



# Specifications Systems Operation Troubleshooting Testing and Adjusting

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## **120M, 12M, 140, 140M, 150, 14M, 160M, 160, 16M Motor Graders Secondary Steering System**

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B92 1-UP (Machine)  
B54 1-UP (Machine)  
B55 1-UP (Machine)  
B56 1-UP (Machine)  
B57 1-UP (Machine)  
B59 1-UP (Machine)  
B9H 1-UP (Machine)  
R9H 1-UP (Machine)  
B9J 1-UP (Machine)  
R9J 1-UP (Machine)  
B9R 1-UP (Machine)  
R9B 1-UP (Machine)  
B9F 1-UP (Machine)  
B9L 1-UP (Machine)  
B9E 1-UP (Machine)  
B9M 1-UP (Machine)  
B9D 1-UP (Machine)  
B9N 1-UP (Machine)  
R9A 1-UP (Machine)  
B9C 1-UP (Machine)  
B9G 1-UP (Machine)  
D9G 1-UP (Machine)  
B9T 1-UP (Machine)

D9T 1-UP (Machine)  
B9W 1-UP (Machine)  
R9C 1-UP (Machine)  
D9W 1-UP (Machine)

## Important Safety Information

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

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

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

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

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



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

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

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

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

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

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### NOTICE

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

**Other parts may not meet certain original equipment specifications.**

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

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

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#### Testing and Adjusting

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# Specifications Section

i04909870

## Electric Drive Pump (Secondary Steering)

**SMCS Code:** 4324; 4325-SE

**Part No. :** 292-5072  
**S/N:** B9H1-Up

**Part No. :** 292-5072  
**S/N:** R9H1-Up

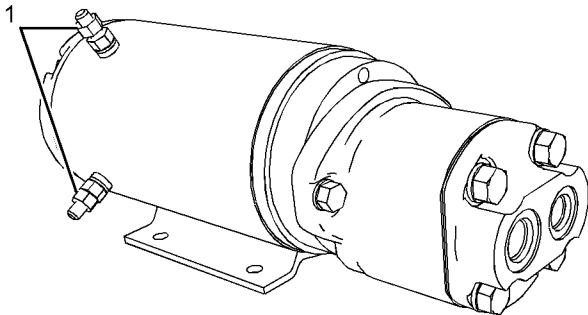


Illustration 1

g02037734

(1) Nuts

Table 1

Specification for 292-5072 Secondary Steering Pump and Electric Motor Gp			
Item	Qty	Part	Specification Description
1	2	-	Torque nuts to $19 \pm 1$ N·m ( $170 \pm 9$ lb in).
-	-	-	Input is 361 amp at 24 VDC.
-	-	-	Output at 17237 kPa (2500 psi) is 19.3 L/min (5.1 US gpm).

i08002112

## Electric Drive Pump (Secondary Steering)

**SMCS Code:** 4324; 4325-SE

**Part No. :** 273-8714  
**S/N:** B921-Up

**Part No. :** 273-8714  
**S/N:** B541-Up

**Part No. :** 273-8714  
**S/N:** B551-Up

**Part No. :** 273-8714  
**S/N:** B561-Up

**Part No. :** 273-8714  
**S/N:** B571-Up

**Part No. :** 273-8714  
**S/N:** B591-Up

**Part No. :** 273-8714  
**S/N:** R9A1-Up

**Part No. :** 273-8714  
**S/N:** R9B1-Up

**Part No. :** 273-8714  
**S/N:** B9C1-Up

**Part No. :** 273-8714  
**S/N:** R9C1-Up

**Part No. :** 273-8714  
**S/N:** B9D1-Up

**Part No. :** 273-8714  
**S/N:** B9E1-Up

**Part No. :** 273-8714  
**S/N:** B9F1-Up

**Part No. :** 273-8714  
**S/N:** B9G1-Up

**Part No. :** 273-8714  
**S/N:** D9G1-Up

**Part No. :** 273-8714  
**S/N:** B9J1-Up

**Part No. :** 273-8714  
**S/N:** R9J1-Up

**Part No. :** 273-8714  
**S/N:** B9L1-Up

**Part No. :** 273-8714  
**S/N:** B9M1-Up

**Part No. :** 273-8714  
**S/N:** B9N1-Up

**Part No. :** 273-8714  
**S/N:** B9R1-Up

**Part No. :** 273-8714  
**S/N:** B9T1-Up

**Part No. :** 273-8714  
**S/N:** D9T1-Up

**Part No. :** 273-8714  
**S/N:** B9W1-Up

**Part No. :** 273-8714  
**S/N:** D9W1-Up

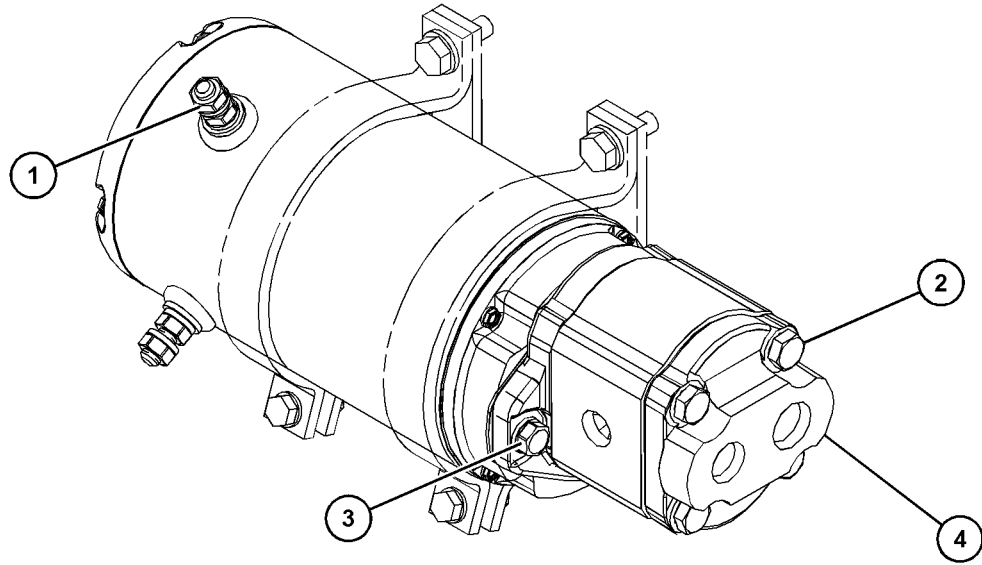


Illustration 2

g06503215

Table 2

Item	Qty	Part	Specification Description
1	2	-	Torque nuts to $19 \pm 1$ N·m (168 $\pm$ 9 lb in).
2	4	-	Torque bolts to $55 \pm 3$ N·m (41 $\pm$ 2 lb ft).
3	2	-	Torque bolts to $37 \pm 3$ N·m (27 $\pm$ 2 lb ft).
4	1	446-6911 Gear Pump Gp	Displacement per revolution is 10 cc (0.61 cubic inch)
-	-	-	Rotation is Counterclockwise.
-	-	-	Input is 397 amp at 24 VDC.
-	-	-	Output at 17237 kPa (2500 psi) is 17.4 L/min (4.6 US gpm).

i05926182

# Pressure Sensor (Secondary Steering)

**SMCS Code:** 1408-PXS

**Part No. :** 237-0957

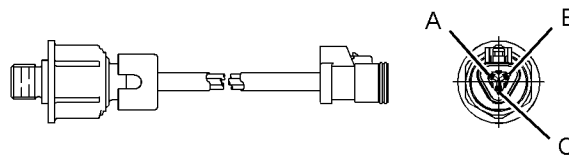


Illustration 3

g03727486

Table 3

Wire Identification		
Pin Number	Circuit	Wire Color
A	Voltage Supply	Orange
B	Ground	Yellow
C	Signal	Green

Table 4

Specification for 237-0957 Pressure Sensor Gp			
Item	Qty	Part	Specification Description
1	1	237-0957 Pressure Sensor Gp	Final installation torque $30 \pm 3$ N·m (265 ± 27 lb in).

i05926189

# Magnetic Switch (Secondary Steering)

SMCS Code: 4334-SE; 7499-SST

Part No. : 179-0006

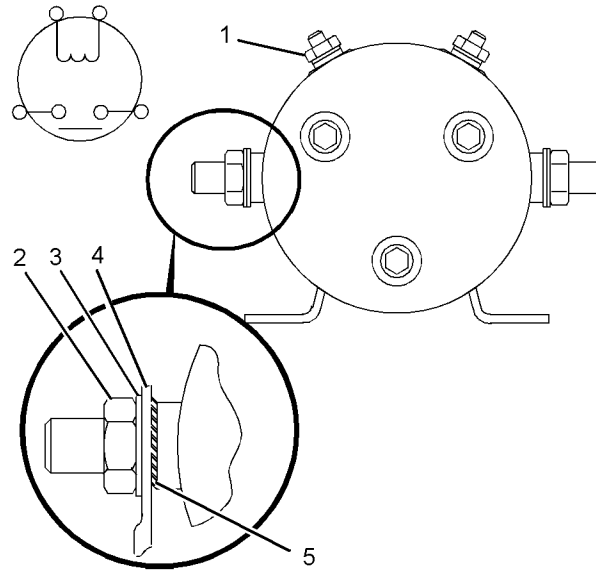


Illustration 4

g03727492

Table 5

Specification for 254-3415 Control Manifold Gp			
Item	Qty	Part	Specification Description
1	2	6V-8378 Nut	Final torque for two nuts $2.25 \pm 0.25$ N·m (20 ± 2 lb in).
2	2	1B-2578 Nut	Final torque for two nuts $13 \pm 2$ N·m (115 ± 18 lb in).
-	-	-	The contact position is normally open
-	-	-	Note: Assemble lock washer (5) first. Harness terminal (4) should be assembled second. Washer (3) should be assembled next. Lastly, assemble nut (2).

i04894401

## Control Manifold (Steering Pilot Oil Backup)

**SMCS Code:** 5051; 5264

**Part No. :** 254-3415  
**S/N:** B921-368

**Part No. :** 254-3415  
**S/N:** B541-Up

**Part No. :** 254-3415  
**S/N:** B551-Up

**Part No. :** 254-3415  
**S/N:** B561-Up

**Part No. :** 254-3415  
**S/N:** B571-Up

**Part No. :** 254-3415  
**S/N:** B591-Up

**Part No. :** 254-3415  
**S/N:** R9A1-Up

**Part No. :** 254-3415  
**S/N:** R9B1-Up

**Part No. :** 254-3415  
**S/N:** B9C1-Up

**Part No. :** 254-3415  
**S/N:** R9C1-Up

**Part No. :** 254-3415  
**S/N:** B9D1-4762

**Part No. :** 254-3415  
**S/N:** B9E1-1143

**Part No. :** 254-3415  
**S/N:** B9F1-Up

**Part No. :** 254-3415  
**S/N:** B9G1-Up

**Part No. :** 254-3415  
**S/N:** D9G1-1585

**Part No. :** 254-3415  
**S/N:** B9H1-Up

**Part No. :** 254-3415  
**S/N:** R9H1-Up

**Part No. :** 254-3415  
**S/N:** B9J1-Up

**Part No. :** 254-3415  
**S/N:** R9J1-Up

**Part No. :** 254-3415  
**S/N:** B9L1-Up

**Part No. :** 254-3415  
**S/N:** B9M1-Up

**Part No. :** 254-3415  
**S/N:** B9N1-Up

**Part No. :** 254-3415  
**S/N:** B9R1-Up

**Part No. :** 254-3415  
**S/N:** B9T1-Up

**Part No. :** 254-3415  
**S/N:** D9T1-1438

**Part No. :** 254-3415  
**S/N:** B9W1-Up

**Part No. :** 254-3415  
**S/N:** D9W1-Up

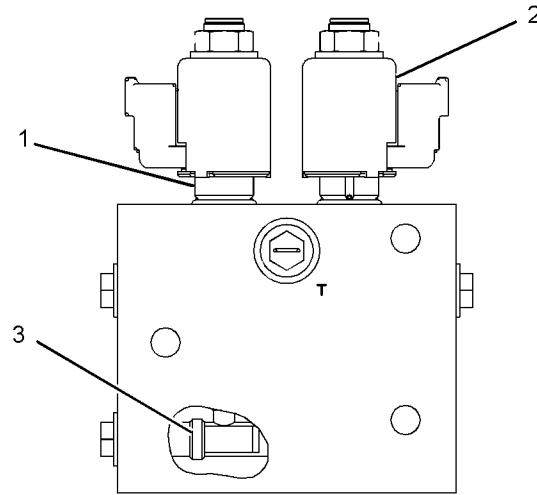


Illustration 5

g03036161

Table 6

Specification for 254-3415 Control Manifold Gp			
Item	Qty	Part	Specification Description
1	2	310-7060 Solenoid Valve Gp -	Torque to $50 \pm 5$ N·m ( $37 \pm 4$ lb ft).
			Torque for nut $13 \pm 1.5$ N·m ( $115 \pm 13$ lb in).
2	2	323-9533 Coil	Nominal Voltage is 12 VDC
			Resistance at 25 °C (77 °F) is $2.2 \pm 0.2$ ohms
Orient coils (1) according to Illustration 5 .			
3	1	6E-5066 Screen	Torque to $6.7 \pm 0.7$ N·m ( $59.3 \pm 6.2$ lb in).

# Systems Operation Section

i03776164

## Introduction

**SMCS Code:** 4300-SE

The secondary steering system provides an emergency backup for the failure of the steering control valve and a failure of the steering pump. The secondary steering system operates under three modes:

- The secondary steering pilot valve is activated.
- The secondary steering pump is activated.
- The secondary steering pump is activated and the secondary steering pilot valve is activated.

The secondary steering system has the following main components:

- Electric drive pump
- Relief valve
- Control manifold
- Check valve
- Pressure sensor
- Hydraulic tank and filter
- Transmission/chassis electronic control module (ECM)
- Secondary steering pilot control valve

## Electric Drive Pump

The electric drive pump is an electric motor that drives a gear pump. The gear pump provides oil flow to the control manifold.

## Relief Valve

The relief valve in the secondary steering system is a safety valve. The relief valve will open preventing system oil pressure from rising too high. The open relief valve directs the excess flow of oil back to the hydraulic tank.

## Control Manifold

When hydraulic pressure is lost in the primary steering system, the control manifold receives hydraulic oil from the secondary steering pump. The control manifold then directs the hydraulic oil to the steering control valve.

## Check Valve

The check valves in the secondary steering system prevent oil from flowing backward through the system.

## Pressure Sensor

The pressure sensor reads the steering system pressure. When the steering system pressure drops below a certain setting the ECM will signal the electric drive pump to start for the secondary steering.

## Hydraulic Tank and Filter

The hydraulic tank supplies oil to the hydraulic system. The filter is remotely located next to the hydraulic tank. The filter screens return oil from the hydraulic system.

## Transmission/Chassis Electronic Control Module (ECM)

The transmission/chassis ECM will perform the necessary electrical functions in order to activate the secondary steering system. The ECM receives an input signal from the implement control ECM 1 and the engine ECM. The ECM will then energize the electric drive pump when the input signal indicates a primary steering failure or an engine failure.

## Secondary Steering Pilot Valve

When the primary steering control valve fails, the secondary steering pilot valve will direct oil to the main control valve spool.

i03776189

## Location of Electrical Components

SMCS Code: 4300-SE

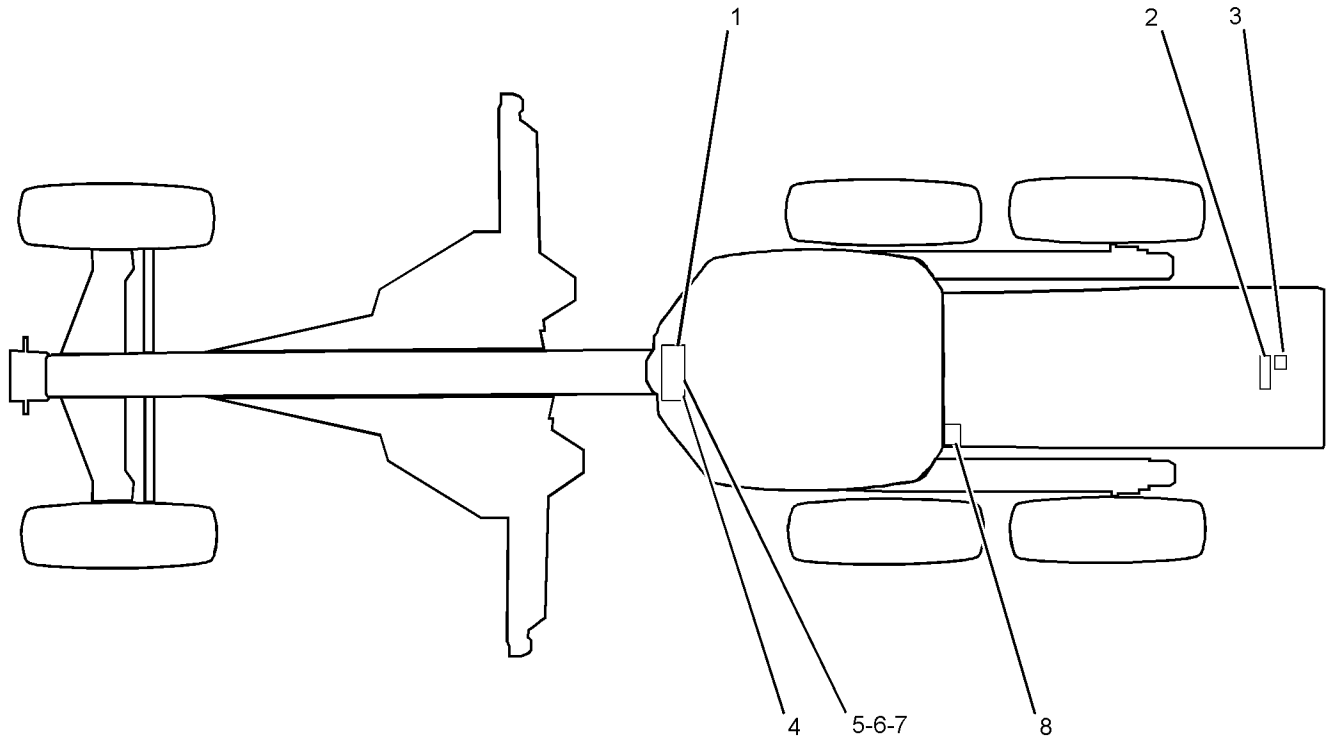


Illustration 6

g01373972

- |                                                          |                                    |                                                       |
|----------------------------------------------------------|------------------------------------|-------------------------------------------------------|
| (1) Dash and indicators                                  | (4) Secondary steering test switch | (7) Alert indicator for the secondary steering system |
| (2) Transmission/chassis electronic control module (ECM) | (5) Warning light                  | (8) Magnetic switch                                   |
| (3) Pressure sensor                                      | (6) Action light                   |                                                       |

## Dash and Indicators

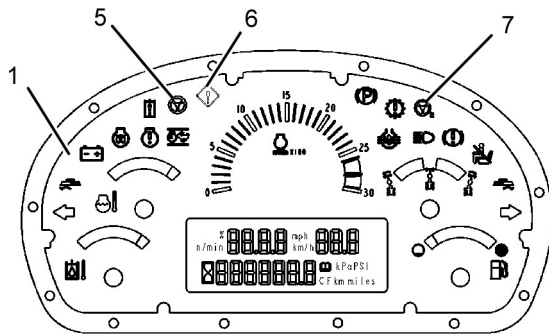


Illustration 7

g01373973

- (1) Dash and indicators
- (5) Warning light
- (6) Action light
- (7) Alert indicator for the secondary steering system

The dash (1) is located at the front of the operator's compartment.

### Warning Light

Warning light (5) is located on the dash.

### Action Light

Action light (6) is located on the dash.

### Alert Indicator for the Secondary Steering System

Alert indicator for the secondary steering system (7) is located on the dash.

## Transmission/Chassis ECM

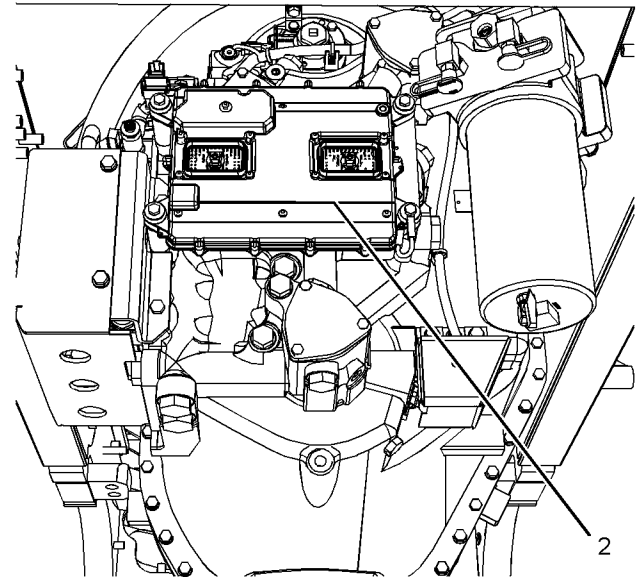


Illustration 8

g01301262

- (2) Transmission/chassis ECM

The transmission/chassis ECM is mounted to the back side of the transmission.

## Pressure Sensor

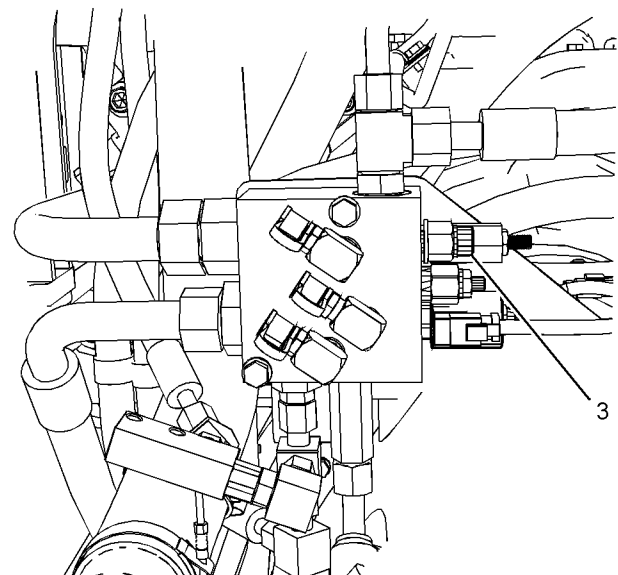


Illustration 9

g01373974

- (3) Pressure sensor

Pressure sensor (3) is located at the rear of the engine compartment. Pressure sensor (3) is mounted to the control manifold.

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## Secondary Steering Test Switch

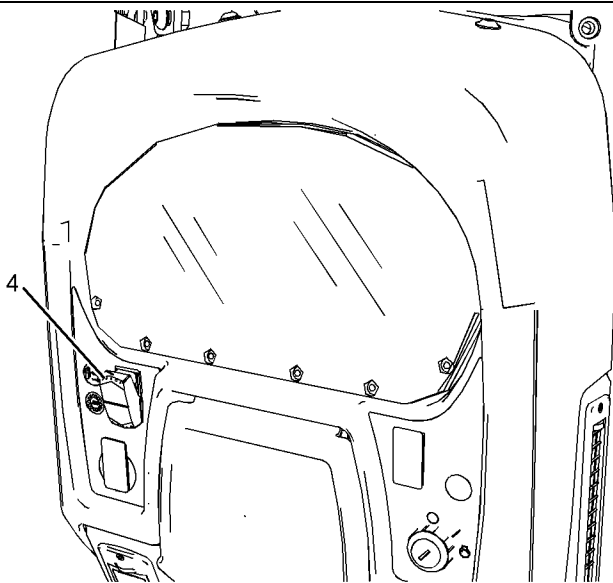


Illustration 10 g01285095  
(4) Secondary steering test switch

Secondary steering test switch (4) is located at the front of the operator compartment.

## Magnetic Switch

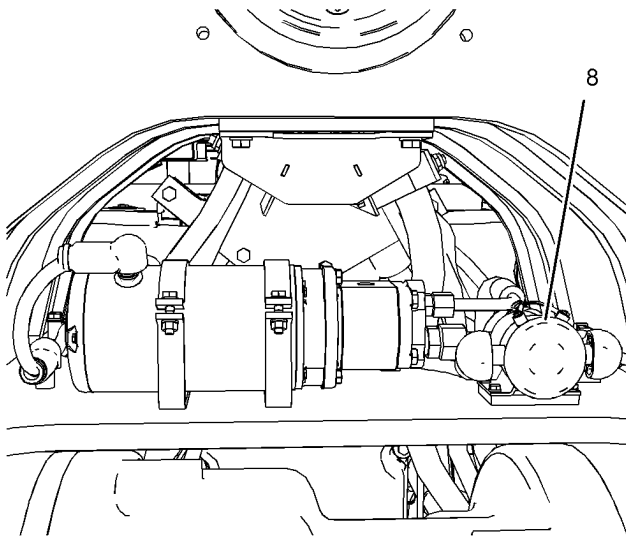


Illustration 11 g01373976  
(8) Magnetic switch

**Note:** Use the above frame assembly for reference only.

Magnetic switch (8) is located in the front of the rear frame near the articulated hitch.

i02865197

## Location of Hydraulic Components

SMCS Code: 4300-SE

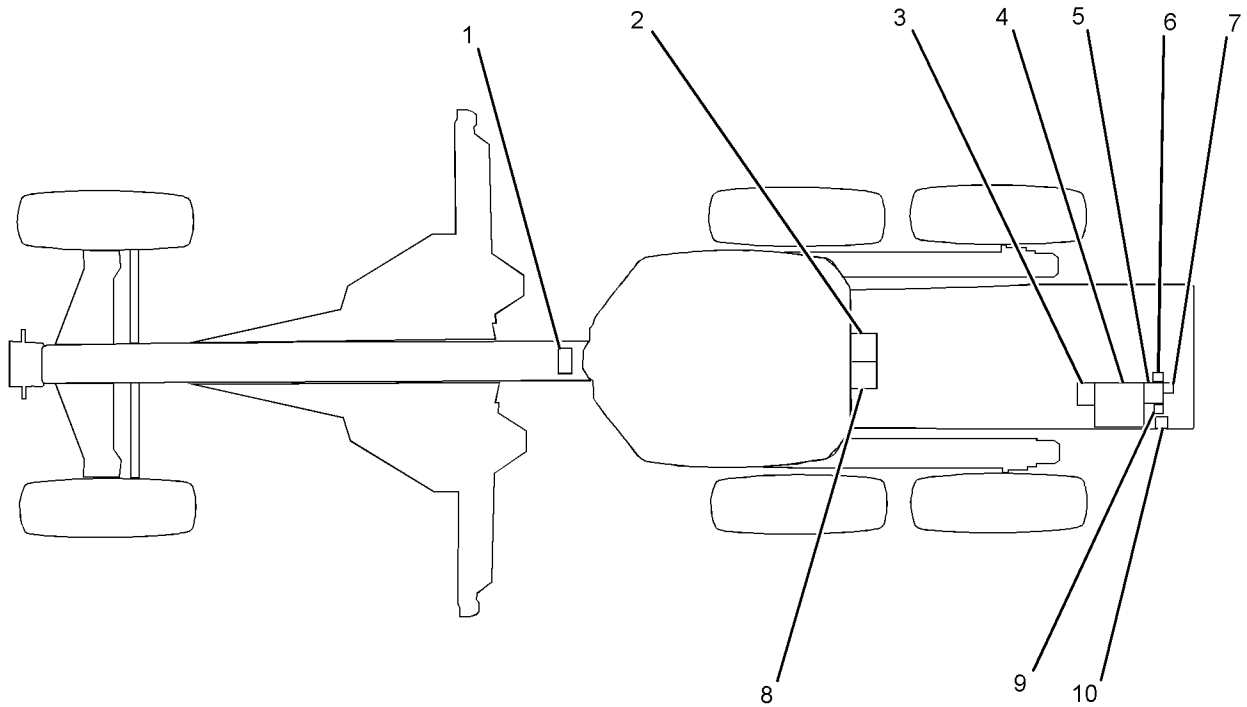


Illustration 12

g01403836

(1) Secondary steering pilot valve  
(2) Secondary steering motor  
(3) Hydraulic oil filter  
(4) Hydraulic tank

(5) Control manifold  
(6) Pressure sensor  
(7) Check valve  
(8) Secondary steering pump

(9) Check valve  
(10) Relief valve

## Secondary Steering Pilot Valve

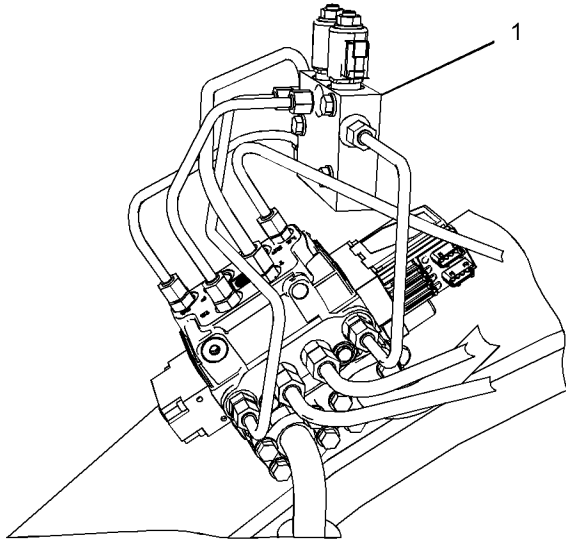


Illustration 13 g01374004  
(1) Secondary steering pilot valve

Secondary steering pilot valve (1) is located in front of the cab.

## Secondary Steering Pump and Motor

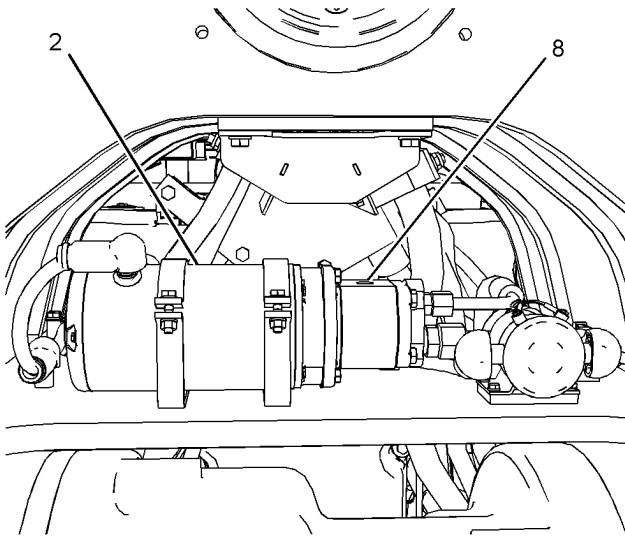


Illustration 14 g01374000  
(2) Secondary steering motor  
(8) Secondary steering pump

**Note:** Use the above frame assembly for reference only.

Secondary steering motor (2) and secondary steering pump (8) are located in the front of the rear frame near the articulated hitch.

## Hydraulic Tank and Filter

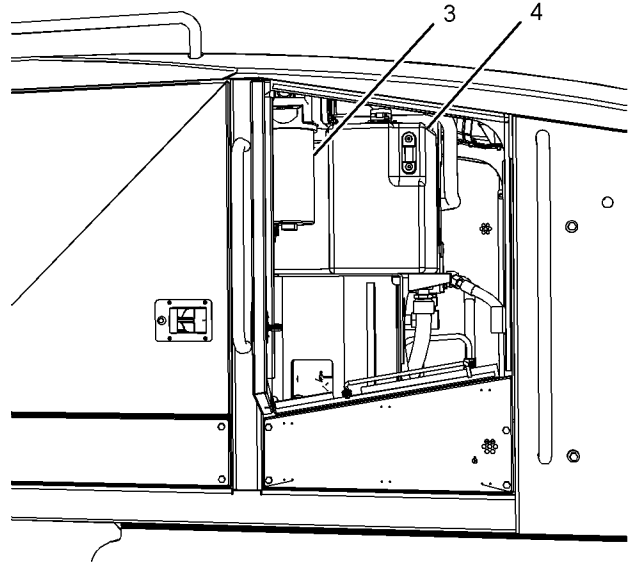


Illustration 15 g01374002  
(3) Hydraulic filter  
(4) Hydraulic tank

Hydraulic tank (4) is located in the rear of the engine compartment on the left hand side. Hydraulic oil filter (3) is located next to hydraulic tank (4).

## Control Manifold

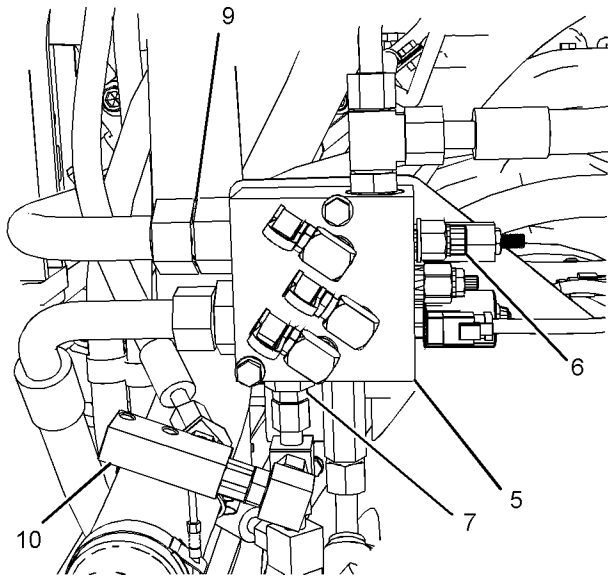


Illustration 16

g01374003

- (5) Control manifold
- (6) Pressure sensor
- (7) Check valve
- (9) Check valve
- (10) Relief valve

Control manifold (5) is located at the rear of the engine compartment on the left side.

### Relief Valve

Relief valve (10) is located next to control manifold (5) that is located at the rear of the engine compartment. Relief valve (10) is located between the following hydraulic lines:

- Secondary steering pump to the control manifold
- Control manifold to the hydraulic filter

### Check Valves

Check valve (9) is located in the line that runs from the implement/steering pump to control manifold (5).

Check valve (7) is located in the line that runs from the secondary steering pump to control manifold (5).

i03776200

## Secondary Steering System

**SMCS Code:** 4300-SE

The secondary steering system will activate the secondary steering pump or the secondary steering system will activate the secondary steering pilot valve under various conditions. The secondary steering pump is activated in automatic mode under the following conditions:

- The main hydraulic pump has failed.
- There is zero engine speed while the machine is moving with ground speed.

The secondary steering system will activate the secondary steering pilot valve under the following conditions:

- An error code is received for the controller for the primary steering control valve.
- A steering signal is detected with no input by the operator.
- A steering signal is not detected with an input signal from the operator.
- A steering signal is detected in the wrong direction from the operator input.

The transmission/chassis electronic control module (ECM) will only turn on the parts of the secondary steering system that are required for machine operation. If the primary steering system solenoids are not functioning properly, only the secondary steering pilot valve will be activated. If the supply pump for the steering fails, only the steering pump will be activated. Both the secondary steering pump and the secondary steering pilot valve can be activated at the same time if both conditions apply.

### Secondary Steering Pump

The secondary steering pump provides hydraulic oil to the steering system in the event of pressure loss in the primary steering system.

The secondary steering motor is powered by the battery. The secondary steering motor will only run for a short time before the battery power has been depleted. Extended use of the secondary steering pump will cause damage to the secondary steering pump. In the event of an engine failure that results in zero engine speed, the machine must be in motion in order to use the secondary steering pump.

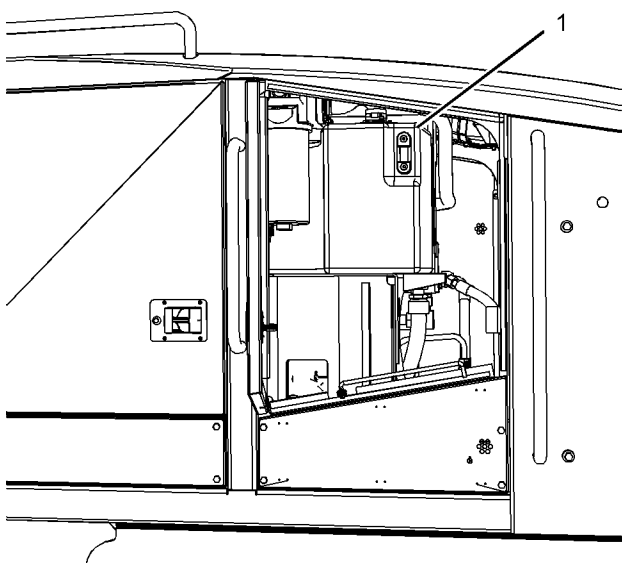


Illustration 17

g01374178

(1) Hydraulic tank

Hydraulic tank (1) supplies hydraulic oil to the secondary steering system.

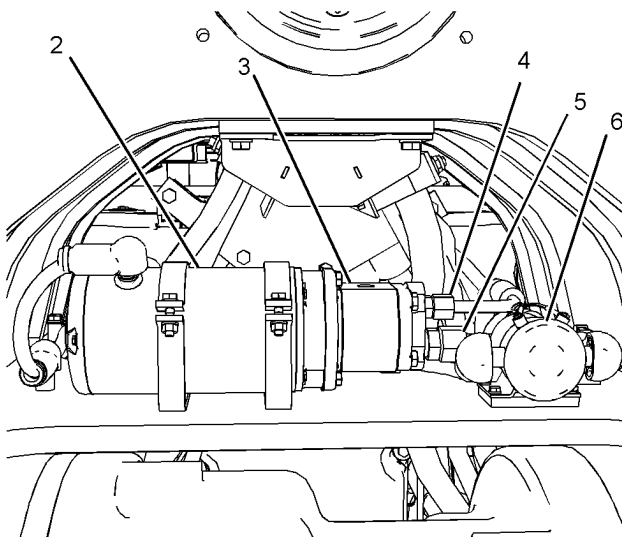


Illustration 18

g01374182

- (2) Electric drive motor
- (3) Electric drive pump
- (4) Line to control manifold
- (5) Line from hydraulic tank
- (6) Magnetic switch

**Note:** Use the above frame assembly for reference only.

Hydraulic oil is supplied from hydraulic tank (1) through line (5) to electric drive pump (3). Hydraulic oil is then pumped through line (4) to the control manifold.

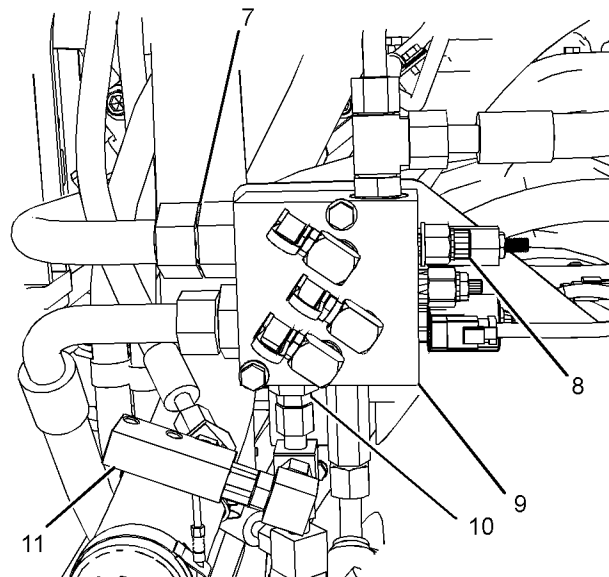


Illustration 19

g01374187

- (7) Check valve
- (8) Pressure sensor
- (9) Control manifold
- (10) Check valve
- (11) Relief valve

Check valve (7) prevents secondary steering oil from flowing back to the hydraulic and steering pump.

Check valve (10) prevents oil from flowing back to electric drive pump (3).

Pressure sensor (8) detects the pressure of the main hydraulic pump. If the implement system and/or the steering system can not maintain standby pressure the secondary steering pump will be activated.

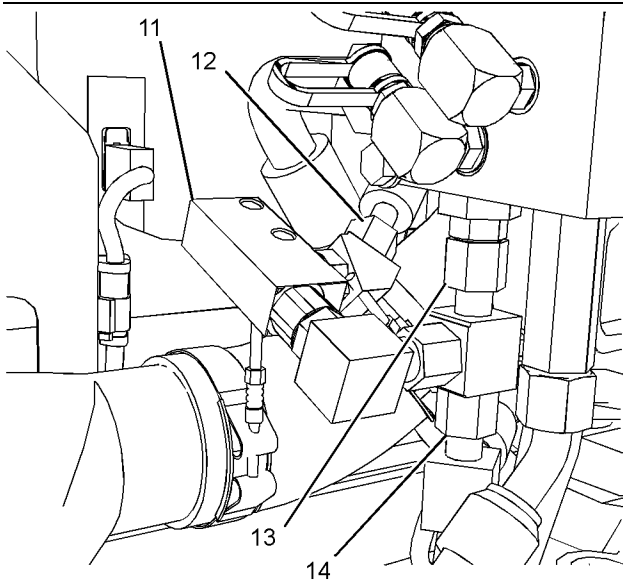


Illustration 20 g01374190

- (11) Relief valve
- (12) Return line
- (13) Line to control manifold
- (14) Supply line from electric drive pump

Relief valve (11) connects supply line (14) from the secondary steering pump to return line (12) to the hydraulic tank. When the pressure in line (13) reaches the relief valve setting, relief valve (11) will open. Hydraulic oil is then sent through line (12) to the hydraulic tank.

**Reference:** For the relief valve setting, refer to Testing and Adjusting, “Relief Valve (Secondary Steering) - Test”.

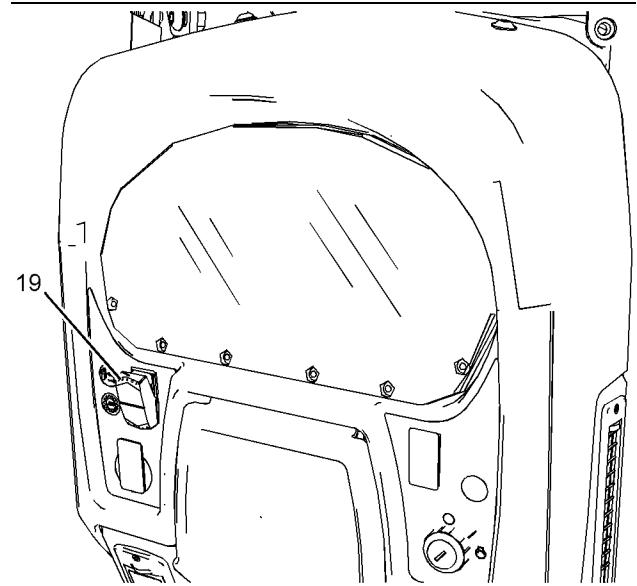


Illustration 22 g01374192

- (19) Secondary steering switch

The secondary steering system may be tested by manually activating the secondary steering system. To manually activate the system, ensure that the battery disconnect switch is in the ON position and that the engine is running at low idle. Then, hold secondary steering switch (19) in the TEST position. Secondary steering switch (19) activates magnetic switch (6). Magnetic switch (6) controls electric drive motor (2). Electric drive motor (2) and electric drive pump (3) will begin to run. Alert indicator (18) for the secondary steering will turn on. Alert indicator (18) will turn amber in color if the secondary steering pump is functioning properly. After switch (19) is released, the switch will return to the OFF position.

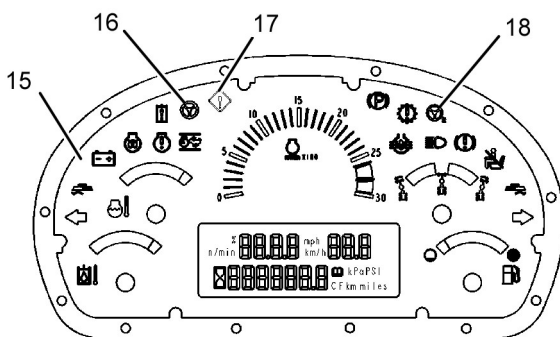


Illustration 21 g01374191

- (15) Dash and Indicators
- (16) Action light
- (17) Warning light
- (18) Alert Indicator for the secondary steering system

**Note:** Any fault with the primary steering system or the secondary steering system will result in a warning category 3.

## Secondary Steering Pilot Valve

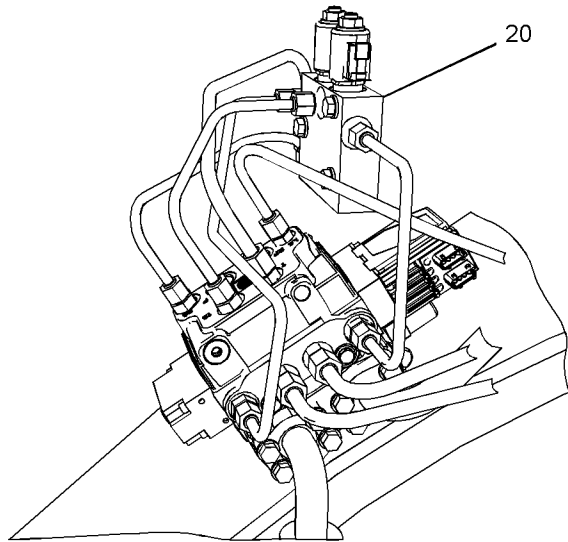


Illustration 23 g01374195

When a solenoid failure arises in the primary steering control valve, the ECM will activate secondary steering pilot valve (20) in order to control the flow of oil to the valve spool of the primary control valve.

**Reference:** For more information on the service procedures of the secondary steering pilot valve, refer to your machine Operation and Maintenance Manual.

i03776216

## Secondary Steering Electrical System

SMCS Code: 4323-SE

### **WARNING**

The machine's batteries must have a normal charge and the secondary steering electrical system must be okay. A low charge condition, or any defect in the battery, battery cells, or electrical circuit can cause loss of secondary steering and could result in personal injury and/or damage to the machine.

### NOTICE

Once the secondary steering system has been activated, it should remain ON no more than one minute. This should be sufficient time to safely steer the machine to a stop. When the machine is stopped, turn the key start switch to the OFF position in order to turn OFF secondary steering. Prolonged use of the secondary steering system will cause the electric motor to overheat and cause damage to its components.

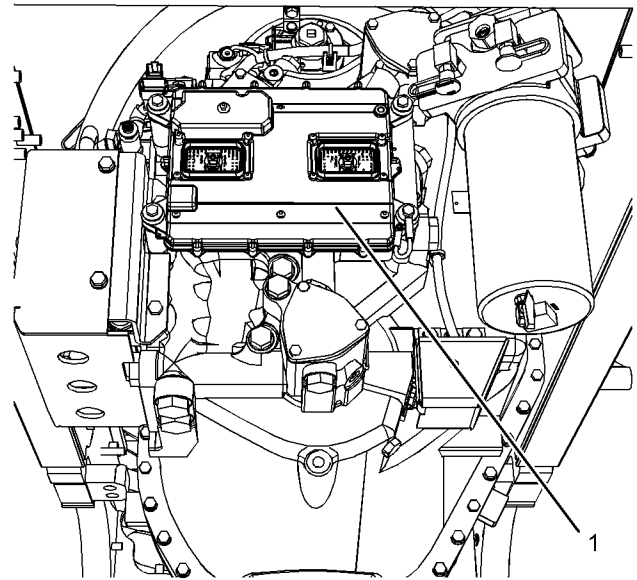


Illustration 24 g01374218

(1) Transmission/chassis electronic control module (ECM)

Transmission/chassis ECM (1) is the central processing unit for the secondary steering system.

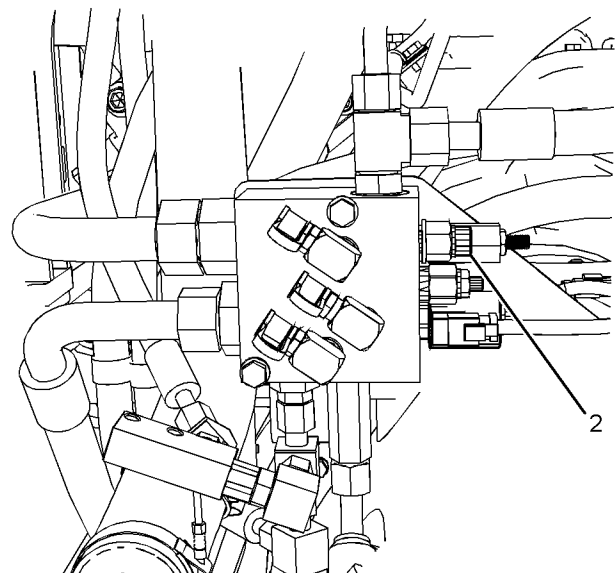


Illustration 25 g01374220

(2) Pressure sensor

Transmission/chassis ECM (1) receives electrical input signals from the implement electronic control module (ECM 1) and the engine electronic control module (ECM). The engine ECM receives a signal from the engine speed sensor once the engine is started.

Pressure sensor (2) measures the pressure of the hydraulic oil in the control manifold. Pressure sensor (2) transmits a signal to the implement ECM 1. Implement ECM 1 sends a signal to transmission/chassis ECM (1). If the pressure is too low, transmission/chassis ECM (1) uses the signal from the pressure sensor to turn the secondary steering pump ON. Transmission/chassis ECM (1) will then assume a pump failure or engine failure has occurred.

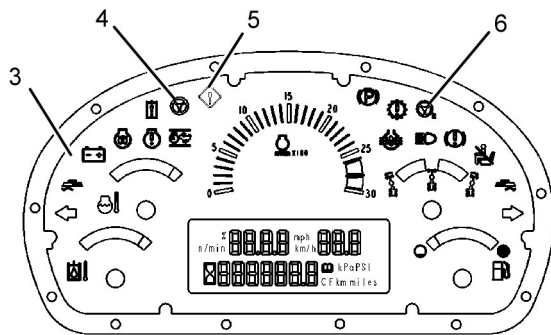


Illustration 26

g01374227

- (3) Dash and indicators
- (4) Action light
- (5) Warning light
- (6) Alert indicator for the secondary steering system

Failure of the primary steering causes the following event to be activated automatically:

- Warning light (5) will come on red in color.
- Pressure sensor (2) measures the pressure of the hydraulic oil in the control manifold.
- Pressure sensor (2) transmits a signal to implement ECM 1.
- Implement ECM 1 transmits a signal to transmission/chassis ECM (1).
- If the pressure is too low, transmission/chassis ECM (1) uses the signal from the pressure sensor to turn the secondary steering pump ON.
- Transmission/chassis ECM (1) will then assume a pump failure or engine failure has occurred.
- Transmission/chassis ECM (1) will send an electronic signal to the magnetic switch in order to activate the electric drive motor.

The secondary steering pump and the secondary steering pilot valve may be tested manually by holding the secondary steering test switch in the TEST position while the machine is stationary with the parking brake ON. Holding the test switch will run the secondary steering pump for maximum 10 second intervals.

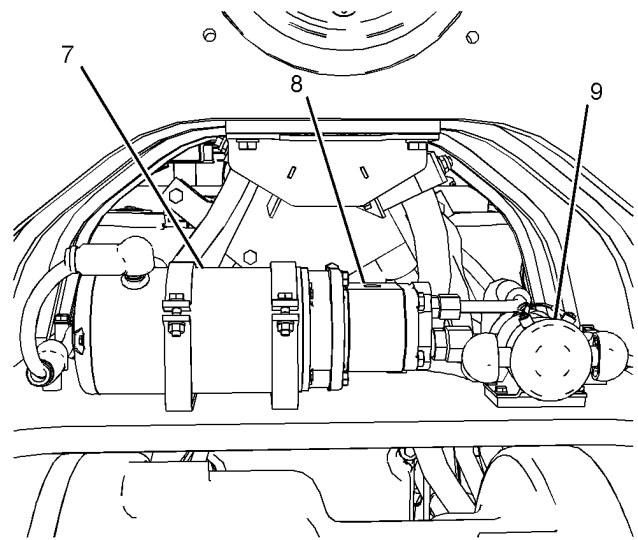


Illustration 27

g01374222

- (7) Electric drive motor
- (8) Electric drive pump
- (9) Magnetic switch

**Note:** Use the above frame assembly for reference only.

The engine start switch must be ON and the engine must be running in order for the secondary steering test switch to function. The battery disconnect switch must be in the ON position in order for the secondary steering test switch to function. Holding the secondary steering test switch in the TEST position causes the following events:

- Closing of magnetic switch (9)
- Turning on of the electric drive motor (7)
- Turning on of the electric drive pump (8)

During the test, alert indicator (6) will be amber in color if the test is successful. If alert indicator (6) turns red in color the test has failed and a warning level 3 will be issued. When the test is finished alert indicator should turn OFF.

**Reference:** Refer to the electrical schematic for your machine for more information on the secondary steering electrical system.

i07695387

## **Secondary Steering Hydraulic System**

**SMCS Code:** 5050-SST

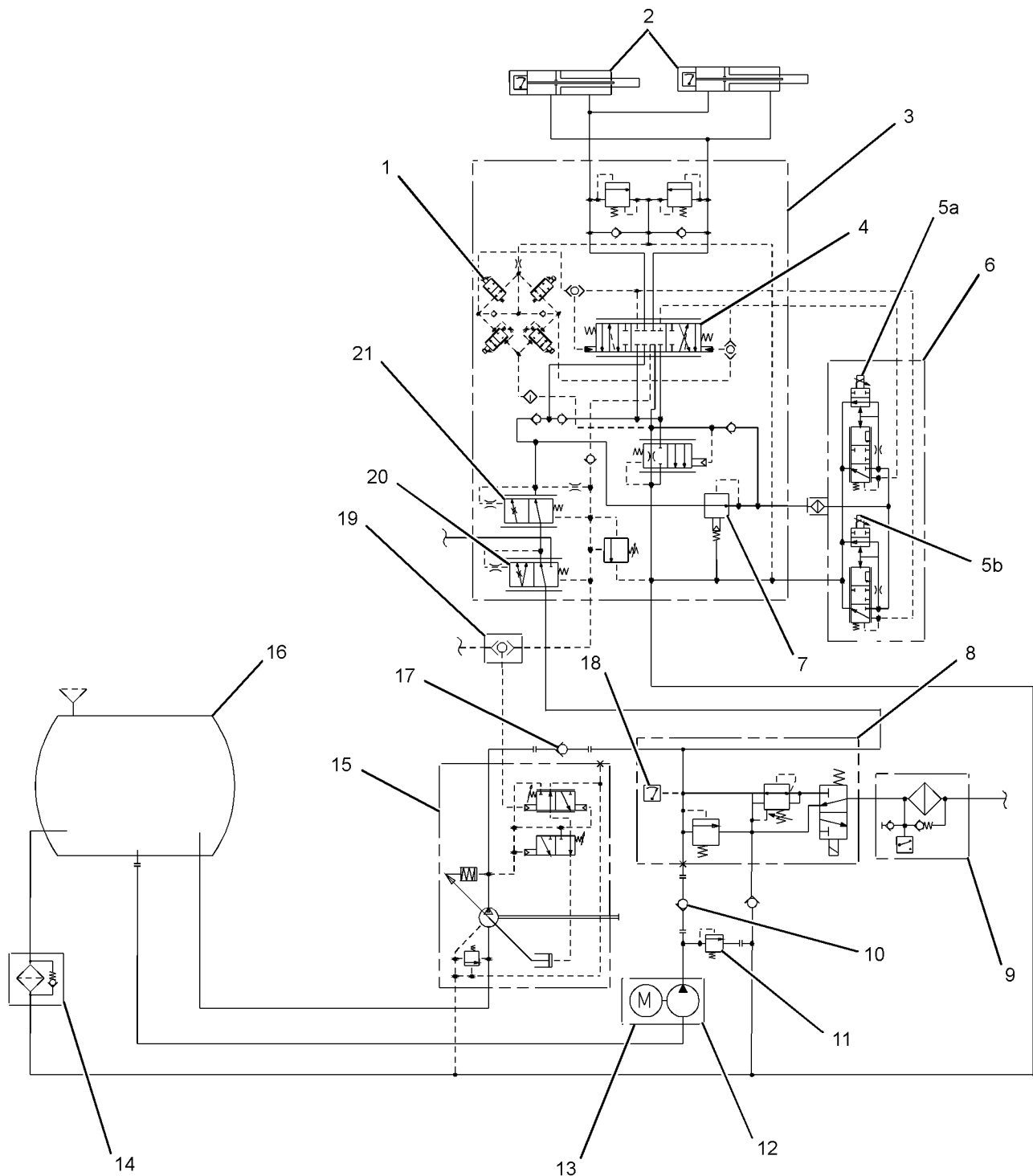


Illustration 28

g01374279

- |                                  |                             |                                  |
|----------------------------------|-----------------------------|----------------------------------|
| (1) Solenoid valve               | (7) Pressure reducing valve | (14) Hydraulic filter            |
| (2) Steering cylinders           | (8) Control manifold        | (15) Implement and steering pump |
| (3) Steering control valve       | (9) Pilot filter            | (16) Hydraulic tank              |
| (4) Spool                        | (10) Check valve            | (17) Check valve                 |
| (5a) Solenoid for right turn     | (11) Relief valve           | (18) Pressure sensor             |
| (5b) Solenoid for left turn      | (12) Electric drive pump    | (19) Shuttle valve               |
| (6) Steering pilot control valve | (13) Electric drive motor   | (20) Priority valve              |

(21) Flow compensator valve

## Secondary Steering Pump

When the secondary steering pump is activated, the machine must be in motion. The secondary steering can be activated in test mode or automatic mode.

Hydraulic oil is supplied from hydraulic tank (16) to secondary steering pump (12). Secondary steering pump (12) pumps hydraulic oil to control manifold (8). Hydraulic oil flows through control manifold (8) to steering control valve (3). When the operator signals for a turn, steering control valve (3) supplies a regulated amount of hydraulic oil to steering cylinders (2).

Two check valves are installed in the steering system to prevent a loss of hydraulic oil backward through the system.

Check valve (17) is installed in the line between the implement and steering pump (12) and control manifold (8). Check valve (17) prevents hydraulic oil from flowing backward to the implement and steering pump (15).

Check valve (10) is installed in the line between secondary steering pump (12) and control manifold (8). When secondary steering pump (12) is not running, check valve (10) prevents the loss of oil from control manifold (8) backward through the secondary steering pump.

When the system pressure exceeds the relief valve setting, relief valve (11) will open. Relief valve (11) directs oil back to hydraulic tank (16).

## Secondary Steering Pilot Valve

When solenoids (1) are not working properly, secondary steering solenoids (5a) and (5b) will be turned on by the transmission/chassis ECM.

Priority valve (20) will be held to the left by the force of the spring. Pump flow will be directed to flow compensator valve (21). Pump flow will satisfy the requirements of the steering system. Pump flow will travel through pressure reducing valve (7) to secondary steering pilot valve (6). Pressure reducing valve (7) will be held open by the spring until the pilot system pressure reaches the predetermined pressure. The transmission/chassis ECM will energize solenoid (5a) when the joystick is moved to the left turn position by the operator. Solenoid (5a) will direct pilot oil to the left side of spool (4). Spool (4) will shift to the right. Pump oil will be directed past spool (4) to steering cylinders (2).

# Troubleshooting Section

## Introduction

i02798712

## General Information

**SMCS Code:** 4300-SE

Visual checks are the first steps in order to troubleshoot a problem. When the visual inspections are complete and the problem is not fully understood, perform operational checks. After visual inspections and operation checks are complete and the problem is not fully understood, perform test procedures. These procedures will help identify system problems. These procedures are located in the Testing and Adjusting module for your machine.

**Reference:** For the locations of your individual system components, refer to the Systems Operation module for your machine.

**Reference:** For more information on the electrical system, refer to the Electrical Schematic for your machine.

**Reference:** For more information on the hydraulic system, refer to the Hydraulic Schematic for your machine.

i01806472

## Visual Inspection

**SMCS Code:** 4300-035-SE

### **WARNING**

**Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.**

A visual inspection of the steering system is the first step in diagnosing a problem. Complete the visual inspections before performing any operation checks. Perform the following visual checks:

- Check the hydraulic oil level.
- Check for cracks in the hoses or check for wear in the hoses.
- Check for cracks in the lines or check for wear in the lines.

- Check for flow restrictions such as sharp bends, incorrectly installed clamps, damaged hoses and damaged lines.
- Check for loose connections.
- Check for damage to components.
- Remove the filter element and the strainer. Check for particles that have been removed from the oil by the filter element. A magnet will separate the ferrous particles from the nonferrous particles. If necessary, replace the filter and clean the strainer.

i02559831

## Operational Checks

**SMCS Code:** 4300-035-SE

Operational tests of the steering system can be used in order to diagnose poor performance. Operational tests can also find the source of oil leakage inside the hydraulic system.

**Note:** Before you proceed with the operational checks of the secondary steering system make sure that the electrical system is functioning correctly. Refer to the electrical troubleshooting section.

When any test is performed on the steering system, the hydraulic oil must be at the normal operating temperature.

## Problem: The Machine Does Not Turn When Activated

### Probable Causes

- There is air in the steering system.
- The solenoid valves for the steering system are not functioning correctly.
- The crossover relief valve has failed.

## Problem: There Is Excessive Drift In the Steering System

### Probable Causes

- There is air in the steering system.
- The spool in the main control valve may not be centered.
- The spool in the main control valve is malfunctioning.

---

**Problem: The Machine Turns Slowly In One Direction****Probable Causes**

- The seals on the steering cylinder leak.
- The check valves leak in the steering control valve.

**Problem: The Machine Turns Too Slowly****Probable Causes**

- The springs for the flow control spool are not adjusted correctly.
- The steering pump is not producing enough flow.
- The seals on the steering cylinder leak.
- The check valve leaks in the steering control valve.
- The main relief valve is malfunctioning or the main relief valve pressure is set too low.

**Problem: The Steering Pump Makes Noise but the Cylinder Rods Do Not Move Smoothly****Probable Causes**

- The steering pump is leaking air into the system.
- The pump is worn.
- The viscosity of oil is wrong.
- The relief valve setting is wrong.
- The steering system is contaminated.

**Problem: The Temperature of the Oil Is Too Hot****Probable causes**

- The viscosity of the oil is wrong.
- The relief valve setting is too low.
- The pump is worn.
- There is a restriction in an oil passage.
- The seals on the steering cylinder leak.

**Problem: The Steering Pump Output Is Low****Probable Causes**

- There is a low oil level in the hydraulic tank.
- The viscosity of the oil is wrong.
- The pump is worn.
- There is a restriction on the inlet side of the steering pump.
- The steering pump is leaking air into the system.

---

# Symptom Procedures

i02563803

## Electrical System

**SMCS Code:** 4300-035-SE

Refer to the Electrical Troubleshooting book for more information on the secondary steering electrical system for your machine.

# Testing And Adjusting Section

## Testing and Adjusting

i03904029

### System Pressure - Release

SMCS Code: 4300-553-PX; 5050-553-PX

#### Hydraulic System

#### WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

#### WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

#### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

### Introduction

The following procedure is used in order to relieve hydraulic pressure in the system.

### Required Tools

Tools are not required for this procedure.

### Machine Preparation

1. Park on a level surface. If you must park on a grade, chock the machine.
2. Apply the service brake in order to stop the machine. Move the transmission control lever to the NEUTRAL position.
3. Move the speed control lever to the LOW IDLE position.
4. Engage the parking brake.
5. Lower all attachments to the ground.
6. Stop the engine.

### Release System Pressure

1. Operate all hydraulic controls through all positions in order to relieve hydraulic pressure. Repeat this step until all hydraulic pressure is released.

- Turn the engine start switch to OFF position and remove the key.

i03901697

## Magnetic Switch (Secondary Steering Relay) - Test

SMCS Code: 4493-081-SST

### WARNING

The machine's batteries must have a normal charge and the secondary steering electrical system must be okay. A low charge condition, or any defect in the battery, battery cells, or electrical circuit can cause loss of secondary steering and could result in personal injury and/or damage to the machine.

### NOTICE

Once the secondary steering system has been activated, it should remain ON no more than two minutes. This should be sufficient time to safely steer the machine to a stop. When the machine is stopped, turn the key start switch to the OFF position in order to turn OFF secondary steering. Prolonged use of the secondary steering system will cause the electric motor to overheat and cause damage to its components.

## Introduction

The following procedure will explain the steps for testing the secondary steering test switch.

## Required Tools

Tools are not required for this test procedure.

## Machine Preparation

- The machine should be stationary. Press the implement lockout switch to the ON position.
- Activate the parking brake. The key should be in the ON position. Start the engine and run the engine.

## Test Procedure

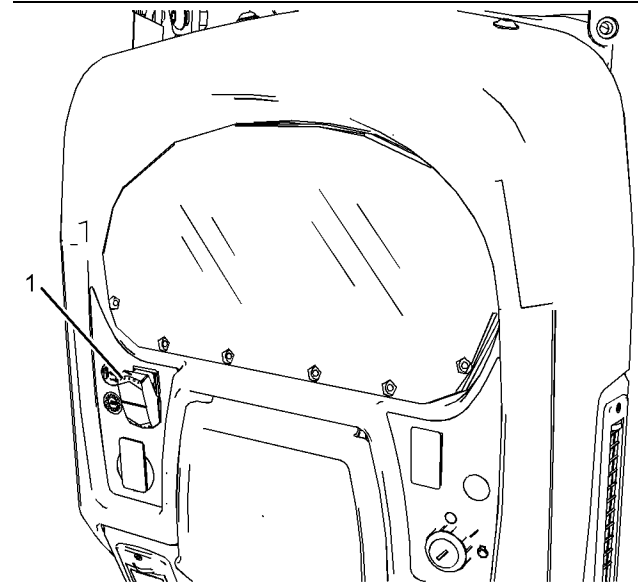


Illustration 29

g01374406

(1) Secondary steering test switch

- Depress the secondary steering test switch (1).
- Continue to depress the secondary steering test switch. The secondary steering pump will run for a maximum of 10 seconds.
- Verify that steering faults or events do not occur.

i08196568

## Relief Valve (Secondary Steering) - Test

SMCS Code: 4322-081-SE

**Note:** To reduce the risk of injuries due to tests/adjusts performed on the equipment with the engine running, use a remote pressure reading with a wireless gauge or add long hoses/wires to keep all personnel away from the machine while the engine is running.

**Reference:** Before you perform any tests, refer to the Testing and Adjusting, "Machine Preparation for Troubleshooting" section.

## Specification

Table 7

Relief Valve Pressure Setting	
17225 kPa (2500 psi)	

### Introduction

The following procedure will explain the steps for testing the secondary steering relief valve.

### Required Tools

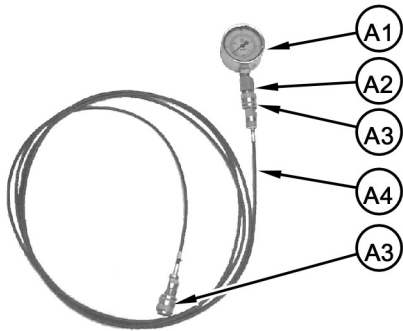


Illustration 30  
Tooling (A)

g02144709

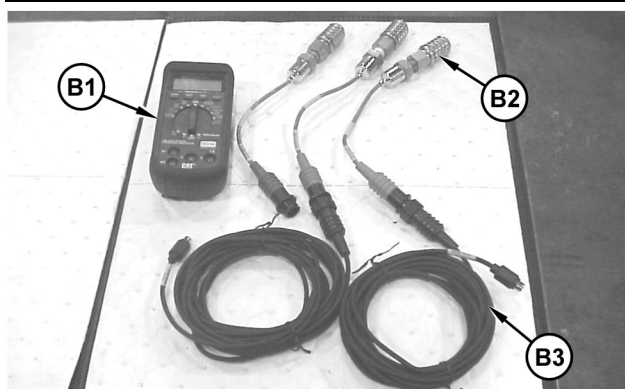


Illustration 31  
Tooling (B)

g02144716

(Table 8, contd)

	B2	198 - 4238	Pressure Sensor Gp (0 to 34,450 kPa (0 to 5,000 psi))	1
	B3	198 - 4236	Adapter Cable As	1
F		110 - 2218	Swivel Tee	1
		5P - 6944	Adapter	1
		6V - 3965	Fitting	1

**Note:** Tooling (A) or Tooling (B) may be used to perform these tests.

### Test Preparation

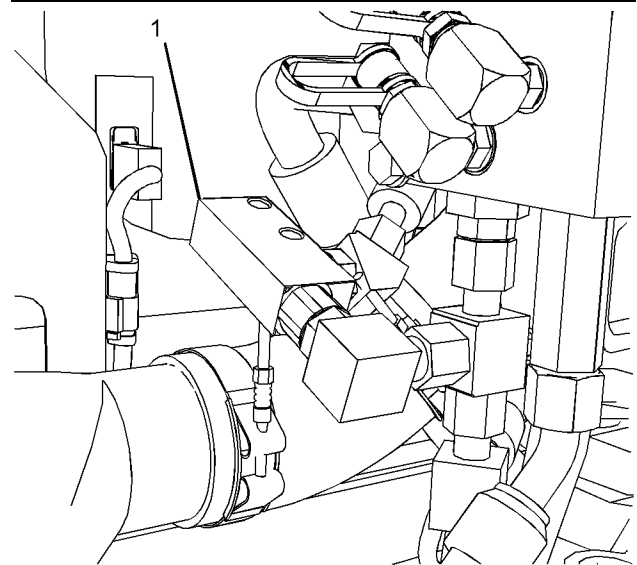


Illustration 32  
(1) Relief valve

g01375996

Table 8

Tool	Item	Part Number	Description	Qty
A	A1	8T - 0859	Pressure Gauge (0 to 25,000 kPa (0 to 3,600 psi))	1
	A2	6V - 3989	Fitting	1
	A3	6V - 4143	Quick Connect Coupler	2
	A4	177 - 7862	Hose As (5.5 m (18 ft))	1
B		198 - 4240	Digital Pressure Indicator Gp	1
	B1	198 - 4234	Digital Indicator	1

(continued)

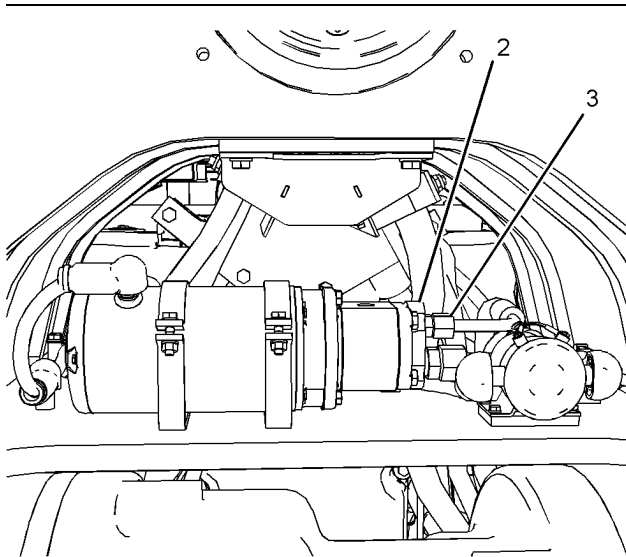


Illustration 33

g01375993

- (2) Secondary steering pump  
(3) Line

1. With the engine off, disconnect line (3) from secondary steering pump (2).
2. Install Tooling (F) to secondary steering pump (2) and connect line (3) to tooling (F).
3. Install Tooling (B) to Tooling (F).

## Test Procedure

1. Turn both the battery disconnect switch and the engine start switch to the ON position. Start the engine and run the engine. Turn the implement lockout switch to the ON position.
2. Hold the secondary steering test switch in the TEST position until the pressure stops rising. The pressure should be 17225 kPa (2500 psi). 17225 kPa (2500 psi) is the correct pressure setting for relief valve (1).

3. If the pressure reading for relief valve (1) is not 17225 kPa (2500 psi), relief valve (1) must be replaced. Relief valve (1) cannot be adjusted. If the pressure reading is incorrect, replace relief valve (1) and repeat Step 2. If the pressure reading for relief valve (1) is correct, remove Tooling (F) and Tooling (B) and reconnect line (3) to secondary steering pump (2).

i04128669

## Control Manifold (Steering Backup) - Test

SMCS Code: 5051-081; 5264-081

### **⚠ WARNING**

The machine's batteries must have a normal charge and the secondary steering electrical system must be okay. A low charge condition, or any defect in the battery, battery cells, or electrical circuit can cause loss of secondary steering and could result in personal injury and/or damage to the machine.

### NOTICE

Once the secondary steering system has been activated, it should remain ON no more than two minutes. This should be sufficient time to safely steer the machine to a stop. When the machine is stopped, turn the key start switch to the OFF position in order to turn OFF secondary steering. Prolonged use of the secondary steering system will cause the electric motor to overheat and cause damage to its components.

## Introduction

This test verifies that the secondary steering solenoids are functioning properly if the main steering solenoids fail.

## Required Tools

Tools are not required for this test procedure.

## Machine Preparation

1. Complete the test procedure Test and Adjusting, "Magnetic Switch (Secondary Steering Relay) - Test" in order to verify that the secondary steering pump functions correctly before starting Step 2.
2. The machine should be stationary. Press the implement lockout switch to the ON position.
3. Activate the parking brake. The key should be in the ON position. Start the engine and run the engine.

## Test Procedure

1. Start the engine and run the engine.

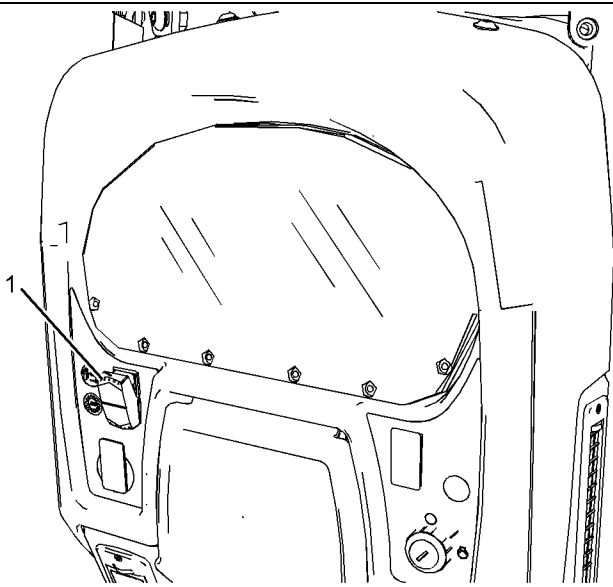


Illustration 34

g01374422

(1) Secondary steering test switch

2. Depress secondary steering test switch (1).
3. While secondary steering test switch (1) is held in the TEST position, provide the following steering inputs with the left-hand joystick:
  - Steer left
  - Steer to the center
  - Steer right

Verify that the movement of the front wheels aligns with each steering input.

**Note:** The secondary steering pump will run for a maximum of 10 second intervals.

4. The alert indicator for the secondary steering should remain amber in color during the test. If the test was not successful, the alert indicator for the secondary steering will be red in color. Verify that steering faults or events do not occur.



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