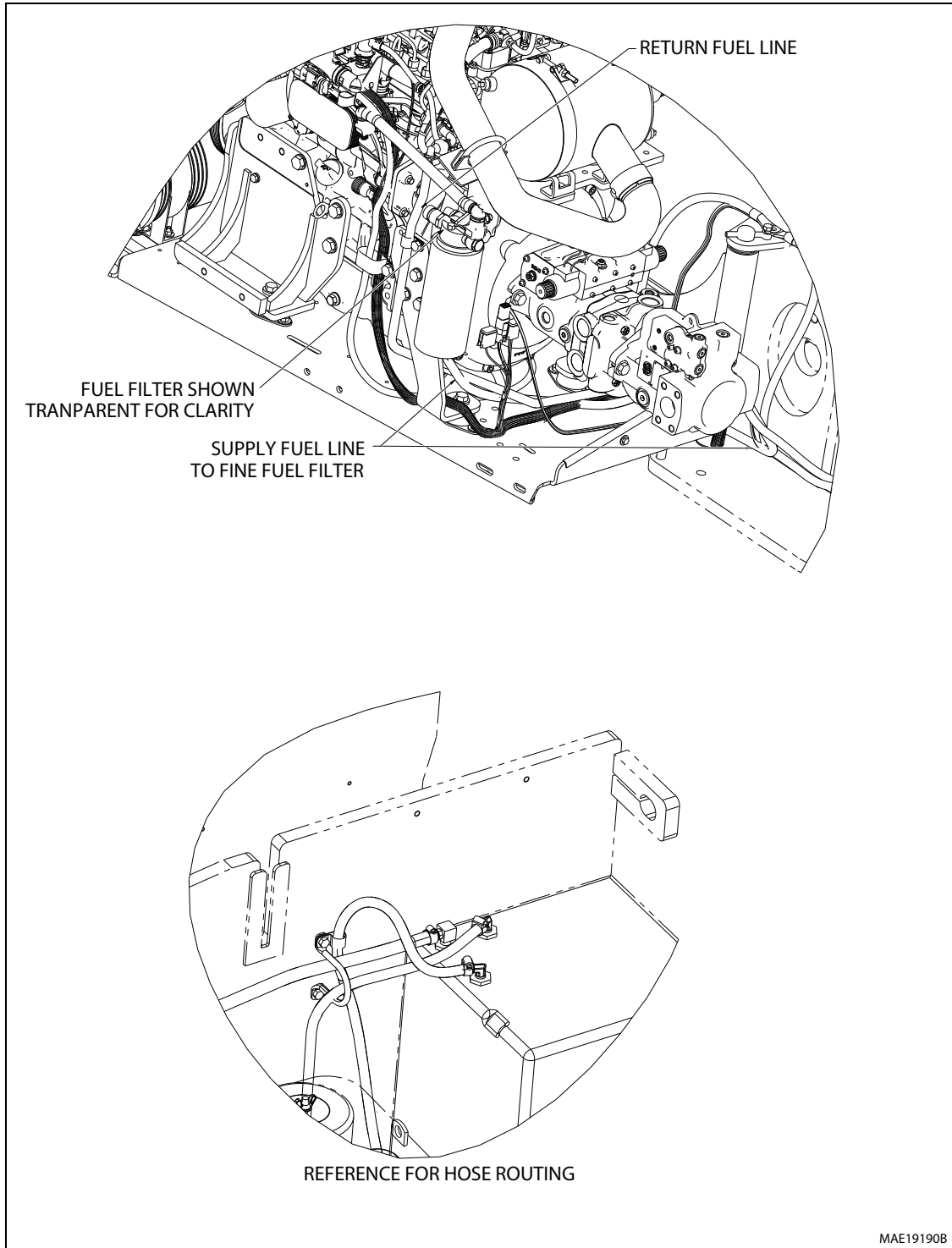


Figure 3-72. Deutz TD2.9L4 China III Engine Installation - Sheet 3 of 7

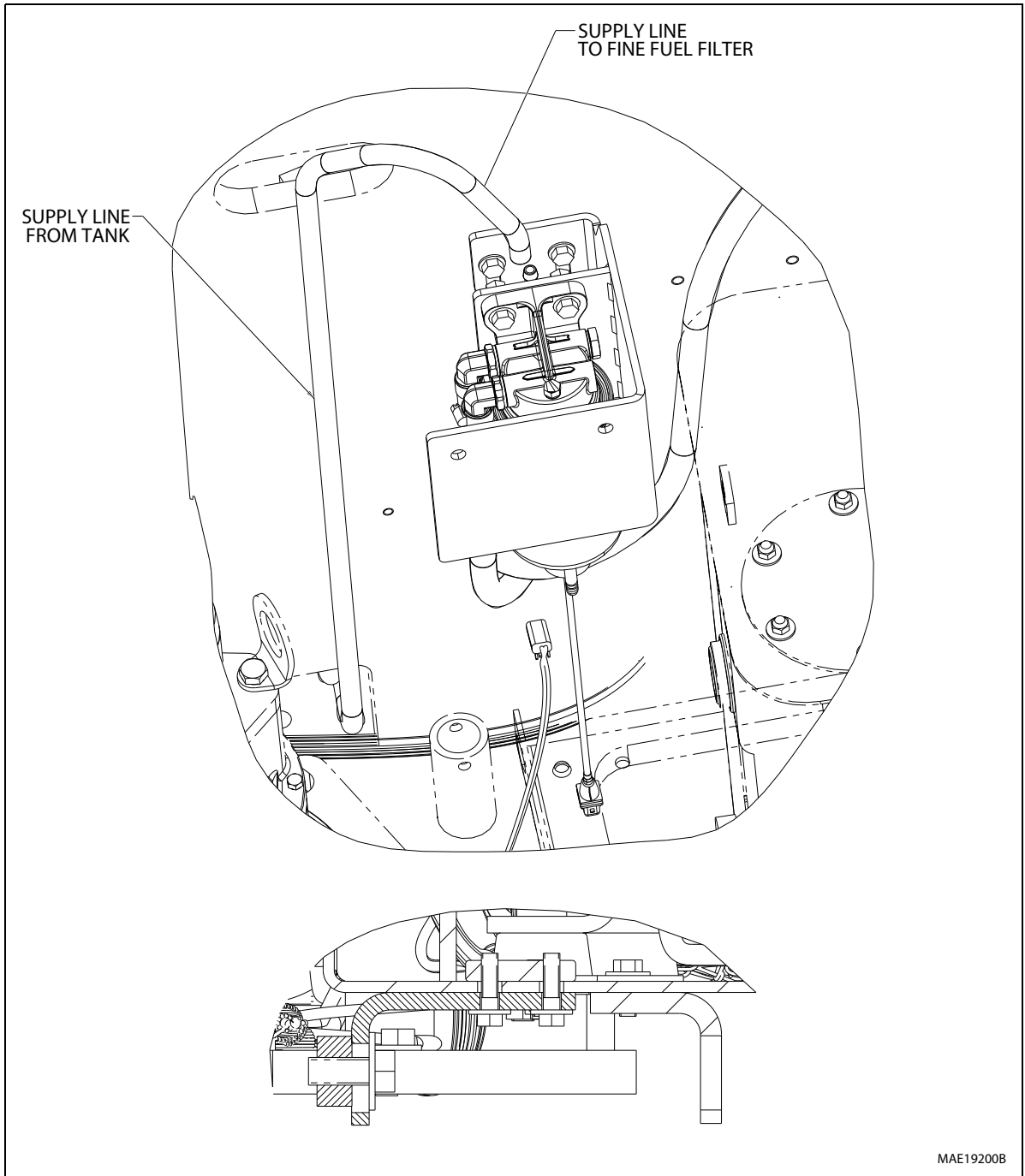


Figure 3-73. Deutz TD2.9L4 China III Engine Installation - Sheet 4 of 7

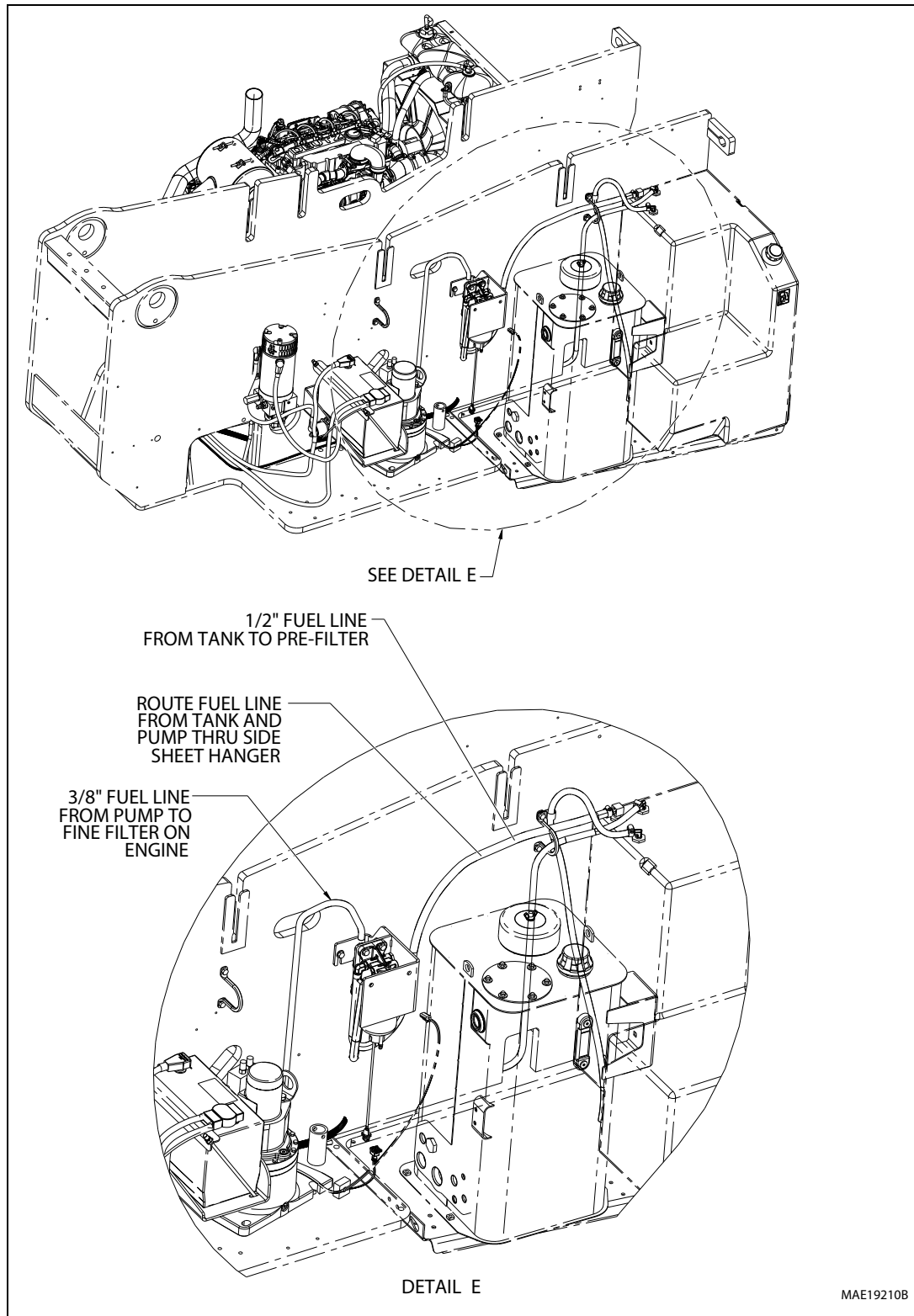


Figure 3-74. Deutz TD2.9L4 China III Engine Installation - Sheet 5 of 7

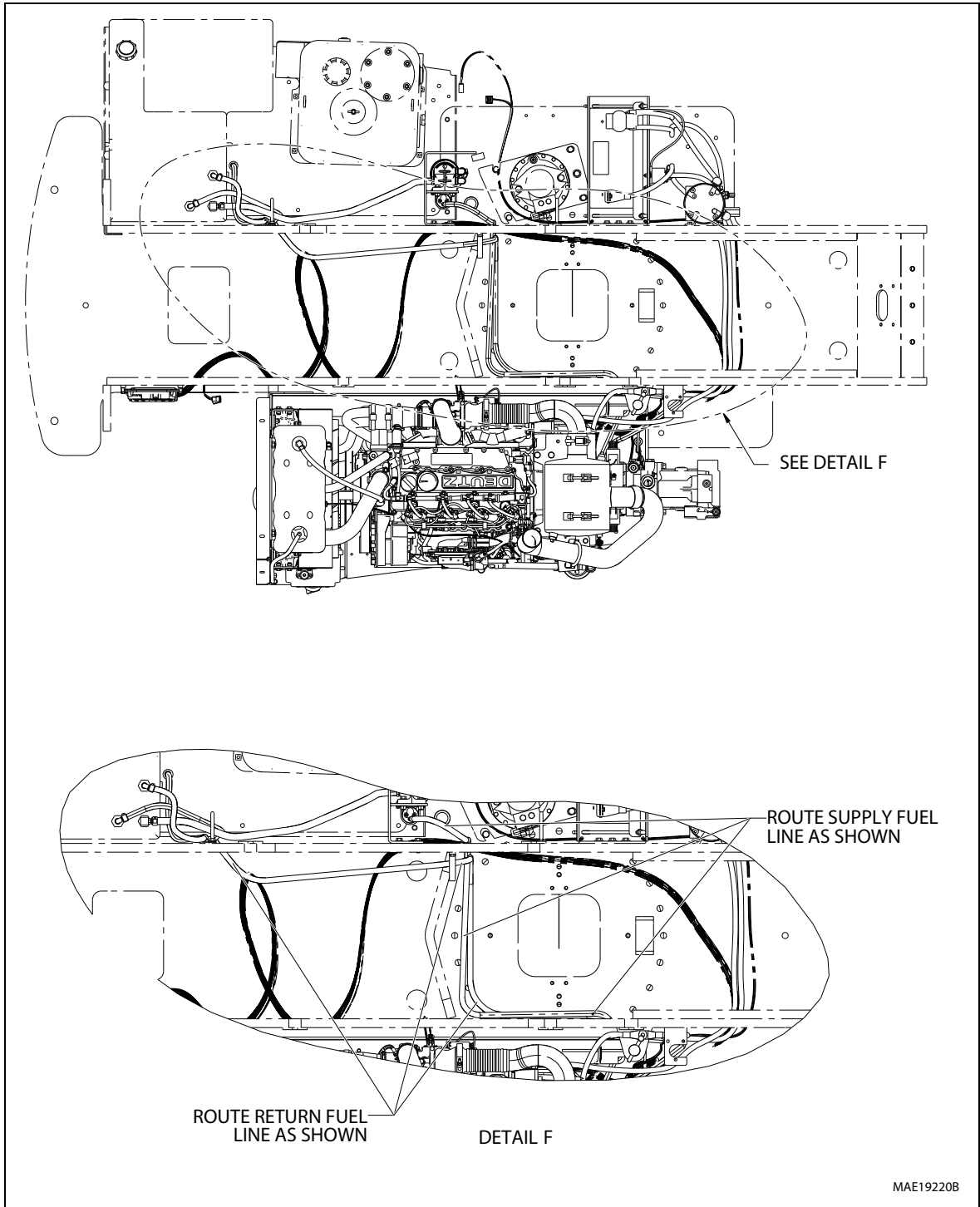


Figure 3-75. Deutz TD2.9L4 China III Engine Installation - Sheet 6 of 7

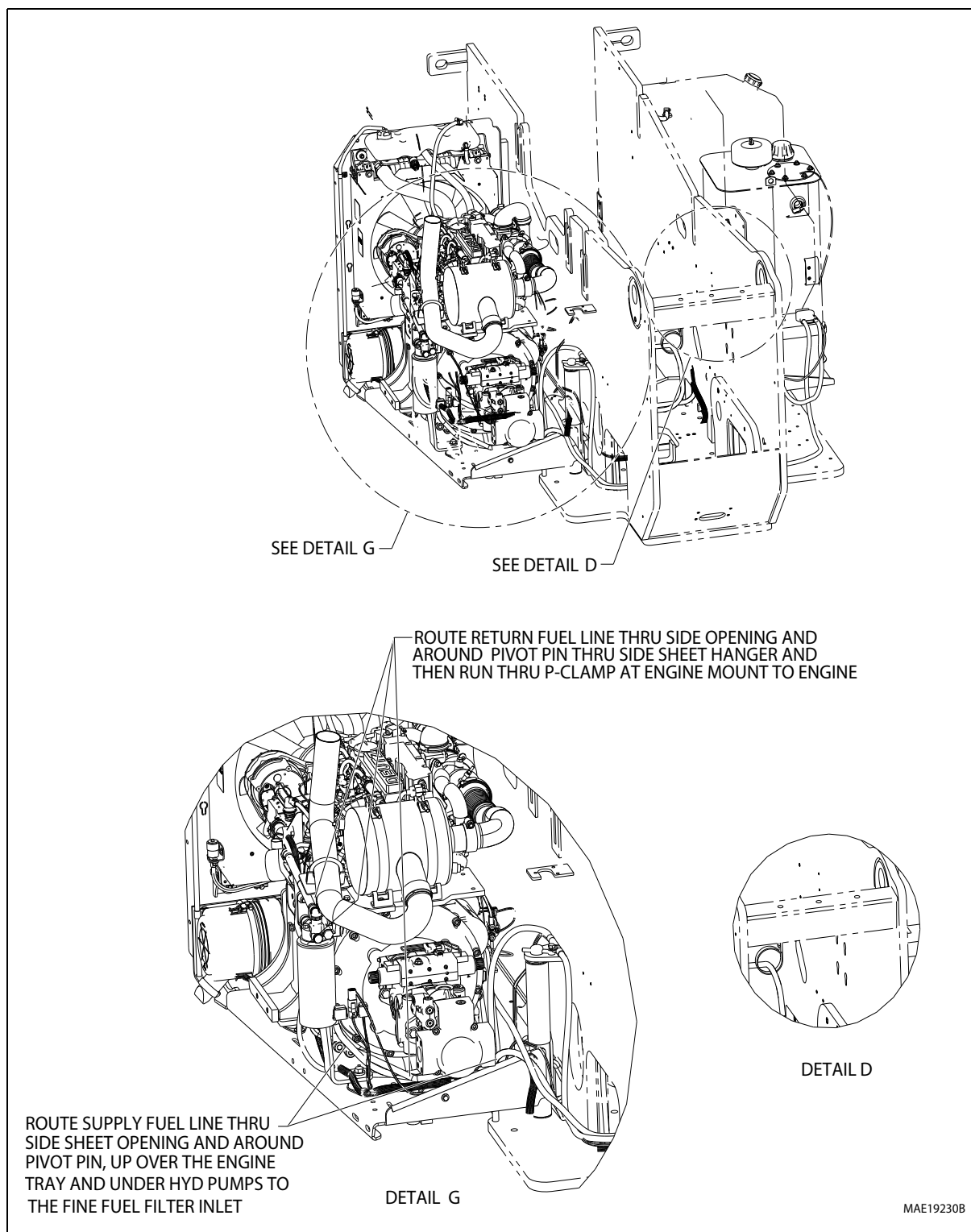
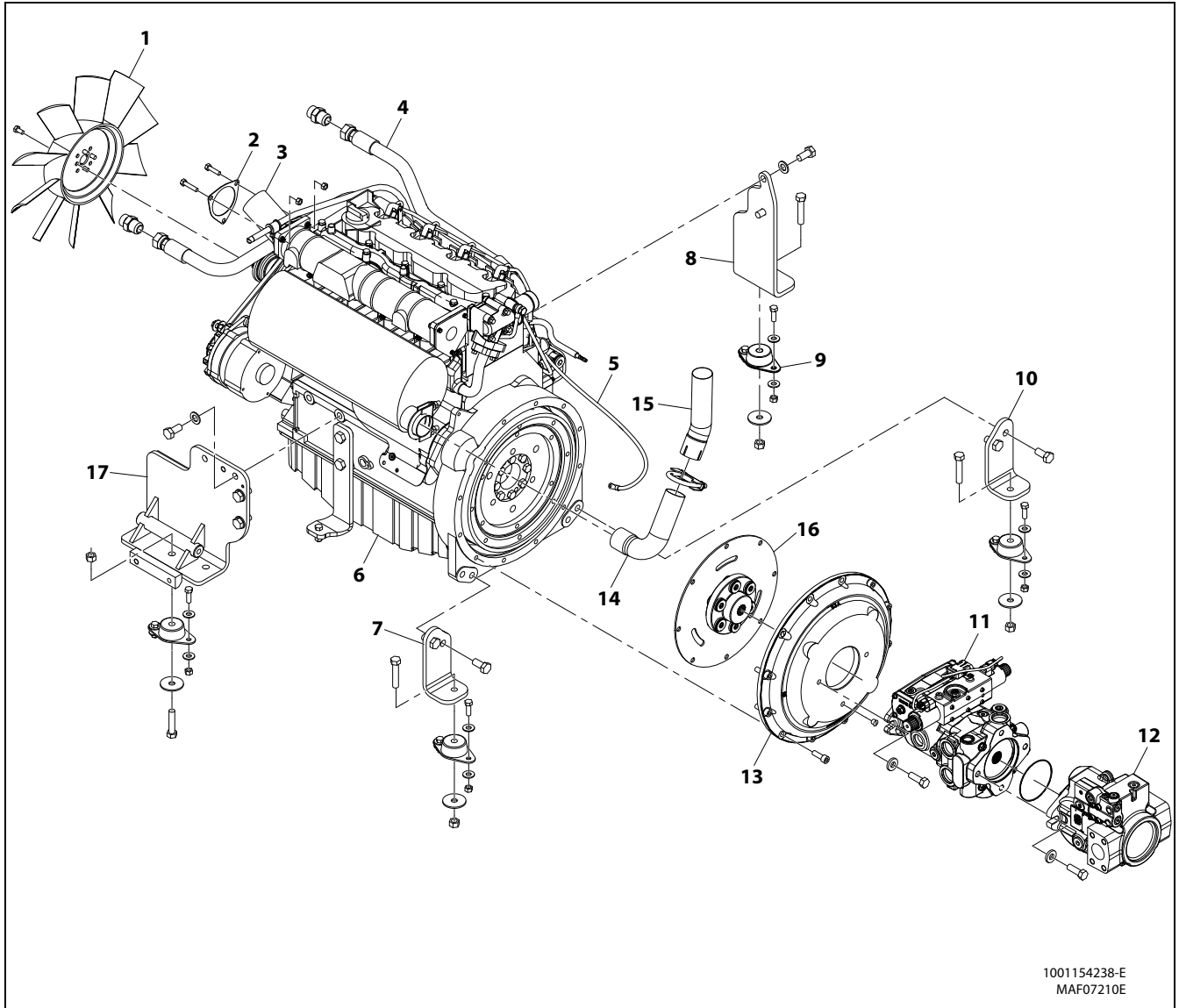


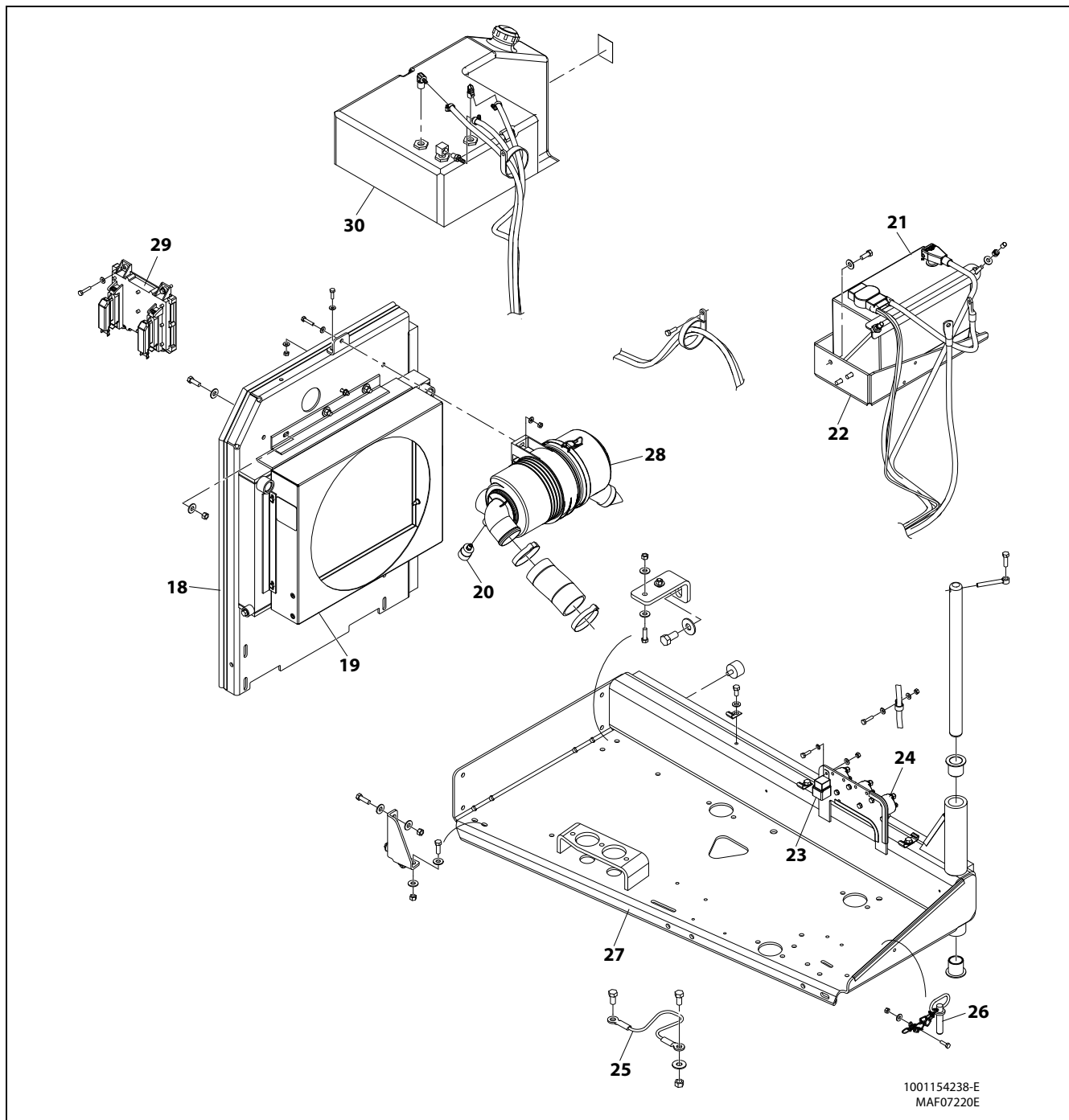
Figure 3-76. Deutz TD2.9L4 China III Engine Installation - Sheet 7 of 7



1001154238-E  
MAF07210E

- |                       |                          |                        |                    |
|-----------------------|--------------------------|------------------------|--------------------|
| 1. Fan                | 6. Deutz D2011L04 Engine | 10. Engine Support     | 14. Exhaust Pipe   |
| 2. Air Intake Gasket  | 7. Engine Support        | 11. Pump Assembly      | 15. Exhaust Tube   |
| 3. Air Intake Adapter | 8. Engine Support        | 12. Gear Pump Assembly | 16. Coupling       |
| 4. Oil Cooler Hose    | 9. Motor Mount           | 13. Pump Adapter Plate | 17. Engine Support |
| 5. Glow Plug Harness  |                          |                        |                    |

Figure 3-77. Deutz D2011L04 Engine Components - Sheet 1 of 2



- |                          |                   |                          |
|--------------------------|-------------------|--------------------------|
| 18. Radiator Mounting    | 23. Relay         | 27. Tray                 |
| 19. Radiator             | 24. Raley         | 28. Air Cleaner assembly |
| 20. Air Intake Indicator | 25. Lanyard Cable | 29. Control Module       |
| 21. Battery              | 26. Hitch Pin     | 30. Fuel Tank            |
| 22. Bracket              |                   |                          |

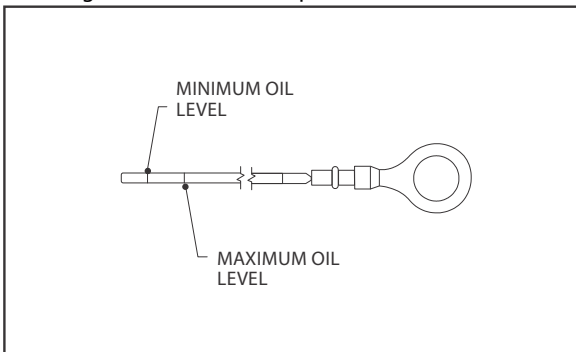
Figure 3-78. Deutz D2011L04 Engine Components - Sheet 2 of 2

### 3.18 DEUTZ ENGINE - TD2.9L4

**NOTE:** Refer to engine manufacturer's manual for detailed operating and maintenance instructions.

#### Check Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.
4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.



**Figure 3-79. Deutz TD2.9L4 Dipstick Markings**

5. Replace dipstick until fully seated.

#### Change Engine Oil

1. Allow engine to warm up. Engine oil should reach approximately 176° F (80° C).
2. Make sure machine and engine are level and switch off engine.
3. Place oil tray under engine.

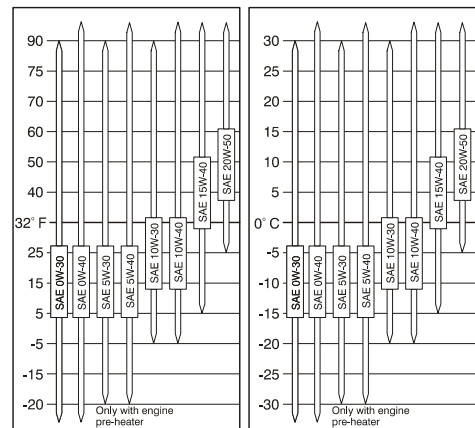
#### **CAUTION**

**HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN DRAINING.**

#### **NOTICE**

**COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.**

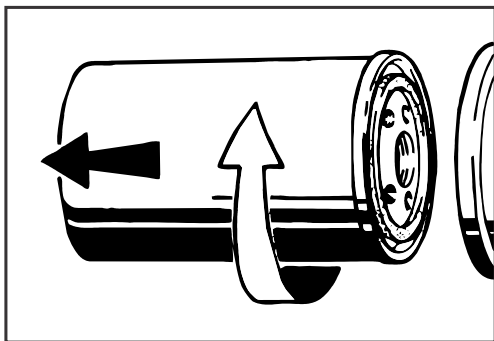
4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-80., Engine Oil Viscosity.



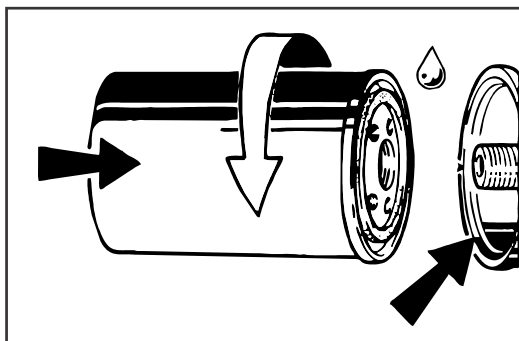
**Figure 3-80. Engine Oil Viscosity**

## Change Oil Filter

1. Wipe area around filter to clean any dirt from area.
2. Using a suitable oil filter removal tool, loosen lube oil filter cartridge and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil
6. Screw in new filter by hand until gasket is flush.
7. Hand-tighten filter another half-turn.



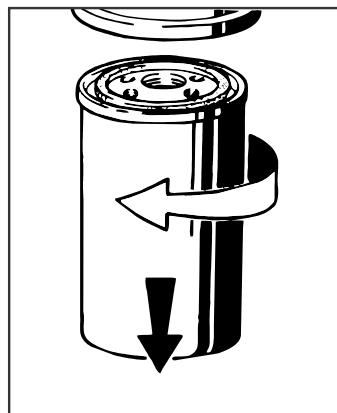
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

## Change Fuel Filters

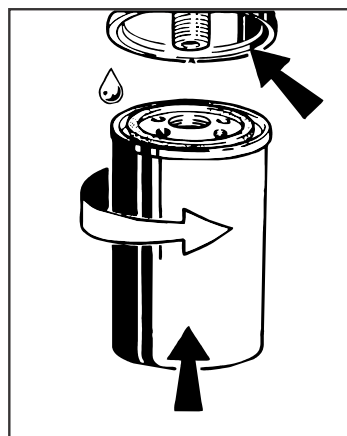
### **⚠ WARNING**

**FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEMS.**

1. Wipe area around filter to clean any dirt from area.
2. Disconnect water sensor connector (Pre-filter Only).
3. Remove fuel filter cartridge. Catch any escaping fuel.



4. Clean dirt from filter carrier sealing surface.
5. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
6. Screw in new filter by hand until gasket is flush. Hand-tighten filter another half-turn.



7. Connect water sensor connector (Pre-filter Only).
8. Open fuel shut-off valve.
9. Check for leaks.

### 3.19 DEUTZ ENGINE - D2011L04

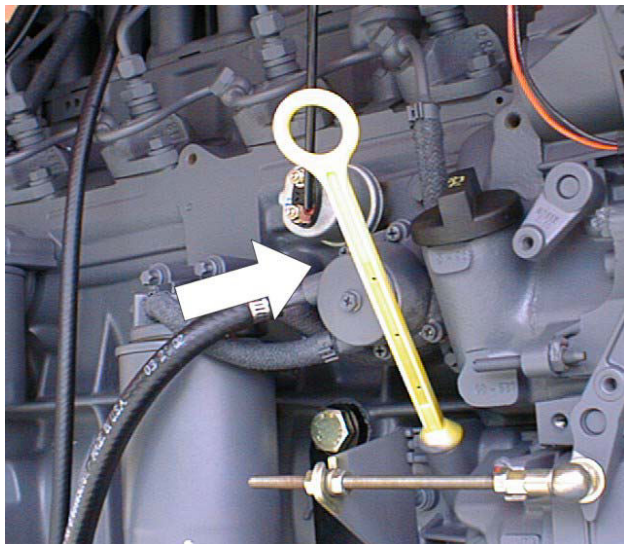
**NOTE:** Refer to engine manufacturer's manual for detailed operating and maintenance instructions. Limited engine maintenance items are presented here for convenience but detailed engine maintenance items and schedule are included in the engine manufacturer's manual.

#### Glow Plugs

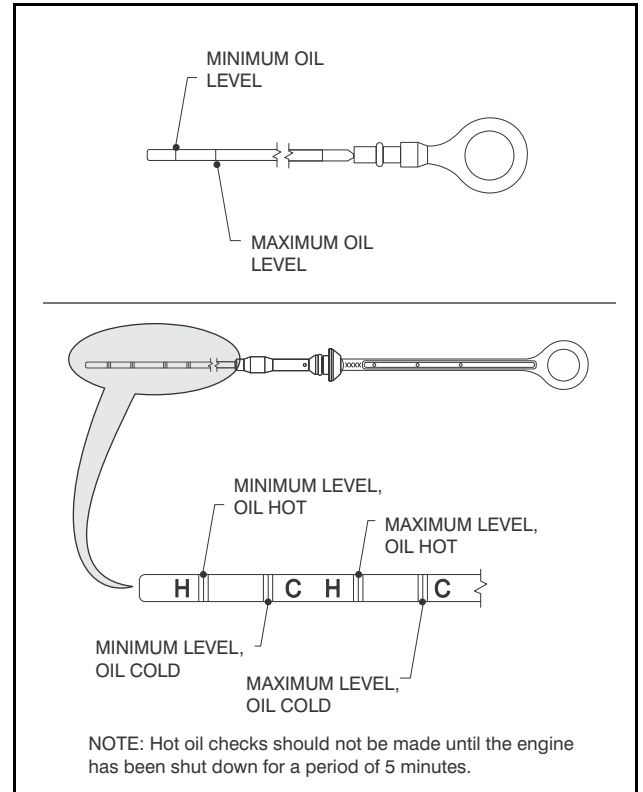
If the glow plug option is enabled in the JLG Control System, the glow plug and indicator lamp will be energized when the Power/Emergency Stop switch is pulled on if the ambient air temperature is less than 50° F (10° C) and the engine coolant temperature is less than 140° F (60° C). This determination will occur one second after the Power/Emergency Stop switch has been pulled on. The lamp and glow plugs will remain energized for the period of time specified by the setting in the JLG Control System. Engine start shall be disabled during this period. On Deutz engines, the glow plugs will continue (post glow) after the engine has started for three times the machine digit setting.

#### Check Oil Level

1. Switch the engine off before checking oil level.
2. Make sure the machine and engine are level.
3. Remove the oil dipstick.
4. Wipe the dipstick with non-fibrous, clean cloth.
5. Insert the dipstick to the stop and remove again. Check



the oil level, and if necessary, top the oil level up to the MAX mark with an approved grade and type of oil as outlined in the engine manufacturer's operator's manual. Refer to Figure 3-81., Deutz D2011I04 Engine Dipstick.



**Figure 3-81. Deutz D2011I04 Engine Dipstick**

6. Replace the dipstick making sure that it is fully seated in the dipstick tube to seal off the crankcase.

## Replacing Engine Oil

1. Allow the engine to warm up. The engine oil should reach approximately 176° F (80° C).
2. Make sure the machine and engine are level.
3. Switch off the engine.
4. Place an oil tray under the engine.

**CAUTION**

HOT ENGINE OIL CAN CAUSE BURNS, AVOID CONTACT WITH HOT OIL WHEN DRAINING.

**NOTICE**

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.



5. Open the oil drain valve.
6. Drain the oil.
7. Close the oil drain valve.

8. Pour in new engine oil. Refer to Section 1 for capacity and refer to Figure 3-82., Engine Oil Viscosity for the proper grade.

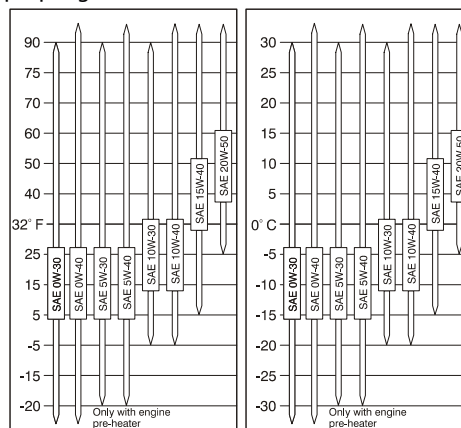
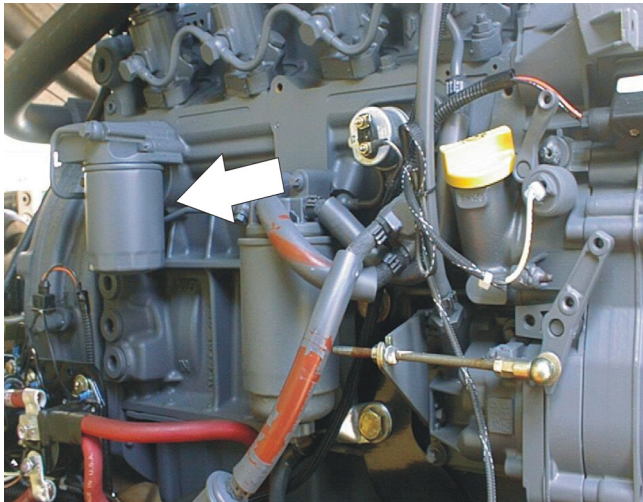
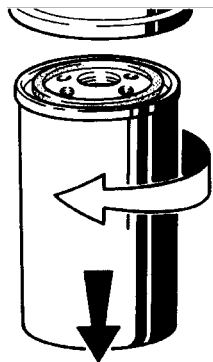


Figure 3-82. Engine Oil Viscosity

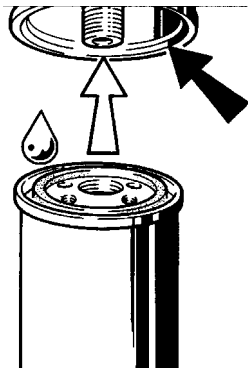
### Replacing the Oil Filter



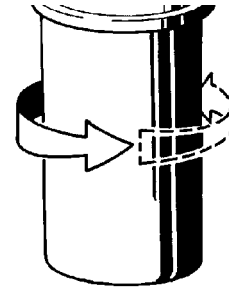
1. Wipe the area around the filter to clean any dirt from the area.
2. Using a suitable oil filter removal tool, loosen lube oil filter element and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.

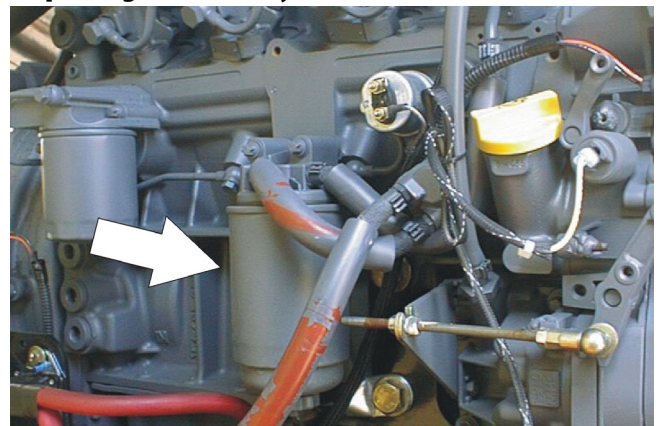


6. Manually screw in the new filter until the gasket is flush.



7. Hand-tighten filter another half-turn.
8. Check oil level.
9. Check oil pressure.
10. Check the oil filter cartridge and make sure there are no leaks.

### Replacing the Primary Fuel Filter



#### **⚠ WARNING**

**FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEMS.**

1. Wipe the area around the filter to clean any dirt from the area.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Undo the fuel filter cartridge and spin off.
4. Catch any escaping fuel.
5. Clean any dirt from the filter carrier sealing surface.
6. Apply a light film of oil or diesel fuel to the rubber gasket of the new filter cartridge.
7. Manually screw in the new filter until the gasket is flush.
8. Tighten the fuel filter cartridge with a final half-turn.
9. Check for leaks.

### 3.20 DUAL FUEL SYSTEM

**⚠ CAUTION**

IT IS POSSIBLE TO SWITCH FROM ONE FUEL SOURCE TO THE OTHER WITHOUT ALLOWING THE ENGINE TO STOP. EXTREME CARE MUST BE TAKEN AND THE FOLLOWING INSTRUCTIONS MUST BE FOLLOWED.

#### Changing from Gasoline to LP Gas

1. Start the engine from the ground control station.
2. Open the hand valve on the LP gas supply tank by turning counterclockwise.

**⚠ CAUTION**

BE SURE ALL GASOLINE IS EXHAUSTED BEFORE SWITCHING TO LP GAS.

3. While the engine is operating, place the two position LPG/Gasoline switch at the platform control station to the LP position. Allow the engine to operate without load until the engine regains smoothness.

#### Changing from LP Gas to Gasoline

1. With engine operating on LP under a no load condition, throw the LPG/Gasoline switch at the platform control station to the "Gasoline" position. Allow the engine to operate with no load until the engine regains smoothness.
2. Close the hand valve on the LP gas supply tank by turn.

### 3.21 DEUTZ EMR 2

The EMR2 consists of the sensors, the control unit and the actuator. Engine-side controls as well as the JLG Control System are connected by means of separate cable harnesses to the EMR control unit.

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters in accordance with the information of the current condition of the engine and the preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The exact position of the regulating rod is reported back and, if necessary, is corrected, by means of the control rod travel sensor, situated together with the rotation magnets in a housing of the actuator.

The EMR2 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

After the programming, that is carried out over the ISO9141 interface, the EMR2 possesses a motor-specific data set and this is then fixedly assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR2 module is matched by serial number to the engine. Modules cannot be swapped between engines.

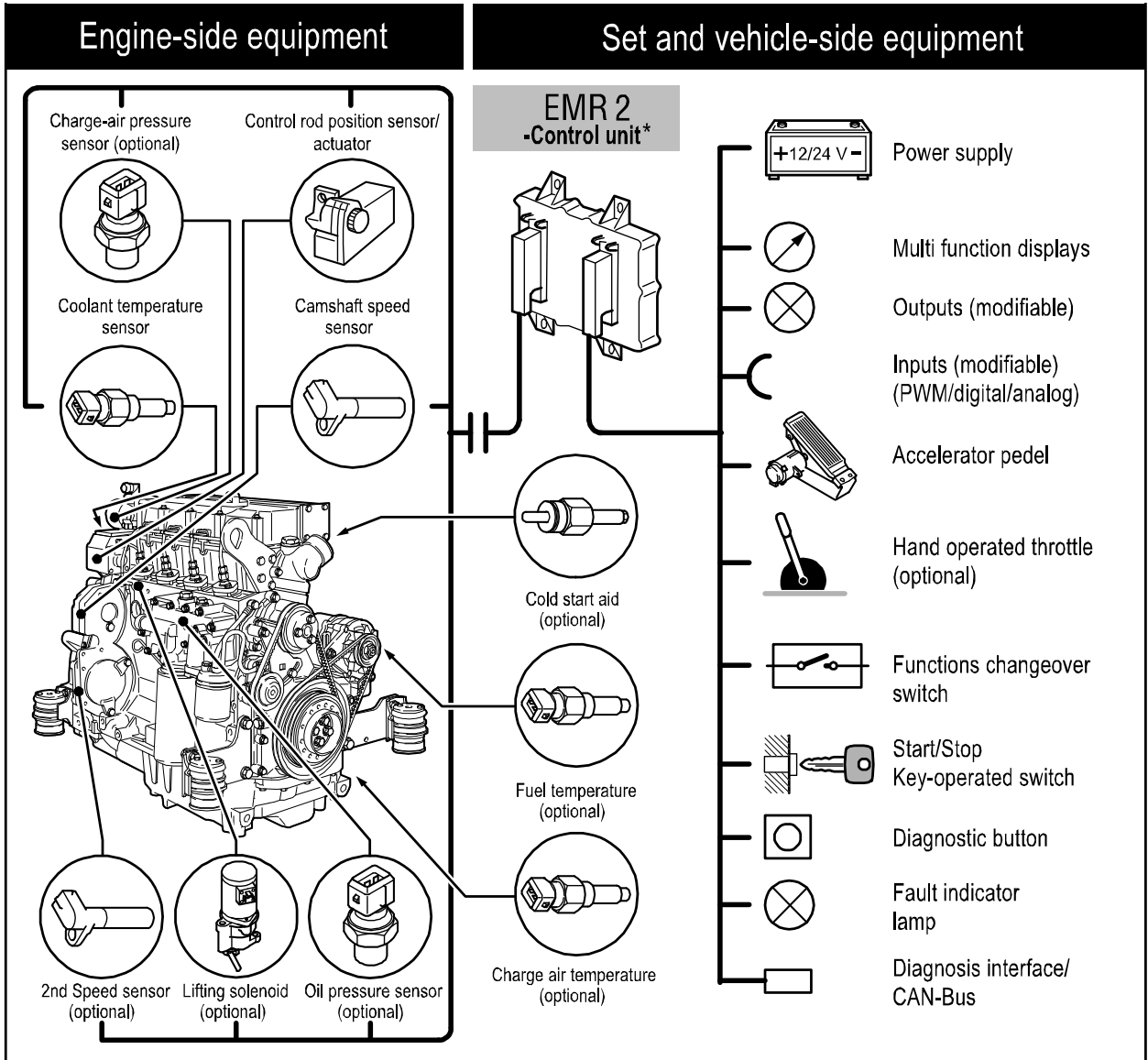


Figure 3-83. EMR 2 Engine Side Equipment

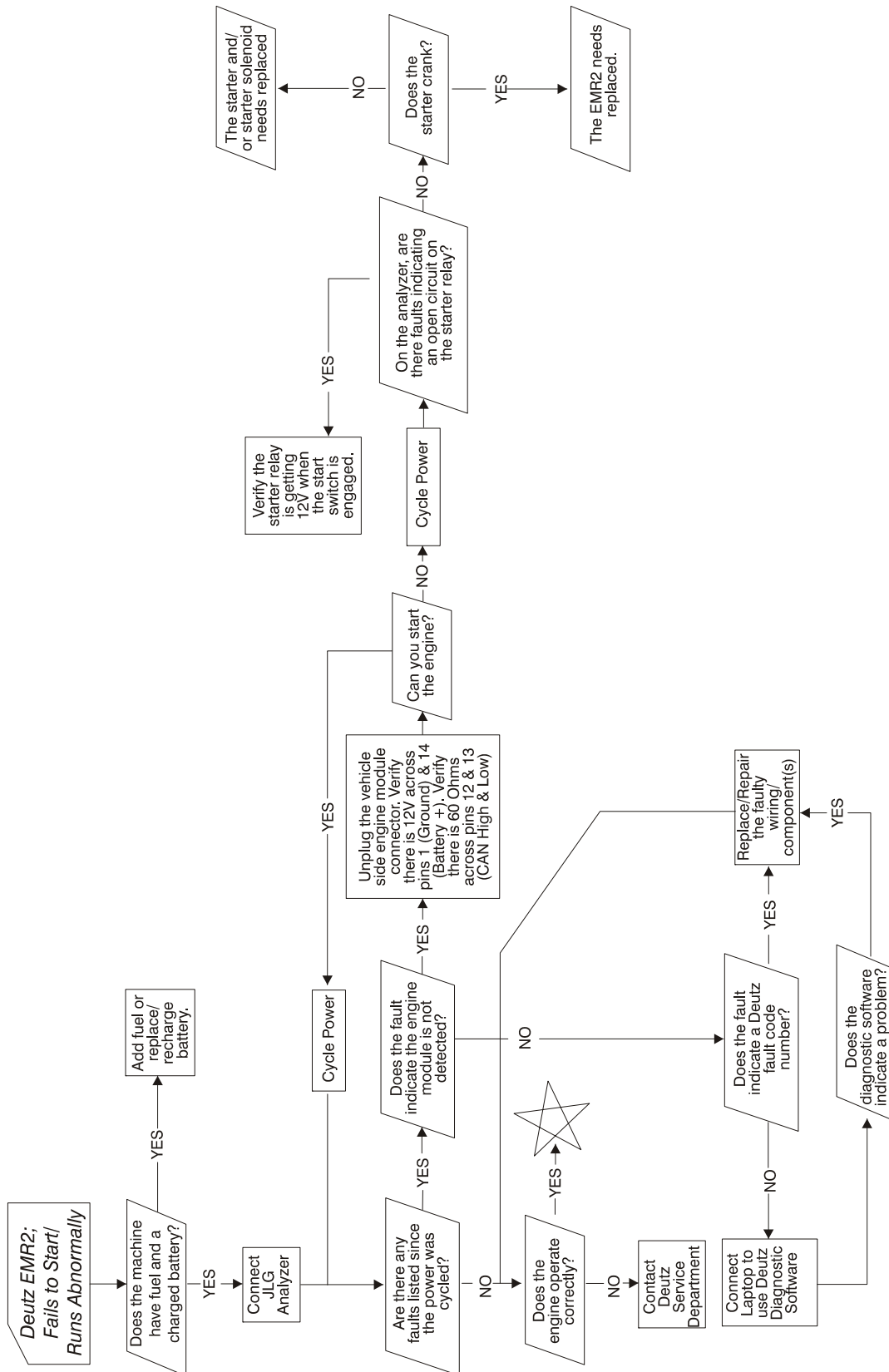


Figure 3-84. Deutz EMR2 Troubleshooting Flow Chart

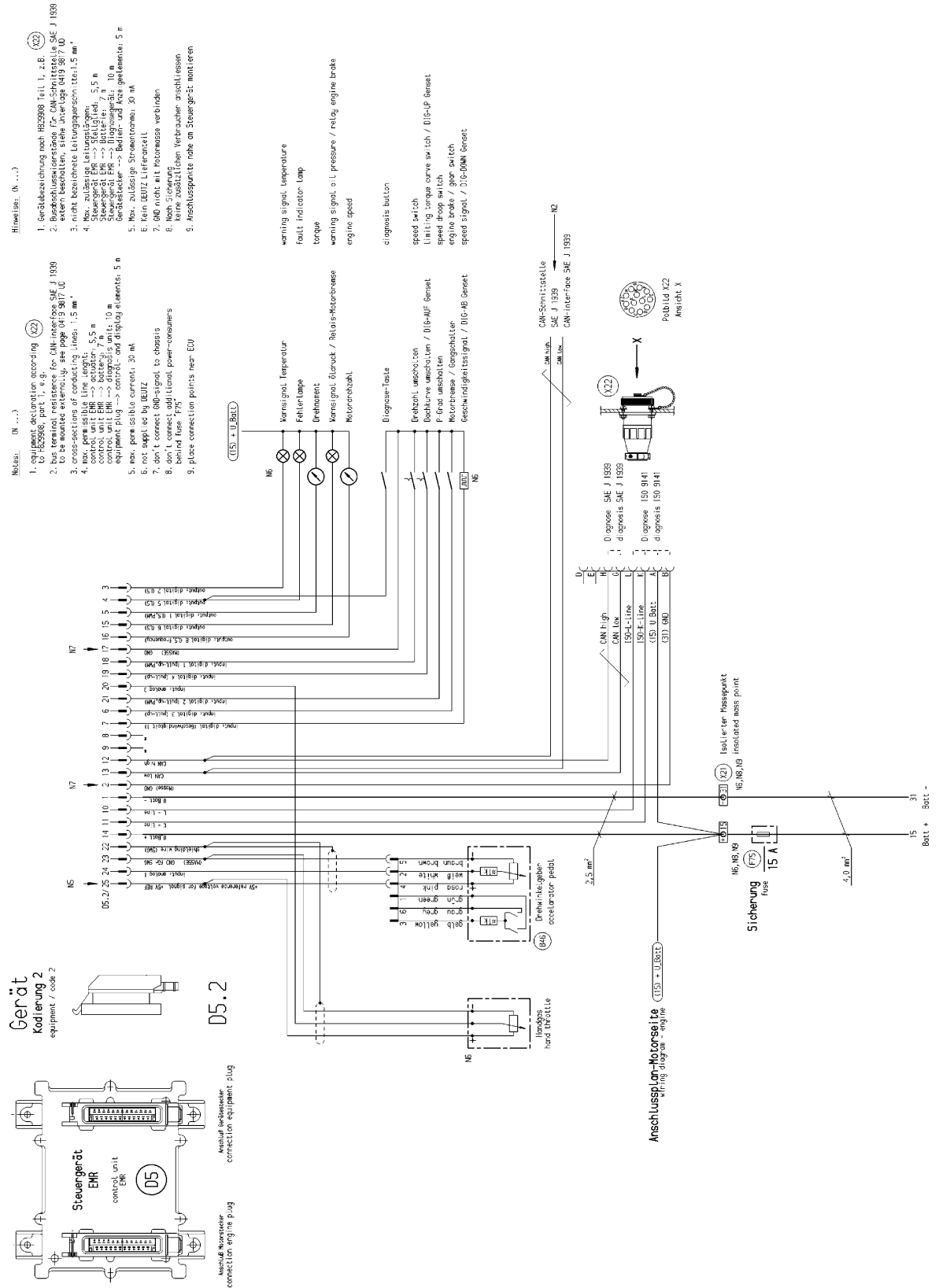


Figure 3-85. Deutz EMR 2 Vehicle Side Connection Diagram



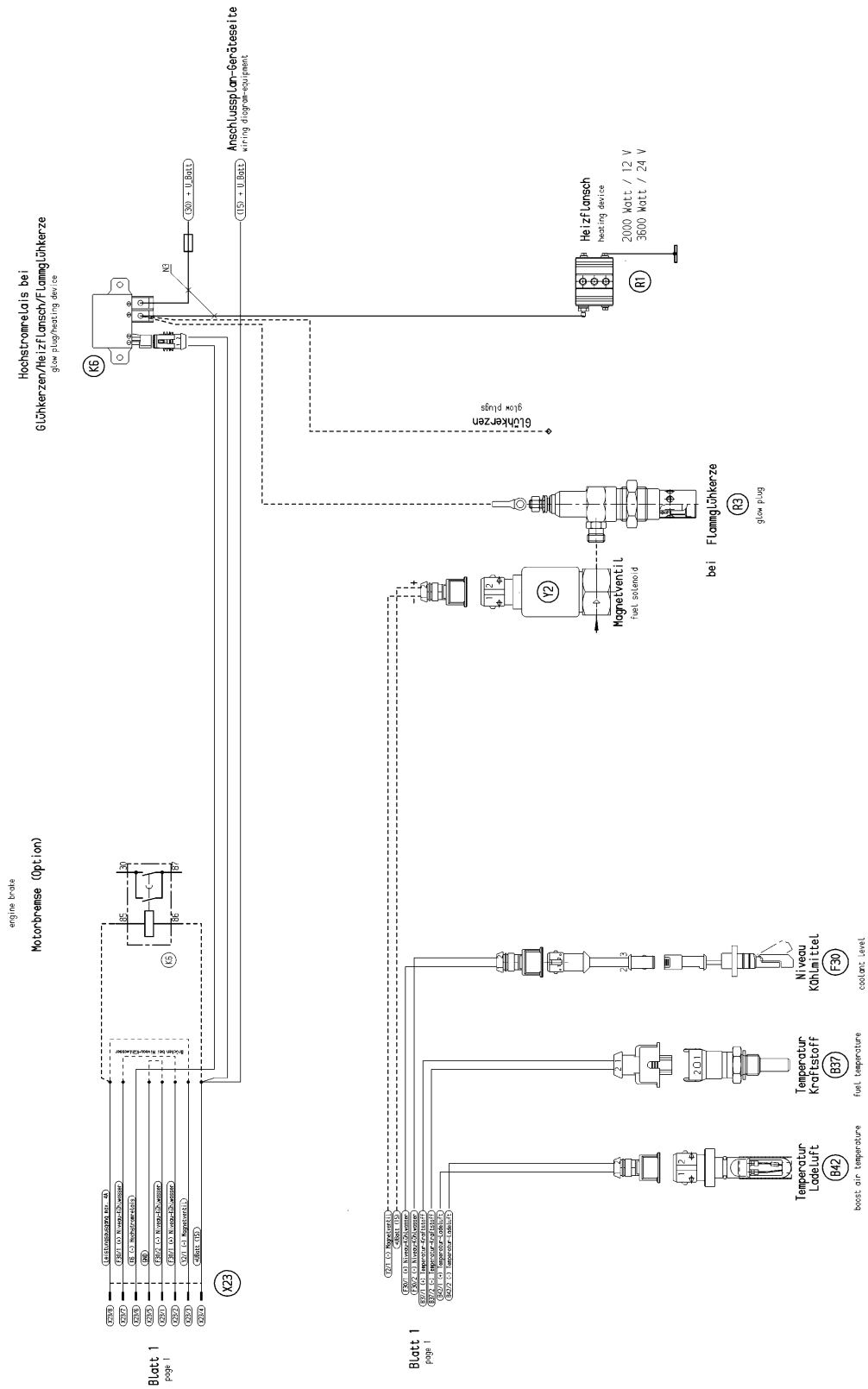
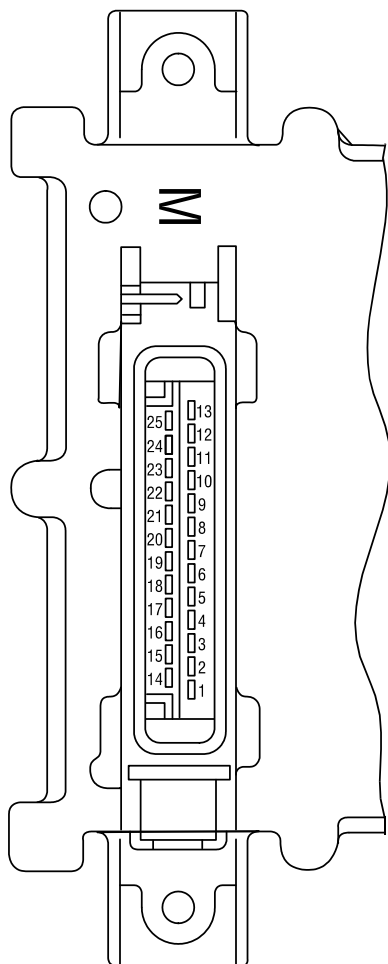


Figure 3-87. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

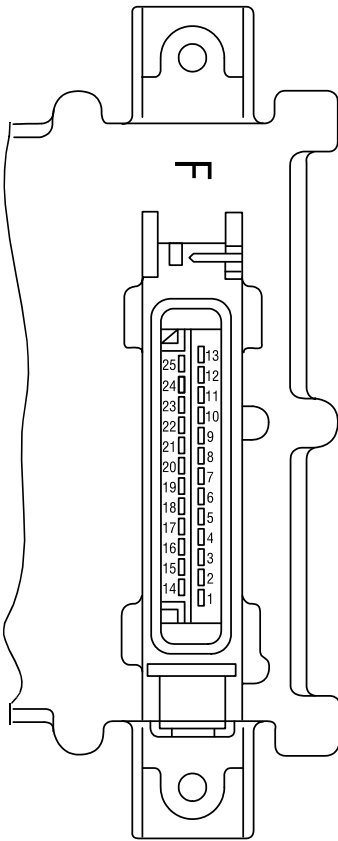


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid <sup>1)</sup>
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature <sup>2)</sup>
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant level / oil level
7	Output: PWM2/digital 6	
8	GND	Reference potential for analog signal at pin 9
9	Input: analog 7	Analog input for Coolant temperature sensor (NTC)
10	GND	Reference potential for analog signal at pin 11
11	Multi-function input: speed 2/DigIn 2	Digital input second engine speed (crankshaft) (optional) and speed signal (optional)
12	GND	Reference potential for analog signal at pin 13
13	Input: speed 1	Digital input first engine speed (camshaft)
14	STG -	PWM output, signal for actuator coil
15	STG +	PWM output, signal for actuator coil
16	Screen	Screening regulating rod travel sensor (for lines 17, 18, 19)
17	RF -	General connection for reference and measuring coil
18	RF REF	Analog input, reference signal of the reference coil
19	RF MESS	Analog input, measuring signal of the measuring coil
20	GND	Reference potential for signal at pin 21
21	Input: analog 4/digital 9	Analog input 4 (sensor signal oil pressure sensor) or digital input 9
22	+5 V REF	+5 V Reference voltage for signal at pin 21 (max. 15 mA)
23	GND	Reference potential for signal at pin 24
24	Input: analog 2/digital 7	Analog input 2 (sensor signal charge air) or digital input 7
25	+5 V LDA	+5 V Reference potential for signal at pin 24 (max. 15 mA)

1) For continuous power: < 4 A

2) Corresponds to special function "fuel temperature compensation at the EMR (0211 2571)

Figure 3-88. EMR 2 Engine Plug Pin Identification



Pin-No.	Designation	Description
1	U Batt -	Negative pole at battery (clamp 31)
2	GND	Reference potential for signal
3	Output: digital 2	PWM or digital output, various functions
4	Input / output: DigInOut	Fault lamp and diagnostic button
5	Output: PWM 1/Dig 1	PWM or digital output, various functions
6	Multi-function input: DigIn 3	Genset applications/gear shift/motor brake
7	Input: digital 10/velocity	Speed signal (tacho input)
8	NC	Not occupied
9	NC	Not occupied
10	L-line	Serial ISO 9141 interface
11	K-line	Serial ISO 9141 interface
12	CAN high	Interface for CAN-Bus
13	CAN low	Interface for CAN-Bus
14	U Batt +	Positive pole for battery (clamp 15)
15	Output: digital 5	Digital output, various functions
16	Output: digital 7/Frequency	Frequency, PWM or digital output, various functions
17	Ground	Reference potential for signal at pins 18, 19 and 21
18	Input: digital 1 / PWM 1	PWM 1 or digital input 1, various functions
19	Multi-function input: DigIn 4	Performance curve switching/genset applications
20	Multi-function input: digital 8 / analog 3	Hand hand throttle/genset applications, Digital (8) or analog input (3)
21	Input: digital 2 / PWM 2	PWM 2 or digital input 2, various functions
22	Screen	Screening (e.g. for lines hand throttle or PWG)
23	GND	Reference potential for signal at pin 24
24	Input: analog 1 / digital 6	Analog input 1 (pedal value sensor, PWG) or digital input 6
25	+5 V REF	+5 V Reference voltage for signal at pin 24

Figure 3-89. EMR 2 Vehicle Plug Pin Identification

**SECTION 3 - CHASSIS & TURNTABLE**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No active faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed). Governor in emergency operation (with sensor 1). Emergency switch-off (if sensor 1 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e. Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	Engine stop.	Check parameter (21). Check speed settings.
Sensors	07	Charge air pressure	102	2			
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

**Figure 3-90. EMR2 Fault Codes - Sheet 1 of 5**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault warning	30	Oil pressure warning	100	1	Oil pressure below speed-dependent warning line characteristic	Fault message (disappears when oil pressure is again above recovery limit). After a delay time - fill limitation.	Check engine (oil level, oil pump). Check oil pressure sensor and cable. Check oil pressure warning line characteristic.
	31	Coolant temperature warning	110	0	Coolant temperature has exceeded warning level.	Fault message (disappears when coolant temperature again drops below recovery level). After a delay time - fill limitation.	Check coolant. Check coolant temperature sensor and cable.
	32	Charge air temperature warning	105	0	Charge air temperature has exceeded warning level.	Fault message (disappears when charge air temperature gain drops below recovery level). After a delay time - fill limitation.	Check charge air. Check charge air-temperature sensor and cable.
	34	Coolant level warning	111	1	Switch input "Low coolant level" is active.	Fault message.	Check coolant level. Check coolant level sensor and cable.
	35	Speed warning (with thrust mode operation).	SID 190	14	revolutions was/is above (top) revolution speed limit. "Thrust mode" function is active.		Check parameters. Check speed settings.
						Check PID setting. Check rods. Check actuator and replace if required. Check speed sensor (impulses on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	Check cable to actuator. Check speed settings.
	36	Fuel temperature warning	174	0	Fuel-temperature has exceeded warning level.	Fault message (disappears when fuel temperature again drops below recovery level).	Check fuel. Check fuel temperature sensor and cable.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-91. EMR2 Fault Codes - Sheet 2 of 5

**SECTION 3 - CHASSIS & TURNTABLE**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault, switch-off	42	Charge air temperature switch-off	105	0	Charge air temperature has exceeded switch-off limit.	Emergency stop	Check charge air. Check charge air-temperature sensor and cable. Check switch-off limit.
	44	Coolant level switch-off	111	1	Switch input "Low coolant level" is active.	Emergency stop. Start lock.	Check coolant level. Check coolant level sensor and cable.
Actuator	50	Feedback	SID 24	12	Actuator not connected. Fault in actuator confirmation.	Emergency switch-off. Actuator cannot be operated.	Check actuator, replace if required. Check cable, check fault limits for "Confirmation".
	52	Reference feedback	SID 24	13			Check actuator, replace if required. Check cable, check fault limits for "Riteness confirmation".
	53	Control travel difference	SID 23	7	Injection pump/actuator jammed or not connected. Difference between nominal/actual control travel is > 10 % of the overall control path.	Fault message (disappears when difference is < 10 %).	Check actuator/actuator rods / injection pump, replace if required. Check actuator cable.
	59	Auto calibration BOSCH-EDC pumps faulty operation	SID 23	13	No automatic actuator equalization possible. Incorrect input of the actuator reference values.	Engine stop / start lock. Governor cannot be taken into use. EDC actuator calibration required.	Check actuator and replaced if required. Check feedback cable. Check fault limits and reference values of the feedback. Program the fault limits for feedback, save values. Switch ignition off and on again. Check again. If faulty, inform DEUTZ-Service and carry out automatic equalization again. Set fault limits again.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

**Figure 3-92. EMR2 Fault Codes - Sheet 3 of 5**

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Hardware inputs/outputs	60	Digital output 3 (Switch-off solenoid, pin M 2)	SID 51	2	Fault (short circuit / cable break) at digital output.	Driver level is switched off.	Check cable of digital output (cable break or short circuit).
	62	Digital output 6, pin M 7	SID 60	2		Fault message.	
	63	Excess voltage switch-off solenoid	SID 51	6			
	67	Error Hand Setp1	91	11			
	68	Error CAN Setp1	898	2			
Communication	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.	Check CAN connection, terminating resistor (see Chapter 12.4), Check control unit.
	71	CAN interface SAE J 1939	SID 231	9	Overflow in input buffer or a transmission cannot be placed on the bus.		Check CAN connection, cable connection. Check sensor and replace if required.
	74	Cable break, short circuit or bus-error	SID 231	14			
Memory	76	Parameter programming (write EEPROM)	SID 253	12	Fault in parameter programming in the governor fixed value memory.		Switch ignition off and on again. Check again, if faulty inform DEUTZ Service
	77	Cyclic program test	SID 240	12	Constant monitoring of program memory shows error (so-called "Flash-test").	Emergency switch-off. engine cannot be started.	
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		Note values of parameters (3895 and 3896). Switch ignition off and on again. Check again, if faulty inform DEUTZ Service.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-93. EMR2 Fault Codes - Sheet 4 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Control unit hardware	80	Power supply (Actuator)	SID 254	2	Power supply for actuator not in the permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	83	Reference voltage 1	SID 254	2	Reference voltage for actuator not in the permissible range.	Fault message (disappears when power again in the normal range). Auxiliary value 5 V	Check voltage supply. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	84	Reference voltage 2	SID 254	2			
	85	Reference voltage 4	SID 254	2			
	86	Internal temperature	171	12	Internal temperature for control unit not in permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	87	Atmospheric pressure	108	12	Atmospheric pressure not in permissible range.	Fault message (disappears when power again in normal range). Atmospheric pressure monitoring function de-activated.	
Program logic	90	Parameter fault (EEPROM retrieval or checksum faulty).	SID 253	2	No data found or checksum of data is faulty (note: fault only occurs during setting of parameter / saving or reset.).	Engine cannot be started.	Check data for correct settings. Save parameters. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	93	Stack overflow	SID 240	2	Internal calculation fault (so-called "Stack overflow" fault).	Emergency switch-off. Engine cannot be started.	Note parameters (3897 and 3898). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	94	Internal fault	SID 254	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-94. EMR2 Fault Codes - Sheet 5 of 5

Table 3-12. DTC to SPN/FMI Cross Reference Chart

SPN Code	FMI Code	DTC	Description
51		2112	Unable to Reach Higher TPS
51	0	221	TPS 2 Signal Voltage Low
51	1	121	TPS 1 Lower Than TPS 2
51	3	123	TPS 1 Signal Voltage High
51	4	122	TPS 1 Signal Voltage Low
51	7	2111	Unable to Reach Lower TPS
51	31	2135	TPS 1/2 Simultaneous Voltages
94	3	92	Fuel Pump High Voltage
100	1	524	Oil Pressure Low
105	0	127	IAT Higher Than Expected 2
105	3	113	IAT High Voltage
105	4	112	IAT Low Voltage
105	15	111	IAT Higher Than Expected 1
106	4	107	MAP Low Voltage
106	16	108	MAP High Pressure
108	0	2229	BP Pressure High
108	1	129	BP Low Pressure
110	0	217	ECT Higher Than Expected 2
110	3	118	ECT High Voltage
110	4	117	ECT Low Voltage
110	15	116	ECT Higher Than Expected 1
168	15	563	System Voltage High
168	17	562	System Voltage Low
174	3	183	Fuel Temp Gasoline High Voltage
174	4	182	Fuel Temp Gasoline Low Voltage
515	0	1112	Spark Rev Limit
515	15	219	Max Govern Speed Override
515	16	1111	Fuel Rev Limit
628	13	601	Flash Checksum Invalid
629	31	606	COP Failure
629	31	1612	RTI 1 loss
629	31	1613	RTI 2 Loss
629	31	1614	RTI 3 Loss
629	31	1615	A/D Loss
629	31	1616	Invalid Interrupt
630	12	604	RAM Failure
636	2	336	Crank Sync Noise
636	4	337	Crank Loss
636	8	16	Crank Never Synced at Start
639	12	1626	CAN Tx Failure
639	12	1627	CAN Rx Failure

**Table 3-12. DTC to SPN/FMI Cross Reference Chart**

SPN Code	FMI Code	DTC	Description
639	13	1628	CAN Address Conflict Failure
639	31	1629	Loss of TSC1
651	5	261	Injector Driver 1 Open
651	6	262	Injector Driver 1 Shorted
652	5	264	Injector Driver 2 Open
652	6	265	Injector Driver 2 Shorted
653	5	267	Injector Driver 3 Open
653	6	268	Injector Driver 3 Shorted
654	5	270	Injector Driver 4 Open
654	6	271	Injector Driver 4 Shorted
723	2	341	Cam Sync Noise
723	4	342	Cam Sensor Loss
724	10	134	EGO 1 Open/Inactive
1079	3	643	External 5V Reference High
1079	4	642	External 5V Reference Low
1384	31	1625	Shutdown Request
1485	3	687	Power Relay Short to Power
1485	4	686	Power Relay Shorted
1485	5	685	Power Relay Open
5294	4	91	Fuel Pump Low Voltage
520200	0	171	Adaptive Learn High Gasoline
520200	1	172	Adaptive Learn Low Gasoline
520202	0	1161	Adaptive Learn High LPG
520202	1	1162	Adaptive Learn Low LPG
520204	0	1155	Closed Loop Multiplier High Gasoline
520204	1	1156	Closed Loop Multiplier Low Gasoline
520206	0	1151	Closed Loop Multiplier High LPG
520206	1	1152	Closed Loop Multiplier Low LPG
520208	10	154	EGO 2 Open/Inactive
520211	10	420	Gasoline Cat Monitor
520213	10	1165	LPG Cat Monitor
520240	3	188	Fuel Temp LPG High Voltage
520240	4	187	Fuel Temp LPG Low Voltage
520251	3	223	TPS 2 Signal High Voltage
520251	4	222	TPS 2 Signal Low Voltage
520260	0	1171	LPG Pressure Higher Than Expected
520260	1	1172	LPG Pressure Lower Than Expected
520260	3	1174	EPR Voltage Supply High
520260	4	1175	EPR Voltage Supply Low
520260	12	1176	EPR Internal Actuator Fault
520260	12	1177	EPR Internal Circuitry Fault
520260	12	1178	EPR Internal Comm Fault
520260	31	1173	EPR Comm Lost

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
29	2	978	1-2-6	Diagnostic fault check of synchronism of hand throttle and Low idle switch (LIS).	Plausibility error between sensor and idle switch	Threshold for error detection is an internal ECU threshold. The accelerator pedal must have detected full load and idle plausibility at least once.
29	3	932	1-2-6	Diagnostic fault check of short circuit to supply voltage (signal range check high) of acceleration pedal signal.	The signal exceeds the applicable threshold; signal range violation	If the signal is below the applicable threshold APP_uRawSRChiHTLIS_C, the signal range violation is reset after the healing debouncing. In case when the CCP is active (CCP_stActive = 1) and the reading from the EEPROM memory is successful, the signal is below the threshold APP_uHTLISCCPi[1], a signal range violation is reset after debouncing.
29	4	937	1-2-6	Diagnostic fault check of short circuit to ground (signal range check low) of acceleration pedal signal	The signal is below the applicable threshold; signal range violation	If the signal exceeds the applicable threshold APP_uRawSRCLoHTLIS_C, the signal range violation is reset after the healing debouncing. In case when the CCP is active (CCP_stActive = 1) and the reading from the EEPROM memory is successful, the signal exceeds the threshold APP_uHTLISCCPLo[1], a signal range violation is reset after debouncing.
91	3	935	2-2-6	Analog accelerator pedal sensor 1 or double accelerator pedal sensor: the voltage measured by ECU is out of the target range or the calculated pedal position is implausible compared with the position of the second pedal	Sensor defect. Short cut to battery or open loop.	Check cabling, check accelerator pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it. If the signal is below the applicable threshold APP_uRaw1SRCHigh_C, the signal range violation is reset after the healing debouncing.
91	4	940	2-2-6	Analog accelerator pedal sensor 1 or double accelerator pedal sensor: the voltage measured by ECU is out of the target range or the calculated pedal position is implausible compared with the position of the second pedal	Short circuit to ground.	Check cabling, check accelerator pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it If the signal exceeds the applicable threshold APP_uRaw1SRCLow_C, the signal range violation is reset after the healing

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
91	11	976	2-2-6	Diagnostic fault check of synchronism of single potentiometer and Low idle switch(LIS).	Measured voltage of accelerator pedal 1 is out of plausible range.	Threshold for error detection is an internal ECU threshold. Check cabling, check accelerator pedal and pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it. When the PWM period APP_tIPWMPer is in between APP_tISRCLoPWMPer_C and APP_tISRCHiPWMPer_C.
94	1	474	216	Low fuel pressure: the low fuel pressure calculated by ECU is underneath the target range; the ECU activates a system reaction	Fuel pressure below warning threshold	Check low fuel pressure system (fuel feed pump, relay, fuse, wiring, sensor) and if necessary repair or replace it.
94	3	472	216	Low fuel pressure sensor: the voltage of sensor measured by ECU is out of the target range	cable break or short circuit, sensor defective, connection cable damaged Short cut to battery or open loop	Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
94	4	473	216	Low fuel pressure sensor: the voltage of sensor measured by ECU is out of the target range	cable break or short circuit, sensor defective, connection cable damaged short cut to ground	Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
97	3	464	228	Fuel filter water level sensor: the voltage of sensor measured by ECU is out of the target range	Sensor not connected or sensor defect.	Check of wiring and water in fuel sensor. Check cabling, if charge Water in Fuel sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
97	4	465	228	Fuel filter water level sensor: the voltage of sensor measured by ECU is out of the target range.	cable break or short circuit, sensor defective, connection cable damaged. Short cut to ground.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
97	12	1157	228	Fuel filter water level sensor: the maximum level is exceeded	Water level in fuel pre-filter reservoir over limit (bad fuel quality)	Measure Voltage at Water in Fuel Sensor and renew harness if needed.
100	1	736	231	Oil pressure is below the target range (warning threshold)	Oil pressure too low (pressure below warning threshold)	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leakage, measure oil pressure external to evaluate sensor value
100	1	737	231	Oil pressure is below the target range (shut off threshold)	Oil pressure too low (pressure below shut off threshold).	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leakage, measure oil pressure external to evaluate sensor value.
100	3	732	224	Oil pressure sensor: the voltage of sensor measured by ECU is out of the target range	short circuit to battery or cable break	check battery and wiring Check cabling. If sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
100	4	733	224	Oil pressure sensor: the voltage of sensor measured by ECU is out of the target range	Short circuit to ground	The sensed raw voltage value Oil_uRawPSwmp is above Oil_SRCPSwmp.uMin_C Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it No detail informationen!
102	1	774	223	charge air pressure below lower limit	measured charge air pressure below the threshold.	Check complete air system of engine for massive leakage, especially from compressor to intake air manifold. Check air filter. Exchange charge air pressure sensor.
102	2	88	223	Charge air pressure measured by sensor is above the shut off threshold.	Charged air cooler pressure below threshold.	Check waste gate system if necessary replace TC, check CAC if all channels are clean, check charge air piping if necessary.
102	2	89	223	Charge air pressure measured by sensor is above the warning threshold	Charge air pressure above shut off threshold	Check waste gate system if necessary replace TC, check CAC if all channels are clean, check charge air piping if necessary.
102	2	772	223	Deviation between sensed intake manifold pressure is not plausible compared to environment pressure. Which sensor is not okay can not be said.	deviation between ambient pressure sensor and charge air pressure sensor at not running engine to high	1) Exchange boost pressure sensor 2) Exchange ECU
102	3	776	223	Charge air pressure sensor: the measured voltage of sensor by ECU is out of the target range	The Sensor Voltage is above the Threshold.	Check cabling, if charge air pressure/temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
102	4	777	223	Charge air pressure sensor: the measured voltage of sensor by ECU is out of the target range	The Sensor Voltage is below the Threshold.	Check cabling, if charge air pressure/temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
105	0	996	233	Charge air temperature downstream calculated by ECU is above the target range. The ECU activates a system reaction.	Charge air temperature (downstream) over warning threshold.	Check CAC system and clean it. Check fan functionality. Check cooling performance with temperature measurement.
105	0	997	233	Charge air temperature downstream calculated by ECU is under the shut down threshold. The ECU activates a system reaction.	Charge air temperature (downstream) over the low threshold.	Check CAC system and clean it. Check fan functionality. Check cooling performance with temperature measurement.
105	1	992	128	Charged Air cooler down stream temperature. Temperature below lower physical threshold.	Sensed temperature within intake air manifold < threshold.	actual temperature below -40°C? exchange sensor
105	3	994	128	Charge air temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to battery. sensor voltage > limit	The sensor raw signal Air_uRawTCACDs (voltage) > Air_SRCACDs.uMin_C. Check CAC-sensor and if necessary replace it, check connection cable and if necessary repair or replace it.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
105	4	995	128	Charge air temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to ground or open load. sensor voltage < limit.	The sensor raw signal Air_uRawTCACDs (voltage) is below Air_SRCTCACDs.uMin_C. Check CAC-sensor and if necessary replace it, check connection cable and if necessary repair or replace it
107	0	752	136	Air filter differential pressure: the pressure difference of the intake air between the filter inlet and outlet calculated by ECU is above the target range and the ECU activates a system reaction	Pressure loss above target range with system reaction, air filter clogged or defective, sensor not working, connection cable damaged Pressure value above warning threshold	Check airfilter and if necessary clean or renew it, check cabling, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
110	0	98	232	Coolant temperature: the coolant temperature calculated by ECU is above the target range; the ECU activates a system reaction	Cooling temperature too high. Coolant temperature above warning threshold	Clean radiator, check fan drive, check coolant level, check cooling system in general, check thermostat function, check water pump
110	0	99	232	Coolant temperature: the coolant temperature calculated by ECU is above the target range. The ECU activates a system reaction	Coolant temperature above shut off threshold.	Clean radiator, check fan drive, check coolant level, check cooling system in general, check thermostat function, check water pump
110	1	93	225	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range.	Suspected components:wiring harness, coolant temperature sensor.	Check wiring harness and connected Coolant Temp Sens.
110	3	96	225	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range	Short cut to battery or open load.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
110	4	97	225	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range	Voltage Surveillance has found shortcut to Ground at Coolant Temperatur Sensor.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it Measure Voltage at Coolant Temperature Sensor and renew harness if needed.
111	1	101	235	Coolant level: the coolant level calculated by ECU is underneath the allowed minimum.	Coolant level too low, leakage in cooling system, sensor defective, wiring damaged.	Check coolant level, inspect cooling system for leakage and if necessary repair it, check sensor and wiring
157	3	877	147	Rail pressure sensor: the voltage of sensor measured by ECU is out of the target range.	Short cut to battery. Damaged rail pressure sensor.	Check cabling, check rail pressure sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
157	4	878	147	Rail pressure sensor: the voltage of sensor measured by ECU is out of the target range.	Check cabling, check rail pressure sensor and if necessary replace it, check connection cable and if necessary repair or replace it.	Check cabling, check rail pressure sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
164	2	1381	839	Rail pressure safety function is not executed correctly	Rail pressure is still above threshold.	Threshold for error detection is an internal ECU threshold. Reset the fault and at reappearance check ECU and injection system
168	0	1180	318	Battery voltage: the voltage measured by ECU is out of the target range	Battery voltage over limit	Check alternator, regulator of alternator and if necessary replace it, check wiring and voltage of alternator
168	1	1181	318	Battery voltage: the voltage measured by ECU is out of the target range	Battery voltage below limit	Check alternator, cabling, contact resistance, safety fuses, too high load in energy system, check battery and if necessary replace it

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
168	2	47	318	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	If Battery voltage (Ubatt_U) > 17V or 31V for more than =0.5sec a warning is generated Battery voltage above warning threshold	Check wiring harness and connected alternator.
168	3	45	318	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	Battery voltage above warning threshold (~38,9Volt), Short cut to battery possible.	Check wiring harness and connected alternator.
168	4	46	318	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	Battery voltage below warning threshold, Short cut to ground	Check wiring harness and connected alternator.
171	3	417	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high	open loop to sensor	Check cabling, if environment temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
171	4	418	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low	short circuit to Ground	Check cabling, if environment temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
172	0	1425	226	sensed intake air temperature at air filter > physical high limit	sensed intake air temperature at air filter > physical high limit	Check outside conditions: Temperature > Threshold within the intake air system of the engine? E.G: engine sucks in air from hot asphalt out of paver bucket Sensor positioned within black air filter housing above engine lid at hot environmental conditions and idling or similar? => if yes check with application team to adapt limits if not check sensor and wiring harness exchange sensor
172	1	1183	226	sensed air temperature within air intake path of engine below physical low limit	sensed air temperature within air intake path of engine below physical low limit	Cold start and ambient temperature < threshold Check wiring harness to AFST-sensor Exchange AFST-sensor
190	0	389	214	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during 1 level of FOC (Failure overrun condition) if engine speed was over Limit.	check powertrain settings regarding overspeed
190	2	421	213	ECU measures a deviation between camshaft and crankshaft angle to target.	Offset error between crankshaft and camshaft.	Threshold for error detection is an internal ECU threshold, occurs by offset between crankshaft and camshaft. Check increment wheel position, clean and adjust if necessary, check sensor position. Check Camshaft and Crankshaft sensor or wiring.
190	8	419	212	Camshaft speed sensor: the ECU receives no signal and uses the signal from crankshaft speed sensor as alternative to calculate the engine speed	When disturbed camshaft signal detected. Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed camshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor position. Check Camshaft Sensor or wiring.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
190	8	422	212	Sensor crankshaft speed; disturbed signal	Error in sensor or wiring. Crankshaft sensor defect.	Threshold for error detection is an internal ECU threshold, occurs by disturbed crankshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor position. Check Crankshaft Sensor or wiring.
190	11	390	214	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during 2 level of FOC (Failure overrun condition) if engine speed was over limit.	check powertrain settings regarding overspeed
190	12	420	212	Camshaft speed sensor: the ECU receives no signal and uses the signal from camshaft speed sensor as alternative to calculate the engine speed Threshold:	Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed or no camshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor position. Check Camshaft Sensor or wiring.
190	12	423	212	Crankshaft speed sensor: the ECU receives no signal and uses the signal from camshaft speed sensor as alternative to calculate the engine speed.	Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed or no Crankshaft signal. Check increment wheel position, clean and adjust if necessary, check Crankshaft sensor position or wiring.
190	14	391	214	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during ORC (Override conditions) if engine speed was over 2900rpm	check powertrain settings regarding overspeed
190	14	1222	2-1-2	Camshaft- and Crankshaft speed sensor signal not available on CAN or defect.	Sensors for engine speed are defect.	Threshold for error detection is an internal ECU threshold. Check wiring, check cables and repair or replace if necessary.
411	0	791	693	delta pressure across venturi in EGR line above physical high limit	sensed value of venturi difference pressure > high limit	Threshold for error detection is an internal ECU threshold. EGR-Valve blocked open EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position => Check intake throttle Exhaust pressure too high => Check Exhaust pressure Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
411	1	792	693	delta pressure across venturi in EGR line below physical low limit	sensed value of venturi difference pressure < low limit	Threshold for error detection is an internal ECU threshold. Check correct mounting of difference pressure sensor at venturi tube Exchange difference pressure sensor broken
411	3	795	693	The sensed raw voltage Air_uRawPEGRDeltaP is above the maximum threshold.	EGR Delta pressure Sensor defect	Check cabling, if charge EGR Delta pressure sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
411	4	381	693	Range check cannot be done or interrupted.	EGR or wiring defect	Check wiring harness and connected EGR.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
411	4	796	693	The sensed raw voltage value Air_uRawPEGRDeltaP is above the minimum threshold.	EGR Delta pressure Sensor defect	Check cabling. If charge EGR Delta pressure sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
411	11	793	693	DFC is stored in EEPROM and status kept until check is allowed to be carried out again DFC can be reset by service routine 216	deviation between desired O2 concentration in intake air manifold and the real O2-concentration within intake air manifold > limit	Threshold for error detection is an internal ECU threshold. EGR-Valve mechanically blocked open or closed EGR-pipe blocked with metall plate instead sealing downstream EGR-Valve EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position => Check intake throttle Exhaust pressure too high => Check Exhaust pressure Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
412	3	1007	682	EGR downstream temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to battery. sensor voltage > limit	Check wiring harness to TEGR-sensor. Exchange TEGR-sensor.
412	4	1008	682	EGR downstream temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to ground or open load. sensor voltage < limit	Check wiring harness to TEGR-sensor. Exchange TEGR-sensor.
630	12	376	281	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Section could not be erased	Threshold for error detection is an internal ECU threshold. There is no healing possible for the error. In the every new initialization phase, the debounce level is set to zero. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it.
630	12	377	281	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Minimum 3 blocks could not be readed, EEPROM has Checksum Error	There is no healing possible for the error. In the every new initialization phase, the debounce level is set to zero. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it
630	12	378	281	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Block could not be written for minimum 3 times	Threshold for error detection is an internal ECU threshold. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it.
639	14	84	271	CAN bus 0: the ECU is not allowed to send messages, because the status "BusOff" is detected.	CAN BusOff error; CAN 0 (Customer CAN)	Threshold for error detection is an internal ECU threshold. BusOff bit for CAN A node is set. Check wiring of CAN bus and if necessary repair it, check connection cable and if necessary repair or replace it, check resistance in CAN lines (120 Ohm)

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
651	3	580	154	Injector cyl. 1: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 1 wiring harness, cable break or short circuit, sensor defective, connection cable damaged	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
651	5	568	154	Injector cyl. 1: interruption of electrical connection	Interruption of electronic connection Injector cyl. 1	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
652	3	581	155	Injector cyl. 2: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 2 wiring harness, cable break or short circuit, sensor defective, connection cable damaged	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
652	5	569	155	Injector cyl. 2: interruption of electrical connection	Interruption of electronic connection Injector cyl. 2	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
653	3	582	156	Injector cyl. 3: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 3 wiring harness, cable break or short circuit, sensor defective, connection cable damaged	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
653	5	570	156	Injector cyl. 3: interruption of electrical connection	Interruption of electronic connection Injector cyl. 3	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
654	3	583	161	Injector cyl. 4: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 4 wiring harness, cable break or short circuit, sensor defective, connection cable	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
654	5	571	161	Injector cyl. 4: interruption of electrical connection	Interruption of electronic connection Injector cyl. 4	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
655	3	584	162	Injector cyl. 5: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 5 wiring harness, cable break or short circuit, sensor defective, connection cable	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
655	5	572	162	Injector cyl. 5: interruption of electrical connection	Interruption of electronic connection Injector cyl. 5	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
656	3	585	163	Injector cyl. 6: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 6 wiring harness, cable break or short circuit, sensor defective, connection cable	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
656	5	573	163	Injector cyl. 6: interruption of electrical connection	Interruption of electronic connection Injector cyl. 6	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
676	11	543	263	Cold start aid relay error.	Relay defect or wire harness problem	Threshold for error detection is an internal ECU threshold. check wire harness, replace relay
676	11	544	263	Cold start aid relay open load	Relay or wire harness	Threshold for error detection is an internal threshold. check wire harness, replace relay
677	3	956	512	Start relay (high side power stage): the current drop measured by ECU is above the target range.	Short cut HighSide-output to battery.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	3	960	512	Start relay (low side power stage): the current drain measured by ECU is above the target range.	Shortcut LowSide-Output to battery.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	4	957	512	Start relay (high side power stage): the current drain measured by ECU is above the target range.	Shortcut HighSide-output to ground.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	4	961	512	Start relay (low side power stage): the current drop measured by ECU is above the target range.	Shortcut LowSide-Output to ground.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable of terminal 50 and if necessary repair or replace it.
677	5	958	512	Start relay (low side power stage): the current drop measured by ECU is above the target range	Open circuit/disconnection LowSide-Output.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	12	959	512	Start relay (low side power stage): the current drop measured by ECU is above the target range.	Temperature over limit.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
691	8	928	928	Supply module heater: PWM time periode out of valid range.	PWM signal for temperature readout from supply module to the control unit is out of range. Supply modul defect, fault in the wiring.	The Time period of the received PWM signal SCR_tiSMPerPwm is within the specified range of 150ms to 250ms Supply module check and replace if necessary. Check the wiring.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
729	3	549	263	wiring to the intake air heater device is faulty.	Intake Air Heater Device: overload, short-circuit	Threshold for error detection is an internal ECU threshold. Electrical error, Check wiring to the intake air heater device.
729	4	551	263	wiring to the air intake heater is faulty	Relay (for cold start aid) cable break or short to ground:	Threshold for error detection is an internal ECU threshold. Electrical error, check wiring to the air intake heater.
729	5	545	263	The cold start aid relay is according to wiring faulty.	Relay defect or wire harness problem	Threshold for error detection is an internal ECU threshold. Electrical error, check wires
729	12	547	263	The cold start aid relay is overheated, which causes this error	High temperature around the cold start relay.	Check the functionality of relay and replace it if needed. Check the temperature around the cold start relay during worst case operation.
898	9	305	118	TimeoutError of CAN-Receive-Frame TSC1TE - active	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus shedding, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
1079	13	946	282	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 1.	Suspected components EDC17cv52 Pin A19: DEF press / Exh.PressBeforeTurb (P3) / Air Pump Press / BrnFuelPressAfterDV2 Pin K19: Fan Speed Sensor Pin A21: LDF6T / OilPress / LowFuelPress Pin A17: Rail Pressure Sensor Suspected components EDC17cv54 Pin A21: CAM speed Pin K44: Delta Press Venturi / Poti EGR or Inlet Throttle Pin A24: LDF6T / OilPress / LowFuelPress Pin K43: Reserve 5V Sensor Supply Pin A09: second footpedal Suspected components EDC17cv56 Pin A21: Cam speed Pin K44: DEF press / Air FilterDiffPress Pin A24: LDF6T / OilPress / LowFuelPress Pin K43: second footpedal Pin A09: Delta Press Venturi	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
1080	13	947	282	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 2.	Suspected components EDC17cv52 Pin K16: second footpedal Pin A20: Exh.PressAfterTurb/DPFDiffPress/ BrnDV1Press/HCIPressDV1DV2 Suspected components EDC17cv54 Pin K45: DPF Diff Press / Exh. Press After Turb / Fan Speed Sensor Pin A46: first footpedal Suspected components EDC17cv56 Pin A22: Fan Speed Sensor Pin K45: Position EGR or Intake throttle flap Pin K46: First footpedal	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
1109	2	121	341	Request of engine shut off: the operator ignores the engine shut off request within an allowed period.	Engine Shut Off demand has been ignored by the user	Depending on error requested a shut off.
1136	0	1398	681	ECU internal temperature; temperature measured by ECU is out of the target range	Short-Circuit in ECU, ECU heated by hot air	Close warm air circuits, replace ECU
1231	14	85	271	CAN bus 1: the ECU is not allowed to send messages, because the status "BusOff" is detected Warning, no diagnostic with SERDIA2010 possible	CAN BusOff error; CAN 1 (Diagnostic CAN)	Threshold for error detection is an internal ECU threshold. BusOff bit for CAN B node is set. Check wiring of CAN bus and if necessary repair it, check connection cable and if necessary repair or replace it, check resistance in CAN lines (120 Ohm)
1235	14	86	271	CAN bus 2: the ECU is not allowed to send messages, because the status "BusOff" is detected. Warning, depends on engine, EAT.	CAN BusOff error; CAN 2 (Engine CAN)	Threshold for error detection is an internal ECU threshold. BusOff bit for CAN C node is set. Check wiring of CAN bus and if necessary repair it, check connection cable and if necessary repair or replace it, check resistance in CAN lines (120 Ohm)
1237	2	747	145	Override switch switch: the ECU receives a permanent signal.	Switch is blocked, taster locked, connection cable damaged plausibility error "override switch > 250ms pressed".	If the Block Button is pressed shorter than the Maximum Plausible pressing Time. Check cabling, if sensor is not working, check switch and if necessary replace it, check connection cable and if necessary repair or replace it.
1761	0	1593	129	The urea tank level sensor detects a value higher than the maximum allowed threshold	Suspected components: Urea Quality Sensor defect mechanical defect at the float gauge	Check level sensor and float gauge
1761	1	1594	129	The DEF tank level sensor detects a value lower than the minimum allowed threshold	Suspected components: Urea Quality Sensor defect mechanical defect at the float gauge	Check level sensor and float gauge
1761	14	1655	138	The urea tank volume ratio is below the threshold of <5%	actual urea tank level SCRUTnk_rVol_mp [%] is below applicable threshold 5%	Check urea level => if empty, then fill in urea Check DEF level sensor. If there is urea in the tank, then move the floater of the level sensor. The floater must be free. If you lift the sensor body, then SCRUTnk_rVol_mp must change. Exchange DEF level sensor, if no change of value or it's implausible.
1761	14	1656	138	The urea tank volume ratio is below the threshold of <2.5%	actual urea tank level SCRUTnk_rVol_mp [%] is below 2.5%	Check urea level => if empty, then fill in urea Check DEF level sensor. If there is urea in the tank, then move the floater of the level sensor. The floater must be free. If you lift the sensor body, then SCRUTnk_rVol_mp must change. Exchange DEF level sensor, if no change of value or it's implausible.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
1761	14	1880	138	The DEF tank level is below the threshold.	actual DEF tank level SCRUTnk_rVol_mp [%] is below the threshold	Check DEF level => if empty, refill Check DEF level sensor. If there is urea in the tank loose the sensor and move it. The floater must be free and move if you lift the sensor body. SCRUTnk_rVol_mp must change. Compare SCRUTnk_rVol_mp to: 1 = SCR_rawUTnkLvl 2 = SCR_rAdapUtnkLvl 3 = SCRUTnk_rActTnkVol *SCRUTnk_facVolPer_mp In case of malfunction, exchange DEF level sensor.
2791	0	1763	415	Internal actuator temperature is above threshold.	Overheating of EGR actuator during operation.	Let EGR actuator cool down and check heat accumulation during worst case operation.
2791	2	1753	415	corrupted CAN communication with actuator.	CAN bus error or faulty EGR actuator.	Threshold for error detection is an internal ECU threshold. Check other CAN bus components. If no message is sent, fix the wiring. If o.k. exchange EGR actuator.
2791	3	1758	415	Overvoltage at EGR actuator.	High voltage from the battery	Check battery voltage.
2791	4	1759	415	Undervoltage at EGR actuator.	Low voltage from the battery.	Check battery voltage.
2791	6	1757	415	Overcurrent to EGR actuator.	High voltage from battery. EGR actuator is blocked or moving very hard.	Check battery voltage. Check if EGR is blocked or not running smoothly. If everything is o.k. change EGR actuator.
2791	7	1752	415	EGR actuator is mechanically blocked.	EGR actuator faulty or blocked.	Threshold for error detection is an internal ECU threshold. Check the EGR actuator and EGR valve to mechanical blockage / clean. Check for free movement of the valve. If it's blocked, then exchange the EGR valve.
2791	7	1761	415	EGR actuator spring broken.	mechanical damage of spring due to overstress.	Threshold for error detection is an internal ECU threshold. Exchange EGR actuator.
2791	12	1755	415	Internal electrical fault of EGR actuator.	Internal damage of EGR actuator due to high temperature or electrical wiring issue.	Threshold for error detection is an internal ECU threshold. Exchange EGR actuator.
2791	13	1754	415	EGR actuator can not learn stop positions. Possibly only second failure if other EGRTV failures occur.	Error detection during the learning process.	Threshold for error detection is an internal ECU threshold. Start Serdia Usecase to reset EGR actuator. Check EGR valve and mounting situation. If o.k. change EGR actuator.
2791	13	1756	415	EGR actuator can not learn stop positions because procedure was interrupted.	Interruption of learning process due to mechanical damage.	Threshold for error detection is an internal ECU threshold. Start Serdia Usecase to reset EGR actuator.
2791	13	1760	415	Stop positions of EGR valve not o.k.	Mechanical damage of EGR actuator. EGR valve is blocked or moving very hard.	Threshold for error detection is an internal ECU threshold. Start Serdia Usecase to reset EGR actuator.
2791	16	1762	415	Internal actuator temperature above threshold.	overheating of EGR actuator	Let EGR actuator cool down, check heat accumulation during worst case operation.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
2797	4	1337	565	Injector diagnosis: Timeout of Injector detection cylinder bank 0	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2797	4	1339	565	Injector test: Short cut to ground on cylinder bank 0	Short-Circuit to ground on component wiring	Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2798	4	1338	566	Injector diagnosis: Timeout of Injector detection cylinder bank 1	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2798	4	1340	566	Injector test: Short cut to ground on cylinder bank 1	Short-Circuit to ground on component wiring	Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
3031	0	1135	669	The urea tank temperature sensor detects a value above the maximum allowed threshold	Sensed urea tank temperature > physical range high limit	Case "CANBUS sensor": Check urea tank temperature: really hot? Check CANBus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea temperature at quality sensor) identical? Tank heater permanently on? Check wiring of DEF-quality sensor Case "analog DEFT & Level sensor": Check urea tank temperature: really hot? Check urea tank temperature SCR_tSensUTnkT Compare urea tank temperature to EnvT_t or to SCR_tSMT (the urea temperature inside the supply module) identical? Tank heater permanently on? Check wiring of analog DEFT & Level sensor
3031	1	1136	669	The urea tank temperature sensor detects a value lower than the minimum allowed threshold.	sensed urea tank temperature < physical range low limit	Case "CANBUS sensor": Check ambient temperature EnvT_t=> About -40 °C? If yes Error could be plausible Check CANBus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea temperature at quality sensor) identical? Check wiring of DEF-quality sensor Check quality sensor Case "analog DEFT & Level sensor": Check urea tank temperature: really that cold? Check ambient temperature EnvT_t=> About -40 °C? If yes Error could be plausible Check urea tank temperature SCR_tSensUTnkT Check wiring of analog DEFT & Level sensor Check analog DEFT & Level sensor
3224	2	129	596	DLC Error of CAN-Receive-Frame AT1IG1Vol NOX Sensor (SCR-system upstream cat; DPF-system downstream cat); length of frame incorrect	Not Used	Threshold for error detection is an internal ECU threshold. Check Nox-Sensor and the wiring from CAN-BUS.

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3224	9	130	597	Timeout Error of CAN-Receive-Frame AT11G1Vol; NOX sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
3234	2	138	114	DLC Error of CAN-Receive-Frame AT101Vol NOX Sensor (SCR-system downstream cat; DPF-system downstream cat); length of frame incorrect	Failure of the CAN Bus message	NOX downstream sensor and sensor connection check
3234	9	139	117	Timeout Error of CAN-Receive-Frame AT10G1Vol; NOX sensor (SCR-system downstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX downstream sensor and sensor connection check
3361	3	1077	677	Urea dosing valve (low side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Threshold for error detection is an internal ECU threshold See substitute function Check the wiring
3361	3	1078	677	Urea dosing valve (high side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Threshold for error detection is an internal ECU threshold Check the wiring
3361	4	1079	677	Urea dosing valve (low side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Check the wiring
3361	4	1080	677	Urea dosing valve (high side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Threshold for error detection is an internal ECU threshold Check the wiring
3361	6	1075	677	Urea dosing valve: the current measured value by ECU at the end of the injection is too high	Fault in the wiring Defect urea dosing injection valve	Check wiring Check the urea dosing injection valve
3519	3	1898	277	The integrated diagnostic of the temperature sensor of the Urea Quality Sensor recognized a short circuit to battery. The UQS Sensor is a combined sensor of tank temperature, filling grade and DEF quality and it is also a CAN sensor --> no PIN	Wrong diagnostic of the short circuits logic inside the temperature sensor of the UQS CAN Communication corrupted	Check the wiring to the suction unit in the DEF tank. Check the CAN bus communication of the suction unit. In case the communication is corrupt, exchange the suction unit.
3519	4	1899	277	The integrated diagnostic of the temperature sensor of the Urea Quality Sensor recognized a short circuit to ground	DEF quality sensor in the suction unit of the DEF tank is defect CAN Communication corrupted	Check the wiring to the suction unit of the DEF tank. Check the CAN bus communication from the suction unit. In case the signal is corrupt, exchange the suction unit in the DEF tank.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3519	12	1895	277	The integrated temperature sensor of the Urea Quality Sensor measures higher temperature than threshold	Temperature sensor inside the UQS defect. CAN Communication corrupted. Overheating of the DEF tank due to malfunction of the heating valve. Flow direction of coolant is wrong due to mixed up the hoses routed to the heating valve. Overheating of the DEF tank due to heat transfer from neighbor parts.	Check the temperature sensor signal for plausibility. In case of improper signal, exchange the suction unit in the tank. Check CAN bus communication for proper signal. In case of improper signal, exchange the suction unit in the tank. Check the function of heating valve and routing of the hoses. The coolant flow through the heating valve must be observed according to the shown arrow. In case all actions above are OK, check the real temperature in the DEF tank during worst case condition and improve the installation of the DEF tank.
3519	13	1908	277	Temperature at UQS out of range the specified thresholds; invalid quality of the temperature	Suspected Components Tank heater DEF sensor	Check temperature system and/or DEF quality sensor
3520	2	1904	2-7-8	Measured DEF Quality from UQS is too low. Quality value received from UQS is < 22% for a certain time and a certain number or for measuring conditions not observed for a certain time.	Suspected components: Urea quality sensor defect Wrong installation (measuring air) Urea level sensor defect Non urea filled in tank CANBUS problems Evaluation conditions for new quality check not fulfilled after one previous mal detection	Check that there is liquid urea of known quality in the tank first Check urea tank level. Add urea until level is at least 10 cm above sensor. Ensure that urea is not frozen / sufficient urea is liquid Check Sensor: Are urea tank temperature and level displayed? Changes the level if you refill urea? Check electrical connection Check CANBus New quality detection is carried out if urea refill is detected or if an quality evaluation was triggered and was not finished successfully: To provoke a quality measurement: refill urea, at least 10 % of tank volume Wait until quality evaluation was carried out, can take up to 30 minutes => check value. It should be about 33 % Exchange quality sensor
3520	3	1896	278	The integrated diagnostic of the Urea Quality Sensor recognized a short circuit to battery	wiring harness of UQS corrupted CAN Communication corrupted	Threshold for error detection is an internal ECU threshold. Check the wiring harness from the ECU to the suction unit of the DEF tank Check the CAN bus communication. If the signal is corrupt, then exchange the suction unit.
3520	4	1897	278	The integrated diagnostic of the Urea Quality Sensor recognized a short circuit to ground.	wiring harness to the suction unit in the DEF tank is corrupted CAN Communication corrupted	Threshold for error detection is an internal ECU threshold. Check the wiring to the suction unit in the DEF tank. Check the CAN bus communication. In case the communication is corrupt, exchange the suction unit in the DEF tank.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3520	13	1907	278	Urea quality at UQS out of range the specified thresholds; invalid quality of the urea quality	Suspected components DEF quality sensor DEF	Check DEF quality and/or DEF quality sensor
3532	3	1911	127	The urea quality value from the sensor is greater than the maximum physical range threshold Comment: tank temperature is measured by the UQS sensor	Suspected Components: UQS defect	Check DEF quality and/or sensor.
3532	4	1912	127	The urea quality value from the sensor is lower than the minimum physical range threshold.	Suspected Components: UQS defect	Check DEF quality and/or Sensor.
3711	12	1455	711	Temperature Phy_tPFWgh, the weighted DPF temperature < Threshold 1 Temperature Phy_tPFWgh, the weighted DPF temperature > Threshold 2 towards the end of the stand-still main phase.	temperature Phy_tPFWgh, the weighted DPF temperature, is below or above the target temperature towards the end of the stand-still main phase.	Check temperature upstream DOC Exh_tSensOxiCatUs within Stand-still: > 450 °C? If not: => Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check temperature difference across DOC by Exh_tSensOxiCatDs - Exh_tSensOxiCatUs within Stand-still: < 100°C? If not: Check exhaust pipe downstream turbo charger for oil? check injectors: is an injector got stuck? Too many hydrocarbons in exhaust? White smoke (at hot EAT system, not at cold start)? Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check exhaust gas temperature sensors within EAT-system: T upstream DOCC, T downstream DOC & T upstream SCR catalyst all three of them can influence Phy_tPFWgh
3936	14	1917	2-8-6	Standstill escalation by time. In case the standstill request will not be released within 50 h by the driver this fault code will be set.	Stand-still request ignored by the operator. Display / stand-still request lamp broken.	Perform Stand-still. If soot load level of DPF has increased too high already call service to perform stand-still. In case the DPF soot load level remove DPF => Exchange DPF.
4334	0	1122	665	The absolute pressure value of the urea pump is greater than an applicable maximal filtered pressure threshold	Suspected Components: Urea pump defect Supply module pressure sensor defect Pump contains dirty parts	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)
4334	1	1123	665	Urea supply module pressure sensor: The absolute pressure value of the urea pump is less than an applicable minimal filtered pressure threshold	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4334	2	1866	665	absolute difference of sensed urea pump pressure (SCR_pAbsSensUPmpP) and ambient pressure (EnvP_p) > limit abs(UPmpP_pDiffPmpEnv_mp) > UPmpP_pDiffPmpEnv_C (250 hPa)	absolute difference of sensed urea pump pressure (SCR_pAbsSensUPmpP) and ambient pressure (EnvP_p) > limit abs(UPmpP_pDiffPmpEnv_mp) > UPmpP_pDiffPmpEnv_C	Check environment pressure sensor (EnvP_p) => plausible value? Engine shut-off and immediately re-started? => Shut-off again. Wait until after run of ECU has finished, re-Start engine Back-flow line free? Does the urea pump pressure show values < 1000 hPa in SCR state emptying (64)? Check revision valve => Does the urea pump pressure show values < 1000 hPa in SCR state emptying (64)? => exchange supply module Supply module pressure sensor defect => exchange supply module
4341	3	1104	675	Urea heater supply line: the current drain measured by ECU is above the target range	electrical error	Threshold for error detection is an internal ECU threshold Check wire harness Check supply line
4341	4	1105	675	Urea heater supply line: the current drain measured by ECU is above the target range	electrical error	Threshold for error detection is an internal ECU threshold Check wire harness Check supply line
4341	5	1102	675	Urea heater supply line: the current drain measured by ECU is above the target range	electrical error	Threshold for error detection is an internal ECU threshold Check wire harness Check supply line
4343	3	1096	673	Urea pressure line heater: the current drain measured by ECU is above the target range	shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 broken heating element in pressure line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4343	4	1097	673	Urea pressure line heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Short cut to ground or broken wiring, broken heating element in pressure line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4343	5	1094	673	Urea pressure line heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring, broken heating element in pressure line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	3	1092	674	Urea backflow line heater: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Short cut to battery or broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	4	1093	674	Urea backflow line heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Short cut to ground or broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4345	5	1090	674	Urea backflow line heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring, broken heating element in back-flow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4360	0	1069	668	The filtered urea cat upstream temperature is greater than an applicable maximum temperature threshold	Sensed temperature upstream SCR > physical high limit	Check temperature difference across DOC (Exh_tOxiCatDs-Exh_TOxiCatUs) at higher engine load => high difference > 100 K? If yes, the engine emits too many Hydrocarbons => check injectors: is an injector got stuck? => Check EGR Valve If difference normal the exhaust out of the engine itself is too hot: => Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function If that error was set while stand-still operation the error source could be exothermal soot burn off in DPF (which should not happen) => Dismount DPF and check it visually exchange temperature sensor upstream SCR
4360	1	1070	668	The filtered temperature before urea cat is less than an applicable minimum temperature threshold	Sensed temperature upstream SCR catalyst < than physical low limit	Cold start and ambient temperature < Threshold? Missdetection? Check wiring harness to UCatUsT-sensor Exchange UCatUsT-sensor
4360	2	1865	668	Error at static plausibility check: absolut temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => see enable conditions for details. Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired.	Error at static plausibility check: absolut temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => see enable conditions for details. Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired.	Check whether temperature sensor upstream of SCR catalyst is physically mounted within exhaust pipe If cold start condition can be made sure (engine was off for at least 8 h) compare values of EnvT_t, EngDa_tEng, Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT at ignition on, without starting the engine. All identical? Compare values of Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT after 15 min in constant operation point: show all similar values (30 K tolerance width). Are ambient temperature and (EnvT_t), cooling water temperature (EngDa_tEng) plausible? Sensor coated with urea crystals? Dismount urea injector and inspect temperature sensor upstream SCR catalyst visually Check wiring of sensor Replace sensor
4361	3	1072	668	Urea catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range	Voltage of temperature sensor upstream SCR catalyst > maximum limit Short circuit to battery	Check sensor Check wiring Replace UCatUsT-sensor
4361	4	1073	668	Urea catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range	Voltage of temperature sensor upstream SCR catalyst < minimum limit Short circuit to ground	Check sensor Check wiring Replace UCatUsT-sensor

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4365	2	1137	6-6-9	Signal error in case of Urea tank temperature transmitted via CAN-signal Com_tUTnKT.	CAN message is not send properly.	Check sensor connector Check CANbus
4365	3	1138	6-6-9	Urea tank temperature sensor: he current drain measured by ECU is above the target range.	Shortcut or open load.	Threshold for error detection is an internal ECU threshold. The Sensed raw voltage value SCR_uRawUTnKT is below SCR_SRCUTnKT.uMax_C. Check wiring.
4365	3	1914	669	Internal error of DEF quality sensor.	Suspected componetes: DEF quality sensor Wiring harness	Check wiring harness and DEF qualitysensor
4365	4	1139	6-6-9	Urea tank temperature sensor: he current drain measured by ECU is above the target range.	Shortcut or open load.	Threshold for error detection is an internal ECU threshold. The sensed raw voltage value SCR_uRawUTnKT is above SCR_SRCUTnKT.uMin_C. Check wiring.
4365	4	1915	6-6-9	Internal error of DEF quality sensor.	Suspected componetes: DEF quality sensor Wiring harness	Check wiring harness and DEF qualitysensor
4366	3	1112	671	Urea tank heating valve: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Urea tank heating valve defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea tank heating valve
4366	4	1113	671	Urea tank heating valve: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Urea tank heating valve defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea tank heating valve
4366	5	1110	671	Urea tank heating valve: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Urea tank heating valve defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea tank heating valve
4375	3	1120	666	Urea supply module pump: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Pump in urea supply module defect	Threshold for error detection is an internal ECU threshold The hardware detects absence of any short circuit to battery on the PWM output power stage for the urea pump module actuator Check wiring Check pump in the urea supply module
4375	4	1121	666	Urea supply module pump: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Pump in urea supply module defect	Threshold for error detection is an internal ECU threshold The hardware detects a short circuit to ground error on the PWM output power stage for the UreaPump Module Motor Actuator. The error is updated by setting bit 1 of measuring point UPmp-Mot_stPrev1stRslt_mp Check wiring Check pump in the urea supply module

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4375	5	1118	666	Urea supply module pump: the ECU can not measure any reaction during pump control	Open load Broken wiring Pump in urea supply module defect	Threshold for error detection is an internal ECU threshold The hardware detects the presence of load on the PWM output power stage for the urea pump module actuator. Check wiring Check pump in the urea supply module
4376	3	1131	667	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Shortcut to battery Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4376	4	1132	667	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Shortcut to ground Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4376	5	1129	667	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Open load Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4765	0	1039	683	The exhaust temperature value from the sensor before DOC is above an applicable upper shutoff threshold TOxiCatUs_tShOffThresHiAds_C = Threshold 1 in Normal and Heatmodes (TOxiCatUs_tShOffThresHiRgn_C = Threshold 2 in stand-still)	sensed temperature upstream DOC > shut-off limit	Check air path of engine: EGR-Valve, Intake-Throttle, Check Turbocharger and Piping each for leakage and correct function Check injectors: is an injector got stuck? Exchange temperature sensor upstream DOC
4765	0	1040	683	The exhaust temperature value from the sensor before DOC is above an applicable upper warning threshold TOxiCatUs_tWarnThresHi_C = Threshold	Sensed temperature upstream DOC > warning limit	Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injectors: is an injector got stuck? Exchange temperature sensor upstream DOC

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4768	2	1036	683	<p>Static plausibility check: The exhaust temperature value from the sensor before DOC, the exhaust temperature value from the sensor after DOC, the temperature value from the sensor before SCR-Cat, the environment temperature and the coolant engine temperature their ratios to each other exceed their related thresholds.</p> <p>Dynamic plausibility check with environment temperature sensor value: The exhaust temperature value from the sensor before DOC is lower than an applicable environment temperature threshold</p>	<p>Static plausibility check: The exhaust temperature value from the sensor before DOC, the exhaust temperature value from the sensor after DOC, the temperature value from the sensor before SCR-Cat, the environment temperature and the coolant engine temperature their ratios to each other exceed their related thresholds. (difference between temperature after DOC and temperature before DOC &gt; Threshold 1 difference between temperature before DOC and before SCR &gt; Threshold 2 difference between temperature after DOC and before SCR &lt; Threshold 3 difference between temperature after DOC and ambient temperature &lt; Threshold 4 difference between temperature ambient temperature and engine temperature &lt; Threshold 5)</p> <p>Dynamic plausibility check with environment temperature sensor value: The exhaust temperature value from the sensor before DOC is lower than an applicable environment temperature threshold (&lt; environmental temperature + Threshold 6)</p>	<p>Check ambient temperature =&gt; value plausible? upstream DOC sensor mounted within exhaust line? T upstream DOC sensor physically mounted in correct position upstream DOC? (not upstream SCR or downstream DOC?) Check T upstream DOC sensor Check other T-sensors within EAT-system (Exh_tOxiCatDs &amp; UCatUsT_tFlt_mp show plausible values? No errors on them?</p>
4768	2	1881	683	<p>At engine cold start conditions the sensed exhaust gas temperature downstream DOC (Exh_tSensTOxiCatDs) has exceeded the sum of ambient temperature (EnvT_t) + offset (40°C) earlier than the sensed exhaust gas temperature upstream of DOC (Exh_tSensTOxiCatUs).</p> <p>The check is only performed once each ignition cycle and only if the start is judged a cold start.</p> <p>Error status is frozen for that ignition cycle. No healing possible.</p>	<p>Difference temperature of exhaust gas temperature downstream DOC and fixed ambient temperature at ignition on exceeds a certain limit earlier than the difference temperature of exhaust gas temperature upstream DOC and fixed ambient temperature at ignition on.</p>	<p>Check whether all exhaust gas temperature sensors within the EAT system are mounted properly: Within the exhaust line and at correct positions. Check the position of the sensor upstream SCR which might be physically mounted in the wrong position. If cold start condition can be made sure (engine was off for at least 8 h) compare values of EnvT_t, EngDa_tEng, Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT at ignition on, without starting the engine. All identical? Then the sensors itself are okay. Check exhaust piping for leakage. Check wiring of sensors Replace sensors Check DOC =&gt; physically intact?</p>
4768	3	1044	683	<p>Oxidation catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range</p>	<p>The sensed raw voltage value Exh_uRawTOxiCatUs is above Exh_SRCTOxiCatUs.uMax_C Shortcut to battery</p>	<p>Check wiring harness to temperature sensor upstream DOC Exchange temperature sensor upstream DOC</p>
4768	4	1045	683	<p>Oxidation catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range</p>	<p>The sensed raw voltage value Exh_uRawTOxiCatUs is below Exh_SRCTOxiCatUs.uMin_C Shortcut to ground</p>	<p>Check wiring harness to temperature sensor upstream DOC Exchange temperature sensor upstream DOC</p>

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
5763	3	1024	594	Actuator of the external EGR valve: the ECU detects a short circuit to battery or open load.	Short cut to battery or open loop.	Check cabling, actuator defect, check actuator and if necessary replace it, check connection cable and if necessary repair or replace it.
5763	3	1226	594	Actuator EGR-valve: short cut to battery is detected	Short-Circuit to battery on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	3	1227	594	Actuator EGR-valve: short cut to battery on ECU pin is detected	Short-Circuit to battery on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	4	1025	594	Actuator of the external EGR valve: the ECU detects a short circuit to ground.	Short cut to ground	Check cabling, actuator defect, check actuator and if necessary replace it, check connection cable and if necessary repair or replace it.
5763	4	1228	594	Actuator EGR-valve: short cut to ground on ECU pin is detected	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	4	1229	594	Actuator EGR-valve: short cut to battery on ECU pin is detected	Short-Circuit to ground on component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	4	1232	5-9-4	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); Voltage below threshold 3.6) Drosselklappe (4.1;6.1;7.8); Voltage below threshold;	Monitoring for CY146 Under Voltage.	Threshold for error detection is an internal ECU threshold. Check wiring, component
5763	5	1023	5-9-4	Actuator error EGR-Valve; signal range check low, measured current is below target	Short circuit to ground.	Check wiring, check cables and repair or replace if necessary, check actuator with SERDIA 2010 test for EGR and if necessary replace it.
5763	6	1014	594	Actuator error EGR-Valve. Signal range check high.	Short cut to batterie.	Check wiring and repair or replace if necessary, check actuator with SERDIA test for EGR and if necessary replace it.
5763	6	1022	5-9-4	Actuator error EGR-Valve; signal range check high, measured current by ECU is over target	Short circuit to battery or open circuit.	Check cabling, actuator defect, check actuator and if necessary replace it, check connection cable and if necessary repair or replace it.
5763	6	1223	594	Actuator EGR-Valve: Open load on ECU output is detected	Open circuit on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	6	1224	594	Actuator EGR-valve: too high current is going into the actuator. Output is switched off	Overload on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
5763	6	1230	5-9-4	Actuator error EGR-valve; Overload by short-circuit	Short Circuit over Load	Threshold for error detection is an internal ECU threshold. Check wiring, component
5763	7	1016	594	Actuator position for EGR valve is not plausible, internal error, angular misalignment of the flap.	Position error of throttle flap (deviation > 7%).	Threshold for error detection is an internal ECU threshold. Threshold for error detection, deviation from setpoint > 7%. Troubleshooting with SERDIA 2010 Use Case "EGR Diagnostic".
5763	11	1231	5-9-4	Power stage overtemperature due to high current.	Temperature dependent Over Current	Threshold for error detection is an internal ECU threshold. Check wiring, component
520521	5	1015	594	Actuator error EGR-Valve. Signal range check low.	Short cut to ground.	Check wiring and repair or replace if necessary, check actuator with SERDIA test for EGR and if necessary replace it.
523009	9	825	253	The pressure relief valve (PRV) has reached the number of allowed activations.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Replace pressure relief valve (PRV) and reset fault with Serdia.
523009	10	833	2-5-3	The pressure relief valve (PRV) has reached the allowed opening time.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Replace pressure relief valve (PRV) and reset fault with Serdia.
523212	9	171	3-3-3	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection	Timeout Error (Missing CAN Bus message)	Check wiring harness and customer devices
523240	9	179	527	Timeout CAN-message FunModCtl; Function Mode Control	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
523350	4	565	151	Injector cylinder bank 1: the current drop measured by ECU is above the target range	Short circuit injection bank 1 (all injectors of this bank can be affected)	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
523352	4	566	152	Injector cylinder bank 2: the current drop measured by ECU is above the target range	Short circuit injection bank 2 (all injectors of this bank can be affected)	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
523354	12	567	153	Internal hardware monitoring: the ECU detects an error of its injector high current output. Chip of CY33x defect power stage components	Defective powerstage in ECU	Threshold for error detection is an internal ECU threshold. If error is not removable, change ECU.
523450	4	839	1-4-3	Diagnostic fault check for min error of COM message.	The sensed raw value is less than the threshold.	Check cabling, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
523470	2	826	146	The pressure relief valve (PRV) has been opened due to excessive pressure.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Threshold for error detection is an internal ECU threshold. Reset the fault and at reappearance check injection system.
523470	2	827	146	The pressure relief valve (PRV) has been opened due to excessive pressure.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Threshold for error detection is an internal ECU threshold. Reset the fault and at reappearance check injection system.

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**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523470	7	876	146	Rail pressure is out of the expected average range.	Rail pressure is out of the expected average range. PRV can not be opened.	(A) Check rail pressure relief valve and replace if necessary. (B) Check high pressure pumps, pressure relief valve and metering unit. (C) Change components if necessary
523470	11	831	146	Rail pressure relief valve can not be opened due to the rail pressure.	Rail pressure out of tolerance range (PRV can not be opened by a pressure peak in this operating point)	Threshold for error detection is an internal ECU threshold. Check rail pressure, check rail pressure sensor for plausibility, check FCU.
523470	11	832	146	Rail pressure is out of the expected average range. The PRV can not be opened at this operating point with a pressure shock.	Averaged rail pressure is outside the expected tolerance range.	Threshold for error detection is an internal ECU threshold. Check PRV and replace if necessary.
523470	12	828	146	Rail pressure relief valve: is open. Shutoff conditions.	Shut Off after PRV Open	Threshold for error detection is an internal ECU threshold. Check PRV opening counter and if necessary replace PRV, check rail-pressure sensor for plausibility and if necessary replace it, check FCU and if necessary replace it.
523470	12	829	146	Rail pressure relief valve is open. Warning conditions.	Warning PRV open	Threshold for error detection is an internal ECU threshold. Check PRV opening counter and if necessary replace PRV, check rail-pressure sensor for plausibility and if necessary replace it, check FCU and if necessary replace it.
523470	14	830	146	Rail pressure relief valve is open. (PRV)	Open PRV	Threshold for error detection is an internal ECU threshold. Only after ECU reset. Check PRV opening counter and if necessary replace it, check rail-pressure sensor for plausibility and if necessary replace it, check FCU and if necessary replace it.
523550	12	980	515	Terminal 50 was operated for more than 2 minutes. This may happen due to short to battery or wrong usage of Terminal 50. Starter control is disabled until this error is healed.	Start information to Starter (T50-switch) erratic/defect.	Threshold for error detection is an internal ECU threshold. Check cabling, if sensor not working, check start switch and if necessary replace it, check connection cable and if necessary repair or replace it.
523601	13	948	282	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 3.	Suspected components EDC17cv52 Pin A18: DeltaPressVenturi / Position intake throttle flap Pin K20: First footpedal Pin K21: Air FilterDiffPress Suspected components EDC17cv54 and cv56 Pin A07: Rail pressure	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
523612	3	644	555	supply voltage too high	not used	Threshold for error detection is an internal ECU threshold.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	4	646	555	supply voltage too low	not used	Threshold for error detection is an internal ECU threshold.
523612	12	387	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Injector shut off demand for the ICO coordinator System responses: not	Threshold for error detection is an internal ECU threshold. Caution! Sequence error, check error memory for other errors.
523612	12	612	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Plausibility check failed (MoCADC_uNTP_mp is higher than MoCADC_uNTPMax_C).	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	613	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Analysis of test voltage (Value is out of the target -> ECU internal error)	Threshold for error detection is an internal ECU threshold. Check wiring, check connected sensors actuators. If error is still present, exchange ECU.
523612	12	614	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Analysis of the ratiometric correction (Value is out of the target -> ECU internal error)	Threshold for error detection is an internal ECU threshold. Check wiring, check connected sensors actuators. If error is still present, exchange ECU.
523612	12	615	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error report due to an error in the plausibility of Function Coordination(FC) and Monitoring Modul(MM)(ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	616	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error report due to an interrupted SPI communication (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	617	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	multiple error in complete ROM-test during postdrive detected (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	618	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Too less bytes received by monitoring memory from CPU as response (ECU internal error). Loss of synchronization sending bytes to the monitoring memory from CPU	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	619	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Suspected components: Injector ECU wiring harness/connector	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	620	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error trying to set MM Response time (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	621	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error detected in the internal ECU communication, Too many SPI errors during MoCSOP execution	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	12	623	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path test of the under voltage detection (ECU internal error). Diagnostic fault check to report the error in undervoltage monitoring	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	624	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path of the monitoring module (ECU internal error).	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	625	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Time out error trying to set or cancelling the alarm task (ECU internal error). Failure setting the alarm task period	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	627	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in time monitoring of the shut-off path test (ECU internal error). Diagnostic fault check to report the timeout in the shut off path test	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	628	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path test of the over voltage detection (ECU internal error). Diagnostic fault check to report the error in overvoltage monitoring	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	629	555	The two voltage values (ADC_VAL1, ADC_VAL2), detected by the accelerator pedal, are not plausible to each other.	Defect pedal or wiring	Threshold for error detection is an internal ECU threshold. Check Pedal, repair or exchange the Pedal. Check wiring. If error is still present, exchange ECU.
523612	12	630	555	Impermissible offset between the engine speed of level 2 and level 1	Calculated engine speed in level 1/2 implausible (-> ECU internal error).	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	631	555	Diagnostic fault check to report the plausibility error between level 1 energizing time and level 2 information	Implausible injection energizing time for either Pilx or MI1 or Polx.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	632	555	Error in the plausibility of the start of energising angles	Implausible start of energising of either Pilx or MI1 or Polx.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	633	555	Error in the plausibility of the energising times of the zero fuel quantity calibration	The energising times of the zero fuel quantity calibration ZFC is out of the target. (-> ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	634	555	Error in the plausibility of Pol2 efficiency.	Error in the plausibility of Pol2 efficiency.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	635	555	Error in the Pol2 shut-off.	Error in the Pol2 shut-off.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	636	555	Error in the plausibility of Pol3 efficiency.	Error in the plausibility of Pol3 efficiency.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	12	637	555	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Error in the plausibility of current energising time with maximum permitted energising time. Diagnostic fault check to report the error due to Over Run	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	638	555	Error in the plausibility of the wave correction parts	Error in the plausibility of the wave correction parts	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	639	555	Plausibility error of the Rail pressure sensor	In case the gradient of rail pressure is larger than the max threshold or lesser than the min threshold. Rail metering unit defect. Leakge in the Rail System.	Threshold for error detection is an internal ECU threshold. Check metering unit or cable. Check Rail pressure. Check the Rail System of leakage.
523612	12	640	555	Error in the torque comparison between permissible engine torque and current actual torque	Error in the torque comparison between the permissible inner engine torque and the current plausible actual torque.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	641	555	Diagnosis of curr path limitation forced by ECU monitoring level 2	The torque comparison is not plausible with the torque monitoring.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	642	555	Diagnosis of lead path limitation forced by ECU monitoring level 2	The setpoint path of the air system is limited by the limitation torque of the functional control unit monitoring.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	643	555	Diagnosis of set path limitation forced by ECU monitoring level 2.	If the quantity setpoint is exceeds the limit of the torque function.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	714	555	Error report "WDA wire is active" due to a defect query/response communication	Error detection by monitoring module	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	715	555	Error report "ABE wire is active" due to undervoltage detection	The reason is that a slow dropping of the vehicle electrical system voltage (defective autobattery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an undervoltage recognition.	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	716	555	Error report "ABE/WDA wire is active" due to overvoltage detection	If the ABE/WDA powerstage shut-off is active due to an overvoltage detection.	Threshold for error detection is an internal ECU threshold. software reset.
523612	12	717	555	Error report "ABE/WDA active" due to an unknown reason	The reason is that a slow dropping of the vehicle electrical system voltage (defective autobattery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an undervoltage recognition.	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	1170	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error during positive test (ECU internal error). Diagnostic fault check to report that the positive test failed	Threshold for error detection is an internal ECU threshold. Reflash ECU. If error is still activ replace ECU.

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	12	1857	555	Fault in the monitoring during the engine start. Start requested in level 1, but not released in level 2 which leads to no fuel injection.	wiring is not according DEUTZ requirements engine start conditions are not observed low battery voltage during start malfunction of starter	Threshold for error detection is an internal ECU threshold. check other active errors and fix them. check all needed engine start conditions, e.g. neutral switch. check the engine speed during starting of the engine. If it's too low, then check the battery voltage and then check the starter for malfunction.
523612	14	973	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Visibility of Software resets in DSM	Threshold for error detection is an internal ECU threshold.
523612	14	974	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Visibility of Software resets in DSM	Threshold for error detection is an internal ECU threshold.
523612	14	975	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Visibility of Software Resets in DSM	Threshold for error detection is an internal ECU threshold. If possible the software update has to be done. Replace the ECU.
523613	0	856	134	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	Pressure governor deviation exceeds the limiting value based on the engine speed.	Threshold for error detection is an internal ECU threshold. (A) Check for leakage (B) Check fuel-primary pressure (C) Change components, check sensor and if necessary replace it, check fuel system and if necessary repair it
523613	0	857	134	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	maximum positive deviation of rail pressure exceeded concerning set flow of fuel.	Threshold for error detection is an internal ECU threshold. (A) Check for leakage (B) Check fuel-primary pressure (C) Change components, check sensor and if necessary replace it, check fuel system and if necessary repair it
523613	0	858	134	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range which is dependant on the engine speed.	leakage is detected based on fuel quantity balance.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	0	859	134	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range which is dependant on the engine speed.	Maximum negative rail pressure deviation with metering unit on lower limit is exceeded.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	0	862	134	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range.	Rail pressure exceeds the limiting value.	(A) Check backflow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523613	1	861	134	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	Rail pressure falls below the limiting value based on the engine speed.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	2	864	134	Rail pressure metering unit, Setpoint of metering unit in overrun mode not plausible.	Pressure pump delivery quantity in overrun exceeds the threshold based on the pressure.	Threshold for detection is an internal ECU threshold. (A) Check backflow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary
523615	3	594	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to battery high side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	3	596	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to battery low side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	4	595	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to ground high side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	4	597	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to ground low side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	5	592	135	Detecting an open load fault in the metering unit	wiring harness defective, cable break	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	12	593	135	powerstage of metering unit is overheated	over temperature	Threshold for error detection is an internal ECU threshold. Check functionality of metering unit and replace it if needed. Check temperature of metering unit and improve the installation in case of overheating.
523632	3	1127	665	Urea supply module pressure sensor: the current drain measured by ECU is above the target range	Shortcut to battery Broken wiring Pressure sensor in urea supply module defect	Check wiring Check pressure sensor in urea supply module
523632	4	1128	665	Urea supply module pressure sensor: the current drain measured by ECU is above the target range The sensed raw voltage value SCR_uRawUPmpP is above SCR_SRCUPmpP.uMin_C	Shortcut to ground Broken wiring Pressure sensor in urea supply module defect	Check wiring Check pressure sensor in urea supply module
523632	11	1117	666	Urea supply module pump: the current drain measured by ECU is above the target range	When the pump motor does not switch to pump actuation mode after temperature measurement has been carried out.	Threshold for error is an internal ECU threshold

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523698	11	122	591	Shut off request from supervisory monitoring function	Engine Shut Off due to supervisory function	Threshold for error detection is an internal ECU threshold. Check error memory for additional errorcode to find root cause. Depending on additional error follow the documented "Take action for repair".
523718	3	1100	676	Urea heater relay: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring, broken relay	Threshold for error detection is an internal ECU threshold Check wiring Check SCR main relay
523718	4	1101	676	Urea heater relay: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring, broken relay	Threshold for error detection is an internal ECU threshold Check wiring Check SCR main relay
523718	5	1098	676	Urea heater relay: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring broken relay	Threshold for error detection is an internal ECU threshold Test SCR main relay Check cabling, if necessary replace relay.
523719	4	1109	672	Urea supply module heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module
523719	5	1106	672	Urea supply module heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module
523720	8	925	148	Supply module heater: Duration of switch on is too long.	uty cycle for temperature readout from supply module heater to the control unit is out of range; Supply modul defect, fault in the wiring.	When the received supply module heater temperature duty cycle SCR_rSMT is out of the failurerange (SCR_rSMFailMax_C < SCR_rSMHtrT < SCR_rSMFailMin_C) Supply module check and replace if necessary. Check the wiring.
523720	8	926	148	Supply module heater: Dutycycle timing over error threshold.	Duty cycle for temperature readout from supply module heater to the control unit is not valid. Supply modul defect, fault in the wiring.	When the received supply module heater duty cycle SCR_rSMHtrT is in the valid range (SCR_r- Supply module check and replace if necessary. Check the wiring.
523721	8	930	689	Supply module heater: Dutycycle timing over error threshold.	Duty cycle for temperature readout from supply module to the control unit is out of range. Supply modul defect, fault in the wiring.	Supply module check and replace if necessary. Check the wiring.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523721	8	931	689	Supply module heater: Duty cycle timing out of valid range.	Duty cycle for temperature readout from supply module to the control unit is not valid. Supply modul defect, fault in the wiring.	When the received supply module duty cycle SCR_rSMT is in the valid range (SCR_rSMTVld-Min_C <= SCR_rSMT <= SCR_rSMTVldMax_C), OR in the failure range (SCR_rSMFailMin_C <= SCR_rSMT <= SCR_rSMFailMax_C) Supply module check and replace if necessary. Check wiring.
523721	11	927	689	Supply module heater: temperature measurement not available.	Duty cycle for temperature readout from supply module heater to the control unit is not available. Supply modul defect, fault in the wiring.	Threshold for detection is an internal ECU threshold. No erasing in the current driving cycle. Supply module check and replace if necessary. Check the wiring.
523722	8	929	691	Supply module heater: Faulty PWM signal from supply module.	PWM Signal for temperature readout from supply module to the control unit is not valid. Supply modul defect, fault in the wiring.	Threshold for error detection is an internal ECU threshold. When valid Sync followed by temperature information signal is received AND valid sync and temperature signal for both information is received one after the other. Supply module check and replace if necessary. Check the wiring.
523776	9	291	119	Timeout Error of CAN-Receive-Frame TSC1TE-active	Timeout Error (Missing CAN Bus message)	Threshold for error detection is an internal ECU threshold. Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
523777	9	292	119	Message TSC1-TE has been missing (passive)	Passive timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range, check actuator
523895	13	559	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 1 (in firing order).	Missing or wrong injector adjustment value for cyl. 1.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA). Use SERDIA UseCase to check it.
523896	13	560	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 2 (in firing order).	Missing or wrong injector adjustment value for cyl. 2	Threshold for error detection is an internal ECU threshold. check dataset and flash correct injector adjustment value (IMA). Use SERDIA UseCase to check it.
523897	13	561	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 3 (in firing order).	Missing or wrong parametrisation of injector adjustment cyl. 3.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523898	13	562	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 4 (in firing order).	Missing or wrong injector adjustment value for cyl. 4.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523899	13	563	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 5 (in firing order).	Missing or wrong injector adjustment value for cyl. 5.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523900	13	564	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 6 (in firing order).	Missing or wrong injector adjustment value for cyl. 6.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523912	4	73	7-2-2	@engines < 4l: Throttle valve error, Open Load or Short cut to Battery, blocked valve or wrong control signal for valve. @engines with Burner T4i: Pressure Sensor error after valve (DV2), lower limit reached	The sensed raw voltage value is below the minimum threshold.	The sensed raw voltage value DPM_uRawBrnDVDsP is above the minimum threshold DPM_SRCBrnDVDsPuMin_C @CRT < 4l: check throttle valve @engines with Burner T4i: check back-pressure valve
523924	4	42	167	Overload at Pins O_V_RH2x: A01, K74, K91. Components on A01, K74, K91 cannot be activated. Internal ECU power stage switched off.	Suspected components: 1- Pin K91: Clutch switch, Brake switch, Engine brake demand, Regeneration activation, Parking brake, GearboxN, Fan control 1 2- Pin K74: Boost air cooler bypass or electrical fuel pump relay, Fan control 2/fuel valve for flame star	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pins A01, K74, K91 and/or reflash ECU. If error is still present, exchange ECU.
523925	3	38	731	Short circuit to battery error of actuator relay 2. Components on Pin A88, K57 cannot be activated. Internal ECU power stage switched off.	Suspected Components: 1- Lamps K57: Warn Ash Charge, Diagnostic, Warn Coolant Temp/Level, Warn Oil, Warn Boost Air, Warn Air Filter, Warn Water in Fuel, SCR, Regeneration, Engine Running. 2- Relay Preheat A88 3- Exhaust Flap A88	Check wiring harness and connected loads on pins A88, K57.
523925	4	43	731	Short circuit to ground actuator relays 3 Overload at Pins O_V_RH3x: A88, K57	Suspected components: 1- Pin A88: Preheat relay, Exhaust flap 2- Pin K57: - control lamps: - OBD, preheat lamp, warning temp., warning oil, maintenance lamp, regeneration indicator, alternator management, engine running, diagnostic	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pins A88, K57. If error is still present, exchange ECU.
523926	4	44	732	Short circuit to ground aktuator relays 4. Overload at Pins O_V_PCV: A90	Suspected components: Fan, Wiring harness	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pin A90. If error is still present, exchange ECU.
523927	3	40	733	Short circuit to battery error of actuator relay 2. Components on Pin A04, A05 cannot be activated. Internal ECU power stage switched off.	Suspected Components: 1- Urea Pump A04 2- SCR Heater A05	Check wiring harness and connected loads on pins A04, A05.
523935	12	168	763	Timeout Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages	Fault is detected if a TimeOut of the EEC3VOL1 frame has occurred.	Check wiring harness and customer nodes
523936	12	169	764	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages	Timeout Error (Missing CAN Bus message)	Check wiring harness and customer nodes

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523938	9	133	766	Timeout Error (BAM to packet) for CAN-Receive-Frame AT11GCVol1 information; factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
523939	9	134	766	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed. Timeout Error (BAM to BAM) for CAN-Receive-Frame AT11GCVol1 information. factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat, DPF-system downstream cat).	Defective Nox sensor, faulty parameterization	NOX sensor and sensor connection check
523940	9	135	766	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT11GCVol1 information; factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
523941	9	140	767	Timeout Error (BAM to packet) for CAN-Receive-Frame AT10GCVol2 information; factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Timeout Error (Missing CAN Bus message)	NOX downstream sensor and sensor connection check
523942	9	141	767	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT10GCVol2 information, Calibration message 1 of the after catalyst NOx sensor has failed. Factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat, DPF-system downstream cat)	Defective Nox sensor, faulty parameterization.	NOX downstream sensor and sensor connection check.
523943	9	142	767	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT10GCVol2 information; factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	The fault is detected when a timeout error in packet 2 of NOxSenVol2Rx frame occurs.	NOX downstream sensor and sensor connection check
523960	0	1011	771	Physical range check high for EGR cooler downstream temperature.	Sensed temperature downstream EGR-cooler > limit.	EGR-Valve blocked open EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position Exhaust pressure too high Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
523960	1	1012	771	Physical range check low for EGR cooler downstream temperature.	sensor voltage > lower limit	EGR-Valve blocked open EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position Exhaust pressure too high Check Nox-sensor upstream SCR catalyst dp venturi sensor defect

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-13. Engine Fault Codes**

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523982	0	360	737	Powerstage diagnosis disabled; Indicating that battery voltage is not high.	Powerstage diagnostic can be deactivated due to too high battery voltage.	Check wiring, check alternator, check cables and repair or replace if necessary.
523982	1	361	737	Powerstage diagnosis disabled; Indicating that battery voltage is not low.	Powerstage diagnostic can be deactivated due to too low battery voltage.	Check wiring, check alternator, check cables and repair or replace if necessary.
523984	3	1239	788	Actuator relay 5: the voltage measured by ECU is out of the target range	Short-Circuit to battery to component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU
523986	4	1241	176	Actuator relay 4: the voltage measured by ECU is out of the target range	Short-Circuit to ground to component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU
523987	4	1242	791	Actuator relay 5: the voltage measured by ECU is out of the target range	Short-Circuit to ground to component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU
524050	11	1434	8-3-6	CAN; not used	not used	not used
524051	11	1435	8-3-7	CAN; not used	not used	not used
524057	2	1505	8-4-3	Low fuel pressure: the low fuel pressure calculated by ECU is underneath the target range; the ECU activates a system reaction	Fuel pressure below warning threshold	Threshold for error detection is an internal ECU threshold. Check low fuel pressure system (fuel feed pump, relay, fuse, wiring, sensor) and if necessary repair or replace it.
524063	3	1558	869	SCR heater main relay; short circuit to battery Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Short-Circuit to battery on wiring to component	Check wiring, component
524063	4	1559	869	Connection between heating valve (Y31) on the control unit Pin A:92 and Load side SCR heater main relay (K31) is a short cut to ground. Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Faulty wiring, faulty heater relay (K27-K31), defective heating valve (Y31), broken element in heating.	Disconnect plug from heating valve (Y31) and reset fault. If fault is still present you have to look in the wiring of Y31 to the control unit Pin A:92. If error is no longer present, you have to check the wiring of Y31 via relay K31 and possibly the heating cables and relay (K27-K30).
524063	5	1555	869	Urea backflow line heater: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open Load on wiring to component	Check wiring, component
524063	5	1556	869	Urea main relay: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	relay defect relay not connected wiring harness broken problems with supply voltage	Check wiring, component
524063	5	1557	869	Urea pressure line heater: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open load on wiring to component	Check wiring, component
524063	5	1560	869	SCR relay for suction line not connected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	relay defect relay not connected wiring harness broken problems with supply voltage	Check wiring, component

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524063	5	1561	869	Open load on wiring to component Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open load on wiring to component	Check wiring, component
524063	5	1562	869	SCR heater tank; open load	Open load on wiring to component	Check wiring, component
524063	12	1646	869	SCR supply module temperature is not reaching a threshold before a calibratable time is exceeded. Corresponding to the environmental Temperature a specific defrosting time is given. After starting the defrosting a clock counter is starting. Does the counter reach the given defrosting time limit, an error will be detected. Is the temperature reached in time the clock counter will be reset Example: by using the calibrated temperature/time curve --> environmental temperature 0°C --> defrosting time limit 6000s --> if the clock counter reaches 6000s the error will be detected	Suspected components: Environment temperature sensor defect SCR supply module temperature sensor defect SCR supply module electrical heater defect	Check Environment temperature sensor SCR supply module temperature sensor SCR supply module electrical heater
524065	0	1565	892	The relativ pressure value of the exhaust gas from the urea cat upstream sensor is greater than an applicable maximum pressure threshold	sensed presure upstream SCR catalyst > physical high range limit f(exhaust volume flow) UCatUsP_pRelFlt_mp > UCatUsP_pMax_mp	Check for crystallisation in exhaust line upstream SCR and dwnstream of urea injector Check correct connection from exhaust line to pressure sensor upstream SCR catalyst: syphons?, water in tube?, water in sensor? Check that exhaust pipe outlet is free (downstream SCR catalyst) Check wiring of pressure sensor upstream SCR catalyst Check pressure sensor upstream SCR catalyst: sensor has no connection to vehicle body? => Ensure that sensor is free Does sensor oscillate heavily at engine low idle / high idle? => try to supress the oscillating Exchange pressure sensor upstream SCR catalyst Check calculated exhaust volume flow of engine within EDC: SCR_dvolSCRUs pausable? If not: Check T sensor upstream SCR catalyst, check complete engine air path: EGR-Valve, Intake throttle, turbocharger, piping for leakage and function Check SCR catalyst: Broken? Exchange SCR-Catalyst

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524065	1	1566	892	The relative pressure value of the exhaust gas from the urea cat upstream sensor is less than an applicable minimum pressure threshold	sensed pressure upstream SCR catalyst > physical high range limit f(exhaust volume flow) UCatUsP_pRelFlt_mp < UCatUsP_pMin_mp	Check correct connection from exhaust line to pressure sensor upstream SCR catalyst: leakage? Check electric connector: 4h pin open / new connector type used? pressure exchange from inside electrical connector with the environment possible Check exhaust line: any leakages upstream of SCR catalyst? Check wiring of pressure sensor upstream SCR catalyst Exchange pressure sensor upstream SCR catalyst Check calculated exhaust volume flow of engine within EDC: SCR_dvolSCRUs pausable? If not: Check T sensor upstream SCR catalyst, check complete engine air path: EGR-Valve, Intake throttle, turbocharger, piping for leakage and function Check SCR catalyst: Broken? Exchange SCR-Catalyst
524065	2	1598	892	Comparison of urea cat upstream exhaust gas- and environment pressure, the difference should not exceed a certain limit abs(UCatUsP_pDiffEnvCat_mp) > Threshold	absolute value of difference between sensed pressure upstream SCR catalyst and environmental pressure > limit abs(UCatUsP_pDiffEnvCat_mp) > Threshold	Check electric connector: 4h pin open / new connector type used? pressure exchange from inside electrical connector with the environment possible? water in sensor? sensor frozen? Check wiring of pressure sensor upstream SCR catalyst Exchange pressure sensor upstream SCR catalyst Check intake manifold pressure sensor (Air_pCACDs) Check ambient pressure sensor (EnvP_p)
524065	3	1569	892	voltage of pressure sensor upstream SCR > voltage high limit	voltage of pressure sensor upstream SCR > voltage high limit	Check wiring of pressure sensor upstream SCR catalyst Check pressure sensor upstream SCR catalyst Exchange pressure sensor upstream SCR catalyst
524065	4	1570	892	voltage of pressure sensor upstream SCR < voltage low limit	voltage of pressure sensor upstream SCR < voltage low limit	Check wiring of pressure sensor upstream SCR catalyst. Check pressure sensor upstream SCR catalyst. Exchange pressure sensor upstream SCR catalyst

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524067	0	1581	894	Filtered urea supply module heater temperature value is above an applicable maximum heater temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of supply module heater > physical high range limit	Compare SCR_tSMT with SCR_tSMHtrT. Both show the same value? Check urea tank temperature (SCR_tAdapUTnkT). Very hot (> 70°C), urea tank heater permanent on? Does the pump never stop working? Check wiring to supply module Compare SCR_tSMT with SCR_tSMHtrT. Both show different values or urea tank temperature (SCR_tAdapUTnkT) is cold: exchange urea pump unit Supply module heater temperature sensor defect Supply module heater defect Supply module defect
524067	0	1585	894	Filtered urea supply module temperature value (SCR_tSMT) is above an applicable maximum temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of urea within supply module > physical high range limit	Compare SCR_tSMT with SCR_tSMHtrT. Both show the same value? Check urea tank temperature (SCR_tAdapUTnkT). Very hot (> 70°C), urea tank heater permanent on? Does the pump never stop working? Check wiring to supply module Compare SCR_tSMT with SCR_tSMHtrT. Both show different values or urea tank temperature (SCR_tAdapUTnkT) is cold: exchange urea pump unit Supply module temperature sensor defect Supply module heater defect Supply module defect
524067	1	1582	894	Filtered urea supply module heater temperature value is below an applicable minimum heater temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of supply module heater < threshold	Check ambient temperature EnvT_t < Threshold? Compare SCR_tSMT with SCR_tSMHtrT Check wiring with regard to supply module heater exchange urea pump unit Supply module heater temperature sensor defect Supply module defect
524067	1	1586	894	Filtered urea supply module temperature (SCR_tSMT) value is below an applicable minimum temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of urea within supply module < physical low range limit	Check ambient temperature EnvT_t < threshold? Compare SCR_tSMT with SCR_tSMHtrT Check wiring with regard to supply module heater exchange urea pump unit Supply module temperature sensor defect Supply module defect

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524067	2	1867	894	absolute difference of sensed temperature of supply module heater temperature and ambient temperature UPmpT_tDiffPmpHtrAmb_mp > threshold	absolute difference of sensed temperature of supply module heater temperature and ambient temperature UPmpT_tDiffPmpHtrAmb_mp > threshold	Compare SCR_tSMT with SCR_tSMHtrT, EnvT_t and CEngTds_t and SCR_tAdapUTnkT => All identical? If not: Has the machine been brought from cold environment into a warm one or vice versa without engine running, e.g. at workshop? Environment temperature sensor defect Coolant temperature sensor defect Supply module temperature sensor defect Problem at Supply module unit (broken?) => exchange supply module
524067	2	1868	894	absolute difference of sensed temperature of supply module temperature and ambient temperature > threshold	absolute difference of sensed temperature of supply module temperature and ambient temperature UPmpT_tDiffPmpAmb_mp > threshold	Compare SCR_tSMT with SCR_tSMHtrT, EnvT_t and CEngTds_t and SCR_tAdapUTnkT => All identical? If not: Has the machine been brought from cold environment into a warm one or vice versa without engine running, e.g. at workshop? Environment temperature sensor defect Coolant temperature sensor defect Supply module temperature sensor defect Problem at Supply module unit (broken?) => exchange supply module
524074	9	1533	246	Open load sensor internally at NOx-sensor downstream SCR	Open load sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor downstream SCR catalyst: water inside? Shake out sensor after dismantling. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration. Check wiring harness Exchange sensor
524075	11	1534	247	Short circuit sensor internally at NOx-sensor downstream SCR	Short circuit sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor downstream SCR catalyst: water inside? Shake out sensor after dismantling. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration? Rearrange if critical and possible Check wiring harness Exchange sensor

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524076	9	1535	248	Open line sensor internally at NOx-sensor downstream SCR NOx Sensors are CAN Sensors --> no HW Pin on the ECU	Open line sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor upstream SCR catalyst: water inside? Shake out sensor after dismounting. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration. Check wiring harness Exchange sensor
524077	11	1536	249	Short circuit sensor internally at NOx-sensor downstream SCR NOx Sensors are CAN Sensors --> no HW Pin on the ECU	Short circuit sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor upstream SCR catalyst: water inside? Shake out sensor after dismounting. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration. Check wiring harness Exchange sensor
524078	9	1537	255	Lambda value of NOx-Sensor downstream SCR is out of range. When the filtered Lambda concentration value at the sensor (ComRxSCR_rFltLamDs_mp) is greater than the physical range check max. lambda threshold	sensed lambda value of Nox-sensor downstream SCR catalyst is > physical high limit ComRxSCR_rCanLamDs_mp > threshold	Check whether NOx-sensor downstream SCR catalyst is physically mounted within the exhaust line Check Lambda values of NOx-sensor downstream SCR catalyst at idle conditions, ComRxSCR_rCanLamDs_mp > threshold? Compare to ComRxSCR_rCanLamUs_mp. Values must be almost identical Check CANBus of NOx-sensor downstream SCR catalyst Check NOx-sensor downstream SCR catalyst wiring Check NOx-sensor downstream SCR catalyst itself Replace NOx-sensor downstream SCR catalyst

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524079	9	1538	256	sensed lambda value of NOx-sensor downstream SCR catalyst is < physical low limit ComRxSCR_rCanLamDs_mp < threshold	sensed lambda value of NOx-sensor downstream SCR catalyst is < physical low limit ComRxSCR_rCanLamDs_mp < threshold	Compare to ComRxSCR_rCanLamUs_mp. ComRxSCR_rCanLamDs_mp must be almost identical! If almost identical, Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injection system of engine. Injector stuck? if sensed lambda upstream SCR higher (ComRxSCR_rCanLamUs_mp): Diesel in Urea-tank? Check CANBus of NOx-sensor downstream SCR catalyst Check NOx-sensor downstream SCR catalyst wiring Check NOx-sensor downstream SCR catalyst itself Replace NOx-sensor downstream SCR catalyst
524080	9	1539	257	sensed lambda value of Nox-sensor upstream SCR catalyst is > physical high limit ComRxSCR_rCanLamUs_mp > Threshold	sensed lambda value of Nox-sensor upstream SCR catalyst is > physical high limit ComRxSCR_rCanLamUs_mp > Threshold	Check whether NOx-sensor upstream SCR catalyst is physically mounted within the exhaust line Check Lambda values of NOx-sensor upstream SCR catalyst at idle conditions, ComRxSCR_rCanLamUs_mp < Threshold? Compare to ComRxSCR_rCanLamDs_mp. Must be almost identical Check CANBus of NOx-sensor upstream SCR catalyst Check NOx-sensor upstream SCR catalyst wiring Check NOx-sensor upstream SCR catalyst itself Replace NOx-sensor upstream SCR catalyst
524081	9	1540	258	sensed lambda value of Nox-sensor upstream SCR catalyst is < physical low limit ComRxSCR_rCanLamUs_mp < Threshold	sensed lambda value of Nox-sensor upstream SCR catalyst is < physical low limit ComRxSCR_rCanLamUs_mp < Threshold	Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injection system of engine. Injector stuck? Check CANBus of NOx-sensor upstream SCR catalyst Check NOx-sensor upstream SCR catalyst wiring Check NOx-sensor upstream SCR catalyst itself Replace NOx-sensor upstream SCR catalyst
524083	9	1542	261	sensed NOx-value of NOx-sensor downstream SCR catalyst < Threshold	sensed Nox-value of Nox-sensor downstream SCR catalyst < physical low limit	Check CANBus of NOx-sensor downstream SCR catalyst Check NOx-sensor downstream SCR catalyst wiring Check NOx-sensor downstream SCR catalyst itself Replace NOx-sensor downstream SCR catalyst

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524085	9	1544	912	sensed Nox-value of Nox-sensor upstream SCR catalyst < Threshold	sensed Nox-value of Nox-sensor upstream SCR catalyst < physical low limit	Check CANBus of NOx-sensor upstream SCR catalyst Check NOx-sensor upstream SCR catalyst wiring Check NOx-sensor upstream SCR catalyst itself Replace NOx-sensor upstream SCR catalyst
524100	9	1666	924	Timeout error of CAN-Transmit-Frame Com-DPFHisDat.	Open load on CANBUS wiring.	Check wiring, component.
524104	9	1676	928	Timeout error of CAN-Receive-Frame Com-RxDPFctl. CM1 Module Customer Recieve Message.	Time out of Check CANBUS EAT Control Receive Message, PGN65348. The message is not received.	Threshold for error detection is an internal ECU threshold. Check CANBUS EAT Control Receive Message, PGN65348. CM1 Module Customer Recieve Message.
524118	9	1672	9-4-2	Timeout error of CAN-Receive-Frame ComRxCM1	If the frame CM1 message is not transmitted successfully	Check CAN Bus cabling (Bus shedding, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524121	9	1683	9-4-5	Timeout error of CAN-Receive-Frame Com-RxTrbChActr	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus shedding, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524125	9	1687	9-4-9	Timeout error of CAN-Receive-Frame Com-TxTrbChActr	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus shedding, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524141	7	1827	192	DEF dosing valve is blocked with crystalized urea or other deposits.	While SCR system is starting up and fter urea pressure reaches 10000 hPa, the DEF dosing module is tested. Expectation is that urea pressure drops below 1500 hPa if injector works properly. The test is repeated up to 3 times before an error is set. SCRsysPresMon_stPresDropDet_mp=0 while SCRCo_stStatus_mp=16. Suspected component: wiring harness DEF dosing valve The error is stored into the EEPROM of the ECU and status at ECU shut down is regained at ignition on.	Check electrical connection of urea injector: - wiring harness - connector Conduct SERDIA use-case "injection test". If it is faulty: - remove urea injector from exhaust line: - check for crystallisation direct on injector nozzle / plate - rinse it thoroughly in water - remount urea injector and conduct SERDIA use-case "injection test" If the error is still active, then exchange urea injector.
524141	7	1858	192	DEF dosing valve is blocked with crystalized urea or other deposits.	While SCR system is starting up and fter urea pressure reaches 10000 hPa, the DEF dosing module is tested. Expectation is that urea pressure drops below 1500 hPa if injector works properly. The test is repeated up to 3 times before an error is set. SCRsysPresMon_stPresDropDet_mp=0 while SCRCo_stStatus_mp=16. Suspected component: wiring harness DEF dosing valve The error is stored into the EEPROM of the ECU and status at ECU shut down is regained at ignition on.	Check electrical connection of urea injector: - wiring harness - connector Conduct SERDIA use-case "injection test". If it is faulty: - remove urea injector from exhaust line: - check for crystallisation direct on injector nozzle / plate - rinse it thoroughly in water - remount urea injector and conduct SERDIA use-case "injection test" If the error is still active, then exchange urea injector.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524147	13	1639	966	No proper urea pressure level could be build up within the SCR system state "Fill Lines" => SCRCO_stStatus_mp = 1 within some minutes	This error shows up, if no proper urea pressure level could be build up within the SCR system state "Fill Lines" => SCRCO_stStatus_mp = 1 within some minutes Once the urea pump pressure has exceeded the threshold the error is declared as okay. Suspected components: Suction line blocked PWM Powerstage has a defect and a default value which leads not to a rising pressure Pump Pressure sensor defect pump filter contains dirty parts reverting valve continuously open	Make sure that frozen lines, pump or tank can be excluded! Check whether there is urea in the urea tank Check urea lines: All lines connected? The right lines connected to the correct places? Suction line blocked? No leakage? Not also urea to the outside but also air into the lines, especially in the suction line! Perform service routine "pressure test": Does the urea pump work? => check wiring harness & PWM signal for pump Does the urea pressure rise? DFC already healed? If all unsuccessful so far: Check urea pressure sensor: At ignition on and SCR system state = 0 ("Init check"), SCR_pAbsAdapUPmpP shall be identical to EnvP_p. Fulfilled: Sensor okay! Check reverting valve => see DFC_SCRCoRevVlvBlk Check pump filter: dirt inside? Suspected components: Urea pump broken Reverting valve continuously open Urea suction line, backflow line broken or connection swapped PWM Powerstage has a defect Pump Pressure sensor broken
524152	2	1874	971	CAN message is not received for a definite time => error is set. As soon as the message is received the error heals.	CAN message is not received for a definite time => error is set. As soon as the message is received the error heals.	Check electrical connection of urea quality sensor Check engine CAN bus Check urea quality sensor itself Exchange urea quality sensor
524153	2	1875	997	CAN message is not received for a definite time => error is set. As soon as the message is received the error heals.	CAN message is not received for a definite time => error is set. As soon as the message is received the error heals.	Check electrical connection of suction unit sensor (combined sensor with tank level and tank temperature) Check engine CAN bus Check level sensor itself Exchange suction unit
524156	9	1705	972	Timeout error of CAN-Receive-Frame ComRxEBC2 from wheel speed sensor.	Timeout Error (Missing CAN Bus message) Defect on wheel speed sensor.	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range. Replace the wheel speed sensor.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524177	7	1863	995	The error shows up, if no proper urea pressure could be build up within the SCR system state "Fill Lines" => SCRCO_stStatus_mp = 1.	This error shows up, if no proper urea pressure could be build up within the SCR system state "Fill Lines" => SCRCO_stStatus_mp = 1. 3 cases can lead to the error: Case A: increasing pressure is detected within 15s the check has passed => no error Case B: The pressure threshold was not reached within the 60s but case A was not positiv. Case C: The minimum pressure of 3000 hPa was not reached within the 60s.	Make sure that DEF lines, pump and tank are not frozen. Check for DEF level in the tank. Check DEF lines: Are all DEF lines connected? Is the suction line blocked? Is there any leakage? Not only urea to the outside but also air into the lines, especially in the suction line! Perform SERDIA usecase "pressure test": Does the DEF pump work? => check wiring harness & PWM signal for pump. Does the urea pressure increase? All errors are already healed? If still unsuccessful so far: Check urea pressure sensor: At ignition on and SCR system state = 0 ("Init check"), SCR_pAbsAdapUPmpP shall be identical to EnvP_p. Fulfilled: Sensor okay! Check DEF pump filter: Is any dirt inside? Suspected components: Suction line PWM Powerstage has a defect and a default value which leads not to a rising pressure DEF pump pressure sensor defect DEF pump filter contains dirty parts

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524178	7	1864	996	The urea pump is not able to control the urea pressure between 9bar and 11 bar.	The urea pump controller is not able to control the urea pressure between 9bar and 11 bar due to malfunction in the SCR system. Suspected components: - DEF pump broken - Reverting valve continuously open - Urea suction line, backflow line broken or connection swapped - PWM Powerstage has a defect - Pump Pressure sensor broken	Make sure that DEF lines, pump and tank are not frozen. Check for DEF level in the tank Check DEF lines: All lines connected? The right lines connected to the correct places? Suction line blocked? Is there any leakage? Not also urea to the outside but also air into the lines, especially in the suction line! Perform SERDIA usecase "pressure test": Does the DEF pump work properly? => check wiring harness & PWM signal for pump Does the DEF pressure rise? Is the error healed? If still unsuccessful so far: - Check DEF pressure sensor: At ignition on and SCR system state = 0 ("Init check"), SCR_pAbsAdapUPmpP shall be identical to EnvP_p. Fulfilled: Sensor okay! - Check reverting valve - Check DEF pump filter: dirt inside? Suspected components: DEF pump broken Reverting valve continuously open DEF suction line, backflow line broken or connection swapped PWM Powerstage has a defect DEF pump pressure sensor broken
524190	14	1891	272	Not enough urea in tank or low urea quality or hardware tampering failure is detected or hardware failure is detected	Low DEF tank level Low DEF quality Hardware Tampering is active Hardware Failure is active	Check DEF level in tank. If there is no DEF, refill up to volume above the warning threshold. Check the DEF quality in the tank. If wrong fluid is filled, refill with proper DEF. Check other errors based on hardware malfunctions.
524191	14	1892	273	A low DEF tank level or a low DEF quality is detected or hardware tampering (system components are pinched off) or hardware failures as shortcut to battery, shortcut to ground etc. are detected.	Low DEF tank level Low DEF quality Hardware Tampering is active Hardware Failure is active	Threshold for error detection is an internal ECU threshold. Check the DEF level in tank. If there is no DEF, refill up above the warning level. Check DEF quality filled in the tank. Check other errors based on hardware tampering or failure.

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524193	8	1893	275	The total time in standstill-regeneration mode exceeds the long-limit threshold within last 500h total engine run time. The error is activated if the engine runs to many times in Standstill regeneration.	Stand-still mode is very often aborted by the operator. Stand-still mode does not reach required temperature level and regeneration level is therefore reached after a short time again	Read out stand-still statistics => see service manual: Stand-still operation finished or often interrupted by driver / engine shut-off? => Run stand-still and instruct operator Stand-still operation required often by soot load => Check dp DPF pressure sensor Stand-still mode does not reach required temperature level: Check engine air path: Intake Trottle, EGR-Valve and turbocharger okay? Any leakage in engine air intake system or exhaust gas system? Check temperature sensors within exhaust system: upstream DOC, downstream DOC If soot load level of DPF allow it: Perform Stand-still and check reached temperature level upstream and downstream DOC: T upstream DOC in the range of 480-550°C? Downstream DOC after 25 min stand-still main phase 590°C are reached? Temperature traces are steady and even? Temperature downstream DOC higher than upstream DOC but difference does not exceed 100 K? Very small difference (< 10 K after 25 min stand-still main phase, 590 °C downstream DOC are not reached) => exchange DOC Very big difference (> 100 K after 25 min stand-still main phase, 590 °C downstream DOC exceeded) => check injection system of engine & engine air path

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524194	8	1894	276	<p>The total time in standstill-regeneration mode exceeds the long-limit threshold: 2,5h stand-still operation within 50h total motor run time.</p> <p>The error is activated if the engine runs too much time in short Standstill regeneration.</p>	<p>Stand-still mode is aborted / interrupted too often by the operator</p> <p>Stand-still is required too often due to miscalculation in the soot model</p> <p>Stand-still mode does not reach temperature level and regeneration level is therefore reached after a short time again.</p>	<p>Read out stand-still statistics =&gt; see service manual:</p> <p>Stand-still operation finished or often interrupted by driver / engine shut-off? =&gt; Run stand-still and instruct operator</p> <p>Stand-still operation required often by soot load =&gt; Check dp DPF pressure sensor</p> <p>Stand-still mode does not reach required temperature level:</p> <p>Check engine air path: Intake Throttle, EGR-Valve and turbocharger okay?</p> <p>Any leakage in engine air intake system or exhaust gas system?</p> <p>Check temperature sensors within exhaust system: upstream DOC, downstream DOC</p> <p>If soot load level of DPF allows it:</p> <p>Perform Stand-still and check reached temperature level upstream and downstream DOC: T upstream DOC in the range of 480-550°C? Downstream DOC after 25 min stand-still main phase 590°C are reached?</p> <p>Temperature traces are steady and even?</p> <p>Temperature downstream DOC higher than upstream DOC but difference does not exceed 100 K?</p> <p>Very small difference (&lt; 10 K after 25 min stand-still main phase, 590 °C downstream DOC are not reached) =&gt; exchange DOC</p> <p>Very big difference (&gt; 100 K after 25 min stand-still main phase, 590 °C downstream DOC exceeded) =&gt; check injection system of engine &amp; engine air path</p>

Table 3-13. Engine Fault Codes

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524195	14	1900	279	The standstill request of detected crystallization is ignored for more than 5h(>300min) This will be activated if there is a standstill request activated by Crystallisation Monitoring.	Back pressure upstream SCR catalyst has reached a level which indicates crystallisation inside of exhaust line. The error detection depends on the sensed pressure upstream of the SCR catalyst and the calculated exhaust volume flow through the mixer pipe. In case of error is set, but no crystallisation can be found in the mixing pipe, a possible reason can be the defect sensors: - exhaust pressure & temperature upstream of the SCR catalyst, - the ambient pressure - the exhaust mass flow => Check air path system at the engine.	Dismount urea injector from exhaust line and inspect visually the injector and the exhaust line for urea crystallisation upstream of SCR catalyst: If crystallisation can be clearly seen, then standstill must be processed. Has the engine been operated in low load for longer time? If yes, then it could be the reason for crystallisation. Does the NOx-Sensors work properly? Compare ComRxSCR_rNOxUs to ComRxSCR_rNOxDs, when ComRxSCR_stNOxRdyUs = 1 & ComRxSCR_stNOxRdyDs = 1 (Warm engine and EAT-system, SCRT_tCatAvgExhGs_mp > 250°C, SCR_stStatus = "Dosing" = 8): sensed NOx upstream of SCR catalyst must be higher than downstream of SCR catalyst. Go to idle and wait until SCR system enters status "stand-by" (no dosing), SCRT_tCatAvgExhGs_mp < 225°C: ComRxSCR_rNOxUs = ComRxSCR_rNOxDs Clean urea injector: rinse it thoroughly under water Check EGR-Path: difference pressure sensor at venturi tube, EGR cooler, EGR-Valve, Reed-Valve, Intake throttle regarding function and leakage. Does the EGR-cooler leak water in the exhaust? Check air path for leakage Check turbocharger No crystallisation can be seen in the mixing pipe: Check exhaust pressure sensor upstream of SCR catalyst (SCR_pSensUCatUsP): tube, water in sensor? Check environmental pressure sensor (EnvP_p): plausible? Check exhaust temperature sensor upstream of SCR-catalyst (SCR_tSensUCatUsT): plausible compared to Exh_tOxiCatUs & Exh_tOxiCatDs e.g. when engine has idled for 20 minutes? => Run stand-still to remove crystallisation and to reset the DFC
5232719	3	1108	672	Urea supply module heater: the current drain measured by ECU is above the target range	Short circuit to battery If this error detected during the heating phase it is a result error:KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module

## 3.22 GM ENGINE GENERAL MAINTENANCE

### Maintenance of the Drive Belt

The serpentine drive belt utilizes a spring loaded tensioner which keeps the belt properly adjusted. The drive belt is an integral part of the cooling and charging systems and should be inspected frequently.

When inspecting the belts check for:

- Cracks or breaks
- Chunking of the belt
- Splits
- Material hanging from the belt
- Glazing and hardening
- Damaged or improperly aligned pulleys
- Improperly performing tensioner

Check the belt tensioner by pressing down on the midway point of the longest stretch between pulleys. The belt should not depress beyond 1/2 inch (13mm). If the depression is more than allowable adjust the tension.

#### NOTICE

THE ENGINE MANUFACTURER DOES NOT RECOMMEND THE USE OF "BELT DRESSING" OR "ANTI SLIPPING AGENTS" ON THE DRIVE BELT.

### Engine Electrical System Maintenance

The engine electrical system incorporates computers and microprocessors to control the engine ignition, fuel control, and emissions. Due to the sensitivity of the computers to good electrical connections periodic inspection of the electrical wiring is necessary. When inspecting the electrical system use the following:

- Check and clean the battery terminal connections and insure the connections are tight
- Check the battery for any cracks or damage to the case
- Check the Positive and Negative battery cables for any corrosion build up, rubbing or chafing, check connection on the chassis to insure they are tight
- Check the entire engine wire harness for rubbing chafing, cuts or damaged connections, repair if necessary
- Check all wire harness connectors to insure they are fully seated and locked

- Check ignition coil and spark plug cables for hardening, cracking, chafing, separation, split boot covers and proper fit
- Replace spark plugs at the proper intervals as prescribed in the engine manufacturer's manual
- Check to make sure all electrical components are fitted securely
- Check the ground and platform control stations to insure all warning indicator lights are functioning

### Checking/Filling Engine Oil Level

#### NOTICE

AN OVERFILLED CRANKCASE (OIL LEVEL OVER THE SPECIFIED FULL MARK) CAN CAUSE AN OIL LEAK, A FLUCTUATION OR DROP IN THE OIL PRESSURE, AND ROCKER ARM "CLATTER" IN THE ENGINE.

#### NOTICE

CARE MUST BE TAKEN WHEN CHECKING THE ENGINE OIL LEVEL. OIL LEVEL MUST BE MAINTAINED BETWEEN THE "ADD" MARK AND "FULL" MARK ON THE DIPSTICK.

To ensure that you are not getting a false reading, make sure the following steps are taken to before check the oil level.

1. Stop the engine if in use.
2. Allow sufficient time (approximately 5 minutes) for the oil to drain back into the oil pan.
3. Remove the dipstick. Wipe with a clean cloth or paper towel and reinstall. Push the dipstick all the way into the dipstick tube.
4. Remove the dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks.

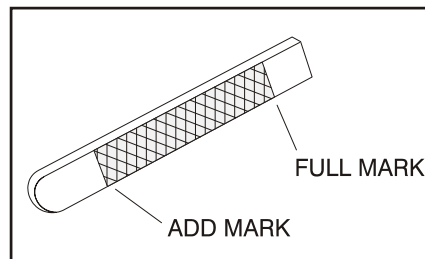


Figure 3-95. Engine Oil Dip Stick

6. If the oil level is below the "ADD" mark, proceed to Step 7 and 8 and reinstall the dipstick into the dipstick tube.
7. Remove the oil filter cap from the valve rocker arm cover.
8. Add the required amount of oil to bring the level up to but not over "FULL" mark on the dipstick.
9. Reinstall the oil fill cap to the valve rocker cover and wipe away any excess oil.

## Changing The Engine Oil

### NOTICE

WHEN CHANGING THE OIL, ALWAYS CHANGE THE OIL FILTER. CHANGE OIL WHEN THE ENGINE IS WARM FROM OPERATION AS THE OILS WILL FLOW FREELY AND CARRY AWAY MORE IMPURITIES.

To change the oil use the following steps:

1. Start the engine and run until it reaches normal operating temperature.
2. Stop the engine.
3. Remove the drain plug and allow the oil to drain.
4. Remove and discard the oil filter and its sealing ring.
5. Coat the sealing ring on the filter with clean engine oil and wipe the sealing surface on the filter mounting surface to remove any dust, dirt and debris. Tighten the filter securely (follow the filter manufacturers instructions). Do not over tighten.
6. Check the sealing ring on drain plug for any damage, replace if necessary, wipe the plug with a clean rag, and wipe the sealing surface on the pan and reinstall the pan plug. Do not over tighten.
7. Fill the crankcase with oil.
8. Start the engine and check for oil leaks.
9. Stop the engine and check the oil level to insure the oil level is at "FULL".
10. Dispose of the oil and filter in a safe manner.

## Coolant Fill Procedure - Dual Fuel Engine

### NOTICE

DAMAGE TO THE ENGINE COULD OCCUR IF NOT PROPERLY FILLED WITH COOLANT. LPG FUELED ENGINES ARE MOST PRONE TO CREATING AN AIR LOCK DURING A COOLANT FILL OPERATION DUE TO THE ELECTRONIC PRESSURE REGULATOR (EPR) BEING THE HIGHEST POINT IN THE COOLING SYSTEM. AN EPR THAT APPEARS TO HAVE FROST FORMING ON IT IS A SIGN THAT THE ENGINE COOLING SYSTEM CONTAINS AIR. THE APPEARANCE AND TEMPERATURE OF THE EPR SHOULD BE MONITORED DURING THE COOLANT FILL OPERATION. A WARM EPR IS AN INDICATION THAT THE COOLING SYSTEM IS PROPERLY FILLED AND FUNCTIONING.

### CAUTION

MAKE SURE ENGINE IS COOL BEFORE PERFORMING ANY MAINTENANCE WORK.

1. Loosen the worm gear clamp on the coolant line running into the EPR as shown below and remove the hose from the EPR. Place a rag under the hose to prevent coolant from running onto the engine/machine.



2. Remove the radiator cap. Fill the radiator with coolant until coolant starts to appear from the previously removed hose at the EPR. Reinstall the hose back onto the EPR and continue to fill radiator with coolant.



3. With the radiator cap still removed, start the engine and run until the thermostat opens. The thermostat opens at 170° F (77° C), which can be checked using the JLG handheld analyzer.

### NOTICE

WHILE ENGINE IS RUNNING, AIR AND/OR STEAM MAY BE PRESENT COMING FROM THE RADIATOR. THIS IS NORMAL.

4. After running the engine for 5 minutes after it has reached operating temperature, shut the engine off and continue to step 5.

**CAUTION**

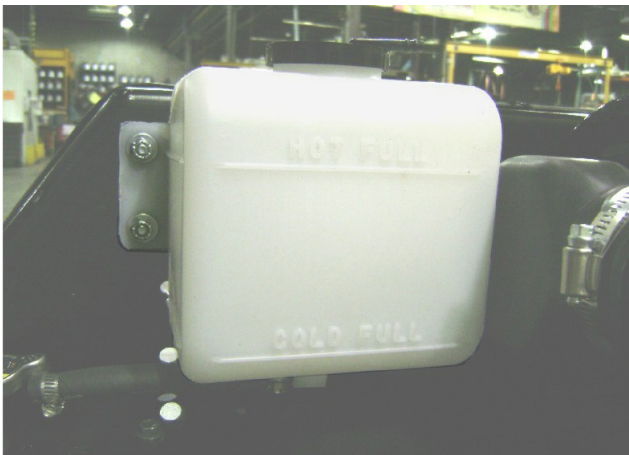
WITH THE ENGINE RUNNING OR WHEN SHUTTING OFF THE ENGINE, SOME HEATED COOLANT MAY SPILL OUT DUE TO AIR "BURPING" OUT OF THE SYSTEM WITH THE RADIATOR CAP OFF.

- Next, verify that the 2 coolant hoses on the EPR are warm. If they are not warm repeat step 3 and 4, otherwise continue to step 6.

**NOTICE**

A PROPERLY PURGED COOLING SYSTEM WILL YIELD A WARM UPPER RADIATOR HOSE AND A WARM EPR HOSE. IF THE UPPER RADIATOR HOSE AND/OR EPR HOSE ARE NOT WARM TO THE TOUCH AFTER THE ENGINE HAS RUN FOR 5-8 MINUTES AFTER REACHING OPERATING TEMPERATURE, THE SYSTEM MAY STILL CONTAIN AIR. IT MAY BE NECESSARY TO REPEAT THE ABOVE STEPS.

- Fill radiator with coolant as needed and install the radiator cap. Next, remove the cap off the coolant recovery bottle and fill just below the HOT FULL line and reinstall the caps.



**3.23 GM ENGINE DUAL FUEL SYSTEM**

**NOTE:** +20° F (-6.6° C) is the low temperature limit for LP gas, for both starting and operation. This applies to all LP gas powered engines.

The Dual Fuel system allows the operator to operate the vehicle on either gasoline or LPG by positioning a selector switch in the operator's platform. When the operator places the selector switch in the gasoline mode the gasoline fuel pump is energized. While in the gasoline mode the LPG fuel lock-off is isolated and will not energize. In addition the gasoline injector circuit is enabled and injector pulses are provided to each injector and the ECM calibration for gasoline is also enabled. When the operator selects the LPG mode the Low Pressure LPG lock-off is energized and fuel from the LPG tank flows to the Electronic Pressure Regulator (EPR). The EPR receives an electronic signal to position the secondary lever for the start or run positions and when the engine begins to crank the mixer air valve will rise and fuel will begin flowing to engine. During

this mode the gasoline fuel pump is isolated and will not be activated. The primary components of the gasoline dual fuel system are the gasoline tank, electric fuel pump and filter, fuel supply line, injector rail and injectors and the fuel pressure regulator. The primary components of the LPG dual fuel system are the LPG fuel tank, in-fuel filter, LPG Low Pressure lock-off, Electronic Pressure Regulator (EPR) and the fuel mixer module. The LPG fuel system operates at pressures which range from 14.0 inches (355.60 mm) of water column up to 312 psi (21.5 BAR).

Components which are shared by both systems include the Electronic Throttle Control and the ECM. The ECM contains a dual calibration; one controls the gasoline fuel system during gasoline operation and one controls the LPG fuel system during LPG operation.

**Fuel Filter**

Propane fuel like all other motor fuels is subject to contamination from outside sources. Refueling of the equipment's tank and removal of the tank from the equipment can inadvertently introduce dirt and other foreign matter into the fuel system. It is therefore necessary to filter the fuel prior to entering the fuel system components downstream of the tank. An inline fuel filter has been installed in the fuel system to remove the dirt and foreign matter from the fuel. The inline filter is replaceable as a unit only. Maintenance of the filter is critical to proper operation of the fuel system and should be replaced as Section 1. In severe operating condition more frequent replacement of the filter may be necessary.

**Electric Lock Off**

The Electric Lock Off device is an integrated assembly. When energized the solenoid opens the valve and allows the Propane fuel to flow through the device. The valve opens during cranking and run cycles of the engine. The lock off supply voltage is controlled by the engine control module (ECM).

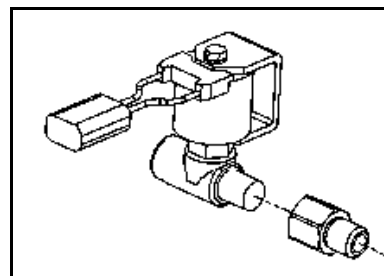
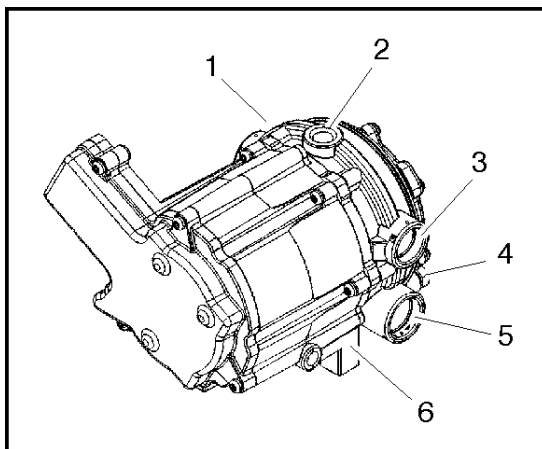


Figure 3-96. Electric Fuel Lock Off

## EPR Assembly

The EPR assembly is a combination Low Pressure Regulator and a Voice Coil Assembly. The Voice coil is an electronic actuator which is controlled by an internal microprocessor. The microprocessor provides output data to the ECM and receives input data over a CAN BUS connection. The internal microprocessor receives electrical signals from the Fuel Pressure Sensor FPS and the Fuel Temperature Pressure FTP and communicates the data to the ECM. The ECM uses the FPS and FTP data to calculate the location of the secondary lever in the LPR and sends that data back to the EPR via the CAN BUS. The internal microprocessor in the EPR will then output a signal, which causes the voice coil to move and position the secondary lever to the correct location.



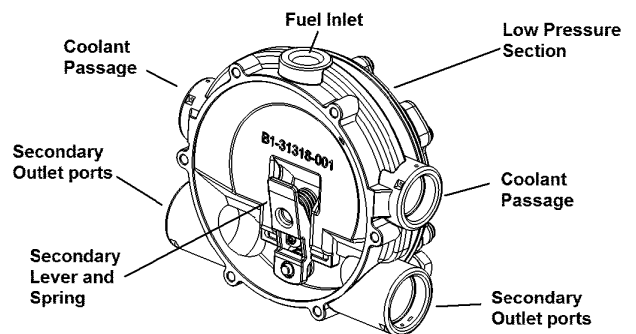
- |                               |                        |
|-------------------------------|------------------------|
| 1. Pressure Regulator Section | 4. Primary Test Port   |
| 2. Fuel Inlet                 | 5. Secondary Test Port |
| 3. Coolant Passage            | 6. Voice Coil Section  |

**Figure 3-97. EPR Assembly**

When the engine is cranking, sufficient vacuum will be introduced into the secondary chamber from the mixer drawing the secondary diaphragm down onto the spring loaded lever and opening the secondary valve allowing vaporized fuel to pass to the mixer. This mechanical action in conjunction with the EPR reactions causes the downward action on the secondary lever causing it to open wider allowing more fuel to flow to the mixer.

### **⚠ WARNING**

**THE VOICE COIL SECTION OF THE EPR ASSEMBLY IS AN EMISSIONS CONTROL DEVICE AND CANNOT BE REBUILT. IF THE COIL ASSEMBLY FAILS TO OPERATE PROPERLY, REPLACE IT WITH AN OEM REPLACEMENT PART ONLY.**



**Figure 3-98. Low Pressure Regulators**

## Low Pressure Regulator (LPR)

The LPR is a combination vaporizer, pressure regulating device. The LPR is a negative pressure, two stage regulator that is normally closed when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line which connects the regulator to the mixer. This partial vacuum opens the regulator permitting fuel to flow to the mixer.

Propane fuel enters the primary port of the LPR and passes through the primary jet and into the primary/ exchanger chamber. As the propane passes through the heat exchanger the fuel expands and creates pressure inside the chamber. The pressure rises as the fuel expands when the pressure rises above 1.5 psi (10.34 kpa), sufficient pressure is exerted on the primary diaphragm to cause the diaphragm plate to pivot and press against the primary valve pin thus closing off the flow of fuel. This action causes the flow of fuel into the regulator to be regulated.

### Air Fuel Mixer

The air valve mixer is an air-fuel metering device and is completely self-contained. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device.

When the engine begins to crank, it draws in air with the air valve covering the inlet, negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through 4 vacuum ports in the air valve assembly. A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum chamber and the atmospheric pressure below the diaphragm. The air valve vacuum spring is calibrated to generate from 4.0 inches (101.6 mm) of water column at start to as high as 14.0 inches (355.60 mm) of water column at full throttle. The vacuum being created is referred to as Air Valve Vacuum (AVV). As the air valve vacuum reaches 4.0 inches (101.6mm) of water column, the air valve begins to lift against the air valve spring. The amount of AVV generated is a direct result of the throttle position. At low engine speed the air valve vacuum is low and the air valve position is low thus creating a small venturi for the fuel to flow. As the engine speed increase the AVV increases and the air valve is lifted higher thus creating a much larger venturi. This air valve vacuum is communicated from the mixer venturi to the LPR secondary chamber via the low pressure fuel supply hose. As the AVV increases in the secondary chamber the secondary diaphragm is drawn further down forcing the secondary valve lever to open wider.

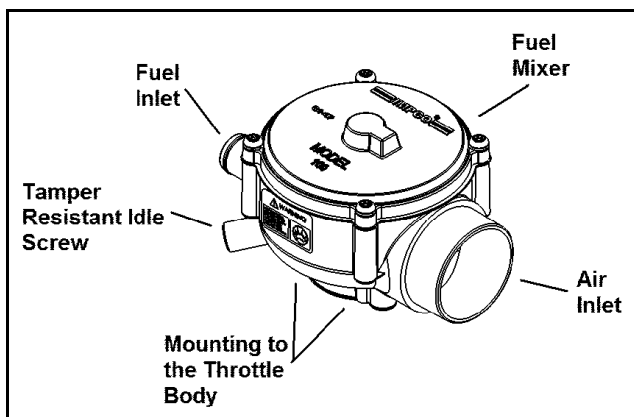


Figure 3-99. Air Fuel Mixer

### Electronic Throttle Control (ETC)

Engine speed and load control is maintained by an ETC device. Speed and load control are determined by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine. The Electronic Throttle Control device or "throttle body assembly" is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft. When the engine is running electrical signals are sent from the equipment controls to the engine ECM when the operator depresses an equipment function switch. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel flow to the engine.

The electronic throttle control device also incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade. The TPS information is used by the ECM to correct speed and load control as well as emission control.

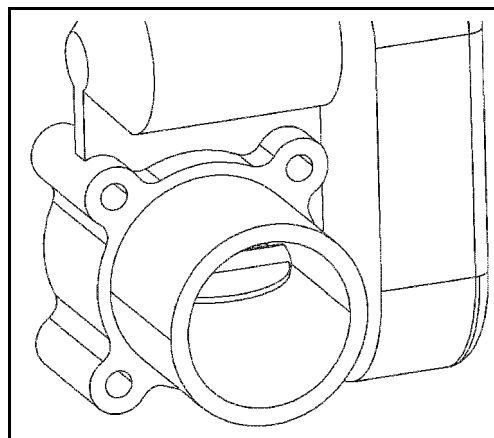


Figure 3-100. ETC throttle control device

## Engine Control Module

To obtain maximum effect from the catalyst and accurate control of the air fuel ratio the emission certified engine is equipped with an onboard computer or Engine Control Unit (ECM). The ECM is a 32 bit controller which receives input data from sensors fitted to the engine and fuel system and then outputs various signals to control engine operation.

One specific function of the controller is to maintain "closed loop fuel control". Closed loop fuel control is accomplished when the exhaust gas oxygen sensor (HEGO) mounted in the exhaust system sends a voltage signal to the controller. The controller then calculates any correction that may need to be made to the air fuel ratio. The controller then outputs signals to the EPR to correct the amount of fuel being supplied to the mixer. At the same time the ECM may correct the throttle blade position to correct speed and load of the engine.

The controller also performs diagnostic functions on the fuel system and notifies the operator of malfunctions by turning on a Malfunction Indicator Light (MIL) mounted in the Ground Control Station and the Platform Control Station. Malfunctions in the system are identified by a Diagnostic Code number. In addition to notifying the operator of the malfunction in the system the controller also stores the information about the malfunction in its memory.

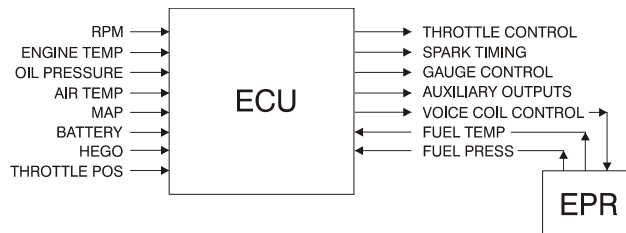


Figure 3-101. LPG Engine Control Unit (ECM)

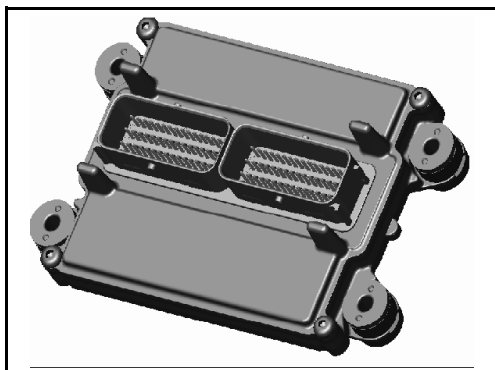


Figure 3-102. ECM Assembly

## Heated Exhaust Gas Oxygen Sensor

There are two Heated Exhaust Gas Oxygen Sensors (HEGO). The first HEGO is mounted in the exhaust system downstream of the engine. It is used to measure the amount of oxygen present in the exhaust stream and communicate that to the ECM via an electrical signal. The amount of oxygen present in the exhaust stream indicates whether the fuel/air ratio is too rich or too lean. If the HEGO sensor signal indicates that the exhaust stream is too rich the ECM will decrease or lean the fuel mixture during engine operation, if the mixture is too lean the ECM will richen the mixture. The ECM continuously monitors the HEGO sensor output. If a rich or lean condition is present for an extended period of time, and the ECM cannot correct the condition, the ECM will set a diagnostic code and turn on the MIL light in control box.

The second HEGO is mounted in the exhaust system after the muffler. It measures the amount of oxygen in the exhaust system after the catalytic treatment has been completed in the muffler. If the ECM detects that the catalytic action in the muffler is not sufficient and fuel correction cannot correct the malfunction the MIL light is illuminated in the control box and a DTC code will be stored in the computer.

### NOTICE

**THE HEATED EXHAUST GAS OXYGEN SENSOR IS AN EMISSION CONTROL DEVICE. IF THE HEGO FAILS TO OPERATE, REPLACE IT WITH AN OEM REPLACEMENT PART. THE HEGO SENSOR IS SENSITIVE TO SILICONE OR SILICONE BASED PRODUCTS AND CAN BECOME CONTAMINATED. AVOID USING SILICONE SEALERS OR HOSES TREATED WITH SILICONE LUBRICANTS IN THE AIR STREAM OR FUEL LINES.**



Figure 3-103. Heated Exhaust Gas Oxygen Sensor (HEGO)

## Gasoline Multi Point Fuel Injection System (MPFI)

The primary components of the Gasoline Multi Point Fuel Injection (MPFI) fuel system are the fuel tank, electric fuel pump, fuel pressure and temperature sensor manifold, fuel filter and fuel rail.

## Gasoline Fuel Pump

The Gasoline is stored as a liquid in the fuel tank and is drawn into the fuel system by an electric fuel pump. The fuel pump will receive a signal from the ECM to prime the fuel system for approximately 2 seconds prior to start. Priming of the fuel system provides for a quicker start, when the engine begins to crank.

## Gasoline Pressure And Temperature Sensor Manifold

This engine is equipped with a fuel injector rail that does not have a pressure regulator or a return circuit to the fuel tank. Fuel pressure for this engine is regulated by the engine's ECM. The ECM receives fuel pressure and temperature feedback from the gasoline fuel sensor manifold and uses this information to control the ground side of the fuel pump. Fuel pressure is regulated by the ECM pulse width modulating (PWM) the fuel pump. The fuel pressure and temperature sensor manifold has a return or "bleed" circuit that connects back to the fuel tank. This circuit is used to bleed off any vapor that develops in the line and return a small amount of fuel to the tank. The fuel comes from the fuel tank and passes through the fuel pump. Fuel exits the fuel pump, passes through the filter and then enters the fuel pressure and temperature manifold assembly. Fuel flows through the feed circuit and is delivered to the fuel injector rail. Fuel that enters the bleed circuits through the bypass valve in the manifold is returned to the fuel tank.

## Fuel Filter

After the fuel is drawn into the fuel pump, the fuel flows through the gasoline fuel filter. The fuel filter will trap small particles as the fuel passes through the filter to remove debris and prevents the fuel pressure and temperature manifold and fuel injectors from becoming damaged. Maintenance of the fuel filter is required as indicated in Section 1.

## Fuel Injector Rail

Fuel flows from the fuel pressure and temperature manifold assembly to the fuel rails where the fuel is delivered to the fuel injectors. The fuel rail also contains a Schrader valve which is utilized to test the regulated pressure of the fuel system.

## Fuel Injector

The fuel supply is maintained on the top of the injector from the injector rail. The injector is fed a "pulse" signal through the wire harness which causes the injector to open. During regular operating conditions the ECM controls the opening and duration of opening of the injector. During lower RPM operation the injector signals or "pulses" are less frequent than when the engine is operating at higher RPMs. The engine has been calibrated to deliver the precise amount of fuel for optimum performance and emission control.

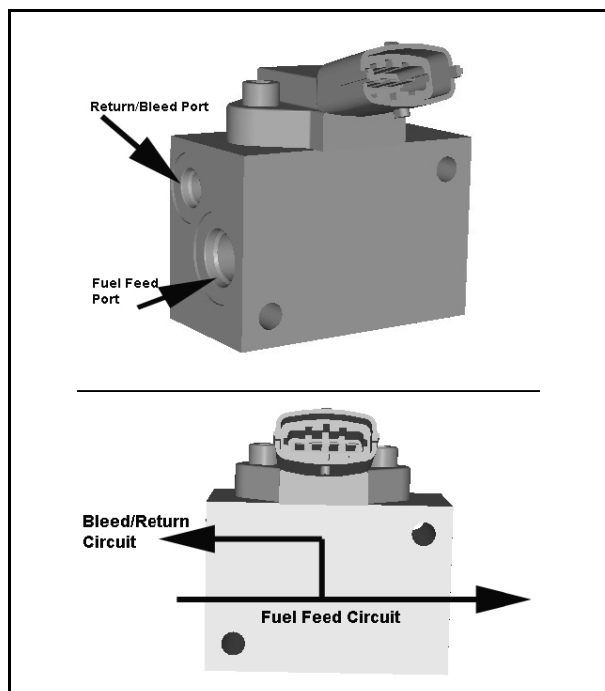


Figure 3-104. Gasoline Fuel Pressure and Temperature Manifold Assembly

## 3.24 GM ENGINE FUEL SYSTEM REPAIR

### Propane Fuel System Pressure Relief

#### **⚠ CAUTION**

THE PROPANE FUEL SYSTEM OPERATES AT PRESSURES UP TO 312 PSI (21.5 BAR). TO MINIMIZE THE RISK OF FIRE AND PERSONAL INJURY, RELIEVE THE PROPANE FUEL SYSTEM PRESSURE (WHERE APPLICABLE) BEFORE SERVICING THE PROPANE FUEL SYSTEM COMPONENTS.

To relieve propane fuel system pressure:

1. Close the manual shut-off valve on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF.

#### **NOTICE**

RESIDUAL VAPOR PRESSURE WILL BE PRESENT IN THE FUEL SYSTEM. ENSURE THE WORK AREA IS WELL VENTILATED BEFORE DISCONNECTING ANY FUEL LINE.

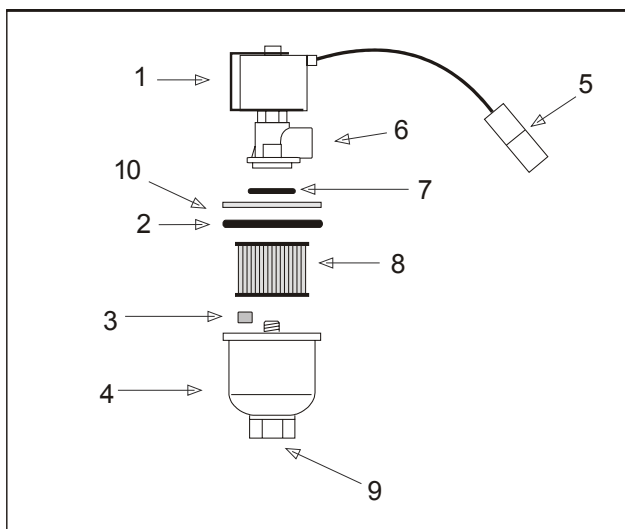
### Propane Fuel System Leak Test

#### **⚠ CAUTION**

NEVER USE AN OPEN FLAME OF ANY TYPE TO CHECK FOR PROPANE FUEL SYSTEM LEAKS.

Always inspect the propane fuel system for leaks after performing service. Check for leaks at the fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector.

## Propane Fuel Filter Replacement



- |                               |                |
|-------------------------------|----------------|
| 1. Electric Lock Off Solenoid | 6. Fuel Outlet |
| 2. Housing Seal               | 7. O-ring      |
| 3. Filter Magnet              | 8. Filter      |
| 4. Filter Housing             | 9. Fuel Inlet  |
| 5. Electrical Connector       | 10. Ring       |

**Figure 3-105. Filter Lock Assembly**

### REMOVAL

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Remove the filter from the housing.
6. Locate Filter magnet and remove it.
7. Remove and discard the housing seal.
8. If equipped, remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

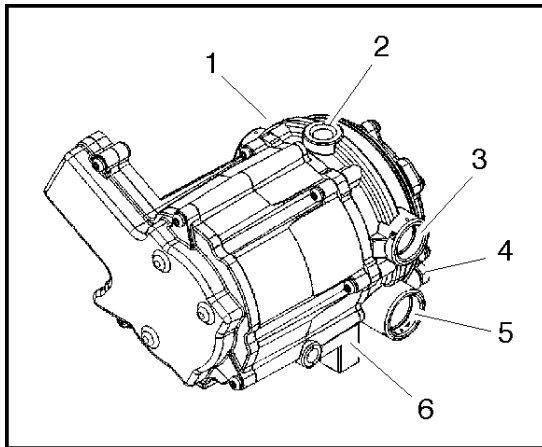
### INSTALLATION

#### **NOTICE**

**BE SURE TO REINSTALL THE FILTER MAGNET INTO THE HOUSING BEFORE INSTALLING NEW SEAL**

1. Install the mounting plate to lock off O-ring seal.
2. If equipped, install the retaining bolt seal.
3. Install the housing seal.
4. Drop the magnet into the bottom of the filter housing.
5. Install the filter into the housing.
6. If equipped, install the retaining bolt into the filter housing.
7. Install the filter up to the bottom of the electric lock off.
8. Tighten the filter retainer to 106 in lbs (12 Nm).
9. Open manual shut-off valve. Start the vehicle and leak check the propane fuel system at each serviced fitting. Refer to Propane Fuel System Leak Test.

## Electronic Pressure Regulator (EPR) Assembly Replacement



- |                               |                        |
|-------------------------------|------------------------|
| 1. Pressure Regulator Section | 4. Primary Test Port   |
| 2. Fuel Inlet                 | 5. Secondary Test Port |
| 3. Coolant Passage            | 6. Voice Coil Section  |

**Figure 3-106. EPR Assembly**

The EPR assembly is made up of two separate components. The Voice Coil Section is not serviceable and can only be replaced as an assembly. The pressure regulator section is serviceable and will be detailed in this section.

### REMOVAL

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly remove the fuel inlet fitting at the Electric Lock Off.

**NOTE:** Residual vapor pressure will be present in the fuel system.

4. Disconnect the electrical connector to the Electric Lock off.
5. Remove the Electric Lock Off from the regulator.
6. Remove the lock pin from the vapor fitting on the regulator housing and remove the fitting and hose and retain the pin.
7. Remove the lock pin from the pressure sensor on the regulator housing and remove the Sensor and retain the pin.
8. Using a clamp pliers pinch off the hoses on the coolant lines to the regulator.
9. Remove the lock pin from both the water fittings on the regulator housing and remove the fittings and hoses and retain the pin.
10. Disconnect the EPR electrical connector.

11. Remove the (3) three nuts from the EPR isolators and the EPR mounting bracket.
12. Remove the EPR from the bracket.
13. Remove the (3) three mounting isolators.

### INSTALLATION

#### **NOTICE**

**DO NOT USE TEFLON TAPE ON ANY FUEL FITTING. USE A LIQUID PIPE THREAD SEALANT WHEN INSTALLING FITTINGS.**

**CHECK ALL THE O-RINGS ON THE VAPOR AND WATER FITTINGS FOR ANY DAMAGE REPLACE IF NECESSARY.**

**LUBE ALL THE O-RINGS WITH AN O-RING LUBE BEFORE INSTALLING.**

1. Install the three (3) rubber isolators to the bottom of the EPR
2. Install the EPR assembly to the bracket and tighten the retaining nuts.

**NOTE:** Do not over tighten the isolators and cause a separation of the isolators.

3. Install the fuel temperature sensor into the regulator opening and lock in place with the locking pin, connect the electrical connector.
4. Insert the fuel vapor line and fitting into the regulator port and lock in place with the locking pin.
5. Install both the water hoses and fittings into the regulator and lock in place with the locking pin remove the clamp pliers from the hoses.
6. Install the electric lock off into the regulator inlet and tighten into proper location, connect the electrical connector.
7. Connect the fuel supply line and tighten until fully seated.
8. Connect the EPR electrical connector.
9. Open the manual valve.

10. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.

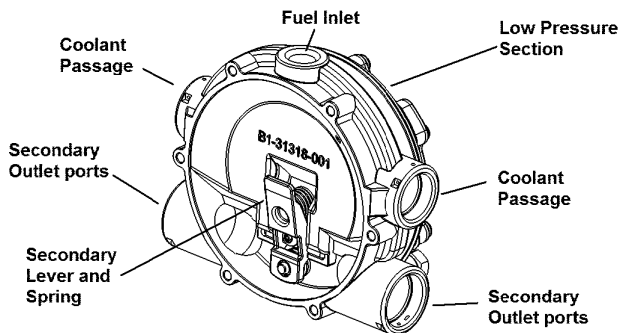


Figure 3-107. Pressure Regulator Section

**PRESSURE REGULATOR SECTION REMOVAL**

1. Remove the EPR refer to EPR Removal Procedure.
2. Remove the six (6) regulator to voice coil screws using the special tool and separate the regulator from the actuator.

**NOTICE**

DO NOT REMOVE THE SECONDARY DIAPHRAGM RETAINING PLATE AND DIAPHRAGM THIS WILL VOID THE WARRANTY OF THE ACTUATOR SECTION.

**PRESSURE REGULATOR SECTION INSTALLATION**

1. Install the regulator to the actuator section using the six (6) retaining screws and tighten 70 in lbs (8 Nm).
2. Install the EPR refer to EPR Installation.

**Temperature Manifold Absolute Pressure (TMAP) Sensor**

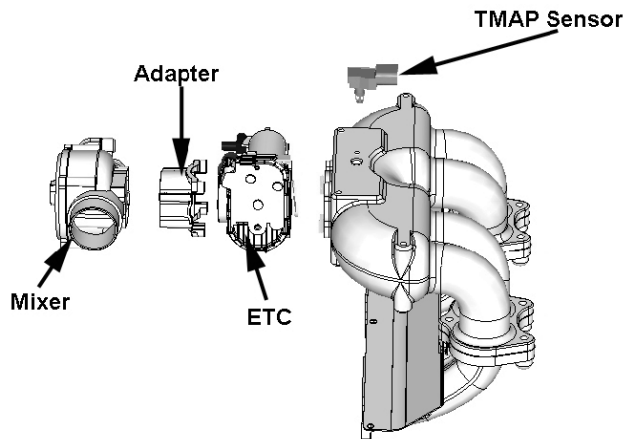


Figure 3-108. (TMAP) Sensor & Electronic Throttle Control (ETC)

**REMOVAL**

1. Disconnect the TMAP electrical connector.
2. Remove the two retaining bolts.
3. Remove the TMAP.

**INSTALLATION**

**NOTE:** Apply a small amount of O-ring lubricant before installation.

1. Install in the TMAP.
2. Tighten retaining bolts to 62 lb-in (7 Nm).

Start the vehicle and check for proper operation.

**Electronic Throttle Control Replacement**

See Figure 3-108.

**REMOVAL**

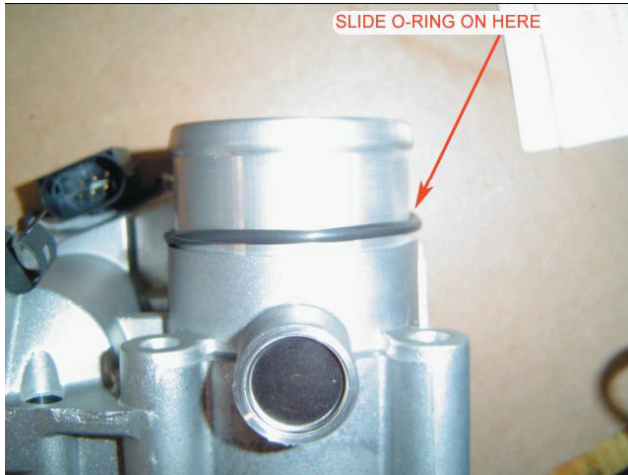
1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Release the hose clamp on the vapor fuel line and remove the vapor hose.
4. Disconnect the TMAP electrical connector.
5. Disconnect the electronic throttle control connector.
6. Remove the manifold to throttle body adapter bolts and remove the throttle body mixer assembly.
7. Pull the throttle body assembly from the adapter.
8. Remove electronic throttle control device.
9. Remove the O-rings gasket and discard.

**INSTALLATION**

**NOTICE**

LIGHTLY LUBRICATE BOTH THROTTLE CONTROL DEVICE TO ADAPTER O-RINGS.

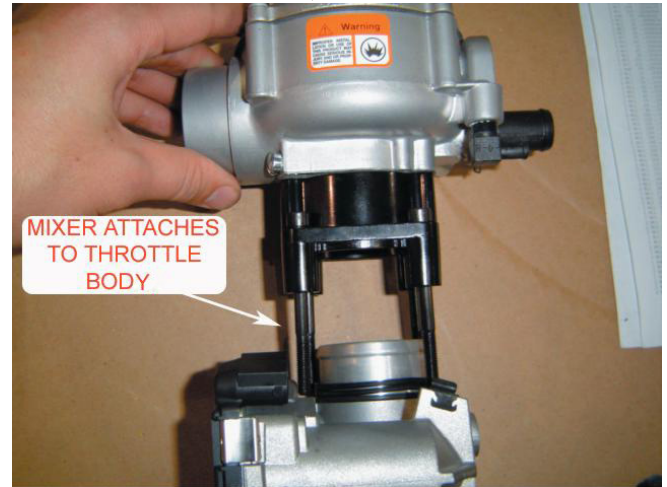
1. Install the O-ring on throttle body. Press it down to the bottom of the surface.



2. Install the two quad seals. Install one seal at a time to insure the seal does not roll. The seal must sit flat on the throttle body.



3. Attach mixer and throttle body together. The two parts do not bolt together; they will be secured when you mount it on the intake. Notice the orientation of the air inlet and throttle body cover.



4. Place gasket on intake manifold and attach mixer/throttle assembly to manifold.

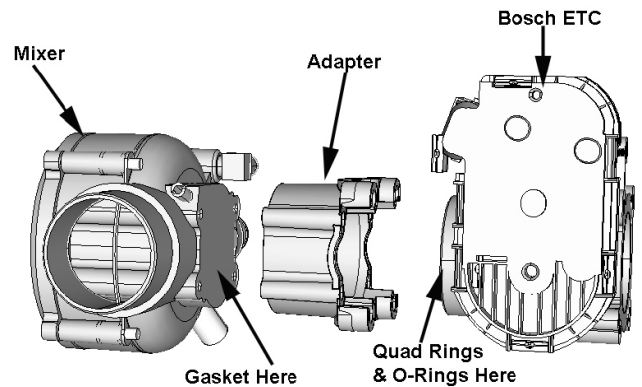


Figure 3-109. Mixer Assembly

**Mixer Replacement**

See Figure 3-109.

**REMOVAL**

1. Remove the Throttle control device Refer to Electronic Throttle Body Replacement.
2. Remove the four (4) bolts to the throttle control device to mixer adapter bolts.
3. Remove and discard the mixer to adapter gasket.

### INSTALLATION

#### **NOTICE**

**COVER THROTTLE BODY ADAPTER OPENING TO PREVENT DEBRIS FROM ENTERING ENGINE UNTIL REASSEMBLY.**

1. Install Mixer to adapter gasket onto the mixer.
2. Install the mixer to the throttle control device to mixer adapter and secure with the 4 retaining screws. Tighten 80 lb-in (9 Nm).
3. Install Throttle body. Refer to Electronic Throttle Control Device Replacement.
4. Start the engine and leak check all fittings and connections.

### Coolant Hose Replacement

#### REMOVAL

1. Drain the coolant.
2. Using hose clamp pliers, disconnect both hose clamps on each hose.
3. Remove the hose from each of the fittings.

#### INSTALLATION

**NOTE:** Use hose material and lengths specified by JLG.

1. Install the hose clamps to each hose and set the clamp back on each hose to make installation easier.
2. Fit the hose to the fittings.
3. Secure by positioning each of the clamps.

### Vapor Hose Replacement

#### REMOVAL

1. Using hose clamp pliers disconnect both hose clamps.
2. Remove the vapor hose from each fitting.

#### INSTALLATION

#### **NOTICE**

**THE VAPOR SUPPLY HOSE IS SPECIFICALLY DESIGNED, DO NOT USE HOSE MATERIAL OR LENGTH OTHER THAN JLG SPECIFIED PARTS.**

1. Install hose clamps and set back on each hose.
2. Reinstall the vapor hose to each fitting.
3. Reset clamps.
4. Start engine and check for leaks.

### Engine Control Module Replacement

#### REMOVAL

1. Disconnect Negative battery cable.
2. Remove controller from mounting bracket.
3. Push connector lock back to unlock connector.
4. Unplug controller and remove.

#### INSTALLATION

#### **NOTICE**

**THE CONTROLLER IS CALIBRATED FOR EACH ENGINE VERIFY YOU HAVE THE CORRECT CONTROLLER**

1. Plug connector into controller.
2. Push lock into place.
3. Mount controller into mounting bracket.
4. Reconnect the battery cable.
5. Start engine.
6. Check for any DTC codes and clear.
7. Verify engine is in closed loop and no warning lights are illuminated.

### Heated Exhaust Gas Oxygen Sensor Replacement

#### REMOVAL

1. Disconnect Negative battery cable.
2. Disconnect the O2 sensor electrical connector.
3. Using an O2 Sensor socket, remove the O2 Sensor and discard.

#### INSTALLATION

#### **NOTICE**

**BEFORE INSTALL THE O2 SENSOR LUBRICATE THREADS WITH ANTI-SEIZE COMPOUND GM P/N 5613695 OR EQUIVALENT. AVOID GETTING COMPOUND ON THE SENSOR TIP.**

1. Install O2 sensor. Tighten to 30 ft.lb. (41 Nm).
2. Start engine.
3. Check for any DTC codes and clear.
4. Verify engine is in closed loop and no warning lights are illuminated.

### 3.25 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

#### Fuel System Description

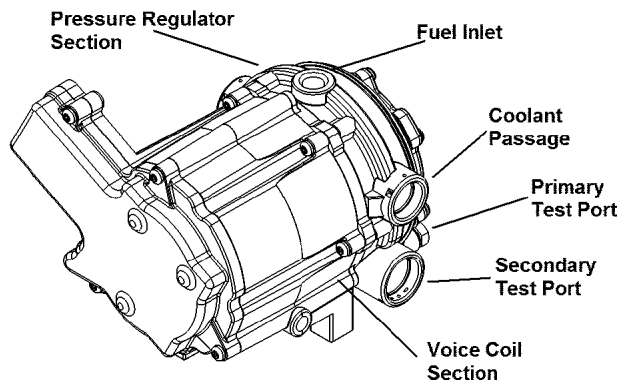


Figure 3-110. EPR Assembly

To maintain fuel and emission control on the LPG fuel system the Engine Control Units (ECM) relies on numerous engine sensor and output data from the Electronic Pressure Regulator (EPR). The ECM will then determine the target fuel calibration and command the EPR to reposition the voice coil to the proper position which, subsequently reposition the secondary lever in the pressure regulator to maintain proper control. The EPR and ECM will continue to communicate back and forth during normal operation.

In the event that the EPR fails to communicate or the Communications Area Network (CAN) cable fails to transmit data the regulator will operate in an open loop configuration. As the air valve vacuum in the mixer venturi is communicated to the secondary chamber of the regulator the secondary diaphragm will be drawn in a downwards motion. This downward motion will cause the secondary lever to open thus allowing more fuel to enter the mixer.

In the (LPR) the fuel is vaporized and the pressure reduced in two stages. The first stage reduces the pressure to approximately 1.0 to 3.0 psi (6.8 to 20.6 kPa). The second stage reduces the pressure to approximately negative 1.5" of water column.

The fuel is then drawn from the secondary chamber of the LPR by the vacuum generated by air flowing through the mixer. This vacuum signal is also used to generate lift for the mixer air valve. This vacuum signal is most commonly referred to as air valve vacuum. In the mixer, the fuel mixes with the air entering the engine. This air/ fuel mixture is then drawn into the engine for combustion.

#### Diagnostic Aids

This procedure is intended to diagnose a vehicle operating on LPG. If the vehicle will not continue to run on LPG, refer to Hard Start for preliminary checks. Before proceeding with this procedure, verify that the vehicle has a sufficient quantity of fuel and that liquid fuel is being delivered to the LPR. Also, ensure that the manual shut off valve on the LPG tank is fully opened and that the excess flow valve has not been activated.

#### Tools Required:

- 7/16 Open end wrench (for test port plugs)
- DVOM (GM J 39200, Fluke 88 or equivalent).
- 12 volt test light

#### Diagnostic Scan Tool

- Diagnostic Display tool.

#### Pressure Gauges

- IMPCO ITK-2 Test kit
- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-10 PSI Gauge

#### Test Description

The numbers below refer to step numbers on the diagnostic table.

5. This step determines if the LPR requires replacement
6. This step determines if the problems are in the mechanical side of the Pressure Regulator or the Electronic Voice Coil
10. This step determines if the Mixer requires replacement
14. This step determines if the Lock Off requires replacement
17. This step determines if the Fuel Filter requires replacement.

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-14. LPG Fuel System Diagnosis**

STEP	ACTION	VALUE(S)	YES	NO
1	Were you referred to this procedure by a DTC diagnostic chart?	--	Go to Step 3	Go to Step 2
2	Perform the On Board Diagnostic (OBD) System Check. Are any DTCs present in the ECM?	--	Go to the applicable DTC Table	Go to Step 3
3	Verify that the LPG fuel tank has a minimum of 1/4 tank of fuel, that the manual valve is open and the tank quick connect is fully engaged Does the vehicle have fuel?	--	Go to Step 4	--
4	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Start the engine and allow it to reach operating temperature. Does the engine start and run?	--	Go to Step 5	Go to Step 8
5	With the engine idling, observe the pressure reading for the LPR secondary pressure. Does the fuel pressure fluctuate rhythmically OUTSIDE the specified range?	-1.0" to -2.0" w.c	Go to Step 25	Go to Step 6
6	1. Disconnect the EPR electrical connectors. NOTE: This action will cause a DTC to be set by the ECM 2. With the engine idling observe the pressure reading on the secondary test port. Is the fuel pressure WITHIN the specified range?	-1.0" to -2.0" w.c	Go to Fuel Control System Diagnosis	Go to Step 7
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. 3. Inspect any vacuum hoses for leaks Was a problem found and corrected?	--	Go to Step 26	Go to Step 22
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	--	Go to Step 12	Go to Step 9
9	1. Remove Air induction hose to the mixer 2. Observe the air valve for movement while the engine is cranking. Note: Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	--	Go to Step 11	Go to Step 10
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer for proper connection and condition. Was a problem found and repaired?	--	Go to Step 26	Go to Step 24
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	--	Go to Step 26	Go to Step 12
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure ABOVE the specified value?	1-3 PSI	Go to Step 22	Go to Step 13
13	1. Turn OFF the ignition. 2. Disconnect the LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 14	Go to Step 16
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	12W - 16W	Go to Step 15	Go to Step 23

Table 3-14. LPG Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
15	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area. 3. Loosen the fuel inlet hose fitting at the inlet of the LPL. Was fuel present when the fitting was loosened?	--	Go to Step 23	Go to Step 17
16	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LPL connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 20	Go to Step 21
17	1. Remove the LPG fuel filter / LPL. 2. Remove the filter from the LPL. 3. Empty the contents of the inlet side of the LPG fuel filter onto a clean surface. 4. Inspect the contents of the LPG fuel filter for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. 5. Verify the LPG fuel filter is not restricted or plugged. Was a problem found?	--	Go to Step 19	Go to Step 18
18	The fuel supply system or hoses are plugged or restricted, locate and repair the problem. Is the action complete?	--	Go to Step 26	--
19	Replace the fuel filter. Refer to Fuel Filter Replacement. Is the action complete?	--	Go to Step 26	--
20	Repair the open in the lock-off ground circuit. Is the action complete?	--	Go to Step 26	--
21	Repair the open in the lock-off power circuit. Is the action complete?	--	Go to Step 26	--
22	Replace the low pressure regulator (LPR). Refer to Low Pressure Regulator Replacement. Is the action complete?	--	Go to Step 26	--
23	Replace the lock-off. Refer to Lock-off Replacement. Is the action complete?	--	Go to Step 26	--
24	Replace the mixer assembly. Refer to Fuel Mixer Replacement. Is the action complete?	--	Go to Step 26	--
25	The fuel supply system is operating normally, if a failure of the control solenoids is suspected. Refer to Fuel Control System Diagnosis.  1. Install the test plug in the LPR secondary chamber. 2. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure. Is the action complete?	--	System OK	--
26	1. Disconnect all test equipment 2. Install the primary and secondary test port plugs. 3. Start the engine. 4. Using SNOOP or equivalent, leak check the test port plugs. Is the action complete?	--	System OK	--

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-15. Symptom Diagnosis**

Checks	Action
<b>Important Preliminary Checks</b>	
Before Using This Section	<p>Before using this section, you should have performed On Board Diagnostic Check and determined that:</p> <ol style="list-style-type: none"> <li>1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly.</li> <li>2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL.</li> </ol> <p>Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks that may save valuable time.</p>
LPG Fuel System Check	<ol style="list-style-type: none"> <li>1. Verify the customer complaint.</li> <li>2. Locate the correct symptom table.</li> <li>3. Check the items indicated under that symptom.</li> <li>4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich.</li> </ol> <p><b>IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.</b></p>
Visual and Physical Checks	<ol style="list-style-type: none"> <li><sup>2</sup> Check all ECM system fuses and circuit breakers.</li> <li><sup>2</sup> Check the ECM ground for being clean, tight and in its proper location.</li> <li><sup>2</sup> Check the vacuum hoses for splits, kinks and proper connections.</li> <li><sup>2</sup> Check thoroughly for any type of leak or restriction.</li> <li><sup>2</sup> Check for air leaks at all the mounting areas of the intake manifold sealing surfaces.</li> <li><sup>2</sup> Check for proper installation of the mixer module assembly.</li> <li><sup>2</sup> Check for air leaks at the mixer assembly.</li> <li><sup>2</sup> Check the ignition wires for the following conditions: <ul style="list-style-type: none"> <li>- Cracking</li> <li>- Hardness</li> <li>- Proper routing</li> <li>- Carbon tracking</li> </ul> </li> <li><sup>2</sup> Check the wiring for the following items: <ul style="list-style-type: none"> <li>- Proper connections, pinches or cuts.</li> </ul> </li> <li><sup>2</sup> The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.</li> </ol>
<b>Intermittent</b>	
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	<ol style="list-style-type: none"> <li><sup>2</sup> Refer to Important Preliminary Checks.</li> <li><sup>2</sup> Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.</li> </ol>
Faulty Electrical Connections or Wiring	<ol style="list-style-type: none"> <li><sup>2</sup> Faulty electrical connections or wiring can cause most intermittent problems.</li> <li><sup>2</sup> Check the suspected circuit for the following conditions: <ul style="list-style-type: none"> <li>- Faulty fuse or circuit breaker</li> <li>- Connectors poorly mated</li> <li>- Terminals not fully seated in the connector (backed out)</li> <li>- Terminals not properly formed or damaged</li> <li>- Terminal to wires poorly connected</li> <li>- Terminal tension insufficient.</li> </ul> </li> <li><sup>2</sup> Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension.</li> <li><sup>2</sup> Checking for poor terminal to wire connections requires removing the terminal from the connector body.</li> </ol>
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.

Table 3-15. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	<p>The following components can cause intermittent MIL and no DTC(s):</p> <ul style="list-style-type: none"> <li><sup>2</sup> A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating.</li> <li><sup>2</sup> The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc.</li> <li><sup>2</sup> The ignition secondary voltage shorted to a ground.</li> <li><sup>2</sup> The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground.</li> <li><sup>2</sup> The Control Module grounds.</li> </ul>
Loss of DTC Memory	<p>To check for the loss of the DTC Memory:</p> <ol style="list-style-type: none"> <li>1. Disconnect the TMAP sensor.</li> <li>2. Idle the engine until the Malfunction Indicator Lamp illuminates.</li> </ol> <p>The ECM should store a TMAP DTC. The TMAP DTC should remain in the memory when the ignition is turned OFF. If the TMAP DTC does not store and remain, the ECM is faulty</p>
Additional Checks	
No Start	
DEFINITION: The engine cranks OK, but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	<p>If a scan tool is available:</p> <ul style="list-style-type: none"> <li><sup>2</sup> Check for proper communication with both the ECM</li> <li><sup>2</sup> Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics.</li> <li><sup>2</sup> Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each circuit.</li> </ul>
Sensor Checks	<ul style="list-style-type: none"> <li><sup>2</sup> Check the TMAP sensor.</li> <li><sup>2</sup> Check the Magnetic pickup sensor (RPM).</li> </ul>
Fuel System Checks	<p><b>Important:</b> A closed LPG manual fuel shut off valve will create a no start condition.</p> <ul style="list-style-type: none"> <li><sup>2</sup> Check for air intake system leakage between the mixer and the throttle body.</li> <li><sup>2</sup> Verify proper operation of the low pressure lock-off solenoids.</li> <li><sup>2</sup> Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis.</li> <li><sup>2</sup> Check for proper mixer air valve operation.</li> </ul>
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.</p> <ul style="list-style-type: none"> <li><sup>2</sup> Check for the proper ignition voltage output with J 26792 or the equivalent.</li> <li><sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS)</li> <li><sup>2</sup> Check the spark plugs for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> </li> <li><sup>2</sup> Check for bare or shorted ignition wires.</li> <li><sup>2</sup> Check for loose ignition coil connections at the coil.</li> </ul>
Engine Mechanical Checks	<p><b>Important:</b> The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.</p> <ul style="list-style-type: none"> <li><sup>2</sup> Check for the following: <ul style="list-style-type: none"> <li>- Vacuum leaks</li> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes.</li> </ul> </li> </ul>

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**Table 3-15. Symptom Diagnosis**

Checks	Action
Exhaust System Checks	<sup>2</sup> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> </ul> <sup>2</sup> Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis
Hard Start	
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	<sup>2</sup> Refer to Important Preliminary Checks. <sup>2</sup> Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	<sup>2</sup> Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111 <sup>2</sup> Check the Crankshaft Position (CKP) sensor. <sup>2</sup> Check the Throttle position (TPS) sensor.
Fuel System Checks	Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. <sup>2</sup> Verify the excess flow valve in the LPG manual shut-off valve is not tripped. <sup>2</sup> Check mixer module assembly for proper installation and leakage. <sup>2</sup> Verify proper operation of the low pressure lock-off solenoids. <sup>2</sup> Verify proper operation of the EPR <sup>2</sup> Check for air intake system leakage between the mixer and the throttle body. <sup>2</sup> Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. <sup>2</sup> Check for the proper ignition voltage output with J 26792 or the equivalent. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> <sup>2</sup> Check for bare or shorted ignition wires. <sup>2</sup> Check for moisture in the distributor cap if applicable. <sup>2</sup> Check for loose ignition coil connections. <b>Important:</b> 1. If the engine starts but then immediately stalls, Check the Crankshaft Position (CKP). 2. Check for improper gap, debris or faulty connections.
Engine Mechanical Checks	Important: The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. <sup>2</sup> Check for the following: <ul style="list-style-type: none"> <li>- Vacuum leaks               <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes.</li> </ul> </li> </ul> <sup>2</sup> Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	<sup>2</sup> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> </ul> <sup>2</sup> Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual

Table 3-15. Symptom Diagnosis

Checks	Action
Additional Checks	<sup>2</sup>
Cuts Out, Misses	
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	<sup>2</sup> Refer to Important Preliminary Checks.
Ignition System Checks	<sup>2</sup> Start the engine. <sup>2</sup> Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. <sup>2</sup> Check for proper ignition output voltage with spark tester J 26792. <sup>2</sup> Check for a cylinder misfire. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Remove the spark plugs in these cylinders and check for the following conditions: <sup>2</sup> Insulation cracks <sup>2</sup> Wear <sup>2</sup> Improper gap <sup>2</sup> Burned electrodes <sup>2</sup> Heavy deposits <sup>2</sup> Visually/Physically inspect the secondary ignition for the following: <sup>2</sup> Ignition wires for arcing, cross-firing and proper routing <sup>2</sup> Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	<sup>2</sup> Perform a cylinder compression check. <sup>2</sup> Check the engine for the following: <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Worn camshaft lobes.</li> <li>- Broken or weak valve springs.</li> </ul> <sup>2</sup> Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	<sup>2</sup> Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). <sup>2</sup> EMI on the reference circuit can cause a missing condition. <sup>2</sup> Monitoring the engine RPM with a scan tool can detect an EMI. <sup>2</sup> A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. <sup>2</sup> If the problem exists, check the routing of the secondary wires and the ground circuit.
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	<sup>2</sup> Check the fuel pressure. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. <sup>2</sup> Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. <sup>2</sup> Check LPL electrical connection <sup>2</sup> Check the mixer air valve for sticking or binding. <sup>2</sup> Check the mixer module assembly for proper installation and leakage. <sup>2</sup> Check the EPR electrical connections.

Table 3-15. Symptom Diagnosis

Checks	Action
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly.</p> <p><sup>2</sup> Check for the proper ignition voltage output with J26792 or the equivalent.</p> <p><sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS)</p> <p><sup>2</sup> Check for faulty spark plug wires</p> <p><sup>2</sup> Check for fouled spark plugs.</p>
Additional Check	<p><sup>2</sup> Check for manifold vacuum or air induction system leaks</p> <p><sup>2</sup> Check the generator output voltage.</p>
Backfire	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	<p><sup>2</sup> Refer to Important Preliminary Checks.</p>
Ignition System Checks	<p><b>Important! LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire.</b></p> <p><sup>2</sup> Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent.</p> <p><sup>2</sup> Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.</p> <p><sup>2</sup> Check the connection at each ignition coil.</p> <p><sup>2</sup> Check for deteriorated spark plug wire insulation.</p> <p><sup>2</sup> Check the spark plugs. The correct spark plugs for LPG are (R42LTS)</p> <p><sup>2</sup> Remove the plugs and inspect them for the following conditions:</p> <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul>
Engine Mechanical Check	<p>Important! The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system.</p> <p><sup>2</sup> Check the engine for the following:</p> <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Engine compression</li> <li>- Manifold vacuum leaks</li> <li>- Intake manifold gaskets</li> <li>- Sticking or leaking valves</li> <li>- Exhaust system leakage</li> </ul> <p><sup>2</sup> Check the intake and exhaust system for casting flash or other restrictions.</p>
Fuel System Checks	<p><sup>2</sup> Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.</p>
Lack of Power, Sluggishness, or Sponginess	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	<p><sup>2</sup> Refer to Important Preliminary Checks.</p> <p><sup>2</sup> Refer to the LPG Fuel system OBD System Check</p> <p><sup>2</sup> Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics</p> <p><sup>2</sup> Remove the air filter and check for dirt or restriction.</p> <p><sup>2</sup> Check the vehicle transmission Refer to the OEM transmission diagnostics.</p>

Table 3-15. Symptom Diagnosis

Checks	Action
Fuel System Checks	<sup>2</sup> Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. <sup>2</sup> Check for proper installation of the mixer module assembly. <sup>2</sup> Check all air inlet ducts for condition and proper installation. <sup>2</sup> Check for fuel leaks between the LPR and the mixer. <sup>2</sup> Verify that the LPG tank manual shut-off valve is fully open. <sup>2</sup> Verify that liquid fuel (not vapor) is being delivered to the LPR.
Sensor Checks	<sup>2</sup> Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. <sup>2</sup> Check for proper operation of the TPS sensor.
Exhaust System Checks	<sup>2</sup> Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure. - Check for possible plugged catalytic converter.
Engine Mechanical Check	Check the engine for the following: <sup>2</sup> Engine compression <sup>2</sup> Valve timing <sup>2</sup> Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.
Additional Check	<sup>2</sup> Check the ECM grounds for being clean, tight, and in their proper locations. <sup>2</sup> Check the generator output voltage. <sup>2</sup> If all procedures have been completed and no malfunction has been found, review and inspect the following items: <sup>2</sup> Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. <sup>2</sup> Check the scan tool data.
<b>Poor Fuel Economy</b>	
<b>DEFINITION:</b> Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an by refueling records.	
Preliminary Checks	<sup>2</sup> Refer to Important Preliminary Checks. <sup>2</sup> Check the air cleaner element (filter) for dirt or being plugged. <sup>2</sup> Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. <sup>2</sup> Check the operators driving habits for the following items: - Is there excessive idling or stop and go driving? - Are the tires at the correct air pressure? - Are excessively heavy loads being carried? - Is their often rapid acceleration? <sup>2</sup> Suggest to the owner to fill the fuel tank and to recheck the fuel economy. <sup>2</sup> Suggest that a different operator use the equipment and record the results.
Fuel System Checks	<sup>2</sup> Check the LPR fuel pressure. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check the fuel system for leakage.
Sensor Checks	<sup>2</sup> Check the Temperature Manifold Absolute Pressure (TMAP) sensor.
Ignition System Checks	<sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits <sup>2</sup> Check the ignition wires for the following items: - Cracking - Hardness - Proper connections
Cooling System Checks	<sup>2</sup> Check the engine thermostat for always being open or for the wrong heat range

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**Table 3-15. Symptom Diagnosis**

Checks	Action
Additional Check	<sup>2</sup> Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. <sup>2</sup> Check for dragging brakes.
Rough, Unstable, or Incorrect Idle, Stalling	
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Check	Refer to Important Preliminary Checks.
Sensor Checks	<sup>2</sup> Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe drive-ability problem. <sup>2</sup> Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: <sup>2</sup> Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	<sup>2</sup> Check for rich or lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. <sup>2</sup> Check for a sticking mixer air valve. <sup>2</sup> Verify proper operation of the EPR. <sup>2</sup> Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. <sup>2</sup> Check the LPR fuel pressure. Refer to the LPG Fuel System Diagnosis. <sup>2</sup> Check mixer module assembly for proper installation and connection.
Ignition System Checks	<sup>2</sup> Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Blistered insulators</li> <li>- Heavy deposits</li> </ul> <sup>2</sup> Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	<b>Important:</b> The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. <sup>2</sup> Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. <sup>2</sup> Check the ECM grounds for being clean, tight, and in their proper locations. <sup>2</sup> Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.
Engine Mechanical Check	<sup>2</sup> Check the engine for the following: <ul style="list-style-type: none"> <li>- Broken motor mounts</li> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes</li> </ul>
Surges/Chuggles	
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.	
Preliminary Checks	Refer to Important Preliminary Checks.
Sensor Checks	<sup>2</sup> Check Heated Exhaust Gas Oxygen Sensor (HEGO) performance.

Table 3-15. Symptom Diagnosis

Checks	Action
Fuel System Checks	<sup>2</sup> Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. <sup>2</sup> Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Verify proper fuel control solenoid operation. <sup>2</sup> Verify that the LPG manual shut-off valve is fully open. <sup>2</sup> Check the in-line fuel filter for restrictions.
Ignition System Checks	<sup>2</sup> Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> <li>- Check the Crankshaft Position (CKP) sensor.</li> </ul>
Additional Check	<sup>2</sup> Check the ECM grounds for being clean, tight, and in their proper locations. <sup>2</sup> Check the generator output voltage. <sup>2</sup> Check the vacuum hoses for kinks or leaks. <sup>2</sup> Check Transmission

**Table 3-16. GM Engine Diagnostics Codes**

SPN Code	FMI Code	DTC	Description
0	3	1561	AUX analog Pull-Down 2 high voltage
0	3	1561	AUX analog Pull-Down 3 high voltage
0	4	1561	AUX analog Pull-Down 2 low voltage
0	4	1561	AUX analog Pull-Down 3 low voltage
0	31	1621	RS-485 Rx inactive
0	31	1622	RS-485 Rx noise
0	31	1623	RS-485 Rx bad packet format
0	31	1624	RS-485 remote shutdown request
0	31	Undefined DTC	Index 10297
0	31	Undefined DTC	Index 10298
0	31	Undefined DTC	Index 10299
29	0	2116	FPP2 higher than IVS
29	1	2140	FPP2 lower than IVS
29	3	2128	FPP2 voltage high
29	4	2127	FPP2 voltage low
51	0	221	TPS1-2 higher than expected
51	1	121	TPS1-2 lower than expected
51	3	123	TPS1 voltage high
51	4	122	TPS1 voltage low
51	7	2112	Unable to reach higher TPS
51	7	2111	Unable to reach lower TPS
51	31	2135	TPS1/2 simultaneous voltages out-of-ran
84	1	502	Roadspeed input loss of signal
91	0	2115	FPP1 higher than IVS
91	1	2139	FPP1 lower than IVS
91	2	1630	J1939 ETC message receipt loss
91	3	2122	FPP1 voltage high
91	4	2123	FPP1 voltage low
91	9	1651	J1939 ETC message receipt loss while in
91	16	2126	FPP1-2 higher than expected
91	18	2121	FPP1-2 lower than expected
91	31	1121	FPP1/2 simultaneous voltages out-of-ran
94	0	88	Fuel pressure higher than expected
94	1	87	Fuel pressure lower than expected
94	3	92	FP high voltage
94	4	91	FP low voltage
100	0	521	Oil pressure sender high pressure
100	1	524	Oil pressure low
100	1	524	Oil pressure sender low pressure
100	3	523	Oil pressure sender high voltage
100	4	522	Oil pressure sender low voltage
100	18	520	Oil pressure sender low pressure stage 1

Table 3-16. GM Engine Diagnostics Codes

SPN Code	FMI Code	DTC	Description
105	0	127	IAT higher than expected stage 2
105	3	113	IAT voltage high
105	4	112	IAT voltage low
105	15	111	IAT higher than expected stage 1
106	4	107	MAP voltage low
106	16	108	MAP pressure high
108	0	2229	BP pressure high
108	1	129	BP pressure low
110	0	1522	CHT higher than expected stage 2
110	0	217	ECT higher than expected stage 2
110	3	118	ECT voltage high
110	4	117	ECT voltage low
110	15	116	ECT higher than expected stage 1
110	16	1521	CHT higher than expected stage 1
168	15	563	Vbat voltage high
168	17	562	Vbat voltage low
173	0	2428	VEGT temperature high
174	3	183	FT high voltage
174	4	182	FT low voltage
441	0	1417	EMWT1 higher than expected stage 2
441	3	1411	EMWT1 voltage high
441	4	1413	EMWT1 voltage low
441	15	1415	EMWT1 higher than expected stage 1
442	0	1418	EMWT2 higher than expected stage 2
442	3	1412	EMWT2 voltage high
442	4	1414	EMWT2 voltage low
442	15	1416	EMWT2 higher than expected stage 1
443	0	1425	ERWT1 higher than expected stage 2
443	3	1419	ERWT1 voltage high
443	4	1421	ERWT1 voltage low
443	15	1423	ERWT1 higher than expected stage 1
444	0	1426	ERWT2 higher than expected stage 2
444	3	1420	ERWT2 voltage high
444	4	1422	ERWT2 voltage low
444	15	1424	ERWT2 higher than expected stage 1
515	0	1112	RPM above spark rev limit level
515	15	219	RPM higher than max allowed govern speed
515	16	1111	RPM above fuel rev limit level
558	5	2130	IVS stuck at-idle, FPP1/2 match
558	6	2131	IVS stuck off-idle, FPP1/2 match
628	13	601	Microprocessor failure - FLASH
629	31	606	Microprocessor failure - COP
629	31	1612	Microprocessor failure - RTI 1

**Table 3-16. GM Engine Diagnostics Codes**

SPN Code	FMI Code	DTC	Description
629	31	1613	Microprocessor failure - RTI 2
629	31	1614	Microprocessor failure - RTI 3
629	31	1615	Microprocessor failure - A/D
629	31	1616	Microprocessor failure - Interrupt
630	12	604	Microprocessor failure - RAM
636	2	336	CRANK input signal noise
636	4	337	Crank signal loss
636	8	16	Crank and/or cam could not synchronize du
639	9	1629	J1939 TSC1 message receipt loss
639	12	1626	CAN-J1939 Tx fault
639	12	1627	CAN-J1939 Rx fault
639	13	1628	J1939 CAN address / engine-number co
645	3	2619	Tach output short to power
645	4	2618	Tach output ground short
651	5	261	Injector 1 open or short to ground
651	6	262	Injector 1 coil shorted
652	5	264	Injector 2 open or short to ground
652	6	265	Injector 2 coil shorted
653	5	267	Injector 3 open or short to ground
653	6	268	Injector 3 coil shorted
654	5	270	Injector 4 open or short to ground
654	6	271	Injector 4 coil shorted
655	5	273	Injector 5 open or short to ground
655	6	274	Injector 5 coil shorted
656	5	276	Injector 6 open or short to ground
656	6	277	Injector 6 coil shorted
657	5	279	Injector 7 open or short to ground
657	6	280	Injector 7 coil shorted
658	5	282	Injector 8 open or short to ground
658	6	283	Injector 8 coil shorted
659	5	285	Injector 9 open or short to ground
659	6	286	Injector 9 coil shorted
660	5	288	Injector 10 open or short to ground
660	6	289	Injector 10 coil shorted
697	5	1631	PWM1-Gauge1 open / ground short
697	6	1632	PWM1-Gauge1 short to power
698	5	1633	PWM2-Gauge2 open / ground short
698	6	1634	PWM2-Gauge2 short to power
699	5	1635	PWM3-Gauge3 open / ground short
699	6	1636	PWM3-Gauge3 short to power
700	5	1637	PWM4 open / ground short
700	6	1638	PWM4 short to power
713	3	1547	AUX analog Pull-Up/Down 4 high voltage

Table 3-16. GM Engine Diagnostics Codes

SPN Code	FMI Code	DTC	Description
713	4	1548	AUX analog Pull-Up/Down 4 low voltage
723	2	341	CAM input signal noise
723	4	342	Loss of CAM input signal
724	10	134	EG01 open / lazy
731	2	326	Knock1 excessive or erratic signa
731	4	327	Knock1 sensor open or not present
920	3	1643	Buzzer control short to power
920	4	1641	Buzzer control ground short
920	5	1642	Buzzer open
<b>925</b>	<b>3</b>	<b>1662</b>	<b>PWM6 short to power</b>
925	5	1661	PWM6 open / ground short
926	2	1664	PWM7 short to power
926	5	1663	PWM7 open / ground short
1079	3	643	Sensor supply voltage 1 high
1079	4	642	Sensor supply voltage 1 low
1079	31	1611	Sensor supply voltage 1 and 2 out-of-range
1080	3	653	Sensor supply voltage 2 high
1080	4	652	Sensor supply voltage 2 low
1127	3	238	TIP high voltage
1127	4	237	TIP low voltage
1192	3	1131	WGP voltage high
1192	4	1132	WGP voltage low
1213	3	1645	MIL control short to power
1213	4	1644	MIL control ground short
1213	5	650	MIL open
1239	7	359	Fuel run-out longer than expected
1268	5	2300	Spark coil 1 primary open or short to ground
1268	6	2301	Spark coil 1 primary shorted
1269	5	2303	Spark coil 2 primary open or short to ground
1269	6	2304	Spark coil 2 primary shorted
1270	5	2306	Spark coil 3 primary open or short to ground
1270	6	2307	Spark coil 3 primary shorted
1271	5	2309	Spark coil 4 primary open or short to ground
1271	6	2310	Spark coil 4 primary shorted
1272	5	2312	Spark coil 5 primary open or short to ground
1272	6	2313	Spark coil 5 primary shorted
1273	5	2315	Spark coil 6 primary open or short to ground
1273	6	2316	Spark coil 6 primary shorted
1274	5	2318	Spark coil 7 primary open or short to ground
1274	6	2319	Spark coil 7 primary shorted
1275	5	2321	Spark coil 8 primary open or short to ground
1275	6	2322	Spark coil 8 primary shorted
1276	5	2324	Spark coil 9 primary open or short to ground

**Table 3-16. GM Engine Diagnostics Codes**

SPN Code	FMI Code	DTC	Description
1276	6	2325	Spark coil 9 primary shorted
1277	5	2327	Spark coil 10 primary open or short to ground
1277	6	2328	Spark coil 10 primary shorted
1321	3	617	Start relay coil short to power
1321	4	616	Start relay ground short
1321	5	615	Start relay coil open
1323	11	1311	Cylinder 1 misfire detected
1323	31	301	Cylinder 1 emissions/catalyst damaging misfire
1324	11	1312	Cylinder 2 misfire detected
1324	31	302	Cylinder 2 emissions/catalyst damaging misfire
1325	11	1313	Cylinder 3 misfire detected
1325	31	303	Cylinder 3 emissions/catalyst damaging misfire
1326	11	1314	Cylinder 4 misfire detected
1326	31	304	Cylinder 4 emissions/catalyst damaging misfire
1327	11	1315	Cylinder 5 misfire detected
1327	31	305	Cylinder 5 emissions/catalyst damaging misfire
1328	11	1316	Cylinder 6 misfire detected
1328	31	306	Cylinder 6 emissions/catalyst damaging misfire
1329	11	1317	Cylinder 7 misfire detected
1329	31	307	Cylinder 7 emissions/catalyst damaging misfire
1330	11	1318	Cylinder 8 misfire detected
1330	31	308	Cylinder 8 emissions/catalyst damaging misfire
1347	5	628	Fuel-pump high-side open or short to group
1347	6	629	Fuel-pump high-side short to power
1348	3	629	Fuel pump relay coil short to power
1348	4	628	Fuel pump relay control ground short
1348	5	627	Fuel pump relay coil open
1384	31	1625	J1939 shutdown request
1485	3	687	Power relay coil short to power
1485	4	686	Power relay ground short
1485	5	685	Power relay coil open
1692	0	234	Boost control overboost failure
1692	1	299	Boost control underboost failure
1692	2	236	TIP active
2646	3	1666	PWM8 short to power
2646	5	1665	PWM8 open / ground short
2647	3	1670	PWM9 short to power
2647	5	1669	PWM9 open / ground short
3056	3	8906	UEGO return voltage shorted high
3056	4	8907	UEGO return voltage shorted low
3217	3	8910	UEGO sense cell voltage high
3217	4	8911	UEGO sense cell voltage low
3218	3	8908	UEGO pump voltage shorted high

Table 3-16. GM Engine Diagnostics Codes

SPN Code	FMI Code	DTC	Description
3218	4	8909	UEGO pump voltage shorted low
3221	3	8904	UEGO cal resistor voltage high
3221	4	8905	UEGO cal resistor voltage low
3221	31	8901	UEGO microprocessor internal fault
3222	0	8916	UEGO sense cell impedance high
3222	3	8902	UEGO heater supply high voltage
3222	4	8903	UEGO heater supply low voltage
3222	10	8914	UEGO sense cell slow to warm up
3225	0	8917	UEGO pump cell impedance high
3225	1	8918	UEGO pump cell impedance low
3225	3	8912	UEGO pump voltage at high drive limit
3225	4	8913	UEGO pump voltage at low drive limit
3225	10	8915	UEGO pump cell slow to warm up
520200	0	171	Adaptive-learn gasoline bank1 high
520200	1	172	Adaptive-learn gasoline bank1 low
520201	0	174	Adaptive-learn gasoline bank2 high
520201	1	175	Adaptive-learn gasoline bank2 low
520202	0	1161	Adaptive-learn LPG high
520202	1	1162	Adaptive-learn LPG low
520203	0	1163	Adaptive-learn NG high
520203	1	1164	Adaptive-learn NG low
520204	0	1155	Closed-loop gasoline bank1 high
520204	1	1156	Closed-loop gasoline bank1 low
520205	0	1157	Closed-loop gasoline bank2 high
520205	1	1158	Closed-loop gasoline bank2 low
520206	0	1151	Closed-loop LPG high
520206	1	1152	Closed-loop LPG low
520207	0	1153	Closed-loop NG high
520207	1	1154	Closed-loop NG low
520208	10	154	EG02 open / lazy
520209	10	140	EG03 open / lazy
520210	10	160	EG04 open / lazy
520211	10	420	Catalyst inactive on gasoline (Bank 1)
520212	10	430	Catalyst inactive on gasoline (Bank 2)
520213	10	1165	Catalyst inactive on LPG
520214	10	1166	Catalyst inactive on NG
520215	3	1515	AUX analog Pull-Down 1 high voltage
520215	4	1516	AUX analog Pull-Down 1 low voltage
520216	3	1511	AUX analog Pull-Up 1 high voltage
520216	4	1512	AUX analog Pull-Up 1 low voltage
520217	3	1513	AUX analog Pull-Up 2 high voltage
520217	4	1514	AUX analog Pull-Up 2 low voltage
520218	3	1517	AUX analog Pull-Up 3 high voltage

Table 3-16. GM Engine Diagnostics Codes

SPN Code	FMI Code	DTC	Description
520218	4	1518	AUX analog Pull-Up 3 low voltage
520219	3	1541	AUX analog Pull-Up/Down 1 high voltage
520219	4	1542	AUX analog Pull-Up/Down 1 low voltage
520220	3	1543	AUX analog Pull-Up/Down 2 high voltage
520220	4	1544	AUX analog Pull-Up/Down 2 low voltage
520221	3	1545	AUX analog Pull-Up/Down 3 high voltage
520221	4	1546	AUX analog Pull-Up/Down 3 low voltage
520222	3	1551	AUX digital 1 high voltage
520222	4	1552	AUX digital 1 low voltage
520223	3	1553	AUX digital 2 high voltage
520223	4	1554	AUX digital 2 low voltage
520224	3	1555	AUX digital 3 high voltage
520224	3	1555	Water Intrusion Detection
520224	4	1556	AUX digital 3 low voltage
520226	3	916	Shift actuator feedback out-of-range
520226	7	919	Shift unable to reach desired gear
520226	31	920	Shift actuator or drive circuit failed
520230	5	1639	PWM5 open / ground short
520230	6	1640	PWM5 short to power
520240	3	188	Gaseous fuel temperature sender high voltage
520240	4	187	Gaseous fuel temperature sender low volt
520241	2	331	Knock2 excessive or erratic signal
520241	4	332	Knock2 sensor open or not present
520250	31	2120	FPP1 invalid voltage and FPP2 disagree
520250	31	2125	FPP2 invalid voltage and FPP1 disagree
520250	31	1122	FPP1/2 do not match each other or IVS
520251	3	223	TPS2 voltage high
520251	4	222	TPS2 voltage low
520252	5	509	IAC coil open/short
520252	6	508	IAC ground short
520260	0	1171	MegaJector delivery pressure higher than
520260	1	1172	MegaJector delivery pressure lower than
520260	3	1174	MegaJector voltage supply high
520260	4	1175	MegaJector voltage supply low
520260	12	1176	MegaJector internal actuator fault detection
520260	12	1177	MegaJector internal circuitry fault detection
520260	12	1178	MegaJector internal comm fault detection
520260	31	1173	MegaJector comm lost
520270	31	1531	Gov1/2/3 interlock failure
520401	0	1182	Fuel impurity level high
520800	7	11	Intake cam / distributor position error
520801	7	24	Exhaust cam position error
520803	31	1183	MegaJector autozero / lockoff failure

3.26 FORD ENGINE

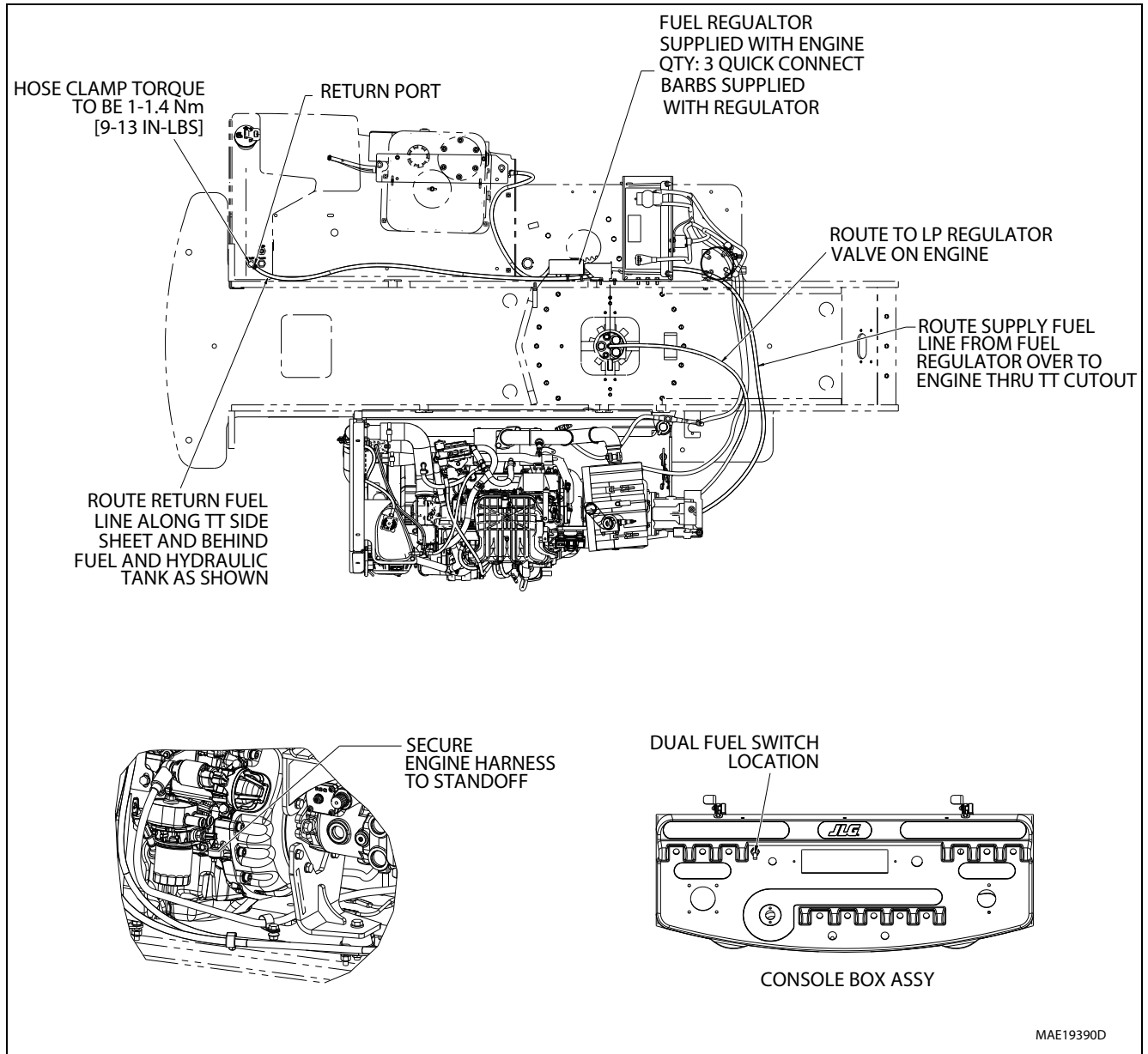


Figure 3-111. Ford Engine Installation - Sheet 1 of 4

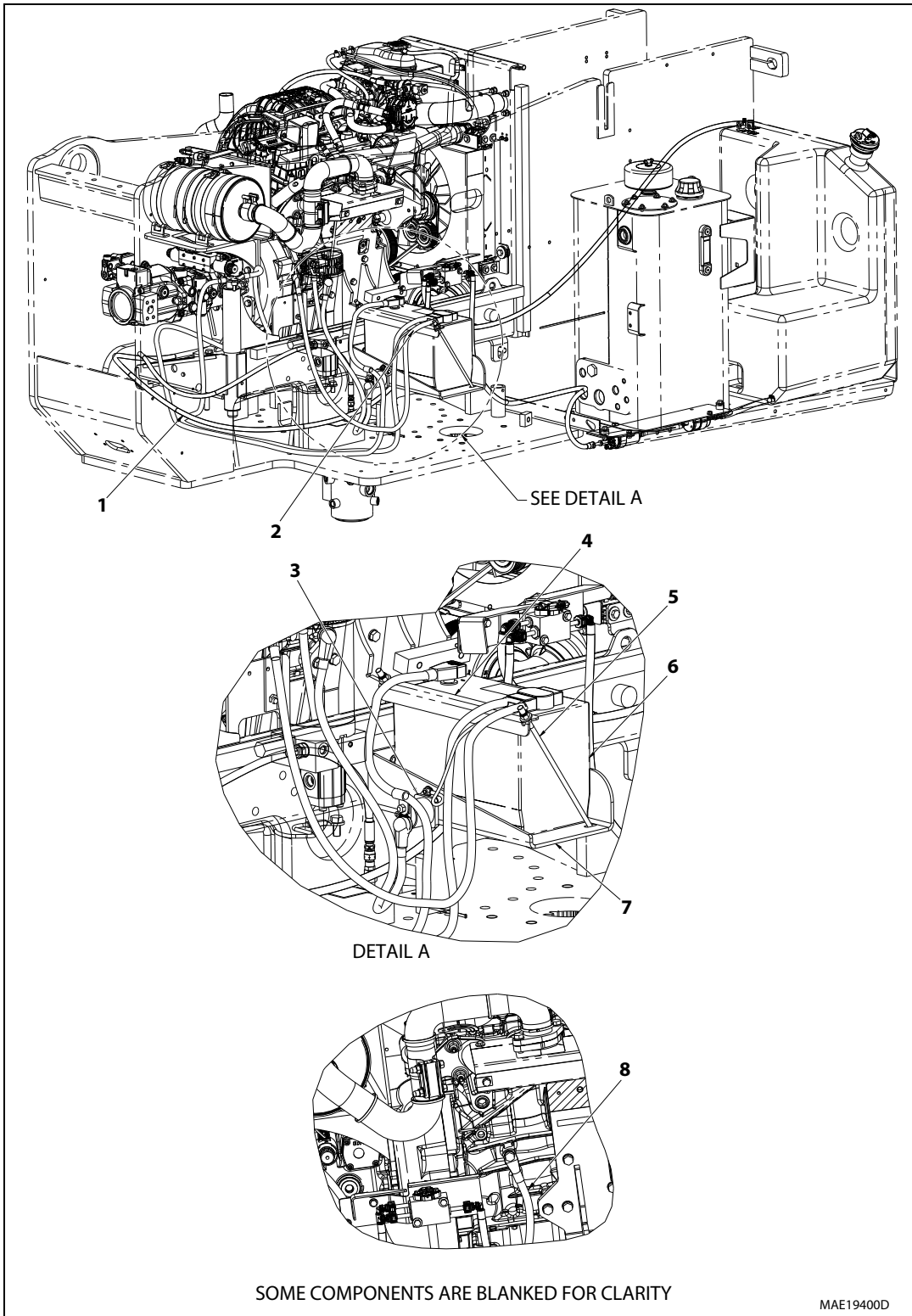


Figure 3-112. Ford Engine Installation - Sheet 2 of 4

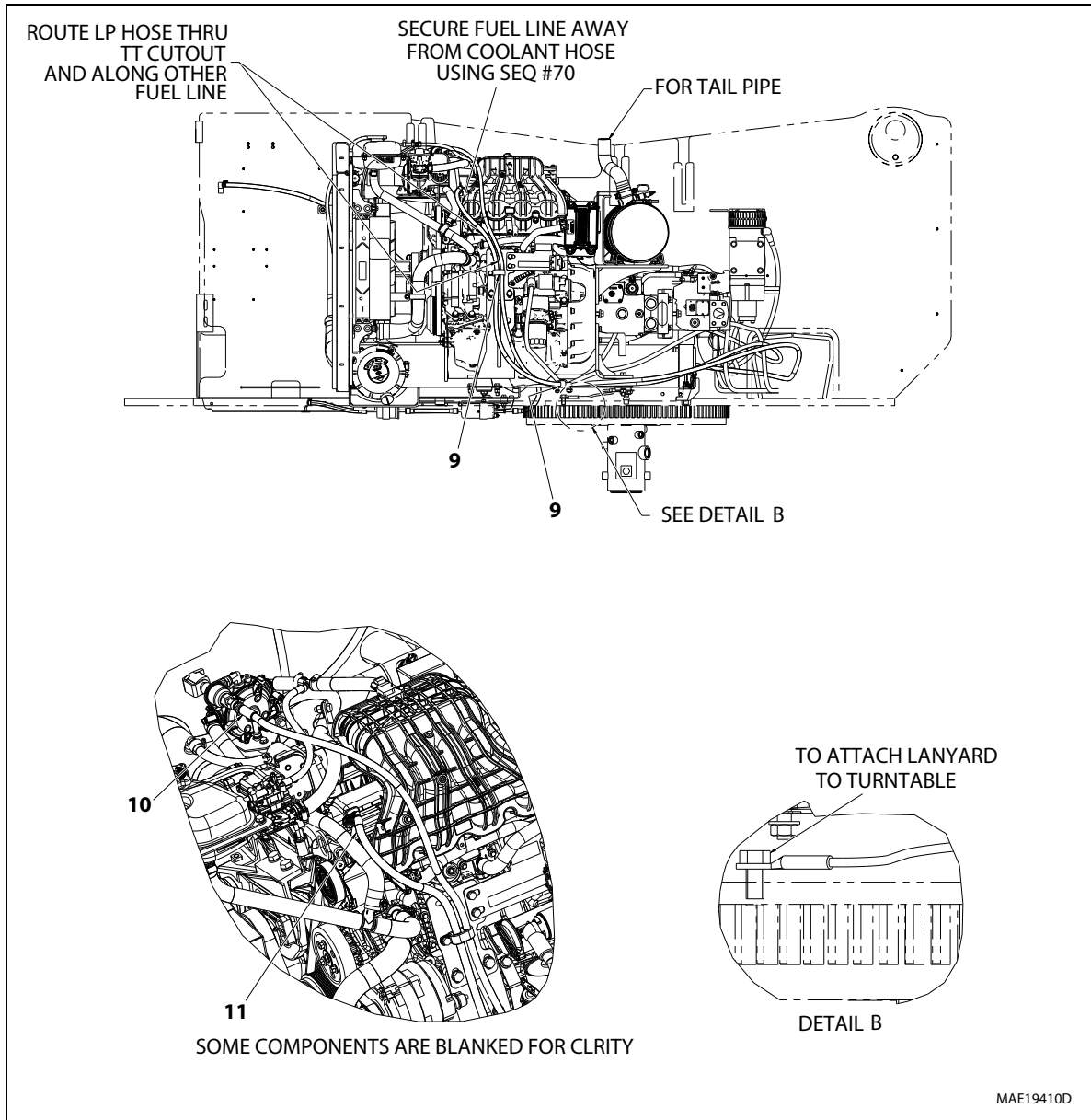
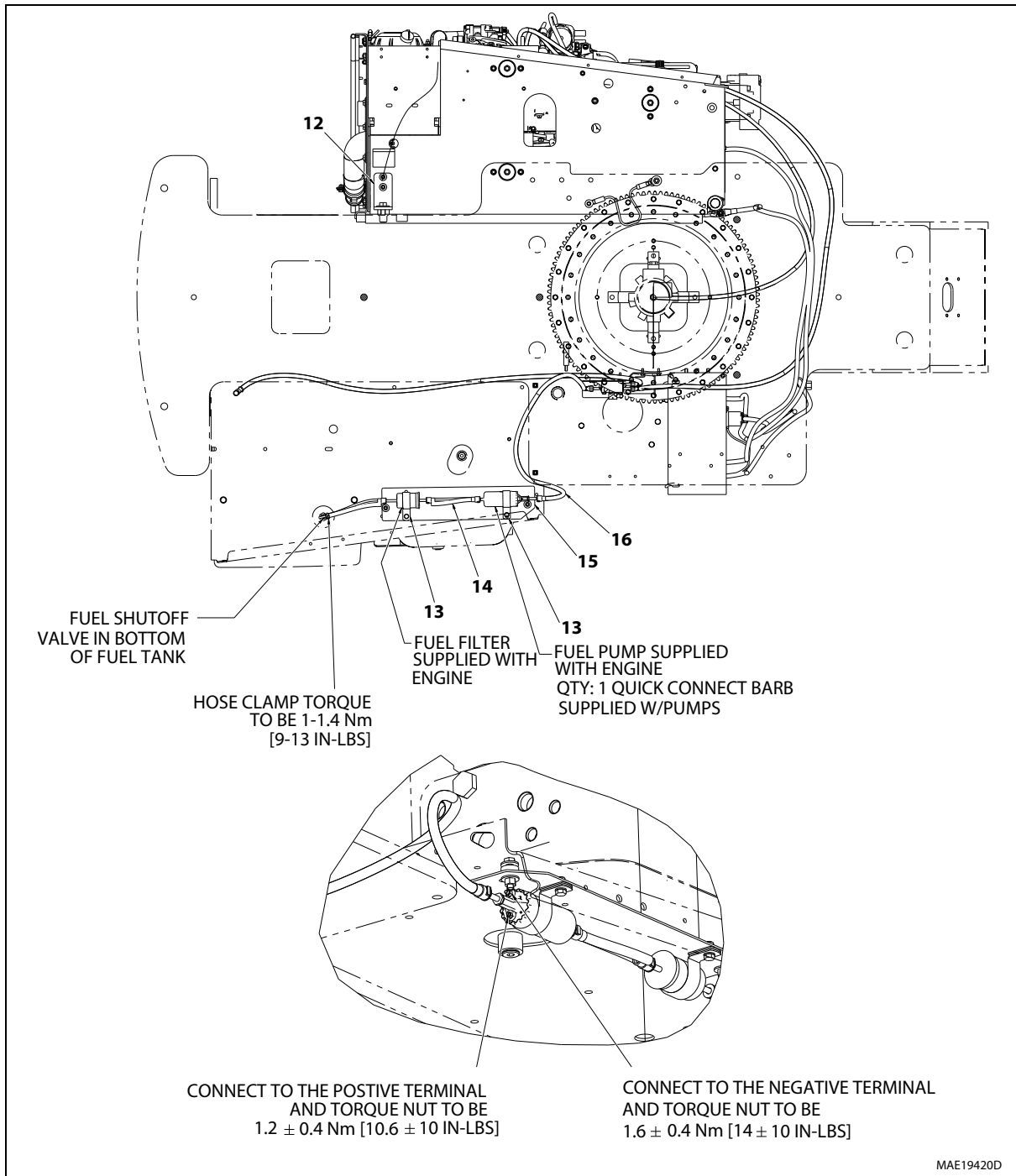


Figure 3-113. Ford Engine Installation - Sheet 3 of 4

**SECTION 3 - CHASSIS & TURNTABLE**



- |                              |                      |                             |                              |
|------------------------------|----------------------|-----------------------------|------------------------------|
| 1. High Pressure Fuel Hose   | 5. J-Bolt            | 9. Clamp                    | 13. P-Clamp                  |
| 2. Battery Cable Kit         | 6. Battery           | 10. LP Gas Hose             | 14. High Pressure Fuel Hose  |
| 3. Solenoid Assembly Relay   | 7. Battery Bracket   | 11. High Pressure Fuel Hose | 15. Fuel Pump Filter Bracket |
| 4. Battery Hold Down Bracket | 8. Battery Cable Kit | 12. Engine Tray Mount       | 16. High Pressure Fuel Hose  |

**Figure 3-114. Ford Engine Installation - Sheet 4 of 4**

Table 3-17. Fault Code Cross Reference List (Ford Engine)

Original DTC Number	Fault Name	Corresponding DTC (Current)
11	Intake cam / distributor position	11
24	Exhaust cam position	24
111	CL high LPG	1151
112	EGO open/lazy pre-cat 1	134
113	EGO open/lazy pre-cat 2/post-cat 1	154
114	EGO open/lazy post-cat 1	140
115	EGO open/lazy post-cat 2	160
121	CL high gasoline bank1	1155
122	CL low gasoline bank1	1156
124	CL low LPG	1152
125	CL high NG	1153
126	CL low NG	1154
131	CL high gasoline bank2	1157
132	CL low gasoline bank2	1158
133	Gasoline cat monitor	420
134	LPG cat monitor	1165
135	NG cat monitor	1166
136	Gasoline cat monitor	430
141	AL high gasoline bank1	171
142	AL low gasoline bank1	172
143	AL high LPG	1161
144	AL low LPG	1162
145	AL high NG	1163
146	AL low NG	1164
147	AL high gasoline bank2	174
148	AL low gasoline bank2	175
161	Battery Voltage High	563
162	Battery Voltage Low	562
163	AUX analog PD1 high	1515
164	AUX analog PD1 low	1516
165	AUX analog PU3 high	1517
166	AUX analog PU3 low	1518
167	AUX analog PUD1 high	1541
168	AUX analog PUD1 low	1542
171	AUX analog PUD2 high	1543
172	AUX analog PUD2 low	1544
173	AUX analog PUD3 high	1545
174	AUX analog PUD3 low	1546
181	AUX DIG1 high	1551
182	AUX DIG1 low	1552
183	AUX DIG2 high	1553
184	AUX DIG2 low	1554

**Table 3-17. Fault Code Cross Reference List (Ford Engine)**

Original DTC Number	Fault Name	Corresponding DTC (Current)
185	AUX DIG3 high	1555
186	AUX DIG3 low	1556
211	IAT high voltage	113
212	IAT low voltage	112
213	IAT higher than expected 1	111
214	IAT higher than expected 2	127
215	Oil pressure low	524
221	ECT/CHT High Voltage	118
222	ECT/CHT Low Voltage	117
223	CHT higher than expected 1	1521
224	CHT higher than expected 2	1522
225	ECT higher than expected 1	116
226	ECT higher than expected 2	217
231	MAP High Pressure	108
232	MAP Low Voltage	107
234	BP high pressure	2229
235	BP low pressure	129
242	Crank sync noise	336
243	Never crank synced at start	16
244	Cam loss	342
245	Cam sync noise	341
246	Crank loss	337
253	Knock 1 sensor Open	327
254	Knock 1 Excessive Signal	326
255	Knock 2 sensor Open	332
256	Knock 2 Excessive Signal	331
261	FP high voltage	92
262	FP low voltage	91
271	FT Gasoline High Voltage	183
272	FT Gasoline Low Voltage	182
273	FT Gaseous fuel high voltage	188
274	FT Gaseous fuel low voltage	187
281	TIP High Voltage	238
282	TIP Low Voltage	237
283	TIP Active	236
301	Emissions/catalyst damaging misfire	301
302	Emissions/catalyst damaging misfire	302
303	Emissions/catalyst damaging misfire	303
304	Emissions/catalyst damaging misfire	304
305	Emissions/catalyst damaging misfire	305
306	Emissions/catalyst damaging misfire	306
307	Emissions/catalyst damaging misfire	307

Table 3-17. Fault Code Cross Reference List (Ford Engine)

Original DTC Number	Fault Name	Corresponding DTC (Current)
308	Emissions/catalyst damaging misfire	308
311	Injector Loop Open or Low-side short to Ground	261
312	Injector Coil Shorted	262
313	Injector Loop Open or Low-side short to Ground	264
314	Injector Coil Shorted	265
315	Injector Loop Open or Low-side short to Ground	267
316	Injector Coil Shorted	268
321	Injector Loop Open or Low-side short to Ground	270
322	Injector Coil Shorted	271
323	Injector Loop Open or Low-side short to Ground	273
324	Injector Coil Shorted	274
325	Injector Loop Open or Low-side short to Ground	276
326	Injector Coil Shorted	277
331	Injector Loop Open or Low-side short to Ground	279
332	Injector Coil Shorted	280
333	Injector Loop Open or Low-side short to Ground	282
334	Injector Coil Shorted	283
335	Injector Loop Open or Low-side short to Ground	285
336	Injector Coil Shorted	286
341	Injector Loop Open or Low-side short to Ground	288
342	Injector Coil Shorted	289
351	FPump motor loop open or high-side shorted to ground	628
352	FPump motor high-side shorted to power	629
353	Megajector delivery pressure higher than expected	1171
354	Megajector delivery pressure lower than expected	1172
355	Megajector comm lost	1173
359	Fuel run-out longer than expected	1181
361	Megajector voltage supply high	1174
362	Megajector voltage supply low	1175
363	Megajector internal actuator fault detection	1176
364	Megajector internal circuitry fault detection	1177
365	Megajector internal comm fault detection	1178
411	Primary Loop Open or Low-side Short to Ground	2300
412	Primary Coil Shorted	2301
413	Primary Loop Open or Low-side Short to Ground	2303
414	Primary Coil Shorted	2304
415	Primary Loop Open or Low-side Short to Ground	2306
416	Primary Coil Shorted	2307
421	Primary Loop Open or Low-side Short to Ground	2309
422	Primary Coil Shorted	2310
423	Primary Loop Open or Low-side Short to Ground	2312
424	Primary Coil Shorted	2313

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-17. Fault Code Cross Reference List (Ford Engine)**

Original DTC Number	Fault Name	Corresponding DTC (Current)
425	Primary Loop Open or Low-side Short to Ground	2315
426	Primary Coil Shorted	2316
431	Primary Loop Open or Low-side Short to Ground	2318
432	Primary Coil Shorted	2319
433	Primary Loop Open or Low-side Short to Ground	2321
434	Primary Coil Shorted	2322
435	Primary Loop Open or Low-side Short to Ground	2324
436	Primary Coil Shorted	2325
441	Primary Loop Open or Low-side Short to Ground	2327
442	Primary Coil Shorted	2328
511	FPP1 high voltage	2122
512	FPP1 low voltage	2123
513	FPP1 higher than IVS limit	2115
514	FPP1 lower than IVS limit	2139
515	FPP1 higher than FPP2	2126
516	FPP1 lower than FPP2	2121
517	IVS stuck-at-idle, FPP1/2 match	2130
518	IVS stuck off-idle, FPP1/2 match	2131
521	FPP2 high voltage	2128
522	FPP2 low voltage	2127
523	FPP2 higher than IVS limit	2116
524	FPP2 lower than IVS limit	2140
525	FPP1/2 simultaneous voltages out of range	1121
526	FPP1 invalid voltage and FPP2 disagrees with IVS	2120
527	FPP2 invalid voltage and FPP1 disagrees with IVS	2125
528	FPP1/2 do not match each other or the IVS	1122
531	TPS1 high voltage	123
532	TPS1 low voltage	122
533	TPS2 high voltage	223
532	TPS2 low voltage	222
535	TPS1 higher than TPS2	221
536	TPS1 lower than TPS2	121
537	Unable to reach higher TPS	2112
538	Unable to reach lower TPS	2111
539	TPS1/2 simultaneous voltages out of range	2135
541	AUX analog PU1 high	1511
542	AUX analog PU1 low	1512
543	AUX analog PU2 high	1513
544	AUX analog PU2 low	1514
545	IVS/Brake/Trans-Park interlock failure	1531
551	Max govern speed override	219
552	Fuel rev limit	1111

Table 3-17. Fault Code Cross Reference List (Ford Engine)

Original DTC Number	Fault Name	Corresponding DTC (Current)
553	Spark rev limit	1112
611	COP failure	606
612	Invalid interrupt	1616
613	A/D loss	1615
614	RTI 1 loss	1612
615	Flash checksum invalid	601
616	RAM failure	604
631	5VE1 low voltage	642
632	5VE1 high voltage	643
633	5VE2 high voltage	653
634	5VE2 low voltage	652
635	5VE 1/2 simultaneous out-of-range	1611
641	Rx Inactive	1621
642	Rx Noise	1622
643	Invalid Packet Format	1623
644	Shutdown Request	1624/1625
646	CAN Tx failure	1626
647	CAN Rx failure	1627
648	CAN address conflict failure	1628
655	RTI 2 loss	1613
656	RTI 3 loss	1614
711	Relay Control ground short	686
712	Relay Coil Open	685
713	Relay coil short to power	687
714	Fpump relay control ground short	628
715	Fpump relay coil open	627
716	Fpump relay coil short to power	629
721	Start relay control ground short	616
722	Start relay coil open	615
723	Start relay coil short to power	617
724	Buzzer control ground short	1641
725	Buzzer open	1642
726	Buzzer control short to power	1643
731	PWM1-Gauge1 open /ground short	1631
732	PWM1-Gauge1 short to power	1632
733	PWM2-Gauge2 open /ground short	1633
734	PWM2-Gauge2 short to power	1634
735	PWM3-Gauge3 open /ground short	1635
736	PWM3-Gauge3 short to power	1636
741	PWM4 open /ground short	1637
742	PWM4 short to power	1638
743	PWM5 open /ground short	1639

**Table 3-17. Fault Code Cross Reference List (Ford Engine)**

<b>Original DTC Number</b>	<b>Fault Name</b>	<b>Corresponding DTC (Current)</b>
744	PWM5 short to power	1640
761	MIL control ground short	1644
762	MIL open	650
763	MIL control short to power	1645
771	Tach output ground short	2618
772	Tach output short to power	2619
1182	Fuel impurity level high	1182
1183	Megajector autozero / lockoff failed	1183
1311	Misfire detected	1311
1312	Misfire detected	1312
1313	Misfire detected	1313
1314	Misfire detected	1314
1315	Misfire detected	1315
1316	Misfire detected	1316
1317	Misfire detected	1317
1318	Misfire detected	1318
1547	AUX analog PUD4 high	1547
1548	AUX analog PUD4 low	1548
1561	AUX analog PD2 high	1561
1562	AUX analog PD2 low	1562
1563	AUX analog PD3 high	1563
1564	AUX analog PD3 low	1564
1629	J1939 TSC1 message receipt lost	1629
1630	J1939 ETC message receipt lost	1630
1661	PWM6 open / ground short	1661
1662	PWM6 short to power	1662
1663	PWM7 open / ground short	1663
1664	PWM7 short to power	1664
1665	PWM8 open / ground short	1665
1666	PWM8 short to power	1666
1669	PWM9 open / ground short	1669
1670	PWM9 short to power	1670

Table 3-18. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
0	31	1531	Gov1/2/3 interlock failure
0	31	1621	RS-485 Rx inactive
0	31	1622	RS-485 Rx noise
0	31	1623	RS-485 Rx bad packet format
0	31	1624	RS-485 remote shutdown request
29	0	2116	FPP2 higher than IVS
29	1	2140	FPP2 lower than IVS
29	3	2128	FPP2 voltage high
29	4	2127	FPP2 voltage low
51	0	221	TPS1-2 higher than expected
51	1	121	TPS1-2 lower than expected
51	3	123	TPS1 voltage high
51	4	122	TPS1 voltage low
51	7	2111	Unable to reach lower TPS
51	7	2112	Unable to reach higher TPS
51	31	2135	TPS1/2 simultaneous voltages out-of-range
84	8	502	Roadspeed input loss of signal
91	0	2115	FPP1 higher than IVS
91	1	2139	FPP1 lower than IVS
91	3	2122	FPP1 voltage high
91	4	2123	FPP1 voltage low
91	9	1651	J1939 ETC message receipt loss while in-gear
91	16	2126	FPP1-2 higher than expected
91	18	2121	FPP1-2 lower than expected
91	19	1630	J1939 ETC message receipt loss
91	31	1121	FPP1/2 simultaneous voltages out-of-range (redundancy lost)
94	3	92	FP high voltage
94	4	91	FP low voltage
100	0	521	Oil pressure sender high pressure
100	1	524	Oil pressure low
100	1	524	Oil pressure sender low pressure
100	3	523	Oil pressure sender high voltage
100	4	522	Oil pressure sender low voltage
102	0	234	Boost control overboost failure
102	1	299	Boost control underboost failure
102	2	236	TIP active
102	3	238	TIP high voltage
102	4	237	TIP low voltage
105	0	127	IAT higher than expected stage 2
105	3	113	IAT voltage high
105	4	112	IAT voltage low
105	15	111	IAT higher than expected stage 1

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-18. CAN to DTC Cross Reference (Ford Engine)**

SPN	FMI	DTC	DTC and Description
106	4	107	MAP voltage low
106	16	108	MAP pressure high
108	0	2229	BP pressure high
108	1	129	BP pressure low
110	0	217	ECT higher than expected stage 2
110	0	1522	CHT higher than expected stage 2
110	3	118	ECT voltage high
110	4	117	ECT voltage low
110	15	116	ECT higher than expected stage 1
110	16	1521	CHT higher than expected stage 1
168	15	563	Vbat voltage high
168	17	562	Vbat voltage low
173	0	2428	EGT temperature high
174	3	183	FT high voltage
174	4	182	FT low voltage
441	0	1417	EMWT1 higher than expected stage 2
441	3	1411	EMWT1 voltage high
441	4	1413	EMWT1 voltage low
441	15	1415	EMWT1 higher than expected stage 1
442	0	1418	EMWT2 higher than expected stage 2
442	3	1412	EMWT2 voltage high
442	4	1414	EMWT2 voltage low
442	15	1416	EMWT2 higher than expected stage 1
515	0	1112	RPM above spark rev limit level
515	15	219	RPM higher than max allowed govern speed
515	16	1111	RPM above fuel rev limit level
558	5	2130	IVS stuck at-idle, FPP1/2 match
558	6	2131	IVS stuck off-idle, FPP1/2 match
628	13	601	Microprocessor failure - FLASH
629	31	606	Microprocessor failure - COP
629	31	1612	Microprocessor failure - RTI 1
629	31	1613	Microprocessor failure - RTI 2
629	31	1614	Microprocessor failure - RTI 3
629	31	1615	Microprocessor failure - A/D
629	31	1616	Microprocessor failure - Interrupt
630	12	604	Microprocessor failure - RAM
632	31	359	Fuel run-out longer than expected
636	2	336	CRANK input signal noise
636	4	337	Crank signal loss
636	8	16	Crank and/or cam could not synchronize during start
639	12	1626	CAN-J1939 Tx fault
639	12	1627	CAN-J1939 Rx fault
639	13	1628	J1939 CAN address / engine-number conflict

Table 3-18. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
645	3	2619	Tach output short to power
645	4	2618	Tach output ground short
651	5	261	Injector 1 open or short to ground
651	6	262	Injector 1 coil shorted
652	5	264	Injector 2 open or short to ground
652	6	265	Injector 2 coil shorted
653	5	267	Injector 3 open or short to ground
653	6	268	Injector 3 coil shorted
654	5	270	Injector 4 open or short to ground
654	6	271	Injector 4 coil shorted
655	5	273	Injector 5 open or short to ground
655	6	274	Injector 5 coil shorted
656	5	276	Injector 6 open or short to ground
656	6	277	Injector 6 coil shorted
657	5	279	Injector 7 open or short to ground
657	6	280	Injector 7 coil shorted
658	5	282	Injector 8 open or short to ground
658	6	283	Injector 8 coil shorted
659	5	285	Injector 9 open or short to ground
659	6	286	Injector 9 coil shorted
660	5	288	Injector 10 open or short to ground
660	6	289	Injector 10 coil shorted
695	9	1629	J1939TSC1 message receipt loss
697	3	1632	PWM1-Gauge1 short to power
697	5	1631	PWM1-Gauge1 open / ground short
698	3	1634	PWM2-Gauge2 short to power
698	5	1633	PWM2-Gauge2 open / ground short
699	3	1636	PWM3-Gauge3 short to power
699	5	1635	PWM3-Gauge3 open / ground short
700	3	1638	PWM4 short to power
700	5	1637	PWM4 open / ground short
701	3	1511	AUX analog Pull-Up 1 high voltage
701	4	1512	AUX analog Pull-Up 1 low voltage
702	3	1513	AUX analog Pull-Up 2 high voltage
702	4	1514	AUX analog Pull-Up 2 low voltage
703	3	1517	AUX analog Pull-Up 3 high voltage
703	4	1518	AUX analog Pull-Up 3 low voltage
704	3	1541	AUX analog Pull-Up/Down 1 high voltage
704	4	1542	AUX analog Pull-Up/Down 1 low voltage
705	3	1543	AUX analog Pull-Up/Down 2 high voltage
705	4	1544	AUX analog Pull-Up/Down 2 low voltage
706	3	1545	AUX analog Pull-Up/Down 3 high voltage
706	4	1546	AUX analog Pull-Up/Down 3 low voltage

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-18. CAN to DTC Cross Reference (Ford Engine)**

SPN	FMI	DTC	DTC and Description
707	3	1551	AUX digital 1 high voltage
707	4	1552	AUX digital 1 low voltage
708	3	1553	AUX digital 2 high voltage
708	4	1554	AUX digital 2 low voltage
709	3	1555	AUX digital 3 high voltage
709	4	1556	AUX digital 3 low voltage
710	3	1515	AUX analog Pull-Down 1 high voltage
710	4	1516	AUX analog Pull-Down 1 low voltage
711	3	1561	AUX analog Pull-Down 2 high voltage
711	4	1561	AUX analog Pull-Down 2 low voltage
712	3	1561	AUX analog Pull-Down 3 high voltage
712	4	1561	AUX analog Pull-Down 3 low voltage
713	3	1547	AUX analog Pull-Up/Down 4 high voltage
713	4	1548	AUX analog Pull-Up/Down 4 low voltage
723	2	341	CAM input signal noise
723	4	342	Loss of CAM input signal
731	2	326	Knock1 excessive or erratic signal
731	4	327	Knock1 sensor open or not present
920	3	1643	Buzzer control short to power
920	4	1641	Buzzer control ground short
920	5	1642	Buzzer open
924	3	1640	PWM5 short to power
924	5	1639	PWM5 open / ground short
925	3	1662	PWM6 short to power
925	5	1661	PWM6 open / ground short
926	3	1664	PWM7 short to power
926	5	1663	PWM7 open / ground short
1079	3	643	Sensor supply voltage 1 high
1079	4	642	Sensor supply voltage 1 low
1079	31	1611	Sensor supply voltage 1 and 2 out-of-range
1080	3	653	Sensor supply voltage 2 high
1080	4	652	Sensor supply voltage 2 low
1110	31	1625	J1939 shutdown request
1192	3	1131	WGP voltage high
1192	4	1132	WGP voltage low
1213	3	1645	MIL control short to power
1213	4	1644	MIL control ground short
1213	5	650	MIL open
1268	5	2300	Spark coil 1 primary open or short to ground
1268	6	2301	Spark coil 1 primary shorted
1269	5	2303	Spark coil 2 primary open or short to ground
1269	6	2304	Spark coil 2 primary shorted
1270	5	2306	Spark coil 3 primary open or short to ground

Table 3-18. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
1270	6	2307	Spark coil 3 primary shorted
1271	5	2309	Spark coil 4 primary open or short to ground
1271	6	2310	Spark coil 4 primary shorted
1272	5	2312	Spark coil 5 primary open or short to ground
1272	6	2313	Spark coil 5 primary shorted
1273	5	2315	Spark coil 6 primary open or short to ground
1273	6	2316	Spark coil 6 primary shorted
1274	5	2318	Spark coil 7 primary open or short to ground
1274	6	2319	Spark coil 7 primary shorted
1275	5	2321	Spark coil 8 primary open or short to ground
1275	6	2322	Spark coil 8 primary shorted
1276	5	2324	Spark coil 9 primary open or short to ground
1276	6	2325	Spark coil 9 primary shorted
1277	5	2327	Spark coil 10 primary open or short to ground
1277	6	2328	Spark coil 10 primary shorted
1321	3	617	Start relay coil short to power
1321	4	616	Start relay ground short
1321	5	615	Start relay coil open
1323	11	1311	Cylinder 1 misfire detected
1323	31	301	Cylinder 1 emissions/catalyst damaging misfire
1324	11	1312	Cylinder 2 misfire detected
1324	31	302	Cylinder 2 emissions/catalyst damaging misfire
1325	11	1313	Cylinder 3 misfire detected
1325	31	303	Cylinder 3 emissions/catalyst damaging misfire
1326	11	1314	Cylinder 4 misfire detected
1326	31	304	Cylinder 4 emissions/catalyst damaging misfire
1327	11	1315	Cylinder 5 misfire detected
1327	31	305	Cylinder 5 emissions/catalyst damaging misfire
1328	11	1316	Cylinder 6 misfire detected
1328	31	306	Cylinder 6 emissions/catalyst damaging misfire
1329	11	1317	Cylinder 7 misfire detected
1329	31	307	Cylinder 7 emissions/catalyst damaging misfire
1330	11	1318	Cylinder 8 misfire detected
1330	31	308	Cylinder 8 emissions/catalyst damaging misfire
1347	5	628	Fuel-pump high-side open or short to ground
1347	6	629	Fuel-pump high-side short to power
1348	3	629	Fuel pump relay coil short to power
1348	4	628	Fuel pump relay control ground short
1348	5	627	Fuel pump relay coil open
1385	0	1425	ERWT1 higher than expected stage 2
1385	3	1419	ERWT1 voltage high
1385	4	1421	ERWT1 voltage low
1385	15	1423	ERWT1 higher than expected stage 1

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-18. CAN to DTC Cross Reference (Ford Engine)**

SPN	FMI	DTC	DTC and Description
1386	0	1426	ERWT2 higher than expected stage 2
1386	3	1420	ERWT2 voltage high
1386	4	1422	ERWT2 voltage low
1386	15	1424	ERWT2 higher than expected stage 1
1485	3	687	Power relay coil short to power
1485	4	686	Power relay ground short
1485	5	685	Power relay coil open
2646	3	1666	PWM8 short to power
2646	5	1665	PWM8 open / ground short
2647	3	1670	PWM9 short to power
2647	5	1669	PWM9 open / ground short
3050	11	420	Catalyst inactive on gasoline (Bank 1)
3050	11	1165	Catalyst inactive on LPG
3050	11	1166	Catalyst inactive on NG
3051	11	430	Catalyst inactive on gasoline (Bank 2)
3056	3	8906	UEGO return voltage shorted high
3056	4	8907	UEGO return voltage shorted low
3217	3	8910	UEGO sense cell voltage high
3217	4	8911	UEGO sense cell voltage low
3217	5	134	EG01 open / lazy
3218	3	8908	UEGO pump voltage shorted high
3218	4	8909	UEGO pump voltage shorted low
3221	3	8904	UEGO cal resistor voltage high
3221	4	8905	UEGO cal resistor voltage low
3221	31	8901	UEGO microprocessor internal fault
3222	0	8916	UEGO sense cell impedance high
3222	3	8902	UEGO heater supply high voltage
3222	4	8903	UEGO heater supply low voltage
3222	10	8914	UEGO sense cell slow to warm up
3225	0	8917	UEGO pump cell impedance high
3225	1	8918	UEGO pump cell impedance low
3225	3	8912	UEGO pump voltage at high drive limit
3225	4	8913	UEGO pump voltage at low drive limit
3225	10	8915	UEGO pump cell slow to warm up
3227	5	154	EG02 open / lazy
3256	5	140	EG03 open / lazy
3266	5	160	EG04 open / lazy
3468	3	188	Gaseous fuel temperature sender high voltage
3468	4	187	Gaseous fuel temperature sender low voltage
3673	3	223	TPS2 voltage high
3673	4	222	TPS2 voltage low
4236	0	1151	Closed-loop LPG high
4236	0	1153	Closed-loop NG high

Table 3-18. CAN to DTC Cross Reference (Ford Engine)

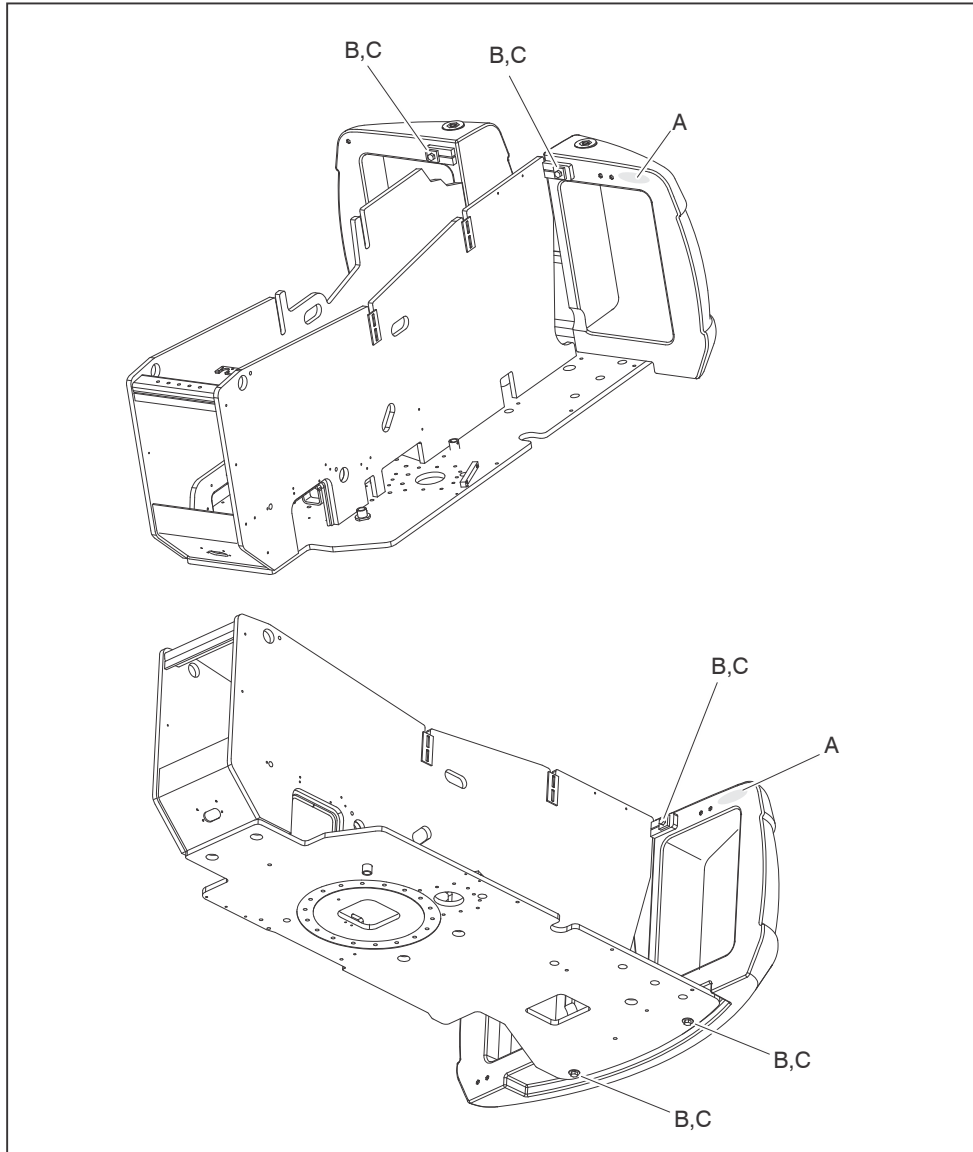
SPN	FMI	DTC	DTC and Description
4236	0	1155	Closed-loop gasoline bank1 high
4236	1	1152	Closed-loop LPG low
4236	1	1154	Closed-loop NG low
4236	1	1156	Closed-loop gasoline bank1 low
4237	0	171	Adaptive-learn gasoline bank1 high
4237	0	1161	Adaptive-learn LPG high
4237	0	1163	Adaptive-learn NG high
4237	1	172	Adaptive-learn gasoline bank1 low
4237	1	1162	Adaptive-learn LPG low
4237	1	1164	Adaptive-learn NG low
4238	0	1157	Closed-loop gasoline bank2 high
4238	1	1158	Closed-loop gasoline bank2 low
4239	0	174	Adaptive-learn gasoline bank2 high
4239	1	175	Adaptive-learn gasoline bank2 low
520197	2	331	Knock2 excessive or erratic signal
520197	4	332	Knock2 sensor open or not present
520199	11	1122	FPP1/2 do not match each other or IVS (redundancy lost)
520199	11	2120	FPP1 invalid voltage and FPP2 disagrees with IVS (redundancy lost)
520199	11	2125	FPP1/2 do not match each other or IVS (redundancy lost)
520201	5	509	IAC coil open/short
520201	6	508	IAC ground short
520260	0	1171	MegaJector delivery pressure higher than expected
520260	1	1172	MegaJector delivery pressure lower than expected
520260	3	1174	MegaJector voltage supply high
520260	4	1175	MegaJector voltage supply low
520260	12	1176	MegaJector internal actuator fault detection
520260	12	1177	MegaJector internal circuitry fault detection
520260	12	1178	MegaJector internal comm fault detection
520260	31	1173	MegaJector comm lost
520401	0	1182	Fuel impurity level high

**3.27 COUNTERWEIGHT**

Both the 800A and the 800AJ share the same tail and frame counterweights regardless of market. However, there is a difference in frame counterweights depending on the equipped tires and wheel drive options. Pneumatic tire machines require more frame counterweight than is required with foam filled tires and 2 wheel drive machines require more counterweight than 4 wheel drives.

Machines originally equipped with foam filled tires cannot be converted to pneumatic tires and 4 wheel drives cannot be converted to 2 wheel drives without adding counterweight. No counterweight difference is required between the narrow and wide pneumatic tire options. Similarly, no counterweight difference is required between the narrow and wide foam filled tires.

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-115.



- A. Actual Weight Stamping
- B. Apply JLG Threadlocker P/N 0100011 to Bolt Threads and to Threads in Counterweight.
- C. Torque to 285 ft. lbs. (386 Nm). Typical Four Places.

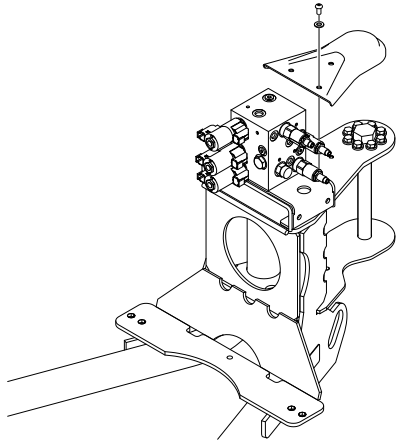
**Figure 3-115. Counterweight**

## SECTION 4. BOOM &amp; PLATFORM

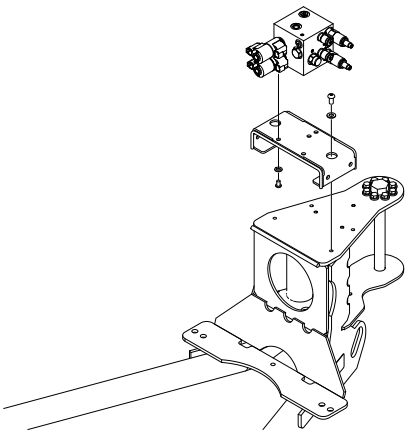
## 4.1 PLATFORM

## Platform Valve Removal

1. Tag and disconnect the hydraulic lines from the platform control valve. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Remove hardware securing cover from the platform support. Remove cover.

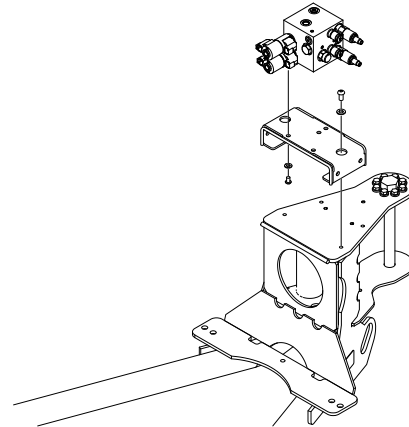


3. Remove hardware securing the mounting bracket to the platform support. Take out the mounting bracket along with platform control valve.
4. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.

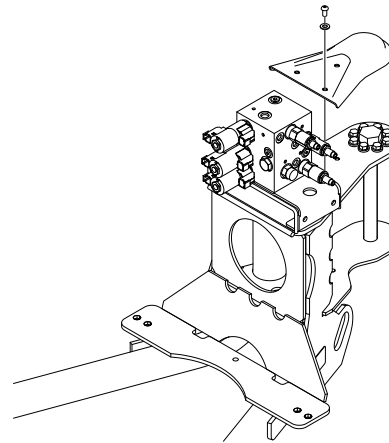


## Platform Valve Installation

1. Install platform control valve onto the mounting bracket and secure using hardware.
2. Install the mounting bracket onto the platform support and secure using hardware.

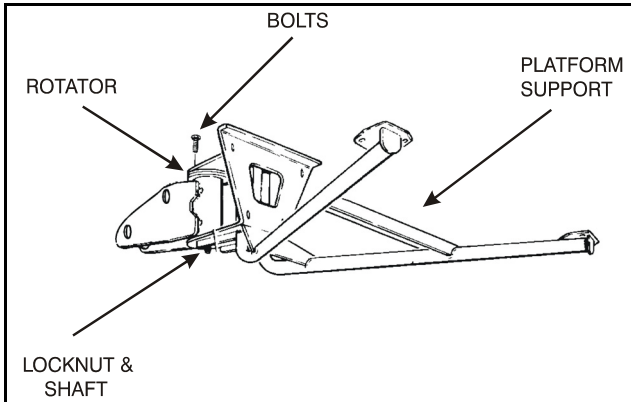


3. Install cover onto the platform support securing the hardware.



4. Remove tag and reconnect the hydraulic lines to the platform control valve.

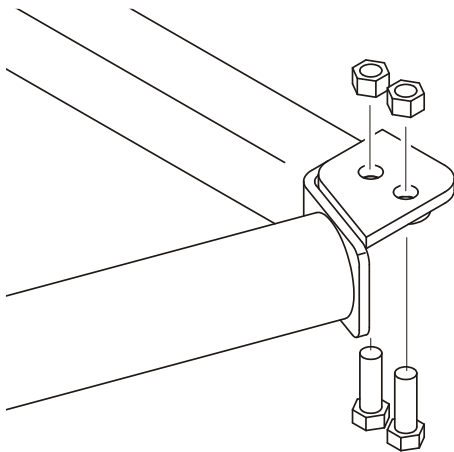
**Support Removal**



**Figure 4-1. Location of Components Platform Support**

1. Disconnect electrical cables from control console.
2. Remove the bolts securing the platform to the platform support, then remove the platform.

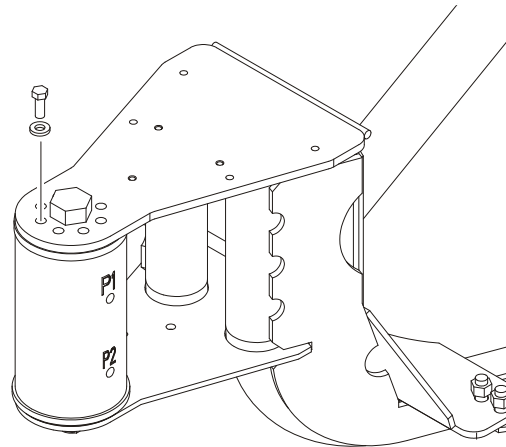
**NOTE:** The Platform Weighs approximately 220 lbs (100 kg).



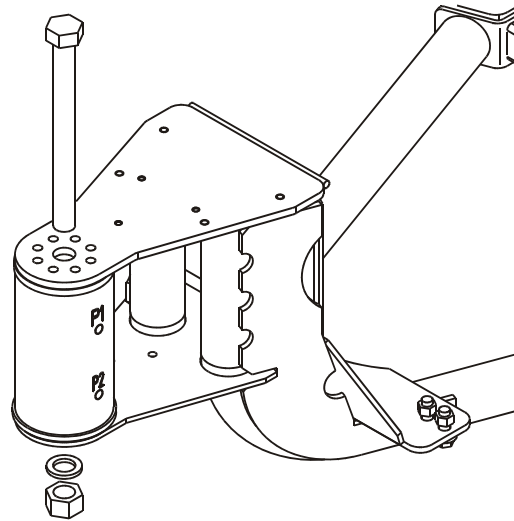
3. Using a suitable device, support the platform support.

**NOTE:** The platform support weighs approximately 77 lbs. (35 kg).

4. Remove the bolts and locknuts securing the support to the rotator.



5. Using a suitable brass drift and hammer, remove the rotator shaft, then remove the support from the rotator.

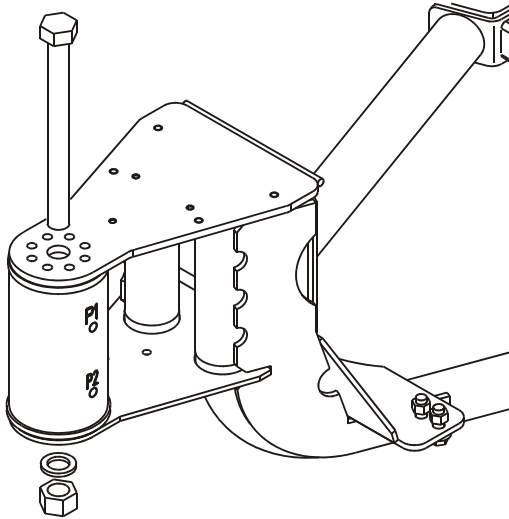


**Support Installation**

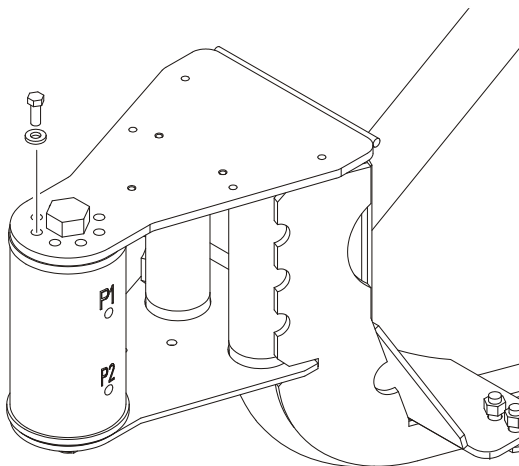
1. Using a suitable device, support the platform support and position it on the rotator.

**NOTE:** The platform support weighs approximately 77 lbs. (35 kg).

2. Install the rotator center bolt.

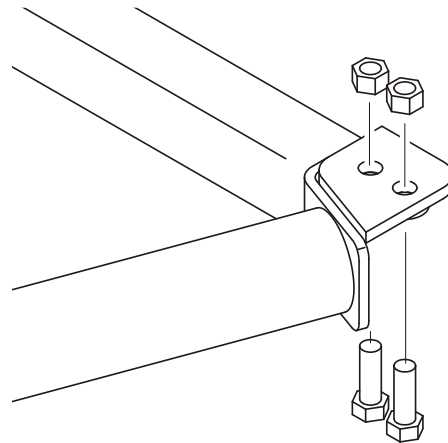


3. Apply JLG Threadlocker P/N 0100011 to the eight bolts and locknuts securing the support to the rotator and install the bolts and locknuts.

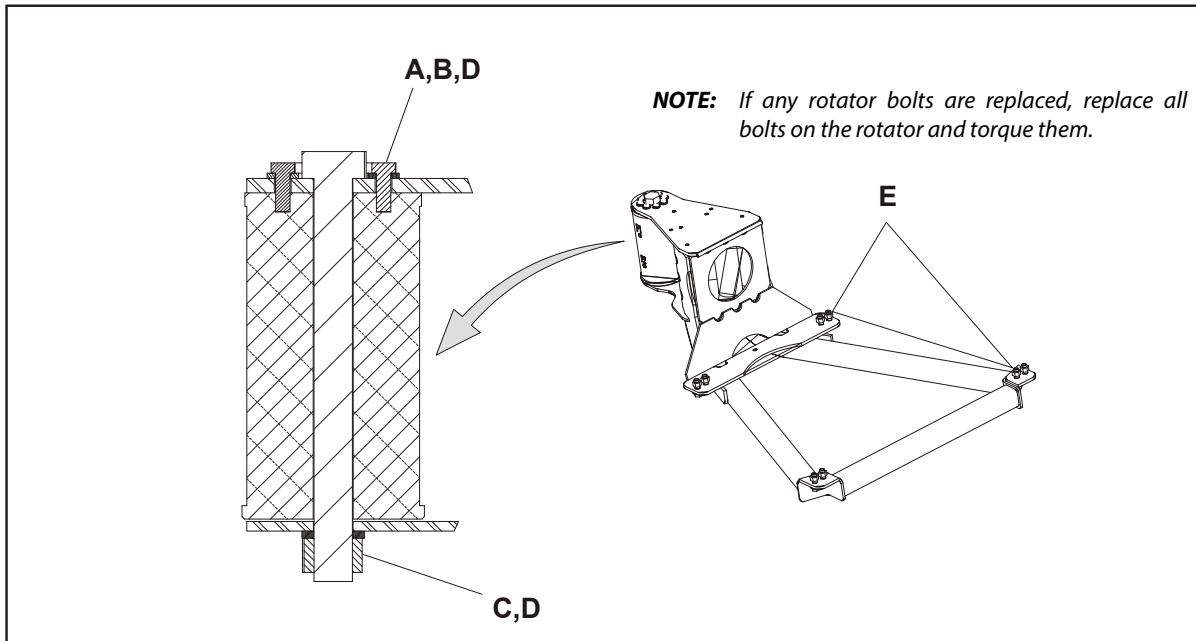


4. Torque the nut on the rotator center bolt to 480 ft. lbs. (651 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support. Torque the bolts to 75 ft. lbs. (102 Nm).



6. Connect the electrical cables to the platform control console.



- A Torque to 40 ft. lbs. (55 Nm)
- B JLG Thread locker (#0100011)
- C Torque to 480 ft. lbs. (650 Nm)
- D Check torque every 150 hours of operation
- E Torque to 75 ft. lbs. (102 Nm)

Figure 4-2. Platform Support Torque Values

## 4.2 ROTATOR AND PLATFORM (SLAVE) CYLINDER

### Removal

1. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Supporting the rotator, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the fly boom.
3. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the fly boom and remove the rotator.
4. Telescope the fly section out approximately 20 inches (50 cm) to gain access to the platform (slave) leveling cylinder. (800 AJ only)
5. Supporting the platform (slave) cylinder, remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom.
6. Tag and disconnect hydraulic lines to the platform (slave) leveling cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the platform (slave) cylinder.

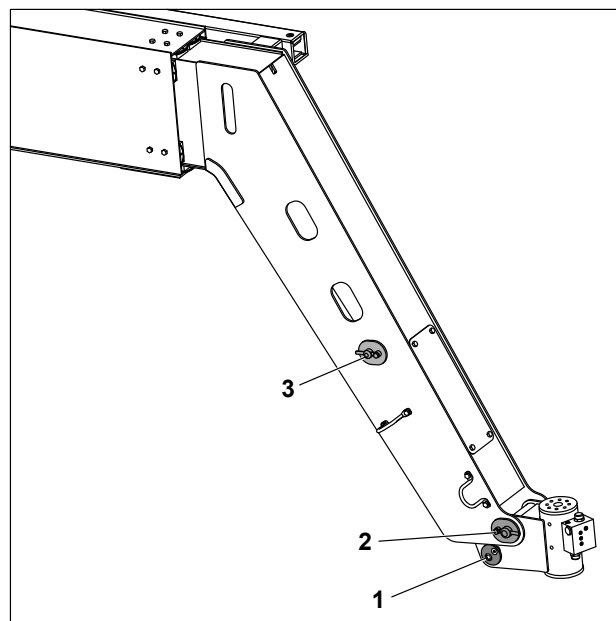


Figure 4-3. Reassembly of Components-Rotator and Leveling Cylinder

## 4.3 BOOM SYSTEM

### Switch Systems

The Capacity Indicator, Transport Position Interlock, and Above Elevation Systems use normally closed electrical switches with "positive opening" contacts.

### Capacity Indicator System (800A only)

The capacity indicator system uses a main boom length switch and a main boom angle switch to activate the 500 lbs. (230 kg) or the 1000 lbs. (450 kg) lights in the platform display panel. This is an indicator system only. The operator is responsible to maintain the safe working envelope indicated by the system for the load in the platform. As described in the Positive Opening Switch System, the "safe" condition of the machine is when 500 lbs. (230 kg) is allowed to be unrestricted (at low boom angles and extended boom lengths).

### Above Elevation (Above Horizontal) Cutout System

The above elevation cutout system uses a main boom angle switch and a tower boom angle switch to sense when the boom is raised substantially above horizontal. The articulated jib of the 800AJ may be in any position. When "above elevation", the drive motors are automatically restricted to their maximum displacement position (slow speed). Additionally when used in conjunction with the "tilt indicator system", the elevation switches will cause an alarm to sound and automatically put the machine in the creep speed mode. With the exception of the speed cutback, this is a warning system only. The machine will continue to function. The operator is responsible to prevent the machine from attaining an unstable position. As described in the Positive Opening Switch System, the "safe" condition of the machine is when high engine and high speed is allowed (at low boom angles).

### Transport Position Interlock System (CE only)

The transport position interlock system uses the "above elevation cutout system" switches with the addition of a main boom telescope switch to sense when the boom is out of the transport (nearly stowed) position. The articulated jib of the 800AJ may be in any position. All controls are simultaneously functional when the booms are within the transport position as on the standard machine. When the booms are outside of the transport position, the control functions are interlocked to prevent simultaneous operation of any boom function with drive/steer. The first function set to be operated in this mode, becomes the master function set. In other words, while operating drive/steer functions the boom functions are inoperable. Likewise, while operating boom functions drive/steer functions are inoperable. In addition to being an interlock, this system also disallows high speed operation while the booms are beyond the transport position. While in this position, the machine will respond in the same way as described in the Above Elevation Cutout System. As described in the Positive Opening Switch System, the "safe" condition of the machine is when the use of multiple function operation is allowed (at low boom angles and short boom lengths).

### Platform Control Enable System

The platform controls make use of a time dependent enable circuit to limit the time availability of "live" or enabled controls. When the footswitch is depressed, the controls are enabled and the operator has 7 seconds to operate any control. The controls will remain enabled as long as the operator continues to use any function and will remain enabled 7 seconds after the last function has been used. While the controls are "live" the enabled light will be illuminated in the platform display panel. When the time limit has been reached, the enabled light will turn off and the controls will be "dead" or disabled. To continue use of the machine the controls must be re-enabled to start the timer system over again. This is done by cycling the footswitch by releasing and redepressed the footswitch.

### Function Speed Control System

The platform controls for the rotate, tower lift, tower telescope, jib lift, and main telescope functions are controlled through a common infinitely variable speed control knob. This knob feeds a common valve driver control circuit allowing a smooth ramp up and controlled maximum output speed. No ramp down is provided. These functions are controlled through common settings in which compromises must be made from function to function due to differences in flow and pressure. Not all functions will respond the same to the changes in the function speed knob position.

### **Platform**

The standard platform utilizes a hinged swing gate for ease of entry and 3/4" expanded metal floor mesh. The optional drop bar gate platform utilizes 1/2" expanded metal floor mesh.

### **Main Lift End Stroke Dampening System**

The main boom lift cylinder is constructed in a way that causes the lift cylinder oil flow to be restricted by an orifice while raising the boom within 5 degrees of maximum elevation. This restriction slows the boom lift speed while raising the boom. The oil flow is not restricted while lowering the boom and therefore the speed is not altered.

### **QuikStick Lift System**

The main boom lift cylinder is pinned between the main boom and the nose of the tower fly boom. This causes an interdependency between the tower and main boom. The main boom changes angle when the tower is raised or lowered. In addition, the maximum angle achieved by the main boom is dependent on the position of the tower boom. When the tower boom is stowed, the main boom's maximum angle is 25 degrees. When the tower boom is fully raised, the main boom's maximum angle is 70 degrees. The main boom can be also be raised or lowered independent of the tower boom within the limits of the boom rests and main boom lift cylinder stroke to a minimum angle of -35 degrees. This allows the platform to reach the ground at any position of the tower boom.

### **Tower Boom Sequence Valve System**

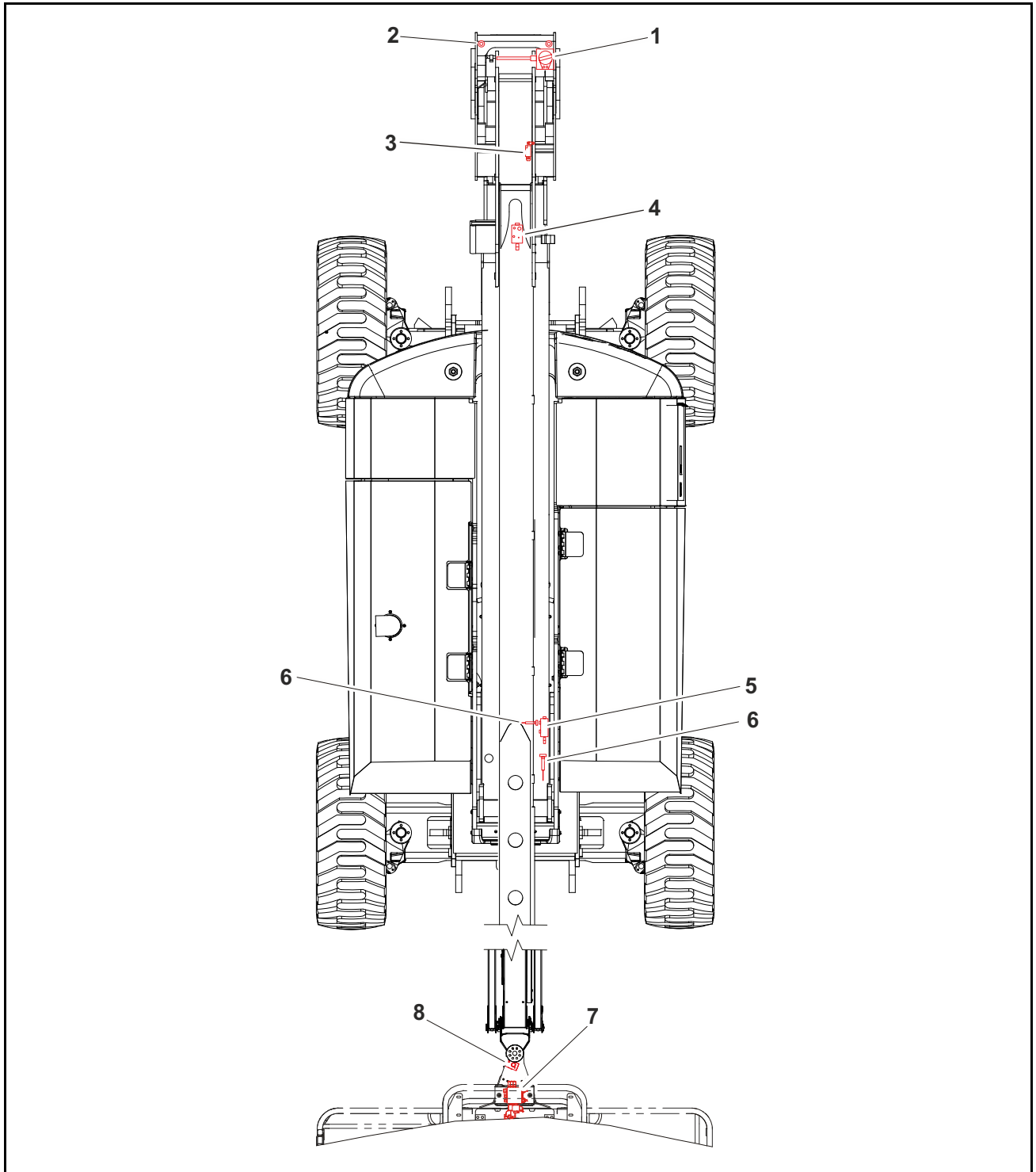
The two section tower boom uses two hydraulic lockout valves to prevent the boom from being telescoped until the boom is fully raised and to prevent the tower boom from being lowered until it is fully retracted. Until the valve mounted in the turntable is actuated by the cam on the tower lift cylinder barrel (at max tower angle), the tower telescope oil flow is blocked preventing the tower from telescoping out. Similarly, until the valve mounted on the tower fly boom is actuated by the tower base boom, the tower lift cylinder oil flow is blocked preventing the tower from lifting down. This is an automatic system.

### **Upright Level Override System**

As the tower boom is raised the upright is leveled by a master-slave cylinder arrangement between the tower lift cylinder and the upright level cylinder. The upright can become out of level in two directions, towards the platform or away from the platform. If the upright is out of level towards the platform, it will automatically correct itself when the tower is lowered by dumping oil from the upright level cylinder over a relief valve mounted in the upright until the tower lift cylinder reaches the end of its stroke. If the upright is out of level away from the platform, the tower lift cylinder is fully retracted with stroke remaining in the upright level cylinder. To correct this condition a re-leveling valve (with a red pull knob) allows the tower to be raised (from ground control) without extending the upright level cylinder. The upright will then correct itself when the tower is lowered to the stowed position.

### **Ground Control Keyswitch System**

The ground control keyswitch is used for selecting the active control of the machine between the platform or ground control stations and as another shut off switch for machine power. On the standard keyswitch, the key is removable only in the off position. This allows the ground control station to have ultimate priority over the platform control.



- |                           |                                  |                             |                           |
|---------------------------|----------------------------------|-----------------------------|---------------------------|
| 1. UMS Sensor             | 3. Tower Boom Angle Switch       | 5. Tower Lift Plunger Valve | 7. Rotator Valve          |
| 2. Main Boom Angle Switch | 4. Tower Telescope Plunger Valve | 6. Proximity Switch         | 8. Platform Control Valve |

**Figure 4-4. Boom Component Location**

## 4.4 MAIN BOOM POWERTRACK

### Removal

1. Disconnect wiring harness connectors located in tower upright.

**NOTICE**

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section. (800A only)
4. Remove hydraulic lines and electrical cables from Powertrack.
5. Using suitable lifting equipment, adequately support Powertrack weight along entire length.

6. Remove bolt #1 securing the push tube on the fly boom section.

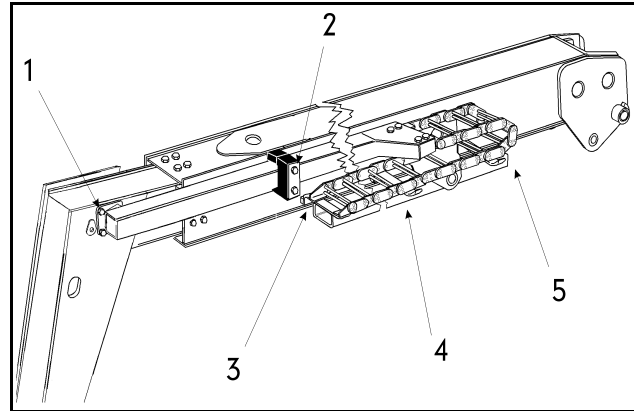


Figure 4-5. Main Boom Powertrack Components

7. Remove bolt #2 securing the push tube on the mid boom section.
8. With Powertrack supported and using all applicable safety precautions, remove bolts #3, #4 and #5 securing rail to the base boom section. Remove Powertrack from boom section.

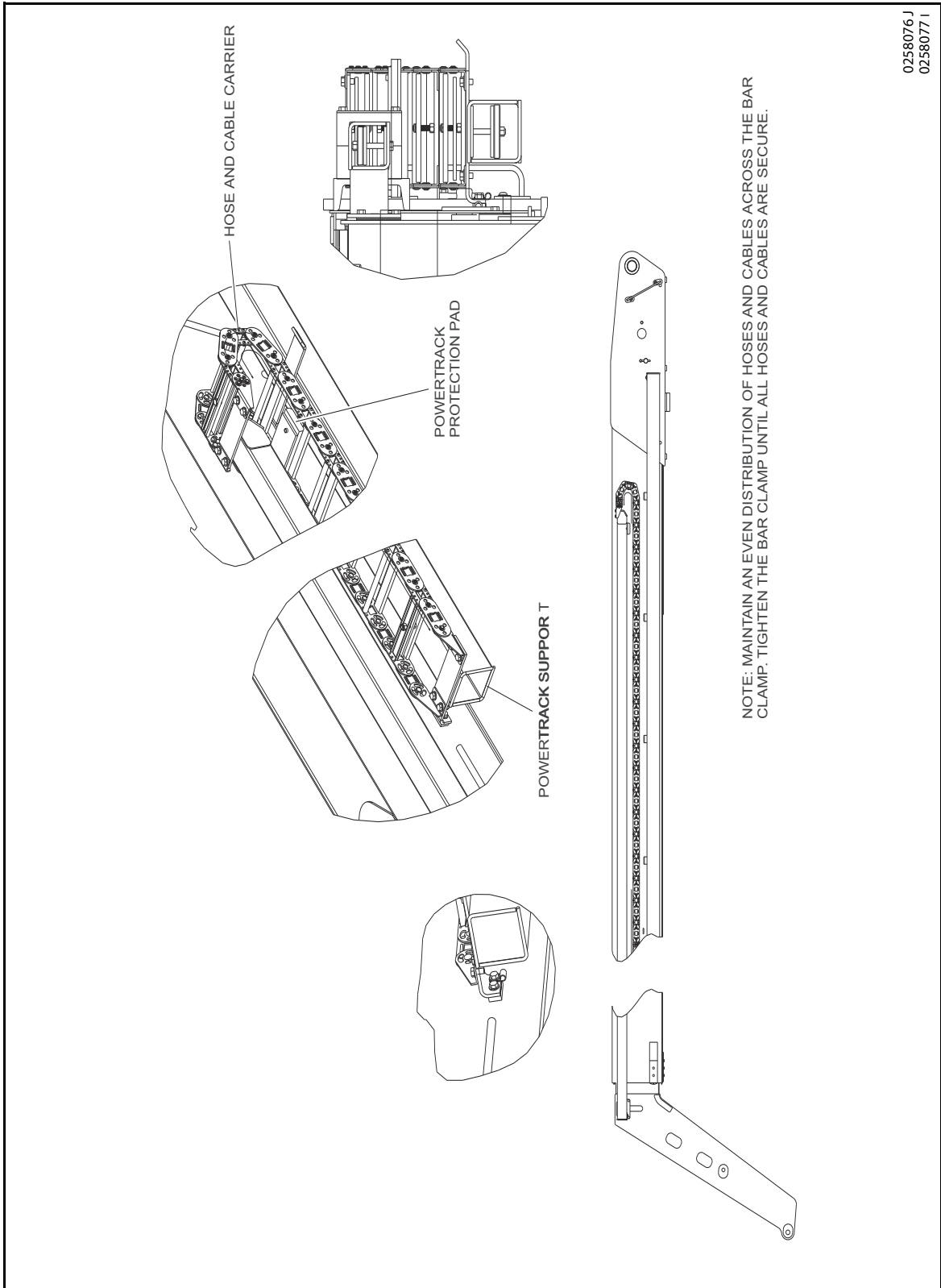


Figure 4-6. Powertrack Installation Main Boom (Sheet 1 of 2)

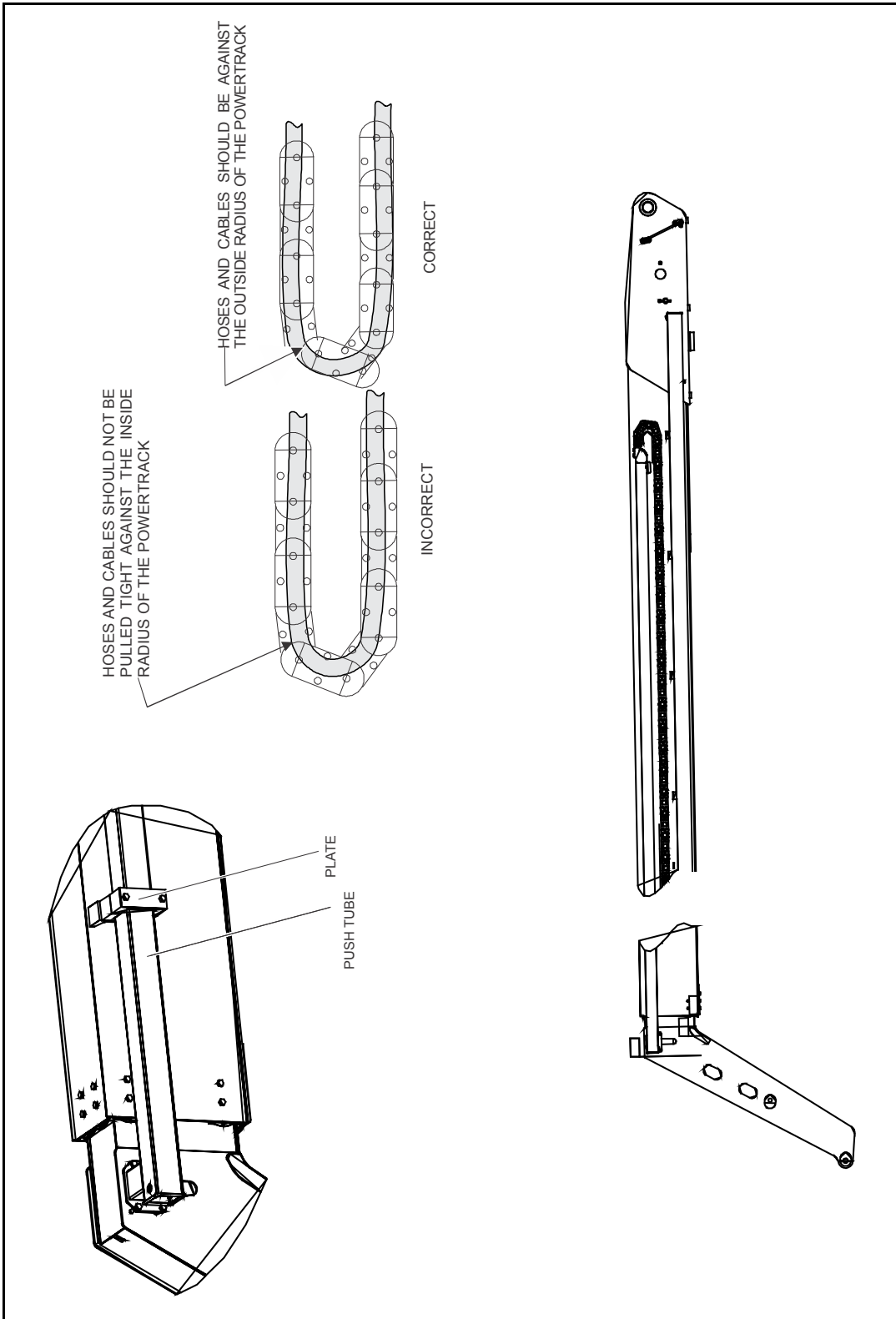
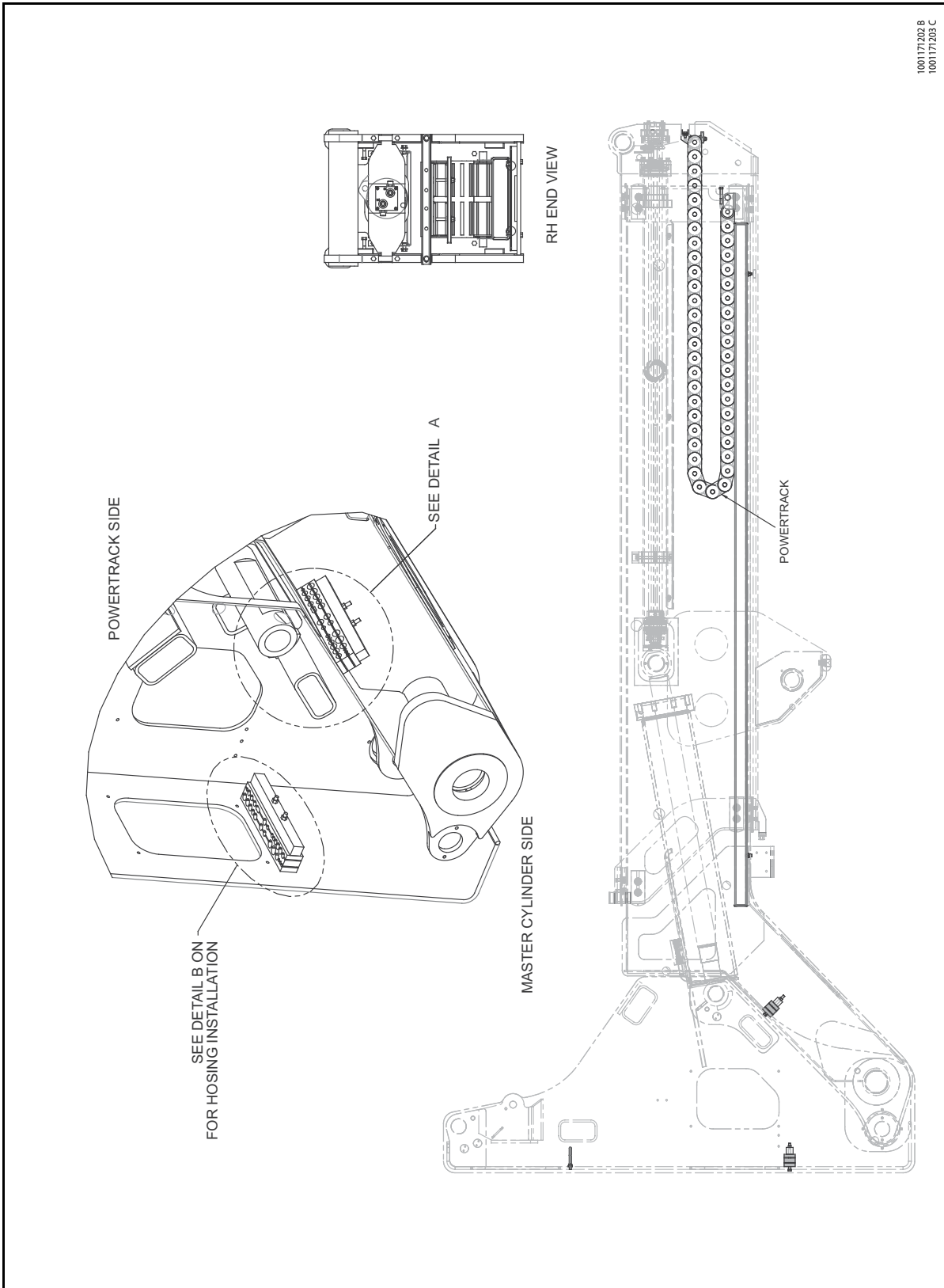


Figure 4-7. Powertrack Installation Main Boom (Sheet 2 of 2)

0258076 J  
0258077 I



100117202 B  
100117203 C

Figure 4-8. Powertrack Installation Tower Boom (Sheet 1 of 3)

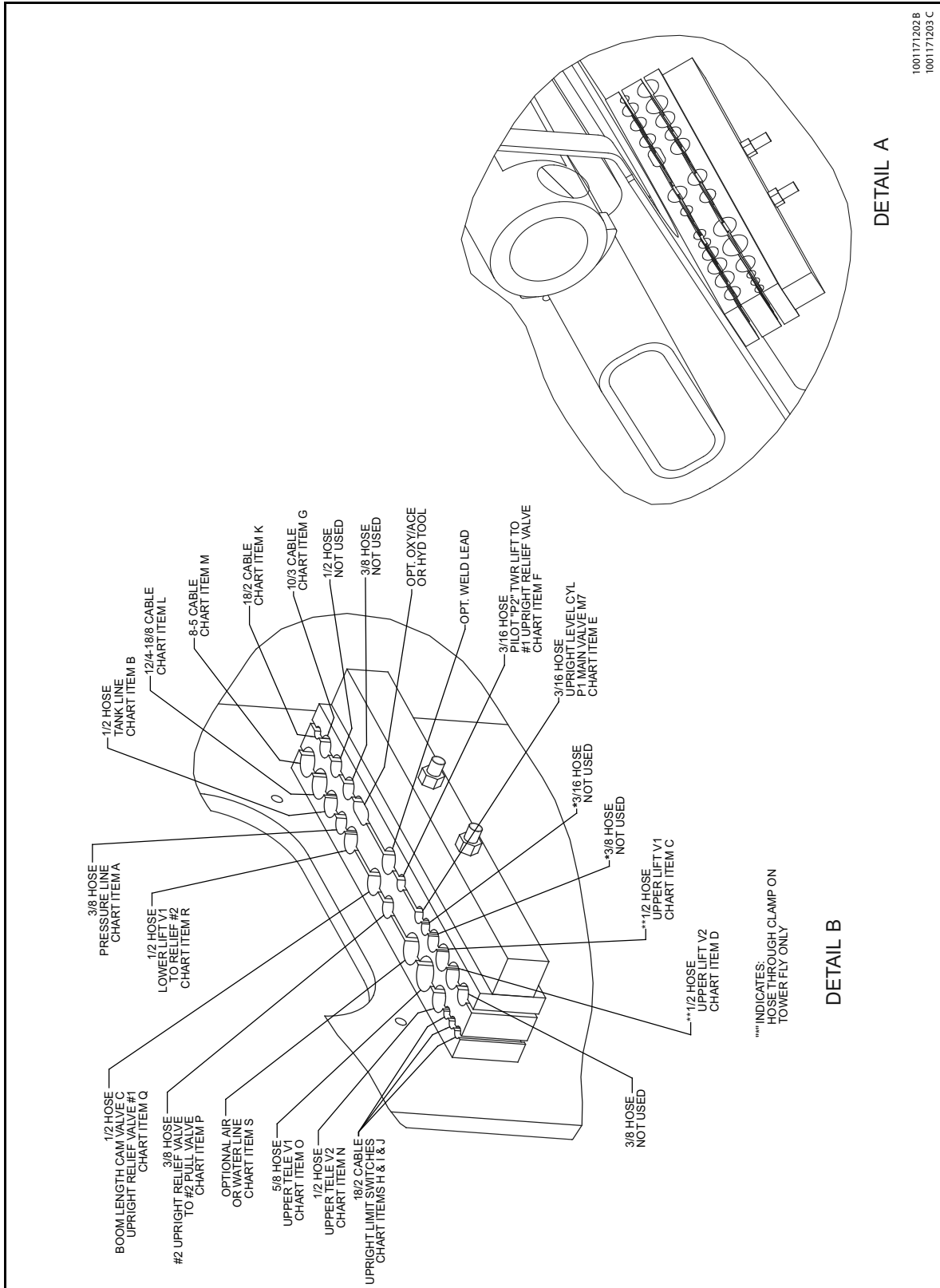
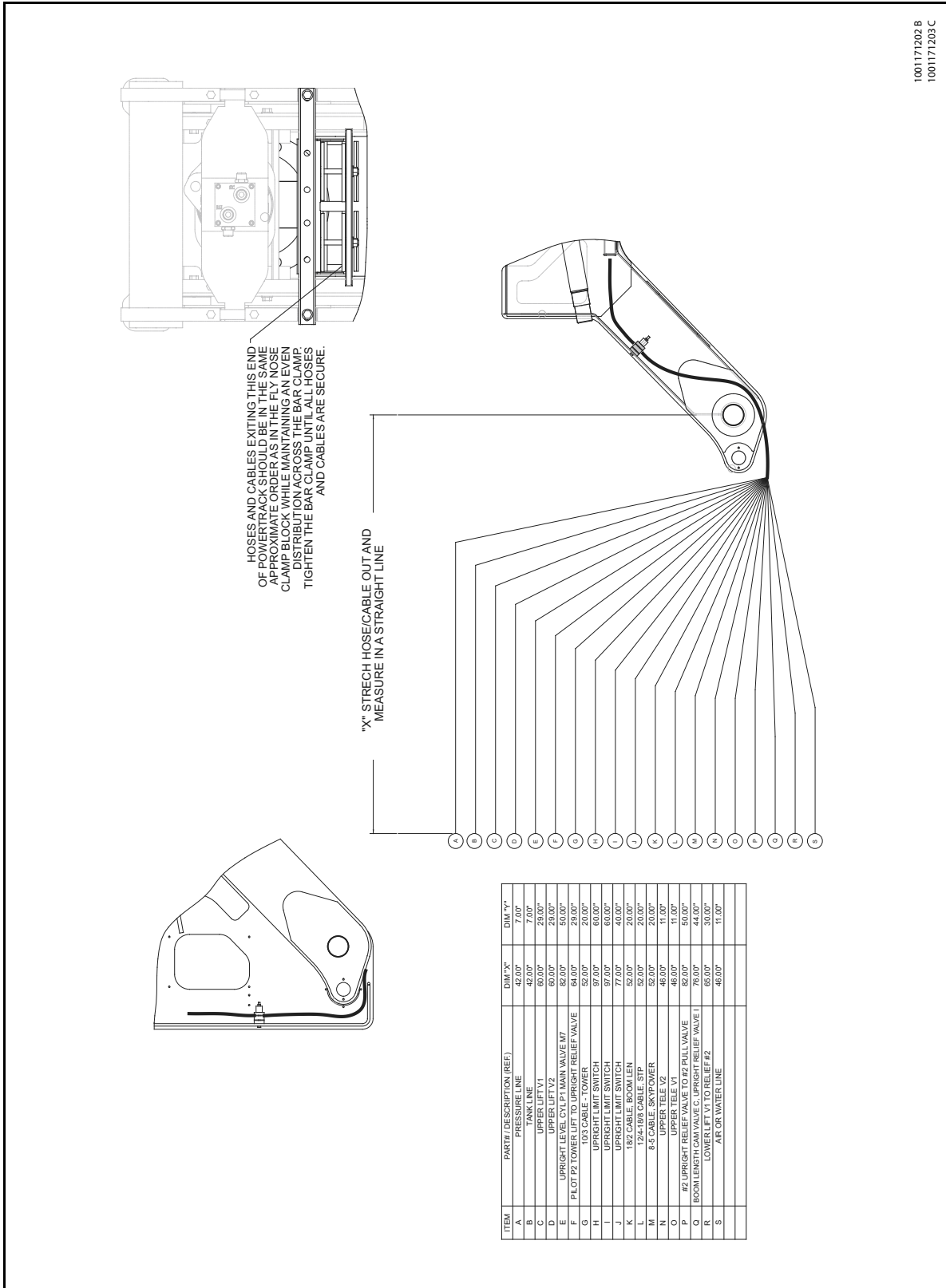


Figure 4-9. Powertrack Installation Tower Boom (Sheet 2 of 3)



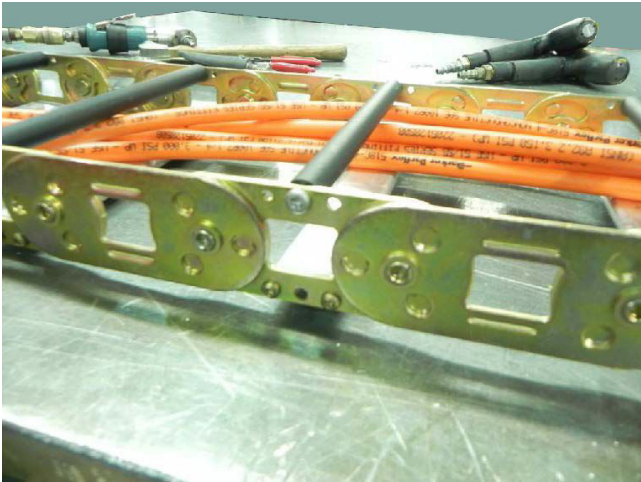
1001171202 B  
1001171203 C

Figure 4-10. Powertrack Installation Tower Boom (Sheet 3 of 3)

## 4.5 POWERTRACK MAINTENANCE

### Flat Bar Removal

**NOTE:** Hoses shown in the Powertrack are for example only. Actual hose and cable arrangements will be different.



1. Use a small ¼" ratchet and a T-20 Torx bit. Remove the 8-32 x 0.500 screws from both sides. (If the track also has a flat bar on the inside of the track instead of round bar/poly, perform the same step to remove it.)



### Round Bar/Poly Bar Removal

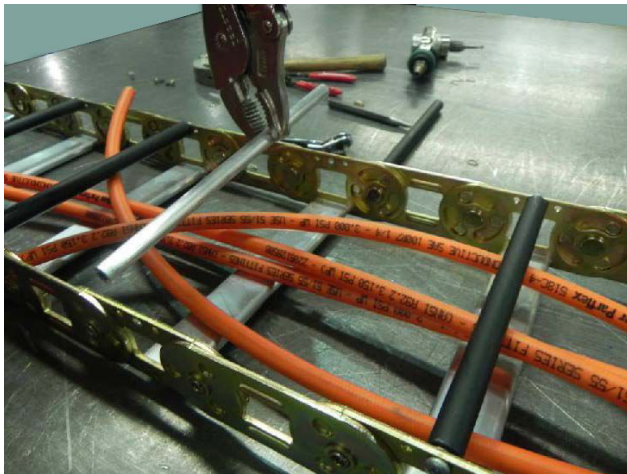
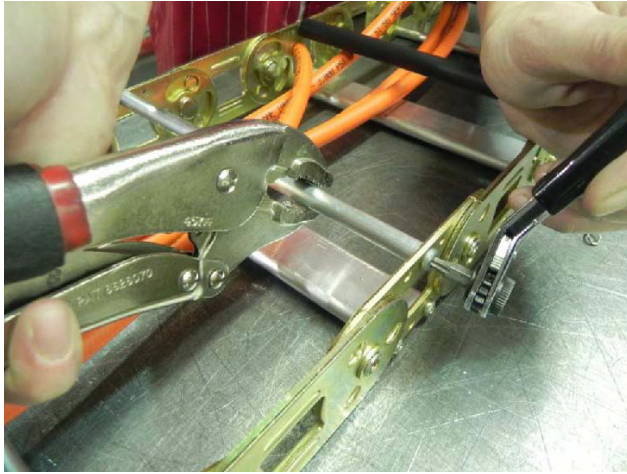
1. Use a small ¼" ratchet with a T-25 Torx bit. Remove the 10-24 x 0.812 screw. (If the bar spins then grip the bar and poly tightly with a vise-grip).



2. Lift up one end of the bar and slide the poly roller off.

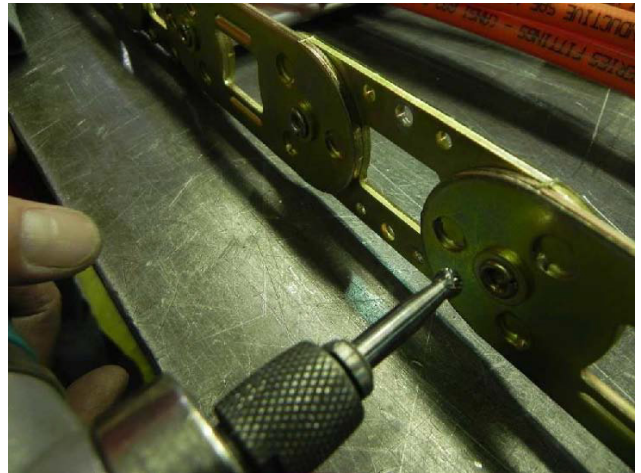


3. While gripping the bar tightly, remove the other 10-24 x 0.812 screw.

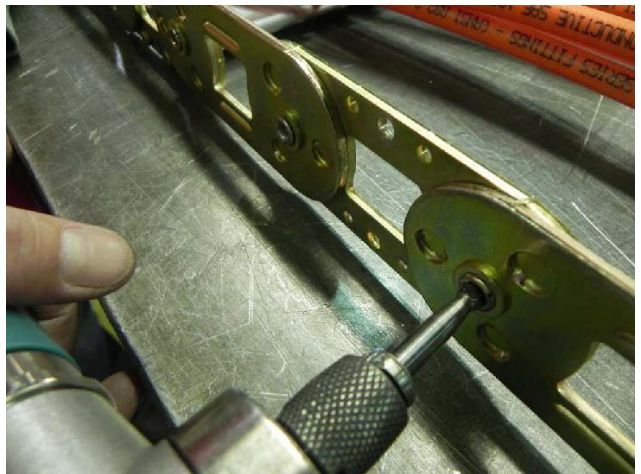


### **Removing and Installing Links**

1. To remove the links, the rivets holding the links together must be removed. The following will show one way this can be done. Use a right angle die grinder with a 1/4" ball double cut bur.



2. Insert the tool into the rolled over end of the rivet as shown. Grind out the middle of the rivet until the rolled over part of the rivet falls off. Repeat this step for all rivets that must be removed.

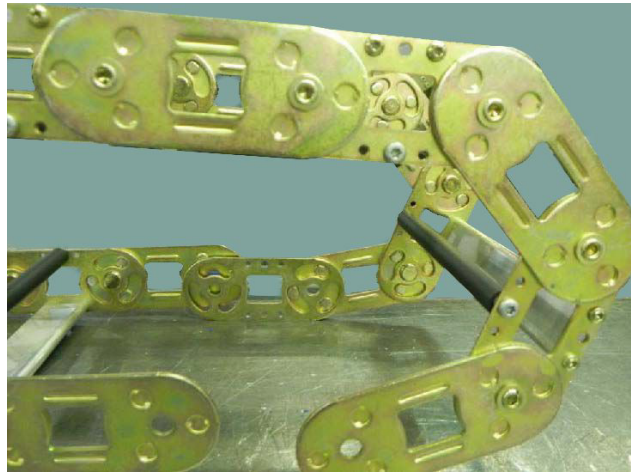
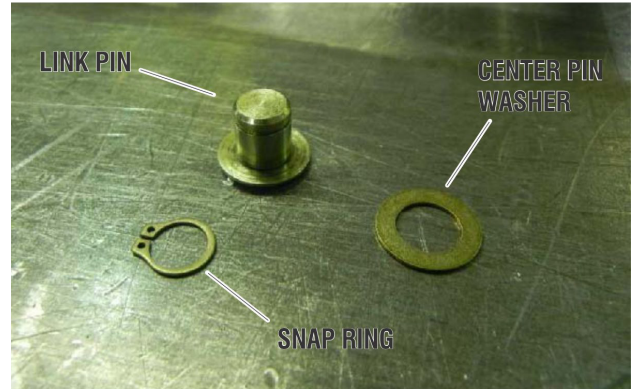


## SECTION 4 - BOOM & PLATFORM

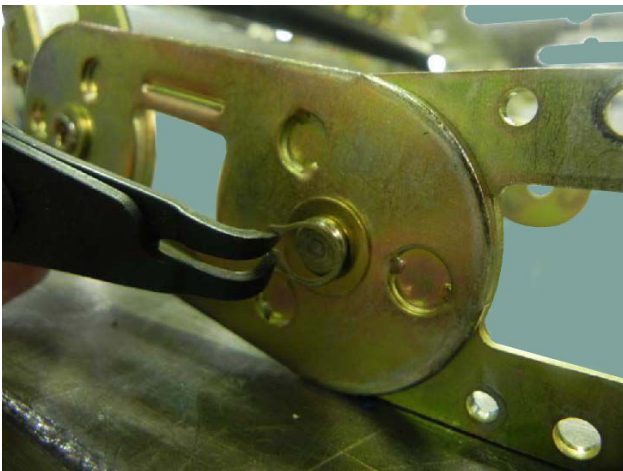
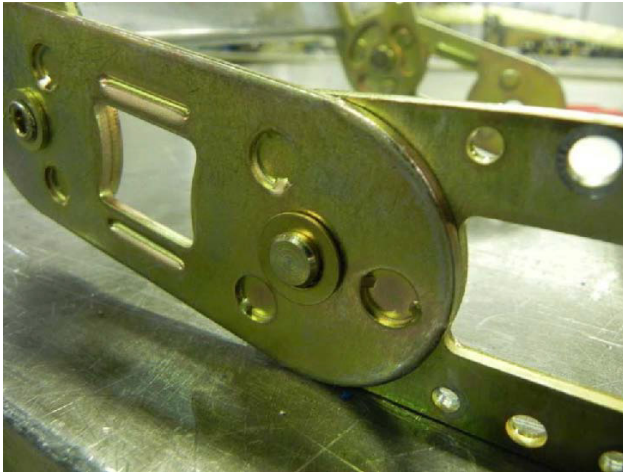
3. After grinding, it is sometimes necessary to use a center punch to punch out the rivet from the link.



4. To install new links, extend the main moving end over the lower part of the track so the new connection point is in the curved part of the track. This will allow the round half-shears to be rotated in a way they will fit into the peanut-shaped cut-outs.



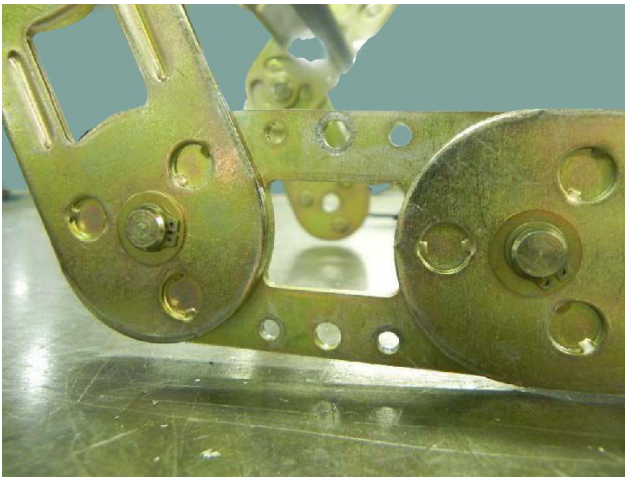
5. Install the pin into the center hole, then slide the washer over the pin. Install the snap ring into the groove in the pin.



**NOTE:** When installing snap rings make sure they are seated in the pin groove and closed properly.

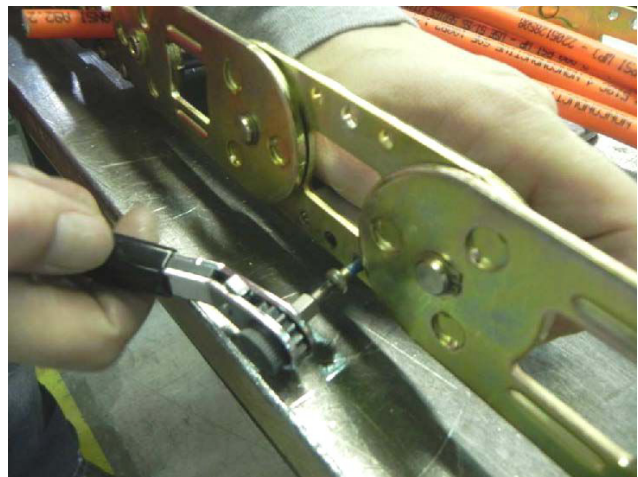


6. Install more pins, washers, and snap rings into all the links where a rivet was removed.



### **Installing a New Flat Bar**

1. While holding the flat bar, install new 8-32 x 0.500 self threading torx screws into both holes on each side of track.



**NOTE:** Maximum tightening torque for the 8-32 screw is 18-20 in-lbs (2-2.2 Nm).

### Installing a New Round Bar/Poly Roller

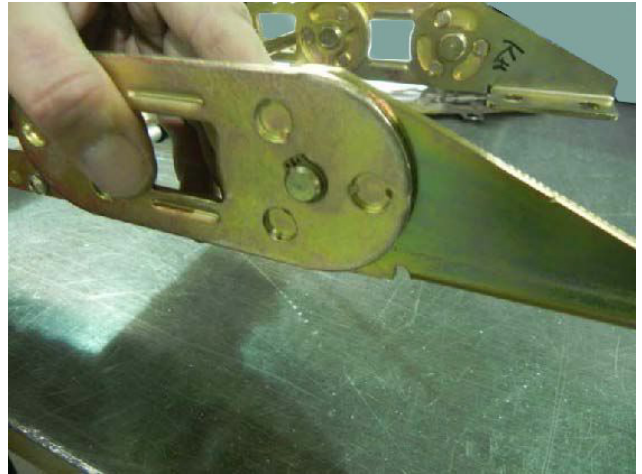
1. While tightly holding the round bar, install the new 10-24 x 0.812 self threading torx screw. Next lift up the other end and slide a new poly roller on. Install another 10-24 x 0.812 screw on the other side.



**NOTE:** Maximum tightening torque for the 10-24 screw is 45-50 in-lbs (5-5.6 Nm).

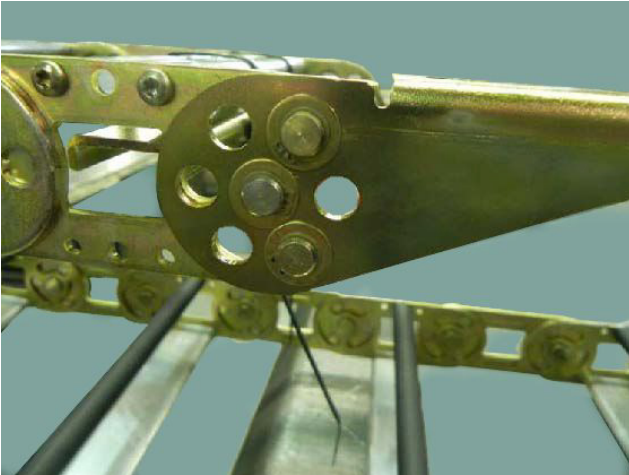
### Replacing a Fixed End Bracket

1. Remove the bracket by removing the center pin, washer, and snap ring. Install a new bracket then reinstall the pin, washer, and new snap ring. After installing the new bracket make sure that it rotates correctly.



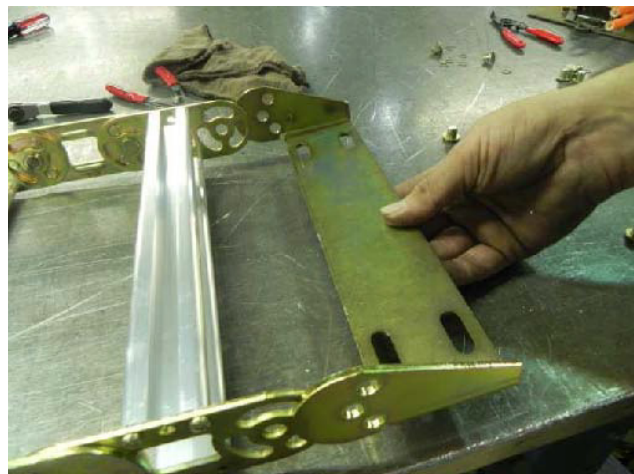
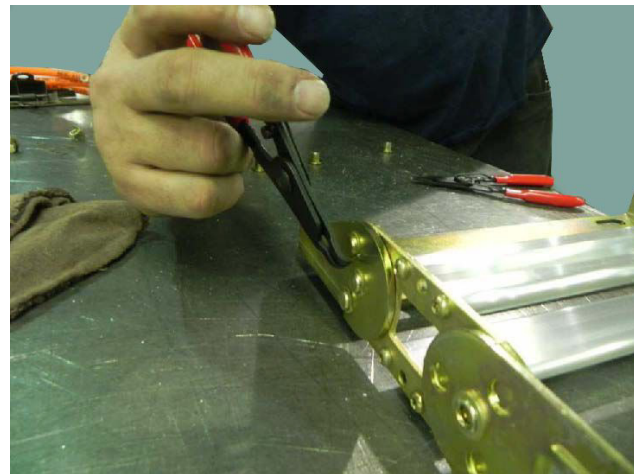
### Replacing a Moving End Bracket

1. Remove bracket by removing all pins, washers, and snap rings. Replace with a new bracket and reinstall the pins, washers, and new snap rings. After installing a new bracket make sure that it rotates correctly.

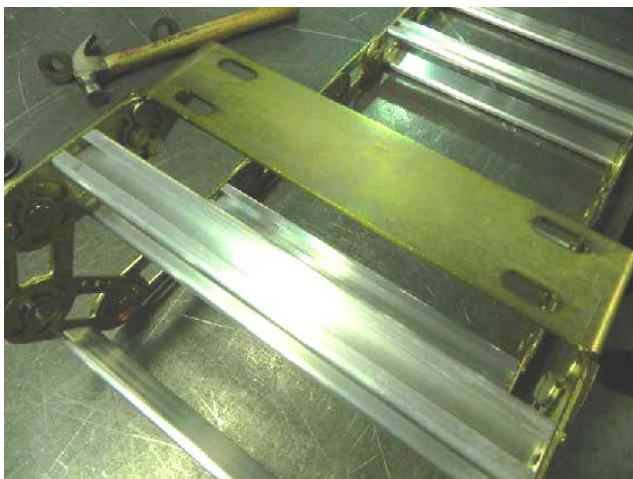


### Replacing a One Piece Bracket

1. Remove all pins, washers, and snap rings and slide the bracket off of the links.



2. To install a new bracket, slide the bracket over the links and reinstall the pins, washers, and new snap rings. After installing the new bracket make sure that it rotates correctly.



#### 4.6 BOOM CLEANLINESS GUIDELINES

The following are guidelines for internal boom cleanliness for machines that are used in excessively dirty environments.

1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.
3. Debris and foreign matter inside of the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Service & Maintenance Manuals.
4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.
5. If pressurized air cannot dislodge the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no "puddling" of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.
6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.

## 4.7 MAIN BOOM ASSEMBLY

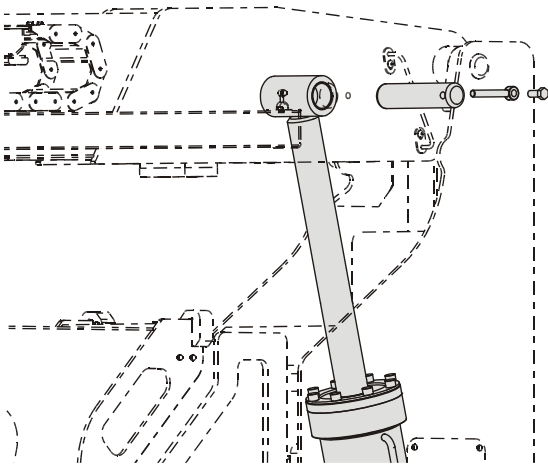
### Removal

1. Using a suitable lifting equipment, adequately support boom assembly weight along entire length.

**NOTICE**

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

2. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Using a suitable brass drift and hammer, remove hardware securing the main boom lift cylinder rod end pin to the base boom section. Remove the main boom lift cylinder pin from base boom. Retract the main boom lift cylinder by using the auxiliary power switch.

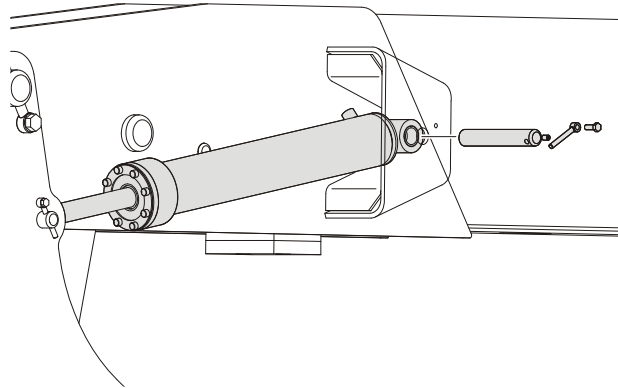


4. Remove the Master Cylinder as follows:
  - a. Using an adequate supporting device, support the master cylinder so it doesn't fall when the retaining pins are removed.

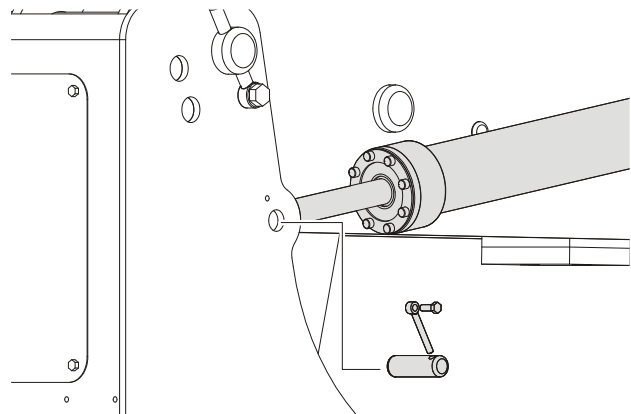
**NOTE:** The master cylinder weighs approximately 58.5 lbs. (26.5 kg).

- b. Tag and disconnect hydraulic lines from Master Cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
- c. Remove the bolt and keeper pin securing the master cylinder barrel end pin to the base boom sec-

tion. Next, install a 3/8-16 UNC threaded lifting eye into the threaded hole of the pin and pull pin out.

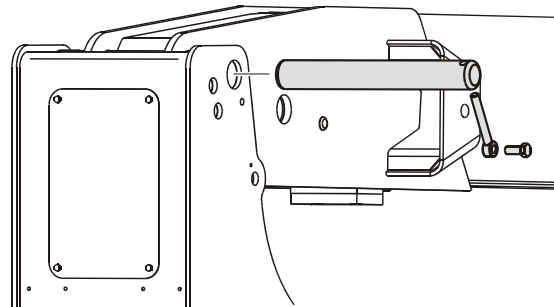


- d. Remove the bolt and keeper pin securing the master cylinder rod end pin to the upright. Remove the pin.



**NOTE:** When installing the master cylinder rod end pin, insert the keeper hardware pin to prevent the pin from inserting too far.

5. Remove the bolt and keeper pin securing the boom pivot pin to the upright. Using a suitable brass drift and hammer, remove the pivot pin from upright.



- Using all applicable safety precautions, carefully lift boom assembly clear of upright and lower to ground or suitably supported work surface.

**NOTE:** *The main boom alone weighs approximately 2226 lbs. (1010 kg). Including the platform (slave) cylinder, rotator, and platform support the assembly weighs approximately 3185 lbs. (1445 kg).*

## Disassembly

- Remove hardware securing telescope cylinder to back end of the base boom section.
- Remove hardware which secures the wear pads to the base boom section; remove the wear pads from the top, sides and bottom of the base boom section.
- Using overhead crane or suitable lifting device, remove fly boom assembly from base section.
- Remove hardware from the telescope cylinder pin. Using a suitable brass drift and hammer remove the cylinder pin from fly boom section.
- Pull the telescope cylinder partially from aft end of the fly boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
- Carefully remove the telescope cylinder and place telescope cylinder on a suitable trestle.

**NOTE:** *The Main Boom Telescope Cylinder can be removed without disassembling the main boom by disconnecting hydraulic lines, top attaching pin of main boom lift cylinder and telescope cylinders as directed above, and pulling out the telescope cylinder from the rear, thru the access plate opening of the upright.*

- Remove hardware which secures the wear pads to the aft end of fly boom section; remove the wear pads from the top, sides and bottom of the fly boom section.

## Inspection

**NOTE:** *When inspecting pins and bearings, refer to Section 2, Pins and Composite Bearing Repair Guidelines.*

- Inspect main boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
- Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins as necessary.
- Inspect main boom lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.

- Inspect inner diameter of boom pivot bearing for scoring, distortion, wear, or other damage. Replace bearing as necessary.
- Inspect all wear pads for excessive wear, or other damage.
- Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
- Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

## Assembly

**NOTE:** *When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.*

- Measure inside dimensions of the base section to determine the number of shims required for proper fit.
- Install side, top and bottom wear pads to the aft end of fly section; shim evenly to the measurements of the inside of base boom section.

### NOTICE

**WHEN ASSEMBLING BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.**

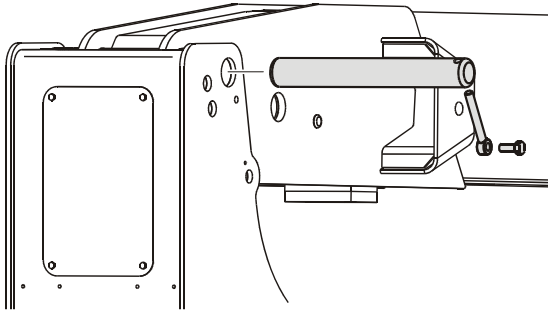
- Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the fly boom section.
- Slide telescope cylinder into the aft end of fly boom section. Align attachment holes in fly boom section with hole in rod end of telescope cylinder.
- Install telescope cylinder pin and secure with mounting hardware.
- Secure the sling and lifting device at the fly boom assembly approximate center of gravity.
- Slide fly boom assembly into the base boom section. Shim boom, if necessary, for a total of 1/32 inch (metric equivalent) clearance.
- Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 1/32 inch (metric equivalent) clearance.
- Align the cylinder with the slots at aft end of base boom section, then secure cylinder with mounting hardware.

### Installation

1. Using all applicable safety precautions, carefully lift boom assembly to align the pivot holes in the boom with those of the upright.

**NOTE:** The main boom alone weighs approximately 2226 lbs. (1010 kg). Including the platform (slave) cylinder, rotator, and platform support the assembly weighs approximately 3185 lbs. (1445 kg).

2. Using a suitable brass drift and hammer, install the pivot pin into the upright. Install the bolt and keeper pin securing the boom pivot pin to the upright.

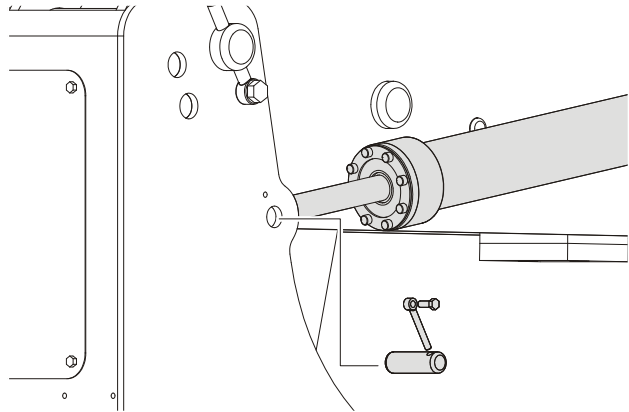


3. Install the Master Cylinder as follows:

- a. Using an adequate supporting device, align the master cylinder with the mounting holes on the boom and upright.

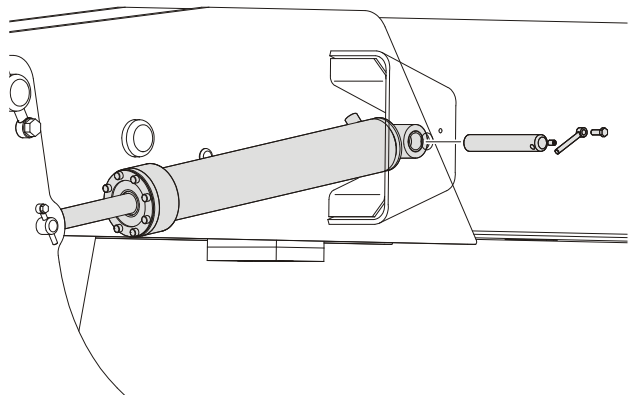
**NOTE:** The master cylinder weighs approximately 58.5 lbs. (26.5 kg).

- b. Install the master cylinder rod end pin. Install the bolt and keeper pin securing the master cylinder rod end pin to the upright.



**NOTE:** When installing the master cylinder rod end pin, insert the keeper hardware pin to prevent the pin from inserting too far.

- c. Install the barrel end retaining pin. Install the bolt and keeper pin securing the master cylinder barrel end pin to the base boom section.



- d. Connect hydraulic lines to the master cylinder as tagged during removal.

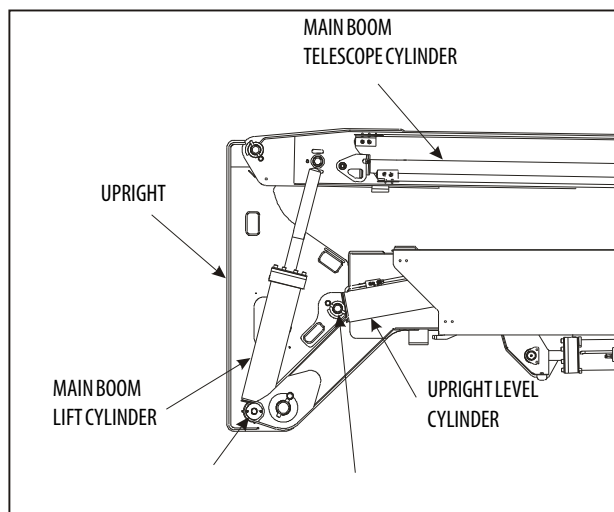
## 4.8 UPRIGHT

### Removal

#### NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

1. Remove the main boom assembly. Refer to Section 4.7, Main Boom Assembly.
2. Tag and disconnect hydraulic lines to the main boom lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove mounting hardware from main boom lift Cylinder barrel end. Using a suitable brass drift and hammer, remove pin #1 from Upright and remove Main Boom Lift Cylinder.



**Figure 4-11. Location of Components - Upright**

4. Disconnect wiring harness to horizontal limit switch.
5. Disconnect the Upright Level Cylinder as follows:
  - a. Using a suitable lifting device, support the Upright.
  - b. Remove mounting hardware securing hose bracket in upright, and remove the hose bracket.
  - c. Remove mounting hardware securing the upright level cylinder to the upright. Using a suitable brass drift and hammer, remove pin #3 from upright and disconnect the upright level cylinder from the upright.
6. Remove mounting hardware from the Upright Pivot Pin using a suitable brass drift and hammer. Remove pin # 4 from tower boom assembly and remove the upright from the machine.

**NOTE:** Steps 7 thru 10 are only necessary if the upright level cylinder is to be removed.

7. With upright removed, override tower telescope limit switch and extend the tower boom to gain access to the upright level cylinder rod end attach pin.
8. Tag and disconnect hydraulic lines to the upright lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
9. Using an overhead crane or suitable lifting device, support the upright lift cylinder, remove mounting hardware from the barrel end of the upright lift cylinder and remove the pin.
10. Carefully remove the upright lift cylinder and place on a suitable work surface.

### Installation

**NOTE:** Steps 1 thru 4 are only necessary if the upright level cylinder is to be removed.

1. Using a suitable lifting device, carefully install the upright lift cylinder into place in the tower boom.
2. Install the pin and mounting hardware at the barrel end of the upright lift cylinder.
3. Connect the hydraulic lines to the upright lift cylinder as tagged during removal.
4. Override the tower telescope limit switch and retract the tower boom.
5. Using an adequate lifting device, install the upright into position. Install pin # 4 into the tower boom assembly and secure it in place with the mounting hardware.
6. Connect the Upright Level Cylinder as follows:
  - a. Align the holes in the cylinder and upright for pin #3, and install the pin into the upright and connect the upright level cylinder to the upright. Install the mounting hardware securing the pin.
  - b. Install the hose bracket and secure in place with the mounting hardware.
7. Connect the wiring harness to horizontal limit switch.
8. Align the holes in the main boom lift cylinder and upright for pin #1 and install the pin. Secure the pin in place with the mounting hardware.
9. Connect the hydraulic lines to the main boom lift cylinder as tagged during removal.
10. Install the main boom. Refer to Section 4.7, Main Boom Assembly.

## 4.9 TOWER BOOM ASSEMBLY

### Removal

**NOTICE**

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

1. Remove the main boom assembly. Refer to Section 4.7, Main Boom Assembly.
2. Using an overhead crane or suitable lifting device, support the entire Tower Boom Assembly and separately support the tower lift cylinder.
3. Remove mounting hardware from tower lift cylinder rod end. with a brass drift and hammer, remove the tower lift cylinder Pin disconnecting the tower lift cylinder.
4. Remove mounting hardware from the tower boom pivot pin. Using a suitable brass drift and hammer, remove pin #2 from turntable assembly.
5. Using all applicable safety precautions, carefully lift the Tower Boom Assembly clear of turntable and lower to ground or a suitable supported work surface.
6. Remove mounting hardware from the upright leveling cylinder rod end. with a brass drift and hammer, remove the pin, disconnecting the upright cylinder. Remove with suitable lifting device.

**NOTE:** Using a suitable lifting device, support the upright.

7. Remove the Tower Fly as follows:
  - a. Mark all hoses and wiring harnesses at bracket on rear end of tower base boom for future assembly. Remove hoses and wiring from tower boom Powertrack.
  - b. Remove mounting hardware that secures the Powertrack to tower base boom and remove the Powertrack.
  - c. Remove mounting hardware from tower boom telescope cylinder barrel and rod end.
  - d. Slide the telescope cylinder out of the base boom, support with an overhead crane or suitable lifting device.
  - e. Remove mounting hardware that secures the wear pads to the front of tower base boom section; Remove the wear pads from the top sides and bottom of the tower base boom.
  - f. Using an overhead crane or suitable lifting device, remove the fly section.

### Inspection

**NOTE:** Refer to Section 2, Pins and Composite Bearing Repair Guidelines.

1. Inspect tower boom pivot pin for wear scoring, tapering, and ovality, or other damage. Replace pins as necessary.
2. Inspect tower boom pivot attach points for scoring, tapering, and ovality, or other damage. Replace pins as necessary.

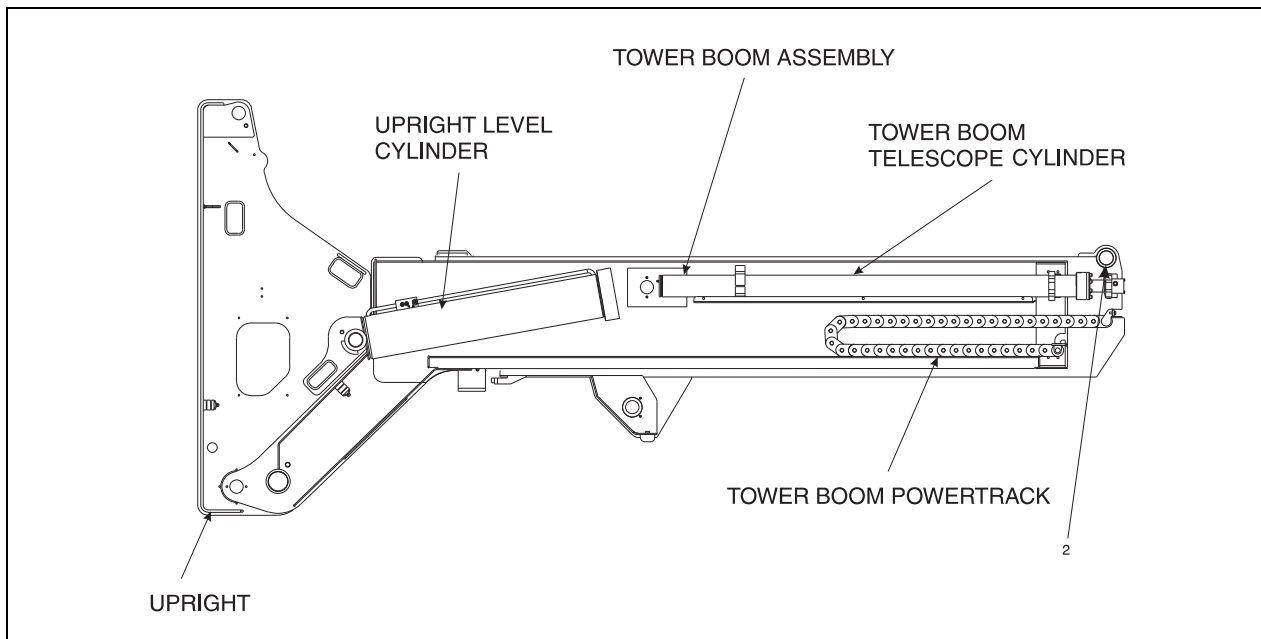


Figure 4-12. Location of Components - Tower Boom Powertrack

3. Inspect inner diameter of tower boom pivot bearings for scoring, distortion, wear, or other damage.
4. Inspect lift cylinder attach pin for wear, scoring, tapering, and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
5. Inspect inner diameter of upright attach point bearings for scoring, distortion, wear, or other damage. Replace bearing as necessary.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of tower boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.
8. Inspect Powertrack for damage such as cracking, wear, or other damage. Replace links or assembly, as necessary.
8. Attach internal Powertrack to tower base boom at bottom only and extended out of boom that the Powertrack links are opened at top.
9. Attach hoses and wiring harnesses at front end of base boom and route thru the Powertrack. Secure hoses and wiring harnesses with hose brackets.
10. Roll the Powertrack back into the base boom section and attach loose end of the Powertrack to the inside top of the fly boom section.

## Installation

1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
4. Connect all wiring connectors to the correct connectors.
5. Connect all hydraulic lines of boom assembly.
6. Using all applicable safety precautions, operate lifting device in order to position boom lift cylinder so that holes in the cylinder rod end and boom structure are aligned. Insert the lift cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
7. Using all applicable safety precautions, operate from the lower controls and raise and extend boom fully, noting the performance of the extension cycle.
8. Retract and lower boom, noting the performance of the retraction cycle.

## Assembly

**NOTE:** *When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.*

1. Measure inside dimensions of the tower base section to determine the number of shims required for proper fit.
2. Install side, top, bottom wear pads to the aft end of tower fly section; shim evenly to the measurements of the inside of the base boom section.

### NOTICE

**WHEN ASSEMBLING TOWER BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.**

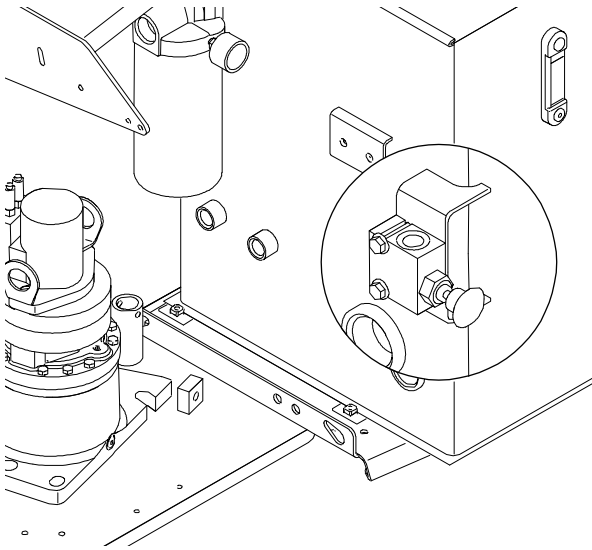
3. Align upright leveling cylinder with attach holes in tower fly boom. Using a soft head mallet, install the cylinder pin into tower fly boom and secure with mounting hardware.
4. Secure the sling and lifting device at the tower fly boom assembly's approximate center of gravity.
5. Slide tower fly boom assembly into the tower base boom section, for a total of 1/32 inch (metric equivalent) clearance.
6. Install wear pads into the forward position of the tower base boom section. Shim boom, if necessary, for a total of 1/32 inch (metric equivalent) clearance.
7. Align the telescope cylinder with the slots at the aft end of tower base boom section, then secure cylinder with mounting hardware.

## **Tower Out of Sync**

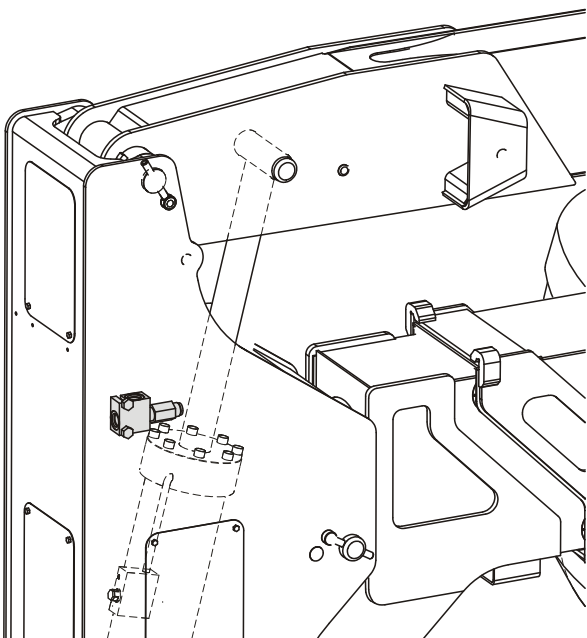
***Tower is out of sync backwards, upright leaning toward the platform.***

When towering down the upright cylinder bottoms out before the lower lift. Problems that could cause this are:

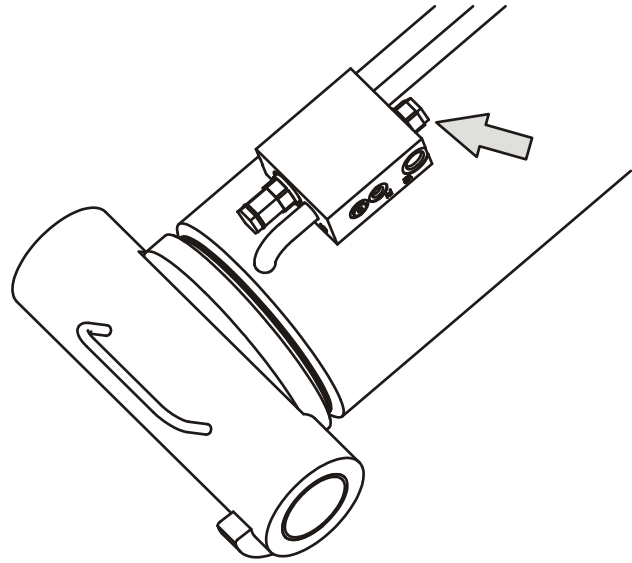
1. The releveling valve (red knob on the oil tank P/N: 4640866), this is a poppet valve that could be leaking fluid out of the closed loop. Manually opening the valve and flushing it can eliminate any contaminate on the seat. The seat could also be damaged, so replacing the cartridge might be necessary.



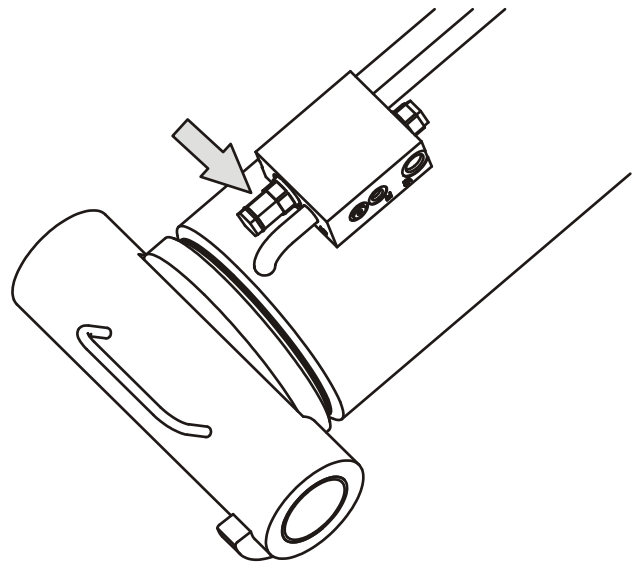
2. A relief valve is located in the upright. This relief valve could be leaking backwards out of the loop. Replace the cartridge. They are pre-set.



3. The counter/balance valve in the piston end of the upright level cylinder. There could be a leak path from the valve port to the pilot port. Replace the counter/balance valve.



4. The counter/balance valve in the rod end of the lower lift cylinder. There could be a leak path from the valve port to the pilot port. Replace the counter/balance valve.

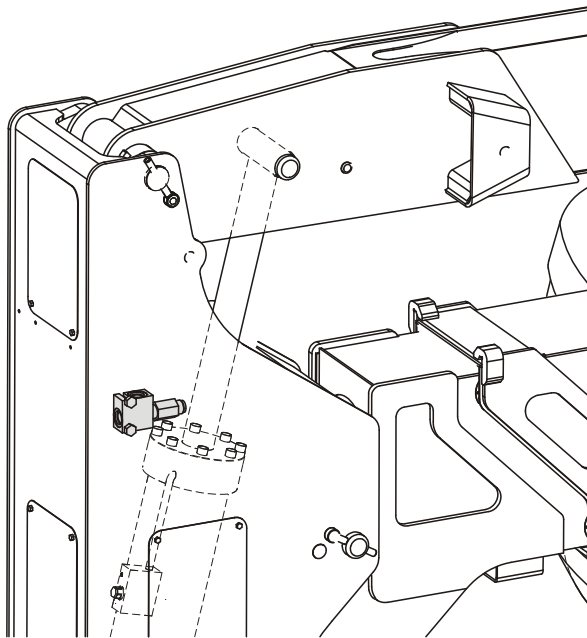


5. The packing on either the upright or lower cylinder can cause this. Do cylinder tests to determine if either cylinder needs new packing.

***Tower is out of sync forwards, upright leaning toward the steer axle.***

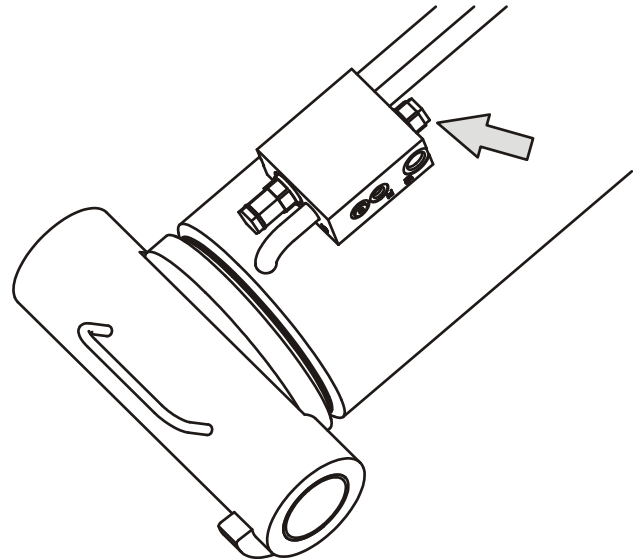
When towering down, the lower lift cylinder bottoms out before the upright level cylinder. This is caused by too much oil between the two cylinders. Problems that could cause this are:

1. The relief valve located in the upright (P/N: 4640929). If this valve is set too low or has contaminate in it causing it to leak prematurely, when lifting down oil can pass through it causing the volume to grow between the cylinders. Flush the valve out and reinstall it, or replace the cartridge. The cartridge pressure is pre-set so no adjustment can be made.

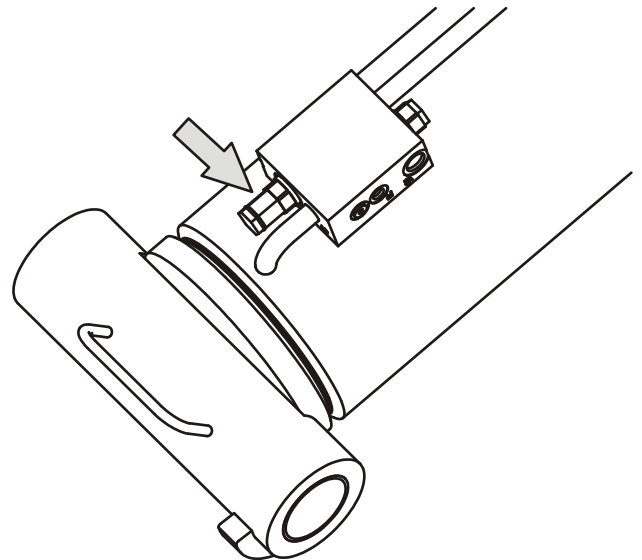


2. The counterbalance valve in the piston end of the upright level cylinder. There could be a leak path from

the pilot port to the valve port. Replace the counterbalance valve.



3. The counterbalance valve in the rod end of the lower lift cylinder. There could be a leak path from the pilot port to the valve port. Replace the counterbalance valve.



4. The packing on the lower lift cylinder can cause this. Do a cylinder test to check this out. Refer to Section 2.4, Cylinder Drift Test.

## **4.10 UPRIGHT MONITORING SYSTEM**

The UMS provides a visual and audible warning to the operator when the limits of the upright assembly alignment have been reached. In addition, the UMS will not allow the tower boom to be lowered when the upright assembly is misaligned in a direction oriented away from the work platform.

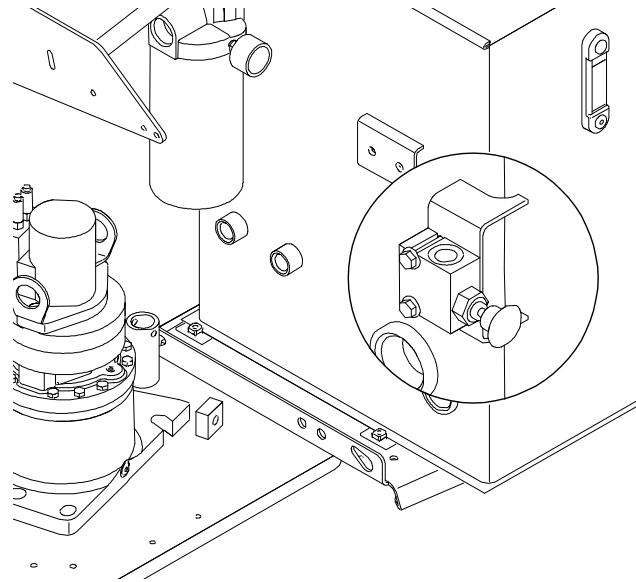
### **Re-Synchronizing Upright**

A pull type control valve allows the operator to adjust the upright level cylinder if the upright is not 90° (vertical) relative to the chassis (Refer to Figure 4-13.). This valve is located in the tank compartment area.

Perform the following steps with the aid of an assistant:

1. Turn the key switch to the ground control position.
2. Start the engine.
3. Pull and hold the red releval knob located next to the main control valve. Refer to Figure 4-13.
4. Raise the tower boom 6 feet (1.8 m).
5. Release the red releval knob.
6. Lower the tower boom fully and continue to hold down the switch to Tower Down for an additional 20 seconds.

7. Repeat steps 3 thru 6 as necessary until the upright is 90° (vertical) relative to the chassis.



**Figure 4-13. Releveling Valve**

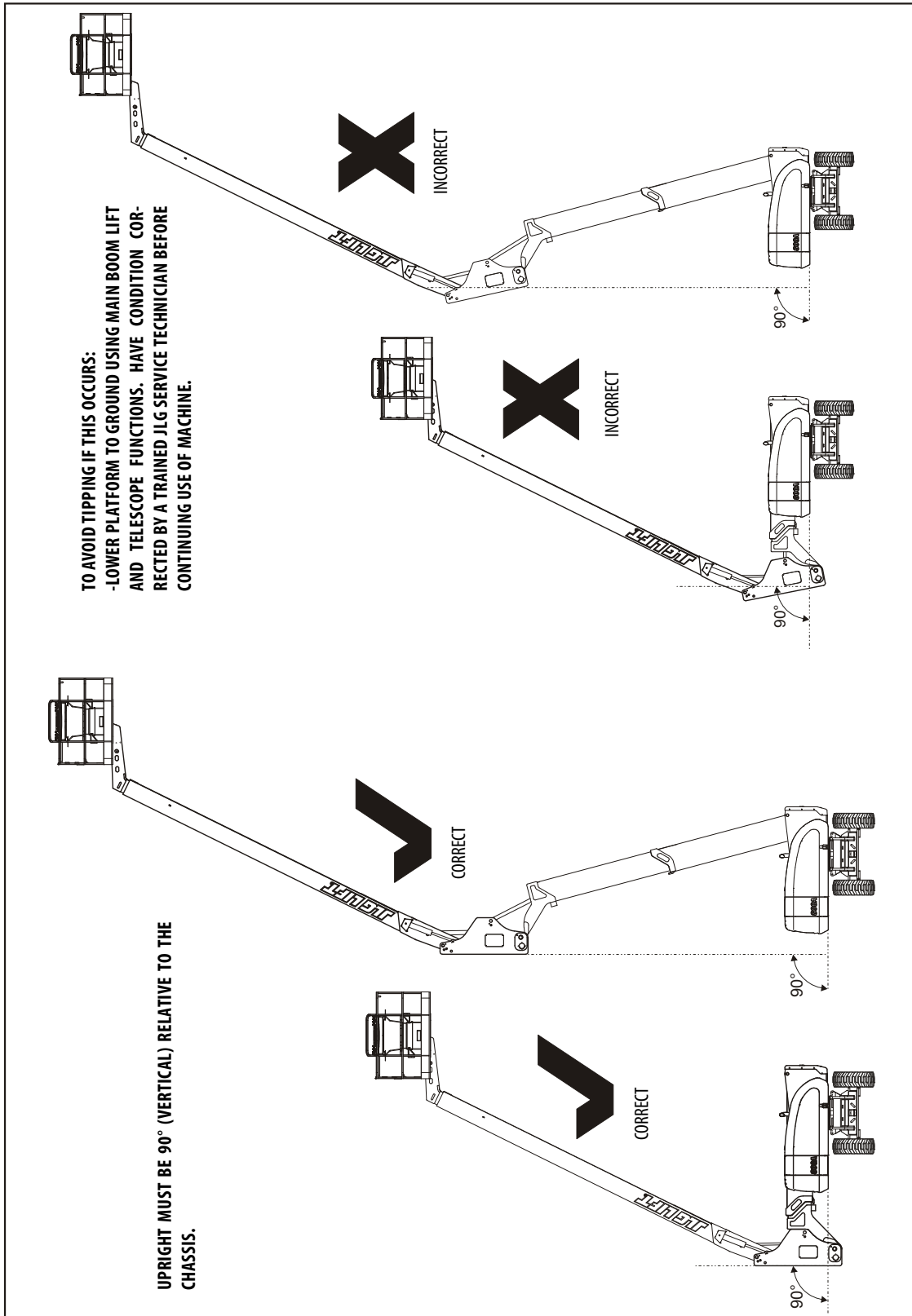


Figure 4-14. Boom Upright Positioning

**Calibration**

1. Connect the JLG Hand-held analyzer to the original analyzer connection in the ground box.

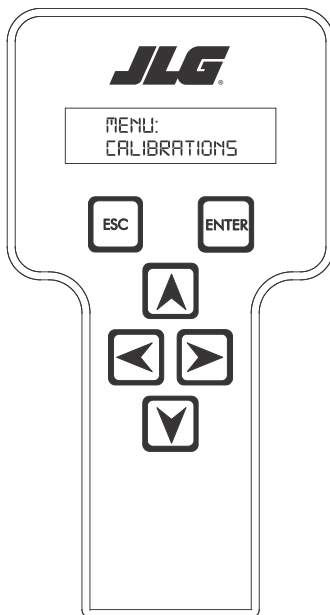
**NOTICE**

**DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.**

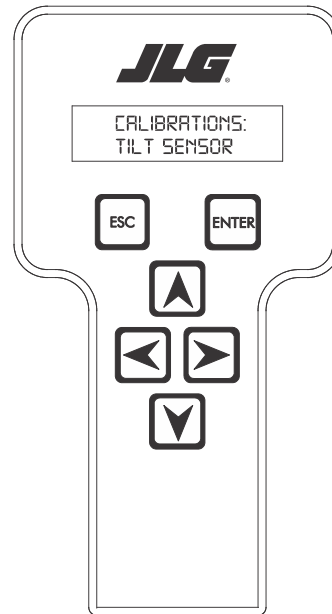
2. Pull out the emergency stop button at the ground control station and start the engine from the ground controls.
3. To calibrate the Upright Monitoring System through the hand-held analyzer, you must be in access level 1. To advance to access level 1, scroll to the ACCESS LEVEL

menu and press "ENTER" . Using the arrows on the keypad, enter the password "33271" and press "ENTER" .

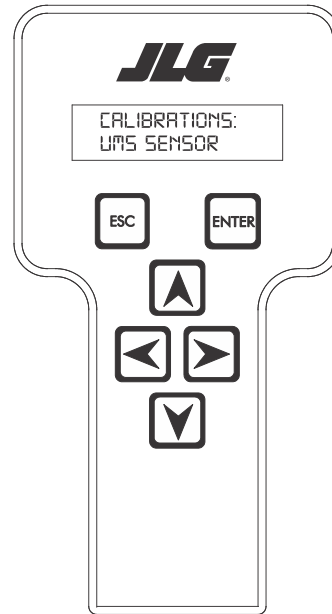
4. Calibrate the upright monitoring system sensor by the following procedure:
  - a. In access level 1, scroll through the menu items until "CALIBRATIONS" is displayed on the second line of the analyzer screen. The screen will display the following:




- b. After pressing 'ENTER' one of the following screens will be displayed:



Or

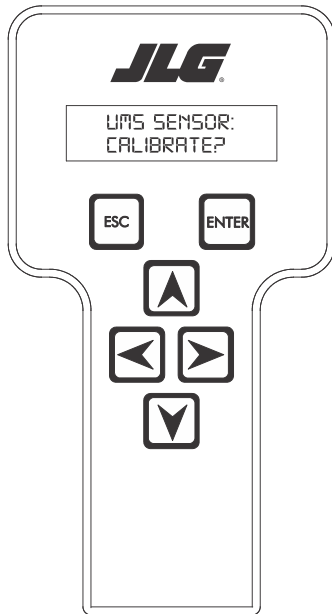


- c. Scroll left to right through the above menu items until "UMS SENSOR" sub menu appears on the bottom line of the analyzer display. Press the "ENTER"  key.


**NOTICE**

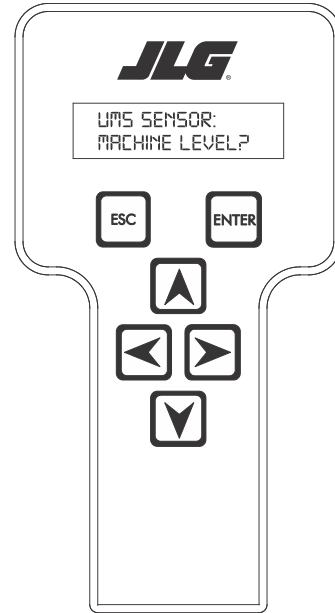
IT IS NOT NECESSARY TO CALIBRATE THE TILT SENSOR IN THE GROUND CONTROL MODULE AT THIS TIME. HOWEVER, WHEN THE TILT SENSOR IN THE GROUND CONTROL MODULE IS RECALIBRATED, THE UPRIGHT MONITORING SYSTEM TILT SENSOR MUST BE RECALIBRATED AS WELL.

- d. After selecting "UMS SENSOR", the following screen will appear:




**NOTE:** By pressing the left or right arrow keys in this screen, you may view the output of the sensor.

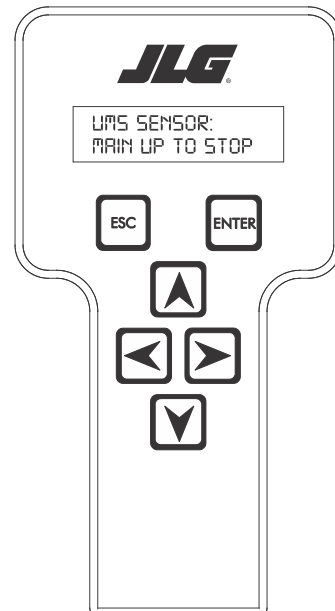
- e. Press "ENTER"  and the next screen will display the following, asking if the machine is on a level surface:




**NOTICE**

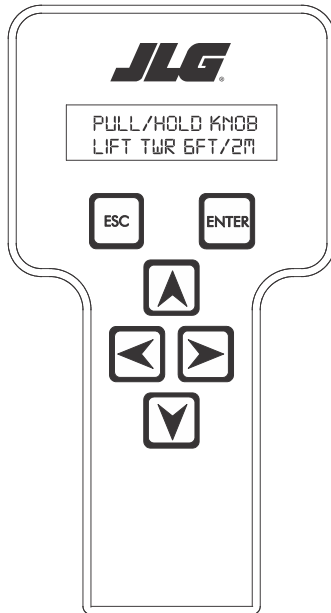
THE MACHINE MUST BE LEVEL FOR PROPER CALIBRATION.

- f. Verify the machine is level and press "ENTER" . The screen will display the following, asking you to fully elevate the main boom:




**g.** After the main boom has been fully elevated, press

"ENTER" . The analyzer will display the following:

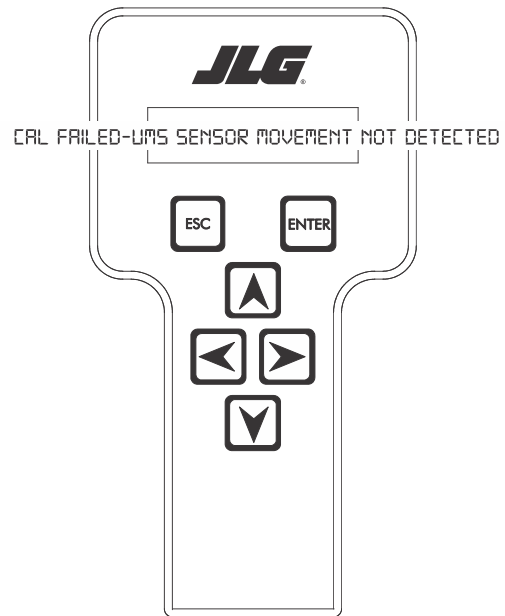


**NOTE:** By pressing the left or right arrows in this screen, you may view the output of each sensor.

**h.** With the aid of an assistant, pull and hold the red re-leveling knob on the hydraulic tank while lifting the tower boom. Raise the tower boom six (6) feet or two (2) meters. After elevating the tower the

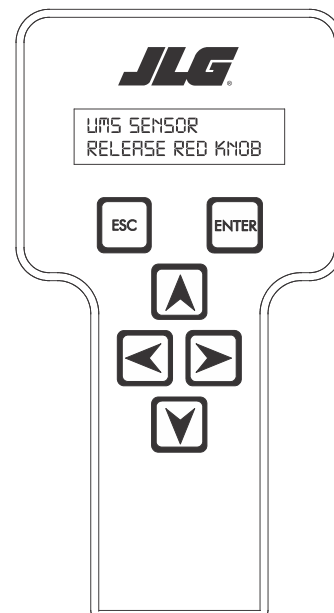
required distance, press "ENTER" .

If the upright monitoring system did not detect adequate sensor activity, the screen will display:




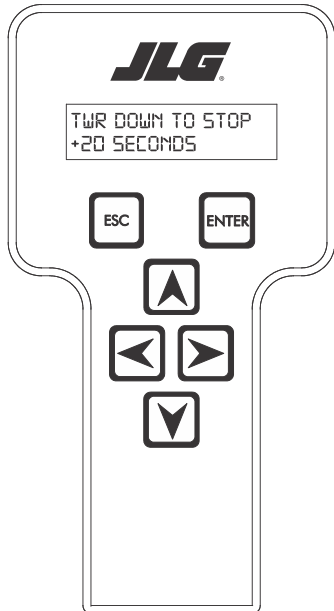
Should you get the above message, verify that the sensor is installed correctly and verify the sensor connection to the sensor harness is secure. Also, ensure the red knob is held fully open for the required time.

If the calibration is executing properly, you shall see the following display:




- i. When viewing the above display, press

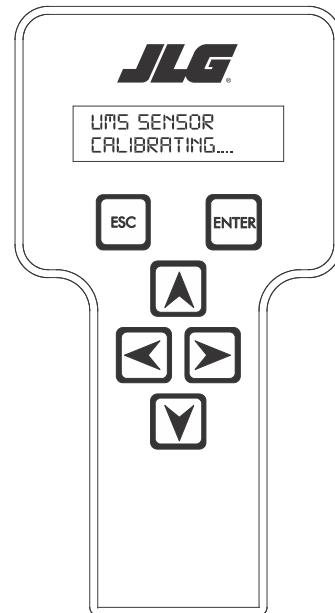
"ENTER" . The screen will display the following:



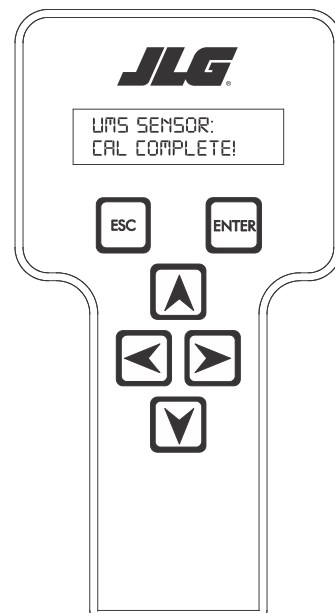
- j. Lower the tower boom onto the boom stop. Continue to hold the tower boom down function for at least twenty (20) seconds **WITHOUT RELEASING THE FUNCTION SWITCH**. The calibration must recognize continuous activation of the tower down function switch for the required time.

After the required activation time has passed, release the function switch and press

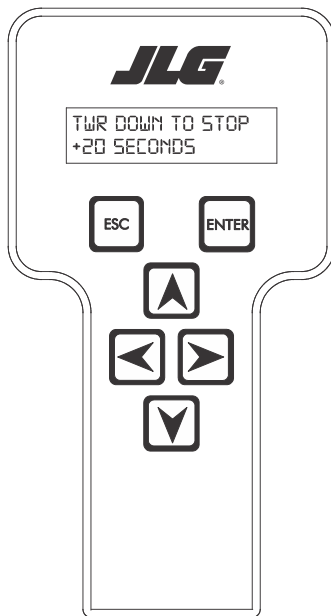
"ENTER" . The analyzer will display the following message:



If the calibration has been completed successfully, the screen will automatically change to:



If the calibration has not been completed successfully, the display will automatically change to:



Repeat step j until the calibration time requirement has been satisfied.

**⚠ WARNING**

**DO NOT RAISE THE TOWER BOOM AGAIN DURING CALIBRATION.**

- k. To correctly complete the calibration process, fully retract and fully lower the main boom. Once the machine is in the stowed position, turn off the machine and disconnect the analyzer.

## Calibration Faults

### CAL Failed-Chassis Not Level

In the event the turntable tilt switch input is logic low indicating that the machine is not level the UMS calibration screens shall display this fault.

### CAL Failed-UMS Sensor Raw Output Out Of Range

The control system shall display a fault in the event the raw sensor output is greater than  $\pm 5^\circ$  for the UMS sensor.

### CAL Failed-Turntable Sensor Raw Output Out Of Range

The control system shall display a fault in the event the raw sensor output is greater than  $\pm 5^\circ$  for the turntable sensor.

### CAL Failed-Calibration Disrupted

If calibration is disrupted, the control system shall display this fault.

### CAL Failed- UMS Sensor Movement Not Detected

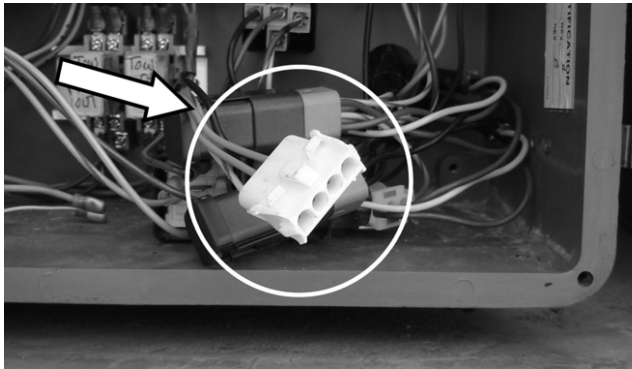
The UMS angle has not detected the required amount of movement during calibration.

## Function Check



### NOTICE

ON ADE EQUIPPED MACHINES, DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.


1. Connect the hand-held analyzer at the ground control station using the four-pin connector.

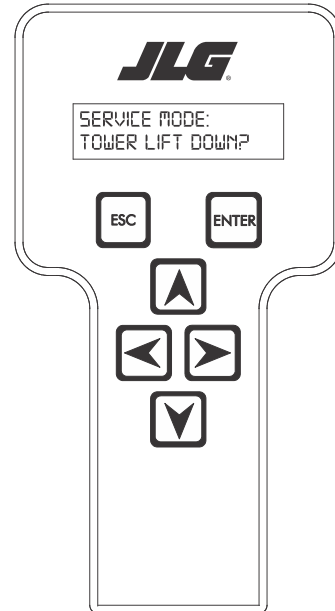


2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.
3. Advance to access level 1 by scrolling to the ACCESS

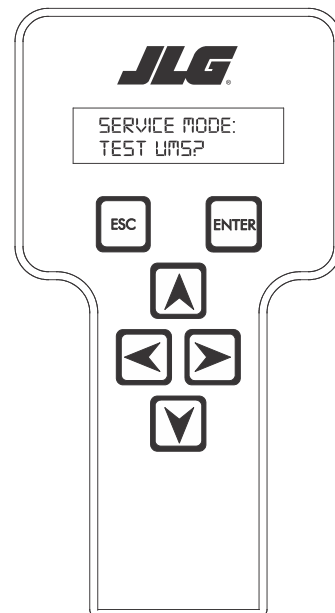
LEVEL menu and press "ENTER" . Using the arrows on the keypad, enter the password "33271" and press "ENTER" .

4. Scroll through the top level menu until SERVICE MODE


appears. Press "ENTER"  to select this menu item. After pressing "ENTER" one of the following screens will be displayed:



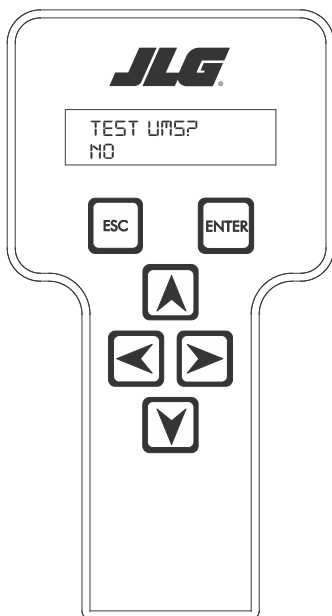
Or



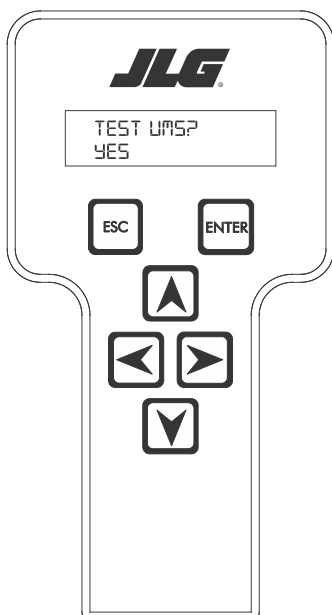
5. Scroll left to right through the above menu items until "TEST UMS?" sub menu appears on the bottom line of

the analyzer display. Press the "ENTER"  key.

6. The controller will now display the following:



or, by pressing the up and down arrow keys:



7. When the "YES" message is displayed, press the "ENTER"



key to automatically perform a function test. Upon the function test, the system will activate the Upright Monitoring System, warning lights, and alarm. Verify that the alarm sounds, the boom malfunction indicator lights (platform and ground) are illuminated.

8. From the ground controls, raise the tower boom several feet. Verify that the tower boom will not lower.
9. To end the system test, press the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

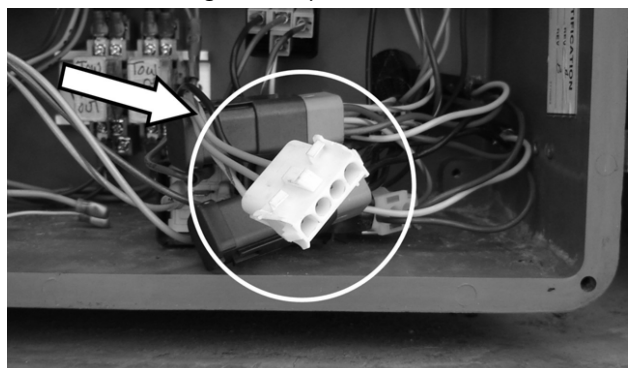
### Service Mode/Tower Boom Retrieval

The UMS software incorporates a service mode to temporarily disengage the UMS and allow a tower lift down operation when the UMS has detected a backward stability concern.



#### NOTICE


**ON ADE EQUIPPED MACHINES, DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.**

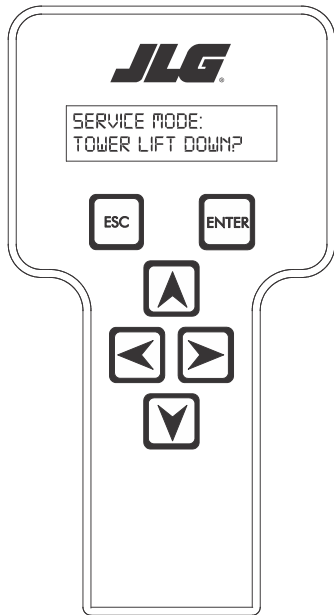
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



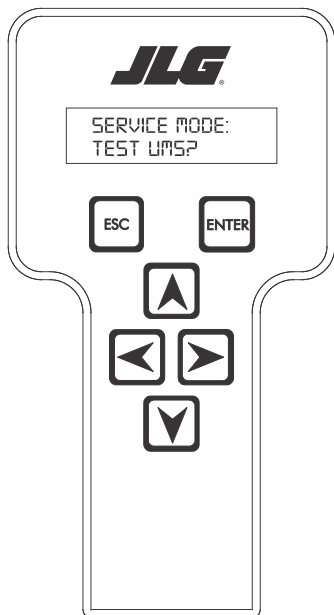
2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.
3. Advance to access level 1 by scrolling to the ACCESS


LEVEL menu and press "ENTER" . Using the arrows on the keypad, enter the password "33271" and press "ENTER" .

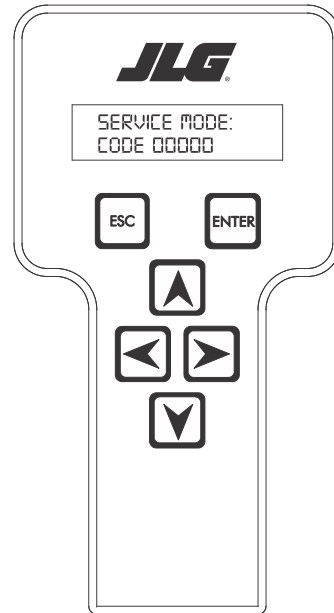
4. Scroll through the top level menu until SERVICE MODE appears. Press "ENTER"  to select this menu item. After pressing "ENTER" one of the following screens will be displayed:



Or



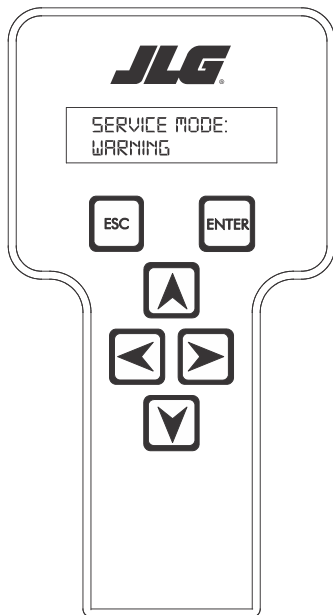
5. Scroll left to right through the above menu items until "TOWER LIFT DOWN?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER"  key.
6. The controller will now display the following:



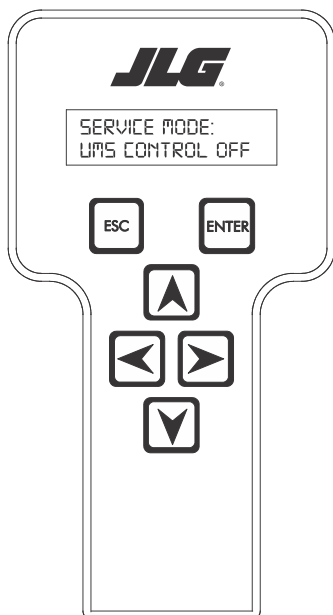
7. Enter the service code "81075" and press the "ENTER"



key. The controller display will now display the following,



followed by:

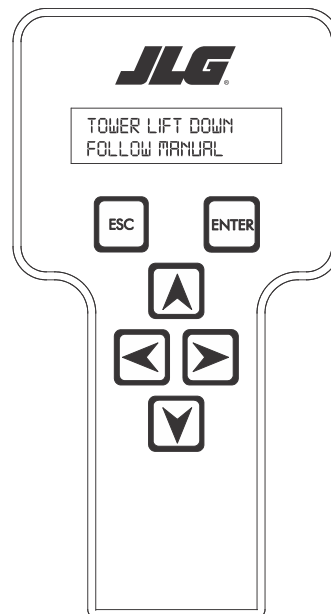


The flashing and scrolling messages will repeat until the



"ENTER" key is pressed.

8. When the "ENTER"  key is pressed, the UMS will be disabled and the display will read:



9. Before using tower lift down adhere to the following:

- Make sure the main boom is fully retracted.
- Make sure the tower boom is fully retracted.
- Slowly lower the tower boom.

10. When the platform has been safely lowered to the ground, exit the service mode by pressing the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

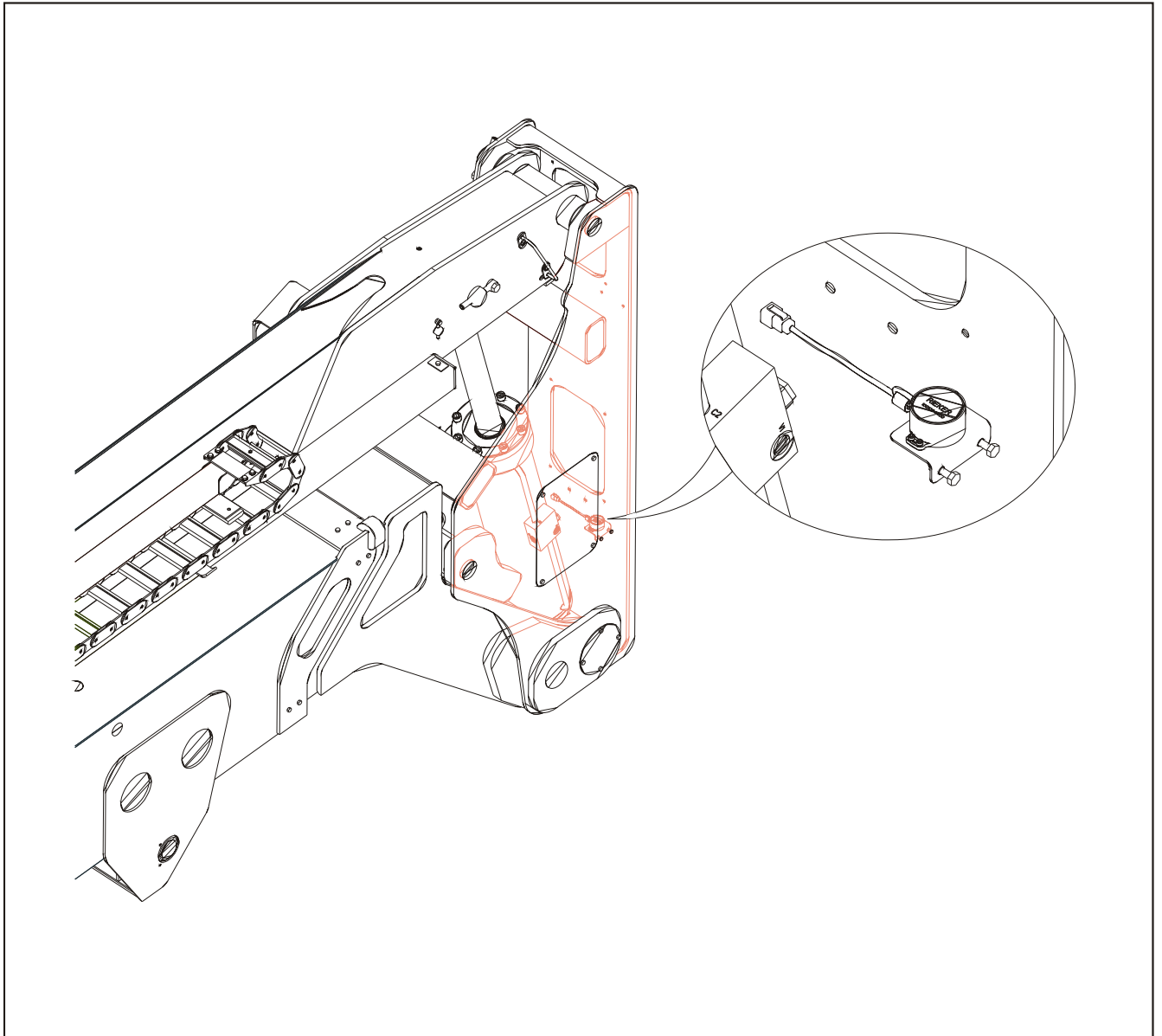


Figure 4-15. UMS Sensor Location

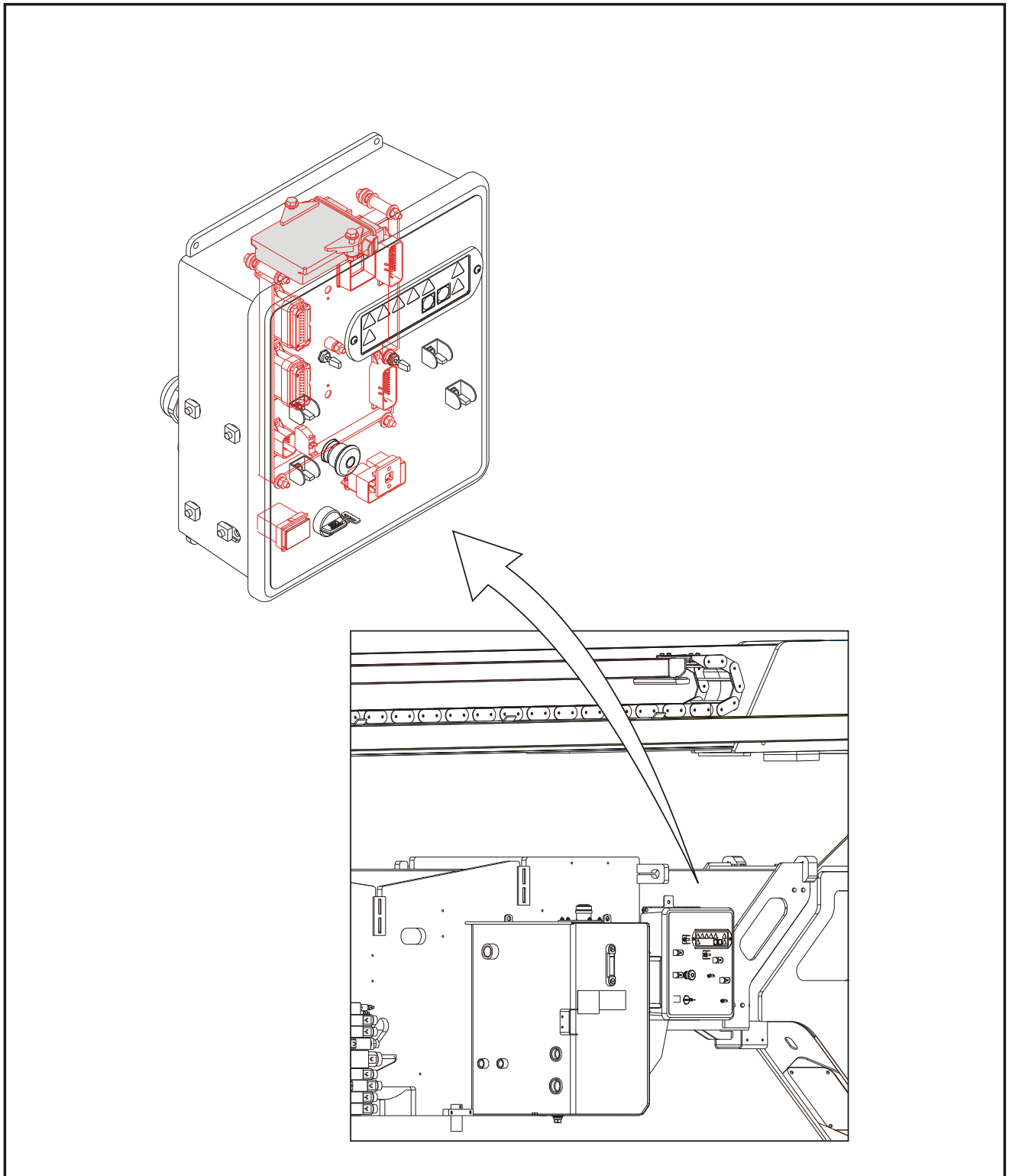


Figure 4-16. UMS Module Location

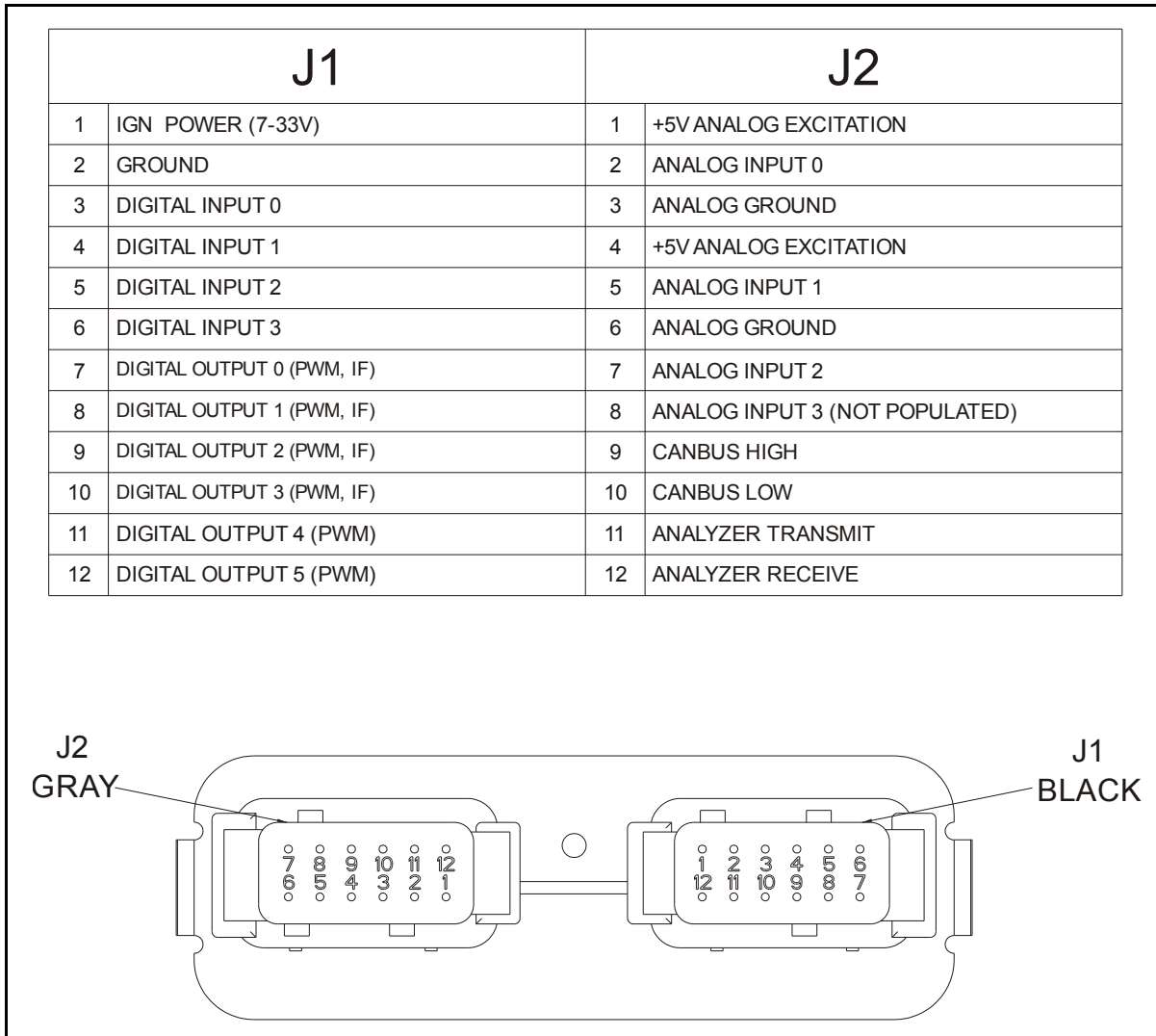


Figure 4-17. UMS Module Pin Identification

## **4.11 UMS TROUBLESHOOTING AND FAULT MESSAGES**

### **Backward Stability Concern Message**

2/5 UMS SENSOR BACKWARD LIMIT REACHED

When the upright angle relative to the turntable is higher than +2.5° (away from the work platform), tower lift down will be disallowed immediately. Tower Lift Down will be re-allowed when the upright angle relative to the turntable is less than 2.0°. If Tower Lift Down is disabled for more than 1.5 seconds, the ground boom malfunction indicator lamp, upright tilted lamp and platform alarm will light/sound continually and a fault shall be raised. These conditions will be latched along with Tower Lift Down until the upright angle is less than 2.0° for 2 seconds and the Tower Lift Down command is returned to neutral.

Solution:

- Inspect sensor mounting.
- Verify sensor calibration on level pad.
- Follow the corrective action listed on decal 1702265 located near the red knob of the machine.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section 5 - Hydraulics.

### **Forward Stability Concern Message**

2/5 UMS SENSOR FORWARD LIMIT REACHED

When the upright angle relative to the turntable is less than -4.0° for longer than 1.5 seconds, the ground control boom malfunction indicator lamp, the platform malfunction indicator lamp, and platform alarm will light/sound continually and a fault will be raised. The light/alarm signal will stop only when the upright angle reaches values greater than -3.0° for 2 seconds.

Solution:

- Inspect sensor mounting.
- Verify sensor calibration on level pad.
- Tower lift down.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section 5 - Hydraulics.

### **Auto Detection Input Low Message**

2/5 AUTO DETECTION INPUT LOW

If the UMS detects a valid ground module software version but digital input 2 is not tied high the UMS module shall report a fault.

Solution:

- Inspect wire harness, there should be 12 volts going into pin J1-5 (black connector) of UMS module.

### **UMS Sensor Communications lost**

6/6 UMS SENSOR COMMUNICATIONS LOST

If the UMS detects a valid ground module software version but digital input 2 is not tied high the UMS module shall report a fault.

Solution:

- Inspect wire harness; CANbus communications are on pins J2-9 & J2-10 (gray connector) of the UMS module.
- Using access level 1 of the UMS module, under "DIAGNOSTICS" CAN, EX/SEC and TX/SEC should be values greater than 0. Also "BUS OFF:" and "BUS ERR:" should be 0 and "PASSIVE:" should be a low value.

### **Out of Usable Range Message**

8/1 UMS SENSOR OUT OF USABLE RANGE

When both the Chassis tilt sensor and the UMS sensor read greater than 10° in the same direction the UMS will be disengaged until the condition no longer exists and a fault shall be raised.

Solution:

- Verify the message clears when operating the machine on grade less than 10°.
- Inspect sensor mounting.
- Verify sensor calibration on level pad.

**UMS Sensor Not Calibrated Message**

8/1 UMS SENSOR NOT CALIBRATED

If the control system detects a sensor out of range condition or a not calibrated fault with the UMS angle sensor, the control system shall report a fault and disable Tower Lift Down and activate the ground boom malfunction indicator lamp, upright tilted lamp and platform alarm continually

If the control system detects that the UMS angle sensor has not been calibrated, the ground boom malfunction lamp will flash at a 3 Hz rate until the system is calibrated or disabled.

Solution:

- Calibrate sensor.

**UMS Sensor Faulted Message**

8/1 UMS SENSOR FAULTED

If the system detects that the UMS sensor frequency outside the 100Hz +/- 5Hz range or the duty cycle is outside 50% +/- 21% range the control system shall report a fault.

Solution:

- Inspect wire harness going to the sensor and UMS module.
- Inspect sensor mounting.
- Replace sensor.

**Incompatible Software Detected Message**

9/9 INCOMPATIBLE SOFTWARE DETECTED

If the control system detects that the ground module software is incompatible with the UMS module, the UMS module shall report a fault and disable the footswitch signal to the ground module.

Solution:

- Update ground module software.

**Calibration Faults**

CAL FAILED-CHASSIS NOT LEVEL

The control system shall display a fault in the event the raw sensor output is greater than  $\pm 5^\circ$  for the chassis sensor.

CAL FAILED-UMS SENSOR RAW OUTPUT OUT OF RANGE

The control system shall display a fault in the event the raw sensor output is greater than  $\pm 5^\circ$  for the UMS sensor.

CAL FAILED-CALIBRATION DISRUPTED

If calibration is disrupted, the control system shall display this fault.

CAL FAILED- UMS SENSOR MOVEMENT NOT DETECTED

The UMS angle has not detected the required amount of movement during calibration.

## 4.12 ARTICULATING JIB

**NOTE:** Pin numbers listed in the following procedures are referenced in Figure 4-18., Location of Components-Articulating Jib.

**NOTE:** Using a suitable lifting device, support the jib.

### Removal

1. For platform/support removal see platform/support removal diagram. (See Section 4.1, Platform).
2. Position the articulating jib boom level with the ground.
3. Remove mounting hardware from platform (slave) cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.
4. Remove mounting hardware from articulating jib boom pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from boom assembly.

### Disassembly

1. Remove mounting hardware from articulating jib boom pivot pins #3 and #4. Using a suitable brass drift and hammer, remove the pins from articulating jib boom pivot weldment.
2. Remove mounting hardware from rotator support pins #5 and #6. Using a suitable brass drift and hammer, remove the pins from rotator support.

3. Remove mounting hardware from lift cylinder pin #7. Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.

### Inspection

**NOTE:** When inspecting pins and bearings Refer to Section 2.5, Pins and Composite Bearing Repair Guidelines.

1. Inspect articulating fly boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect articulating fly boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of articulating fly boom pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary.
4. Inspect lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
5. Inspect inner diameter of rotator attach point bearings for scoring, distortion, wear, or other damage.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.

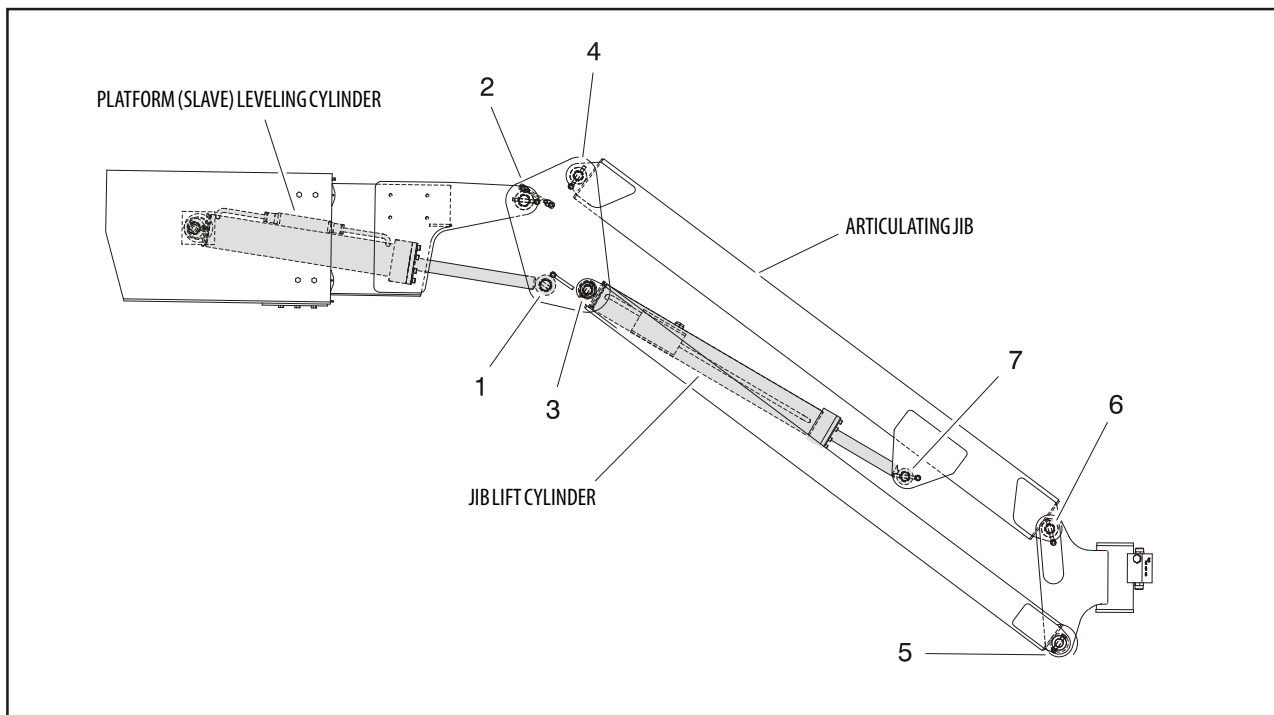


Figure 4-18. Location of Components-Articulating Jib

7. Inspect structural units of articulating jib boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

### Assembly

1. Align lift cylinder with attach holes in articulating jib boom. Using a soft head mallet, install cylinder pin #7 into articulating jib boom and secure with mounting hardware.
2. Align rotator support with attach hole in articulating jib boom. Using a soft head mallet, install rotator support pin #6 into articulating jib boom and secure with mounting hardware.
3. Align bottom tubes with attach holes in rotator support. Using a soft head mallet, install rotator support pin #5 into articulating jib boom and secure with mounting hardware.
4. Align articulating jib boom with attach hole in articulating jib boom pivot weldment. Using a soft head mallet, install rotator support pin #4 into articulating jib boom and secure with mounting hardware.
5. Align bottom tubes with attach holes in articulating jib boom pivot weldment. Using a soft head mallet, install rotator support pin #3 into articulating jib boom pivot weldment and secure with mounting hardware.
6. Align articulating jib boom pivot weldment with attach holes in fly boom assembly. Using a soft head mallet, install pivot pin #2 into fly boom assembly and secure with mounting hardware.
7. Align the platform (slave) leveling cylinder with attach holes in articulating jib boom pivot weldment. Using a soft head mallet, install platform (slave) leveling cylinder pin #1 into articulating jib boom pivot weldment and secure with mounting hardware.

### 4.13 SEQUENCE FOR HOSE REPLACEMENT IN THE TOWER BOOM

1. Remove the tower boom front cover bolts, exposing the Powertrack.
2. Remove bolts to disconnect the top bar of the Powertrack
3. Pull the Powertrack out of base boom. (as far as hoses will allow)
4. At left side rear of upright, remove access cover plate (4) bolts. (others if necessary)
5. Remove access cover plate, (4) bolts, from bottom front of fly boom.
6. Cut cable ties that attach hose to be replaced.

7. Disconnect hose that is to be replaced, and cap the male fitting.
8. Attach the new hose to the end of the hose to be replaced.
9. Pull these lines thru the upright and out the bottom, then feed back into the fly boom.
10. At the Powertrack, in front of the tower boom, open the Powertrack links to expose the hose to be replaced.
11. Pull hose to be replaced, attached to the new hose, thru the fly boom and thru the Powertrack links.
12. Disconnect new hose from the replaced hose and connect to fitting where the damaged hose was connected.
13. Roll Powertrack back into base, and attach the top bar of the Powertrack (2) bolts to the inside top of the fly boom section.
14. Check for leaks and hardware tightened securely.
15. Replace access cover plates and front cover.

### 4.14 LIMIT SWITCHES ADJUSTMENT

#### Main Boom Horizontal Limit Switch

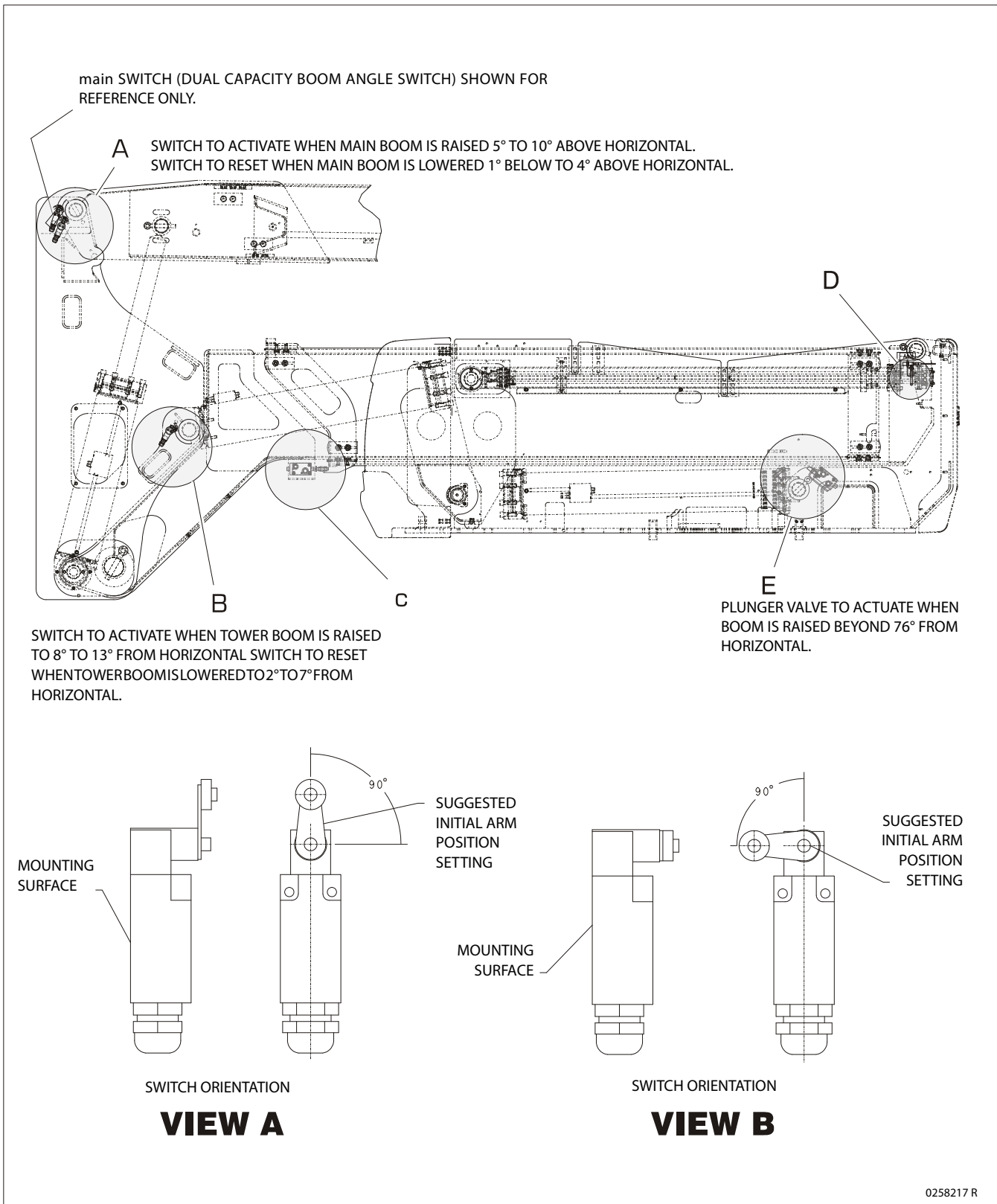
1. Place machine on level surface.
2. Raise main boom 5 to 10 degrees above horizontal. limit switch should activate before this point.
3. Lower main boom until limit switch resets. This should be 1 degree above to 4 degrees below horizontal. (See Figure 4-22. for adjustments)

**NOTE:** Angle indicator should be placed approx. 2 ft. from the main boom pivot pin and the attach point on the main boom. Tower angle switch must be reset before main boom angle switch can be activated.

#### Tower Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise Tower Boom 8 to 13 degrees above horizontal. The tower angle limit switch should activate at this point.
3. Lower the tower boom until the limit switch resets. This should be 2 to 7 degrees below where the switch was activated. (See Figure 4-19. and Figure 4-20. for adjustments).

**SECTION 4 - BOOM & PLATFORM**



**Figure 4-19. Boom Valve and Limit Switches Location (Sheet 1 of 3)**

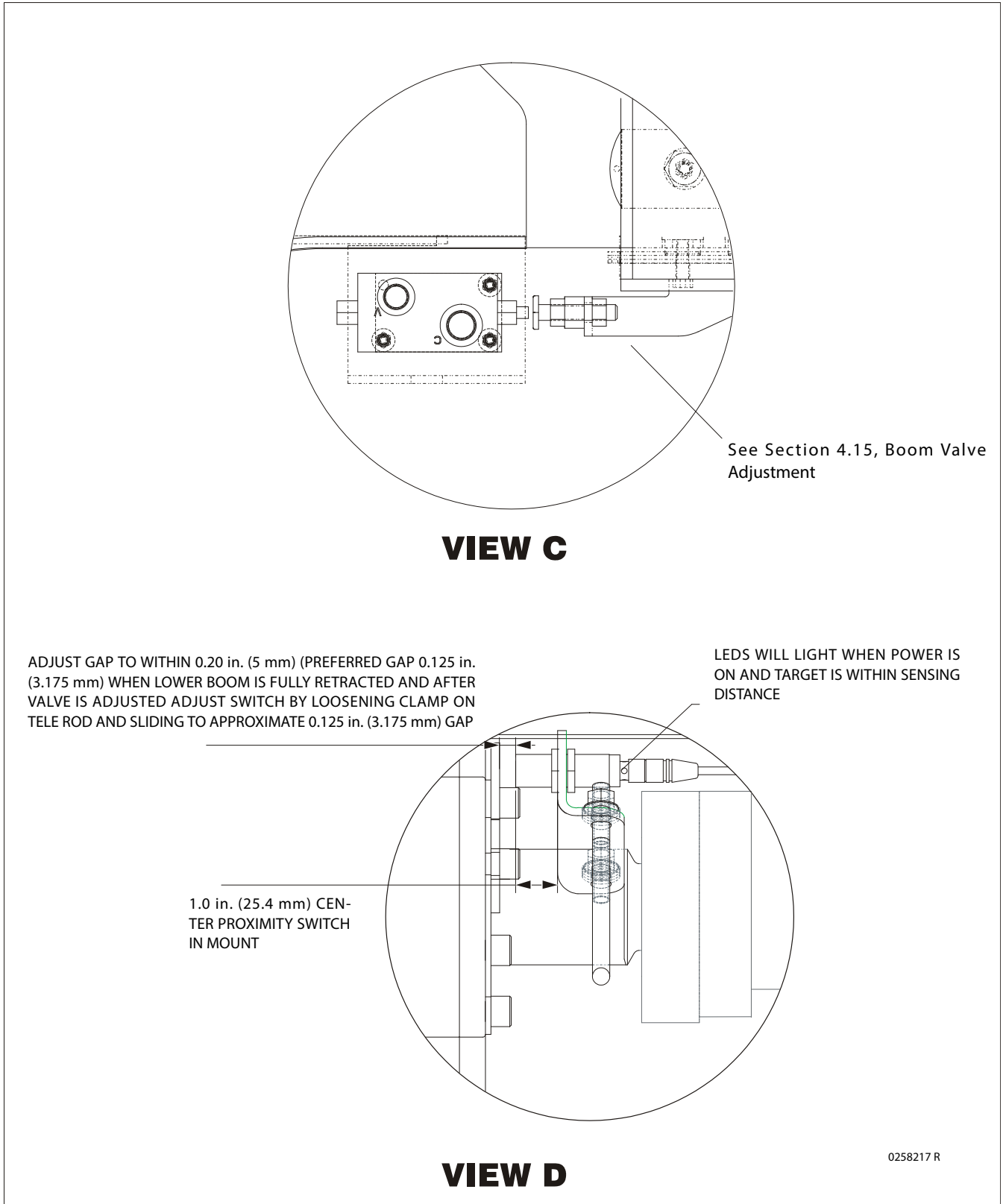
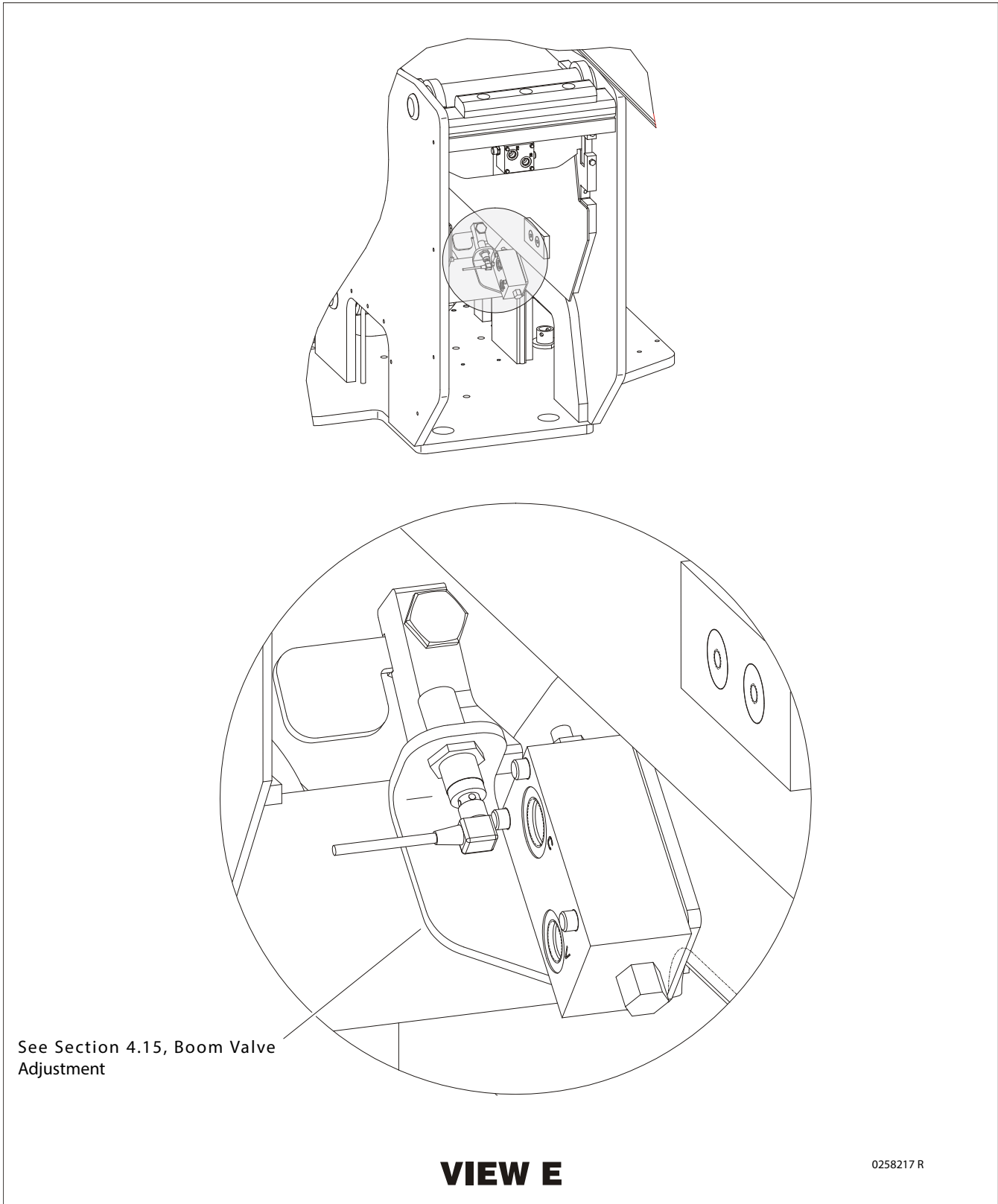


Figure 4-20. Boom Valve and Limit Switches Location (Sheet 2 of 3)



**Figure 4-21. Boom Valve and Limit Switches Location (Sheet 3 of 3)**

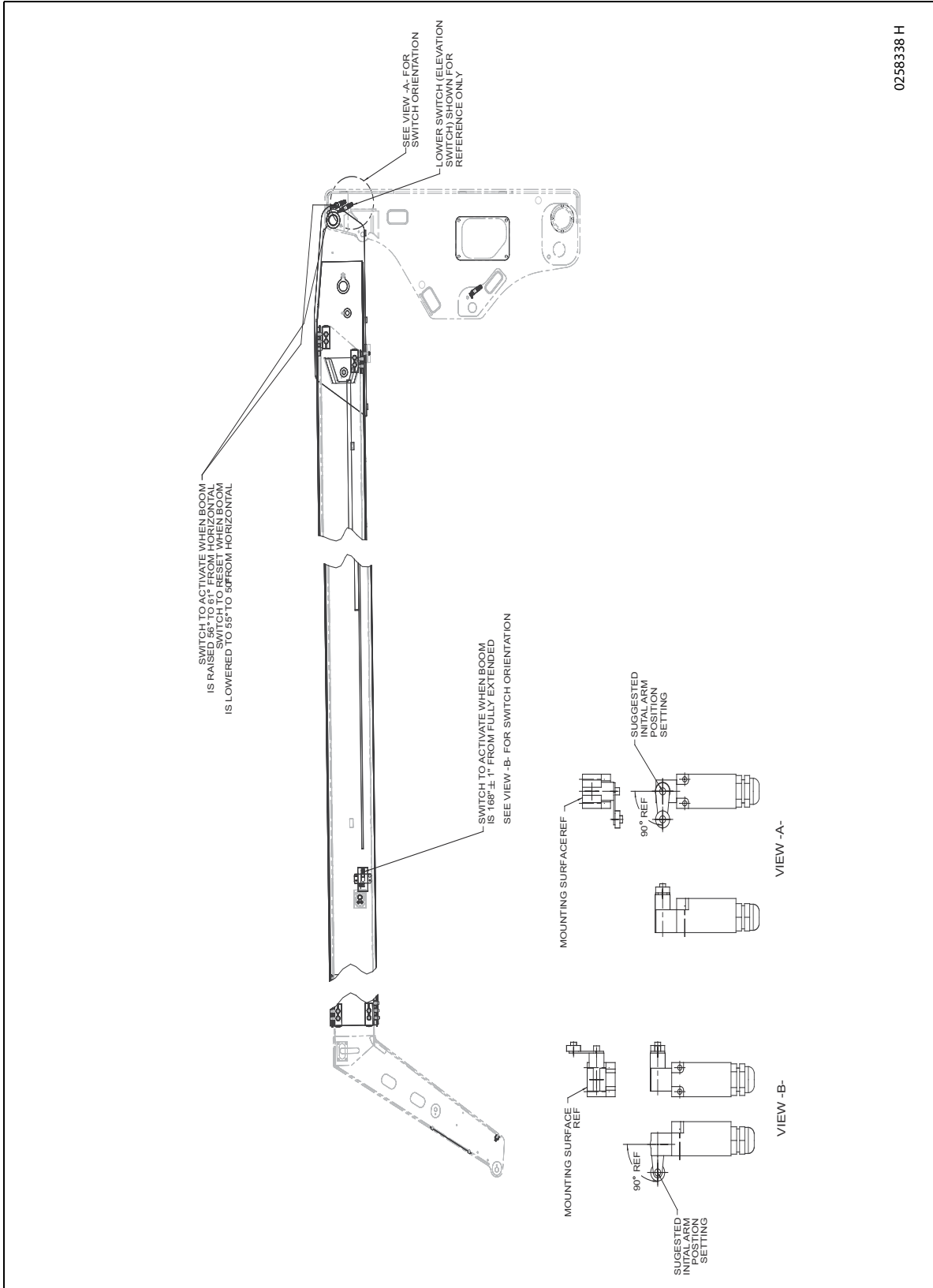


Figure 4-22. Dual Capacity Switches Installation (800 Only if equipped)

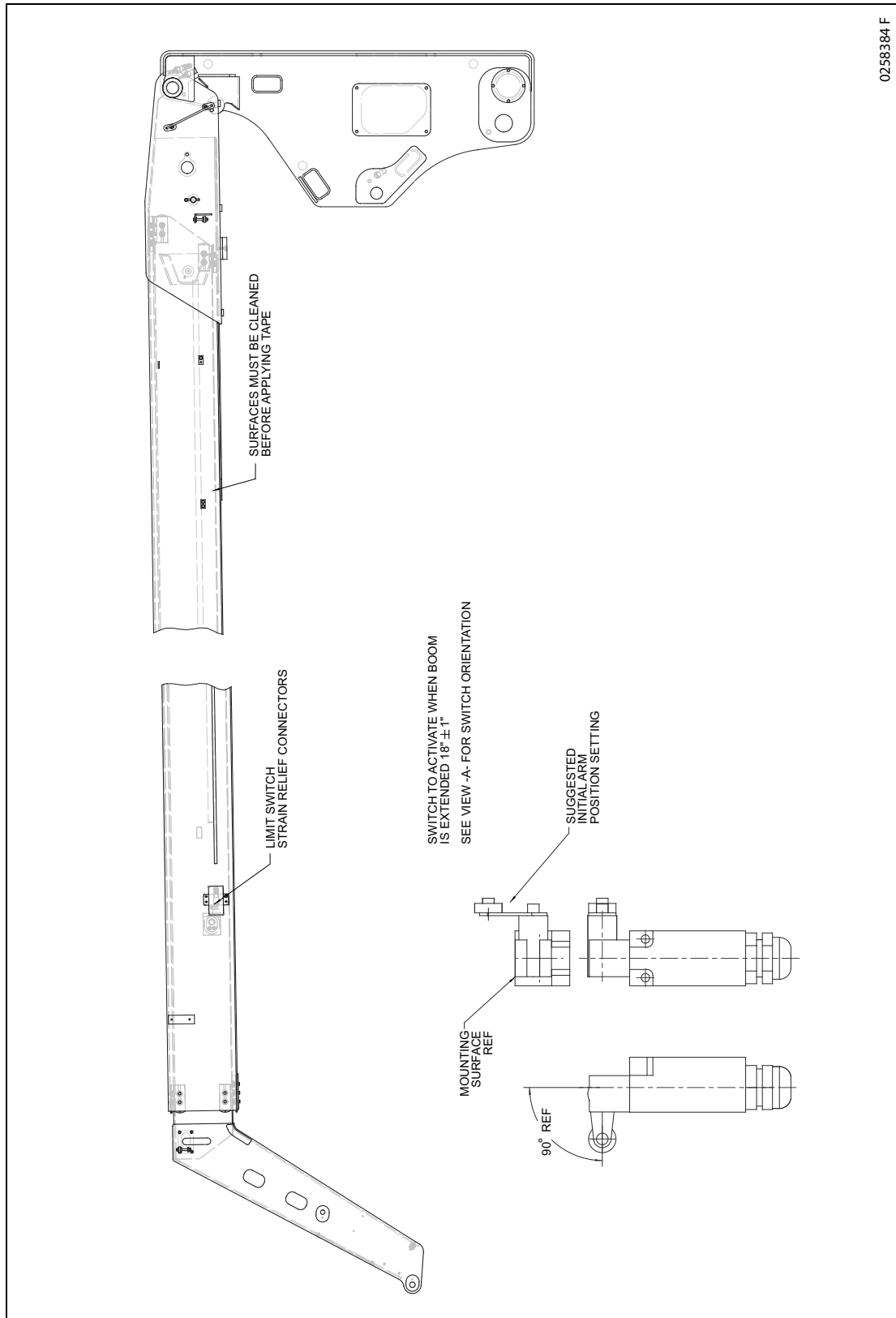


Figure 4-23. Transportation Switch Installation (CE only)

**Dual Capacity Angle Limit Switch (800A only)**

**NOTE:** *The boom position and location of the Main Boom Dual Capacity Switch requires a working surface 20 ft. (6m) high to safely check and adjust the switch.*

1. Place machine on level surface.
2. From platform control, with less than 500 lbs. (227 kg) in platform, raise tower boom to maximum angle. Extend main boom until the capacity indicator lights change from 1000 lbs. (454 kg) to 500 lbs. (227 kg).
3. With main boom length in this position, raise the main boom until the indicator lights change back to the 1000 lbs. (454 kg) indicator.
4. The Dual Capacity Limit Switch, located at the telescope cylinder of the Main Boom, Figure 4-22., will activate the 1000 lb. light when the main boom is at 56 to 61 degrees.

**NOTE:** *Place angle indicator on main base boom at least 2 ft. (0.6m) from pivot pin.*

5. Lower main boom until 500 lb. light comes on. The boom angle at this point should be 50 to 55 degrees.

**NOTE:** *If limit switch settings need to be changed, you will need to recheck that the 500 lb. light comes on at 50 degrees to 55 degrees when lifting down.*

6. Raise, extend, retract, and lower main boom. Check for smooth operation.

**Main Boom Length Switch (800A only)**

1. Lift main boom to approximately horizontal.
2. Telescope boom out until 500 lb. light comes on (may need to use auxiliary power to position boom correctly).
3. Mark the wear pad location on the main fly boom.
4. Telescope the main boom to full extension.
5. Measure from the mark on the fly boom to the wear pad. The dimension should be 167" to 169".
6. Lower the tower boom until limit switch resets. This should be 2 to 7 degrees below where the switch

### 4.15 BOOM VALVE ADJUSTMENT

1. Adjust the screws so the plunger on the valves has 0.250 in. (6.35 mm) travel remaining when the lower boom is fully raised and retracted.
2. After the valves are adjusted, adjust the proximity switches to within 0.20 in. (5 mm) of their target. The LED's on the proximity switches will light when the power is on and the switch is within 0.20 in. (5 mm) of the target. There is a proximity switch to back up both valves.

**NOTE:** *The cam valve under the boom requires the tower boom to be completely lowered and the cam valve mounted on T/T requires the tower boom to be fully elevated prior to adjustment.*

#### Tower Boom

1. Shim up wear pads until 1/32 inch (0.8 mm) clearance to adjacent surface.
2. When adjusting wear pads, removing or adding shims, bolt length must also be changed.
  - a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
  - b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

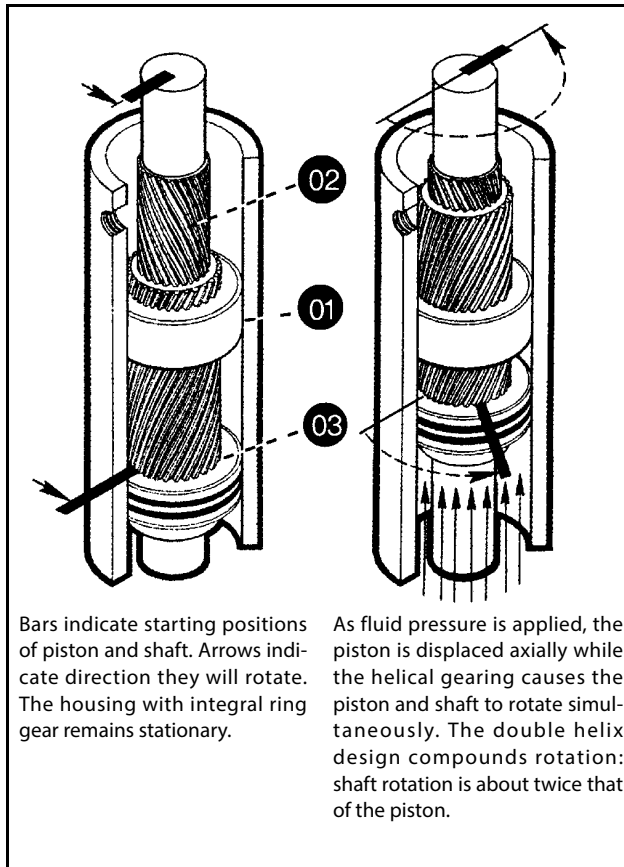
#### Main Boom

1. Shim up wear pads to within 1/32 inch (0.8 mm) clearance between wear pad and adjacent surface.
2. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
  - a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
  - b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and Sheaves and wire rope must be replaced as sets.

## 4.16 ROTATOR ASSEMBLY

### Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and the annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the in- side diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position.



The shaft is supported radially by the large main radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the main and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

### Required Tools

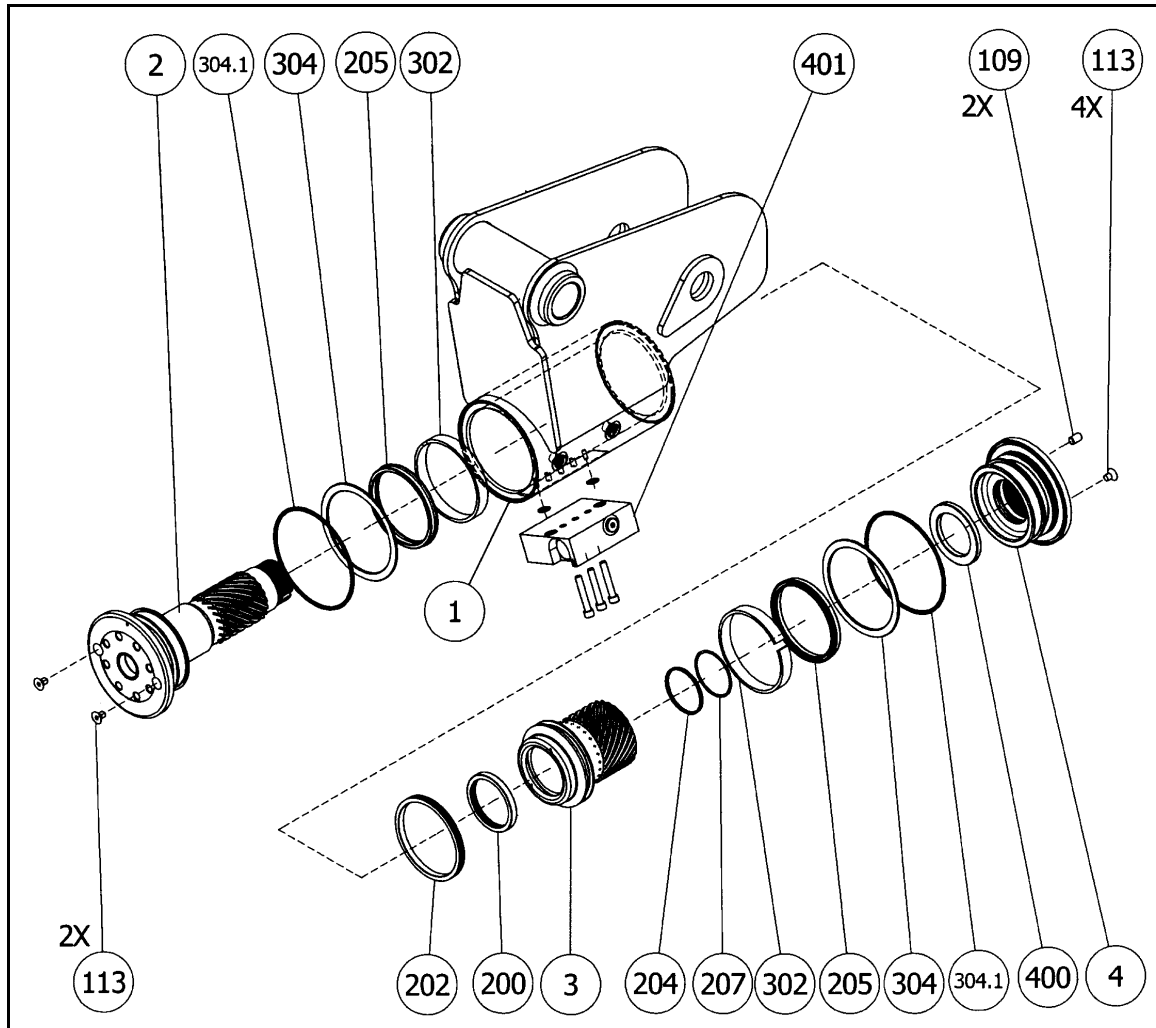
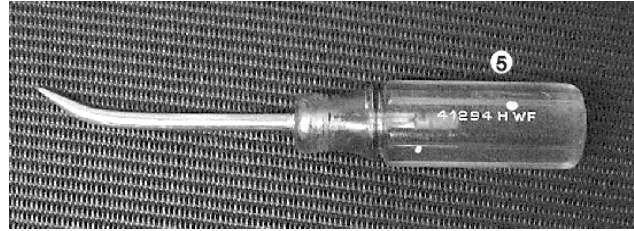
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:



1. Flashlight - helps examine timing marks, component failure and overall condition.
2. Felt Marker - match mark the timing marks and outline troubled areas.
3. Allen wrench - removal of port plugs and set screws.
4. Box knife - removal of seals.
5. Seal tool - assembly and disassembly of seals and wear guides.
6. Pry bar - removal of end cap and manual rotation of shaft.
7. Rubber mallet- removal and installation of shaft and piston sleeve assembly.
8. Nylon drift - installation of piston sleeve
9. End cap dowel pins - removal and installation of end cap (sold with Helac seal kit).

## SECTION 4 - BOOM & PLATFORM

The seal tool is merely a customized standard flat head screwdriver. To make this tool you will need to heat the flat end with a torch. Secure the heated end of the screwdriver in a vice and physically bend the heated end to a slight radius. Once the radius is achieved round off all sharp edges of the heated end by using a grinder. There may be some slight modifications for your own personal preference.



### PARTS

- 1. Housing
- 2. Shaft
- 3. Piston Sleeve
- 4. End Cap

### HARDWARE

- 103.1. Screw
- 103.2. Washer
- 106.1. Port Plug
- 106.2. Port Plug
- 109. Lock Pin
- 113. Capscrew

### SEALS

- 200. T-Seal
- 202. T-Seal
- 204. O-ring
- 205. Cup Seal
- 207. Backup Ring
- 304.1. Wiper Seal

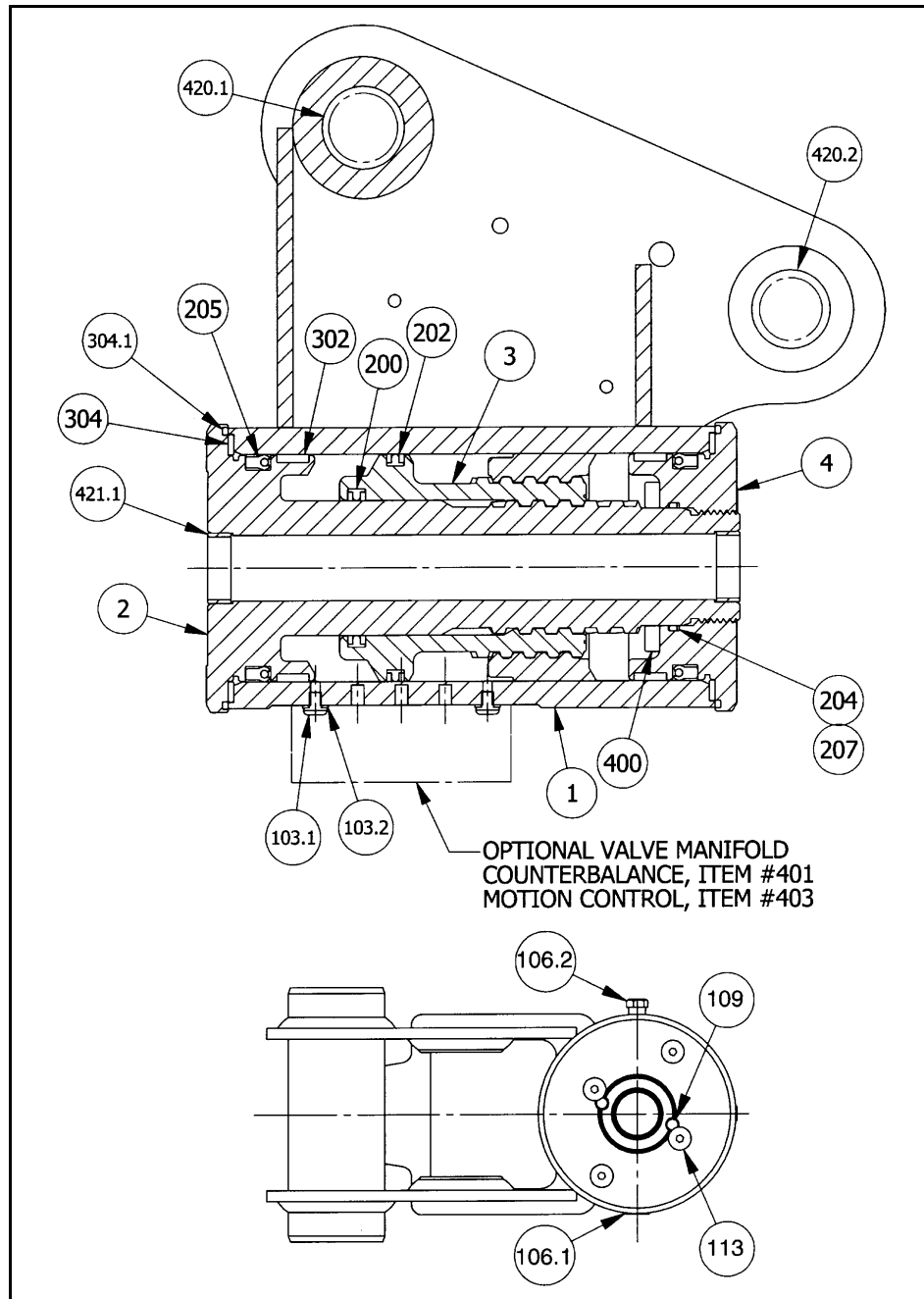
### BEARINGS

- 302. Wear Guide
- 304. Thrust Washer

### ACCESSORIES

- 400. Stop Tube
- 420.1 Bushing
- 420.2 Bushing
- 421.1 Bushing

**Figure 4-24. Rotator - Exploded View**



PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-25. Rotator- Assembly Drawing

## Disassembly

**CAUTION**

SECURE PRODUCT TO SLOTTED TABLE OR VISE.

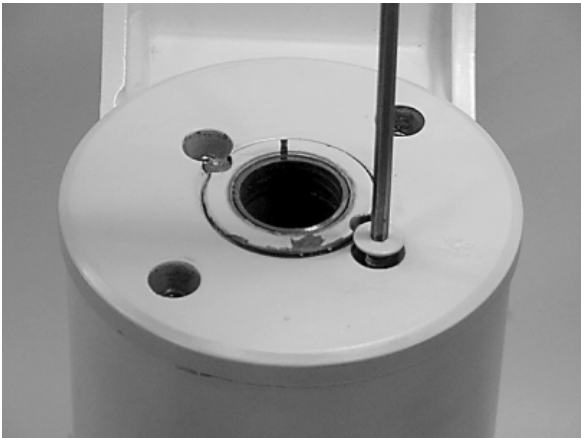
**CAUTION**

CONTENTS UNDER PRESSURE. WEAR APPROVED EYE PROTECTION. USE CAUTION WHEN REMOVING PORT PLUGS AND FITTINGS.

**NOTICE**

MAKE SURE WORK AREA IS CLEAN.

1. Remove the cap screws (113) over end cap lock pins (109).



2. Using a 1/8" (3.18mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16" (4.76mm).

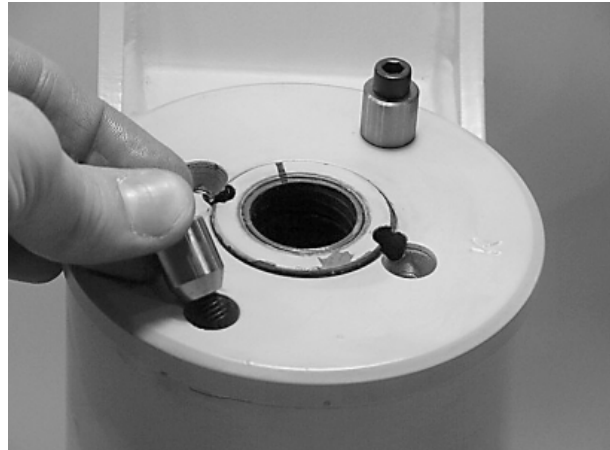


3. Remove the lock pins using an "Easy Out" (a size #2 is shown).



If the pin will not come out with the "Easy Out", use 5/16" drill bit to a depth of 1/2" (12.7mm) to drill out the entire pin.

4. Install the end cap (4) removal tools provided with the Helac seal kit.



5. Using a metal bar, or similar tool, unscrew the end cap (4) by turning it counter clockwise.



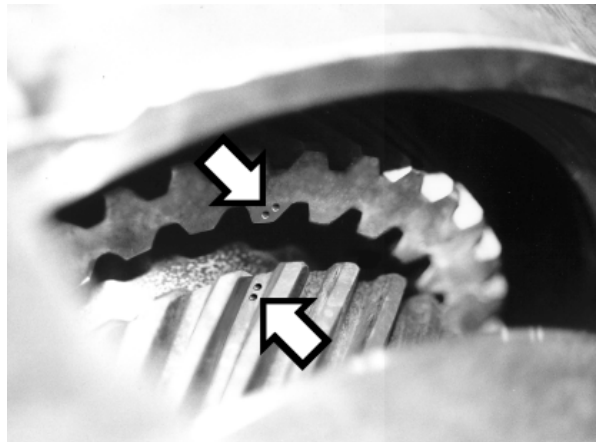
6. Remove the end cap (4) and set aside for later inspection.



7. Remove the stop tube if equipped. The stop tube is an available option to limit the rotation of the actuator.



8. Every actuator has timing marks for proper engagement.



9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.



## SECTION 4 - BOOM & PLATFORM

10. Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.



11. Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).



12. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is not damaged.



13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.



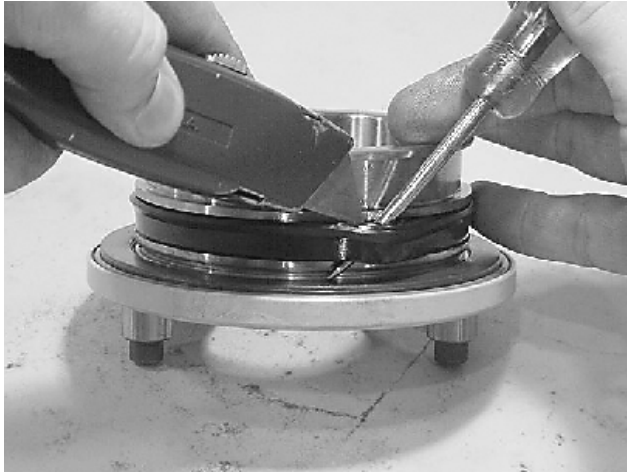
14. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.



15. Remove the wear guides (302) from the end cap (4) and shaft (2).



- 16.** To remove the main pressure seals (205), it is easiest to cut them using a sharp razor blade being careful not to damage the seal groove.



- 19.** Remove the piston O.D. seal (202) from the piston.



- 17.** Remove the thrust washers (304), from the end cap (4) and shaft (2).



- 20.** Remove the piston I.D. seal (200). You may now proceed to the inspection process.



- 18.** Remove the wiper seal (304.1) from its groove in the end cap (4) and shaft (2).



## Inspection

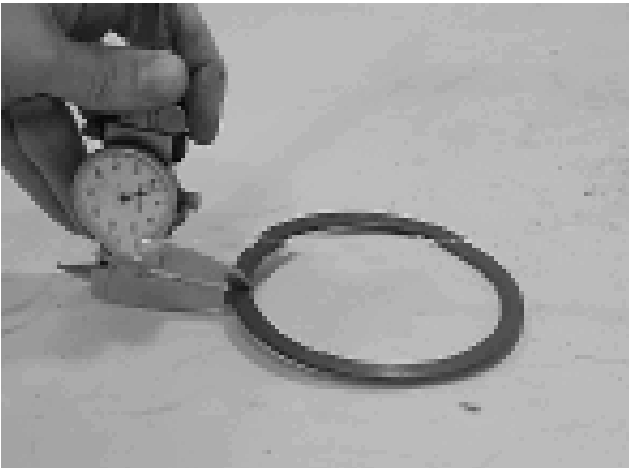
### NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

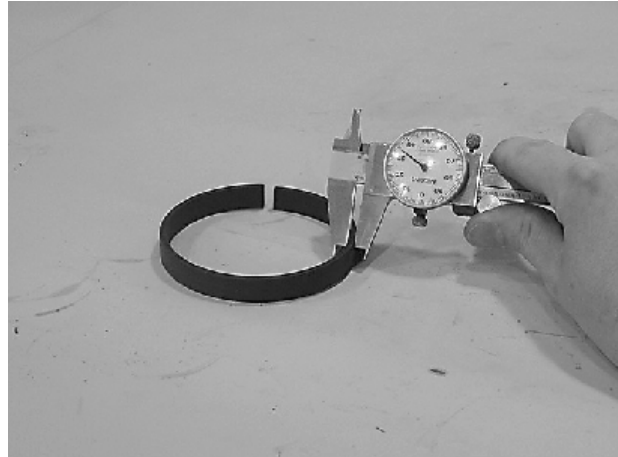
1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.



2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure its thickness to make sure it is within specifications (Not less than 0.092" or 2.34 mm).

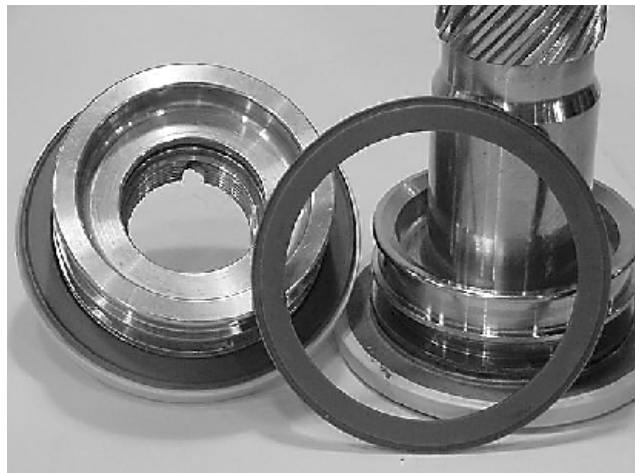


3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

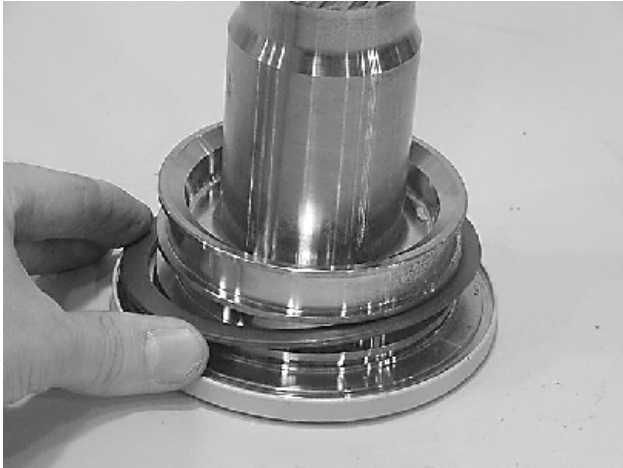


## Assembly

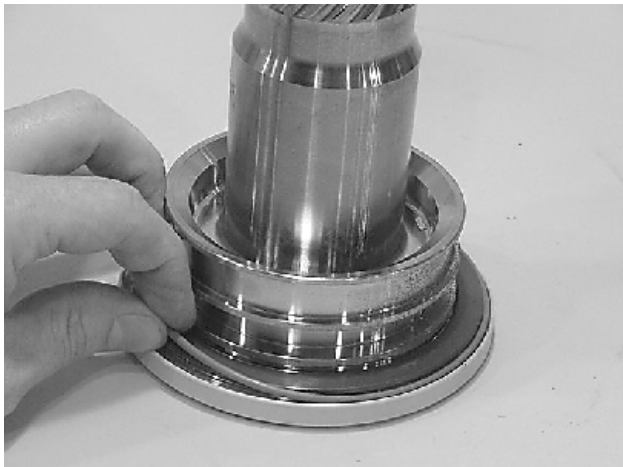
1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.



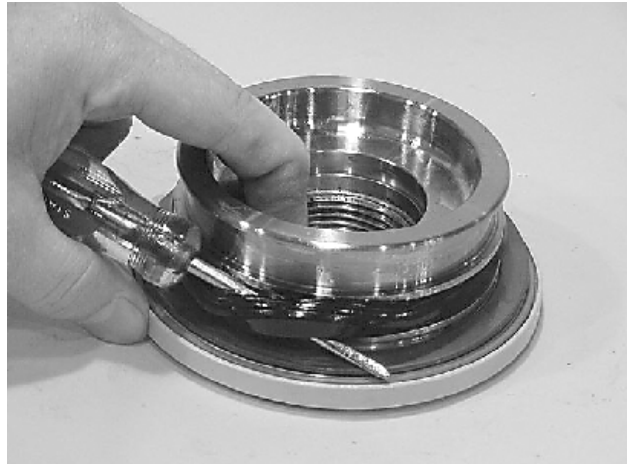
2. Install the thrust washer (304) onto shaft (2) and end cap (4).



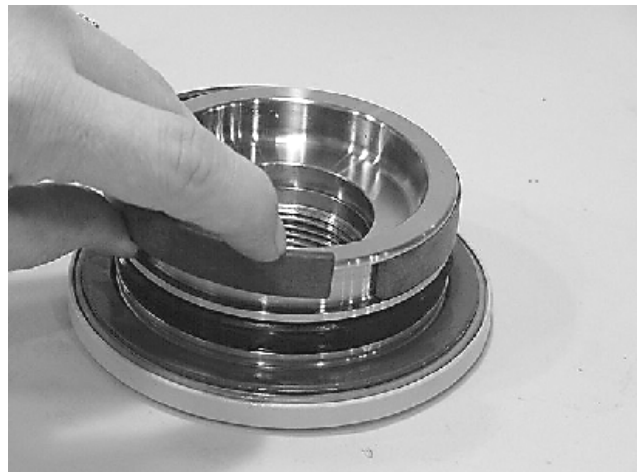
3. Install the wiper seal (304.1/green O-ring) into the groove on the shaft (2) and end cap (4) around the outside edge of the thrust washer (304).



4. Using a seal tool install the main pressure seal (205) onto shaft (2) and end cap (4). Use the seal tool in a circular motion.



5. Install the wear guide (302) on the end cap (4) and shaft (2).



## SECTION 4 - BOOM & PLATFORM

6. Install the O-ring (204) and back-up ring (207) into the inner seal groove on the end cap (4).



7. Install the inner T-seal (200) into the piston (3) using a circular motion.

Install the outer T-seal (202) by stretching it around the groove in a circular motion.

Each T-seal has 2 back-up rings (see drawing for orientation).

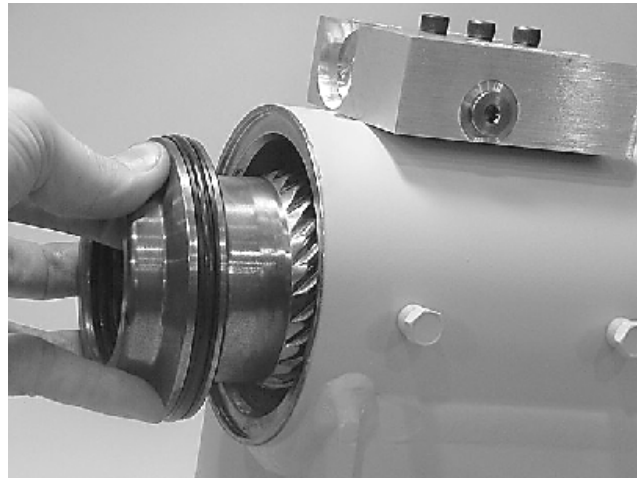


Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

Repeat this step for the outer seal (202).



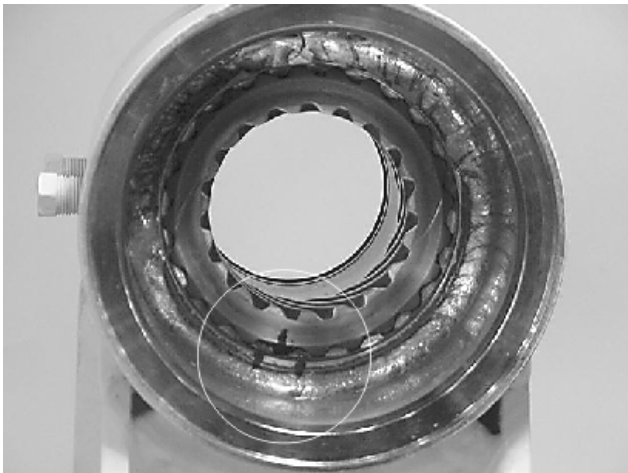
8. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



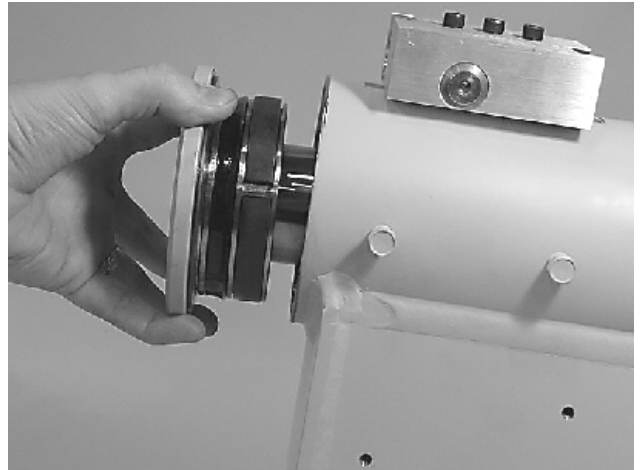
- 9.** Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



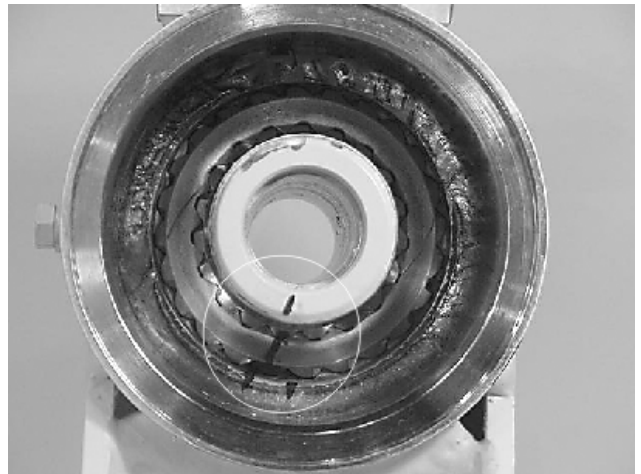
- 10.** Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



- 11.** Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



- 12.** Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.

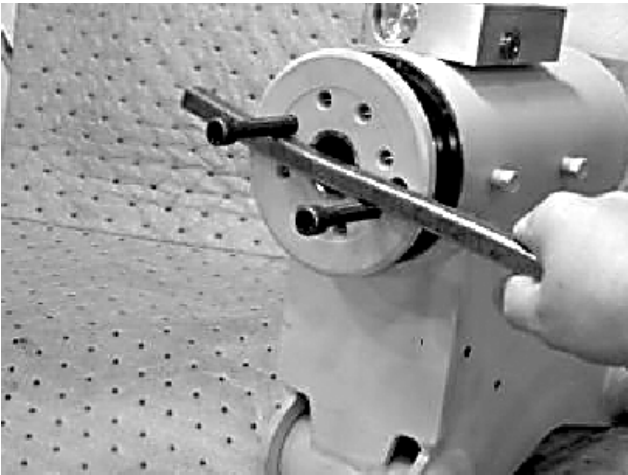


## SECTION 4 - BOOM & PLATFORM

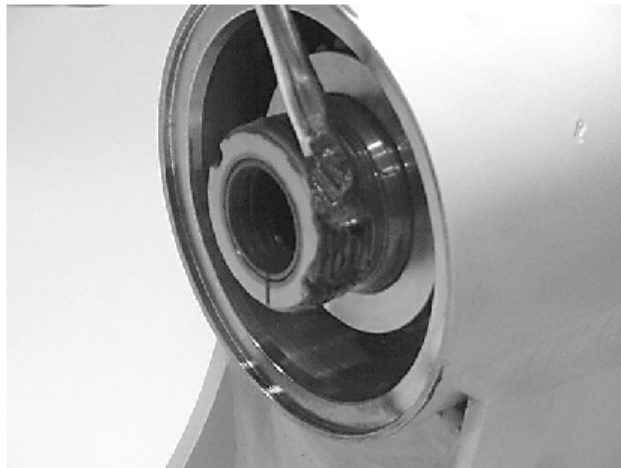
13. Install 2 bolts in the threaded holes in the flange. Using a bar, rotate the shaft in a clockwise direction until the wear guides are seated inside the housing bore.

### NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSE GEARING.



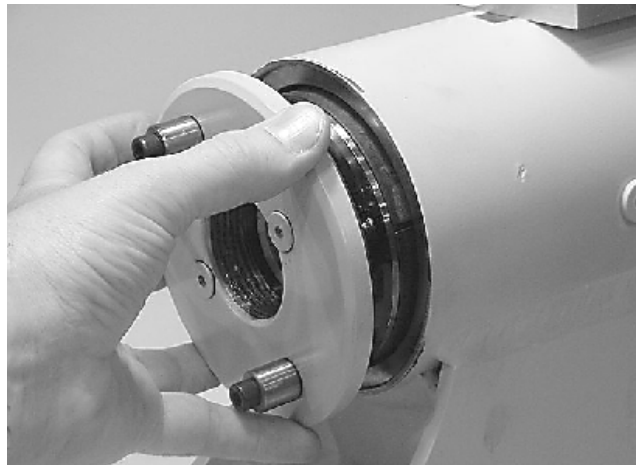
14. Install the stop tube onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.
15. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.



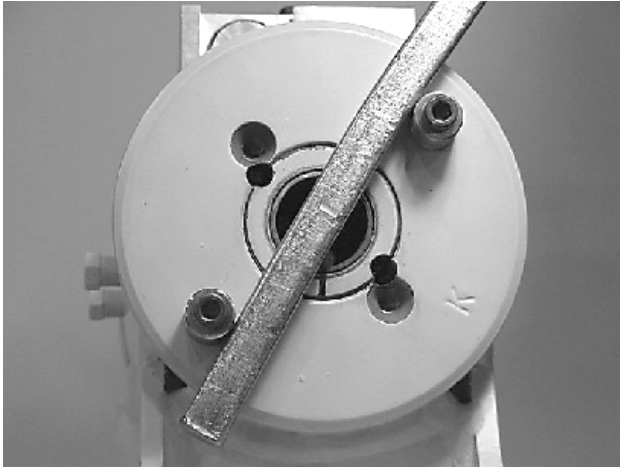
16. Install the O-ring (204) and back-up ring (207) into the inner seal groove on the end cap (4).



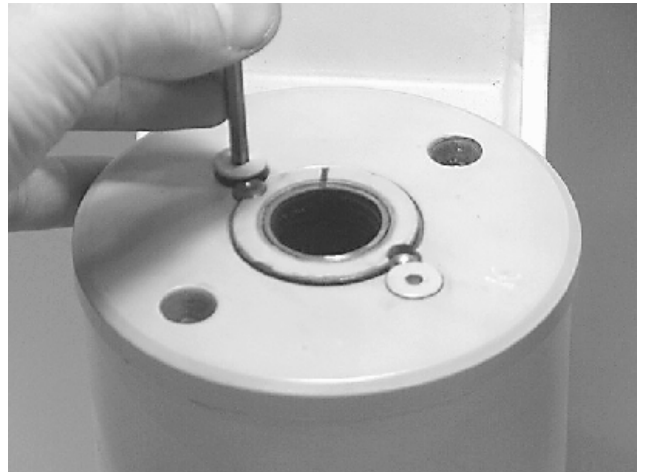
17. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide remains in place on the end cap as it is threaded into the housing (1).



- 18.** Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



- 20.** Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



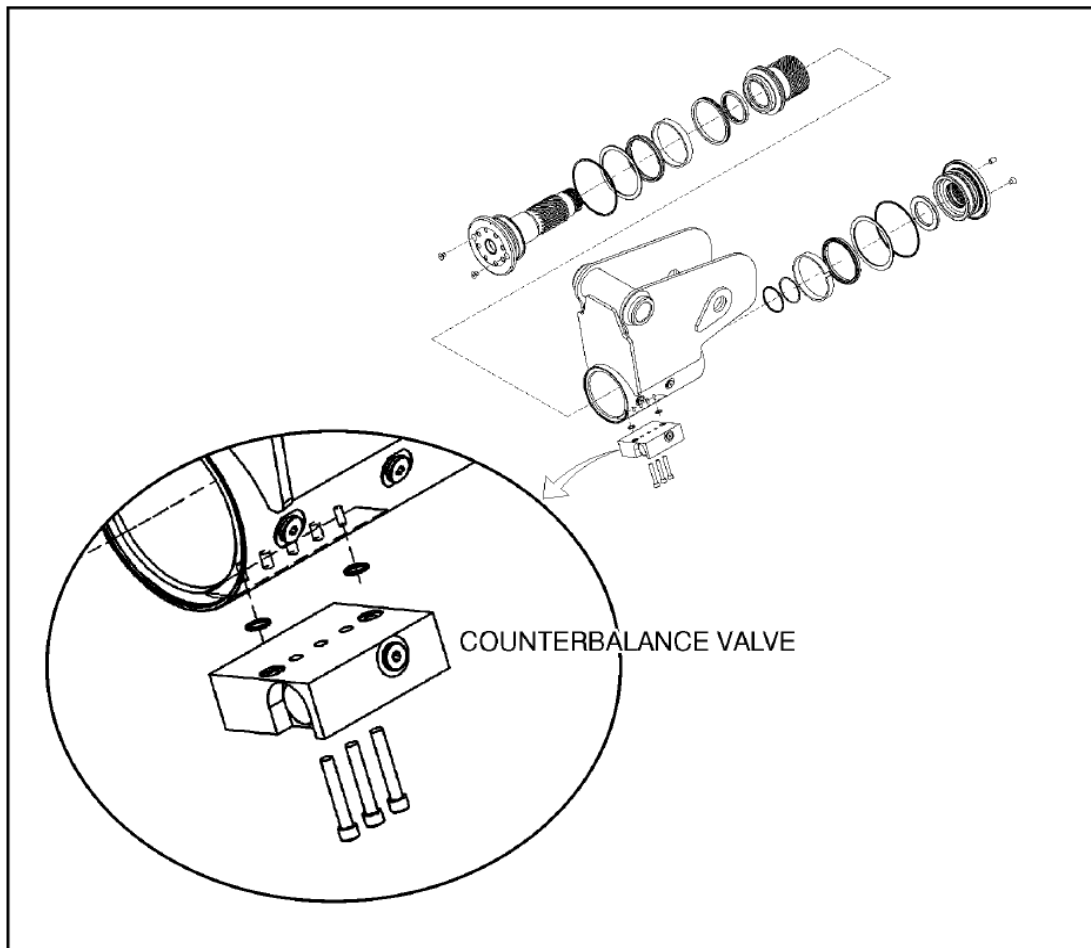
- 19.** Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.



## **Installing Counterbalance Valve**

Refer to Figure 4-26., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old JLG Threadlocker P/N 0100011.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. JLG Threadlocker P/N 0100011 should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 in.lbs. (12.4 to 13.5 Nm). Do not torque over 125 in.lbs. (14.1 Nm). Torque the 5/16-inch bolts 140 in.lbs. (15.8 Nm). Do not torque over 145 in.lbs. (16.3 Nm).
5. Make sure the valve is seated against the housing valve flat. If it is raised up on any side or corner, remove the valve to determine what the obstruction is. If possible, test this using a hydraulic hand pump or electric test.



**Figure 4-26. Rotator Counterbalance Valve**

## Greasing Thrust Washers

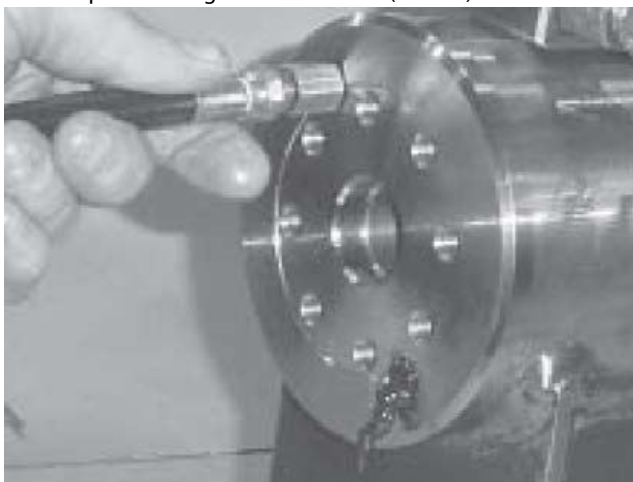
1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.
2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with cap screws (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)



### NOTICE

**IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAP SCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.**

3. Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the cap screws into the grease ports and tighten to 25 in-lbs. (2.8 Nm).



## Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle the actuator at least 25 times at 3000 psi (210 bar) pressure. After the 25 rotations, increase the pressure to 4500 psi (315 bar) to check for leaks and cracks. Perform the test again at the end of the rotation in the opposite direction.

### TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with a counterbalance valve, plug the valve ports. Connect the hydraulic lines to the housing ports. Bleed all air from the actuator (see Installation and Bleeding) Rotate the shaft to the end of rotation at 3000 psi (210 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

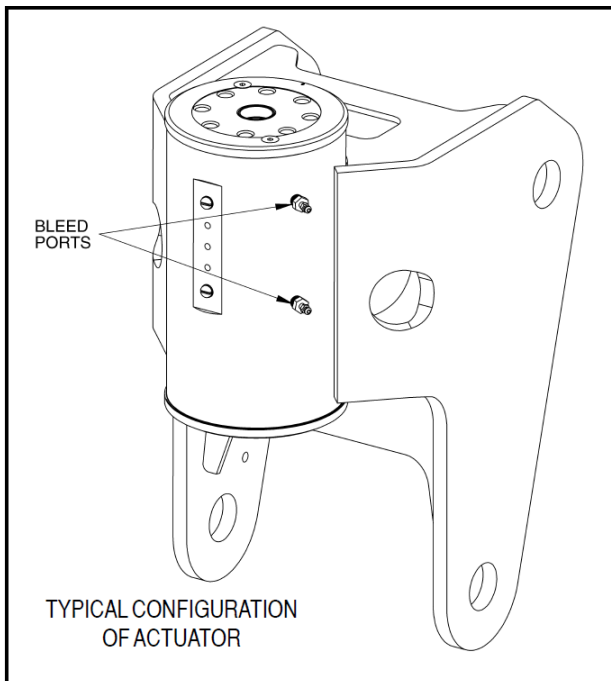
### Installation and Bleeding

After installation of the actuator on the equipment, it is important that all safety devices such as tie rods or safety cables are properly reattached.

To purge air from the hydraulic lines, connect them together to create a closed loop and pump hydraulic fluid through them. Review the hydraulic schematic to determine which hydraulic lines to connect. The linear feet and inside diameter of the hydraulic supply lines together with pump capacity will determine the amount of pumping time required to fully purge the hydraulic system.

Bleeding may be necessary if excessive backlash is exhibited after the actuator is connected to the hydraulic system. The following steps are recommended when a minimum of two gallons (8 liters) is purged.

1. Connect a 3/16" inside diameter x 5/16" outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.



2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.
3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.

### 4.17 FOOT SWITCH ADJUSTMENT

Adjust so that functions will operate when pedal is at center of travel. If switch operates within last 1/4 in. (6.35 mm) of travel, top or bottom, it should be adjusted.

## Troubleshooting

**Table 4-1. Troubleshooting**

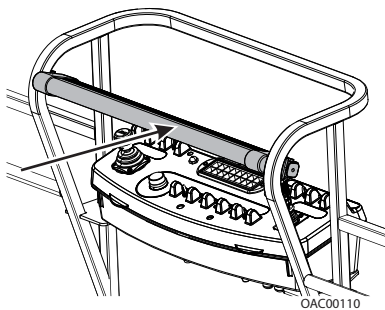
Problem	Cause	Solution
1. Shaft rotates slowly or not at all	<ul style="list-style-type: none"> <li>a. Insufficient torque output</li> <li>b. Low rate of fluid flow</li> <li>c. Control or counterbalance valve has internal leak</li> <li>d. Piston and/or shaft seal leak</li> <li>e. Corrosion build-up on the thrust surfaces</li> <li>f. Swollen seals and composite bearings caused by incompatible hydraulic fluid</li> </ul>	<ul style="list-style-type: none"> <li>a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.</li> <li>b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.</li> <li>c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.</li> <li>d. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.</li> <li>e. Re-build the actuator. Remove all rust then polish. Replacement parts may be needed.</li> <li>f. Re-build the actuator. Use fluid that is compatible with seals and bearings.</li> </ul>
2. Operation is erratic or not responsive	<ul style="list-style-type: none"> <li>a. Air in actuator</li> </ul>	<ul style="list-style-type: none"> <li>a. Purge air from actuator. See bleeding procedures.</li> </ul>
3. Shaft will not fully rotate	<ul style="list-style-type: none"> <li>a. Twisted or chipped gear teeth</li> <li>b. Port fittings are obstructing the piston</li> </ul>	<ul style="list-style-type: none"> <li>a. Check for gear binding. Actuator may not be able to be rebuilt and may need to be replaced. Damage could be a result of overload or shock.</li> <li>b. Check thread length of port fittings. Fittings should during stroke not reach inside the housing bore.</li> </ul>
4. Selected position cannot be maintained	<ul style="list-style-type: none"> <li>a. Control or counterbalance valve has internal leak</li> <li>b. Piston and/or shaft seal leak</li> <li>c. Air in actuator</li> </ul>	<ul style="list-style-type: none"> <li>a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.</li> <li>b. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test.</li> <li>c. Purge air from actuator. See bleeding procedures</li> </ul>

## 4.18 SKYGUARD®

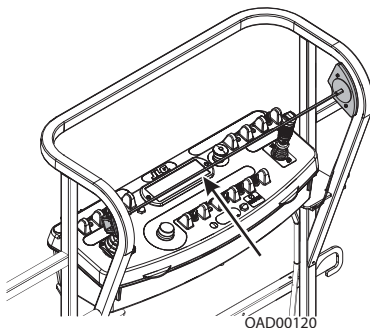
### Operation

SkyGuard provides enhanced control panel protection. When the SkyGuard sensor is activated, functions in use at the time of actuation will reverse or cutout. The SkyGuard Function Table provides more details on these functions.

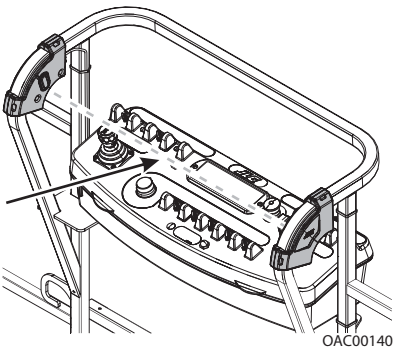
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™



**WARNING**

THE MACHINE OPERATOR IS REQUIRED TO PERFORM A DAILY FUNCTION TEST TO ENSURE PROPER OPERATION OF THE SKYGUARD SYSTEM.

### Function Test

#### SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops then telescope in function operates for a short duration. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure normal operation available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

#### BOTH SKYGUARD AND SOFT TOUCH

Perform this procedure if **both SkyGuard and Soft Touch** are selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

**NOTE:** Machine will treat Soft Touch/SkyGuard override switch as if it is a Soft Touch and SkyGuard switch.

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure sure normal operation is available.

In Ground Mode:

1. Operation is allowed regardless of SkyGuard activation.

**SOFT TOUCH ONLY**

If **Soft Touch only** is selected in machine setup (refer to Table 6-2), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

**SKYGUARD NOT SELECTED IN MACHINE SETUP**

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to Table 6-2), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

**Diagnostics & Troubleshooting**

If SkyGuard does not function when the sensor is engaged, first verify the configuration under the MACHINE SETUP: SKYGUARD OPTION menu using the hand-held Analyzer. Ensure the selected configuration matches the actual system installed on the machine. If not, select the correct configuration, then verify operation.

Additionally, use the handheld analyzer to navigate to the DIAGNOSTICS: FEATURES → SKYGUARD INPUTS menu to determine additional SkyGuard fault information.

Engage the SkyGuard sensor and observe the Analyzer to determine if the switch/relay closes.

If the status of the switch/relay remains OPEN while the SkyGuard sensor is actively engaged, it is possible the sensor has failed and should be replaced immediately.

If the status of the switch/relay remains CLOSED while the SkyGuard sensor is actively engaged, a power or ground wire may not be making good contact or may be loose or broken. Additionally, there is a low probability that both relays may have failed.

If the switch/relay status is in disagreement, then one may have failed or is not installed correctly. In this case, the machine will be inoperable.

**FAULT CODES**

Refer to Table 6-13 for more fault code information

- **0039** - SkyGuard switch activation fault
- **2563** - switch disagreement fault

**Table 4-2. SkyGuard Function Table**

Drive Forward	Drive Reverse	Steer	Swing	Tower Lift Up	Tower Tele Out	Tower Lift Down	Boom Tele In	Boom Lift Up	Boom Lift Down	Boom Tele In	Boom Tele Out	Jib Lift	Basket Level	Basket Rotate
R*/C**	R	C	R	R	C	C	C	R	R	R	C	C	C	C
R = Indicates Reversal is Activated														
C = Indicates Cutout is Activated														
*DOS (Drive Orientation System) Enabled														
** DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active														
<b>Note:</b> If SkyGuard is enabled with the SOft Touch system, functions will cutout instead of reversing.														

### 4.19 BOLT-ON EXTERNAL FALL ARREST

The Bolt-On External Fall Arrest system is designed to provide a lanyard attach point while allowing the operator to access areas outside the platform. Exit/Enter the platform through the gate area only. The system is designed for use by one person.

Personnel must use fall protection at all times. A full body harness is required with lanyard not to exceed 6 ft. (1.8 M) in length, that limits the maximum arrest force to 900 lbs. (408 kg).

Bolt-On External Fall Arrest System capacity is 310 lb (140 kg) - one (1) person maximum.

Do not move the platform during use of the Bolt-On External Fall Arrest system.

**⚠ WARNING**

**DO NOT OPERATE ANY MACHINE FUNCTIONS WHILE OUTSIDE OF PLATFORM. BE CAREFUL WHEN ENTERING/EXITING THE PLATFORM AT ELEVATION.**

**⚠ WARNING**

**IF THE BOLT-ON EXTERNAL FALL ARREST SYSTEM IS USED TO ARREST A FALL OR IS OTHERWISE DAMAGED, THE ENTIRE SYSTEM MUST BE REPLACED AND THE PLATFORM FULLY INSPECTED BEFORE RETURNING TO SERVICE. REFER TO THE SERVICE MANUAL FOR REMOVAL AND INSTALLATION PROCEDURES.**

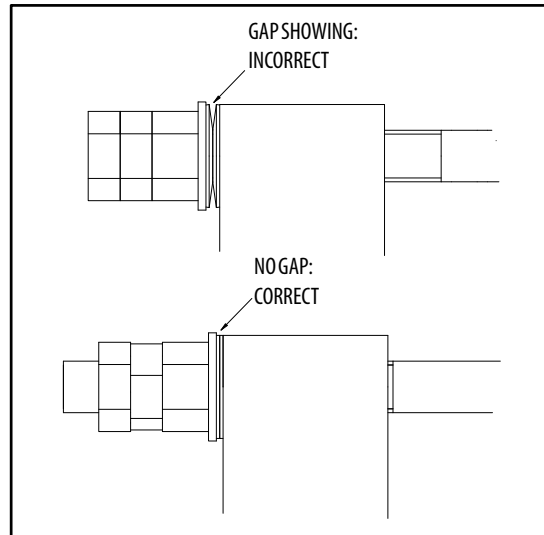
**THE BOLT-ON EXTERNAL FALL ARREST SYSTEM REQUIRES AN ANNUAL INSPECTION AND CERTIFICATION. THE ANNUAL INSPECTION AND CERTIFICATION MUST BE PERFORMED BY A QUALIFIED PERSON OTHER THAN THE USER.**

#### Inspection Before Use

The Bolt-On External Fall Arrest system must be inspected before each use of the aerial work platform. Replace components if there are any signs of wear or damage.

Before each use, perform a visual inspection of the following components:

- Cable: Inspect cable for proper tension, broken strands, kinks, or any signs of corrosion.

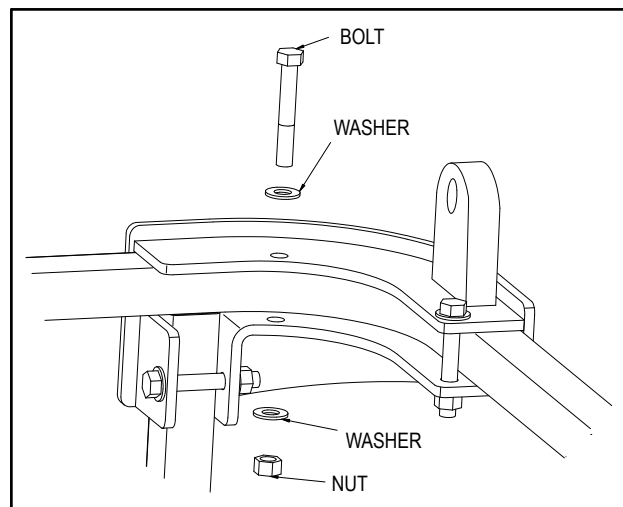


**Figure 4-27. Bolt-On External Fall Arrest Cable Tension**

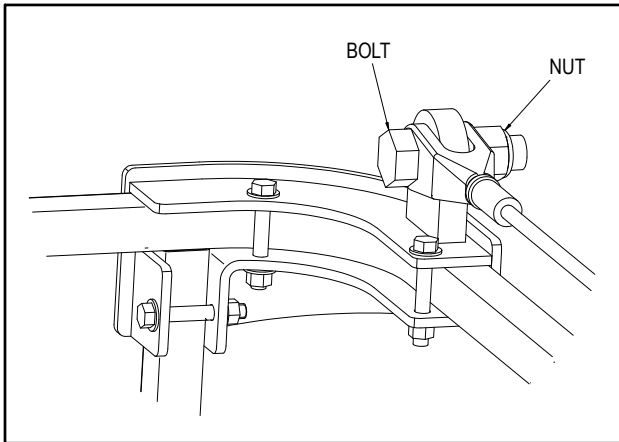
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are no missing components and hardware is properly tightened.
- Platform Rails: No visible damage is acceptable.

#### Installation

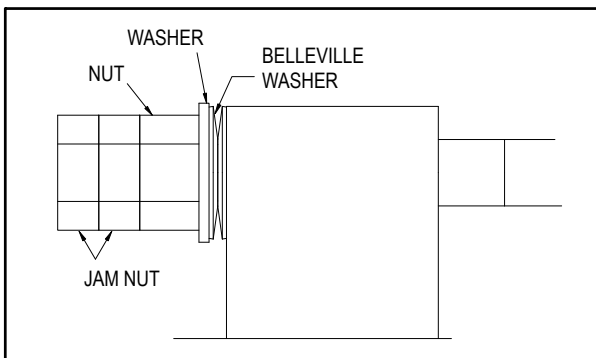
1. Install the retaining hardware (bolts, nuts, and washers) and secure the brackets to the platform rail. Tighten the nuts but do not torque them yet.



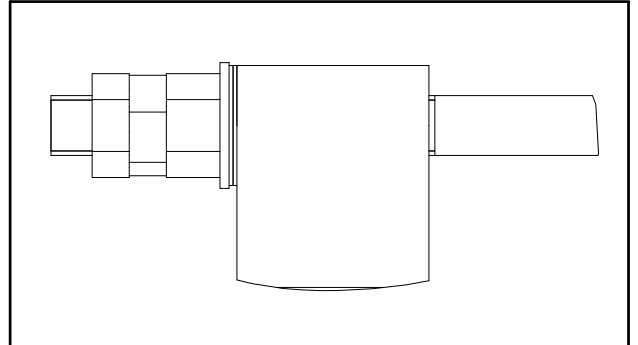
2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.



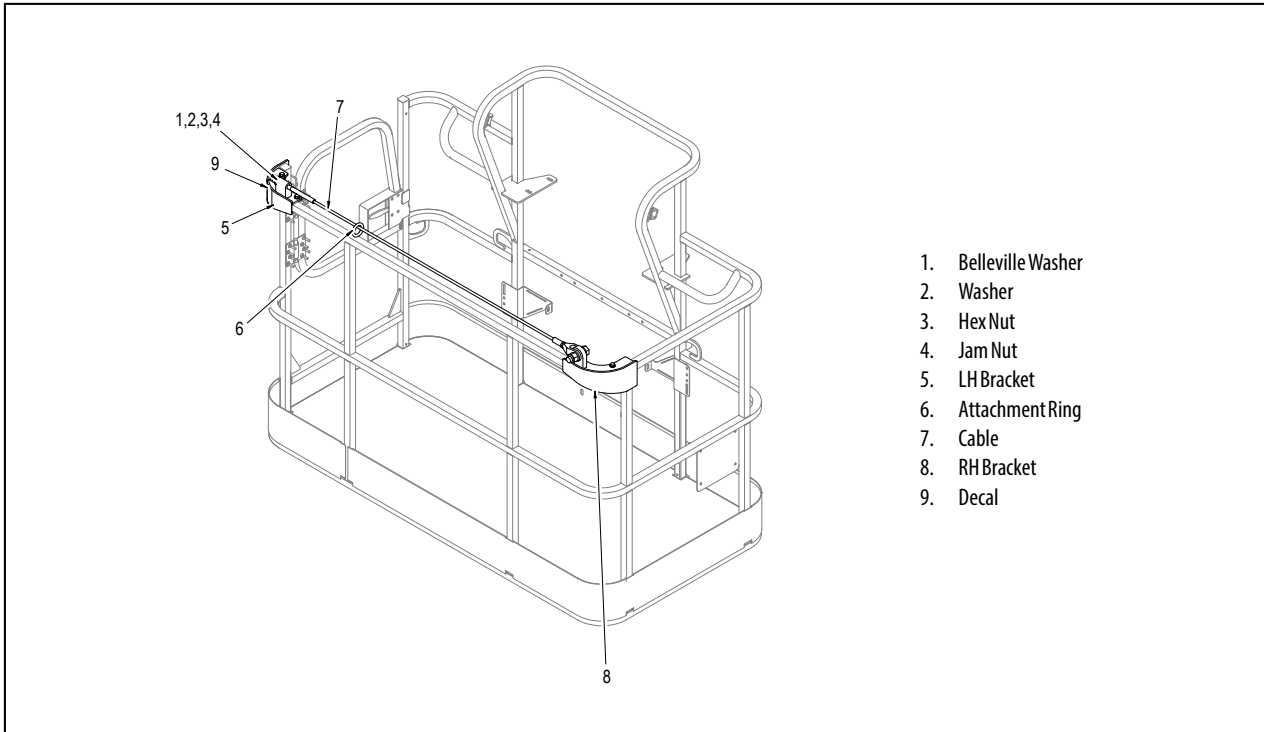
3. Install the Attachment Ring onto the cable.
4. Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. Orient the hardware as shown below and with the belleville washers so the gap is present at the outside diameter of the washers. install the nuts onto the cable finger tight so the mark on the cable does not move.



5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.
7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).



**Figure 4-28. Bolt-On External Fall Arrest System**

## SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

### 5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

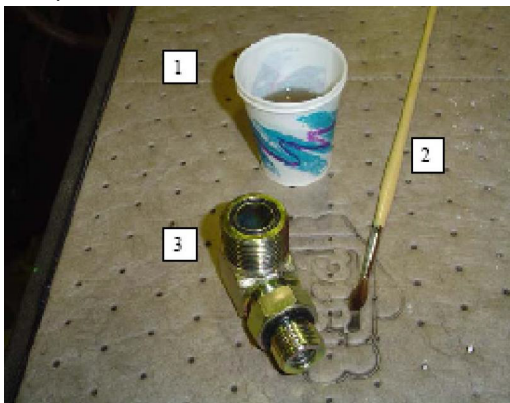
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

**NOTE:** All O-ring fittings must be pre-lubricated with hydraulic oil prior to assembly.

#### Cup and Brush

The following is needed to correctly oil the o-ring in this manner:

- A small container for hydraulic oil
- Small paint brush



1. Hold the fitting in one hand while using the brush with the other hand to dip into the container. Remove excess hydraulic oil from the brush so an even film of oil is applied on the o-ring.



2. Holding the fitting over the hydraulic oil container, brush an even film of oil around the entire o-ring in the fitting, making sure the entire o-ring is completely saturated.



3. Turn the o-ring on the other side of the fitting and repeat the previous step, ensuring the entire o-ring is coated with hydraulic oil.



### Dip Method

**NOTE:** This method works best with Face Seal o-rings, but will work for all o-ring fitting types.

The following is needed to correctly oil the o-ring in this manner:

- A small leak proof container
  - Sponge cut to fit inside the container
  - A small amount of hydraulic oil to saturate the sponge.
1. Place the sponge inside the container and add hydraulic oil to the sponge until it is fully saturated.
  2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.



3. O-ring Boss type fittings will require more pressure in able to immerse more of the fitting into the saturated sponge. This will also cause more oil to be dispersed from the sponge.



### Spray Method

This method requires a pump or trigger spray bottle.

1. Fill the spray bottle with hydraulic oil.
2. Hold the fitting over a suitable catch can.
3. Spray the entire o-ring surface with a medium coat of oil.



### Brush-on Method

This method requires a sealed bottle brush.

1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.



## 5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

### Tapered Thread Types

NPTF = national tapered fuel (Dry Seal) per SAE J476/J512

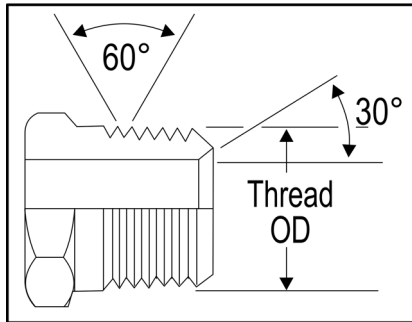


Figure 5-1. NPTF Thread

BSPT = British standard pipe tapered per ISO7-1

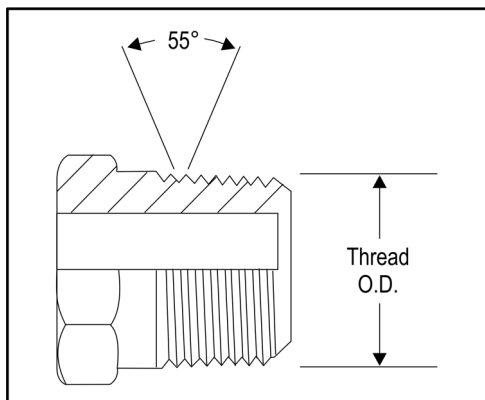


Figure 5-2. BSPT Thread

### Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

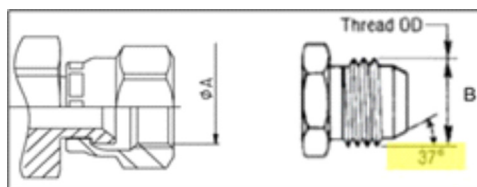


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

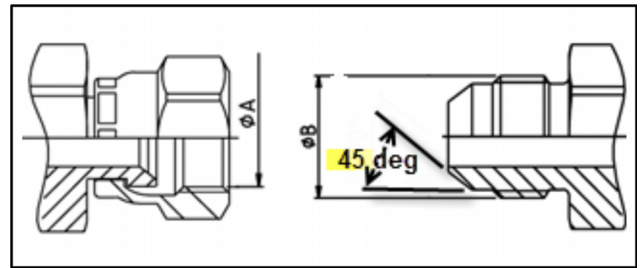


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

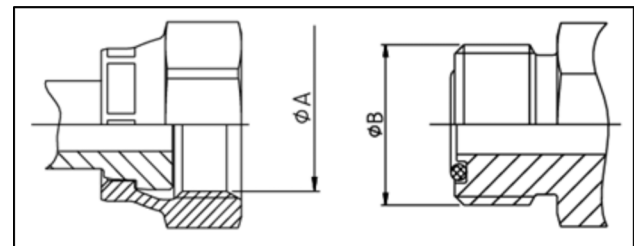


Figure 5-5. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353

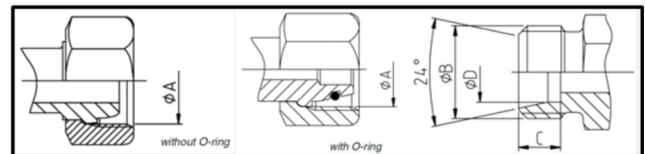


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

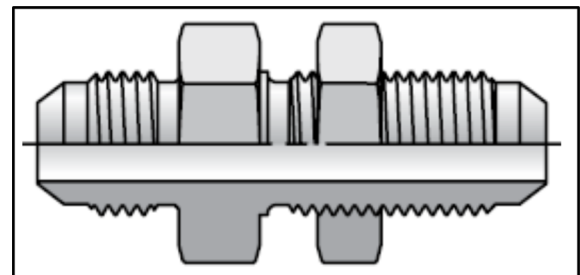


Figure 5-7. Bulkhead Thread

### Straight Thread Types, Port Connections

ORB = o-ring boss per SAE J1926, ISO 11926

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852

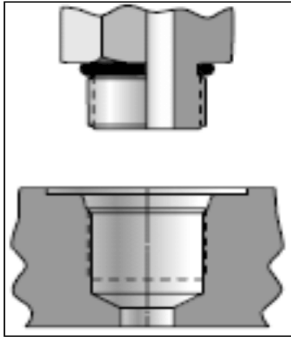


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

BSPB = British standard parallel pipe per ISO 1179-1, DIN 3852-2

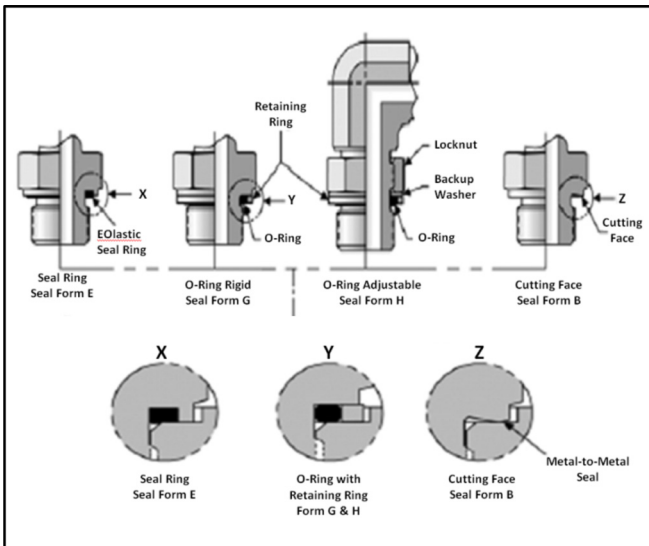


Figure 5-9. MFF-BSPB Thread

### Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

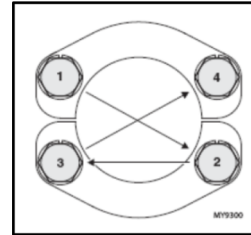


Figure 5-10. ORB-MPP Thread

### Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft-lbs [4 N-m] Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats from Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

## Assembly And Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

### GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
  - a. Avoid using dirty or oily rags when handling fittings.
  - b. If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
  - c. Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
  - d. Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
  - e. Sealant should only be applied to the male threads.
  - f. Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
  - g. When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
  - h. When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.
4. Take care to identify the material of parts to apply the correct torque values.
  - a. Verify the material designation in the table headings.
  - b. If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the main limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.
6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection

**Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.**

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Loctite 567, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

**⚠ CAUTION**

**OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.**

**NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.**

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

**NOTE:** TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:

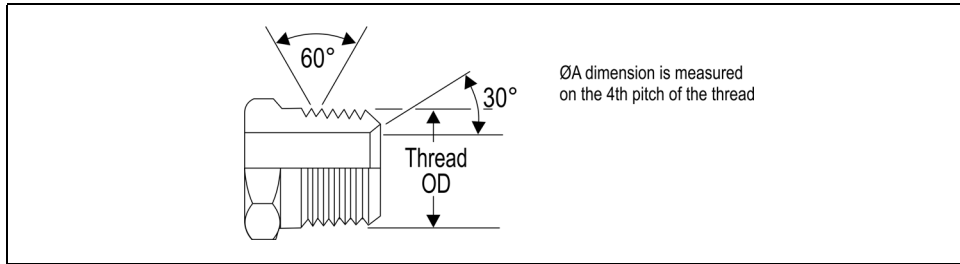
- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

**Table 5-1. NPTF Pipe Thread**

TYPE/FITTING IDENTIFICATION					
Material	Dash Size	Thread Size	ØA*		Turns From Finger Tight (TFFT)**
		(UNF)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-27	0.40	10.24	2 to 3
	4	1/4-18	0.54	13.61	2 to 3
	6	3/8-18	0.67	17.05	2 to 3
	8	1/2-14	0.84	21.22	2 to 3
	12	3/4-14	1.05	26.56	2 to 3
	16	1-11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4-11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2-11 1/2	1.89	48.05	1.5 to 2.5
	32	2-11 1/2	2.37	60.09	1.5 to 2.5

\* ØA thread dimension for reference only.

\*\* See FFWR and TFFT Methods subsection for TFFT procedure requirements.



### Assembly Instructions for British Standard Pipe Thread Tapered (BSPT) Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Loctite 567, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

**⚠ CAUTION**

**OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.**

**NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS**

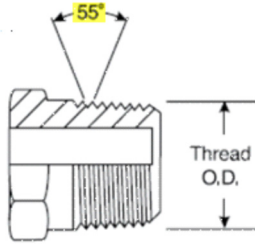
**TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.**

5. Rotate male fitting the number of turns per Table 5-2, BSPT Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

**NOTE:** TFFT values provided in Table 5-2, BSPT Pipe Thread are applicable for the following material configurations:

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-2. BSPT Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size	ØA*		
		(BSPT)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-28	0.38	9.73	2 to 3
	4	1/4-19	0.52	13.16	2 to 3
	6	3/8-19	0.66	16.66	2 to 3
	8	1/2-14	0.83	20.96	2 to 3
	12	3/4-14	1.04	26.44	2 to 3
	16	1-11	1.31	33.25	1.5 to 2.5
	20	1 1/4-11	1.65	41.91	1.5 to 2.5
	24	1 1/2-11	1.88	47.80	1.5 to 2.5
32	2-11	2.35	59.61	1.5 to 2.5	

\* ØA thread dimension for reference only.  
 \*\* See Appendix B for TFFT procedure requirements.

### Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

**⚠ CAUTION**

**DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.**

2. Align tube to fitting and start threads by hand.

**⚠ CAUTION**

**THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

3. Torque assembly to value listed in Table Table 5-3, 37° Flare (JIC)Thread - Steel or Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

**NOTE:** *Torque values provided in Table Table 5-3, 37° Flare (JIC)Thread - Steel and Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-3. 37° Flare (JIC) Thread - Steel

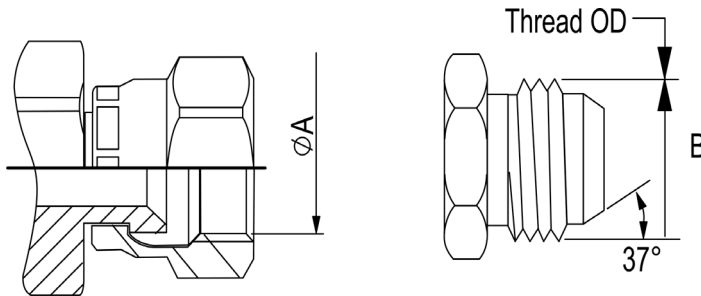
Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1	

\* ØA and ØB thread dimensions for reference only.

\*\* See Appendix B for FFWR procedure requirements.

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**Table 5-4. 37° Flare (JIC)Thread - Aluminum/Brass**



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size (UNF)	ØA*		ØB*		[Ft-Lb]			[N-m]			
			(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	11/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	13/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	15/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	15/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	17/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
32	2 1/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1	

\* ØA and ØB thread dimensions for reference only.

\*\* See FFWR and TFFT Methods for FFWR procedure requirements.

### Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

**⚠ CAUTION**

**DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.**

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

**⚠ CAUTION**

**THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

Torque fitting to value listed in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass while using the Double Wrench Method outlined in this section. Refer to FFWR and TFFT Methods for procedure requirements if using the TFFT method.

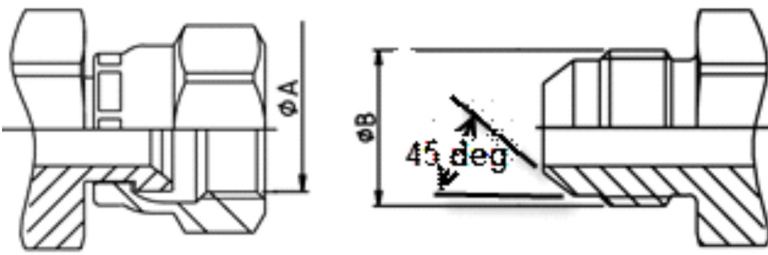
**NOTE:** *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

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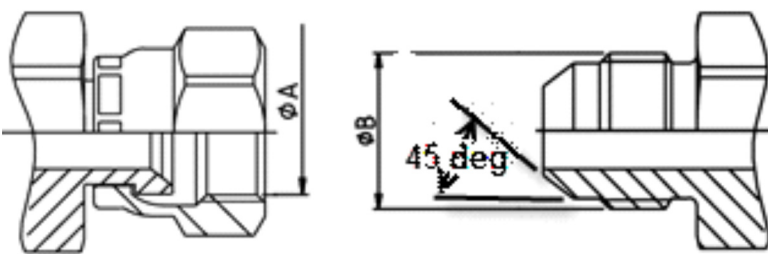
**Table 5-5. 45° Flare (SAE) - Steel**



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	1 1/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

\* ØA and ØB thread dimensions for reference only.  
 \*\* See FFWR and TFFT Methods for FFWR procedure requirements.

**Table 5-6. 45° Flare (SAE) - Aluminum/Brass**



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	1 1/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83

\* ØA and ØB thread dimensions for reference only.  
 \*\* See FFWR and TFFT Methods for TFFT procedure requirements.

### Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).
2. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

**⚠ CAUTION**

**CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.

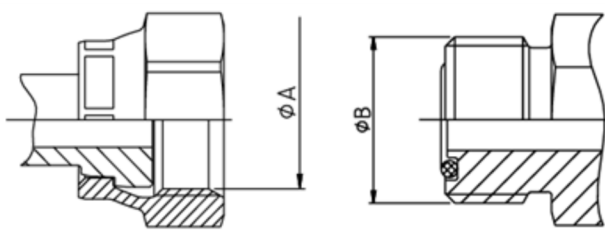
5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

**NOTE:** Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components

**Table 5-7. O-ring Face Seal (ORFS) - Steel**



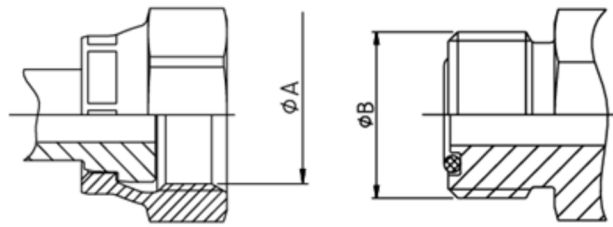
TYPE/FITTING IDENTIFICATION						Torque						Flats from Wrench Resistance (F.F.W.R)**		
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	1 1/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
32	2 1/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4	

\* ØA and ØB thread dimensions for reference only.

\*\* See FFWR and TFFT Methods for FFWR procedure requirements.

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**Table 5-8. O-ring Face Seal (ORFS) - Aluminum/Brass**



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

\* ØA and ØB thread dimensions for reference only.

\*\* See FFWR and TFFT Methods for FFWR procedure requirements.

## Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

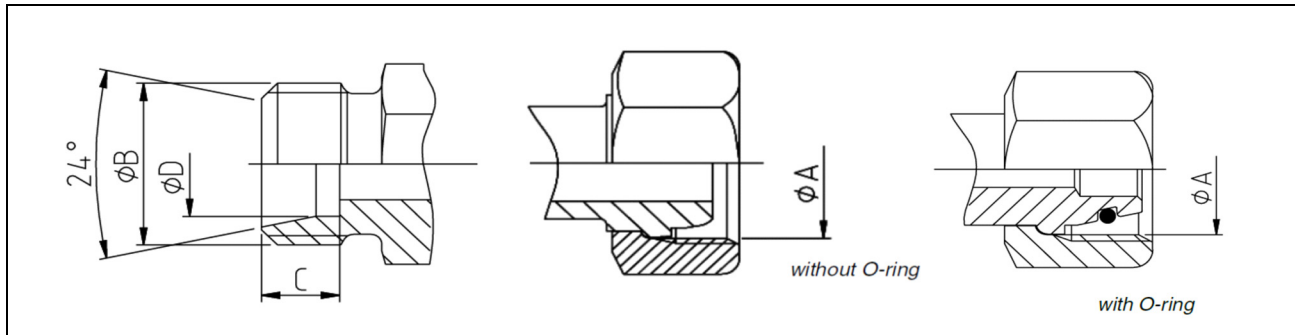
**⚠ CAUTION**

**A NON-SQUARE TUBE END CAN CAUSE IMPROPERLY SEATED FITTINGS AND LEAKAGE.**

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table Table 5-9, DIN 24°Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

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**Table 5-9. DIN 24° Cone (MBTL & MBTS)**



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)							
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance (F.F.W.R)**	
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	[Ft-Lb]			[N-m]				
								Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly.  Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection.  Refer to the specific procedure in the						1.5 to 1.75	
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75	
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75	
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75	
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75	
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75	
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75	
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75	
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75	
	42	M52x2	49.90	52.00	11.00	42.30	1.5 to 1.75								
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance (F.F.W.R)**
			(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	[Ft-Lb]			[N-m]			
									Min	Nom	Max	Min	Nom	Max	
		DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly.  Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection.  Refer to the specific procedure in the						1.5 to 1.75
			8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
			10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
			12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
			14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
			16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
20			M30x2	27.90	30.00	10.50	20.20	1.5 to 1.75							
25	M36x2		33.90	36.00	12.00	25.20	1.5 to 1.75								
30	M42x2	39.90	42.00	13.50	30.20	1.5 to 1.75									
38	M52x2	49.90	52.00	16.00	38.30	1.5 to 1.75									

\* ØA, ØB, C, & ØD thread dimensions for reference only.

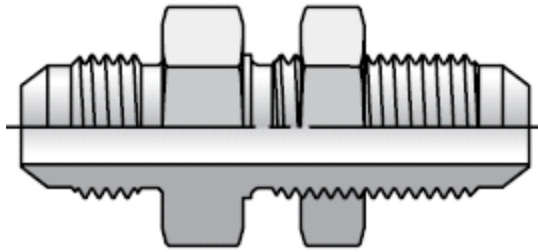
\*\* See Appendix B for FFWR procedure requirements.

### **Assembly Instructions for Bulkhead (BH) Fittings**

- 1.** Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
- 2.** Remove the locknut from the bulkhead assembly.
- 3.** Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
- 4.** Hand thread the locknut onto the bulkhead end of the fitting body.
- 5.** Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

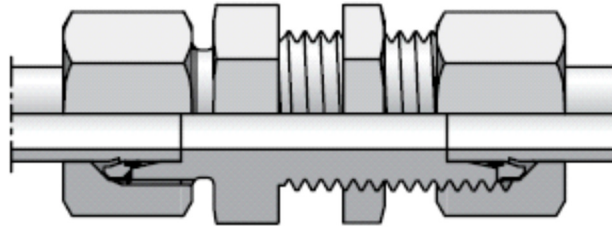
**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**Table 5-10. Bulkhead Fittings (BH) - INCH**



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors							
MATERIAL	TYPE	Dash Size	Thread Size	Torque							
				[Ft-Lb]			[N-m]				
			(UNF)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23		
		6	11/16-16	25	27	28	34	37	38		
		8	13/16-16	55	58	61	75	79	83		
		10	1-14	85	90	94	115	122	127		
		12	13/16-12	135	142	149	183	193	202		
		14	15/16-12	170	179	187	230	243	254		
		16	17/16-12	200	210	220	271	285	298		
		20	111/16-12	245	258	270	332	350	366		
	24	2-12	270	284	297	366	385	403			
	37° FLARE (JIC) BULKHEAD FITTING	TYPE	Dash Size	Thread Size	Torque						
					[Ft-Lb]			[N-m]			
						Min	Nom	Max	Min	Nom	Max
						(UNF)					
			3	3/8-24	8	9	9	11	12	12	
			4	7/16-20	13	14	14	18	19	19	
			5	1/2-20	20	21	22	27	28	30	
			6	9/16-18	25	27	28	34	37	38	
			8	3/4-16	50	53	55	68	72	75	
			10	7/8-14	85	90	94	115	122	127	
			12	11/16-12	135	142	149	183	193	202	
			14	13/16-12	170	179	187	230	243	254	
			16	15/16-12	200	210	220	271	285	298	
20			15/8-12	245	258	270	332	350	366		
24	17/8-12	270	284	297	366	385	403				
32	2 1/2-12	310	326	341	420	442	462				

Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
		(mm)	(metric)	[Ft-Lb]			[N-m]		
				Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
25	M36x2	150	157	164	203	213	222		
30	M42x2	155	162	169	210	220	229		
38	M52x2	220	230	240	298	312	325		

## Assembly Instructions for O-Ring Boss (ORB)

### Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

**⚠ CAUTION**

**CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-12 thru Table 5-17 while using the Double Wrench Method.
  - a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
  - b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
    - STEEL fittings with ALUMINUM or BRASS mating components
    - ALUMINUM or BRASS fittings with STEEL mating components
    - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6

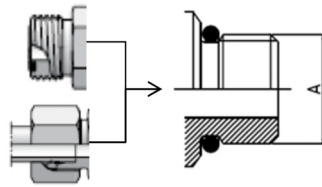
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

\* ØA Thread OD dimension for reference only.

\*\* Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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**Table 5-13. O-ring Boss (ORB) - Table 2 of 6**



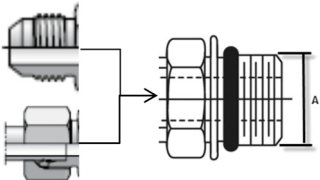
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

\* ØA Thread OD dimension for reference only.

\*\*Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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Table 5-14. O-ring Boss (ORB) - Table 3 of 6



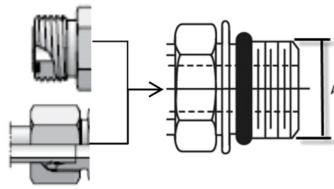
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

\* ØA Thread OD dimension for reference only.

\*\* Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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**Table 5-15. O-ring Boss (ORB) - Table 4 of 6**



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	

\* ØA Thread OD dimension for reference only.

\*\*Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

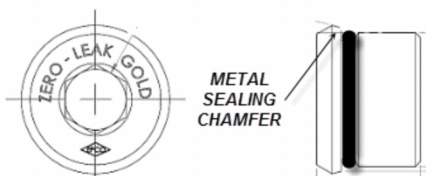
SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

Table 5-16. O-ring Boss (ORB) - Table 5 of 6

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
32	2 1/2-12	2.50	63.50	375	394	413	510	534	560	
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
32	2 1/2-12	2.50	63.50	244	256	268	331	347	363	
* ØA Thread OD dimension for reference only.										
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.										

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**Table 5-17. O-ring Boss (ORB) - Table 6 of 6**



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
32	2 1/2-12	2.50	63.50							
TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
32	2 1/2-12	2.50	63.50							

\* ØA Thread OD dimension for reference only.

\*\*Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

## Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

### CAUTION

**CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

3. Pre-lubricate the O-ring with Hydraulic Oil.
  4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
  5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
    - a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
    - b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
      - STEEL fittings with ALUMINUM or BRASS mating components
      - ALUMINUM or BRASS fittings with STEEL mating components
      - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
  7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

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**Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3**

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

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Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

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**Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3**

TYPE/FITTING IDENTIFICATION		BANJO FITTINGS with L series DIN (MBTL) opposite end							HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end							FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D. (mm)	Torque						Torque						Torque						
	(metric)		[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14	
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27	
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39	
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61	
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72	
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99	
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149	
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248	
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397	
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9	
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18	
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26	
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39	
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46	
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64	
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98	
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161	
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258	
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258	

Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
	(metric)	(mm)	[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

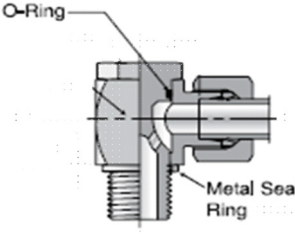
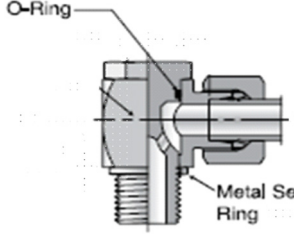
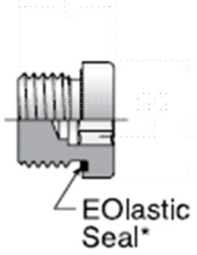
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**Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3**

TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size (metric)	Connecting Tube O.D. (mm)	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

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Table 5-23. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

																													
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end									HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end									FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS								
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque									Torque									Torque								
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]											
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max									
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--									
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--									
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--									
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--									
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88									
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--									
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--									
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--									
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--									
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--									
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--									
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--									
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--									
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--									
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57									
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--									
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--									
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--									
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--									
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--									

## Assembly Instructions for Metric ISO 6149 (MPP)

### Port Assembly Stud Ends

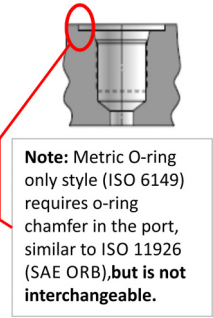
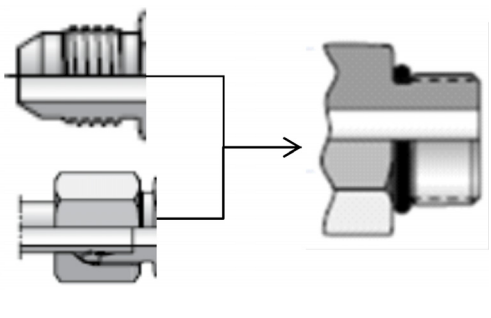
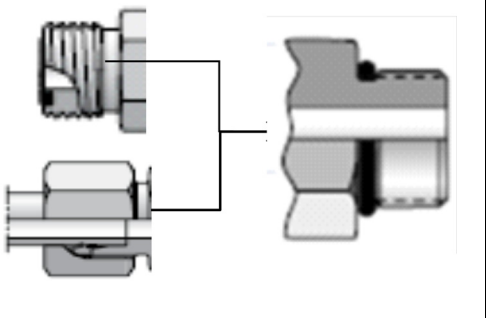
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

**⚠ CAUTION**

**CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

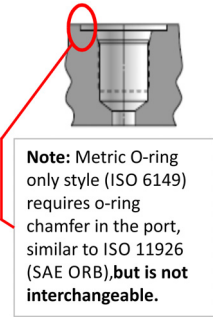
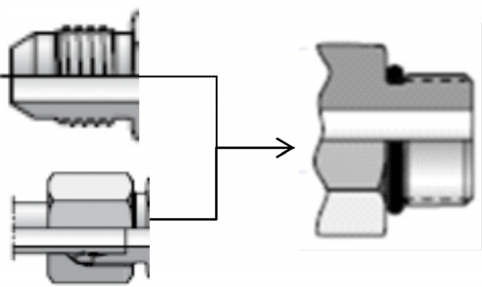
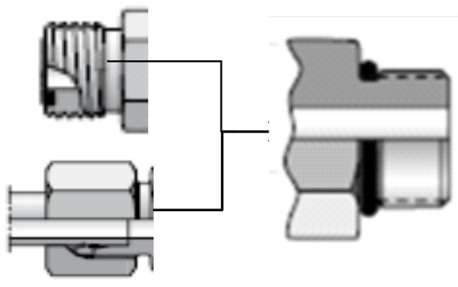
3. Pre-lubricate the O-ring with Hydraulic Oil.
  4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
  5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
    - a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
    - b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
      - STEEL fittings with ALUMINUM or BRASS mating components
      - ALUMINUM or BRASS fittings with STEEL mating components
      - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
  7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)

 <p><b>Note:</b> Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), but is not interchangeable.</p>														
<b>TYPE/FITTING IDENTIFICATION</b>			<b>STUD ENDS</b> with 37° (JIC) or L series DIN (MBTL) opposite end						<b>STUD ENDS</b> with (ORFS) or S series DIN (MBTS) opposite end					
<b>MATERIAL</b>	<b>Thread M Size</b>	<b>Connecting Tube O.D.</b>	<b>Torque</b>						<b>Torque</b>					
			<b>[Ft-Lb]</b>			<b>[N-m]</b>			<b>[Ft-Lb]</b>			<b>[N-m]</b>		
	<b>(metric)</b>	<b>(mm)</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>
<b>STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN- LUBRICATED THREADS</b>	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462	
M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552	

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)**

 <p><b>Note:</b> Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), but is not interchangeable.</p>														
<b>TYPE/FITTING IDENTIFICATION</b>			<b>STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end</b>						<b>STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end</b>					
<b>MATERIAL</b>	<b>Thread M Size</b>	<b>Connecting Tube O.D.</b>	<b>Torque</b>						<b>Torque</b>					
			<b>[Ft-Lb]</b>			<b>[N-m]</b>			<b>[Ft-Lb]</b>			<b>[N-m]</b>		
	<b>(metric)</b>	<b>(mm)</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>	<b>Min</b>	<b>Nom</b>	<b>Max</b>
<b>ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS</b>	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301	
M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359	

### Assembly Instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

**⚠ CAUTION**

**CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.**

3. Pre-lubricate the O-ring with Hydraulic Oil.
  4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
  5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
    - a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
    - b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:
      - STEEL fittings with ALUMINUM or BRASS mating components
      - ALUMINUM or BRASS fittings with STEEL mating components
      - ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.
  7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3**

TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B**(CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

\*Typical for JLG Straight Male Stud Fittings

\*\* Non typical for JLG Straight Male Stud Fittings, reference only.

\*\*\* Typical for JLG Adjustable Fittings

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

Table 5-26. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3

TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386

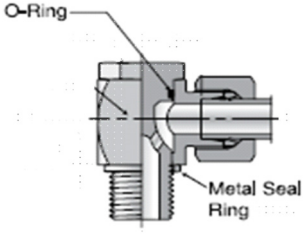
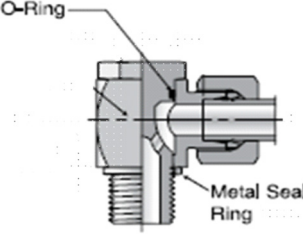
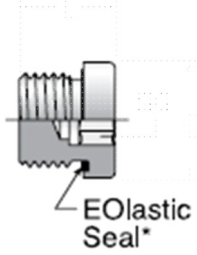
\*Typical for JLG Straight Male Stud Fittings

\*\* Non typical for JLG Straight Male Stud Fittings, reference only.

\*\*\* Typical for JLG Adjustable Fittings

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**Table 5-27. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3**

																													
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end									HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end									FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS								
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque									Torque									Torque								
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]											
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max									
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15									
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33									
	G 1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33									
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65									
	G 1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88									
	G 1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88									
	G 3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153									
	G 1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221									
	G 1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450									
	G 1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495									
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9									
	G 1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22									
	G 1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22									
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42									
	G 1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57									
	G 1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57									
	G 3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99									
	G 1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144									
	G 1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321									
	G 1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321									

\* Typical for JLG Straight Male Stud Fittings

\*\* Non typical for JLG Straight Male Stud Fittings, reference only.

\*\*\* Typical for JLG Adjustable Fittings

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

Table 5-28. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3

TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

\* Typical for JLG Straight Male Stud Fittings

\*\* Non typical for JLG Straight Male Stud Fittings, reference only.

\*\*\* Typical for JLG Adjustable Fittings

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3**

TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

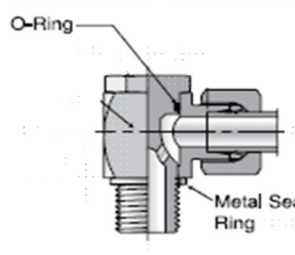
\* Typical for JLG Straight Male Stud Fittings

\*\* Non typical for JLG Straight Male Stud Fittings, reference only.

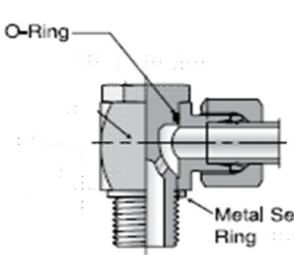
\*\*\* Typical for JLG Adjustable Fittings

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3


TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
			Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						



O-Ring  
Metal Seal Ring



O-Ring  
Metal Seal Ring



**Note:** BSPP O-ring only style (ISO 228-1) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), but is not interchangeable. Not typically used on JLG machines.

\* Typical for JLG Straight Male Stud Fittings

\*\* Non typical for JLG Straight Male Stud Fittings, reference only.

\*\*\* Typical for JLG Adjustable Fittings

**Assembly Instructions for Flange Connections:  
(FL61 and FL62)**

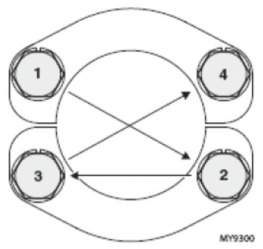
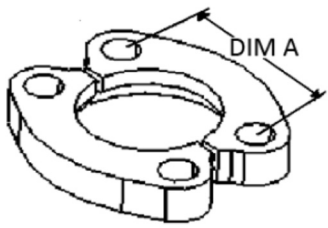
1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See Figure for O-ring installation instructions.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on Table Table 5-31 and Table 5-32.

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

Table 5-31. Flange Code (FL61 & FL62) -Inch Fasteners

TYPE/FITTING IDENTIFICATION		STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)																
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
		(in)	(mm)	(in)	(mm)		[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
							Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495

\* A dimension for reference only.



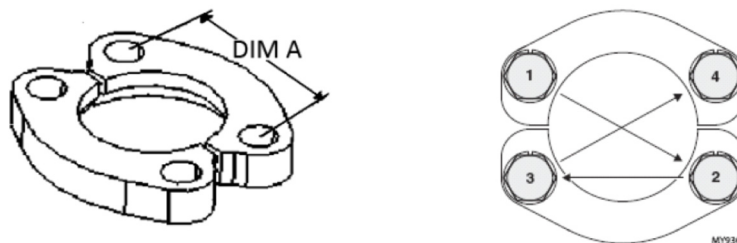
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**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners**

TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)												
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size (Metric)	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
		(in)	(mm)	(in)	(mm)		[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
							Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
	12	0.75	19	1.88	47.75	M8x1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8x1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10x1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14x2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16x2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20x2.5	--	--	--	--	--	--	406	426	446	550	578	605

\* A dimension for reference only.



### Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one back-up wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections,

the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.

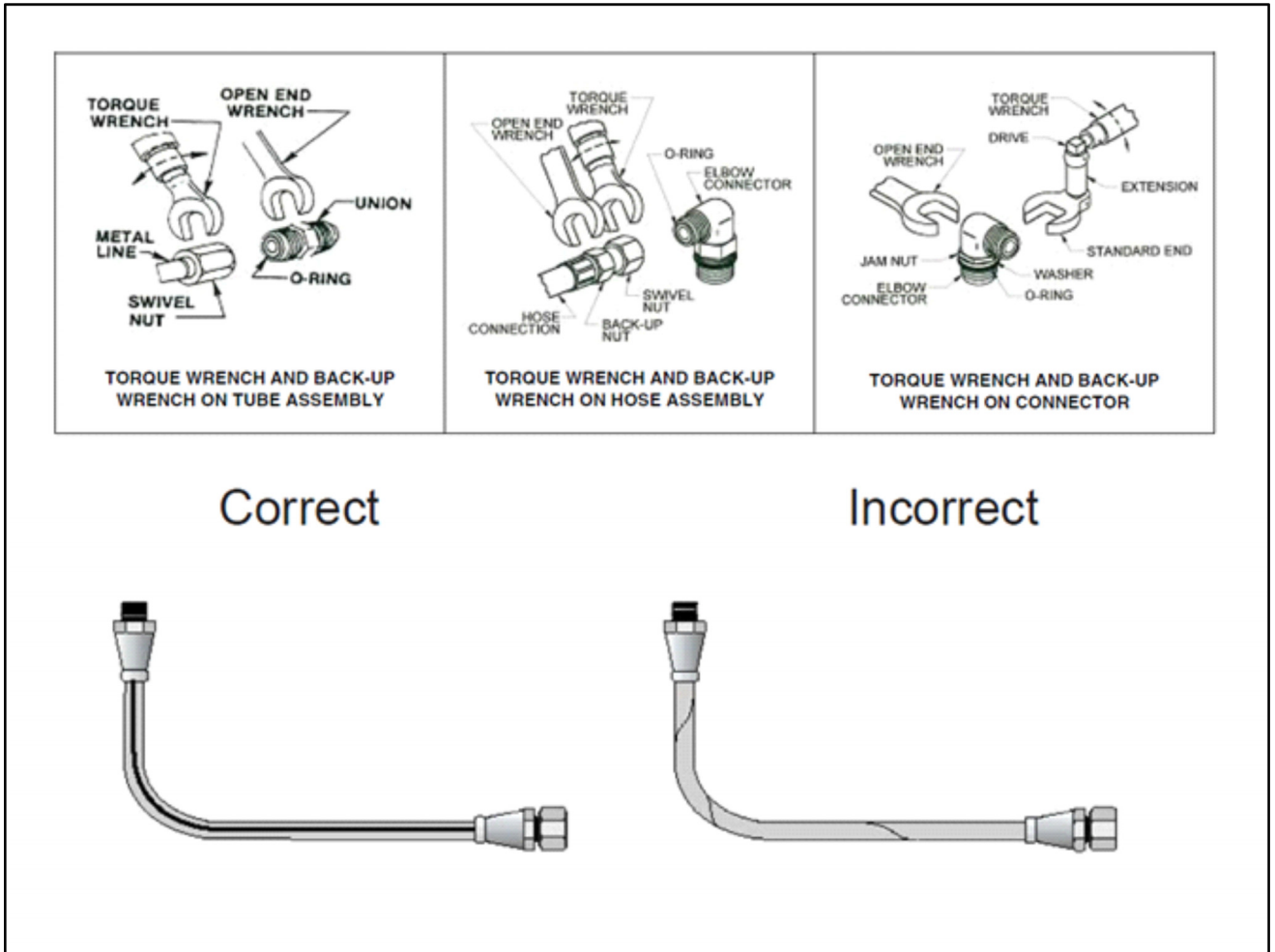


Figure 5-12. Double Wrench Method

### FFWR and TFFT Methods

#### FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. See Figure B.1.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in Figure B.1. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

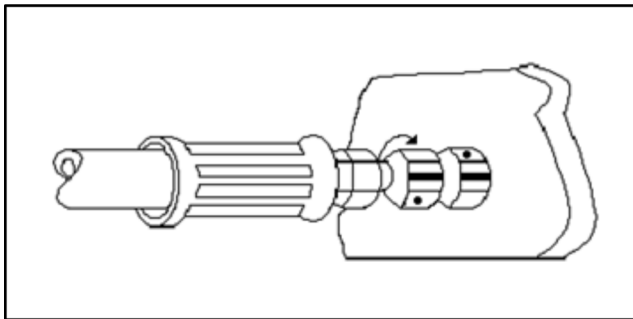


Figure 5-13. FFWR Method

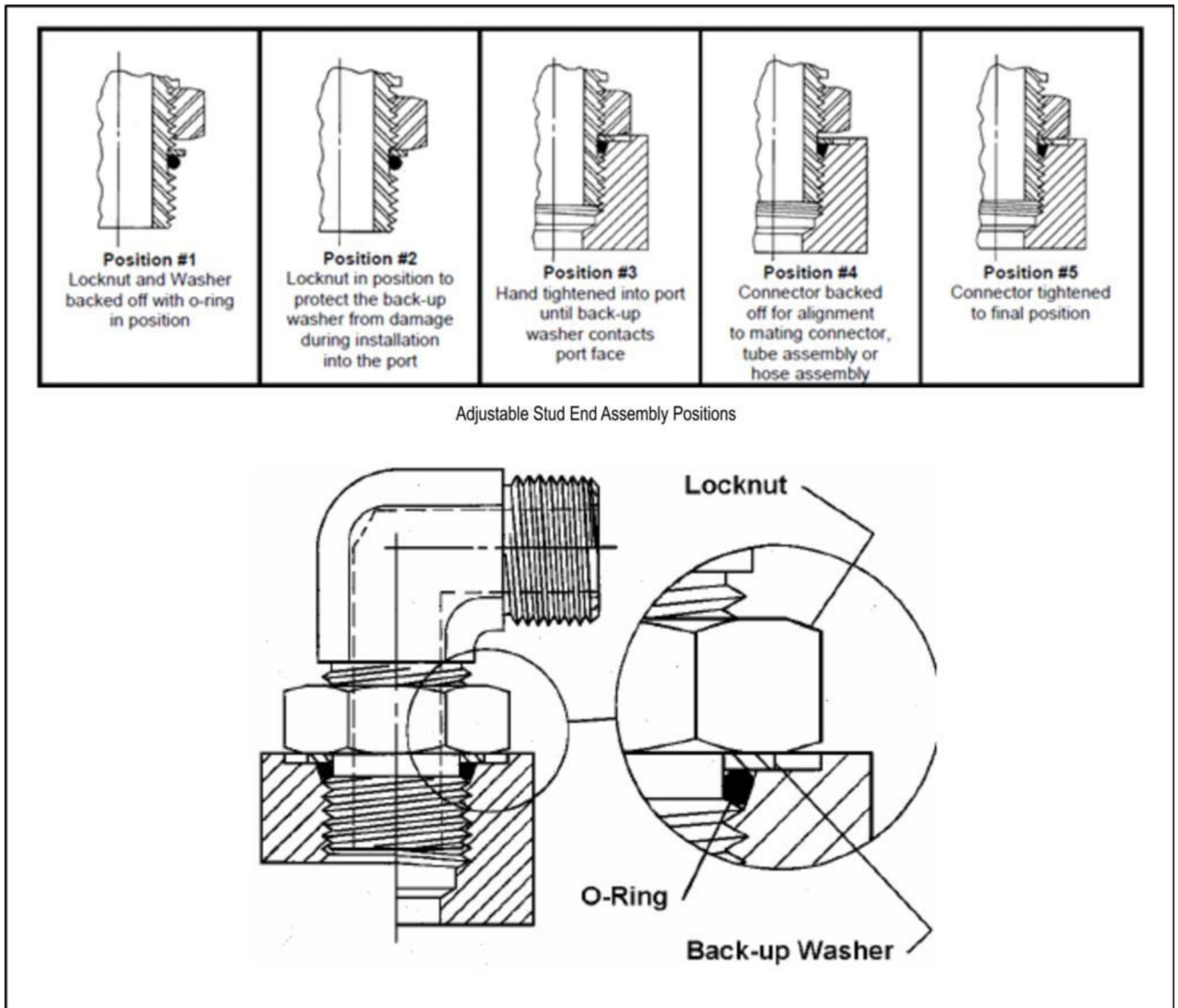
#### TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

### Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the back-up washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the back-up washer as shown. The locknut in this position will eliminate potential back up washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal back-up washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.



**Figure 5-14. Adjustable Stud End Assembly**

### O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

## 5.3 HYDRAULIC CYLINDERS

### Axle Lockout Cylinder

#### DISASSEMBLY

#### **NOTICE**

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

#### **⚠ WARNING**

ROD CAN FALL OUT OF BARREL AND CAUSE INJURY OR DAMAGE TO THE EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE ROD TO FALL OUT OF BARREL.

1. Open bleeder valve. Rotate rod and remove from barrel.
2. Remove wiper. Do not scratch barrel bore.
3. Remove two wear rings and rod seal from grooves of rod bore. Do not scratch barrel bore.
4. Remove counterbalance valve.

#### CLEANING AND INSPECTION

1. Inspect bore and rod for scoring, pitting, or excessive wear.
2. Remove minor surface blemishes with wet sandpaper. Pitting requires replacement of barrel and rod.
3. Clean all parts with approved solvent and dry with compressed air.

#### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

#### **NOTICE**

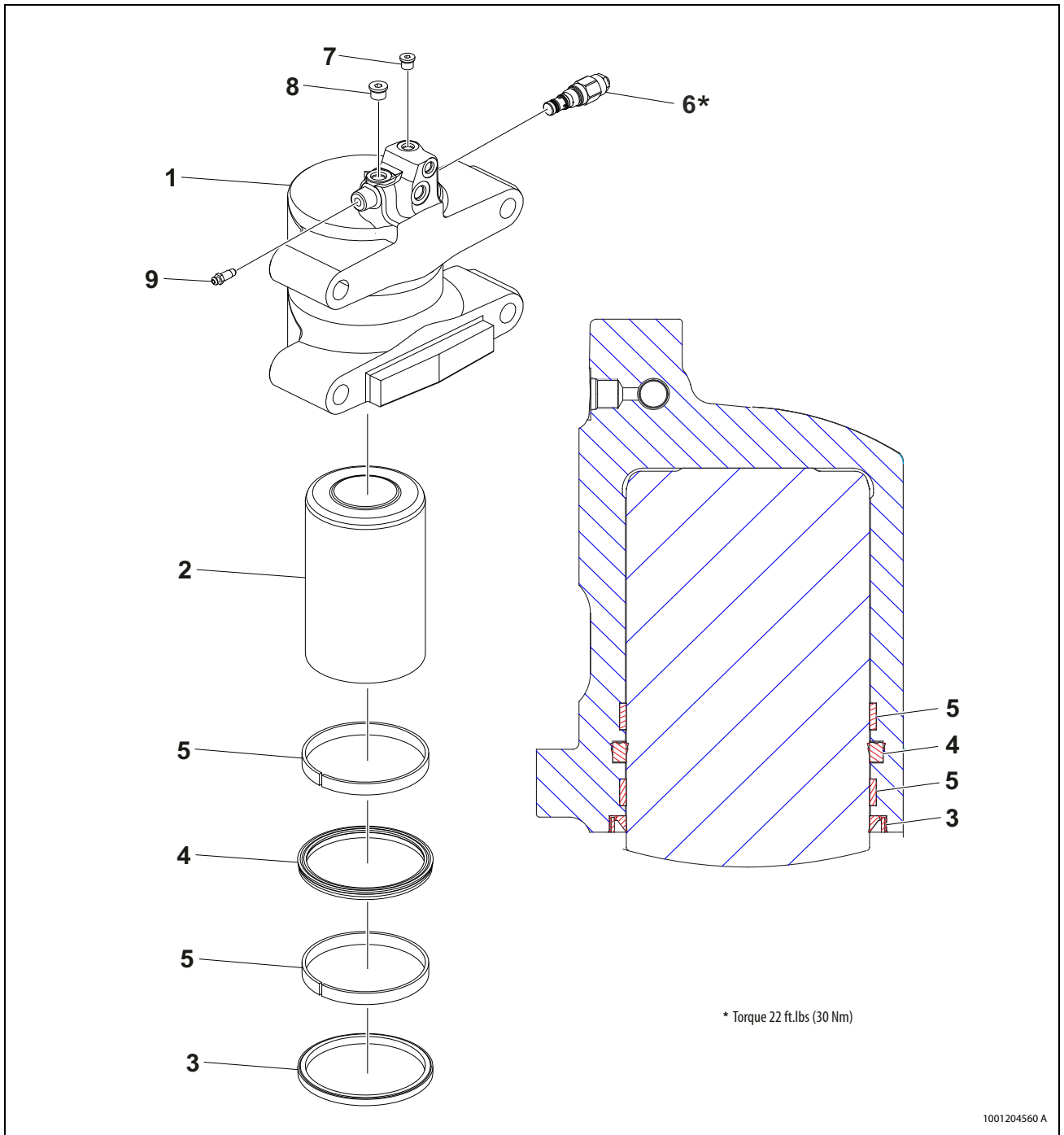
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

1. Install two new wear rings and rod seal in rod bore grooves. Make sure they are not twisted.
2. Install new wiper in barrel.
3. Lubricate rod bore with clean hydraulic fluid.

#### **NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE ROD. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE ROD AND CYLINDER BARREL SURFACES.

4. Install rod in bore and push to top of the bore.
5. Install counterbalance valve. Torque to 22 ft.lbs. (30 Nm).
6. Bleed system.



- |              |                         |
|--------------|-------------------------|
| 1. Barrel    | 6. Counterbalance Valve |
| 2. Rod       | 7. O-ring Plug          |
| 3. Wiper     | 8. O-ring Plug          |
| 4. Rod Seal  | 9. Bleeder Valve        |
| 5. Wear Ring |                         |

Figure 5-15. Axle Lockout Cylinder

**Platform Level Cylinder (800AJ - SN 0300183034 to Present, 800A - SN 0300183034 through 0300245050)**

**DISASSEMBLY**

**NOTICE**

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

**WARNING**

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

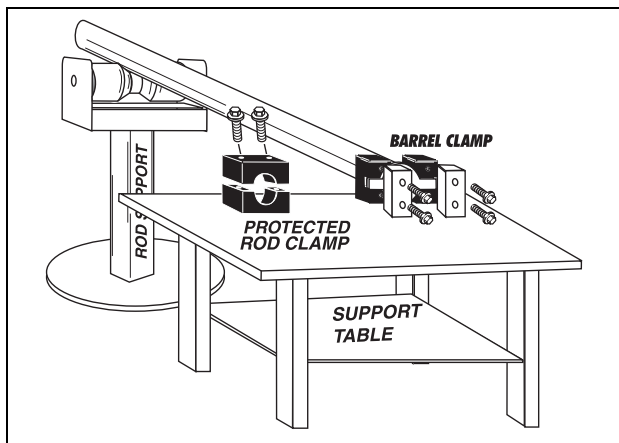


Figure 5-16. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

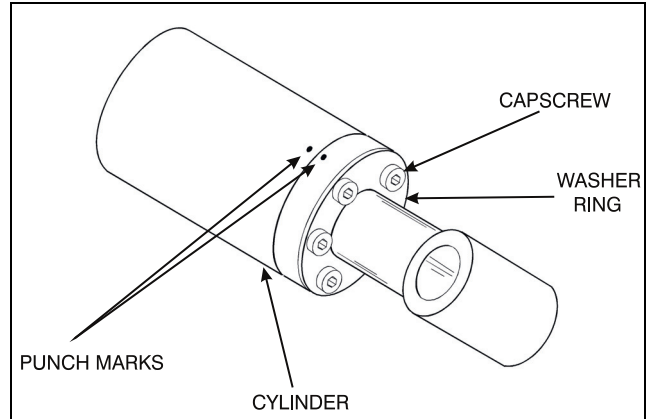


Figure 5-17. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

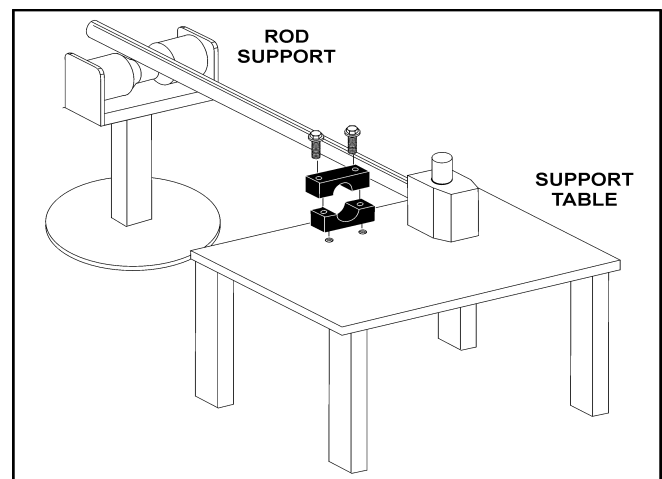
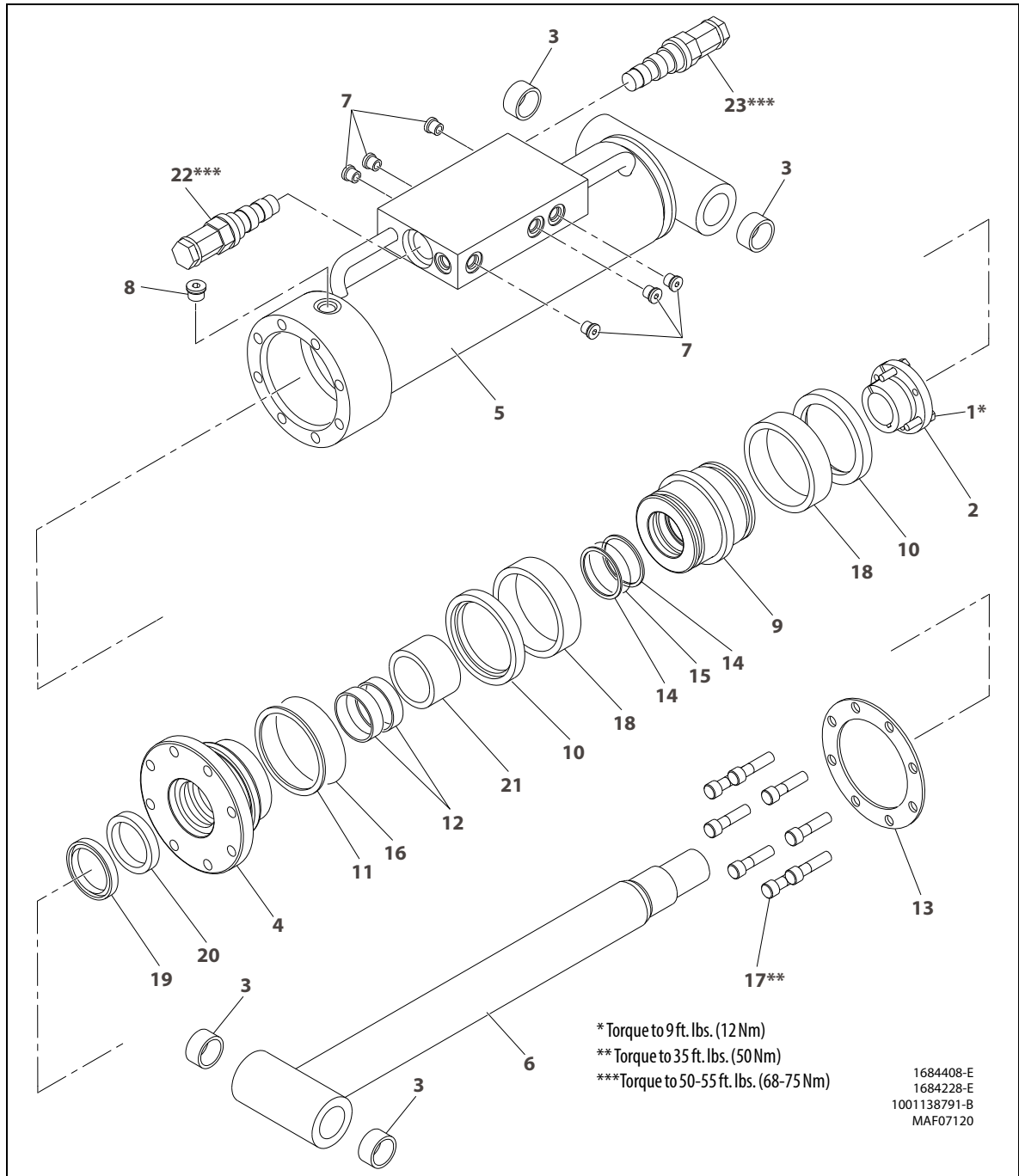


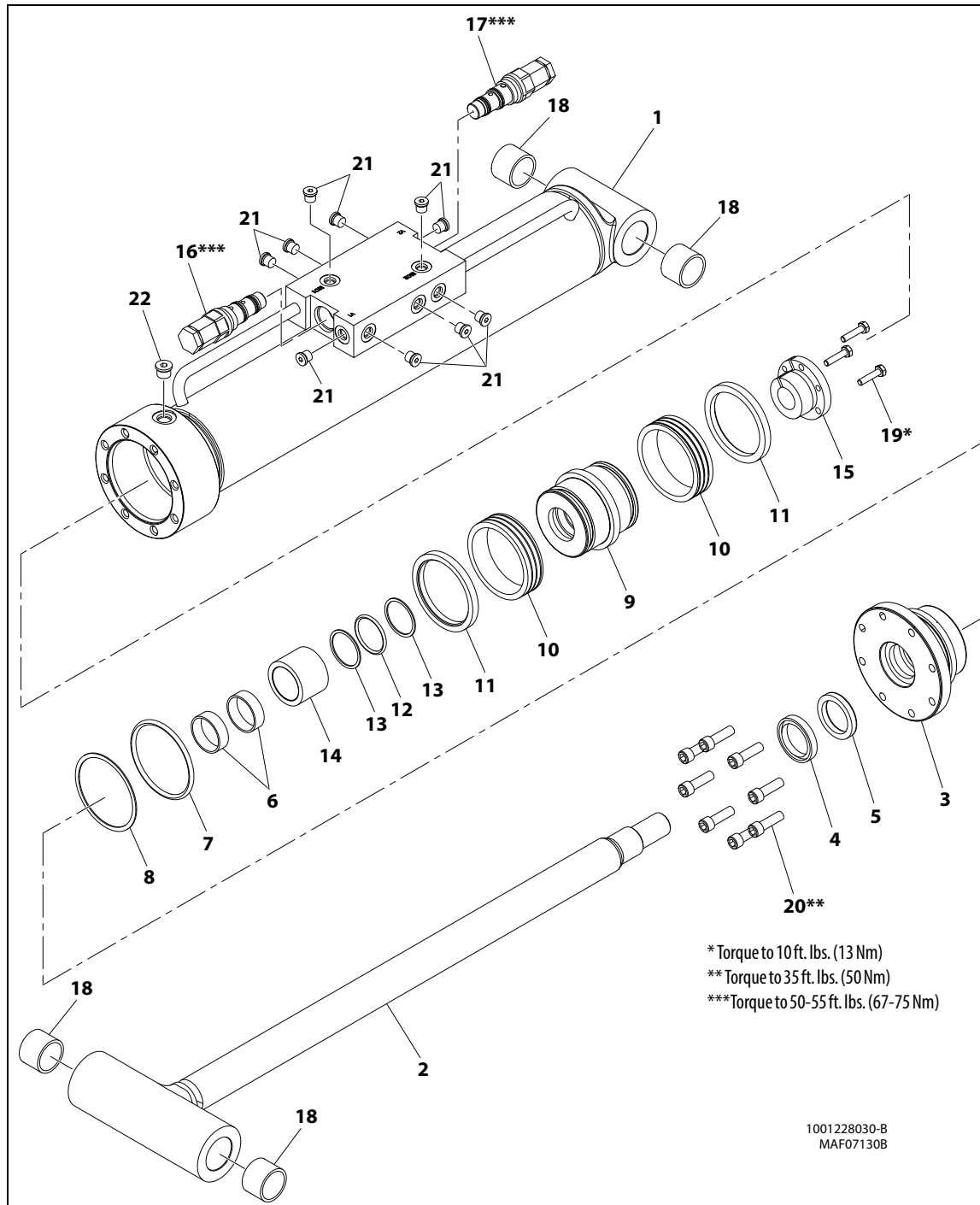
Figure 5-18. Cylinder Rod Support



- |                    |               |                 |              |                     |
|--------------------|---------------|-----------------|--------------|---------------------|
| 1. Capscrew        | 6. Rod        | 11. Backup Ring | 16. O-ring   | 21. Tube Spacer     |
| 2. Tapered Bushing | 7. Plug       | 12. Wear Ring   | 17. Capscrew | 22. Cartridge Valve |
| 3. Bushing         | 8. Plug       | 13. Washer Ring | 18. Seal     | 23. Cartridge Valve |
| 4. Head            | 9. Piston     | 14. Backup Ring | 19. Wiper    |                     |
| 5. Barrel          | 10. Lock Ring | 15. O-ring      | 20. Seal     |                     |

**Figure 5-19. Platform Level Cylinder (800A - SN 0300183034 through 0300245050, 800AJ - SN 0300183034 through 0300240878)**

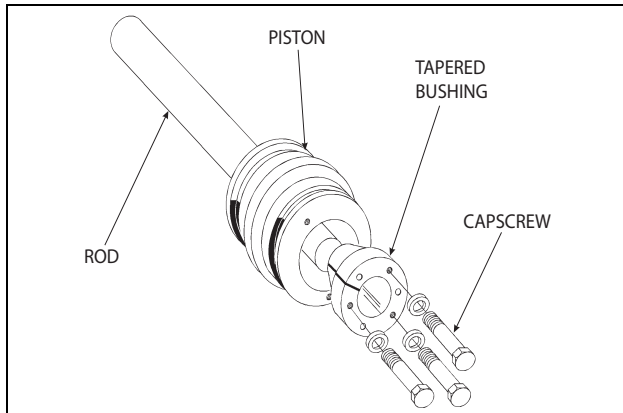
**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |           |                |                     |                     |          |
|-----------|----------------|---------------------|---------------------|----------|
| 1. Barrel | 6. Wear Ring   | 11. Lock Ring       | 16. Cartridge Valve | 21. Plug |
| 2. Rod    | 7. O-ring      | 12. O-ring          | 17. Cartridge Valve | 22. Plug |
| 3. Head   | 8. Backup Ring | 13. Backup Ring     | 18. Bushing         |          |
| 4. Wiper  | 9. Piston      | 14. Tube Spacer     | 19. Capscrew        |          |
| 5. Seal   | 10. seal       | 15. Tapered Bushing | 20. Capscrew        |          |

**Figure 5-20. Platform Level Cylinder (800AJ - SN 0300240879 to Present)**

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



**Figure 5-21. Tapered Bushing Removal**

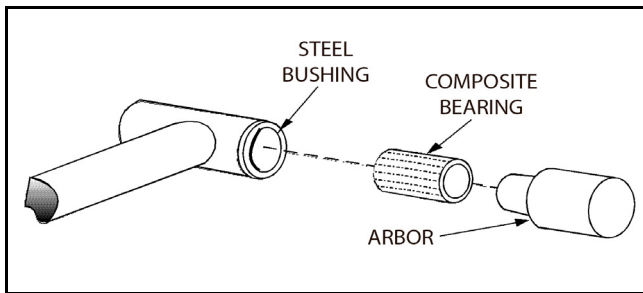
11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-22. Composite Bearing Installation**

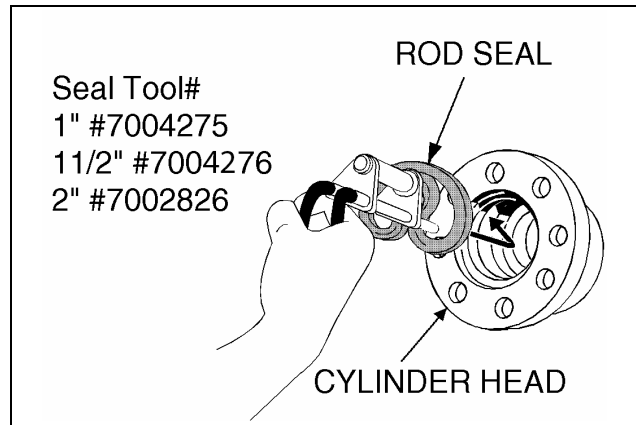
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

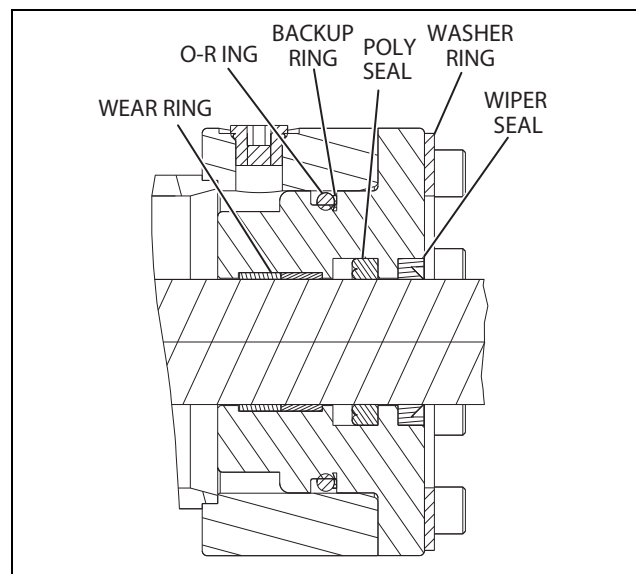
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-23. Rod Seal Installation**

### NOTICE

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-24. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

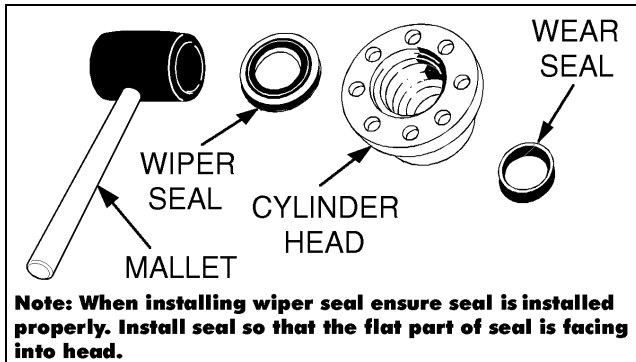


Figure 5-25. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

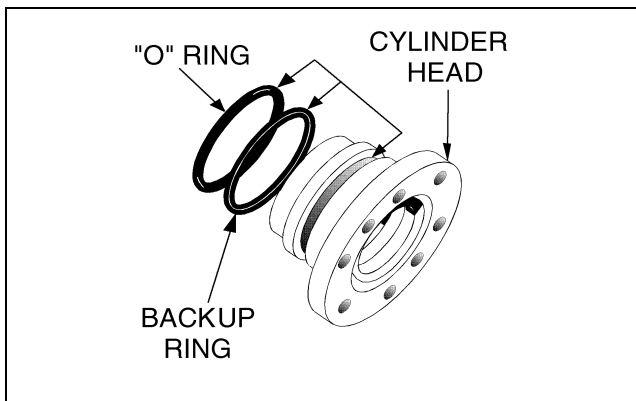


Figure 5-26. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new o-ring and back-up rings in the inner piston diameter groove.
7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
8. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

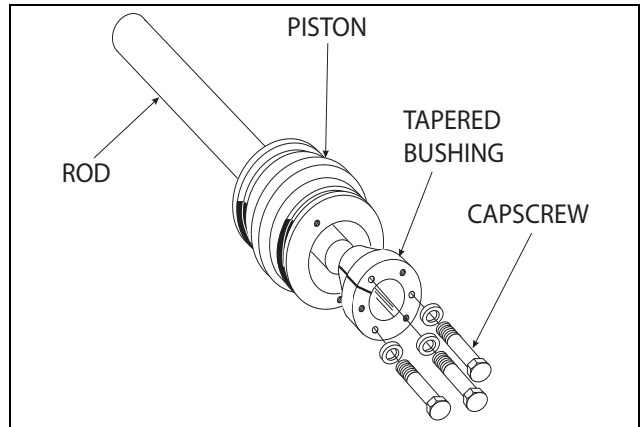


Figure 5-27. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively and torque capscrews as shown in Figure 5-19. and Figure 5-20.
11. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

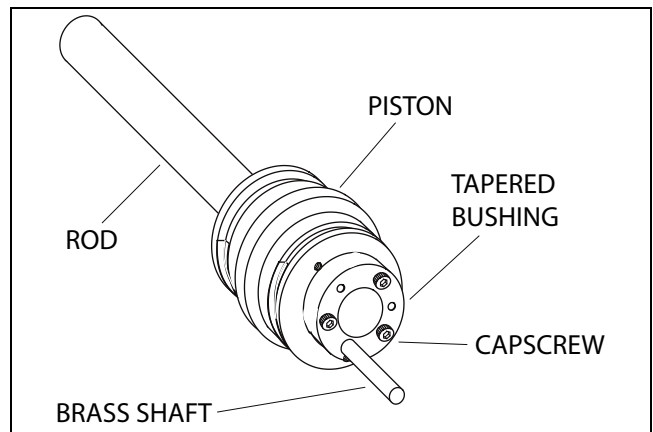


Figure 5-28. Seating the Tapered Bearing

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

12. Rotate the capscrews evenly and progressively in rotation to torque as shown in Figure 5-19, and Figure 5-20.
13. Remove the cylinder rod from the holding fixture.

### NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

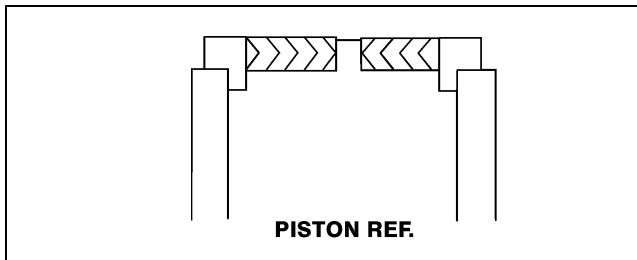


Figure 5-29. Hydrolock Piston Seal Installation

14. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

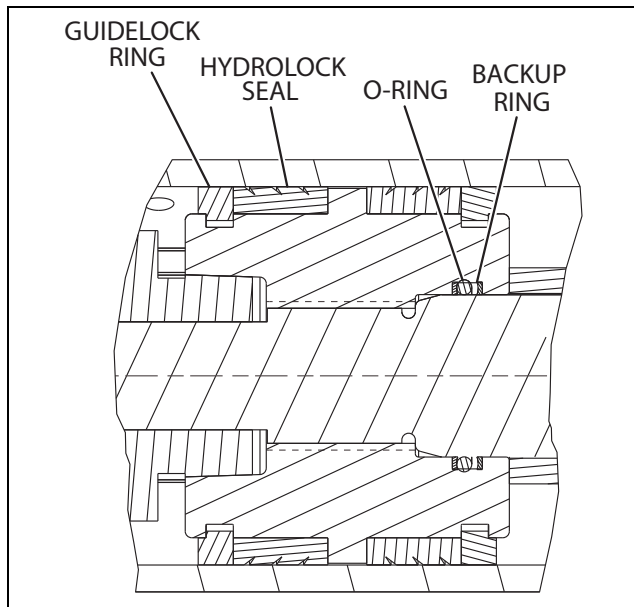


Figure 5-30. Piston Seal Kit Installation

15. Position the cylinder barrel in a suitable holding fixture.

### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

16. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
17. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

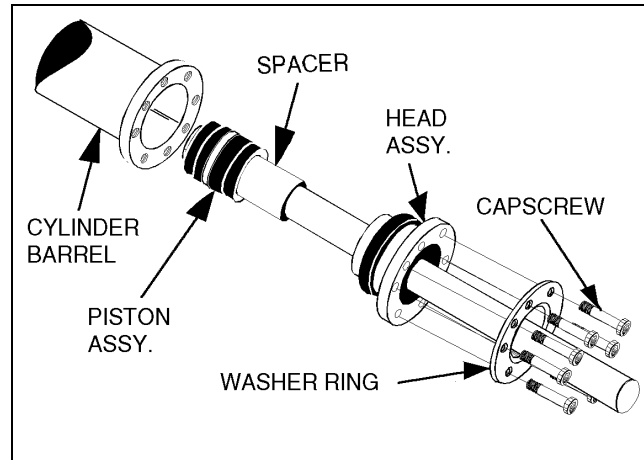


Figure 5-31. Rod Assembly Installation

18. Apply JLG Threadlocker if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 35 ft.lbs. (50 Nm).
19. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
20. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valve to 50-55 ft.lbs. (68-75 Nm).

**Platform Level Cylinder (800A - SN 0300245051 to Present)**

**DISASSEMBLY**

**NOTICE**

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

**WARNING**

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance valves and plugs from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

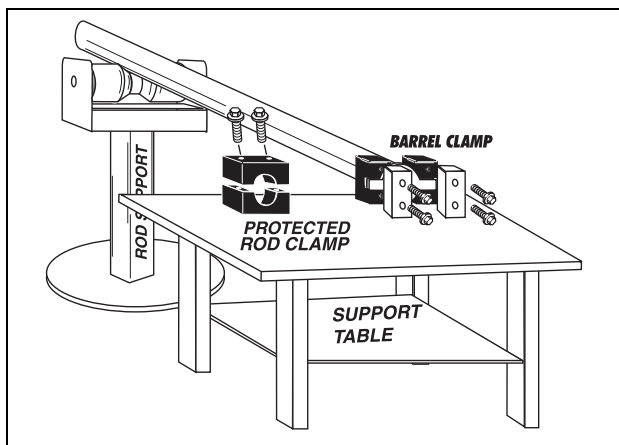
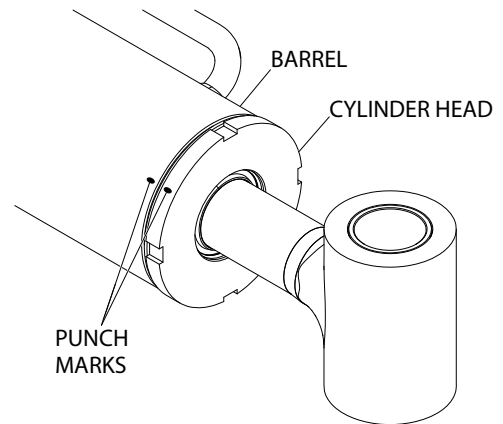


Figure 5-32. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using a hook spanner, unscrew the cylinder head from the barrel.



MAF00070

Figure 5-33. Cylinder Head Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

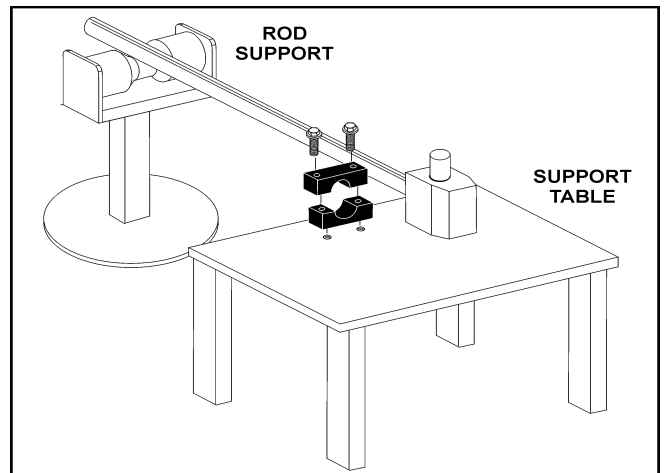
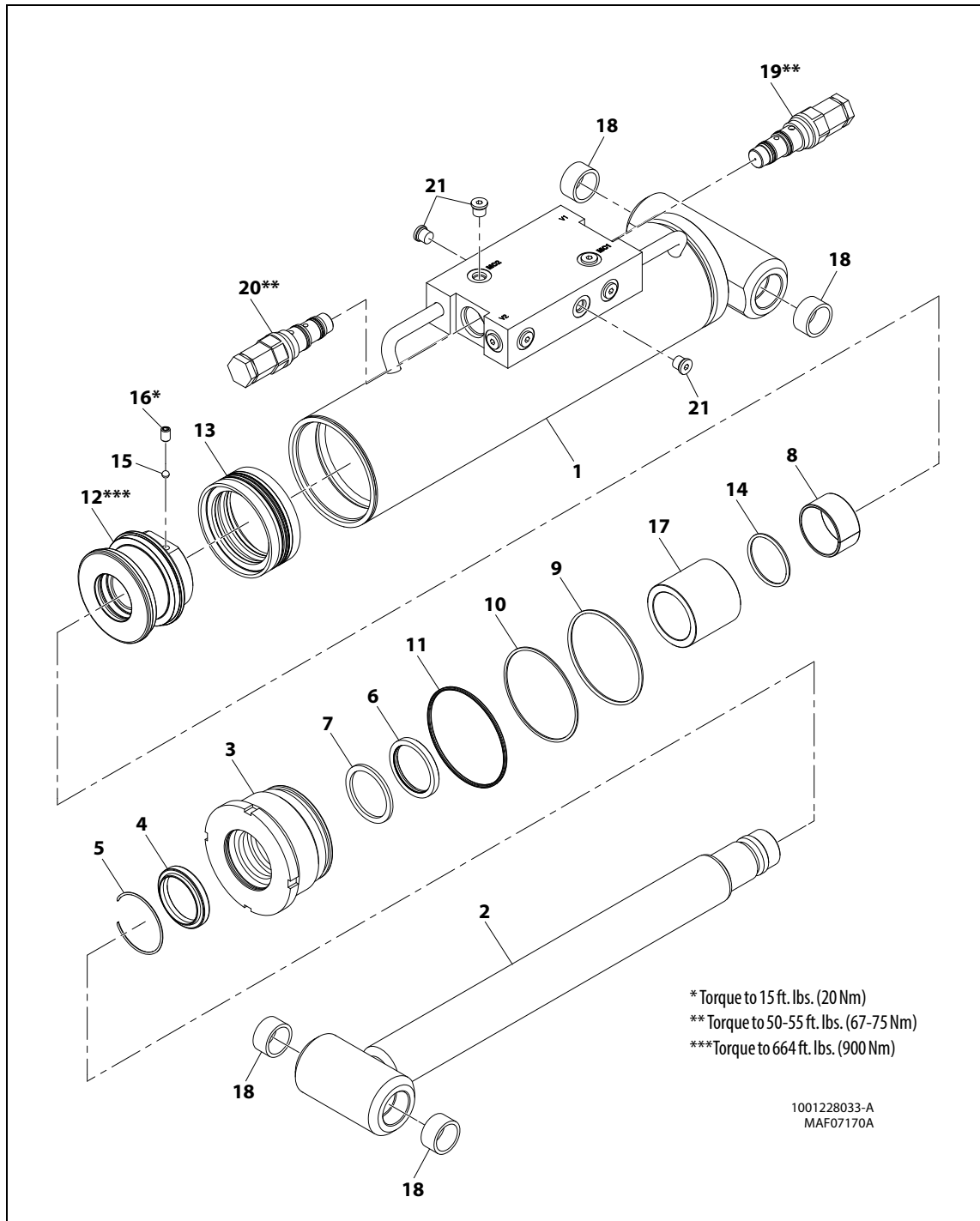


Figure 5-34. Cylinder Rod Support



- |           |                 |                 |                 |                     |
|-----------|-----------------|-----------------|-----------------|---------------------|
| 1. Barrel | 6. Rod Seal     | 11. O-ring      | 15. Ball        | 19. Cartridge Valve |
| 2. Rod    | 7. Backup Ring  | 12. Piston      | 16. Setscrew    | 20. Cartridge Valve |
| 3. Head   | 8. Spacer       | 13. Piston Seal | 17. Spacer Tube | 21. Plug            |
| 4. Wiper  | 9. O-ring       | 14. O-ring      | 18. Bushing     |                     |
| 5. Seal   | 10. Backup Ring |                 |                 |                     |

Figure 5-35. Platform Level Cylinder (800A - SN 0300245051 to Present)

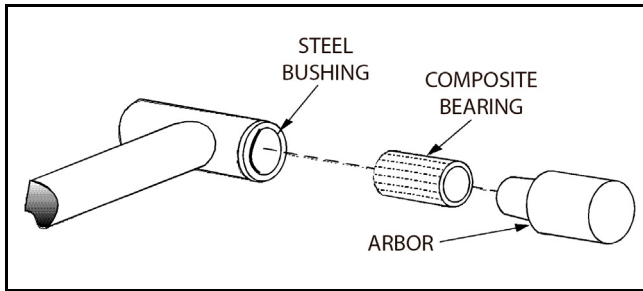
8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Loosen and remove the setscrew and ball which attaches the piston to the rod.
10. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
11. Remove and discard the piston seal.
12. Remove the rod from the holding fixture. Remove the cylinder head. Discard the o-rings, backup ring, rod seal, bearing, retaining ring and wiper seal.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inner side of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-36. Composite Bearing Installation**

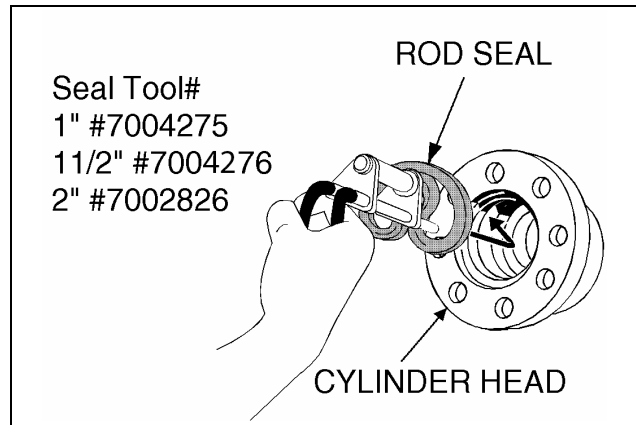
14. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

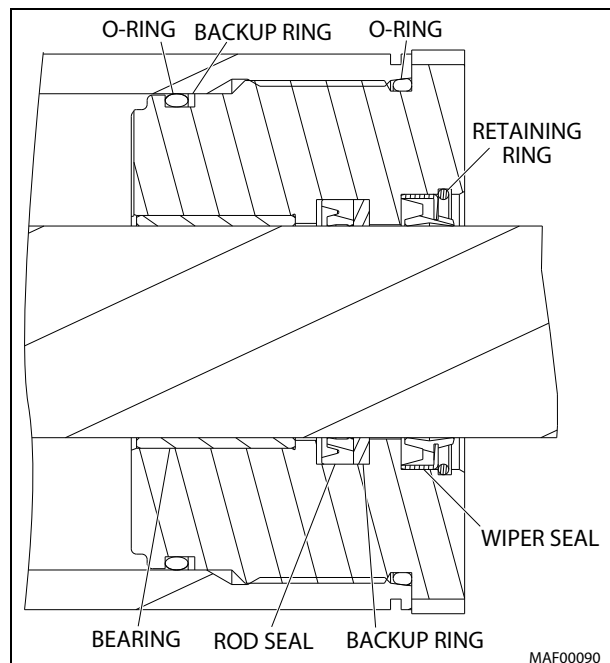
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-37. Rod Seal Installation**

### NOTICE

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-38. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install a new retaining ring, rod seal, backup ring and bearing into the applicable inside diameter of the cylinder head groove.

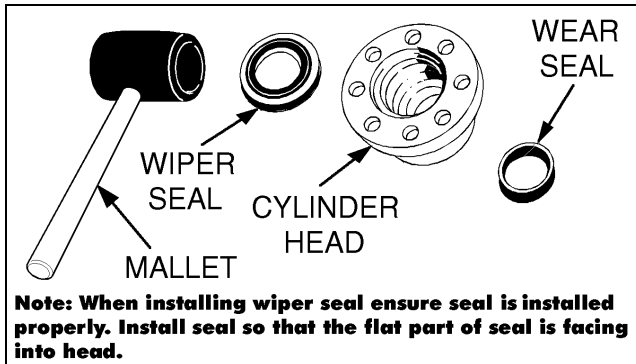


Figure 5-39. Wiper Seal Installation

3. Place new o-rings and backup ring in the applicable outside diameter groove of the cylinder head.

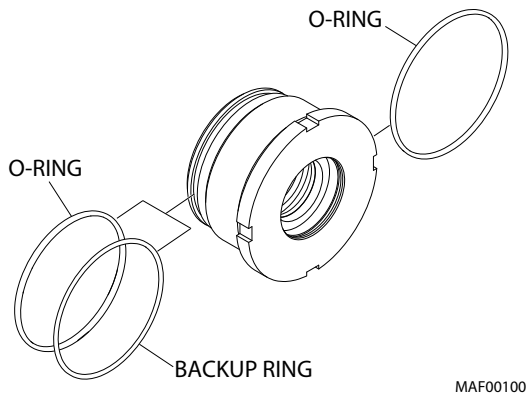


Figure 5-40. Wiper Seal Installation

4. Carefully install the cylinder head on the rod, ensuring that the wiper seal, retaining ring and rod seals are not damaged or dislodged. Push the head along the rod to the rod end.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new o-ring in the applicable inside diameter of the piston.
7. Carefully thread the piston on the cylinder rod, ensuring that the o-ring is not damaged or dislodged and torque piston to 664 ft. lbs (900 Nm).
8. Secure piston using ball and setscrew. Torque setscrew to 15 ft. lbs (20 Nm).

9. Remove the cylinder rod from the holding fixture. Place new piston seal in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

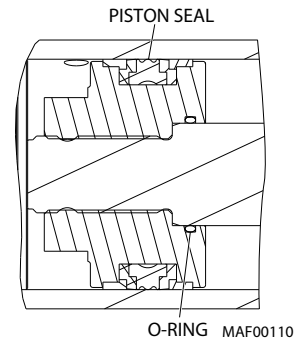


Figure 5-41. Piston Seal Kit Installation

10. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston loading end into the barrel cylinder. Ensure that the piston loading piston seal are not damaged or dislodged.
12. Continue pushing the rod into the barrel until the cylinder head can be inserted into the cylinder barrel.
13. Screw the cylinder head into the barrel using a hook spanner.
14. Caulk at the machined area of the cylinder barrel end so that it locks the cylinder head in place and it does not unscrew from the barrel.

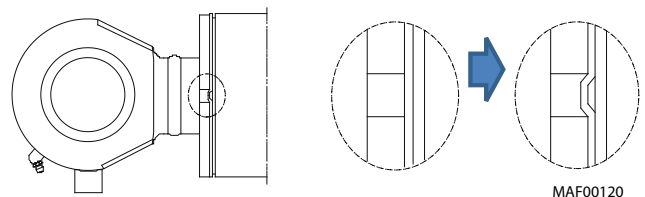


Figure 5-42. Caulking

15. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.
16. Install the new plugs into the cylinder port block. Install the counterbalance valves in the rod port block and torque to 50-55 ft. lbs. (67-75 Nm).

## Upright Level Cylinder

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

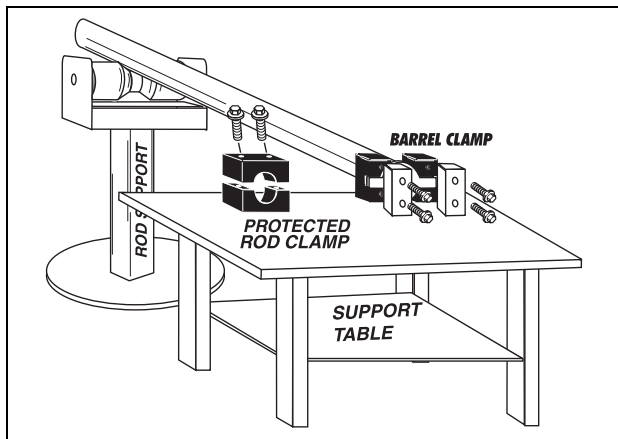


Figure 5-43. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

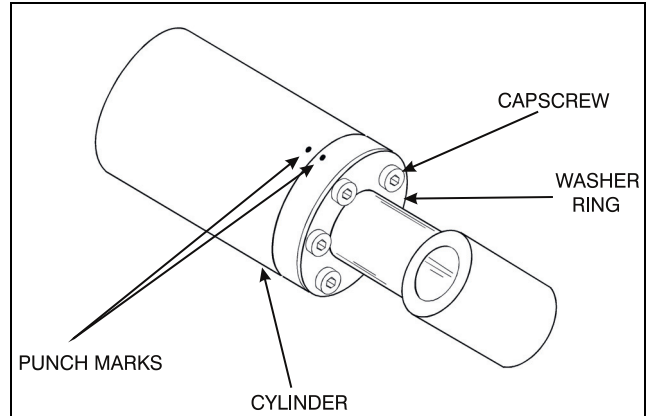


Figure 5-44. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

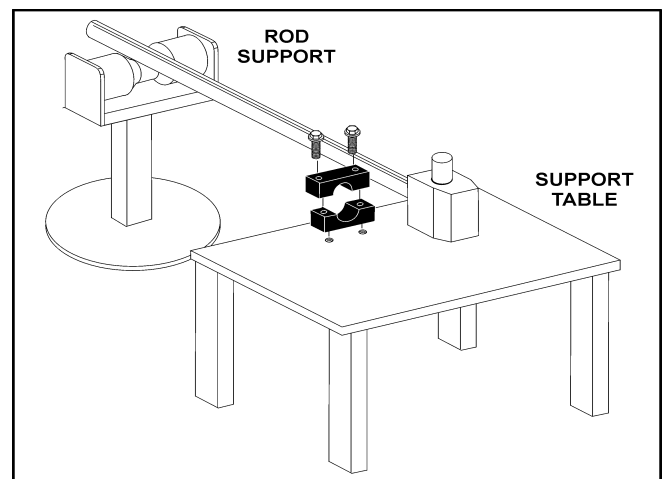
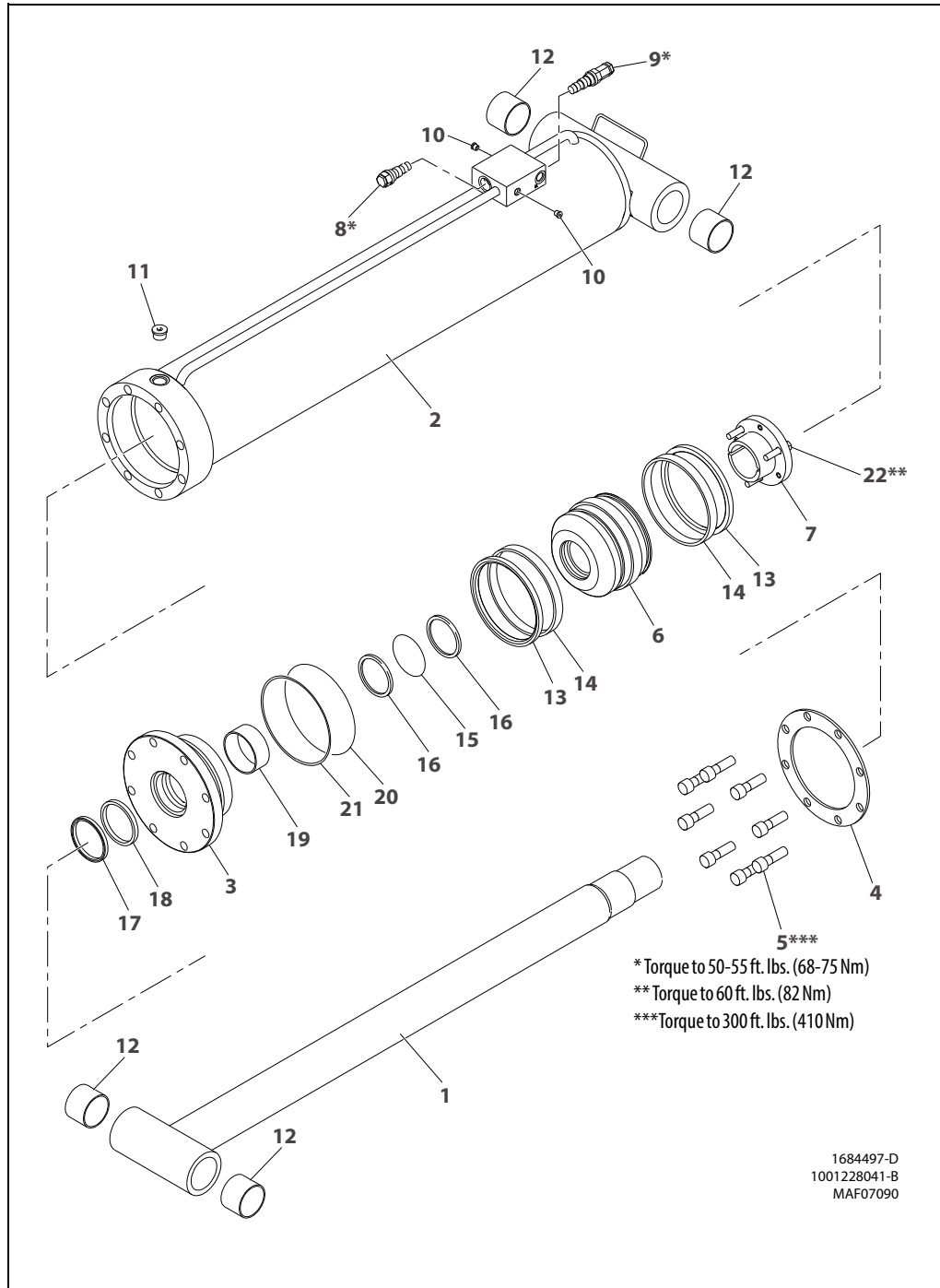


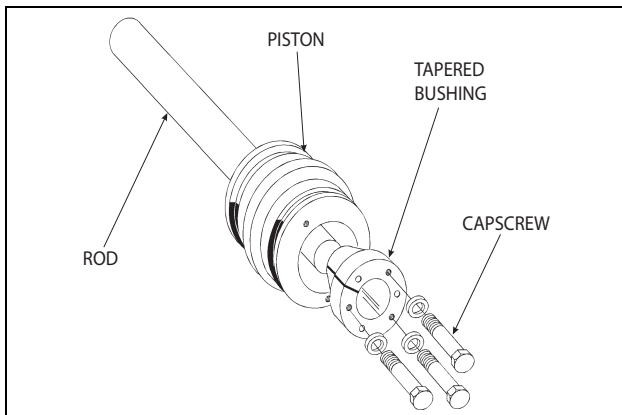
Figure 5-45. Cylinder Rod Support



- |                |                    |                 |                 |                 |
|----------------|--------------------|-----------------|-----------------|-----------------|
| 1. Rod         | 6. Piston          | 11. O-ring Plug | 15. Washer Ring | 19. Wear Ring   |
| 2. Barrel      | 7. Tapered Bushing | 12. Bushing     | 16. Backup Ring | 20. O-ring      |
| 3. Head        | 8. Cartridge Valve | 13. Lock Ring   | 17. Wiper       | 21. Backup Ring |
| 4. Washer Ring | 9. Cartridge Valve | 14. Seal        | 18. Rod Seal    | 22. Bolt        |
| 5. Bolt        | 10. O-ring Plug    |                 |                 |                 |

Figure 5-46. Upright Level Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



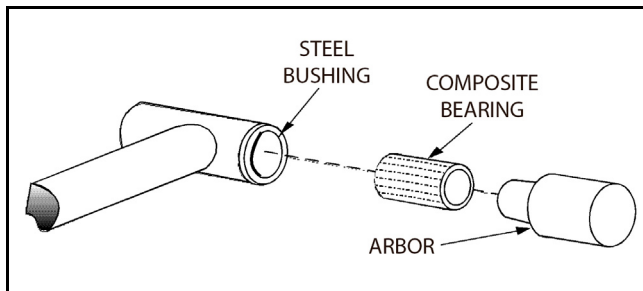
**Figure 5-47. Tapered Bushing Removal**

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-48. Composite Bearing Installation**

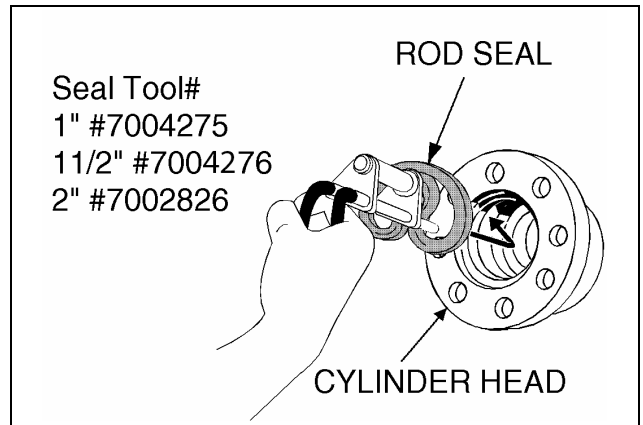
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

**ASSEMBLY**

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

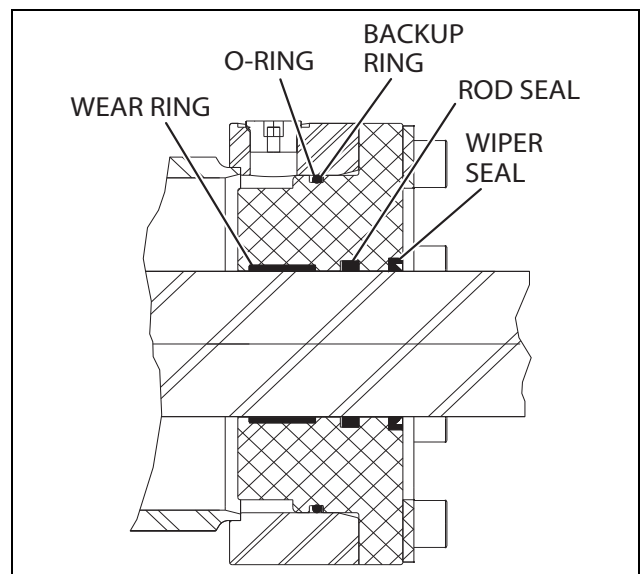
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-49. Rod Seal Installation**

**NOTICE**

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-50. Cylinder Head Seal Installation**

- Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

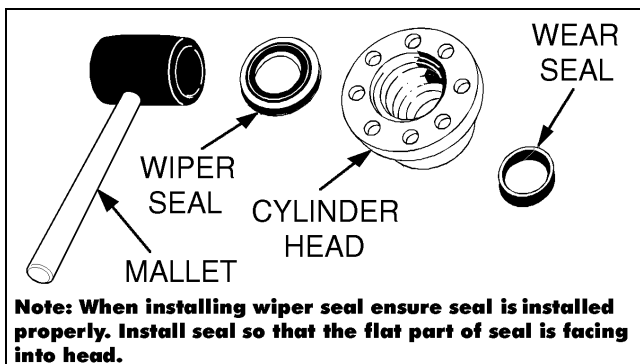


Figure 5-51. Wiper Seal Installation

- Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

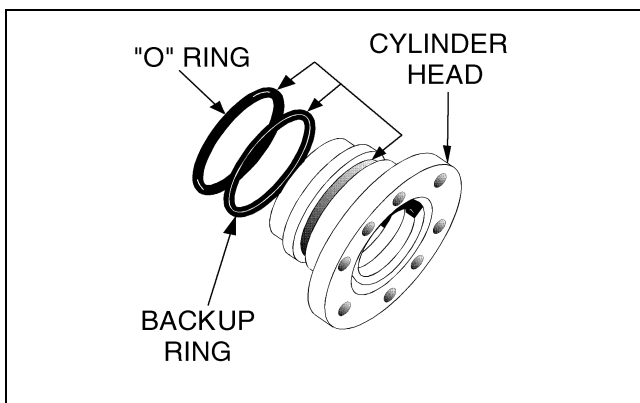


Figure 5-52. Installation of Head Seal Kit

- Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
- Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Place a new o-ring and back-up rings in the inner piston diameter groove.
- Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
- Thread piston onto rod and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

- Install the bolt in tapered bushing.

- Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

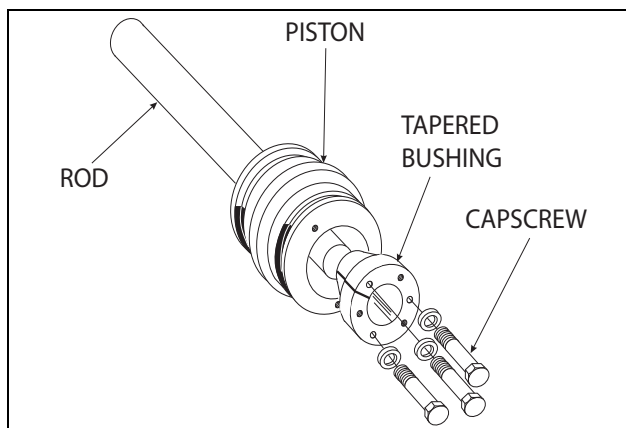


Figure 5-53. Tapered Bushing Installation

- Tighten the capscrews evenly and progressively in rotation to 60 ft.lbs. (82 Nm).
- After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

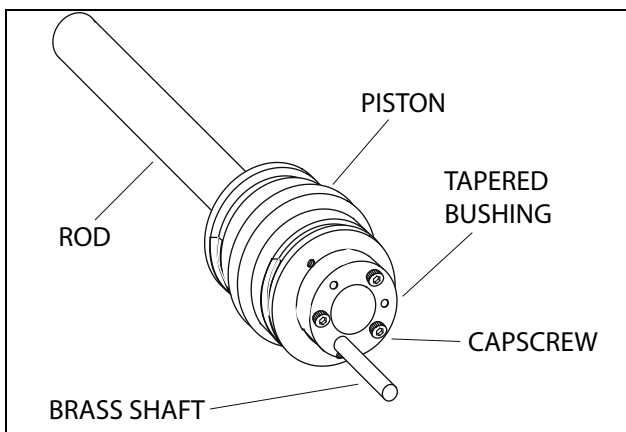


Figure 5-54. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 60 ft.lbs. (82 Nm).
14. Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCKK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

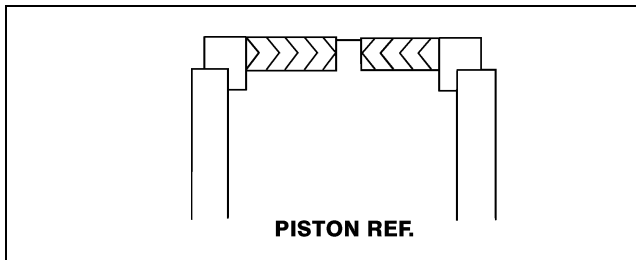


Figure 5-55. Hydrolock Piston Seal Installation

15. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

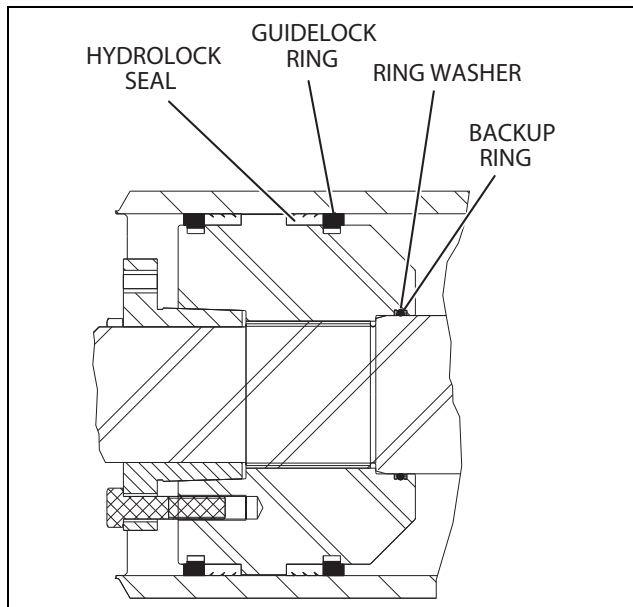


Figure 5-56. Piston Seal Kit Installation

16. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

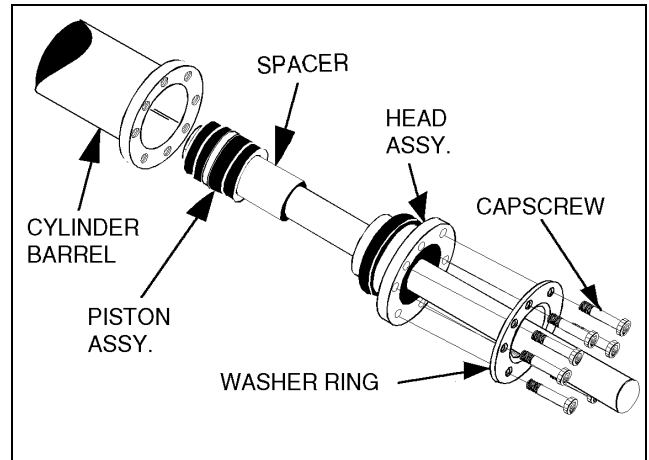


Figure 5-57. Rod Assembly Installation

19. Apply JLG Threadlocker if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 300 ft.lbs. (410 Nm).
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
21. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft.lbs. (68-75 Nm).

## Jib Lift Cylinder (800AJ Only)

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the counterbalance holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

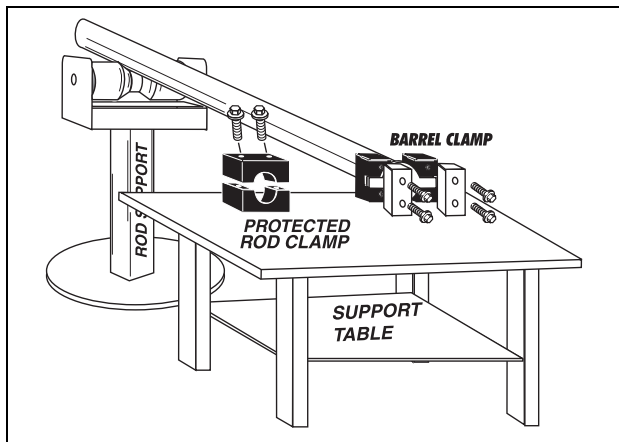


Figure 5-58. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

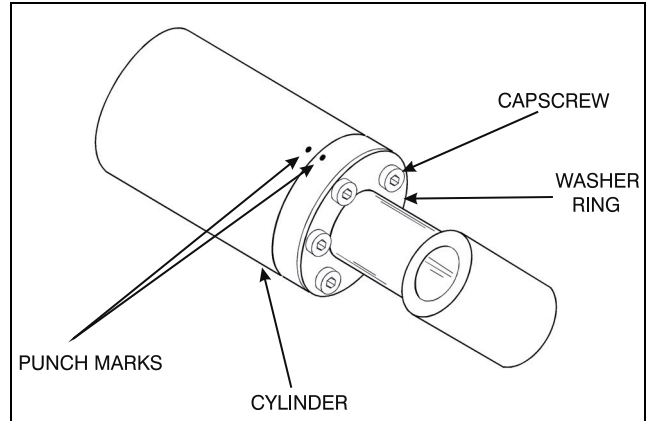


Figure 5-59. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

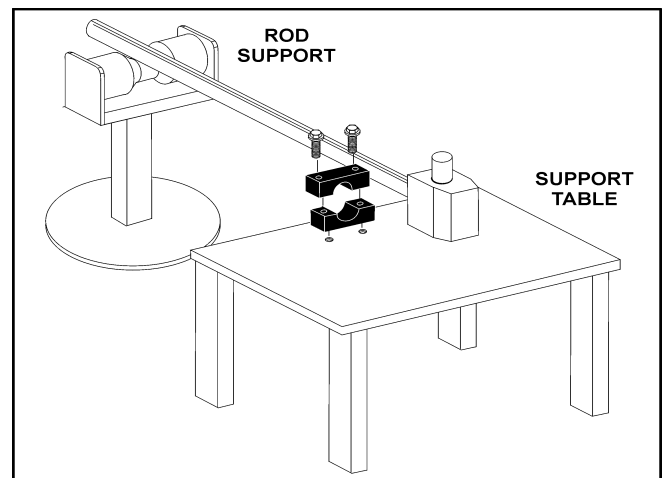
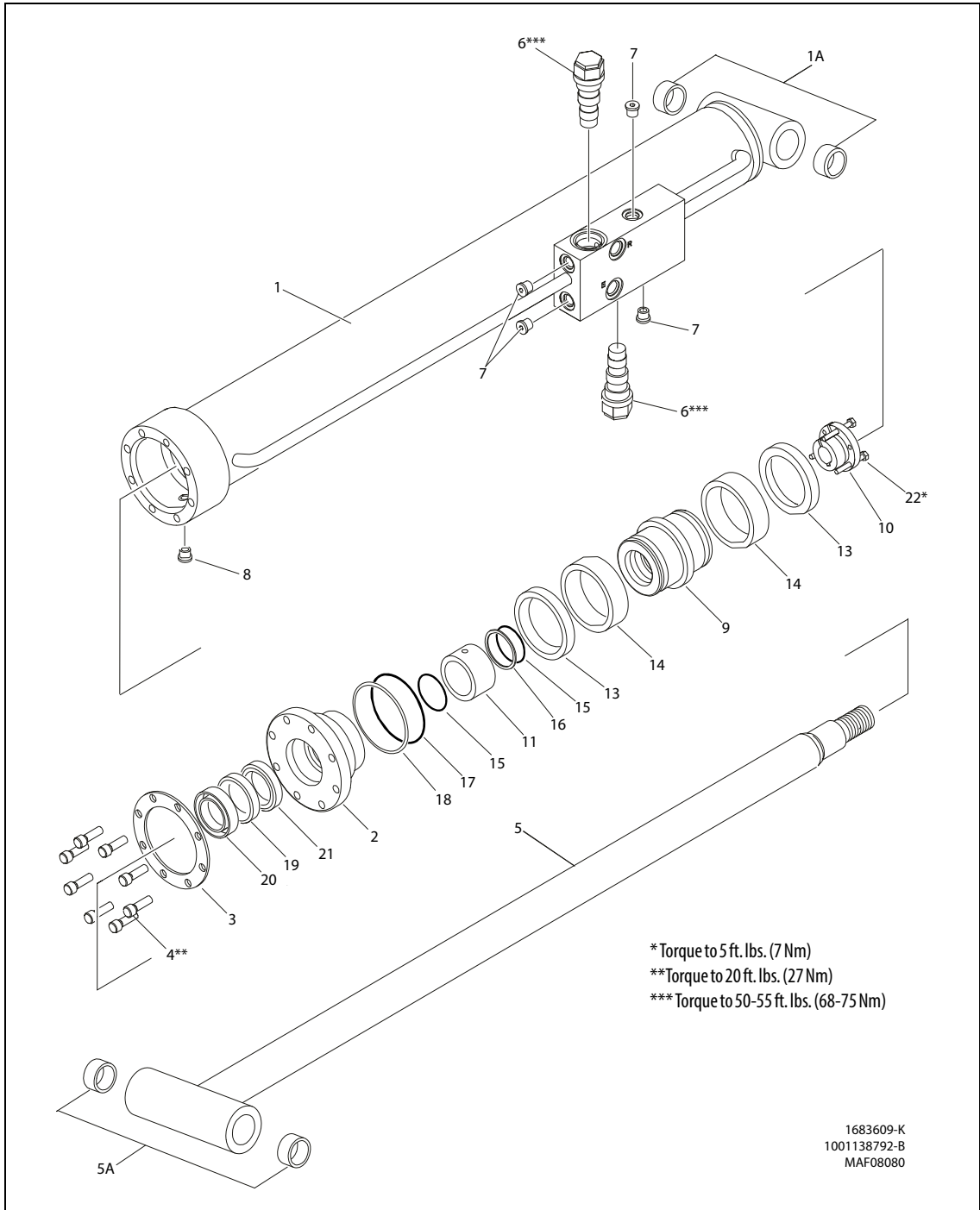


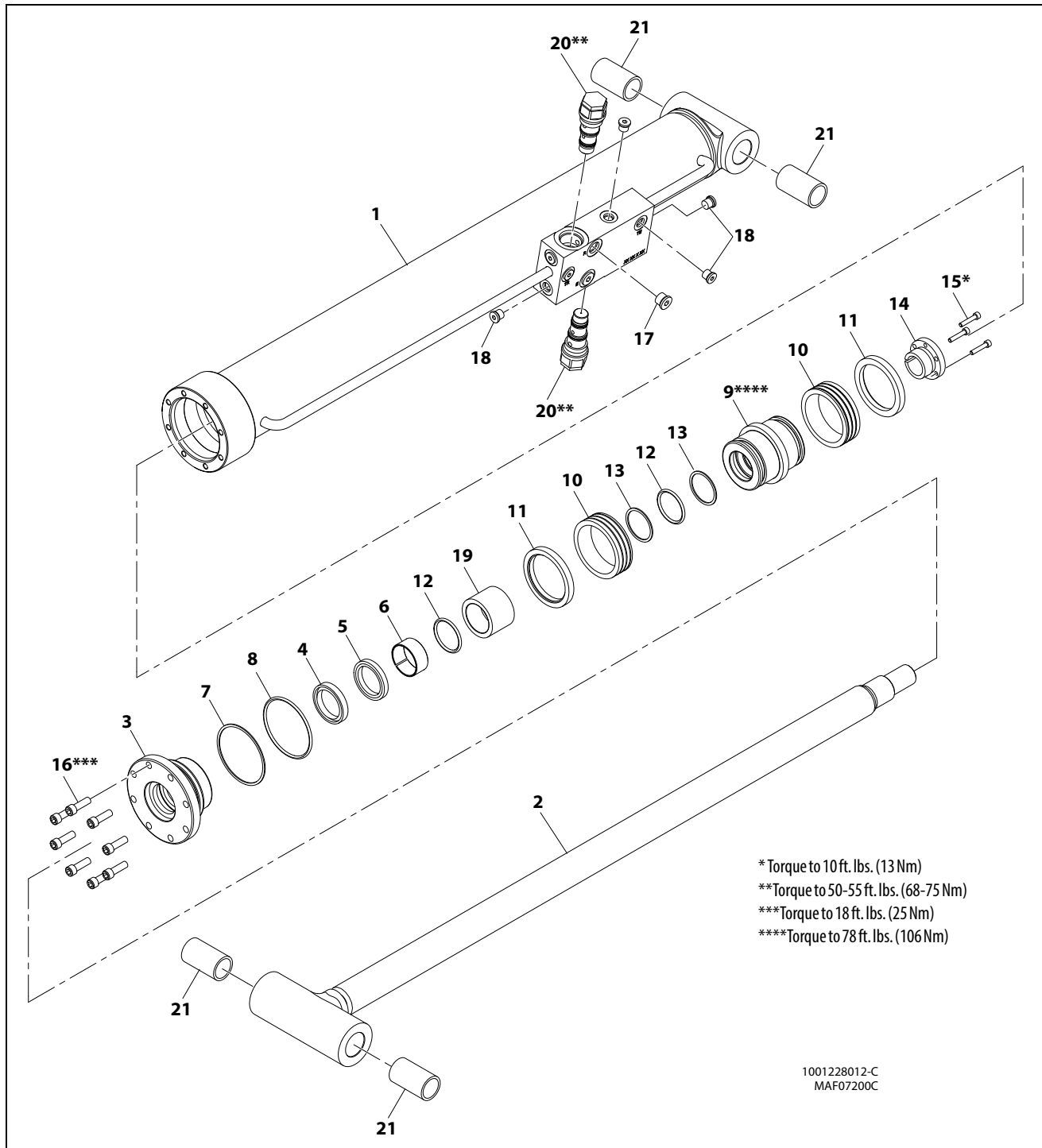
Figure 5-60. Cylinder Rod Support



- |                |                         |                     |                 |                |
|----------------|-------------------------|---------------------|-----------------|----------------|
| 1. Barrel      | 5. Rod                  | 9. Piston           | 14. Piston Seal | 19. Rod Seal   |
| 1A. Bushing    | 5A. Bushing             | 10. Tapered Bushing | 15. O-ring      | 20. Wiper Seal |
| 2. Head        | 6. Counterbalance Valve | 11. Tube Spacer     | 16. Backup Ring | 21. Wear Ring  |
| 3. Ring Washer | 7. O-ring Plug          | 12. Setscrew        | 17. O-ring      | 22. Capscrew   |
| 4. Bolt        | 8. O-ring Plug          | 13. Lock Ring       | 18. Backup Ring |                |

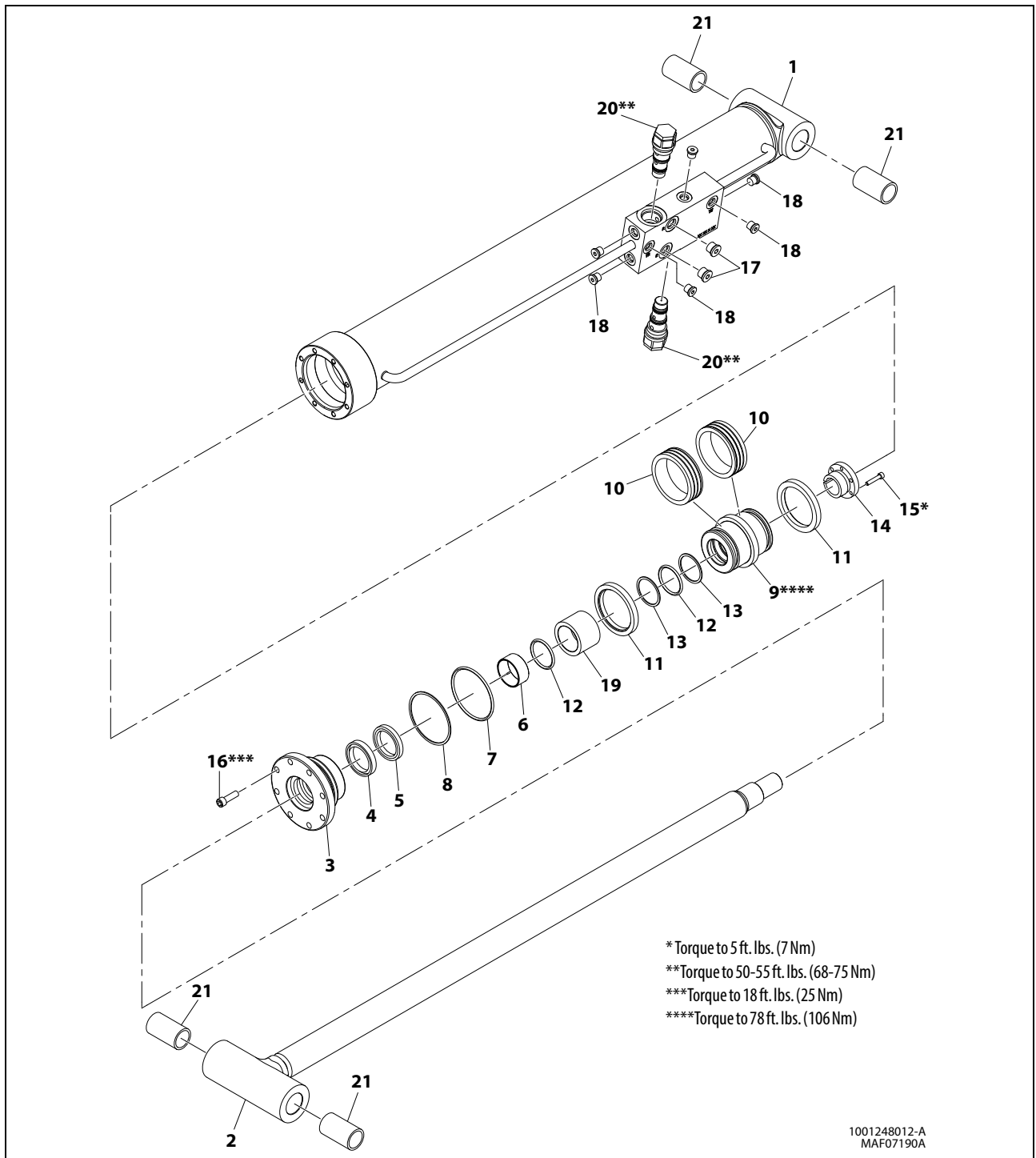
Figure 5-61. Jib Lift Cylinder (SN 0300183034 through 0300245050)

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |               |                 |                     |                 |                          |
|---------------|-----------------|---------------------|-----------------|--------------------------|
| 1. Barrel     | 6. Wear Ring    | 11. Lock Ring       | 16. Capscrew    | 20. Counterbalance Valve |
| 2. Rod        | 7. Backup Ring  | 12. O-ring          | 17. O-ring Plug | 21. Bushing              |
| 3. Head       | 8. O-ring       | 13. Backup Ring     | 18. O-ring Plug |                          |
| 4. Rod Seal   | 9. Piston       | 14. Tapered Bushing | 19. Tube Spacer |                          |
| 5. Wiper Seal | 10. Piston Seal | 15. Capscrew        |                 |                          |

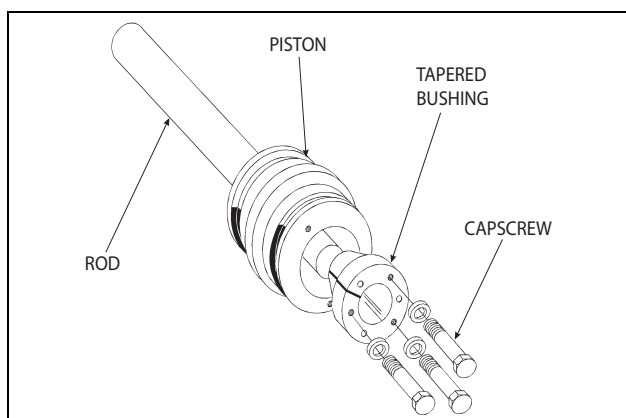
**Figure 5-62. Jib Lift Cylinder (SN 0300245051 through 0300245146)**



- |               |                 |                     |                 |                          |
|---------------|-----------------|---------------------|-----------------|--------------------------|
| 1. Barrel     | 6. Wear Ring    | 11. Lock Ring       | 16. Capscrew    | 20. Counterbalance Valve |
| 2. Rod        | 7. O-ring       | 12. O-ring          | 17. O-ring Plug | 21. Bushing              |
| 3. Head       | 8. Backup Ring  | 13. Backup Ring     | 18. O-ring Plug |                          |
| 4. Wiper Seal | 9. Piston       | 14. Tapered Bushing | 19. Tube Spacer |                          |
| 5. Rod Seal   | 10. Piston Seal | 15. Capscrew        |                 |                          |

Figure 5-63. Jib Lift Cylinder (SN 0300245051 through 0300245146, SN 0300245147 to Present)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



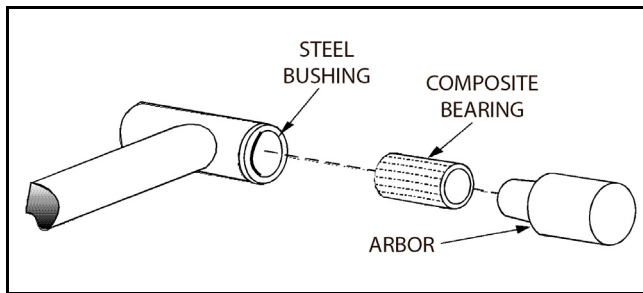
**Figure 5-64. Tapered Bushing Removal**

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-65. Composite Bearing Installation**

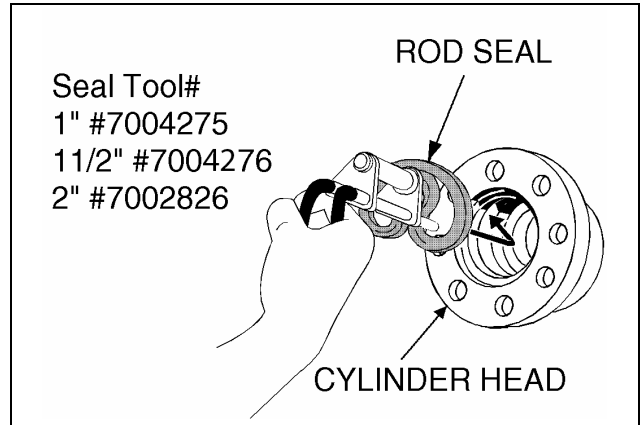
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

**ASSEMBLY**

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

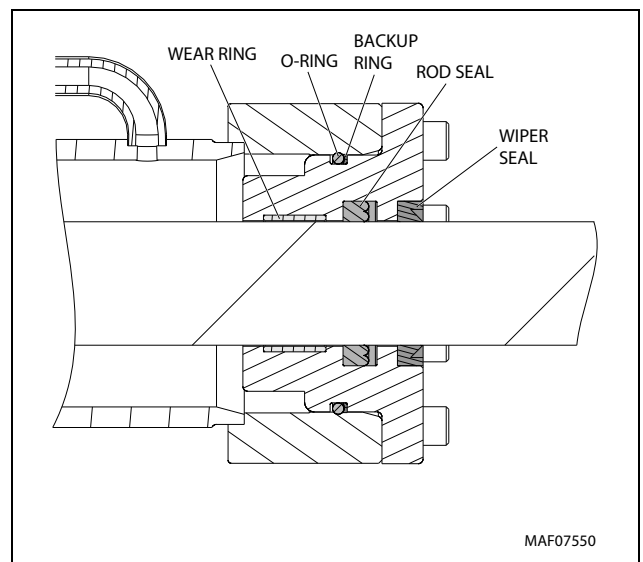
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-66. Rod Seal Installation**

**NOTICE**

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-67. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

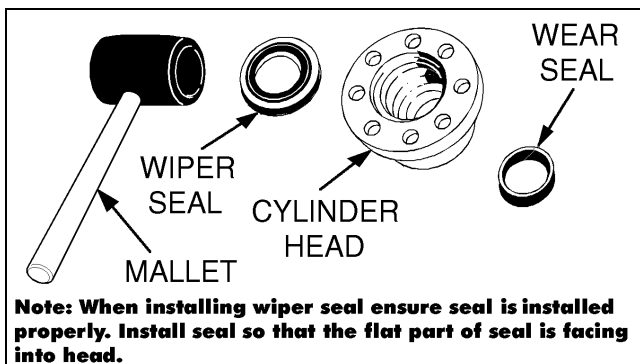


Figure 5-68. Wiper Seal Installation

3. Place a new o-ring and back-up ring in the applicable outside diameter groove of the cylinder head.

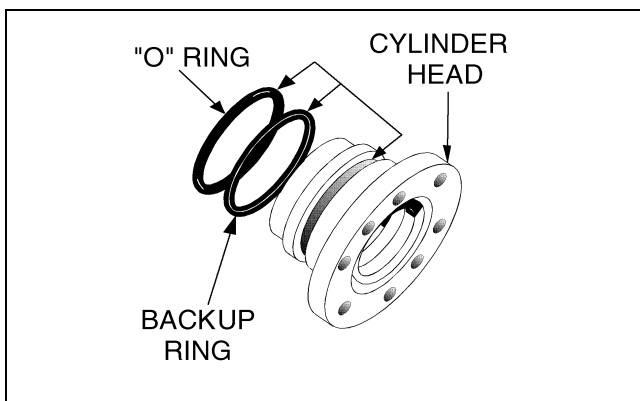


Figure 5-69. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on the rod.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Place a new o-ring and back-up rings in the inner piston diameter groove.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end. Torque piston as shown in Figure 5-61., Figure 5-62. and Figure 5-63. Install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

10. Install the bolts in tapered bushing.
11. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

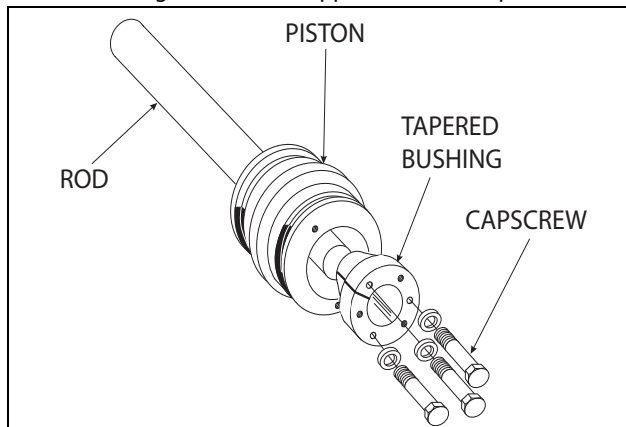


Figure 5-70. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation and torque as shown in Figure 5-61., Figure 5-62. and Figure 5-63.
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

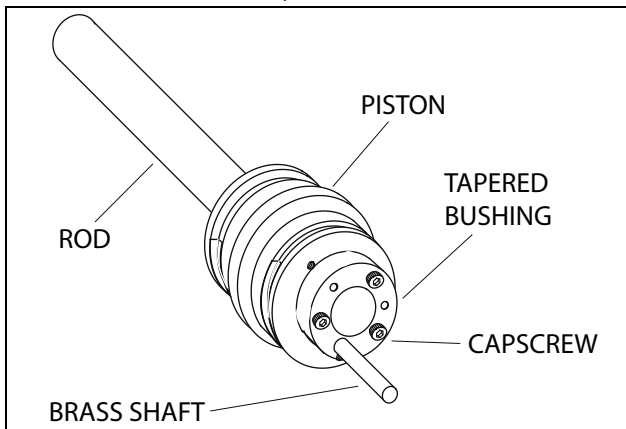


Figure 5-71. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation and torque as shown in Figure 5-61., Figure 5-62. and Figure 5-63.
15. Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

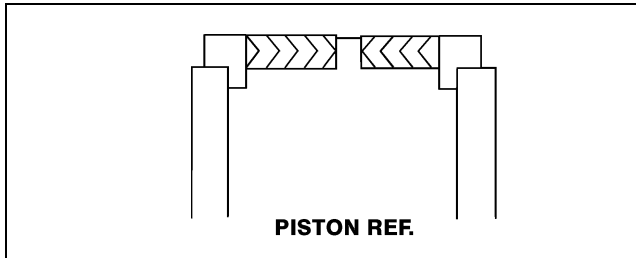


Figure 5-72. Hydrolock Piston Seal Installation

16. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

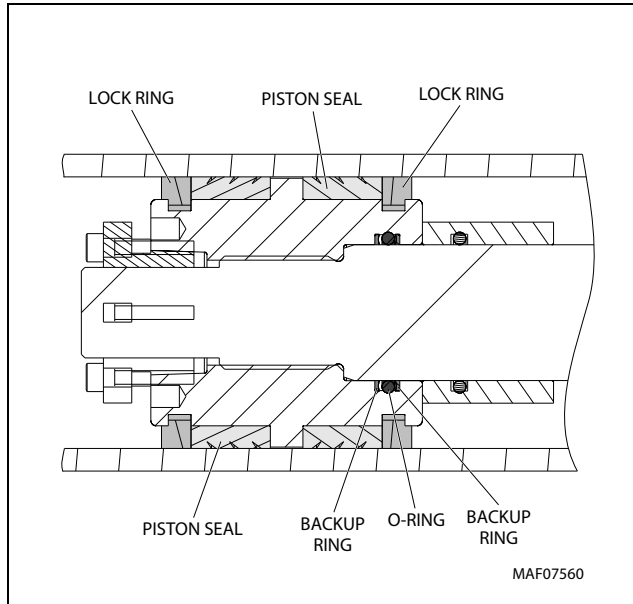


Figure 5-73. Piston Seal Kit Installation

17. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

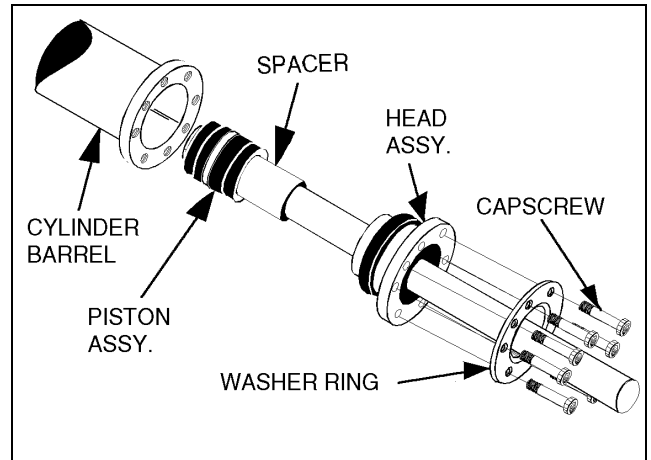


Figure 5-74. Rod Assembly Installation

20. Apply JLG Threadlocker if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts as shown in Figure 5-61., Figure 5-62. and Figure 5-63.
21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves as shown in Figure 5-61., Figure 5-62. and Figure 5-63.

## Main Boom Lift Cylinder

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

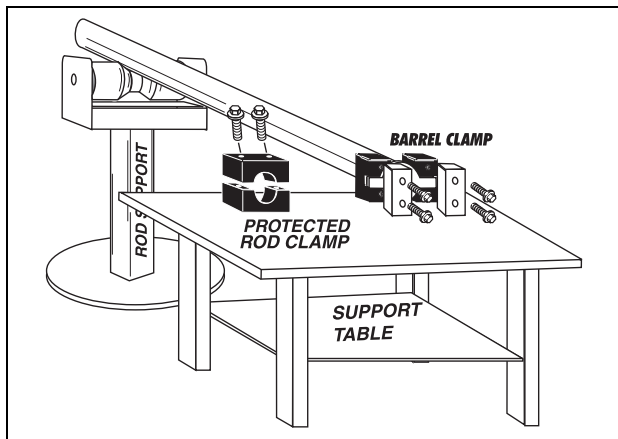


Figure 5-75. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

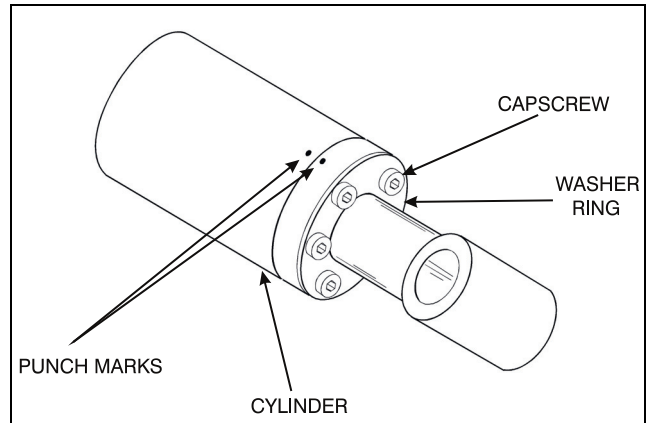


Figure 5-76. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

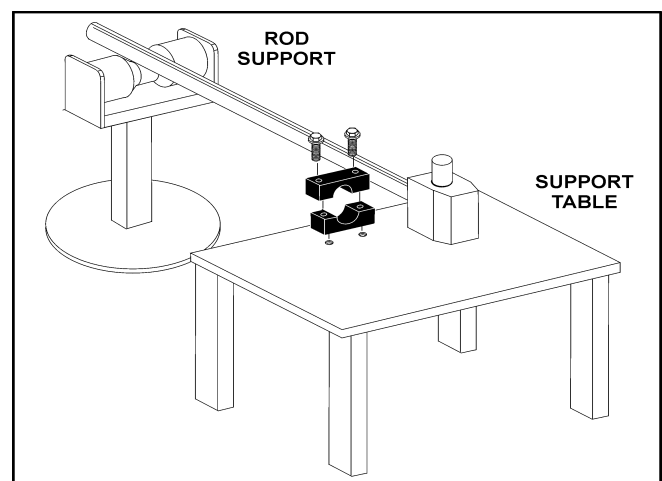
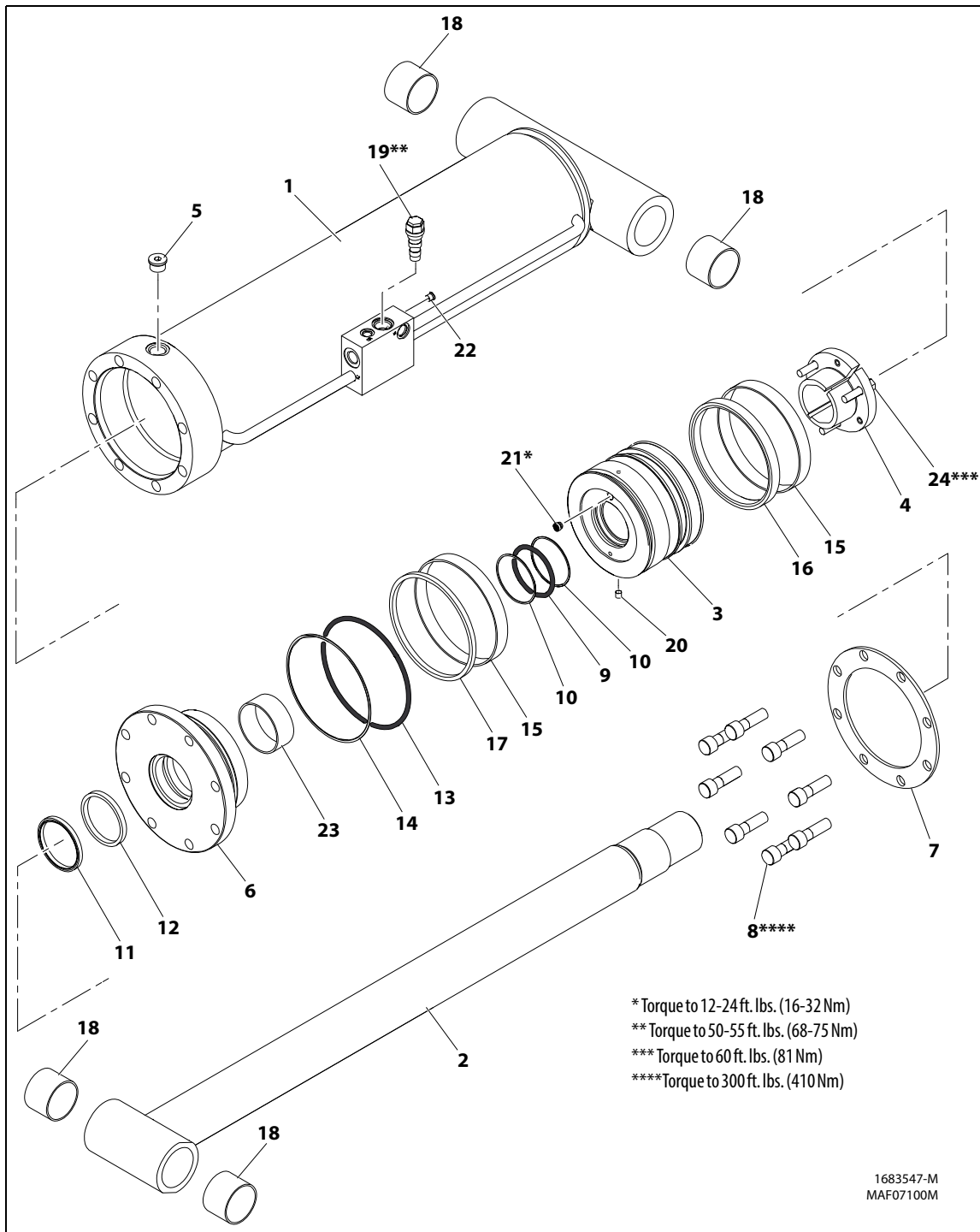


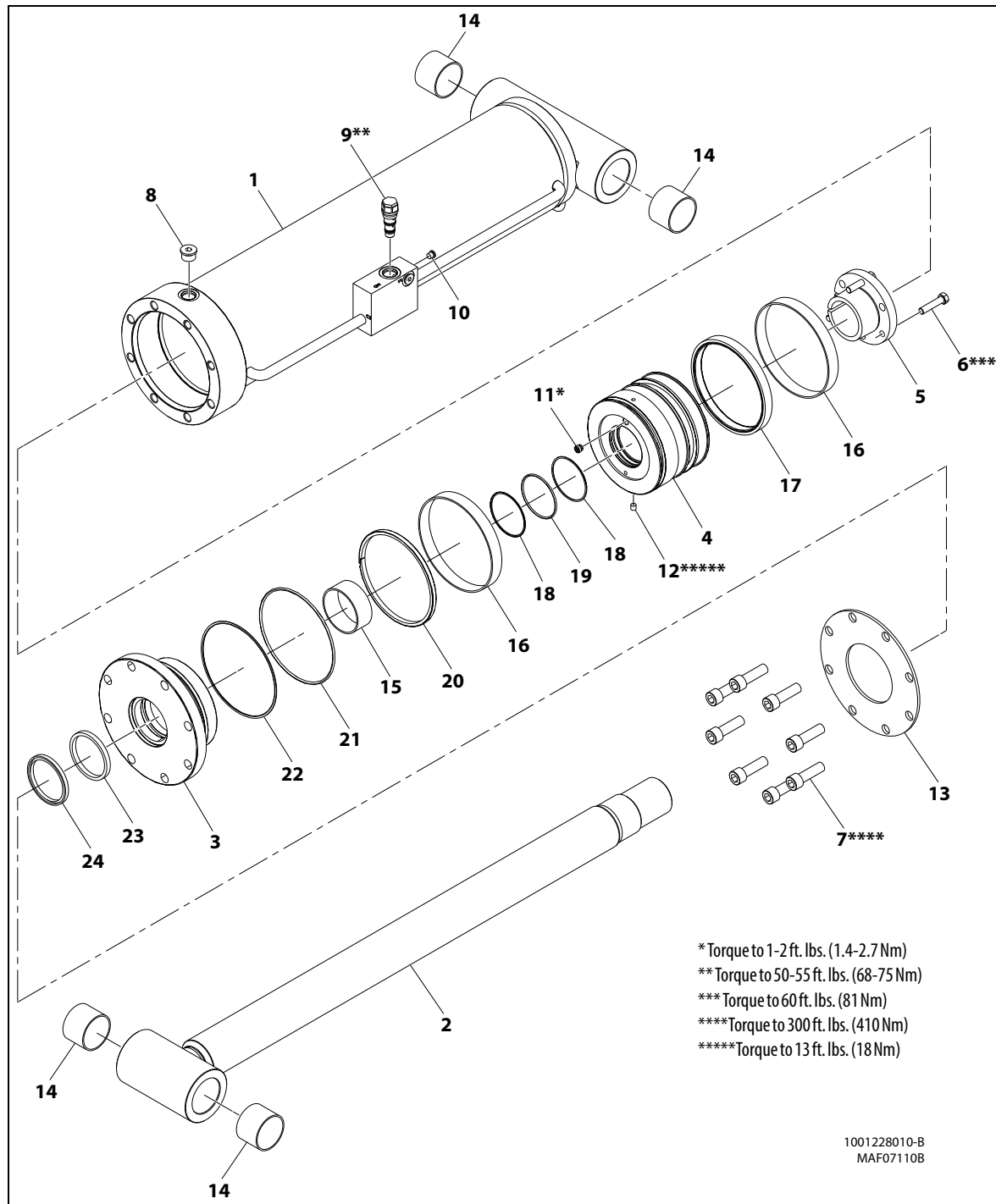
Figure 5-77. Cylinder Rod Support



- |                    |                 |                 |                     |                 |
|--------------------|-----------------|-----------------|---------------------|-----------------|
| 1. Barrel          | 6. Head         | 11. Wiper       | 16. T-Seal          | 21. Check Valve |
| 2. Rod             | 7. Washer Ring  | 12. Rod Seal    | 17. Seal            | 22. Plug        |
| 3. Piston          | 8. Bolt         | 13. O-ring      | 18. Bushing         | 23. Wear Ring   |
| 4. Tapered Bushing | 9. O-ring       | 14. Backup Ring | 19. Cartridge Valve | 24. Bolt        |
| 5. O-ring Plug     | 10. Backup Ring | 15. Wear Ring   | 20. Orifice         |                 |

Figure 5-78. Main Boom Lift Cylinder (SN 0300183034 through 0300239885)

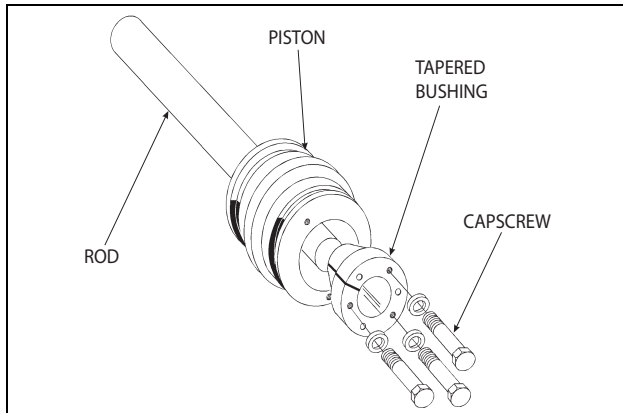
**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |                    |                    |                 |                 |                 |
|--------------------|--------------------|-----------------|-----------------|-----------------|
| 1. Barrel          | 6. Bolt            | 11. Check Valve | 16. Wear Ring   | 21. O-ring      |
| 2. Rod             | 7. Bolt            | 12. Orifice     | 17. T-Seal      | 22. Backup Ring |
| 3. Head            | 8. Plug            | 13. Washer Ring | 18. Backup Ring | 23. Rod Seal    |
| 4. Piston          | 9. Cartridge Valve | 14. Bushing     | 19. O-ring      | 24. Wiper       |
| 5. Tapered Bushing | 10. Plug           | 15. Wear Ring   | 20. Seal        |                 |

**Figure 5-79. Main Boom Lift Cylinder (SN 0300239886 to Present)**

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



**Figure 5-80. Tapered Bushing Removal**

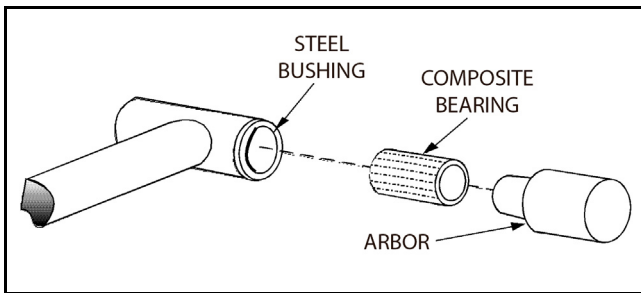
11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove check valve from the piston.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-81. Composite Bearing Installation**

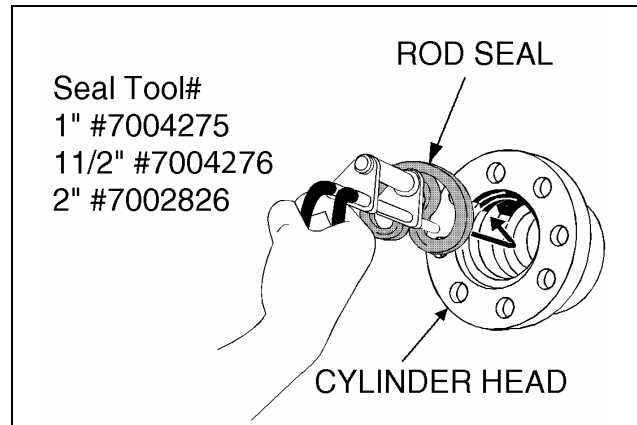
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

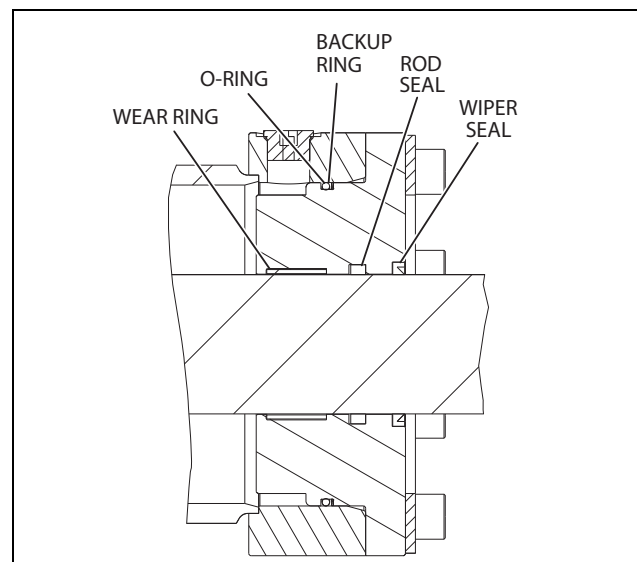
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-82. Rod Seal Installation**

### NOTICE

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-83. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

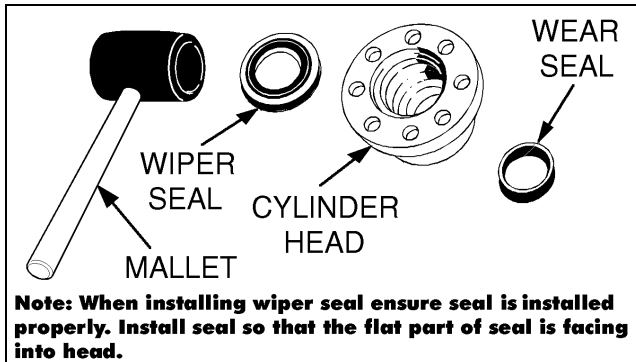


Figure 5-84. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

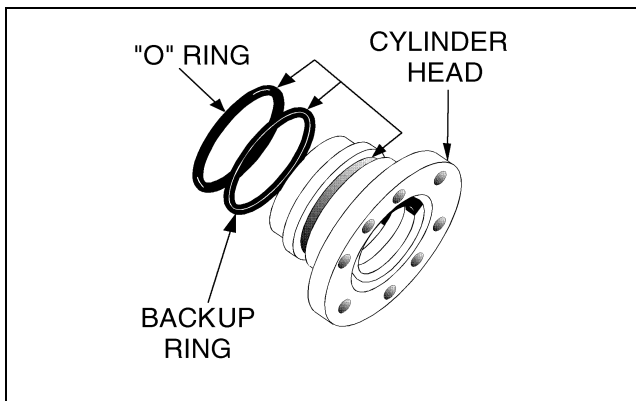


Figure 5-85. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new o-ring and back-up rings in the inner piston diameter groove.
7. Install orifice and check valve on the piston and torque as shown in Figure 5-78. and Figure 5-79.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
9. Thread piston onto rod hand tight and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

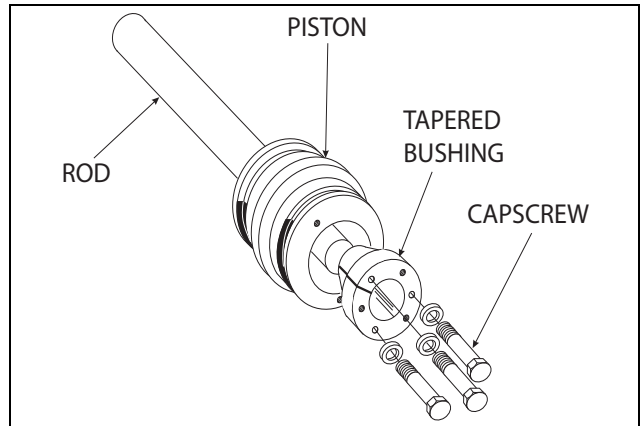


Figure 5-86. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 60 ft.lbs. (81 Nm).
12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

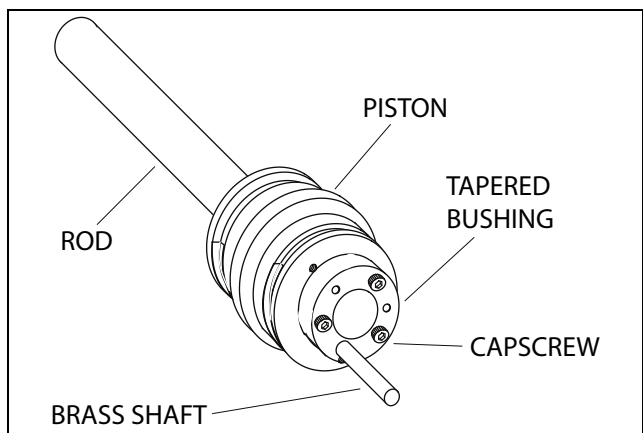
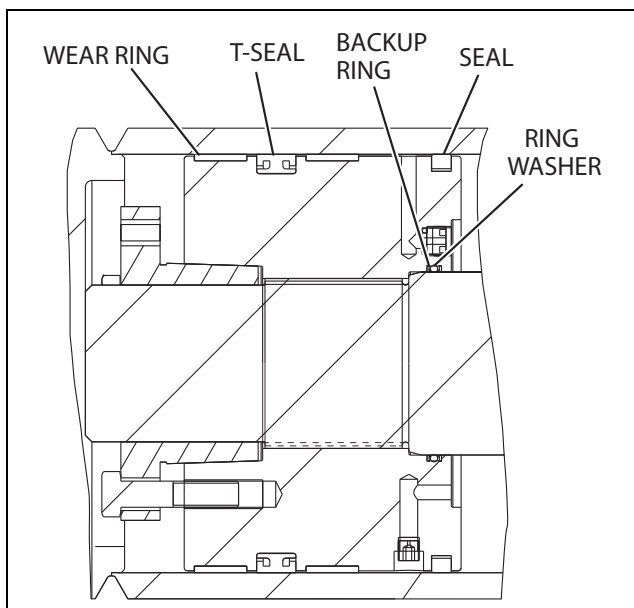


Figure 5-87. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 60 ft.lbs. (81 Nm).
14. Remove the cylinder rod from the holding fixture.
15. Place new T-seal and wear rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).



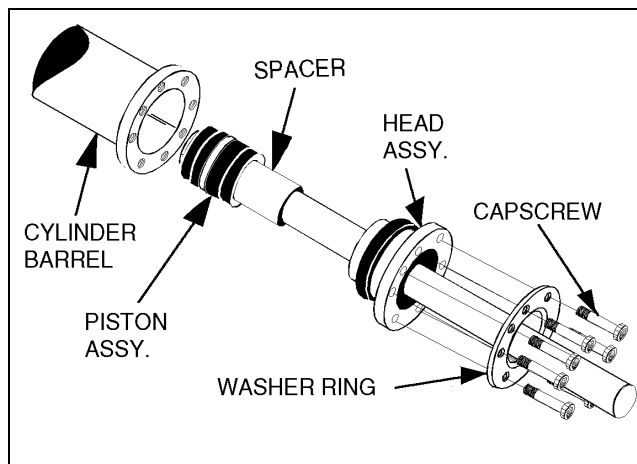
**Figure 5-88. Piston Seal Kit Installation**

16. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

**EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.**

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.



**Figure 5-89. Rod Assembly Installation**

19. Apply JLG Threadlocker as applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 300 ft.lbs. (410 Nm).
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
21. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft.lbs. (68-75 Nm).

## Tower Boom Lift Cylinder

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

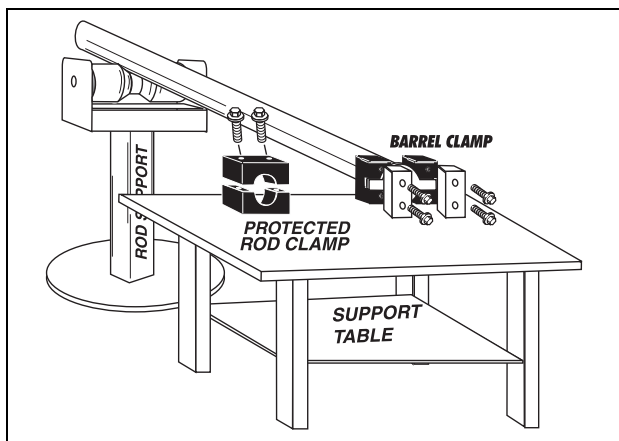


Figure 5-90. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

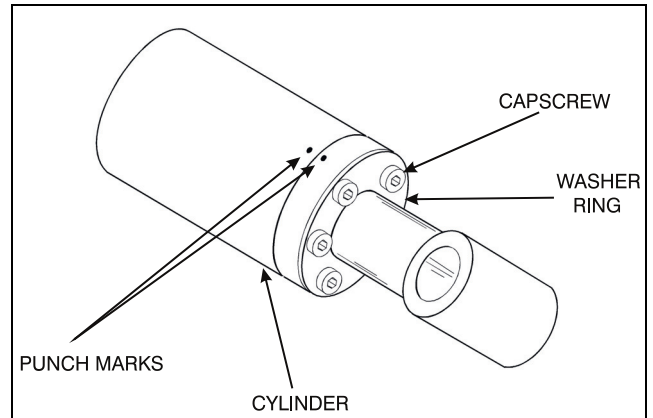


Figure 5-91. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

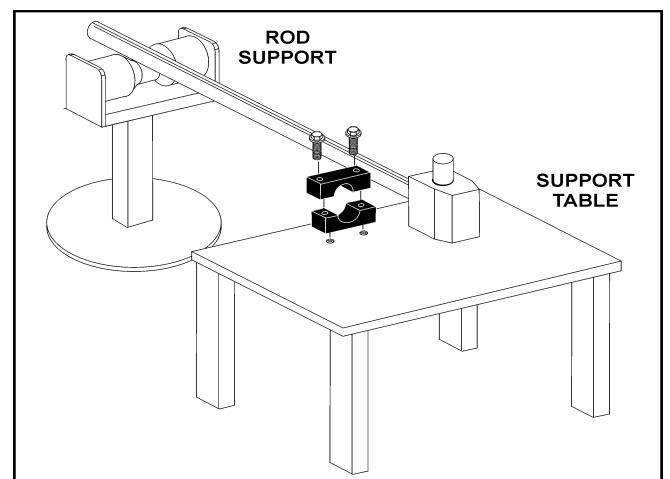
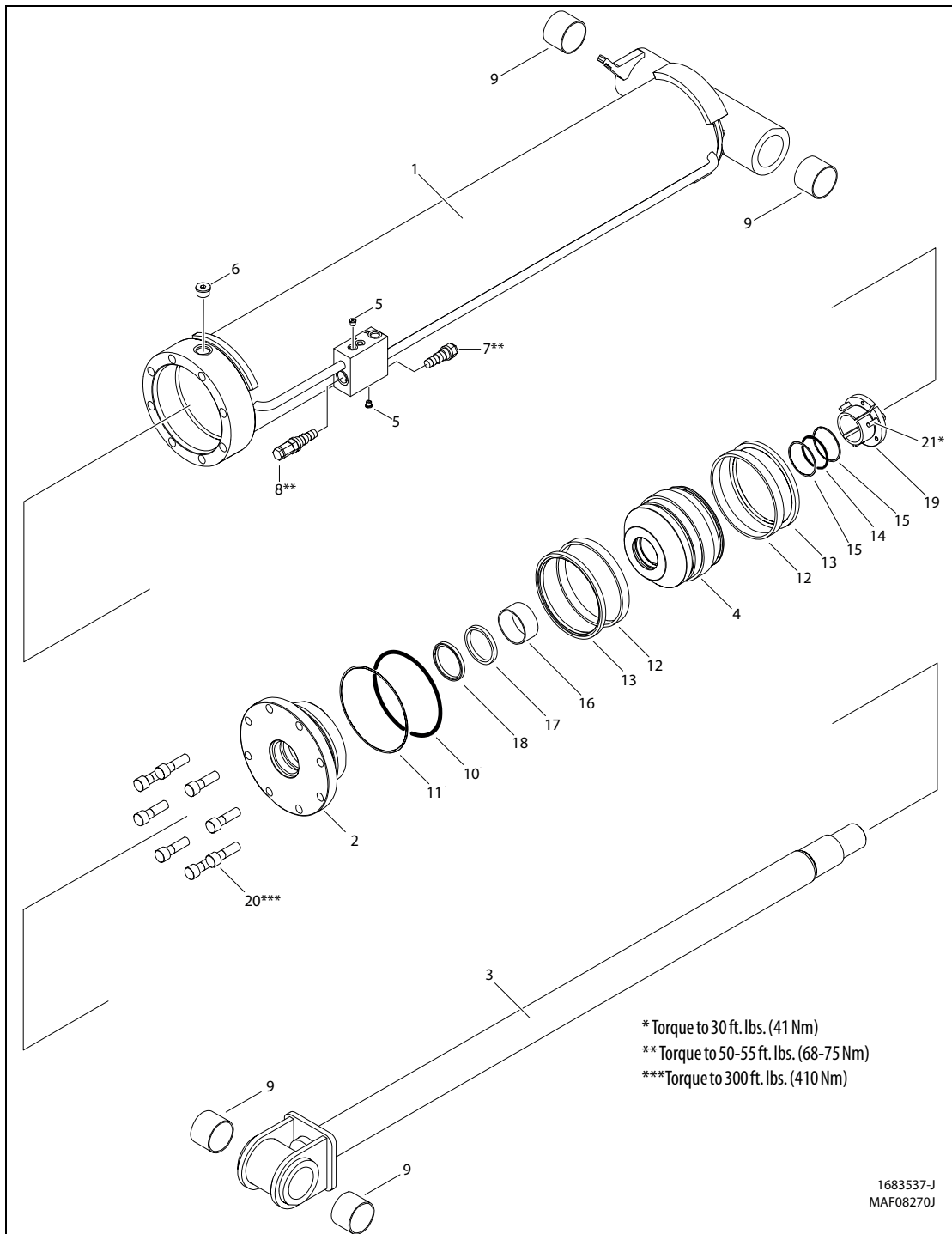


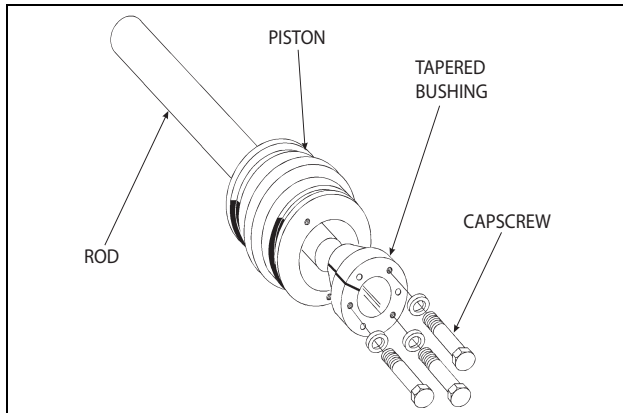
Figure 5-92. Cylinder Rod Support



- |                |                    |               |                 |                     |
|----------------|--------------------|---------------|-----------------|---------------------|
| 1. Barrel      | 6. O-ring Plug     | 10. O-ring    | 14. O-ring      | 18. Wiper           |
| 2. Head        | 7. Cartridge Valve | 11. Lock Ring | 15. Backup Ring | 19. Tapered Bushing |
| 3. Rod         | 8. Cartridge Valve | 12. Seal      | 16. Wear Ring   | 20. Capscrew        |
| 4. Piston      | 9. Bushing         | 13. Lock Ring | 17. Seal        | 21. Bolt            |
| 5. O-ring Plug |                    |               |                 |                     |

Figure 5-93. Tower Boom Lift Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



**Figure 5-94. Tapered Bushing Removal**

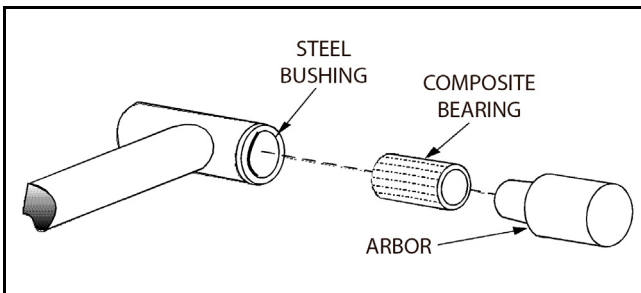
11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-95. Composite Bearing Installation**

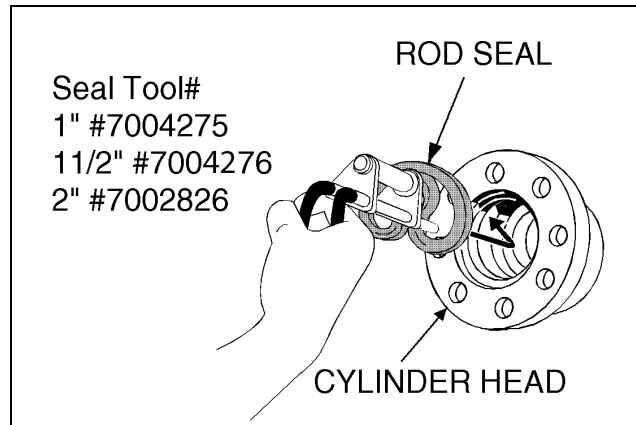
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

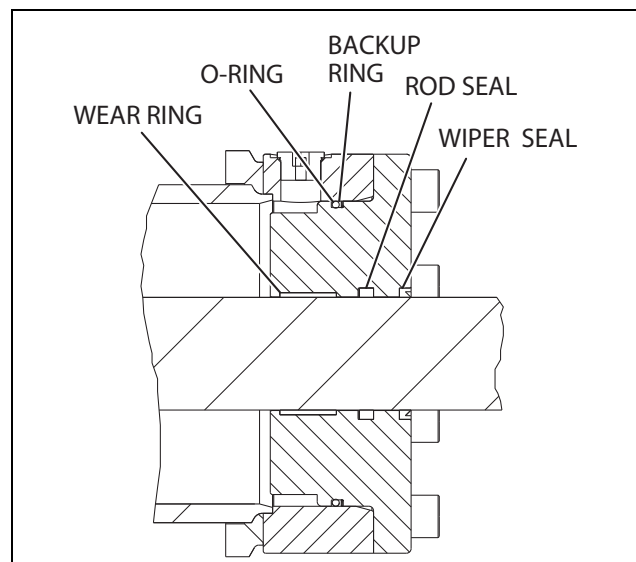
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-96. Rod Seal Installation**

### NOTICE

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-97. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

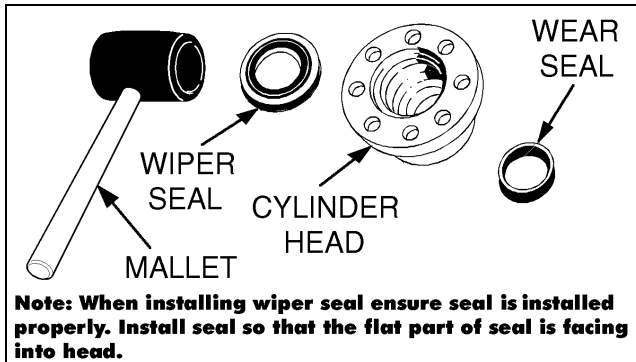


Figure 5-98. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

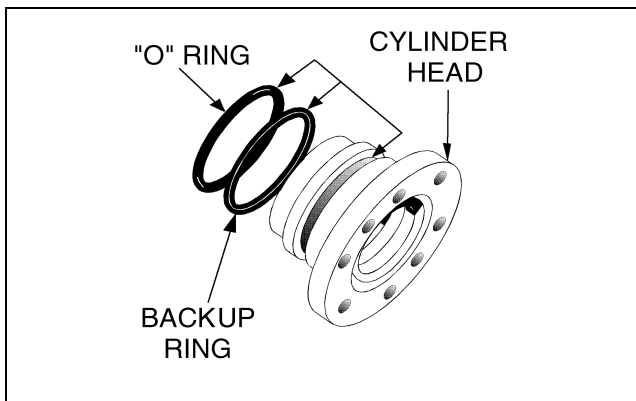


Figure 5-99. Installation of Head Seal Kit

4. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new o-ring and back-up rings in the inner piston diameter groove.
7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
8. Thread piston onto rod hand tight and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

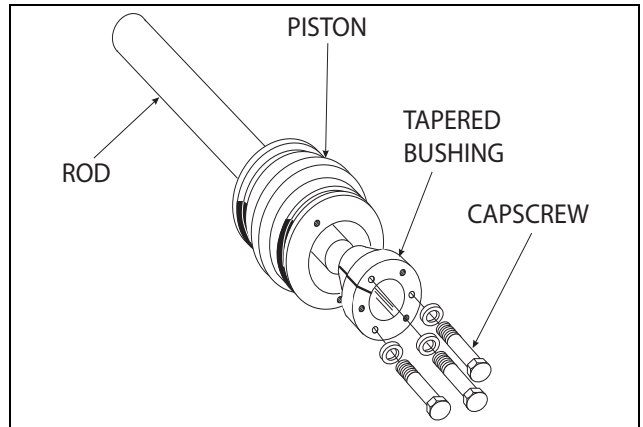


Figure 5-100. Tapered Bushing Installation

10. Tighten the capscrews evenly and progressively in rotation to 30 ft.lbs. (41 Nm).
11. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

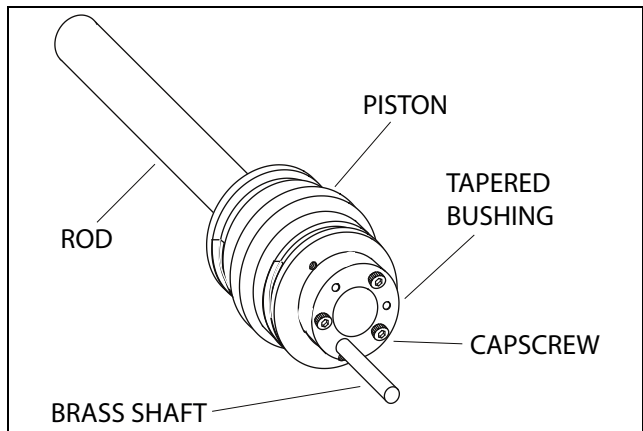


Figure 5-101. Seating the Tapered Bearing

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

12. Rotate the capscrews evenly and progressively in rotation to 30 ft.lbs. (41 Nm).
13. Remove the cylinder rod from the holding fixture.

### NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

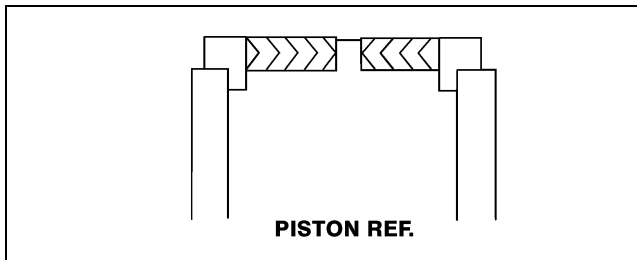


Figure 5-102. Hydrolock Piston Seal Installation

14. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

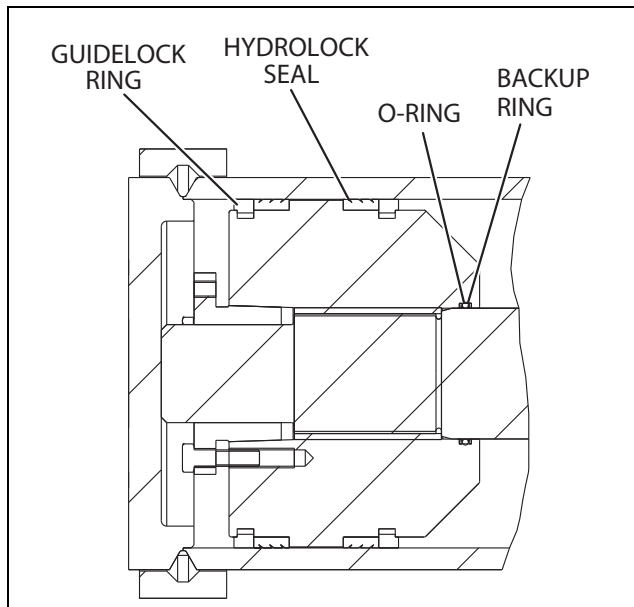


Figure 5-103. Piston Seal Kit Installation

15. Position the cylinder barrel in a suitable holding fixture.

### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

16. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
17. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

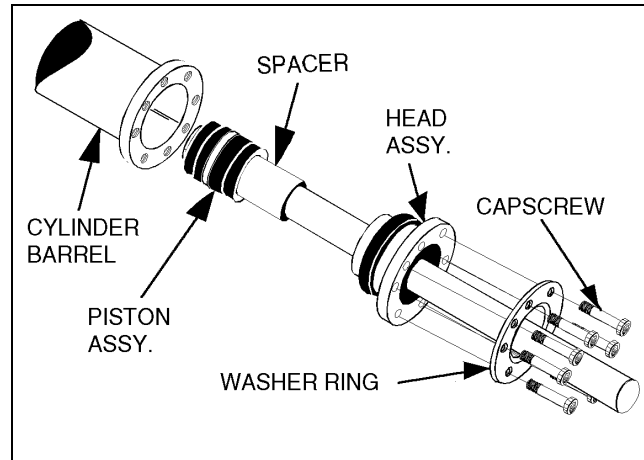


Figure 5-104. Rod Assembly Installation

18. Apply JLG Threadlocker if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 300 ft.lbs. (410 Nm).
19. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
20. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft.lbs. (68-75 Nm).

## Master Cylinder (800A)

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

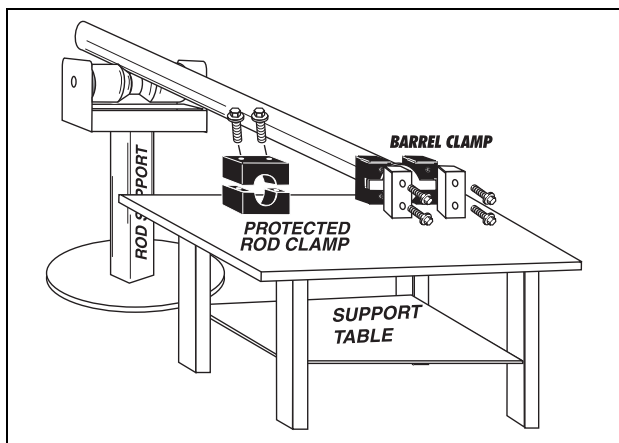


Figure 5-105. Cylinder Barrel Support

4. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

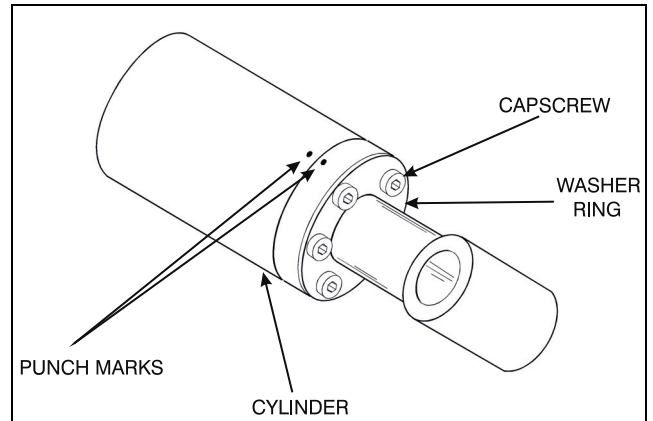


Figure 5-106. Capscrew Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

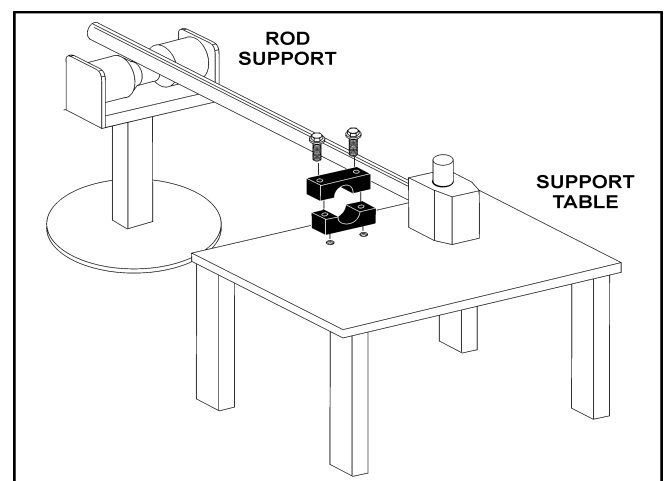
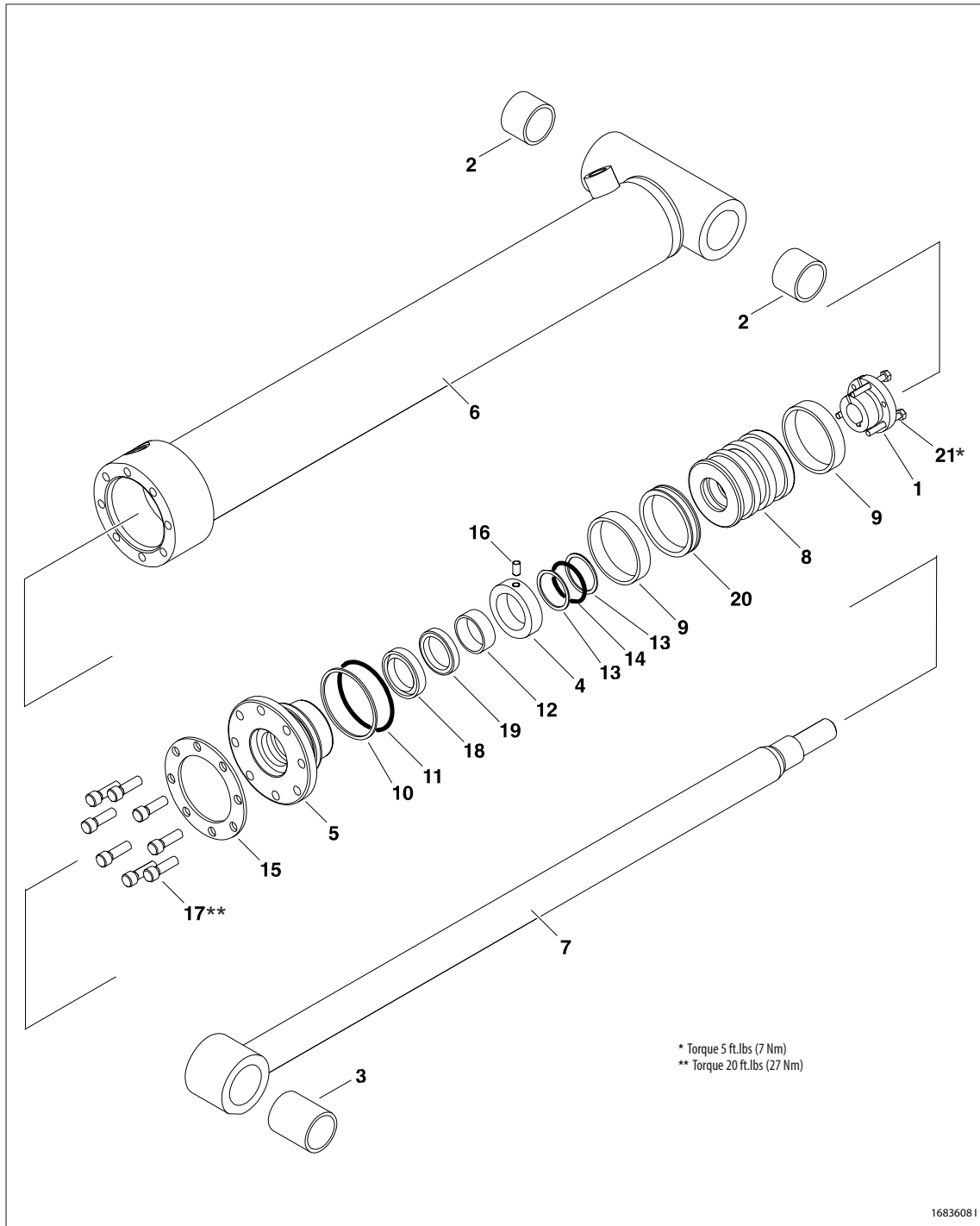


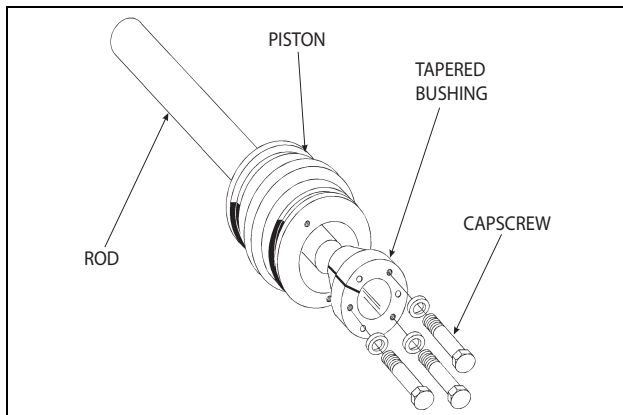
Figure 5-107. Cylinder Rod Support



- |                    |              |                 |                 |              |
|--------------------|--------------|-----------------|-----------------|--------------|
| 1. Tapered Bushing | 6. Barrel    | 10. Backup Ring | 14. O-ring      | 18. Wiper    |
| 2. Bushing         | 7. Rod       | 11. O-ring      | 15. Washer Ring | 19. Seal     |
| 3. Bushing         | 8. Piston    | 12. Wear Ring   | 16. Setscrew    | 20. T-Seal   |
| 4. Tube Spacer     | 9. Wear Ring | 13. Backup Ring | 17. Capscrew    | 21. Capscrew |
| 5. Head            |              |                 |                 |              |

Figure 5-108. Master Cylinder (800A)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
9. Remove the bushing from the piston.



**Figure 5-109. Tapered Bushing Removal**

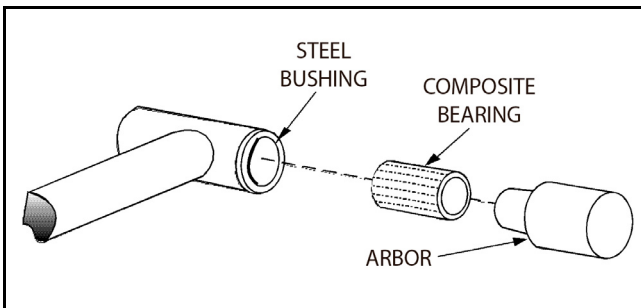
10. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
11. Remove and discard the piston o-rings, seal rings, and backup rings.
12. Remove the setscrew from the piston spacer. Remove spacer from the rod.
13. Remove the rod from the holding fixture. Remove capscrews and washer ring. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-110. Composite Bearing Installation**

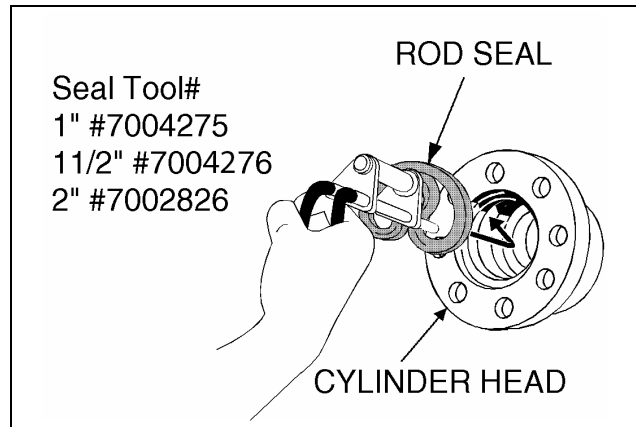
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

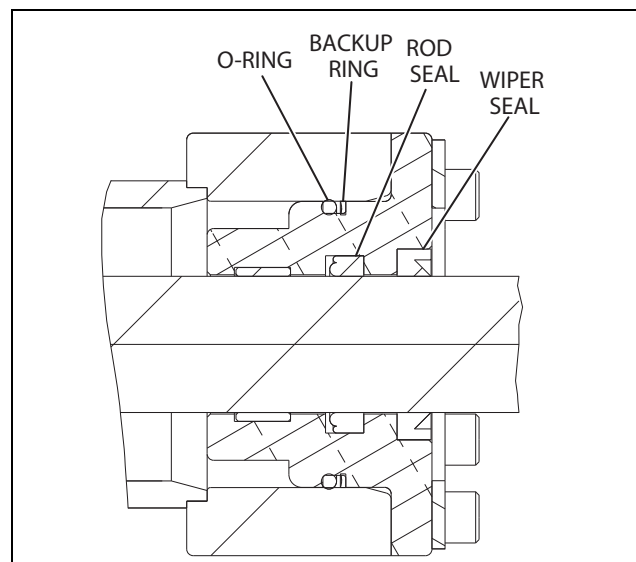
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-111. Rod Seal Installation**

### NOTICE

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-112. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

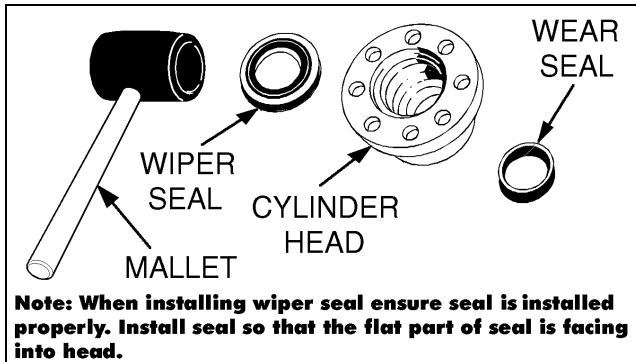


Figure 5-113. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

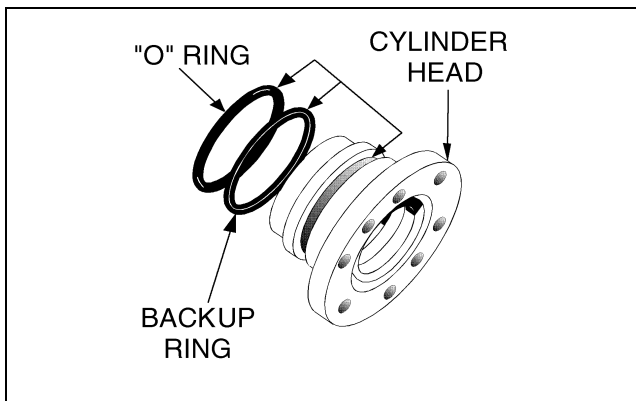


Figure 5-114. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new o-ring and back-up rings in the inner piston diameter groove.
7. Carefully slide piston spacer onto the cylinder rod. Install setscrew on the spacer.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

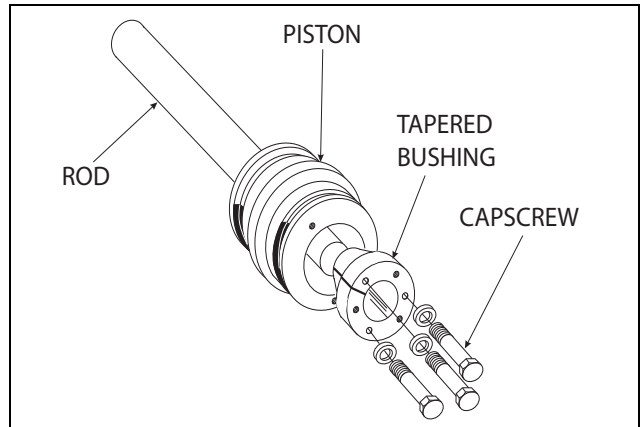


Figure 5-115. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 5 ft.lbs. (7 Nm).
12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

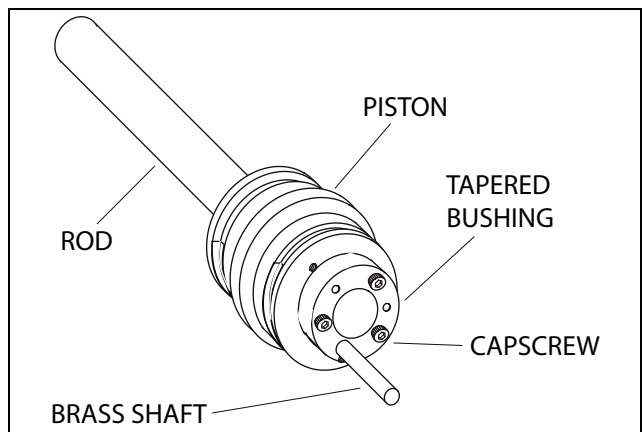


Figure 5-116. Seating the Tapered Bearing

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

13. Rotate the capscrews evenly and progressively in rotation to 5 ft.lbs. (7 Nm).
14. Remove the cylinder rod from the holding fixture.
15. Place new T-seal and wear rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

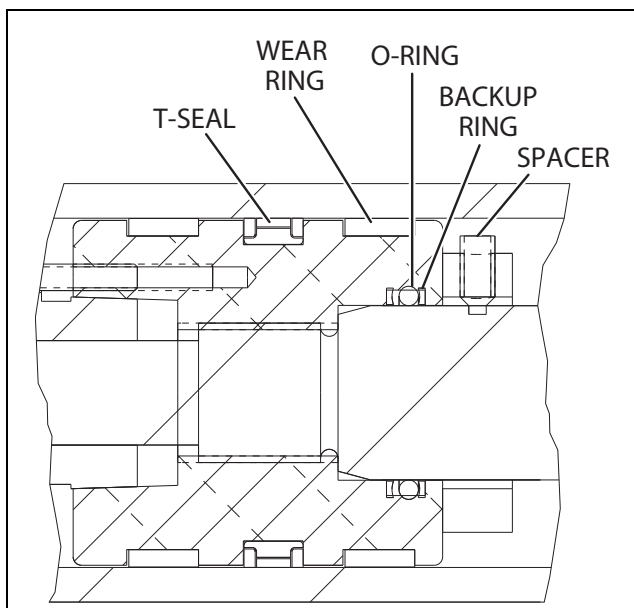


Figure 5-117. Piston Seal Kit Installation

16. Position the cylinder barrel in a suitable holding fixture.

### NOTICE

**EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.**

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

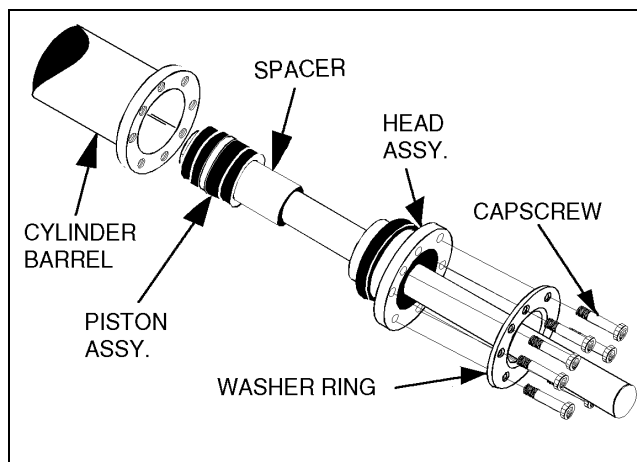


Figure 5-118. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 20 ft.lbs. (27 Nm).
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves, if applicable.

## Master Cylinder (800AJ)

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

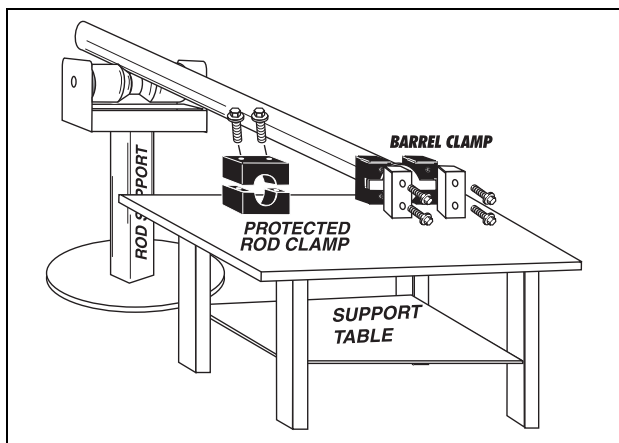


Figure 5-119. Cylinder Barrel Support

4. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

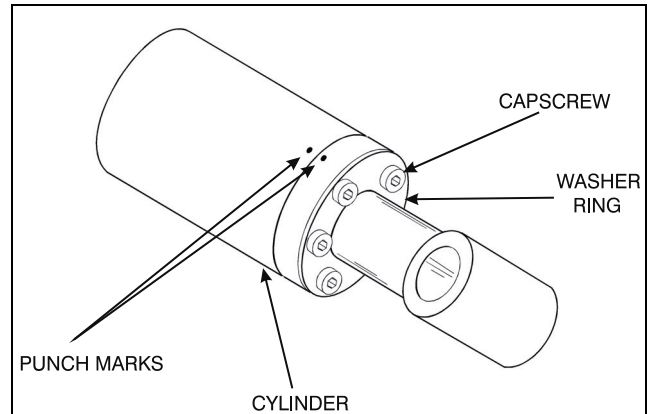


Figure 5-120. Capscrew Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

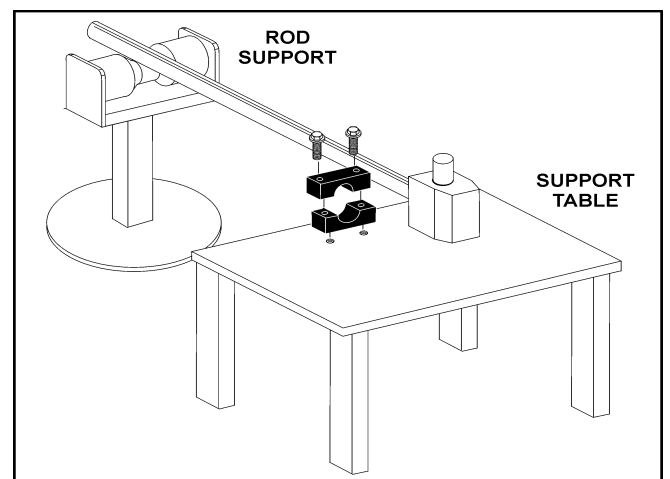
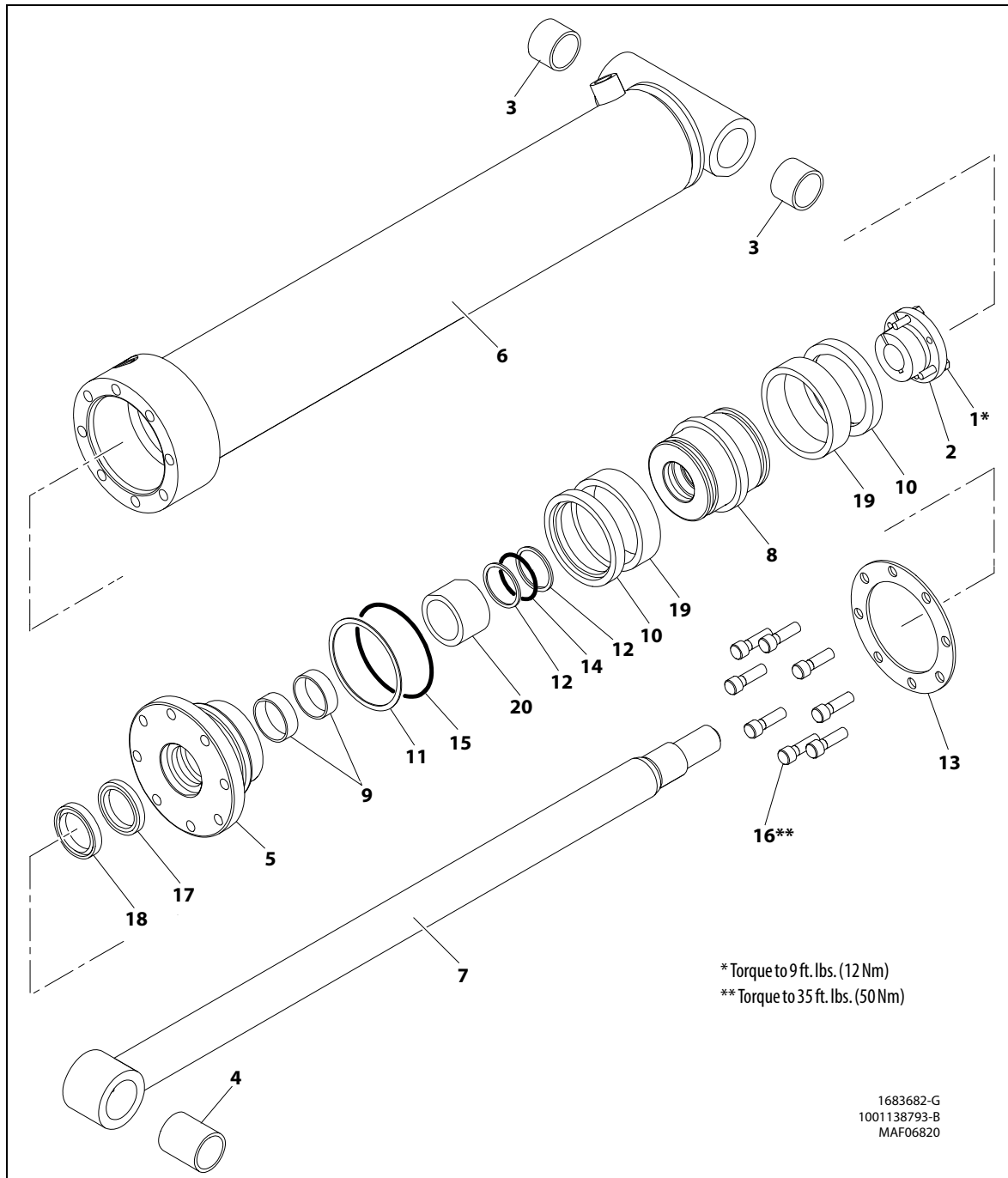
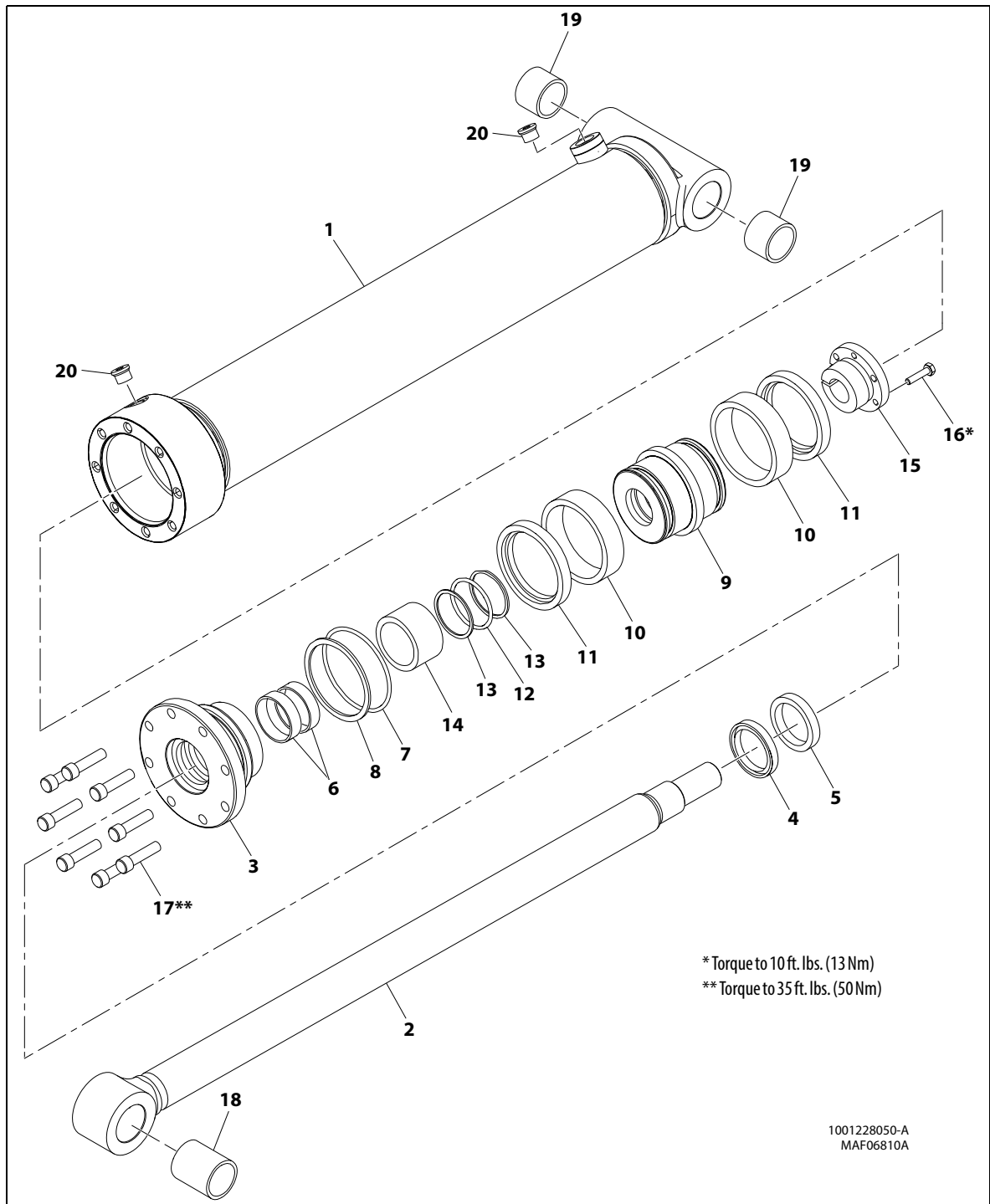


Figure 5-121. Cylinder Rod Support



- |                    |           |                 |                 |                 |
|--------------------|-----------|-----------------|-----------------|-----------------|
| 1. Capscrew        | 5. Head   | 9. Wear Ring    | 13. Washer Ring | 17. Rod Seal    |
| 2. Tapered Bushing | 6. Barrel | 10. Lock Ring   | 14. O-ring      | 18. Wiper       |
| 3. Bushing         | 7. Rod    | 11. Backup Ring | 15. O-ring      | 19. Seal        |
| 4. Bushing         | 8. Piston | 12. Backup Ring | 16. Capscrew    | 20. Tube Spacer |

Figure 5-122. Master Cylinder (SN 0300183034 through 0300243317)



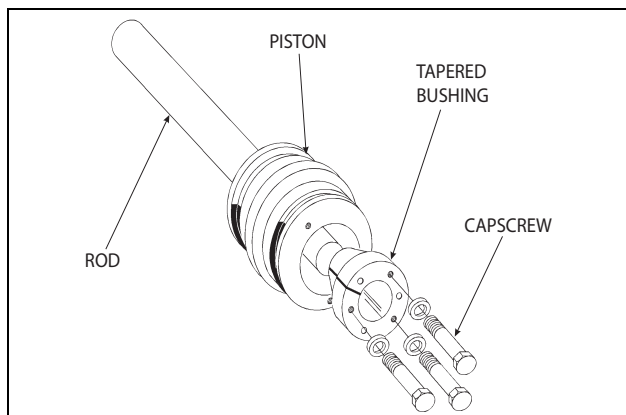
\*Torque to 10 ft. lbs. (13 Nm)  
 \*\*Torque to 35 ft. lbs. (50 Nm)

1001228050-A  
 MAF06810A

- |           |                |               |                     |              |
|-----------|----------------|---------------|---------------------|--------------|
| 1. Barrel | 5. Rod Seal    | 9. Piston     | 13. Backup Ring     | 17. Capscrew |
| 2. Rod    | 6. Wear Ring   | 10. Wear Ring | 14. Tube Spacer     | 18. Bushing  |
| 3. Head   | 7. O-ring      | 11. Lock Ring | 15. Tapered Bushing | 19. Bushing  |
| 4. Wiper  | 8. Backup Ring | 12. O-ring    | 16. Capscrew        | 20. Plug     |

Figure 5-123. Master Cylinder (SN 0300243318 to Present)

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
9. Remove the bushing from the piston.



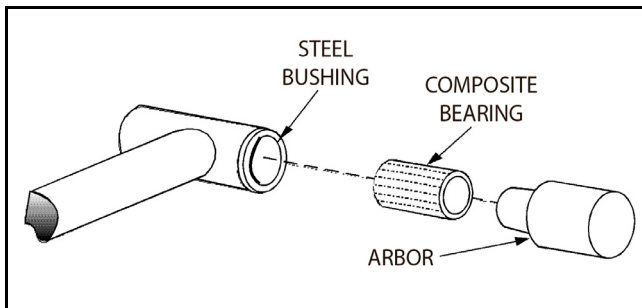
**Figure 5-124. Tapered Bushing Removal**

10. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
11. Remove and discard the piston o-rings, seal rings, and backup rings.
12. Remove piston spacer from the rod.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-125. Composite Bearing Installation**

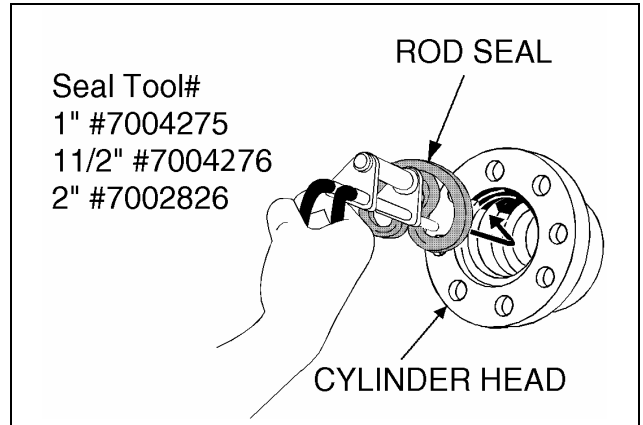
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

**ASSEMBLY**

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

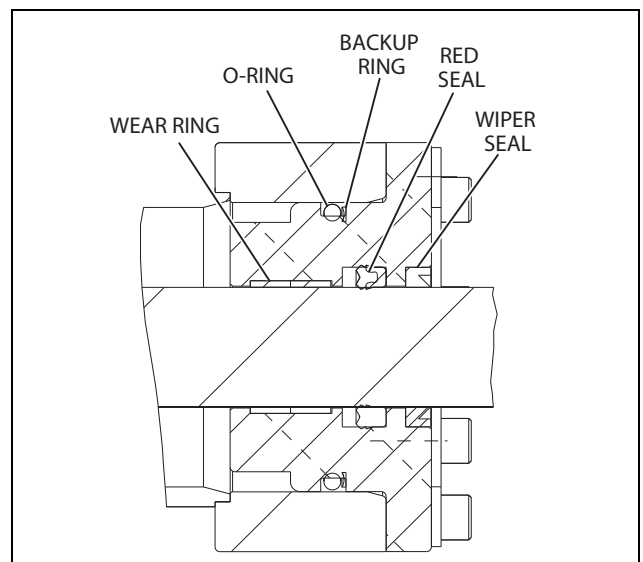
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-126. Rod Seal Installation**

**NOTICE**

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-127. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

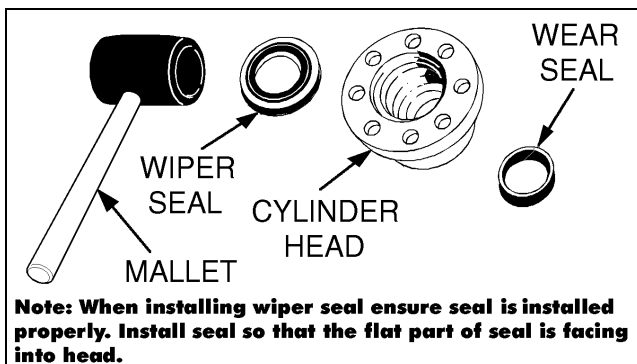


Figure 5-128. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

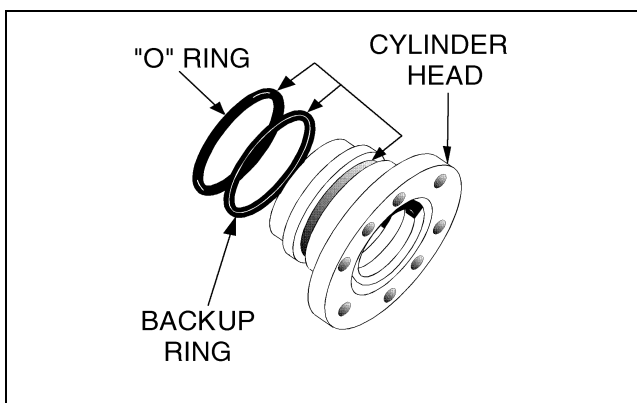


Figure 5-129. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Place a new o-ring and back-up rings in the inner piston diameter groove.
7. Install piston spacer onto the cylinder rod.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

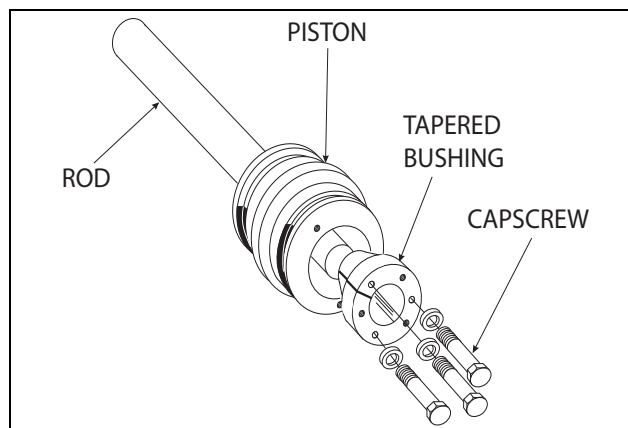


Figure 5-130. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation and torque as shown in Figure 5-122. and Figure 5-123.
12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

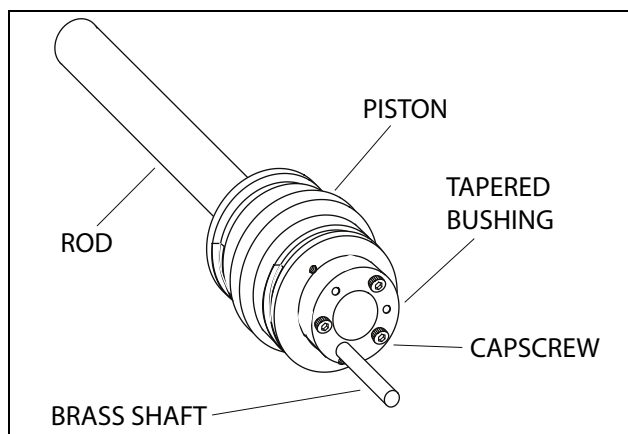


Figure 5-131. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation and torque as shown in Figure 5-122. and Figure 5-123.
14. Remove the cylinder rod from the holding fixture.

**NOTICE**

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

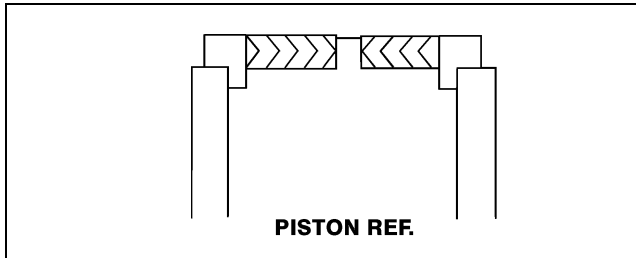


Figure 5-132. Hydrolock Piston Seal Installation

15. Place new guidelock rings and hydrolock seal or wear ring as applicable in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

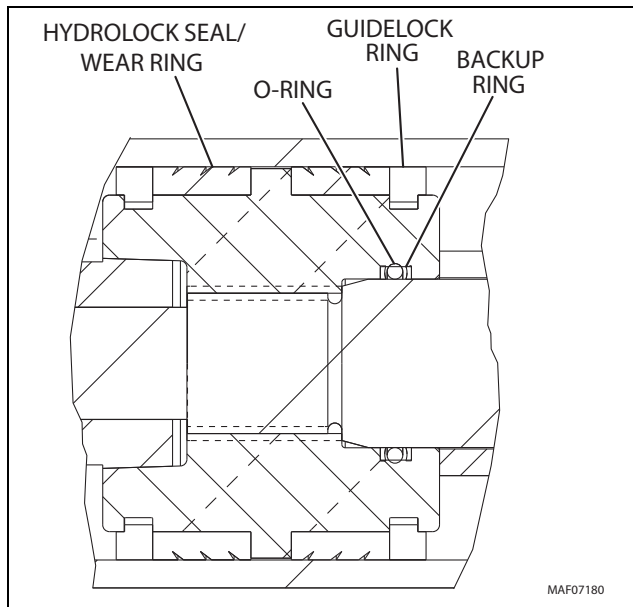


Figure 5-133. Piston Seal Kit Installation

16. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

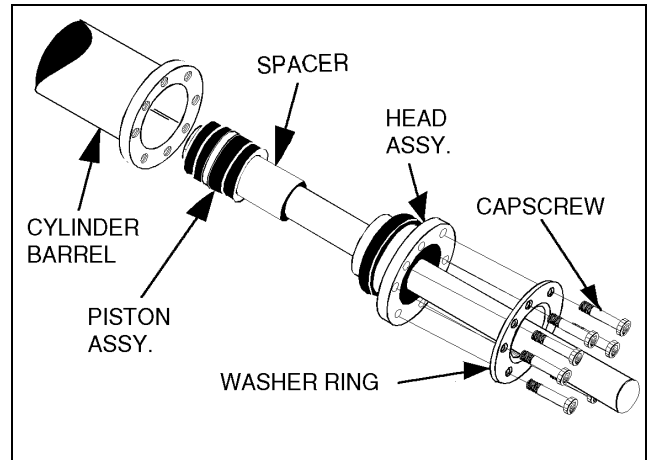


Figure 5-134. Rod Assembly Installation

19. Apply JLG Threadlocker if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 35 ft.lbs. (50 Nm).

## Steer Cylinder

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Place the cylinder barrel into a suitable holding fixture.

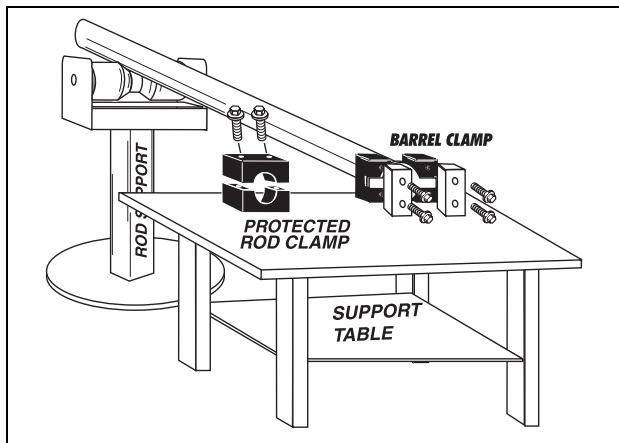


Figure 5-135. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

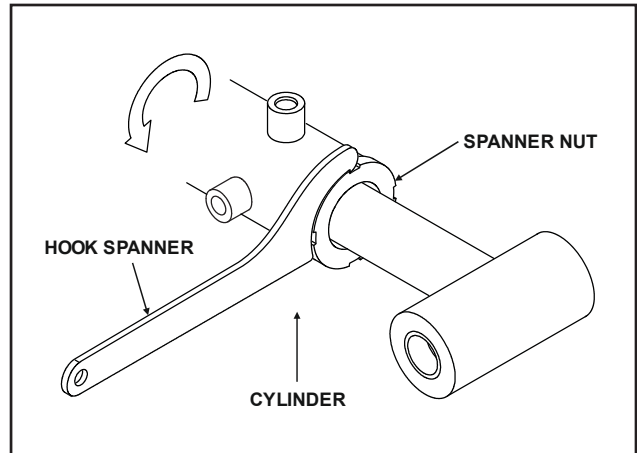


Figure 5-136. Spanner Nut Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

6. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

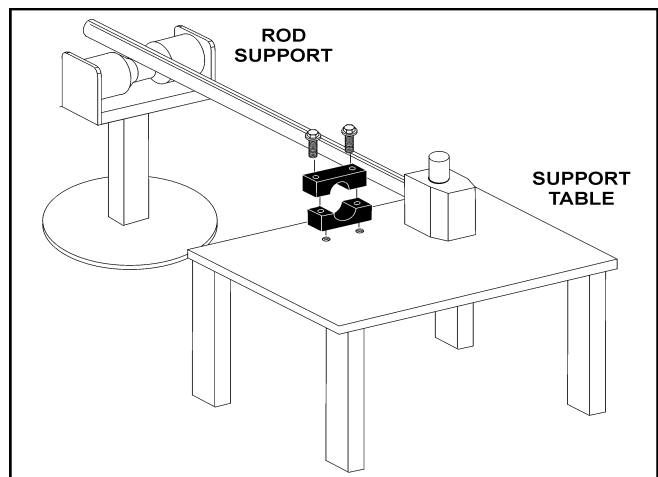
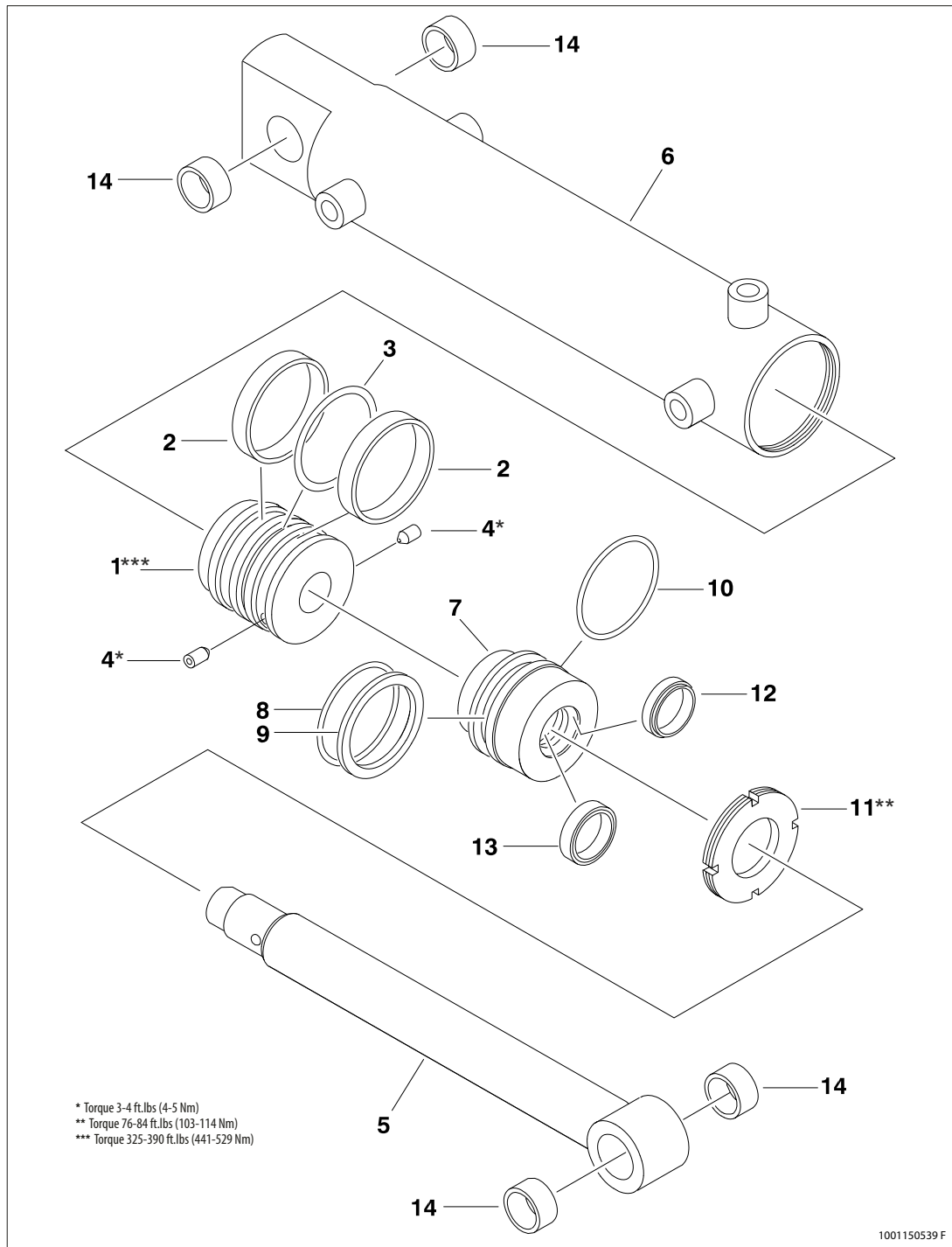


Figure 5-137. Cylinder Rod Support



- |              |                |                 |
|--------------|----------------|-----------------|
| 1. Piston    | 6. Barrel      | 11. Spanner Nut |
| 2. Wear Ring | 7. Head        | 12. Wiper Seal  |
| 3. Seal      | 8. O-ring      | 13. Rod Seal    |
| 4. Setscrew  | 9. Backup Ring | 14. Bushing     |
| 5. Rod       | 10. C-Ring     |                 |

Figure 5-138. Steer Cylinder

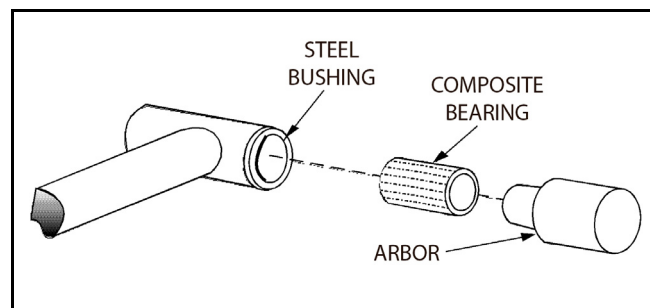
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove the setscrews from the piston.
9. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
10. Remove and discard the piston seal and wear rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, back-up ring, c-ring, rod seal, and wiper seal.

**Cleaning and Inspection**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of barrel for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.

11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

**NOTE:** *Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.*



**Figure 5-139. Composite Bearing Installation**

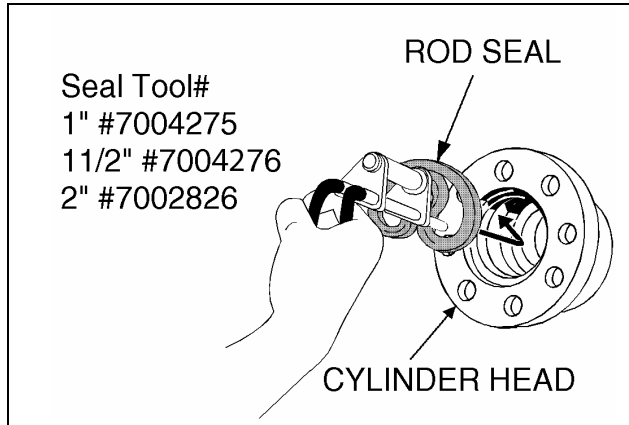
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

**ASSEMBLY**

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

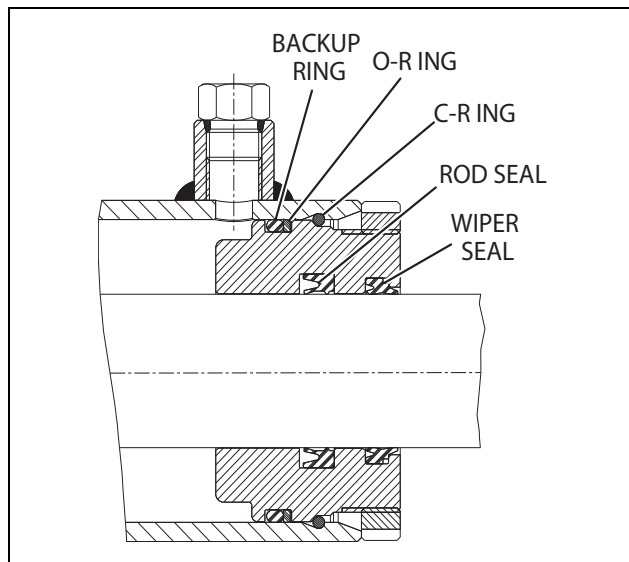
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-140. Rod Seal Installation**

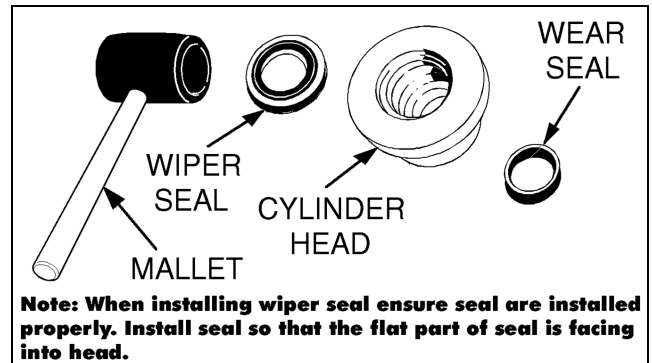
**NOTICE**

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



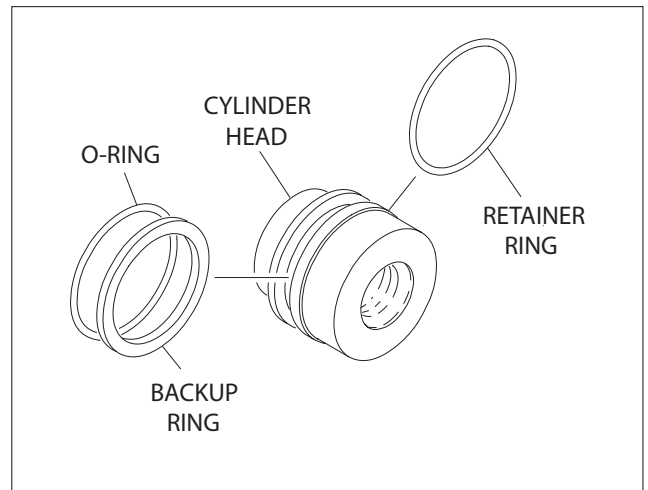
**Figure 5-141. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.



**Figure 5-142. Wiper Seal Installation**

3. Place a new o-ring, back-up ring and c-ring in the applicable outside diameter groove of the cylinder head.



**Figure 5-143. Installation of Head Seal Kit**

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
7. Install the setscrews on the piston.
8. Remove the cylinder rod from the holding fixture.

9. Place new seal and wear ring in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

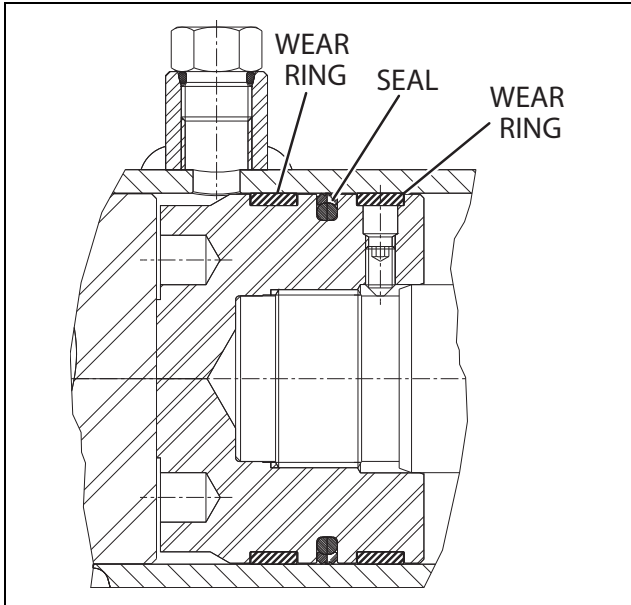


Figure 5-144. Piston Seal Kit Installation

10. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

**EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.**

11. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
12. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
13. Secure spanner nut into the cylinder barrel. Torque nut to 325-390 ft.lbs. (441-529 Nm).
14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves, if applicable.

**Main Boom Telescope Cylinder (800A  
SN 0300183034 through 0300245050,  
800AJ SN 0300183034 to Present)**

**DISASSEMBLY**

**NOTICE**

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

**WARNING**

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove capscrews and valve assembly from the barrel end. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

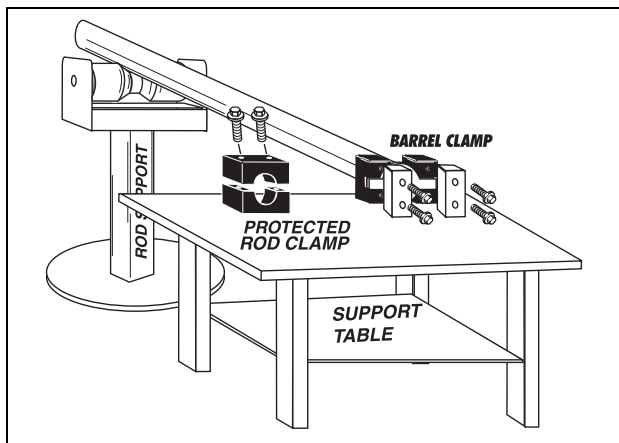


Figure 5-145. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

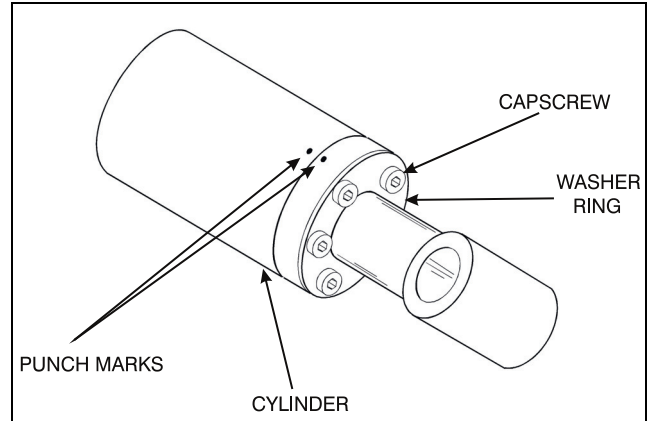


Figure 5-146. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

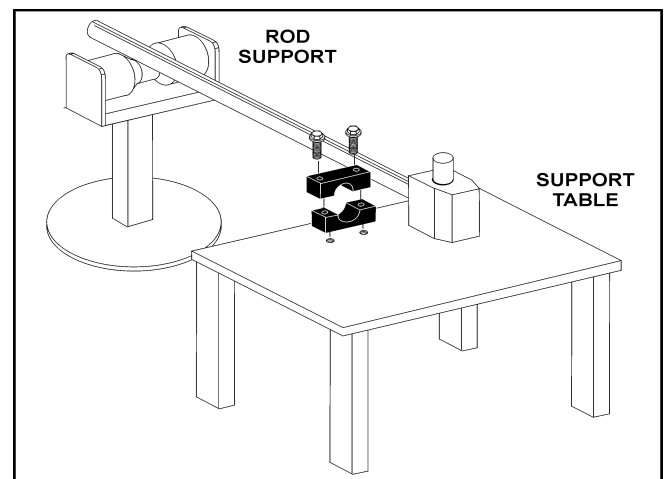
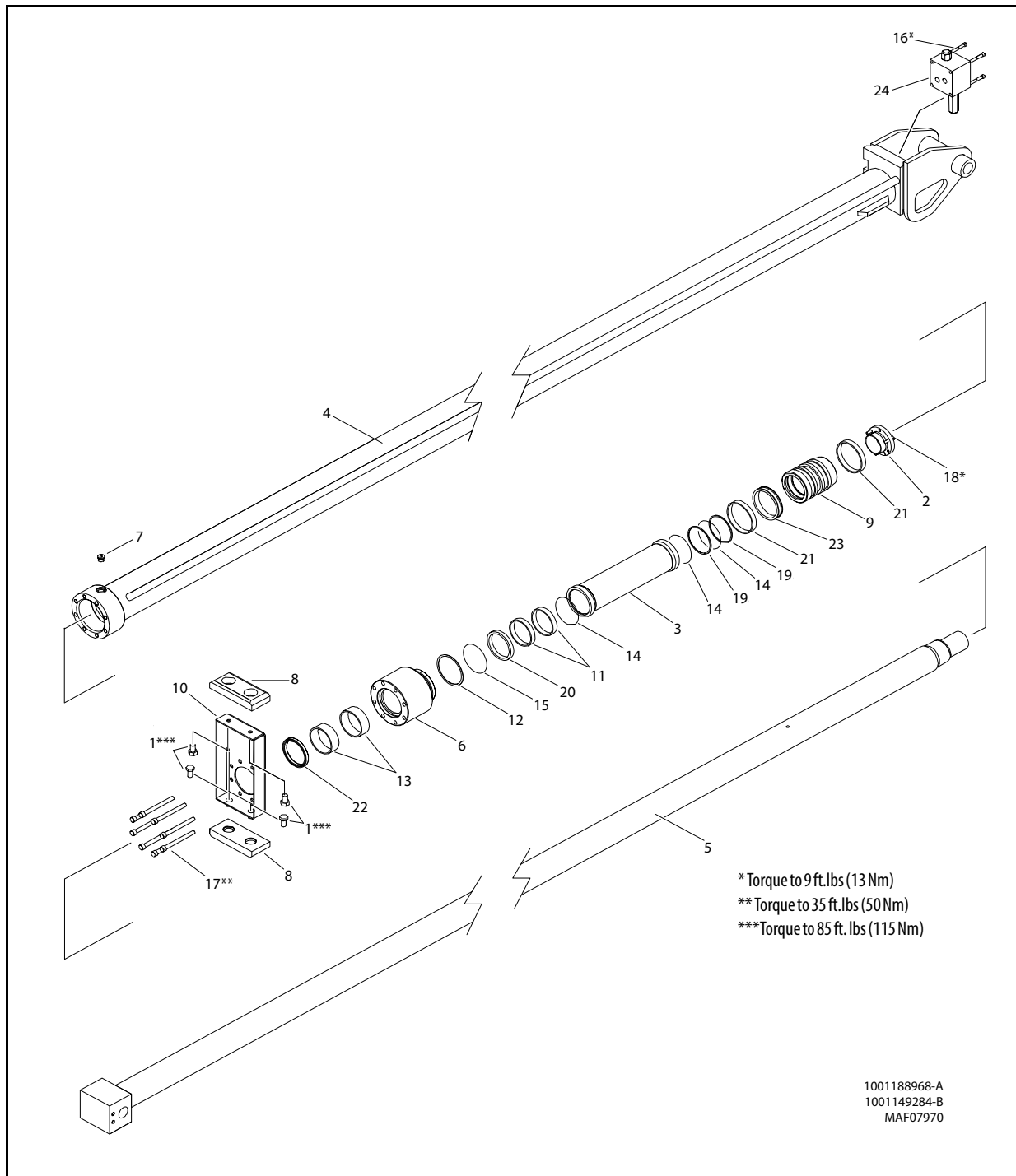


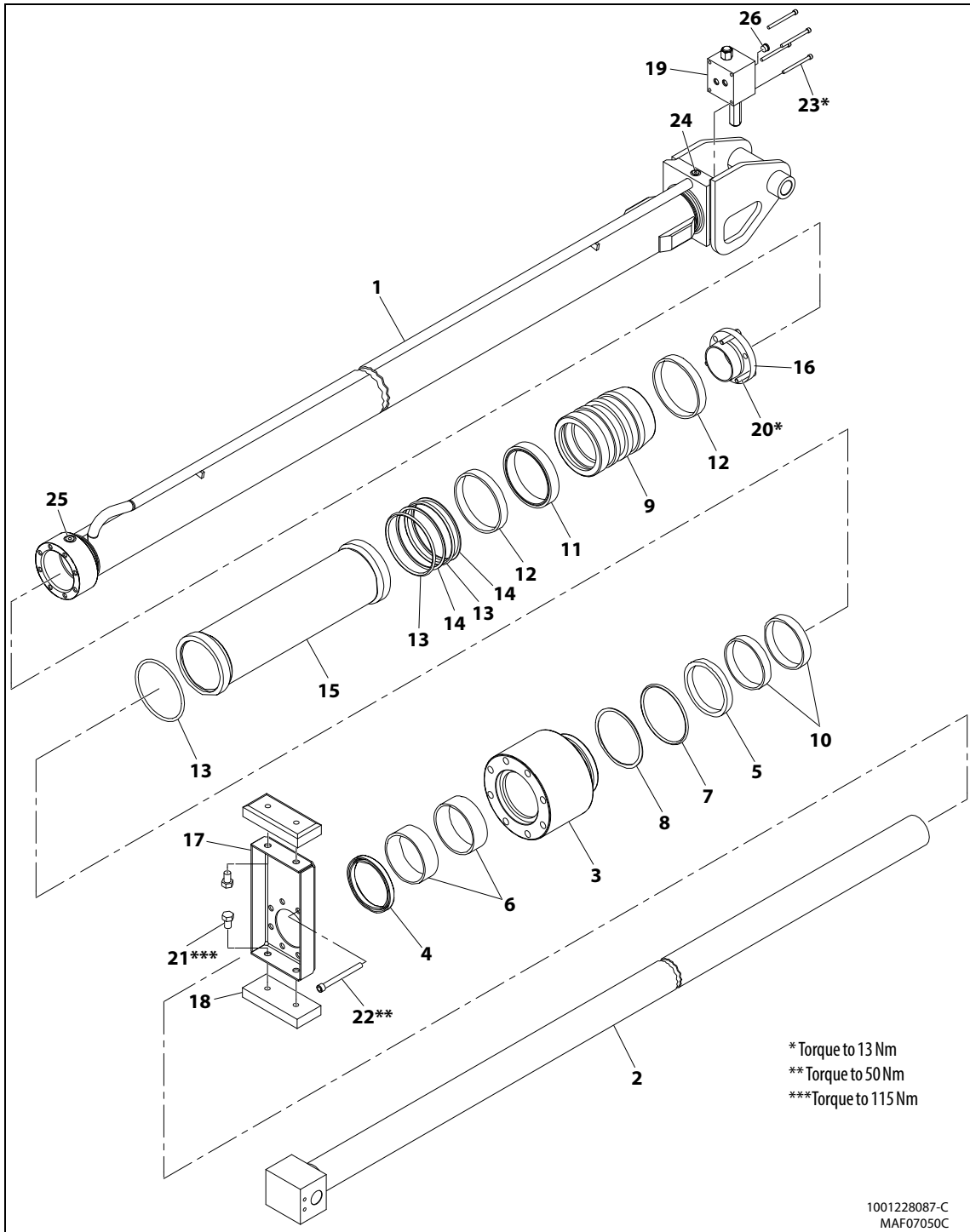
Figure 5-147. Cylinder Rod Support

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |                    |                |                 |                 |                    |
|--------------------|----------------|-----------------|-----------------|--------------------|
| 1. Bolt            | 6. Head        | 11. Wear Ring   | 16. Capscrew    | 21. Wear Ring      |
| 2. Tapered Bushing | 7. O-ring Plug | 12. Backup Ring | 17. Capscrew    | 22. Wiper          |
| 3. Tube Spacer     | 8. Wear Pad    | 13. Wear Ring   | 18. Bolt        | 23. T-Seal         |
| 4. Barrel          | 9. Piston      | 14. O-ring      | 19. Backup Ring | 24. Valve Assembly |
| 5. Rod             | 10. Plate      | 15. O-ring      | 20. Rod Seal    |                    |

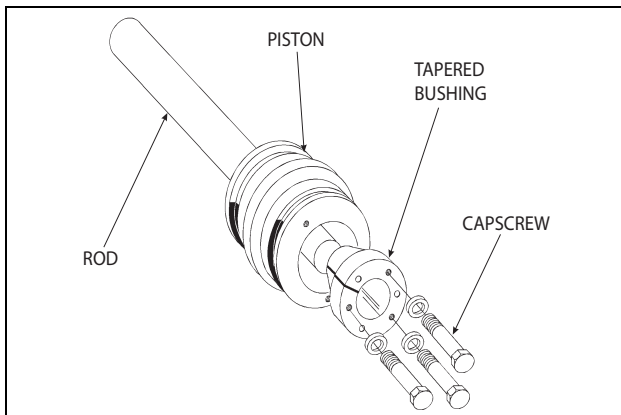
**Figure 5-148. Main Boom Telescopic Cylinder (800A SN 0300183034 through 0300245050, 800AJ SN 0300183034 through 0300243317)**



- |               |                |                 |                     |                 |                 |
|---------------|----------------|-----------------|---------------------|-----------------|-----------------|
| 1. Barrel     | 6. Wear Ring   | 11. Piston Seal | 16. Tapered Bushing | 21. Capscrew    | 25. O-ring Plug |
| 2. Rod        | 7. O-ring      | 12. Wear Ring   | 17. Plate           | 22. Capscrew    | 26. O-ring Plug |
| 3. Head       | 8. Backup Ring | 13. O-ring      | 18. Wear Pad        | 23. Capscrew    |                 |
| 4. Wiper Seal | 9. Piston      | 14. Backup Ring | 19. Valve Assembly  | 24. O-ring Plug |                 |
| 5. Rod Seal   | 10. Wear Ring  | 15. Spacer      | 20. Capscrew        |                 |                 |

Figure 5-149. Main Boom Telescopic Cylinder (800AJ SN 0300243318 to Present)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



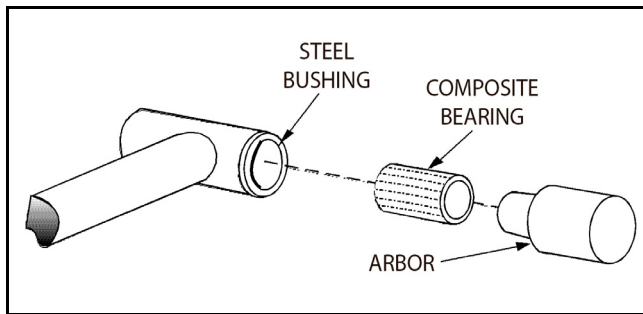
**Figure 5-150. Tapered Bushing Removal**

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove o-rings from piston spacer. Remove piston spacer from the rod.
14. Remove capscrews to remove plate and wear pads.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-151. Composite Bearing Installation**

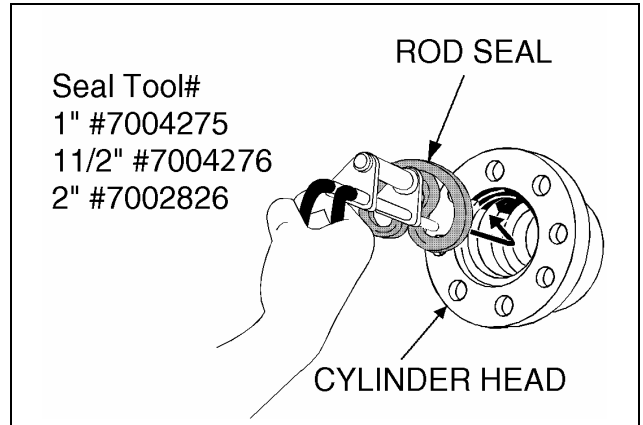
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

**ASSEMBLY**

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

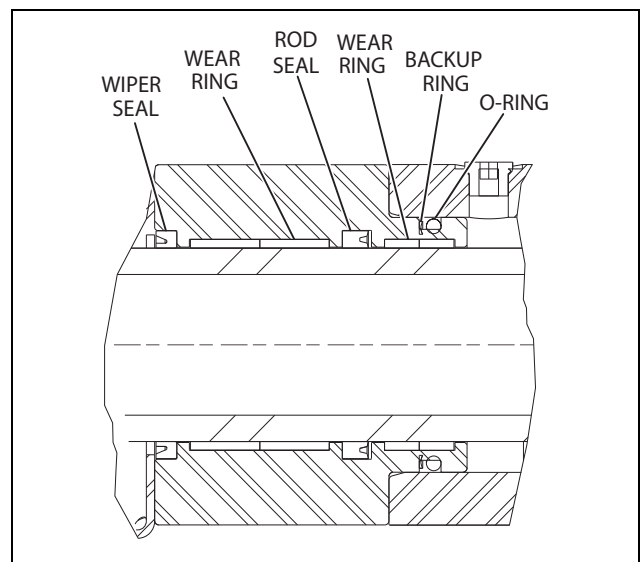
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-152. Rod Seal Installation**

**NOTICE**

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-153. Cylinder Head Seal Installation**

- Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

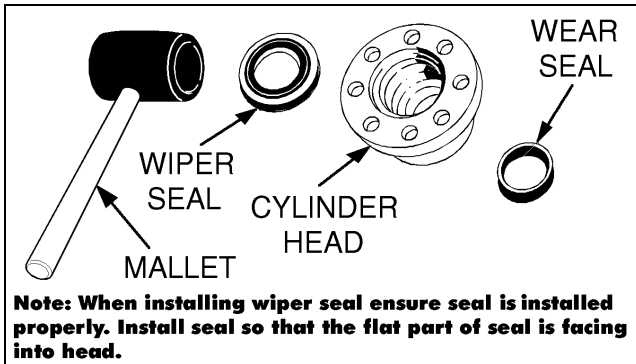


Figure 5-154. Wiper Seal Installation

- Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

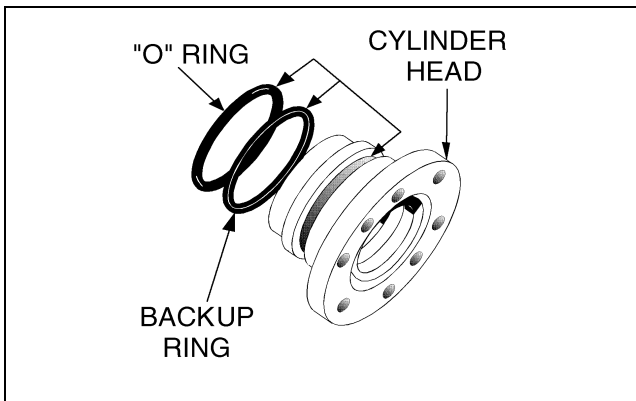


Figure 5-155. Installation of Head Seal Kit

- Install plate on to the rod. Use capscrews to attach wear pads on the plate.
- Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
- Install o-rings inside grooves of the piston spacer. Carefully slide the spacer on the rod.
- Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Place a new o-ring and back-up rings in the inner piston diameter groove.
- Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
- Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

- Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

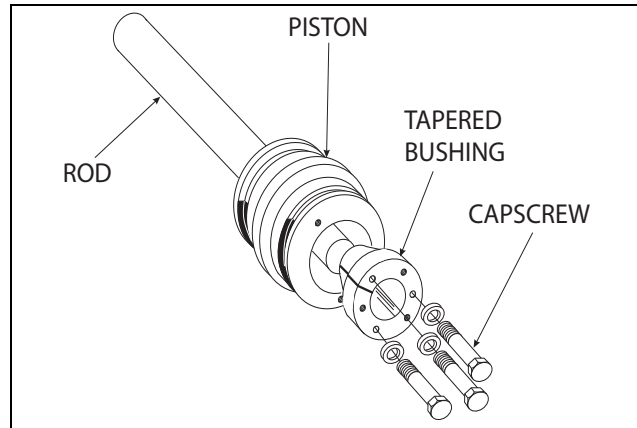


Figure 5-156. Tapered Bushing Installation

- Tighten the capscrews evenly and progressively in rotation and torque as shown in Figure 5-148. and Figure 5-149.
- After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

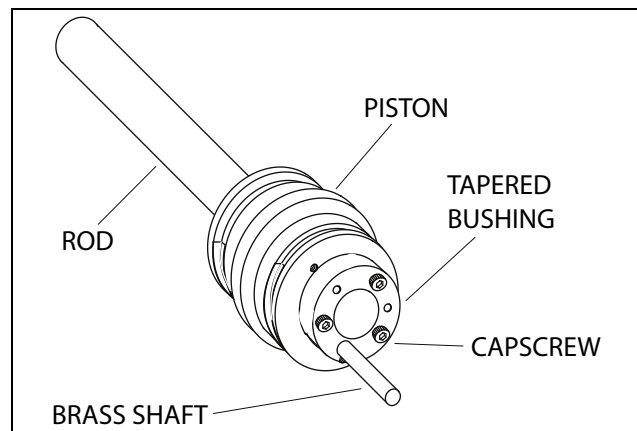


Figure 5-157. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation and torque as shown in Figure 5-148. and Figure 5-149.
15. Remove the cylinder rod from the holding fixture.
16. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

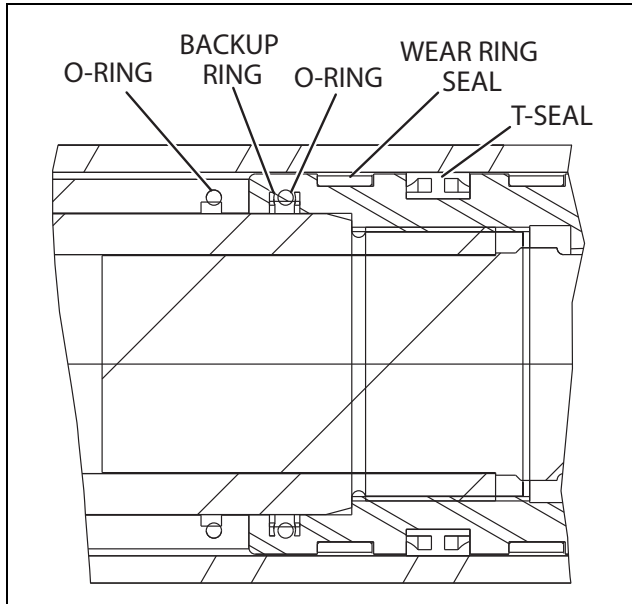


Figure 5-158. Piston Seal Kit Installation

17. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

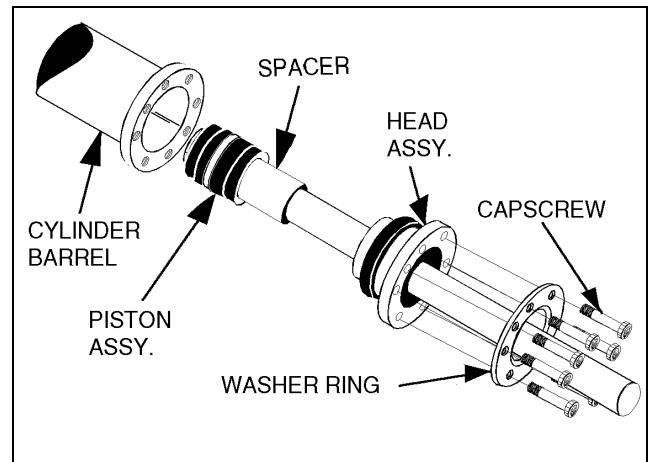


Figure 5-159. Rod Assembly Installation

20. Apply JLG Threadlocker as applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts as shown in Figure 5-148. and Figure 5-149.
21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
22. Install the valve assembly. Torque capscrews as shown in Figure 5-148. and Figure 5-149.

## Main Boom Telescope Cylinder (SN 0300245051 to Present)

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. Remove the capscrews securing the valve block to the barrel end of the cylinder. Remove the valve assembly.
4. Remove the counterbalance valves and plugs from the valve block and cylinder port block. Discard o-rings.
5. Place the cylinder barrel into a suitable holding fixture.

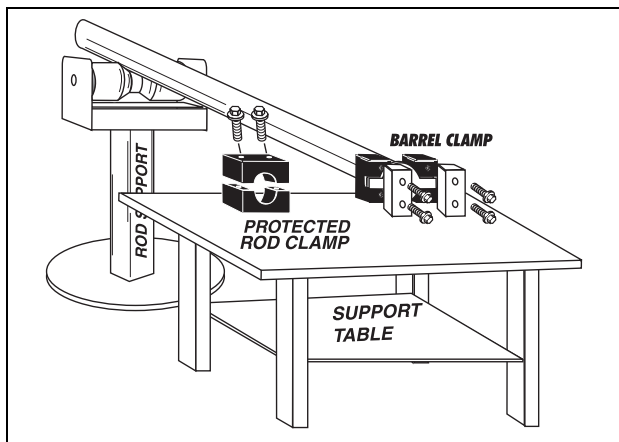


Figure 5-160. Cylinder Barrel Support

6. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen and remove the capscrews securing the wearpad plate and cylinder head to the barrel. Remove the hardware securing the wear pads to the plate. Remove the wear pads.

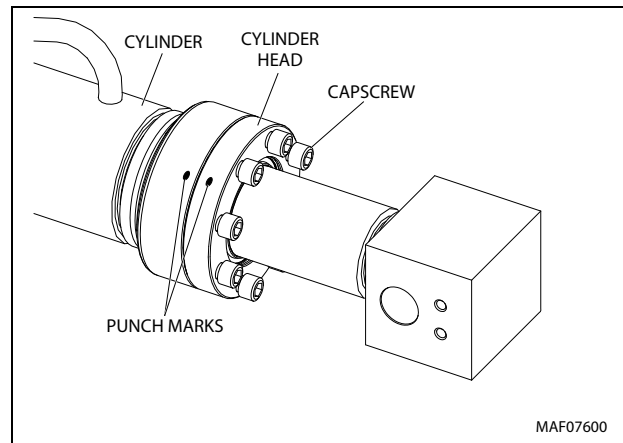


Figure 5-161. Cylinder Head Removal

7. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

8. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

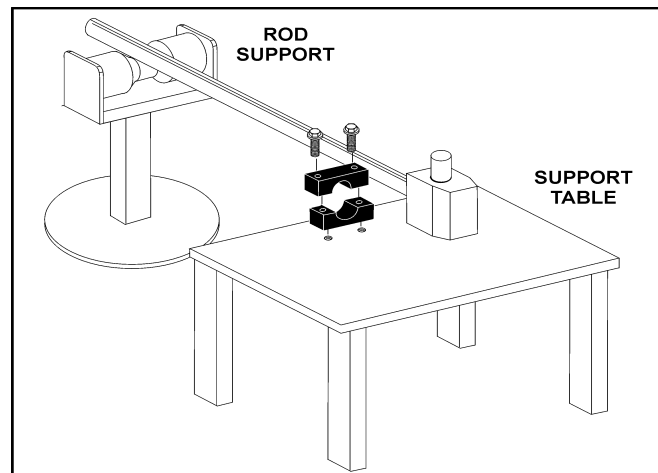
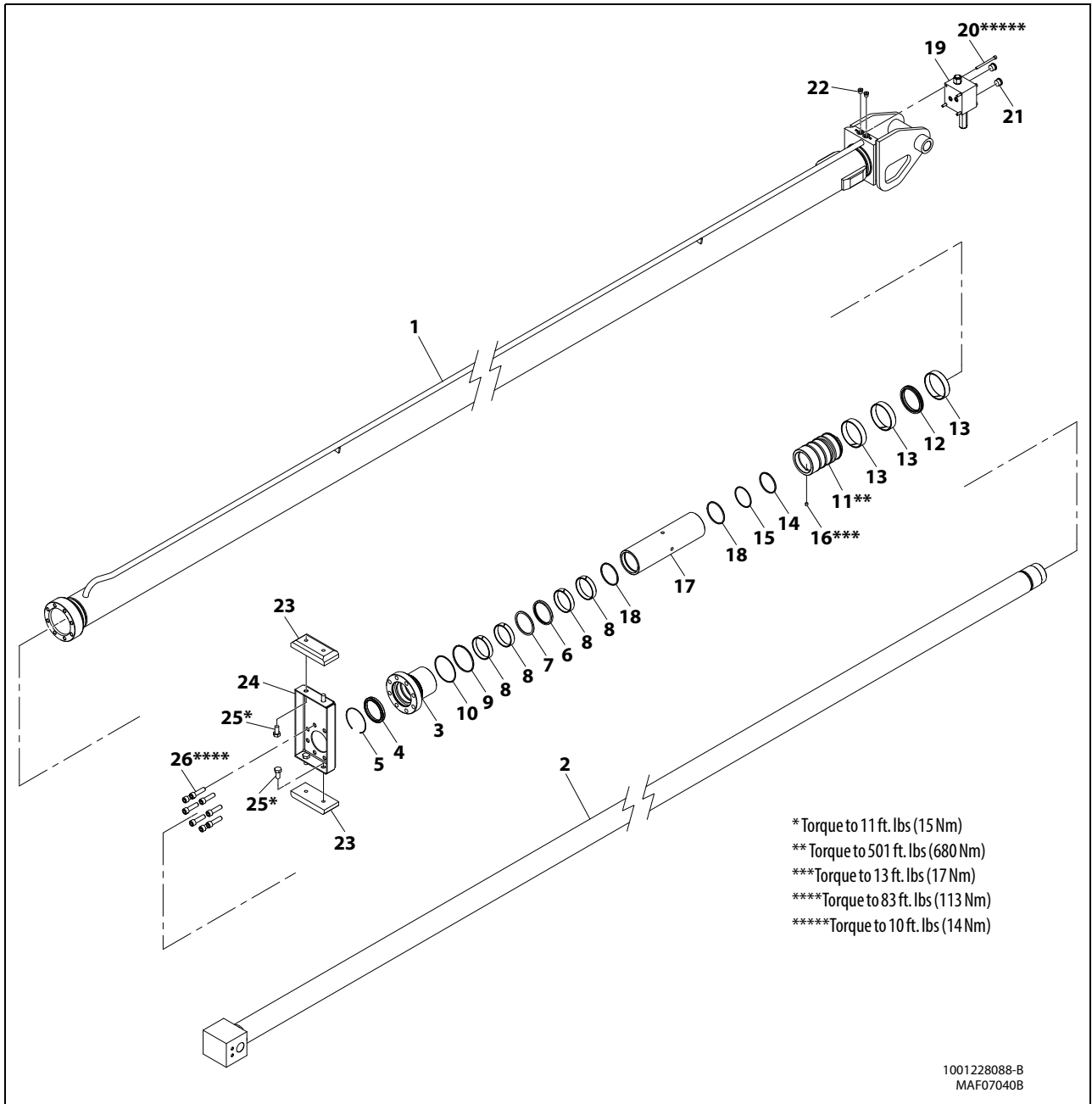


Figure 5-162. Cylinder Rod Support



- |                   |                 |                 |                    |                 |              |
|-------------------|-----------------|-----------------|--------------------|-----------------|--------------|
| 1. Barrel         | 6. Rod Seal     | 11. Piston      | 16. Setscrew       | 21. O-ring Plug | 25. Capscrew |
| 2. Rod            | 7. Backup Ring  | 12. Seal        | 17. Tube Spacer    | 22. O-ring Plug | 26. Capscrew |
| 3. Head           | 8. Wear Ring    | 13. Wear Ring   | 18. O-ring         | 23. Wear Pad    |              |
| 4. Wiper Seal     | 9. O-ring       | 14. O-ring      | 19. Valve Assembly | 24. Plate       |              |
| 5. Retaining Ring | 10. Backup Ring | 15. Backup Ring | 20. Capscrew       |                 |              |

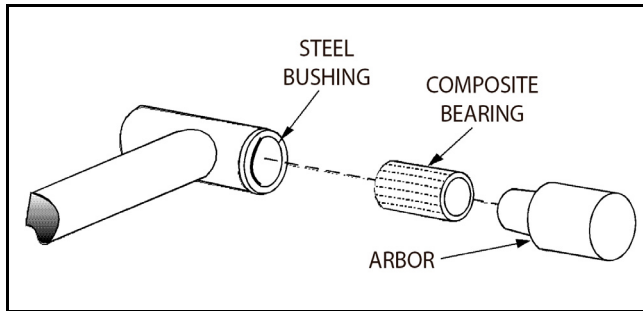
Figure 5-163. Main Boom Telescopic Cylinder (800A SN 0300245051 to Present)

9. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
10. Remove the setscrews from the piston.
11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-ring, seal rings, backup rings and wear rings.
13. Remove piston spacer from the rod. Remove and discard the o-rings from the spacer.
14. Remove the rod from the holding fixture. Remove cylinder head. Discard the o-rings, backup ring, wear rings, retaining ring rod seal and wiper seal.

### CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring, tapering, ovality or other damage. Replace if necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if necessary.
  - a. Thoroughly clean hole (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inner side of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-164. Composite Bearing Installation**

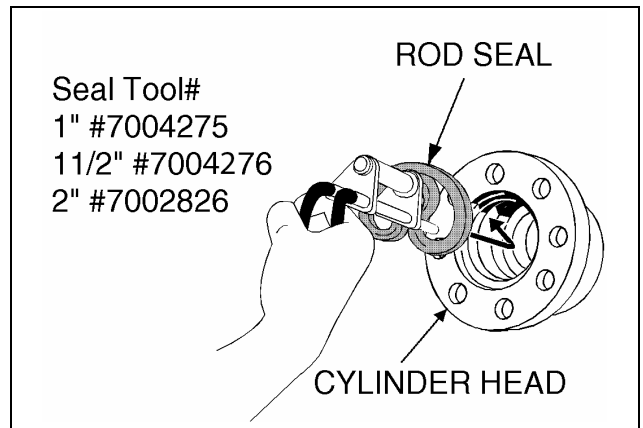
14. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. Inspect o-ring groove in spacer for burrs and sharp edges. Dress applicable surfaces as necessary.
16. Inspect port block fittings and holding valve. Replace if necessary.
17. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.
18. Inspect piston rings for cracks or other damage. Replace if necessary.

**ASSEMBLY**

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

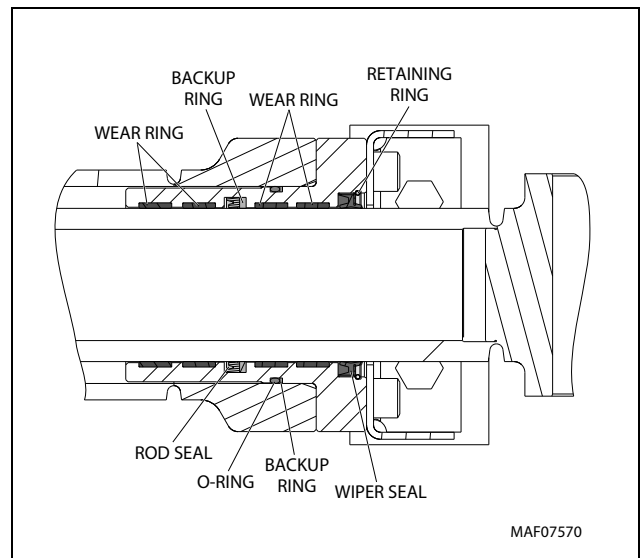
1. A special tool is used to install a new rod seal into the applicable cylinder head groove.



**Figure 5-165. Rod Seal Installation**

**NOTICE**

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-166. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head groove. Install new wear rings into the applicable inside diameter of the cylinder head groove.

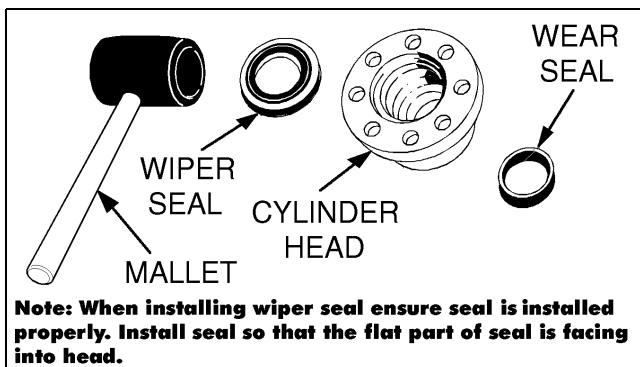


Figure 5-167. Wiper Seal Installation

3. Place new o-ring and backup ring in the applicable outside diameter groove of the cylinder head.

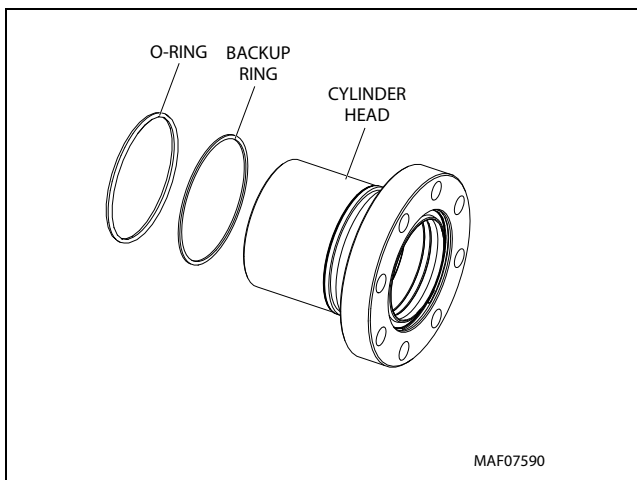


Figure 5-168. Installation of Head Seal Kit

4. Carefully install the cylinder head on the rod, ensuring that the wear ring, rod seal and wiper seal are not damaged or dislodged. Push the head along the rod to the rod end.

5. Place new o-rings in the applicable inside diameter groove of spacer.
6. Install the spacer tube onto the cylinder rod ensuring that the o-rings are not damaged or dislodged.
7. Place a new o-ring and backup rings in the inner piston diameter groove.
8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Carefully thread the piston on the cylinder rod till it abuts the spacer, ensuring that the o-ring and backup ring is not damaged or dislodged. Torque piston to 501 ft. lbs (680 Nm).
10. Install the setscrew on the piston. Torque setscrew to 13 ft. lbs (17 Nm).

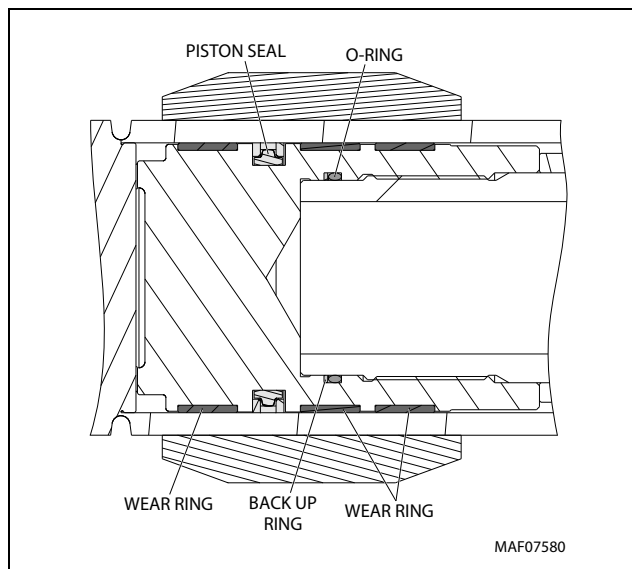


Figure 5-169. Piston Seal Kit Installation

11. Remove the cylinder rod from the holding fixture.
12. Place new piston seal and wear rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

13. Position the cylinder barrel in a suitable holding fixture.

**NOTICE**

**EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.**

14. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
15. Continue pushing the rod into the barrel until the cylinder head can be inserted into the barrel cylinder.
16. Install wear pads onto the wearpad plate using bolts, washers and nuts and torque bolts to 11 ft. lbs (15 Nm).
17. Secure the cylinder head to the barrel using the wearpad plate and capscrews. Torque capscrews to 83 ft. lbs (113 Nm).
18. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.
19. Install new plugs in the cylinder port block.
20. Install the counterbalance valves onto the valve block.
21. Install the valve assembly at the barrel end of the cylinder and secure using capscrews. Torque to 10 ft. lbs (14 Nm).

## Tower Boom Telescope Cylinder

### DISASSEMBLY

#### NOTICE

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

#### WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

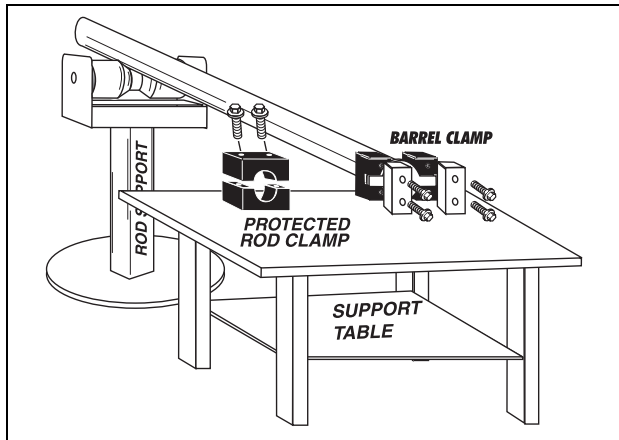


Figure 5-170. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer capscrews, and remove capscrews from cylinder barrel.

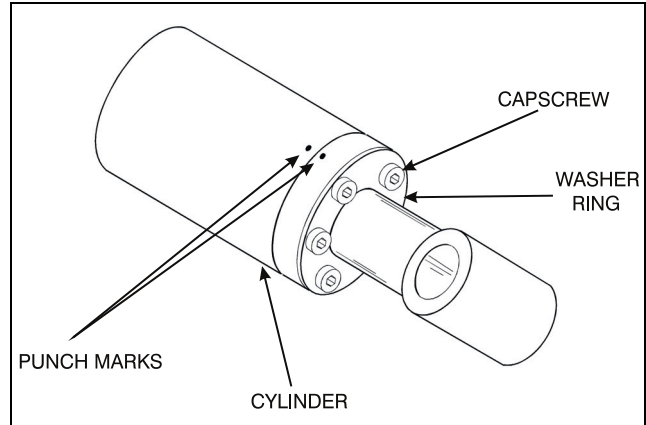


Figure 5-171. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

#### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

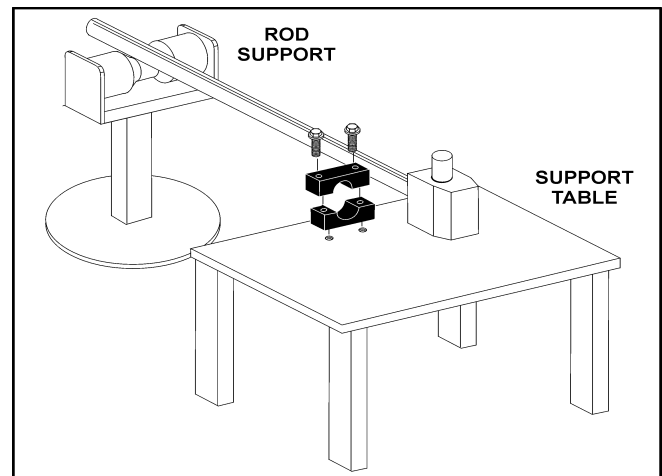
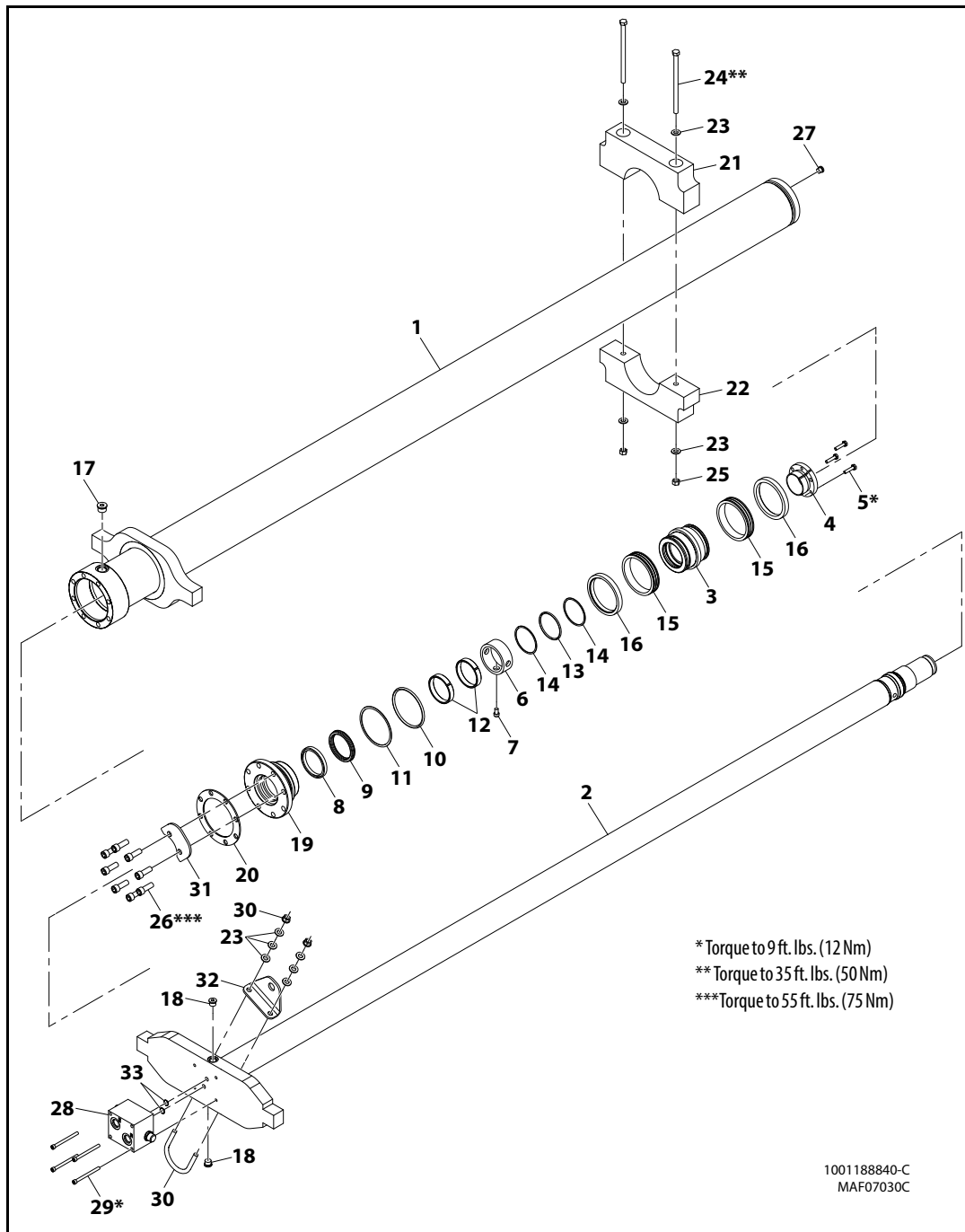
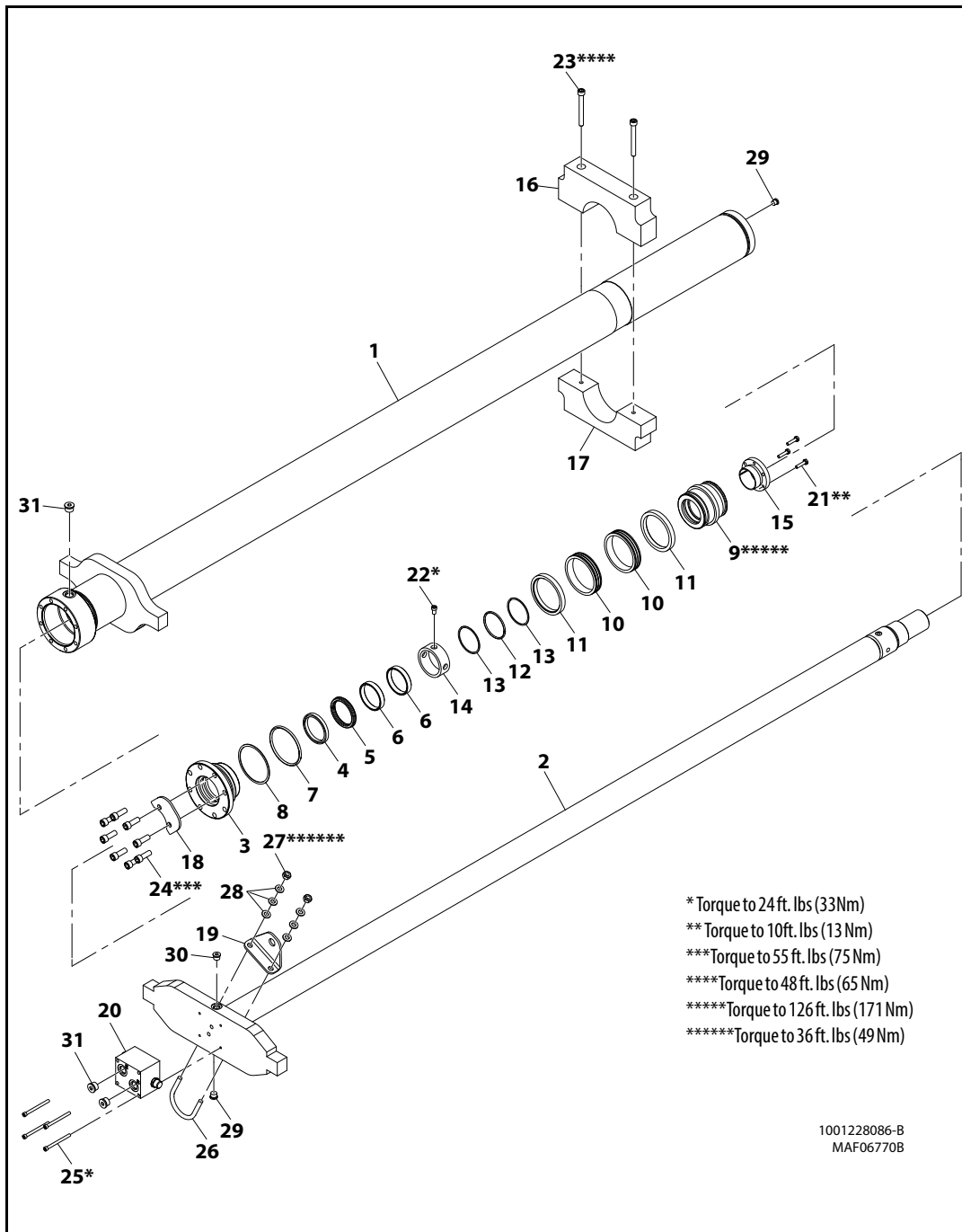


Figure 5-172. Cylinder Rod Support



- |                    |                 |                  |                    |                  |
|--------------------|-----------------|------------------|--------------------|------------------|
| 1. Barrel          | 8. Wiper        | 15. Seal         | 22. Support Pad    | 29. Capscrew     |
| 2. Rod             | 9. Seal         | 16. Lock Ring    | 23. Washer         | 30. U Bolt       |
| 3. Piston          | 10. O-ring      | 17. Plug, O-ring | 24. Bolt           | 31. Target Plate |
| 4. Tapered Bushing | 11. Backup Ring | 18. Plug, O-ring | 25. Nut            | 32. Mount Plate  |
| 5. Bolt            | 12. Wear Ring   | 19. Head         | 26. Capscrew       | 33. O-ring       |
| 6. Tube Spacer     | 13. O-ring      | 20. Washer Ring  | 27. Plug           |                  |
| 7. Setscrew        | 14. Backup Ring | 21. Support Pad  | 28. Valve Assembly |                  |

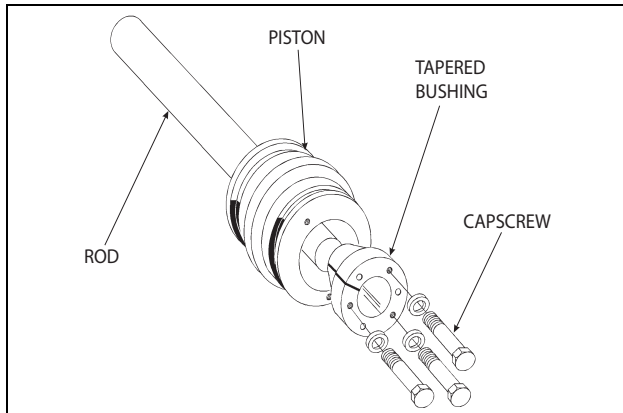
Figure 5-173. Tower Boom Telescopic Cylinder (SN 0300183034 through 0300243317)



- |              |                 |                     |                |          |
|--------------|-----------------|---------------------|----------------|----------|
| 1. Barrel    | 8. Backup Ring  | 15. Tapered Bushing | 22. Setscrew   | 29. Plug |
| 2. Rod       | 9. Piston       | 16. Support Pad     | 23. Bolt       | 30. Plug |
| 3. Head      | 10. Seal        | 17. Support Pad     | 24. Capscrew   | 31. Plug |
| 4. Wiper     | 11. Lock Ring   | 18. Target Plate    | 25. Capscrew   |          |
| 5. Rod Seal  | 12. O-ring      | 19. Mount Plate     | 26. U Bolt     |          |
| 6. Wear Ring | 13. Backup Ring | 20. Valve Assembly  | 27. Nut        |          |
| 7. O-ring    | 14. Tube Spacer | 21. Bolt            | 28. Flatwasher |          |

Figure 5-174. Tower Boom Telescopic Cylinder (SN 0300243318 to Present)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.



**Figure 5-175. Tapered Bushing Removal**

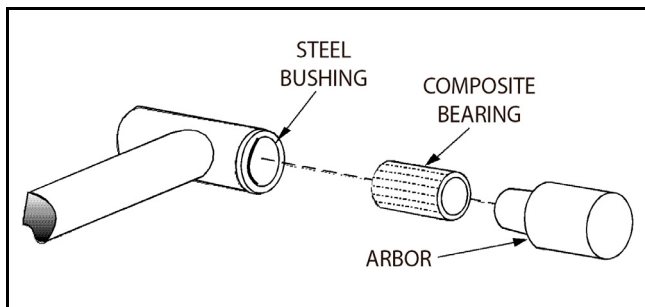
11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove setscrew from the piston spacer. Remove spacer from the rod.
14. Remove the rod from the holding fixture. Remove capscrews, target plate and washer ring if available. Remove the cylinder head gland. Discard the o-rings, back-up rings, rod seals, and wiper seals.

**CLEANING AND INSPECTION**

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
  - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
  - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
  - c. Lubricate inside of steel bushing prior to bearing installation.
  - d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Install pin into the composite bearing dry. Lubrication is not required with nickel plated pins and bearings.



**Figure 5-176. Composite Bearing Installation**

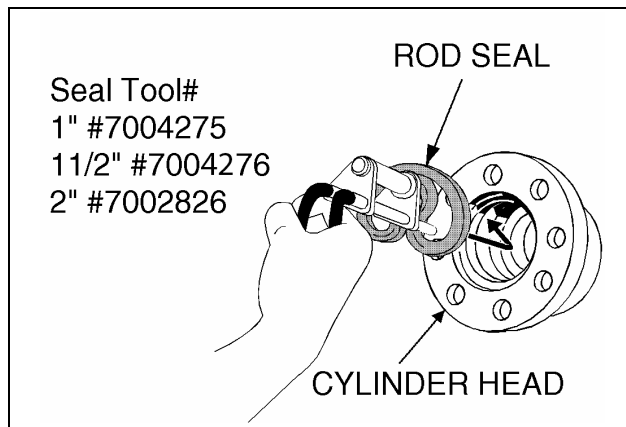
12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

### ASSEMBLY

**NOTE:** Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.

**NOTE:** Apply a light film of hydraulic oil to all components prior to assembly.

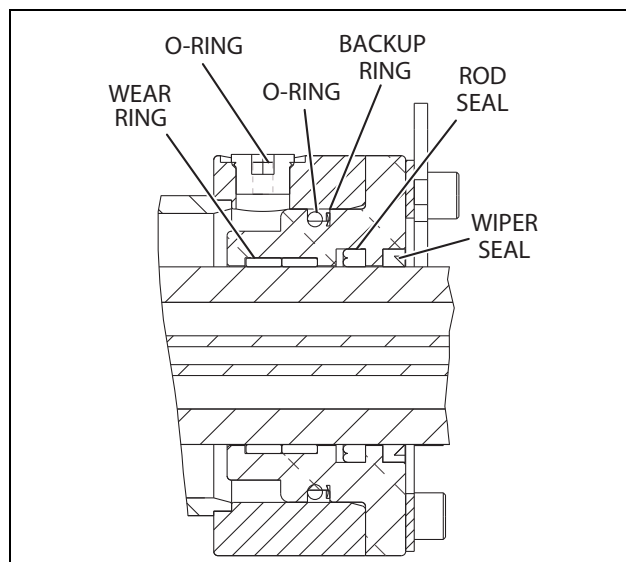
1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.



**Figure 5-177. Rod Seal Installation**

### NOTICE

**WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.**



**Figure 5-178. Cylinder Head Seal Installation**

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

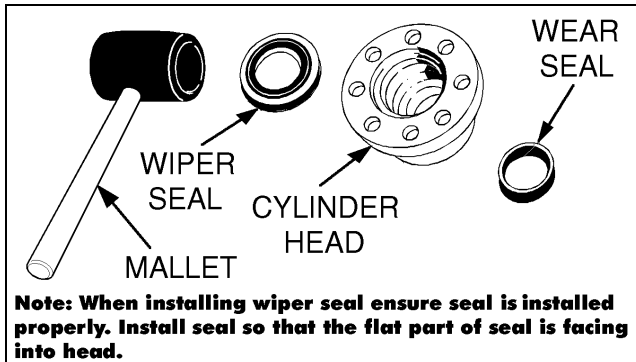


Figure 5-179. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

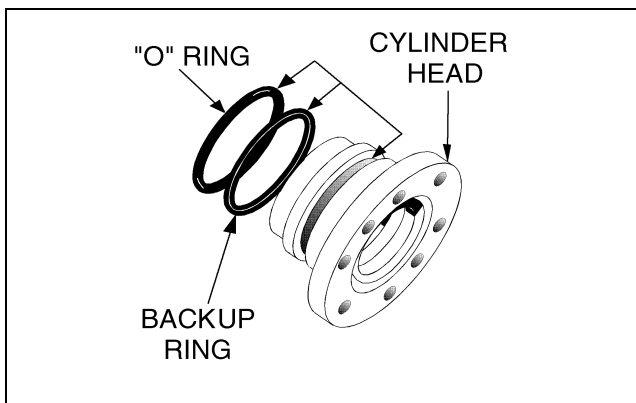


Figure 5-180. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on the rod. Install setscrew on the spacer. Torque setscrew as shown in Figure 5-173. and Figure 5-174.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Place a new o-ring and back-up rings in the inner piston diameter groove.
8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
9. Thread piston onto rod until it abuts the spacer end and torque piston as shown in Figure 5-173. and Figure 5-174. Install the tapered bushing.

**NOTE:** When installing the tapered bushing, piston and mating end of rod must be free of oil.

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

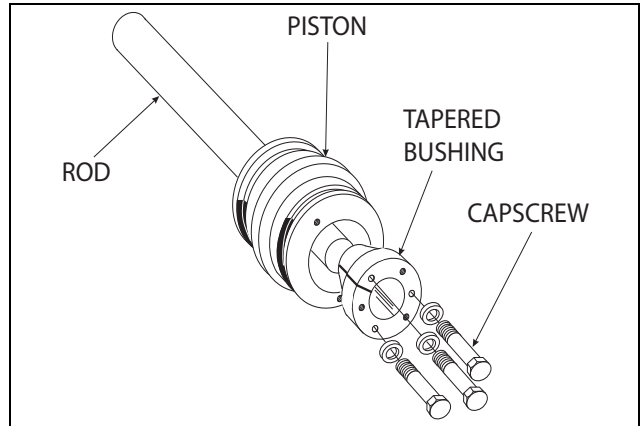


Figure 5-181. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation and torque capscrews as shown in Figure 5-173. and Figure 5-174.
12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
  - a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
  - b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

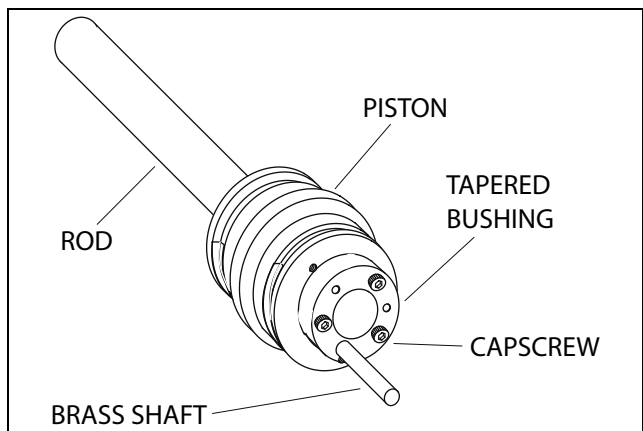


Figure 5-182. Seating the Tapered Bearing

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

13. Rotate the capscrews evenly and progressively in rotation and torque capscrews as shown in Figure 5-173. and Figure 5-174.
14. Remove the cylinder rod from the holding fixture.

### NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

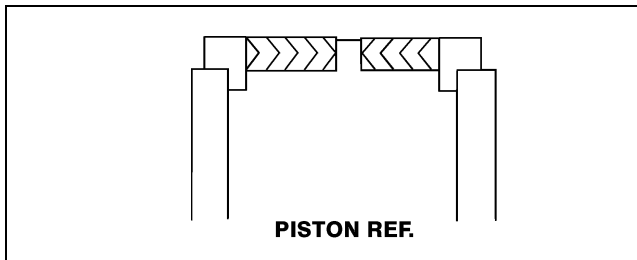


Figure 5-183. Hydrolock Piston Seal Installation

15. Place new hydrolock seal and guidelock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

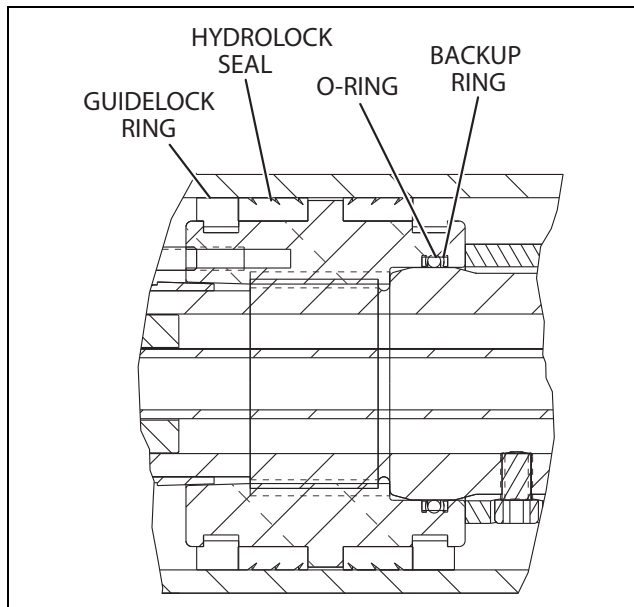


Figure 5-184. Piston Seal Kit Installation

16. Position the cylinder barrel in a suitable holding fixture.

### NOTICE

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

17. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
18. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

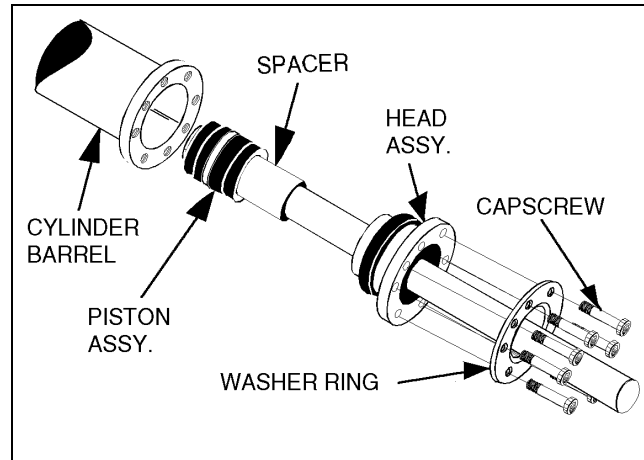


Figure 5-185. Rod Assembly Installation

19. Apply JLG Threadlocker if applicable to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts as shown in Figure 5-173. and Figure 5-174.
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the re-installation of any holding valve or valves.
21. Install the valve assembly. Torque capscrews as shown in Figure 5-173. and Figure 5-174.

## 5.4 CYLINDER REMOVAL AND INSTALLATION

### Main Boom Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Extend the boom to gain access to main fly boom telescope cylinder rod end pin.
3. Remove the hardware securing the telescope cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.

**NOTE:** The Main Boom weighs approximately 2528 lbs. (1147 kg).

4. Using a suitable sling and lifting device, secure the platform end of the boom.
5. Place blocking under the main lift cylinder to prevent it from falling when the attaching hardware is removed.
6. Remove the hardware securing the main lift cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.

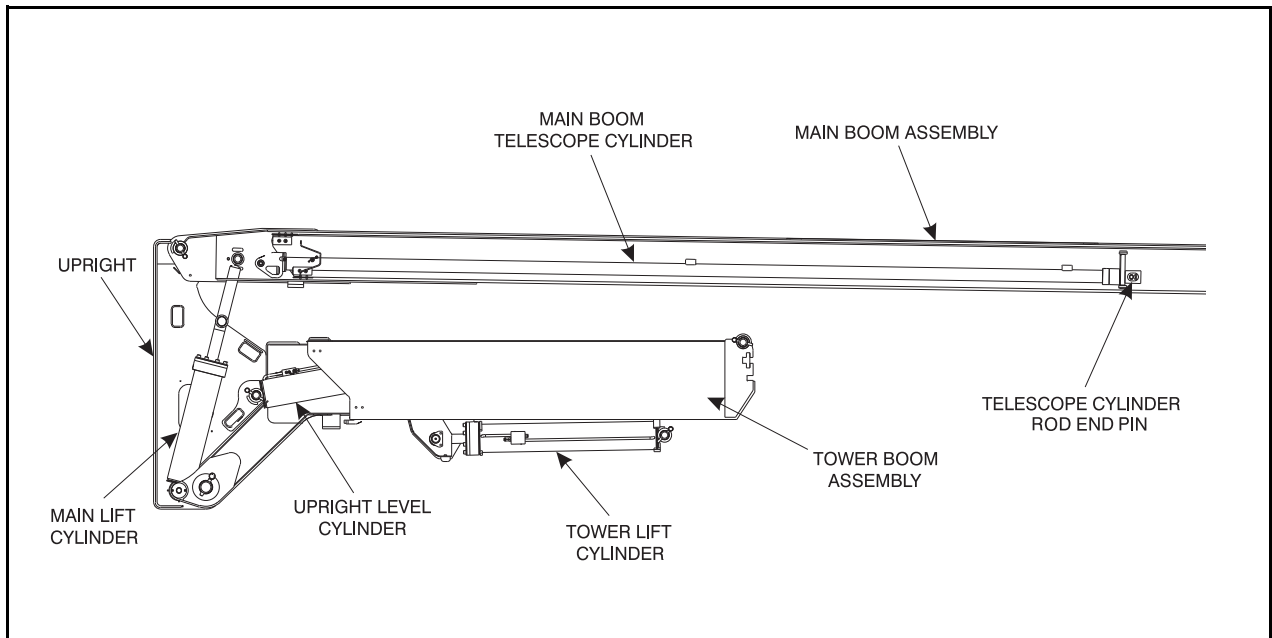
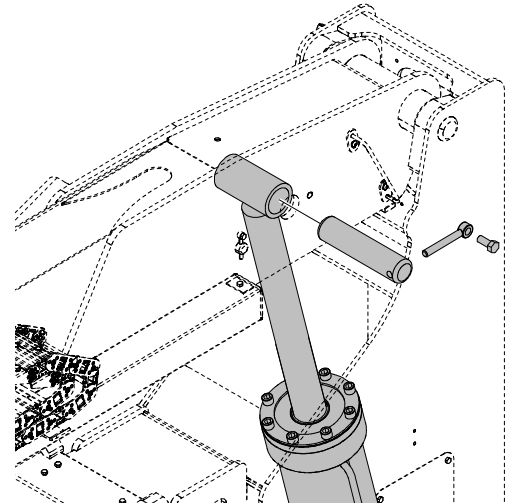
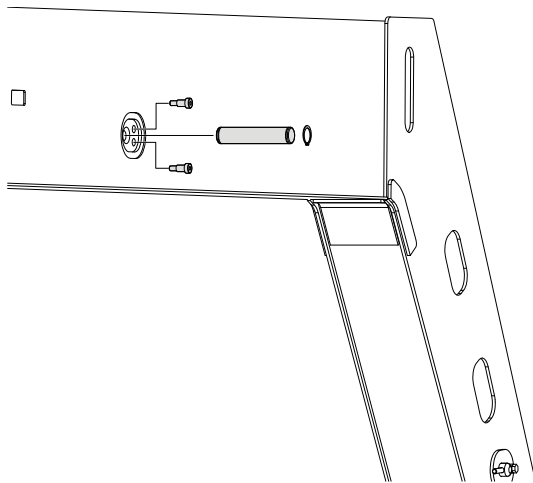
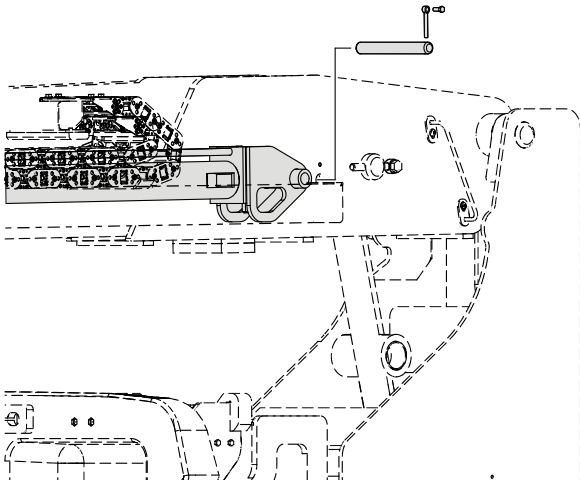


Figure 5-186. Components Main Boom and Tower Boom

7. Using auxiliary power from ground controls, retract the lift cylinder rod completely.
8. Remove hardware securing cover plate on the rear of the main boom. Remove cover plate.
9. Remove mounting hardware securing the telescope cylinder barrel to the main base boom.



10. Using an external pump, extend the cylinder as far as the hydraulic lines will allow to enable a lifting device to be attached to the telescope cylinder.

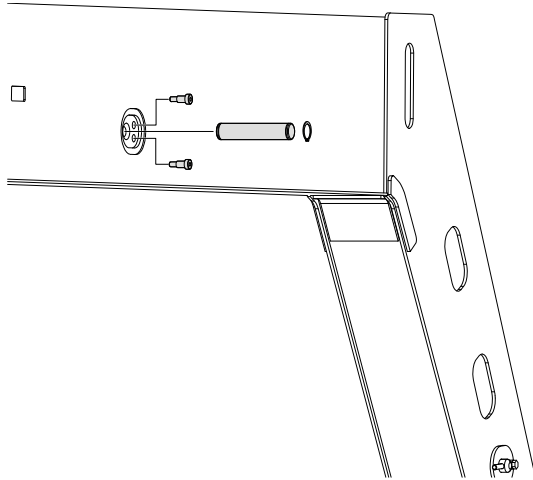
**NOTICE**

**HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID THE ENTRY OF CONTAMINANTS INTO THE SYSTEM**

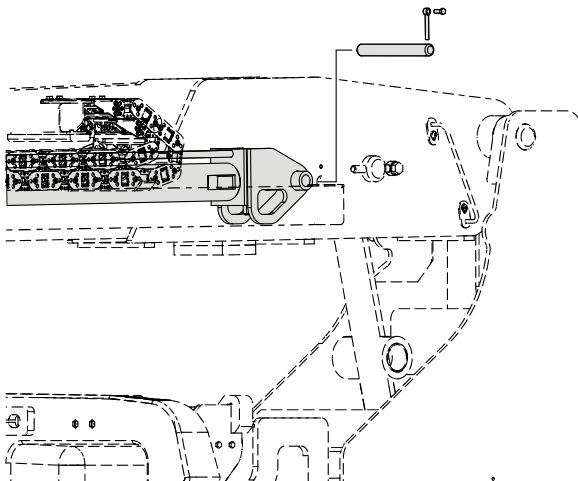
11. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
- NOTE:** *The Telescope Cylinder weighs approximately 522 lbs. (237 kg).*
12. Secure the telescope cylinder with a suitable sling and lifting device.
  13. Carefully remove the telescope cylinder from the main boom assembly and place in a suitable work area.

### Main Boom Telescope Cylinder Installation

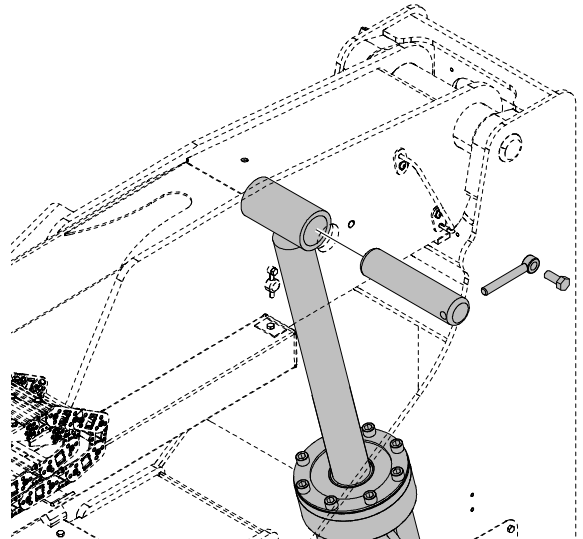
1. Using suitable lifting equipment, carefully insert the cylinder into the boom assembly.
2. Carefully install main telescope cylinder rod pin through the fly boom and secure it with the retaining rings.



3. Remove applicable hydraulic line and port caps and properly connect the hydraulic lines to the telescope cylinder. Ensure all hoses are correctly routed.
4. Carefully install the telescope cylinder barrel end support into mounting block in base boom and secure with blocks and torque the bolts to 35 ft.lbs. (48 Nm). Use JLG Threadlocker P/N 0100011 on bolts. Shim as necessary.



5. Remove the lifting device from the main telescope cylinder and retract the main telescope cylinder.
6. Extend the main lift cylinder using the auxiliary control from the ground controls to align with rod end hole in main base boom.
7. Carefully insert the main lift cylinder rod end pin through the base boom and install the mounting hardware.

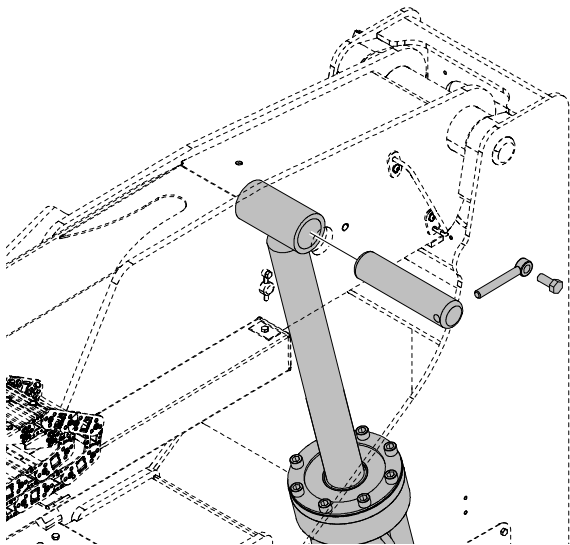


8. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
9. Check fluid level of hydraulic tank and adjust as necessary.

### Main Lift Cylinder Removal

**NOTE:** The Main Boom weighs approximately 2528 lbs. (1147 kg).

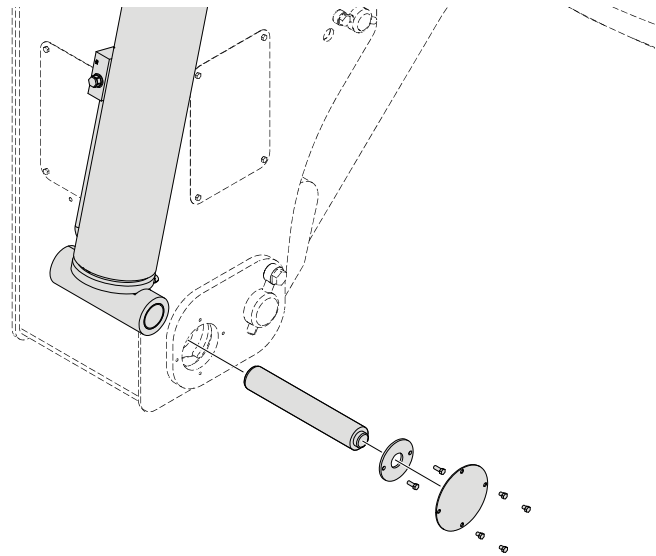
1. Place the machine on a flat and level surface. Attach a suitable lifting device and sling, sufficient to lift the main boom assembly, to the approximate center of the main boom assembly.
2. Place blocking under the cylinder to prevent it from falling when the attaching hardware is removed.
3. Remove the hardware securing the main lift cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



4. Using auxiliary power from ground controls, retract the lift cylinder rod completely.
5. Disconnect, cap, and tag the main boom lift cylinder hydraulic lines and ports.
6. Attach a suitable lifting device and sling to the main lift cylinder.
7. Remove hardware securing cover plate on the bottom of the upright. Remove cover plate.

**NOTE:** The Main Lift Cylinder weighs approximately 445 lbs. (202 kg).

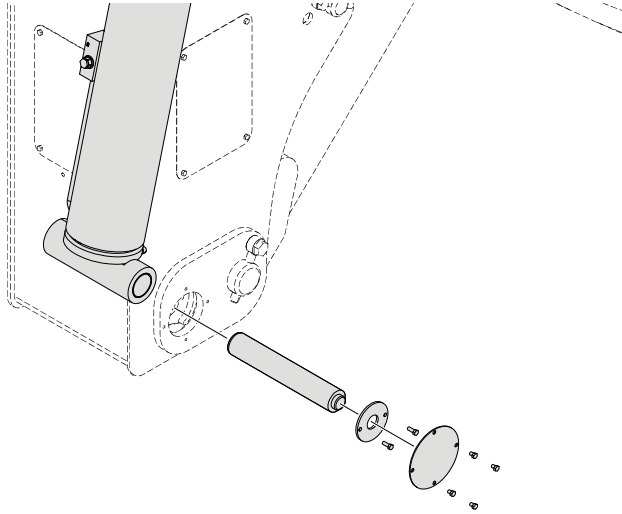
8. Use a suitable brass drift and hammer to remove main lift cylinder barrel end pin from Upright.



9. Using a suitable brass drift drive out the barrel end attach pin from the tower upright. Raise the main boom assembly with the lifting device and sling to allow enough space to remove the main lift cylinder from the upright top.
10. Carefully lift the cylinder clear of the boom assembly and lower to the ground or suitably supported work area.
11. Lower the boom assembly to the stowed position.

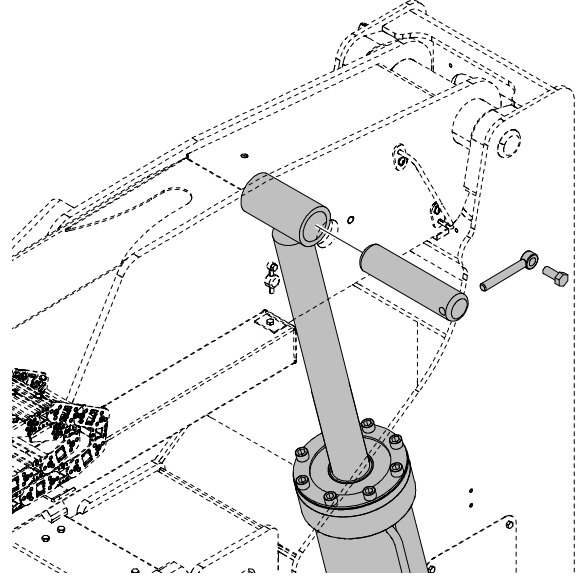
### Main Lift Cylinder Installation

1. Lift the main boom to allow enough space to lower the main boom lift cylinder to align with pin mounting holes of the tower fly boom and barrel end of main lift cylinder.
2. Using a suitable brass drift, drive barrel end attach pin through the mounting holes in the lift cylinder and the tower fly boom. Secure in place with the pin and torque the bolts to 35 ft. lbs. (48 Nm). Use Threadlocker P/N 0100011 on bolts.



3. Remove cylinder port plugs and hydraulic line caps and attach lines to cylinder ports as tagged during removal.
4. Using auxiliary power extend the cylinder rod until the attach pin hole aligns with those in the main boom.

5. Using a suitable drift drive cylinder rod attach pin through the aligned holes, taking care to align the grooved pin holes. Secure the pin in place and torque the bolt to 285 ft. lbs. (388 Nm). Use JLG Threadlocker P/N 0100011 on bolts.



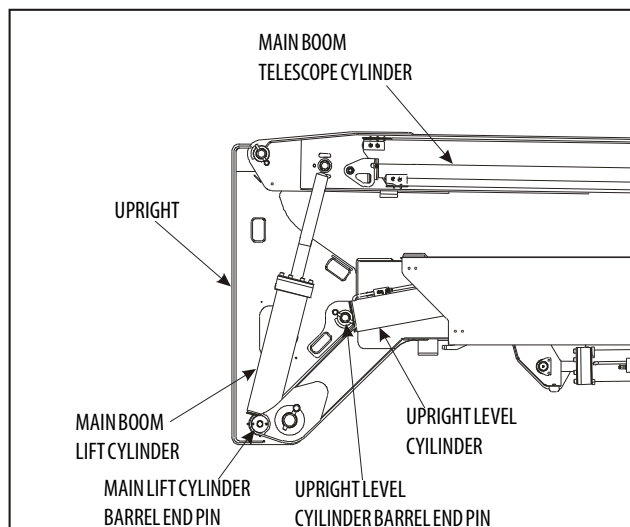
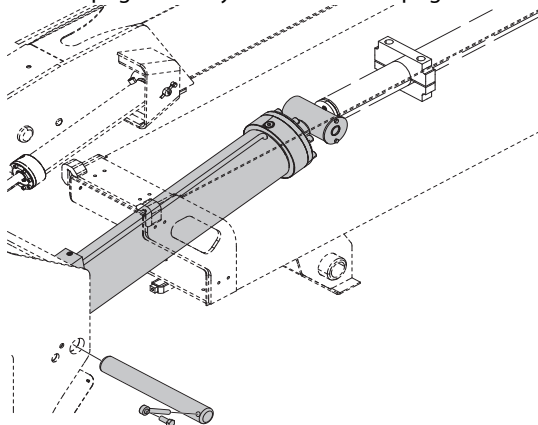
6. Remove lifting device and sling. Activate hydraulic system.
7. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
8. Check fluid level of hydraulic tank and adjust as necessary.

## Upright Level Cylinder Removal

### NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

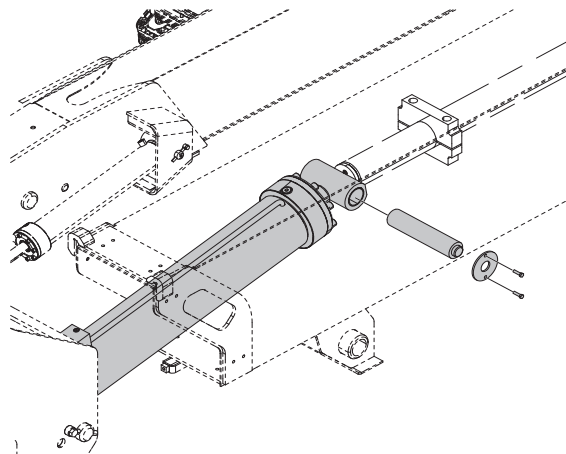
1. Remove the Main Boom. Refer to Main Boom removal.
2. Tag and disconnect hydraulic lines to the main lift cylinder. Use suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove mounting hardware from the main boom lift cylinder barrel end. Use a suitable brass drift and hammer to remove main lift cylinder barrel end pin from Upright and remove main lift cylinder.
4. Disconnect the Upright Level Cylinder as follows:
  - a. Use a suitable lifting device to support the Upright.
  - b. Remove mounting hardware securing the Upright Level Cylinder to the upright. Use a suitable brass drift and hammer to remove upright level cylinder barrel end pin from upright and disconnect the upright level cylinder from the Upright.



**NOTE:** The Upright weighs approximately 1136 lbs. (515 kg).



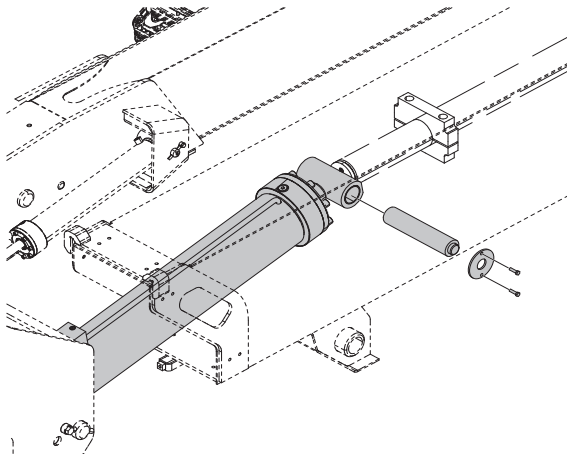
5. Before extending the tower boom, support the tower boom from the bottom.
6. Extend the Tower Boom to get access to the Upright level cylinder rod end pin by using an external auxiliary pump.
7. Tag, disconnect and cap the hydraulic lines of the Upright level Cylinder barrel.
8. Attach a suitable lifting device to support the Upright Level Cylinder.
9. Remove mounting hardware from the upright level cylinder rod end and remove the pin.



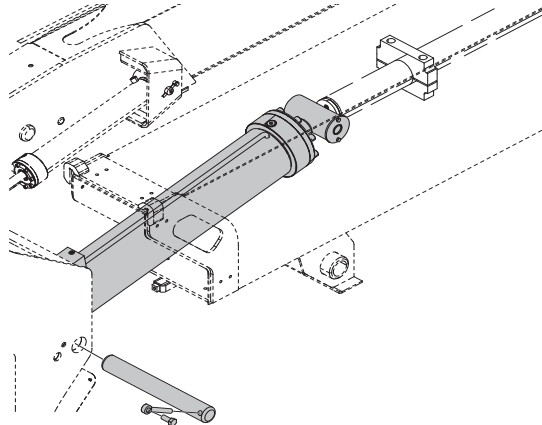
10. Remove the Upright Level Cylinder from the Tower Fly Boom. Place the Upright level Cylinder in a suitable work area.

## Upright Level Cylinder Installation

1. Put the leveling cylinder in position in the tower boom, align holes in the tower boom and leveling cylinder rod end.
2. Secure the leveling cylinder rod end pin to tower boom and torque the bolts to 35 ft. lbs. (48 Nm). Use JLG Threadlocker P/N 0100011 on bolts.



3. Remove Cylinder Port plugs and hydraulic line caps. Properly attach lines to Cylinder ports as tagged during removal.
4. Use all applicable safety precautions, operate the lifting device to move upright assembly into proper position.
5. Align holes in upright and barrel end of level cylinder. Use a suitable rubber mallet to install level barrel end pin. Secure pin and torque the bolt 285 ft. lbs. (388 Nm). Use JLG Threadlocker P/N 0100011 on bolts.



6. Install Main Lift Cylinder.
7. Install Main Boom. Refer to Main Boom installation.
8. Remove hydraulic line caps and attach all the hydraulic and electrical lines as tagged during removal.

9. Use all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks.
10. Check fluid level of hydraulic tank and add fluid, if required.

## Tower Boom Lift Cylinder Removal

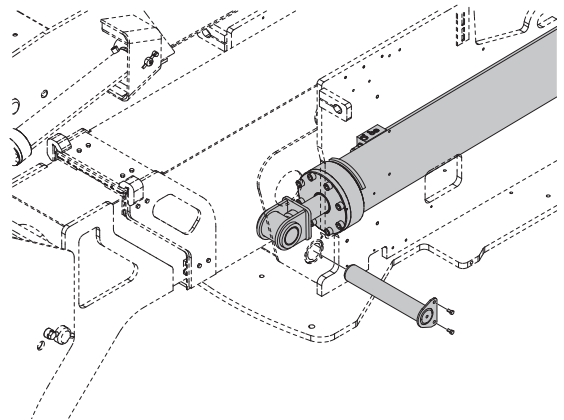
1. Place machine on a flat and level surface. Place the main boom in a horizontal position with the telescope cylinder fully retracted. Place the tower boom in a fully elevated and fully retracted position.

**NOTE:** The Main Boom weighs approximately 2528 lbs. (1147 kg), Upright weighs approximately 1136 lbs. (515 kg) & Tower Boom weighs approximately 2944 lbs. (1335 kg).

2. Support the main boom, upright and tower boom with adequate overhead crane.

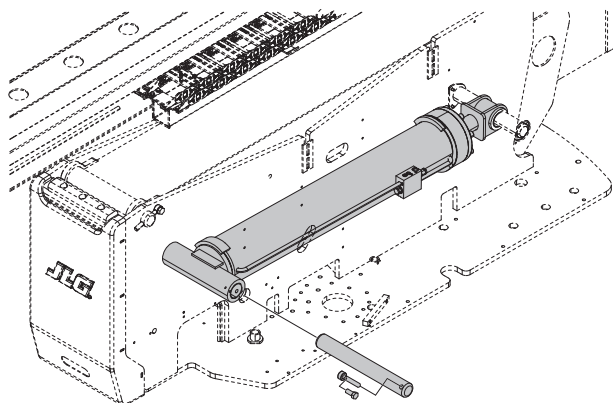
**NOTE:** The Tower lift cylinder weighs approximately 544 lbs. (247 kg).

3. Adequately support the tower lift cylinder.
4. Remove mounting hardware securing the lift cylinder rod pin to the tower boom. Using a suitable brass drift, drive out the tower lift cylinder rod attach pin.



5. Using all applicable safety precautions, operate auxiliary power, activate tower lift down and fully retract lift cylinder.
6. Tag, disconnect, and cap the tower lift cylinder hydraulic lines and ports.

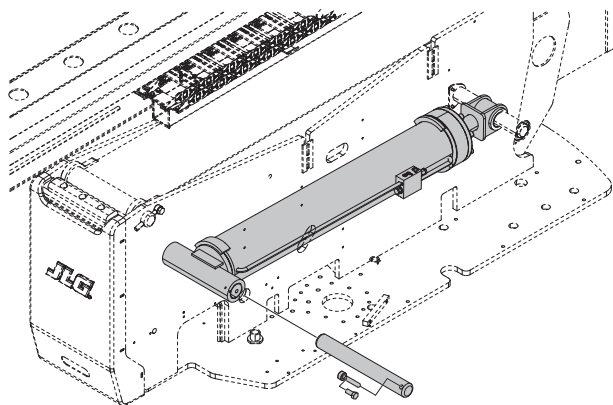
7. Remove mounting hardware securing the tower lift cylinder barrel pin to the turntable. Using a suitable brass drift, drive out the tower lift cylinder barrel pin.



8. Carefully remove the tower lift cylinder from turntable. Place in a suitable work area.

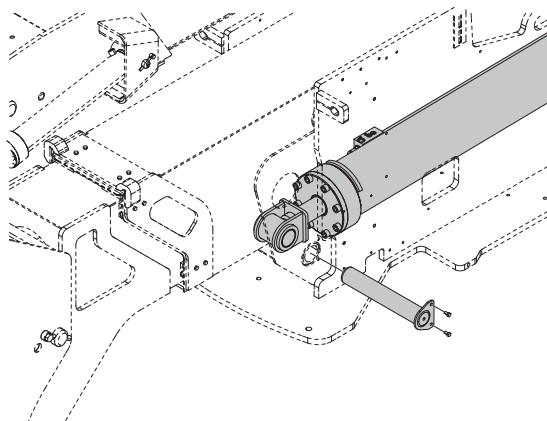
### Tower Boom Lift Cylinder Installation

1. Support the main boom and tower boom, place the tower lift cylinder on the turntable and align the holes. Install the cylinder barrel pin and torque the bolt to 285 ft. lbs. (388 Nm). Use JLG Threadlocker P/N 0100011 on bolts.



2. Remove caps from cylinder hydraulic lines properly and install lines to cylinder as previously tagged.
3. Using auxiliary power, activate tower lift function and extend cylinder rod until the cylinder rod bushing aligns with bushings on boom.

4. Using an appropriate brass drift, drive the tower lift cylinder rod end attach pin through the aligned bushings. Secure pin and torque the bolt 35 ft. lbs. (48 Nm). Use JLG Threadlocker P/N 0100011 on bolts.



5. Remove main boom support and lifting device supporting the upright.
6. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank and add fluid, if required.

### Tower Telescope Cylinder Removal

1. Place machine on flat and level surface.
2. Remove the tower telescope cylinder rod end trunion hardware.
3. Using an external pump, extend the tower telescope cylinder as far enough to attach the lifting device.
4. Tag, disconnect and cap hydraulic hoses to Tower Telescope Cylinder. Plug cylinder ports. Remove the hoses.

**NOTE:** The Tower Telescope Cylinder weighs approximately 233 lbs. (105kg).

5. Properly secure the Tower Telescope Cylinder by using a suitable sling or support.
6. Remove the tower telescope cylinder barrel end trunion hardware.
7. Carefully remove the Tower Telescope Cylinder from the Boom. Place cylinder on a suitable work area.

### Tower Telescope Cylinder Installation

1. Slide the telescope cylinder into the boom, aligning the cylinder port block end with slotted holes in Base Boom.
2. Secure the telescope cylinder barrel end to the fly boom by using retaining plate and torque the bolts 35 ft. lbs. (48Nm). Use JLG Threadlocker P/N 0100011 on bolts.
3. Secure telescope cylinder rod end and torque the bolts to 35 ft. lbs. (48 Nm). Use JLG Threadlocker P/N 0100011 on bolts.
4. Remove caps and plugs from hydraulic lines and ports. Properly connect hydraulic lines to cylinder. Reinstall cover plate.
5. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
6. Check fluid level of hydraulic tank and add fluid, if required.

### Platform (Slave) Cylinder Removal

1. Place the machine on a flat surface and lower the main boom and tower boom to the lowest position.
2. Using auxiliary power, retract the platform (slave) cylinder rod completely.

**NOTE:** Step 3 is applicable for 800AJ models only.

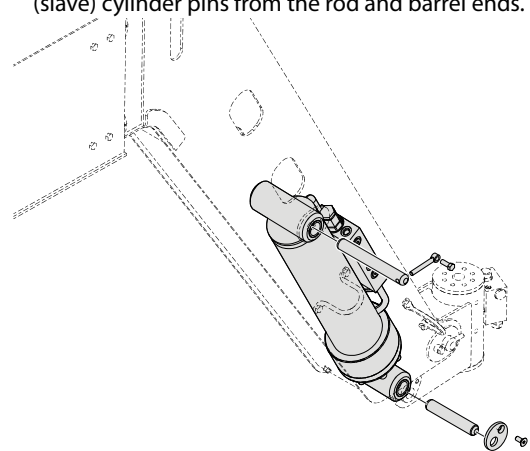
3. Raise the jib to gain access to the Platform (Slave) Cylinder piston end Pin.

**NOTE:** The Platform (Slave) Cylinder weighs approximately 68 lbs (31 kg).

4. Using a suitable lifting device, properly secure the platform to prevent the platform from tilting backward or forward during removal of the platform (slave) cylinder.
5. Tag and disconnect the platform (slave) cylinder hydraulic hoses. Cap hoses to prevent the hydraulic system from being contaminated.
6. Properly secure the platform (slave) cylinder by using a suitable sling or support.

**NOTE:** The Platform (Slave) cylinder weighs approximately 68 lbs (31 kg).

7. Remove the platform (slave) cylinder pin retaining hardware. Using a suitable brass drift, remove the platform (slave) cylinder pins from the rod and barrel ends.



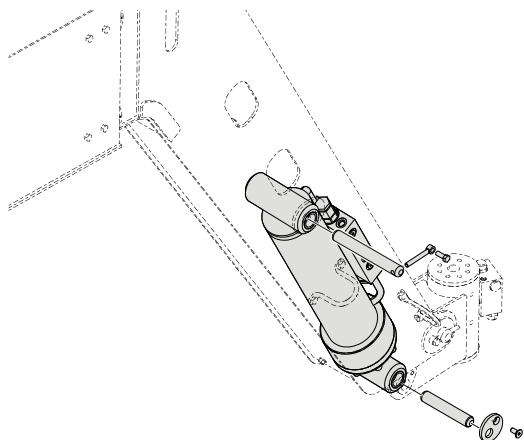
8. Carefully remove the platform (slave) cylinder.
9. Clean and inspect the cylinder pins and retaining hardware for reuse. Replace if necessary.

### Platform (Slave) Cylinder Installation

1. Remove caps from the hydraulic hoses and attach hoses to the proper cylinder ports.

**NOTE:** The Platform (Slave) cylinder weighs approximately 68 lbs (31 kg).

2. Use suitable slings or support to position the Platform (Slave) cylinder in place. Align barrel end mounting holes with the holes in main fly boom.
3. Use suitable mallet to install the barrel end attach pin and torque the bolts to 35 ft. lbs. (48 Nm).
4. Extend the platform (slave) cylinder rod until the rod attach pin hole aligns with holes in the platform pivot. Use suitable mallet and keeper to install the rod end pin.



5. Remove lifting device from the platform (slave) cylinder and support from the platform.
6. Use all applicable safety precautions, start the machine from the ground control. Fully raise and lower the main boom through several cycles to bleed the platform level hydraulic circuit.
7. Check for proper operation and hydraulic leaks.
8. Check the fluid level of hydraulic tank. Fill the tank, if required.

### 5.5 HYDRAULIC PUMP W/HAYES PUMP DRIVE COUPLING LUBRICATION

Any time pump or pump drive coupling is removed coat, pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT) coupling is greased prior to assembly.

### 5.6 PRESSURE SETTING PROCEDURES

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within  $\pm 5\%$  of specified pressures.

To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps must be followed.
2. Set up of the function pump.
3. Adjustments Made at the Main Valve Block.
4. Adjustments Made at the Platform Valve Block

## Set Up the Function Pump

(the pump that is mounted on the back of the drive pump).

### 1. Set Stand by pressure or load sense pressure

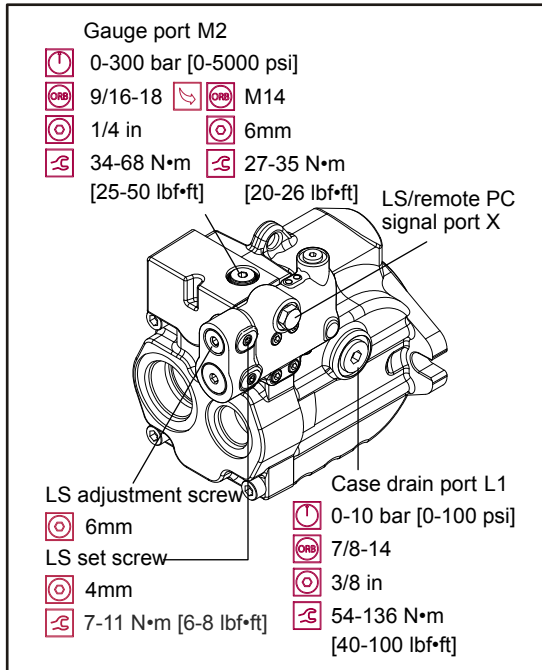


Figure 5-187. Load Sensing Control Adjustment

- Install a low pressure gauge at port "MP" of the main valve block. A gauge capable of reading **400 psi (28 bar)**.
- Start the engine and let it idle. The gauge should be reading between **400-440 psi (28-30 bar)**.
- To make an adjustment to this pressure, go to the engine compartment, locate the function pump. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top.
- To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it by 1 turn.
- Using a 6 mm wrench adjust clockwise to increase or counterclockwise to decrease the pressure. The pressure should read between **400-440 psi (28-30 bar)**.

### 2. Set High pressure relief

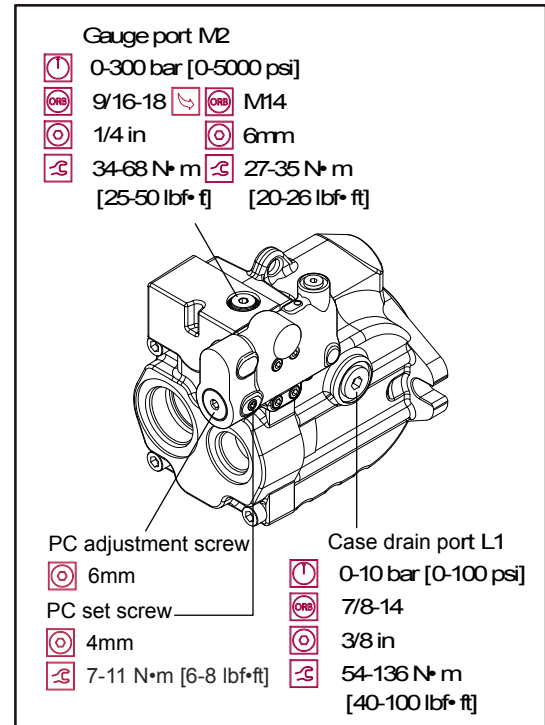


Figure 5-188. Pressure Compensation Control Adjustment

- Install a high pressure gauge at the "MP" port of the main valve block.
- Activate main boom telescope in. The gauge should read **2600-2700 psi (179-186 bar)**.
- To make an adjustment to this pressure, go to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.
- Using the 4 mm wrench, loosen the setscrew on the side of the compensator which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it by 1 turn.
- Using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. This is the **maximum** relief pressure for all functions governed by this pump.

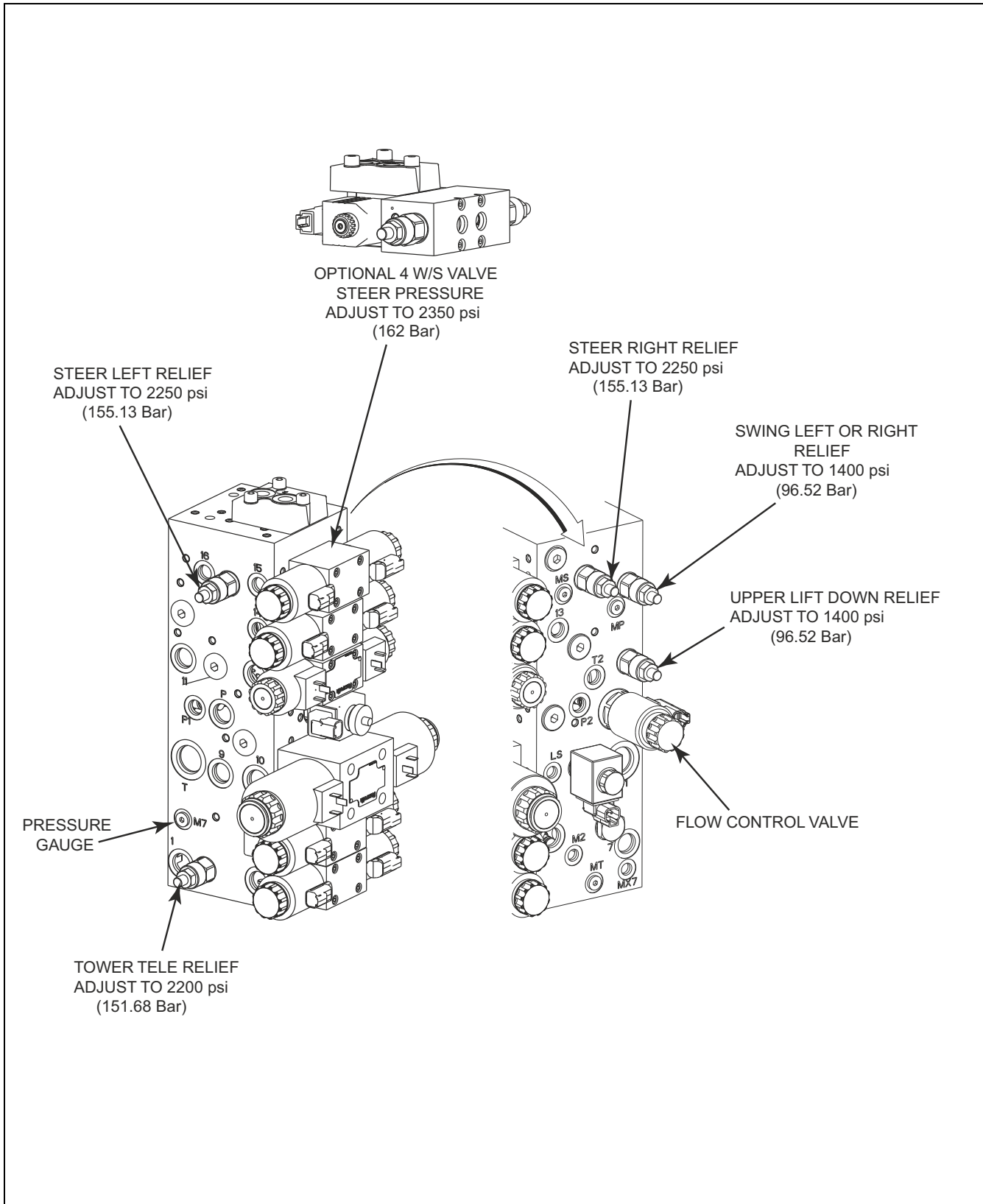
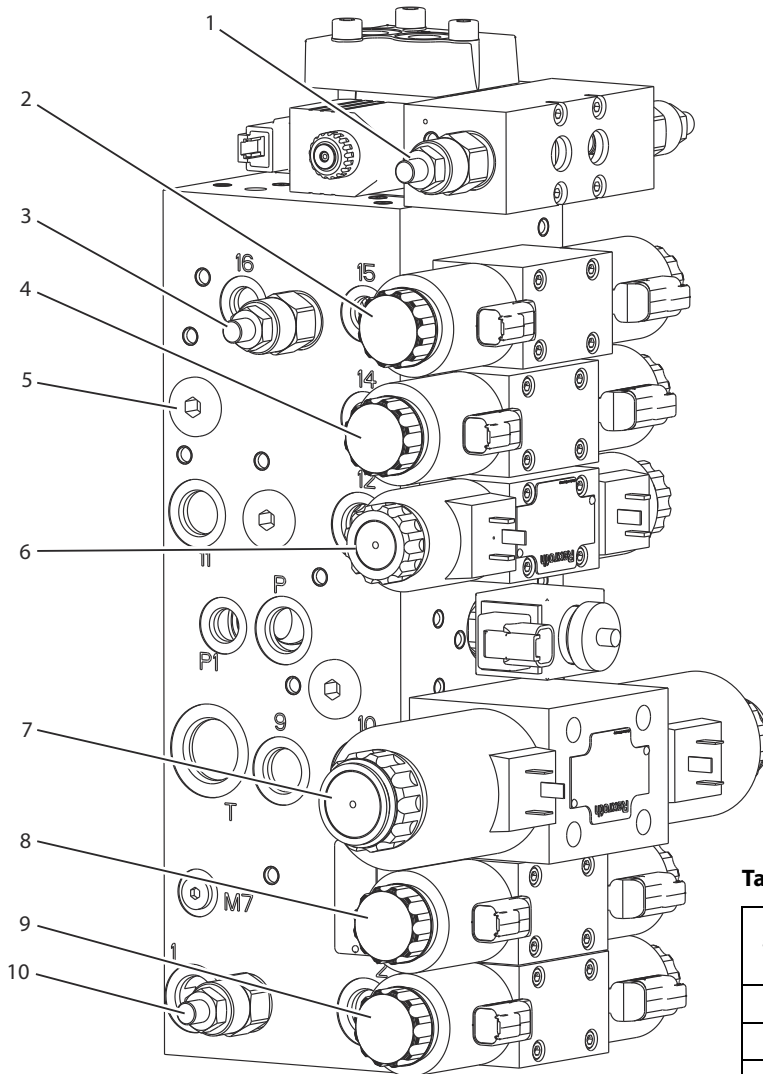


Figure 5-189. Main Control Valve Pressure Adjustments



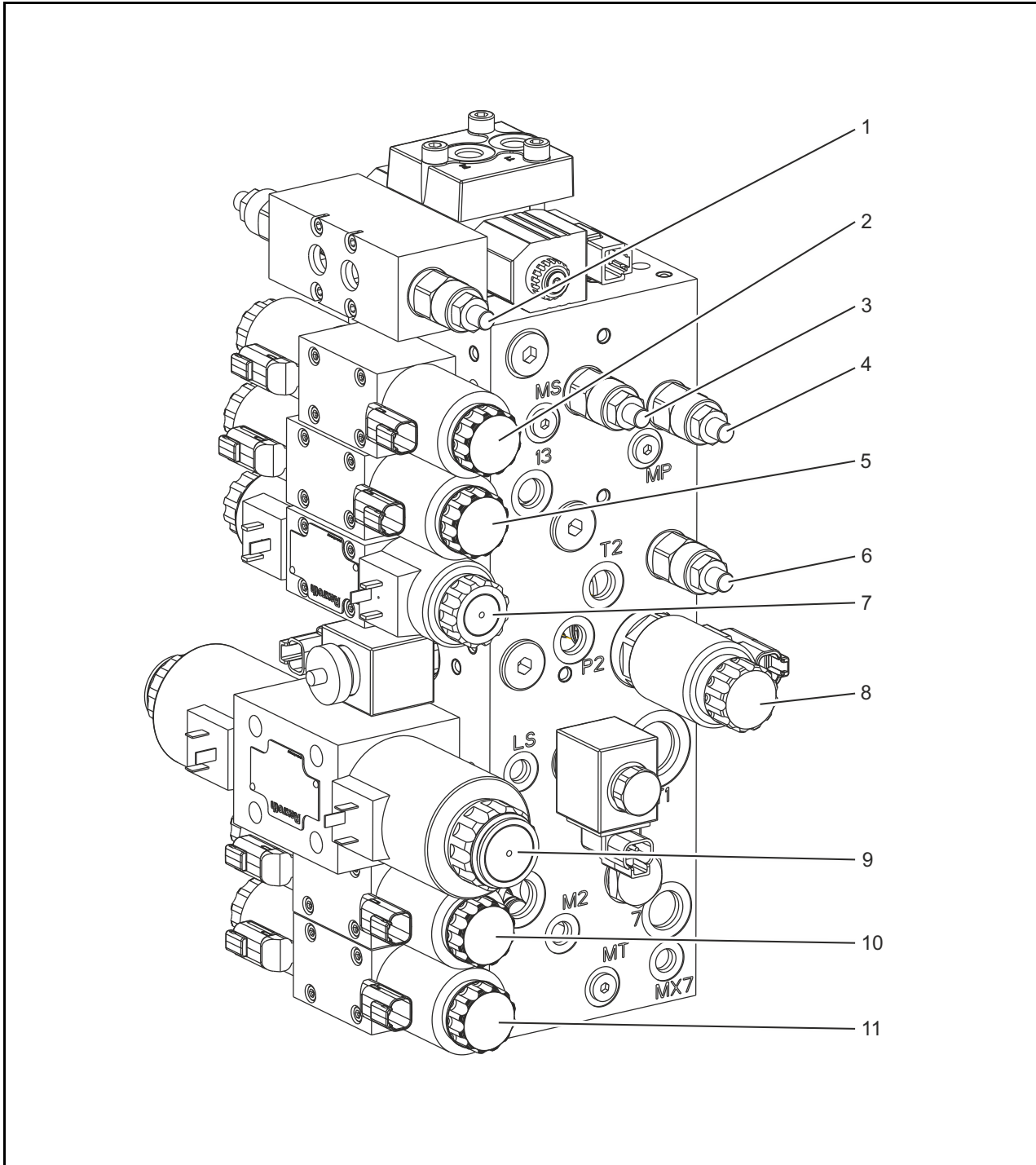
**Table 5-33. Main Control valve Coil Resistance**

#	Item	Coil Resistance @20°C (Ohms)
1	Rear Steer Right Solenoid	5.3
2	Front Steer Right Solenoid	5.3
4	Shuttle Valve	5.3
6	Main Lift Down Solenoid	2
7	Main Tele In Solenoid	5.3
8	Tower Lift Up Solenoid	4.1
9	Tower Tele In Solenoid	4.1

- |                               |                            |                           |                           |
|-------------------------------|----------------------------|---------------------------|---------------------------|
| 1. Rear Steer Right Solenoid  | 4. Shuttle Valve           | 7. Main Tele In Solenoid  | 9. Tower Tele In Solenoid |
| 2. Front Steer Right Solenoid | 5. Swing left Solenoid     | 8. Tower Lift Up Solenoid | 10. Tower Tele Relief     |
| 3. Front Steer left Solenoid  | 6. Main Lift Down Solenoid |                           |                           |

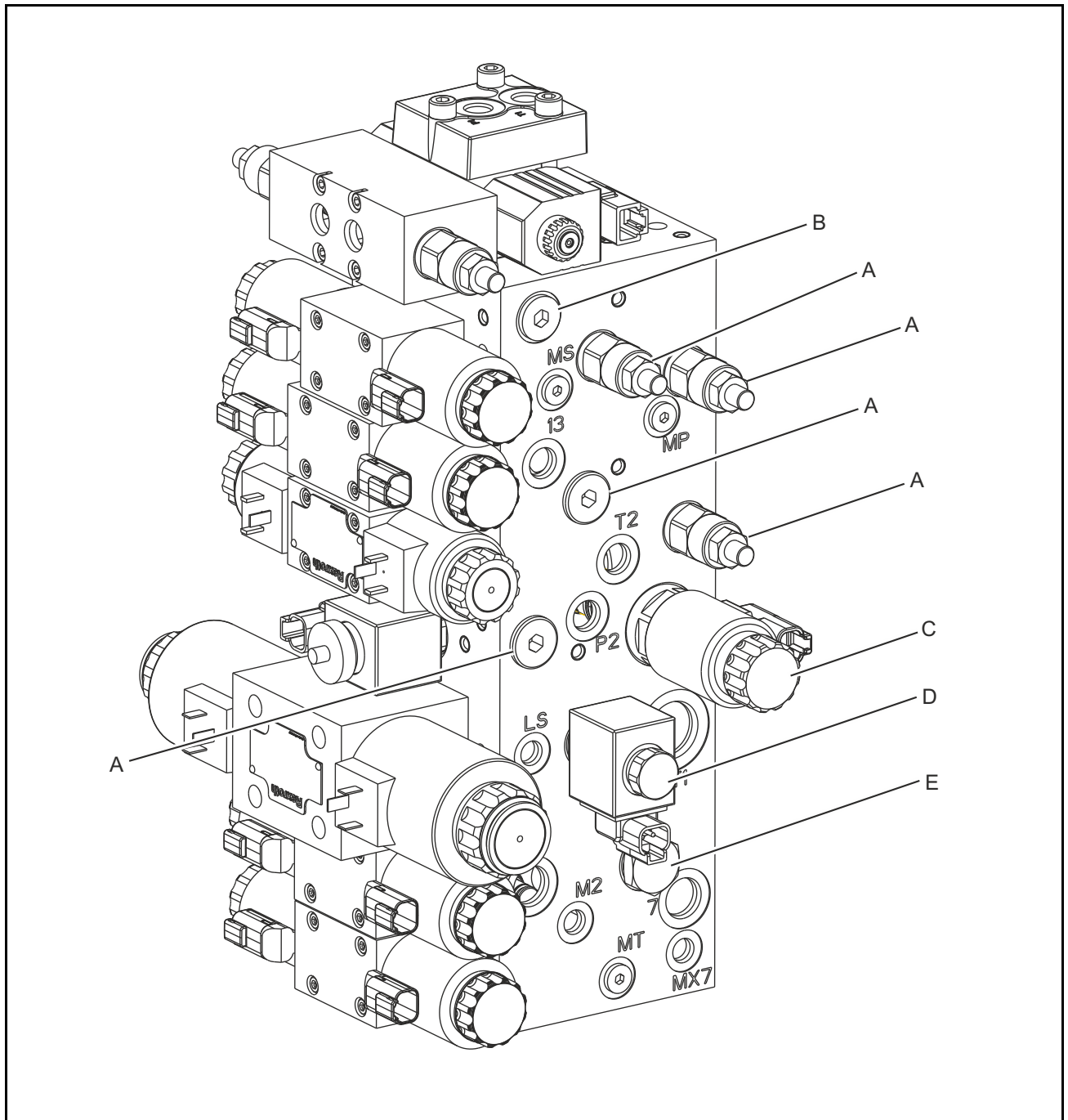
**Figure 5-190. Main Valve Components - Sheet 1 of 2**

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |                              |                                 |                            |                              |
|------------------------------|---------------------------------|----------------------------|------------------------------|
| 1. Rear Steer Left Solenoid  | 4. Main Boom Lift Down Solenoid | 7. Main Lift Down Solenoid | 10. Tower Lift Down Solenoid |
| 2. Front Steer Left Solenoid | 5. Swing Left or Right Relief   | 8. Flow Control Valve      | 11. Tower Tele Out Solenoid  |
| 3. Front Steer Right Relief  | 6. Swing Right Solenoid         | 9. Main Tele Out Solenoid  |                              |

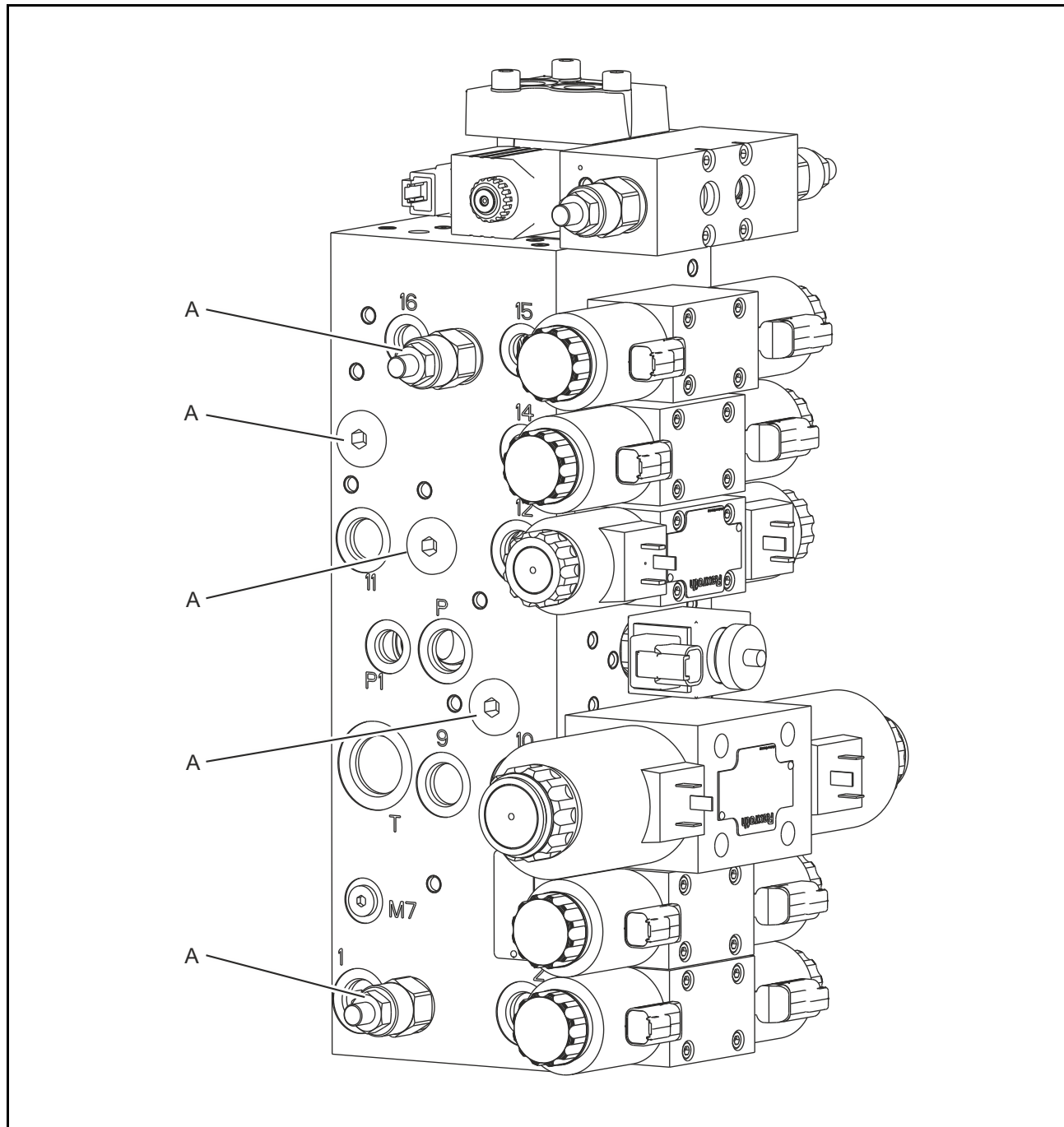
**Figure 5-191. Main Valve Components - Sheet 2 of 2**



	Ft. Lbs.	Nm
A	25-30	33.8-40.6
B	25.1-30.2	34-41
C	121.1-132.8	164.2-180
D	28.8-37.6	39-51
E	30-35	40.6-47.5

**NOTE:** When removing control valves from the manifold, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way as the tag on the valve that was removed. The bolt pattern on the control valves is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down and forcing the bolts will result in cross-threading. Check the tag, and if necessary, rotate the valve 180 degrees.

Figure 5-192. Valve Component Torque - Sheet 1 of 2



	Ft. Lbs.	Nm
A	25-30	33.8-40.6

**NOTE:** When removing control valves from the manifold, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way as the tag on the valve that was removed. The bolt pattern on the control valves is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down and forcing the bolts will result in cross-threading. Check the tag, and if necessary, rotate the valve 180 degrees.

Figure 5-193. Valve Component Torque - Sheet 2 of 2

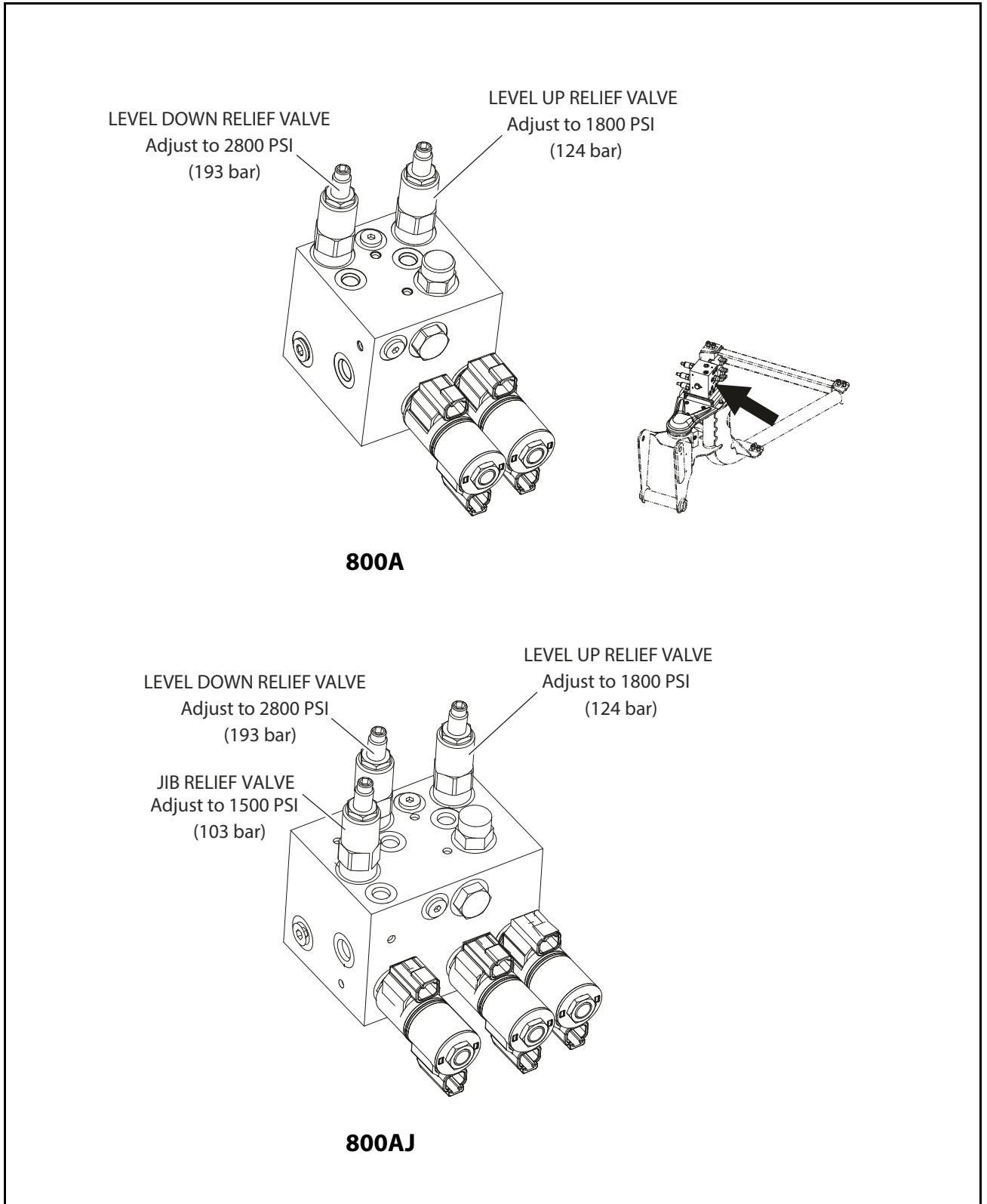


Figure 5-194. Platform Control Valve Pressure Adjustments

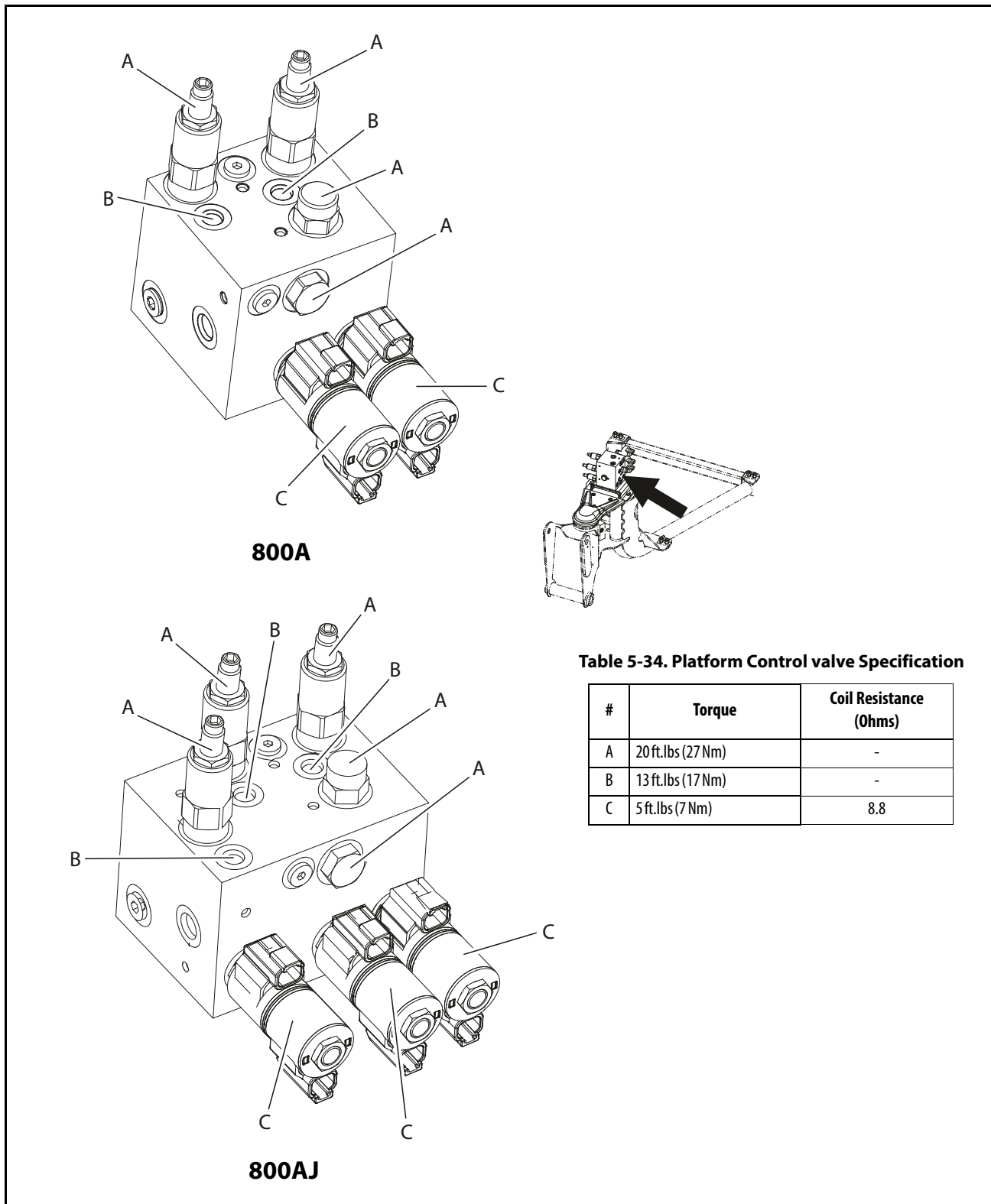


Figure 5-195. Platform Control Valve Component Torque

## Adjustments Made at the Main Valve Block

### MAIN LIFT DOWN

1. Install a high pressure gauge capable of reading **3000 psi** into the external pressure tap at the tee fitting in port "L.S" of main control valve, right side of manifold.
2. Activate main boom lift down. The gauge should read **2100 psi (145 bar)**.
3. The adjustment cartridge is located to the right of port #T2. Turn clockwise to increase, counterclockwise to decrease.

### SWING

**NOTE:** *left and right are done with one adjustment.*

1. Install a high pressure gauge at the "MP" port of the main valve block. Lock the turntable lock pin.
2. Activate swing, the gauge should read **1400 psi (97 bar)**. The adjustment cartridge is located on the right side of the block, right above port "MP".
3. Turn clockwise to increase, and counterclockwise to decrease.

### 2 WHEEL STEER

1. Install a high pressure gauge at the "MS" port of the main valve block. Activate steer left or right. The gauge should read **1800 psi (124 bar)** (2-wheel steer) both directions.
2. One relief cartridge is located on the right side of the block, above port "MS". The other one is located on the left side next to port #15.
3. Turn clockwise to increase, and counterclockwise to decrease.

### 4 WHEEL STEER

1. Install a high pressure gauge at the "MS" port of the main valve block.
2. Activate front wheel steer left or right. One relief cartridge is located on the right side of the block, above port "MS". The other one is located on the left side next to port #15. Turn clockwise to increase, counterclockwise to decrease.
3. Adjust to **2350 psi (162 bar)** front steer. Remove the coil from the front wheel steer directional valve.

4. Activate 4 wheel steer. Adjust the rear wheel steer reliefs to **2250 psi (155 bar)**. Those reliefs are located on the both sides of the 4-wheel steer block bolted on the top of the main control valve.]
5. There must be a minimum of 100 psi difference between the front axle relief pressure and rear axle relief pressure.

### TOWER TELESCOPE OUT

1. Install a high pressure gauge at gauge port "M2" located on the right side of the valve block, at the bottom.
2. Activate tower telescope out, the gauge should read **2200 psi (152 bar)**. This can be done with the tower lift down or up. If the tower lift is up, run the tower telescope out to the end of stroke.
3. The tower telescope out relief valve is located on the left side, at the bottom next to port #1. Turn clockwise to increase, counterclockwise to decrease.

## Adjustments Made at the Platform Valve Block

### PLATFORM LEVEL UP

1. Install a high pressure gauge at the gauge port "M1" of the platform valve. There is pressure trapped at this test port.
2. To release this Pressure, activate level down to the end of stroke (the pressure in the up side goes to 0). This will allow to snap a gauge on at this port.
3. Activate level up to the end of stroke, the gauge should read **2600-2700 psi (179-186 bar)**. The level up relief valve is located next to the port "M1".
4. Turn clockwise to increase, and counterclockwise to decrease.

### PLATFORM LEVEL DOWN

1. Install a high pressure gauge at the gauge port "M2" of the platform valve.
2. To get a gauge on this point activate level up to the end of stroke (the pressure in the down side will go to 0, allowing to snap a gauge on). Activate level down to the end of stroke, the gauge should read **1800psi. (124 bar)**.
3. The level down relief valve is located next to port "M2". Turn clockwise to increase and counterclockwise to decrease.

### ARTICULATING JIB DOWN

1. Install a high pressure gauge on port "M3" of the platform valve.
2. Activate jib down, the gauge should read **1500 psi. (103 bar)**.
3. The down relief valve is located next to port "M3". Turn clockwise to increase and counterclockwise to decrease.

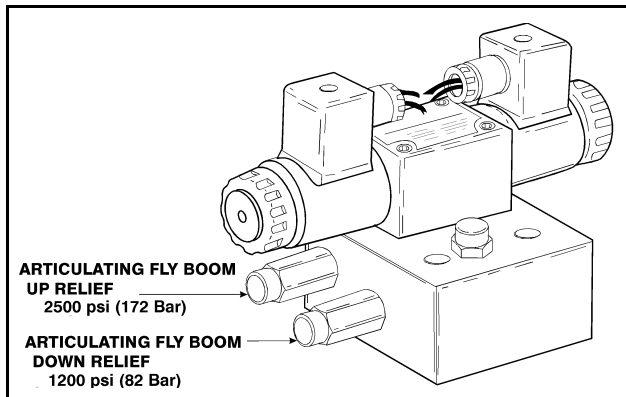


Figure 5-196. Articulating Jib Boom Pressure adjust.

### 4 WHEEL STEER (IF EQUIPPED)

1. At the platform console using the steer select switch activate "4 wheel steer".
2. Install a pressure gauge in port "G" on the control valve.
3. With the aid of an assistant, activate steer left and right, adjust front steer relief valve to **2500 psi (172.4 bar)**. This pressure only affects the front axle.
4. At the platform console using the steer select switch activate "crab" or "coordinated" steer.
5. At the main control valve block disconnect the wire din connectors on the front steer valve. When steer is activated only the rear steer will work.
6. Install a pressure gauge in port "G" on the control valve.
7. With the aid of an assistant, activate steer left and right, adjust rear steer relief valve to **2500 psi (172 bar)** Reading at the valve bank. **2500 psi (172 bar)** will give you **2000 psi (138 bar)** at the cylinders.
8. Re-connect the front steer din connectors at the valve bank.

## 5.7 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered

to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

### **⚠ WARNING**

**THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.). WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.**

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

**NOTE:** *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

**NOTE:** *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the main case drain port.

**NOTE:** *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

**NOTE:** *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

**NOTE:** *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

### **WARNING**

**DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.**

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

**NOTE:** *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

### **WARNING**

**INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.**

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

## **5.8 HYDRAULIC DRIVE PUMP PRE-FILL PROCEDURE**

** CAUTION**

**HYDRAULIC DRIVE PUMP MUST BE PRE-FILLED BEFORE STARTING THE ENGINE. FAILURE TO DO SO CAN CAUSE PREMATURE FAILURE OF THE PUMP.**

1. Fill the hydraulic reservoir.
2. Determine if the hydraulic oil tank sight level gauge is higher than other hydraulic components.
  - a. Determine if the hydraulic oil tank sight level gauge is higher than the hydraulic drive pump assembly.
  - b. Determine if the hydraulic oil tank sight level gauge is higher than all hydraulic hose loops and the routings between the hydraulic tanks and the hydraulic drive pump assembly.
  - c. If sight level gauge is the highest hydraulic oil level point, proceed to step 3.
  - d. If sight level gauge is NOT the highest oil level point, low pressure air may need to be applied to the hydraulic oil tank (fill cap via air regulator) in conjunction with step 4 to get hydraulic oil to move over the air locks created by these high spots.
3. If the machine is to be equipped with a hydraulic oil cooler option.
  - a. Determine if there is hydraulic "tee" fittings installed at the hydraulic drive pump that has a "cap" fittings attached to it. (this will generally be at or near the top of the hydraulic drive pump body). This "cap" fitting is to be used to manually fill the hydraulic drive pump case.
  - b. Remove "cap" fitting.
  - c. Fill hydraulic drive pump case with hydraulic oil.
  - d. Attach and torque "cap" fitting.
  - e. Pre-filling of hydraulic drive pump w/oil cooler option is complete. (Step #4 can be omitted at this point).
4. If machine is NOT equipped with a hydraulic oil cooler option.
  - a. Locate a case access port on the hydraulic drive pump. Preferably one located on at or near the top or under sides of the pump.
  - b. Using the proper wrench, Remove the O-ring plug to allow air to escape from the hydraulic drive pump case.
  - c. Hydraulic oil will flow by gravity from the hydraulic tank to the drive pump.
  - d. The pump is full, when hydraulic oil starts to flow out of this port.
  - e. Install the O-ring plug and torque.
5. Pre-filled of the hydraulic drive pump is complete.

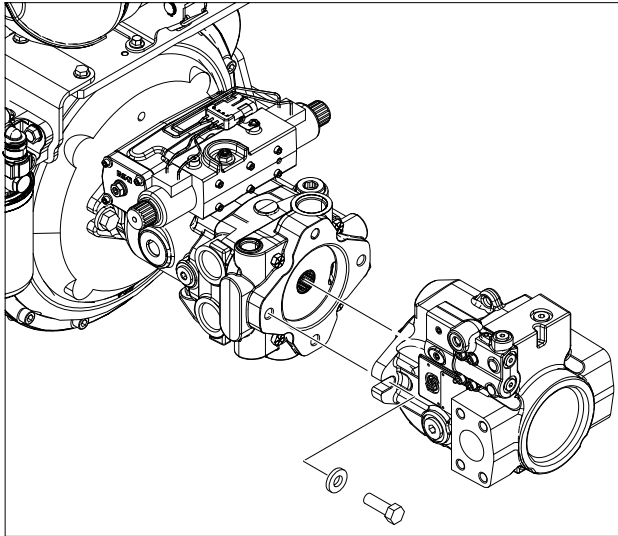
## 5.9 FUNCTION PUMP

### Removal

1. Place machine on level surface and allow the engine and system fluids to cool.
2. Properly relieve any pressure in hydraulic system.
3. Tag and disconnect the hydraulic lines and fittings from the function pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

**NOTE:** The function pump weighs approximately 35 lbs. (16 kg).

4. Use a suitable device to support the function pump.
5. Remove two bolts and washers attaching the function pump to the drive pump. Remove function pump from the machine as shown.



6. Remove and discard o-ring, if applicable.
7. Place function pump in the clean work area.

### Installation

**NOTE:** The function pump weighs approximately 35 lbs. (16 kg).

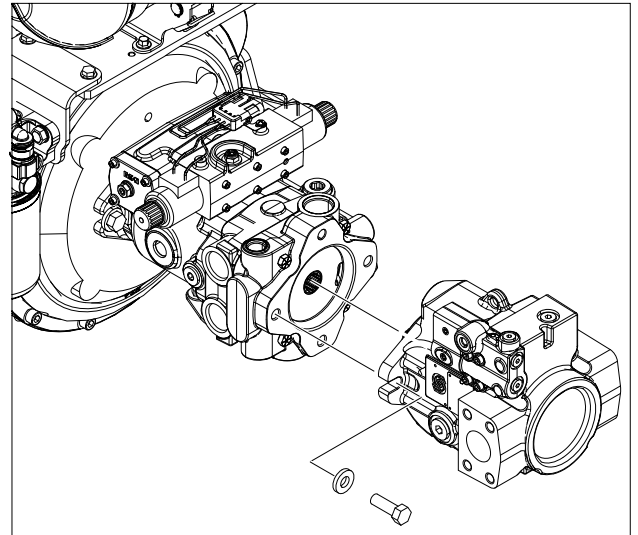
1. Use a suitable device to support the function pump.
2. If applicable, install the o-ring on to the function pump.
3. Align and install the function pump to the drive pump.

**NOTE:** Make sure that the pump shaft is properly aligned.

### **CAUTION**

**INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.**













4. Secure function pump with two bolts and washers as shown. Apply JLG Threadlocker P/N 0100011 to the bolts before installation. Torque bolts to 85 ft. lbs. (116Nm).



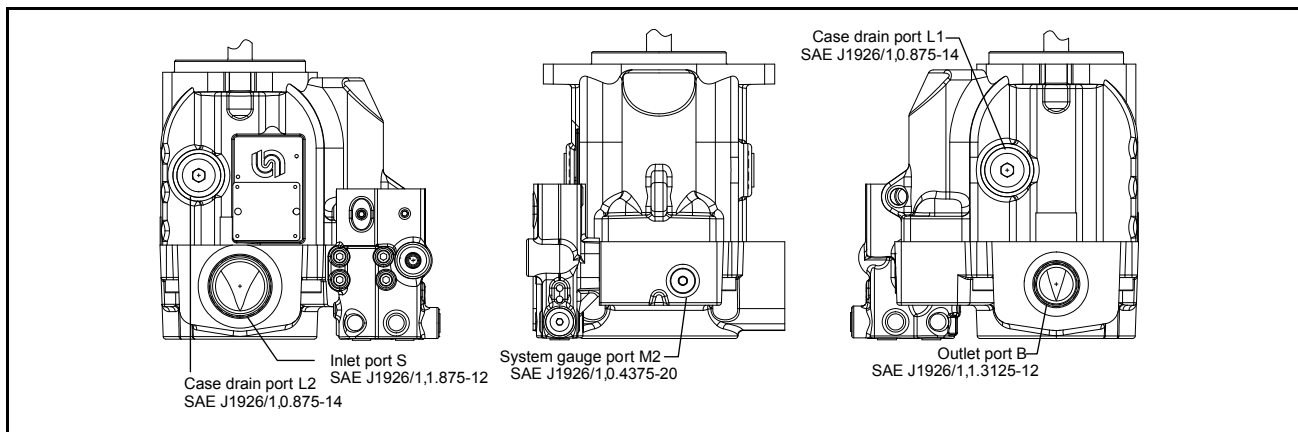
5. Remove tag and reconnect the hydraulic lines to the function pump.
6. Reconnect the battery power and make sure for proper working of the function pump.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**Table 5-35. Symbols Used**

Symbol	Meaning	Symbol	Meaning
	Non-reusable part, use a new part		Inspect for wear or damage
	Option - either part may exist		Note correct orientation
	Internal hex head		Torque specification
	O-ring boss port		Pull out with tool - press fit
	Lubricate with hydraulic fluid		Cover splines with installation sleeve
	Apply grease/petroleum jelly		Pressure measurement / gauge location or specification

The symbols above can be found in the pump illustrations. The legend above is provided to define each symbol and explain its purpose.



**Figure 5-197. Gauge Port Locations**

**Table 5-36. Gauge and Port information**

Port	Purpose	Range of Pump	Fitting
M2	System pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
M4	Servo pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
L1,L2	Case pressure	0-100 psi [0-10 bar]	7/8 - 14 o-ring fitting
X1	Load Sense signal	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting (tee into Load Sense signal line)

## Initial Start-up Procedures

Follow this procedure when starting-up a new pump or when the pump has been removed.

1. Install the pump on the engine. Ensure the pump shaft is properly aligned.

### CAUTION

**INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.**

2. Fill the main pump housing with clean hydraulic fluid. Pour filtered oil directly into the main most case drain port.
3. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
4. To ensure the pump stays filled with oil, install the case drain line in the main most case drain port.
5. Install a gauge at port M2 to monitor system pressure during start up.
6. While watching the pressure gauge installed at M2, jog the engine or run at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shutdown the engine, determine cause, and take corrective action. Refer to Troubleshooting.
7. Operate the hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation. Refer to Adjustments.
9. Shut down the engine and remove the pressure gauge. Replace plug at port M2.
10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The pump is now ready for operation.

**Troubleshooting**

**Table 5-37. Excessive Noise and/ or Vibration**

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will cause cavitation.	Fill the reservoir to proper level.
Check for air in system.	Air in system will cause noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
Check pump inlet pressure / vacuum.	Improper inlet conditions will cause erratic behavior and low output flow.	Correct pump inlet pressure / vacuum conditions. Refer to Hydraulic parameters.
Inspect shaft couplings.	A loose or incorrect shaft coupling will cause excessive noise and/or vibration.	Repair or replace coupling and ensure that correct coupling is being used.
Check shaft alignment.	Misaligned shafts will create excessive noise and/or vibration.	Correct shaft misalignment.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.

**Table 5-38. Actuator Response Is Sluggish**

Item	Description	Action
Check external system relief valve setting.	Low external relief valve setting will slow down system.	Adjust external relief valve setting per manufacturer's recommendations. External relief setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and LS control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check Load Sense control signal pressures.	Incorrect Load Sense signal will not allow pump to operate correctly.	Inspect system, ensure that proper Load Sense signal is transmitted to the pump.
Internal system leaks.	Worn internal parts will not allow the pump to operate properly.	Refer to Authorized Service Center for repairs as required.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system valving.	Malfunctioning valving may not allow system to respond properly.	Repair or replace system valving as required.
Check pump case pressure.	High case pressure will cause the system to be sluggish.	Correct case drain line restrictions.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.

**Table 5-39. System Operating Hot**

<b>Item</b>	<b>Description</b>	<b>Action</b>
Check fluid level in reservoir.	Insufficient volume of hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level. Verify proper size of reservoir.
Inspect heat exchanger. Check air flow and input air temperature for the heat exchanger.	Insufficient air flow, high input air temperature, or undersized heat exchanger will not meet cooling demands of the system.	Clean, repair, or replace heat exchanger as required. Verify proper size of heat exchanger.
Check external system relief valve setting.	Fluid passing through relief valve adds heat to system.	Adjust external system relief valve setting per manufacturer's recommendations. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check pump inlet pressure / vacuum.	High inlet vacuum adds heat to system.	Correct inlet pressure / vacuum conditions.

**Table 5-40. Low Pump Output Flow**

<b>Item</b>	<b>Description</b>	<b>Action</b>
Check fluid level in reservoir.	Insufficient hydraulic fluid will limit output flow and cause internal damage to pump.	Fill the reservoir to proper level.
Hydraulic fluid viscosity above acceptable limits.	Fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system relief valve setting.	External relief valve set below Pressure Compensator setting will cause low output flow.	Adjust external relief valve per manufacturer's recommendation. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and Load Sense control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.
Check input speed.	Low input speeds decrease flow.	Adjust input speed.
Check pump rotation.	Incorrect rotational configuration will cause low flow.	Use pump with appropriate rotational configuration.

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**Table 5-41. Pressure or Flow Instability**

Item	Description	Action
Check for air in system.	Air in system will cause erratic operation.	Activate Pressure Compensator, allowing system to bleed air. Check inlet line for leaks and eliminate source of air ingress.
Check control spools.	Sticking control spools will cause erratic operation.	Inspect spools for free movement in bore. Clean or replace as needed.
Check Load Sense setting.	Low Load Sense setting may cause instability.	Adjust Load Sense setting to proper level. See Adjustments.
Check Load Sense signal line.	Blocked Load Sense signal line will interfere with proper Load Sense operation.	Remove blockage.
Check external relief valve and Pressure Compensator setting.	Insufficient pressure differential between Pressure Compensator Pressure Compensator setting and external relief valve.	Adjust external relief valve or Pressure Compensator control settings to appropriate level. Relief valve setting must be above Pressure Compensator setting for proper operation.
Check external relief valve.	Chattering external relief valve may cause unstable feedback to pump control.	Adjust or replace relief valve.

**Table 5-42. System Pressure Not Reaching Pressure Compensator Setting**

Item	Description	Action
Check Pressure Compensator control setting.	System pressure will not rise above Pressure Compensator setting.	Adjust Pressure Compensator to appropriate setting.
Check external relief valve.	External relief valve setting below Pressure Compensator setting will prevent pressure compensation.	Adjust external relief valve per manufacturer's recommendations. External relief valve must be set above Pressure Compensator setting for proper operation.
Inspect Pressure Compensator control spring.	Broken, damaged, or missing spring will cause erratic operation.	Replace spring as required.
Inspect Pressure Compensator spool for wear.	Wear of the Pressure Compensator spool will cause internal leakage in the control.	Replace the spool as required.
Inspect Pressure Compensator spool for proper orientation.	Improper orientation will result in poor operation.	Correct orientation of spool.
Check Pressure Compensator control for contamination.	Contamination may interfere with movement of the Pressure Compensator Spool.	Clean Pressure Compensator control components, take appropriate action to eliminate contamination.

Table 5-43. High Inlet Vacuum

Item	Description	Action
<p><b>⚠ CAUTION</b>  <b>HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.</b></p>		
Check fluid temperature.	Low temperature increases viscosity. High fluid viscosity causes high inlet vacuum.	Allow system to warm up before operation.
Inspect inlet screen.	Blocked or restricted inlet screen will cause high inlet vacuum.	Clean screen / remove blockage.
Check inlet piping.	Too many fittings, bends, or long piping will cause high inlet vacuum.	Eliminate fittings to make path more direct.
Hydraulic fluid viscosity above acceptable limits.	High fluid viscosity causes high inlet vacuum.	Select fluid with appropriate viscosity for expected operating temperature.

## Shaft Seal Replacement

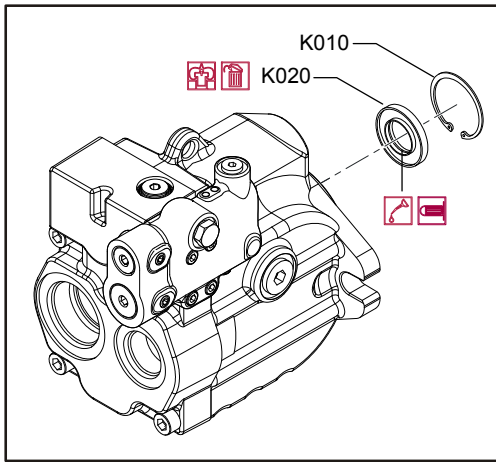


Figure 5-198. Shaft Seal and Retaining Ring

A lip type shaft seal is used in the pump and can be replaced without major disassembly of the unit. Replacement of the shaft seal requires removal of the pump from the machine.

### REMOVAL

1. Using the appropriate snap-ring pliers, remove the retaining ring (K010) from the housing.
2. Remove the shaft seal (K020) from the bore in the pump housing and discard. Avoid damaging the pump housing or shaft. Puncture the face of the seal with a packing hook, or use a slide-hammer type puller to remove the seal.

### INSTALLATION

1. Inspect the pump housing and new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
2. Lubricate the lip of the new shaft seal with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation.

### **CAUTION**

**PREMATURE BEARING FAILURE CAN RESULT IF THE SHAFT SEAL CONTACTS THE SHAFT BEARING. PRESS THE SEAL INTO THE HOUSING ONLY FAR ENOUGH TO CLEAR THE RETAINING RING GROOVE.**

3. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation.
4. Using the appropriate snap ring pliers, install the seal retaining ring.
5. Remove the installation sleeve.

## Control Assembly

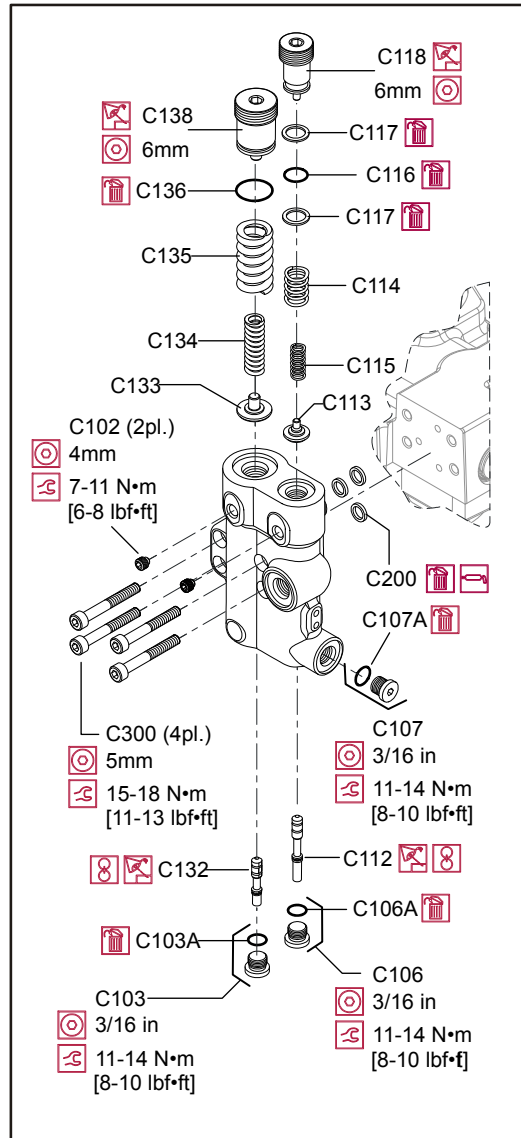


Figure 5-199. Control Assembly

### DISASSEMBLY

1. Remove the four screws (C300) holding the control housing onto the end cap.
2. Remove the control and discard the three interface o-rings (C200).
3. Remove the Pressure Compensator set screw (C102), Pressure Compensator adjustment screw (C138), o-ring (C136), springs (C135, C134), and seat (C133). Discard the o-ring.
4. Remove the plug (C103), o-ring (C103A), and Pressure Compensator spool (C132) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.
5. Remove the plug (C107) and o-ring (C107A); discard the o-ring.

**NOTE:** For Pressure Compensator only controls, skip steps 6 and 7.

6. Remove the Load Sense set screw (C102), Load Sense adjustment screw (C118), o-ring (C116), back-up rings (C117), springs (C114, C115), and seat (C113); discard the o-ring.
7. Remove the plug (C106), o-ring (C106A), and Load Sense spool (C112) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.

### INSPECTION

1. Inspect the adjustment screws for wear at the tips and where they contact the springs; replace as necessary.
2. Inspect the springs and spring guides for wear or damage; replace as necessary.
3. Carefully inspect the spools. Ensure the sealing lands are free of nicks and scratches. Check the ends that contact the spring guides for wear. Replace spools as necessary.
4. Inspect the control housing for damage. Check the spool bores for excessive wear.
5. Clean all parts and lubricate spools, springs, guides and new o-rings with clean hydraulic fluid.

### REASSEMBLY

1. Install the Pressure Compensator spool, spherical end first, into the Pressure Compensator bore. The Pressure Compensator spool is the shorter of the two. Using a new o-ring, install the plug (C103). Torque to 8-10 ft.lb. [11-14 Nm].
2. Place the two Pressure Compensator springs onto the spring guide and install into the Pressure Compensator bore. Place a new o-ring onto the Pressure Compensator adjustment screw and thread it into the Pressure Compensator bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lb. [7-11 Nm].

**NOTE:** For Pressure Compensator only controls, skip steps 15 and 16.

3. Install the Load Sense spool, spherical end first, into the Load Sense bore. The Load Sense spool is the longer of the two. Using a new o-ring, install the plug (C106). Torque to 8-10 ft.lb. [11-14 Nm].
4. Place the two Load Sense springs onto the spring guide and install into the Load Sense bore. Place a new o-ring and backup rings onto the Load Sense adjustment screw and thread it into the Load Sense bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lb. [7-11 Nm].
5. Using a new o-ring, install the plug (C107). Torque to 8-10 ft.lb. [11-14 Nm].
6. Using petroleum jelly to retain them, install the three interface o-rings (C200) in the recesses on the control housing.
7. Install the control assembly onto the endcap using the four screws (C300). Torque to 11-13 ft.lb. [15-18 Nm]. Torque screws in a criss-cross pattern and re-torque the first screw to ensure proper torque retention.

### Plug and Fitting Sizes and Torques

If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a

composite. Your configuration may differ but the appropriate wrench size and torque can be found here.

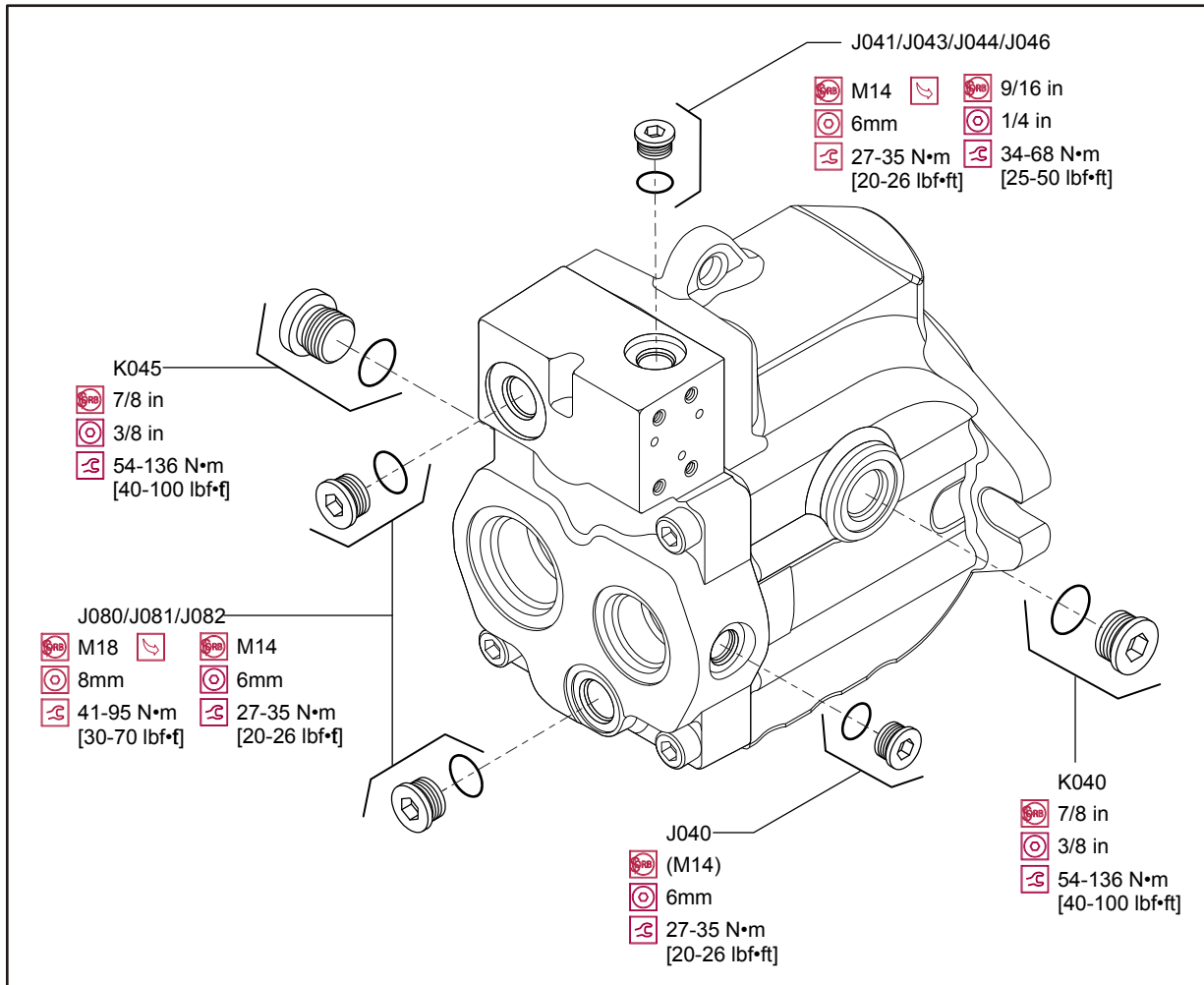


Figure 5-200. Plug Locations, Sizes, and Torques

## 5.10 DRIVE PUMP

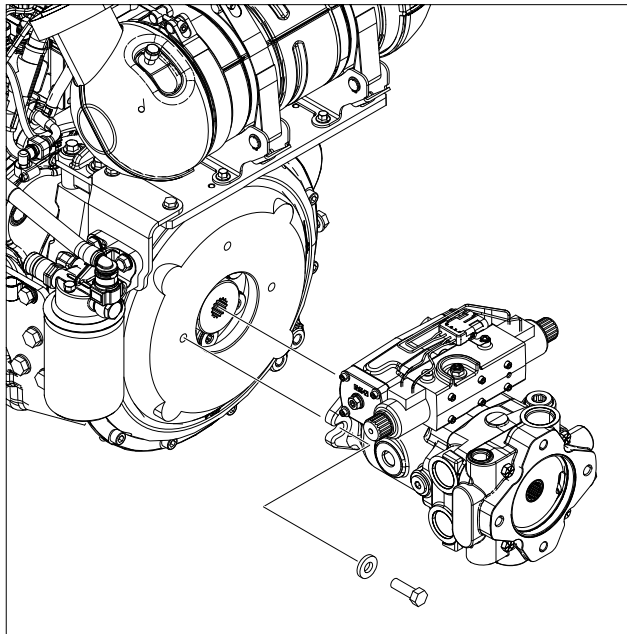
### Removal

**NOTE:** Remove the function pump from the machine first, refer Section 5.9, Function Pump.

1. Tag and disconnect the hydraulic lines and fittings from the drive pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

**NOTE:** The drive pump weighs approximately 62 lbs. (28 kg).

2. Use a suitable device to support the drive pump.
3. Remove two bolts and washers attaching the drive pump to the engine assembly. Remove drive pump from the machine as shown.



4. Remove and discard o-ring from the drive pump groove.
5. Place drive pump in the clean work area.

### Installation

**NOTE:** The drive pump weighs approximately 62 lbs. (28 kg).

1. Use a suitable device to support the drive pump.
2. Install the new o-ring in to the drive pump groove.
3. Align and install the drive pump to the engine assembly.

**NOTE:** Make sure that the pump shaft is properly aligned.

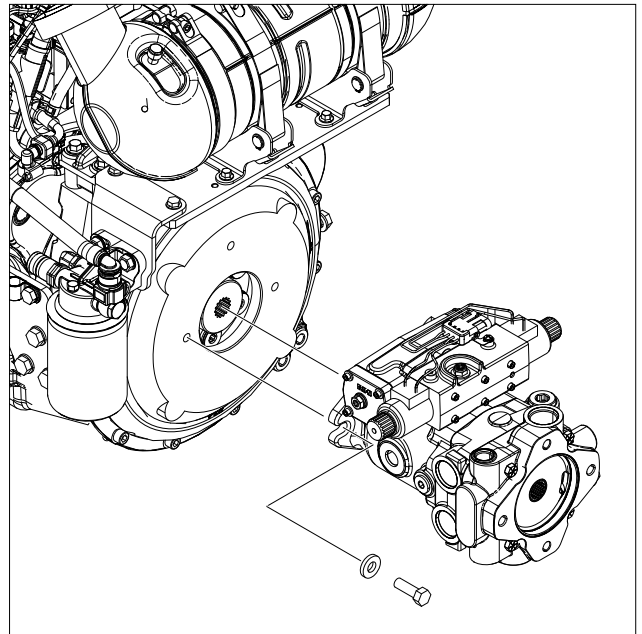
### CAUTION

**INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.**

4. Secure drive pump with two bolts and washers as shown.

**NOTE:** Apply JLG Threadlocker P/N 0100011 to the bolts before installation.

5. Torque bolt to 50 ft. lbs. (68Nm).



6. Remove tag and reconnect the hydraulic lines and fittings to the drive pump.

## Servo Controlled Piston Pump

### DISASSEMBLY

The following instructions apply to a single servo controlled piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the cap screws up. Mark the relationship of the working ports (for assembly identification) to the servo control assembly with a scribe. Remove the four cap screws retaining endcover.
2. Lift the charge pump adapter assembly straight up off endcover, shaft and gerotor. Gerotor may stay in adapter or on endcover.
3. Remove o-ring from charge pump adapter.
4. Remove outer gerotor ring from either the charge pump adapter or the inner gerotor ring.

**NOTE:** Refer to "Charge Pump Adapter Assembly" for disassembly and inspection of charge pump adapter assembly.

5. Remove the inner gerotor ring and key from drive shaft or inner gerotor ring and coupler assembly from shaft.
6. Lift endcover straight up off shaft and housing. Remove valve plate from endcover or from rotating kit assembly, still in housing.
7. From endcover, remove bypass valve or plug, and relief valve assemblies. Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

### Endcover Inspection

- Check the bearing (press fit) in endcover. If needles remain in cage, move freely, and setting is at the dimension shown in Figure 5-201. removal not required.
- Check roll pin in endcover. If tight and set to the dimension shown in Figure 5-201. removal not required.

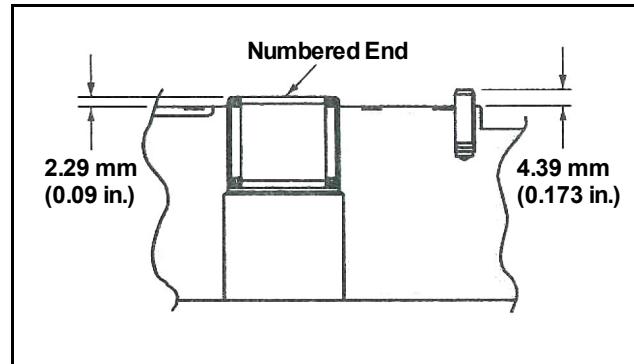


Figure 5-201. Endcover Inspection

1. Remove housing gasket from housing or endcover.
2. With pump still in vise, remove the six cap screws retaining the manual servo control assembly. Remove the control assembly and control housing gasket from the housing. Remove orifice plates, noting location for reassembly. Remove nut and lock washer from control arm, remove arm. Note position of control arm for reassembly.

**NOTE:** Refer to "Manual Servo Control Basic Assembly" for disassembly and inspection of control assembly.

3. To remove rotating kit assembly from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing and shaft from rotating kit assembly, and swashplate.
4. Remove swash plate from rotating kit assembly and servo piston follower from swashplate.

**NOTE:** Refer to "Rotating Kit Assembly" for disassembly and inspection of rotating kit.

**Swashplate Inspection**

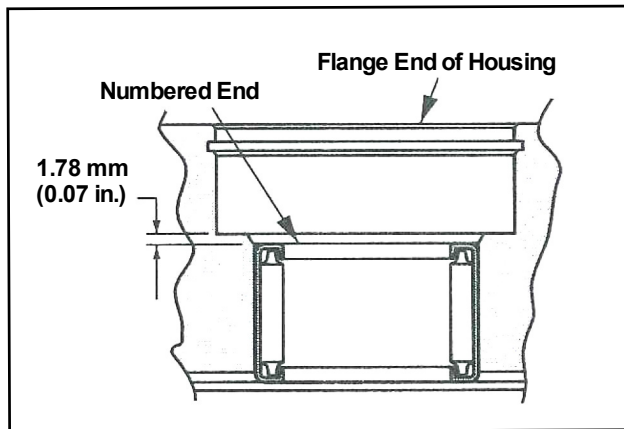
- The finish on the piston shoe surfaces of the swash plate should show no signs of scoring.
  - Inspect swashplate bushing surface for wear and surface for coating transfer from bushing.
1. To remove servo piston assembly from housing, start with the four each cap screws and washers retaining each cover plate.
  2. In removing the cover plate from the servo piston bolt, remove jam nut, washer, and seal washer. Hold the servo piston bolt with hex key and unscrew cover plate off of bolt.
  3. Remove servo piston assembly and seal sub-assemblies (two sets) from housing.

**NOTE:** Disassembly of servo piston assembly is not required.

4. Remove retaining ring from the front of housing. Press the shaft, shaft seal or spacer, and washer from housing. Remove retaining ring, thrust washer, thrust bearing, second thrust washer, and second retaining ring from shaft.

**Housing Inspection**

- Check the bearing (press fit) in housing. If needles remain in cage, move freely, and setting at the dimension shown in Figure 5-202., removal not required.



**Figure 5-202. Housing Inspection**

1. To remove cradle sub-assembly, remove the two cap screws retaining cradle inside housing. Removing cradle subassembly from housing.
2. Remove button head cap screws (2 Qty.) to remove bushing from cradle.

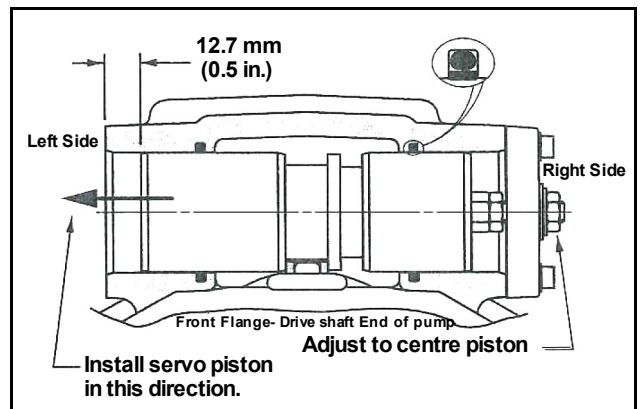
**Bushing Inspection**

- Inspect bushing for contamination embedment within coating of bushing surface coming in contact with swash-plate.
1. Remove all plugs from housing.
  2. Discard the shaft seal, gaskets, and o-rings from all assemblies. Replace with new seals upon reassembly.

**ASSEMBLY**

1. All parts should be cleaned and critical moving parts lubricated before reassembly.
2. If necessary, press new bearing in housing to dimension shown in Figure 5-202. with the numbered end of bearing outward.
3. Install the two new seal sub-assemblies into the servo piston cavity of housing.
4. Screw the cover plate onto the servo piston assembly. Install new cover plate gasket in place on housing. Install servo piston assembly and cover plate into servo piston bore in right side of housing (as shown in Figure 5-203. Retain cover plate with four each washers and cap screws. Torque cap screws 40 to 48 in.lbs (4.5 to 5.4 Nm). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston 0.5 in. (12.7 mm) from surface of housing servo bore as shown in Figure 5-203..

**NOTE:** Re-adjustment may be required for neutral at unit start-up.



**Figure 5-203. Servo Piston Installation**

5. Install new seal washer, washer, and jam nut to servo piston bolt. Holding servo piston bolt with hex key wrench Torque jam nut (150 to 160 in.lbs) 17 to 18 Nm. Check the centering of servo piston assembly. Install new cover plate gasket and cover plate to left side of servo piston and retain with four each washers and #10-24 cap screws. Torque cap screws 40 to 48 in.lbs (4.5 to 5.4 Nm).

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6. To assemble cradle sub-assembly, install bushing onto cradle retaining with button head cap screws. Torque button head cap screw 14 to 16 in.lbs (1.6 to 1.8 Nm).
7. Place cradle sub-assembly into housing making sure cradle is completely seated into housing. Retain cradle sub-assembly with two cap screws. Torque cap screws 20 to 24 ft.lbs (27 to 33 Nm).
8. To install shaft, place exterior retaining ring, thrust race, thrust bearing, second thrust race, and second retaining ring onto shaft. Position washer and shaft seal or spacer onto shaft.
9. Install shaft assembly into front of housing for units with spacer, retain with interior retaining ring and go on to step 10. For units with shaft seal. seat seal into position with seal driver and retain with interior retaining ring.
10. Install servo piston follower onto swashplate dowel pin. Install swashplate carefully onto bushing (coat bushing surface with hydraulic oil), aligning servo piston follower with slot in servo piston assembly.

**NOTE:** Refer to "Rotating Kit Assembly" for reassembly of rotating kit assembly.

11. To install rotating kit assembly, leave housing and shaft in the horizontal position. Holding swashplate into position with screw driver thru controller linkage passage-way at the top of housing. place rotating kit assembly over shaft and into housing until pistons are in against swashplate. Make sure all parts are in housing completely and properly positioned. Return the pump to the vise with open end of housing up. clamping housing on the outer portion of the flange.
12. Install gasket on to housing.
13. If necessary, press new bearing and roll pin in endcover to dimension shown in figure 1-3. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.
14. Install new o-ring on relief valves. Install relief valve in its original cavity in endcover that it was removed. Torque 100 to 110 ft.lbs (136 to 149 Nm).
15. Install new o-ring on bypass valve or plug. Install bypass valve or plug into endcover. Note: Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.
16. Apply a small amount of petroleum jelly to the steel side of valve plate to hold in place for installation. Aligning the index pin, place the valve plate in position onto the endcover, with steel side against endcover.
17. Install endcover assembly onto housing assembly. Make sure ports are positioned correctly, valve plate and gasket stay in place.

18. Install key and inner ring gerotor onto shaft or coupler assembly. Lubricate inner ring gerotor.

**NOTE:** Refer to "Charge Pump Adapter Assembly" for assembly of charge relief valve in adapter plate.

19. Install o-ring and outer ring gerotor onto adapter plate. Lubricate both a-ring and outer ring to hold in position during assembly of adapter plate. Install adapter plate onto endcover. Make sure o-ring and gerotor ring stay in place.
20. Retain endcover and adapter plate (when used) with four cap screws, Torque 27 to 31 ft.lbs (37 to 42 Nm).

**NOTE:** Refer to "Manual Servo Control Basic Assembly" for reassembly of manual servo control assembly.

21. Install control housing gasket onto housing. Install orifices into control assembly and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly onto housing making sure feedback link entered small groove in servo piston assembly.
22. Retain control assembly with six cap screws, torque 40 to 48 in.lbs (4.5 to 5.4 Nm).
23. Install control arm onto control assembly input arm. Retain with lock washer and nut, torque 4 to 6 ft.lbs (5 to 8 Nm).
24. Install new o-rings on all plugs. Install plugs into housing. Torque 3/4 in. plug 21 to 24 ft.lbs (28 to 32 Nm). Torque 1-1/4 in. plug 40 to 45 ft.lbs (54 to 61 Nm).
25. Refer to "Start-up Procedure".

## Charge Pump Adapter Assembly

### DISASSEMBLY

1. Remove plug, shims, spring, and poppet from adapter assembly as shown in Figure 5-205.

### Inspection

- Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that seat is smooth and free of burrs or other defects.
- Inspect the charge pump relief valve spring.
- Inspect the bearing or bushing inside the charge pump adapter. The bearing needles must remain in the bearing cage and bearing at dimension shown in Figure 5-204. The bushing must have no excessive scoring.
- Inspect the gerotor pocket inside the charge pump adapter assembly. It should not be scored excessively.

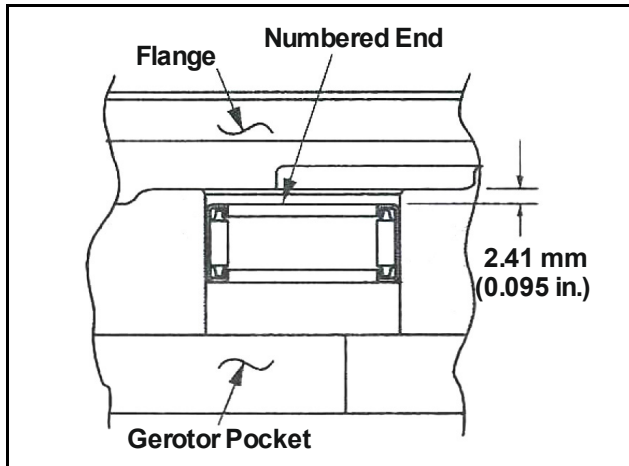
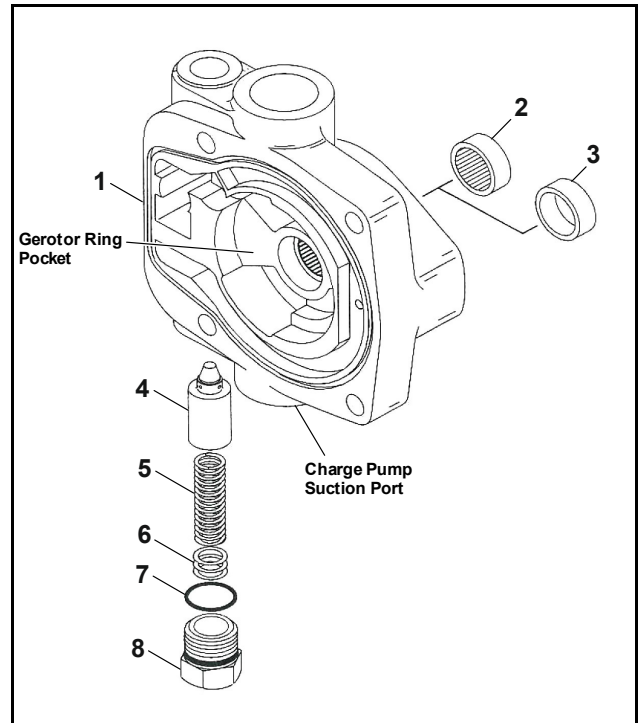


Figure 5-204. bearing or bushing inspection

### ASSEMBLY

1. If necessary, press new bearing or bushing in adapter assembly. The bearing to dimension shown in Figure 5-204. with the numbered end of bearing outward and closest to mounting flange. The bushing is to be pressed flush to 0.254 mm [0.010 in.] recessed.
2. Install poppet, spring, shims, new o-ring on plug, and plug into adapter assembly. Torque plug 30 to 27 ft.lbs. (40.7 to 36.6 Nm).



- |                        |           |
|------------------------|-----------|
| 1. Charge Pump Adapter | 5. Spring |
| 2. Bearing             | 6. Shims  |
| 3. Bushing             | 7. O-ring |
| 4. Poppet              | 8. Plug   |

Figure 5-205. Charge Pump Adapter Assembly

## Manual Servo Control Basic Assembly

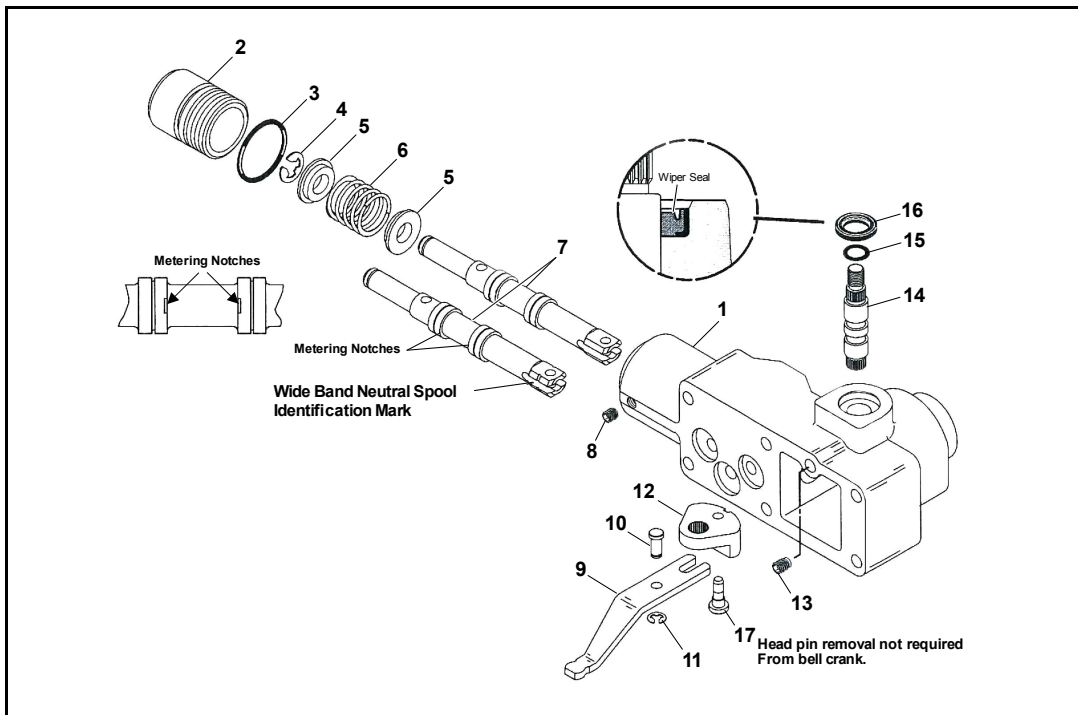
### DISASSEMBLY

1. Remove wiper seal with screw driver. Remove set screw retaining input shaft and remove input shaft from control housing.
2. Remove set screw from plug retaining valve spool and remove plug.
3. Remove E-ring from pin retaining feedback link and valve spool. Remove pin, feedback link, valve spool, and bell crank from control housing.
4. Compress spring and remove E-ring, spring retainer, spring, and second spring retainer from valve spool.
5. Remove o-rings from plug and input shaft. Clean all parts and lubricate in prep for reassembly.

### ASSEMBLY

1. Install spring retainer, spring, and second spring retainer onto spool. Compress spring with retainer and retain with E-ring onto valve spool.

2. Install valve spool into control housing making sure that metering notches on valve spool can be seen in the metering ports. Notches shown in Figure 5-206.
3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool, aligning holes, and install dowel pin retaining with E-ring.
4. Install new o-ring onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.
5. JLG Threadlocker P/N 0100011 or equivalent to set screw and install, retaining input shaft. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.
6. Install wiper seal on input shaft as shown in Figure 5-206. Install new o-ring onto plug, retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw. Torque set screw 17 to 25 in.lbs (2 to 3 Nm).



- |                    |                           |                    |                 |
|--------------------|---------------------------|--------------------|-----------------|
| 1. Control Housing | 6. Spool Centering Spring | 10. Dowel Pin      | 14. Input Shaft |
| 2. Plug            | 7. Valve Spool            | 11. Retaining Ring | 15. O-ring      |
| 3. O-ring          | 8. Set Screw              | 12. Bell Crank     | 16. Wiper Seal  |
| 4. Retaining Ring  | 9. Feedback Link          | 13. Set Screw      | 17. Head Pin    |
| 5. Spring Retainer |                           |                    |                 |

Figure 5-206. Manual Servo Control Basic Assembly

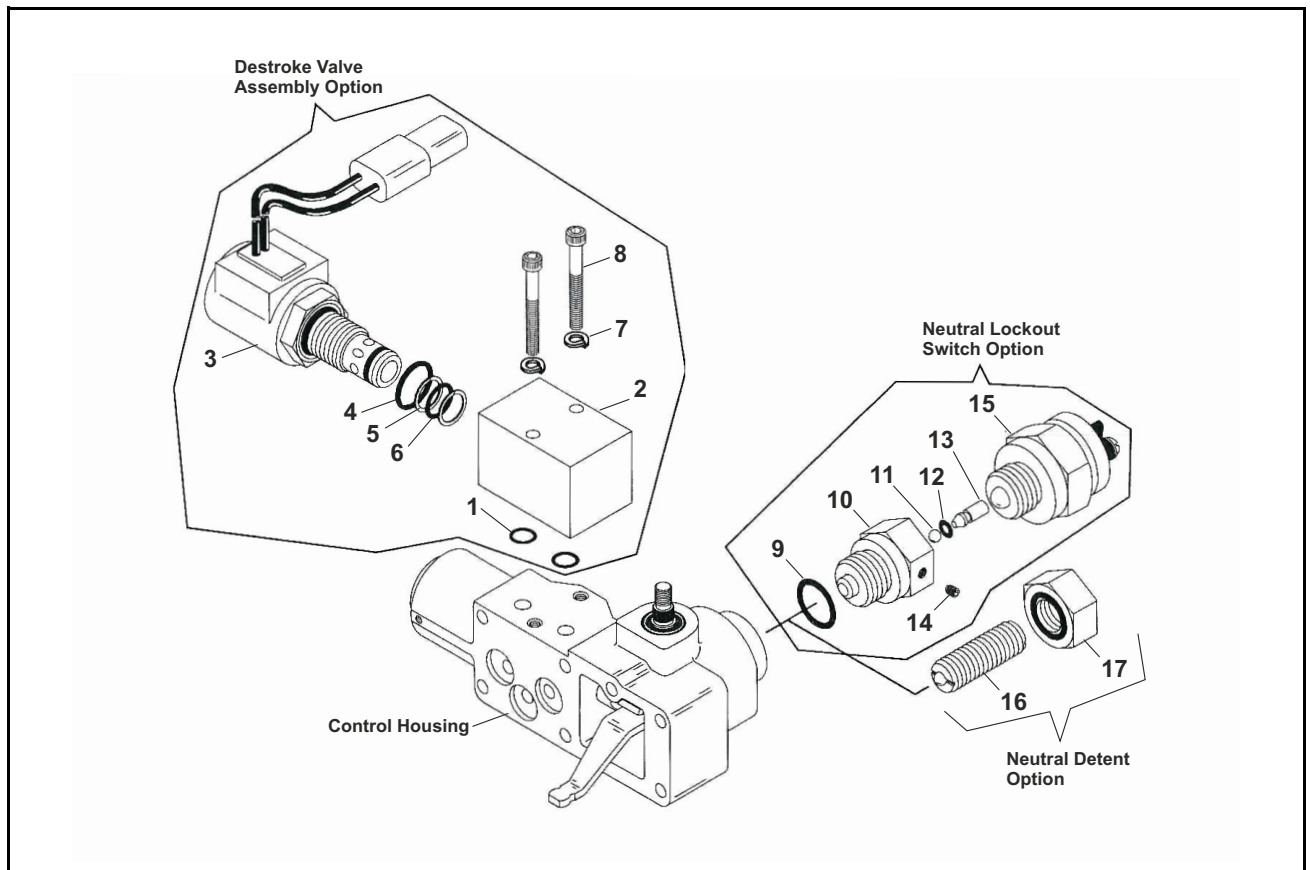
### Manual Servo Control Assembly Options

#### DISASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Remove the two cap screws and lock washers from manifold. Removing destroke valve assembly and two a-rings.
2. Remove destroke valve from manifold in order to remove o-rings and back-up washers. Note: in order to remove destroke valve the solenoid may need to be removed from core first (not shown).

#### ASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Install new o-rings and back-up washers onto destroke valve.
2. Install destroke valve into manifold by hand until top o-ring is met by manifold. Then wrench tighten to 25 ft.lbs. (34 Nm) max. Loosen Nut retaining coil to reposition if necessary and re-torque 4 to 5 ft.lbs. (5.4 to 7 Nm).
3. Lubricate the two o-rings and install onto manifold. Install destroke valve assembly onto control assembly. Retain with lock washers and cap screws. Torque 2.2 to 2.6 ft.lbs. (3 to 3.5 Nm).



- |                   |                |                             |                            |
|-------------------|----------------|-----------------------------|----------------------------|
| 1. O-ring         | 6. O-ring      | 10. Neutral Lockout Adapter | 14. Set Screw              |
| 2. manifold       | 7. Lock Washer | 11. Ball                    | 15. Neutral Lockout Switch |
| 3. Destroke Valve | 8. Cap Screw   | 12. O-ring                  | 16. Ball Plunger           |
| 4. O-ring         | 9. O-ring      | 13. Pin                     | 17. Nut Seal               |
| 5. Back-up Washer |                |                             |                            |

Figure 5-207. Manual Servo Control Basic Assembly Option

**DISASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION**

1. Loosen set screw in adapter and remove neutral lockout switch from adapter.
2. Remove neutral lockout adapter from control assembly.
3. Remove pin, ball, and a-rings from adapter.

**ASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION**

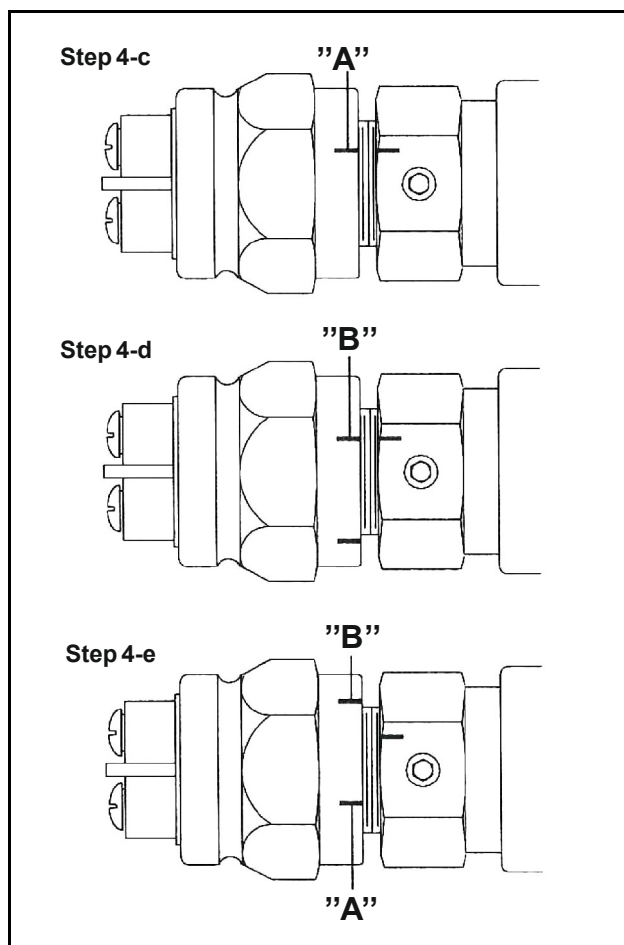
1. Install new a-ring onto adapter and new o-ring onto pin.
2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.
3. Install adapter into control assembly. Torque 44 to 53 ft.lbs. (60 to 70 Nm).
4. Apply Loctite #222 or equivalent to threads of switch and install neutral lockout switch into adapter. The adjustment procedures for the switch are as follows.
  - a. Install switch, while moving control arm back and forth, until "detent" action is detected. Back out the switch until the "detent" action is very slight.
  - b. Obtain a test light or use a multimeter. Attach the leads from the test light to the switch or the wiring connector.
  - c. Move the control arm out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position "A". See Figure 5-208. Move the control arm to the detent position and the test light should come back on.
  - d. Leaving the control arm in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position "B".
  - e. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the hex socket head set screw in one of the main quadrants of the hex of the switch adapter. See Figure 5-208. Torque set screw 2.3 to 2.8 in.lbs (3.2 to 3.8 Nm).
5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.
6. Remove test light and put servo control assembly into operation.

**DISASSEMBLY - NEUTRAL DETENT OPTION**

1. Loosen seal nut and remove ball plunger from control housing.

**ASSEMBLY- NEUTRAL DETENT OPTION**

1. Install ball plunger into control housing until contact with bell crank detent is detected. After contact screw in 1/2 turn and retain with seal nut. Torque nut 10 to 22 ft.lbs. (14 to 30 Nm).



**Figure 5-208. Neutral Lockout Switch Assembly**

## Rotating Kit Assembly

### DISASSEMBLY

Disassembly of rotating assembly is required for inspection only.

1. Remove the nine piston assemblies, shoe retainer, and shoe retainer pivot from cylinder barrel.

### Inspection

- Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the swashplate. **Do not lap piston shoes.**
  - Examine the shoe retainer for wear in the pivot area.
  - Examine the pivot to insure smoothness and no signs of wear.
  - Inspect the cylinder barrel surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. Do not lap piston block.
  - The pistons should move freely in the cylinder barrel bore. If they are sticky in the bore, examine the bore for scoring or contamination.
2. To inspect pins and spring caution should be taken in removing spring. The spring is highly compressed and the retaining ring should not be removed without compressing the spring safely.

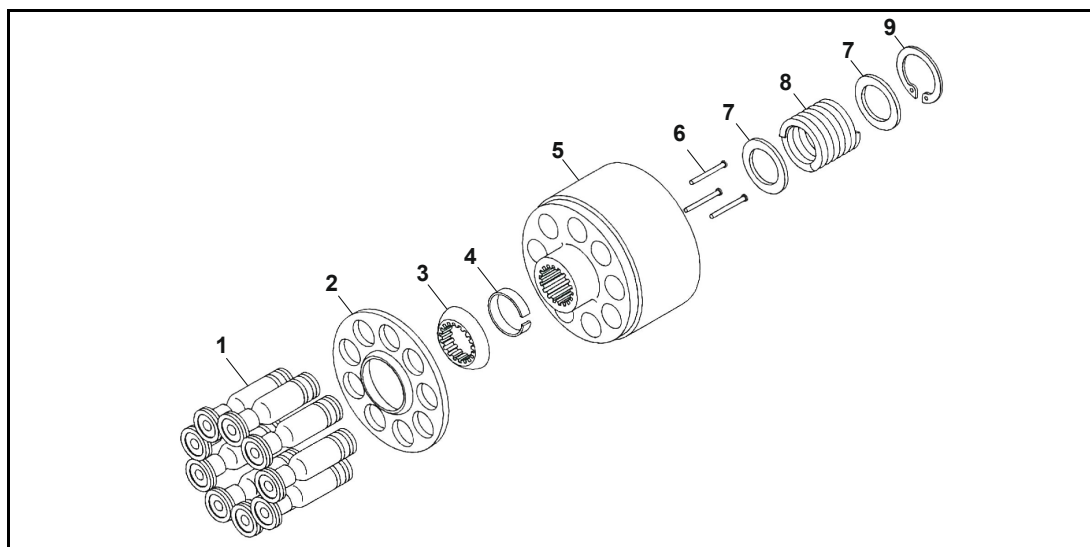
The following parts are required to disassemble the cylinder barrel:

- |       |  |
|-------|--|
| 2 ea. | 3/8 in. I.D. x 1-1/8 in. O.D. flat washers |
| 1 ea. | 3/8 in. x 3-1/4 in. N.C. cap screw, and    |
| 1 ea. | 3/8 in. N.C. nut                           |

To remove spring, place one of the flat washers over the 3/8 in. x 3-1/4 in. cap screw. Put cap screw through the center of the cylinder barrel and apply the second washer. Let washer rest on the three pins and retain with nut. Turning nut and compressing spring inside the barrel. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove nut, bolt, and the two washers from barrel. Remove the washer, spring, second washer, three pins, and pin keeper at the same time.

### ASSEMBLY

1. To reassemble the rotating kit assembly complete the following: Compress the pin keeper and install in the spline of the cylinder barrel. Install the three pins with head end to the inside of the barrel and position in the special grooves of the cylinder barrel spline.
2. Install the washer, spring, and second washer into the cylinder barrel. Use the two 3/8 in. I. D. washers, nut, and 3/8 in. x 3-1/4 in. cap screw to compress the spring and retain with retaining ring. Remove the nut, cap screw, and the two washers.
3. Install the pivot onto the three pins, shoe retainer on the pivot, and piston assemblies thru the shoe retainer and into cylinder barrel. resting on shoe retainer.



- |                        |                    |           |                   |
|------------------------|--------------------|-----------|-------------------|
| 1. Piston assemblies   | 4. Retainer        | 6. Pins   | 8. Spring         |
| 2. Shoe Retainer       | 5. Cylinder Barrel | 7. Washer | 9. Retaining Ring |
| 3. Shoe Retainer Pivot |                    |           |                   |

Figure 5-209. Rotating Kit Assembly

**Fault-logic Trouble Shooting**

Match the transmission symptoms with the problem statements and follow the action steps shown in the box diagrams. This will give expedient aid in correcting minor problems eliminating unnecessary machine down time.

Following the fault - logic diagrams are diagram action comments of the action steps shown in the diagrams. Where applicable, the comment number of the statement appears in the action block of the diagrams.

**RECOMMENDED GAUGE LOCATIONS**

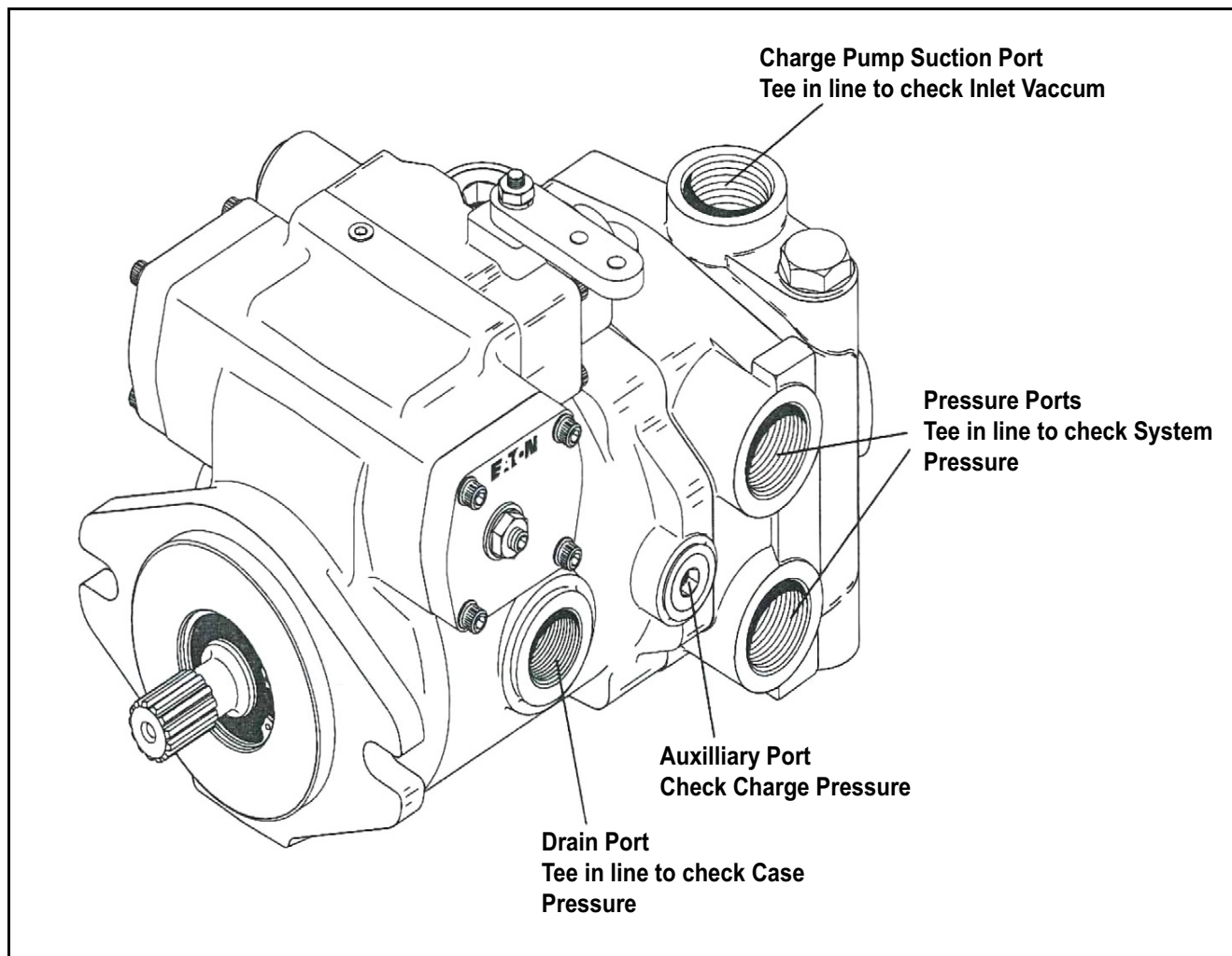
**Gauges Recommended**

Inlet vacuum gauge: 30 PSI to 14.8 PSI (2 bar to 1 bar)

System pressure gauge: 10,000 PSI (700 bar)

Charge pressure gauge: 0 to 600 PSI (0 to 50 bar)

Case pressure gauge: 0 to 300 PSI (0 to 25 bar)



**Figure 5-210. Gauge Locations**

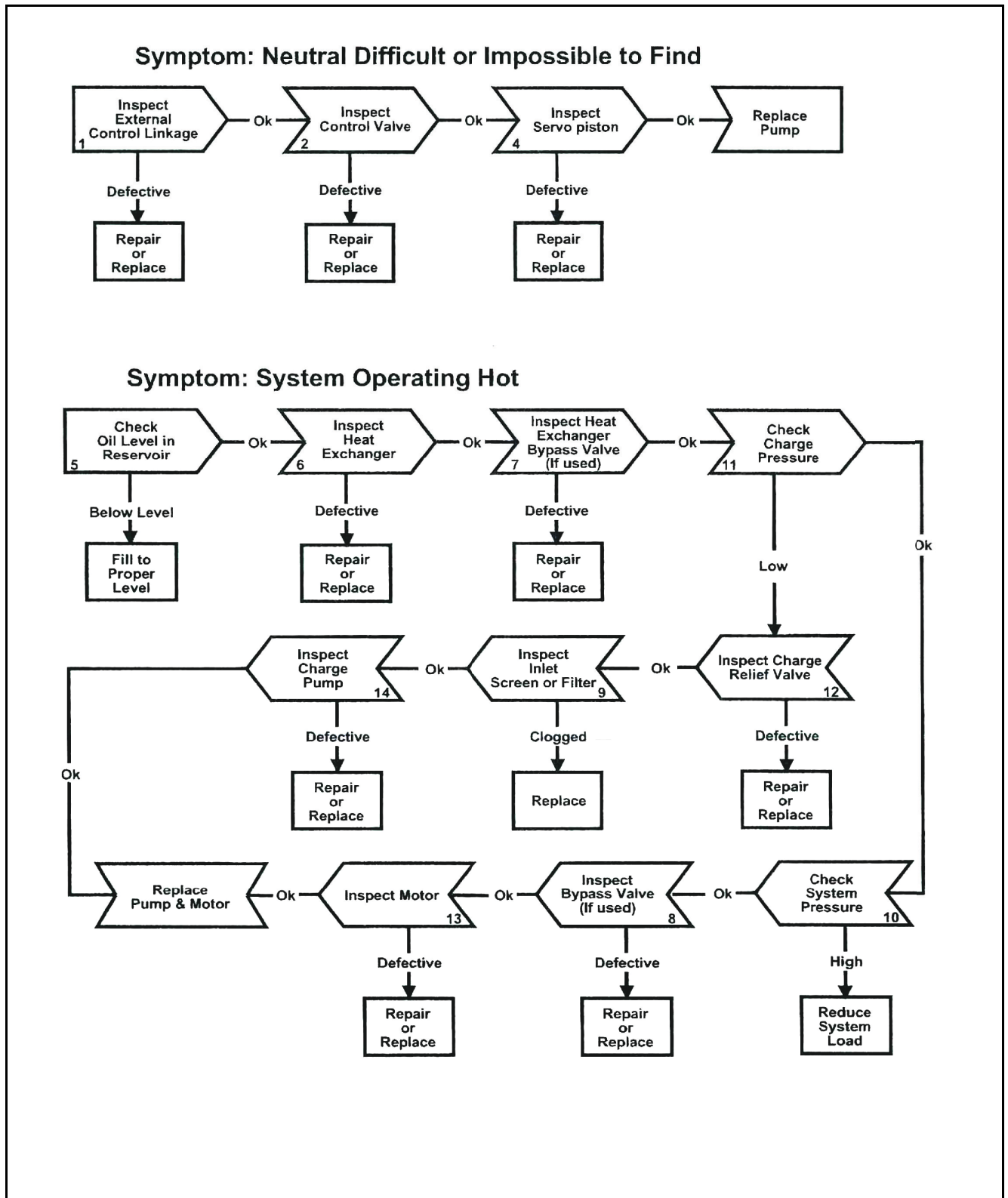


Figure 5-211. Fault-logic Troubleshooting

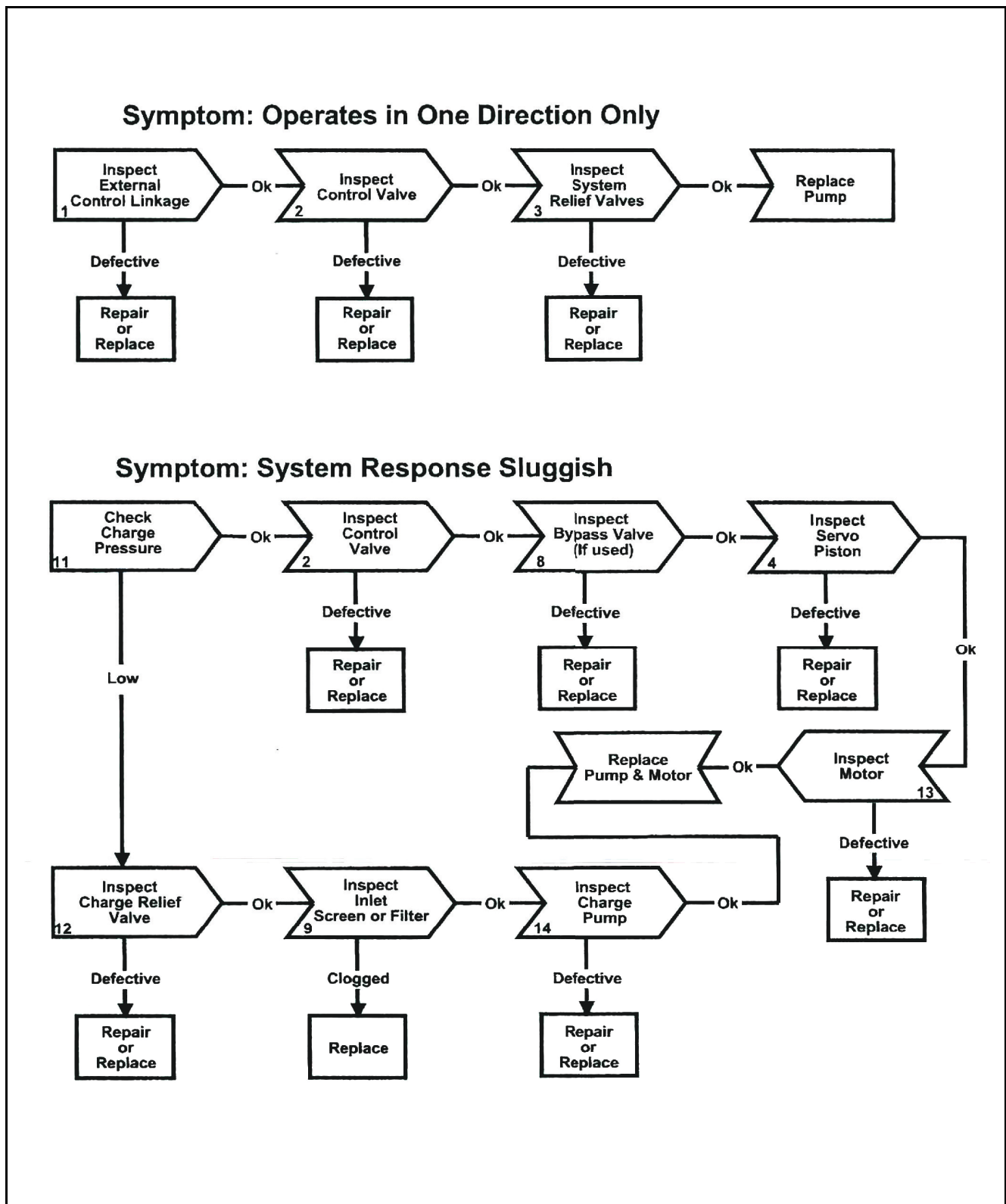


Figure 5-212. Fault-logic Troubleshooting

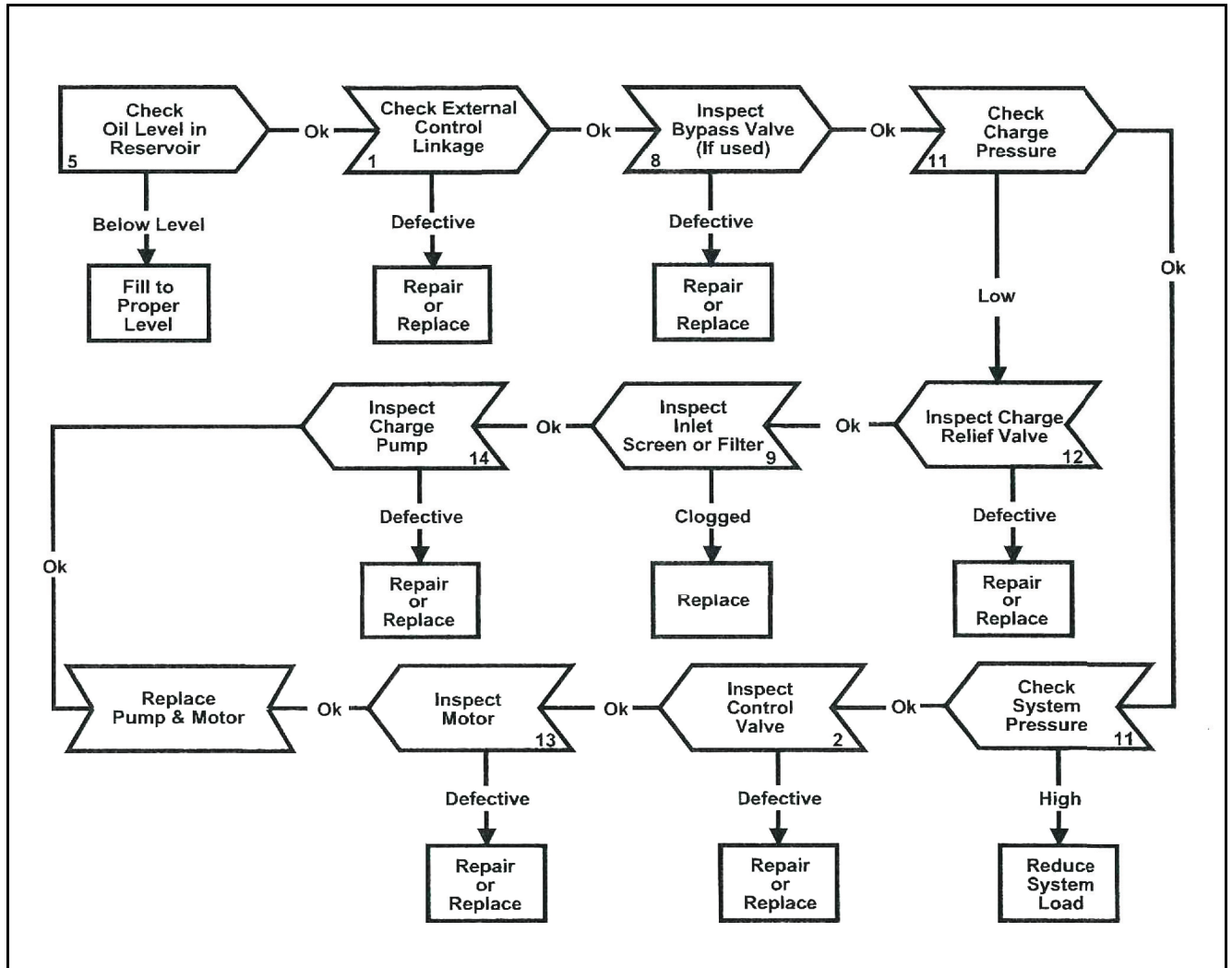


Figure 5-213. Fault-logic Troubleshooting

**DIAGRAM ACTION STEP COMMENTS**

- 1. Inspect External Control Linkage for:**
  - a. Misadjusted or disconnected
  - b. Binding, bent or broken
- 2. Inspect Control Valve for:**
  - a. Plugged control orifice(s)
  - b. Damaged mounting gasket
  - c. Misadjusted, damaged or broken neutral return spring
  - d. Broken control connector pin
  - e. Faulty destroke valve (if used)
  - f. Galled or stuck control spool
  - g. Neutral detent or lockout switch misadjusted (if used)
- 3. Inspect System Relief Valves for:**
  - a. Improper pressure relief setting
  - b. Damaged or broken spring
  - c. Valve held off seat
  - d. Damaged valve seat
- 4. Inspect Servo Piston for:**
  - a. Misadjusted, damaged or broken neutral return spring assembly
  - b. Galled or stuck servo piston
  - c. Damaged or missing o-ring and/or back-up ring
- 5. Check Oil Level in Reservoir:**
  - a. Consult owner/operators manual for the proper type fluid and level
- 6. Inspect Heat Exchanger for:**
  - a. Obstructed air flow (air cooled)
  - b. Obstructed water flow (water cooled)
  - c. Improper plumbing (inlet to outlet)
  - d. Obstructed fluid flow
- 7. Inspect Heat Exchanger Bypass Valve for:**
  - a. Improper pressure adjustment
  - b. Stuck or broken valve
- 8. Inspect Bypass Valve for: (if used)**
  - a. Held in a partial or full open position
- 9. Inspect Inlet Screen or Filter for:**
  - a. Plugged or clogged screen or filter element
  - b. Obstructed inlet or outlet
  - c. Open inlet to charge pump

- 10. Check System Pressure:**
  - a. See Figure 5-206. for location of pressure gauge installation
  - b. Consult owner/operators manual for maximum system relief valve settings
- 11. Check Charge Pressure:**
  - a. See Figure 5-206. for location of charge pressure gauge installation
  - b. Consult owner/operators manual for maximum charge relief valve settings
- 12. Inspect Charge Relief Valve for:**
  - a. Improper charge relief pressure setting
  - b. Damaged or broken spring
  - c. Poppet valve held off seat
- 13. Inspect Motor for:**
  - a. Consult owner/operator manual for motor operation and trouble shooting
- 14. Inspect Charge Pump for:**
  - a. Broken or missing drive key
  - b. Damaged or missing o-ring
  - c. Excessive gerotor clearance
  - d. Galled or broken gerotor set

**System/Charge Relief Valve Pressure Settings**

Inlet Vacuum	2.94 PSI (0.203 bar) max.
Case Pressure	25 PSI (1.7 bar) maximum
Charge Pressure	250 to 300 PSI (17.24 to 20.68 bar)
System Pressure	5000 PSI (345 bar) maximum 3000 PSI (207 bar) continuous

The high pressure relief valves are all factory preset and cannot be readjusted.

The pressure setting is stamped on each valve with a three digit number. To identify, multiply the noted number by 10 to get the valves pressure setting.

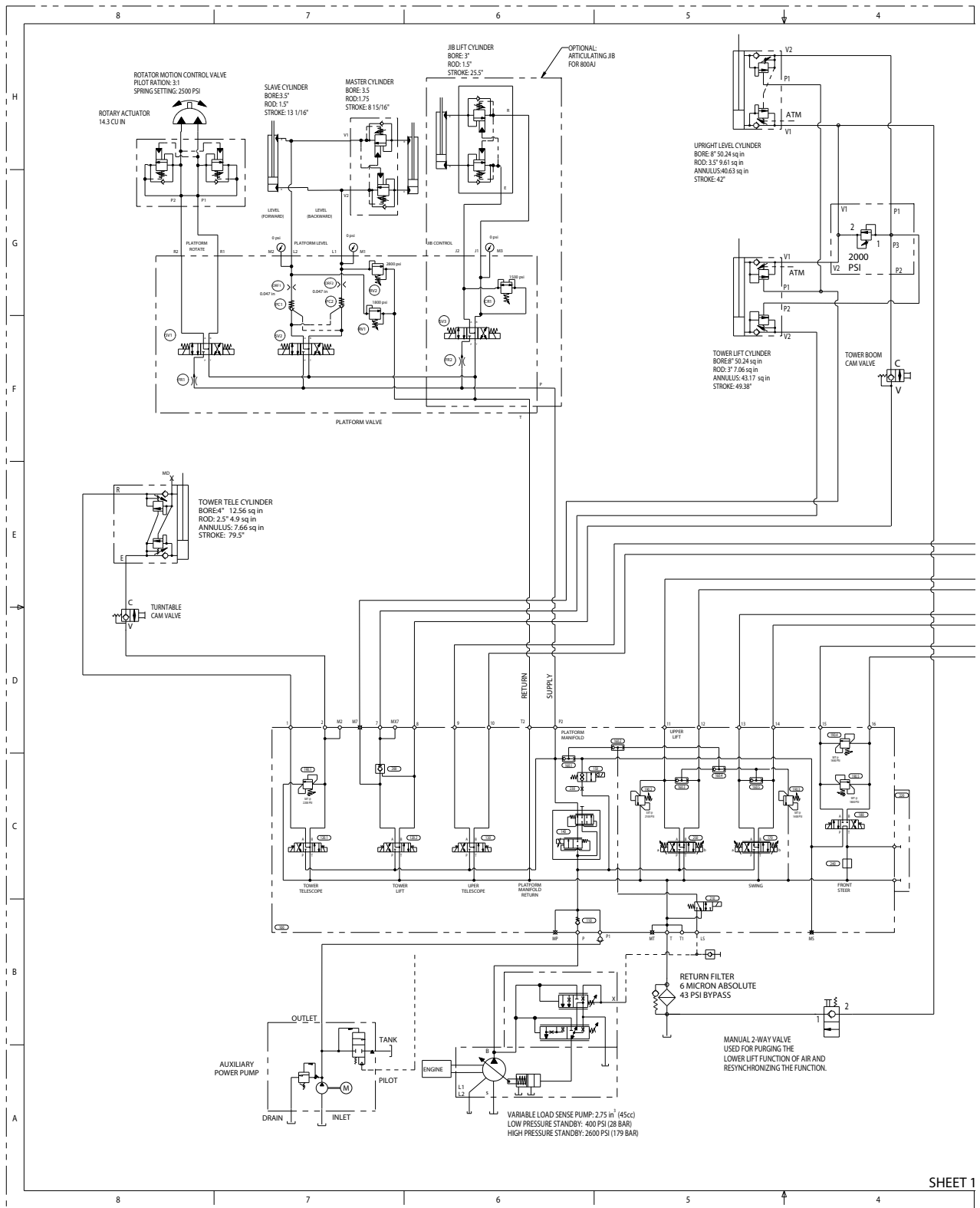
Example: 10 x 500 = 5000 PSI (345 bar)

**Start-up Procedure**

When initially starting a new or a rebuilt transmission system, it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged of air before start-up.

1. After the transmission components have been properly installed, fill the servo pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.
2. Install and adjust all control linkage.
3. Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Refer to Eaton Hydraulics Technical Data sheet number 3-401 titled Hydraulic Fluid Recommendations.
4. Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds.
5. Replace the coil wire or return the fuel flow to the injectors. Place the transmission unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.
6. After the system starts to show signs of fill, slowly move pump swashplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.
7. Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.
8. Check all line connections for leaks and tighten if necessary.
9. The machine is now ready to be put into operation.
10. Frequent filter changes are recommended for the first two changes after placing the machine back into operation. Change the first filter in 3-5 hours and the second at approximately 50 hours. Routinely scheduled filter changes are recommended for maximum life of the hydraulic system.

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



SHEET 1

**Figure 5-214. Hydraulic Schematic - Sheet 1 of 6**

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

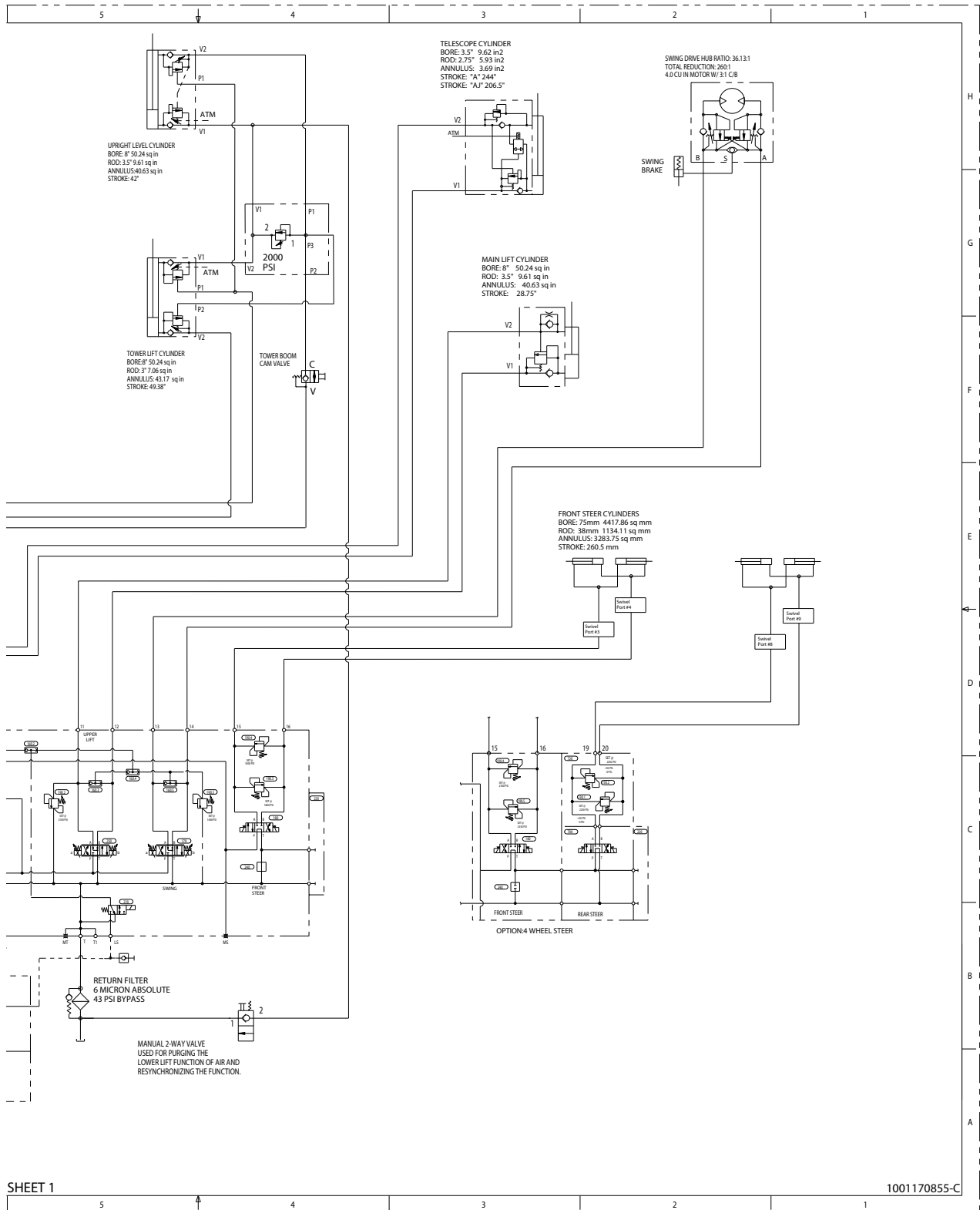
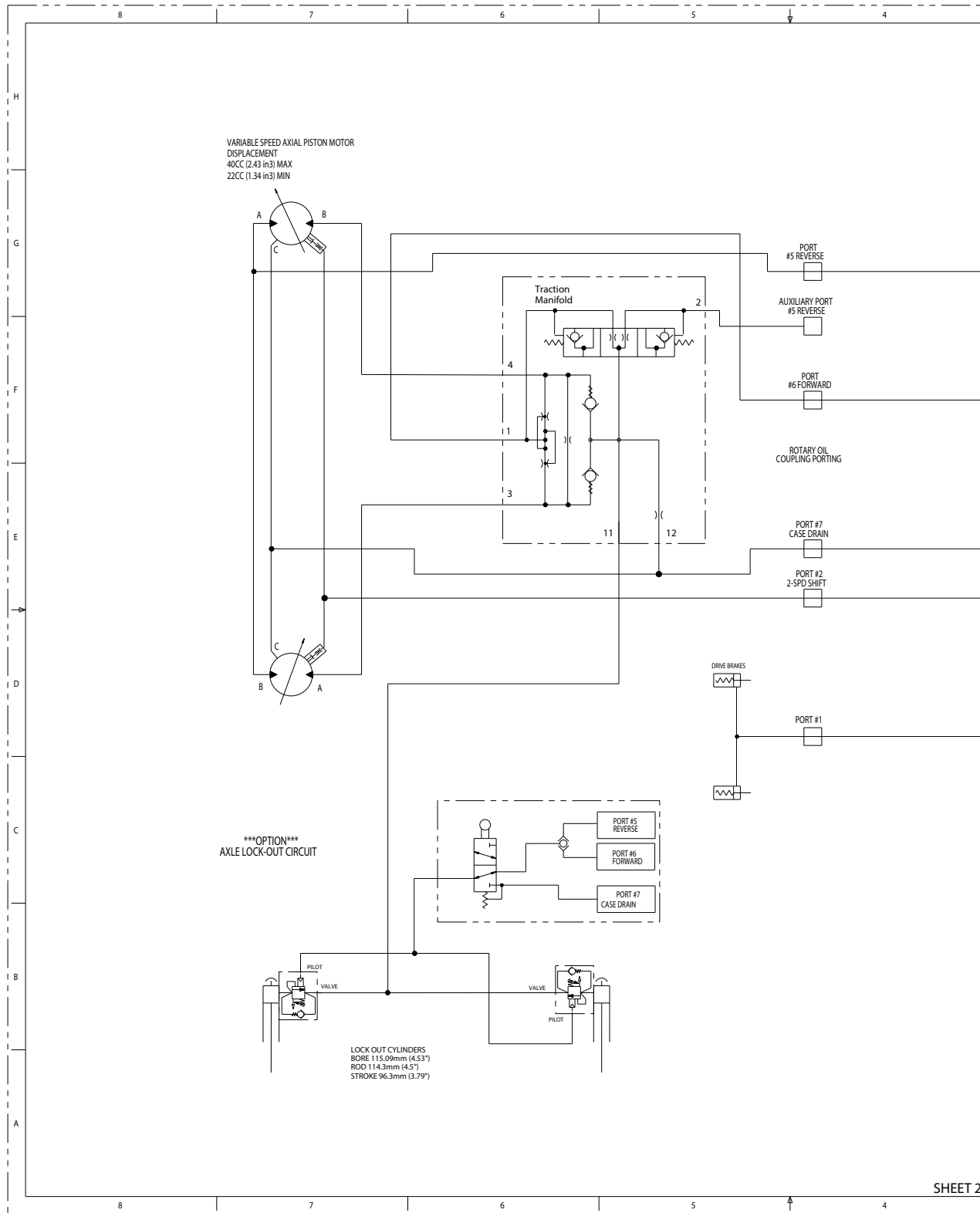


Figure 5-215. Hydraulic Schematic - Sheet 2 of 6

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



**Figure 5-216. Hydraulic Schematic - Sheet 3 of 6**

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

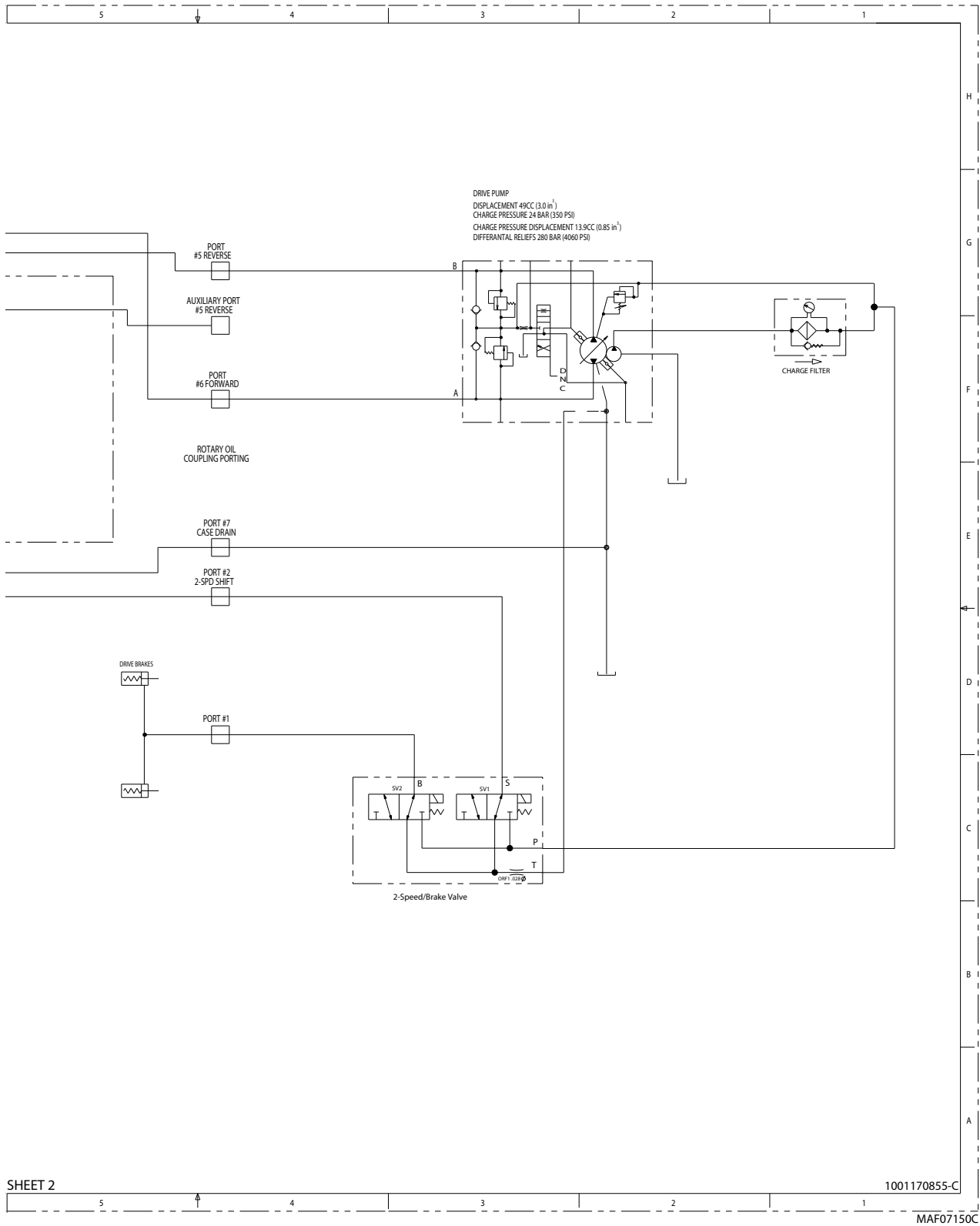
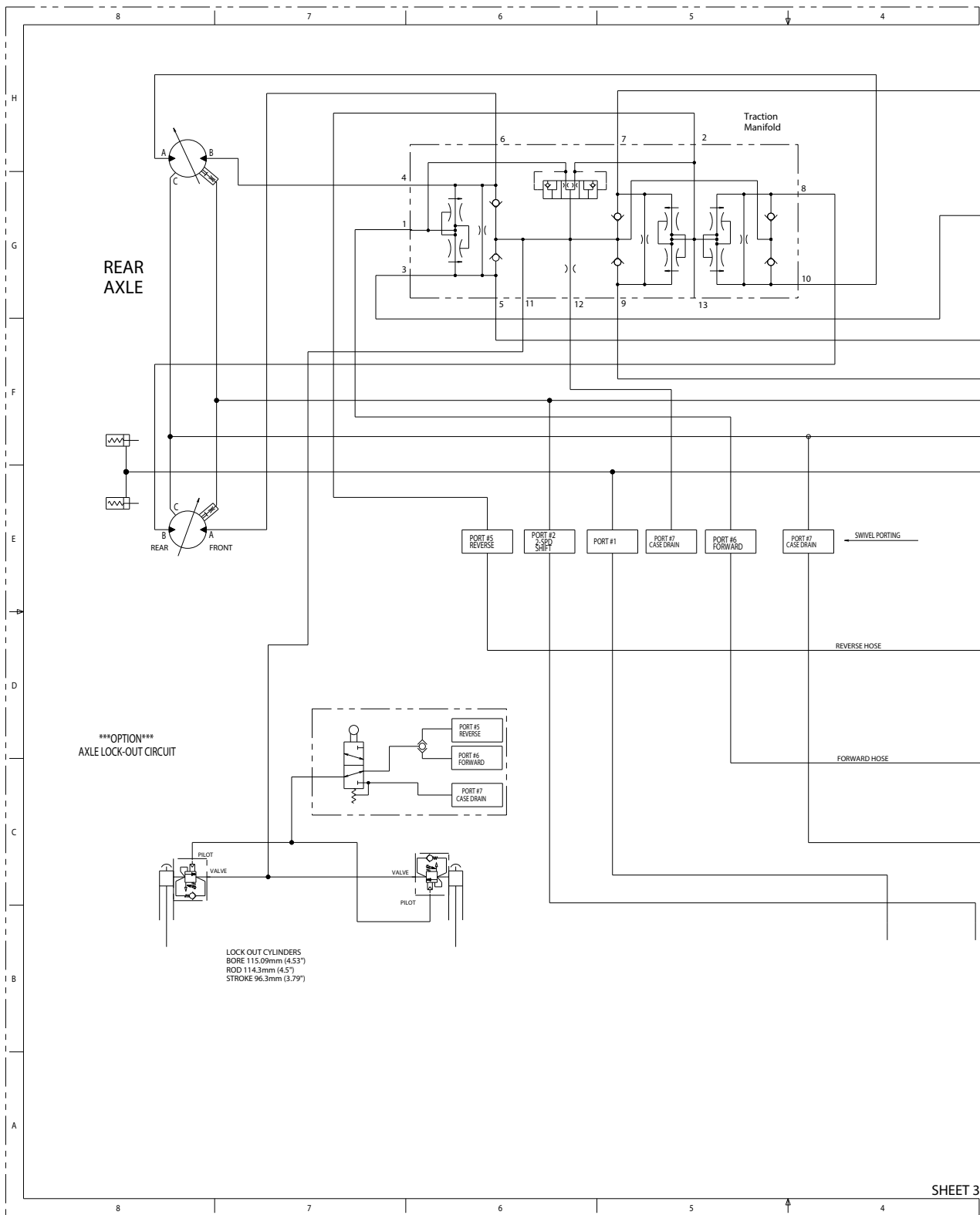


Figure 5-217. Hydraulic Schematic - Sheet 4 of 6

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



**Figure 5-218. Hydraulic Schematic - Sheet 5 of 6**

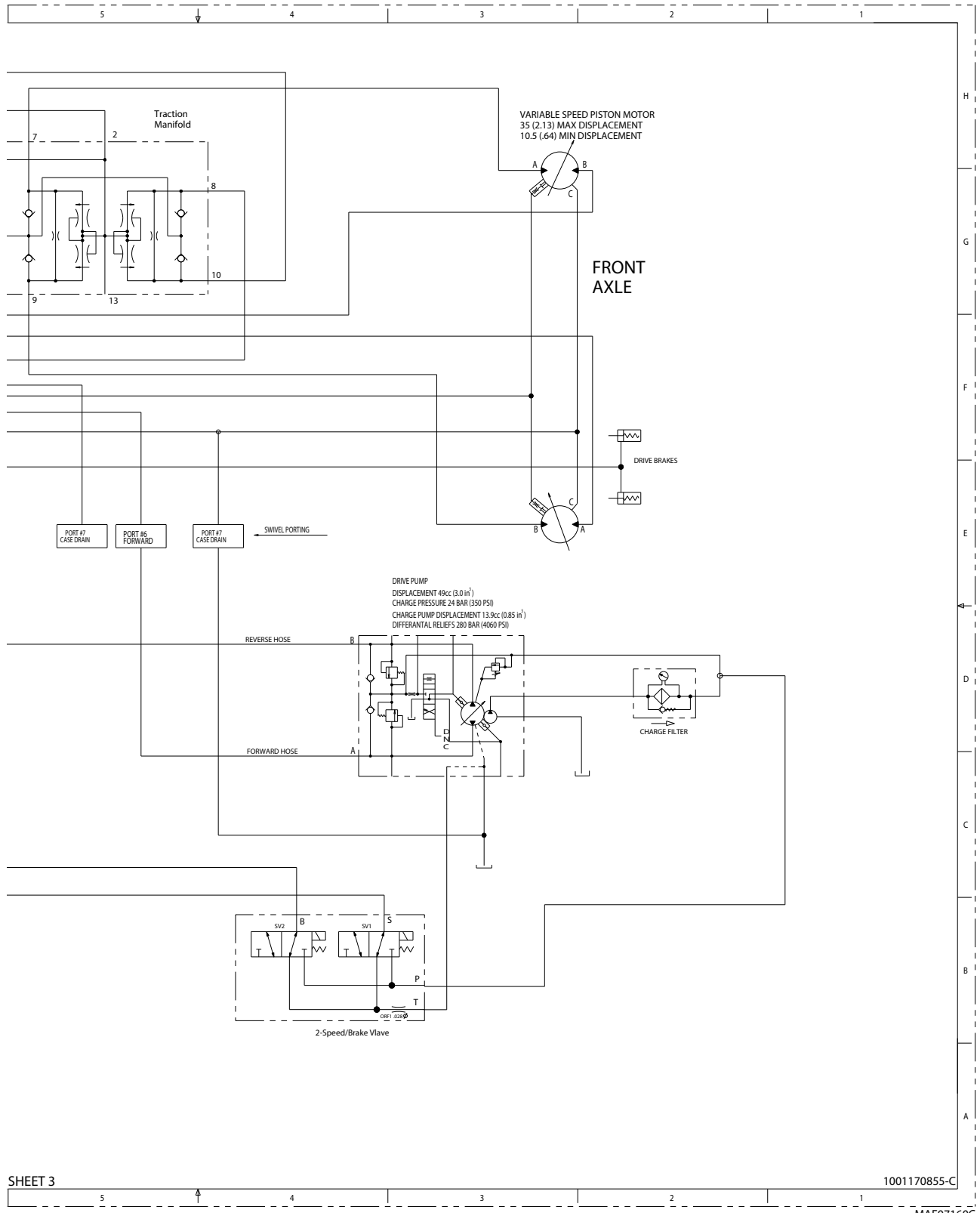


Figure 5-219. Hydraulic Schematic - Sheet 6 of 6



## SECTION 6. JLG CONTROL SYSTEM

## 6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

## Introduction

**NOTICE**

WHEN INSTALLING A NEW POWER MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

**NOTICE**

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in

viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The main lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

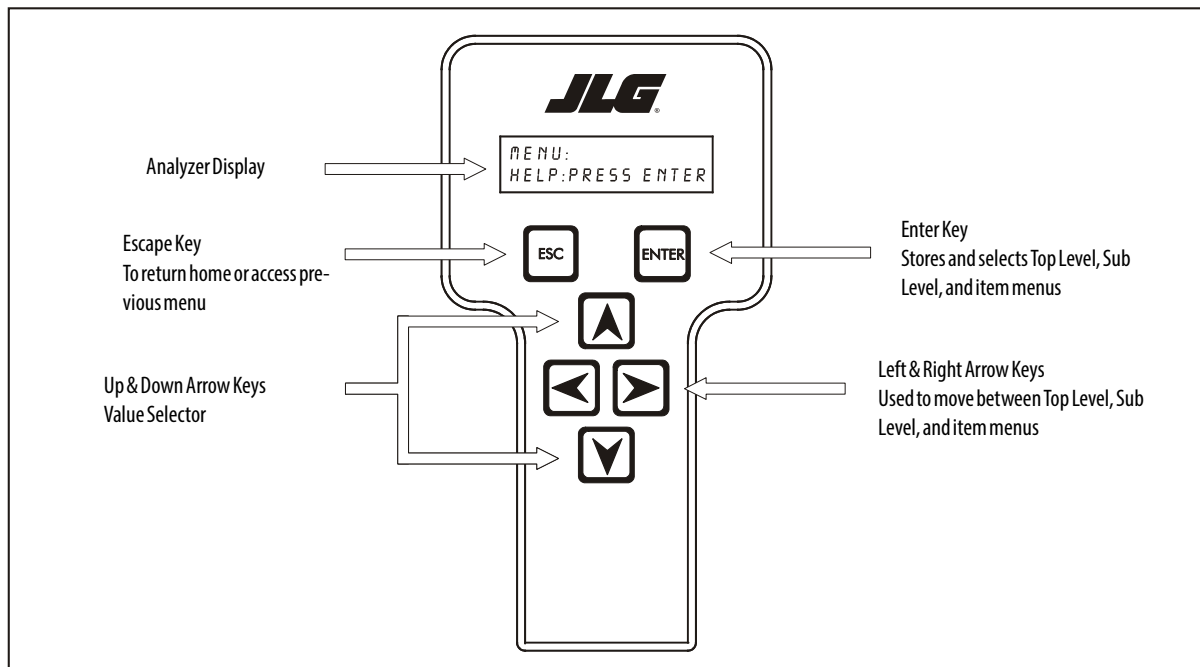


Figure 6-1. Hand Held Analyzer

### To Connect the JLG Control System Analyzer

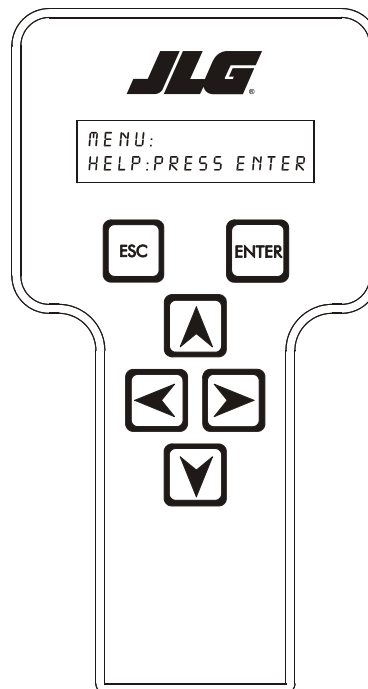
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

**NOTE:** The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.





2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

### Using the Analyzer

With the machine power on and the analyzer connected properly, the analyzer will display the following:





**HELP:  
PRESS ENTER**

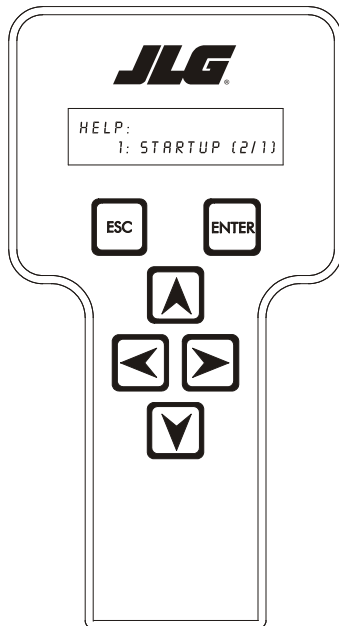
At this point, using the RIGHT  and LEFT  arrow keys, you can move between the top level menu items. To select a displayed menu item, press ENTER . To cancel a selected menu item, press Escape ; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

- HELP
- DIAGNOSTICS
- ACTIVATE TEST
- ACCESS LEVEL
- PERSONALITIES
- MACHINE SETUP
- LEVEL VEHICLE (level 1 only)
- CALIBRATIONS (view only)

If you press **ENTER** , at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK**. If powered up at the ground station, the display will read: **GROUND OK**.

If **ENTER**  is pressed again, the display moves to the following display:




**LOGGED HELP**  
**1: STARTUP (2/1)**


At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the

beginning, press **ESCAPE**  two times. **STARTUP (2/1)** indicates a power up.

When a top level menu is selected, a new set of menu items may be offered: for example:

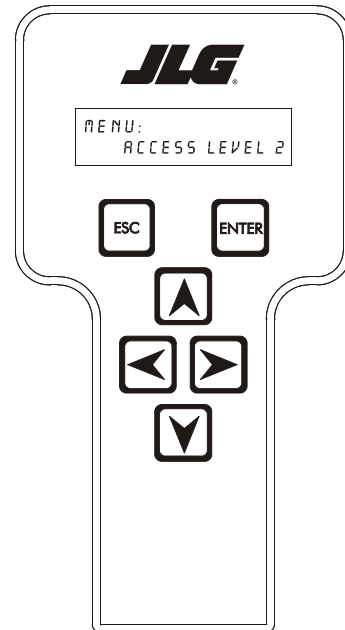
- DRIVE
- BOOM
- SYSTEM
- DATALOG
- VERSIONS

Pressing **ENTER**  with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected


menu item by pressing the **ESCAPE**  key.

**Changing the Access Level of the Hand Held Analyzer**

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:




**ACCESS LEVEL:**  
**CODE 00000**

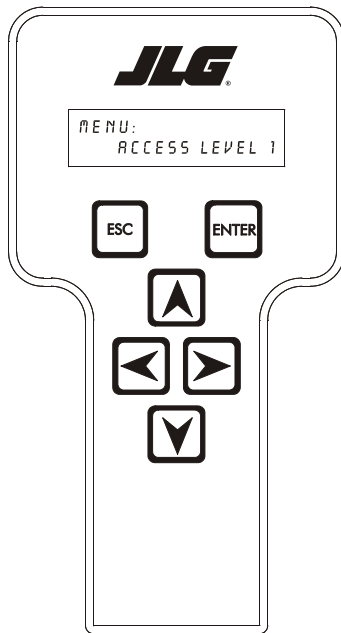
Press **ENTER**  to select the **ACCESS LEVEL** menu.

Using the **UP**  or **DOWN**  arrow keys, enter the first digit of the password, 3.

Then using the **RIGHT**  arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP**  or **DOWN**  arrow key to enter the second digit of the password which is 33271.

Once the correct password is displayed, press **ENTER** . The access level should display the following, if the password was entered correctly:



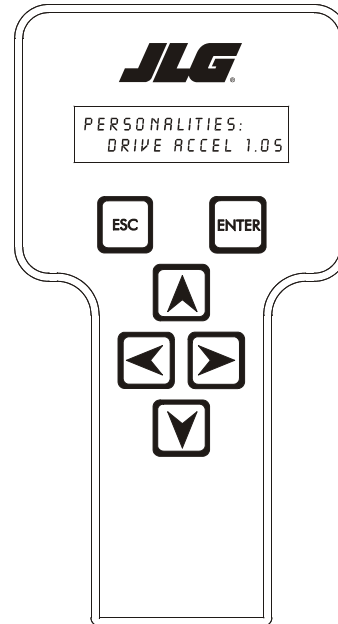
**MENU:  
ACCESS LEVEL 1**

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

## Adjusting Parameters Using the Hand Held Analyzer


Once you have gained access to level 1, and a personality item


is selected, press the **UP**  or **DOWN**  arrow keys to adjust its value, for example:





**PERSONALITIES:  
DRIVE ACCEL 1.5s**

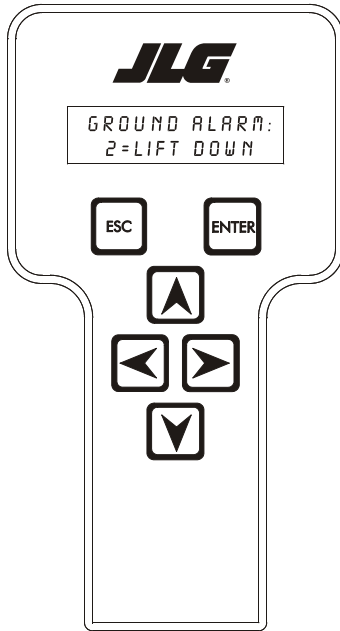
There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP**

 arrow is pressed when at the maximum value nor will

the value decrease if the **DOWN**  arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at access level 1.

## Machine Setup

When a machine digit item is selected, press the **UP**  or **DOWN**  arrow keys to adjust its value, for example:



### GROUND ALARM: 2 = LIFT DOWN

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when driving. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

**NOTE:** Refer to *Personality Ranges/Defaults* for the recommended factory settings.

**NOTE:** Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

### ELEVATION CUTBACK

## WARNING

**CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.**

## NOTICE

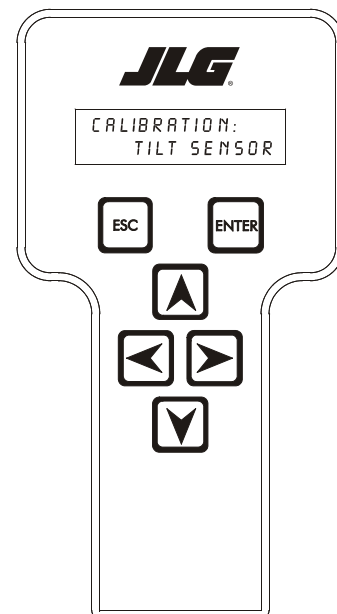
IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

## Level Vehicle Description

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

## WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

To level machine chose:

### CALIBRATION: TILT SENSOR

Press **ENTER** .

When prompted, swing machine 180°

Press **ENTER** .

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-1. Analyzer Abbreviations**

ABBREVIATION	MEANING
ACCEL	ACCELERATE
ACT	ACTIVE
A/D	ANALOG DIGITAL CONVERTER COUNT
AMB.	AMBIENT
ANG	ANGLE
AUX	AUXILIARY
BCS	BOOM CONTROL SYSTEM
BM	BOOM LENGTH ANGLE MODULE
BLAM	BOOM LENGTH ANGLE MODULE
BR	BROKEN
BSK	BASKET
CAL	CALIBRATION
CL	CLOSED
CM	CHASSIS MODULE
CNTL	CONTROL
CNTRL	CONTROL
C/O	CUT OUT
CONT(S)	CONTRACTOR(S)
COOR	COORDINATED
CRK PT	CRACK POINT
CRP	CREEP
CUT	CUTOUT
CYL	CYLINDER
DECEL	DECELERATE
D	DOWN
DN	DOWN
DWN	DOWN
DEG.	DEGREE
DOS	DRIVE ORIENTATION SYSTEM
DRV	DRIVE
E	ERROR
E&T	ELEVATED & TILTED
ELEV	ELEVATION
ENG	ENGINE
EXT	EXTEND
F	FRONT
FL	FLOW
FNT	FRONT
FOR	FORWARD
FWD	FORWARD
FSW	FOOT SWITCH
FUNC	FUNCTION
G	GROUND

**Table 6-1. Analyzer Abbreviations**

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT
ROT.	ROTATE
RT	RIGHT

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	main or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

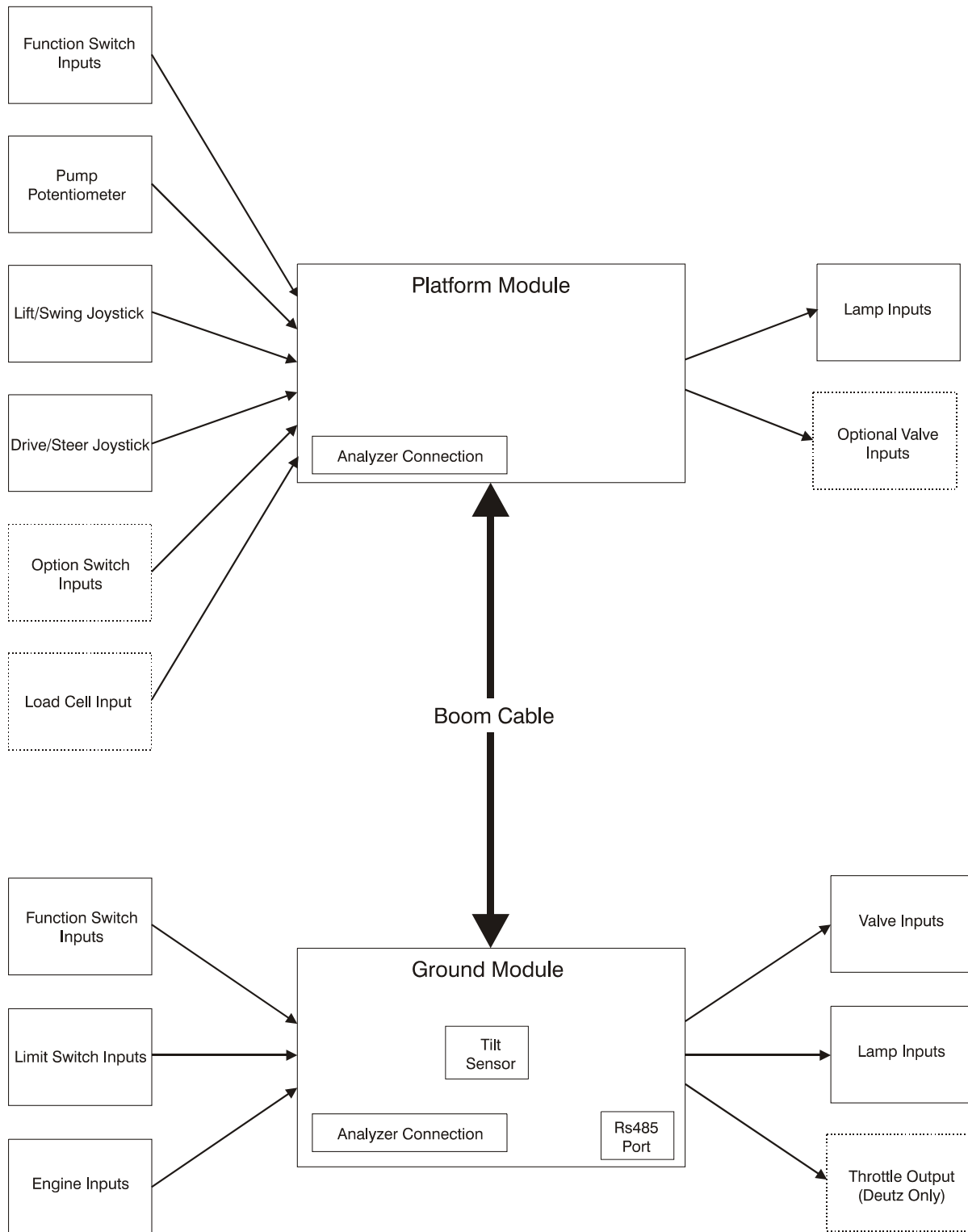


Figure 6-2. ADE Block Diagram

Table 6-2. Machine Configuration Programming Information (Software Version P6.22)

Configuration Digit	Number	Description	Default Number
<p><b>NOTE:</b> For version <b>P6.22 software</b>, some screens may not be available depending upon machine configuration and software versions.</p> <p><b>NOTE:</b> The machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default values.</p>			
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	
	6	GB	

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-2. Machine Configuration Programming Information (Software Version P6.22)**

Configuration Digit	Number	Description	Default Number
ENGINE: 3* * Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	<b>14</b>
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT.3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT.3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GASTIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	<b>14</b>	<b>PERKINSECM</b>	
	15	CAT ECM	
	16	DEUTZ ECM T4F: Deutz Engine Control Module (Tier 4 Final)	
	17	FORD DUAL FUEL	
FLYWHEEL TEETH: 4* *This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	<b>1</b>
	<b>1</b>	<b>110 TEETH: 110 flywheel teeth.</b>	

Table 6-2. Machine Configuration Programming Information (Software Version P6.22)

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	<b>IN-CYLINDER: Glow plugs installed in each cylinder.</b>	
STARTER LOCKOUT: 6	0	<b>DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.</b>	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
FUEL CUTOUT 7 * This menu item is only visible if non dual fuel engines are selected.	0	<b>RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached.</b>	0
	1	ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached.	
	2	ENGINE STOP: Engine not able to restart when very low fuel level is reached.	
ENGINE SHUTDOWN: 8	0	DISABLED: No engine shutdown.	1
	1	<b>ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.</b>	

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-2. Machine Configuration Programming Information (Software Version P6.22)**

Configuration Digit	Number	Description	Default Number
TILT: 9* *Certain market selections will limit tilt options and alter default setting.  <i>Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.</i>	1	<b>5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.</b>	1
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	6	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	7	5 DEGREES + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	8	4 DEGREES + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	9	3 DEGREES + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
JIB: 10* *Only visible under certain model selections.	0	<b>NO: No jib installed.</b>	0
	1	YES: Jib installed which has up and down movements only.	
4 WHEEL STEER: 11* *Only visible under certain model selections.	0	<b>NO: No four-wheel steer installed.</b>	0
	1	YES: Four-wheel steer installed.	

Table 6-2. Machine Configuration Programming Information (Software Version P6.22)

Configuration Digit	Number	Description	Default Number
ST TOUCH / SKYGUARD: 12	0	<b>NONE: No soft touch or skyguard system installed.</b>	0
	1	SOFT TOUCH - Soft touch only installed.	
	2	SKYGUARD - Skyguard only installed.	
	3	BOTH (CUTOUT) - Soft touch and Skyguard installed.	
GENSET/WELDER: 13	0	<b>NO: No generator installed.</b>	0
	1	BELT DRIVE: Belt driven setup.	
GENSET CUTOUT: 14* * Only visible if Gen Set / Welder Menu selection is not 0.	0	<b>MOTION ENABLED: Motion enabled when generator is ON.</b>	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
H & T LIGHTS: 15	0	<b>NO: No head and tail lights installed.</b>	0
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 16* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0	<b>NO: No broken cable switch installed.</b>	0
	1	YES: Broken cable switch installed.	

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-2. Machine Configuration Programming Information (Software Version P6.22)**

Configuration Digit	Number	Description	Default Number
LOAD SYSTEM: 17* * Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting. * LOAD SYSTEM will not be visible in CE and defaulted to CUTOUT ALL for machines equipped with MSSO.	0	<b>NO: No load sensor installed.</b>	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	
LOAD SENSOR: 18* * Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	<b>4 UNDER PLATFORM: Use the EIM for load sensing.</b>	
	2	SINGLE CELL: Single Cell, CANbus based sensor.	
FUNCTION CUTOUT: 19* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	0	<b>NO: No drive cutout.</b>	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUTE&T: Drive & steer cutout above elevation and tilted.	
GROUND ALARM: 20* * Certain market selections will alter default setting.	0	NO: No ground alarm installed.	3
	1	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	2	DESCENT: Descent alarm sounds when lift down is active (Option).	
	3	<b>MOTION: Motion alarm sounds when any function is active (Option).</b>	
DRIVE: 21* * Only visible under certain model selections.	0	<b>4WD: Four wheel drive.</b>	0
	1	2WD: Two wheel drive.	
	2	2WD W/2-SPEED: Two wheel drive with 2-speed valve.	

Table 6-2. Machine Configuration Programming Information (Software Version P6.22)

Configuration Digit	Number	Description	Default Number
DISPLAY UNITS: 22* *Certain market selections will alter default setting.	0	<b>IMPERIAL: DEG F, PSI, LBS.</b>	0
	1	METRIC: DEG C, KPA, KGS	
LEVELING MODE: 23* *Only visible on 800S models.	0	<b>ALL FUNCTIONS: Platform level with all functions.</b>	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	
DRIVE CONTROL: 24	0	NORMAL: Drive coils are energized from the Ground Module.	2
	1	PROPULSION: Drive coils are energized from the Propulsion Module.	
	2	<b>ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.</b>	
DRIVE PUMP 25 *Only visible on 600A, 600S, and 800S models.	0	<b>SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump</b>	0
	1	EATON: Machine equipped with Eaton drive pump	
	2	M46 - XXXX: Machine equipped with M46 - XXXX drive pump	
	3	830XXXXX: Machine equipped with 830XXXXX: drive pump	
BOOM CONTROL: 26	0	<b>NORMAL: Boom function coils are energized from the Ground Module.</b>	0
	1	ENHANCED: Boom function are energized from the Ground Module and the ground side of the drive coils and brought back to current feedback returns.	
FUNCTION SPEED KNOB 27	0	<b>YES: Machine is equipped with Function Speed Knob.</b>	0
	1	NO: Machine is equipped with Operation Speed Switch.	
CLEARSKY: 28	0	<b>NO: Clearsky (telematics) option is disabled.</b>	0
	1	YES: Clearsky (telematics) option is enabled.	

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-2. Machine Configuration Programming Information (Software Version P6.22)**

Configuration Digit	Number	Description	Default Number
CRIBBING OPTION: 29	0	<b>NO: Cribbing Option is disabled.</b>	0
	1	YES: Cribbing Option is enabled.	
FUEL TANK SIZE: 30	0	<b>31 Gallon Tank</b>	0
	1	52 Gallon Tank	
ALARM / HORN: 31	0	<b>SEPERATE: Separate alarm and horn.</b>	0
	1	COMBINED: Combination alarm / horn.	
ALERT / BEACON: 32	0	<b>OFF FOR CREEP: Alert beacon will not flash while in Creep</b>	0
	1	20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep.	
TEMP CUTOUT: 33	0	<b>NO: Temp Cutout is Disabled</b>	0
	1	YES: Temp Cutout is Enabled	
PLAT LVL OVR CUT: 34	0	<b>NO: Platform Level Override will always be functional</b>	0
	1	YES: Platform Level Override will only be functional when In Transport.	
WATER IN FUEL SENSOR: 35* *This menu item is only visible if Deutz EMR 4 engine is selected. *Only visible under certain model selections.	0	<b>NO: Water in Fuel Sensor Disabled</b>	0
	1	YES: Water in Fuel Sensor Enabled	
DUAL CAPACITY 36	0	<b>NO: Dual Capacity is Disabled.</b>	0
	1	YES: Dual Capacity is enabled.	

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**Table 6-3. 800A Machine Configuration Programming Settings (Software Version P6.22)**

800 A	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Model Number	9	9	9	9	9	9
Market	0	1	2	3	4	5
Engine	12	12	12	12	12	12
Flywheel Teeth	0	0	0	0	0	0
	1	1	1	1	1	1
Glow Plugs	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0
	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Engine Shutdown	0	0	0	0	0	0
	1	1	1	1	1	1
Tilt	1	1	1	X	X	1
	2	2	2	X	2	2
	3	3	3	X	3	3
	4	4	4	4	4	4
	5	5	5	5	5	5
	6	6	6	X	X	6
	7	7	7	X	X	7
	8	8	8	8	8	5
	9	9	9	9	9	9
Jib	0	0	0	0	0	0
4 Wheel Steer	0	0	0	0	0	0
Soft Touch/Skyguard	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
	3	3	3	3	3	3
Gen Set / Welder	0	0	0	0	0	0
	1	1	1	1	1	1
Gen Set Cutout	0	0	0	0	0	0
	1	1	1	1	1	1
Head & Taillights	0	0	0	0	0	0
	1	1	1	1	1	1
Cable Breaks Switch	0	0	0	0	0	0
	1	1	1	1	1	1

**Table 6-3. 800A Machine Configuration Programming Settings (Software Version P6.22)**

800 A	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Load System	0	0	0	0	0	0
	X	1	X	X	X	1
	X	2	X	2	2	2
	X	3	X	3	X	3
	X	4	X	X	X	4
Load Sensor	X	0	X	0	0	0
	1	1	1	1	1	1
	X	2	X	2	2	2
Function Cutout	0	0	0	0	0	0
	X	1	1	1	1	1
	2	2	2	X	2	2
	X	3	3	X	3	3
Ground Alarm	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
	3	3	3	3	3	3
Drive Type	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Display Units	0	0	0	0	0	0
	1	1	1	1	1	1
Leveling Mode	0	0	0	0	0	0
	1	1	1	1	1	1
Drive Control	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Drive Pump	0	0	0	0	0	0
	1	1	1	1	1	1
	X	X	X	X	X	X
	X	X	X	X	X	X
Boom Control	0	0	0	0	0	0
	1	1	1	1	1	1
Function Speed Knob	0	0	0	0	0	0
	1	1	1	1	1	1
Clearsky	0	0	0	0	0	0
	1	1	1	1	1	1
Cribbing Option	0	0	0	0	0	0
	1	1	1	1	1	1

**SECTION 6 - JLG CONTROL SYSTEM**

**Table 6-3. 800A Machine Configuration Programming Settings (Software Version P6.22)**

800 A	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Fuel Tank Size	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Alarm / Horn	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Alert Beacon	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Temp Cutout	X	<b>0</b>	X	<b>0</b>	X	X
	X	1	X	1	X	X
Plat Lvl Ovr Cut	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Water in Fuel Sensor	X	<b>0</b>	X	X	X	X
	X	1	X	X	X	X
Dual Capacity	0	0	0	<b>0</b>	<b>0</b>	0
	<b>1</b>	<b>1</b>	<b>1</b>	1	1	<b>1</b>

**BOLD TEXT** indicates the default setting. Plain text indicates another available selection. **ITALIC TEXT** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

**Table 6-4. 800AJ Machine Configuration Programming Settings (Software Version P6.22)**

800 AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Model Number	<b>9</b>	<b>9</b>	<b>9</b>	<b>9</b>	<b>9</b>	<b>9</b>
Market	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Engine	<b>12</b>	<b>12</b>	<b>12</b>	<b>12</b>	<b>12</b>	<b>12</b>
Flywheel Teeth	0	0	0	0	0	0
	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
Glow Plugs	0	0	0	0	0	0
	1	1	1	1	1	1
	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
Starter Lockout	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Fuel Cutout	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
	2	2	2	2	2	2
Engine Shutdown	0	0	0	0	0	0
	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
Tilt	1	1	1	X	X	1
	2	2	2	X	2	2
	3	3	3	X	3	3
	4	4	4	4	4	4
	5	5	5	5	5	5
	6	6	6	X	X	6
	<b>7</b>	<b>7</b>	<b>7</b>	X	X	<b>7</b>
	8	8	8	<b>8</b>	<b>8</b>	8
	9	9	9	9	9	9
Jib	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
4 Wheel Steer	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Soft Touch/Sky-guard	0	0	0	0	0	0
	1	1	1	1	1	1
	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
Gen Set / Welder	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Gen Set Cutout	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Head & Taillights	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Cable Breaks Switch	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1

**Table 6-4. 800AJ Machine Configuration Programming Settings (Software Version P6.22)**

800 AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Load System	<b>0</b>	<b>0</b>	<b>0</b>	0	0	0
	X	<b>1</b>	X	X	X	<b>1</b>
	X	2	X	2	<b>2</b>	2
	X	3	X	<b>3</b>	X	3
	X	4	X	X	X	4
Load Sensor	X	0	X	0	0	0
	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
Function Cutout	X	2	X	2	2	2
	<b>0</b>	<b>0</b>	<b>0</b>	0	<b>0</b>	<b>0</b>
	X	1	1	<b>1</b>	1	1
	2	2	2	X	2	2
Ground Alarm	X	3	3	X	3	3
	0	0	0	0	0	0
	1	1	1	1	1	1
	2	2	2	2	2	2
Drive Type	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
	0	0	0	0	0	0
	1	1	1	1	1	1
Display Units	2	2	2	2	2	2
	<b>0</b>	<b>0</b>	0	0	0	0
Leveling Mode	1	1	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Drive Control	1	1	1	1	1	1
	0	0	0	0	0	0
	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
Drive Pump	0	0	0	0	0	0
	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
	X	X	X	X	X	X
Boom Control	X	X	X	X	X	X
	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Function Speed Knob	1	1	1	1	1	1
	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Clearsky	1	1	1	1	1	1
	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Table 6-4. 800AJ Machine Configuration Programming Settings (Software Version P6.22)**

800 AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan
Cribbing Option	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Fuel Tank Size	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Alarm / Horn	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Alert Beacon	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Temp Cutout	X	<b>0</b>	X	<b>0</b>	X	X
	X	1	X	1	X	X
Plat Lvl Ovr Cut	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	1	1	1	1	1	1
Water in Fuel Sensor	X	<b>0</b>	X	X	X	X
	X	1	X	X	X	X
Dual Capacity	0	0	0	<b>0</b>	<b>0</b>	0
	<b>1</b>	<b>1</b>	<b>1</b>	1	1	<b>1</b>

**BOLD TEXT** indicates the default setting. Plain text indicates another available selection. **ITALIC TEXT** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

**6.2 MACHINE PERSONALITY SETTINGS AND FUNCTION SPEEDS**

**NOTE:** Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.

**Table 6-5. Machine Personality Settings**

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY	RANGE	DEFAULTS (800A Sauer Danfoss)	DEFAULTS (800A Eaton)
DRIVE:	ACCEleration	0.0 to 5.0s	2.0	2.0
	DECEleration	0.0 to 3.0s	2.0	2.0
	FORward MINimum speed	1 to 35%	4	15
	FORward MAXimum speed	1 to 100%	30	55
	REVerse MINimum speed	1 to 35%	4	15
	REVerse MAXimum speed	1 to 100%	34	55
	ELEVATED MAXimum speed	1 to 100%	15	28
	CREEP MAXimum speed	1 to 90%	15	32
STEER:	MAXimum speed	1 to 100%	100	100
MAIN LIFT:	ACCEleration	0.0 to 5.0s	2.9	2.9
	DECEleration	0.0 to 3.0s	1.0	1.0
	MINimum LEFT speed	1 to 60%	26	26
	MAXimum LEFT speed	1 to 100%	88	88
	CREEP maximum LEFT speed	1 to 65%	62	62
	MINimum RIGHT speed	1 to 60%	25	25
	MAXimum RIGHT speed	1 to 100%	95	95
	CREEP maximum RIGHT speed	1 to 75%	69	69
TOWER LIFT:	ACCEleration	0.0 to 5.0s	2.8	2.8
	DECEleration	0.0 to 3.0s	0.8	0.8
	MINimum UP speed	1 to 60%	53	53
	MAXimum UP speed	1 to 100%	90	90
	MINimum DOWN speed	1 to 60%	53	53
	MAXimum DOWN speed	1 to 100%	90	90
	Medium Speed	0.01 to 1.00	0.30	0.30
SWING	ACCEleration	0.0 to 5.0s	2.8	2.8
	DECEleration	0.0 to 3.0s	2.5	2.5
	MINimum LEFT speed	1 to 50%	25	25
	MAXimum LEFT speed	1 to 100%	70	70
	CREEP maximum LEFT speed	1 to 65%	62	62
	MINimum RIGHT speed	1 to 50%	25	25
	MAXimum RIGHT speed	1 to 100%	73	73
	CREEP maximum RIGHT speed	1 to 65%	62	62

Table 6-5. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY	RANGE	DEFAULTS (800A Sauer Danfoss)	DEFAULTS (800A Eaton)
MAIN TELESCOPE:	ACCEleration	0.0 to 5.0s	3.5	3.5
	DECEleration	0.0 to 3.0s	0.8	0.8
	MINimum IN speed	1 to 65%	40	40
	MAXimum IN speed	1 to 100%	75	75
	MINimum OUT speed	1 to 65%	40	40
	MAXimum OUT speed	1 to 100%	70	70
	Medium Speed	0.01 to 1.00	0.50	0.50
TELESCOPE TOWER:	ACCEleration	0.0 to 5.0s	1.0	1.0
	DECEleration	0.0 to 3.0s	0.5	0.5
	MINimum IN speed	1 to 65%	45	45
	MAXimum IN speed	1 to 100%	90	90
	MINimum OUT speed	1 to 65%	55	55
	MAXimum OUT speed	1 to 100%	90	90
	Medium Speed	0.01 to 1.00	0.40	0.40
PLATFORM LEVEL:	ACCEleration	0.0 to 5.0s	2.5	2.5
	DECEleration	0.0 to 3.0s	1.0	1.0
	MINimum UP speed	1 to 65%	45	45
	MAXimum UP speed	1 to 100%	55	55
	MINimum DOWN speed	1 to 65%	45	45
	MAXimum DOWN speed	1 to 100%	55	55
	Medium Speed	0.01 to 1.00	0.60	0.60
PLATFORM ROTATE:	ACCEleration	0.0 to 5.0s	1.8	1.8
	DECEleration	0.0 to 3.0s	0.5	0.5
	MINimum LEFT speed	1 to 100%	25	25
	MAXimum LEFT speed	1 to 100%	60	60
	MINimum RIGHT speed	1 to 100%	25	25
	MAXimum RIGHT speed	1 to 100%	60	60
	Medium Speed	0.01 to 1.00	0.35	0.35
JIB LIFT	Lift ACCEleration	0.0 to 5.0s	2.5	2.5
	Lift DECEleration	0.0 to 3.0s	1.0	1.0
	MINimum UP speed	1 to 65%	27	27
	MAXimum UP speed	1 to 100%	50	50
	MINimum down	1 to 65%	26	26
	Max Down	1 to 100%	45	45
	Medium Speed	0.01 to 1.00	0.35	0.35

**Table 6-5. Machine Personality Settings**

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY	RANGE	DEFAULTS (800A Sauer Danfoss)	DEFAULTS (800A Eaton)
GROUND MODE	Tower LIFT UP speed	1 to 100%	89	89
	Tower LIFT DOWN speed	1 to 100%	89	89
	Main LIFT UP speed	1 to 100%	87	87
	Main LIFT DOWN speed	1 to 100%	94	94
	SWING speed	1 to 100%	65	65
	Main TELEscope speed	1 to 100%	69	69
	Tower TELEscope speed	1 to 100%	89	89
	PLATFORM ROTATE speed	1 to 100%	59	59
	PLATFORM LEVEL speed	1 to 100%	54	54
	JIB LIFT speed	1 to 100%	44	44
<i>Note: Ground Mode speed are automatically limited to being lower than platform speed for a given function.</i>				
4150365-1				

### 6.3 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

**Tower Lift:** main Boom Horizontal, Telescoped In. Tower Lift Up, Record Time. Tower Lift Down, Record Time.

**Tower Telescope:** Tower Lift Fully Elevated, main Boom Horizontal, Telescoped In. Tower Tele Out, Record Time. Tower Tele In, Record Time.

**Lift:** Tower Lift Fully Elevated, Tower Telescope Fully Extended, Main Telescope Fully Retracted.

**Swing:** Boom at Full Elevation. Telescope Retracted. Swing the Turntable off center and stop. Swing the opposite direction and start the test when the turntable is centered up. This eliminates ramp up and down on the controller affecting times.

**Telescope:** Boom at Full Elevation; Telescope Retracted; Telescope Out, Record Time. Telescope In, Record Time.

**Drive (Forward/Reverse):** Test should be done on a smooth level surface. Drive Select Switch should be set to high speed. Start approximately 25 ft. (7.62 m) from the starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. (60.96 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

**Drive (Above Horizontal):** Test should be done on a smooth, level surface. Drive Select Switch should be set to Low Engine, Low Drive. The Platform Speed Control Knob should be positioned to Creep Speed. This simulates machine speed when the boom is above horizontal. Results should be recorded for a 50 ft. (15.2 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

**Platform Rotate:** Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

**Articulating Jib:** Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

### Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. Drive test results reflect 15x19.5 or 18x19.5 tires, pneumatic or foam filled.
3. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
4. The platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
6. Some flow control functions may not work with the speed knob clicked into the creep position.

**Table 6-6. Function Speeds**

Function	Speed (In Seconds)
Main Lift Up	45-50
Main Lift Down	45-50
Swing Right & Left	79-101
<b>NOTE:</b> No more than 10% difference between swing left and swing right.	
Main Telescope In	
800A	30-40
800AJ	24-34
Main Telescope Out	
800A	35-45
800AJ	30-40
Platform Rotate Right & Left	19-30
<b>NOTE:</b> No more than 15% difference between rotator left and rotator right.	
Jib Up	20-30
Jib Down	30-40
Tower Lift Up	57-70
Tower Lift Down	44-53
Tower Telescope Out	24-32
Tower Telescope In	15-25
Drive (2WD) Forward & Reverse	33-45
Drive (4WD) Forward & Reverse	33-45
Drive Horizontal Above Elevation (2 & 4WD) Forward & Reverse (CE)	122 Min
Drive Horizontal Above Elevation 2WD Forward & Reverse (ANSI)	61-70
Drive Horizontal Above Elevation 4WD Forward & Reverse (ANSI)	122 Min

4150241-H

### 6.4 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Jib Module, Ground Module, Boom Length Angle Module and the Chassis Module providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal; both wires "float" (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

The GROUND MODULE (UGM) is the master system controller. Most functions are dispatched and coordinated from this module, The PLATFORM MODULE handle sub-tasks. All characterized information (values) are stored into the ground module (i.e., Personalities or Calibrations).

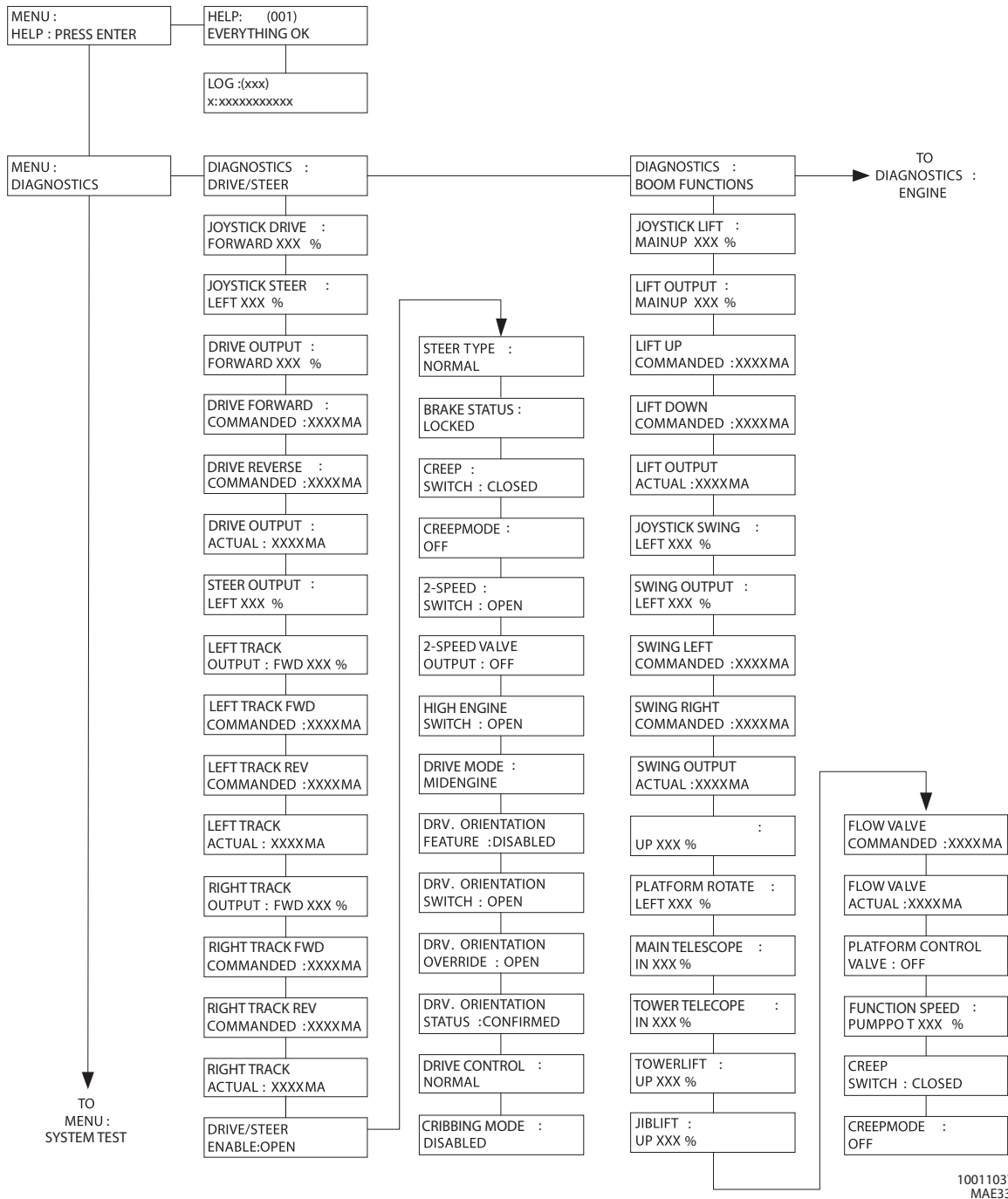
**Interlocks:** Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc;)

**Platform Level:** The GROUND MODULE stores the default values and handles interlocks. The PLATFORM MODULE reads the sensors mounted on the platform assembly and controls the Level Up / Down valves to maintain setpoint sent from the GROUND MODULE.

**Steer:** The GROUND MODULE stores crack points and sends desired drive direction, steering mode and axle extend/retract commands. The PLATFORM MODULE reports the steering switch position to the GROUND MODULE.

**Drive:** The GROUND MODULE stores crack points, sends commands for each drive pump. (Command is computed from drive joystick input, interlocks, wheel angle, etc).

**Lift, Tele, & Swing:** The GROUND MODULE stores default values and handles interlocks and calibration information. Lift, Telescope and Swing commands are dependent upon interlocks through out the machine. Boom angle, length and swing are controlled by the GROUND MODULE.

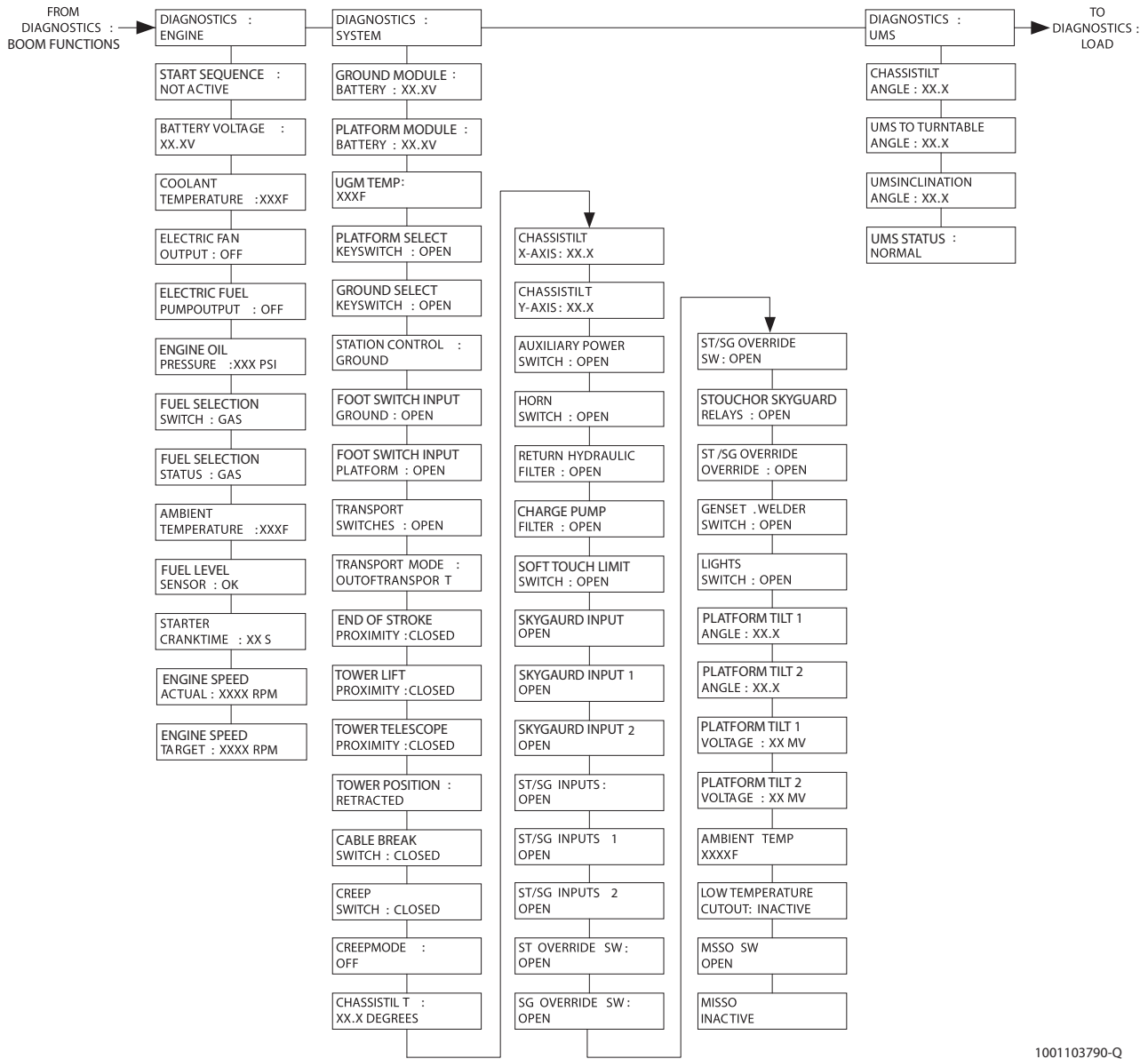


1001103790-Q  
MAE33180Q

**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-3. Analyzer Flow Chart (Software Version P6.22) -Sheet 1 of 9

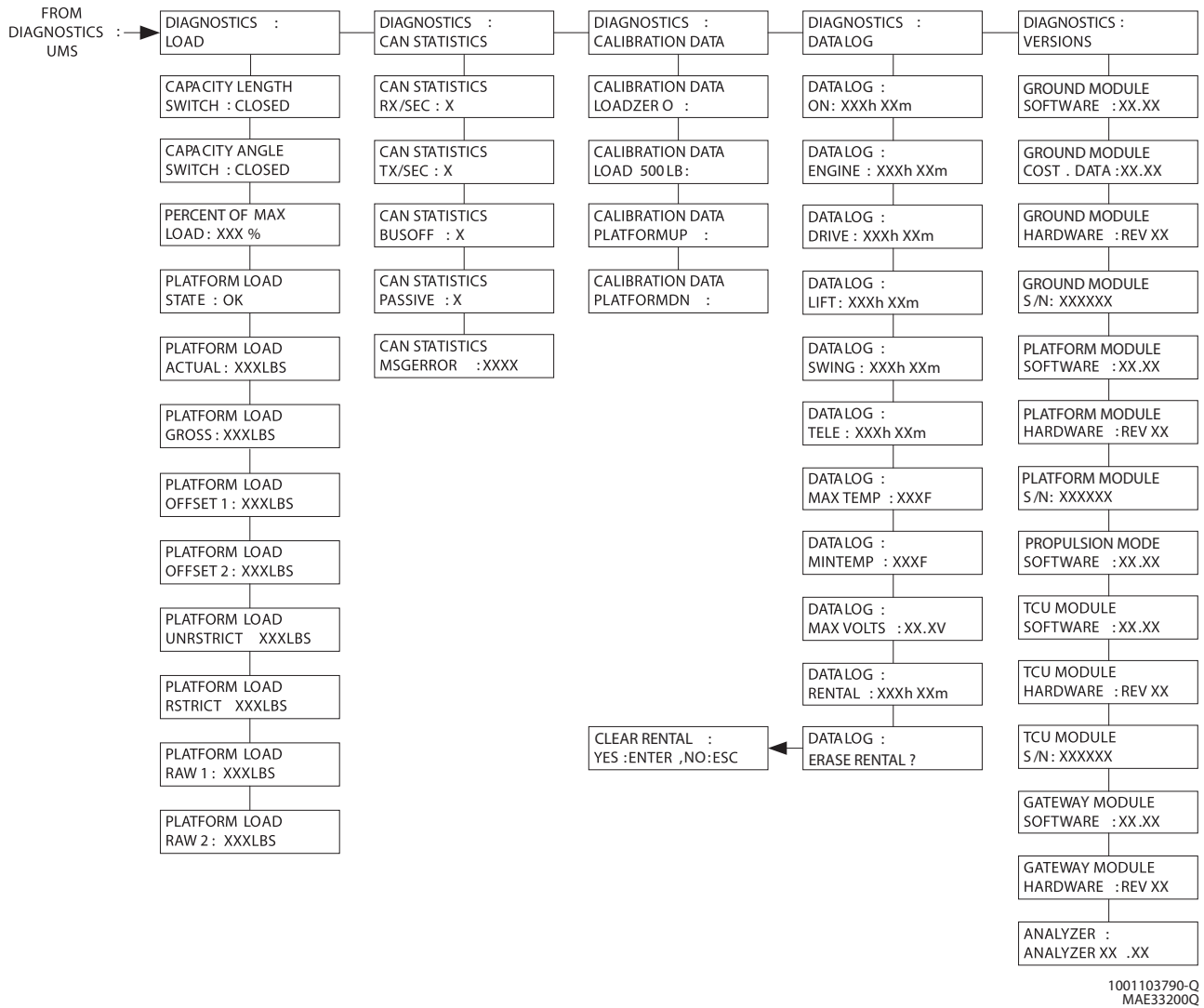
**SECTION 6 - JLG CONTROL SYSTEM**



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MAE33190Q

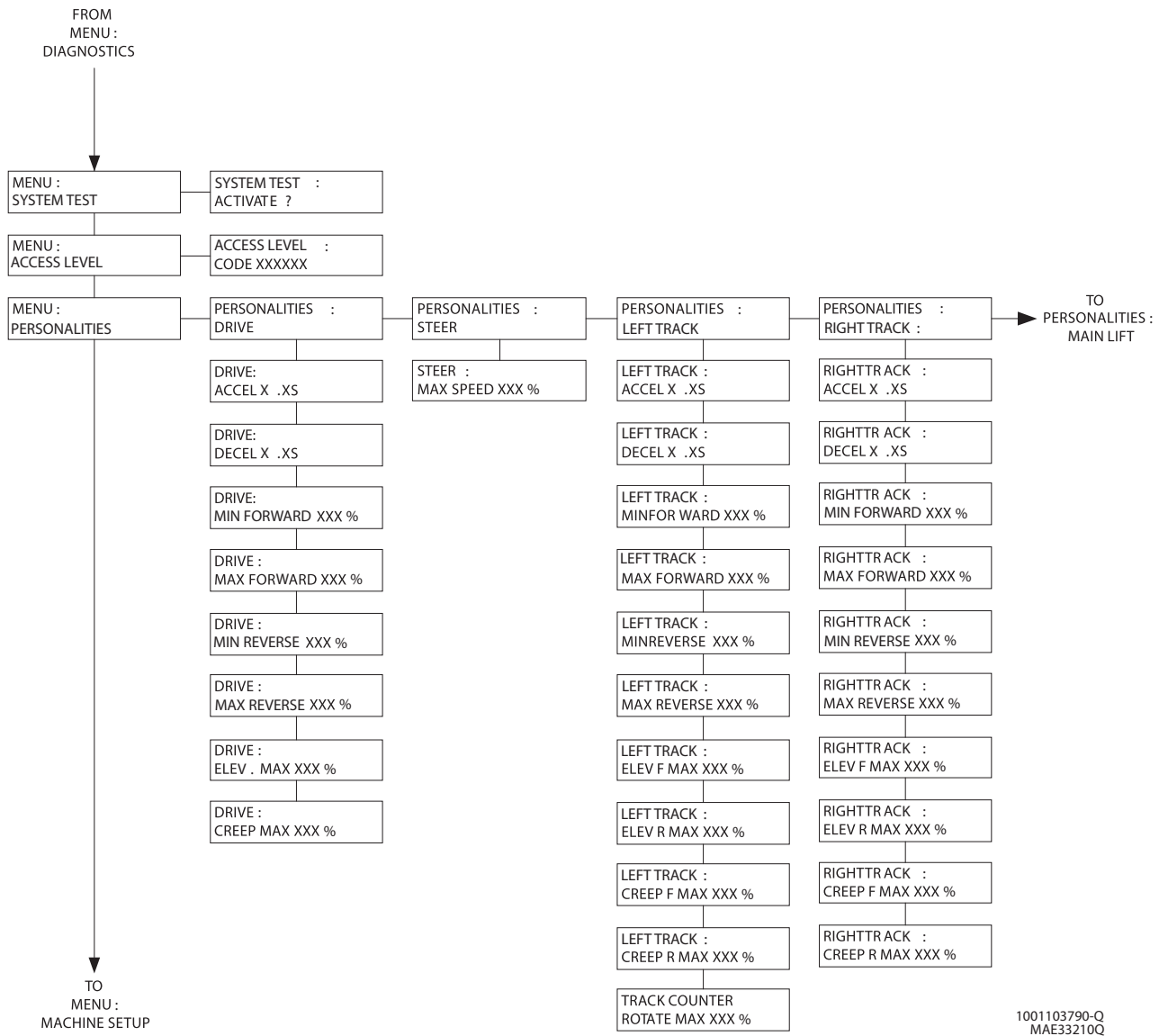
**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

**Figure 6-4. Analyzer Flow Chart (Software Version P6.22) -Sheet 2 of 9**



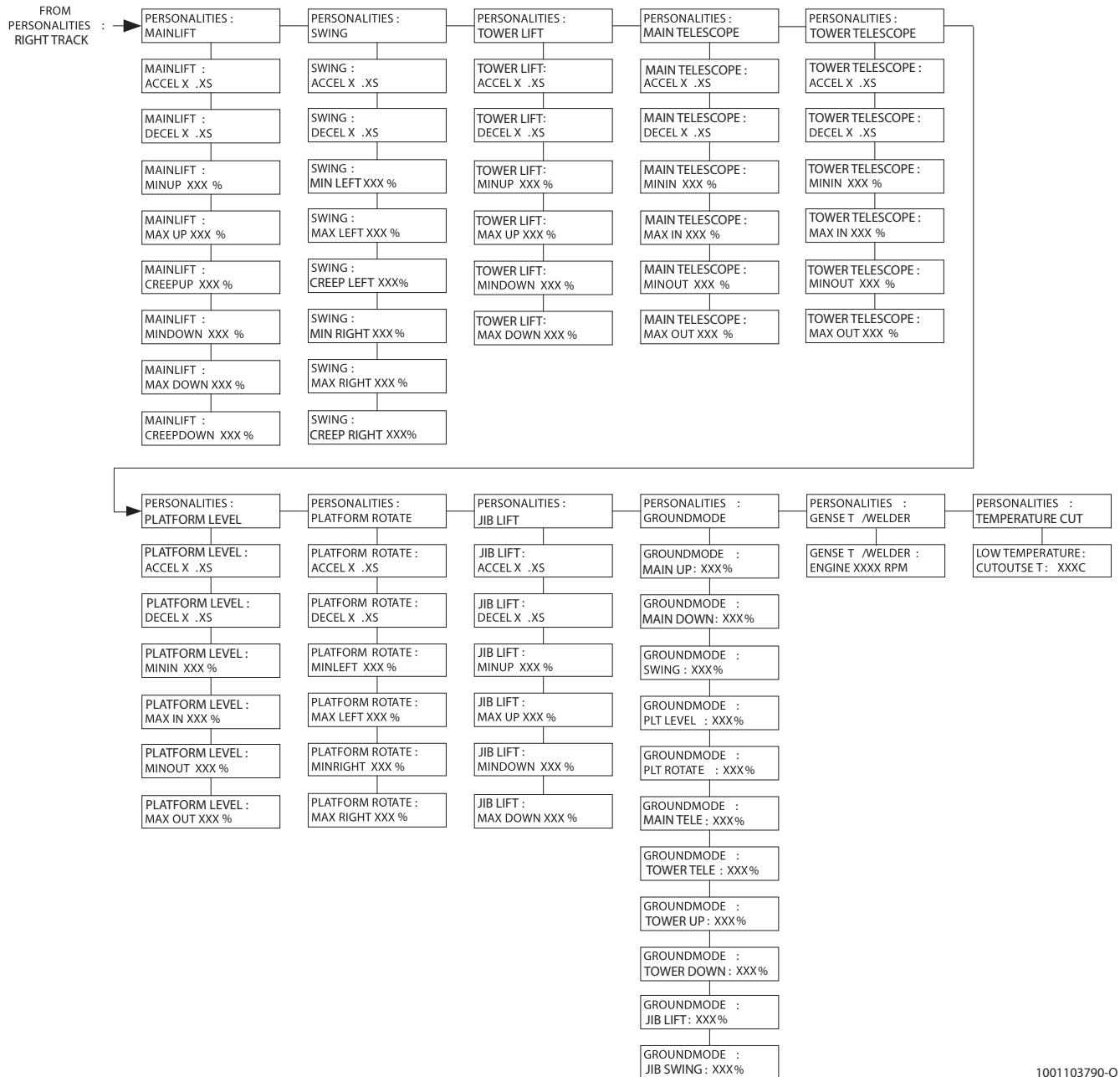
**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

**Figure 6-5. Analyzer Flow Chart (Software Version P6.22) -Sheet 3 of 9**



**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-6. Analyzer Flow Chart (Software Version P6.22) -Sheet 4 of 9

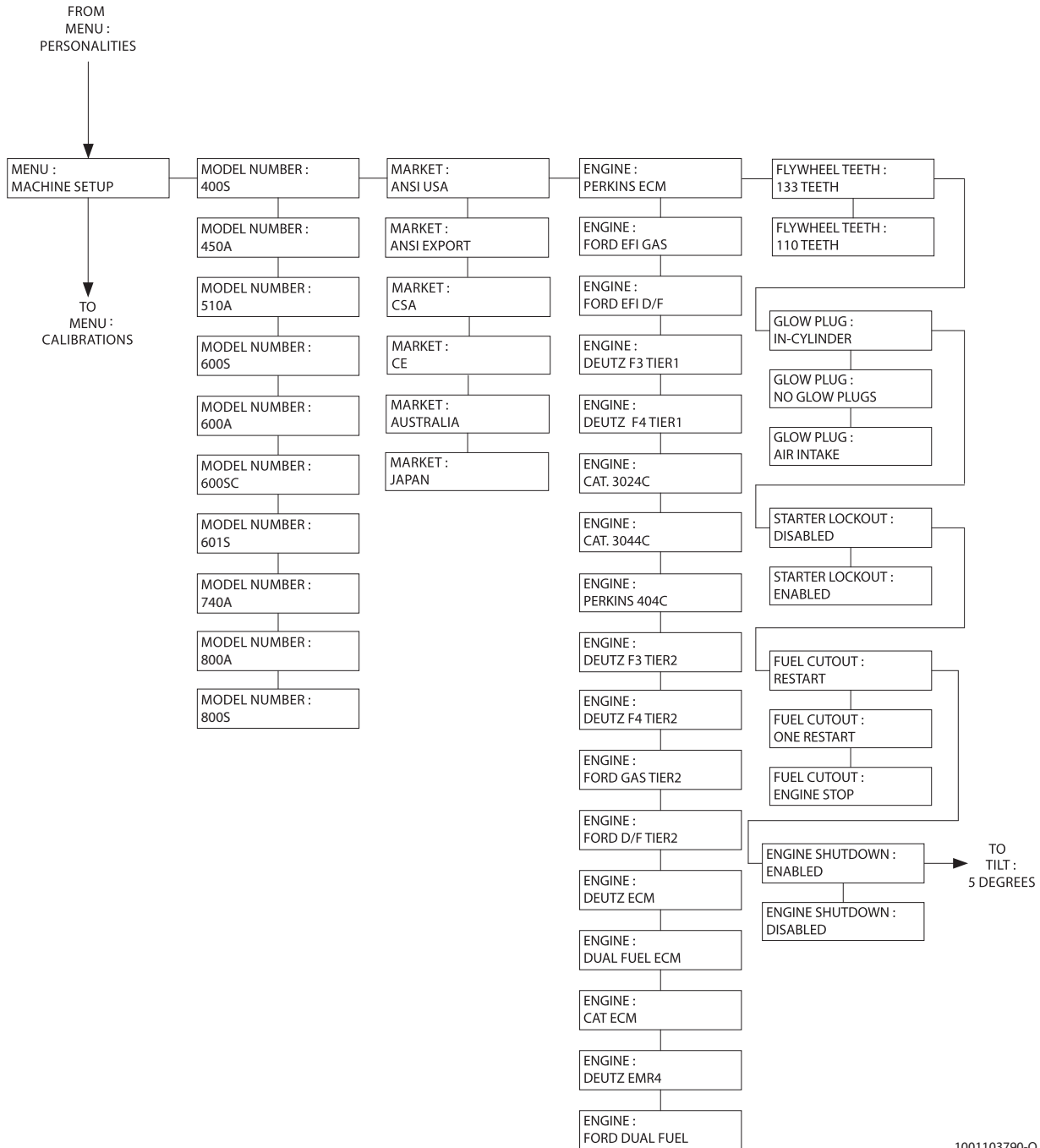


1001103790-Q  
MAE33220Q

**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

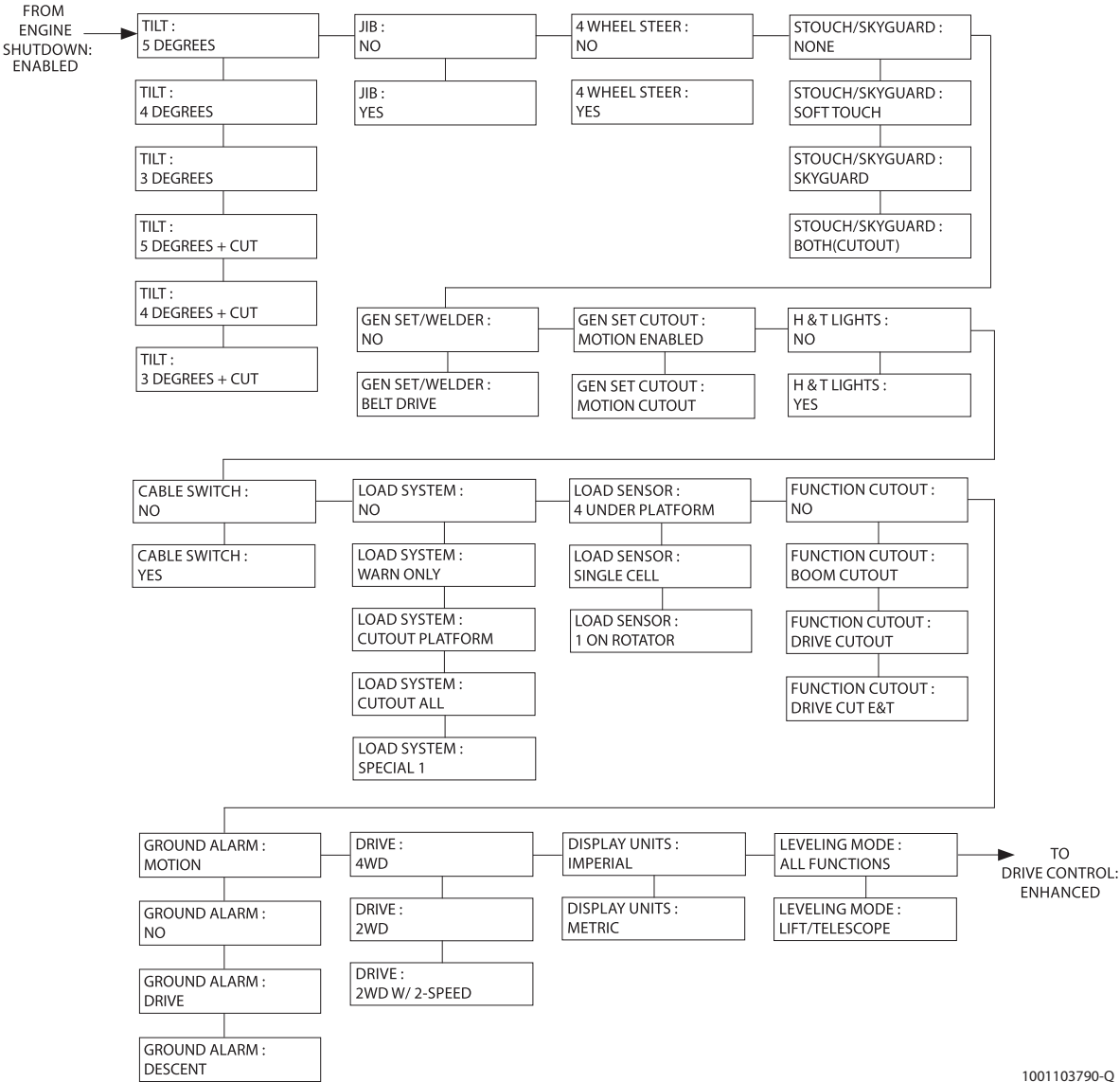
Figure 6-7. Analyzer Flow Chart (Software Version P6.22) -Sheet 5 of 9

# SECTION 6 - JLG CONTROL SYSTEM



**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

**Figure 6-8. Analyzer Flow Chart (Software Version P6.22) -Sheet 6 of 9**

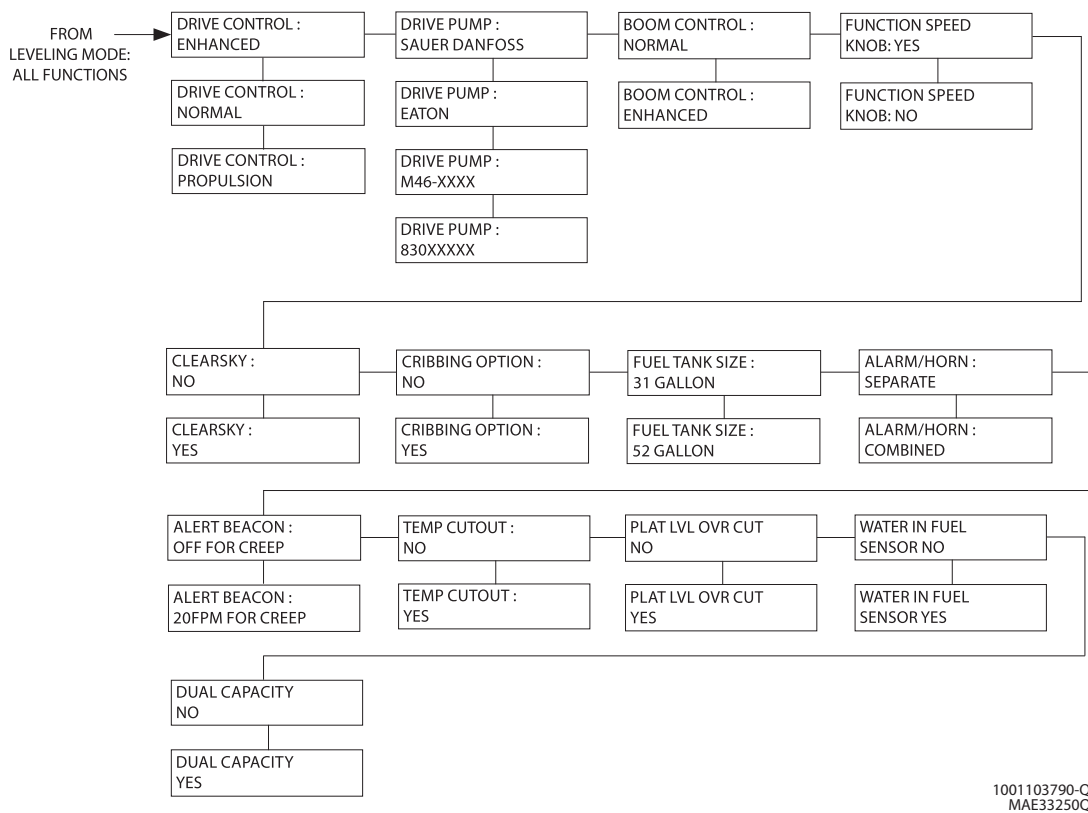


1001103790-Q  
MAE33240Q

**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-9. Analyzer Flow Chart (Software Version P6.22) -Sheet 7 of 9

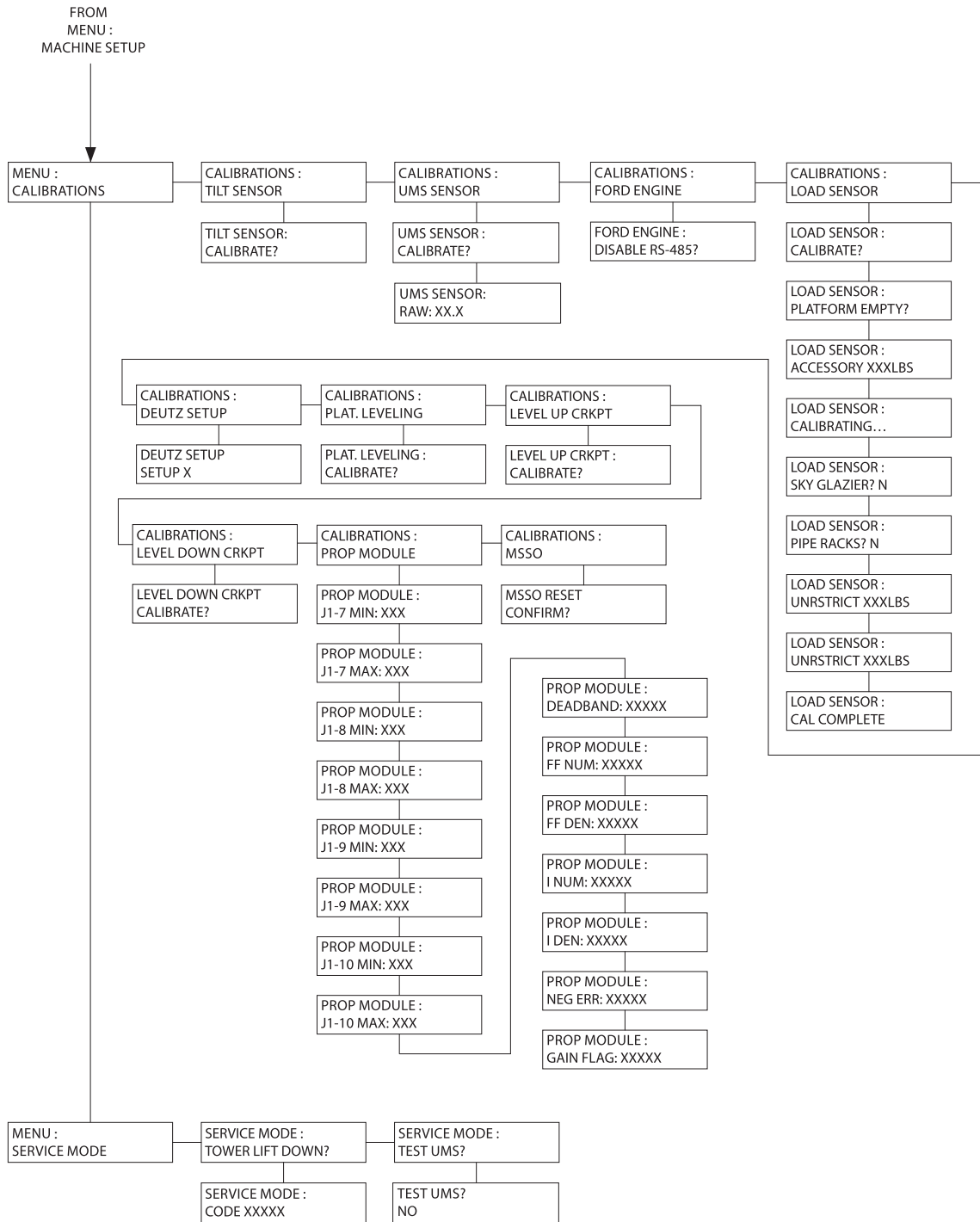
**SECTION 6 - JLG CONTROL SYSTEM**



1001103790-Q  
MAE33250Q

**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

**Figure 6-10. Analyzer Flow Chart (Software Version P6.22) -Sheet 8 of 9**



1001103790-Q  
MAE33260Q

**NOTE:** The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.

Figure 6-11. Analyzer Flow Chart (Software Version P6.22) -Sheet 9 of 9

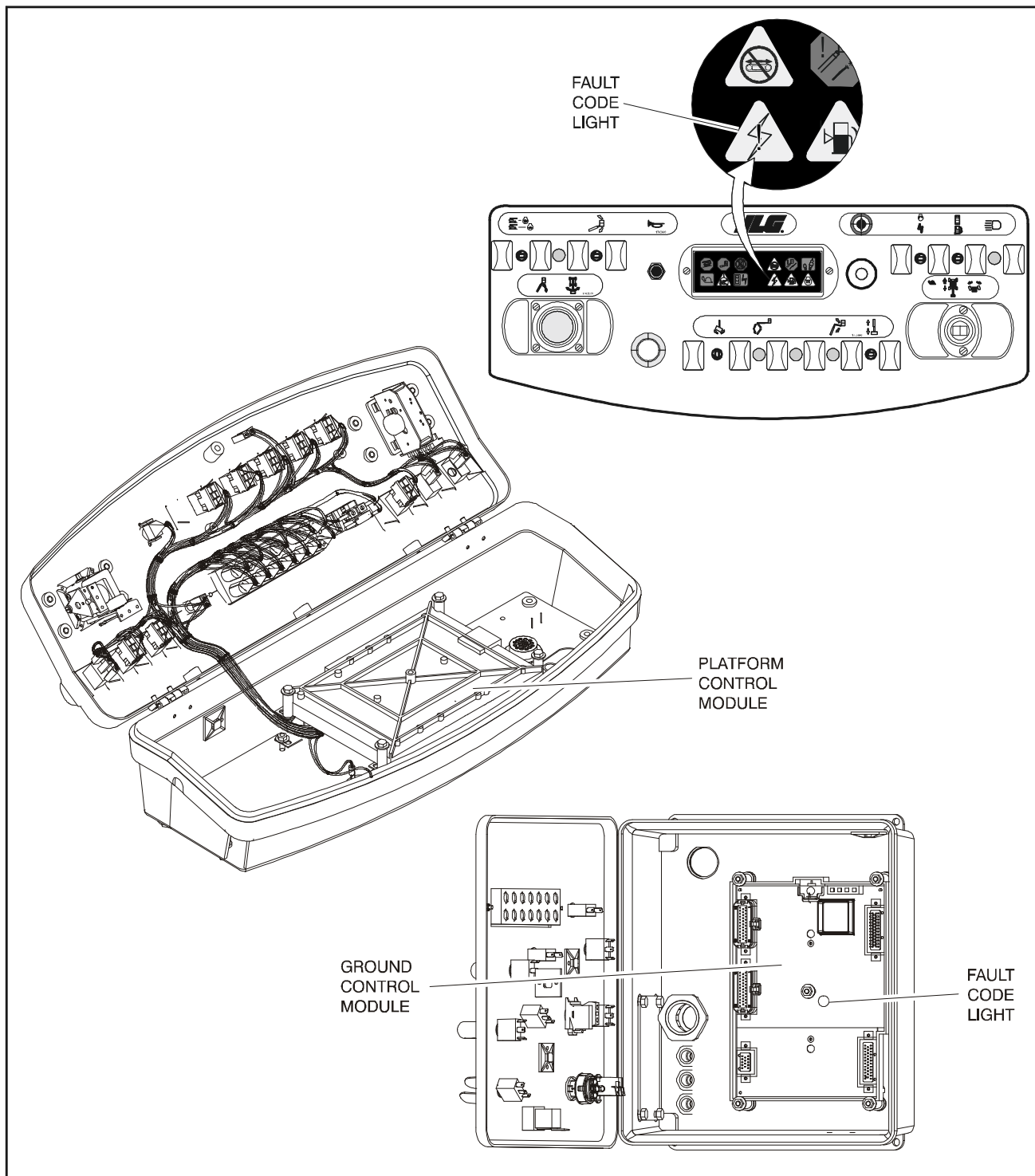
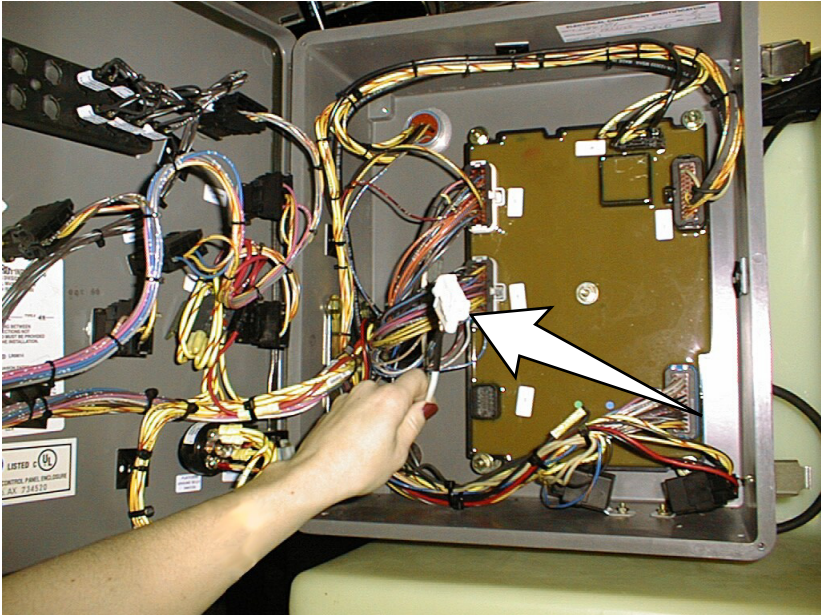


Figure 6-12. Fault Code Light Location



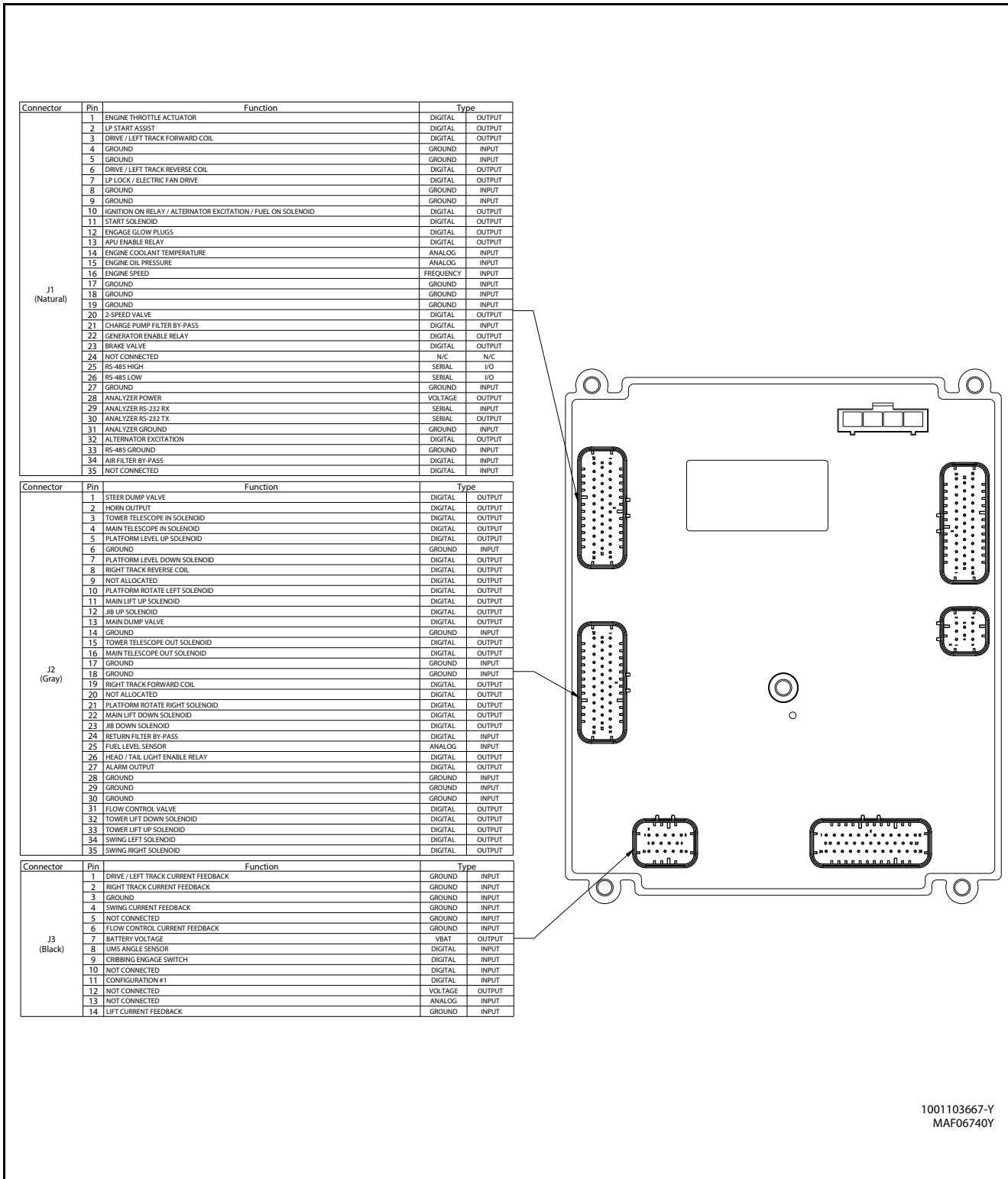
PLATFORM CONNECTION



GROUND CONTROL CONNECTION

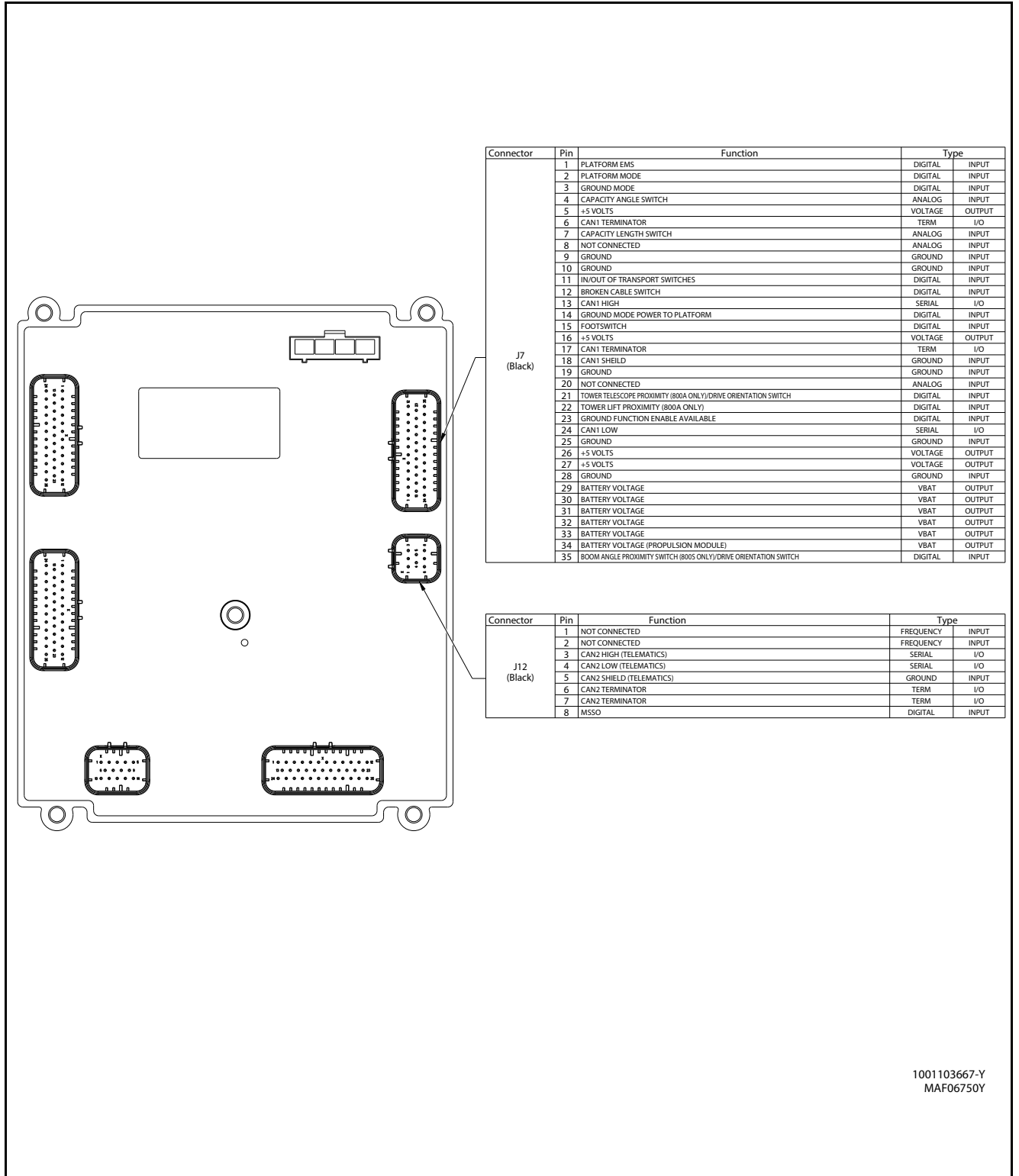
Figure 6-13. Analyzer Connecting Points

# SECTION 6 - JLG CONTROL SYSTEM



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MAF06740Y

Figure 6-14. Ground Control Module - Sheet 1 of 3

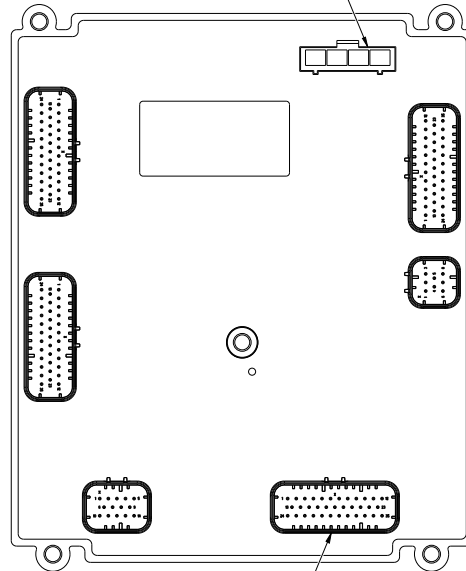


1001103667-Y  
MAF06750Y

Figure 6-15. Ground Control Module - Sheet 2 of 3

# SECTION 6 - JLG CONTROL SYSTEM

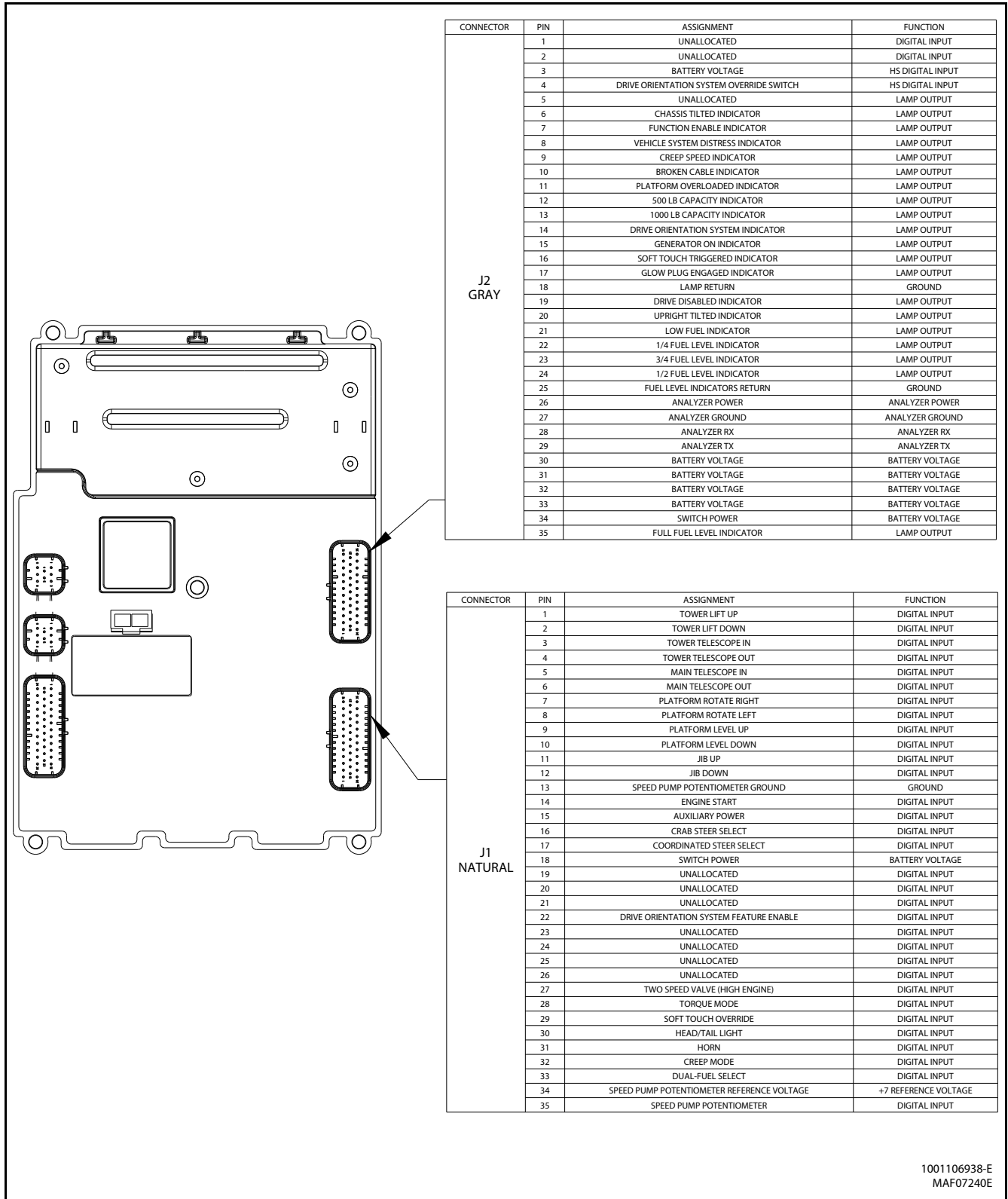
Connector	Pin	Function	Type	
J8 (Black)	1	MODULE GROUND	GROUND	OUTPUT
	2	MODULE POWER	VBAT	INPUT
	3	GROUND TO PLATFORM MODULE	GROUND	INPUT
	4	POWER TO PLATFORM MODULE	VBAT	OUTPUT



Connector	Pin	Function	Type	
J4 (Blue)	1	CRIBBING ENGAGED INDICATOR	DIGITAL	OUTPUT
	2	500 LB CAPACITY LAMP	DIGITAL	OUTPUT
	3	GLOWPLUG INDICATOR	DIGITAL	OUTPUT
	4	ENGINE START	DIGITAL	INPUT
	5	PLATFORM LEVEL DOWN	DIGITAL	INPUT
	6	PLATFORM ROTATE LEFT	DIGITAL	INPUT
	7	MAIN TELESCOPE IN	DIGITAL	INPUT
	8	JIB DOWN	DIGITAL	INPUT
	9	JIB LEFT	DIGITAL	INPUT
	10	TOWER LIFT UP	DIGITAL	INPUT
	11	TOWER TELESCOPE IN	DIGITAL	INPUT
	12	HOURMETER	DIGITAL	OUTPUT
	13	RETURN FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	14	PLATFORM OVERLOADED INDICATOR	DIGITAL	OUTPUT
	15	BOOM MALFUNCTION INDICATOR	DIGITAL	OUTPUT
	16	AUXILIARY POWER / FUNCTION ENABLE	DIGITAL	INPUT
	17	PLATFORM LEVEL UP	DIGITAL	INPUT
	18	PLATFORM ROTATE RIGHT	DIGITAL	INPUT
	19	JIB UP	DIGITAL	INPUT
	20	JIB RIGHT	DIGITAL	INPUT
	21	TOWER LIFT DOWN	DIGITAL	INPUT
	22	TOWER TELESCOPE OUT	DIGITAL	INPUT
	23	MAIN LIFT UP	DIGITAL	INPUT
	24	BATTERY VOLTAGE	VBAT	OUTPUT
	25	BATTERY VOLTAGE - (GROUND ENABLE PRESENT)	VBAT	OUTPUT
	26	BATTERY LOW / NOT CHARGING INDICATOR	DIGITAL	OUTPUT
	27	CHARGE PUMP FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	28	ENGINE HIGH COOLANT TEMPERATURE INDICATOR	DIGITAL	OUTPUT
	29	ENGINE LOW OIL PRESSURE INDICATOR	DIGITAL	OUTPUT
	30	MAIN TELESCOPE OUT	DIGITAL	INPUT
	31	GROUND	GROUND	INPUT
	32	GROUND	GROUND	INPUT
	33	MAIN LIFT DOWN	DIGITAL	INPUT
	34	SWING LEFT	DIGITAL	INPUT
	35	SWING RIGHT	DIGITAL	INPUT

1001103667-Y  
MAF06760Y

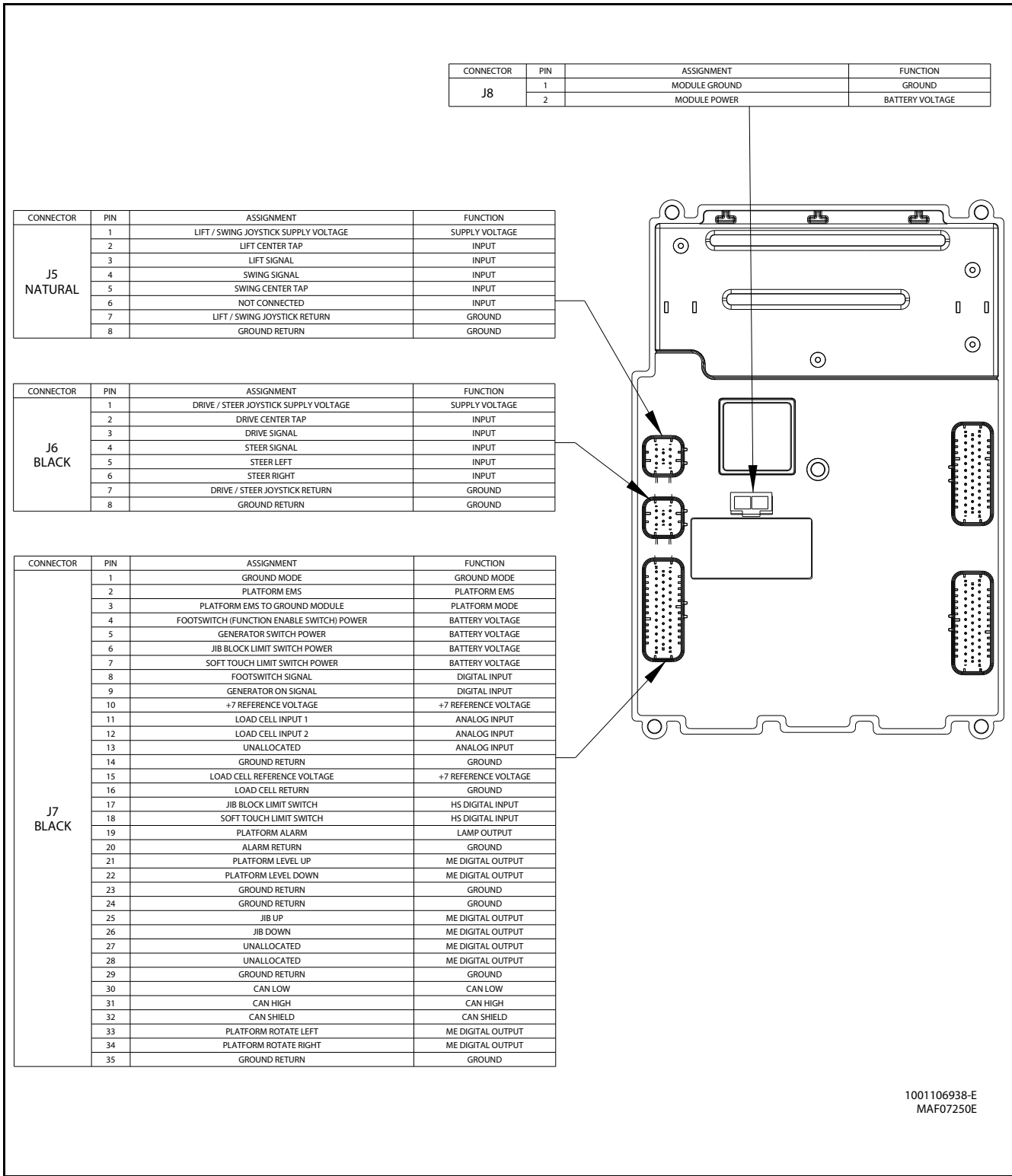
Figure 6-16. Ground Control Module - Sheet 3 of 3



1001106938-E  
MAF07240E

Figure 6-17. Platform Control Module - Sheet 1 of 2

# SECTION 6 - JLG CONTROL SYSTEM



1001106938-E  
MAF07250E

Figure 6-18. Platform Control Module - Sheet 2 of 2

### Analyzer Diagnostics Menu Structure

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to the next outer level. The LEFT /RIGHT arrow keys

move between items in the same level. The UP or DOWN arrow keys alter a value if allowed

**Table 6-7. Adjustments - Personality Descriptions**

DRIVE	
ACCEL	Displays/adjusts drive acceleration
DECEL	Displays/adjusts drive deceleration
MIN FORWARD	Displays/adjusts minimum forward drive speed
MAX FORWARD	Displays/adjusts maximum forward drive speed
MIN REVERSE	Displays/adjusts minimum reverse drive speed
MAX REVERSE	Displays/adjusts maximum reverse drive speed
ELEVATED MAX	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX	Displays/adjusts the maximum steer speed
LIFT	
ACCEL	Displays/adjusts main lift acceleration
DECEL	Displays/adjusts main lift deceleration
MIN UP	Displays/adjusts minimum main lift up speed
MAX UP	Displays/adjusts maximum main lift up speed
CREEP UP	Displays/adjusts maximum main lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN	Displays/adjusts minimum main lift down speed
MAX DOWN	Displays/adjusts maximum main lift down speed
CREEP DOWN	Displays/adjusts maximum main lift down speed NOTE: used when creep switch on pump pot is active
SWING	
ACCEL	Displays/adjusts swing acceleration
DECEL	Displays/adjusts swing deceleration
MIN LEFT	Displays/adjusts minimum swing left speed
MAX LEFT	Displays/adjusts maximum swing left speed

**Table 6-7. Adjustments - Personality Descriptions**


CREEP LEFT	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT	Displays/adjusts minimum swing right speed
MAX RIGHT	Displays/adjusts maximum swing right speed
CREEP RIGHT	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
<b>main TELESCOPE</b>	
ACCEL	Displays/adjusts telescope acceleration
DECEL	Displays/adjusts telescope deceleration
MIN IN	Displays/adjusts minimum telescope in speed
MAX IN	Displays/adjusts maximum telescope in speed
MIN OUT	Displays/adjusts minimum telescope out speed
MAX OUT	Displays/adjusts maximum telescope out speed
<b>BASKET LEVEL</b>	
ACCEL	Displays/adjusts basket level acceleration
DECEL	Displays/adjusts basket level deceleration
MIN UP	Displays/adjusts minimum basket level up speed
MAX UP	Displays/adjusts maximum basket level up speed
MIN DOWN	Displays/adjusts minimum basket level down speed
MAX DOWN	Displays/adjusts maximum basket level down speed
<b>BASKET ROTATE</b>	
ACCEL	Displays/adjusts basket rotate acceleration
DECEL	Displays/adjusts basket rotate deceleration
MIN LEFT	Displays/adjusts minimum basket rotate left speed
MAX LEFT	Displays/adjusts maximum basket rotate left speed
MIN RIGHT	Displays/adjusts minimum basket rotate right speed
MAX RIGHT	Displays/adjusts maximum basket rotate right speed
JIB LIFT	Not displayed if JIB = NO
ACCEL	Displays/adjusts jib acceleration
DECEL	Displays/adjusts jib deceleration
MIN UP	Displays/adjusts minimum jib up speed
MAX UP	Displays/adjusts maximum jib up speed
MIN DOWN	Displays/adjusts minimum jib down speed

**Table 6-7. Adjustments - Personality Descriptions**

MAX DOWN	Displays/adjusts maximum jib down speed
MIN LEFT	Displays/adjusts minimum jib left speed
MAX LEFT	Displays/adjusts maximum jib left speed
MIN RIGHT	Displays/adjusts minimum jib right speed
MAX RIGHT	Displays/adjusts maximum jib right speed
<b>STEER</b>	
MAX SPEED	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
<b>GROUND MODE</b>	
LIFT UP	Displays/adjusts fixed lift up speed
LIFT DOWN	Displays/adjusts fixed lift down speed
SWING	Displays/adjusts fixed swing speed
TELE	Displays/adjusts fixed telescope speed
BASKETLEVEL	Displays/adjusts fixed basket level speed
BASKETROTATE	Displays/adjusts fixed basket rotate speed
JIB (U/D)	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)	Displays/adjusts jib swing speed Not displayed if JIB = NO

### 6.5 LSS SYSTEM

The JLG-designed Load Sensing System (LSS) measures platform load via a sensor mounted in the platform support structure. If the actual platform load exceeds the selected Rated Load, the following will occur:

1. The Overload Visual Warning Indicator will flash at the selected control position (platform or ground). 
2. The Platform and Ground Alarms will sound 5 seconds On, and 2 seconds Off.
3. All normal movement will be prevented from the platform control position (optional - ground control functions may be prevented).
4. Further movement is permitted by:
  - a. Removing the excess platform load until actual platform load is less than Rated Load.
  - b. Operation of the overriding emergency system (Auxiliary Power Unit).
  - c. By an authorized person at the ground control position (optional - ground control functions may be prevented).

#### **NOTICE**

**THE LOAD SENSING SYSTEM MUST BE CALIBRATED WHEN ONE OR MORE OF THE FOLLOWING CONDITIONS OCCUR:**

- a. LSS Sensor removal or replacement
- b. Addition or removal of certain platform mounted accessories. (Refer to Calibration)
- c. Platform is removed, replaced, repaired or shows evidence of impact.



#### **NOTICE**

**THE LOAD SENSING SYSTEM REQUIRES PERIODIC FUNCTION VERIFICATION NOT TO EXCEED 6 MONTHS FROM PREVIOUS VERIFICATION. REFER TO TESTING & EVALUATION.**

All calibration procedures are menu driven through the use of a JLG Analyzer.

## Diagnostic Menu

The Diagnostic Menu is another troubleshooting tool for the Load Sensing System. Sensor and status information is presented in real-time for the technician. Several sub-menus exist to organize the data.

To access the Diagnostic Menu, use the LEFT  and RIGHT  Arrow keys to select DIAGNOSTICS from the Top Level

Menu. Press the ENTER key  to view the menu.

Press the LEFT and RIGHT Arrow keys to view the displays and select the various sub-menus. To access a sub-menu, press the ENTER key. Once in a sub-menu, press the LEFT and RIGHT Arrow keys to view the various displays (just like a Top Level


menu). To exit a sub-menu, press the ESC key .

Table 6-8, Diagnostic Menu Descriptions details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

**Table 6-8. Diagnostic Menu Descriptions**

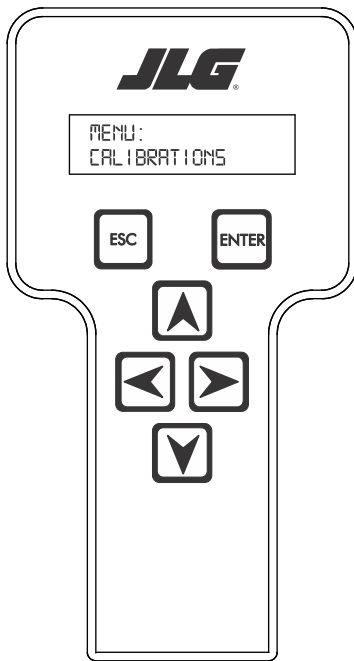
Diagnosics Menu (Displayed on Analyzer 1 <sup>st</sup> Line)	Parameter (Displayed on Analyzer 2 <sup>nd</sup> Line)	Parameter Value (Displayed on Analyzer 2 <sup>nd</sup> Line)	Description
PLATFORM LOAD	STATE:	OK / OVERLOAD	LSS Status.
PLATFORM LOAD	ACTUAL:	XXX.X KG	Calibrated weight of the platform. ??? if Platform Load is Unhealthy**.
PLATFORM LOAD (service*)	GROSS:	XXX.X KG	Gross weight of the platform. ??? if both Cells are Unhealthy**.
PLATFORM LOAD (service*)	OFFSET 1:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	OFFSET 2:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	ACCESSORY	XXX.X KG	Stored accessory weight. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	UNRESTRICT	XXX.X KG	UGM will set Unrestricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RESTRICT	XXX.X KG	UGM will set Restricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RAW 1:	XXX.X KG	Gross value from Cell 1. ??? if Unhealthy**.
PLATFORM LOAD (service*)	RAW 2:	XXX.X KG	Gross value from Cell 2. ??? if Unhealthy**.

\* Indicates only visible in service view mode


\*\* Typically indicates a DTC is active

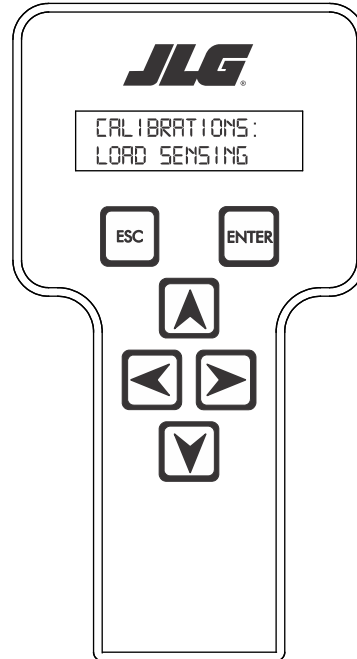
**Calibration Procedure**

1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service Access Password 33271.
3. The platform should be approximately level for calibration. Level the platform from ground control (if necessary) to within +/- 5°.
4. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:

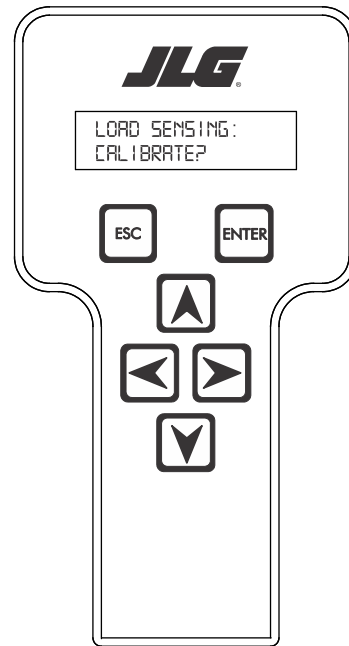


**NOTE:** The Calibration Menu is not available in OPERATOR ACCESS.


5. Press the ENTER key  to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:




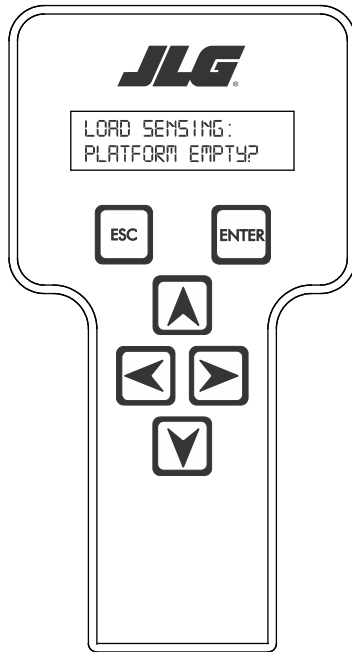
6. Press Enter . The Screen will read:




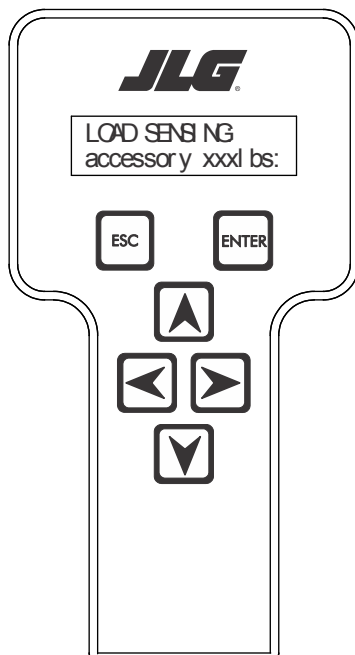
**NOTE:** Calibration will auto fail if LSS DTC's are active (443, 444, 4479, 4480, 663, 821, 822, 823, 824, 8218, 8222 -> 8238, 991, 992, 993, 994 or 99285).

Pressing the ESC key  after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER . The analyzer screen will read:




8. If the platform is empty, press ENTER . The screen will read:



**NOTE:** Accessory weight will reset to 0 lbs. each time the machine is re-calibrated and will need to be re-entered.

**NOTE:** The Accessory weight will be temporarily stored in the Control System until calibration has been completed successfully.

Refer to Table 6-9, Accessory Weights. Use the up and down analyzer keys to enter the accessory weight(s) (in lbs). When all the accessory weights are entered, press

ENTER . The screen will read:

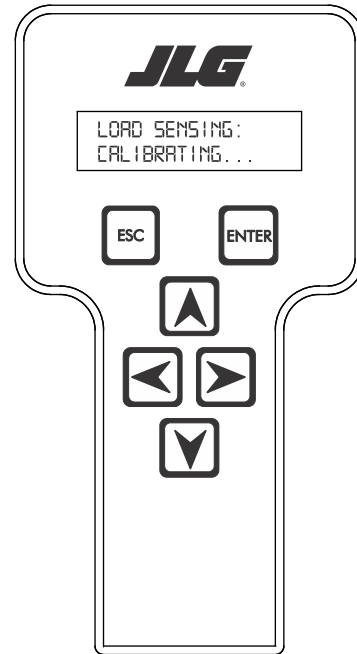


Table 6-9. Accessory Weights

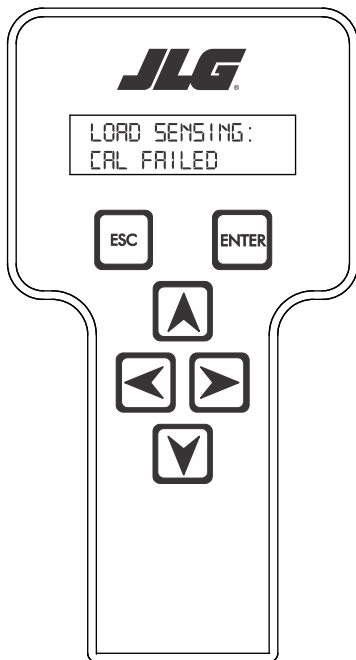
Accessory	Weight
SkyWelder (stick welder)	70 lb (32 kg)
SkyWelder Prep	Prep only = 15 lb (7 kg) Full install = 70 lb (32 kg)
SkyCutter (plasma cutter)	70 lb (32 kg)
SkCutter / SkyWelder Combo	140 lb (64 kg)
Fire Extinguisher	45 lb (20 kg)
Overhead SoftTouch	80 lb (36 kg)
Work Surface	20 lb (9 kg)

**NOTE:** Not all Accessories are available on every JLG model. Some Accessory combinations are prohibited due to excessive weight and/or load restriction. If any installed JLG Accessories are labeled with weight decals but are not listed in the table above, include their weight when entering the ACC WEIGHT value.


## SECTION 6 - JLG CONTROL SYSTEM

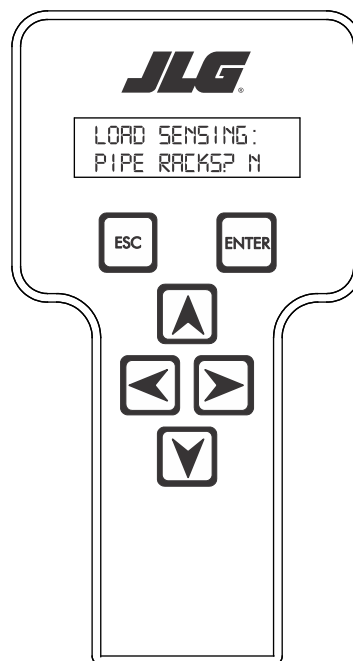
9. The control system will calculate the load cell readings and ensure it is greater than 130 lbs. (59 kg), but less than 575 lbs.(261 kg).


If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:

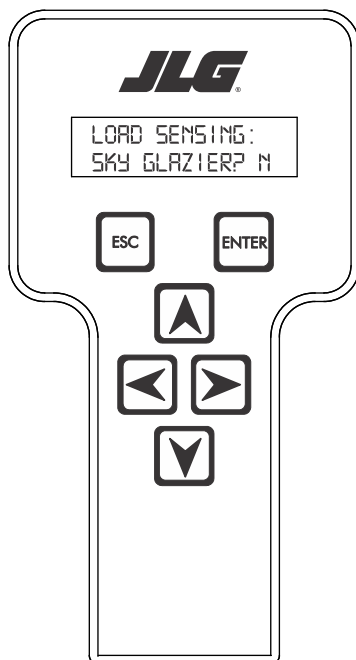


11. Use the analyzer keys to select N for no or Y for yes. Press


ENTER . The screen will read:



10. Press ENTER . The control system will ask for installed accessories. The screen will show the following:



12. Use the analyzer keys to select N for no or Y for yes. Press

ENTER . The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to Table 6-10, SkyGlazier Capacity Reductions and Table 6-11, Pipe Rack Capacity Reductions.

The screen will read:

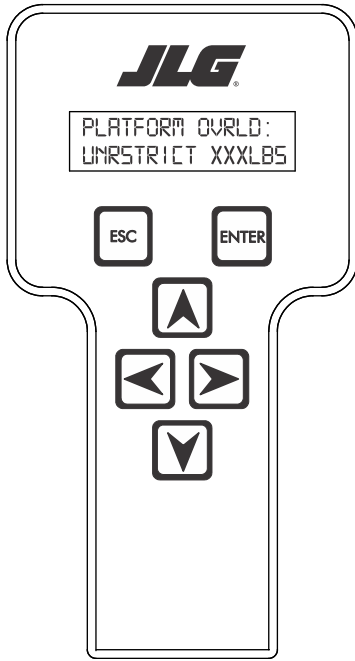


Table 6-10. SkyGlazier Capacity Reductions


Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	400 lb (181 kg)	n/a
600 lb (272 kg)	400 lb (181 kg)	n/a
750 lb (340 kg)	n/a	590 lb (268 kg)
1000 lb (454 kg)	n/a	750 lb (340 kg)

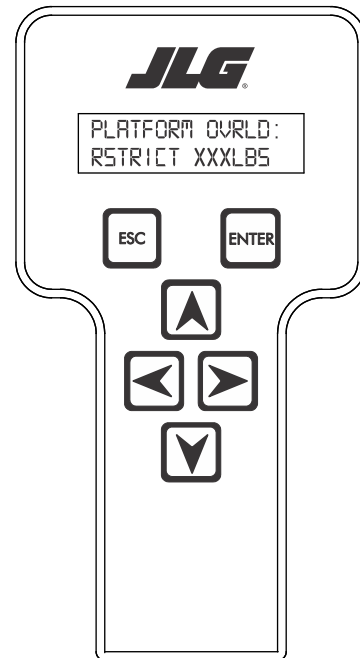
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.


Table 6-11. Pipe Rack Capacity Reductions

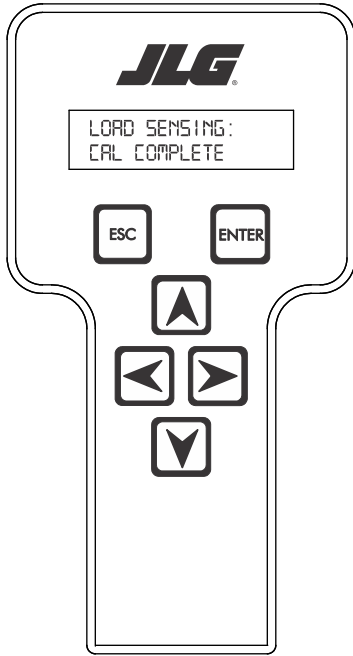
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	450 lb (204 kg)	n/a
600 lb (272 kg)	500 lb (227 kg)	n/a
750 lb (340 kg)	n/a	650 lb (295 kg)
1000 lb (454 kg)	n/a	900 lb (408 kg)

Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.

13. Press ENTER . The following screen will be displayed for restricted capacity, which can be adjusted if necessary. Refer to Table 6-10, SkyGlazier Capacity Reductions and Table 6-11, Pipe Rack Capacity Reductions.



14. Press ENTER . If calibration is successful, the screen will read:



## Testing & Evaluation

Refer to Troubleshooting if the Load Sensing System fails to meet these guidelines.

1. Connect the JLG Analyzer.
2. Level the Platform. The platform should be approximately level for analysis, or the guidelines below will not be applicable. Level the platform from Ground Control (if necessary) to within  $\pm 5$  degrees.
3. Observe the Empty Platform Weight. Proceed to the DIAGNOSTICS, PLTLOAD sub-menu and observe the measured platform load. All tools, debris, and customer-installed devices shall be removed during evaluation. Ideally, the PLTLOAD should be zero but can vary  $\pm 15$ lbs ( $\pm 7$ kg). Further, the reading should be stable and should not vary by more than  $\pm 2$ lbs ( $\pm 1$ kg) (unless there is heavy influence from wind or vibration).
4. Use the Technician's Weight to Evaluate. The technician should enter the platform and record the PLTLOAD reading while standing in the center of the platform.
5. Confirm Control System Warnings and Interlocks. Using the keyswitch, select Platform Mode and power-up. Start the vehicle's engine and ensure that all controls are functional and the Load Sensing System's Overload Visual and Audible Warnings are not active. Simulate an Overload by unplugging the Shear Beam Load Cell. The Overload Visual Warning should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, and 2 seconds Off. With the engine running, all control should be prevented. Cycle the Platform EMS to stop the engine and then power-up again. The Overload Visual and Audible Warning should continue. Confirm that controls are responsive when using the Auxiliary Power Unit for emergency movement. Reconnect the Load Cell. The Overload Visual and Audible Warnings should cease and normal control function should return. Switch the vehicle's keyswitch to Ground Mode and repeat the above procedure. The Overload Visual Warning at the Ground Controls should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, 2 seconds Off. However, the controls should remain functional when using the engine and the Auxiliary Power Unit (if the Control System's MACHINE SETUP, LOAD is set to "2=CUTOUT PLT". If set to "3=CUTOUT ALL", then Ground Controls will be prevented when using the engine as in the platform).
6. Confirm Control System Capacity Indication (optional for vehicles with Dual Capacity Ratings). For vehicles equipped with a Capacity Select switch on the Platform Console Box, it is necessary to examine an additional interface between the Load Sensing System and the Control System. Using the keyswitch, select Platform Mode and power-up. If necessary, put the boom in the transport position (completely stowed) and center the Jib Plus (if equipped). Place the Capacity Select switch in the unrestricted position and ensure that the proper indicator illuminates on the Platform Console Box. Plug the JLG Analyzer into the Analyzer connection and proceed to the DIAGNOSTICS, SYSTEM submenu. Ensure that the CAPACITY displays indicate OFF. Place the Capacity Select switch in the unrestricted position (if so equipped) and ensure that the proper indicator illuminates on the Platform Console Box (but does not flash). For vehicles with unrestricted capacity, ensure that the unrestricted CAPACITY display indicates ON but the restricted CAPACITY indicates OFF. For vehicles with restricted capacity, ensure that the unrestricted CAPACITY display indicates OFF but the restricted CAPACITY indicates ON.
7. Confirm Load Sensing System Performance with Calibrated Weights. Operate the vehicle from Ground Control and place the boom in the transport position (fully stowed) for safety. Plug the JLG Analyzer into the control system connection and proceed to the DIAGNOSTICS, PLTLOAD display. Place 500lbs (230kg) in the platform and ensure that PLTLOAD is with  $\pm 5\%$  of the actual weight. For Dual Capacity vehicles, do the same for the alternate capacity (unrestricted or restricted).

**Troubleshooting**

The following tables are furnished to provide possible resolutions for common difficulties. Difficulties are classified as General, Calibration, Measurement Performance, and Host System Functionality.

**Table 6-12. LSS Troubleshooting Chart**

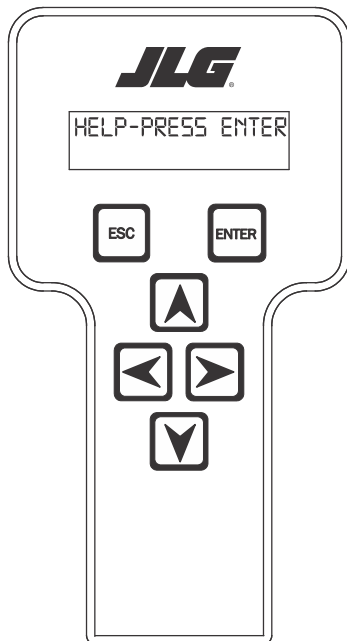
Difficulty	Possible Resolution
<p>Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within <math>\pm 15\text{lbs}</math> (<math>\pm 7\text{kg}</math>) of zero.</p> <p>or</p> <p>Platform Load readings (DIAGNOSTICS, PLATFORM LOAD) are unstable by more than <math>\pm 2\text{lbs}</math> (<math>\pm 1\text{kg}</math>) (without the influence of vibration or wind).</p> <p>or</p> <p>There are large variations in Platform Load (DIAGNOSTICS, PLATFORM LOAD) based on the location of the load. Tolerance to variations is 20lbs for an evaluation using the technician's weight, and <math>\pm 5\%</math> of Rated Load when using calibrated weights.</p>	<p>The LSS System is unable to properly measure the platform weight.</p> <ol style="list-style-type: none"> <li>1. The Load Cell is not properly plugged into the LSS Harness. It is possible poor electrical contact is made.</li> <li>2. Wiring leading to the Load Cell is damaged. Carefully inspect sensor wiring where it passes through cable clamps for signs of damage. Inspect wiring where damage to the channel is apparent.</li> <li>3. The Load Cell was not assembled properly during installation. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable. It is often helpful to apply slight downward pressure above the sensor and observe that its output increases (increasing force measurement; decreasing means the sensor is mounted upside-down).</li> <li>4. The Load Cell is contaminated by debris or moisture. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable and stable (not changing by more than <math>\pm 2\text{lbs}</math> (<math>\pm 1\text{kg}</math>) (without the influence of vibration or wind). Lack of measurement stability is a key indication of contamination. Unplug the connector and inspect for dirt or moisture. Look carefully into the female connector on the sensor's cordset for evidence of contamination. Debris should be brushed away with a soft bristle brush (do not introduce any cleaners as they will leave conductive residue). Moisture should be allowed to evaporate or accelerated with a heat-gun (use low heat and be carefully to not melt connector materials). Moisture intrusion into the molded portion of the connector (capillary action into the wire bundle) or the Shear Beam Load Cell itself will require replacement of the sensor.</li> <li>5. The Load Cell has been mechanically damaged. If the Load Cell is physically deformed or has damage to the cover it should be replaced immediately. It is also possible to have invisible mechanical damage resulting from an extreme overload (<math>&gt;6000\text{lbs}</math> [<math>&gt;2722\text{kg}</math>]).</li> </ol>
<p>The Visual and Audible Overload Warnings fail to sound when platform is loaded beyond Rated Load, or when simulated by unplugging the Load Cell. Controls remain functional at Platform and Ground Control positions.</p>	<p>The Control System is failing to regard the overload signal from the LSS System, or the signal is shorted.</p> <ol style="list-style-type: none"> <li>1. The Load Sensing System must be enabled within the Control System. Plug the JLG Analyzer into the Control System, enter the Access Level 1 password (33271), and examine the MACHINE SETUP, LOAD sub-menu. The selection "2=CUTOUT PLT" should be displayed (platform controls prevented during overload, ground controls remain operational). In country- or customer-specific circumstance, the selection "3=CUTOUT ALL" is used (platform and ground controls prevented during overload).</li> </ol>
<p>The Ground Audible Warning fails to sound, but the Platform Audible Warning sounds properly.</p>	<p>The Ground Alarm is missing or improperly installed. Verify that the device is mounted. Verify wiring from the Main Terminal Box and Ground Module.</p>
<p>Controls remain functional at the Ground Control position during an overload, or when simulated by unplugging the Load Cell. The Controls at the Platform Control position are prevented when using the engine, but not when using the Auxiliary Power Unit.</p>	<p>The JLG Control System is configured to prevent platform controls only in the event of overload. Alternately, the Host Control System can be configured to prevent ground and platform controls for country- or customer-specific circumstances.</p> <p>Using the JLG Analyzer, enter the Access Level 1 password (33271). Proceed to the MACHINE SETUP, LOAD sub-menu. Set this parameter to "2=CUTOUT PLT" to prevent platform controls in the event of overload. Set this parameter to "3=CUTOUT ALL" to prevent platform and ground controls in the event of overload.</p>



## 6.6 RESETTING THE MSSO SYSTEM

1. Use the following procedure to reset the MSSO system.
2. Position the Platform/Ground select switch to the desired position.
3. Plug the analyzer into the connector coming from the ground control module or from the platform console.

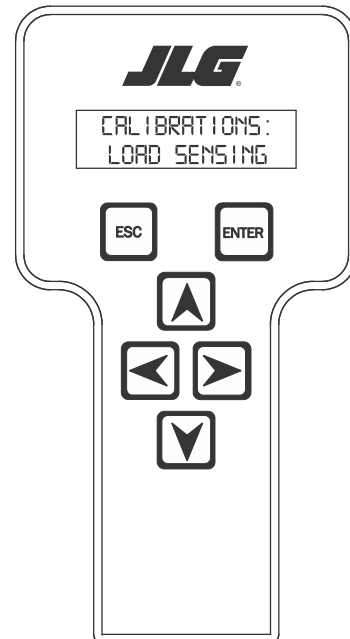
**NOTE:** If performing the procedure from the platform console, the Emergency Stop switch on the ground console must also be pulled out.



4. Pull out the Emergency Stop switch.
5. The analyzer screen should read:



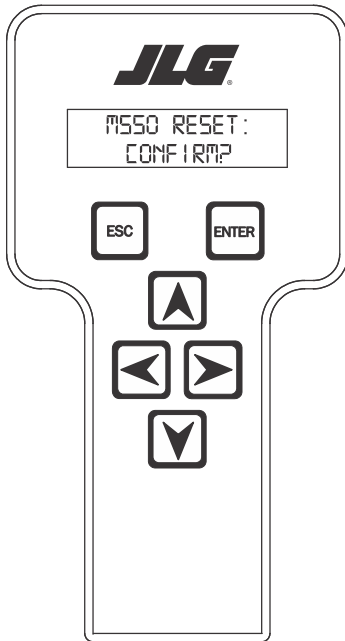
6. Use the arrow button to reach OPERATOR ACCESS. Press  Enter.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach MENU: CALIBRATIONS. Press Enter .

9. Use the arrow keys to reach the LOAD SENSING menu. The screen should read:



10. Press ENTER .
11. Use the Down  arrow to reach MSSO RESET.

12. Press Enter . The screen will read:





13. Press Enter . The JLG Control System will reset an active 873 DTC and the MSSO System will be reset. Press Escape  to return to the CALIBRATIONS menu.

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
001	00	1	EVERYTHING OK	The normal help message in Platform Mode.	No response required for this DTC.
002	00	2	GROUND MODE OK	The normal help message in Platform Mode.	No response required for this DTC.
0010	00	10	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" while the vehicle is out of transport position. The normal help message in Ground Mode.	Response described in Drive Modes section.
<b>000</b>	<b>00</b>	<b>0</b>	<b>&lt;&lt;&lt; HELP COMMENT &gt;&gt;&gt;</b>		
0011	00	11	FSW OPEN (Foot switch open)	A drive / boom function was selected with the Footswitch open.	The UGM shall not Enable the Machine.
0012	00	12	RUNNING AT CREEP - CREEP SWITCH OPEN	All functions at creep while the Creep Switch is open.	The UGM shall limit the machine to Creep speed.
0013	00	13	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All functions at creep while the Platform is elevated and the Chassis is tilted.	
0014	00	14	CHASSIS TILT SENSOR OUT OF RANGE	The Chassis is tilted > 19 degrees for more than 4 seconds.	Not reported during power-up.
0015	00	15	LOAD SENSOR READING UNDER WEIGHT	The Load Sensing System indicates > 20% under calibrated zero point.	
0031	00	31	FUEL LEVEL LOW - ENGINE SHUTDOWN	Engine Shutdown has occurred due to Fuel Level = EMPTY condition.	Response described in Fuel Shutdown section.
0035	00	35	APU ACTIVE	Auxiliary Power/Emergency Descent Mode is active.	Response described in Auxiliary Power/Emergency Descent Mode section.
0039	00	39	SKYGUARD ACTIVE - FUNCTIONS CUTOFF	Response described in Auxiliary Power/Emergency Descent Mode section.	Response described in Sky-Guard section.
0040	00	40	RUNNING AT CREEP - CREEP SWITCH CLOSED	All Function speeds are limited to creep because the creep switch is closed.	
<b>210</b>	<b>21</b>	<b>0</b>	<b>&lt;&lt;&lt; POWER-UP &gt;&gt;&gt;</b>		
211	21	1	POWER CYCLE	The normal help message is issued at each power cycle.	
212	21	2	KEYSWITCH FAULTY	Both Platform and Ground modes are selected simultaneously.	The UGM shall assume a station selection of Ground.
213	21	3	FSW FAULTY	Both Footswitches are closed for more than one second.	The UGM shall not Enable the Machine.
<b>220</b>	<b>22</b>	<b>0</b>	<b>&lt;&lt;&lt; PLATFORM CONTROLS &gt;&gt;&gt;</b>		
227	22	7	STEER SWITCHES FAULTY	Both Steer Left and Steer Right inputs are closed simultaneously.	The UGM shall prohibit Steer; The UGM shall limit Drive to Creep The Steer Left switch input = Low; The Steer Right switch input = Low; Steer and full Drive speed permitted after controls are initialized
2211	22	11	FSW INTERLOCK TRIPPED	The Footswitch was closed for more than seven seconds.	Can be reported during power-up.

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2212	22	12	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A drive function was selected with Footswitch open.	Can be reported during power-up.
2213	22	13	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	A steer function was selected with Footswitch open.	The UGM shall not Enable the Machine.
2214	22	14	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE	Drive/Steer was selected before Enable switch activated.	
2216	22	16	D/S JOY. OUT OF RANGE HIGH	The D/S Joystick reference voltage is > 8.1V.	Resistive joysticks. If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2217	22	17	D/S JOY. CENTER TAP BAD	The D/S Joystick center tap voltage is < 3.08V or > 3.83V.	Resistive joysticks. - There is a +/- .1V range around these values due to resistor tolerances.
2219	22	19	L/S JOY. OUT OF RANGE HIGH	The L/S Joystick reference voltage is > 8.1V.	Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2220	22	20	L/S JOY. CENTER TAP BAD	The L/S Joystick center tap voltage is < 3.08V or > 3.83V.	Resistive joysticks. - There is a +/- .1V range around these values due to resistor tolerances.
2221	22	21	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A lift / swing function was selected with Footswitch open.	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall prohibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine.
2222	22	22	WAITING FOR FSW TO BE OPEN	The Footswitch was closed during Platform selection.	Can be reported during power-up.
2223	22	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	A boom function was selected with Footswitch open.	The UGM shall not Enable the Machine.
2224	22	24	FOOTSWITCH SELECTED BEFORE START	The Footswitch was closed during engine start.	The UGM shall prohibit Engine Start.
2269	22	69	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER		

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
234	23	4	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function has both directions selected together.	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/Aux at fault, disable Engine Start but permit Auxiliary Power/ Emergency Descent.
235	23	5	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	A boom function was selected before aux power.	
236	23	6	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	A boom function was selected before engine start.	
237	23	7	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The Start Switch was closed during power-up.	The UGM shall prohibit Engine Start.
23163	23	163	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	The MSSO switch input = Low at Startup.	No response required for this DTC Power Cycled.
<b>240</b>	<b>24</b>	<b>0</b>	<b>&lt;&lt;&lt; OTHER CONTROLS &gt;&gt;&gt;</b>		
241	24	1	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	MACHINE SETUP > TEMP CUTOUT = YES; Ambient Temperature sensor reading - 50C.	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; If the Machine is in Ground Mode; No response required for this DTC.
242	24	2	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	Ambient Temperature sensor reading $\geq$ 85C.	Check Ambient Temperature sensor reading < 85C.
<b>250</b>	<b>25</b>	<b>0</b>	<b>&lt;&lt;&lt; FUNCTION PREVENTED &gt;&gt;&gt;</b>		
259	25	9	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
2513	25	13	GENERATOR MOTION CUTOUT ACTIVE	Driving is not possible while the vehicle generator is running AND is configured to prevent drive.	The UGM shall not Enable the Machine.
2514	25	14	BOOM PREVENTED - DRIVE SELECTED	Boom functions are not possible while the vehicle is being driven AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit all boom functions.
2516	25	16	DRIVE PREVENTED - ABOVE ELEVATION	Driving is not possible while Boom functions are selected AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit Drive and Steer.
2517	25	17	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Driving is not possible while the vehicle is tilted and above elevation AND is configured to prevent drive while tilted and above elevation.	The UGM shall prohibit Drive and Steer.

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**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2518	25	18	DRIVE PREVENTED - BOOM SELECTED	MACHINE SETUP > FUNCTION CUTOUT = BOOM CUTOUT The boom is Above Elevation Any boom function is already active The operator attempts to activate Drive or Steer.	The UGM shall prohibit Drive and Steer.
2519	25	19	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE	Drive Selected while tilted and extended and tilt is configured to cutout drive.	
2520	25	20	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER		
2530	25	30	UMS SENSOR FORWARD LIMIT REACHED	The Upright angle relative to the turntable is less than -4.0 degree.	
2531	25	31	UMS SENSOR OUT OF USABLE RANGE	Both the turntable tilt sensor and the UMS sensor read greater then +/-10 degree in the same direction.	
2532	25	32	UMS SENSOR BACKWARD LIMIT REACHED	The Upright angle relative to the turntable is greater than +2.5 degree.	
2563	25	63	SKYGUARD SWITCH - DISAGREEMENT	MACHINE SETUP > SKYGUARD = YES; Machine is in Platform Mode; [(SkyGuard input #1 Platform Module J7-18) ≠ (SkyGuard input #2 Platform Module J1-23)] > 160ms	Response detailed in Sky-Guard section.
2568	25	68	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	Low Temperature Cutout = Active	If the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
2576	25	76	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	Platform Level Override Cutout = Enabled; The Platform Level Up or Down switch input = High; Footswitch is active.	The UGM shall suspend Platform Level Up and Down commands; The UGM shall prohibit Platform Level Up and Down
2577	25	77	DRIVE PREVENTED - START BATTERY CONNECTED	Start battery is connected	Check the battery.
<b>330</b>	<b>33</b>	<b>0</b>	<b>&lt;&lt;&lt; GROUND OUTPUT DRIVER &gt;&gt;&gt;</b>		
331	33	1	BRAKE - SHORT TO BATTERY	There is a Short to Battery to the Brake Valve.	Check Harness for damage.
332	33	2	BRAKE - OPEN CIRCUIT	There is an Open Circuit to the Brake Valve.	Check Harness for damage.
3311	33	11	GROUND ALARM - SHORT TO BATTERY	There is a Short to Battery to the Ground Alarm.	Ground Alarm equipped vehicles only.
3336	33	36	ALTERNATOR POWER - SHORT TO GROUND	There is a Short to Ground to the Alternator/ECM.	Check Harness for damage.
3340	33	40	AUX POWER - SHORT TO GROUND	There is a Short to Ground to the Auxiliary Power Pump Relay.	Check Harness for damage.
3341	33	41	AUX POWER - OPEN CIRCUIT	There is an Open Circuit to the Auxiliary Power Pump Relay.	Check Harness for damage.
3342	33	42	AUX POWER - SHORT TO BATTERY	There is a Short to Battery to the Auxiliary Power Pump Relay.	Check Harness for damage.

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3346	33	46	ELECTRIC FAN - SHORT TO GROUND	There is a short to ground to the Electric Fan.	Check Harness for damage.
3347	33	47	ELECTRIC FAN - OPEN CIRCUIT	There is an Open Circuit to the Electric Fan.	Check Harness for damage.
3348	33	48	ELECTRIC FAN - SHORT TO BATTERY	There is a Short to Battery to the Electric Pump.	Check Harness for damage.
3349	33	49	ELECTRIC PUMP - SHORT TO GROUND	There is a Short to Ground to the Pump Relay.	Check Harness for damage.
3350	33	50	ELECTRIC PUMP - OPEN CIRCUIT	There is an Open Circuit to the Pump Relay.	Check Harness for damage.
3351	33	51	ELECTRIC PUMP - SHORT TO BATTERY	There is a Short to Battery to the Pump Relay.	Check Harness for damage.
3352	33	52	LP LOCK - SHORT TO GROUND	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3353	33	53	LP LOCK - OPEN CIRCUIT	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3354	33	54	LP LOCK - SHORT TO BATTERY	There is a short to Battery to the LP Lock.	Check Harness for damage.
3355	33	55	LP START ASSIST - SHORT TO GROUND	There is a short to ground to the LP Start Assist.	Check Harness for damage.
3356	33	56	LP START ASSIST - OPEN CIRCUIT	There is an Open Circuit to the LP Start Assist.	Check Harness for damage.
3357	33	57	LP START ASSIST - SHORT TO BATTERY	There is a short to battery to the LP Start Assist.	Check Harness for damage.
3358	33	58	MAIN DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Dump Valve.	Check Harness for damage.
3359	33	59	MAIN DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Dump Valve.	Check Harness for damage.
3360	33	60	MAIN DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Dump Valve.	Check Harness for damage.
3361	33	61	BRAKE - SHORT TO GROUND	There is a Short to Ground to the Brake Valve.	Check Harness for damage.
3362	33	62	START SOLENOID - SHORT TO GROUND	There is a Short to Ground to the Start Relay.	Check Harness for damage.
3363	33	63	START SOLENOID - OPEN CIRCUIT	There is an Open Circuit to the Start Relay.	Check Harness for damage.
3364	33	64	START SOLENOID - SHORT TO BATTERY	There is a Short to Battery to the Start Relay.	Check Harness for damage.
3365	33	65	STEER DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Steer Dump Valve.	Check Harness for damage.
3366	33	66	STEER DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Steer Dump Valve.	Check Harness for damage.
3367	33	67	STEER DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Steer Dump Valve.	Check Harness for damage.
3368	33	68	TWO SPEED VALVE - SHORT TO GROUND	There is a Short to Ground to the Two Speed Valve.	Check Harness for damage.
3369	33	69	TWO SPEED VALVE - OPEN CIRCUIT	There is an Open Circuit to the Two Speed Valve.	Check Harness for damage.
3370	33	70	TWO SPEED VALVE - SHORT TO BATTERY	There is a Short to Battery to the Two Speed Valve.	Check Harness for damage.

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**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3371	33	71	GROUND ALARM - SHORT TO GROUND	There is a Short to Ground to the Ground Alarm.	Check Harness for damage.
3372	33	72	GROUND ALARM - OPEN CIRCUIT	There is an Open Circuit to the Ground Alarm.	Check Harness for damage.
3373	33	73	GEN SET/WELDER - SHORT TO GROUND	There is a Short to Ground to the Generator Relay.	Check Harness for damage.
3374	33	74	GEN SET/WELDER - OPEN CIRCUIT	There is an Open Circuit to the Generator Relay.	Check Harness for damage.
3375	33	75	GEN SET/WELDER - SHORT TO BATTERY	There is a Short to Battery to the Generator Relay.	Check Harness for damage.
3376	33	76	HEAD TAIL LIGHT - SHORT TO GROUND	There is a Short to Ground to the Head Light Relay.	Check Harness for damage.
3377	33	77	HEAD TAIL LIGHT - OPEN CIRCUIT	There is an Open Circuit to the Head Light Relay.	Check Harness for damage.
3378	33	78	HEAD TAIL LIGHT - SHORT TO BATTERY	There is a Short to Battery to the Head Light Relay.	Check Harness for damage.
3379	33	79	HOOR METER - SHORT TO GROUND	There is a Short to Ground to the Hour Meter.	Check Harness for damage.
3382	33	82	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve	Check Harness for damage.
3383	33	83	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
3384	33	84	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve	Check Harness for damage.
3388	33	88	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Down Valve	Check Harness for damage.
3389	33	89	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
3390	33	90	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Down Valve	Check Harness for damage.
3394	33	94	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3395	33	95	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3396	33	96	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3397	33	97	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3398	33	98	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.
3399	33	99	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
33100	33	100	JIB LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
33101	33	101	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.
33102	33	102	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33103	33	103	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
33104	33	104	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
33105	33	105	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
33106	33	106	TOWER LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Up Valve.	Check Harness for damage.
33107	33	107	TOWER LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Up Valve.	Check Harness for damage.
33108	33	108	TOWER LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Up Valve.	Check Harness for damage.
33109	33	109	TOWER LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Down Valve.	Check Harness for damage.
33110	33	110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Down Valve.	Check Harness for damage.
33111	33	111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Down Valve.	Check Harness for damage.
33112	33	112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope In Valve.	Check Harness for damage.
33113	33	113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope In Valve.	Check Harness for damage.
33114	33	114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope In Valve.	Check Harness for damage.
33115	33	115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope Out Valve.	Check Harness for damage.
33116	33	116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope Out Valve.	Check Harness for damage.
33117	33	117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope Out Valve.	Check Harness for damage.
33118	33	118	SWING RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Right Valve.	Check Harness for damage.
33119	33	119	SWING RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Right Valve.	Check Harness for damage.
33120	33	120	TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope In Valve.	Check Harness for damage.
33121	33	121	SWING RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Swing Right Valve.	Check Harness for damage.
33122	33	122	SWING LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Left Valve.	Check Harness for damage.
33123	33	123	TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope Out Valve.	Check Harness for damage.
33130	33	130	THROTTLE ACTUATOR - SHORT TO GROUND	There is a Short to Ground to the Throttle Actuator.	Check Harness for damage.
33131	33	131	THROTTLE ACTUATOR - OPEN CIRCUIT	There is an Open Circuit to the Throttle Actuator.	Check Harness for damage.
33132	33	132	THROTTLE ACTUATOR - SHORT TO BATTERY	There is a Short to Battery to the Throttle Actuator.	Check Harness for damage.

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33170	33	170	LIFT DOWN VALVE - OPEN CIRCUIT	There is a Short to Ground to the Lift Down Valve.	Check Harness for damage.
33171	33	171	LIFT DOWN VALVE - SHORT TO BATTERY	There is an Open Circuit to the Lift Down Valve.	Check Harness for damage.
33172	33	172	LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Battery to the Lift Down Valve.	Check Harness for damage.
33175	33	175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
33176	33	176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
33177	33	177	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
33178	33	178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
33179	33	179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
33180	33	180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
33182	33	182	LIFT VALVES - SHORT TO BATTERY	There is a Short to Battery to the Lift Valves.	Check Harness for damage.
33186	33	186	TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope Out Valve.	Check Harness for damage.
33188	33	188	TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope Out Valve.	Check Harness for damage.
33189	33	189	TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope In Valve.	Check Harness for damage.
33190	33	190	TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope In Valve.	Check Harness for damage.
33207	33	207	HORN - OPEN CIRCUIT	There is an Open Circuit to the Horn.	Check Harness for damage.
33208	33	208	HORN - SHORT TO BATTERY	There is a Short to Battery to the Horn.	Check Harness for damage.
33209	33	209	HORN - SHORT TO GROUND	There is a Short to Ground to the Horn.	Check Harness for damage.
33279	33	279	GLOWPLUG - OPEN CIRCUIT	There is an Open Circuit to the Glow Plugs.	Check Harness for damage.
33280	33	280	GLOWPLUG - SHORT TO BATTERY	There is a Short to Battery to the Glow Plugs.	Check Harness for damage.
33281	33	281	GLOWPLUG - SHORT TO GROUND	There is a Short to Ground to the Glow Plugs.	Check Harness for damage.
33287	33	287	LIFT - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized
33295	33	295	SWING LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Left Valve.	Check Harness for damage.

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33306	33	306	SWING LEFT VALVE - SHORT TO BATTERY	There is short to Battery to the Swing Left Valve.	Check Harness for damage.
33314	33	314	FLOW CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Flow Control Valve.	Check Harness for damage.
33315	33	315	FLOW CONTROL VALVE - SHORT TO BATTERY	There is short to Battery to the Flow Control Valve	Check Harness for damage.
33316	33	316	FLOW CONTROL VALVE - SHORT TO GROUND	There is short to Ground to the Flow Control Valve	Check Harness for damage.
33317	33	317	DRIVE FORWARD VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Forward Valve.	Check Harness for damage.
33318	33	318	DRIVE FORWARD VALVE - SHORT TO BATTERY	There is short to Battery to the Drive Forward Valve.	Check Harness for damage.
33319	33	319	DRIVE FORWARD VALVE - SHORT TO GROUND	There is short to Ground to the Drive Forward Valve.	Check Harness for damage.
33320	33	320	DRIVE REVERSE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Reverse Valve.	Check Harness for damage.
33321	33	321	DRIVE REVERSE VALVE - SHORT TO BATTERY	There is a short to Battery to the Drive Reverse Valve.	Check Harness for damage.
33322	33	322	DRIVE REVERSE VALVE - SHORT TO GROUND	There is a short to Ground to the Drive Reverse Valve.	Check Harness for damage.
33323	33	323	LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Lift Up Valve.	Check Harness for damage.
33324	33	324	LIFT UP VALVE - SHORT TO BATTERY	There is a short to Battery to the Lift Up Valve.	Check Harness for damage.
33325	33	325	LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Lift Up Valve.	Check Harness for damage.
33331	33	331	DRIVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33410	33	410	DRIVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33412	33	412	SWING VALVES - SHORT TO BATTERY	There is a short to Battery to the Swing Valves.	Check Harness for damage.
33414	33	414	SWING - CURRENT FEEDBACK READING TOO LOW	Current feedback into controller is below threshold value.	Check wiring and coil.

**SECTION 6 - JLG CONTROL SYSTEM**

**Table 6-13. Diagnostic Trouble Code Chart**

<b>DTC</b>	<b>Flash Code</b>	<b>Sequence</b>	<b>Fault Message</b>	<b>Fault Description</b>	<b>Check</b>
33415	33	415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33417	33	417	LIFT - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized.
33418	33	418	SWING - CURRENT FEEDBACK READING LOST	Current feedback into controller not detected.	Check wiring and coil.
33419	33	419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33488	33	488	SWING FLOW CONTROL VALVE - SHORT TO GROUND	There is a short to the Ground to the Swing Flow Control Valve.	Check Harness for damage.
33575	33	575	ECM PULL DOWN RESISTOR - OPEN CIRCUIT	There is an Open Circuit to the ECM Pull Down Resistor.	Check Harness for damage.
<b>340</b>	<b>34</b>	<b>0</b>	<b>&lt;&lt;&lt; PLATFORM OUTPUT DRIVER &gt;&gt;&gt;</b>		
341	34	1	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
342	34	2	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve.	Check Harness for damage.
343	34	3	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve.	Check Harness for damage.
344	34	4	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
345	34	5	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
346	34	6	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Level Down Valve.	Check Harness for damage.
347	34	7	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a short to the Ground to the Platform Level Down Valve.	Check Harness for damage.
348	34	8	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
349	34	9	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3410	34	10	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3411	34	11	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3412	34	12	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3413	34	13	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
3414	34	14	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3415	34	15	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.
3416	34	16	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.
3417	34	17	JIB LIFT UP VALVE - SHORT TO GROUND	There is a short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
3418	34	18	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
3419	34	19	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
3420	34	20	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
3421	34	21	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
3422	34	22	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
3423	34	23	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
3424	34	24	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
3425	34	25	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
3426	34	26	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
<b>430</b>	<b>43</b>	<b>0</b>	<b>&lt;&lt;&lt; ENGINE &gt;&gt;&gt;</b>		
431	43	1	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	The Fuel Sensor reading is > 4.3V.	Energize fuel sensor per System Indicators
432	43	2	FUEL SENSOR - SHORT TO GROUND	The Fuel Sensor reading is < 0.2V.	Energize fuel sensor per System Indicators
433	43	3	OIL PRESSURE - SHORT TO BATTERY	The Oil Pressure Sensor reading is > 6.6V.	Deutz engine only.
434	43	4	OIL PRESSURE - SHORT TO GROUND	The Oil Pressure Sensor reading is < 0.1V for more then 5 seconds.	Deutz engine only. - Not reported during engine start.
435	43	5	COOLANT TEMPERATURE - SHORT TO GROUND	The Coolant Temperature Sensor reading is < 0.1V.	Deutz engine only.
436	43	6	FORD FAULT CODE ##	All ford fault codes except 63 are simply passed through from the Ford ECM. They only occur if a Ford Engine is selected in the machine configuration digits. Can be reported during power-up sequence.	

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
437	43	7	ENGINE TROUBLE CODE	Displays engine SPN/FMI code.	Report and log in Help If [(MACHINE SETUP > DEUTZ EMR2) or (MACHINE SETUP > DEUTZ EMR4) and SPN:FMI = 535:7], prohibit engine cranking.
438	43	8	HIGH ENGINE TEMP	(Ford engine only) The engine temperature is > 117 C. (Deutz engine only) The engine temperature is > 130 C.	Ford / Deutz engine only.
439	43	9	AIR FILTER BYPASSED	The Air Filter is clogged.	Check Airfilter for clogging
4310	43	10	NO ALTERNATOR OUTPUT	Battery voltage is < 11.5 volts for more then 15 seconds after engine start.	Activate the No Charge indicator J4-26 per System Indicators.
4311	43	11	LOW OIL PRESSURE	(Ford engine only) The ECM has reported a low oil pressure fault. (Deutz engine only) Oil pressure is < 8 PSI for more then 10 seconds after engine start.	Ford / Deutz engine only.
4312	43	12	485 COMMUNICATIONS LOST	This fault only occurs with a Ford Engine. It occurs when no response are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
4313	43	13	THROTTLE ACTUATOR FAILURE	The engine RPM is > XXX for more then XX seconds.	
4314	43	14	WRONG ENGINE SELECTED - ECM DETECTED	A ECM was detected with a non- ECM type engine selected.	
4322	43	22	LOSS OF ENGINE SPEED SENSOR	The engine RPM sensor indicates 0 RPM AND the Oil Pressure Sensor indicates > 8 PSI for three seconds.	Diesel engine only.
4323	43	23	SPEED SENSOR READING INVALID SPEED	The engine RPM sensor indicates > 4000 RPM.	Diesel engine only.
4331	43	31	SOOT LOAD WARNING - LOW	SPN/FMI 3719 / 16 3703 / 31	Check Engine.
4332	43	32	SOOT LOAD WARNING - HIGH	SPN/FMI 3719 / 0 3714 / 31	Check Engine.
4333	43	33	SOOT LOAD WARNING - SEVERE	SPN/FMI 3715 / 31	Check Engine.
4334	43	34	ENGINE COOLANT - LOW LEVEL	MACHINE SETUP > ENGINE = DEUTZ EMR4; ECM transmits a J1939 DM1 message for an engine coolant low level fault (SPN:FMI 111:1) on CAN2 or uses the J1939 Transport Protocol every one second to send this information if multiple engine faults exist.	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28.
<b>440</b>	<b>44</b>	<b>0</b>	<b>&lt;&lt;&lt; BATTERY SUPPLY &gt;&gt;&gt;</b>		
441	44	1	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	Battery voltage is < 9V.	
442	44	2	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	Battery voltage is > 16V.	
445	44	5	BATTERY VOLTAGE LOW	Battery voltage is < 11V for more then 5 seconds.	

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
<b>660</b>	<b>66</b>	<b>0</b>	<b>&lt;&lt;&lt;COMMUNICATION&gt;&gt;&gt;</b>		
662	66	2	CANBUS FAILURE - PLATFORM MODULE	Platform Module CAN communication lost.	
664	66	4	CANBUS FAILURE - ACCESSORY MODULE	The accessory module is not receiving CAN messages. This is probably due to wiring problem.	Check the Wiring.
666	66	6	CANBUS FAILURE - ENGINE CONTROLLER	Engine Control Module CAN	ECM equipped engine only.
6620	66	20	CANBUS FAILURE - UMS SENSOR	communication lost.	
6622	66	22	CANBUS FAILURE - TCU MODULE	Machine Setup/ Telematics=YES, No device heartbeat for 30 sec	
6623	66	23	CANBUS FAILURE - GATEWAY MODULE	Machine Setup/ Telematics=YES, No device heartbeat for 30 sec	
6629	66	29	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH		
6657	66	57	CANBUS FAILURE - TEMPERATURE SENSOR	MACHINE SETUP > TEMP CUTOUT = YES; UGM does not receive any CAN messages from the Ambient Temperature sensor in 250ms	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
671	67	1	ACCESSORY FAULT		
<b>680</b>	<b>68</b>	<b>0</b>	<b>&lt;&lt;&lt;TELEMATICS&gt;&gt;&gt;</b>		
681	68	1	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP		
<b>810</b>	<b>81</b>	<b>0</b>	<b>&lt;&lt;&lt;TILT SENSOR&gt;&gt;&gt;</b>		
813	81	3	CHASSIS TILT SENSOR NOT CALIBRATED	The Chassis Tilt Sensor has not been calibrated.	
815	81	5	CHASSIS TILT SENSOR DISAGREEMENT		
816	81	6	UMS SENSOR NOT CALIBRATED	The Control System detects a sensor out of range condition or a not calibrated fault with UMS angle sensor	
817	81	7	UMS SENSOR FAULT	The system detects that the UMS sensor frequency outside the 100Hz +/- 5Hz range or the duty cycle is outside 50% +/- 21% Range	
<b>820</b>	<b>82</b>	<b>0</b>	<b>&lt;&lt;&lt;PLATFORM LOAD SENSE&gt;&gt;&gt;</b>		
825	82	5	LSS HAS NOT BEEN CALIBRATED	The Load Sensing System Module has not been calibrated.	UGM to set Platform Load State = Overloaded

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
826	82	6	RUNNING AT CREEP - PLATFORM OVERLOADED	All functions at creep, the Load Sensing System indicates the Platform is overloaded AND is configured to warn only while the Platform is overloaded.	
827	82	7	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	Driving and boom functions are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent drive and boom functions while the Platform is overloaded.	
828	82	8	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	Lift up and telescope out are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent Lift up and telescope out while the Platform is overloaded.	
8639	86	39	FRONT LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Left Steer Valve	Check Harness for damage.
8640	86	40	FRONT LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Left Steer Valve	Check Harness for damage.
8641	86	41	FRONT LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Left Steer Valve	Check Harness for damage.
8642	86	42	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Right Steer Valve	Check Harness for damage.
8643	86	43	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Right Steer Valve	Check Harness for damage.
8644	86	44	FRONT RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Right Steer Valve	Check Harness for damage.
8645	86	45	REAR LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Left Steer Valve	Check Harness for damage.
8646	86	46	REAR LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Left Steer Valve	Check Harness for damage.
8647	86	47	REAR LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Left Steer Valve	Check Harness for damage.
8648	86	48	REAR RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Right Steer Valve	Check Harness for damage.
8649	86	49	REAR RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Right Steer Valve	Check Harness for damage.
8650	86	50	REAR RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Right Steer Valve	Check Harness for damage.
871	87	1	RETURN FILTER BYPASSED	Hydraulic Return Filter Clogged	Check Hydraulic Return Filter.
872	87	2	CHARGE PUMP FILTER BYPASSED	Charge Pump Filter Clogged	Check Charge Pump Filter.
873	87	3	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	MSSO = Active	Response described in MSSO Influence on Machine Operation section.

Table 6-13. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
998	99	8	EEPROM FAILURE - CHECK ALL SETTINGS	The Ground Module has reported an EEPROM failure.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start); reset the section of EEPROM where the failure occurred to defaults.
9910	99	10	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	The Platform Module software version is not compatible with the rest of the system.	Activate the platform alarm continuously Creep mode is active If Platform Mode is active, disable all Drive, Steer, and Boom functions and do not permit Machine Enable.
9914	99	14	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	The Platform Module software requires an update.	
9915	99	15	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	The Chassis Tilt Sensor gain calibration has been lost.	
9916	99	16	CHASSIS TILT SENSOR GAIN OUT OF RANGE	The Chassis Tilt Sensor gain calibration has become corrupted.	
9919	99	19	GROUND SENSOR REF VOLTAGE OUT OF RANGE	The Ground Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9920	99	20	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	The Platform Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9921	99	21	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	The Ground Module has reported that its high side driver cutout failed.	
9922	99	22	PLATFORM MODULE FAILURE - HWFS CODE 1	The Platform Module has reported that the V(Low) FET has failed.	
9923	99	23	GROUND MODULE FAILURE - HWFS CODE 1	The Ground Module has reported that the V(Low) FET has failed.	
9924	99	24	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	The machine is powered up and no model has been selected yet in the MACHINE SETUP menu	Display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP->MODEL NUMBER Do not report any other faults Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
9944	99	44	CURRENT FEEDBACK GAINS OUT OF RANGE	The factory set current feedback gains are out of range.	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-13. Diagnostic Trouble Code Chart**

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
9945	99	45	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	The factory set current feedback checksum is not correct.	
9979	99	79	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Temporary fault for the telematics project. The model needs to be a 600S or 1350S if not this fault will be generated and Platform controls will be prevented. This fault was to ensure that the software will only work for these two models.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).

## SECTION 7. BASIC ELECTRICAL INFORMATION & SCHEMATICS

### 7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop.

**NOTE:** *Some of the procedures/connectors shown in this section may not be applicable to all models.*

### 7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

#### Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

#### Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

#### Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the Voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

#### Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the lead on the other port goes to the positive side of the signal.

#### Scale

M = Mega = 1,000,000 \* (Displayed Number)

k = kilo = 1,000 \* (Displayed Number)

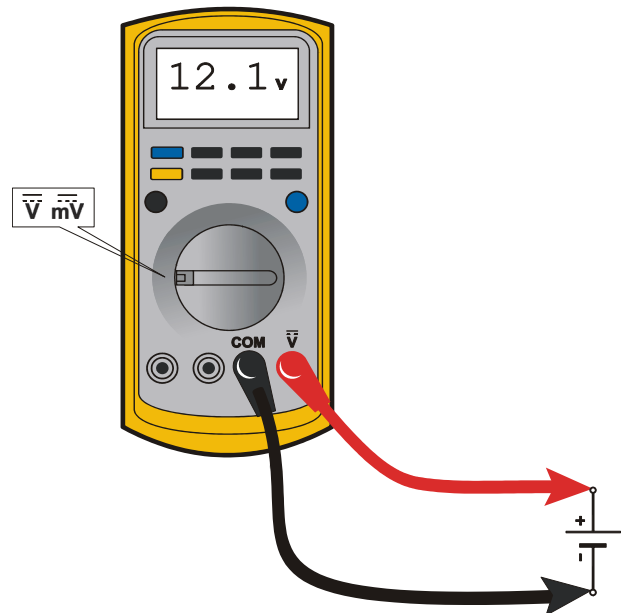
m = milli = (Displayed Number) / 1,000

$\mu$  = micro = (Displayed Number) / 1,000,000

Example: 1.2 kW = 1200 W

Example: 50 mA = 0.05 A

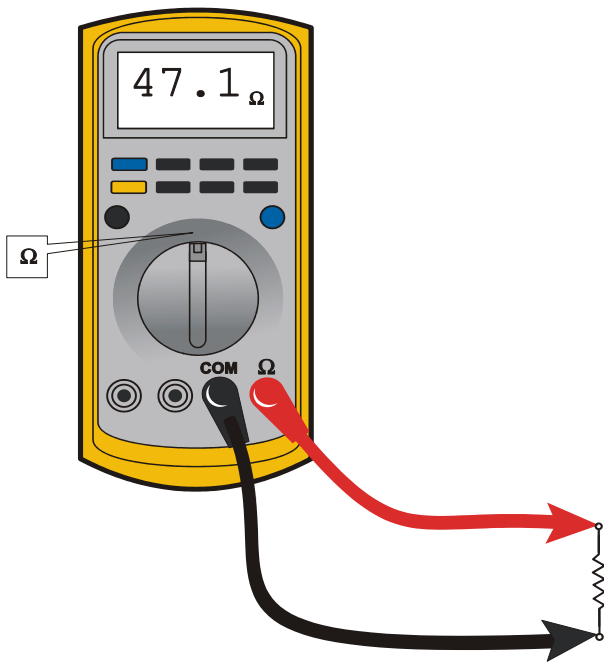
#### Voltage Measurement



**Figure 7-1. Voltage Measurement (DC)**

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual).
- Use firm contact with meter leads.

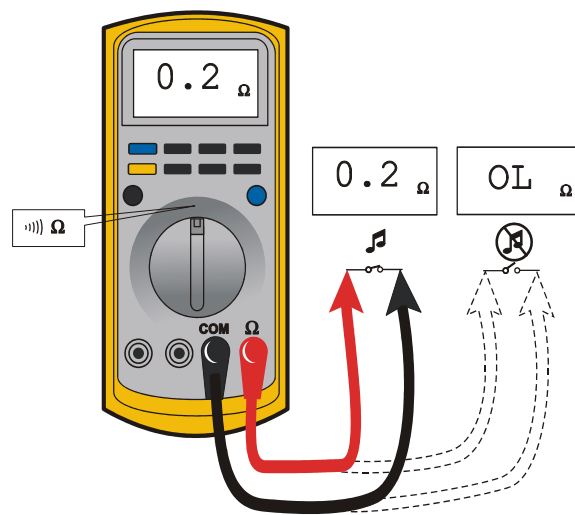
### Resistance Measurement



**Figure 7-2. Resistance Measurement**

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance).
- Circuit power must be turned OFF before testing resistance.
- Disconnect component from circuit before testing.
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual).
- Use firm contact with meter leads.

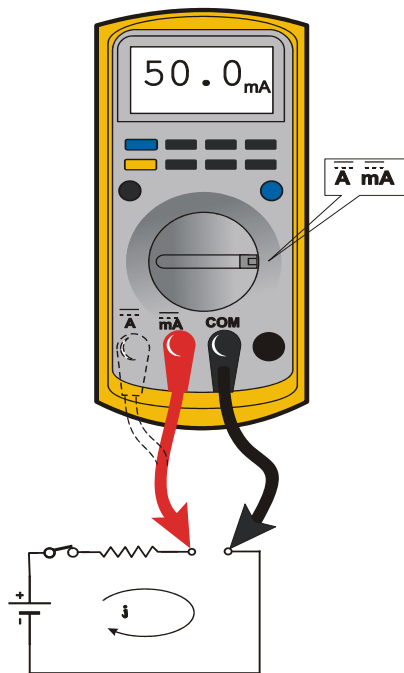
### Continuity Measurement



**Figure 7-3. Continuity Measurement**

- Some meters require a separate button press to enable audible continuity testing.
- Circuit power must be turned OFF before testing continuity.
- Disconnect component from circuit before testing.
- Use firm contact with meter leads.
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity.

## Current Measurement



**Figure 7-4. Current Measurement (DC)**

- Set up the meter for the expected current range.
- Be sure to connect the meter leads to the correct jacks for the current range you have selected.
- If meter is not auto ranging, set it to the correct range (See multi meter's operation manual).
- Use firm contact with meter leads.

## 7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

**NOTE:** This section is not applicable for battery terminals.

### NOTICE

JLG P/N 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.

**NOTE:** Do NOT apply dielectric grease to the following connections:

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

**NOTE:** Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

**NOTE:** This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.

- Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

**NOTE:** *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

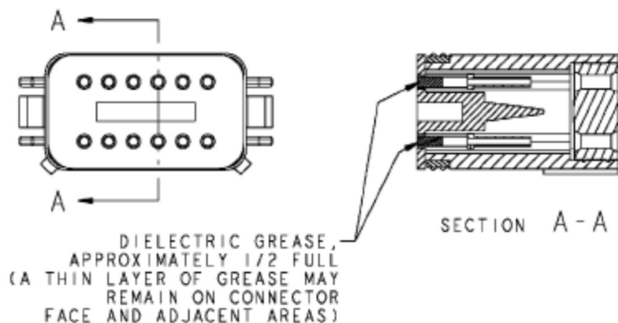
When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

Dielectric grease could be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

**Installation of Dielectric Grease**

Before following these instructions, refer to excluded connector types (See Exclusions below).

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to the female contact (fill it approximately 1/2 full; see example below).
- Leave a thin layer of dielectric grease on the face of the connector.
- Assemble the connector system immediately to prevent moisture ingress or dust contamination.
- Pierce one of the unused wire seals prior to assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.



**Deutsch HD, DT, DTM, DRC Series**

The Deutsch connector system is commonly used for harsh environment interconnect. Follow the installation instructions.



**AMP Seal**

The AMP Seal connector system is used on the Control ADE Platform and Ground Modules.

Apply dielectric grease to the male contact. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug (JLG #4460905) to prevent moisture ingress.

Note that seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and then corrected).



**Figure 7-5. Application to Male Contacts**

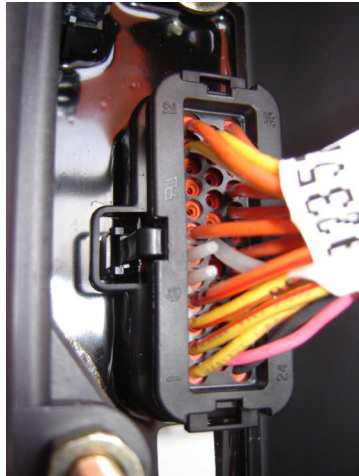


Figure 7-6. Use of Seal Plugs

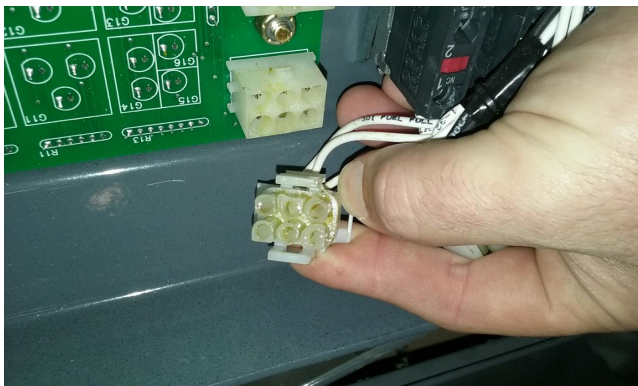
### DIN Connectors

This connector is typically used on hydraulic valves. Follow the installation instructions.



### AMP Mate-N-Lok

This connector system is widely used inside enclosures for general purpose interconnect. Follow the installation instructions



**Exclusions**

A limited number of connectors do not benefit from dielectric grease, or may be permanently damaged by application. Dielectric grease may not be required in properly sealed enclosures.

**BRAD HARRISON / PHOENIX CONTACT M12**

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to achieve electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required). The JLG Load Sensing System and Rotary Angle Sensors are examples of components with the M12 connector system.



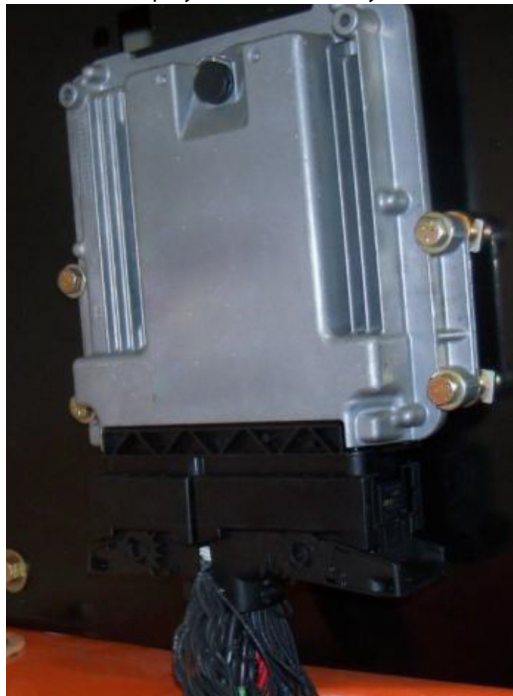
Figure 7-7. Brad-Harrison M12



Figure 7-8. Phoenix Contact M12

**AMP JUNIOR TIMER**

These connectors use back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The EMR2 engine control module from Deutz employs this connector system (for example).



**SEALED ENCLOSURES**

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP66 (dust tight; protected from powerful jets of water). The enclosure must be fitted with a high quality, continuous gasket and all wiring must pass through cable entrances.



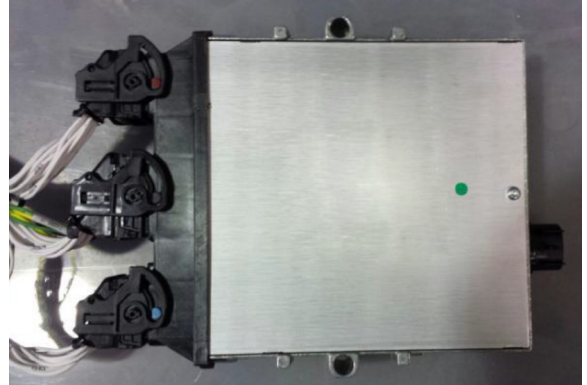
**MIL-C-5015 SPEC CONNECTOR'S**

Crown Connector Inc's recommendation is to not use dielectric grease for this series connector. For similar model series connectors, the manufacturer should be contacted for confirmation before applying dielectric grease. A typical application for this connector is on David Clark Intercom connections in Aerial Work Platforms.



**MOLEX CMC SERIES CONNECTORS**

The CMC connector family is a sealed, high-density connection system using matte-seal technology for CP 0.635 and 1.50 mm terminals. To guarantee IP6K7 and IP6K9 sealing, a seal plug option is used. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The flexbox control modules from JDES employ this connector system (for example).



## 7.4 AMP CONNECTOR

### Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

### Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-9.). Proceed as follows:

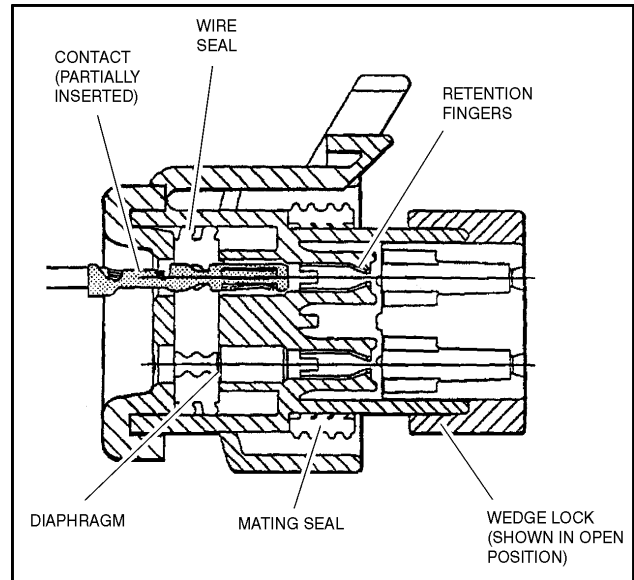


Figure 7-9. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-11.).
2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 7-11.).

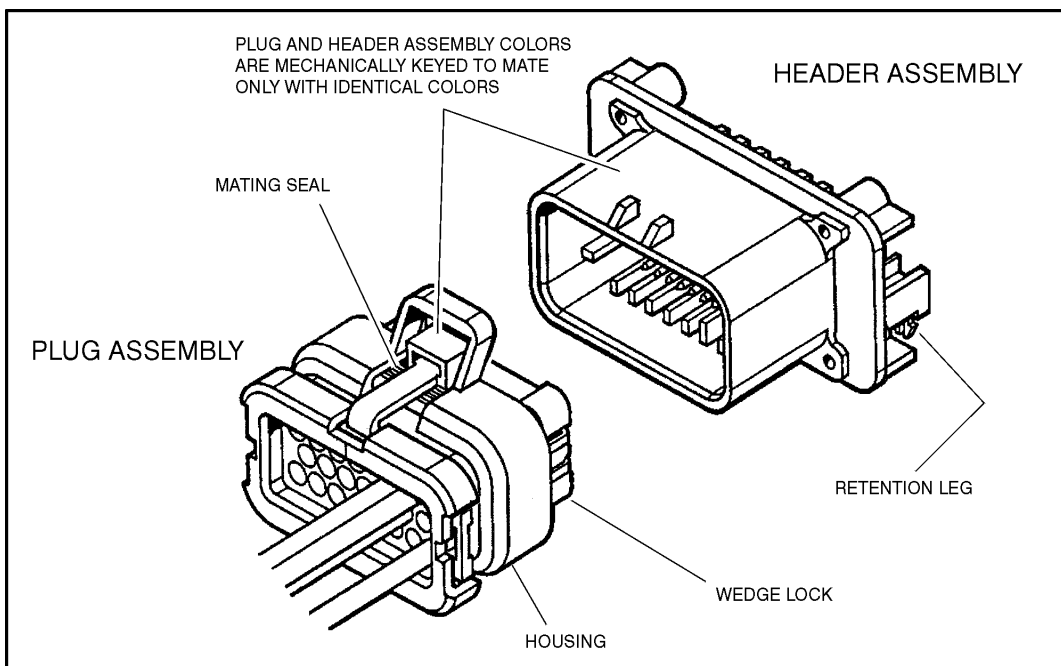


Figure 7-10. AMP Connector

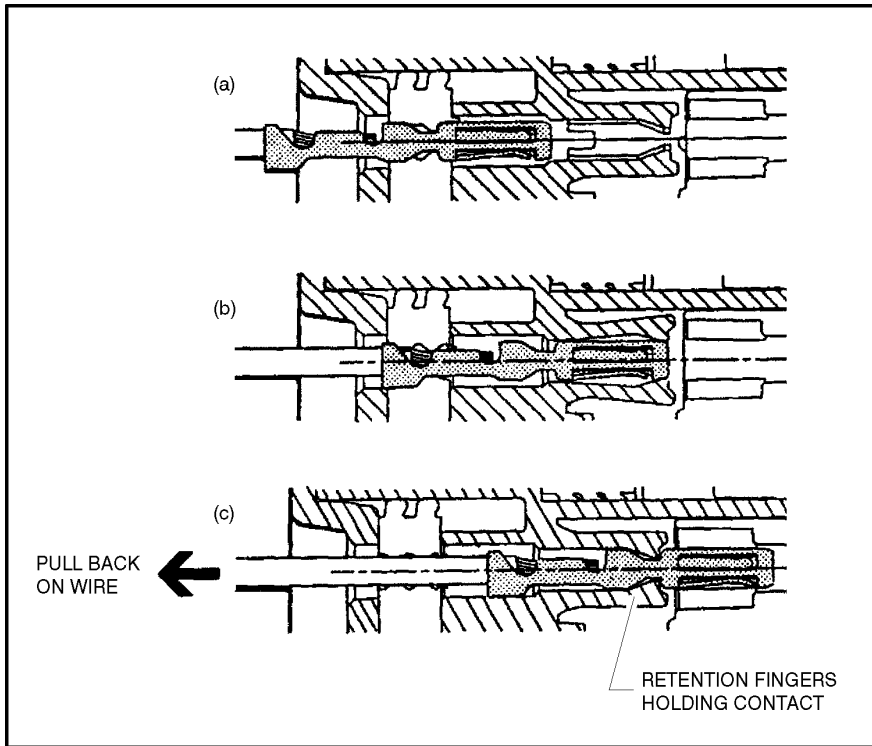


Figure 7-11. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-12.).

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-13.).

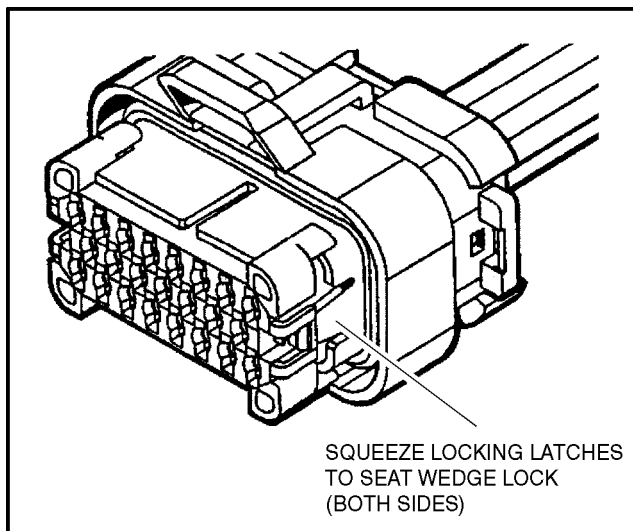


Figure 7-12. Connector Assembly Figure 3

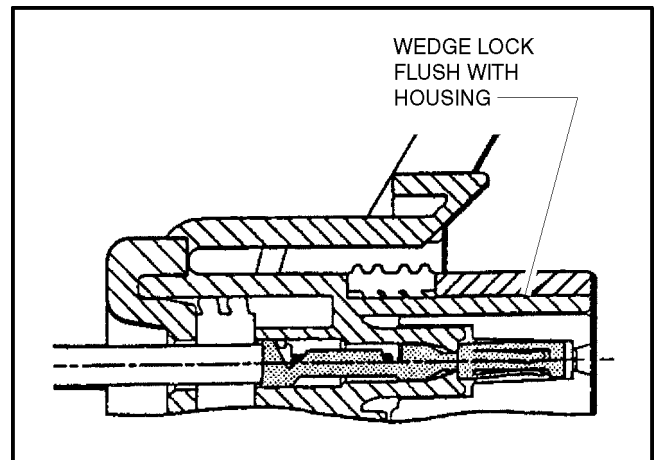


Figure 7-13. Connector Assembly Figure 4

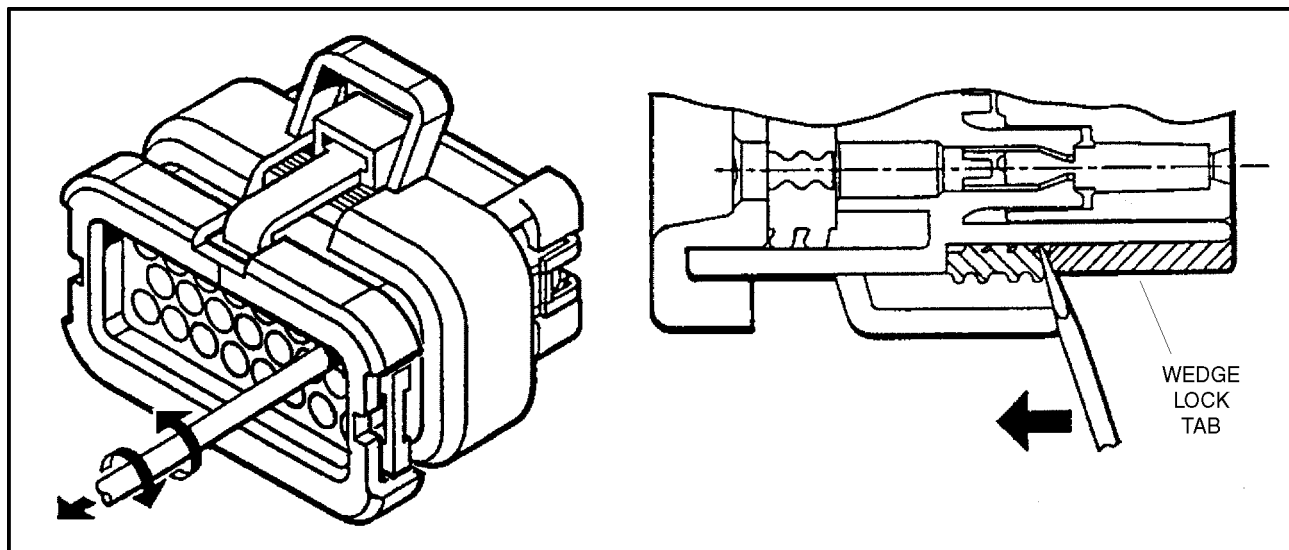


Figure 7-14. Connector Disassembly

### Disassembly

5. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
6. Pry open the wedge lock to the open position.
7. While rotating the wire back and forth over a half turn (1/4 turn in each direction), gently pull the wire until the contact is removed.

**NOTE:** The wedge lock should never be removed from the housing for insertion or removal of the contacts.

### Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field, by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

### Service - Voltage Reading

#### **NOTICE**

**DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.**

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

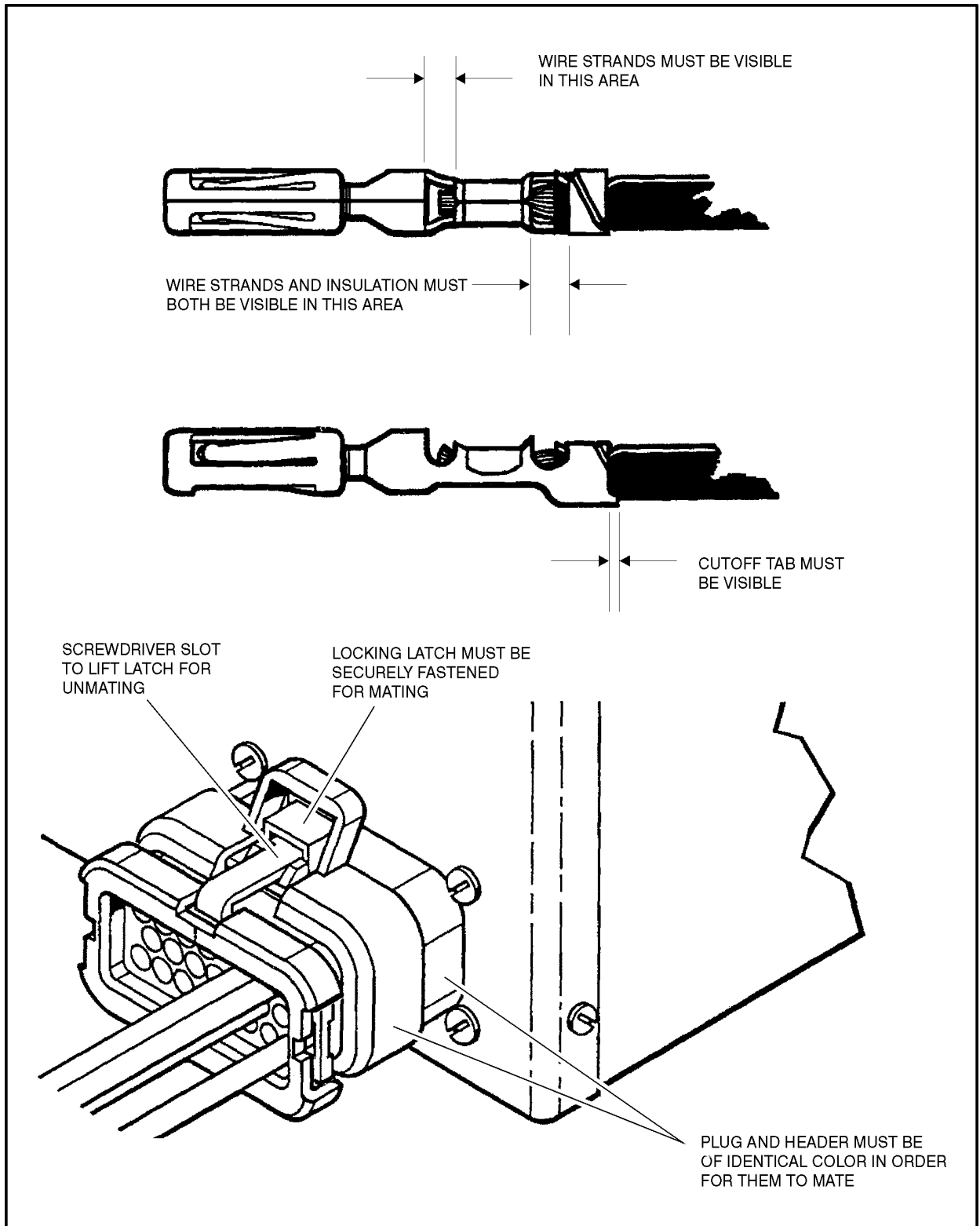


Figure 7-15. Connector Installation

## 7.5 DEUTSCH CONNECTORS

### DT/DTP Series Assembly

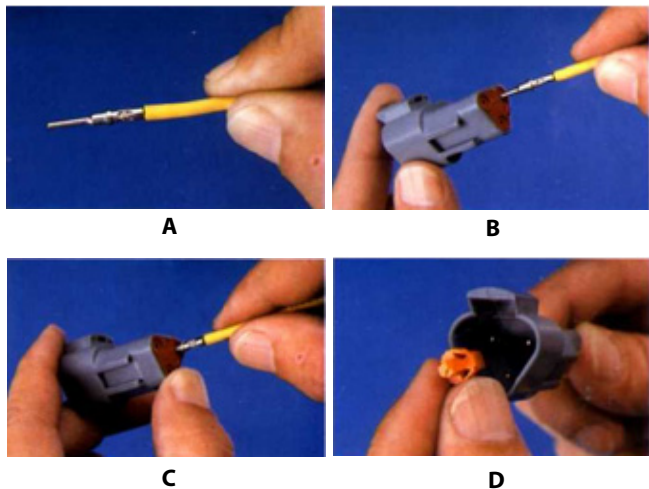


Figure 7-16. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

**NOTE:** The receptacle is shown - use the same procedure for plug.

### DT/DTP Series Disassembly

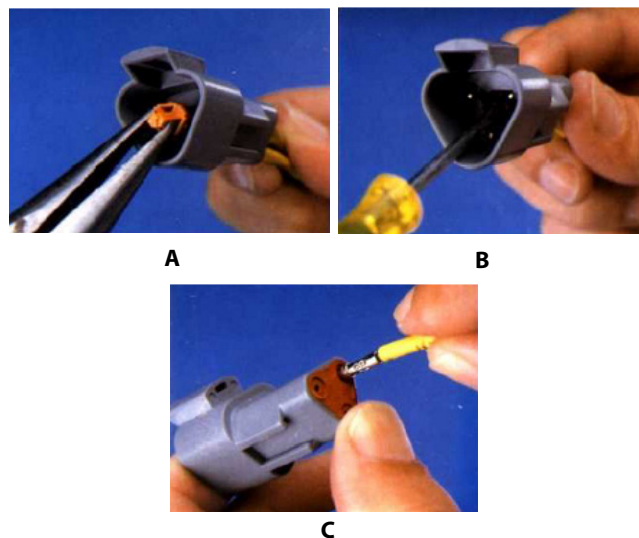
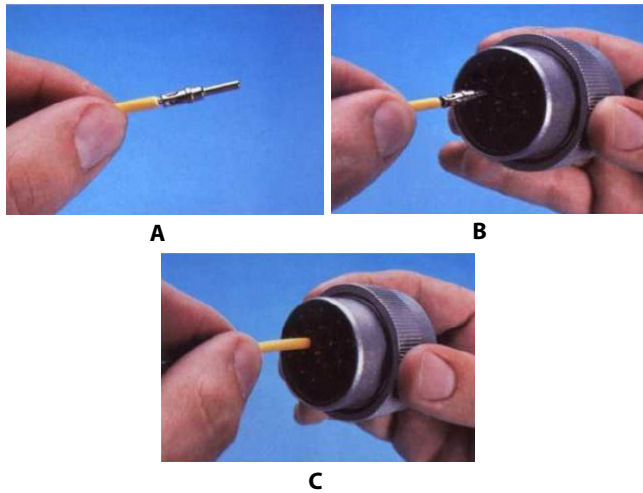


Figure 7-17. DT/DTP Contact Removal

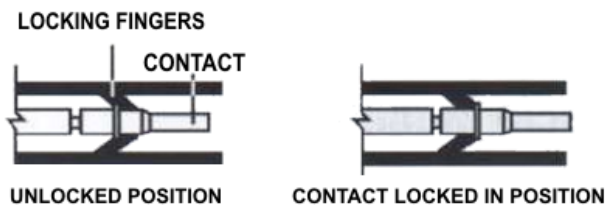
5. Remove wedgelock using needle nose pliers or a hook shaped wire to pull wedge straight out.
6. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.
7. Hold the rear seal in place, as removing the contact may displace the seal.

**HD30/HDP20 Series Assembly**



**Figure 7-18. HD/HDP Contact Installation**

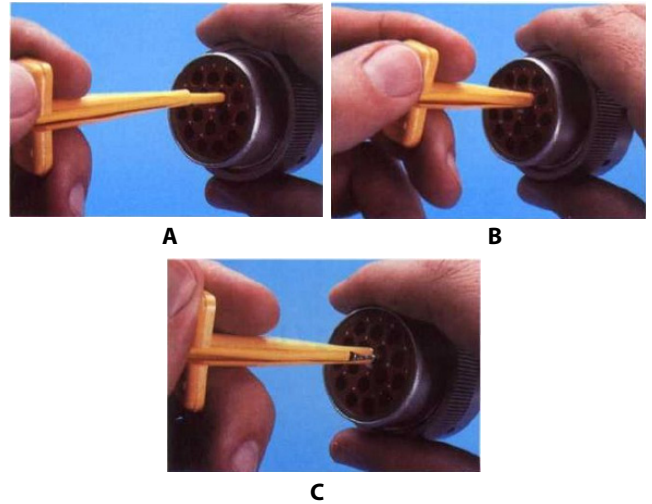
8. Grasp contact about 25mm behind the contact crimp barrel.
9. Hold connector with rear grommet facing you.
10. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.



**Figure 7-19. HD/HDP Locking Contacts Into Position**

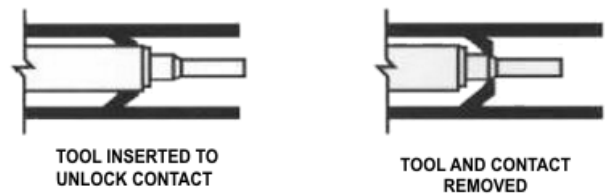
**NOTE:** For unused wire cavities, insert sealing plugs for full environmental sealing.

**HD30/HDP20 Series Disassembly**



**Figure 7-20. HD/HDP Contact Removal**

11. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
12. Slide tool along into the insert cavity until it engages contact and resistance is felt.
13. Pull contact-wire assembly out of connector.



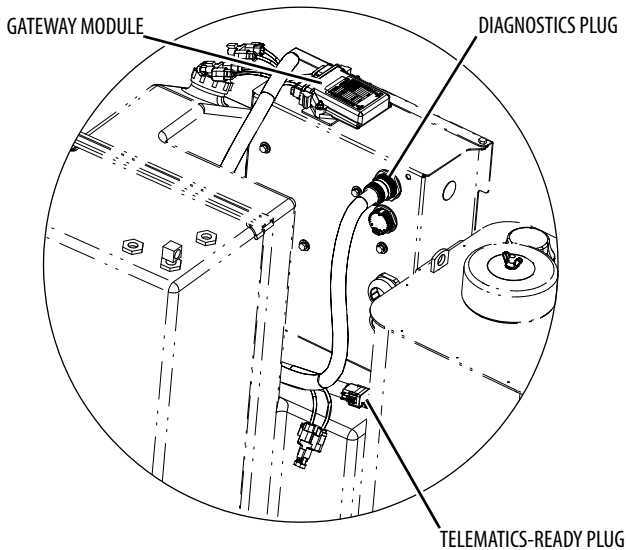
**Figure 7-21. HD/HDP Unlocking Contacts**

**NOTE:** Do Not twist or insert tool at an angle.

**7.6 TELEMATICS GATEWAY**

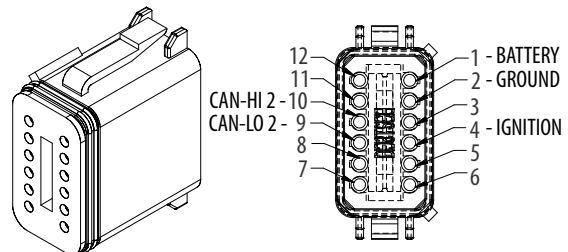
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

JLG LABEL	DESCRIPTION	UNIT
Engine Speed	Actual engine speed.	RPM
DEF Tank Level (If Equipped)	Indicates the level of DEF (diesel exhaust fluid) within the DEF tank if the machine is equipped with DEF tank. <ul style="list-style-type: none"> <li>• 0% = Empty</li> <li>• 100% = Full</li> </ul>	Percentage (%)
JLG Machine Faults: Active / Not-Active	<ul style="list-style-type: none"> <li>• 00 - No Machine Faults</li> <li>• 01 - Active Machine Fault</li> <li>• 10 - Error</li> <li>• 11 - Not available</li> </ul>	Bit
Total Idle Fuel Used	Total amount of fuel used during vehicle operation during idle conditions.	Liters
Total Idle Hours	Total time of engine operation during idle conditions.	Seconds
Total Engine Hours	Total time of engine operation.	Seconds
Total Fuel Used	Total amount of fuel used during vehicle operation.	Liters
Fuel Rate	Amount of fuel consumed by engine per unit of time.	Liters/Hour
Fuel Level	Ratio of fuel volume to the total volume of the fuel storage container. When a low fuel limit switch is present, the fuel level will indicate "full" until the switch opens, which will then indicate 10% fuel remaining.  When Fuel Level 2 (SPN 38) is not used, Fuel Level 1 represents the total fuel in all fuel storage containers. When Fuel Level 2 is used, Fuel Level 1 represents the fuel level in the primary or left side fuel storage container.	Percentage (%)
DM1 Engine Faults	Shows actual engine fault codes.	N/A



**Telematics-Ready (TCU) Plug**

The telematics-ready (TCU) plug is a standard 12-pin Deutsch connector. Pin-out locations are shown below:



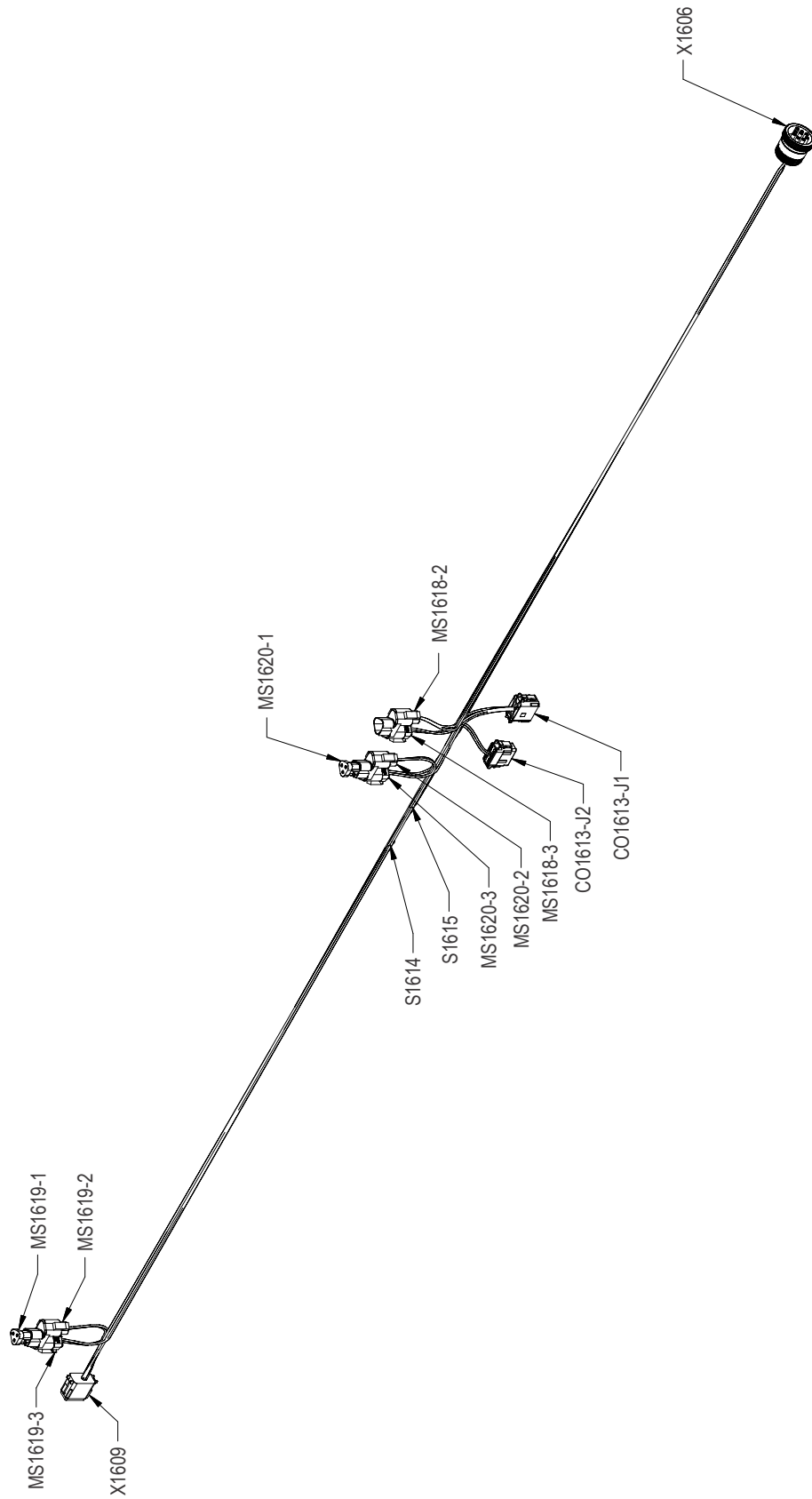


Figure 7-22. Telematics Gateway Harness - Sheet 1 of 3

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**

X1609 (TCU)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-0 BAT	16 AWG	GXL	X1606 (B)
2	BLK	0-0 GND	16 AWG	GXL	S1615 (1)
4	ORN	2-0 IGN	16 AWG	GXL	S1614 (1)
9	GRN	CANL2	18 AWG	GXL	MS1619-2 (B)
10	YEL	CANH2	18 AWG	GXL	MS1619-2 (A)

MS1619-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	X1609 (10)
B	GRN	CANL2	18 AWG	GXL	X1609 (9)

MS1619-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1620-2 (A)
B	GRN	CANL2	18 AWG	GXL	MS1620-2 (B)

CO1613-J1 (GATEWAY 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CAN1	18 AWG	GXL	MS1618-2 (B)
10	YEL	CANH1	18 AWG	GXL	MS1618-2 (A)
11	BLK	0-2 GND	16 AWG	GXL	S1615 (2)
12	ORN	2-2 IGN	16 AWG	GXL	S1614 (2)

CO1613-J2 (GATEWAY 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CANL2	18 AWG	GXL	MS1620-3 (B)
10	YEL	CANH2	18 AWG	GXL	MS1620-3 (A)

MS1620-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1619-3 (A)
B	GRN	CANL2	18 AWG	GXL	MS1619-3 (B)

MS1620-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	CO1613-J2 (10)
B	GRN	CANL2	18 AWG	GXL	CO1613-J2 (9)

S1614					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORN	2-0 IGN	16 AWG	GXL	X1609 (4)
2	ORN	2-1 IGN	16 AWG	GXL	X1606 (H)
2	ORN	2-2 IGN	16 AWG	GXL	CO1613-J1 (12)

S1615					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-0 GND	16 AWG	GXL	X1609 (2)
2	BLK	0-1 GND	16 AWG	GXL	X1606 (A)
2	BLK	0-2 GND	16 AWG	GXL	CO1613-J1 (11)

MS1618-2 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	CO1613-J1 (10)
B	GRN	CANL1	18 AWG	GXL	CO1613-J1 (9)

MS1618-3 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	X1606 (C)
B	GRN	CANL1	18 AWG	GXL	X1606 (D)

X1606 (DIAG)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-1 GND	16 AWG	GXL	S1615 (2)
B	RED	1-0 BAT	16 AWG	GXL	X1609 (1)
C	YEL	CANH1	18 AWG	GXL	MS1618-3 (A)
D	GRN	CANL1	18 AWG	GXL	MS1618-3 (B)
H	ORN	2-1 IGN	16 AWG	GXL	S1614 (2)

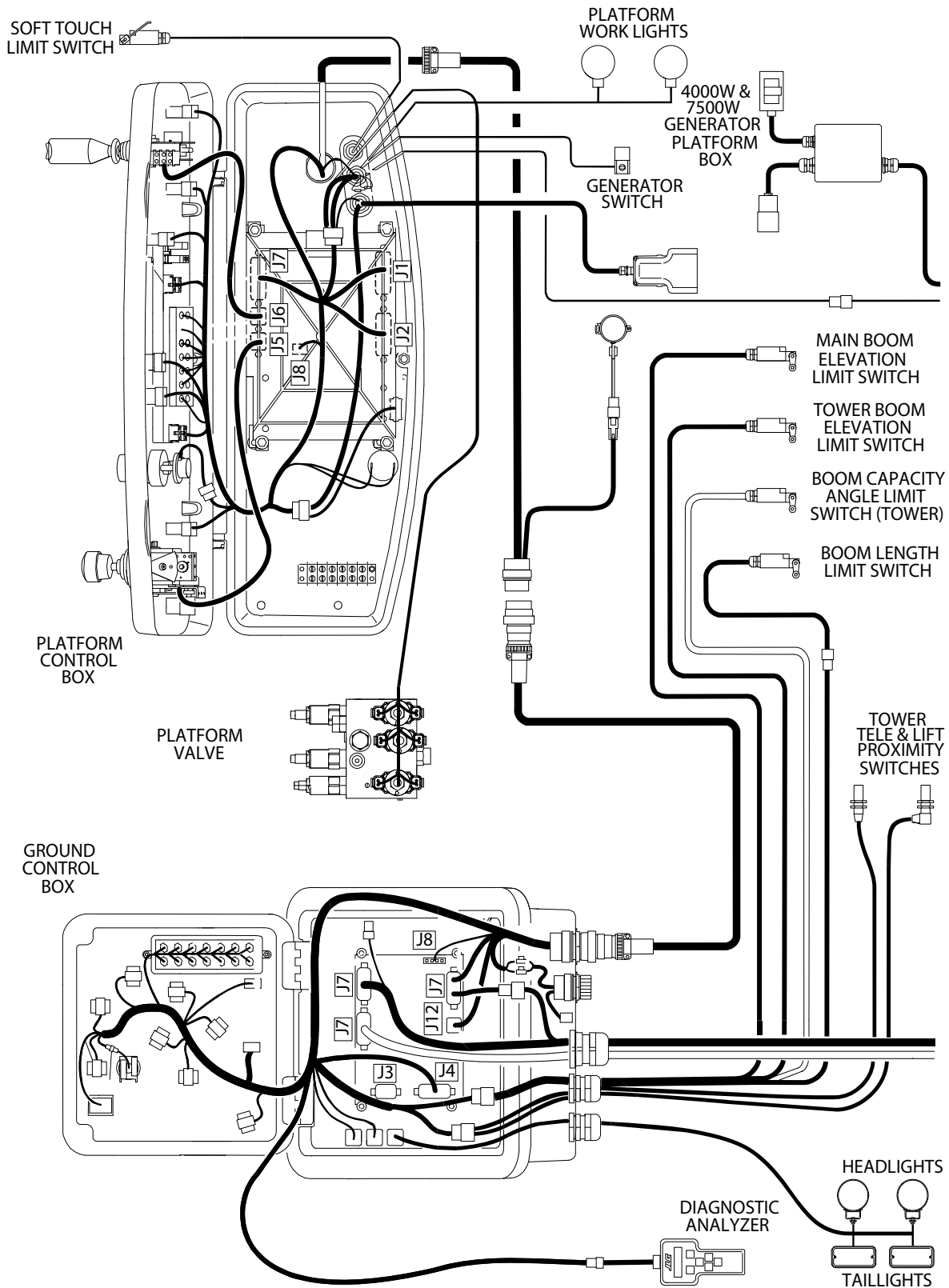
**Figure 7-23. Telematics Gateway Harness - Sheet 2 of 3**

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**

					FROM		TO	
WIRE NO.	COLOR	WIRE GAUGE	LENGTH (mm)	JACKET	REFERENCE	PIN	REFERENCE	PIN
CAN L2	GRN	18 AWG	1151	GXL	MS1619-3	B	MS1620-2	B
CAN L2	GRN	18 AWG	151	GXL	X1609	9	MS1619-2	B
CAN L1	GRN	18 AWG	157	GXL	MS1618-2	B	CO1613-J1	9
CAN L2	GRN	18 AWG	225	GXL	MS1620-3	B	CO1613-J2	9
CAN L1	GRN	18 AWG	1076	GXL	MS1618-3	B	X1606	D
CAN H2	YEL	18 AWG	155	GXL	X1609	10	MS1619-2	A
CAN H2	YEL	18 AWG	233	GXL	MS1620-3	A	CO1613-J2	10
CAN H1	YEL	18 AWG	157	GXL	MS1618-2	A	CO1613-J1	10
CAN H2	YEL	18 AWG	1150	GXL	MS1619-3	A	MS1620-2	A
CAN H1	YEL	18 AWG	1079	GXL	MS1618-3	A	X1606	C
0-0 GND	BLK	16 AWG	1006	GXL	X1609	2	S1615	1
0-1 GND	BLK	16 AWG	1145	GXL	X1606	A	S1615	2
0-2 GND	BLK	16 AWG	223	GXL	CO1613-J1	11	S1615	2
1-0 BAT	RED	16 AWG	2150	GXL	X1609	1	X1606	B
2-0 IGN	ORN	16 AWG	939	GXL	X1609	4	S1614	1
2-1 IGN	ORN	16 AWG	1212	GXL	S1614	2	X1606	H
2-2 IGN	ORN	16 AWG	287	GXL	CO1613-J1	12	S1614	2

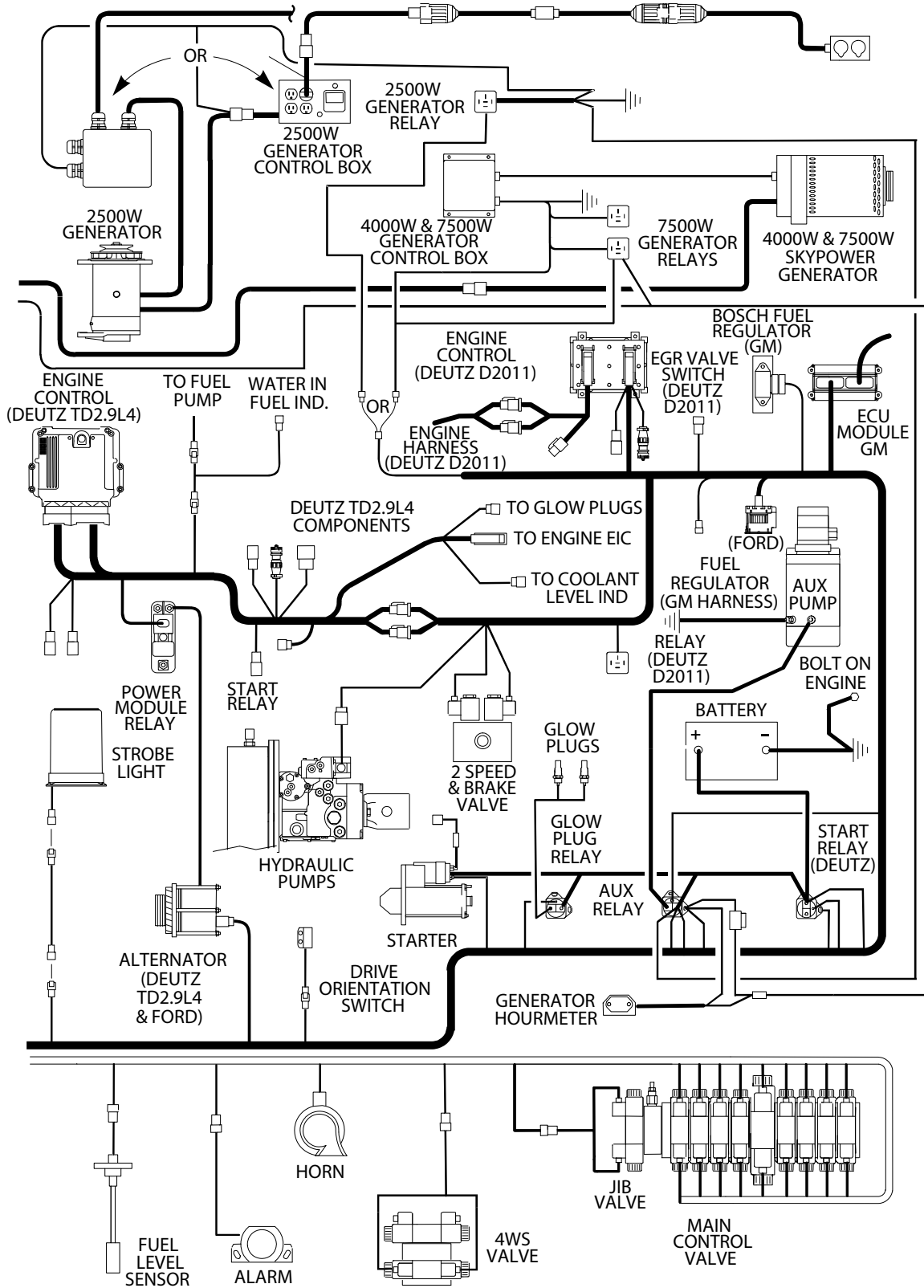
**Figure 7-24. Telematics Gateway Harness - Sheet 3 of 3**

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



MAE19440

**Figure 7-25. Electrical Components Installation - Sheet 1 of 2**

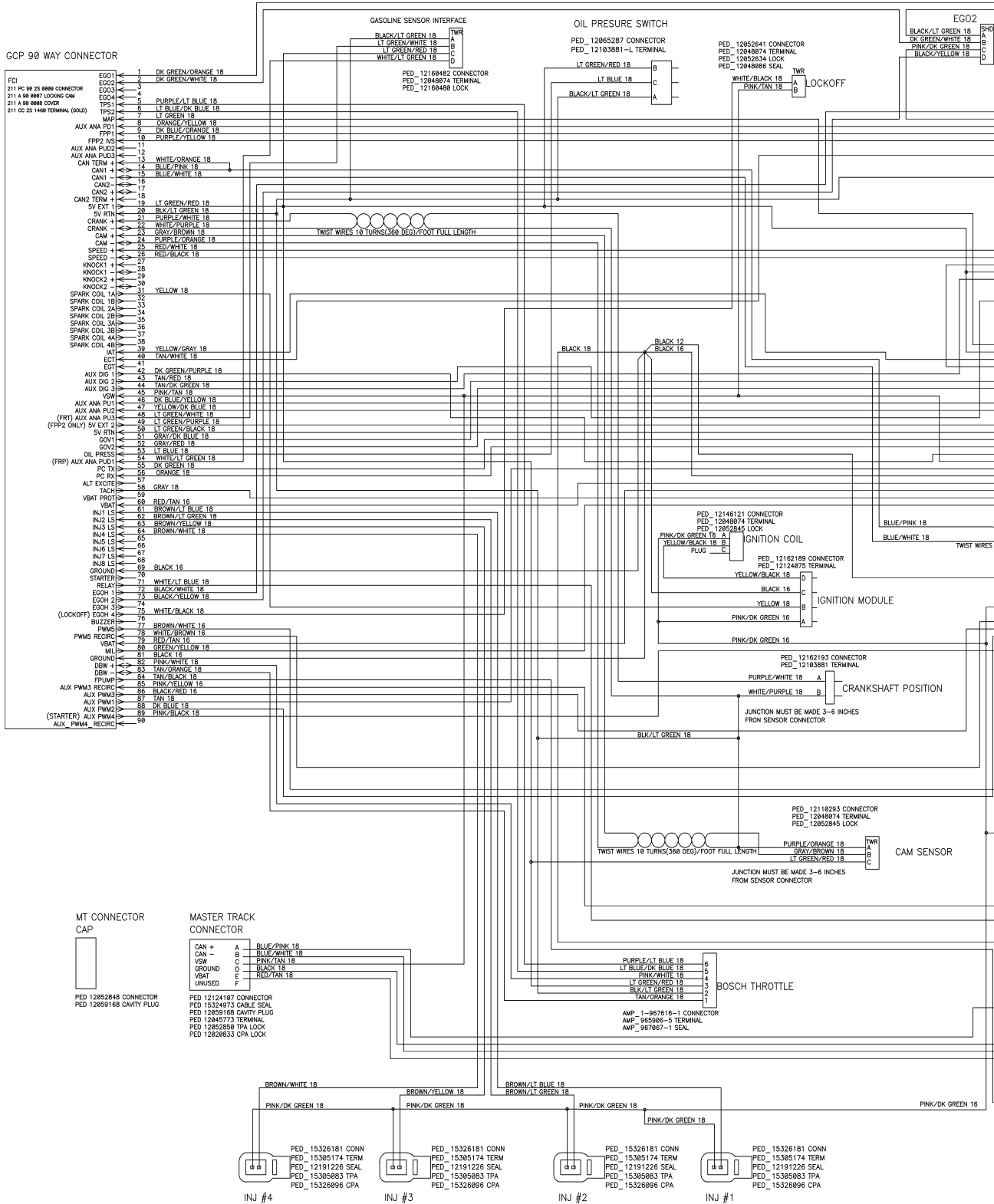


MAE19450

Figure 7-26. Electrical Components Installation - Sheet 2 of 2

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**

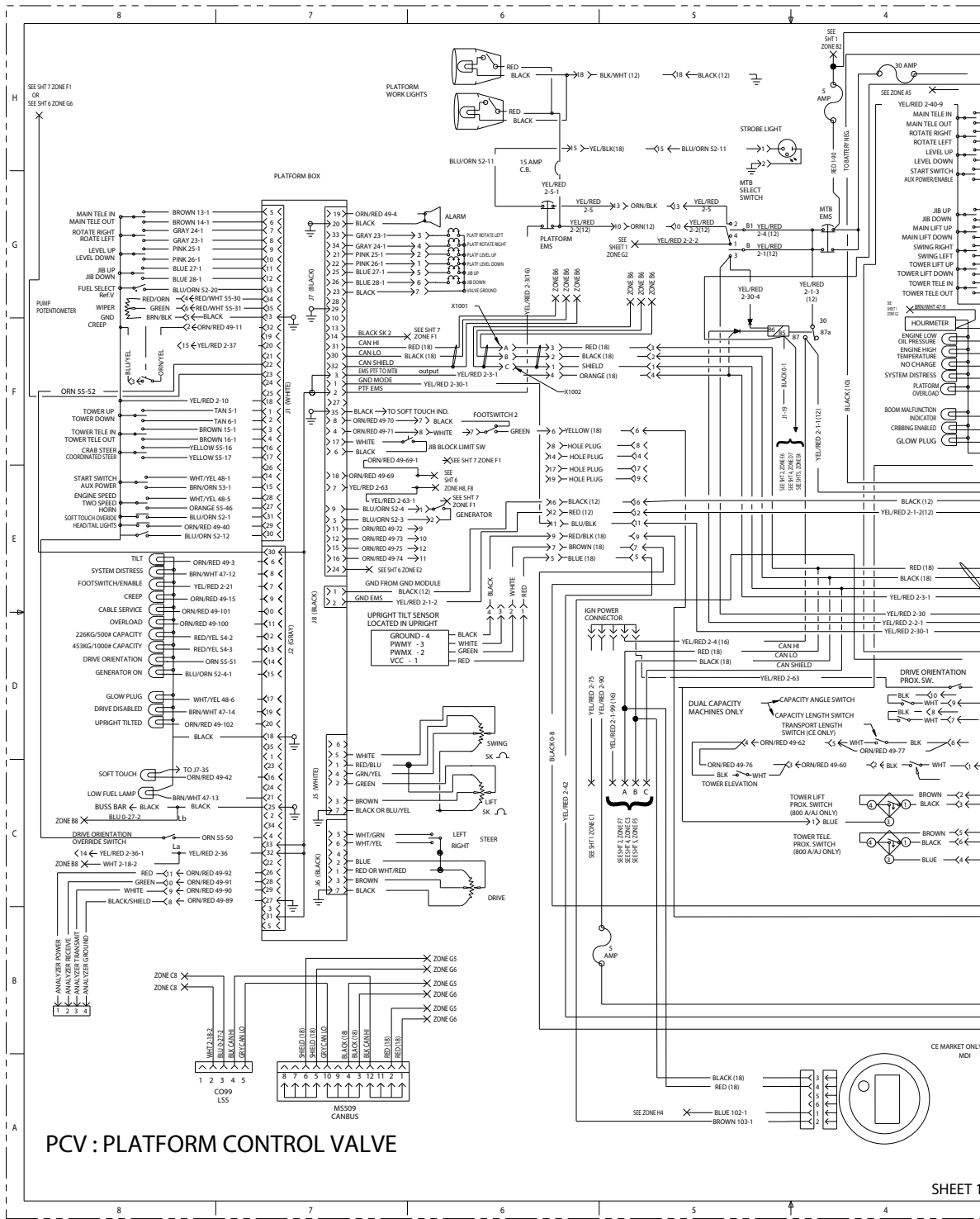
**7.7 ELECTRICAL SCHEMATIC**



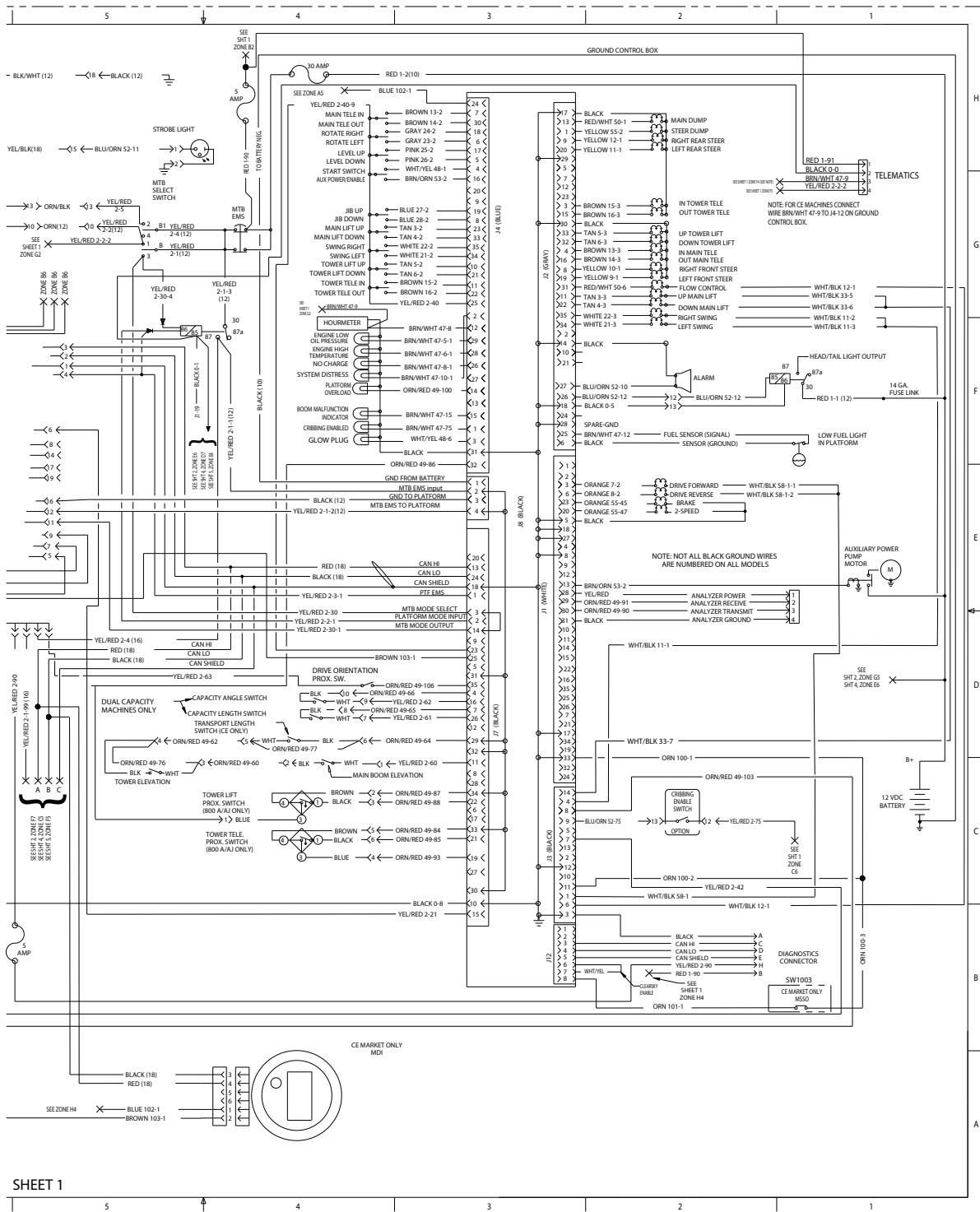
**Figure 7-27. Electrical Schematic GM - Sheet 1 of 2**



# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



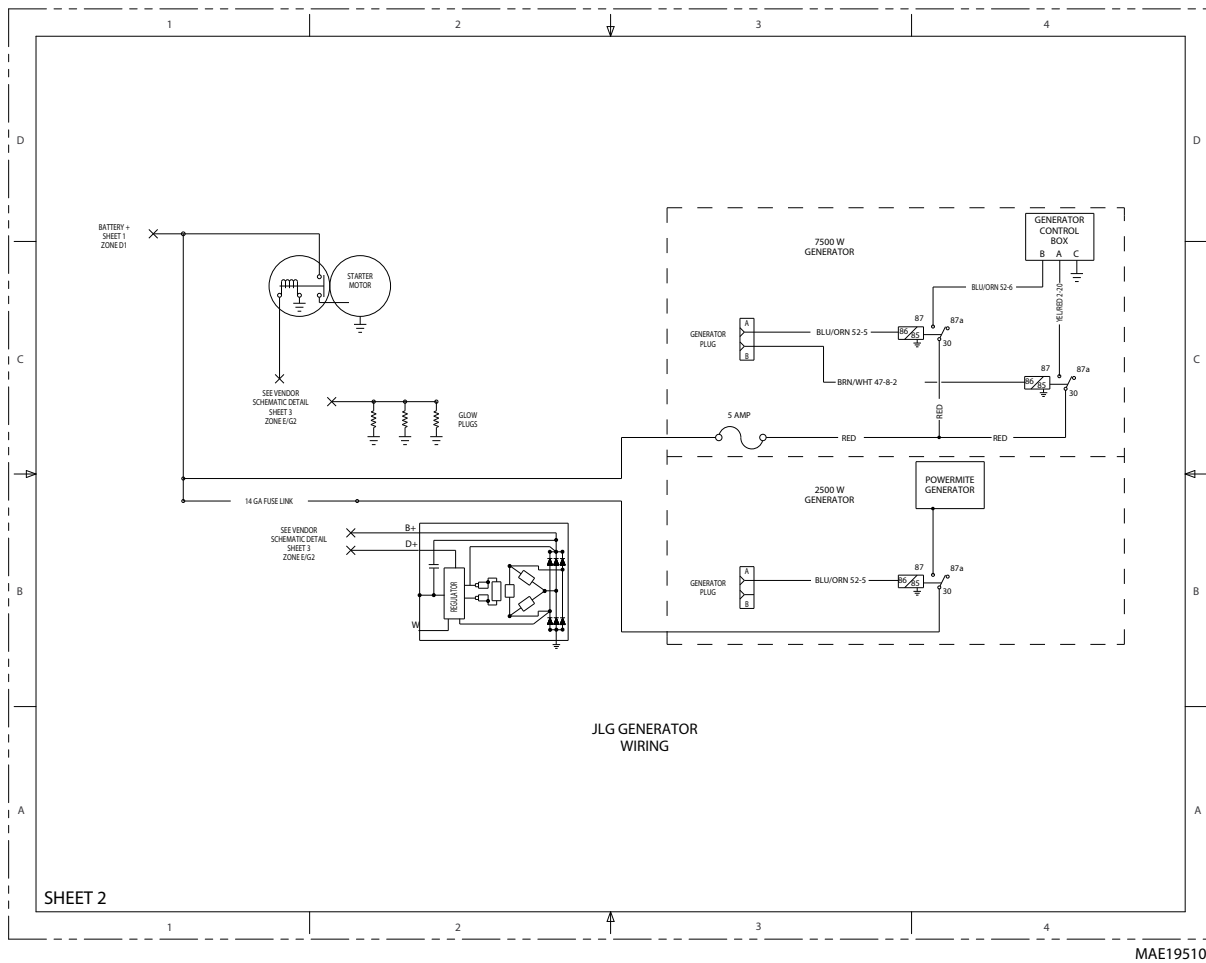
SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



MAE195001

Figure 7-30. Electrical Schematic - Sheet 2 of 13

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-31. Electrical Schematic - Sheet 3 of 13**

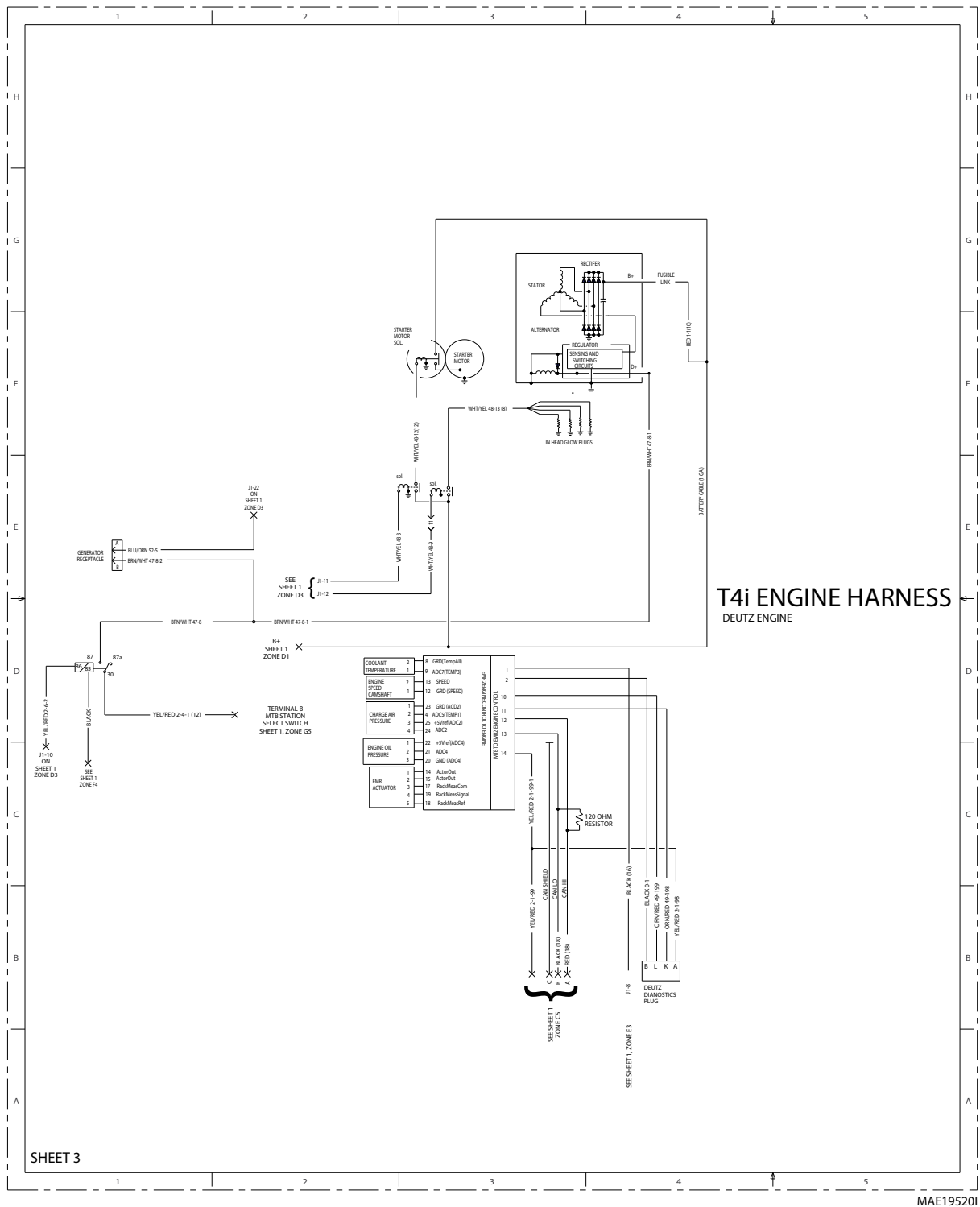
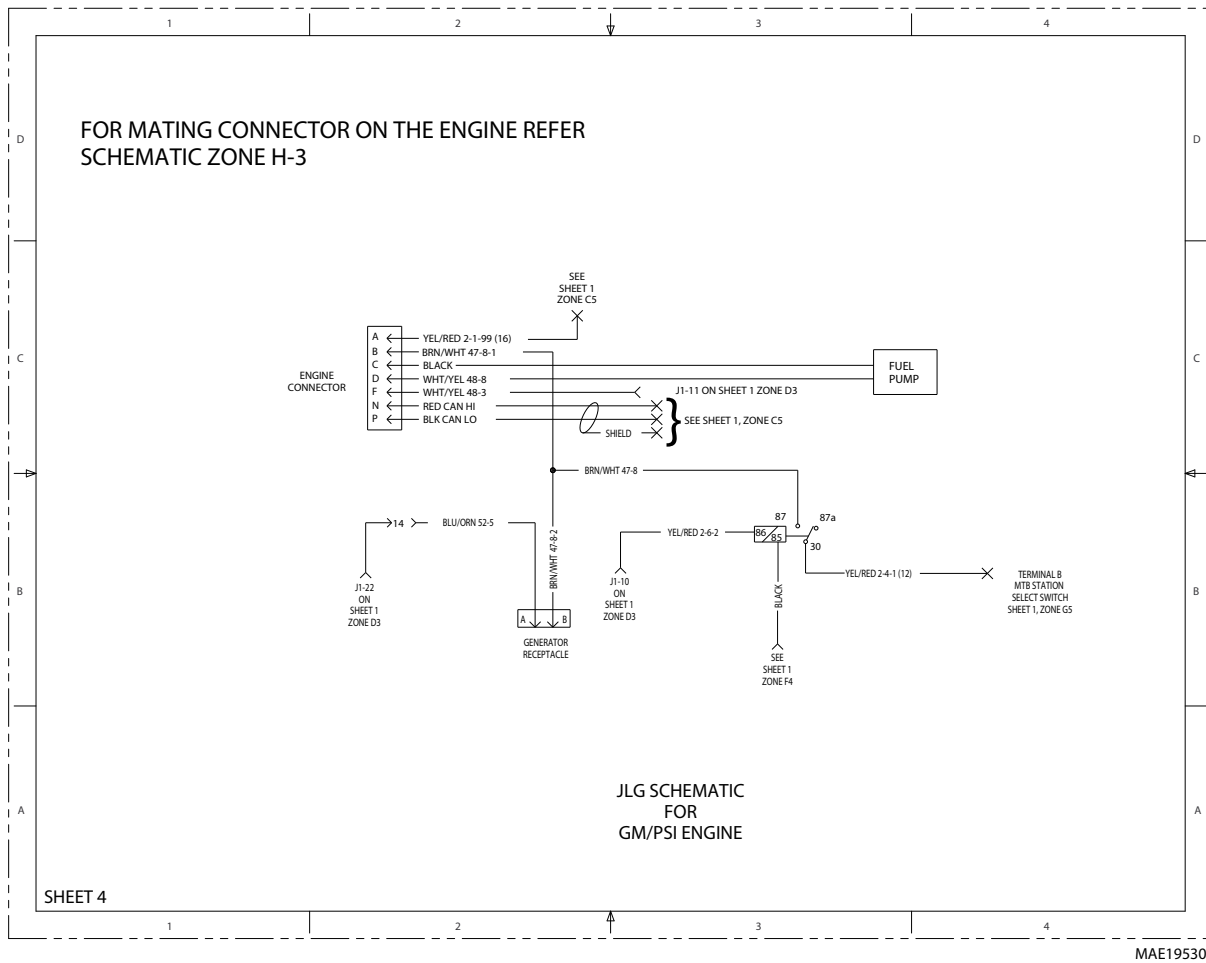


Figure 7-32. Electrical Schematic - Sheet 4 of 13

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-33. Electrical Schematic - Sheet 5 of 13**

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SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

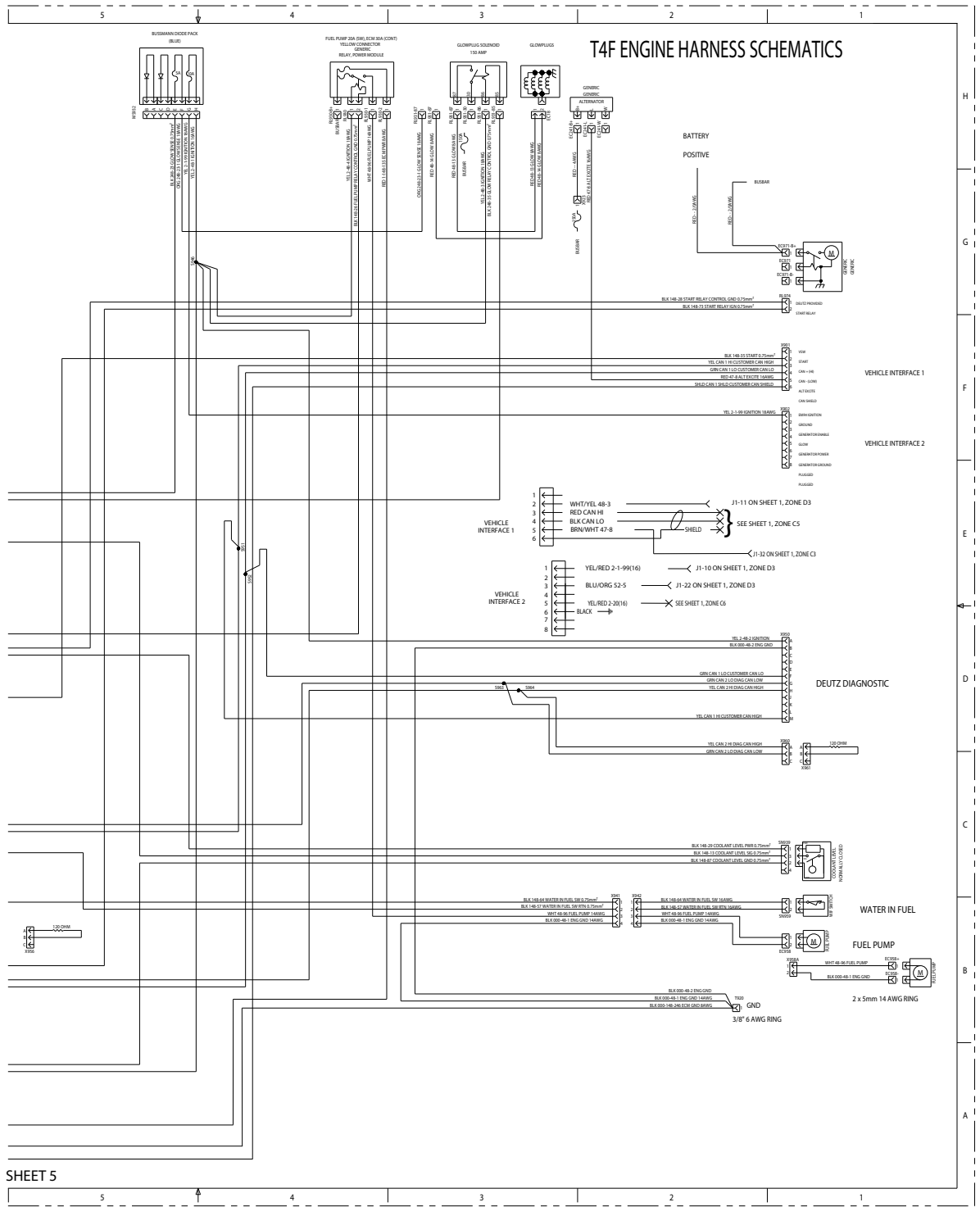
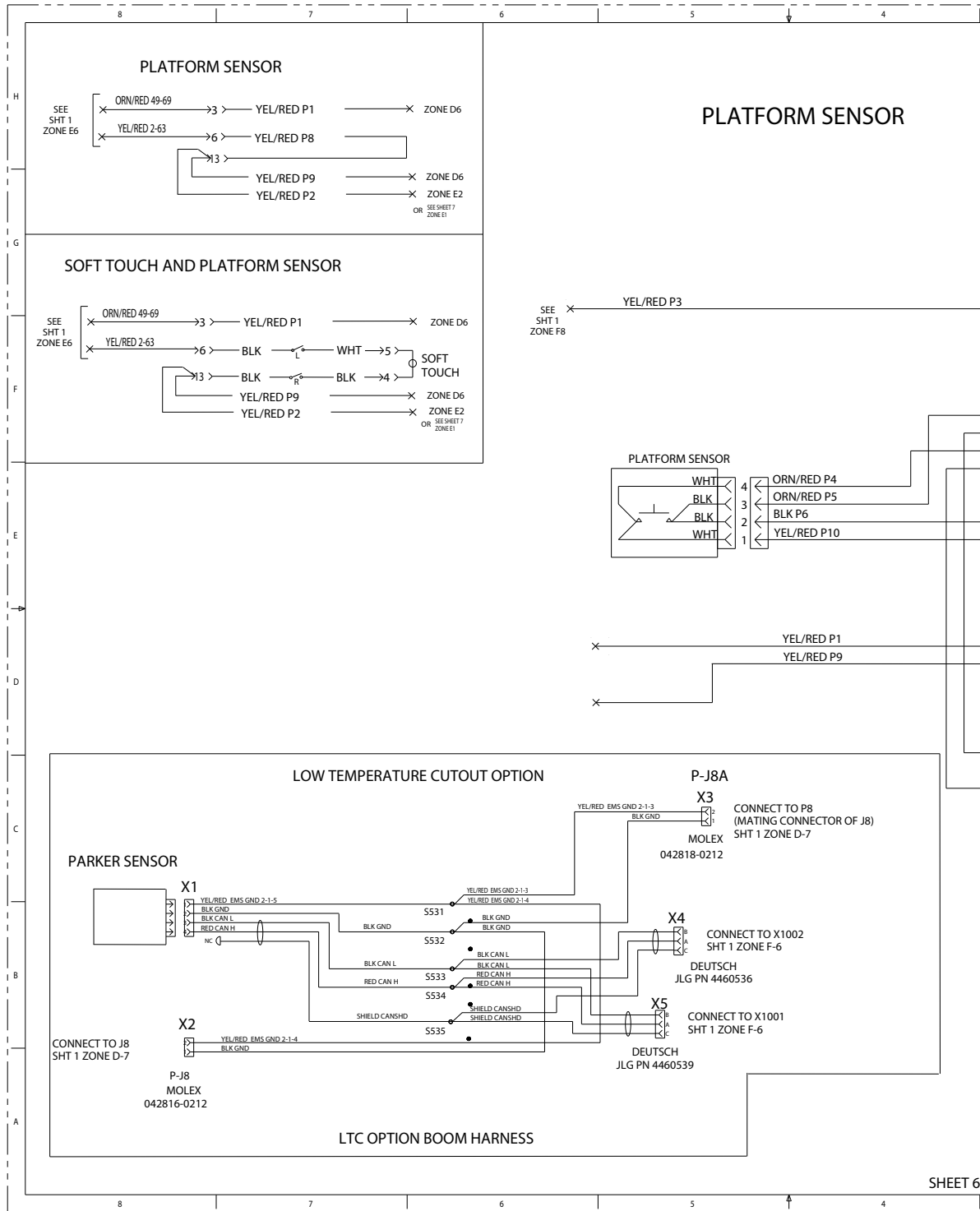


Figure 7-35. Electrical Schematic - Sheet 7 of 13

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-36. Electrical Schematic - Sheet 8 of 13**

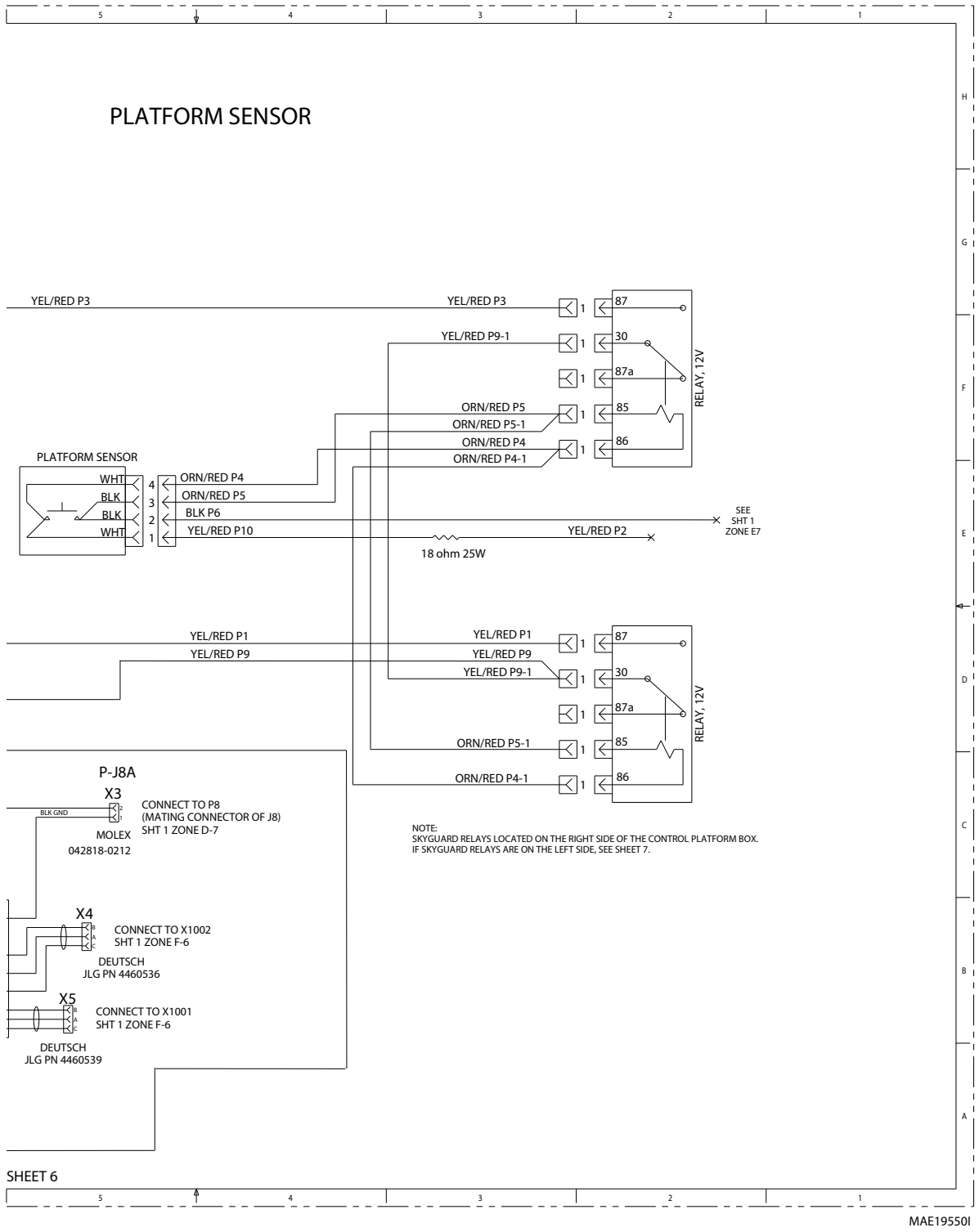
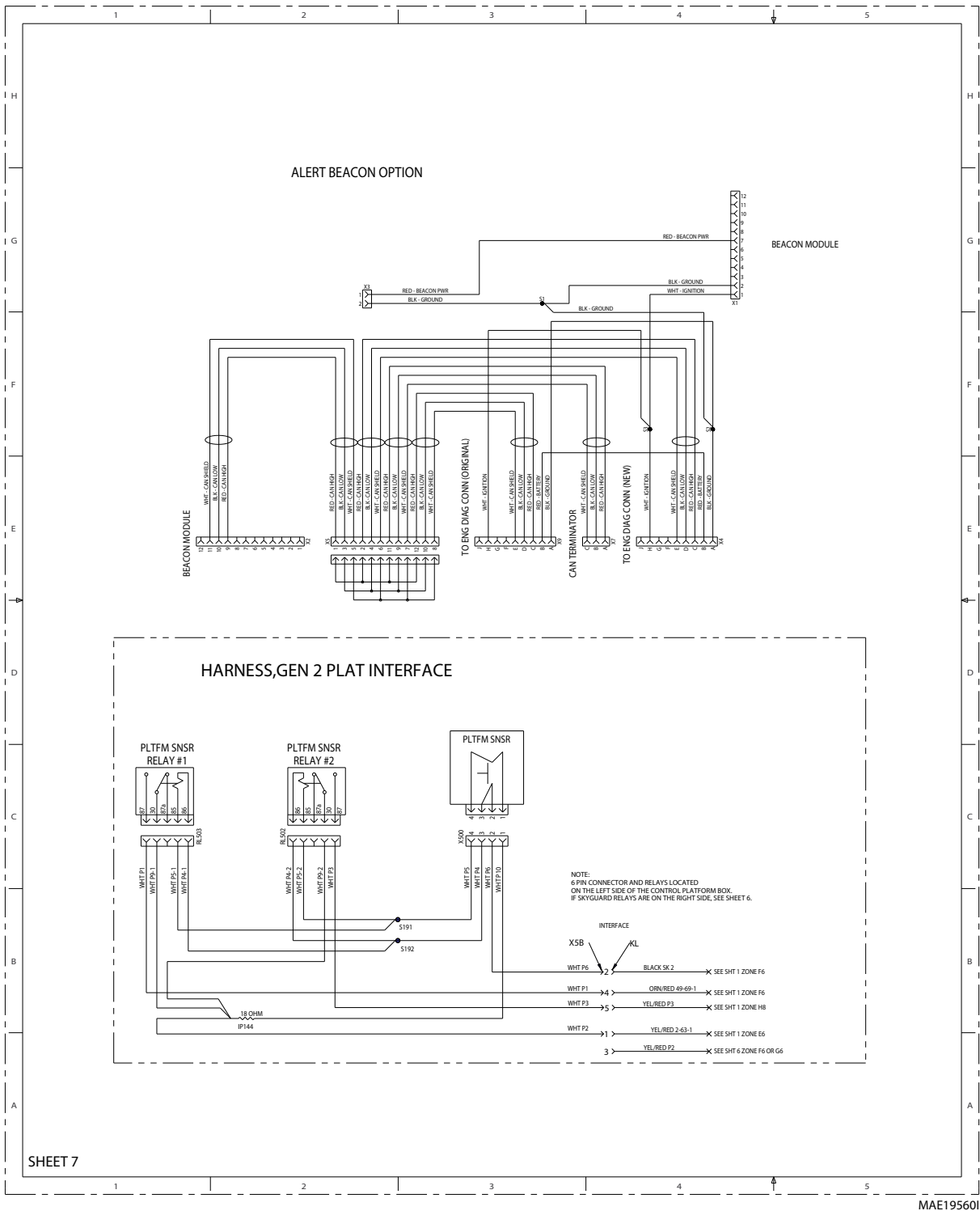


Figure 7-37. Electrical Schematic - Sheet 9 of 13

**SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS**



**Figure 7-38. Electrical Schematic - Sheet 10 of 13**

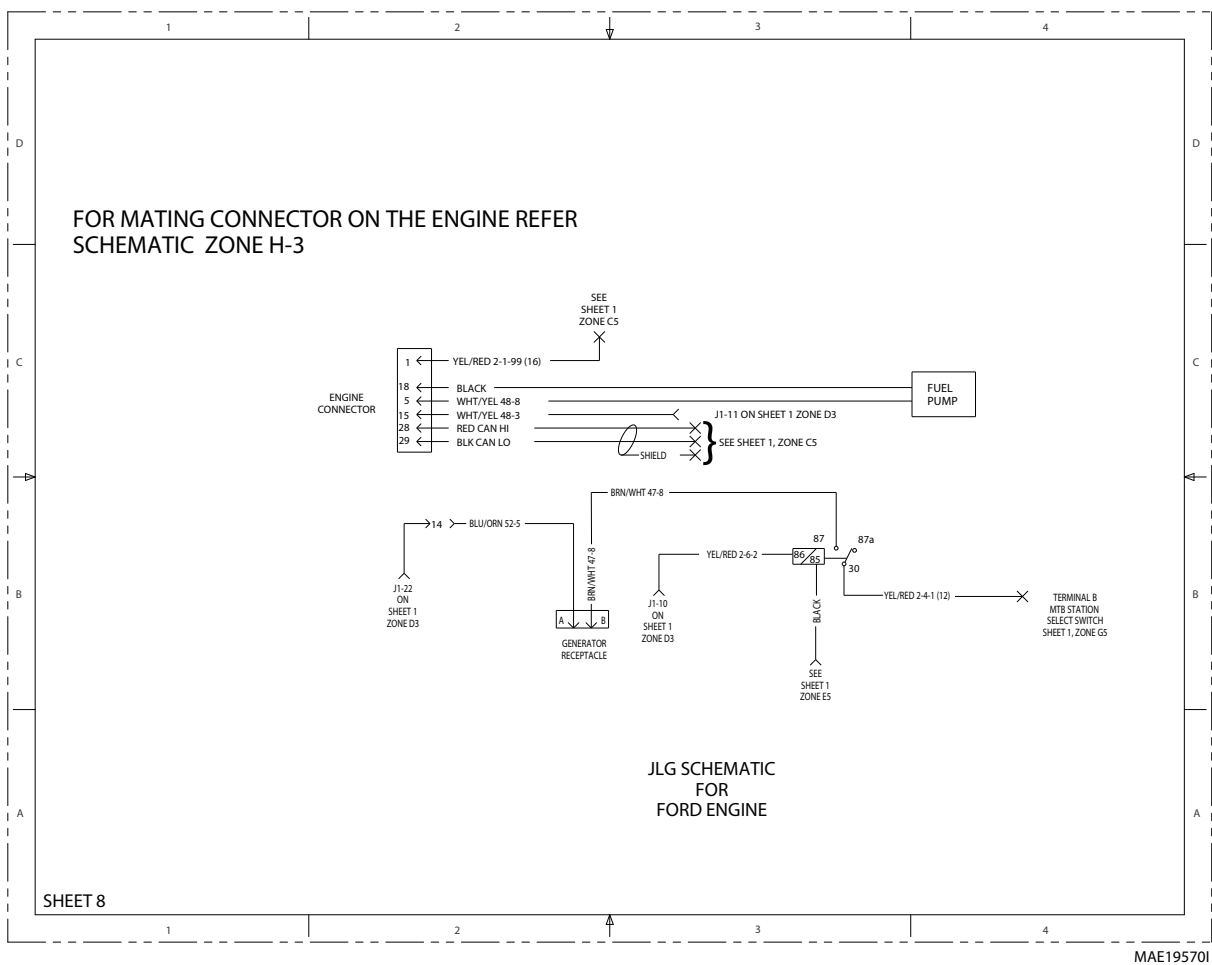


Figure 7-39. Electrical Schematic - Sheet 11 of 13

# SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

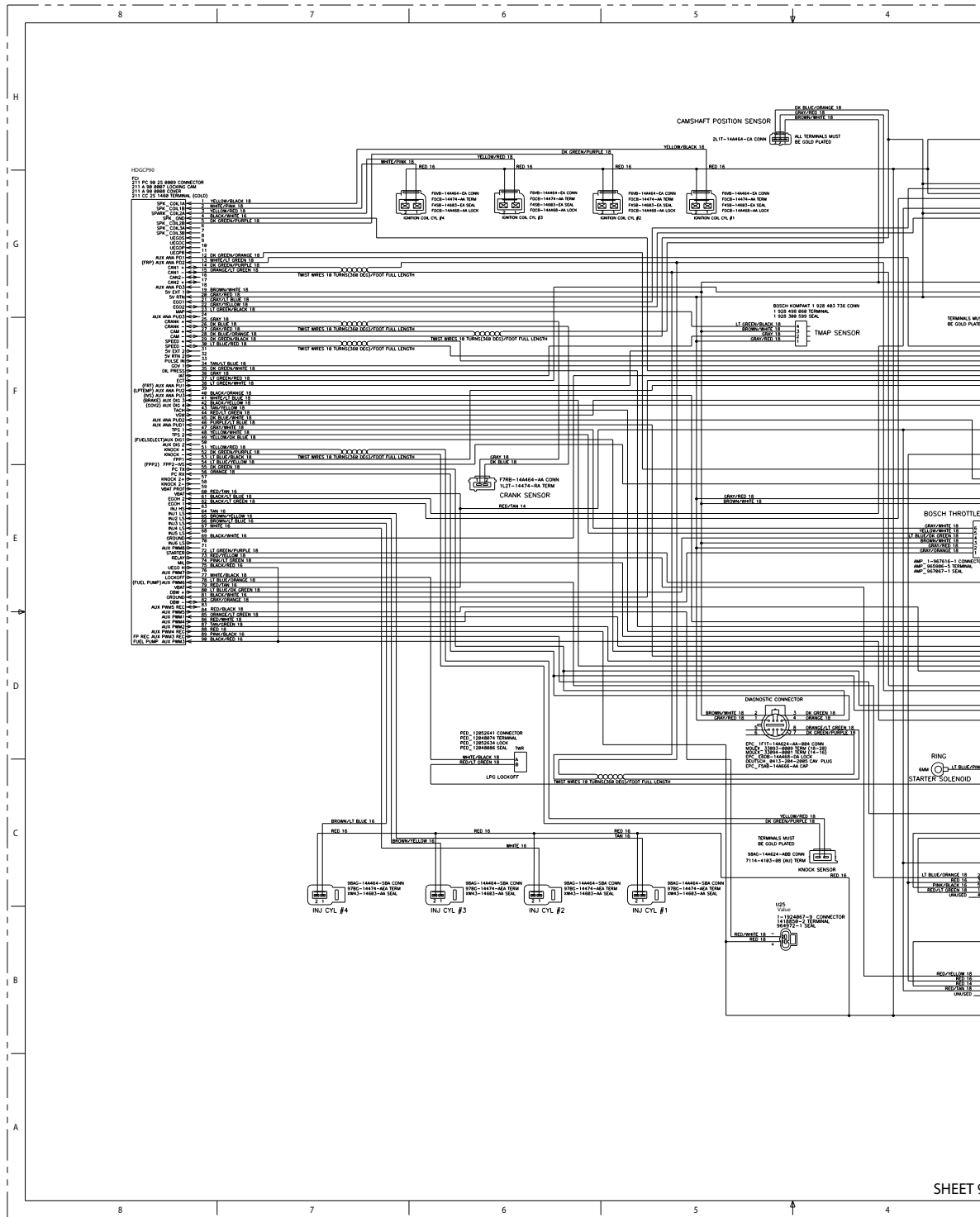


Figure 7-40. Electrical Schematic - Sheet 12 of 13

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

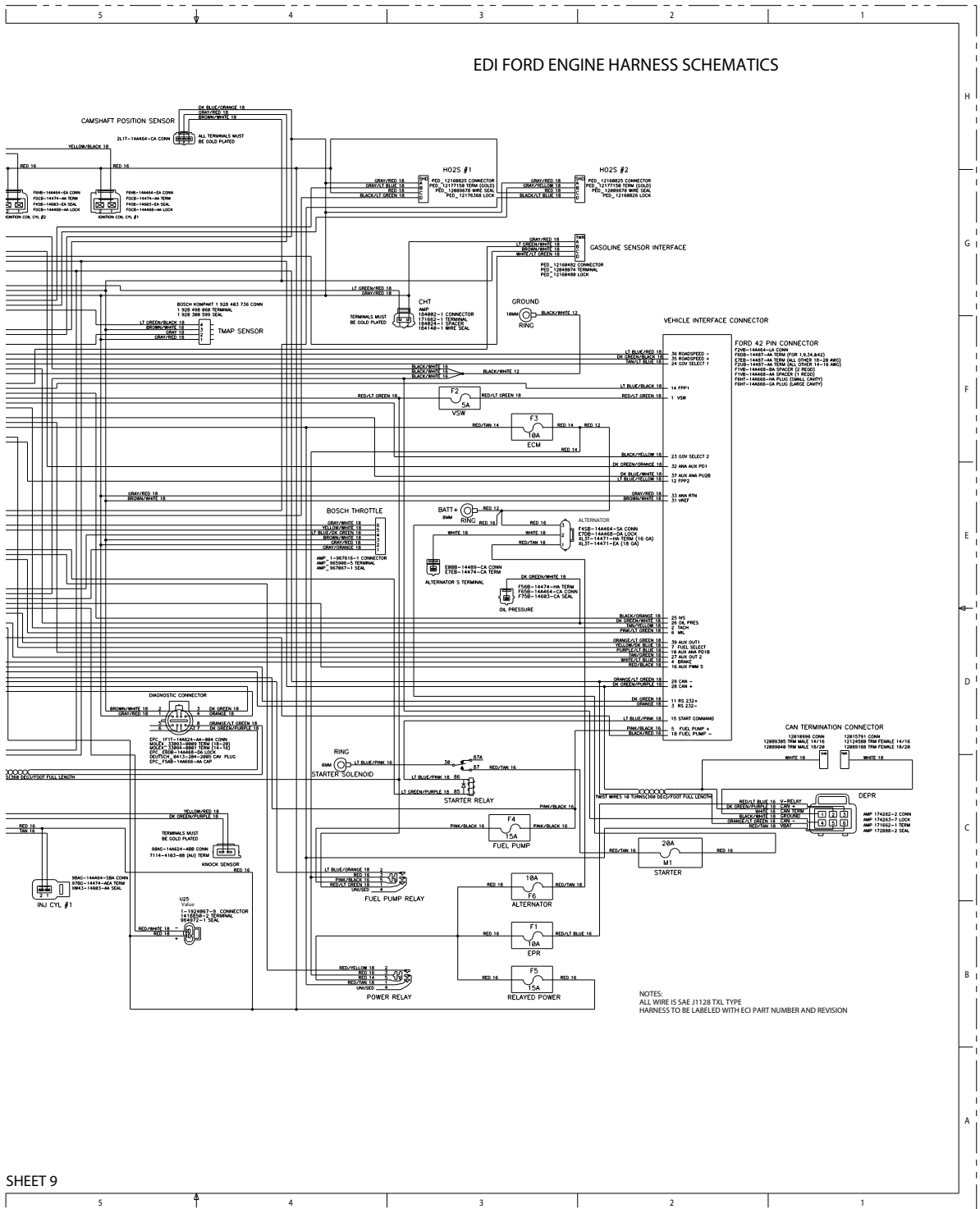


Figure 7-41. Electrical Schematic - Sheet 13 of 13







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**Corporate Office**  
**JLG Industries, Inc.**  
**1 JLG Drive**  
**McConnellsburg, PA 17233-9533 USA**  
**☎ (717) 485-5161 (Corporate)**  
**☎ (877) 554-5438 (Customer Support)**  
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