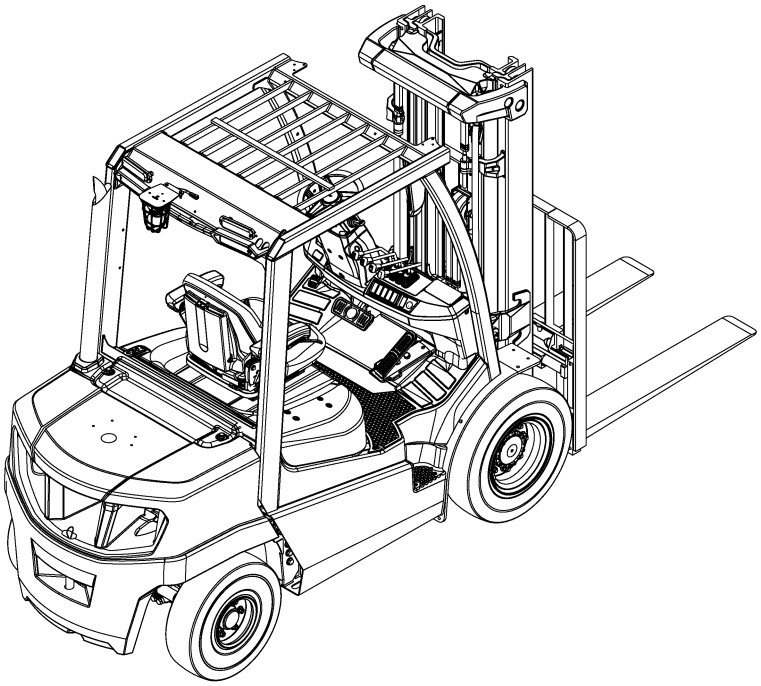
HYDRAULICS

H2.0A, H2.5A6, H2.5A, H3.0A, H3.5A (H40A, H50A6, H60A, H70A) [R177]



HYSTER

PART NO. 4277936

1900 SRM 2302

SAFETY PRECAUTIONS
MAINTENANCE AND REPAIR

- The Service Manuals are updated on a regular basis, but may not reflect recent design changes to the product. Updated technical service information may be available from your local authorized Hyster® dealer. Service Manuals provide general guidelines for maintenance and service and are intended for use by trained and experienced technicians. Failure to properly maintain equipment or to follow instructions contained in the Service Manual could result in damage to the products, personal injury, property damage or death.
- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- DISCONNECT THE BATTERY before doing any maintenance or repair on electric lift trucks. Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See HOW TO PUT THE LIFT TRUCK ON BLOCKS in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER ® APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a DO NOT OPERATE tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

NOTE: The following symbols and words indicate safety information in this manual:



WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury and property damage.

On the lift truck, the WARNING symbol (and word, if present) are on orange background. The CAUTION symbol (and word, if present) are on yellow background.

WARNING

Installing improper electrical accessories or installing an electrical accessory incorrectly can increase the risk of equipment damage, personal injury and fire. DO NOT install electrical accessories to the truck unless you have been trained and authorized to do so. Personnel installing the electrical accessories must document the changes made to the truck. DO NOT install accessories which affect the truck's compliance with standard ANSI/ITSDF B56.1, UL 558, or UL 583, or which otherwise affect the safe operation of the truck.

WARNING

Installing improper electrical accessories or installing an electrical accessory incorrectly can increase the risk of equipment damage, personal injury and fire. DO NOT install electrical accessories to the truck unless you have been trained and authorized to do so. Personnel installing the electrical accessories must document the changes made to the truck. DO NOT install accessories which affect the truck's compliance with standard EN 1175:2020.

WARNING

California Proposition 65 - Operating, servicing and maintaining a powered industrial truck can expose you to chemicals including engine exhaust, carbon monoxide, phthalates, and lead, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

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Introduction

GENERAL
202001-001

NOTE: For any fasteners in this manual that feature standard torque specifications, please refer to **Metric and Inch (SAE) Fasteners** 8000SRM0231 for correct specifications.

Hydraulic system repair

HYDRAULIC PUMP REPAIR 202001-061

REMOVE

WARNING

Putting the Lift Truck on Blocks

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the following assemblies will cause large changes in the center of gravity: mast, drive axle, engine, transmission, and counterweight. When the lift truck is put on blocks, put additional blocks in the following positions to maintain stability:

- **Before removing the mast and drive axle, put blocks under the counterweight so the lift truck cannot fall backward.**
- **Before removing the counterweight, put blocks under the mast assembly so the lift truck cannot fall forward.**

The surface must be solid, even, and level when the lift truck is put on blocks. Make sure any blocks used to support the lift truck are solid, one-piece units.

NOTE: Worn or damaged seals and O-rings are the most common cause of pump damage. The pump shaft, plugs, and plates also wear. They must be checked during disassembly. DO NOT make any repairs to the parts. To prevent more failures, always replace parts that are worn or damaged. If several main parts need replacing, replace the with a new pump. See **Parts Manual** for replacement parts.

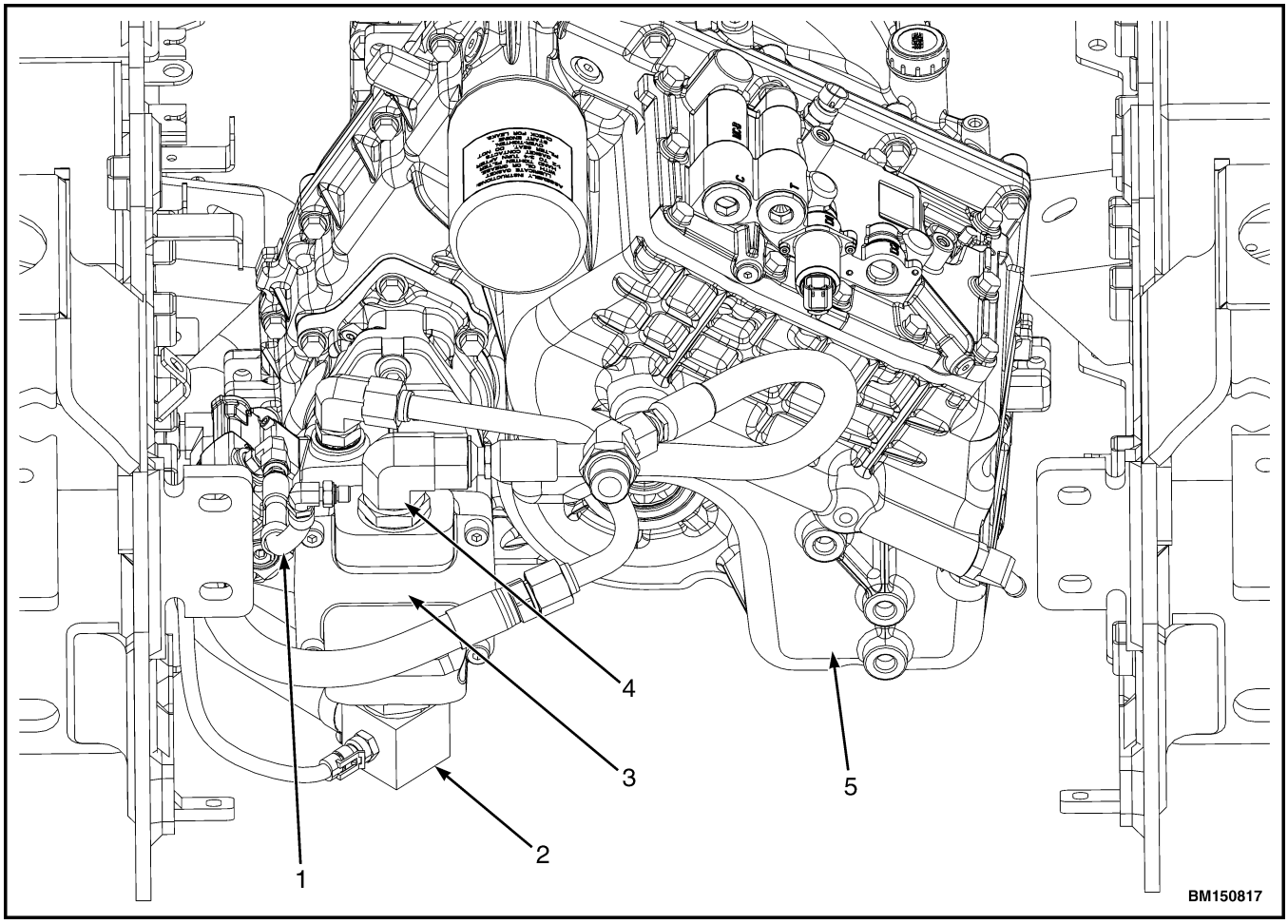
1. Put the lift truck on blocks. See the **Operating Manual** or **Periodic Maintenance Manual** for your lift truck for the procedures to put the lift truck on blocks.

2. Place a drain pan under hydraulic hoses being removed. See **Operating Manual** or **Periodic Maintenance Manual** for your lift truck for hydraulic oil quantity and specifications.

WARNING

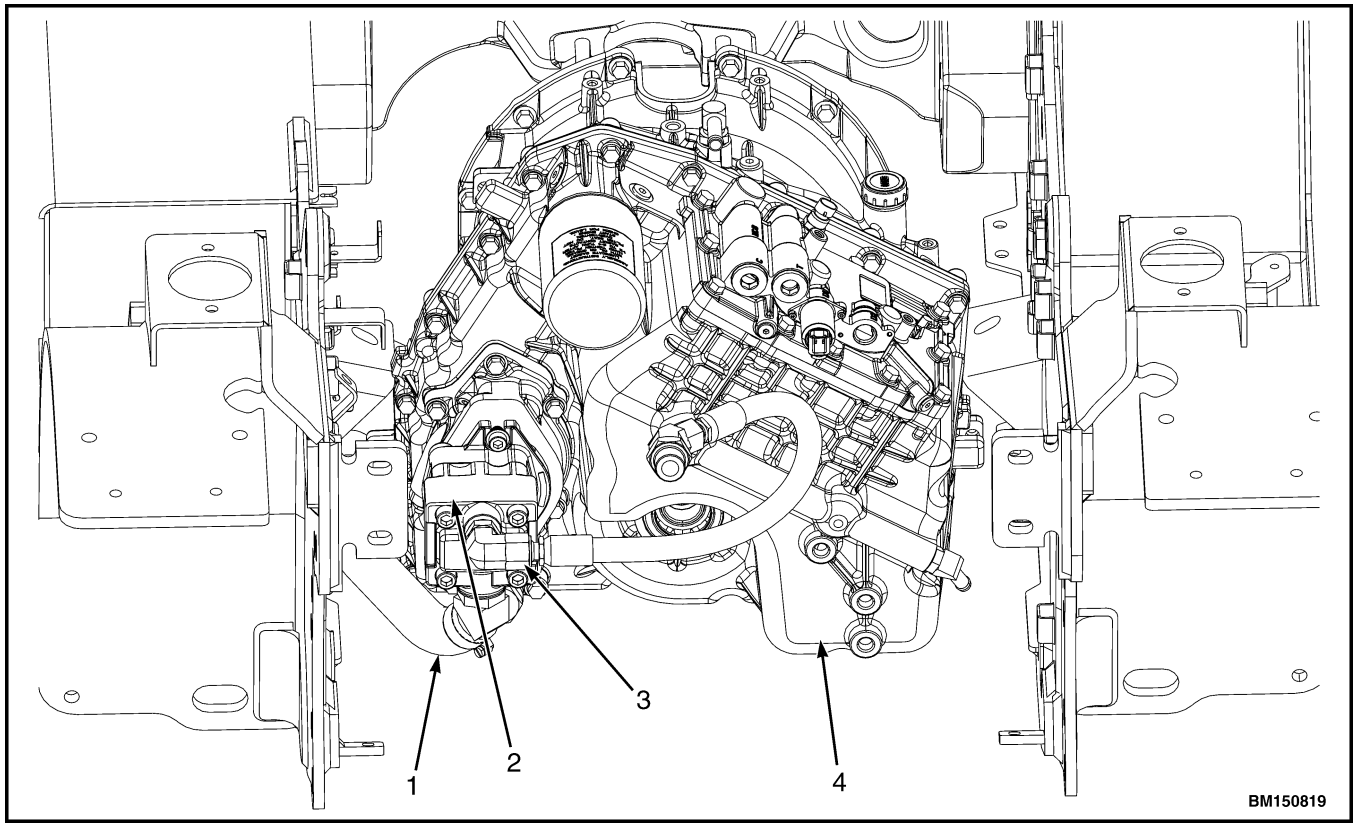
Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

3. Tag and disconnect hydraulic hoses from the hydraulic pump. Put caps on hose fittings and open ports.
   - For lift trucks with a powershift transmission and Variable Displacement Pump (VDP), see Figure 1.
   - For lift trucks with a powershift transmission and hydraulic gear pump, see Figure 2.



1. LOAD SENSE LINE
2. SUCTION HOSE
3. VARIABLE DISPLACEMENT PUMP
4. PRESSURE OUT HOSE/VALVE SUPPLY HOSE
5. TRANSMISSION

Figure 1. Powershift Transmission and Variable Displacement Pump Arrangement

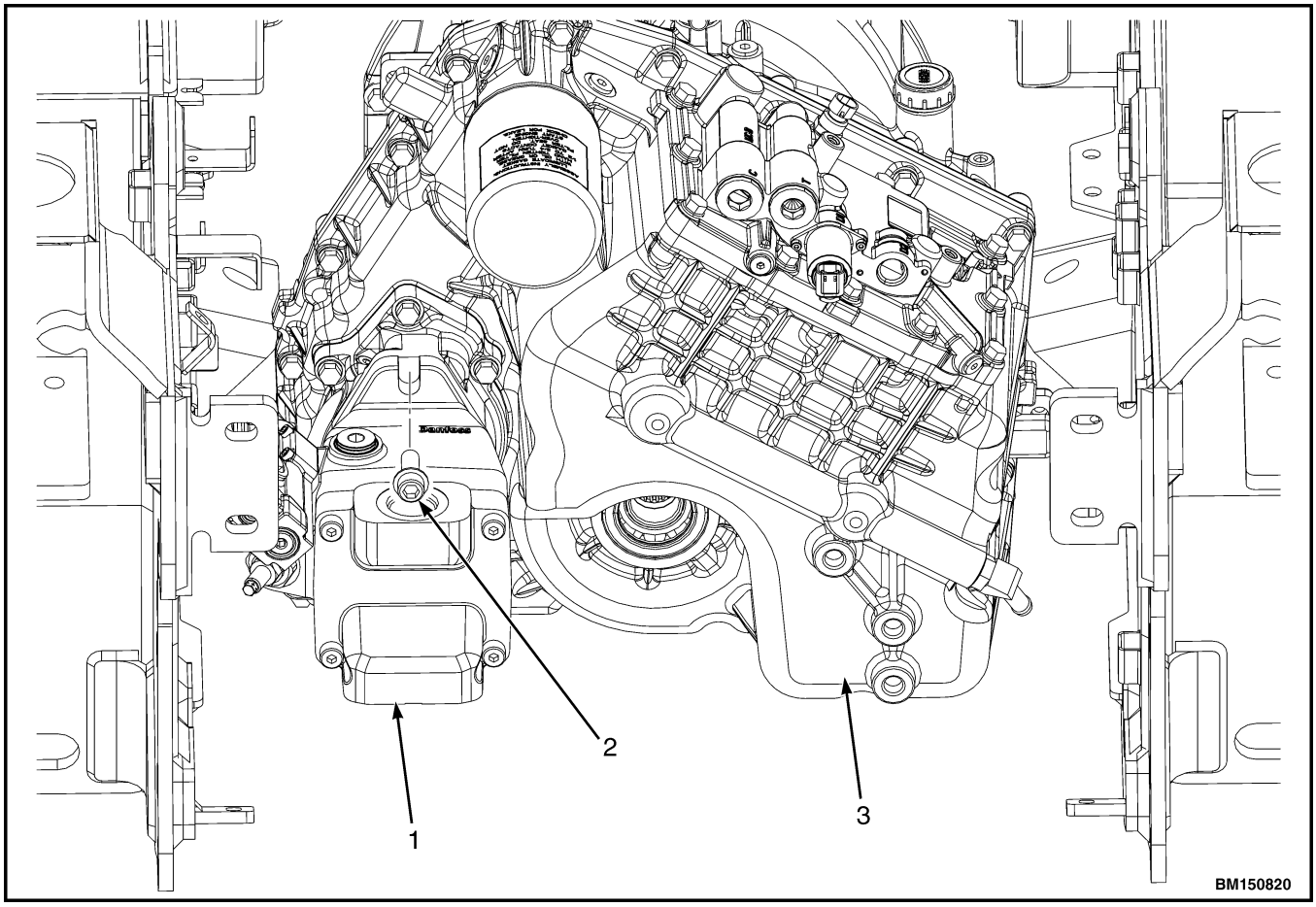


1. SUCTION HOSE
2. HYDRAULIC GEAR PUMP
3. PRESSURE OUT HOSE/VALVE SUPPLY HOSE
4. TRANSMISSION

Figure 2. Powershift Transmission and Hydraulic Gear Pump Arrangement

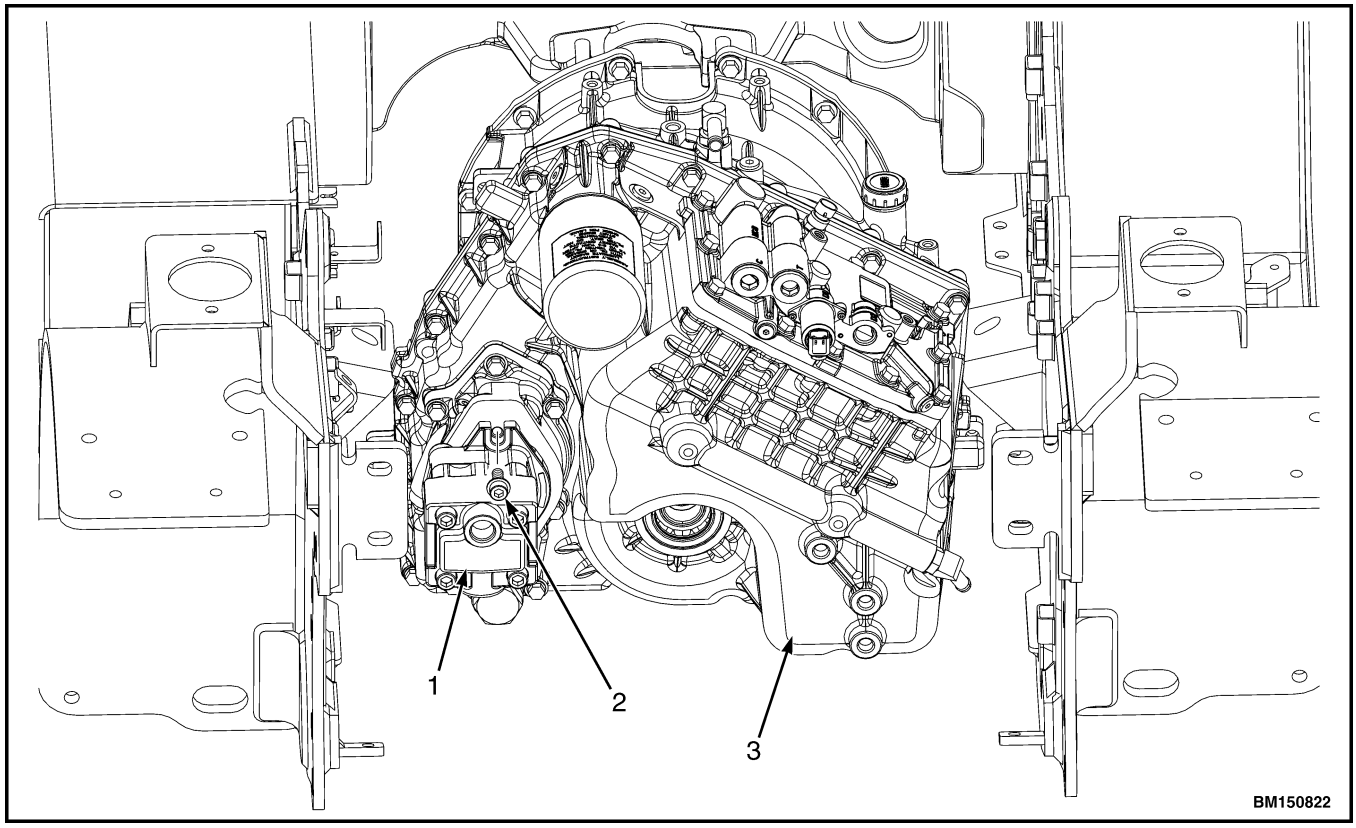
4. Support the pump to prevent it from falling. Remove two capscrews and the pump from transmission housing.

- For lift trucks with a powershift transmission and Variable Displacement Pump (VDP), see Figure 3.
- For lift trucks with a powershift transmission and hydraulic gear pump, see Figure 4.



1. VARIABLE DISPLACEMENT PUMP
2. CAPSCREWS
3. TRANSMISSION

Figure 3. Powershift Transmission and Variable Displacement Pump Removal



1. HYDRAULIC GEAR PUMP
2. CAPSCREWS
3. TRANSMISSION

Figure 4. Powershift Transmission and Hydraulic Gear Pump Removal

DISASSEMBLE

Variable Displacement Pump

1. Put the variable displacement pump in a vise.

WARNING

Protect the drive shaft from damage before removing the retaining ring and shaft seal.

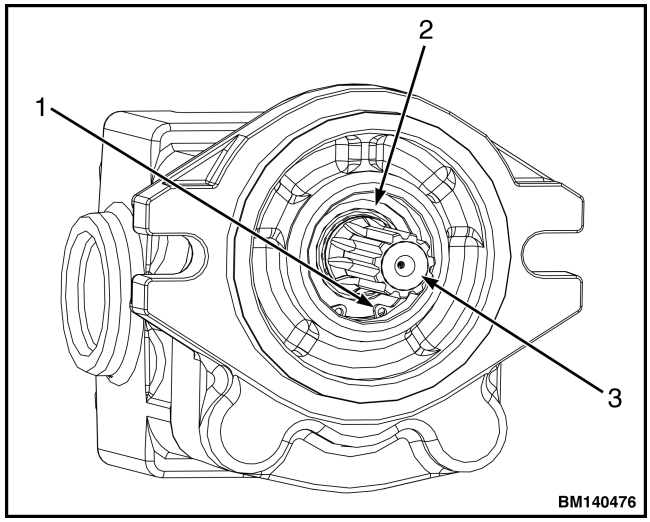
NOTE: Perform Step 2 ONLY if shaft seal is leaking.

NOTE: Kits are available that include materials and tools to remove and install shaft seal. See the **Parts Manual** for kit part numbers.

2. Remove retaining ring and shaft seal from drive shaft as described below:

a. Clean shaft and shaft seal area. Wrap pump drive shaft splines in tape or other protective material to protect drive shaft before removing retaining ring and shaft seal. See Figure 5.

b. Remove the retaining ring.

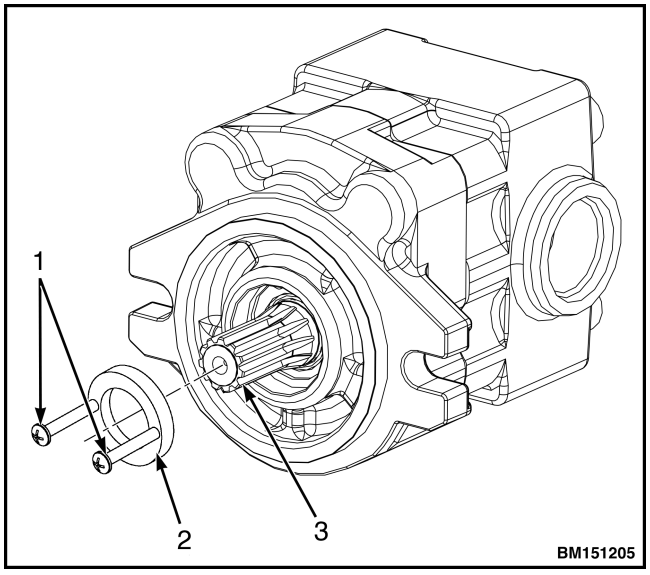


1. RETAINING RING
2. SHAFT SEAL
3. DRIVE SHAFT

Figure 5. Retaining Ring Removal

c. Punch two holes into top surface of old shaft seal being replaced. Make sure holes are 180° apart from each other. Insert two screws into holes and into steel layer of the shaft seal. Pull on screws and remove existing shaft seal from drive shaft. See Figure 6.

d. Inspect and clean shaft and internal shaft sealing area. Remove any metal shavings created while inserting screws into old shaft seal.



1. SCREWS
2. SHAFT SEAL
3. DRIVE SHAFT

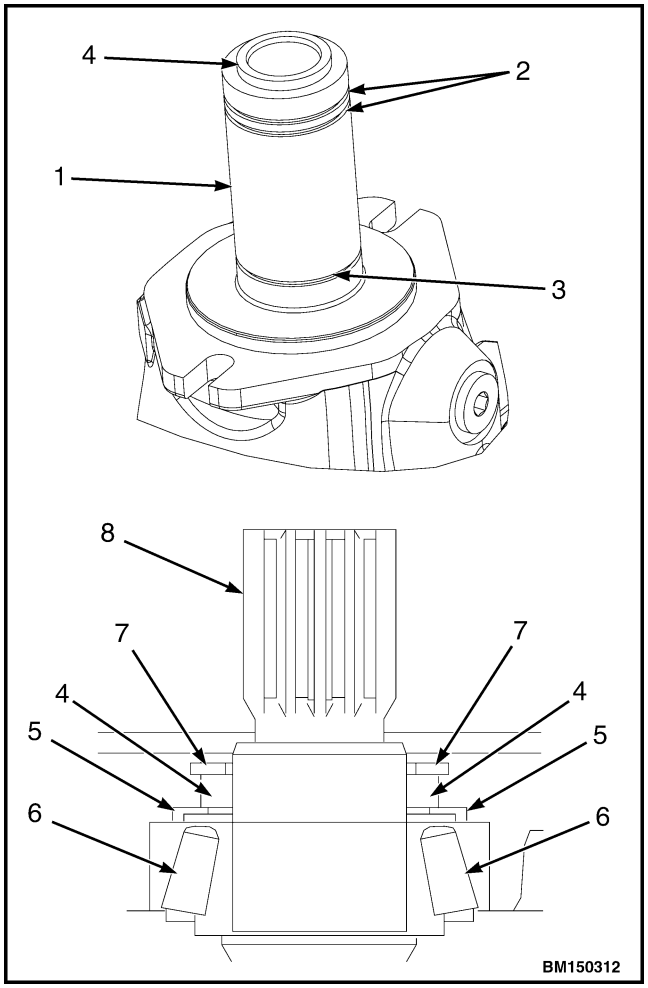
Figure 6. Shaft Seal Removal

NOTE: Be sure solid surface area of shaft seal is pointing outwards from pump.

NOTE: Use the end of the VDP shaft seal installation tool that has one ring to install the shaft seal. See Figure 7.

e. Install new shaft seal onto drive shaft. Use special VDP shaft seal installation tool, Part Number 4035565, and seat shaft seal down onto pump stop ring.

f. Use rubber hammer and tap on VDP shaft seal tool until VDP shaft seal tool shoulder stops against the face of VDP housing.

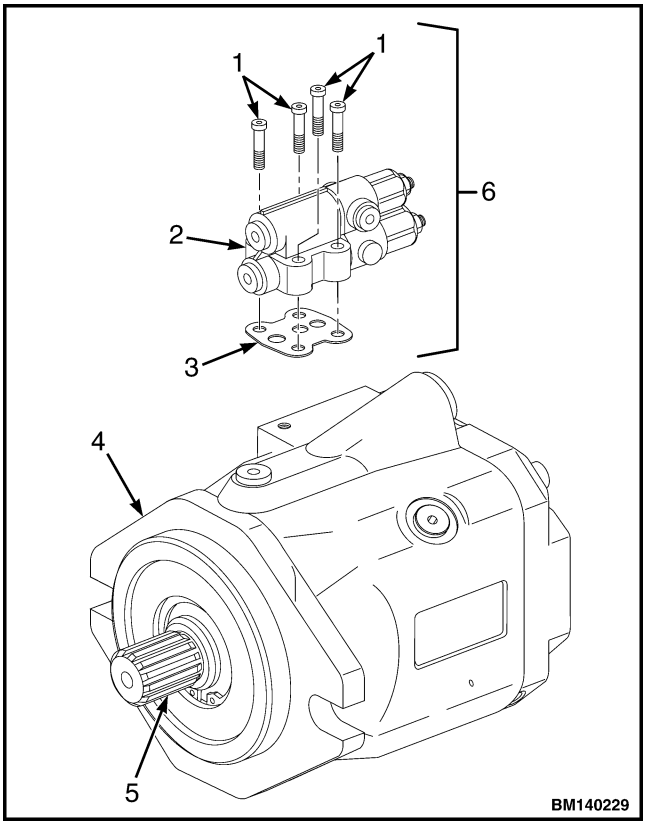


1. VDP SHAFT SEAL TOOL
2. TWO RINGS
3. ONE RING
4. VDP SHAFT SEAL TOOL SHOULDER
5. STOP RING
6. BEARING
7. RETAINING RING
8. DRIVE SHAFT

Figure 7. Shaft Seal Installation

g. Install the retaining ring. Be sure retaining ring correctly rests in the groove. See Figure 5.

3. Remove four socket head screws from pressure control valve and VDP. Remove seal from control valve. See Figure 8.



1. SOCKET HEAD SCREW
2. CONTROL VALVE
3. SEAL
4. VARIABLE DISPLACEMENT PUMP
5. DRIVE SHAFT
6. PRESSURE CONTROL VALVE

Figure 8. Variable Displacement Pump Disassembly

CLEAN

WARNING

Cleaning solvents can be flammable and toxic, can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

Clean all components in solvent. Dry components with compressed air. DO NOT dry components with a cloth. Make sure all surfaces are free of scratches and sharp edges.

INSPECT

Check the control valve seal, drive shaft seal, and retaining ring for wear or damage and replace if necessary. Check the rest of the variable displacement pump assembly. If any parts other than the control valve seal, drive shaft seal, and retaining ring are worn or damaged, replace with a new variable displacement pump.

Check parts for wear and damage. If any parts are worn or damaged, replace the damaged parts. If the pump housing is damaged, replace the pump.

ASSEMBLE

Variable Displacement Pump

1. Coat seal with clean hydraulic oil. Install seal, control valve, and four socket head screws on VDP. See Figure 8.

2. Apply clean hydraulic oil to shaft seal and retaining ring. Install shaft seal and retaining ring onto drive shaft.

INSTALL

1. Clean pump flange and transmission mounting surfaces and put a 3 - 5 mm (0.118 - 0.197 in.) bead of Loctite™ High Performance RTV Silicone Gasket Maker (Part No. 1584621) on pump flange or transmission mounting surface.

2. Position pump on transmission housing and install two capscrews.
   - For lift trucks with a powershift transmission and Variable Displacement Pump (VDP), see Figure 3.
     - Torque capscrews to 90 N•m (66.4 lbf ft).
   - For lift trucks with a powershift transmission and hydraulic gear pump, see Figure 4.
     - Torque capscrews to 52 N•m (38.4 lbf ft).

3. Remove caps and connect hydraulic hoses to the hydraulic pump. Put caps on hose fittings and open ports.
   - For lift trucks with a powershift transmission and Variable Displacement Pump (VDP), see Figure 1.
   - For lift trucks with a powershift transmission and hydraulic gear pump, see Figure 2.

4. Remove lift truck from blocks. See **Operating Manual** or **Periodic Maintenance Manual** for your lift truck for the procedures to remove lift truck from blocks.

WARNING

DO NOT try to locate hydraulic leaks by placing hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

5. Start the engine while operating the hydraulic functions. Check for leaks.

6. Check hydraulic tank oil level. Fill the hydraulic tank with clean hydraulic oil as specified in **Periodic Maintenance Manual**.

VARIABLE DISPLACEMENT PUMP CHECKS AND ADJUSTMENTS

Pump Margin Pressure

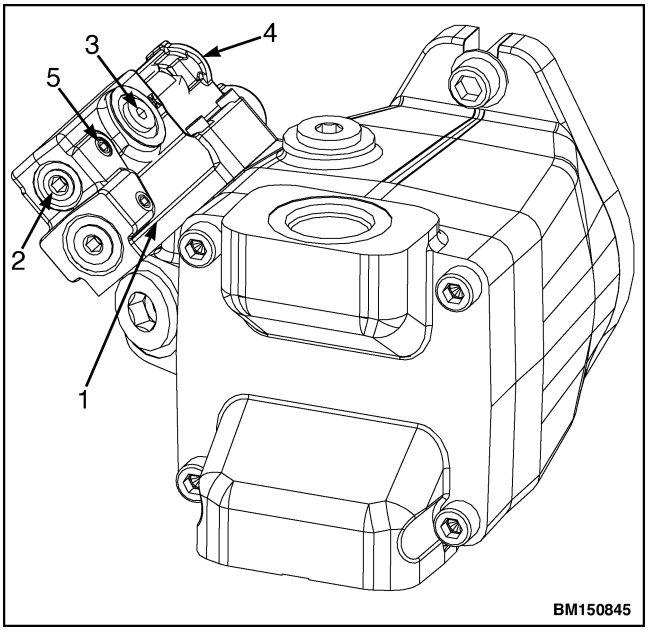
The margin pressure is the difference between the pressure at the P-port and X-port on the pressure control valve of the Variable Displacement Pump (VDP). If the margin pressure is not within range, the flow of hydraulic oil out of the pump will be either too low or too high.

NOTE: Execute all pressure measurements with **NO** load on the hydraulic system, engine at idle and the hydraulic oil at operating temperature.

1. Place the forks on the ground, set the park brake, and switch the engine **OFF**.

2. Tag and disconnect LS hydraulic hose from the pressure control valve.

3. Install digital pressure gauges with a range of 0 - 40 MPa (0 - 5,000 psi), one gauge on port P and one gauge on the LS diagnostic port on main valve. See Figure 9.



1. PRESSURE CONTROL VALVE
2. MARGIN PRESSURE ADJUSTMENT PLUG
3. PORT X
4. PORT P
5. SETSCREW

Figure 9. Pressure Control Valve

4. Start the engine and allow the hydraulic system pressure to stabilize.

5. Observe the pressure reading on both pressure gauges. The pump margin pressure is obtained by subtracting the reading on port X from the reading on port P (P-X). Pressure should be within 1.45 ±0.1 MPa (210.3 ±14.5 psi).

- If pressure is not within range, proceed to Step 6 to adjust the pump margin pressure.
- If pressure is within range, proceed to Step 9.

6. Loosen the setscrew that locks the margin pressure adjustment plug.

NOTE: One full turn of the margin pressure adjustment plug equals about 1.7 MPa (250 psi).

7. Turn the margin pressure adjustment plug, either direction, until you achieve the correct pressure.

8. Tighten the setscrew that locks the margin pressure adjustment plug. Torque setscrew to 9 N•m (7 lbf ft).

9. Remove the pressure gauges and install hydraulic hose and port plug. Torque plug to 12 N•m (9 lbf ft).

10. Check for oil leaks.

HYDRAULIC CONTROL VALVE REPAIR 202001-062

MANUAL CONTROL VALVE

Remove

WARNING

Lower carriage completely before working on control valve or hydraulic system. Do not work under a raised carriage. Put mast in a vertical position, with no forward or back tilt, and lower carriage completely before disconnecting any parts of hydraulic system. The mast can lower suddenly and cause injury if the carriage is not lowered.

NOTE: Most of the individual valve components can be removed and replaced while the control valve is installed in the truck. Removal of the control valve for repairs is normally only required to replace a valve section, replace the O-rings between the sections, or to remove a manual valve control spool.

1. Disconnect the hydraulic levers from them manual hydraulic control valve by removing the cotter pins and rod end pins that connect the hydraulic lever linkages to the spools. See Figure 10.

2. Remove four capscrews and the hydraulic lever assembly from the cowl.

3. Tag and disconnect electrical connectors from control valve. See Figure 11 or Figure 12.

4. Tag and disconnect electrical connectors from control valve. See Figure 12.

5. Tag and disconnect hydraulic hoses from the control valve. Install plugs or caps on all open hose ends and valve ports to prevent contamination. See Figure 11 or Figure 12.

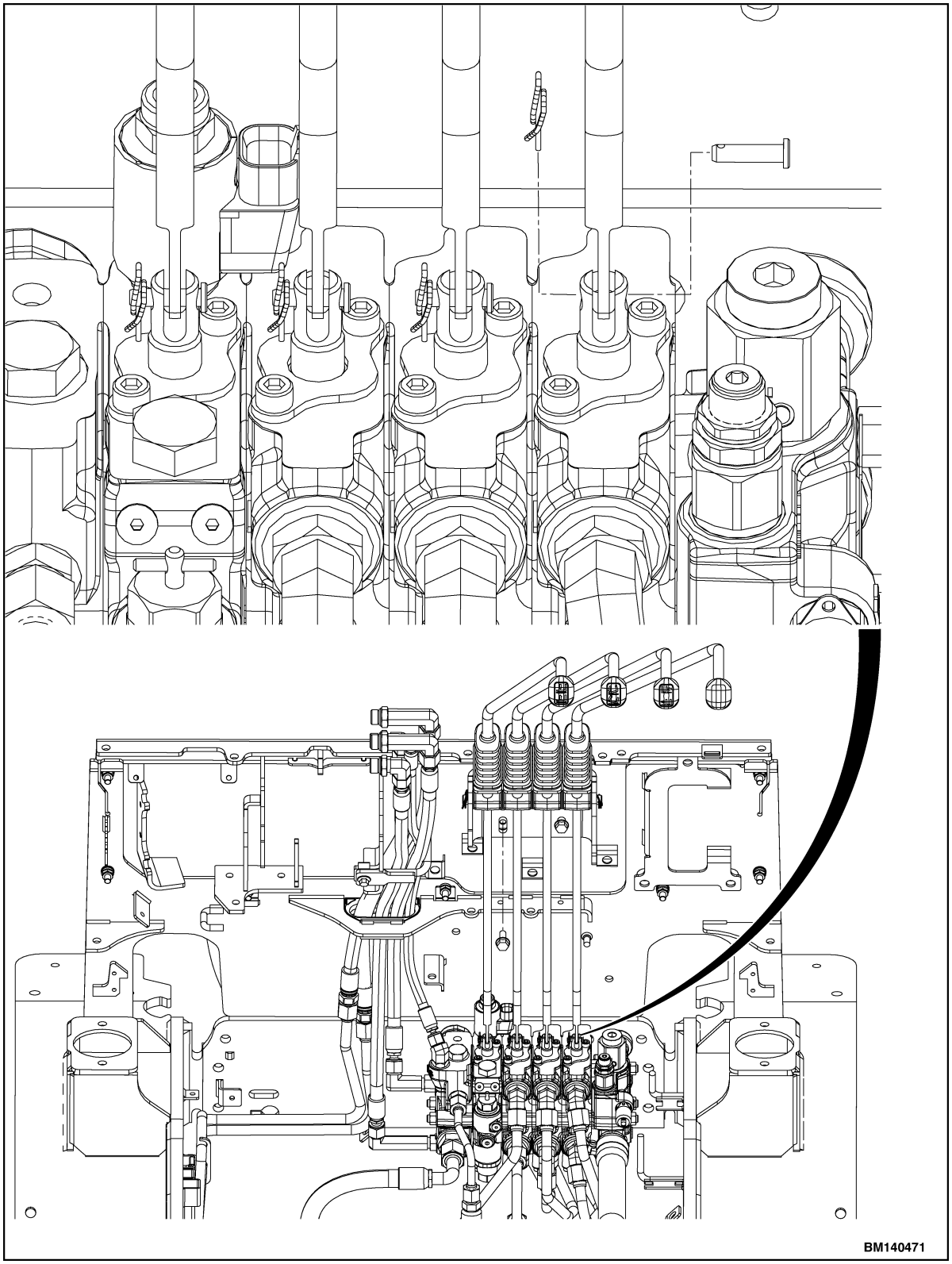
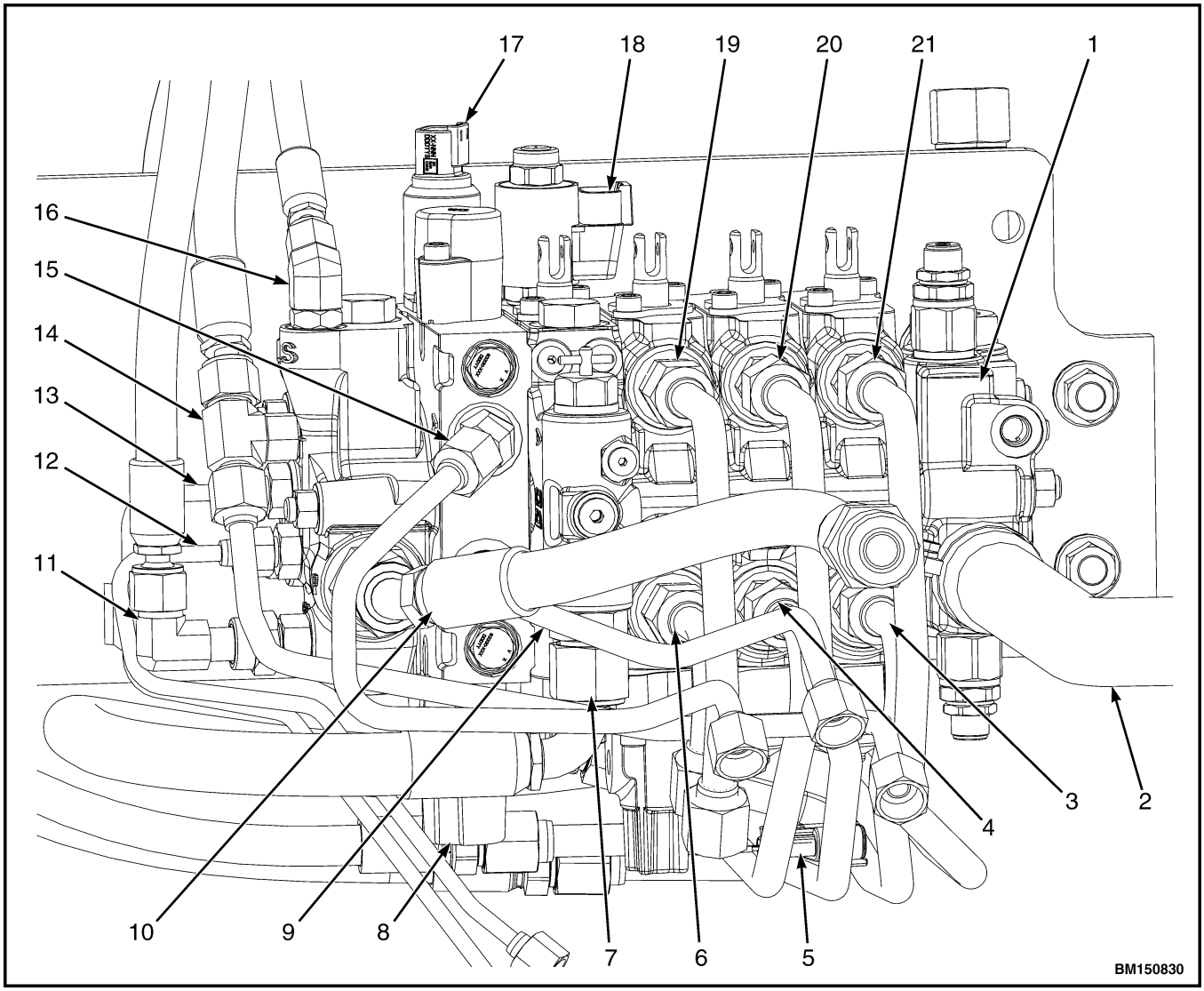


Figure 10. Hydraulic Levers

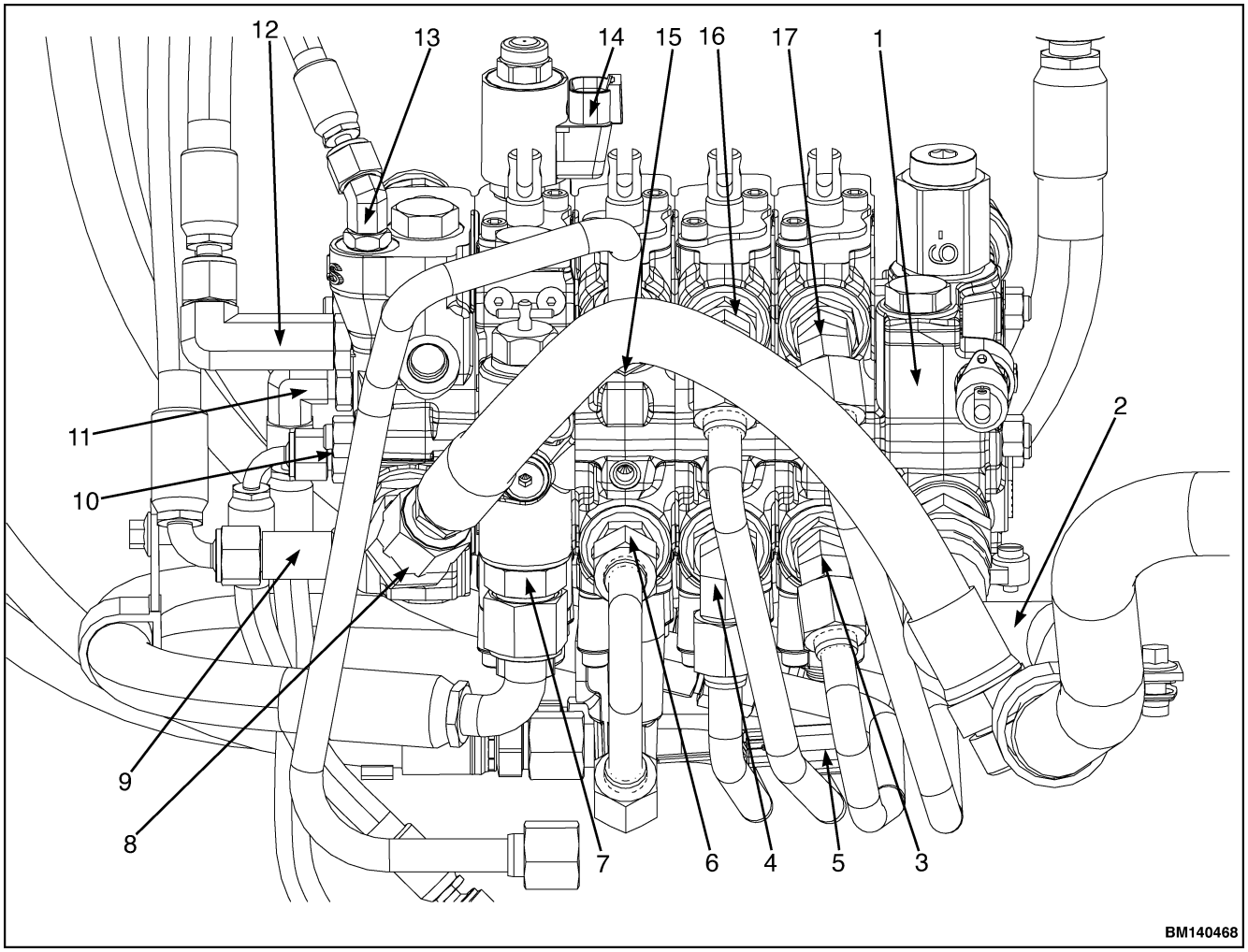
Legend for Figure 10.

1. COWL
2. HYDRAULIC LEVER ASSEMBLY
3. CAPSCREW
4. HYDRAULIC CONTROL VALVE
5. COTTER PIN
6. ROD END PIN



1. MANUAL HYDRAULIC CONTROL VALVE
2. OUTLET SECTION - TO TANK
3. AUXILIARY 2 SECTION PORT B
4. AUXILIARY 1 SECTION PORT B
5. TILT SECTION - CONNECTOR CPS656
6. TILT SECTION PORT B - TO ROD SIDE
7. LIFT SECTION HOIST LINE PORT B - TO PISTON SIDE
8. FAN DRIVE SECTION - CONNECTOR CPS646
9. FAN DRIVE SECTION PORT B
10. INLET SECTION PORT P - FROM PUMP
11. INLET SECTION PORT SS - STEER SUPPLY
12. INLET SECTION PORT P - BRAKE SUPPLY
13. INLET SECTION PORT T - BRAKE RETURN
14. INLET SECTION PORT T - STEER RETURN
15. FAN SECTION PORT A
16. INLET SECTION PORT SLS - STEER LOW SIDE
17. FAN SECTION - CONNECTOR CPS645
18. LIFT SECTION - CONNECTOR CPS678
19. TILT SECTION PORT A - TO PISTON SIDE
20. AUXILIARY 1 SECTION PORT A
21. AUXILIARY 2 SECTION PORT A

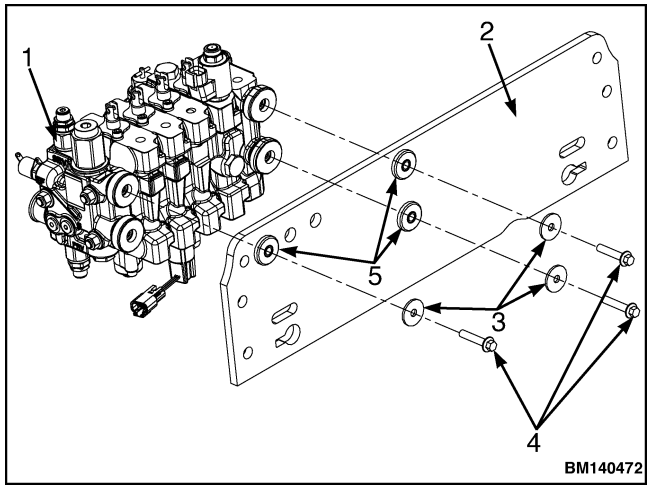
Figure 11. Manual Hydraulic Control Valve Connections (with Hydraulic Fan Drive)



1. MANUAL HYDRAULIC CONTROL VALVE
2. RETURN HOSE
3. AUXILIARY 2 SECTION PORT B
4. AUXILIARY 1 SECTION PORT B
5. TILT SECTION CONNECTOR
6. TILT SECTION PORT B FITTING
7. LIFT SECTION HOIST LINE PORT B FITTING
8. INLET SECTION PORT P FITTING
9. INLET SECTION PORT SS FITTING
10. INLET SECTION PORT P FITTING
11. INLET SECTION PORT T FITTING
12. INLET SECTION PORT T FITTING
13. INLET SECTION PORT STEER LOAD SENSE FITTING
14. OPERATOR PRESENCE SENSOR CONNECTOR
15. TILT SECTION PORT A FITTING
16. AUXILIARY 1 SECTION PORT A FITTING
17. AUXILIARY 2 SECTION PORT A FITTING

Figure 12. Manual Hydraulic Control Valve Connections

6. Remove three capscrews, washers, and the control valve from the frame and place on a flat surface for disassembly. See Figure 13.



1. MANUAL HYDRAULIC CONTROL VALVE
2. CROSS MEMBER
3. WASHERS
4. CAPSCREWS
5. ISOLATOR

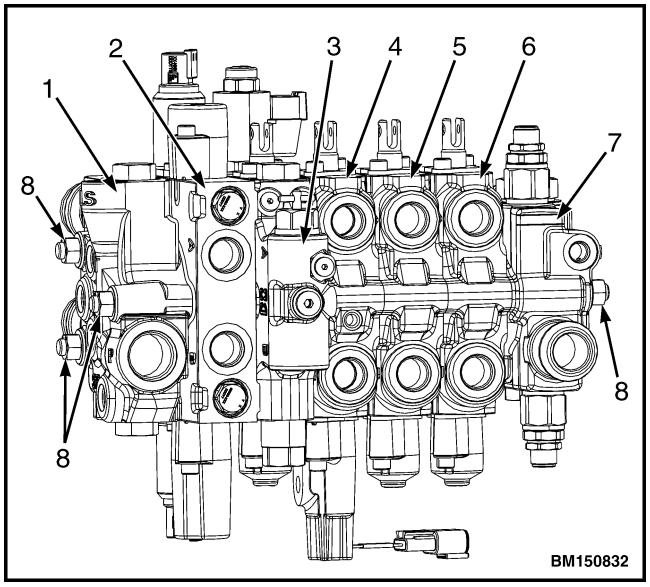
Figure 13. Manual Hydraulic Control Valve Removal

Disassemble

1. Label each section and remove three nuts from one side of the control valve. See Figure 14 or Figure 15.

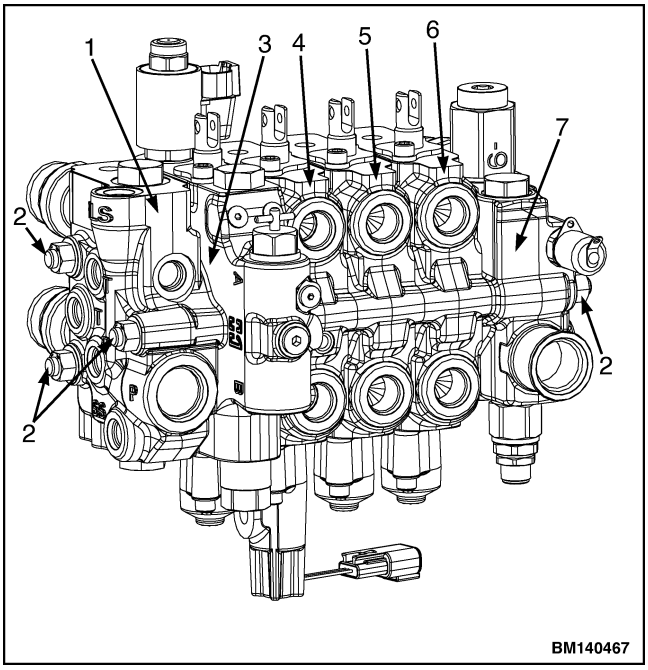
2. Slowly slide the sections off of the tie-rods and set aside for reassembly.

NOTE: Take care that springs, spools, and shuttle disks are not lost during disassembly.



1. INLET VALVE SECTION
2. FAN DRIVE CONTROL VALVE SECTION
3. LIFT CONTROL VALVE SECTION
4. TILT CONTROL VALVE SECTION
5. AUXILIARY 1 CONTROL VALVE SECTION
6. AUXILIARY 2 CONTROL VALVE SECTION
7. OUTLET VALVE SECTION
8. NUTS AND TIE-RODS

Figure 14. Manual Hydraulic Control Valve Disassembly (with Hydraulic Fan Drive)



1. INLET VALVE SECTION
2. NUTS AND TIE-RODS
3. LIFT CONTROL VALVE SECTION
4. TILT CONTROL VALVE SECTION
5. AUXILIARY 1 CONTROL VALVE SECTION
6. AUXILIARY 2 CONTROL VALVE SECTION
7. OUTLET VALVE SECTION

Figure 15. Manual Hydraulic Control Valve Disassembly

Clean and Inspect

WARNING

Solvent cleaners are flammable and poisonous, and can cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners, and petroleum-based cleaners. To avoid serious personal injury when using solvent cleaners, carefully follow the manufacturer's product instructions and the following procedures.

WARNING

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **DO NOT use gasoline or solvents that contain gasoline. Gasoline can explode.**
- **Use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.**

CAUTION

- **Use only solvent cleaners to clean ground or polished metal parts. Hot solution tanks or water and alkaline solutions will damage these parts. Isopropyl alcohol, kerosene, or diesel fuel can be used for this purpose.**
- **If required, use a gasket scraper to remove gasket material from parts. Be careful not to damage the ground or polished surfaces.**

1. Remove all old O-rings and gasket material.
2. Clean dirt and debris from all components disassembled or removed.
3. Check the solenoids for damage and replace damaged solenoids.
4. Check the tie-rods and nuts for thread damage and replace if necessary.

Assemble

NOTE: Lubricate all parts using hydraulic oil before assembly. Use only new O-rings and seals.

1. Install all new O-rings onto each of the sections.
2. Slide the sections onto the threaded studs the same way they were removed and labeled. See Figure 14 or Figure 15.
3. Install the three nuts.

Install

1. Install three capscrews, washers, and the control valve on the frame. Torque capscrews to 19.2 N•m (14.2 lbf ft). See Figure 13.
2. Remove plugs and connect hydraulic hoses to the control valve. See Figure 11 or Figure 12.
3. Connect electrical connectors to control valve.
4. Install four capscrews and the hydraulic lever assembly on the cowl. See Figure 10.

5. Connect the hydraulic levers to the control valve by installing the cotter pins and rod end pins to connect the hydraulic lever linkages to the spools.

WARNING

DO NOT try to locate hydraulic leaks by placing hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

6. Start the engine and then operate the hydraulic functions. Check for leaks.

7. Check hydraulic tank oil level. Fill the hydraulic tank with clean hydraulic oil as specified in **Periodic Maintenance Manual**.

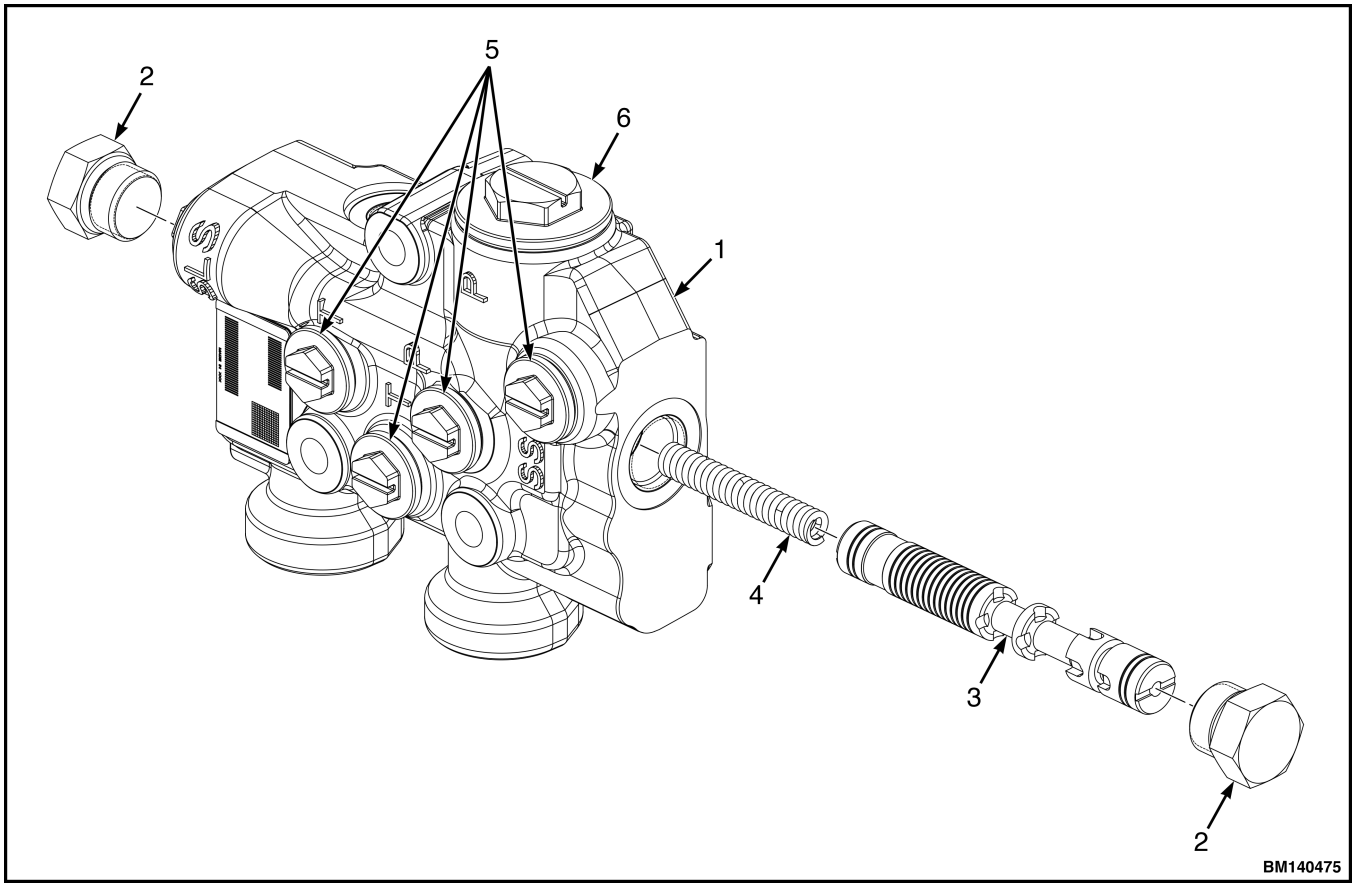
Inlet Valve Section

Disassemble

1. Loosen and remove the spool plugs (2) gradually to ensure that the steer priority spool (3) does not fall out of the valve housing (1). Remove the spool plug. See Figure 16.

2. Remove the spring (4) and steer priority spool from the valve housing.

3. Remove plugs (5 and 6).



1. VALVE HOUSING
2. SPOOL PLUG
3. STEER PRIORITY SPOOL
4. SPRING
5. PLUG
6. PLUG

Figure 16. Inlet Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the inlet valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.
2. If not all components have been removed, clean the valve section using a lint-free cloth.

Inspect

NOTE: If the valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the valve section.

Inspect the valve section mating surfaces for damage. If the mating surface is damaged, replace the valve section.

Assemble

1. Install plugs (5). Torque plugs to 1.36 ±0.35 N•m (1 ±0.25 lbf ft). See Figure 16
2. Install plug (6). Torque plug to 2.71 ±0.35 N•m (2 ±0.25 lbf ft).
3. Install spring (4) and steer priority spool (3) into valve housing (1) with spring installed as shown.
4. Install spool plug (2). Torque plug to 73.5 ±3.5 N•m (54.2 ±2.6 lbf ft).

Fan Drive Control Valve Section

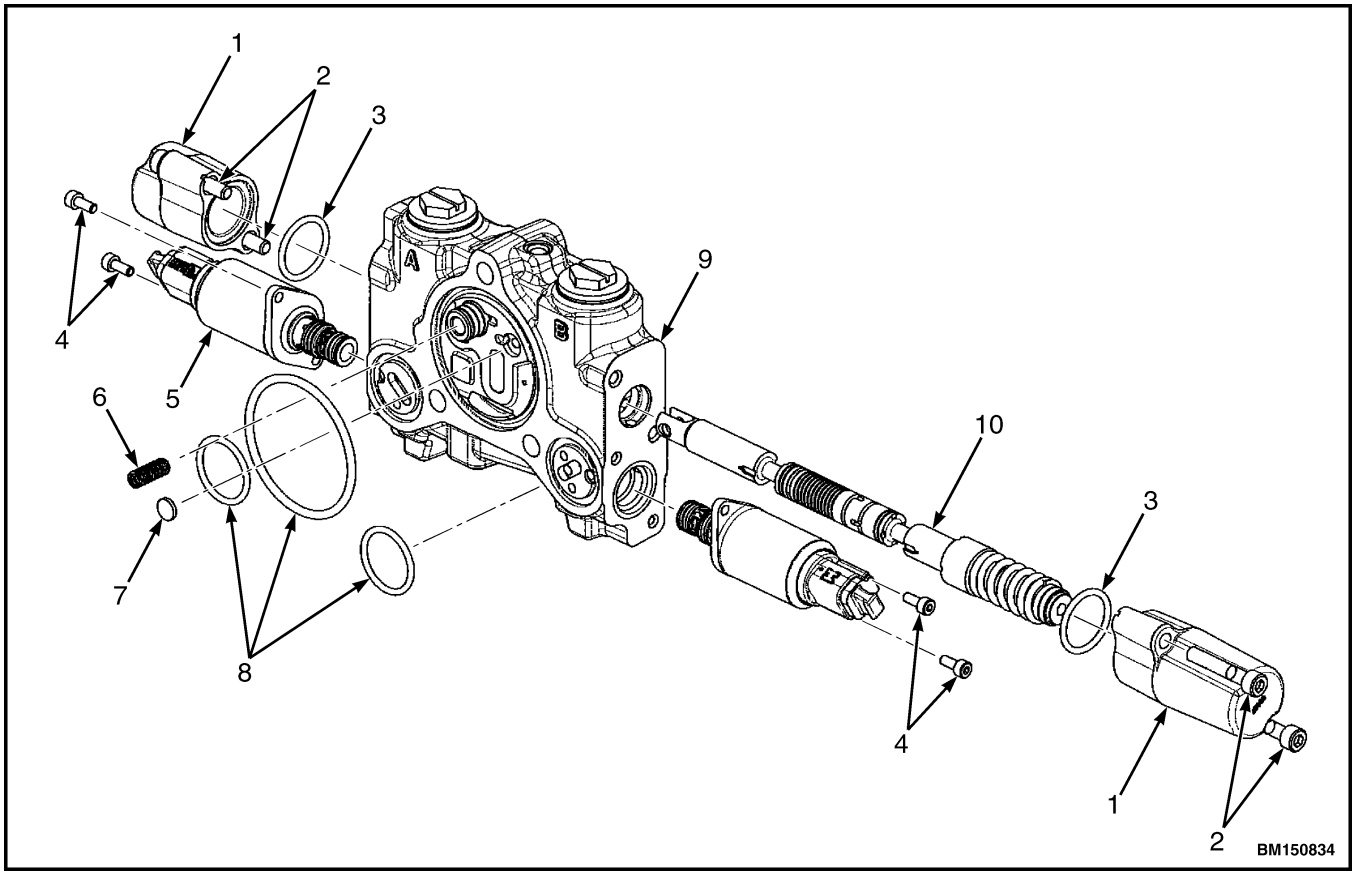
Disassemble

NOTE: Note placement of O-rings prior to disassembly to aid in assembly.

1. Loosen and remove the spool end capscrews gradually to ensure that the spool does not fall out of the valve housing. Remove the spool end caps and discard the O-rings. See Figure 17.
2. Remove the spool assembly from the valve housing.

NOTE: Note orientation of solenoid connector prior to removal.

3. Remove the capscrews and solenoids from valve housing.
4. Remove the interface spring, O-rings, and shuttle from valve housing. Discard the O-ring.



1. SPOOL END CAP
2. CAPSCREWS
3. O-RINGS
4. CAPSCREWS
5. SOLENOIDS
6. INTERFACE SPRING
7. INTERFACE SHUTTLE
8. INTERFACE O-RINGS
9. VALVE HOUSING
10. SPOOL ASSEMBLY

Figure 17. Fan Drive Control Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install the interface spring, new O-rings, and shuttle on the valve housing. See Figure 17.
2. Install capscrews and solenoids on valve housing. Torque capscrews to 2.7 ±0.3 N•m (2 ±0.2 lbf ft).
3. Install the spool assembly into housing.
4. Install new O-rings, spool end caps, and capscrews on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

Lift Control Valve Section

Disassemble

NOTE: Note order and orientation of wiper and O-ring prior to removal.

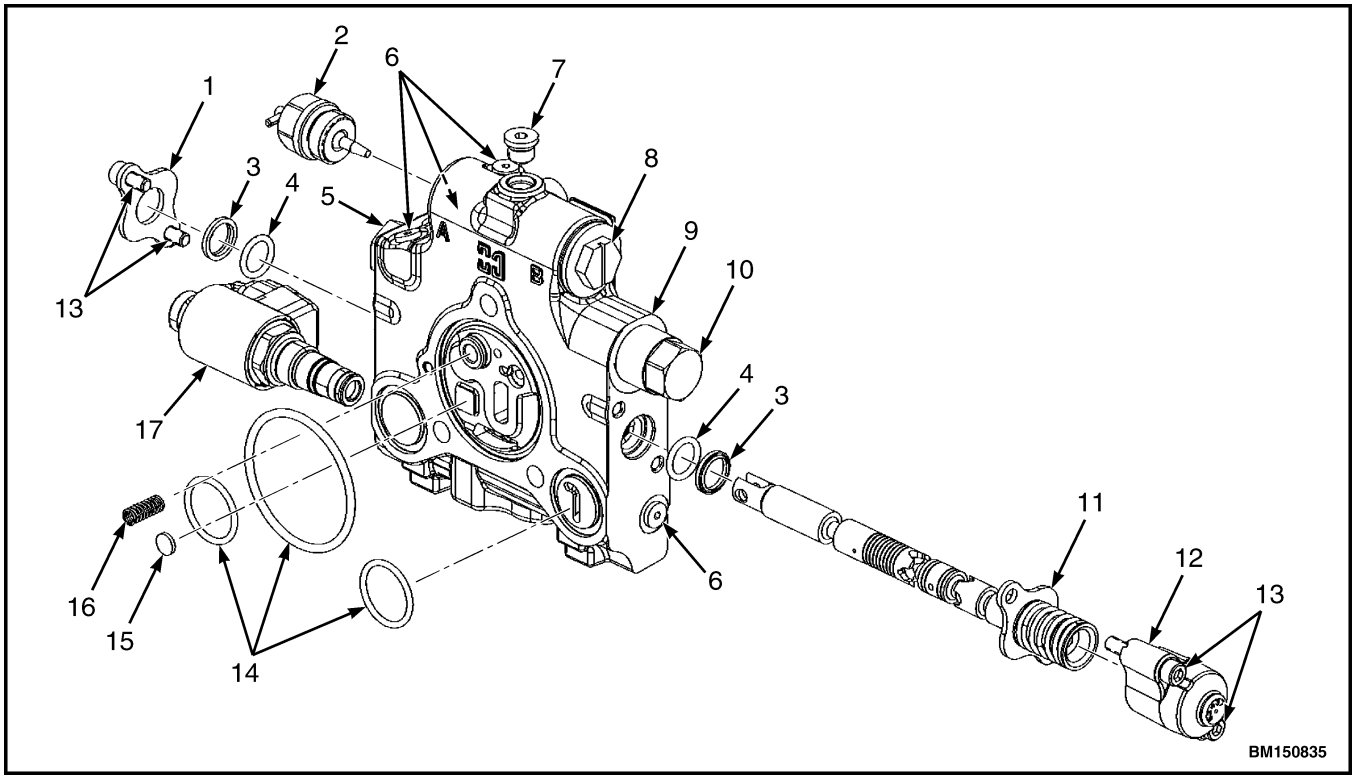
1. Loosen and remove the spool end capscrews (13) gradually to ensure that the spool assembly (11) does not fall out of the valve housing (9). Remove the spool end caps (12) and discard the wiper (3) and O-ring (4). See Figure 18.
2. Remove the spool assembly from the valve housing.

NOTE: Note order and orientation of wiper and O-ring prior to removal.

3. Remove the capscrews and seal plate (1) from valve housing. Discard the wiper (3) and O-ring (4).

NOTE: Note orientation of solenoid connector prior to removal.

4. Remove the emergency lowering valve (2), lowering compensator (10), check valve (5), and solenoid (17) from valve housing.
5. Remove remaining plugs (6, 7, and 8).
6. Remove the compensator spring (16), O-ring (14), and load sense shuttle (15) from valve housing. Discard the O-rings.



1. SEAL PLATE
2. EMERGENCY LOWERING VALVE
3. WIPERS
4. O-RINGS
5. CHECK VALVE
6. PLUGS
7. PLUG
8. PLUG
9. VALVE HOUSING
10. LOWERING COMPENSATOR
11. SPOOL ASSEMBLY
12. SPOOL END CAP
13. CAPSCREWS
14. INTERFACE O-RINGS
15. LOAD SENSE SHUTTLE
16. COMPENSATOR SPRING
17. OPS SOLENOID

Figure 18. Lift Control Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.
2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install the compensator spring, new O-rings, and load sense shuttle on the valve housing. See Figure 18.

2. Install plugs.
   - Torque plugs (6) to 7.3 ±0.4 N•m (5.4 ±0.3 lbf ft).
   - Torque plug (7) to 21 ±0.95 N•m (15.5 ±0.7 lbf ft).
   - Torque plug (8) to 2.7 ±0.34 N•m (2 ±0.25 lbf ft).

3. Install emergency lowering valve, lowering compensator, check valve, and solenoid on valve housing.
   - Torque emergency lowering valve and lowering compensator to 104.9 ±5 N•m (77.4 ±3.7 lbf ft).
   - Torque check valve to 73.5 ±3.5 N•m (54.2 ±2.6 lbf ft).
   - Torque solenoid to 42 ±4.1 N•m (31 ±3 lbf ft).

4. Install new wiper and O-ring, seal plate, and capscrews on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

5. Install spool assembly into housing.

6. Install new wiper and O-ring, capscrews, and spool end caps on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

Lift Control Valve Section (with Spool Position Sensor)

Disassemble

NOTE: Note order and orientation of wiper and O-ring prior to removal.

1. Loosen and remove the spool end capscrews (12) gradually to ensure that the spool assembly (10) does not fall out of the valve housing (7). Remove the spool end caps (11) and discard the wiper (3) and O-ring (4). See Figure 19.

2. Remove the spool assembly from the valve housing.

NOTE: Note order and orientation of wiper and O-ring prior to removal.

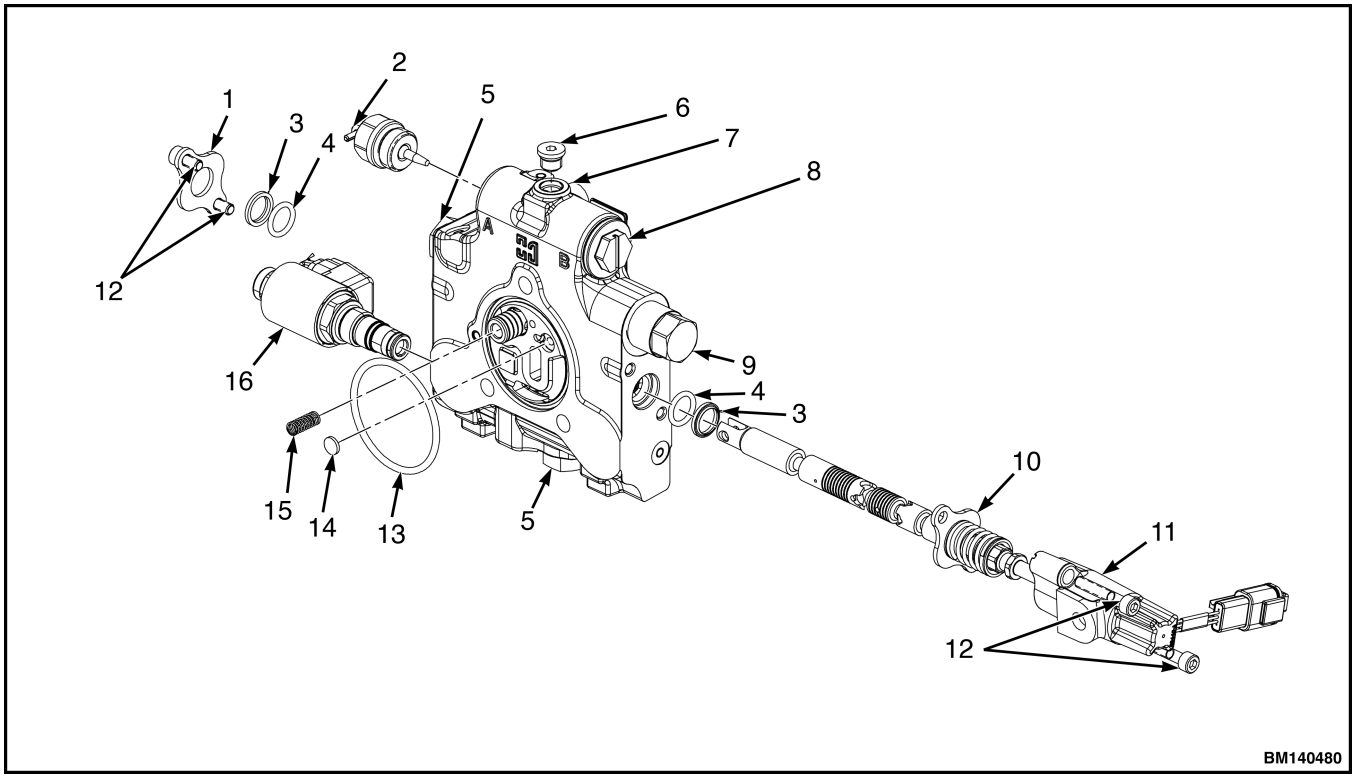
3. Remove the capscrews and seal plate (1) from valve housing. Discard the wiper (3) and O-ring (4).

NOTE: Note orientation of solenoid connector prior to removal.

4. Remove the emergency lowering valve (2), lowering compensator (9), check valves (5), and solenoid (16) from valve housing.

5. Remove remaining plugs (6 and 8).

6. Remove the compensator spring (15), interface O-ring (13), and load sense shuttle (14) from valve housing. Discard the O-ring.



1. SEAL PLATE
2. EMERGENCY LOWERING VALVE
3. WIPER
4. O-RING
5. CHECK VALVE
6. PLUG
7. VALVE HOUSING
8. PLUG
9. LOWERING COMPENSATOR
10. SPOOL ASSEMBLY
11. SPOOL END CAP WITH SPOOL POSITION SENSOR
12. CAP SCREWS
13. INTERFACE O-RING
14. LOAD SENSE SHUTTLE
15. COMPENSATOR SPRING
16. OPS SOLENOID

Figure 19. Lift Control Valve Section (with Spool Position Sensor)

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.
2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install the compensator spring, new O-rings, and load sense shuttle on the valve housing. See Figure 19.

2. Install plugs.
   - Torque plug (6) to 21 ±0.95 N • m (15.5 ±0.7 lbf ft).
   - Torque plug (8) to 2.7 ±0.34 N • m (2 ±0.25 lbf ft).

3. Install emergency lowering valve, lowering compensator, check valve, and solenoid on valve housing.
   - Torque emergency lowering valve and lowering compensator to 104.9 ±5 N • m (77.4 ±3.7 lbf ft).
   - Torque check valves to 73.5 ±3.5 N • m (54.2 ±2.6 lbf ft).
   - Torque solenoid to 42 ±4.1 N • m (31 ±3 lbf ft).

4. Install new wiper and O-ring, seal plate, and capscrews on valve housing. Torque capscrews to 9.5 ±1.4 N • m (7 ±1 lbf ft).

5. Install spool assembly into housing.

6. Install new wiper and O-ring, capscrews, and spool end caps on valve housing. Torque capscrews to 9.5 ±1.4 N • m (7 ±1 lbf ft).

Tilt/Auxiliary Control Valve Sections

Disassemble

NOTE: Note order and orientation of wiper and O-ring prior to removal.

1. Loosen and remove the spool end capscrews (1) gradually to ensure that the spool assembly (6) does not fall out of the valve housing (4). Remove the spool end caps (5) and discard the wiper (2) and O-ring (3). See Figure 20 and Figure 21.

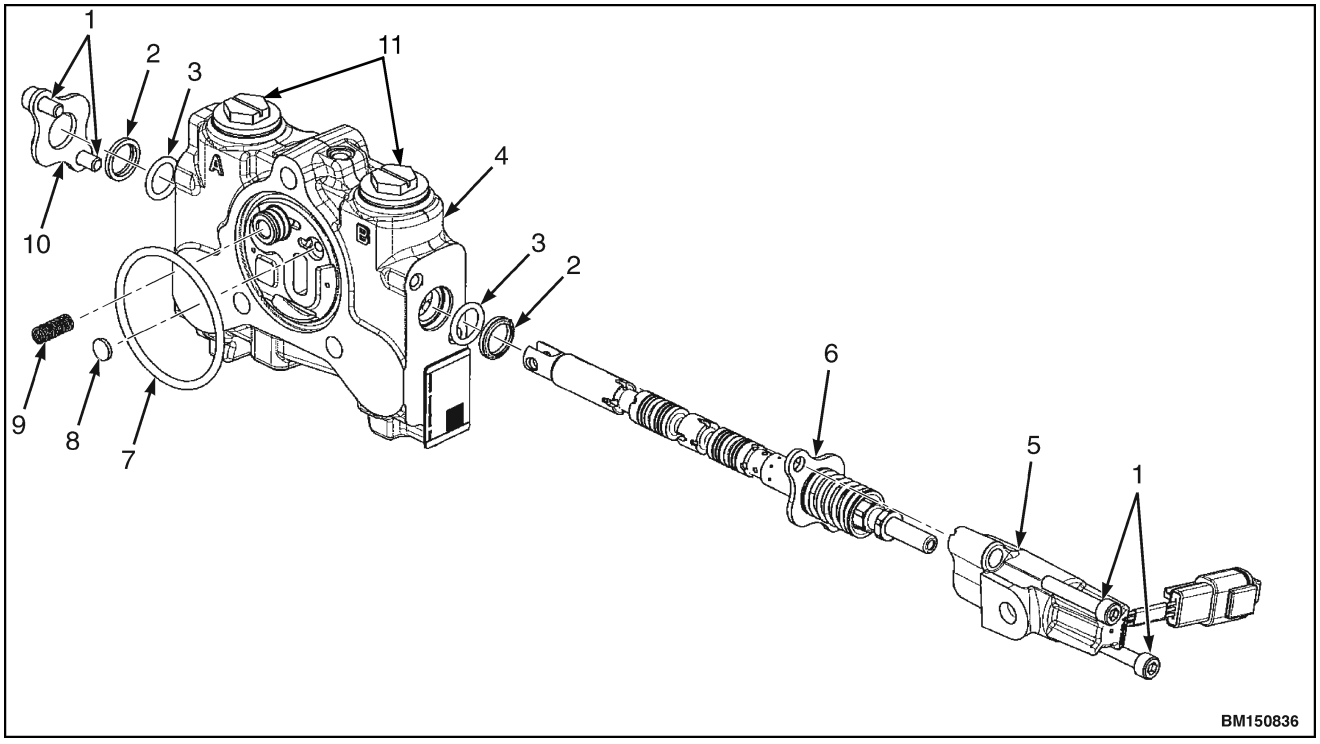
2. Remove the spool assembly from the valve housing.

NOTE: Note order and orientation of wiper and O-ring prior to removal.

3. Remove the capscrews (1) and seal plate (10) from valve housing. Discard the wiper (2) and O-ring (3).

4. Remove plug (11).

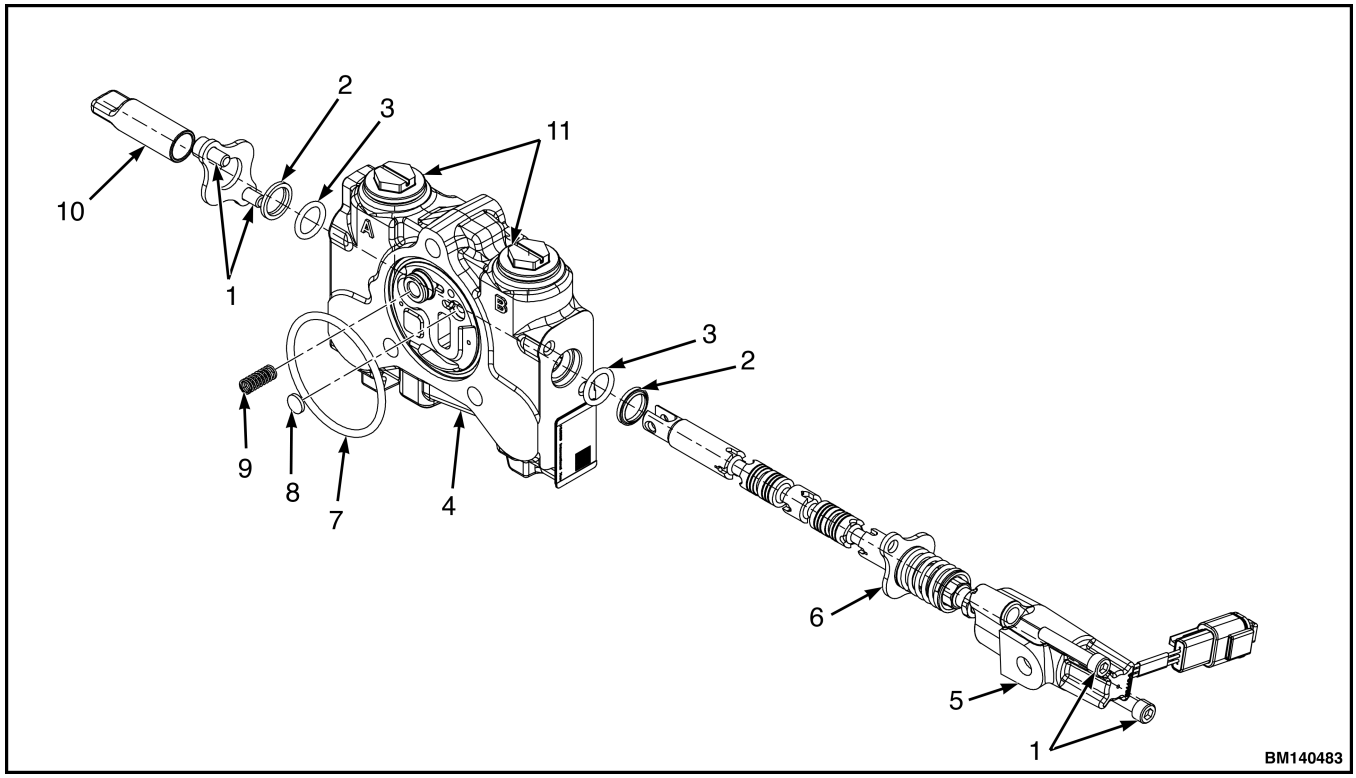
5. Remove the compensator spring (9), O-ring (7), and load sense shuttle (8) from valve housing. Discard the O-ring.



NOTE: TILT CONTROL VALVE SHOWN WITH SPOOL POSITION SENSOR. TILT CONTROL VALVES WITHOUT SPS INSTALL SIMILARLY.

1. CAPSCREWS
2. WIPER
3. O-RING
4. VALVE HOUSING
5. SPOOL END CAP
6. SPOOL ASSEMBLY
7. INTERFACE O-RING
8. LOAD SENSE SHUTTLE
9. COMPENSATOR SPRING
10. SEAL PLATE
11. PLUG

Figure 20. Tilt Control Valve Section



NOTE: AUXILIARY CONTROL VALVE SHOWN WITH SPOOL POSITION SENSOR. AUXILIARY CONTROL VALVES WITHOUT SPS INSTALL SIMILARLY.

1. CAPSCREWS
2. WIPER
3. O-RING
4. VALVE HOUSING
5. SPOOL END CAP
6. SPOOL ASSEMBLY
7. INTERFACE O-RING
8. LOAD SENSE SHUTTLE
9. COMPENSATOR SPRING
10. SEAL PLATE
11. PLUG

Figure 21. Auxiliary Control Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

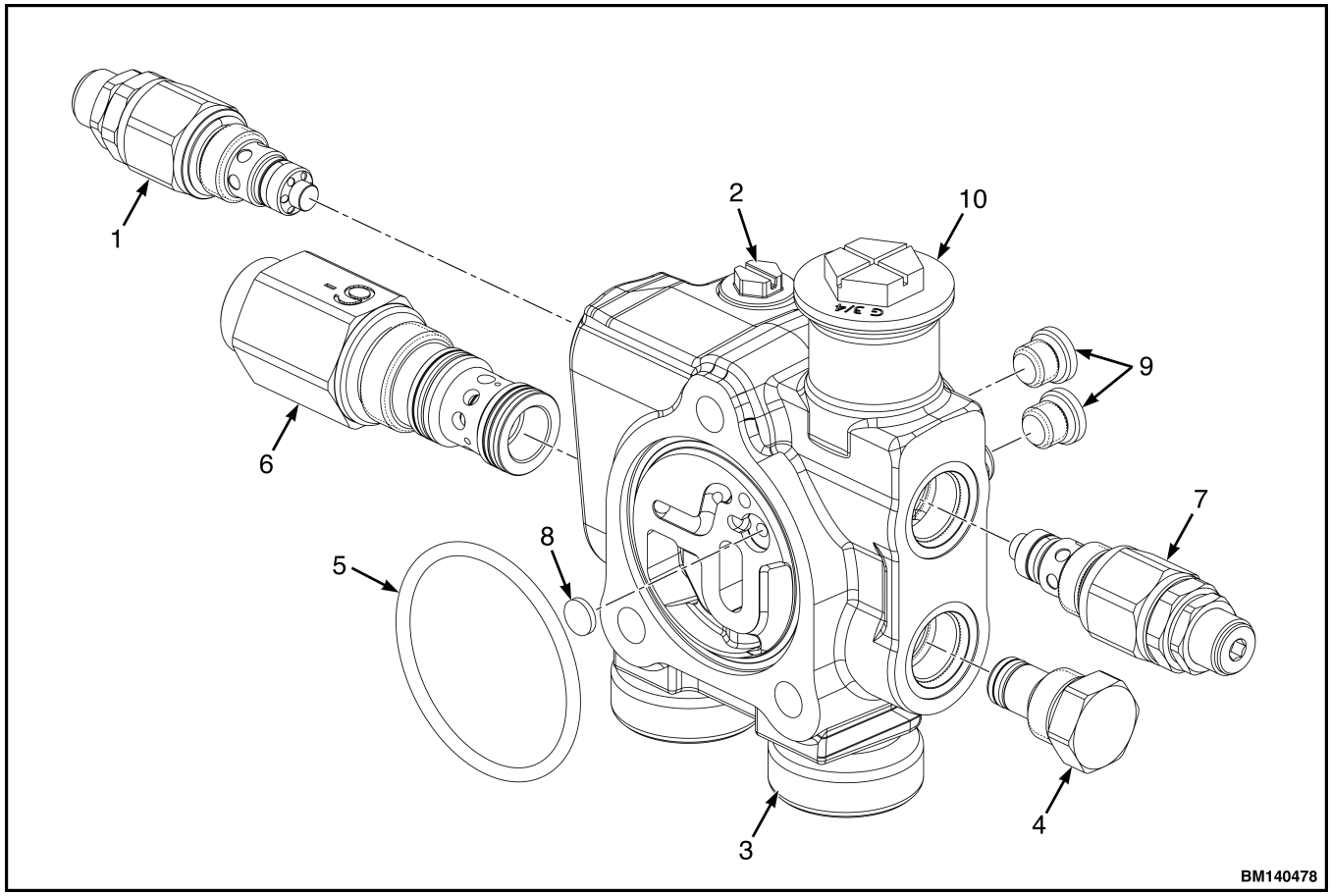
1. Install plug (11). Torque plug to 2.7 ±0.34 N•m (2 ±0.25 lbf ft). See Figure 20 and Figure 21.
2. Install the compensator spring, new O-ring, and load sense shuttle on the valve housing.
3. Install new wiper and O-ring, seal plate, and capscrews on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).
4. Install spool assembly into valve housing.
5. Install new wiper and O-ring, capscrews, and spool end caps on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

Outlet Valve Section

Disassemble

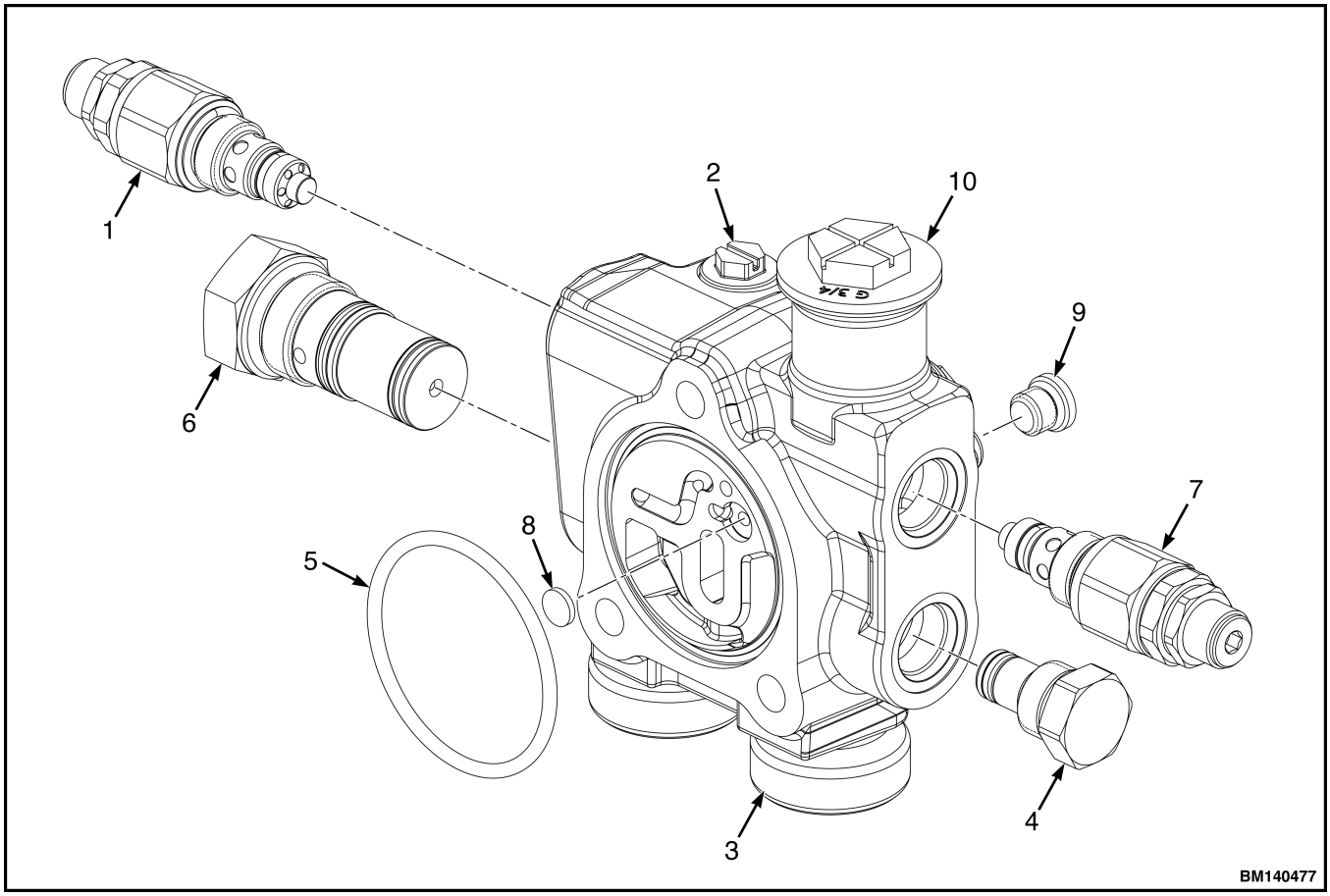
NOTE: Note placement of O-rings prior to disassembly to aid in assembly.

1. Remove the relief valves (1 and 7) and shut-off plugs (4 and 6) from valve housing (3). See Figure 22 or Figure 23.
2. Remove plugs (2, 9, and 10).
3. Remove interface O-ring (5) and shuttle (8). Discard the interface O-ring.



1. PRIMARY RELIEF VALVE
2. PLUG
3. VALVE HOSUING
4. SHUT-OFF PLUG
5. INTERFACE O-RING
6. UNLOADER SHUT-OFF PLUG
7. SECONDARY RELIEF VALVE
8. SHUTTLE
9. PLUG
10. PLUG

Figure 22. Outlet Control Valve Section (Gear Pump)



1. PRIMARY RELIEF VALVE
2. PLUG
3. VALVE HOUSING
4. SHUT-OFF PLUG
5. INTERFACE O-RING
6. LS DIAGNOSTIC PORT
7. SECONDARY RELIEF VALVE
8. SHUTTLE
9. PLUG
10. PLUG

Figure 23. Outlet Control Valve Section (Variable Displacement Pump)

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the outlet valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the valve section using a lint-free cloth.

Inspect

NOTE: If the valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the valve section.

Inspect the valve section mating surfaces for damage. If the mating surface is damaged, replace the valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install new interface O-ring and shuttle on valve housing. See Figure 22 or Figure 23.
2. Install plugs on valve housing.
   - Torque plugs (2) to 1.4 ±0.34 N•m (1 ±0.25 lbf ft).
   - Torque plug (9) to 21 ±0.95 N•m (15.5 ±0.7 lbf ft).
   - Torque plug (10) to 2.4 ±0.34 N•m (1.75 ±0.25 lbf ft).
3. Install relief valves and shut-off plugs on valve housing.
   - Torque relief valves (1 and 7) to 42 ±4.2 N•m (31 ±3.1 lbf ft).
   - Torque shut-off plug (4) to 89.2 ±4.2 N•m (65.8 ±3.1 lbf ft).
   - Torque shut-off plug/LS diagnostic port (6) to 122 ±12.2 N•m (90 ±9 lbf ft).

Accumulator

The accumulator is a non-repairable part and cannot be adjusted. If the accumulator appears to be malfunctioning, consult the Observed Symptoms troubleshooting in the Service Diagnostic Tool for test procedures to determine if the accumulator is working properly. If accumulator needs to be replaced, follow the procedures below. See **Parts Manual** for replacement part.

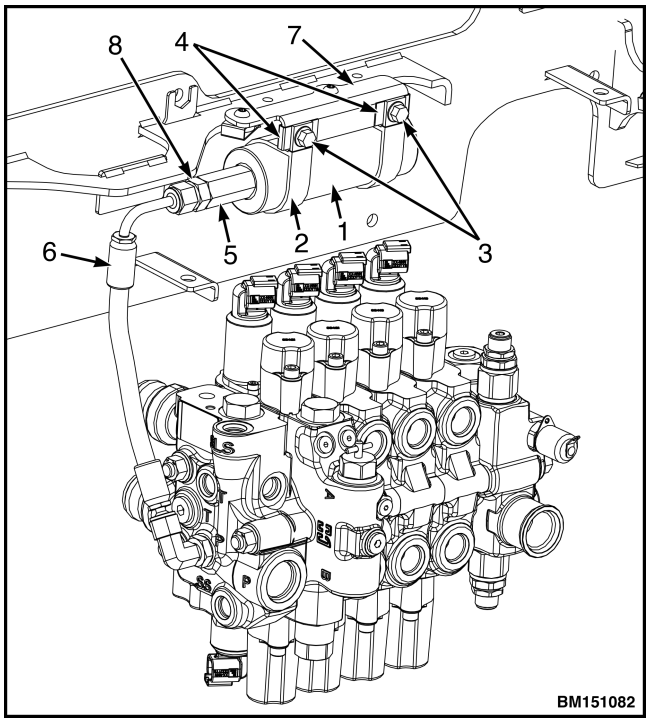
Remove

WARNING

The accumulator is filled with high-pressure nitrogen gas. Keep unprotected hands and face away from valves and hose ends. Use face protection and gloves. Failure to use protection can result in serious injury to personnel.

DO NOT breathe nitrogen gas. Serious injury to personnel can result.

1. The accumulator is located behind the kick panel. Remove the kick panel. See Covers repair section in the **Frame and Main Components** 8000SRM2306 manual.
2. Disconnect the hydraulic line, fitting, and flow control fitting from the accumulator. See Figure 24.
3. Remove the two capscrews and foldover nuts attaching the accumulator and clamps to the mounting bracket.
4. Remove the accumulator.



1. PILOT PRESSURE ACCUMULATOR
2. CLAMP
3. CAPSCREW
4. FOLDOVER NUT
5. FLOW CONTROL FITTING
6. HYDRAULIC LINE
7. MOUNTING BRACKET
8. FITTING

Figure 24. Accumulator

Install

1. Locate the new accumulator.
2. Install flow control fitting onto accumulator and tighten to standard torque.

3. Install hose end onto fitting and tighten to standard torque.

4. Install hose end with fitting onto flow control fitting and tighten to standard torque.

5. Remove the two clamps from the old accumulator and install on the new accumulator.

6. Align the holes on the clamps with the two holes on the mounting bracket.

7. Use the two capscrews and foldover nuts to secure the accumulator and clamps to the mounting bracket.

8. Install the kick panel. See Covers repair section in the **Frame and Main Components** 8000SRM2306 manual.

ELECTRONIC CONTROL VALVE

Remove

WARNING

Lower carriage completely before working on control valve or hydraulic system. Do not work under a raised carriage. Put mast in a vertical position, with no forward or back tilt, and lower carriage completely before disconnecting any parts of hydraulic system. The mast can lower suddenly and cause injury if the carriage is not lowered.

NOTE: Most of the individual valve components can be removed and replaced while the control valve is installed in the truck. Removal of the control valve for repairs is normally only required to replace a valve section, replace the O-rings between the sections, or to remove a manual valve control spool.

1. Tag and disconnect electrical connectors from hydraulic control valve. See Figure 25 or Figure 26.

2. Tag and disconnect hydraulic hoses from the control valve. Install plugs or caps on all open hose ends and valve ports to prevent contamination.

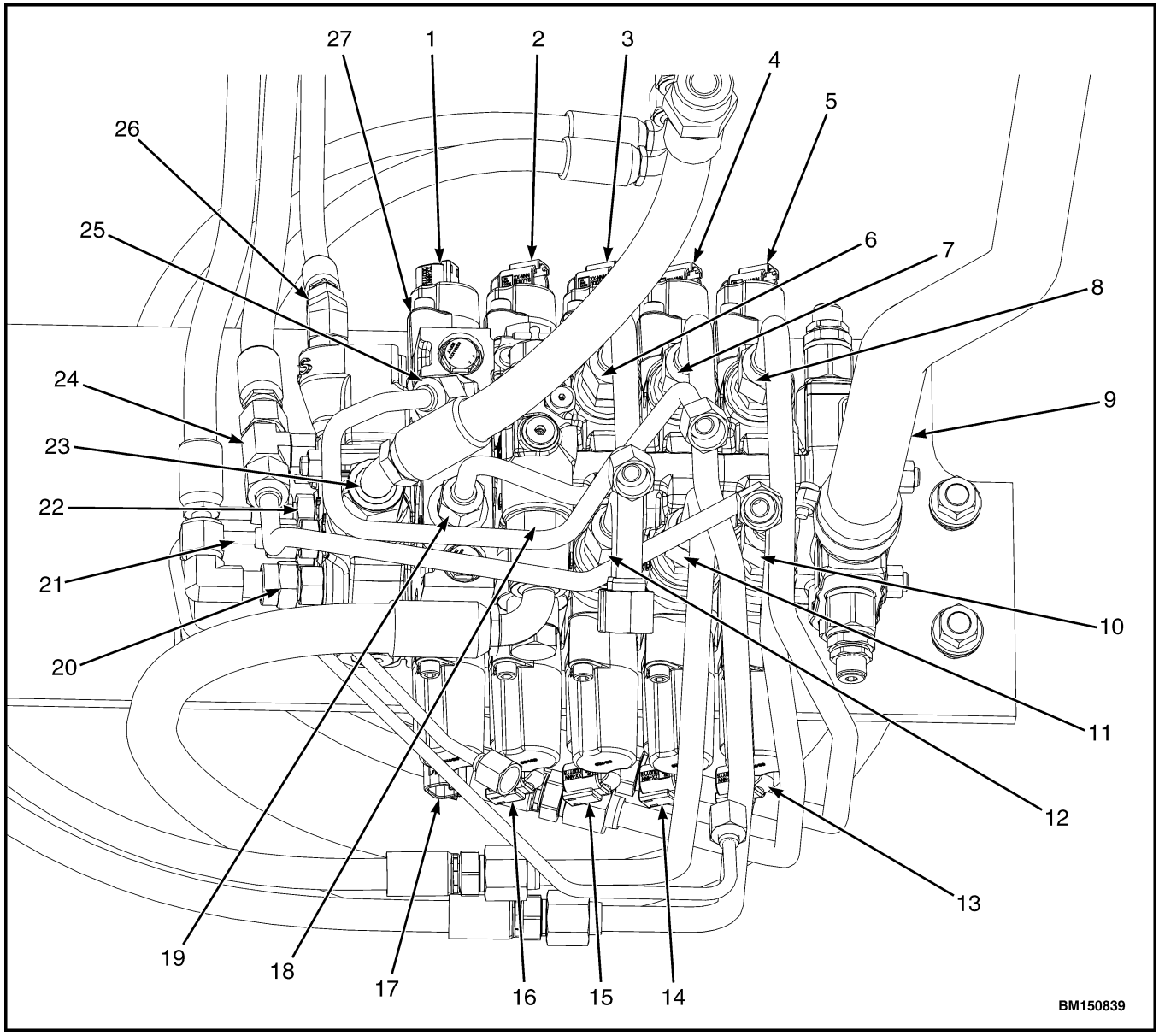
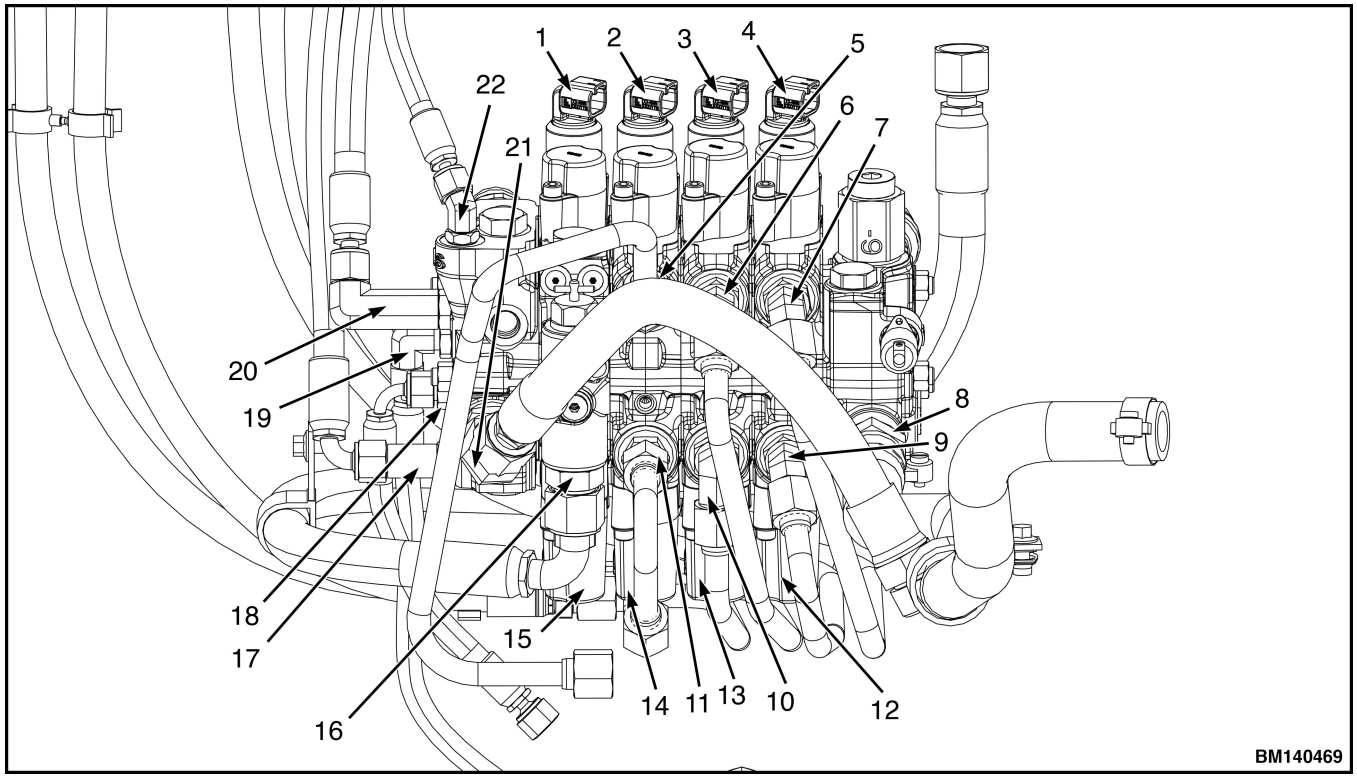


Figure 25. Electric Hydraulic Control Valve Connections (with Hydraulic Fan Drive)

Legend for Figure 25.

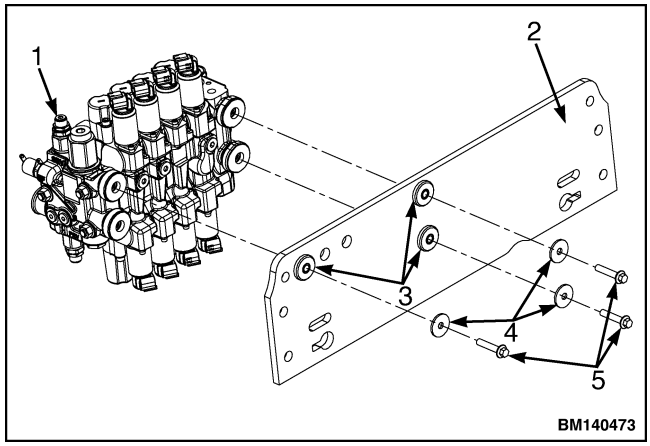
1. FAN DRIVE SECTION - CONNECTOR CPS645 (FAN REVERSE)
2. LIFT SECTION - CONNECTOR CPS622 (FORKS UP)
3. TILT SECTION - CONNECTOR CPS625 (TILT FORWARD)
4. AUXILIARY 1 SECTION - CONNECTOR CPS626
5. AUXILIARY 2 SECTION - CONNECTOR CPS628
6. TILT SECTION PORT A - TO PISTON SIDE
7. AUXILIARY 1 SECTION PORT A
8. AUXILIARY 2 SECTION PORT A
9. OUTLET SECTION - TO TANK
10. AUXILIARY 2 SECTION - PORT B
11. AUXILIARY 1 SECTION - PORT B
12. TILT SECTION PORT B - TO ROD SIDE
13. AUXILIARY 2 SECTION - CONNECTOR CPS629
14. AUXILIARY 1 SECTION - CONNECTOR CPS627
15. TILT SECTION - CONNECTOR CPS624 (TILT BACKWARD)
16. LIFT SECTION - CONNECTOR CPS623 (FORKS DOWN)
17. FAN DRIVE SECTION - CONNECTOR CPS646 (FAN FORWARD)
18. LIFT SECTION PORT B - TO PISTON SIDE
19. FAN DRIVE SECTION PORT B
20. INLET SECTION PORT SS - STEER SUPPLY
21. INLET SECTION PORT P - BRAKE SUPPLY
22. INLET SECTION PORT T - BRAKE RETURN
23. INLET SECTION PORT P - FROM PUMP
24. INLET SECTION PORT T - STEER RETURN
25. FAN DRIVE SECTION PORT A
26. INLET SECTION PORT SLS - STEER LOW SIDE
27. ELECTRIC HYDRAULIC CONTROL VALVE



1. LIFT SECTION - CONNECTOR CPS622 (FORKS UP)
2. TILT SECTION - CONNECTOR CPS625 (TILT FORWARD)
3. AUXILIARY 1 SECTION - CONNECTOR CPS626
4. AUXILIARY 2 SECTION - CONNECTOR CPS628
5. TILT SECTION PORT A - TO PISTON SIDE
6. AUXILIARY 1 SECTION PORT A
7. AUXILIARY 2 SECTION PORT A
8. OUTLET SECTION - TO TANK
9. AUXILIARY 2 SECTION - PORT B
10. AUXILIARY 1 SECTION - PORT B
11. TILT SECTION PORT B - TO ROD SIDE
12. AUXILIARY 2 SECTION - CONNECTOR CPS629
13. AUXILIARY 1 SECTION - CONNECTOR CPS627
14. TILT SECTION - CONNECTOR CPS624 (TILT BACKWARD)
15. LIFT SECTION - CONNECTOR CPS623 (FORKS DOWN)
16. LIFT SECTION PORT B - TO PISTON SIDE
17. INLET SECTION PORT SS - STEER SUPPLY
18. INLET SECTION PORT P - BRAKE SUPPLY
19. INLET SECTION PORT T - BRAKE RETURN
20. INLET SECTION PORT T - STEER RETURN
21. INLET SECTION PORT P - FROM PUMP
22. INLET SECTION PORT SLS - STEER LOW SIDE

Figure 26. Electric Hydraulic Control Valve Connections

3. Remove three capscrews, washers, and the control valve from the frame and place on a flat surface for disassembly. See Figure 27.



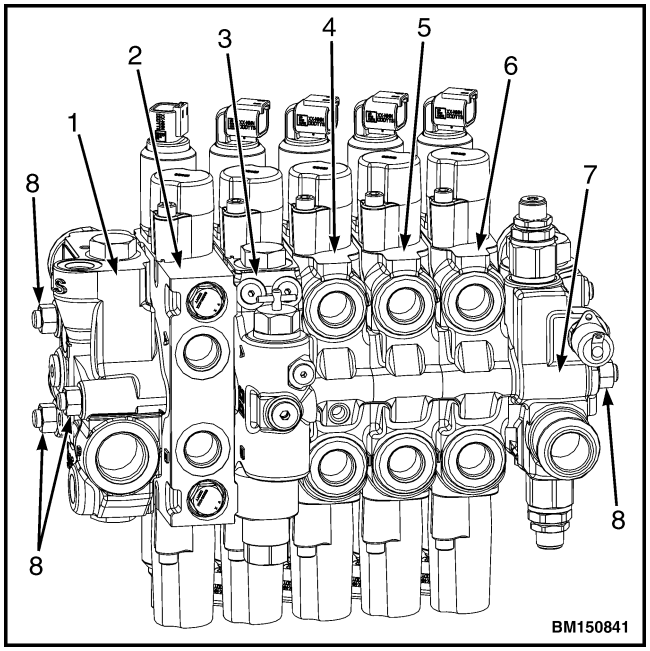
1. ELECTRO HYDRAULIC CONTROL VALVE
2. FRAME
3. ISOLATOR
4. WASHERS
5. CAPSCREWS

Figure 27. Electric Hydraulic Control Valve Removal

Disassemble

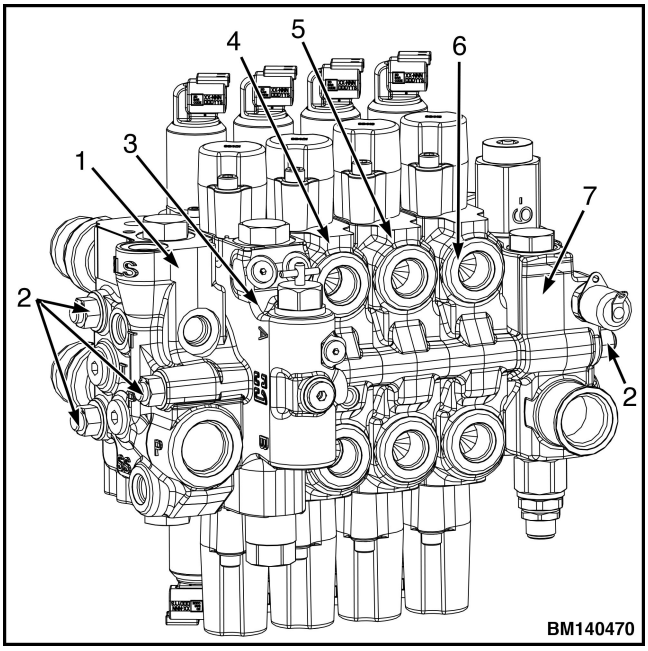
1. Label each section and remove three nuts from one side of the control valve. See Figure 28 or Figure 29.

2. Slowly slide the sections off of the threaded studs and set aside for reassembly.



1. INLET VALVE SECTION
2. FAN DRIVE CONTROL VALVE SECTION
3. LIFT CONTROL VALVE SECTION
4. TILT CONTROL VALVE SECTION
5. AUXILIARY 1 CONTROL VALVE SECTION
6. AUXILIARY 2 CONTROL VALVE SECTION
7. OUTLET VALVE SECTION
8. NUTS AND TIE-RODS

Figure 28. Electronic Hydraulic Control Valve Disassembly (with Hydraulic Fan Drive)



1. INLET VALVE SECTION
2. NUTS AND TIE-RODS
3. LIFT CONTROL VALVE SECTION
4. TILT CONTROL VALVE SECTION
5. AUXILIARY 1 CONTROL VALVE SECTION
6. AUXILIARY 2 CONTROL VALVE SECTION
7. OUTLET VALVE SECTION

Figure 29. Electronic Hydraulic Control Valve Disassembly

Clean and Inspect

WARNING

Solvent cleaners are flammable and poisonous, and can cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners, and petroleum-based cleaners. To avoid serious personal injury when using solvent cleaners, carefully follow the manufacturer's product instructions and the following procedures.

WARNING

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **DO NOT use gasoline or solvents that contain gasoline. Gasoline can explode.**
- **Use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.**

CAUTION

- **Use only solvent cleaners to clean ground or polished metal parts. Hot solution tanks or water and alkaline solutions will damage these parts. Isopropyl alcohol, kerosene, or diesel fuel can be used for this purpose.**
- **If required, use a gasket scraper to remove gasket material from parts. Be careful not to damage the ground or polished surfaces.**

1. Remove all old O-rings and gasket material.
2. Clean all dirt and debris from all components disassembled or removed.

Assemble

1. Install all new O-rings onto each of the sections.
2. Slide the sections onto the threaded studs the same way they were removed and labeled. See Figure 28 or Figure 29.
3. Install the three nuts.

Install

1. Install three capscrews, washers, and the control valve on the frame. Torque capscrews to 19.2 N•m (14.2 lbf ft). See Figure 27.
2. Remove plugs and connect hydraulic hoses on the control valve. See Figure 25 or Figure 26.
3. Connect electrical connectors to control valve. See Figure 25 or Figure 26.

WARNING

DO NOT try to locate hydraulic leaks by placing hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

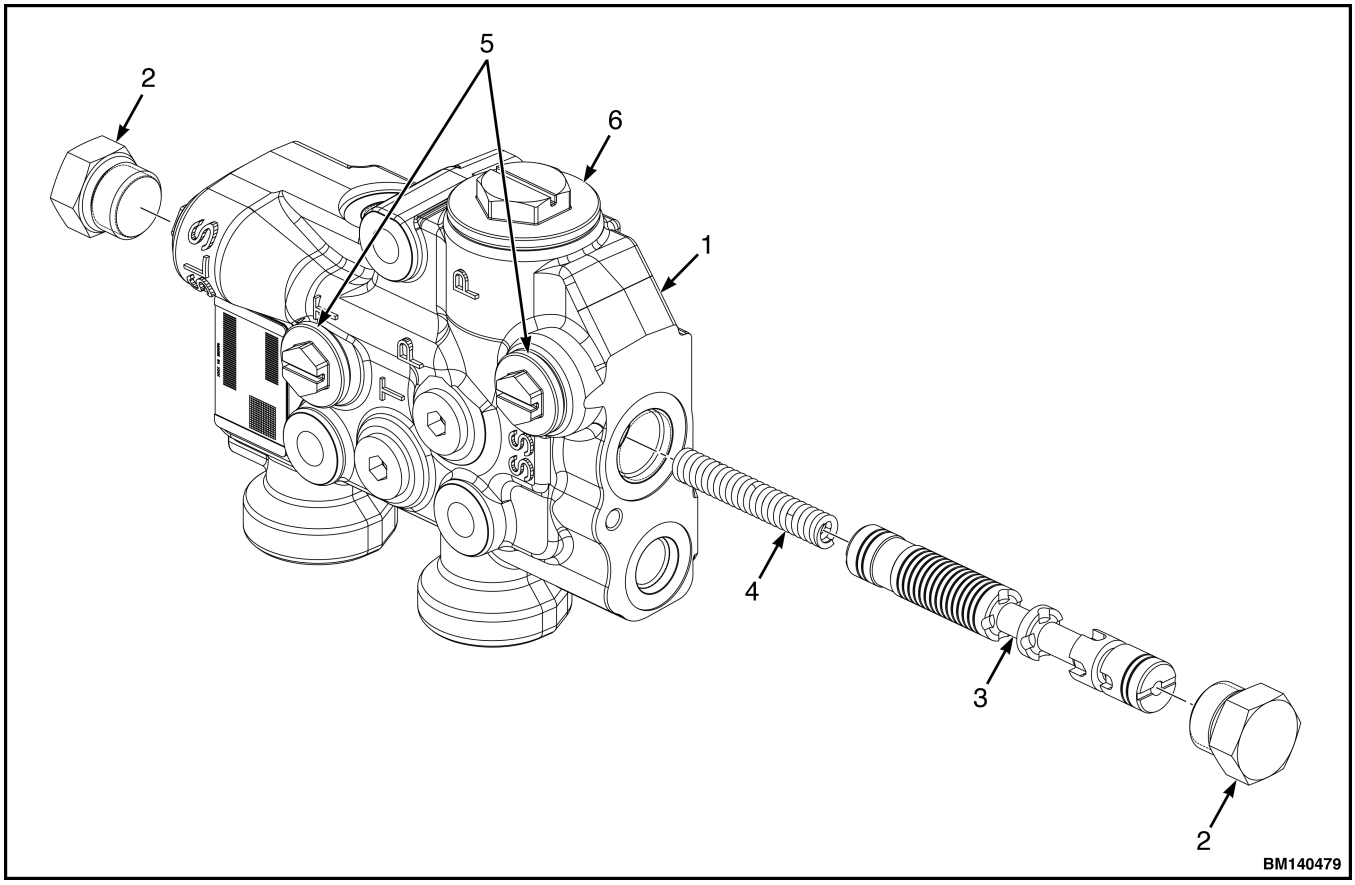
4. Start the engine while operating the hydraulic functions. Check for leaks.

5. Check hydraulic tank oil level. Fill the hydraulic tank with clean hydraulic oil as specified in **Periodic Maintenance Manual**.

Inlet Valve Section

Disassemble

1. Loosen and remove the spool plugs (2) gradually to ensure that the steer priority spool (3) does not fall out of the valve housing (1). Remove the spool plug. See Figure 30.
2. Remove the spring (4) and steer priority spool from the valve housing.
3. Remove plugs (5 and 6).



1. VALVE HOUSING
2. SPOOL PLUG
3. STEER PRIORITY SPOOL
4. SPRING
5. PLUG
6. PLUG

Figure 30. Inlet Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the inlet valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the valve section using a lint-free cloth.

Inspect

NOTE: If the valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the valve section.

Inspect the valve section mating surfaces for damage. If the mating surface is damaged, replace the valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install plugs (5 and 6). See Figure 30.
   - Torque plug (5) to 1.4 ±0.34 N•m (1 ±0.25 lbf ft).
   - Torque plug (6) to 2.7 ±0.34 N•m (2 ±0.25 lbf ft).

2. Install spring and steer priority spool into valve housing with spring installed as shown.

3. Install spool plug (2). Torque plug to 73.5 ±3.5 N•m (54.2 ±2.6 lbf ft).

Fan Drive Control Valve Section

Disassemble

NOTE: Note placement of O-rings prior to disassembly to aid in assembly.

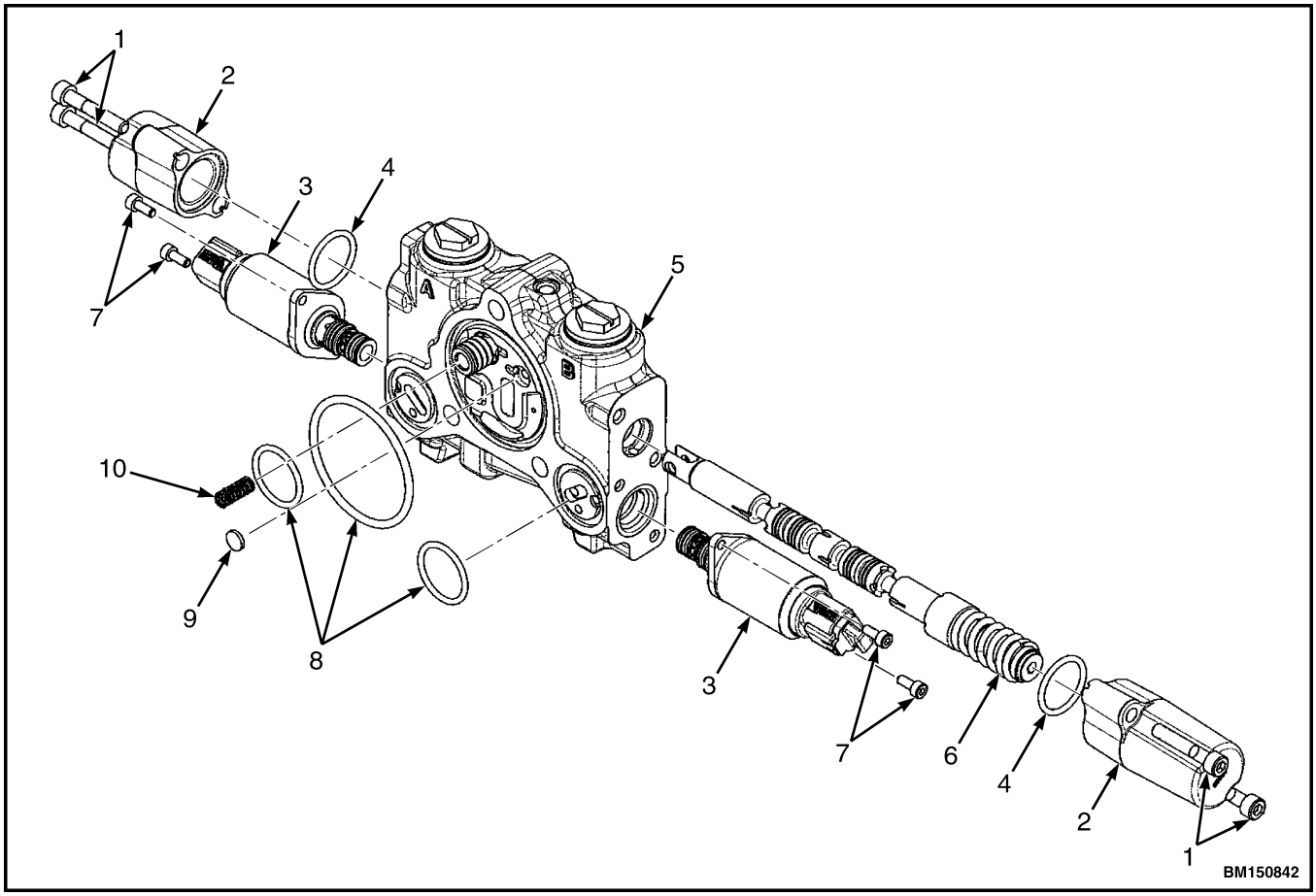
1. Loosen and remove the spool end capscrews gradually to ensure that the spool does not fall out of the valve housing. Remove the spool end caps and discard the O-rings. See Figure 31.

2. Remove the spool assembly from the valve housing.

NOTE: Note orientation of solenoid connector prior to removal.

3. Remove the capscrews and solenoids from valve housing.

4. Remove the interface spring, O-rings, and shuttle from valve housing. Discard the O-rings.



1. CAPSCREWS
2. SPOOL END CAP
3. SOLENOIDS
4. O-RINGS
5. VALVE HOUSING
6. SPOOL ASSEMBLY
7. CAPSCREWS
8. INTERFACE O-RINGS
9. INTERFACE SHUTTLE
10. INTERFACE SPRING

Figure 31. Fan Drive Control Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install the interface spring, new O-rings, and shuttle on the valve housing. See Figure 31.
2. Install capscrews and solenoids on valve housing. Torque capscrews to 2.7 ±0.3 N•m (2 ±0.2 lbf ft).
3. Install the spool assembly into housing.
4. Install new O-rings, spool end caps, and capscrews on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

Lift Control Valve Section

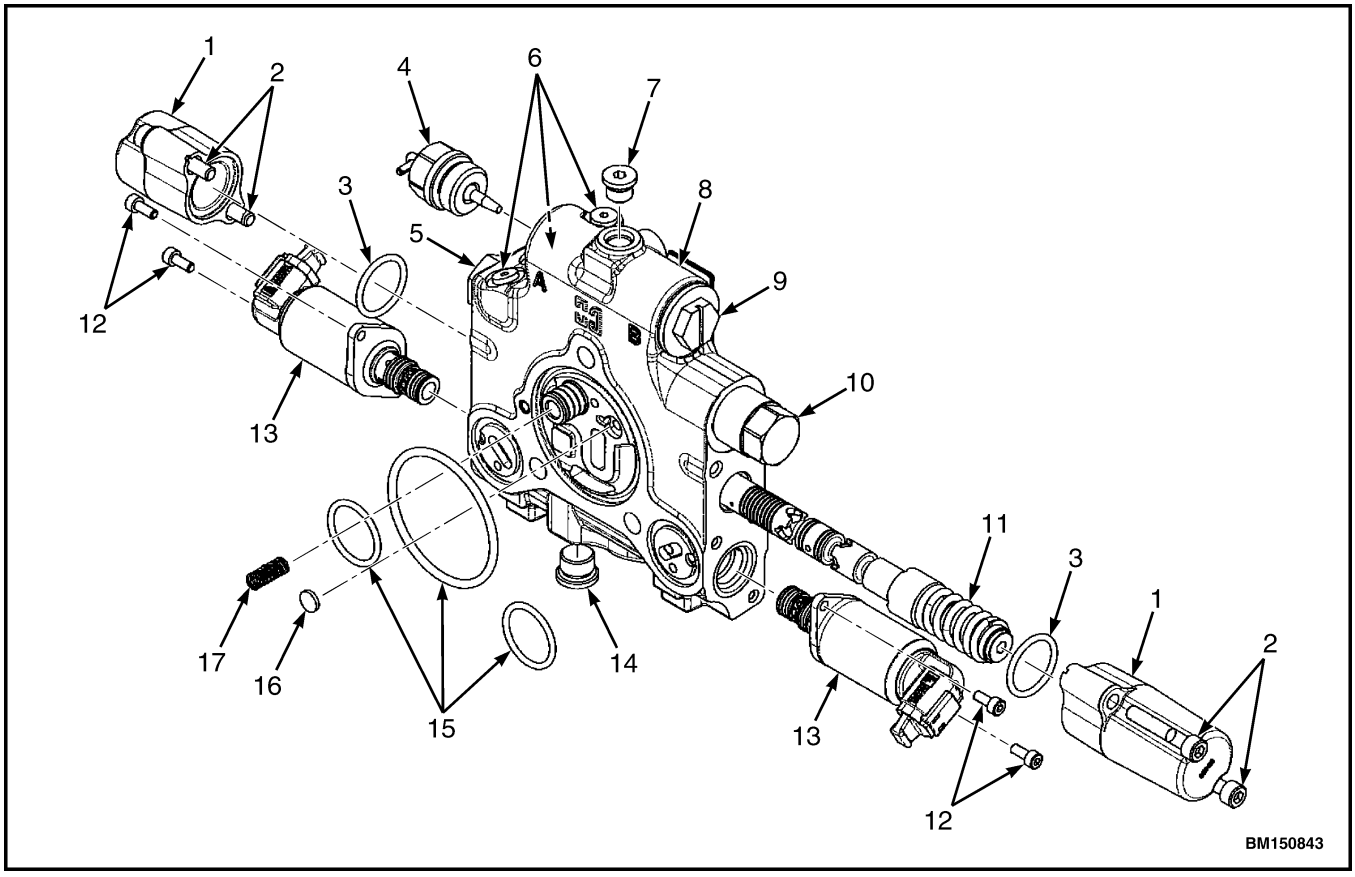
Disassemble

NOTE: Note placement of O-rings prior to disassembly to aid in assembly.

1. Loosen and remove the spool end capscrews (2) gradually to ensure that the spool assembly (11) does not fall out of the valve housing (8). Remove the spool end caps (1) and discard the O-rings (3). See Figure 32.
2. Remove the spool assembly from the valve housing.

NOTE: Note orientation of solenoid connector prior to removal.

3. Remove capscrews (12) and solenoids (13) from valve housing.
4. Remove the emergency lowering valve (4), lowering compensator (10), and check valve (5) from valve housing.
5. Remove remaining plugs (6, 7, 9, and 14).
6. Remove the compensator spring (17), interface O-rings (15), and load sense shuttle (16) from valve housing. Discard the O-rings.



1. SPOOL END CAP
2. CAPSCREWS
3. O-RING
4. EMERGENCY LOWERING VALVE
5. CHECK VALVE
6. PLUGS
7. PLUG
8. VALVE HOUSING
9. PLUG
10. LOWERING COMPENSATOR
11. SPOOL ASSEMBLY
12. CAPSCREWS
13. SOLENOIDS
14. PLUG
15. INTERFACE O-RINGS
16. LOAD SENSE SHUTTLE
17. COMPENSATOR SPRING

Figure 32. Lift Control Valve Section

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install the compensator spring, new O-rings, and load sense shuttle on the valve housing. See Figure 32.

2. Install plugs.
   - Torque plugs (6) to 7.3 ±0.4 N•m (5.4 ±0.3 lbf ft).
   - Torque plug (7) to 21 ±0.95 N•m (15.5 ±0.7 lbf ft).
   - Torque plug (9) to 2.7 ±0.34 N•m (2 ±0.25 lbf ft).
   - Torque plug (14) to 47.2 ±2.3 N•m (34.8 ±1.7 lbf ft).

3. Install emergency lowering valve, lowering compensator, and check valve on valve housing.
   - Torque emergency lowering valve and lowering compensator to 104.9 ±5 N•m (77.4 ±3.7 lbf ft).
   - Torque check valve to 73.5 ±3.5 N•m (54.2 ±2.6 lbf ft).

4. Install capscrews and solenoids on valve housing. Torque capscrews to 2.7 ±0.27 N•m (2 ±0.2 lbf ft).

5. Install spool assembly into housing.

6. Install new O-rings, capscrews, and spool end caps on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

Tilt/Auxiliary Control Valve Sections

Disassemble

NOTE: Note placement of O-rings prior to disassembly to aid in assembly.

1. Loosen and remove the spool end capscrews (2) gradually to ensure that the spool assembly (6) does not fall out of the valve housing (5). Remove the spool end caps (1) and discard the O-rings (3). See Figure 33.

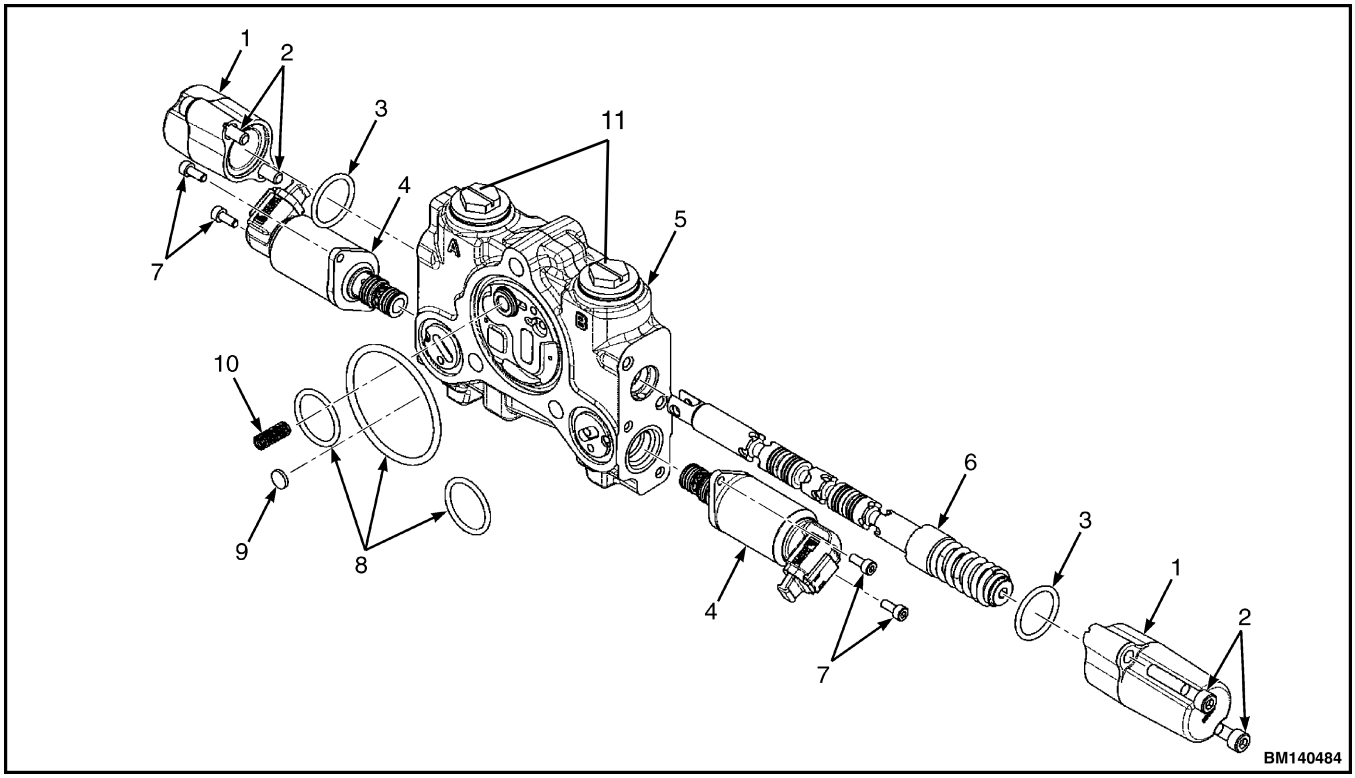
2. Remove the spool assembly from the valve housing.

NOTE: Note orientation of solenoid connector prior to removal.

3. Remove the capscrews (7) and solenoids (4) from valve housing.

4. Remove the compensator spring (10), O-rings (8), and load sense shuttle (9) from valve housing. Discard the O-rings.

5. Remove plug (11).



1. SPOOL END CAP
2. CAPSCREWS
3. O-RINGS
4. SOLENOIDS
5. VALVE HOUSING
6. SPOOL ASSEMBLY
7. CAPSCREWS
8. INTERFACE O-RINGS
9. LOAD SENSE SHUTTLE
10. COMPENSATOR SPRING
11. PLUG

Figure 33. Tilt/Auxiliary Control Valve Sections

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the control valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.
2. If not all components have been removed, clean the control valve section using a lint-free cloth.

Inspect

NOTE: If the control valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the control valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the control valve section.

Inspect the control valve section mating surfaces for damage. If the mating surface is damaged, replace the control valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

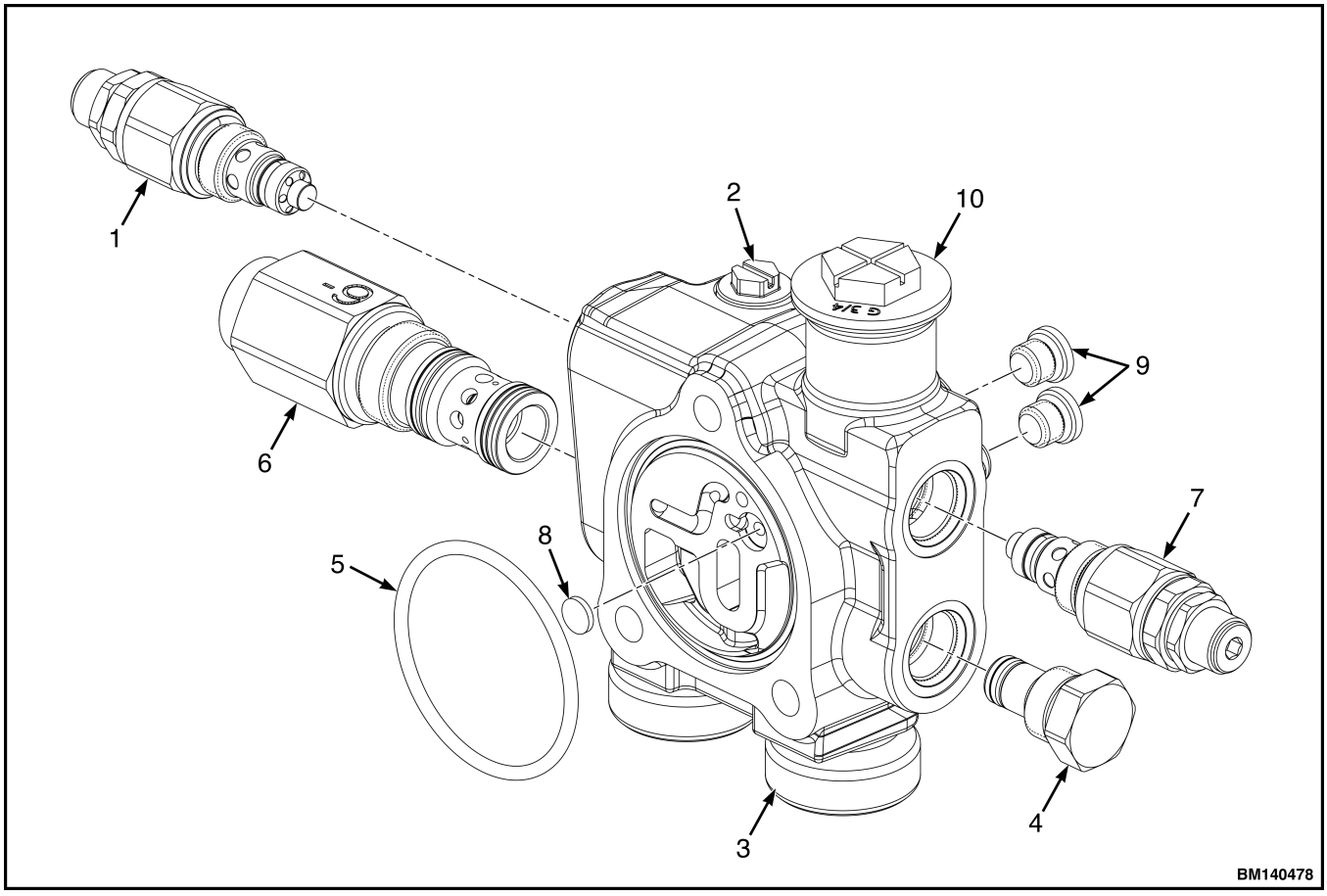
1. Install plug (11). Torque plug to 2.7 ±0.34 N•m (2 ±0.25 lbf ft). See Figure 33.
2. Install the compensator spring, new O-rings, and load sense shuttle on the valve housing.
3. Install solenoids and capscrews on valve housing. Torque capscrews to 2.7 ±0.27 N•m (2 ±0.2 lbf ft).
4. Install spool assembly into housing.
5. Install new O-rings, capscrews, and spool end caps on valve housing. Torque capscrews to 9.5 ±1.4 N•m (7 ±1 lbf ft).

Outlet Valve Section

Disassemble

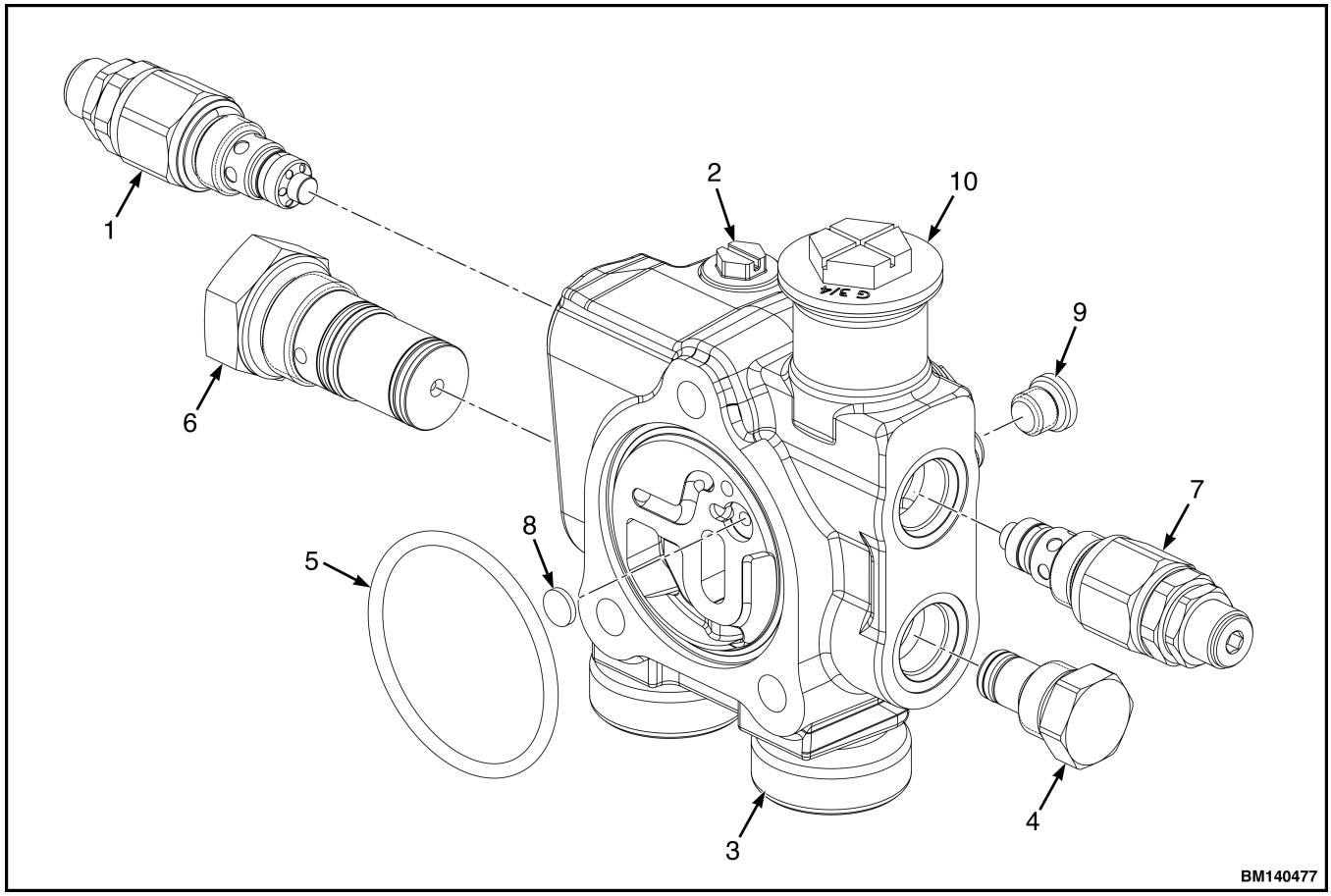
NOTE: Note placement of O-rings prior to disassembly to aid in assembly.

1. Remove the relief valves (1 and 7) and shut-off plugs (4 and 6) from valve housing (3). See Figure 34 or Figure 35.
2. Remove plugs (2, 9, and 10).
3. Remove the interface O-ring (5) and shuttle (8). Discard the O-ring.



1. PRIMARY RELIEF VALVE
2. PLUG
3. VALVE HOSUING
4. SHUT-OFF PLUG
5. INTERFACE O-RING
6. UNLOADER SHUT-OFF PLUG
7. SECONDARY RELIEF VALVE
8. SHUTTLE
9. PLUG
10. PLUG

Figure 34. Outlet Valve Section (Gear Pump)



1. PRIMARY RELIEF VALVE
2. PLUG
3. VALVE HOUSING
4. SHUT-OFF PLUG
5. INTERFACE O-RING
6. LS DIAGNOSTIC PORT
7. SECONDARY RELIEF VALVE
8. SHUTTLE
9. PLUG
10. PLUG

Figure 35. Outlet Valve Section (Variable Displacement Pump)

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

1. If all components of the inlet valve section have been removed, clean the valve section using cleaning solvent and dry using compressed air.

2. If not all components have been removed, clean the valve section using a lint-free cloth.

Inspect

NOTE: If the valve section is not to be reassembled immediately, coat surfaces with clean hydraulic oil to prevent the possibility of rust. Cover the valve section with a clean, dry, lint-free cloth to prevent the possibility of contaminants entering the valve section.

Inspect the valve section mating surfaces for damage. If the mating surface is damaged, replace the valve section.

Assemble

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install new interface O-ring on valve housing. See Figure 34 or Figure 35.

2. Install plugs (2, 9, and 10) on valve housing.
   - Torque plug (2) to 1.4 ±0.34 N•m (1 ±0.25 lbf ft).
   - Torque plug (9) to 21 ±0.95 N•m (15.5 ±0.7 lbf ft).
   - Torque plug (10) to 2.4 ±0.34 N•m (1.75 ±0.25 lbf ft).

3. Install relief valves and shut-off plugs on valve housing.
   - Torque relief valves to 42 ±4.2 N•m (31 ±3.1 lbf ft).
   - Torque shut-off plug (4) to 89.2 ±4.2 N•m (65.8 ±3.1 lbf ft).
   - Torque shut-off plug/LS diagnostic port (6) to 122 ±12.2 N•m (90 ±9 lbf ft).

PRESSURE RELIEF VALVE CHECK AND ADJUSTMENT

NOTE: The main control valve has two relief valves: a primary relief valve and a secondary relief valve. Both relief valves are located on the outlet valve section.

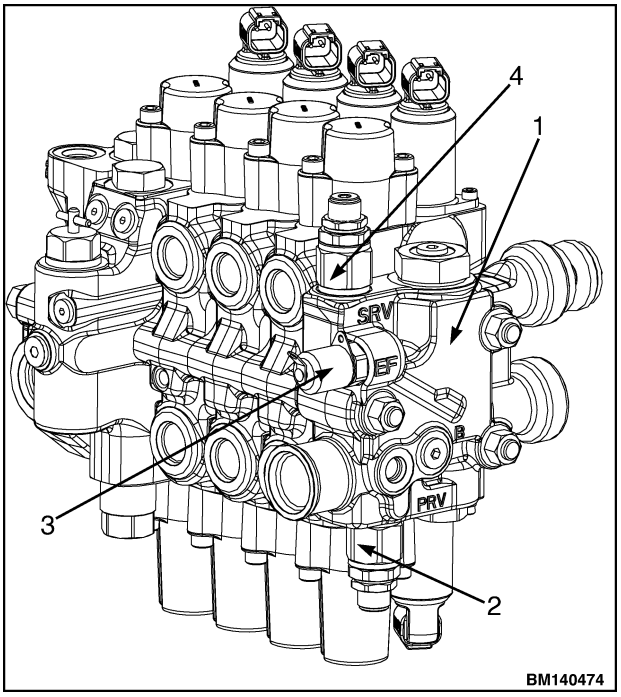
NOTE: There are two hydraulic control valve versions, manual and electric. Pressure relief valve check and adjustment is the same for both versions. Electric hydraulic control valve is shown.

Primary Relief Valve

WARNING

Never allow anyone under a raised carriage. Do not put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the key switch is OFF.

1. Install a digital pressure gauge with a range of 0 - 35 MPa (0 - 5,000 psi) on the EF port. See Figure 36.



1. OUTLET VALVE SECTION
2. PRIMARY RELIEF VALVE
3. EF PORT
4. SECONDARY RELIEF VALVE

Figure 36. Pressure Relief Valve Adjustment

2. Start the engine and operate the hydraulic system to warm the hydraulic oil to operating temperature.

CAUTION

During this test, the mast must be fully extended. Make sure there is enough overhead clearance in the building, or do the test outdoors.

3. Raise the mast until it stops. Hold the lever and record the reading of the gauge when the relief valve opens. Pressure should be 24 ±2.4 MPa (3,481 ±348 psi).
   - If measured reading is not within range, proceed to Step 4 to adjust the relief valve pressure setting.
   - If measured reading is within range, proceed to Step 7.

4. Loosen the lock nut that locks the relief valve pressure adjustment plug.

5. Turn the relief valve pressure adjustment plug, either direction, until you achieve the correct pressure.

6. Tighten the lock nut to lock the relief valve pressure adjustment plug.

7. Completely lower the mast and shut the engine off.

8. Remove the pressure gauge and, if necessary, install the hydraulic hose.

9. Check for leaks.

Secondary Relief Valve

1. Install a digital pressure gauge with a range of 0 - 35 MPa (0 - 5,000 psi) on the EF port.

2. Start the engine and operate the hydraulic system to warm the hydraulic oil to operating temperature.

CAUTION

During this test, the mast must be fully extended. Make sure there is enough overhead clearance in the building, or do the test outdoors.

3. Tilt the mast until it stops. Hold the lever and record the reading of the gauge when the relief valve opens. Pressure should be 18 ±1.8 MPa (2,611 ±261 psi).
   - If measured reading is not within range, proceed to Step 4 to adjust the relief valve pressure setting.
   - If measured reading is within range, proceed to Step 7.

4. Loosen the lock nut that locks the relief valve pressure adjustment plug.

5. Turn the relief valve pressure adjustment plug, either direction, until you achieve the correct pressure.

6. Tighten the lock nut to lock the relief valve pressure adjustment plug.

7. Completely lower the mast and shut the engine off.

8. Remove the pressure gauge and, if necessary, install the hydraulic hose.

9. Check for leaks.

HYDRAULIC SUPPLY AND RETURN REPAIR 202001-063

HYDRAULIC SUPPLY AND RETURN HOSES

Remove

WARNING

Lower carriage completely before working on control valve or hydraulic system. Do not work under a raised carriage. Put mast in a vertical position, with no forward or back tilt, and lower carriage completely before disconnecting any parts of hydraulic system. The mast can lower suddenly and cause injury if the carriage is not lowered.

1. Place a drain pan under hydraulic hoses being removed.

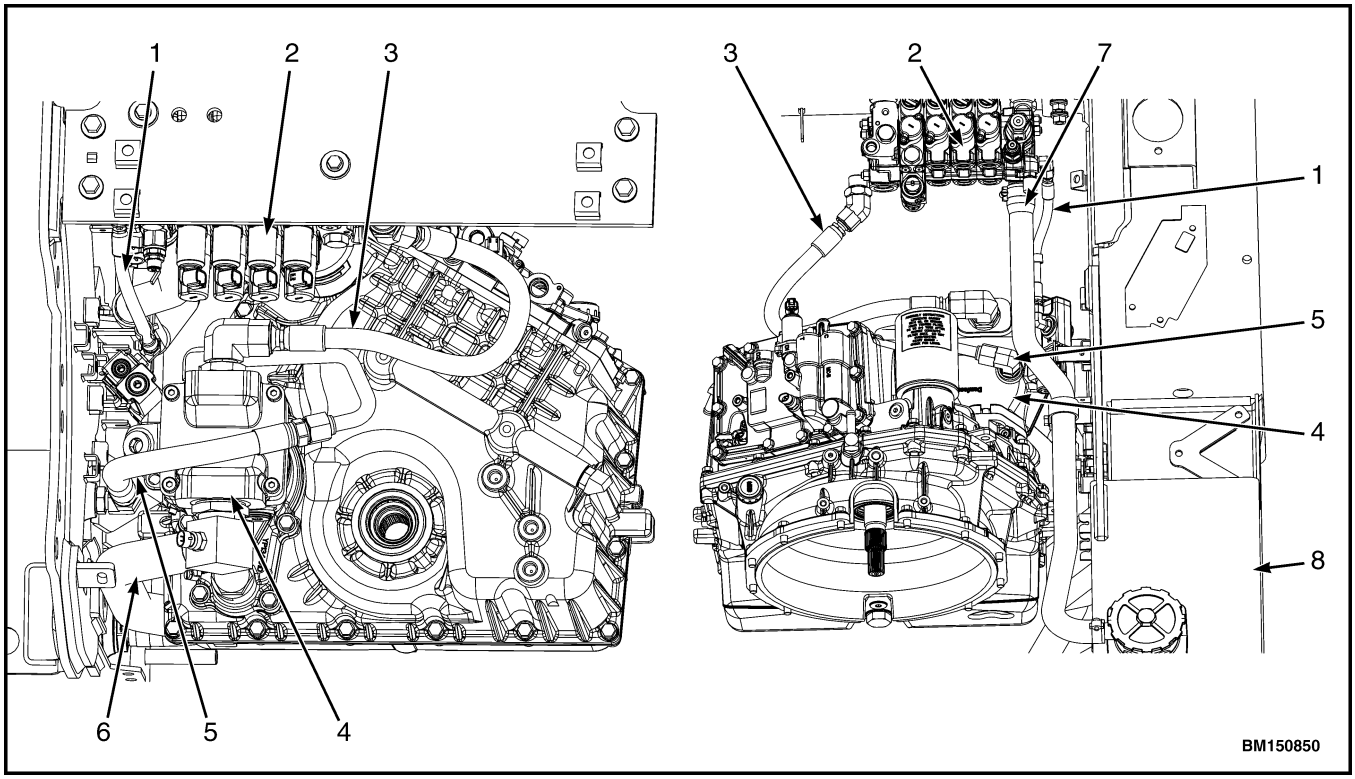
2. Tag and disconnect the pump suction hose from hydraulic pump and tank. Remove the pump suction hose.
   - For lift trucks with a powershift transmission and Variable Displacement Pump (VDP), see Figure 37.
   - For lift trucks with a powershift transmission and hydraulic gear pump, see Figure 38.

3. Tag and disconnect the system supply hose from hydraulic pump and hydraulic control valve. Remove the system supply hose.

4. Tag and disconnect the system return hose from hydraulic control valve and hydraulic tank. Remove the system return hose.

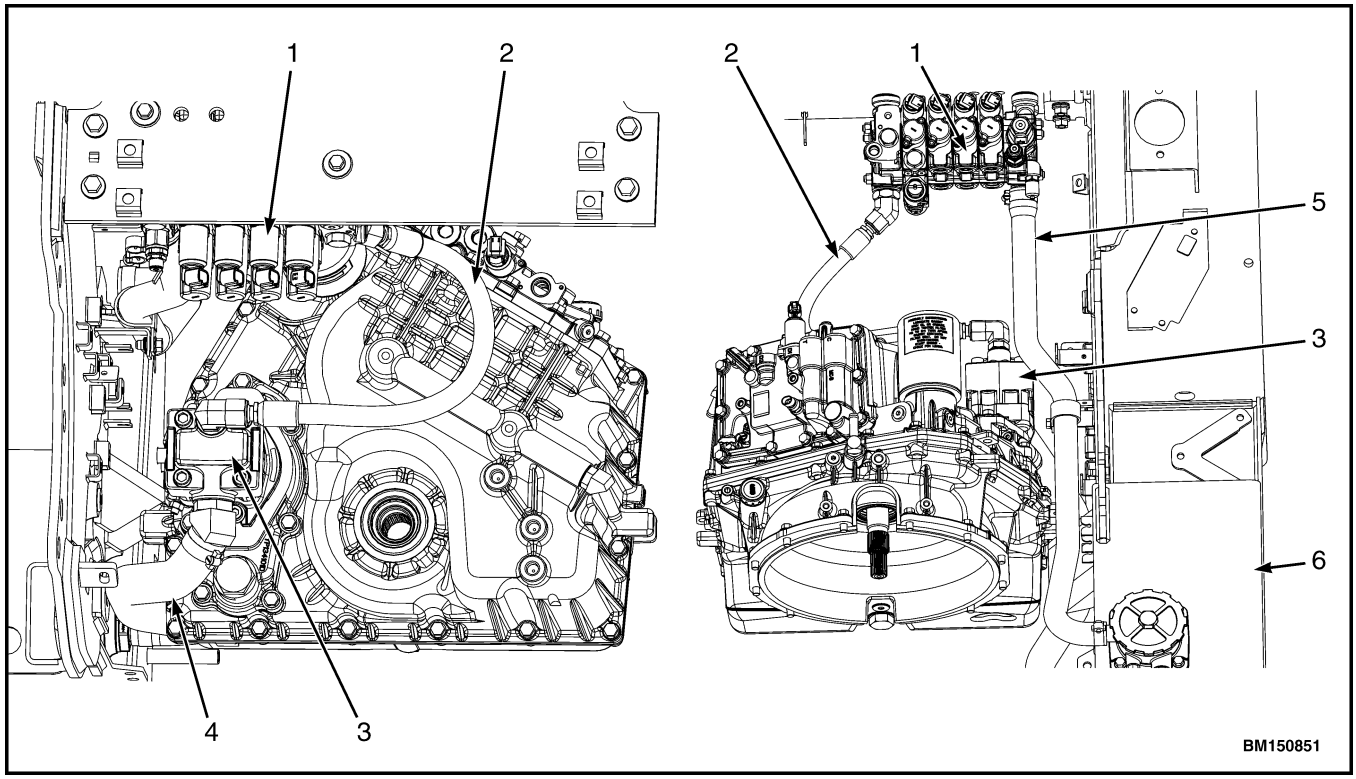
5. For trucks with variable displacement pump, tag and disconnect the pump load sense hose from hydraulic pump and hydraulic control valve. Remove the pump load sense hose.

6. For trucks with variable displacement pump, tag and disconnect the pump drain hose from hydraulic pump and hydraulic tank. Remove the pump drain hose.



1. PUMP LOAD SENSE HOSE
2. HYDRAULIC CONTROL VALVE
3. SYSTEM SUPPLY HOSE
4. VARIABLE DISPLACEMENT PUMP
5. PUMP DRAIN HOSE
6. PUMP SUCTION HOSE
7. SYSTEM RETURN HOSE
8. HYDRAULIC TANK

Figure 37. Powershift Transmission and Variable Displacement Pump



1. HYDRAULIC CONTROL VALVE
2. SYSTEM SUPPLY HOSE
3. GEAR HOSE
4. PUMP SUCTION HOSE
5. SYSTEM RETURN HOSE
6. HYDRAULIC TANK

Figure 38. Powershift Transmission and Gear Pump

Install

1. For trucks with variable displacement pump, install and connect the pump drain hose to hydraulic pump and hydraulic tank.

- For lift trucks with a powershift transmission and Variable Displacement Pump (VDP), see Figure 37.
- For lift trucks with a powershift transmission and hydraulic gear pump, see Figure 38.

2. For trucks with variable displacement pump, install and connect the pump load sense hose to hydraulic pump and hydraulic control valve.

3. Install and connect the system return hose to hydraulic control valve and hydraulic tank.

4. Install and connect the system supply hose to hydraulic pump and hydraulic control valve.

5. Install and connect the hydraulic suction hose to hydraulic pump and tank.

WARNING

DO NOT try to locate hydraulic leaks by placing hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

6. Start the engine while operating the hydraulic functions. Check for leaks.

7. Check hydraulic tank oil level. Fill the hydraulic tank with clean hydraulic oil as specified in **Periodic Maintenance Manual**.

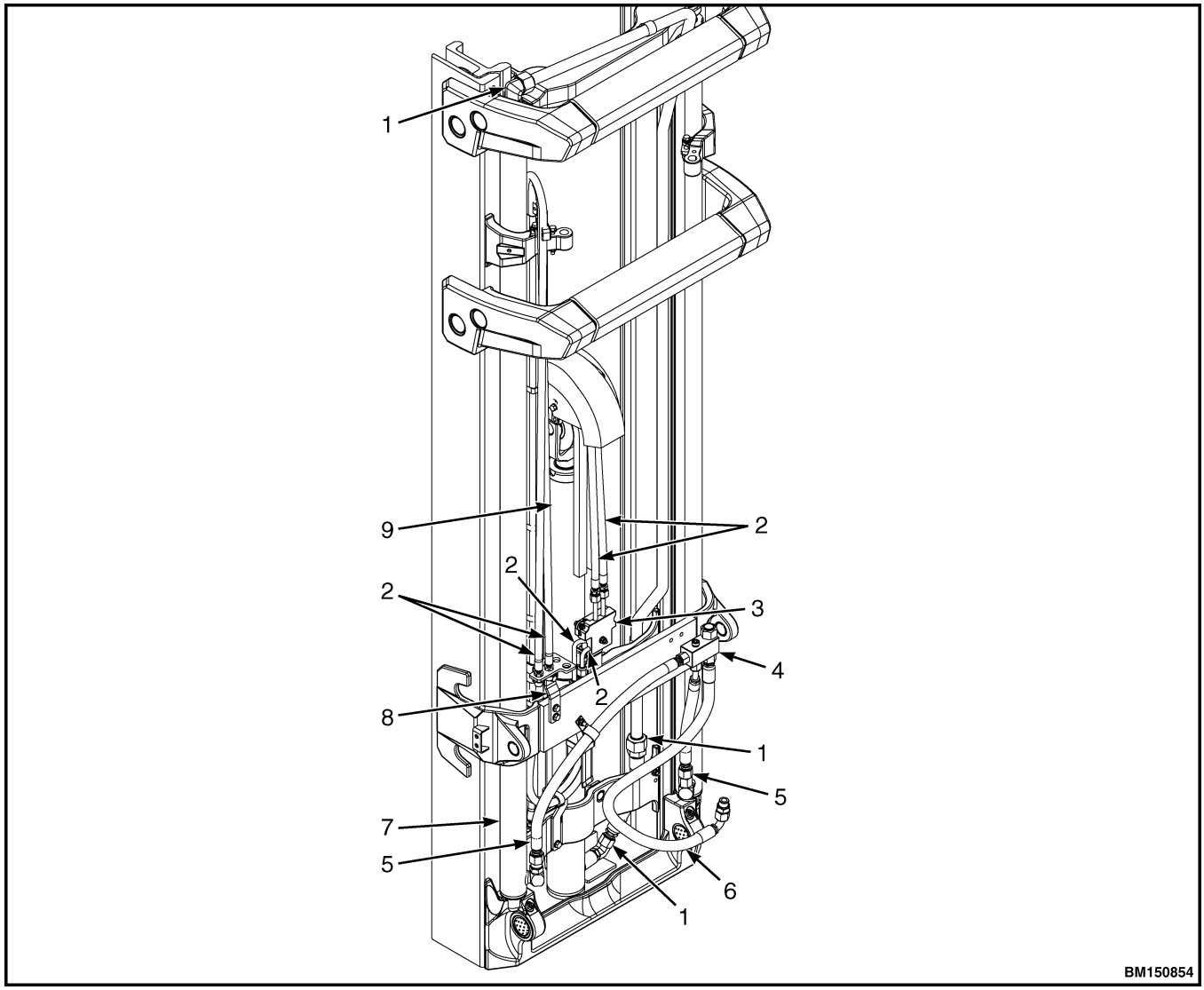
MAST HOSES

Remove

WARNING

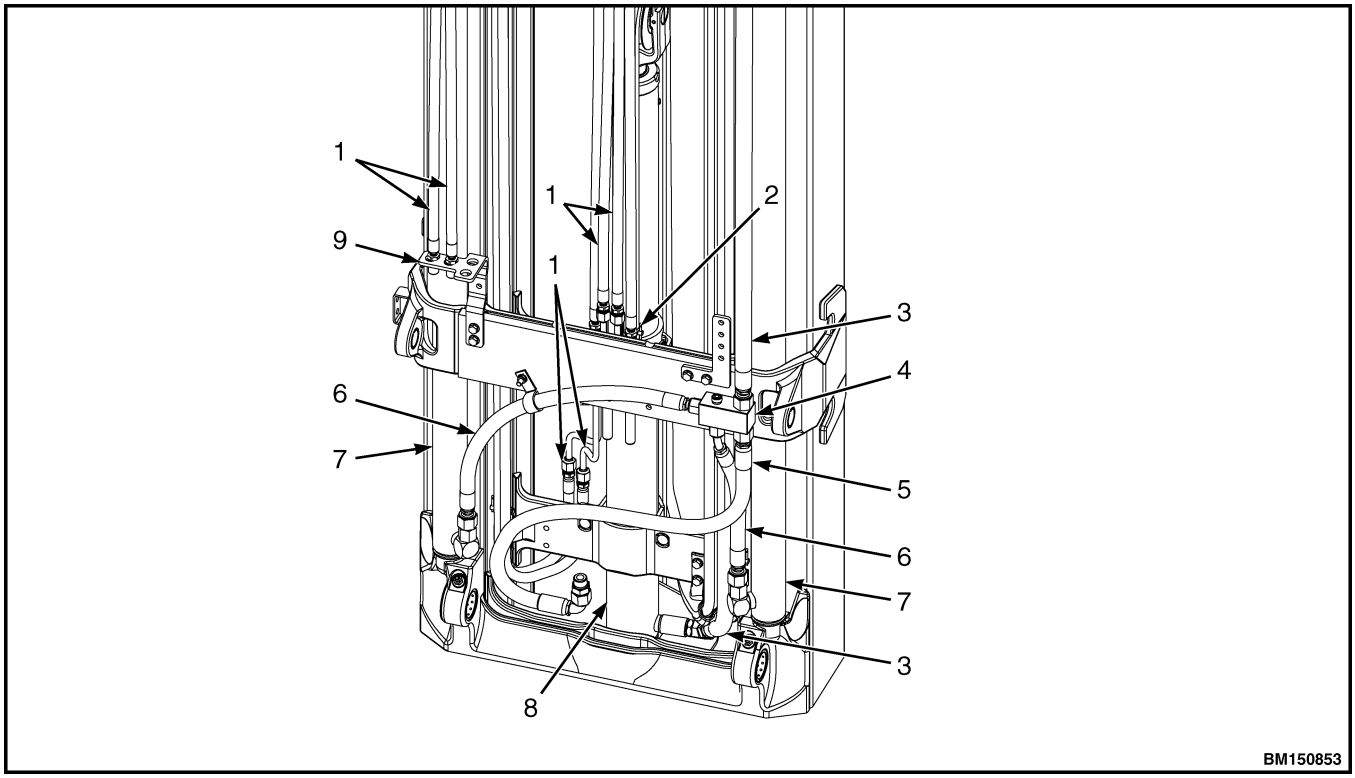
Lower carriage completely before working on control valve or hydraulic system. Do not work under a raised carriage. Put mast in a vertical position, with no forward or back tilt, and lower carriage completely before disconnecting any parts of hydraulic system. The mast can lower suddenly and cause injury if the carriage is not lowered.

1. Place a drain pan under hydraulic hoses being removed.
2. Tag and disconnect the mast supply/return hose from hydraulic control valve and mast supply/return manifold. Remove the mast supply/return hose.
   - For 2-stage masts, see Figure 39.
   - For 3-stage masts, see Figure 40.
   - For 4-stage masts, see Figure 41.
3. Tag and disconnect lift cylinder supply/return hoses from lift cylinders and mast supply/return manifold. Remove the lift cylinder supply/return hoses.
4. Tag and disconnect the carriage supply/return hoses from carriage, header hoses bracket, and freelift tube assembly. Remove the carriage supply/return hoses.
5. For 2-stage and 4-stage masts, tag and disconnect the freelift supply/return hoses from lift cylinder and freelift cylinder. Remove freelift supply/return hoses.
6. For 3-stage masts, tag and disconnect the freelift supply/return hose from freelift cylinder and mast supply/return manifold. Remove freelift supply/return hose.
7. For 4-stage masts, tag and disconnect the lift cylinder rod end supply/return hoses from lift cylinder and fitting. Remove lift cylinder rod end supply/return hoses.



1. FREELIFT SUPPLY/RETURN HOSE
2. CARRIAGE SUPPLY/RETURN HOSES
3. FREELIFT TUBE ASSEMBLY
4. MAST SUPPLY/RETURN MANIFOLD
5. LIFT CYLINDER SUPPLY/RETURN HOSES
6. MAST SUPPLY/RETURN HOSE
7. LIFT CYLINDERS
8. HEADER HOSES BRACKET
9. FREELIFT CYLINDER

Figure 39. 2-Stage Mast Hydraulic Connections



1. CARRIAGE SUPPLY/RETURN HOSES
2. FREELEFT TUBE ASSEMBLY
3. FREELIFT SUPPLY/RETURN HOSE
4. MAST SUPPLY/RETURN MANIFOLD
5. MAST SUPPLY/RETURN HOSE
6. LIFT CYLINDER SUPPLY/RETURN HOSES
7. LIFT CYLINDERS
8. FREELIFT CYLINDER
9. HEADER HOSES BRACKET

Figure 40. 3-Stage Mast Hydraulic Connections

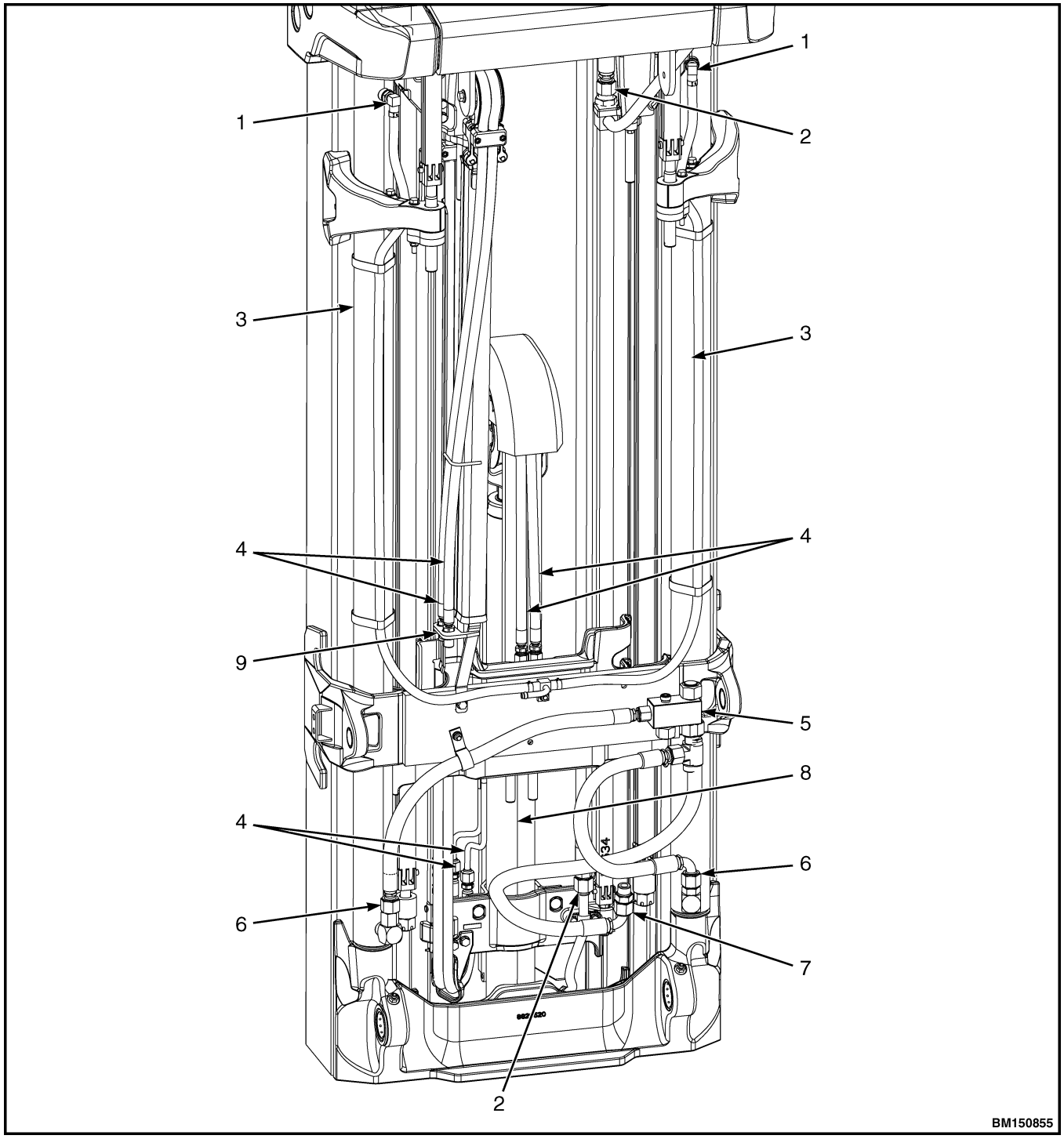


Figure 41. 4-Stage Mast Hydraulic Connections

Legend for Figure 41.

1. LIFT CYLINDER ROD END SUPPLY/RETURN HOSES
2. FREELIFT SUPPLY/RETURN HOSE
3. LIFT CYLINDERS
4. CARRIAGE SUPPLY/RETURN HOSES
5. MAST SUPPLY/RETURN MANIFOLD
6. LIFT CYLINDER PISTON END SUPPLY/RETURN HOSES
7. MAST SUPPLY/RETURN HOSE
8. FREELIFT CYLINDER
9. HEADER HOSES BRACKET

Install

1. For 4-stage masts, connect the lift cylinder rod end supply/return hoses to lift cylinder and fitting.

- For 2-stage masts, see Figure 39.
- For 3-stage masts, see Figure 40.
- For 4-stage masts, see Figure 41.

2. For 3-stage masts, connect the freelift supply/return hose to freelift cylinder and mast supply/return manifold.

3. For 2-stage and 4-stage masts, connect the freelift supply/return hoses to lift cylinder and freelift cylinder.

4. Connect the carriage supply/return hoses to carriage, header hoses bracket, and freelift tube assembly.

5. Connect lift cylinder supply/return hoses to lift cylinders and mast supply/return manifold.

6. Connect the mast supply/return hose to hydraulic control valve and mast supply/return manifold.

WARNING

DO NOT try to locate hydraulic leaks by placing hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

7. Start the engine while operating the mast functions. Check for leaks.

8. Check hydraulic tank oil level. Fill the hydraulic tank with clean hydraulic oil as specified in **Periodic Maintenance Manual**.

HYDRAULIC TANK

Inspect

WARNING

Special procedures must be followed when large leaks or other repairs need welding or cutting. All work must be done by authorized personnel. If the tank is cleaned inside a building, make sure there is enough ventilation. See the following manuals for additional information:

- ***Safe Practices for Welding and Cutting Containers That Have Held Combustibles* by the American Welding Society, F4.1 - 1999.**
- ***Safety in Welding and Cutting*, American National Standard, AWS Z 49.1 - 1999.**

WARNING

DO NOT use tools that can make sparks, heat, or static electricity. The vapors in the tank can cause an explosion.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

Make a visual inspection of all sides of tank. Inspect welds for cracks and leakage. Check for wet areas, accumulation of dirt, and loose or missing paint caused by leakage. Areas of tank that are not easily seen can be checked with an inspection mirror and a light that is approved for locations with flammable vapors.

1. Place a drain pan with enough capacity to hold all fluid from tank under tank's drain plug.

2. Remove drain plug and drain contents of tank into drain pan.

3. After all fluid has been drained, reinstall drain plug and remove drain pan from under lift truck.

Clean

WARNING

When cleaning the tank, DO NOT use solutions that make dangerous gases at normal temperatures or when heated. Wear eye and face protection. Protect the body from burns.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

WARNING

Be careful when cleaning with steam. Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

When cleaning with steam, use a hose with a minimum diameter of 19 mm (0.75 in.). Control pressure of steam by a valve installed at nozzle of hose. If a metal nozzle is used, it must be made of a material that does not make sparks. Make an electrical connection between nozzle and tank. Connect a ground wire to tank to prevent static electricity.

Steam Method of Cleaning

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

WARNING

Be careful when cleaning with steam. Steam can cause serious burns. Wear protective clothing, gloves, and eye protection. Never expose your skin to steam.

Use following procedure to clean tank with steam:

1. Remove all parts from tank. Install drain plug.
2. Fill tank 1/4 full with a solution of water and sodium bicarbonate or sodium carbonate. Mix 0.5 kg (1 lb) per 4 liter (1 gal) of water.
3. Mix solution in tank using air pressure. Make sure all surfaces on inside of tank are flushed with solution. Drain tank.
4. Put steam into tank until tank does not have odors and metal is hot. Steam vapors must come from all openings.
5. Flush inside of tank with boiling water. Make sure all loose material is removed from inside of tank.
6. Make an inspection of inside of tank. If it is not clean, repeat Step 4 and Step 5 and make another inspection. When making inspections, use a light that is approved for locations with flammable vapors.
7. Put plugs in all openings in tank. Wait 15 minutes, then remove inlet and outlet plugs. Test a sample of vapor with a special indicator for gas vapors. If amount of flammable vapors is above lower flammable limit, repeat cleaning procedures.

Chemical Solution Method of Cleaning

WARNING

When cleaning the tank, DO NOT use solutions that make dangerous gases at normal temperatures or when heated. Wear eye and face protection. Protect the body from burns.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

Disposal of lubricants, fluids, and chemicals must meet local environmental regulations.

If tank cannot be cleaned with steam, use following procedure:

1. Mix a solution of water and trisodium phosphate or a cleaning compound with an alkaline base. Follow instructions given by manufacturer.
2. Fill tank with cleaning solution. Use compressed air to mix solution in tank.
3. Drain tank. Flush inside of tank with hot (boiling) water. Make sure all cleaning compound is removed.
4. Make an inspection of inside of tank. If tank is not clean, repeat Step 1 through Step 3. Make another inspection of tank. When making inspections, use a light that is approved for locations with flammable vapors.
5. Check tank for flammable vapors using special indicator for gas vapors. If amount of flammable vapors is not below lower flammable limit, repeat cleaning procedures.

Additional Preparations for Repair

If nitrogen gas or carbon dioxide gas is available, prepare tank for welding using these gases. See manual *Safe Practices for Welding and Cutting Containers That Have Held Combustibles* by the American Welding Society, F4.1 - 1999. If these gases are not available, another method using water can be used as follows:

1. Fill tank with water to just below point where work will be done. Make sure space above level of water has a vent.
2. Use acceptable welding practices to repair tank. See the American National Standard *Safety in Welding and Cutting*, AWS Z 49.1 - 1999.

Small Leaks, Repair

Use following procedure to repair small leaks:

1. Use steam to clean area around leak. Remove all paint and dirt around leak.
2. Apply Loctite® 290 to leak. Follow instructions of manufacturer.

Large Leaks, Repair

1. Use one of procedures described under Clean to clean and prepare tank for repairs.
2. Contact your dealer for **Hyster** lift trucks for welding instructions.
3. Use acceptable welding practices to repair tank. See the American National Standard *Safety in Welding and Cutting*, AWS Z 49.1 - 1999.

Preparations for use After Repair

1. Add more water to tank so that water goes above point of where work was done. Check for any leaks coming from tank.
2. If there are no leaks coming from tank, remove all water from the tank.

HYDRAULIC OIL COOLER 202001-347

HYDRAULIC OIL COOLER

Remove

1. Remove fasteners and radiator cover from counterweight.

NOTE: Note swivel clamp placement prior to removal to aid in installation.

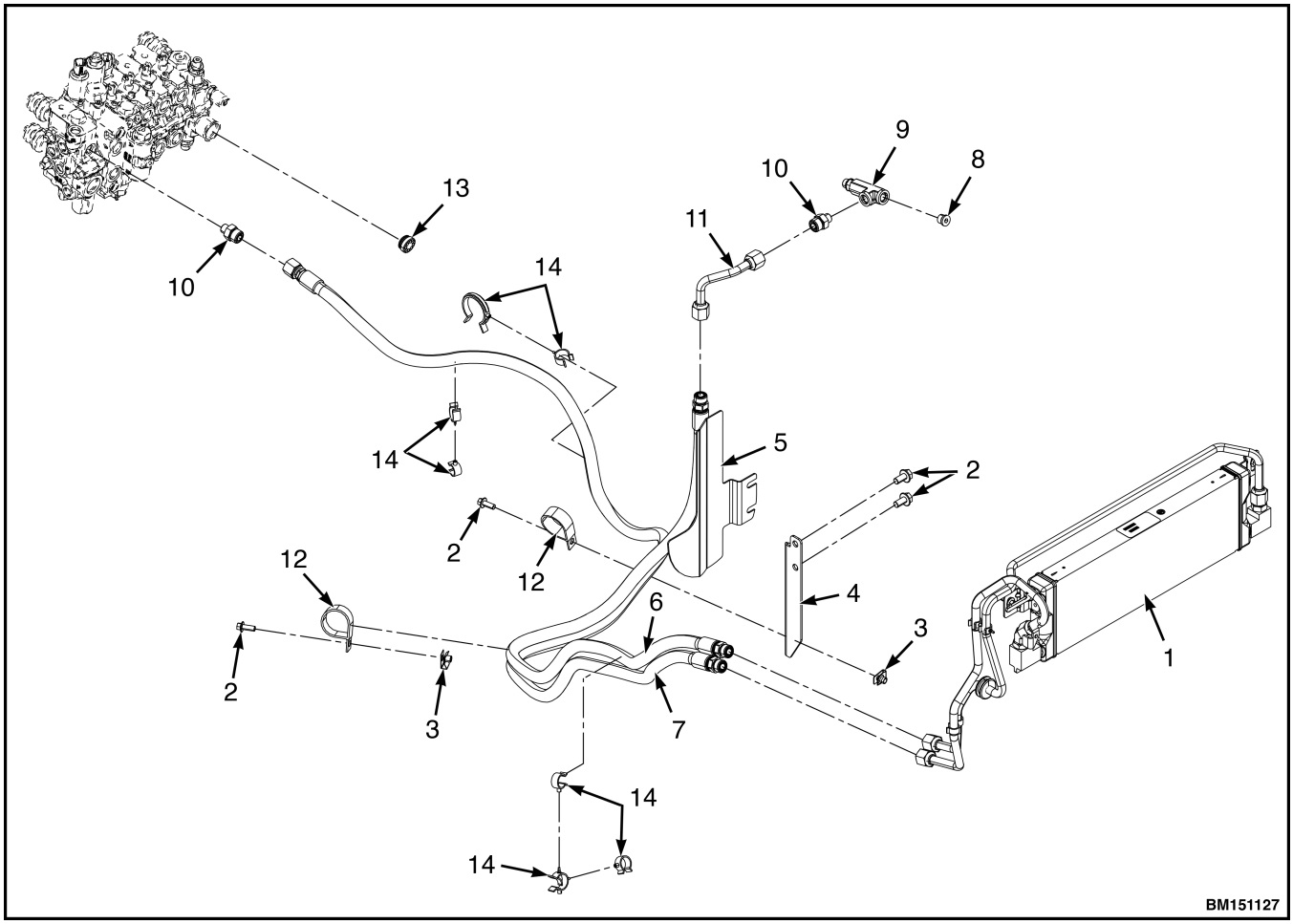
2. Remove swivel clamps from hydraulic oil cooler supply and return hose assemblies. See Figure 42.

3. Disconnect hydraulic oil cooler return tube assembly (11) from hydraulic oil cooler return hose assembly (6). Remove fitting (8), t-fitting (9), and fitting (10) from hydraulic oil cooler return tube assembly (11). Remove and discard O-rings. See Figure 42.

4. Disconnect hydraulic oil cooler return hose assembly (6) from hydraulic cooler assembly (1). See Figure 42.

5. Disconnect hydraulic oil cooler supply hose assembly (7) from hydraulic cooler assembly (1). See Figure 42.

6. Remove two capscrews and hydraulic oil cooler assembly from radiator. See Figure 42.



NOTE: HYDRAULIC OIL COOLER WITH VDP SHOWN, HYDRAULIC OIL COOLER WITH GEAR PUMP SIMILAR.

1. HYDRAULIC OIL COOLER ASSEMBLY
2. CAPSCREW
3. FOLD-OVER NUT
4. BRACKET
5. DPF HEATSHIELD
6. HYDRAULIC OIL COOLER RETURN HOSE ASSEMBLY
7. HYDRAULIC OIL COOLER SUPPLY HOSE ASSEMBLY
8. FITTING W/O-RING
9. T-FITTING
10. FITTING
11. HYDRAULIC OIL COOLER RETURN TUBE ASSEMBLY
12. CLAMP
13. CHECK VALVE
14. SWIVEL CLAMP

Figure 42. Hydraulic Oil Cooler Plumbing

Disassemble

1. Disconnect and remove hydraulic oil cooler supply tube and fitting from left side of hydraulic oil cooler. See Figure 43.

2. Disconnect and remove hydraulic oil cooler return tube and fitting from right side of hydraulic oil cooler. See Figure 43.

3. Remove and discard O-rings from fittings.

4. If damaged, remove grommet on hydraulic oil cooler return tube. See Figure 43.

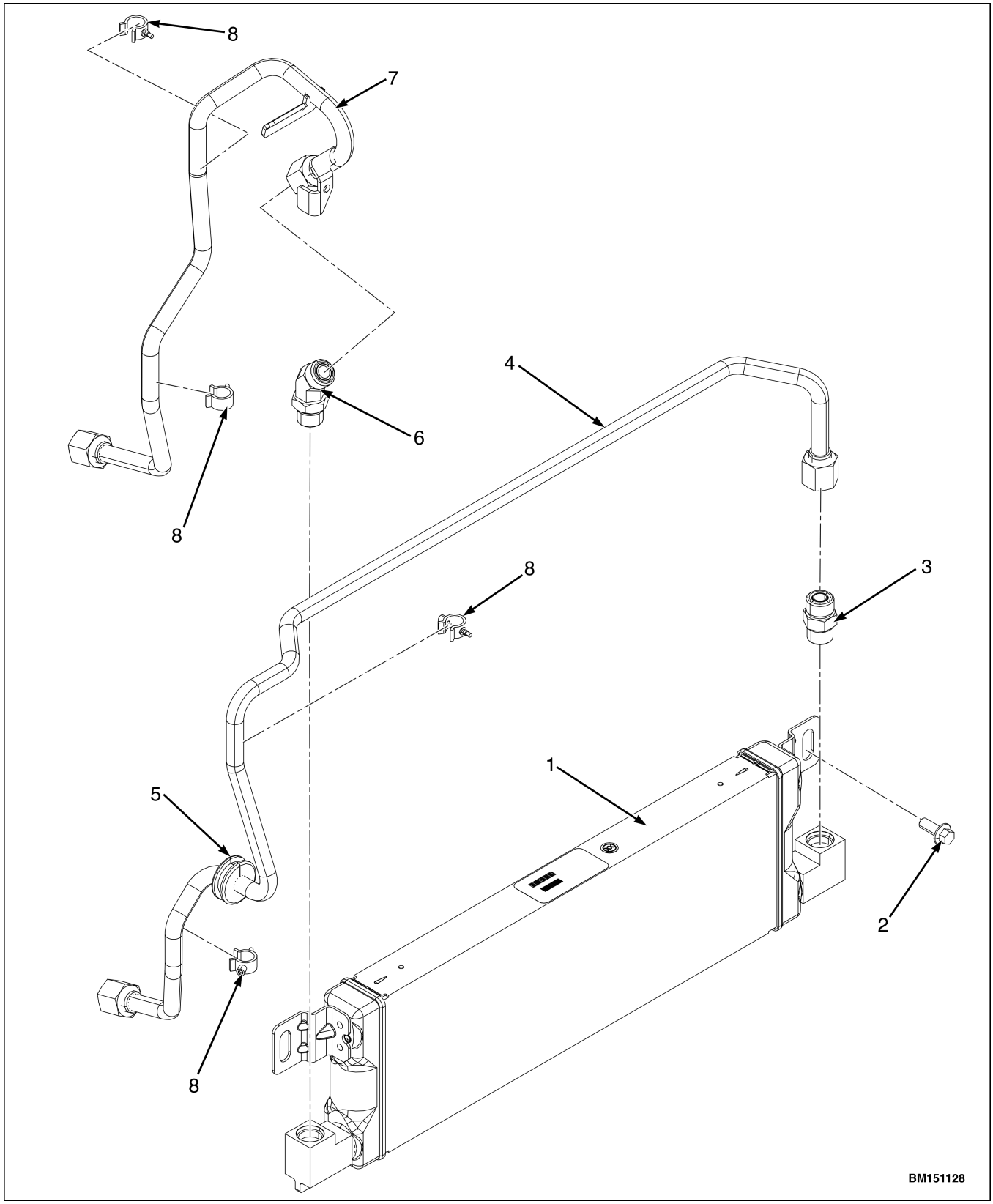


Figure 43. Hydraulic Oil Cooler

Legend for Figure 43.

1. HYDRAULIC OIL COOLER
2. CAPSCREW
3. FITTING
4. HYDRAULIC OIL COOLER RETURN TUBE
5. GROMMET
6. FITTING
7. HYDRAULIC OIL COOLER SUPPLY TUBE

Assemble

1. If removed, install new grommet on hydraulic oil cooler return tube. See Figure 43.
2. Install new O-rings on fittings.
3. Connect fitting to right side of hydraulic oil cooler. Connect hydraulic oil cooler return tube to fitting. See Figure 43.
4. Connect fitting to left side of hydraulic oil cooler. Connect hydraulic oil cooler supply tube to fitting. See Figure 43.

Install

1. Install hydraulic oil cooler assembly and two capscrew on radiator. See Figure 42.
2. Connect hydraulic oil cooler supply hose assembly to hydraulic cooler assembly. See Figure 42.
3. Connect hydraulic oil cooler return hose assembly to hydraulic cooler assembly. See Figure 42.
4. Install new O-rings on fittings. Install fitting (8) to t-fitting (9). Install t-fitting (9) to fitting (10). Install hydraulic oil cooler return tube assembly (11) to hydraulic oil cooler return hose assembly (6). See Figure 42.
5. Install swivel clamps on hydraulic oil cooler return and supply hose assemblies as noted during removal. See Figure 42.
6. Install radiator cover and fasteners on counterweight.

HYDRAULIC CALIBRATIONS 202001-219

Calibration must be done any time a component of the hydraulic control valve has been repaired. Each function of the hydraulic control valve has unique instructions for calibration and must be performed using the control levers and the User Interface display.

For more instructions on the User Interface display and calibration procedures, see User interface (display) section in **Electrical, software, and controls** 2200SRM2304 manual.

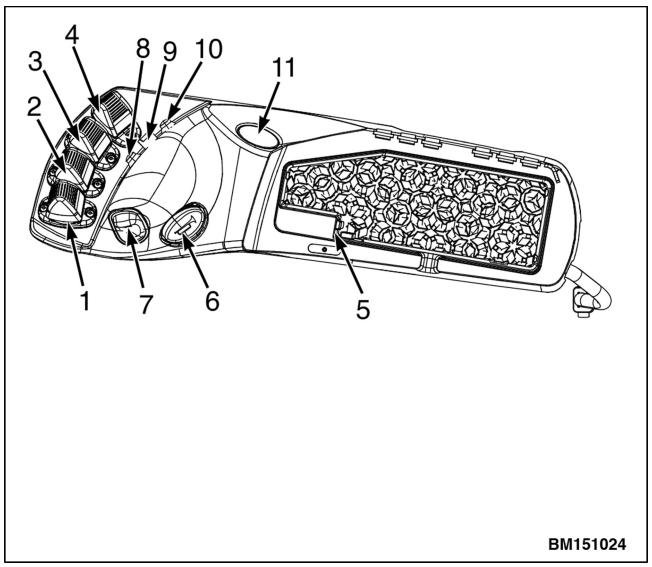
Table 1. Hydraulic calibrations

Calibration procedure	All units	3 Func. E-hyd valve	4 Func. E-hyd valve
Service password entry	X		
Hydraulic valve calibration warmup		X	X
Lift valve threshold		X	X
Lower valve threshold		X	X
Tilt valve threshold (Forward)		X	X
Tilt valve threshold (Back)		X	X

Table 1. Hydraulic calibrations (Continued)

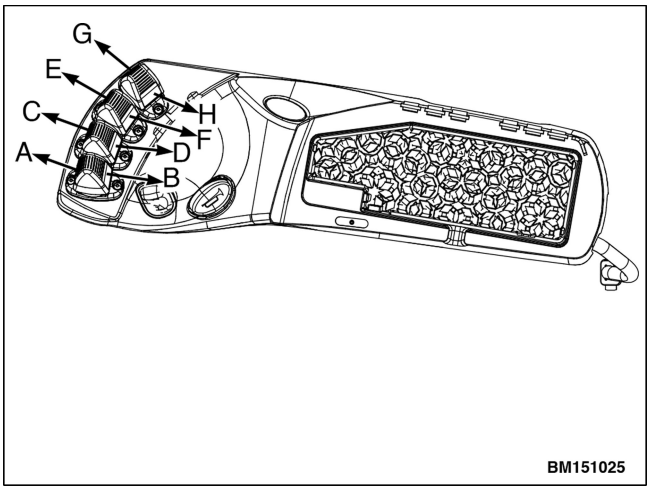
Calibration procedure	All units	3 Func. E-hyd valve	4 Func. E-hyd valve
Auxiliary 1 Direction A valve output threshold		X	X
Auxiliary 1 Direction B valve output threshold		X	X
Auxiliary 2 Direction A valve output threshold			X
Auxiliary 2 Direction B valve output threshold			X

E-HYDRAULIC CONTROLS OPTIONS



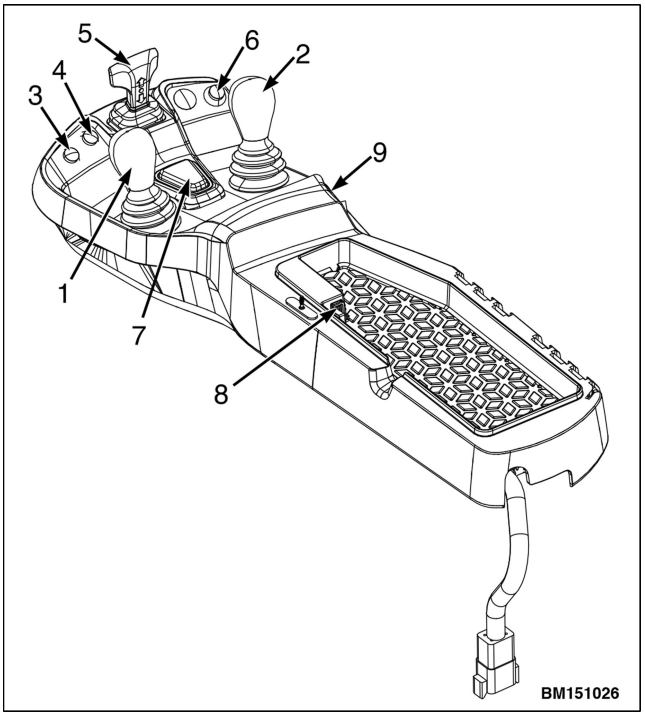
1. LIFT/LOWER FUNCTION
2. TILT FUNCTION
3. AUX FUNCTION (3 AND 4 FUNC.)
4. AUX 2 FUNCTION (4 FUNC.)
5. USB PORT
6. HORN
7. DIRECTION CONTROL SWITCH
8. PUSH BUTTON SWITCH
9. PUSH BUTTON SWITCH
10. PUSH BUTTON SWITCH
11. E-STOP

Figure 44. Mini-Lever Module (MLM) controls



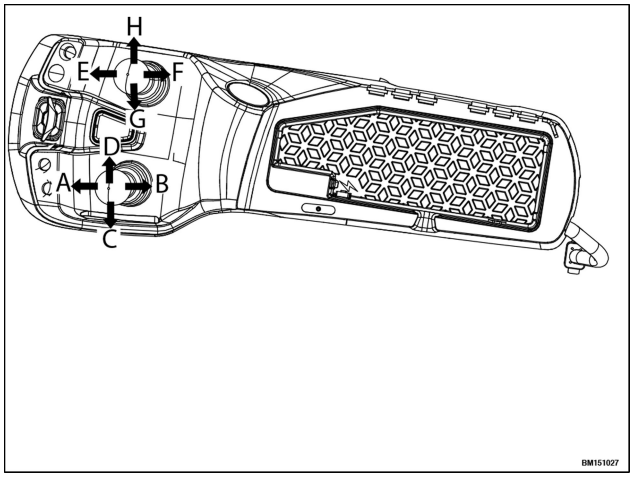
A. LOWER
B. LIFT
C. TILT (FORWARD)
D. TILT (BACK)
E. AUX.1 DIRECTION A
F. AUX.1 DIRECTION B
G. AUX.2 DIRECTION A
H. AUX.2 DIRECTION B

Figure 45. Mini-Lever Module (MLM) functions



1. JOYSTICK POS 1 (LIFT/LOWER/TILT)
2. JOYSTICK POS 2 (AUX. 1/AUX. 2)
3. PUSH BUTTON SWITCH
4. PUSH BUTTON SWITCH
5. DIRECTION CONTROL SWITCH
6. PUSH BUTTON SWITCH
7. HORN
8. USB PORT
9. E-STOP

Figure 46. Joystick lever controls



A. LOWER
B. LIFT
C. TILT (FORWARD)
D. TILT (BACK)
E. AUX.1 DIRECTION A
F. AUX.1 DIRECTION B
G. AUX.2 DIRECTION A
H. AUX.2 DIRECTION B

Figure 47. Joystick lever functions

CALIBRATION PROCEDURES

Service password entry

NOTE: Service related items are protected from inadvertent access. A password must be entered by authorized technician in order for the service procedures to be performed.

1. Turn ignition ON.

2. Swipe (left or right) on the display or use the buttons on the keypad to select the *Information* screen icon from the menu bar.

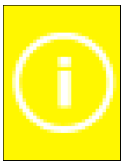


Figure 48. Information screen icon

3. Select **Log In** to reveal the *Password* screen.

4. The password screen will appear. A key icon in the upper left corner will display when the screen is locked. Use the keypad on the screen to enter the 5-digit password.

5. Select the GREEN check mark to save.

6. Access has been granted and the *Home* screen displays.

Hydraulic valve calibration warmup

NOTE: Perform a hydraulic valve calibration warmup any time a hydraulic calibration items must also be performed.

1. Cycle the lift valve and cylinders to remove any trapped air from the system.

NOTE: It is necessary to bleed air from the hoist valve if the carriage moves slightly (approximately 1/4 of an inch) when the engine is started, without activating the lift control.

2. Cycle the hoist valve to remove any trapped air from the system.
   - Activate the control from neutral to full-lift and back to neutral at a rate of one or two times per second.
   - Repeat until the lift function is operating smoothly and there is no mast movement at engine start.
3. Confirm:
   - Lift truck ignition is ON.
   - Engine is at high idle.
   - Transmission is in NEUTRAL.
   - Park brake is applied.
4. Cycle hydraulic functions to warm up hydraulic fluid to 50 and 60°C (120 and 149°F).
5. The calibration procedure for the specific hydraulic function may now be performed.

Lift valve threshold

NOTE: Perform this calibration when the lift valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 49. Calibrations icon

4. Select **Hydraulics**.
5. Select **H1 Lift/Lower**.
6. Select **H1c.5 Lift Valve Output**.
7. Follow the prompt on the display and pull the lever all the way back (100%). Return the lever to neutral.
8. Pull the lever back 50-70% stroke and hold to see if lifting motion has started.
9. If motion has not started yet, repeat pulling the lever fully to 100%. Return the level to neutral.
10. Pull the lever back 50-70% stroke and hold to see if lifting motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Lower valve threshold

NOTE: Perform this calibration when the lower valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 50. Calibrations icon

4. Select **Hydraulics**.
5. Select **H1 Lift/Lower**.
6. Select **H1c.7 Lower Valve Output**.
7. Follow the prompt on the display and push the lever all the way forward (100%). Return the lever to neutral.
8. Push the lever back 50-70% stroke and hold to see if lowering motion has started.
9. If motion has not started yet, repeat pushing the lever fully to 100%. Return the level to neutral.
10. Push the lever forward 50-70% stroke and hold to see if lowering motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Tilt valve threshold (Forward)

NOTE: Perform this calibration when the tilt valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 51. Calibrations icon

4. Select **Hydraulics**.
5. Select **H2 Tilt**.
6. Select **H2c.7 Tilt FWD Output**.
7. Follow the prompt on the display and push the lever all the way forward (100%). Return the lever to neutral.
8. Push the lever forward 50-70% stroke and hold to see if tilting motion has started.
9. If motion has not started yet, repeat pushing the lever fully to 100%. Return the lever to neutral.
10. Push the lever forward 50-70% stroke and hold to see if tilting motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Tilt valve threshold (Back)

NOTE: Perform this calibration when the tilt valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 52. Calibrations icon

4. Select **Hydraulics**.
5. Select **H2 Tilt**.
6. Select **H2c.9 Tilt BWD Output**.
7. Follow the prompt on the display and push the lever all the way forward (100%). Return the lever to neutral.
8. Pull the lever back 50-70% stroke and hold to see if tilting motion has started.
9. If motion has not started yet, repeat pulling the lever fully to 100%. Return the lever to neutral.
10. Pull the lever back 50-70% stroke and hold to see if tilting motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Auxiliary 1 Direction A valve output threshold

NOTE: Perform this calibration when the auxiliary 1 valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 53. Calibrations icon

4. Select **Hydraulics**.
5. Select **H3c Third Hyd Function**.
6. Select **H3c.7 Dir A Output**.
7. Follow the prompt on the display and push the lever all the way forward (100%). Return the lever to neutral.
8. Push the lever forward 50-70% stroke and hold to see if motion has started.
9. If motion has not started yet, repeat pushing the lever fully to 100%. Return the lever to neutral.
10. Push the lever forward 50-70% stroke and hold to see if motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Auxiliary 1 Direction B valve output threshold

NOTE: Perform this calibration when the auxiliary 1 valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 54. Calibrations icon

4. Select **Hydraulics**.
5. Select **H3c Third Hyd Function**.
6. Select **H3c.9 Dir B Output**.
7. Follow the prompt on the display and pull the lever all the way back (100%). Return the lever to neutral.
8. Pull the lever back 50-70% stroke and hold to see if motion has started.
9. If motion has not started yet, repeat pulling the lever fully to 100%. Return the lever to neutral.
10. Pull the lever back 50-70% stroke and hold to see if motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Auxiliary 2 Direction A valve output threshold

NOTE: Perform this calibration when the auxiliary 2 valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 55. Calibrations icon

4. Select **Hydraulics**.
5. Select **H4c Fourth Hyd Function**.
6. Select **H4c.7 Dir A Output**.
7. Follow the prompt on the display and push the lever all the way forward (100%). Return the lever to neutral.
8. Push the lever forward 50-70% stroke and hold to see if motion has started.
9. If motion has not started yet, repeat pushing the lever fully to 100%. Return the lever to neutral.
10. Push the lever forward 50-70% stroke and hold to see if motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Auxiliary 2 Direction B valve output threshold

NOTE: Perform this calibration when the auxiliary 2 valve has been replaced, when valve components have been serviced or when oil type has been changed.

NOTE: Creep is defined as the threshold when a function first starts to move very slowly.

1. Perform Hydraulic valve calibration warmup and leave the truck running.
2. Activate lift control to raise the carriage 0.6 m (2 ft) with no load on the forks or attachment.
3. Swipe (left or right) on the display or use the buttons on the keypad to select the *Calibrations* screen icon from the menu bar.



Figure 56. Calibrations icon

4. Select **Hydraulics**.
5. Select **H4c Third Hyd Function**.
6. Select **H4c.9 Dir B Output**.
7. Follow the prompt on the display and pull the lever all the way back (100%). Return the lever to neutral.
8. Pull the lever back 50-70% stroke and hold to see if motion has started.
9. If motion has not started yet, repeat pulling the lever fully to 100%. Return the lever to neutral.
10. Pull the lever back 50-70% stroke and hold to see if motion has started.
11. Once motion is detected, select the GREEN check mark to save.

Steer system hydraulics repair

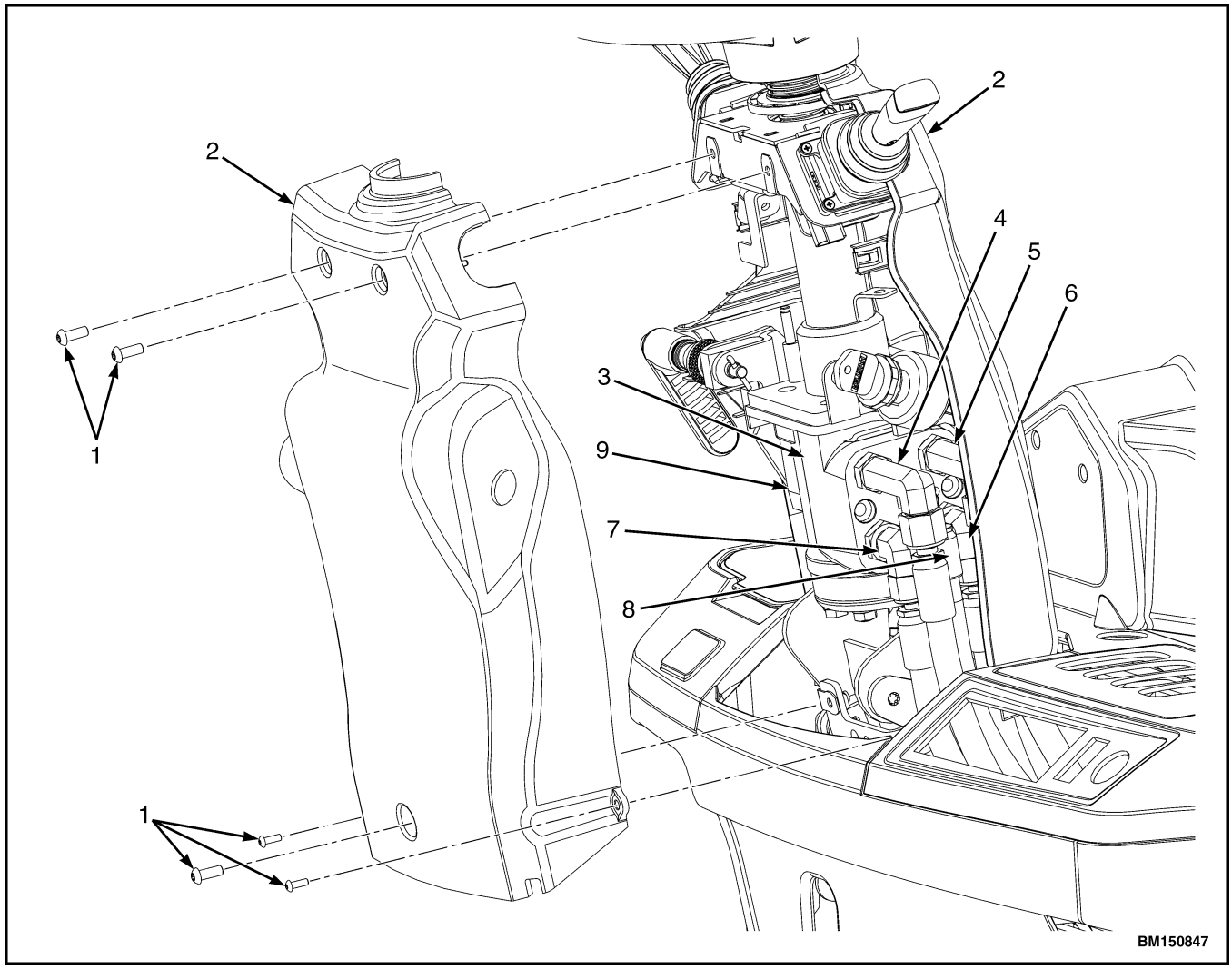
STEERING CONTROL UNIT (SCU) REPAIR 202001-064

REMOVE

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

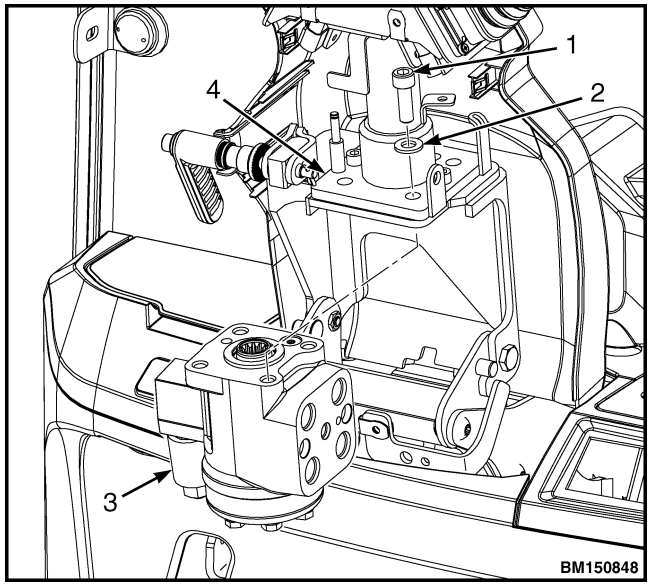
1. Tilt the steering column fully to the forward position.
2. Remove five capscrews and the steering column back cover. See Figure 57.
3. Place a drain pan under hydraulic hoses being removed.
4. Tag and disconnect hydraulic hoses from Steering Control Unit (SCU).
5. If truck has sync steer, tag and disconnect the electrical connector from the SCU.



1. CAPSCREWS
2. STEERING COLUMN COVER
3. STEERING CONTROL UNIT
4. PORT T - RETURN
5. PORT L - LEFT SIDE STEER AXLE
6. PORT R - RIGHT SIDE STEER AXLE
7. PORT P - SUPPLY
8. PORT LS - LOAD SENSE
9. CONNECTOR CPS162 - SYNC STEER (IF AVAILABLE)

Figure 57. SCU Connections

6. Remove four socket head screws, washers, and the SCU from the steering column. See Figure 58.



1. SOCKET HEAD SCREWS
2. WASHERS
3. STEERING CONTROL UNIT
4. STEERING COLUMN

Figure 58. SCU Removal

DISASSEMBLE

1. Place the SCU into a soft-jaw vise with the splined end facing down.

NOTE: Note the position of the pin bolt screw when removed, so that it will be installed in the same positions at assembly of the SCU.

2. Remove the capscrews, pin bolt screw, and washers. Rotate the SCU 90° sideways in the vise. See Figure 59.

3. Remove the end cover, gear ring, gear, distributor plate, and O-rings from the SCU. Discard the O-rings.

4. Remove the cardan shaft from the spool assembly.

5. Remove the spool assembly from the control unit housing.

6. Remove the thrust washers and thrust bearing from the shaft end of the spool assembly.

7. Remove the retaining ring from the spool assembly.

8. Press the cross pin out of the spool assembly.

9. Press the spool from the sleeve. Remove the springs from the spool.

NOTE: To aid in installation of the emergency steering check ball, note the hole position of the emergency steering check ball during removal.

10. Remove the emergency steering check ball from the control unit housing.

NOTE: To aid in installation of the load sense check ball and bearing stop, note the hole position of the load sense check ball during removal.

11. Remove the load sense bearing stop and load sense check ball from the control unit housing.

12. Remove the spool seal and seal ring from the control unit housing. Discard the spool seal.

13. Remove the check valve from the control unit housing.

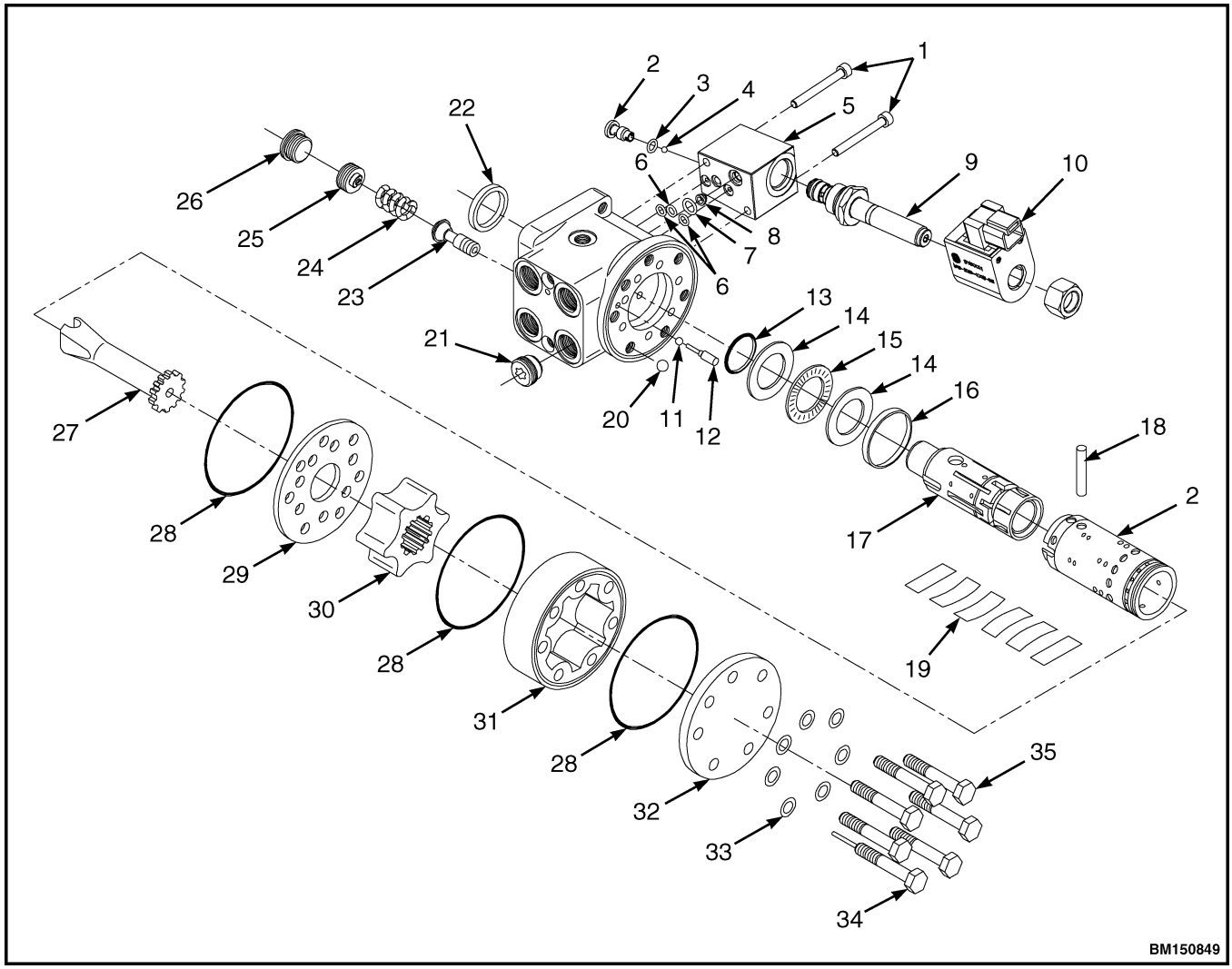
14. Remove the relief valve plug, piston, spring, and adjustment screw from the control unit housing.

NOTE: Only perform Step 15 through Step 17 if sync steer is installed.

15. Remove nut, solenoid coil, and valve from valve block.

16. Remove plug, O-ring, and bearing from valve block. Discard the O-ring.

17. Remove two socket head screws, valve body, O-rings, and filter from control unit housing. Discard O-rings and filter.



NOTE: ITEMS #1 - #10 ARE ONLY IF SYNC STEER IS INSTALLED.

1. SOCKET HEAD SCREWS
2. PLUG
3. O-RING
4. BEARING
5. VALVE BLOCK
6. O-RING
7. O-RING
8. FILTER
9. SOLENOID VALVE
10. SOLENOID COIL
11. LOAD SENSE CHECK BALL
12. LOAD SENSE BEARING STOP
13. SEAL
14. THRUST WASHER
15. THRUST BEARING
16. RETAINING RING
17. CROSS PIN
18. SPRING SET
19. SPOOL
20. EMERGENCY STEER CHECK BALL
21. CHECK VALVE
22. SEAL RING
23. RELIEF VALVE PISTON
24. RELIEF VALVE SPRING
25. RELIEF VALVE ADJUSTMENT SCREW
26. PLUG
27. CARDAN SHAFT
28. O-RING
29. DISTRIBUTOR PLATE
30. GEAR
31. GEAR RING
32. END COVER
33. WASHERS
34. PIN BOLT SCREW
35. CAPSCREWS

Figure 59. SCU Disassembly

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety precautions.

WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

Clean all the parts in solvent. Dry the parts with compressed air. Do not dry the parts with a cloth. Make sure all surfaces are free of scratches and sharp edges.

INSPECT

Inspect all parts for damage, if any parts other than those parts contained in parts kits Hyster P/N 1579908 (seal kit) or P/N 1581858 (capscrew kit) are damaged, replace the SCU. Coat the machined mating surface with a light coat of hydraulic oil and install plugs in any open ports to prevent the possibility of any foreign matter getting into the SCU.

ASSEMBLE

NOTE: Coat all O-rings with a light coat of clean hydraulic oil to make installation easier.

1. Install the relief valve plug, piston, spring, and adjustment screw on the control unit housing. See Figure 59.
2. Install the check valve in the control unit housing. Torque check valve to 25 ±5.0 N•m (18 ±3.7 lbf ft).
3. Install the new spool seal and seal ring on the control unit housing.
4. Install the load sense bearing stop and load sense check ball on the control unit housing. Torque bearing stop to 1 ±0.1 N•m (8.9 ±0.9 lbf in).
5. Install the emergency steering check ball on the control unit housing.
6. Install the spool and spring set in the sleeve and insert the cross pin.
7. Install the retaining ring, thrust washers, and thrust bearing on the shaft end of the spool.
8. Install the spool assembly in the control unit housing.
9. Insert the cardan shaft in the spool assembly.
10. Install the end cover, gear ring, gear, distributor plate, and new O-rings on the SCU.
11. Install the capscrews, pin bolt screw, and washers. Torque capscrews and pin bolt screw to 30 ±6.0 N•m (22 ±4.4 lbf ft).

NOTE: Only perform Step 12 through Step 14 if sync steer is installed.

12. Install two socket head screws, valve block, new O-rings, and new filter on control unit housing.
13. Install plug, new O-ring, and bearing on valve block.
14. Install nut, solenoid coil, and valve on valve block.

INSTALL

1. Position SCU on steering column and install four capscrews and washers. See Figure 58.
2. Connect hydraulic hoses to SCU. See Figure 57.
3. If truck has sync steer, connect electrical connector to the SCU.
4. Install five capscrews and steering column back cover.

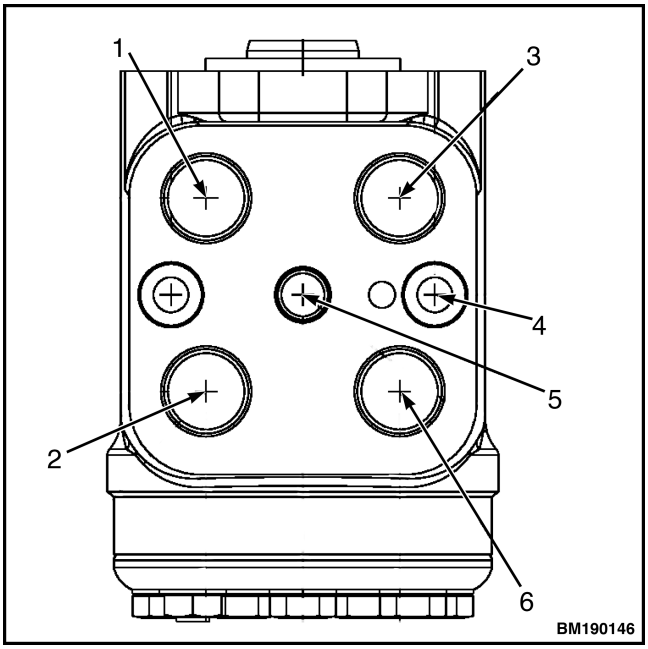
WARNING

DO NOT try to locate hydraulic leaks by placing hands on pressurized hydraulic components. Hydraulic oil can be injected into the body by pressure.

5. Start the engine while operating the steering functions. Check for leaks.

SCU ADJUSTMENT

1. Measure the steering relief pressure by tapping into the LS line connecting SCU and hydraulic control valve when the truck reaches 50 to 65°C (122 to 149°F). See Table 2. If the steering relief pressure is not correct, adjust the pressure by turning the plug clockwise (increase pressure) or counterclockwise (decrease pressure) until the correct pressure is reached. See Figure 60.



1. PORT T (TANK)
2. PORT P (CONTROL UNIT)
3. PORT L (LEFT)
4. PLUG
5. PORT LS (LOAD SENSE)
6. PORT R (RIGHT)

Figure 60. SCU Adjustment

Table 2. Steering Relief Pressures

Lift Truck Model	Steering Relief Pressure @ 800 RPM
H2.0A, H2.5A6, H2.5A, H3.0A, H3.5A (H40A, H50A, H60A, H70A) (R177)	14.0 ±0.5 MPa (2030.5 ±72.5 psi)

Brake system hydraulics repair

DRY BRAKE HYDRAULICS REPAIR 202001-066

For repair procedures related to the brake system on trucks featuring a dry brake drive axle, see the following service manuals:

- For drive axle service brakes and master cylinder repair see **Drive Train** 0900SRM2301 service manual.
- For brake adjustments, see **Drive Train** 0900SRM2301 service manual.
- For brake pedal repair, see **Operator's Cab** 0100SRM2298 service manual.
- For park brake repair, see **Operator's Cab** 0100SRM2298 service manual.

WET BRAKE HYDRAULICS REPAIR, WITH POWERSHIFT TRANSMISSION 202001-065

REMOVE

WARNING

When putting the lift truck on blocks, make sure the surface is solid, even, and level. Any blocks used to support the lift truck must be solid, one-piece units.

1. Put blocks on each side (front and back) of the steering tires to prevent movement of the lift truck.

2. Raise the lift truck and put blocks under the frame so that the drive wheels do not touch the floor. Put blocks under the counterweight for stability. See How to put a lift truck on blocks in **Periodic Maintenance** 8000SRM2305.

3. Remove the mast assembly as described in **Front End** 4000SRM2303.

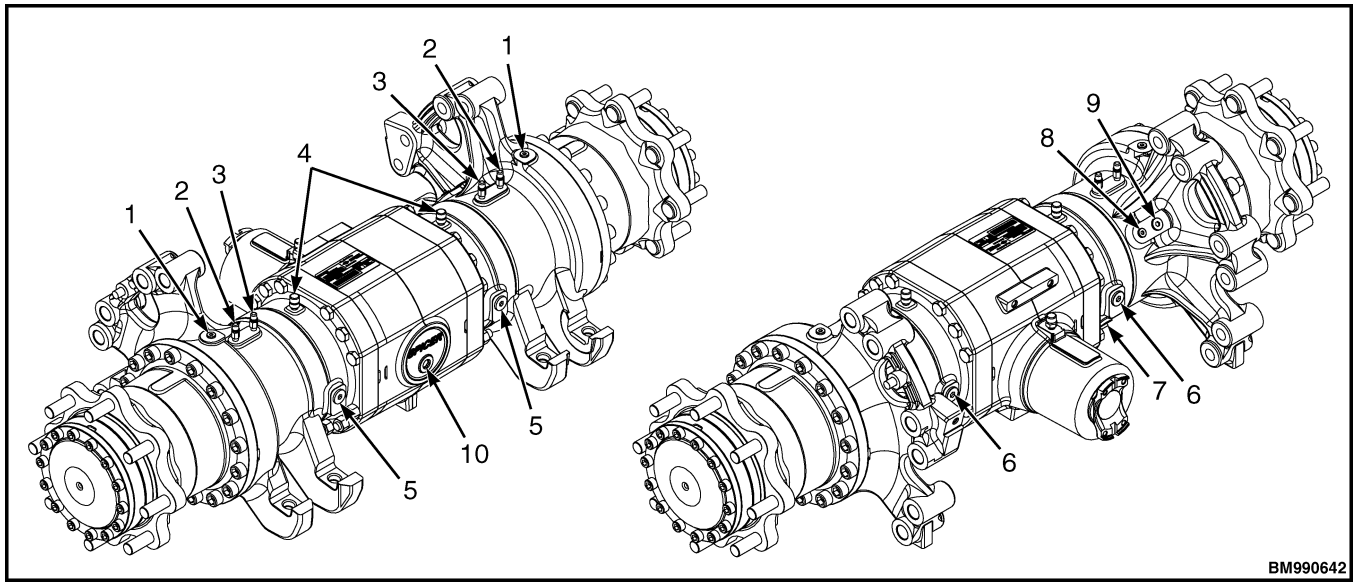
WARNING

On lift trucks with pneumatic tires, completely remove air from tires before removing them from lift truck. Air pressure in tires can cause tire and rim parts to explode, which can cause serious injury or death. Never loosen nuts that hold together inner and outer wheel halves when there is air pressure in tire.

4. Remove the wheels.

5. Remove the oil fill/level plugs on both sides of the drive axle. See Figure 61.

6. Remove the oil drain plug (item 10, Figure 61) from the drive axle to drain the brake oil into a suitable container.



1. BRAKE COOLING INLET PORT
2. BLEEDING SCREW FOR DISC BRAKES
3. BLEEDING SCREW FOR PARK BRAKES
4. BREATHER
5. OIL FILL/LEVEL PLUG
6. BRAKE COOLING OUTLET PORT
7. OPTIONAL COOLING PORT
8. CONNECTOR FOR PARK BRAKE
9. CONNECTOR FOR DISC BRAKE
10. OIL DRAIN PLUG

Figure 61. Oil fill plugs and drain plugs

7. Remove the park brake cable. See Park brake section in the **Operator's Cab** 0100SRM2298 manual.

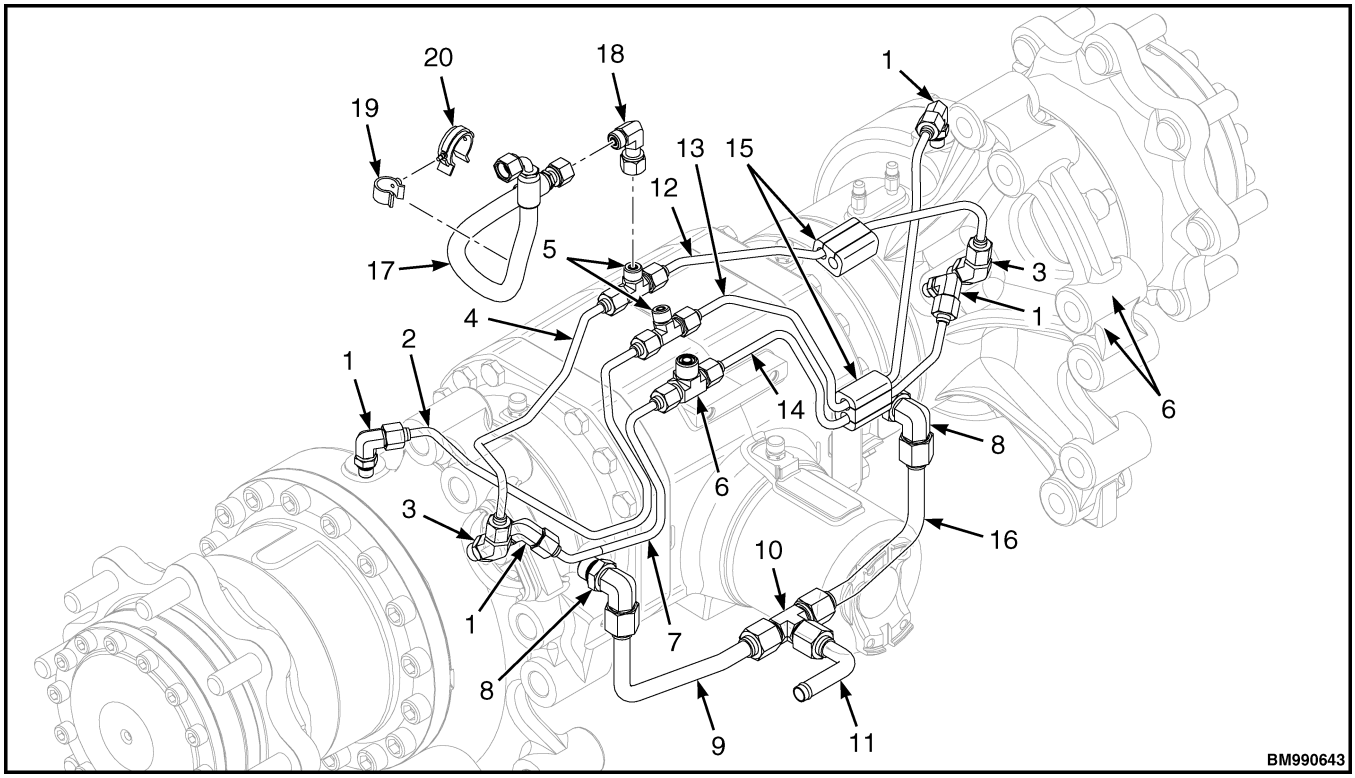
8. Disconnect the brake actuation hose and fitting from the drive axle. See Figure 62.

9. Disconnect the LH service brake tube (item 4) and RH service brake tube (item 12) and fittings from the drive axle. See Figure 62.

10. Disconnect the LH cooling tube (item 2) and RH cooling tube (item 13) and fittings from the drive axle. See Figure 62.

11. Disconnect the LH SAHR tube (item 7) and RH SAHR tube (item 14) and fittings (item 1) from the drive axle. See Figure 62.

12. Disconnect the two cooling return tubes (item 9 and 16) and fittings (item 8) from the drive axle. See Figure 62.



1. FITTING
2. LH COOLING TUBE
3. FITTING
4. LH SERVICE BRAKE TUBE
5. FITTING
6. T-FITTING
7. LH SAHR TUBE
8. FITTING
9. LH COOLING RETURN TUBE
10. FITTING
11. COOLING RETURN TUBE
12. RH SERVICE BRAKE TUBE
13. RH COOLING TUBE
14. RH SAHR TUBE
15. BRAKE TUBE MOUNTING BLOCK
16. RH COOLING RETURN TUBE
17. BRAKE ACTUATION HOSE
18. FITTING
19. CLAMP
20. CLAMP

Figure 62. Wet Brake Drive axle cooling hoses and brake lines

INSTALL

1. Connect the two cooling return tubes (item 9 and 16) and fittings (item 8) to the drive axle. See Figure 62.

2. Connect the LH SAHR tube (item 7) and RH SAHR tube (item 14) and fittings (item 1) to the drive axle. See Figure 62.

3. Connect the LH cooling tube (item 2) and RH cooling tube (item 13) and fittings to the drive axle. See Figure 62.

4. Connect the LH service brake tube (item 4) and RH service brake tube (item 12) and fittings to the drive axle. See Figure 62.

5. Connect the brake actuation hose and fitting from the drive axle. See Figure 62.

6. Install the park brake cable. See Park brake section in the **Operator's Cab** 0100SRM2298 manual.

7. Insert the oil drain plug (LH) on the drive axle. See Figure 61.

8. Insert the oil drain plug (RH and center section) on the drive axle. See Figure 61.

9. Install the brake oil drain plug on the drive axle. See Figure 61.

10. Fill the sections of the drive axle with the proper fluid. For correct fluid, quantity, and fill procedure for lift truck models, see **Periodic Maintenance** 8000SRM2305.

11. Insert the oil fill/level plugs on both sides of the drive axle (item 5, Figure 61).

CAUTION

If a new drive axle is being installed, perform Step 12. Failure to do so will cause damage to the drive axle.

12. Remove and discard plastic protective caps from the breather.

13. Remove the air from the brake system as described in Service brake in **Drive Train** 0900SRM2301.

WARNING

Add air to the tires only in a safety cage. Inspect safety cage for damage before use. When adding air, use a clip-on chuck with enough hose to let the operator stand clear of the cage.

14. Inflate the tires using a safety cage. Install the wheels and nuts and tighten the nuts to 339 to 380 N•m (250 to 280 lbf ft) for M18 x 1.5 tires or 450 to 500 N•m (332 to 369 lbf ft) for M20 X 1.5 tires.

15. Install the mast assembly as described in **Front End** 4000SRM2303.

16. Raise the lift truck and remove blocks from under frame and from under the counterweight. Lower the lift truck.

17. Remove the blocks on each side (front and back) of the steering tires.

18. Operate the lift truck and check for proper operation and leaks.

WET BRAKE HYDRAULICS REPAIR, WITH HYDROSTATIC TRANSMISSION 202001-065

REMOVE

WARNING

When putting the lift truck on blocks, make sure the surface is solid, even, and level. Any blocks used to support the lift truck must be solid, one-piece units.

1. Put blocks on each side (front and back) of the steering tires to prevent movement of the lift truck.

2. Raise the lift truck and put blocks under the frame so that the drive wheels do not touch the floor. Put blocks under the counterweight for stability. See How to put a lift truck on blocks in **Periodic Maintenance** 8000SRM2305.

3. Remove the mast assembly as described in **Front End** 4000SRM2303.

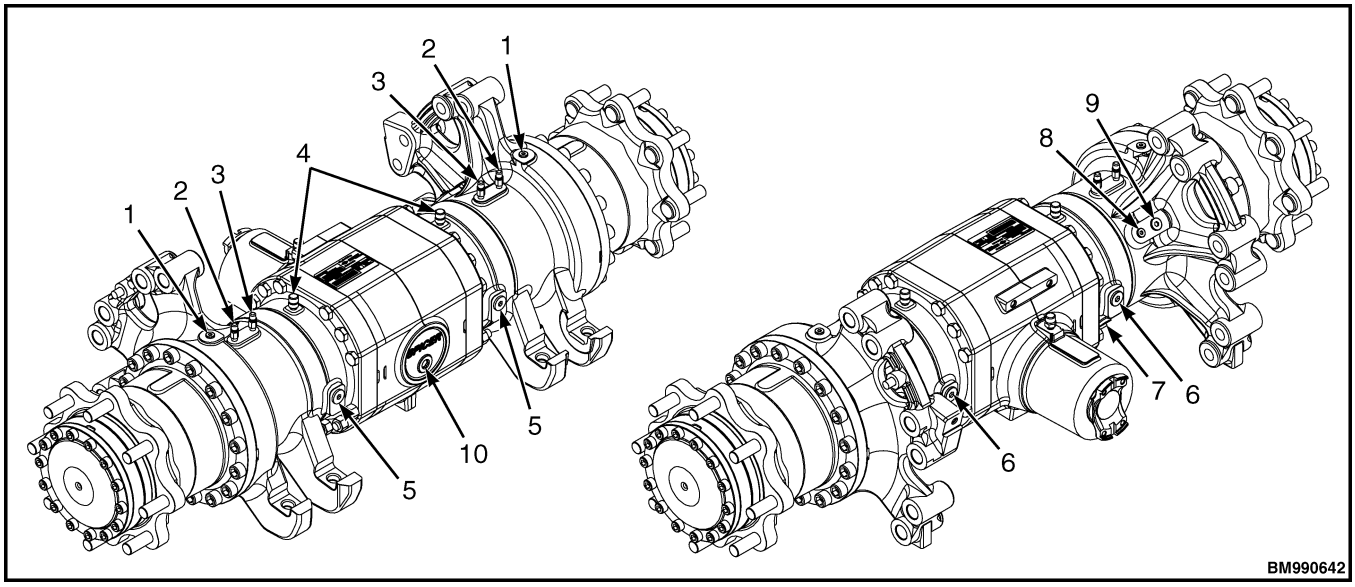
WARNING

On lift trucks with pneumatic tires, completely remove air from tires before removing them from lift truck. Air pressure in tires can cause tire and rim parts to explode, which can cause serious injury or death. Never loosen nuts that hold together inner and outer wheel halves when there is air pressure in tire.

4. Remove the wheels.

5. Remove the oil fill/level plugs on both sides of the drive axle. See Figure 63.

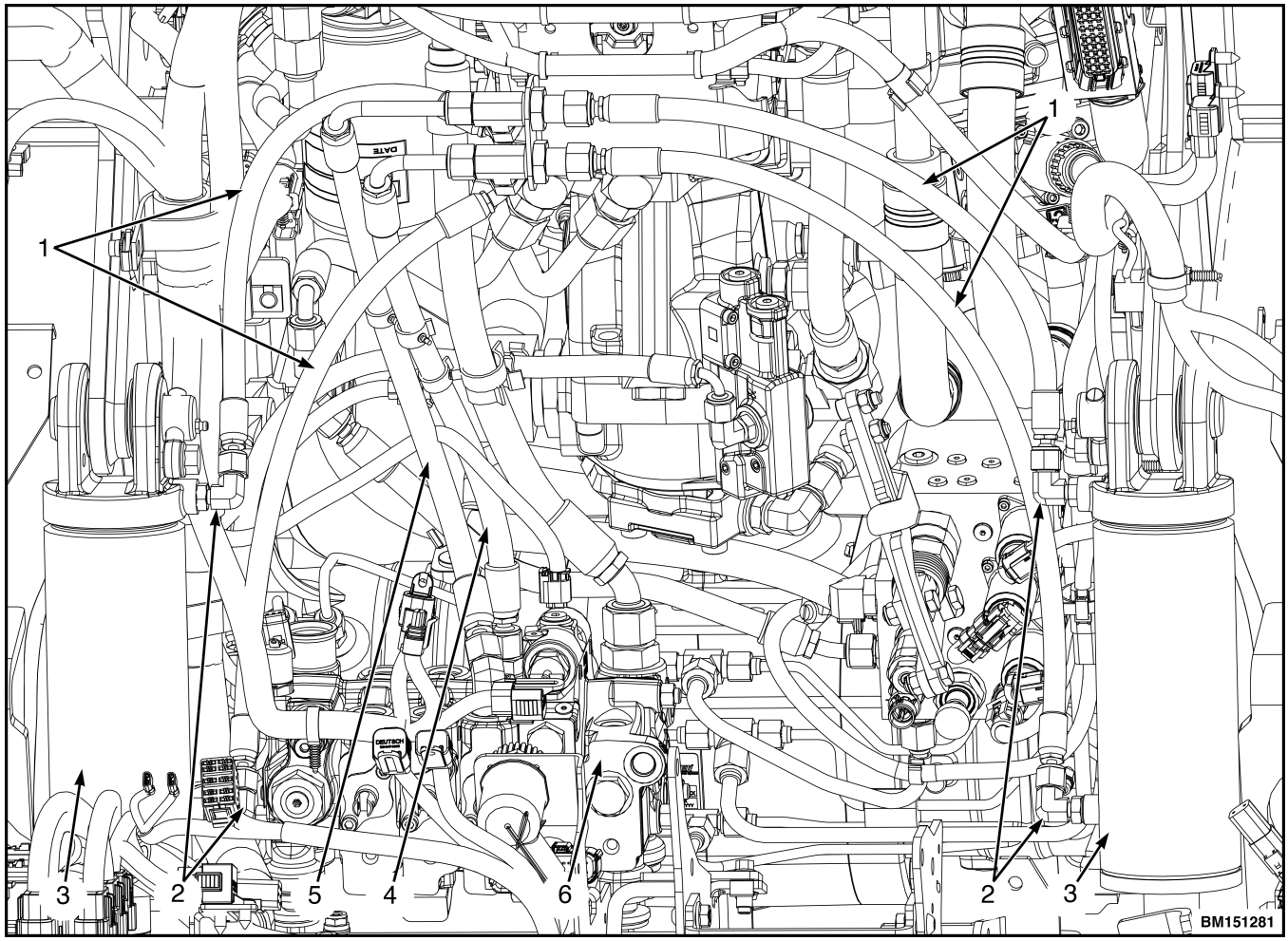
6. Remove the oil drain plug (item 10, Figure 63) from the drive axle to drain the brake oil into a suitable container.



1. BRAKE COOLING INLET PORT
2. BLEEDING SCREW FOR DISC BRAKES
3. BLEEDING SCREW FOR PARK BRAKES
4. BREATHER
5. OIL FILL/LEVEL PLUG
6. BRAKE COOLING OUTLET PORT
7. OPTIONAL COOLING PORT
8. CONNECTOR FOR PARK BRAKE
9. CONNECTOR FOR DISC BRAKE
10. DIFFERENTIAL OIL FILL PLUG

Figure 63. Oil fill plugs and drain plugs

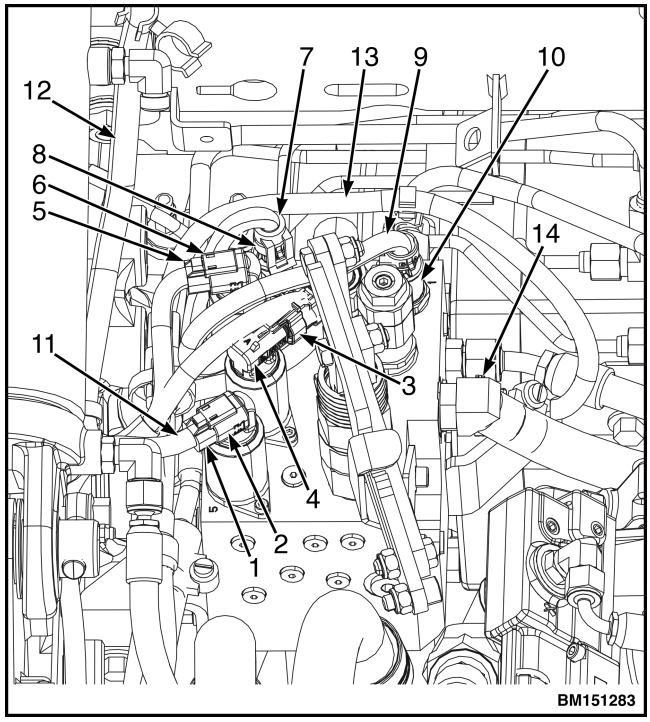
7. Disconnect the tilt hoses (item 1, Figure 64) and fittings (item 2) at the tilt cylinders (item 3).



1. TILT HOSES
2. TILT HOSE FITTINGS
3. TILT CYLINDERS
4. HOSE
5. HOSE
6. CONTROL VALVE

Figure 64. Tilt hoses

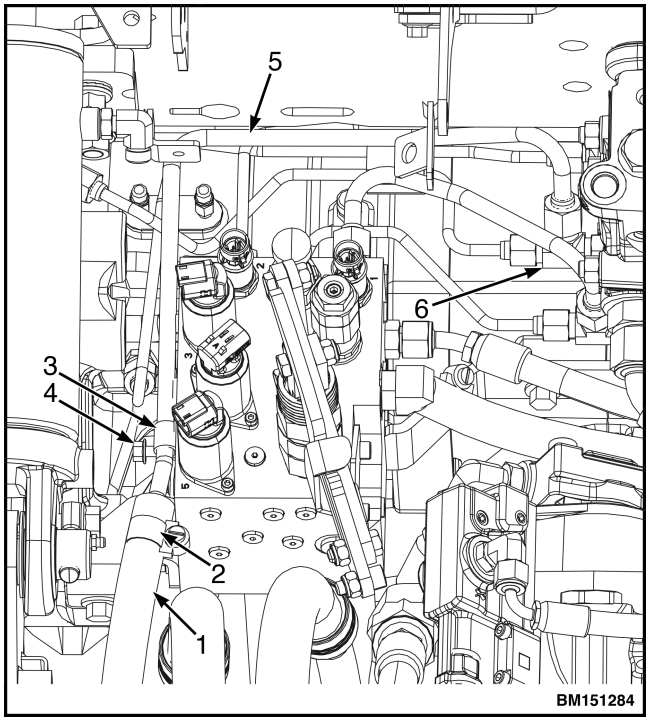
8. Disconnect all wire harness connectors from the SAHR valve and move the harnesses out of the way to access the HST brake cooling hose. See Figure 65.



1. CONNECTOR CPS634
2. SERVICE BRAKE SOLENOID
3. CONNECTOR CPS635
4. SERVICE BRAKE SOLENOID
5. CONNECTOR CPS632
6. PARK BRAKE SOLENOID
7. CONNECTOR CPS633
8. PRESSURE SENSOR
9. CONNECTOR CPS631
10. PRESSURE SENSOR
11. HST CHASSIS HARNESS
12. PARK BRAKE WIRE HARNESS
13. HST WIRE HARNESS
14. CONNECTOR CPS640

Figure 65. SAHR valve harness connectors

9. Loosen the hose clamp (item 2, Figure 66) and disconnect the HST brake cooling hose (item 1) from the cooling tube (item 5).



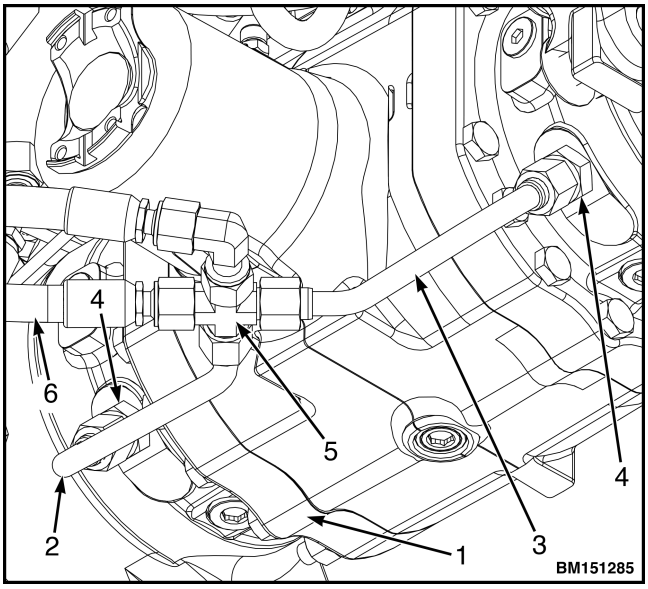
1. HST BRAKE COOLING HOSE
2. HOSE CLAMP
3. CLAMP
4. CAPSCREW
5. COOLING TUBE
6. T-FITTING

Figure 66. brake cooling hose

10. Disconnect the other end of the cooling tube from the t-fitting (item 6, Figure 66).

11. Remove the capscrew (item 4, Figure 66) retaining the hose clamp (item 3) to the SAHR valve and remove the cooling tube.

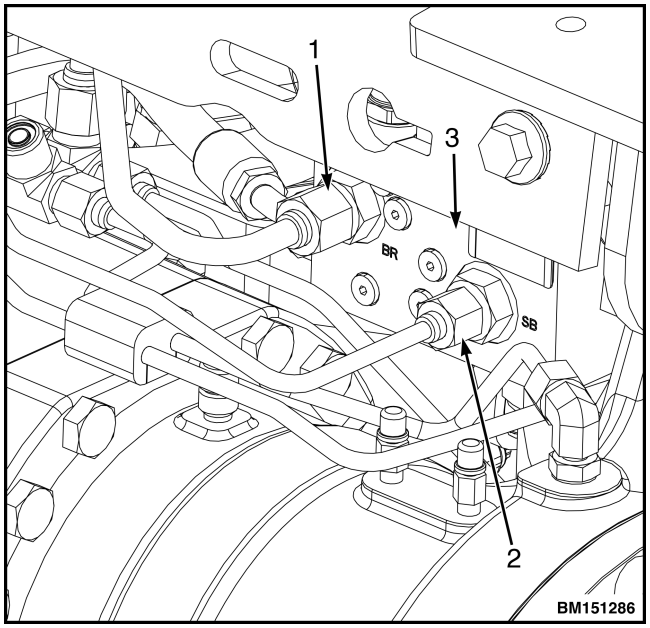
12. From underneath the truck, disconnect the RH tube assembly (item 3, Figure 67) and LH tube assembly (item 2) from the fittings (item 4) on the drive axle.



1. DRIVE AXLE
2. LH TUBE ASSEMBLY
3. RH TUBE ASSEMBLY
4. FITTING
5. CROSS FITTING
6. BRAKE PUMP HOSE

Figure 67. Drive axle tubes

13. Disconnect the top front and rear tubes from the drive axle at the SAHR valve. See Figure 68.



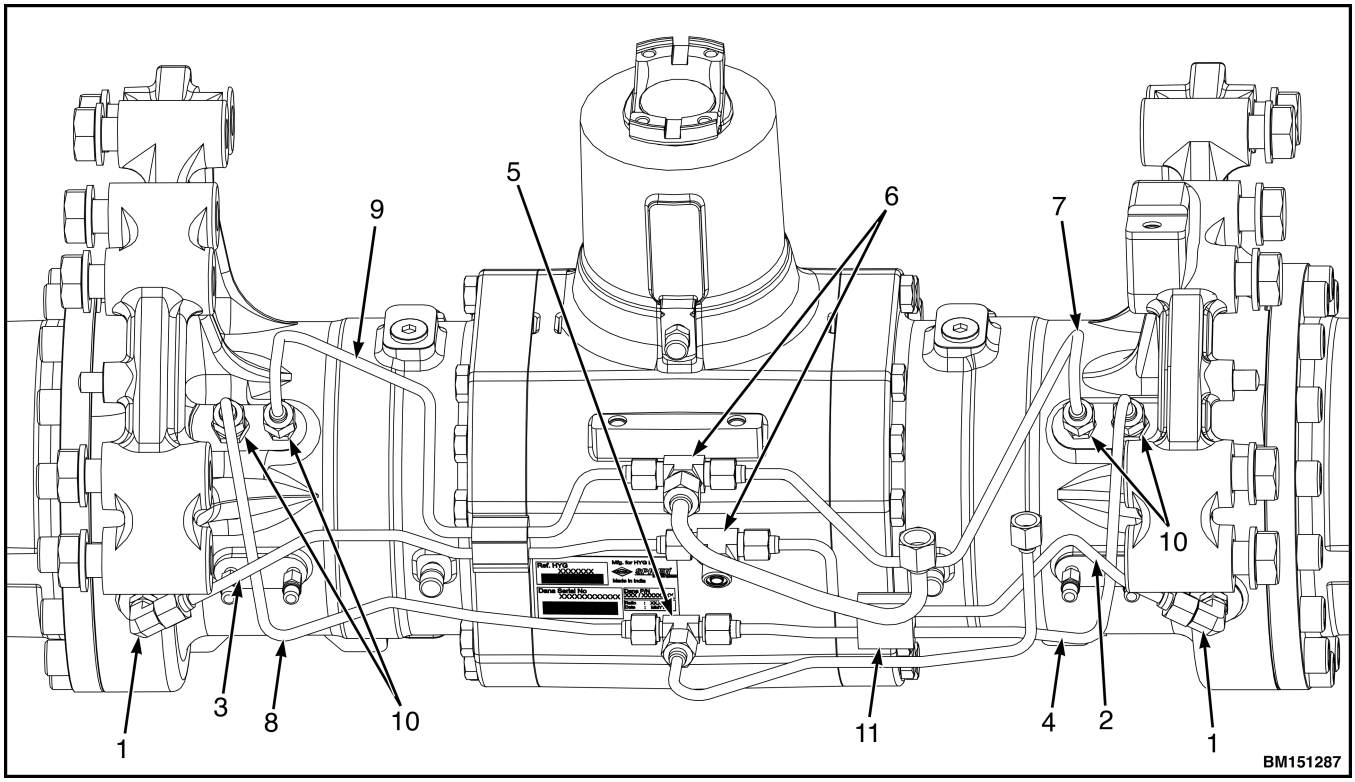
1. TOP DRIVE AXLE TUBE (REAR)
2. TOP DRIVE AXLE TUBE (FRONT)
3. SAHR VALVE

Figure 68. Top tubes-drive axle

14. Disconnect the LH service brake tube (item 4) and RH service brake tube (item 8) and fittings (item 10) from the drive axle. See Figure 69.

15. Disconnect the LH cooling tube (item 2) and RH cooling tube (item 3) and fittings (item 1) from the drive axle. See Figure 69.

16. Disconnect the LH SAHR tube (item 7) and RH SAHR tube (item 9) and fittings (item 10) from the drive axle. See Figure 69.



1. FITTING
2. LH COOLING TUBE
3. RH COOLING TUBE
4. LH SERVICE BRAKE TUBE
5. T FITTING
6. T-FITTING
7. LH SAHR TUBE
8. RH SERVICE BRAKE TUBE
9. RH SAHR TUBE
10. FITTING
11. BRAKE TUBE MOUNTING BLOCK

Figure 69. Wet Brake Drive axle cooling hoses and brake lines

INSTALL

1. Connect the LH SAHR tube (item 7) and RH SAHR tube (item 9) and fittings (item 10) to the drive axle. See Figure 69.

2. Connect the LH cooling tube (item 2) and RH cooling tube (item 3) and fittings (item 1) to the drive axle. See Figure 69.

3. Connect the LH service brake tube (item 4) and RH service brake tube (item 8) and fittings (item 10) to the drive axle. See Figure 69.

4. Connect the top front and rear tubes on the drive axle to the SAHR valve. See Figure 68.

5. From underneath the truck, connect the RH tube assembly (item 3, Figure 67) and LH tube assembly (item 2) to the fittings (item 4) on the drive axle.

6. Connect one end of the cooling tube to the t-fitting (item 6, Figure 66).

7. Insert the capscrew (item 4, Figure 66) to secure the hose clamp (item 3) on the cooling tube to the SAHR valve.

8. Connect the HST brake cooling hose (item 1, Figure 66) to the cooling tube (item 5) and tighten the hose clamp (item 2).

9. Connect all wire harness connectors to the SAHR valve. See Figure 65.

10. Connect the tilt hoses (item 1, Figure 64) and fittings (item 2) to the tilt cylinders (item 3).

11. Insert the oil drain plug (LH) on the drive axle. See Figure 63.

12. Insert the oil drain plug (RH and center section) on the drive axle. See Figure 63.

13. Install the brake oil drain plug on the drive axle. See Figure 63.

14. Fill the sections of the drive axle with the proper fluid. For correct fluid, quantity, and fill procedure for lift truck models, see **Periodic Maintenance** 8000SRM2305.

15. Insert the oil fill/level plugs on both sides of the drive axle (item 5, Figure 63).

CAUTION

If a new drive axle is being installed, perform Step 16. Failure to do so will cause damage to the drive axle.

16. Remove and discard plastic protective caps from the breather.

17. Remove the air from the brake system as described in Service brake in **Drive Train** 0900SRM2301.

WARNING

Add air to the tires only in a safety cage. Inspect safety cage for damage before use. When adding air, use a clip-on chuck with enough hose to let the operator stand clear of the cage.

18. Inflate the tires using a safety cage. Install the wheels and nuts and tighten the nuts to 339 to 380 N•m (250 to 280 lbf ft) for M18 x 1.5 tires or 450 to 500 N•m (332 to 369 lbf ft) for M20 X 1.5 tires.

19. Install the mast assembly as described in **Front End** 4000SRM2303.

20. Raise the lift truck and remove blocks from under frame and from under the counterweight. Lower the lift truck.

21. Remove the blocks on each side (front and back) of the steering tires.

22. Operate the lift truck and check for proper operation and leaks.

REPLACING THE SAHR VALVE (WET BRAKE DRIVE AXLE WITH POWERSHIFT TRANSMISSION) 202001-428

REMOVE

WARNING

When putting the lift truck on blocks, make sure the surface is solid, even, and level. Any blocks used to support the lift truck must be solid, one-piece units.

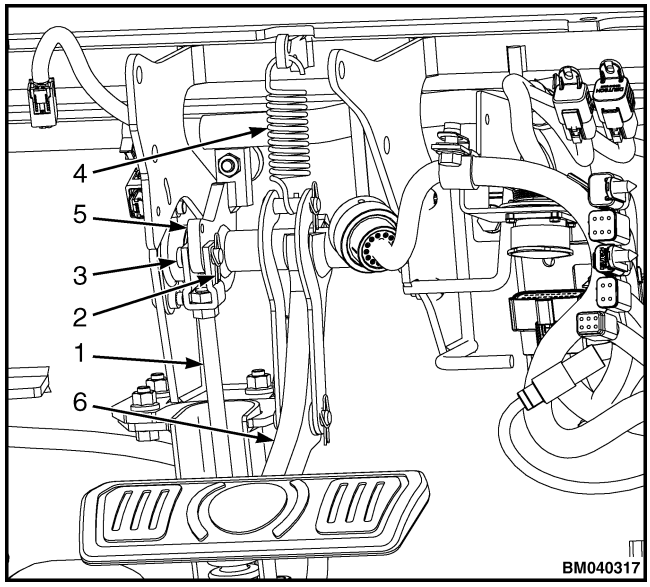
1. Put blocks on each side (front and back) of the steering tires to prevent movement of the lift truck.

2. Raise the lift truck and put blocks under the frame so that the drive wheels do not touch the floor. Put blocks under the counterweight for stability. See How to put a lift truck on blocks in **Periodic Maintenance** 8000SRM2305.

3. Raise the carriage and chain as described in Safety Procedures When Working Near Mast in **Front End** 4000SRM2303.

4. Remove the floor plate, lower kick panel, and seal plate from the lift truck. See Covers repair, in **Frame and Main Components** 8000SRM2306.

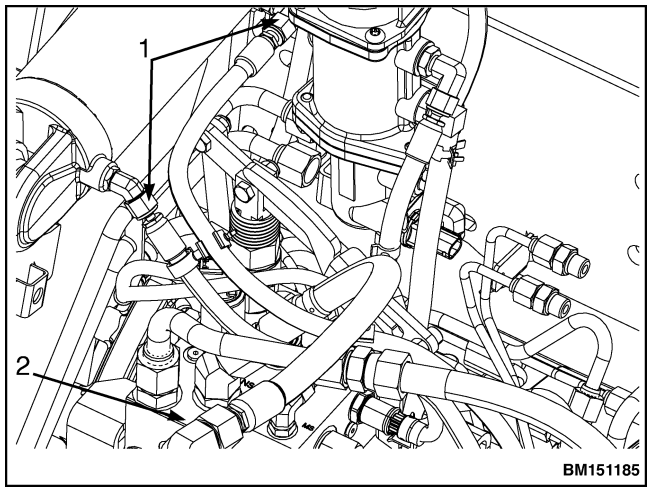
5. Remove the pin (3, Figure 70) on the master cylinder linkage to free the service brake. Push the brake pedal out of the way to access the tilt cylinder hoses.



1. MASTER CYLINDER
2. COTTER PIN
3. PIN
4. SPRING
5. BRAKE PEDAL LINKAGE
6. BRAKE PEDAL

Figure 70. Remove brake linkage pin

6. Remove the two LH tilt cylinder hoses to access the SAHR valve hoses. See Figure 71.



1. LH TILT CYLINDER HOSES
2. SAHR VALVE

Figure 71. Tilt cylinder hoses

7. Locate the manual override plunger on the SAHR valve. See Figure 72.

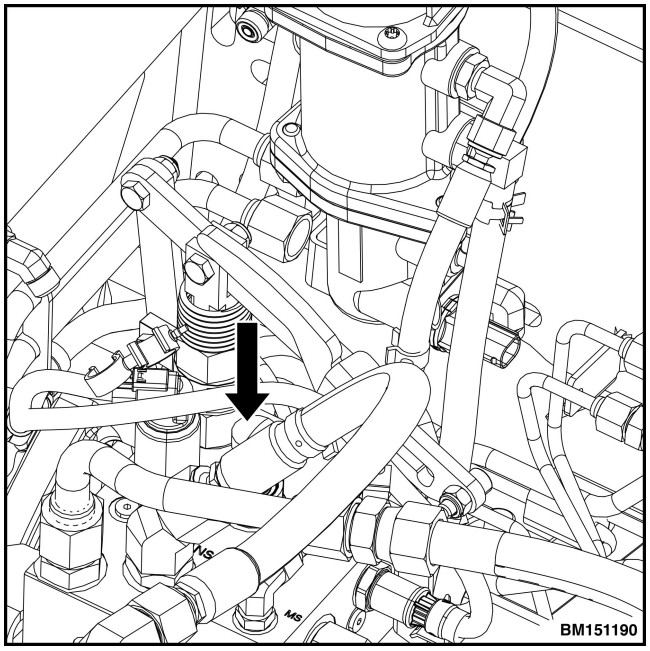
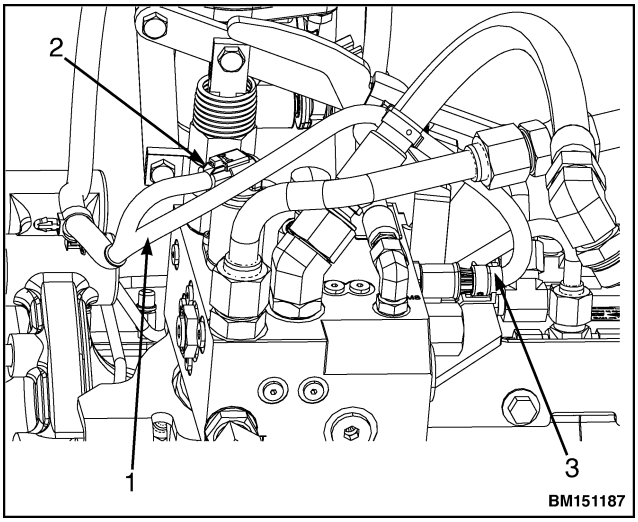


Figure 72. Manual override plunger

8. Discharge the accumulator to relieve pressure from hydraulic lines:

- Push the plunger on the manual override all the way down.
- Pull the plunger back up.
- Repeat steps at least three more times to ensure there is no pressure left in the hydraulic lines.

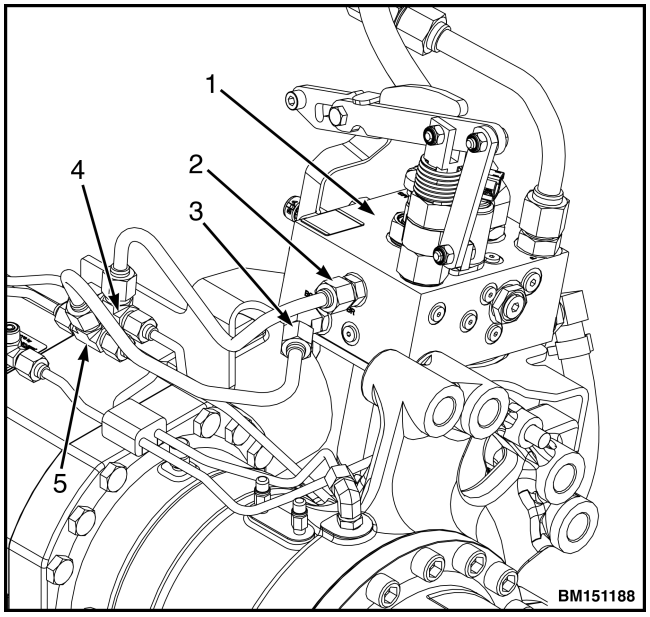
9. Disconnect the park brake wire harness connectors from the two connectors on the SAHR valve. See Figure 73.



1. PARKING BRAKE WIRE HARNESS
2. MANIFOLD CONNECTOR (CPS632)
3. MANIFOLD PRESSURE SENSOR CONNECTOR (CPS631)

Figure 73. SAHR connectors

10. Locate the upper SAHR tube (item 2, Figure 74) that connects to the T-fitting (item 4) and RH and LH SAHR tubes. Disconnect the upper SAHR tube from the fitting at the SAHR valve.

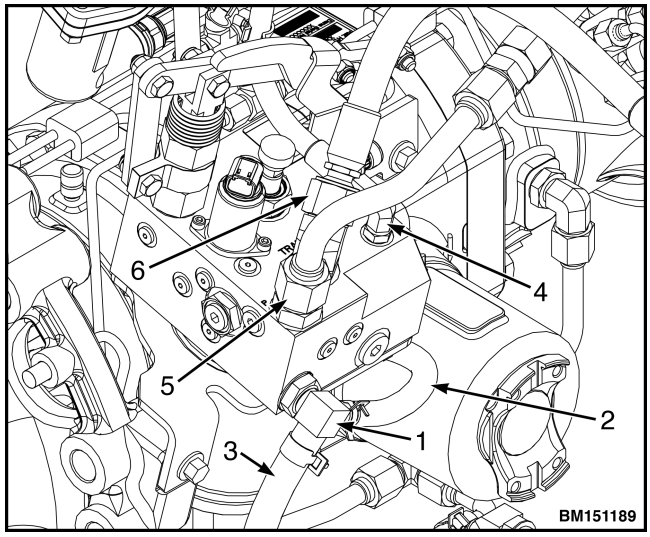


1. SAHR VALVE
2. UPPER SAHR TUBE
3. LOWER SAHR TUBE
4. T-FITTING
5. T-FITTING

Figure 74. SAHR tubes

11. Disconnect the lower SAHR tube (item 3, Figure 74) from the fitting on the SAHR valve.

12. Disconnect the fitting (item 1, Figure 75) that connects the brake actuation hose (item 2) and brake cooling hose (item 3).



1. FITTING
2. BRAKE ACTUATION HOSE
3. BRAKE COOLING HOSE
4. FITTING
5. BRAKE HOSE TUBE
6. COOLING HOSE

Figure 75. SAHR hoses

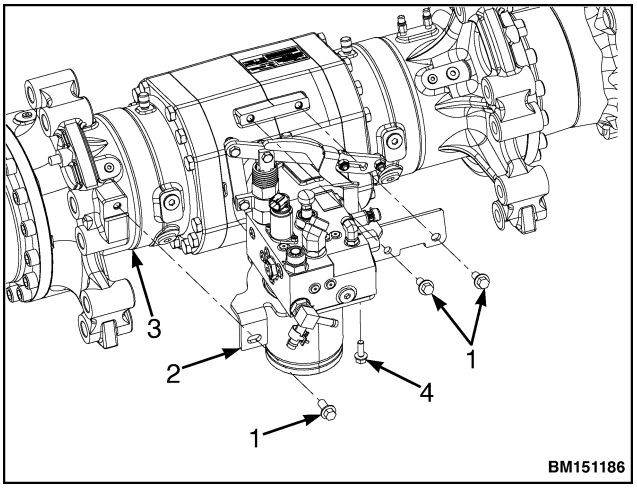
13. Disconnect the high temp hose from the fitting (item 4, Figure 75).

14. Disconnect the cooling hose (item 6, Figure 75) and brake hose tube (item 5) from the fittings.

NOTE: Perform the next step only if the mounting bracket must be replaced. Otherwise, skip to Step 16

15. Remove the three cap screws (item 1, Figure 76) retaining the SAHR valve mounting bracket to the drive axle. Remove the mounting bracket.

16. Remove the three cap screws (item 4, Figure 76) retaining the SAHR valve to the bottom of the mounting bracket.



1. CAP SCREW
2. SAHR VALVE MOUNTING BRACKET
3. DRIVE AXLE
4. CAP SCREW

Figure 76. Remove/install SAHR valve

17. Remove the SAHR valve from the mounting bracket.

DISASSEMBLE

Hand Pump

1. Remove two cap screws securing hand pump bracket to SAHR valve. See Figure 77.

2. Remove hand pump cartridge valve from SAHR valve.

Solenoid

1. Remove two cap screws securing solenoid to SAHR valve. See Figure 77.

2. Remove solenoid from SAHR valve.

Pressure Sensor

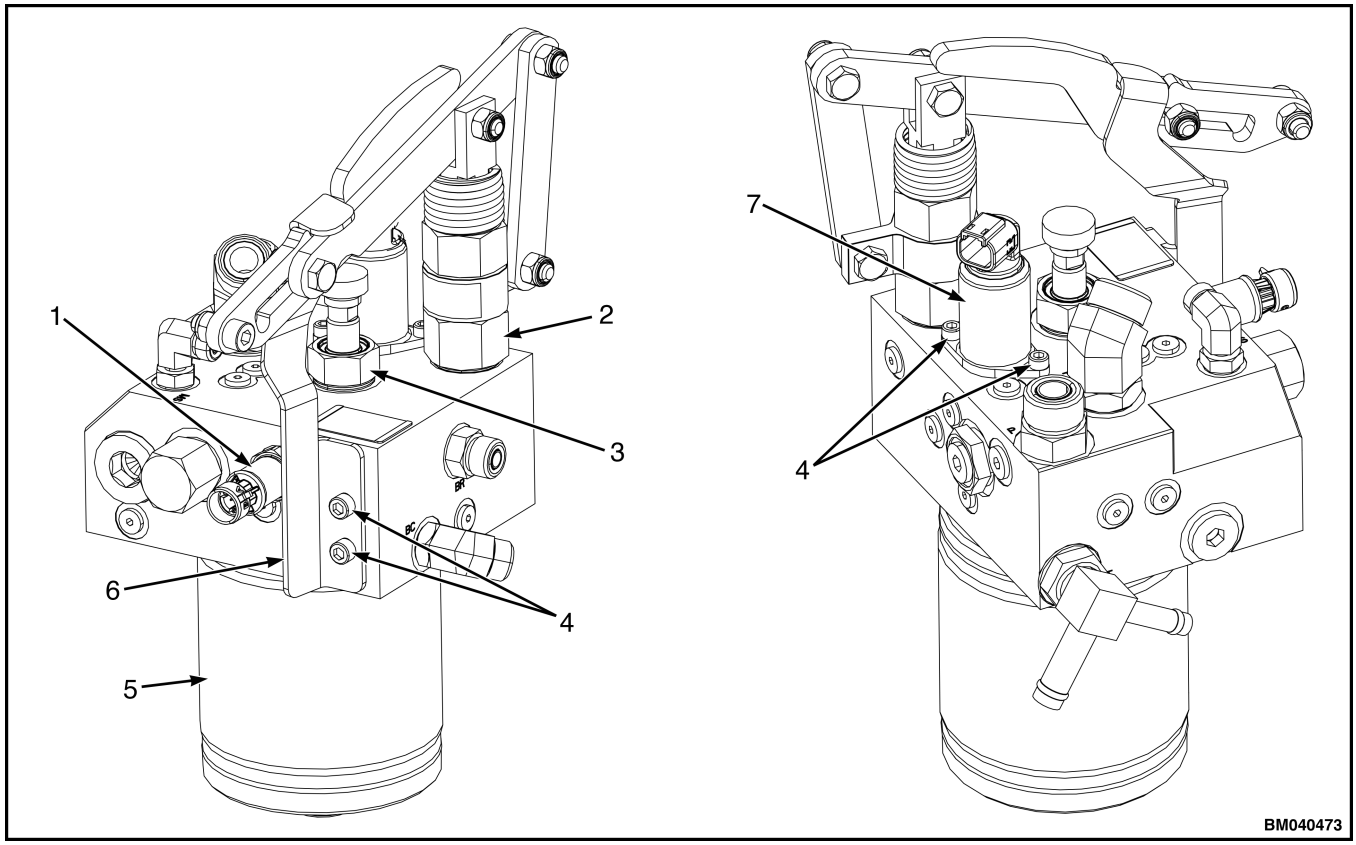
1. Remove pressure sensor from SAHR valve. See Figure 77.

Manual Release Bypass Valve

1. Remove manual release bypass valve from SAHR valve. See Figure 77.

Accumulator

1. Remove accumulator from SAHR valve. See Figure 77.



1. PRESSURE SENSOR
2. HAND PUMP CARTIDGE VALVE
3. MANUAL RELEASE BYPASS VALVE
4. CAP SCREW
5. ACCUMULATOR
6. HAND PUMP BRACKET
7. SOLENOID

Figure 77. SAHR Valve Assembly

Fittings

NOTE: All SAHR valve hose fittings are removed from the SAHR valve in the same manner.

1. Remove fitting from SAHR valve. See Figure 78.

CLEAN AND INSPECT

Inspect the SAHR valve assembly for damage. Replace any component if there is damage.

ASSEMBLE

Hand Pump

1. Install hand pump cartridge valve onto SAHR valve. Torque to 42 ±4 N • m (31 ±3 lbf ft). See Figure 77.

2. Install two cap screws to mount hand pump bracket to SAHR valve. Torque cap screws to 7 to 9 N • m (5.2 to 6.6 lbf ft).

Solenoid

1. Install solenoid onto SAHR valve. See Figure 77.

2. Install two cap screws to secure solenoid to SAHR valve. Torque cap screws to 4 ±0.4 N • m (3 ±0.3 lbf ft).

Pressure Sensor

1. Install pressure sensor onto SAHR valve. Torque to 20.3 ±2 N • m (15 ±1.5 lbf ft) See Figure 77.

Manual Release Bypass Valve

1. Install manual release bypass valve onto SAHR valve. Torque to 65 ±6.5 N•m (48 ±5 lbf ft). See Figure 77.

Accumulator

1. Install accumulator onto SAHR valve. Torque to 65 ±6.5 N•m (48 ±5 lbf ft). See Figure 77.

Fittings

NOTE: All SAHR valve fittings are removed in the same manner.

1. Install fitting onto SAHR valve. See Figure 78 and Table for torque specifications.

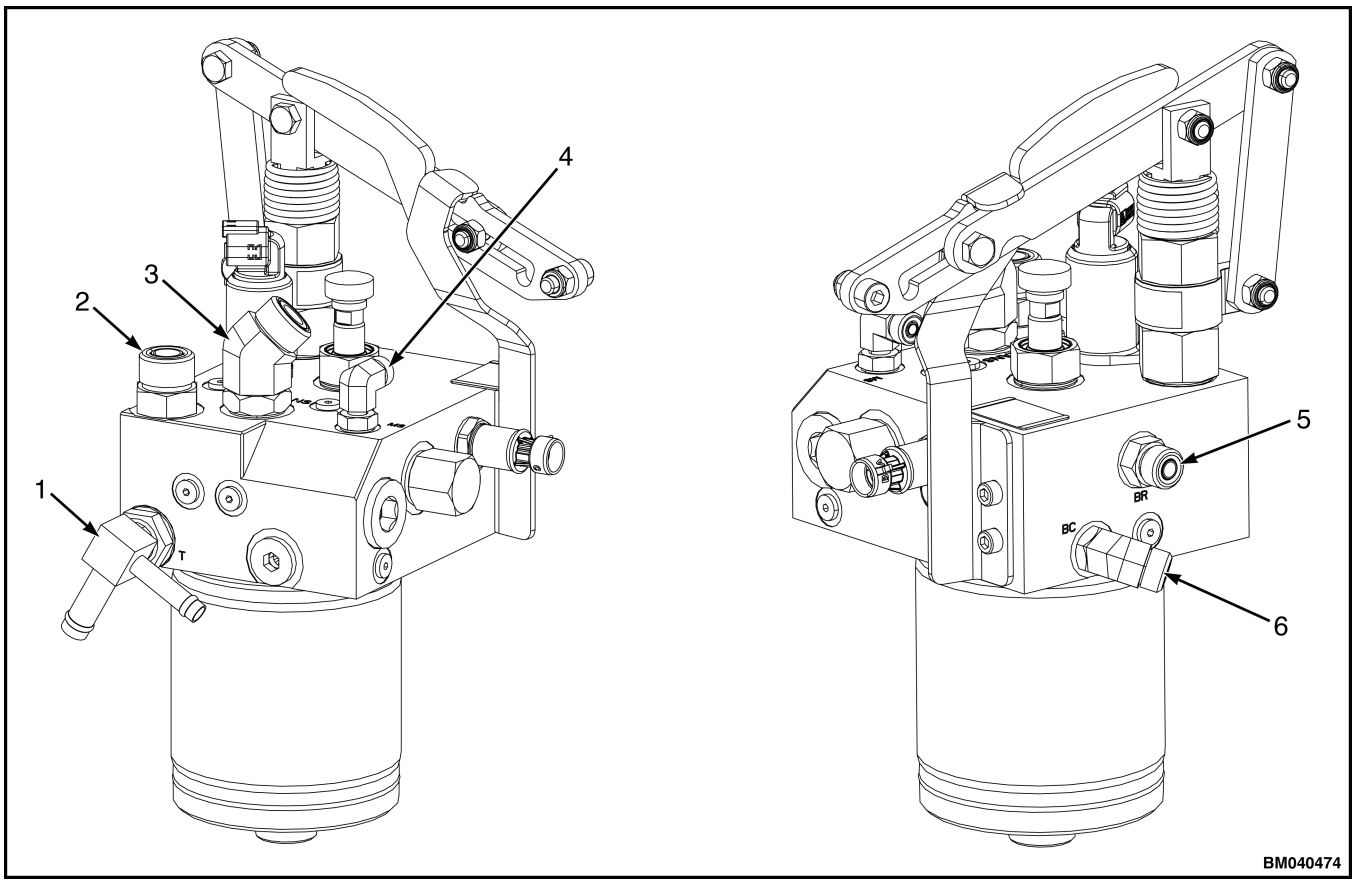


Figure 78. SAHR Valve Fittings

Legend No.	Port	Item	Description	Torque Value
1	T	Special Nipple Hose Ftg 8X8 and 8X6	8X8: Park Brake Return 8X6: Boost Return	52 ±5 N•m (38 ±3.8 lbf ft)-
2	P	Straight ORFS Ftg 10	Park Brake Supply	59 to 64 N•m (43.5 to 47.2 lbf ft)
3	TRANS	45° ORFS Ftg -10	Transmission Supply	59 to 64 N•m (43.5 to 47.2 lbf ft)
4	MS	90° ORFS Ftg 4X4	Boost Supply	18 to 20 N•m (13.3 to 14.8 lbf ft)
5	BR	Straight ORFS 6	Park Brake Pressure	18 to 20 N•m (13.3 to 14.8 lbf ft)
6	BC	45° ORFS Ftg 6X6	Service Brake Pressure	29 to 33 N•m (21.4 to 24.3 lbf ft)

INSTALL

1. Install the SAHR valve into the mounting bracket.
2. Insert the three cap screws (item 4, Figure 76) to secure the SAHR valve to the bottom of the mounting bracket.
3. Torque the cap screws to 19 to 23 N•m (14 to 17 lbf ft).

NOTE: Follow the next step only if the mounting bracket was removed.

4. Align the three holes on the mounting bracket with the three holes on the drive axle. Insert the three cap screws to secure the mounting bracket. See Figure 76.
5. Torque the cap screws to 38 to 42 N•m (28 to 31 lbf ft).
6. Connect the cooling hose (item 6, Figure 75) and brake hose tube (item 5) to the fittings.
7. Connect the high temp hose to the fitting (item 4, Figure 75).
8. Connect the fitting (item 1, Figure 75) that connects the brake actuation hose (item 2) and brake cooling hose (item 3).
9. Connect the lower SAHR tube (item 3, Figure 74) to the fitting on the SAHR valve.
10. Connect the upper SAHR tube (item 2, Figure 74) to the fitting on the SAHR valve.
11. Connect the park brake wire harness to the two connectors on the SAHR valve. See Figure 73.
12. Install the two LH tilt cylinder hoses. See Figure 71.
13. Place the brake pedal back into position and insert the pin (3, Figure 70) to secure the master cylinder linkage.
14. Install the seal plate, lower kick panel, and floorplate to the lift truck. See Covers repair, in **Frame and Main Components** 8000SRM2306.
15. Lower the carriage and remove the chain and as as described in Safety Procedures When Working Near Mast in **Front End** 4000SRM2303.
16. Remove the blocks and lower the lift truck. See How to put a lift truck on blocks in **Periodic Maintenance** 8000SRM2305.

REPLACING THE SAHR VALVE (WET BRAKE DRIVE AXLE WITH HYDROSTATIC TRANSMISSION) 202001-428

REMOVE

WARNING

When putting the lift truck on blocks, make sure the surface is solid, even, and level. Any blocks used to support the lift truck must be solid, one-piece units.

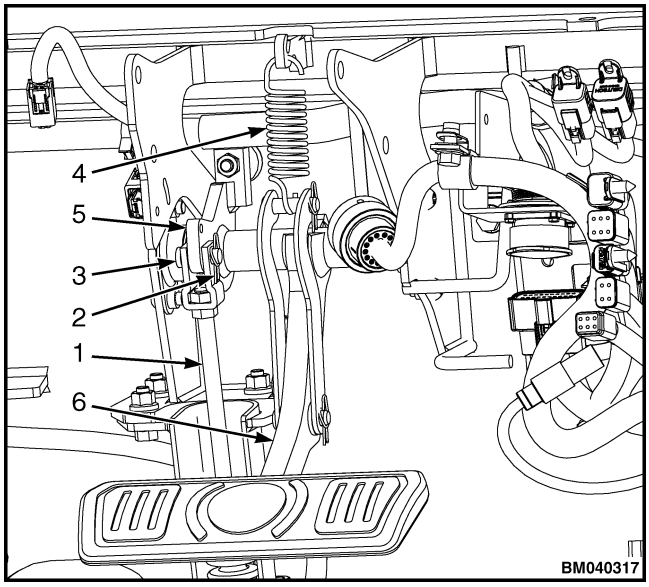
1. Put blocks on each side (front and back) of the steering tires to prevent movement of the lift truck.

2. Raise the lift truck and put blocks under the frame so that the drive wheels do not touch the floor. Put blocks under the counterweight for stability. See How to put a lift truck on blocks in **Periodic Maintenance** 8000SRM2305.

3. Raise the carriage and chain as described in Safety Procedures When Working Near Mast in **Front End** 4000SRM2303.

4. Remove the floor plate, lower kick panel, and seal plate from the lift truck. See Covers repair, in **Frame and Main Components** 8000SRM2306.

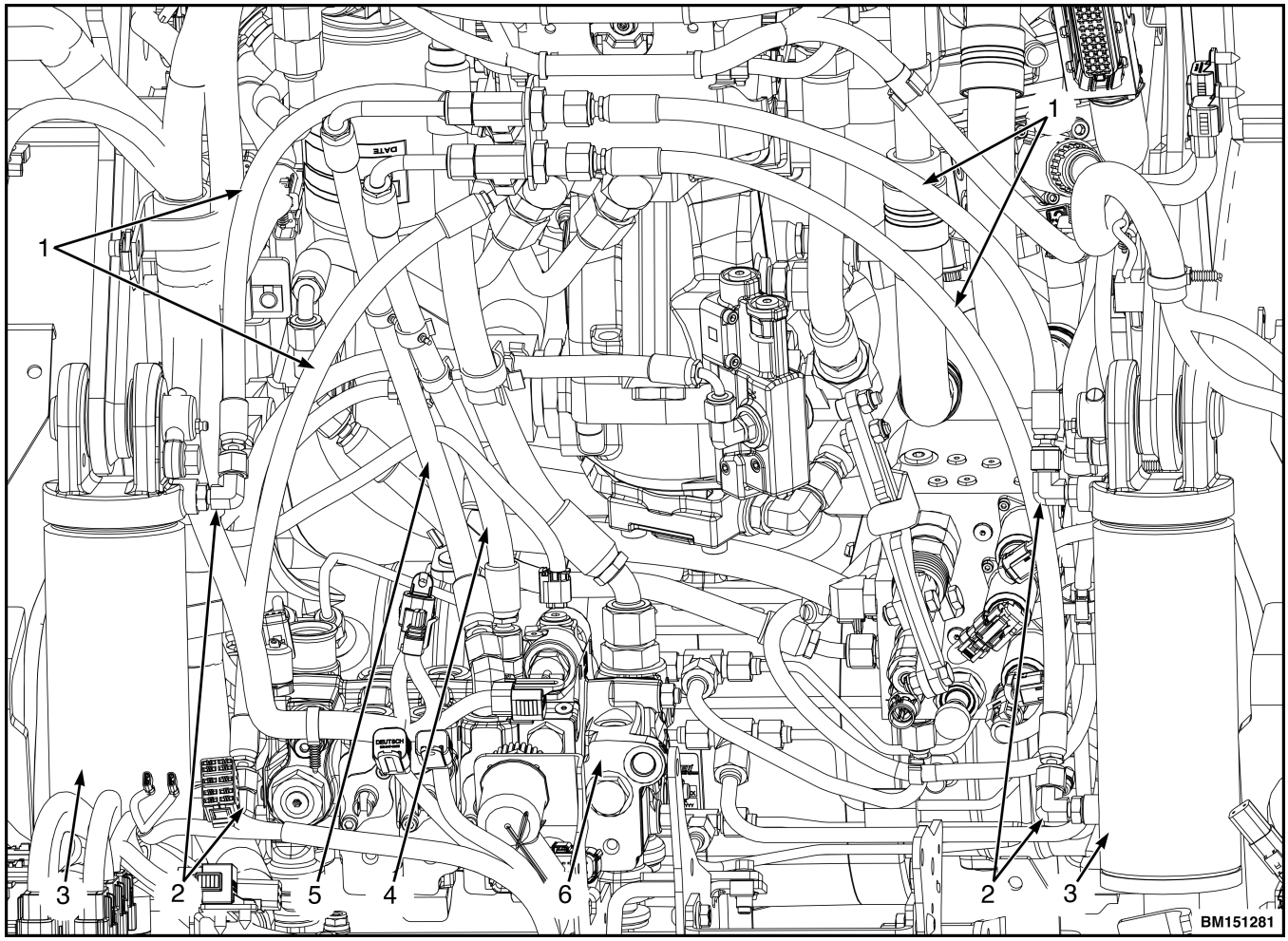
5. Remove the pin (3, Figure 79) on the master cylinder linkage to free the service brake. Push the brake pedal out of the way to access the tilt cylinder hoses.



1. MASTER CYLINDER
2. COTTER PIN
3. PIN
4. SPRING
5. BRAKE PEDAL LINKAGE
6. BRAKE PEDAL

Figure 79. Remove brake linkage pin

6. Remove the two LH tilt cylinder hoses to access the SAHR valve hoses. See Figure 80.



1. TILT CYLINDER HOSES
2. TILT HOSE FITTINGS
3. TILT CYLINDER
4. HOSE
5. HOSE
6. CONTROL VALVE

Figure 80. Tilt cylinder hoses

7. Locate the manual override plunger on the SAHR valve. See Figure 81.

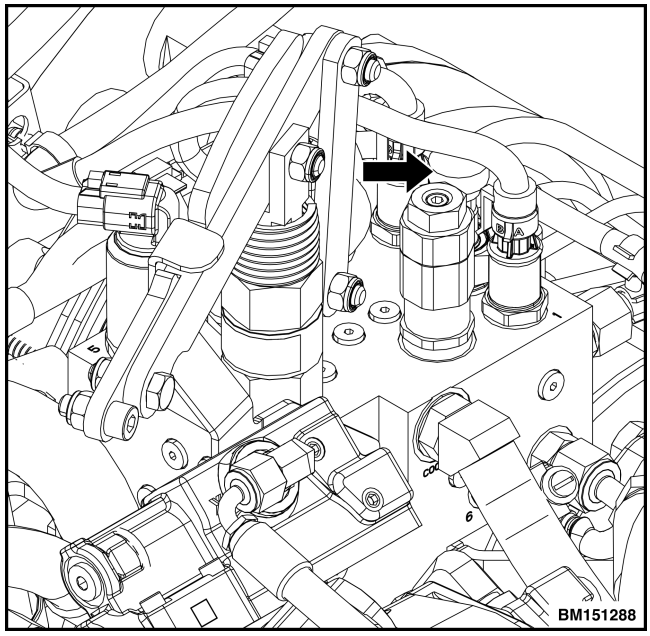
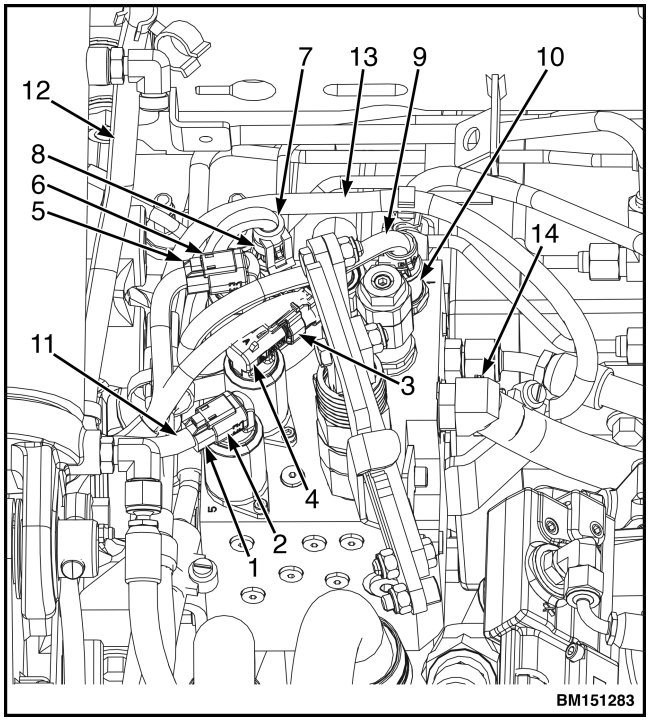


Figure 81. Manual override plunger

8. Disconnect all wire harness connectors from the SAHR valve. See Figure 82.



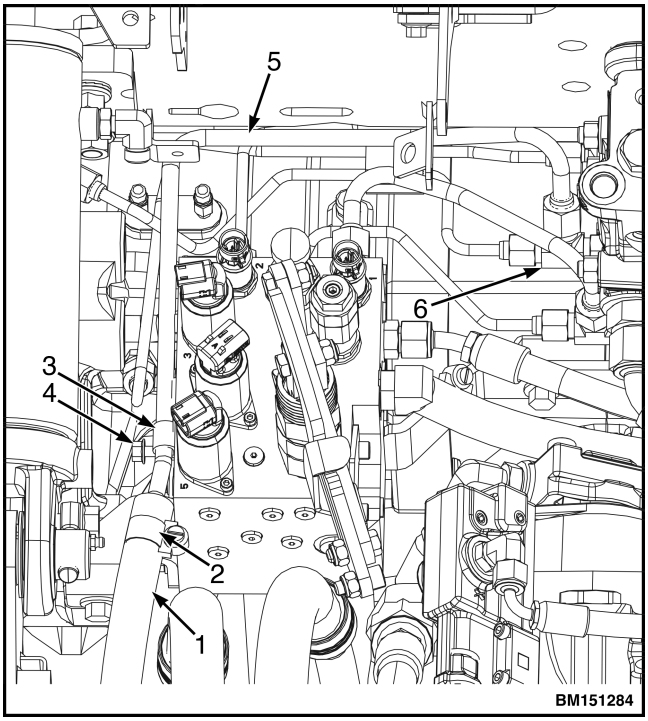
1. CONNECTOR CPS634
2. SERVICE BRAKE SOLENOID
3. CONNECTOR CPS635
4. SERVICE BRAKE SOLENOID
5. CONNECTOR CPS632
6. PARK BRAKE SOLENOID
7. CONNECTOR CPS633
8. PRESSURE SENSOR
9. CONNECTOR CPS631
10. PRESSURE SENSOR
11. HST CHASSIS HARNESS
12. PARK BRAKE WIRE HARNESS
13. HST WIRE HARNESS
14. CONNECTOR CPS640

Figure 82. SAHR connectors

CAUTION

Oil will leak from the cooling hose when the cooling hose is disconnected.

9. Loosen the hose clamp (item 2, Figure 83) and disconnect the HST brake cooling hose (item 1) from the cooling tube (item 5).

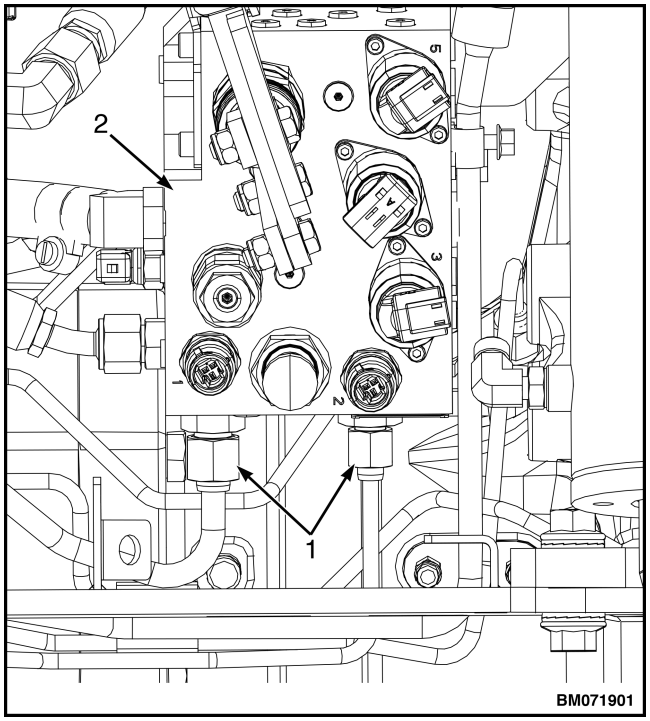


1. HST BRAKE COOLING HOSE
2. HOSE CLAMP
3. CLAMP
4. CAPSCREW
5. COOLING TUBE
6. T-FITTING

Figure 83. brake cooling hose

10. Disconnect the other end of the cooling tube from the t-fitting (item 6, Figure 83).

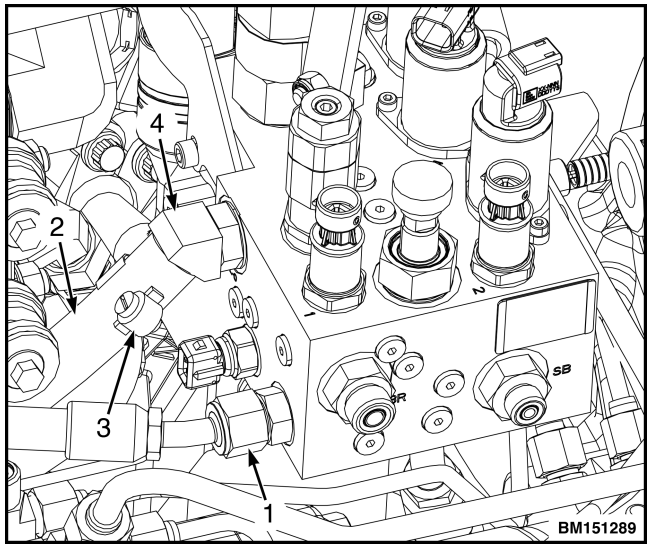
11. Disconnect the two tubes from the drive axle at the SAHR valve. See Figure 84.



1. DRIVE AXLE TUBE
2. SAHR VALVE

Figure 84. Drive axle tubes

12. Disconnect the brake pump hose (item 1, Figure 85) from the SAHR valve.

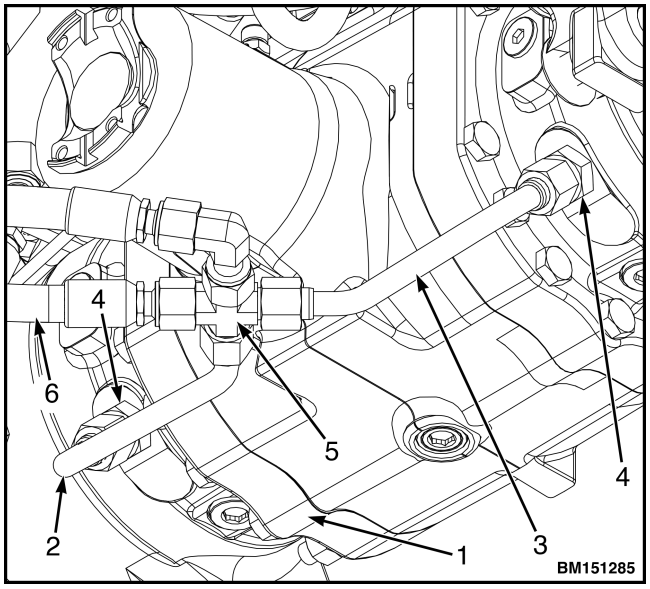


1. BRAKE PUMP HOSE
2. BRAKE COOLING HOSE
3. HOSE CLAMP
4. FITTING

Figure 85. SAHR hoses

13. Disconnect the brake cooling hose (item 2, Figure 85) from the SAHR valve.

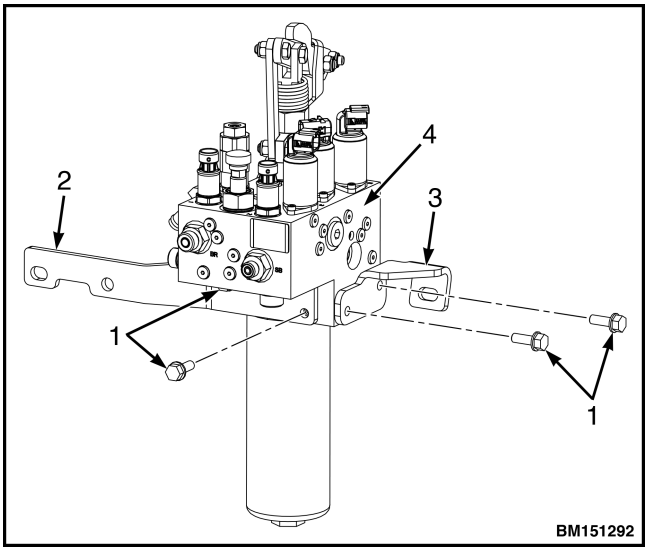
14. Disconnect the brake pump hose (item 6, Figure 86) from the T-fitting.



1. DRIVE AXLE TUBE (REAR)
2. DRIVE AXLE TUBE (FRONT)
3. SAHR VALVE
4. FITTINGS
5. T-FITTING
6. BRAKE PUMP HOSE

Figure 86. Brake hose

15. Remove the cap screws (item 1, Figure 87) retaining the SAHR valve to the large mounting bracket and small mounting bracket.



1. CAP SCREW
2. LARGE VALVE MOUNTING BRACKET
3. SMALL VALVE MOUNTING BRACKET
4. SAHR VALVE

Figure 87. Remove/install SAHR valve

16. Remove the SAHR valve.

DISASSEMBLE

Hand Pump

1. Remove two cap screws (item 4, Figure 88) securing the hand pump bracket (item 6) to the SAHR valve.

2. Remove the hand pump cartridge valve (item 2, Figure 88) from the SAHR valve.

Solenoids

1. Remove the two cap screws (item 8, Figure 88) securing each solenoid (item 7) to SAHR valve.

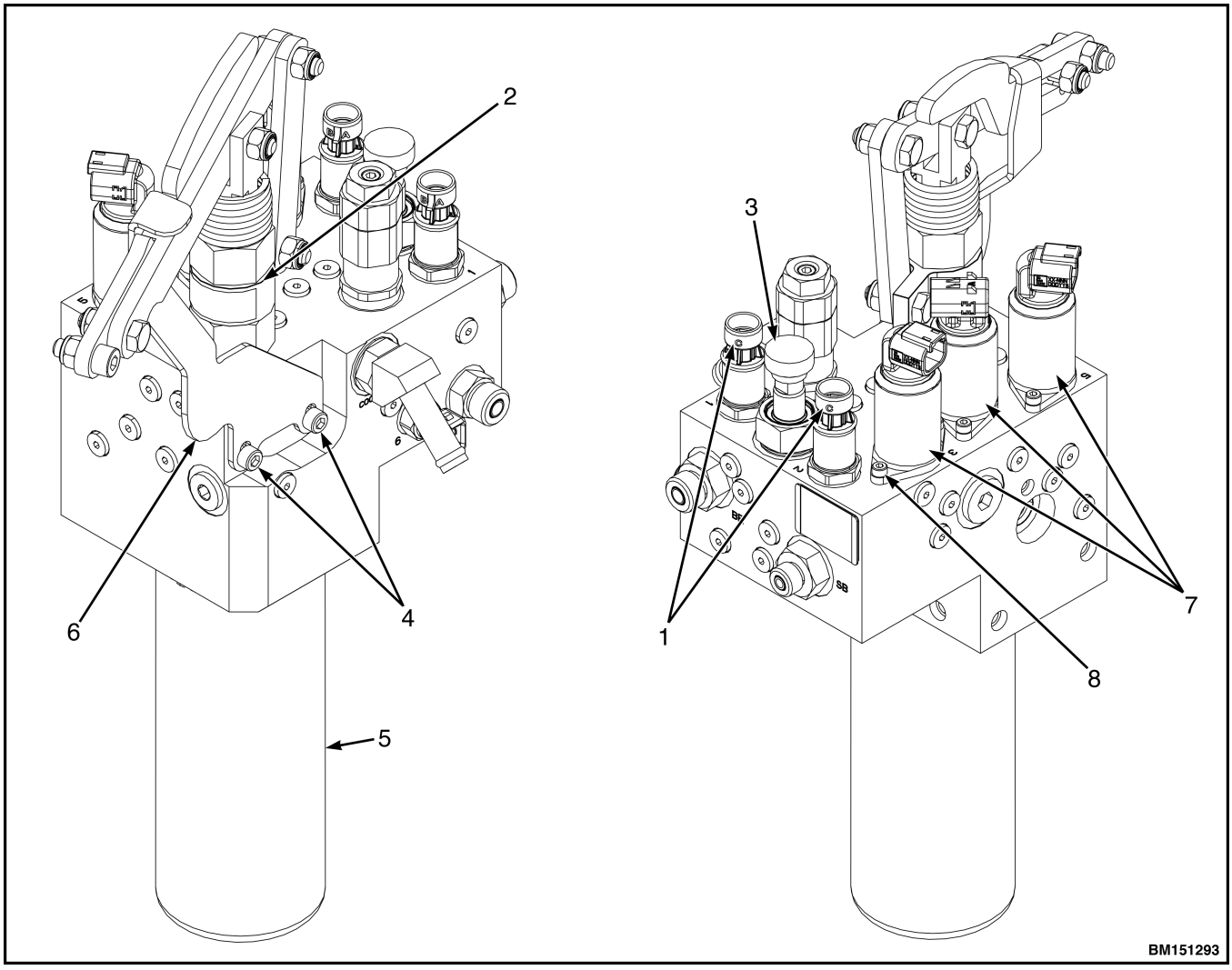
2. Remove the solenoids from the SAHR valve.

Pressure Sensor

1. Remove each pressure sensor from the SAHR valve. See Figure 88.

Manual Release Bypass Valve

1. Remove manual release bypass valve (item 3, Figure 88) from SAHR valve.



1. PRESSURE SENSOR
2. HAND PUMP CARTIDGE VALVE
3. MANUAL RELEASE BYPASS VALVE (PLUNGER)
4. CAP SCREW
5. ACCUMULATOR
6. HAND PUMP BRACKET
7. SOLENOID
8. CAPSCREW

Figure 88. SAHR Valve Assembly

Fittings

NOTE: All SAHR valve hose fittings are removed from the SAHR valve in the same manner.

1. Remove fitting from SAHR valve. See Figure 89.

CLEAN AND INSPECT

Inspect the SAHR valve assembly for damage. Replace any component if there is damage.

ASSEMBLE

Hand Pump

1. Install the hand pump cartridge valve onto the SAHR valve. Torque to 38 to 46 N•m (30.7 to 31.3 lbf ft). See Figure 88.

2. Install the two cap screws to mount the hand pump bracket to the SAHR valve. Torque cap screws to 8.5 to 10.5 N•m (6 to 8 lbf ft).

Solenoids

1. Install each solenoid onto the SAHR valve. See Figure 88.

2. Install two cap screws to secure the solenoid to the SAHR valve. Torque cap screws to 3.6 to 4.4 N•m (2.7 to 3.3 lbf ft).

Pressure Sensors

1. Install each pressure sensor onto the SAHR valve. Torque to 18 to 22 N•m (13.5 to 16.5 lbf ft) See Figure 88.

Manual Release Bypass Valve

1. Install the manual release bypass valve onto the SAHR valve. Torque to 58.5 to 71.5 N•m (43 to 53 lbf ft). See Figure 88.

Fittings

NOTE: All SAHR valve fittings are removed in the same manner.

1. Install fitting onto SAHR valve. See Figure 89 and for Table torque specifications.

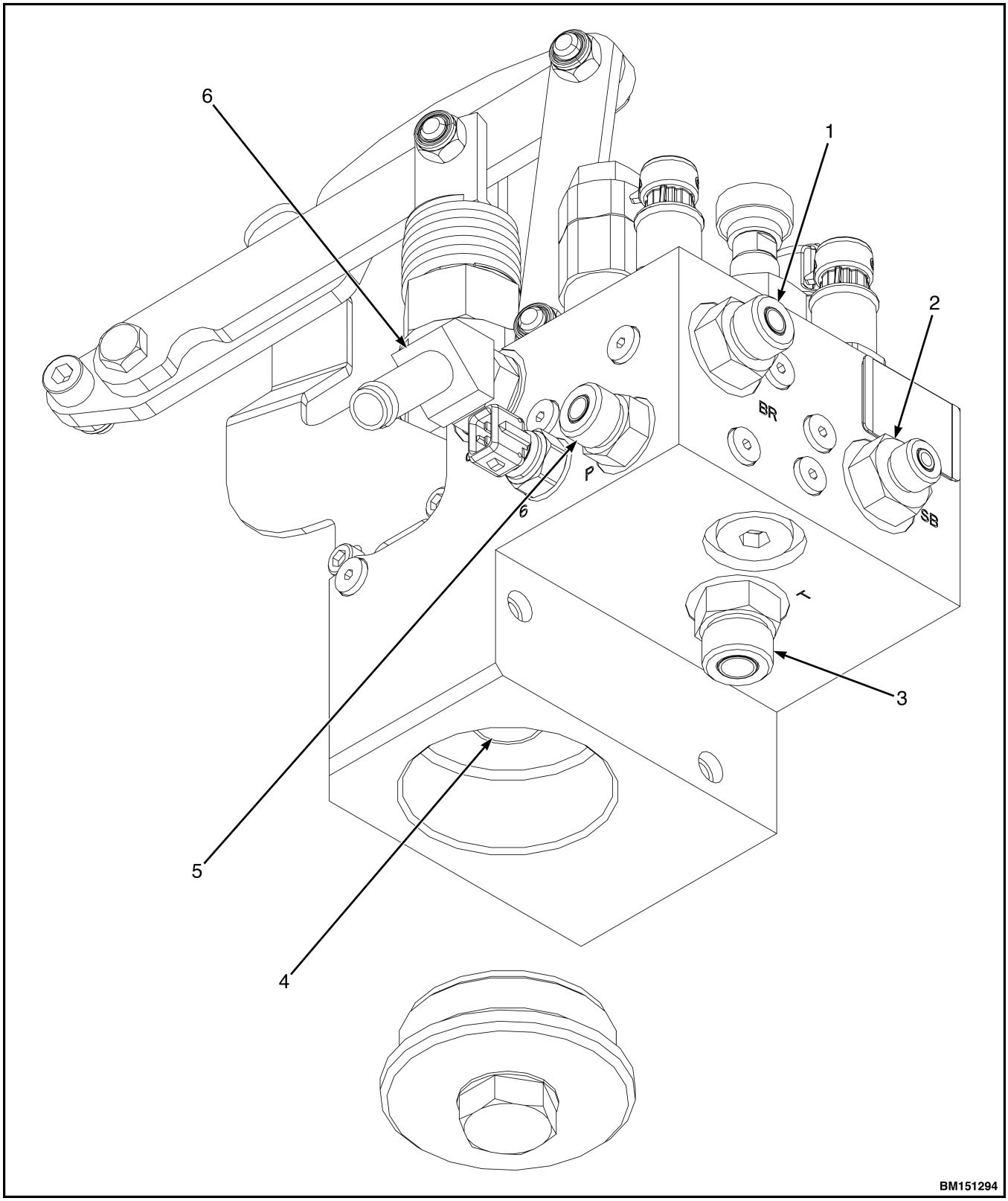


Figure 89. SAHR Valve Fittings

Legend No.	Port	Torque Value
1	BR	40 to 49.4 N•m (29.5 to 36.5 lbf ft)-
2	SB	40 to 49.4 N•m (29.5 to 36.5 lbf ft)
3	T	40 to 49.4 N•m (29.5 to 36.5 lbf ft)
4	Filter speed	90 to 110 N•m (66.6 to 81.1 lbf ft)
5	P	21.7 to 27.1 N•m (16 to 20 lbf ft)
6	COOL-O	40 to 49.4 N•m (29.5 to 36.5 lbf ft)

INSTALL

1. Install the SAHR valve into the mounting bracket.
2. Insert the two cap screws (item 1, Figure 87) to secure the SAHR valve to the large mounting bracket.
3. Torque the cap screws to 19 to 23 N•m (14 to 17 lbf ft).
4. Insert the two cap screws (item 1, Figure 87) to secure the SAHR valve to the small mounting bracket.
5. Torque the cap screws to 19 to 23 N•m (14 to 17 lbf ft).

NOTE: Follow the next step only if the mounting bracket was removed.

6. Align the two holes on the large mounting bracket with the holes on the drive axle. Insert the two cap screws to secure the mounting bracket. See Figure 87.
7. Torque the cap screws to 38 to 42 N•m (28 to 31 lbf ft).
8. Align the hole on the small mounting bracket with the hole on the drive axle. Insert the cap screw to secure the mounting bracket. See Figure 87.
9. Torque the cap screws to 38 to 42 N•m (28 to 31 lbf ft).
10. From underneath the truck, connect the brake pump hose (item 2, Figure 86) to the bottom of the SAHR valve.
11. Connect the brake cooling hose (item 2, Figure 85) to the SAHR valve.
12. Connect the brake pump hose (item 1, Figure 85) to the SAHR valve.
13. Connect the front and rear tubes from the drive axle to the SAHR valve. See Figure 84.
14. Install the cooling tube (item 5, Figure 83) and connect one end to the t-fitting (item 6, Figure 83).
15. Insert the capscrew (item 4, Figure 83) to secure the hose clamp (item 3) on the cooling tube to the SAHR valve.
16. Connect the HST brake cooling hose (item 1, Figure 83) to the other end of the cooling tube (item 5) and tighten the hose clamp (item 2).
17. Connect all wire harness connectors to the SAHR valve. See Figure 82.
18. Install the two LH tilt cylinder hoses to access the SAHR valve hoses. See Figure 80.
19. Place the brake pedal back into position and insert the pin (3, Figure 79) to secure the master cylinder linkage.
20. Install the seal plate, lower kick panel, and floorplate to the lift truck. See Covers repair, in **Frame and Main Components** 8000SRM2306.
21. Lower the carriage and remove the chain and as as described in Safety Procedures When Working Near Mast in **Front End** 4000SRM2303.

22. Remove the blocks and lower the lift truck. See How to put a lift truck on blocks in **Periodic Maintenance** 8000SRM2305.

Cylinder repair

TILT CYLINDER REPAIR 202001-067

REMOVE

WARNING

Before removing the tilt cylinder(s), tilt the mast forward. Use a chain to hold the mast to the frame and prevent the mast from moving forward.

Before working on or near the mast, see Safety Procedures When Working Near Mast.

CAUTION

Cylinders can be heavy, weighing approximately 7.1 to 10.0 kg (15.7 to 22.0 lb). Make sure lifting devices are suitable and of adequate capacity to hold and lift the cylinder.

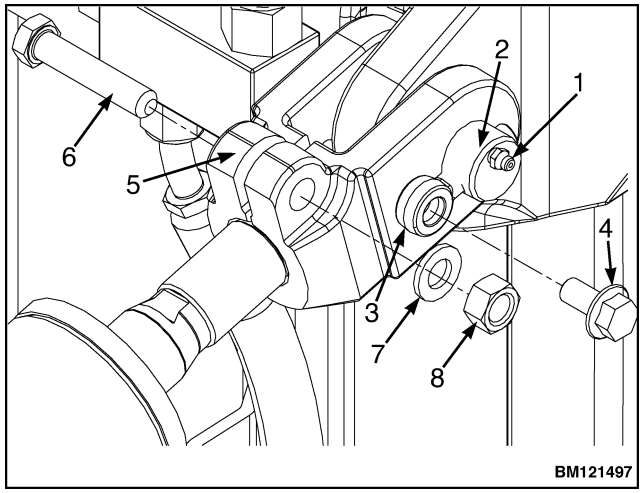
1. Attach a lifting device to the tilt cylinder to hold the cylinder in place during removal.

WARNING

DO NOT push the anchor pins out of the rod end with your fingers.

DO NOT permit the tilt cylinders to drop and cause damage.

2. At the mast, remove the anchor screw (item 4, Figure 90) retaining the pin anchor (item 3). Remove the anchor.



1. GREASE FITTING
2. PIN
3. PIN ANCHOR
4. ANCHOR SCREW
5. ROD END
6. CAPSCREW
7. WASHER
8. NUT

Figure 90. Tilt cylinder-mast end

3. Use a drift pin or similar tool to push the pin (item 2, Figure 90) out of the rod end (item 5).

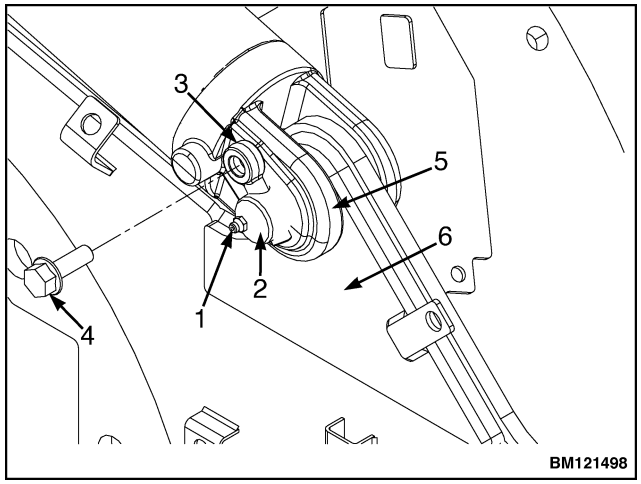
4. Stroke cylinder to the full back tilt position.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

5. Put a drain pan, with appropriate capacity, under the area of hydraulic fittings. Disconnect hydraulic lines at the tilt cylinder and drain hydraulic oil. Install caps on hydraulic lines and in cylinder ports.

6. At the truck end, remove the anchor screw (item 4, Figure 91) from the pin anchor (item 3). Remove the anchor.



NOTE: HYDRAULIC HOSES ARE SHOWN DISCONNECTED FOR CLARITY.

1. GREASE FITTING
2. PIN
3. PIN ANCHOR
4. ANCHOR SCREW
5. ROD END
6. TRUCK FRAME

Figure 91. Tilt cylinder-truck frame end

7. Use a drift pin or similar tool to push the pin (item 2, Figure 91) out of the frame.

8. Use the lifting device to remove the tilt cylinder from truck.

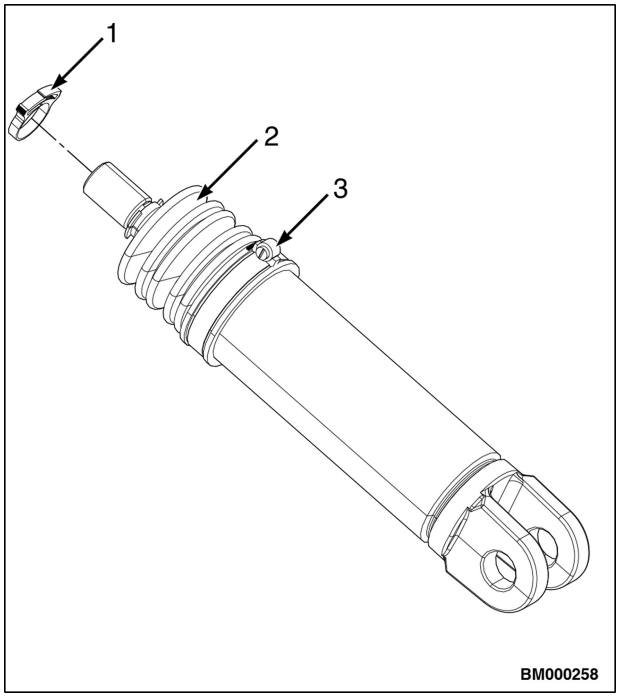
9. Repeat Step 1 through Step 8 for opposite tilt cylinder.

DISASSEMBLE

NOTE: The following steps contain detailed disassembly instructions. Perform only those steps required to repair the tilt cylinder.

NOTE: To aid in re-installation, note the position of the rod end and number of turns used to remove rod end.

1. Place tilt cylinder in a soft-jaw vise. If the tilt cylinder features an optional boot for protection, remove the boot by removing the clamp (item 1, Figure 92) and snap-grip clamp (item 3).



1. CLAMP
2. BOOT
3. SNAP-GRIP CLAMP

Figure 92. Tilt cylinder boot

2. Loosen the nut (item 8, Figure 90) washer (item 7), and capscrew (item 6) retaining the rod end on the rod.

3. Remove the rod end (item 5, Figure 90) from the rod.

4. Using a pin-type spanner wrench, remove the gland from rod and tube. See Figure 93.

5. Remove the rod and piston assembly from the tube. See Figure 93.

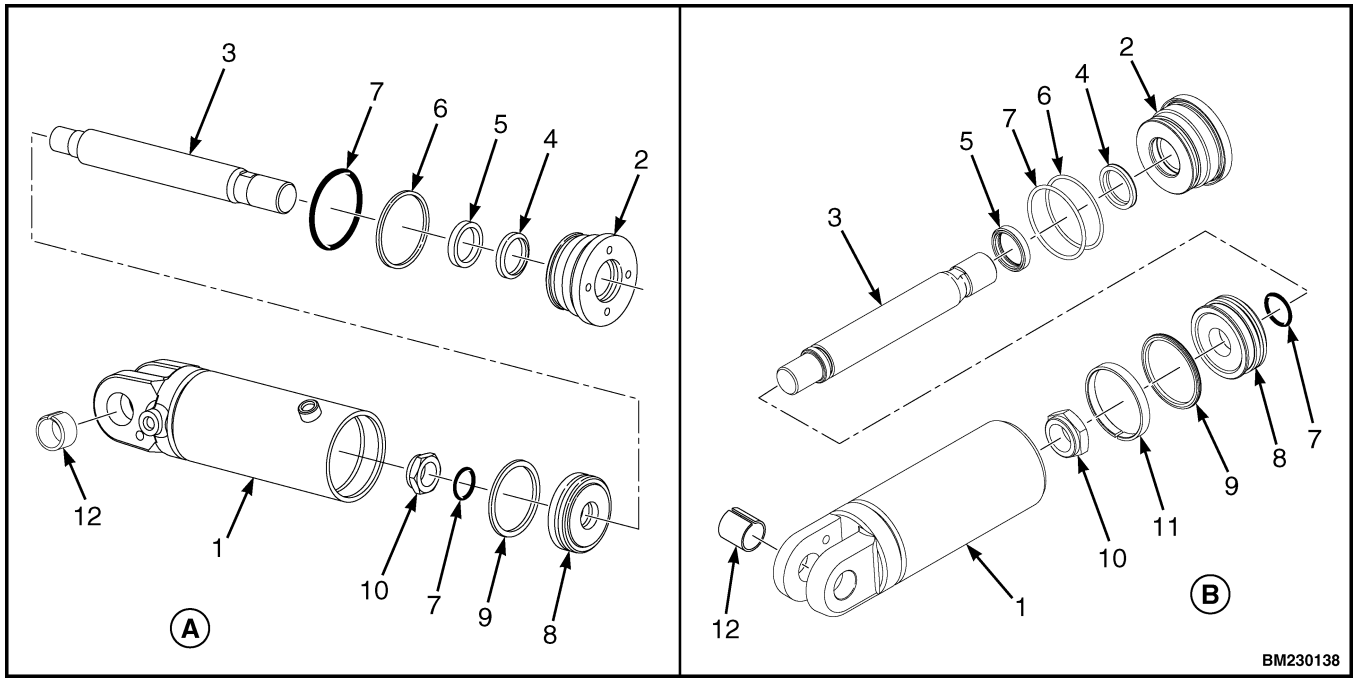
NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

6. Remove and discard O-ring, backup ring, seal, and wiper from gland. See Figure 93.

NOTE: Perform Step 7 and Step 8 only if piston is damaged.

7. Place rod in a soft-jaw vise. Remove nut and piston from the rod. See Figure 93.

8. Remove and discard the O-ring and piston seal from piston. See Figure 93.



A. H2.0A, H2.5A6, H2.5A (H40A, H50A6) (R177)

B. H3.0A, H3.5A (H60A, H70A) (R177)

1. TUBE
2. GLAND
3. ROD
4. ROD WIPER RING
5. ROD SEAL
6. BACKUP RING
7. O-RING
8. PISTON
9. PISTON SEAL
10. NUT
11. WEAR RING
12. BUSHING

Figure 93. Tilt Cylinder Assembly

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components, as it will damage those components.

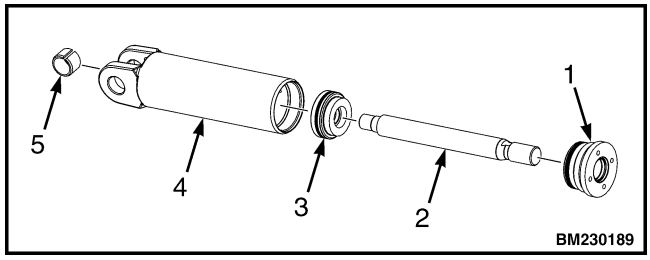
Clean all metal parts in solvent and dry with compressed air.

INSPECT

NOTE: If any part needs to be replaced, see **Parts Manual** for replacement parts.

1. Inspect gland for damage to threads and seal surfaces. Replace gland if damaged. See Figure 94.
2. Inspect rod for damage to rod surface and ensure that rod is not bent. Replace rod if damaged or bent. See Figure 94.
3. Inspect piston for any damage to seal surfaces and replace if damaged. See Figure 94.
4. Inspect inner surface of tube for damage. If tube is damaged, replace cylinder. See Figure 94.

5. Inspect bushings for damage. If damaged, replace bushings. See Figure 94.



1. GLAND
2. ROD
3. PISTON
4. INNER SURFACE OF TUBE
5. BUSHINGS

Figure 94. Tilt Cylinder Inspection

ASSEMBLE

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

NOTE: Lubricate new seals, O-rings, and rings with clean hydraulic oil before installation.

1. Install a new piston seal and O-ring on piston. See Figure 93.

2. Place the rod in a soft-jaw vise and lubricate the threads of the nut with hydraulic oil. Install the piston on the rod and tighten the nut to:

- 170 to 220 N•m (125 to 162 lbf ft) for H2.0A, H2.5A6, H2.5A (H40A, H50A6) (R177)
- 320 to 400 N•m (236 to 295 lbf ft) for H3.0A, H3.5A (H60A, H70A) (R177)

3. Install new wiper, seal, backup ring, and O-ring on gland. See Figure 93.

4. Install rod and piston assembly in the tube.

5. Using a pin-type spanner, install gland on rod and tube. Tighten gland to:

- 170 to 220 N•m (125 to 162 lbf ft) for H2.0A, H2.5A6, H2.5A (H40A, H50A6) (R177)
- 320 to 400 N•m (236 to 295 lbf ft) for H3.0A, H3.5A (H60A, H70A) (R177)

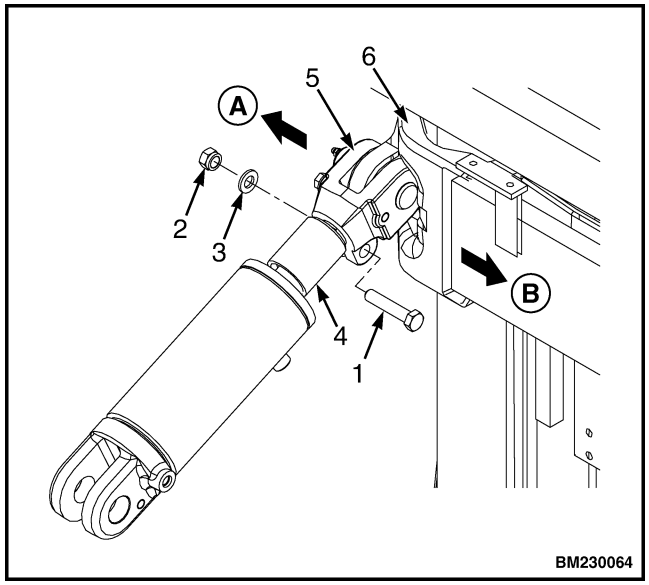
6. Place cylinder in a soft-jaw vise and install tilt spacer, if equipped, and rod end on rod as noted during removal.

7. Lubricate threads on the capscrew with lubricant, Hyster P/N 186061. Insert the capscrew (item 1, Figure 95) in rod end so that the capscrew head is on the inboard side of rod end.

8. Install the washer (item 3, Figure 95) and nut (item 2) on the capscrew. The washer and nut must be on the outboard side of rod end. Tighten nut to 90 N•m (66 lbf ft). See Figure 95.

9. Repeat Step 1 through Step 6 for opposite tilt cylinder.

10. If installing an optional boot on the tilt cylinder, install the boot on the cylinder and secure with the clamp (item 1, Figure 92) and snap-grip clamp (item 3).



A. OUTBOARD SIDE
B. INBOARD SIDE

1. CAPSCREW
2. NUT
3. WASHER
4. ROD END
5. MAST END MOUNT

Figure 95. Rod End

INSTALL

1. Use a lifting device to place the tilt cylinder in mounting position on the truck frame.

NOTE: Lubricate threads on capscrew with lubricant, Hyster P/N 186061.

2. Use a drift pin or similar tool to push the pin through the rod end and into the frame of the lift truck. See Figure 91.

3. Install the pin anchor to retain the pin and insert the anchor screw (item 4, Figure 91) into the anchor. Tighten the screw to 38 N•m (28 lbf ft).

4. Use a drift pin or similar tool to push the pin through the rod end and into the mast of the lift truck. See Figure 90.

5. Install the pin anchor to retain the pin and insert the anchor screw (item 4, Figure 90) into the anchor. Tighten the screw to 38 N•m (28 lbf ft).

6. Connect hydraulic lines to tilt cylinder. Slowly stroke tilt cylinders until rod holes line up with the mast tilt anchor holes.

7. Repeat Step 1 through Step 6 for opposite tilt cylinder.

8. Remove chain holding mast to frame.

9. Operate tilt cylinders. Check for correct operation and leakage. Adjust tilt cylinders.

TILT CYLINDERS, ADJUST

WARNING

When the tilt cylinders have tilt limit spacers, make sure they are installed during installation procedures. Without the tilt limit spacers, the mast can tilt too much and cause an accident or serious injury.

Check the tilt cylinder stroke by slowly tilting the mast fully forward and backward several times. Both tilt cylinders must stop their stroke at the same time. Adjust the rod ends as indicated in Tilt Cylinders With Tilt Limit Spacers and Tilt Cylinders Without Tilt Limit Spacers. There must be no twist in the mast weldments.

Tilt Cylinders With Tilt Limit Spacers

1. Adjust the rod ends to 20 mm (0.80 in.), Dimension A, Figure 96.

2. Slowly tilt mast forward until one cylinder rod stops. On the opposite tilt cylinder, loosen capscrews on rod end.

3. Use a wrench and turn tilt cylinder rod **IN** as necessary.

4. Repeat Step 2 and Step 3 until both tilt cylinder rods stop at the same position within 0.50 mm (0.02 in.). See Figure 96.

5. Slowly tilt mast backward until one rod end just contacts the tilt limit spacer. Add shims to fill the gap at opposite rod end until both tilt cylinder rod ends contact limit spacers within 0.50 mm (0.02 in.). See Figure 96.

6. Tilt mast fully backward and measure the tilt angle. See Nameplate for tilt angles. If necessary, add an equal number of shims to both rods for the correct angle.

7. After adjustments are completed, tighten nuts on tilt cylinder rod ends to 90 N•m (66 lbf ft). See Figure 96.

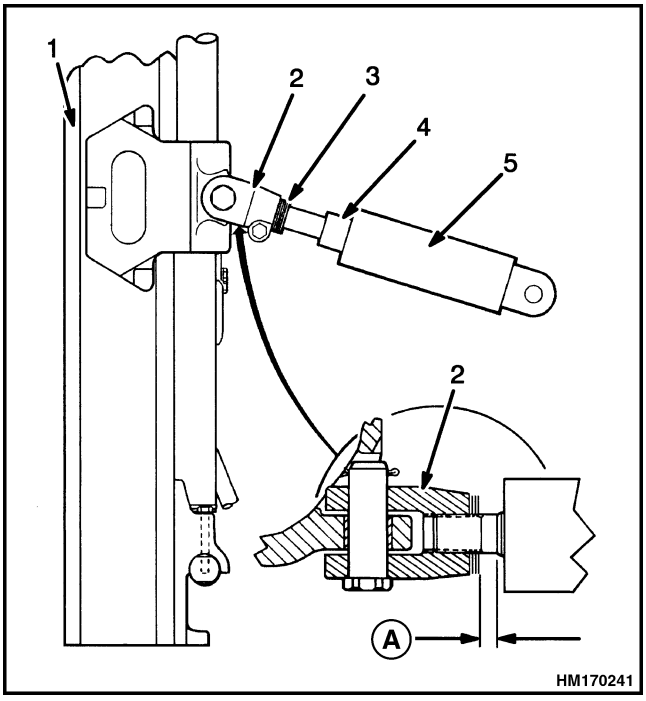


Figure 96. Tilt Cylinder Adjustments, Tilt Cylinder With Tilt Limit Spacer

Legend for Figure 96.

A. DIMENSION A = 20 mm (0.80 in.)

1. MAST
2. ROD END
3. SHIMS
4. TILT LIMIT SPACER
5. TILT CYLINDER

Tilt Cylinders Without Tilt Limit Spacers

1. Adjust the rod ends to 20 mm (0.80 in.), Dimension A, Figure 97.

2. Slowly tilt mast forward until one cylinder rod stops. On the opposite tilt cylinder, loosen capscrews on rod end.

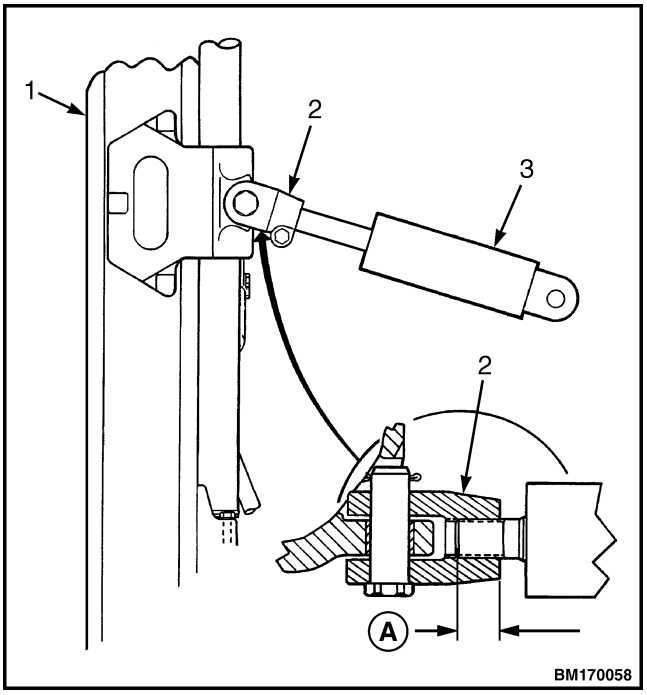
3. Measure distance from end of tilt cylinder to back end of rod end.

4. Use a wrench and turn tilt cylinder rod **IN** until dimension starts to decrease, then stop.

5. Repeat Step 2 and Step 4 until both tilt cylinder rods stop at the same position within 0.50 mm (0.02 in.). See Figure 97.

6. Tilt mast fully backward and measure the tilt angle. See Nameplate for tilt angles. If necessary, add an equal number of shims to both rods for the correct angle.

7. After adjustments are completed, tighten nuts on tilt cylinder rod ends to 90 N•m (66 lbf ft). See Figure 97.



A. DIMENSION A = 20 mm (0.80 in.)

1. MAST
2. ROD END
3. TILT CYLINDER

Figure 97. Tilt Cylinder Adjustments, Tilt Cylinder Without Tilt Limit Spacer

TILT CYLINDER LEAK CHECK

1. Put a capacity load on forks. Use a safety chain to hold load to carriage. Raise load approximately 2.5 m (8 ft). Put mast in a 90 degree vertical position.

2. To check for leakage, perform steps below:

a. Measure distance that the rod on the tilt cylinder extends from the tube shown as Dimension A in both Figure 96 and Figure 97.

b. Wait 10 minutes.

c. Measure the distance that the rod extends from the tube again, this will be Distance B.

d. Subtract distance A from distance B to get the amount the tilt cylinder has moved in 10 minutes, this is Distance C.

e. Divide Distance C by 10, to get the distance the tilt cylinder traveled in per minute, this is Distance D.

f. Compare Distance D to the value in Table 3 for the temperature of the hydraulic oil in the truck.

Table 3. Movement Rates (Maximum) for Tilt Cylinders

Lift Truck Model	Hydraulic Oil Temperature/ Mast Tilt Rate			
	20°C (68°F)		60°C (140°F)	
	mm/min	in./min	mm/min	in./min
H2.0A, H2.5A6, H2.5A (H40A, H50A6) (R177)	1.0	0.04	6.3	0.25

3. If tilt rate is greater than the specifications in Table 3, lower mast and remove load from forks. Install a gate valve between port at the front of tilt cylinder and hydraulic line. The gate valve must be able to completely shut off the flow of hydraulic oil.

4. Put a load on forks again. Close gate valve.

5. Tilt mast forward just past the vertical position. If mast continues to tilt SLOWLY forward, the seals on the piston are leaking and need to be replaced. See **Parts Manual** for replacement parts.

6. If the mast does not move, open gate valve and check movement again. If mast moves forward when gate valve is open, check for leaks in hydraulic lines and fittings. If leaks are not found, the main control valve may be worn or damaged.

7. Repeat Step 1 through Step 6 for both cylinders.

8. Remove load from forks when checks are completed.

LIFT CYLINDER REPAIR 202001-068

TWO-STAGE LIMITED-FREE-LIFT (LFL)

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on lift truck.

1. Remove carriage as described in carriage removal procedures located in **Front End** 4000SRM2303.

2. Raise and chain the mast as instructed in **Safety Procedures When Working Near Mast** section. The mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment. The mast must be chained before proceeding to the next step in this procedure.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: Steps below contain procedure for both main lift cylinders.

3. Remove snap ring and shims at top of cylinder. See Figure 98.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

4. Put a drain pan, with a capacity of 3.8 liter (1 gal), under the area of the hydraulic fittings. Disconnect hydraulic lines from fitting with hydraulic velocity fuse and drain hydraulic oil. Cap hydraulic lines. See Figure 98.

5. Use a special tool to remove fitting with hydraulic velocity fuse. Cap cylinder ports. See Figure 98.

6. Remove locknut, capscrew, and spacer from cylinder mounting plate and chain support anchor. See Figure 98.

WARNING

Cylinders can be heavy, weighing approximately 16.3 to 59.9 kg (35.9 to 132.0 lb). Make sure lifting devices are suitable and of adequate capacity to lift the cylinder.

NOTE: For cylinder removal, the rod needs to be completely retracted into the cylinder.

7. Using a lifting device, remove lift cylinder from mast.

8. Repeat Step 3 through Step 7 for opposite lift cylinder.

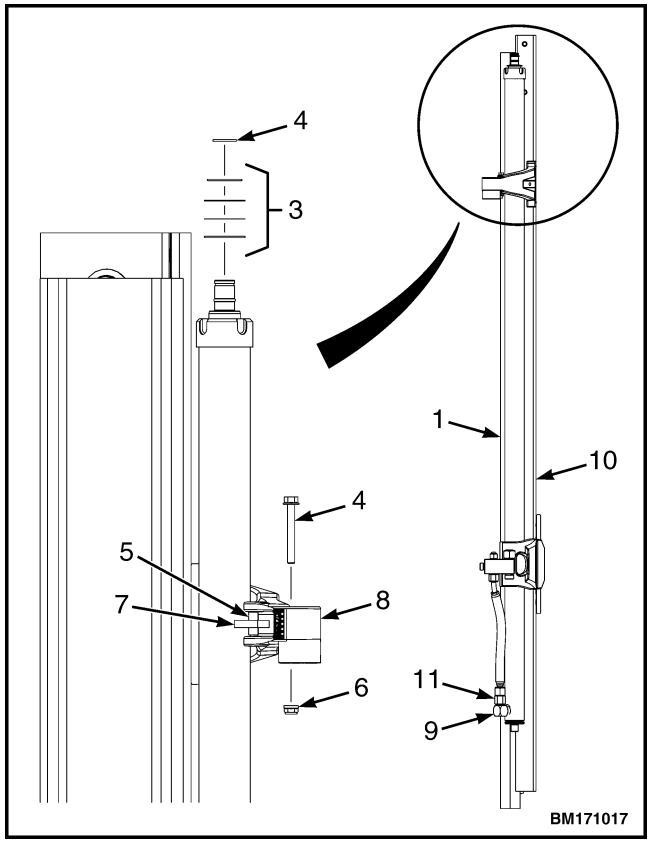


Figure 98. 2-Stage LFL cylinder remove/install

Legend for Figure 98.

1. MAIN LIFT CYLINDER
2. SNAP RING
3. SHIM
4. CAPSCREW
5. SPACER
6. LOCKNUT
7. CYLINDER MOUNTING PLATE
8. CHAIN SUPPORT ANCHOR
9. CYLINDER PORT
10. OUTER MAST
11. HYDRAULIC VELOCITY FUSE

Disassemble

NOTE: Steps below contain procedure for both lift cylinders.

1. Loosen gland with spanner wrench.

2. Remove O-ring and gland from rod and tube. See Figure 99.

3. Remove rod and piston assembly from tube. Drain any remaining hydraulic oil into drain pan. See Figure 99.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

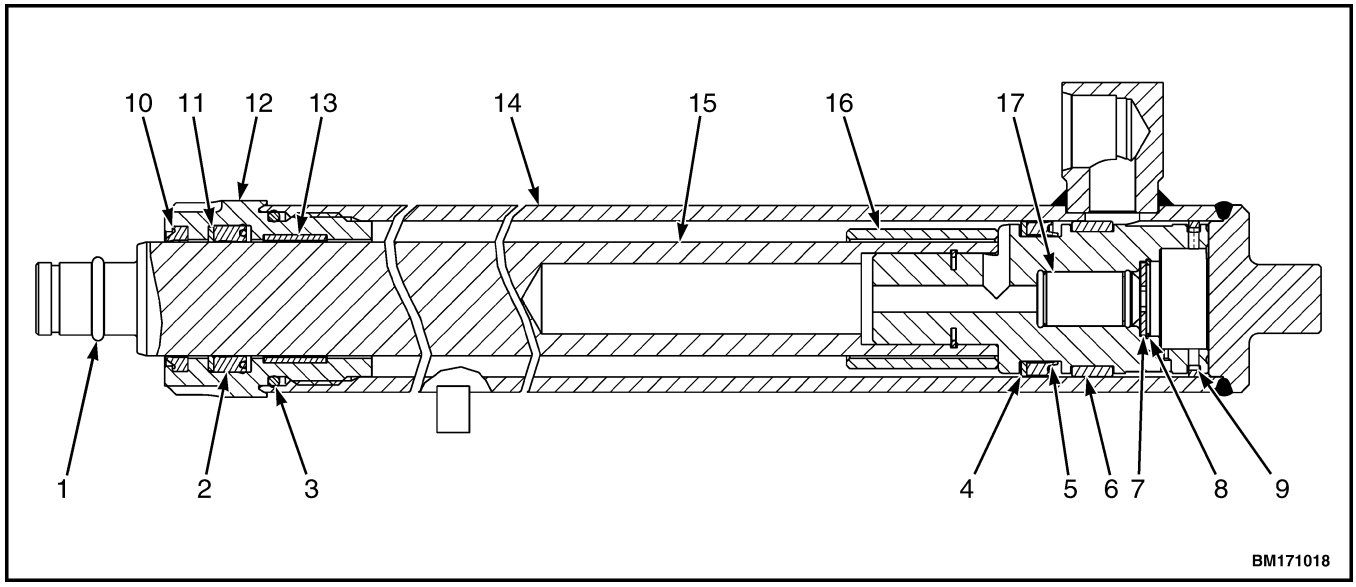
4. Remove rod wiper, backup ring, rod seal, O-ring, and wear ring from gland. See Figure 99.

5. Remove backup ring, piston seal, wear ring, and piston ring from rod and piston assembly. Discard backup ring, piston seal, and wear ring. Remove spacer, if present, from rod. See Figure 99.

6. Remove snap ring, washers, and check valve with O-ring from piston base. Remove and discard O-ring from check valve. See Figure 99.

NOTE: Perform Step 7 only if piston is damaged.

7. Remove piston from rod using spanner wrench. See Figure 99.



1. O-RING
2. ROD SEAL
3. O-RING
4. BACKUP RING
5. PISTON SEAL
6. PISTON WEAR RING
7. WASHER
8. SNAP RING
9. PISTON RING
10. ROD WIPER
11. BACKUP RING
12. GLAND
13. WEAR RING
14. TUBE
15. ROD AND PISTON ASSEMBLY
16. SPACER
17. CHECK VALVE WITH O-RING

Figure 99. 2-Stage LFL lift cylinder assembly

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

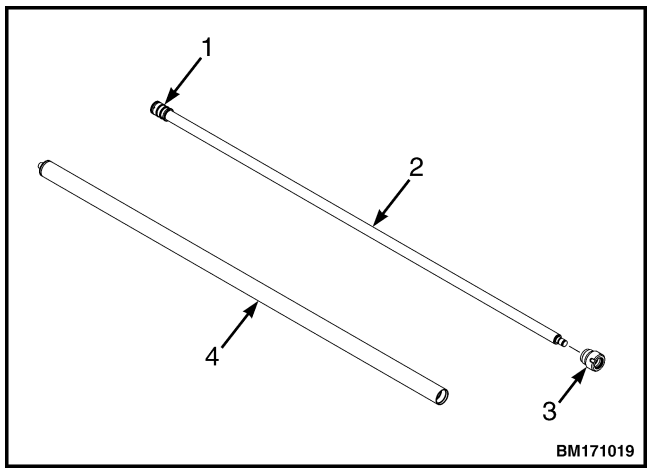
NOTE: If any parts need to be replaced, see **Parts Manual** for replacement part.

1. Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland. See Figure 100.

2. Inspect the piston for damage to the seal surfaces. If damaged, replace piston. See Figure 100.

3. Inspect the rod for damage to the rod surface and ensure that the rod is not bent. If rod is damaged, replace rod. See Figure 100.

4. Inspect the inner surface of the cylinder tube for damage. If damaged, replace cylinder assembly. See Figure 100.



1. PISTON SEAL SURFACES
2. ROD SURFACE
3. GLAND THREADS AND SEAL SURFACES
4. INNER SURFACE OF CYLINDER TUBE

Figure 100. 2-Stage LFL lift cylinder inspection

Assemble

NOTE: Steps below contain procedure for both main lift cylinders.

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform Step 2 if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft). See Figure 99.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals, see Seal Kit Installation. Most lift cylinder maintenance is cause by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install new O-ring on check valve. Install check valve, washers, and snap ring on piston base. See Figure 99.

4. Install new piston ring, wear ring, piston seal, and backup ring on rod and piston assembly. Install spacer on rod and piston assembly. See Figure 99.

5. Install wear ring, O-ring, rod seal, backup ring, and rod wiper on gland. See Figure 99.

6. Install rod and piston assembly into tube. See Figure 99.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in tube. Tighten gland to 340 to 410 N•m (251 to 302 lbf ft). Install O-ring on rod. See Figure 99.

Install

WARNING

Cylinders can be heavy, weighing approximately 16.3 to 59.9 kg (35.9 to 132.0 lb). Make sure lifting devices are suitable and of adequate capacity to lift the cylinder.

NOTE: Make sure the mast is raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment.

NOTE: Steps below contain procedure for both main lift cylinders.

1. Using a lifting device, install lift cylinder on mast.

2. Install spacer, capscrew and nut on cylinder mounting plate and chain support anchor. Tighten nut to 40 N•m (30 lbf ft). See Figure 98.

3. Uncap cylinder port and install fitting with hydraulic velocity fuse using special tool. See Figure 98.

4. Uncap hydraulic line and connect to fitting with hydraulic velocity fuse. See Figure 98.

5. Install shims, as needed, and snap ring at the top of main lift cylinder. See Figure 98.

6. Repeat Step 1 through Step 5 for opposite cylinder.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

7. Dispose of drain pan contents.

8. Connect main lift chains and adjust as described in **Front End** 4000SRM2303.

9. Install carriage as described in installation procedures located in **Front End** 4000SRM2303.

TWO-STAGE FULL-FREE-LIFT (FFL)

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on truck.

1. Remove carriage as described in carriage removal procedures located in **Front End** 4000SRM2303.

2. Raise and chain the mast as instructed in **Safety Procedures When Working Near Mast** section. The mast must be chained before proceeding to the next step in this procedure. The mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment.

3. Remove fitting from top of left-hand lift cylinder. See Figure 101.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

NOTE: Perform step below for right and left main lift cylinders.

4. Remove snap ring and shims at top of cylinder. See Figure 101.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

5. Put a drain pan, with a capacity of 3.8 liter (1 gal), under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder port on left-hand cylinder. Disconnect hydraulic lines at fitting with hydraulic velocity fuse on right-hand cylinder. Remove fitting with hydraulic velocity fuse from right-hand cylinder. Drain oil from hydraulic lines and cylinder ports. Cap hydraulic lines and cylinder ports. See Figure 101.

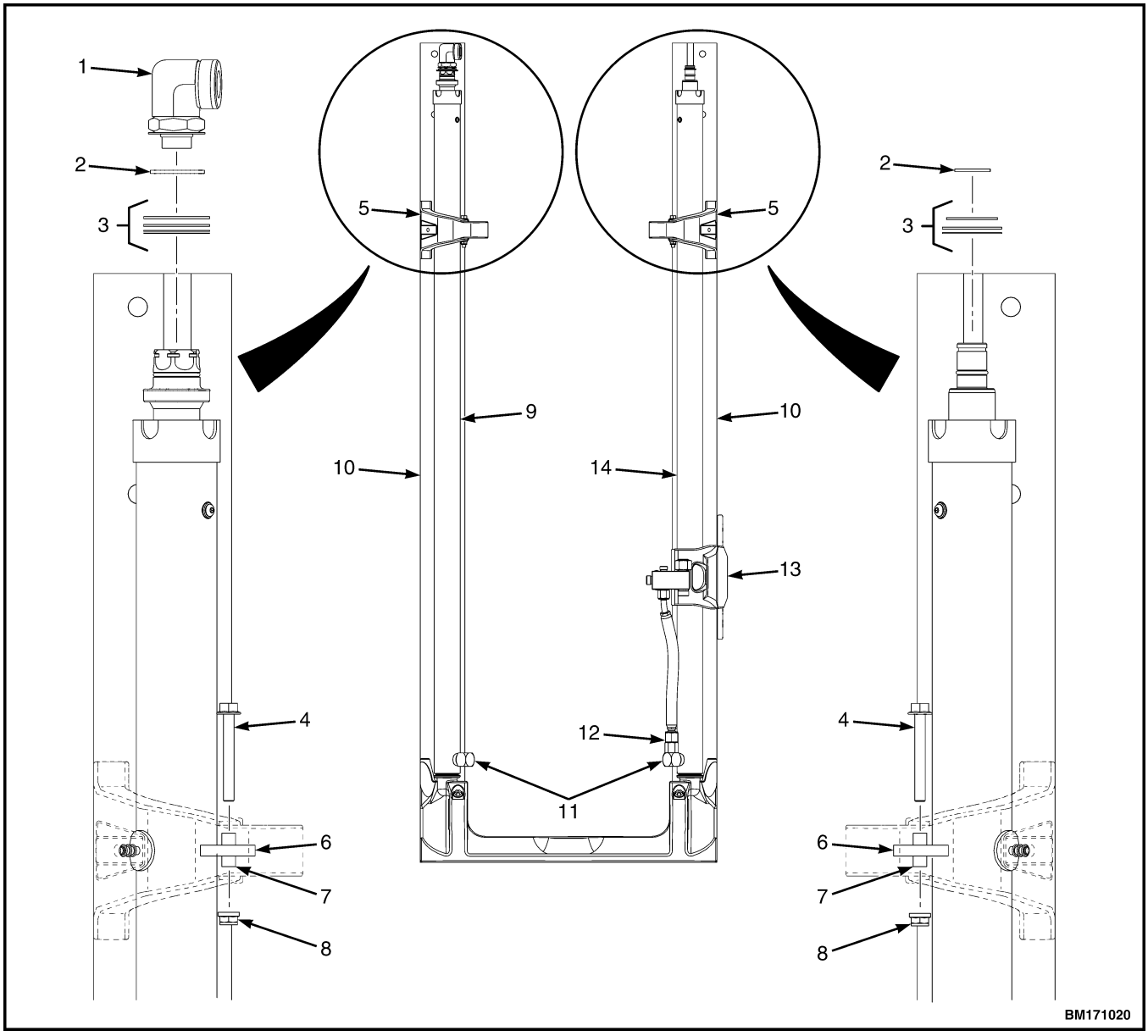
6. Remove locknut, capscrew, and spacer from cylinder mounting plate and chain support anchor. See Figure 101.

WARNING

Cylinders can be heavy, weighing approximately 16.3 to 59.9 kg (35.9 to 132.0 lb). Make sure lifting devices are suitable and of adequate capacity to lift the cylinder.

NOTE: After cylinder has been completely disconnected from the mast, the mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment. For cylinder removal, the rod needs to be completely retracted into the cylinder.

7. Using a lifting device, remove main lift cylinders from mast.



1. FITTING
2. SNAP RING
3. SHIM
4. CAPSCREW
5. CHAIN SUPPORT ANCHOR
6. CYLINDER MOUNTING PLATE
7. SPACER
8. LOCKNUT
9. LEFT-HAND MAIN LIFT CYLINDER
10. OUTER MAST
11. CYLINDER PORT
12. FITTING WITH HYDRAULIC VELOCITY FUSE
13. TILT ANCHOR
14. RIGHT-HAND MAIN LIFT CYLINDER

Figure 101. 2-Stage FFL cylinder remove/install

Disassemble

Left-Hand Cylinder

1. Loosen gland with spanner wrench.

2. Remove gland from rod and tube. See Figure 102.

3. Remove rod assembly from tube. Drain any remaining hydraulic oil into drain pan. See Figure 102.

4. Remove and discard O-ring (item 1, Figure 102) from rod assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

5. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 102.

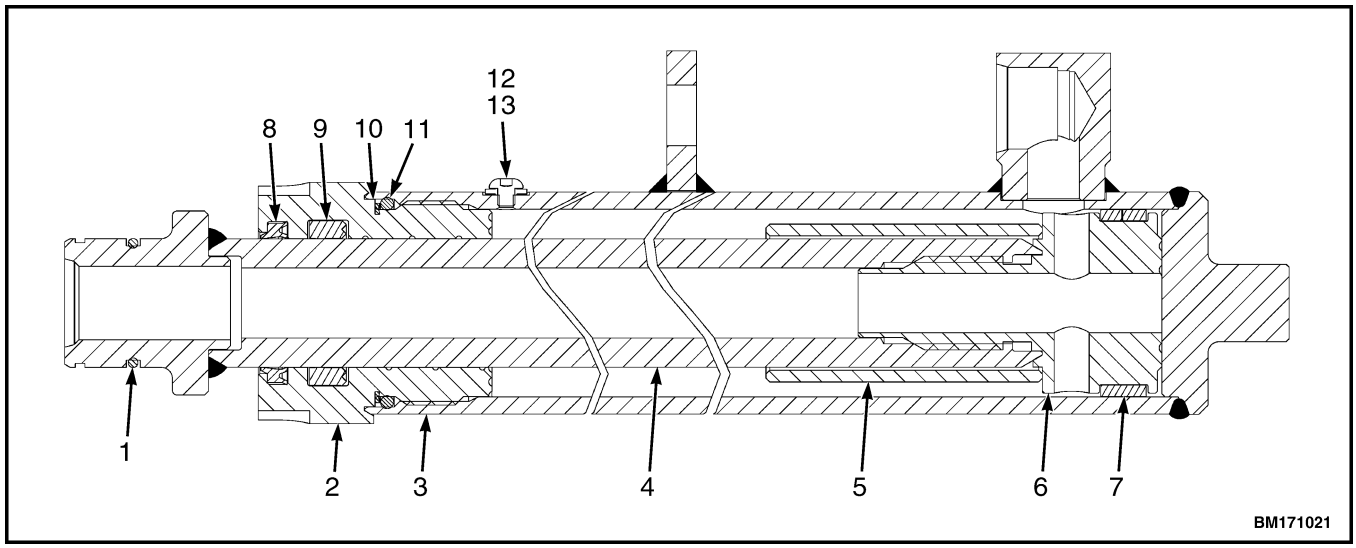
6. Remove spacer, if present, from rod assembly.

7. Remove and discard wear ring from piston end of rod. See Figure 102.

8. Remove special capscrews and stato seal. Discard stato seal. See Figure 102.

NOTE: Perform Step 9 only if piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 102.



1. O-RING
2. GLAND
3. TUBE
4. ROD ASSEMBLY
5. SPACER (OPTIONAL)
6. PISTON
7. WEAR RING
8. ROD WIPER
9. ROD SEAL
10. BACKUP RING
11. O-RING
12. STATO SEAL
13. SPECIAL CAPSCREW

Figure 102. 2-Stage FFL left-hand cylinder assembly

Right-Hand Cylinder

1. Loosen gland with spanner wrench.

2. Remove gland from rod and tube. See Figure 103.

3. Remove rod assembly from tube. Drain any remaining hydraulic oil into drain pan. See Figure 103.

4. Remove and discard O-ring (item 1, Figure 103) from rod assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

5. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 103.

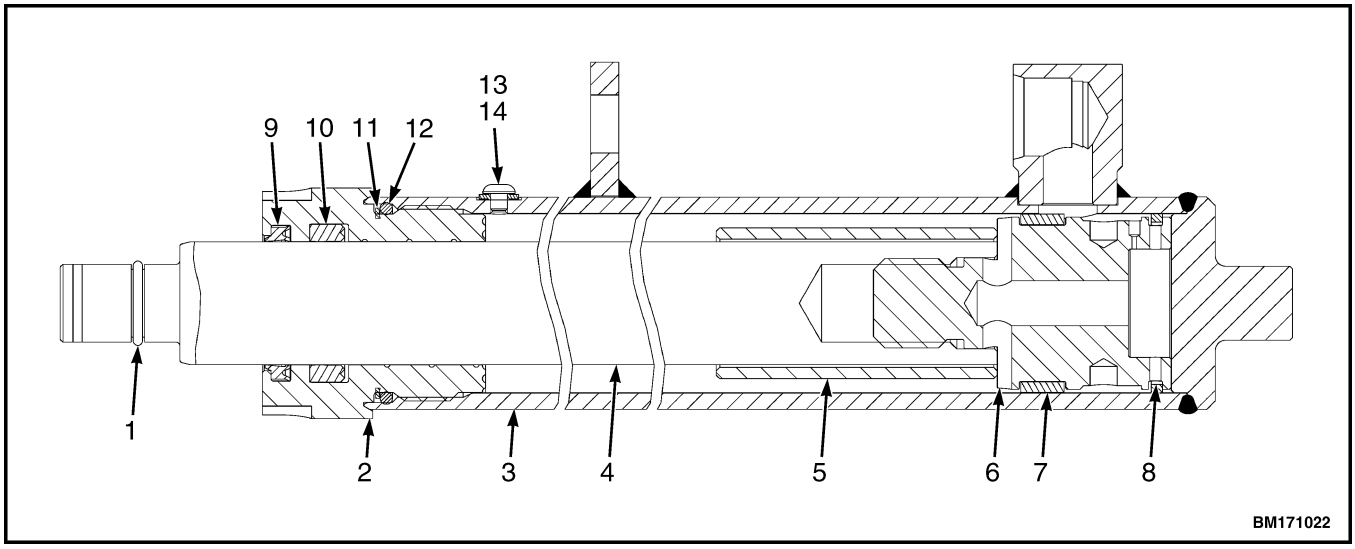
6. Remove spacer, if present, from rod assembly.

7. Remove and discard wear ring and piston ring from piston end of rod. See Figure 103.

8. Remove special capscrews and stato seal. Discard stato seal. See Figure 103.

NOTE: Perform Step 9 only if piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 103.



1. O-RING
2. GLAND
3. TUBE
4. ROD ASSEMBLY
5. SPACER (OPTIONAL)
6. PISTON
7. PISTON WEAR RING
8. PISTON RING
9. ROD WIPER
10. ROD SEAL
11. BACKUP RING
12. O-RING
13. STATO SEAL
14. SPECIAL CAPSCREW

Figure 103. 2-Stage FFL right-hand cylinder assembly

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

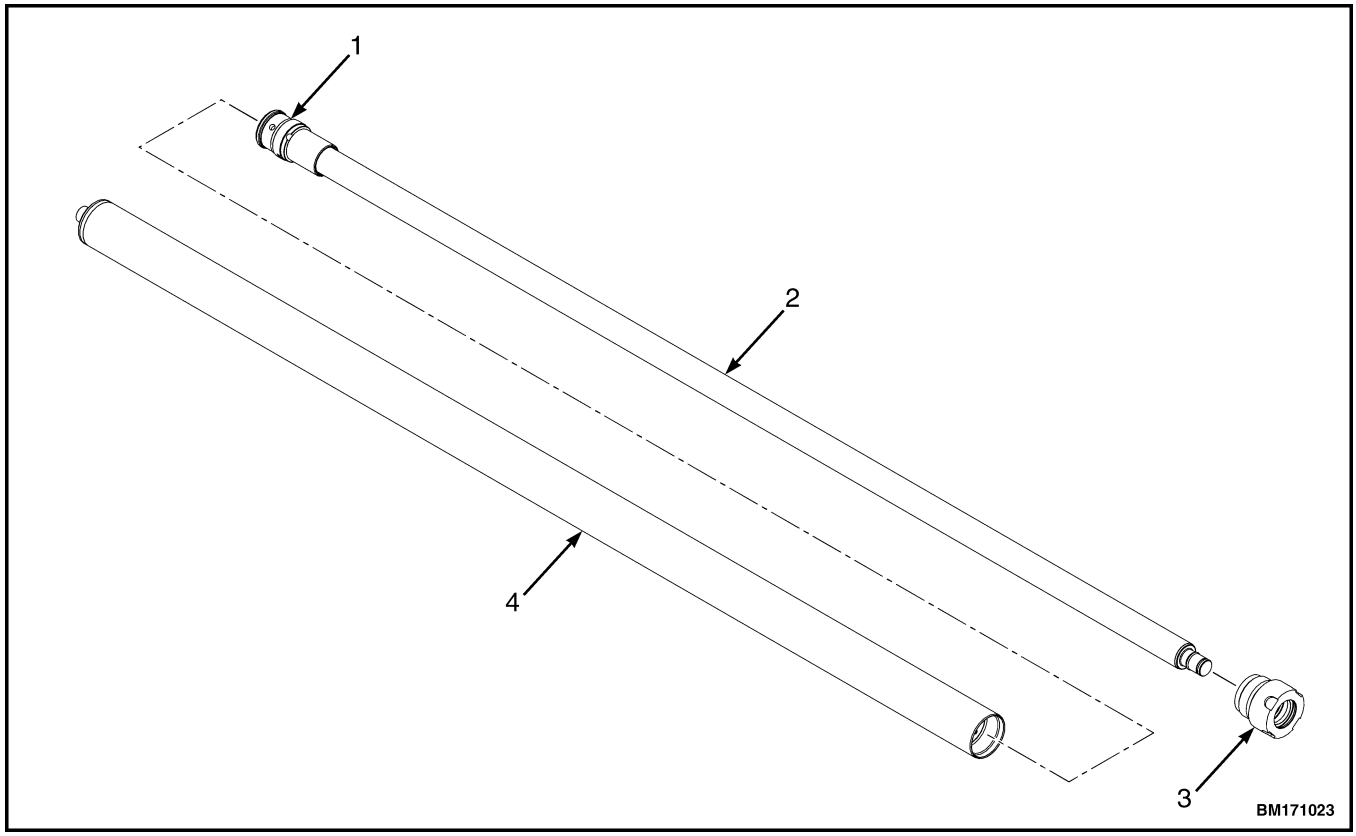
DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

NOTE: If any parts need to be replaced, see **Parts Manual** for replacement part.

1. Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland. See Figure 104.
2. Inspect the piston for damage to the seal surfaces. If damaged, replace piston. See Figure 104.
3. Inspect the rod for damage to the rod surface and ensure that the rod is not bent. If rod is damaged, replace rod. See Figure 104.
4. Inspect the inner surface of the cylinder tube for damage. If damaged, replace cylinder assembly. See Figure 104.



1. PISTON SEAL SURFACES
2. ROD SURFACE
3. GLAND THREADS AND SEAL SURFACES
4. INNER SURFACE OF CYLINDER TUBE

Figure 104. 2-Stage FFL cylinder inspection

Assemble

Left-Hand Cylinder

1. Lubricate all internal parts of lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform Step 2 if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft). See Figure 102.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install wear ring on piston end of rod. Install spacer, if removed, on rod and piston assembly. See Figure 102.

4. Install new backup ring, O-ring, rod seal, and rod wiper on gland. See Figure 102.

5. Install rod and piston assembly into tube. See Figure 102.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

6. Install gland on rod in tube. Tighten gland to 340 to 410 N•m (251 to 302 lbf ft). See Figure 102.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

7. Pour 150 cc (5 oz) hydraulic oil into cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install new stato seal and special capscrew. Tighten special capscrew to 4.5 to 5.5 N•m (40 to 49 lbf in). See Figure 102.

Right-Hand Cylinder

1. Lubricate all internal parts of lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform Step 2 if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 170 to 200 N•m (125 to 148 lbf ft). See Figure 102.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install wear ring, and piston ring on piston end of rod. Install spacer, if removed, on rod and piston assembly. See Figure 102.

4. Install new backup ring, O-ring, rod seal, and rod wiper on gland. See Figure 102.

5. Install rod and piston assembly into tube. See Figure 102.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

6. Install gland on rod in tube. Tighten gland to 340 to 410 N•m (251 to 302 lbf ft). See Figure 102.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

7. Pour 150 cc (5 oz) hydraulic oil into cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install new stato seal and special capscrew. Tighten special capscrew to 4.5 to 5.5 N•m (40 to 49 lbf in). See Figure 102.

Install

NOTE: Steps below contain procedure for both main lift cylinders.

1. Using lifting device, install lift cylinders in mount at bottom of outer mast.

2. Install capscrew and nut on cylinders and mounting plates. Tighten nuts to 40 N•m (30 lbf ft). See Figure 101.

3. Use lifting device to lower the inner mast onto lift cylinders. Install shims and snap ring at top of cylinders. Install fitting to top of left-hand lift cylinder. Connect tube assembly to fitting.

4. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 101.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.

6. Connect main lift chains and adjust as described in **Front End** 4000SRM2303.

7. Install carriage as described in **Front End** 4000SRM2303.

System Air Bleed Procedure

NOTE: The procedures for bleeding air out of main lift cylinders apply only to trucks equipped with a two-stage FFL mast. Trucks equipped with a two-stage LFL or three-stage FFL mast do not need to have air bled out of main lift cylinders.

1. Loosen capscrew two turns to permit oil flow around treads of capscrew. See Figure 102.

2. With forks unloaded, raise carriage using hydraulic control. Raise carriage 300 mm (12 in.) and then stop for 10 seconds to reduce pressure in lift cylinder. Repeat this procedure until oil flowing from around the threads is free of air bubbles.

3. Stop carriage to top of cylinder stroke. Tighten capscrew to 6 to 8 N•m (53 to 71 lbf in).

THREE-STAGE FULL-FREE-LIFT (FFL)

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on truck.

1. Remove carriage as described in carriage removal procedures located in **Front End** 4000SRM2303.

2. Raise and chain the mast as instructed in **Safety Procedures When Working Near Mast** section. The mast must be chained before proceeding to the next step in this procedure. The mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

NOTE: Steps below contain procedure for both main lift cylinders.

3. Remove snap ring and shims (washers) at top of main lift cylinders. See Figure 105.

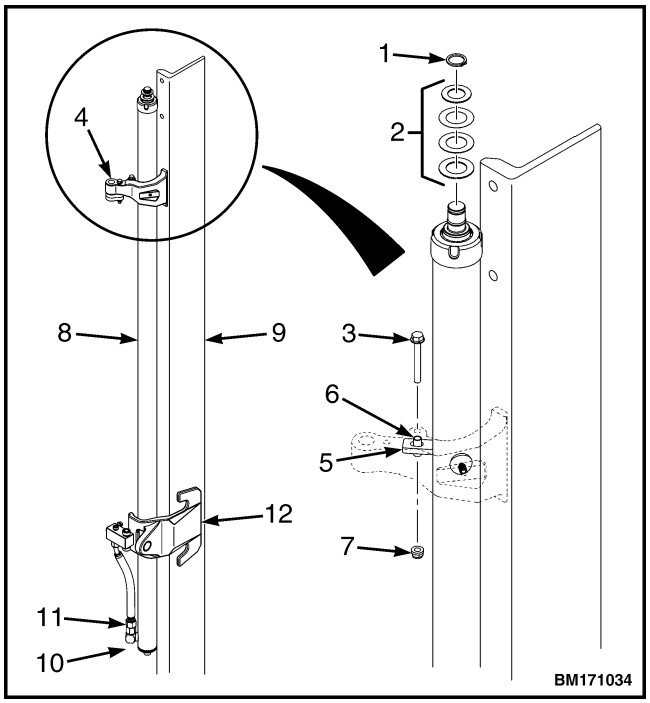
4. Put a drain pan, with a capacity of 3.8 liter (1 gal), under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. Cap hydraulic lines and cylinder ports. See Figure 105.

5. Remove the capscrew and locknut at the mounting plate. See Figure 105.

WARNING

Cylinders can be heavy, weighing approximately 16.3 to 59.9 kg (35.9 to 132.0 lb). Make sure lifting devices are suitable and of adequate capacity to lift the cylinder.

6. Using a lifting device, remove lift cylinder from mast.



1. SNAP RING
2. SHIM (WASHER)
3. CAPSCREW
4. CHAIN SUPPORT ANCHOR
5. CYLINDER MOUNTING PLATE
6. SPACER
7. LOCKNUT
8. MAIN LIFT CYLINDER
9. OUTER MAST
10. CYLINDER PORT
11. FITTING WITH HYDRAULIC VELOCITY FUSE
12. TILT ANCHOR

Figure 105. 3-Stage FFL cylinder remove/install

Disassemble

NOTE: Steps below contain procedure for both lift cylinders.

1. Loosen gland with spanner wrench.
2. Remove O-ring and gland from rod and tube. See Figure 106.
3. Remove rod and piston assembly from cylinder. See Figure 106. Drain hydraulic oil into container.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove rod wiper, backup ring, rod seal, O-ring, and wear ring. Discard rod seal, O-ring, and wear ring. See Figure 106.

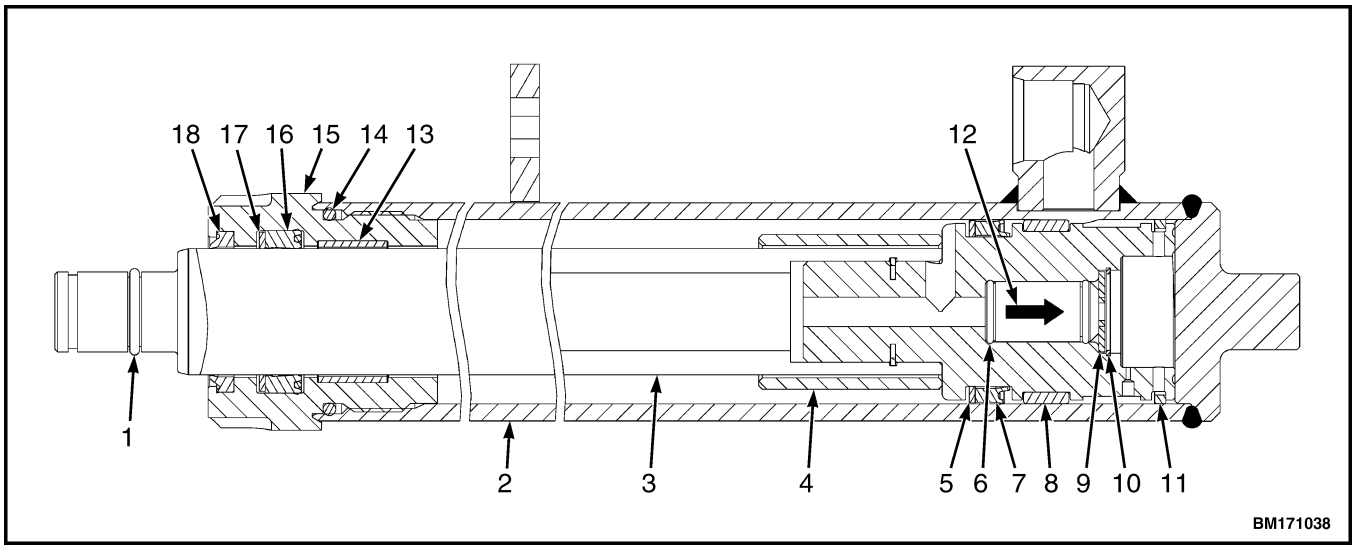
WARNING

Be careful when removing or install snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

5. Remove snap ring, washer and check valve from base of piston. See Figure 106.
6. Remove and discard O-ring from check valve. See Figure 106.
7. Remove spacer, if present, from rod assembly. See Figure 106.
8. Remove piston ring, wear ring, piston seal, backup ring, and spacer from base of piston. Discard wear ring and piston seal. See Figure 106.

NOTE: Perform Step 9 only if piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 106.



1. O-RING
2. TUBE
3. ROD ASSEMBLY
4. SPACER
5. BACKUP RING
6. O-RING
7. PISTON SEAL
8. WEAR RING
9. WASHER
10. SNAP RING
11. PISTON RING
12. CHECK VALVE
13. WEAR RING
14. O-RING
15. ROD SEAL
16. GLAND
17. BACKUP RING
18. ROD WIPER

Figure 106. 3-Stage FFL lift cylinder assembly

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the pant of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

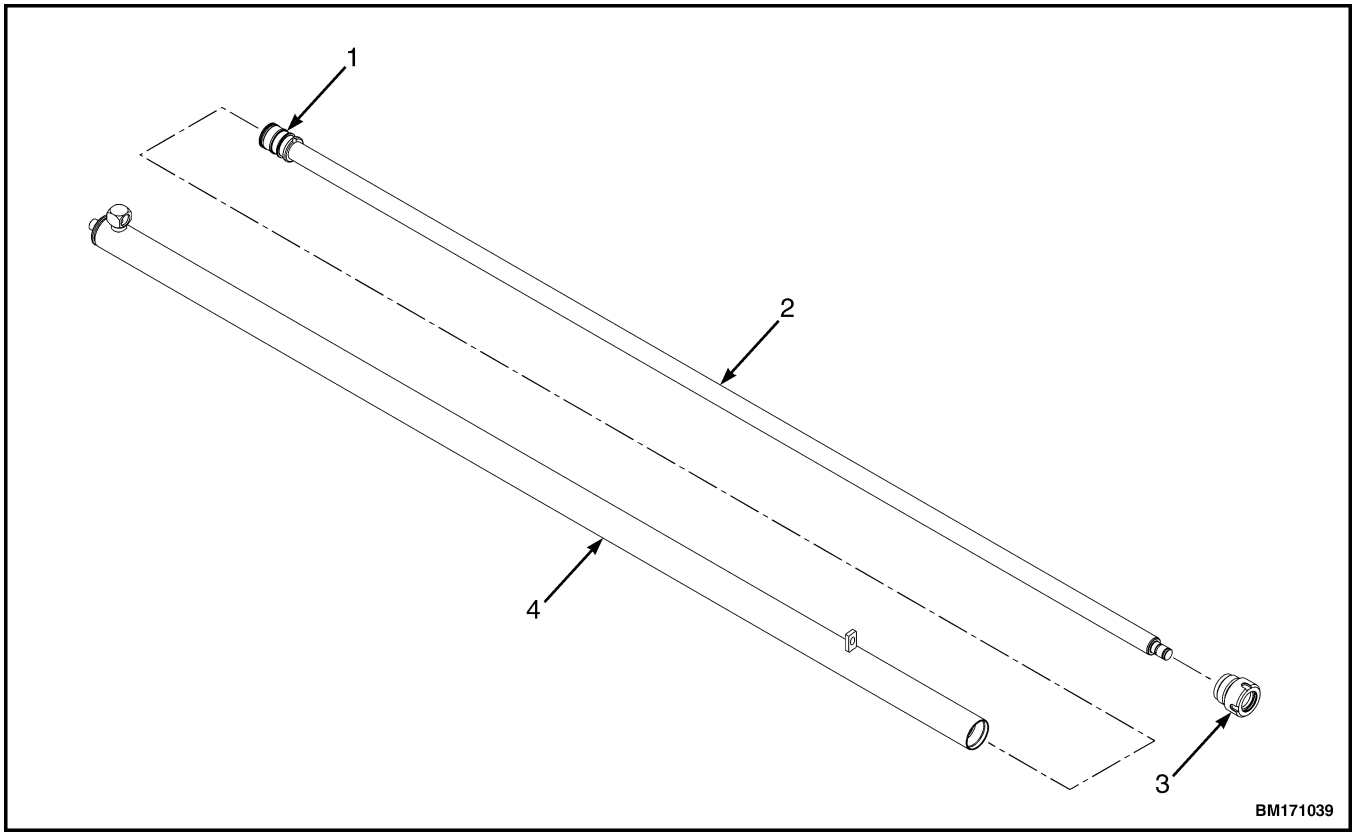
DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

NOTE: If any parts need to be replaced, see **Parts Manual** for replacement part.

1. Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland. See Figure 107.
2. Inspect the piston for damage to the seal surfaces. If damaged, replace piston. See Figure 107.
3. Inspect the rod for damage to the rod surface and ensure that the rod is not bent. If rod is damaged, replace rod. See Figure 107.
4. Inspect the inner surface of the cylinder tube for damage. If damaged, replace cylinder assembly. See Figure 107.



1. PISTON SEAL SURFACES
2. ROD SURFACE
3. GLAND THREADS AND SEAL SURFACES
4. INNER SURFACE OF CYLINDER TUBE

Figure 107. 3FFL cylinder inspection

Assemble

NOTE: Steps below contain procedures for both lift cylinders.

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform Step 2 only if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 140 to 200 N•m (103 to 148 lbf ft). See Figure 106.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install O-ring on check valve. Install check valve, washer, and snap ring on piston base. See Figure 106.

4. Install backup ring, piston seal, wear ring, and piston ring on piston. Install spacer, if removed, on rod and piston assemble. See Figure 106.

5. Install wear ring, O-ring, rod seal, backup ring, and rod wiper on gland. See Figure 106.

6. Install rod and piston assembly into tube. See Figure 106.

NOTE: To prevent possible damage to rod and piston assembly, use care when installing gland.

7. Install gland onto rod in tube. Tighten gland to 340 to 410 N•m (251 to 302 lbf ft). Install O-ring on rod. See Figure 106.

Install

NOTE: Make sure the mast is raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment.

NOTE: Steps below contain procedure for both main lift cylinders.

1. Using a lifting device, install lift cylinder on mast.
2. Install capscrew and nut on cylinder mounting plate and mast. Tighten nut to 40 N•m (30 lbf ft). See Figure 105.
3. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 105.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

4. Install shims and snap ring at top of lift cylinder.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.
6. Connect main lift chains and adjust as described in **Front End** 4000SRM2303.
7. Install carriage as described in **Front End** 4000SRM2303.
8. Lower mast completely.

FOUR-STAGE FULL-FREE-LIFT (FFL)

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

NOTE: The following procedures are for the removal of lift cylinders with the mast installed on truck.

1. Remove carriage as described in carriage removal procedures located in **Front End** 4000SRM2303.
2. Raise and chain the mast as instructed in **Safety Procedures When Working Near Mast** section. The mast must be chained before proceeding to the next step in this procedure. The mast needs to be raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

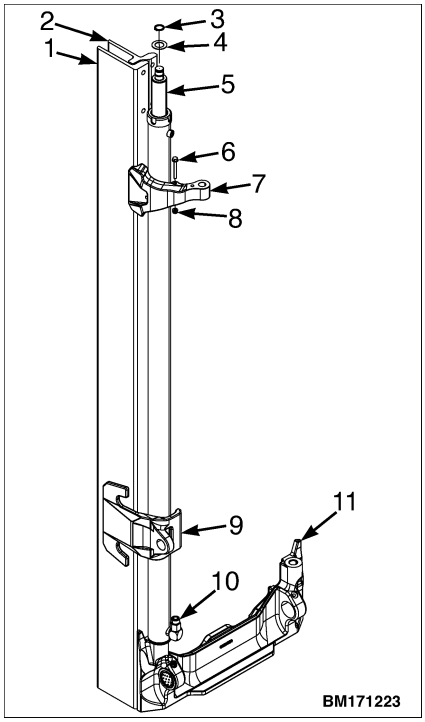
NOTE: Steps below contain procedure for both main lift cylinders.

3. Remove snap ring and shims (washers) at top of main lift cylinders. See Figure 108.
4. Put a drain pan, with a capacity of 3.8 liter (1 gal), under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain oil. Cap hydraulic lines and cylinder ports. See Figure 108.
5. Remove the capscrew and locknut at the mounting plate. See Figure 108.

WARNING

Cylinders can be heavy, weighing approximately 34.46 to 40.93 kg (75.97 to 90.24 lb). Make sure lifting devices are suitable and of adequate capacity to lift the cylinder.

6. Using a lifting device, remove lift cylinder from mast.



1. OUTER MAST
2. INTERMEDIATE MAST
3. SNAP RING
4. SHIM (WASHER)
5. MAIN LIFT CYLINDER
6. CAPSCREW
7. CHAIN SUPPORT ANCHOR
8. LOCKNUT
9. TILT ANCHOR
10. HYDRAULIC VELOCITY FUSE
11. OUTER BOTTOM CROSSMEMBER

Figure 108. 4-Stage FFL cylinder remove/install

Disassemble

Left-Hand main lift cylinder

1. Loosen gland with spanner wrench.

2. Remove O-ring and gland from rod and tube. See Figure 109.

3. Remove rod and piston assembly from cylinder. See Figure 109. Drain hydraulic oil into container.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove rod wiper, backup ring, rod seal, O-ring, and wear ring. Discard rod seal, O-ring, and wear ring. See Figure 109.

WARNING

Be careful when removing or install snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

5. Remove snap ring, washer and check valve from base of piston. See Figure 109.

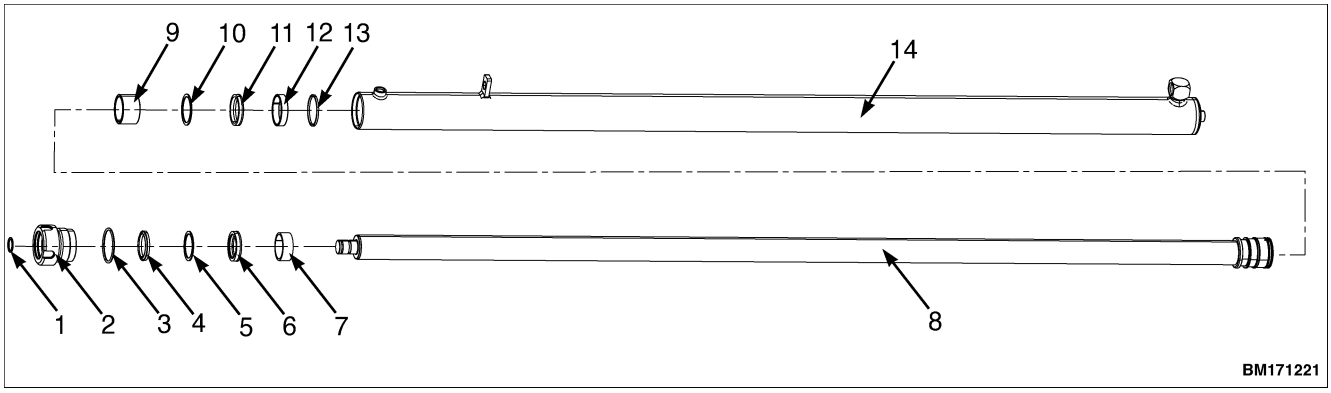
6. Remove and discard O-ring from check valve. See Figure 109.

7. Remove spacer, if present, from rod assembly. See Figure 109.

8. Remove piston ring, wear ring, piston seal, backup ring, and spacer from base of piston. Discard wear ring and piston seal. See Figure 109.

NOTE: Perform Step 9 only if piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 109.



1. O-RING
2. GLAND
3. O-RING
4. ROD WIPER
5. BACK UP RING
6. SEAL
7. WEAR RING
8. ROD ASSEMBLY
9. SPACER
10. BACK UP RING
11. PISTON RING
12. WEAR RING
13. PISTON RING
14. TUBE

Figure 109. Left-Hand main lift cylinder

Right-Hand main lift cylinder

1. Loosen gland with spanner wrench.

2. Remove O-ring and gland from rod and tube. See Figure 110.

3. Remove rod and piston assembly from cylinder. See Figure 110. Drain hydraulic oil into container.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove rod wiper, backup ring, rod seal, O-ring, and wear ring. Discard rod seal, O-ring, and wear ring. See Figure 110.

WARNING

Be careful when removing or install snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

5. Remove snap ring, washer and check valve from base of piston. See Figure 110.

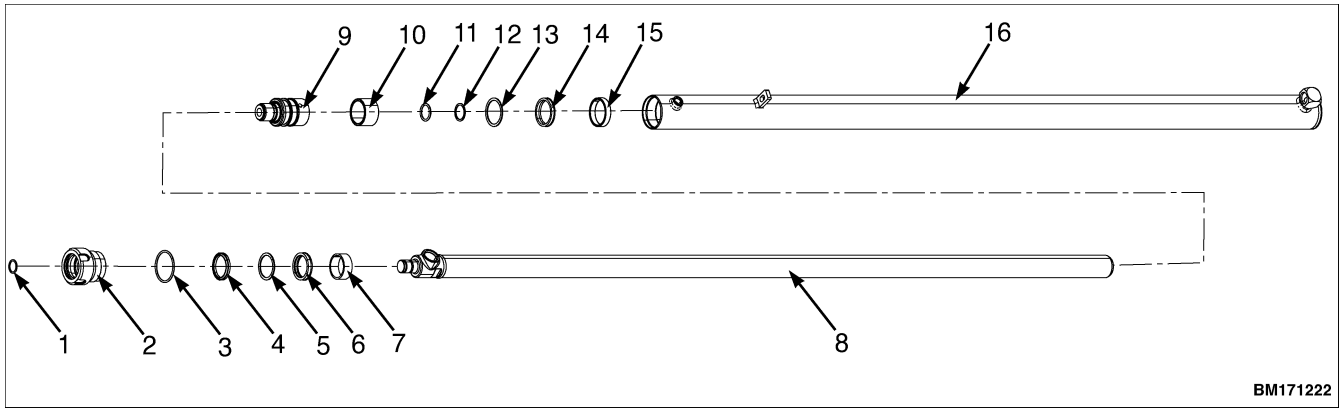
6. Remove and discard O-ring from check valve. See Figure 110.

7. Remove spacer, if present, from rod assembly. See Figure 110.

8. Remove piston ring, wear ring, piston seal, backup ring, and spacer from base of piston. Discard wear ring and piston seal. See Figure 110.

NOTE: Perform Step 9 only if piston is damaged.

9. Remove piston from rod using spanner wrench. See Figure 110.



1. O-RING
2. GLAND
3. O-RING
4. ROD WIPER
5. BACK UP RING
6. SEAL
7. WEAR RING
8. ROD ASSEMBLY
9. PISTON CYLINDER
10. SPACER
11. O-RING
12. BACK UP RING
13. BACK UP RING
14. PISTON SEAL
15. WEAR RING
16. TUBE

Figure 110. Right-Hand main lift cylinder

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the pant of the compressed air is away form all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

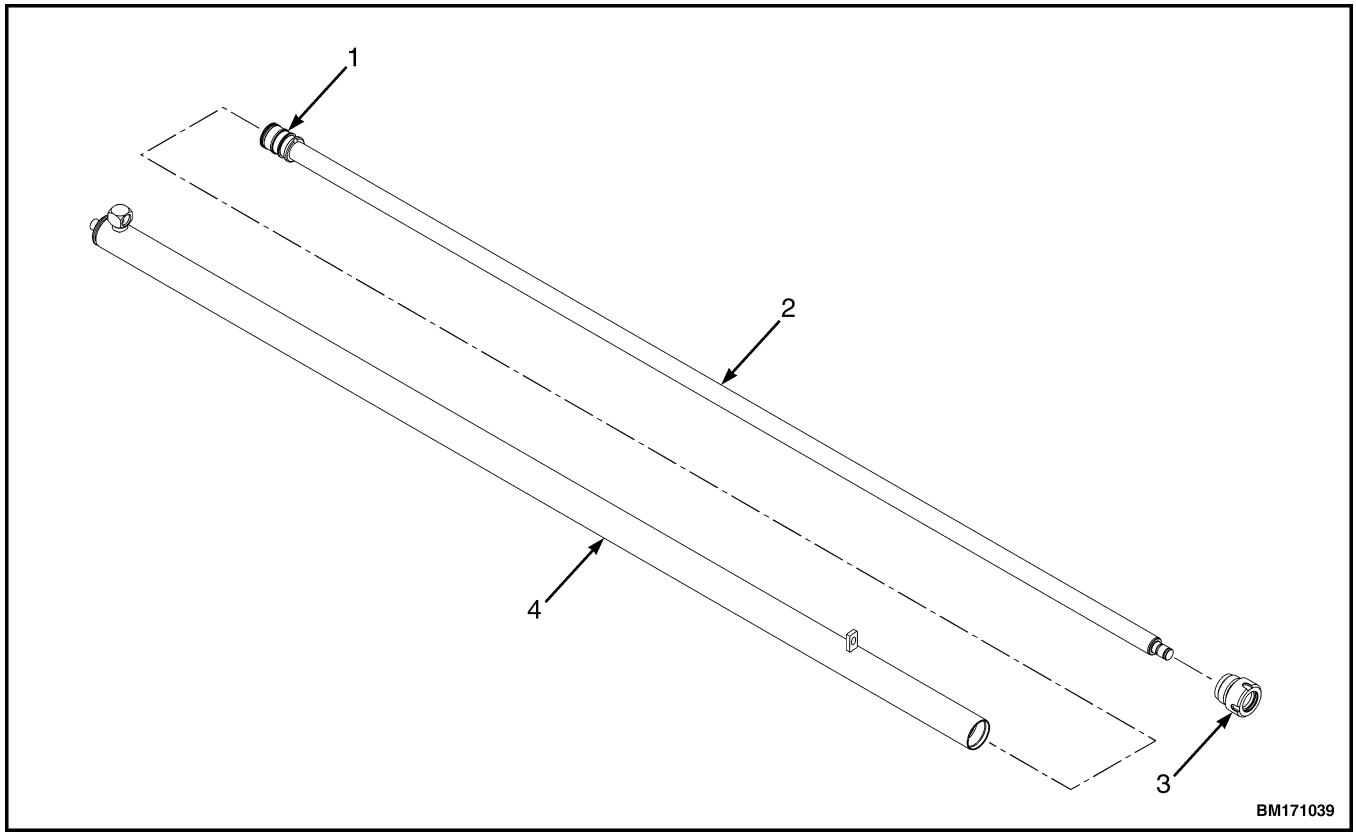
DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

NOTE: If any parts need to be replaced, see **Parts Manual** for replacement part.

1. Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland. See Figure 111.
2. Inspect the piston for damage to the seal surfaces. If damaged, replace piston. See Figure 111.
3. Inspect the rod for damage to the rod surface and ensure that the rod is not bent. If rod is damaged, replace rod. See Figure 111.
4. Inspect the inner surface of the cylinder tube for damage. If damaged, replace cylinder assembly. See Figure 111.



1. PISTON SEAL SURFACES
2. ROD SURFACE
3. GLAND THREADS AND SEAL SURFACES
4. INNER SURFACE OF CYLINDER TUBE

Figure 111. 3FFL cylinder inspection

Assemble

NOTE: Steps below contain procedures for both lift cylinders.

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil. Use new O-rings, seals, and wear rings.

NOTE: Perform Step 2 only if piston was removed from rod.

2. Install piston onto rod. Tighten piston to 140 to 200 N•m (103 to 148 lbf ft). See Figure 109 or Figure 110.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by leal leaks. DO NOT damage any parts during assembly.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

3. Install O-ring on check valve. Install check valve, washer, and snap ring on piston base. See Figure 109 or Figure 110.

4. Install backup ring, piston seal, wear ring, and piston ring on piston. Install spacer, if removed, on rod and piston assemble. See Figure 109 or Figure 110.

5. Install wear ring, O-ring, rod seal, backup ring, and rod wiper on gland. Figure 109 or Figure 110.

6. Install rod and piston assembly into tube. See Figure 109 or Figure 110.

NOTE: To prevent possible damage to rod and piston assembly, use care when installing gland.

7. Install gland onto rod in tube. Tighten gland to 340 to 410 N•m (251 to 302 lbf ft). Install O-ring on rod. See Figure 109 or Figure 110.

Install

NOTE: Make sure the mast is raised high enough for the bottom of the cylinder to clear the crossmember on the outer mast weldment.

NOTE: Steps below contain procedure for both main lift cylinders.

1. Using a lifting device, install lift cylinder on mast.

2. Install capscrew and nut on cylinder mounting plate and mast. Tighten nut to 40 N•m (30 lbf ft). See Figure 108.

3. Uncap hydraulic lines and cylinder ports. Connect hydraulic lines to cylinder ports. See Figure 108.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

4. Install shims and snap ring at top of lift cylinder.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

5. Dispose of drain pan contents.

6. Connect main lift chains and adjust as described in **Front End** 4000SRM2303.

7. Install carriage as described in **Front End** 4000SRM2303.

   Lower mast completely.

FREE-LIFT CYLINDER

Remove

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast.

1. Remove carriage as described in **Front End** 4000SRM2303.

WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until the oil in the system is cool.

2. Put a drain pan, with a capacity of 3.8 liter (1 gal), under the area of the hydraulic fittings. Disconnect hydraulic lines at lift cylinder and drain hydraulic oil. Cap hydraulic lines and cylinder ports. See Figure 113.

   Put drain pan under the area of the hydraulic fittings.

   Disconnect hydraulic lines at free-lift cylinder and drain oil from cylinder. Cap hydraulic lines and cylinder ports.

3. Remove capscrew, two washers, pin, and chain guard from right side of crosshead. Repeat for left side of crosshead. See Figure 112.

4. Remove lift chains from chain sheaves.

NOTE: Note placement of components during removal to aid in installation.

5. Remove brackets, capscrews, washers, and nuts holding free-lift cylinder to mast. See Figure 113.

WARNING

Cylinders can be heavy, weighing approximately 23.2 to 42.5 kg (51.1 to 93.8 lb). Make sure lifting devices are suitable and of adequate capacity to lift the cylinder.

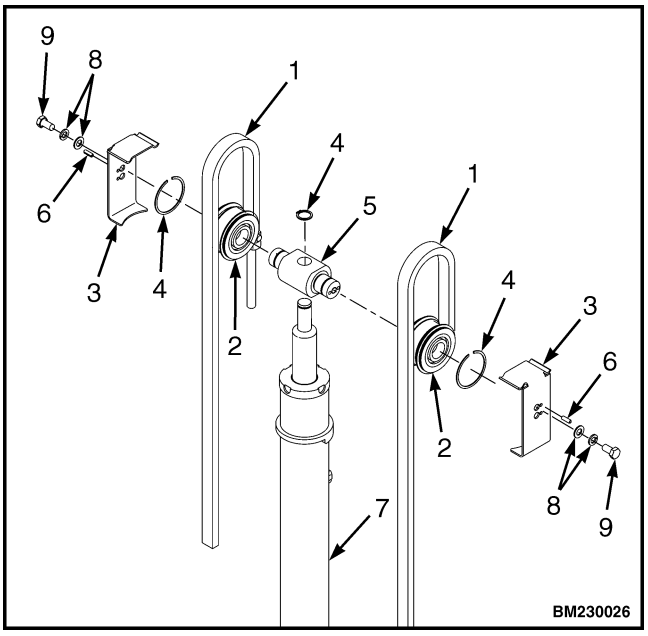
6. Using a lifting device, as necessary, remove free-lift cylinder from mast.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

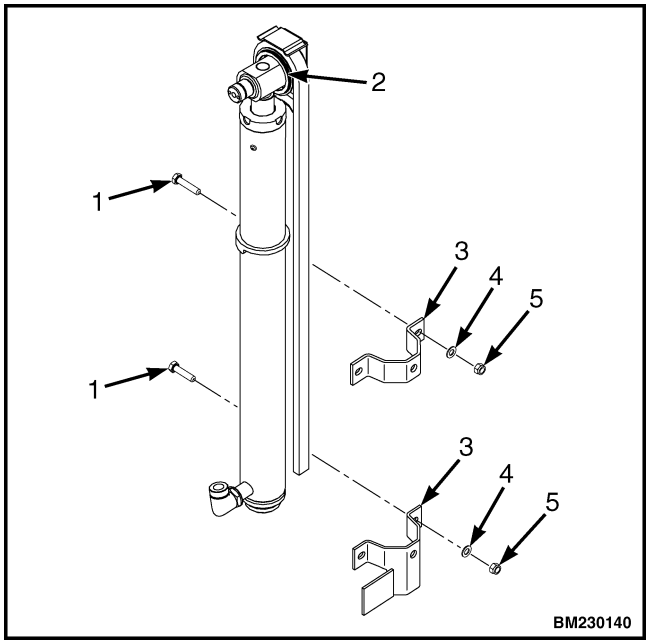
7. Remove snap ring and chain sheaves from crosshead. See Figure 112.

8. Remove snap ring and crosshead from cylinder rod. Disassemble crosshead as necessary. See Figure 112.



1. LIFT CHAIN
2. CHAIN SHEAVE
3. CHAIN GUARD
4. SNAP RING
5. CROSSHEAD
6. PIN
7. FREE-LIFT CYLINDER
8. WASHER
9. CAPSCREW

Figure 112. Crosshead assembly



1. CAPSCREW
2. CROSSHEAD ASSEMBLY
3. BRACKET
4. WASHER
5. NUT

Figure 113. Free-Lift cylinder mounting

Disassemble

NOTE: Perform only those steps below required to repair free-lift cylinder.

1. Loosen gland with spanner wrench.

2. Remove gland from rod and shell. See Figure 114.

3. Remove rod and piston assembly from shell. Drain any remaining hydraulic oil into drain pan.

NOTE: To prevent damage to sealing surfaces, use brass tools when removing seals and O-rings.

4. Remove and discard rod wiper, rod seal, backup ring, and O-ring from gland. See Figure 114.

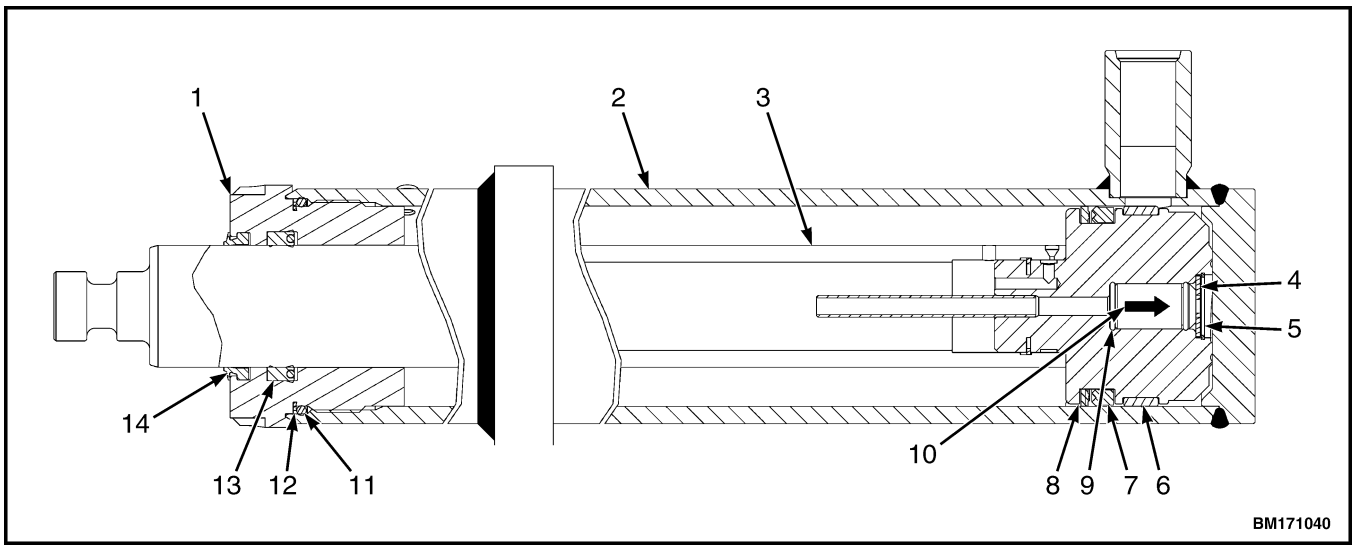
5. Remove and discard wear ring, rod seal, and backup ring from piston. See Figure 114.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

6. Remove snap ring, washer, and check valve from piston base. Remove and discard O-ring from check valve. See Figure 114.

7. Remove capscrew and seal from shell. Discard seal. See Figure 114.



1. ROD WIPER
2. ROD SEAL
3. BACKUP RING
4. O-RING
5. CHECK VALVE
6. O-RING
7. BACKUP RING
8. PISTON SEAL
9. WEAR RING
10. SNAP RING
11. WASHER
12. GLAND
13. CAPSCREW
14. SEAL
15. SHELL
16. ROD AND PISTON ASSEMBLY

Figure 114. Free-Lift cylinder assembly

Clean

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they cause injury to the user or to other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvent to come in contact with rubber components. It will damage those components.

Clean all metal parts in solvent and dry with compressed air.

Inspect

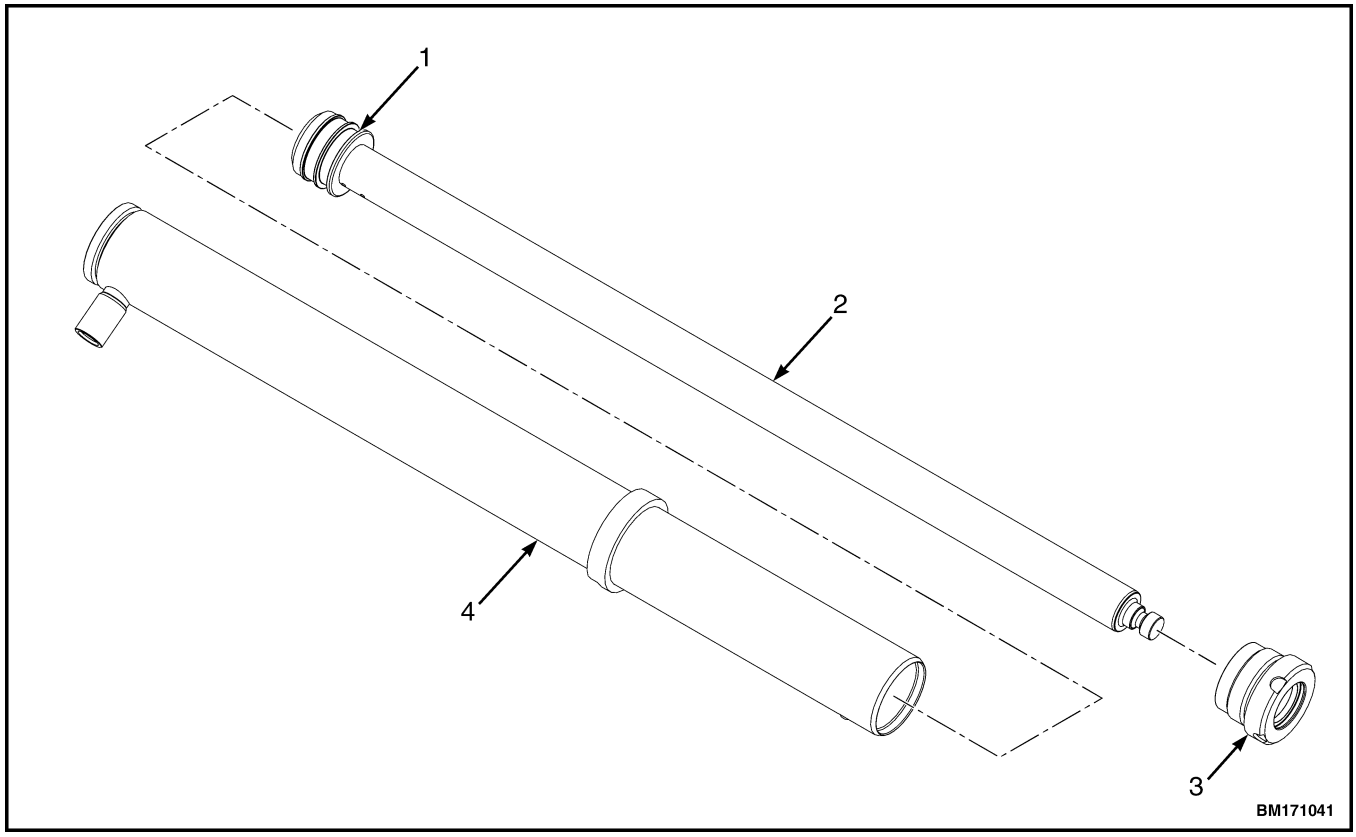
NOTE: If any parts need to be replaced, see **Parts Manual** for replacement part.

Inspect the gland for damage to the threads and the seal surfaces. If damaged, replace gland. See Figure 115.

Inspect the piston for damage to the seal surfaces. If damaged, replace piston. See Figure 115.

Inspect the rod for damage to the rod surface and ensure that the rod is not bent. If rod is damaged, replace rod. See Figure 115.

Inspect the inner surface of the cylinder tube for damage. If damaged, replace cylinder assembly. See Figure 115.



1. PISTON SEAL SURFACES
2. ROD SURFACE
3. GLAND THREADS AND SEAL SURFACES
4. INNER SURFACE OF CYLINDER TUBE

Figure 115. Free-Lift cylinder inspection

Assemble

1. Lubricate all internal parts of the free-lift cylinder with clean hydraulic oil. Use new O-rings, seals, backup rings, and wear ring.

NOTE: To prevent damage to sealing surfaces, use brass tools when installing seals and O-rings.

2. Install O-ring onto check valve. See Figure 114.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Install check valve, washer, and snap ring into piston base. Make sure arrow on check valve is toward piston base. See Figure 114.

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. DO NOT damage any parts during assembly.

4. Install backup ring, rod seal, and wear ring onto piston. See Figure 114.

5. Install backup ring, O-ring, rod sea, and rod wiper onto gland. See Figure 114.

6. Install rod and piston assembly into shell.

NOTE: To prevent possible damage to rod and piston assembly, use care while installing gland.

7. Install gland onto rod in shell. Tighten gland to 475 to 540 N•m (350 to 398 lbf ft). See Figure 114.

CAUTION

Additives may damage the hydraulic system. Before using additives, contact your local Hyster dealer.

8. Pour 150 cc (5 oz) hydraulic oil into cylinder through the capscrew hole. This oil provides a hydraulic cushion when cylinder reaches the top of its stroke. Install new stato seal and special capscrew. Tighten special capscrew to 6 to 8 N•m (53 to 71 lbf in). See Figure 102.

Install

1. Assemble crosshead, if disassembled. Install crosshead and snap ring onto cylinder rod. Tighten crosshead capscrews to 435 N•m (321 lbf ft). See Figure 112.

2. Install chain sheaves and snap rings onto crosshead. See Figure 112.

3. Using lifting device, install free-lift cylinder into mast.

4. Install brackets, washers, capscrews, and nuts onto crossmembers to hold free-lift cylinder on mast as noted during removal. Tighten nuts to 53 N•m (39 lbf ft). See Figure 113.

5. Install lift chains to chain sheaves. See Figure 112.

6. Install chain guard, pin, two washers, and capscrew into crosshead. Tighten capscrews to 38 N•m (28 lbf ft). See Figure 112.

CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

7. Uncap hydraulic line and cylinder port. Connect hydraulic line to free-lift cylinder. Dispose of drain pan contents.

8. Install carriage to mast. See **Front End** 4000SRM2303.

9. Adjust free-lift cylinder as described in **Front End** 4000SRM2303.

SEAL KIT INSTALLATION

External Installation (Seal and Backup Ring)

NOTE: It is recommended that seal is heated in hydraulic oil prior to installation to make it more flexible and pliable.

1. Lubricate seal, backup ring, external installation sleeve, and piston rod groove with hydraulic oil.

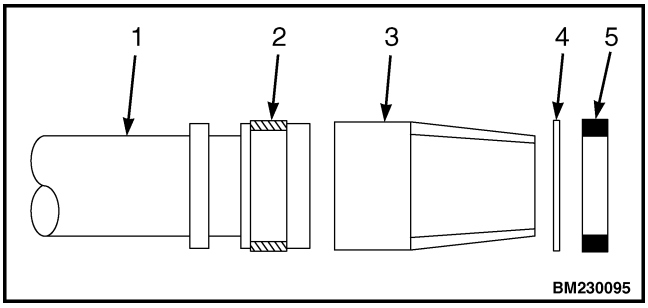
2. Install wear ring onto piston rod assembly. See Figure 116.

3. Slide external installation sleeve over piston rod assembly and wear ring.

4. Install backup ring into piston rod groove. See Figure 116.

5. Slide seal over external installation sleeve and into piston rod groove.

6. Remove external installation sleeve. See Figure 116.



1. PISTON ROD ASSEMBLY
2. WEAR RING
3. EXTERNAL INSTALLATION SLEEVE
4. BACKUP RING
5. SEAL

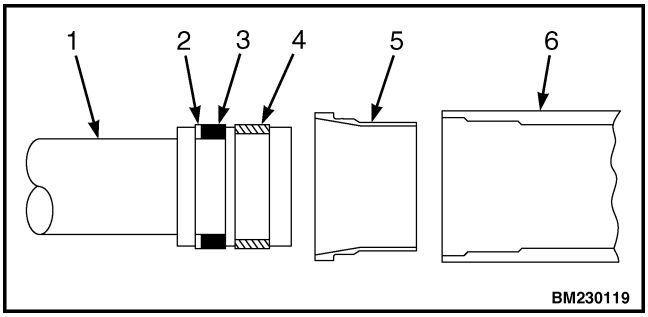
Figure 116. Cylinder external seal installation

Internal Installation (Piston Rod Assembly)

1. Insert internal installation sleeve into end of cylinder tube. See Figure 117.

2. Install piston rod assembly into cylinder tube.

3. Remove internal installation sleeve from cylinder tube and piston rod assembly. See Figure 117.



1. PISTON ROD ASSEMBLY
2. BACKUP RING
3. SEAL
4. WEAR RING
5. INTERNAL INSTALLATION SLEEVE
6. CYLINDER TUBE

Figure 117. Cylinder internal installation

LIFT CYLINDER LEAK CHECK

WARNING

During the test procedures for the hydraulic system, use chains to fasten the load to the carriage to prevent it from falling. Keep all people away from the lift truck during the tests.

Do NOT try to find hydraulic leaks by putting your hand on hydraulic components under pressure. Hydraulic oil can be injected into the body by the pressure.

1. Operate hydraulic system. Put capacity load on forks. Use safety chain to hold load to carriage. Raise and lower load several times. Lower load and tilt mast forward and backward several times. Check for leaks.

2. Raise carriage and load 1 m (3 ft). If carriage slowly lowers when control valve is in **NEUTRAL** position, there are leaks in the hydraulic system. The maximum speed the carriage is allowed to lower is 50 mm (2 in.) per 10 minutes when hydraulic oil is 30°C (86°F). If oil temperature is 70°C (158°F), the maximum speed the carriage can lower is 150 mm (6 in.) per 10 minutes.

3. Check lift cylinders for internal leaks. Remove load from forks. Install valve in supply line between main control valve and mast. Put capacity load on forks again. Raise carriage 1 m (3 ft). Close valve. If carriage or mast lower slowly, seals in lift cylinders have leaks.

4. If carriage does not move, open valve and check movement again. If carriage lowers when valve is open, check for leaks in hydraulic lines and fittings. If no leaks are found, main control valve can be worn or damaged. Remove load from forks.

INTEGRAL SIDESHIFT CYLINDER REPAIR 202001-208

GENERAL

This section outlines the integral sideshift cylinder repair procedures for lift truck models H40A-70A (H2.0A-H3.5A, H2.5A6) (R177).

REMOVE

WARNING

Before working on or near the mast, see the Safety Procedures When Working Near Mast section of the Front End 4000SRM2303 **service manual.**

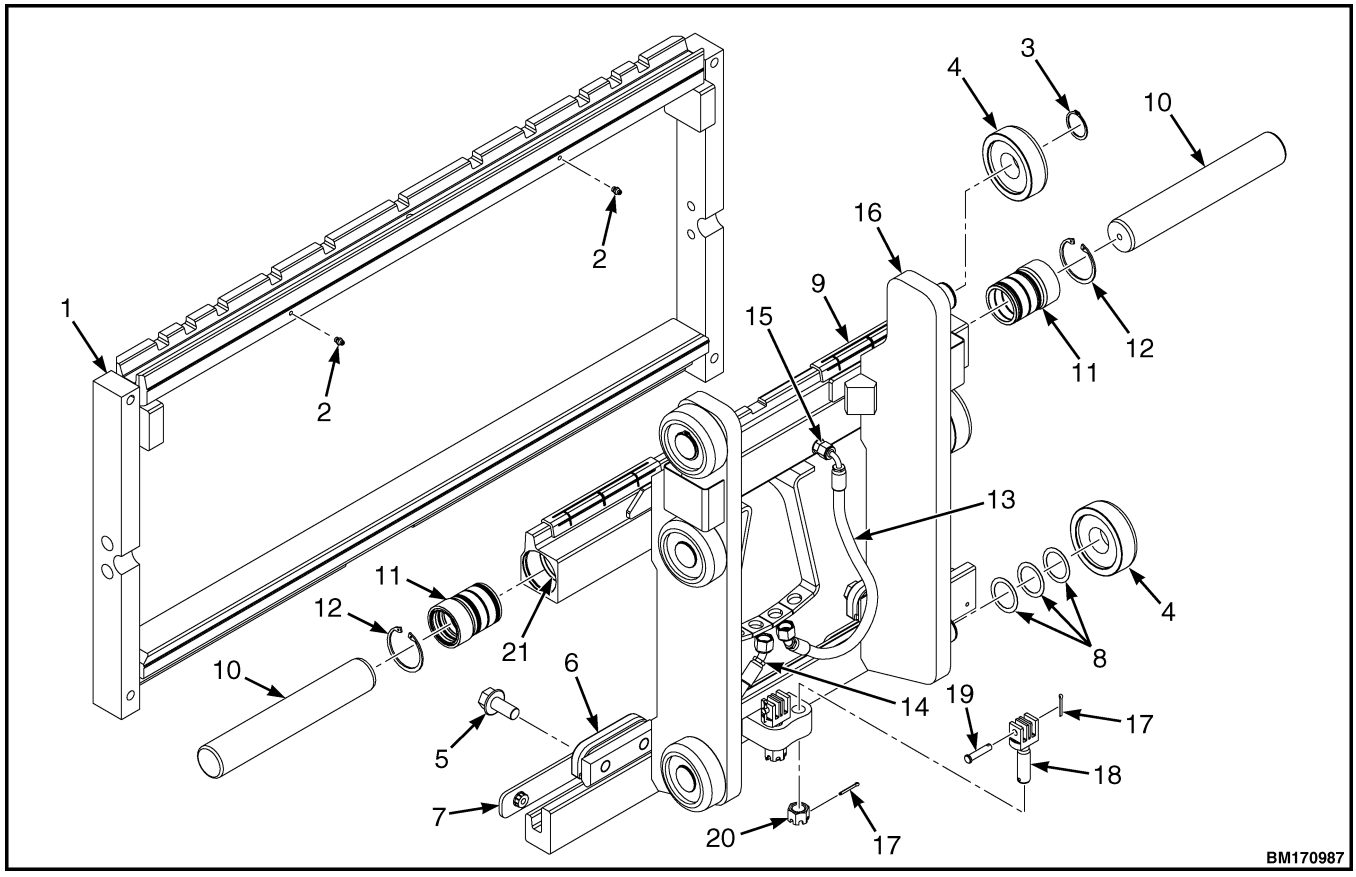
WARNING

Hydraulic oil is hot after system operation and can cause burns. DO NOT disconnect any hydraulic hoses until oil in the system is cool.

1. Remove the outer frame from the carriage as described in the Carriage repair, 3-stage full free lift section of the **Front End** 4000SRM2303 service manual.

NOTE: Remove the integral sideshift cylinder only as necessary for repairs. Most repairs to the integral sideshift cylinder will be for replacement of O-rings, wipers, and seals, to stop leaks. If any of these parts must be replaced, see **Parts Manual.**

2. Locate the cylinder rod and gland assembly for each side. See Figure 118.



1. OUTER FRAME
2. LUBE FITTING
3. SNAP RING
4. LOAD ROLLER
5. CAPSCREW
6. HOOK
7. LOWER BEARING
8. SHIM
9. UPPER BEARINGS
10. CYLINDER ROD
11. GLAND ASSEMBLY
12. SNAP RING
13. HOSE
14. HOSE
15. FITTING
16. INNER FRAME
17. COTTER PIN
18. CHAIN ANCHOR
19. CHAIN ANCHOR PIN
20. NUT
21. CYLINDER BORE

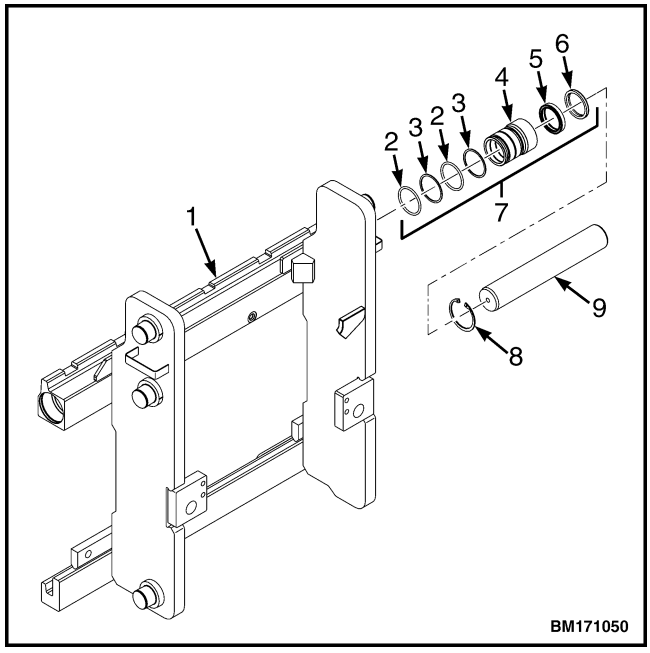
Figure 118. Integral Sideshift Component Parts

3. Pull one of the cylinder rods free from the cylinder bore of the inner frame. See Figure 118.

4. Remove the snap ring securing the gland assembly inside the cylinder bore.

5. Pull the gland assembly free of the cylinder bore of the inner frame.

6. Remove the seal, wiper, and O-ring from the gland assembly with a brass O-ring tool. **DO NOT** scratch cylinder grooves. See Figure 119.



1. INTEGRAL SIDESHIFT CYLINDER TUBE
2. O-RING
3. BACK-UP RING
4. GLAND
5. SEAL
6. ROD WIPER
7. GLAND ASSEMBLY
8. SNAP RING
9. CYLINDER ROD

Figure 119. Integral Sideshift Cylinder

7. Repeat Step 2 through Step 6 for the cylinder on the opposite side of the inner frame. See Figure 118.

CLEAN

WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

WARNING

Compressed air can move particles so they can cause injury to the user or other personnel. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

CAUTION

DO NOT allow cleaning solvents to come in contact with rubber components. It will damage those components.

Clean the gland and cylinder rod with cleaning solvents and dry with compressed air. See Figure 119.

INSPECT

Inspect the cylinder rod for damage to the surface and ensure that the cylinder rod is not bent or scored. If damaged, replace the cylinder rod. See **Parts Manual.**

ASSEMBLE

1. Assemble the integral sideshift cylinder as follows:

   a. Lubricate new O-ring, seals, and wipers with clean hydraulic oil.

   b. Install seal, wiper, and O-ring into the gland grooves.

   c. Form seals and O-rings into a "kidney" shape (see Figure 120) to ease placement into the grooves. Note the direction of the seals. **Pressure seals are installed with the lip toward the pressure side of the cylinder (facing the inner frame of the integral sideshift carriage). See Seal Kit Installation.**

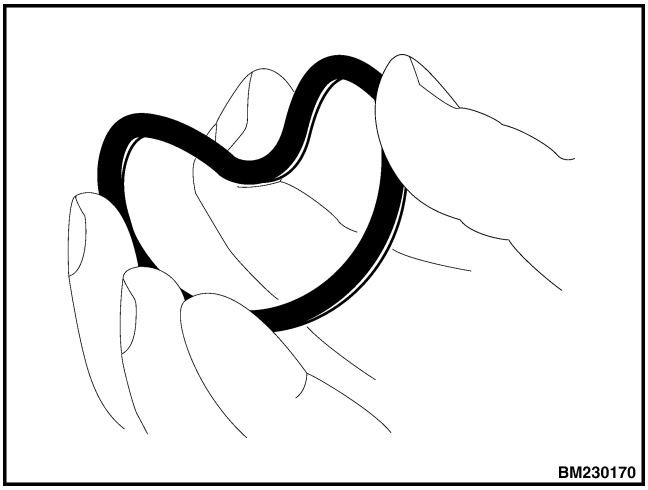


Figure 120. Forming Seals Into Kidney Shape Prior To Installation

INSTALL

1. Make sure the inside of the cylinder bore on the inner frame is free of all sediment and other particles.

2. Apply a thin film of hydraulic oil to the inside of the cylinder bore.

3. Push the gland assembly (with seal, wiper, and O-ring installed), into the cylinder bore.

4. Insert the snap ring into the cylinder bore and fully seat to secure the gland assembly. See Figure 119.

5. Insert the cylinder rod into the gland assembly, leaving no more than 75 mm (2.9 in.) of the cylinder rod exposed from the face of the gland, to allow for installation of outer frame.

6. Install the outer frame of the carriage back onto the inner frame. See the Carriage repair, 3-stage full free lift section of the **Front End** 4000SRM2303 service manual.

7. Install the carriage back onto the mast. See the Carriage repair, 3-stage full free lift section of the **Front End** 4000SRM2303 service manual.

INTEGRAL SIDE-SHIFT CYLINDER GLAND LEAK CHECKS

If a leak on one of the glands is suspected, clean the integral side-shift cylinder assembly of grease and dirt, then actuate cylinder at least five full strokes, lock to lock. If a leak is still suspected, perform the following to correct any leaks

1. Inspect the snap ring used for securing the gland assembly, to confirm it is fully seated and functional.

2. If a leak is still suspected, remove the cylinder rod, snap ring, and gland assembly. Inspect the O-ring, backup ring and seal. Replace component if damage is found. See **Parts Manual**.

3. If a leak is still occurring after performing Step 1 and Step 3, replace the entire rod and gland assembly with new parts. See **Parts Manual**.

Hydraulic cleanliness

FLUSHING HYDRAULICS AFTER REPAIR 202001-069

HYDRAULIC SYSTEM FLUSHING TECHNIQUES

Techniques for flushing hydraulic systems vary in cost and complexity. Before discussing some of these methods, let's first distinguish between **Flushing the Fluid** and **Flushing the System**.

- The objective of **Flushing the Fluid**, commonly referred to as Fluid Conditioning, is to eliminate contaminants such as particles and water. This is usually accomplished using a filter caddy or by diverting system flow through an external fluid-conditioning tool. If there is substantial component failure, **Flushing the System** is advised to removed contaminated oil from all components.
- The objective of **Flushing the System** is to eliminate sludge, varnish, debris and contaminated or degraded fluid from the reservoir, conductor walls, other component internal surfaces and system dead spots. Flushing the system is always advisable after a major component failure, which could introduce contamination into system components.

The technique or combination of techniques selected will depend on the type of system and its size, your reliability objectives for the equipment and the reason for the flush.

Double Oil and Filter Change

CAUTION

There is risk of secondary failures in steering control units and control valves if residual contaminants are not removed from the system.

NOTE: This procedure should only be used for lightly contaminated systems or degraded fluid and not for systems that have experienced major component failures. Perform fluid sampling practices to determine how contaminated a system is. See Hydraulic oil sampling.

NOTE: The installation of large volumes of new oil and disposal of the contaminated oil can be costly. If the oil is not degraded, this is a waste of oil since it is contaminated but not degraded. The filter caddy can be used to "condition the fluid" by removing the particles and water.

This technique involves an initial oil drain and filter change, which removes a large percentage of contaminants and degraded fluid. The system is then filled with pre-filtered oil and the fluid circulated at low pressure until operating temperature is reached, each hydraulic function has been operated three full cycles, and the fluid has been turned over at least five times.

The oil is drained, system refilled with filtered oil and the filters changed a second time. After the fluid has been circulated, each circuit operated three full cycles, and the system warmed to operating temperature, an appropriate oil sample should be taken to determine the success of the flush.

Mechanical Cleaning

The use of mechanical cleaning after a major pump or cylinder failure must be incorporated in the flushing strategy. This involves the use of a pneumatic projectile gun and sponge projectiles to clean tubes and hoses. It also involves disassembly of other components for cleaning using brushes and clean solvents. It is essential that the reservoir is mechanically cleaned to remove residual contamination particles.

Mechanical cleaning is labor intensive, but is the most effective method for restoring the system to reliable operation after major mechanical failure.

Cleaning of Components

Plumbing should be cleaned in isolation from pumps, valves and actuators. These can be cleaned while still installed in the equipment as discussed in the following sections. The decision to disassemble and mechanically clean components will depend on the type of equipment, your reliability objectives and the reason for the flush. Once the conductors and components have been cleaned and clean oil is installed, valves and actuators can be gradually included in the flushing circuit as the process proceeds.

For more hydraulic cleanliness procedures, see Proper Flushing after Major Hydraulic Repairs in **Hydraulic Cleanliness Procedures** 1900SRM1620 for procedure.

FLUID CONDITIONING AND SYSTEM FLUSHING 202001-070

OPERATION OF THE FILTER CADDY

WARNING

Read the safety messages in the operating manual of the filter caddy. Follow these warnings and instructions carefully. Review them frequently. Be sure all operators of the filter caddy understand every safety message. Replace safety labels immediately if missing or damaged.

The filter caddy is designed to remove particulate contamination in fluid powered systems. The filter caddy is an oil filtering system that captures contaminant particles using a high performance filter(s). The filter caddy can also be equipped with an optional water removal filter that can be used in place of one of the standard filters to remove free water. The filter caddy can also be used to transfer fluid from an oil drum to the truck reservoir, or to condition the fluid (clean up fluid) already in the truck reservoir as part of a preventive maintenance program.

Filter caddy operation

DANGER

The Mobile Filtration System is designed for the transfer and filtering of hydraulic and lubrication oils only. It is not to be used for highly volatile fluids such as gasoline or paint thinners. Failure to follow this warning could lead to death or serious injury.

CAUTION

Never start or run a dry pump. Allowing the pump to run without fluid flowing through it will greatly reduce pump life. During fluid transfer operation it is critical that the pump inlet stay submerged in fluid. Failure to do so will cause galling, seizing or destructive wear between the rotors, end plates and casting.

CAUTION

The maximum operating temperature for the filter caddy is 65°C (150°F). Higher operating temperatures could lead to hose damage.

CAUTION

The 1½ HP electric motor draws 12.6/6.3 amps at 115/230 volts, 60 Hz at full load. Starting current is approximately 88/44 amps at 115/230 volts, 60 Hz. A proper circuit breaker should be installed to protect the motor and meet national and local electric codes. Recommended size for an extension cable is 12-3 conductor with a maximum length of 25 feet.

NOTE: Minimal repair service is generally required on filter caddies. It is recommended that any failed parts be replaced with new parts. For parts list, see the **Parts Manual** for your lift truck model.

NOTE: Below are summarized instructions for operating the filter caddy. See the filter caddy operating manual for full details.

NOTE: All safety procedures associated with the operation of electrical powered equipment must be observed.

1. On a new unit, prime the suction hose to ensure the pump does not run dry. Pumps that are allowed to run dry will not be covered by warranty.

2. Place the suction hose into the fluid to be filtered or transferred. Place the discharge hose into the machinery reservoir or waste container depending on desired operation. Ensure that the wands are secured to avoid possible fluid loss.

3. Ensure selector switch is in **OFF** position. Check that the power source being utilized complies with the requirements of the filtration cart motor before actual hook-up. To energize the unit, connect to appropriate electrical outlet.

4. Switch on the Mobile Filtration System's motor. Visually check that the fluid is actually being pumped through the filter unit and out of the outlet hose.

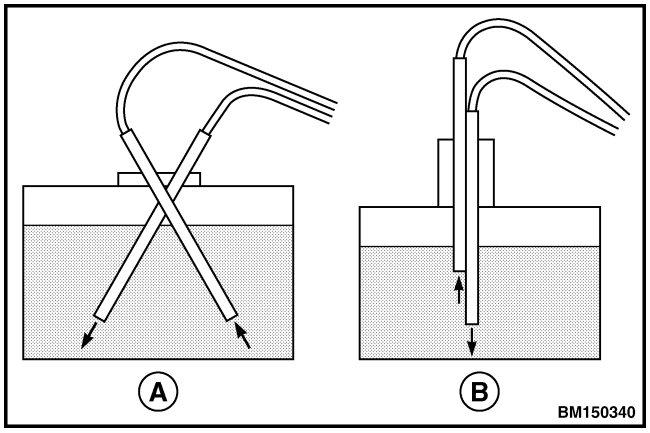
FLUID CONDITIONING PROCEDURE

Fluid conditioning is used to eliminate contaminants such as particles and water as part of a preventive maintenance program. Fluid conditioning can be accomplished using a filter caddy. It is usually done in response to a Fluid Analysis Report that shows higher than normal contaminant particle counts or high water content and can be done as long as the additives have not degraded. If the water content is high, install a water removal filter on the filter caddy. If the additives have degraded, the system fluid needs to be drained and replaced with new fluid. Fluid conditioning does not address significant contamination that results from major component failures that have spread contamination throughout the system. See System flushing procedure below if there has been a major component failure.

NOTE: Wand positioning is an important part of maximizing the cleaning speed of the filter caddy. In order to ensure the proper cleaning of the reservoir fluid, position the ends of both the inlet and the outlet hose or tube as far apart as possible inside the reservoir.

1. Remove the filter housing cap, filter element, and element bowl to allow full access to the reservoir interior.

2. Position the filter wands inside the reservoir per the following guideline:
   - The best situation occurs when the reservoir has a large but short opening. That way the wands can be crossed and separated to create turbulence throughout the reservoir and filter the fluid faster. When the reservoir opening is smaller and has a long or narrow opening, the wands have to be offset at different heights. See Figure 121. In this orientation, the flow and cleaning speed will be lower than the widely separated tubes.



A. CROSSED CONFIGURATION
B. OFFSET CONFIGURATION

Figure 121. Filter station wand configuration

Filter caddy start-Up

After set up is complete, the filter caddy is now ready for start-up and cleaning of the reservoir fluid.

1. Run the reservoir cleaning process for the time outlined in Table 4. Different filter machines have different flow rates, requiring different run times to achieve the required cleanliness. If not utilizing one of the listed filter units, see the operating manual for the flow rate and filter Beta rating of your filter caddy to determine if the run time needs to be adjusted upward. Reduced flow rates, lower filter Beta ratings, and fewer filters in series require longer flushing times.

2. After the run time has been completed, install the filter element bowl, a new filter element, and filter housing cap.

3. The system is now ready to start.

4. Operate the individual hydraulic functions until the system is up to operating temperature (50°C (120°F)).

5. Take an oil sample from designated test port and send off for analysis.

6. Return lift truck to service.

7. Review oil analysis report to ensure fluid has been sufficiently cleaned. Repeat conditioning sequence if required.

SYSTEM FLUSHING PROCEDURE

System flushing is used to eliminate sludge, varnish, debris, contaminated or degraded fluid from conductor walls and other internal surfaces, and system dead spots after a major component failure. The use of mechanical cleaning after a major component failure (pump or cylinder), must be incorporated in the flushing strategy. This involves the use of a pneumatic gun and sponge projectiles to clean tubes and hoses. It also involves disassembly of other components for cleaning using brushes and clean solvents.

Mechanical cleaning is labor intensive but is the most effective method for restoring the system to reliable operation in cases of major component failure. **Reservoirs, hoses, tubes and cylinders must be cleaned prior to filling the system with oil and flushing the system**.

Before proceeding with the component cleaning procedure, drain all fluid from the system and then proceed to clean the components as outlined below. Failure to do so may result in damage to the pump(s) or other components on start-up. On large systems where it may be cost prohibitive to change the fluid, the fluid can be removed from the reservoir and pumped into a clean storage container with the filter caddy. It can then be filtered to the target ISO cleanliness, then returned after the reservoir cleaning is complete (this assumes the fluid is not already degraded).

Component cleaning procedure

NOTE: The following steps outline the basic procedures for cleaning a heavily contaminated system after a major component failure. The technique or combination of techniques employed will depend on size and type of system, your reliability objectives for the equipment and the reason for the flush.

Reservoir cleaning procedure

1. Ensure absolute cleanliness in all work procedures.
2. Clean the top of the filter housing, cap, and surrounding reservoir surface to avoid adding any additional contaminant to the hydraulic reservoir.

NOTE: It is an acceptable alternative to perform Step 5 prior to Step 3.

3. Remove the filter housing cap, filter element, and element bowl to allow full access to the reservoir interior.

CAUTION

Dispose of fluids in accordance with local environmental regulations.

4. Utilize the filter caddy to pump fluid from the reservoir to a storage container for disposal.
5. Drain and remove all residual oil from reservoir.
6. Remove and discard the suction strainer.
7. Remove and discard the reservoir breather.
8. Clean the reservoir to ensure it is free of metallic debris and other containments.
9. Clean all accumulated metallic particles from the magnetic plug and reinstall.
10. Install new reservoir breather.
11. Install new suction strainer.
12. Cover the reservoir openings until ready to perform flushing operation.

Cylinder cleaning procedure

1. Ensure absolute cleanliness in all work procedures.
2. Before loosening fittings and components, clean the external surfaces using industrial, residue free wipes.
3. Cover all connecting hose and cylinder openings immediately with protective caps in order to prevent dirt and debris from penetrating the system.
4. Disassemble the cylinder and wash all parts with filtered petroleum based solvent to remove contamination particles. Pay particular attention to cleaning seal grooves, and gland nut and port threads. See the **Cylinder Repair** section in this manual.
5. Install new seal kits. See the **Cylinder Repair** section in this manual.

6. Fill the cylinder with filtered hydraulic fluid. This displaces the air and reduces the risk of air compression inside the cylinder that can cause dieseling during initial pressurization at start-up. Dieseling will result in damage to the cylinder and seals.

7. Plug all ports and reinstall in the truck. See the **Cylinder Repair** section in this manual.

Hose and tube cleaning procedure

WARNING

Compressed air can move particles and make them become airborne, which may cause injury. Make sure the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent eye injury.

CAUTION

Disposal of contaminated sponge projectiles must meet local environmental regulations.

NOTE: A sponge projectile launcher cannot be use to clean pump suction line hoses with spring wire inserts. These suction lines must be removed and flushed with clean solvent.

A handheld sponge projectile launcher can be used to quickly and efficiently remove contaminated oil and contamination particles from hoses and tubes without removing them from the lift truck. The required air supply for the projectile launcher consists of the following:

- 5.5 to 7.5 bar (80 to 110 psi)
- 1/2" ID air hose to ensure 55 SCFM (1.6 m3/min) air flow
- A 5 micron filter, pressure regulator, and pressure gage

Dirty, moisture laden air will add contamination to the hoses and tubes.

Consult the Ultra Clean Owner's manual for detailed recommendations for the required air pressure and supply line size.

1. Closely inspect hoses and replace any that are suspect.

2. Disconnect each end of the hose and tube assembly to be cleaned.

3. Place one end of the hose/tube assembly into the catcher bucket.

4. Install the appropriate sized nozzle on the launcher and place the sponge projectile into the launcher.

5. Place the projectile launcher at the opposite end of the hose/tube assembly.

6. Launch the sponge projectile through the hose/tube assembly.

7. The first projectile will remove the residual oil from the hose/tube assembly.

8. Launch additional sponge projectiles through the hose/tube assembly until all oil and contaminants are removed and the projectiles come out clean. Generally, four to six projectiles should be enough. Wipe off the nozzle each time to eliminate potential contaminants.

9. Check the catcher bucket each time to ensure that the projectile has been discharged into the bucket and has not been trapped inside the hose/tube.

10. Prior to launching the final projectile and reconnecting the hose/tube assembly, wipe off each end of the assembly to remove any accumulated oil or visible contaminants.

Valve cleaning procedure

NOTE: This procedure is a general outline. The exact procedure will depend on the valves in the system. More complex systems will require more valves to be cleaned.

1. Ensure absolute cleanliness in all work procedures.

NOTE: Make note of position and setting of valve prior to disassembly to help in resetting after flushing is complete.

2. **Primary Relief Valve:** Disassemble the relief valve assembly, clean all parts, reassemble, and leave setting at low pressure for initial flushing operation.

3. **Unloader and Spool Valve (if applicable) :** Remove and clean all parts. Some assemblies may not contain these components.

NOTE: Make note of position and setting of valve prior to disassembly to help in resetting after flushing is complete.

4. **Secondary Relief Valve:** Disassemble the relief valve assembly, clean all parts, reassemble, and leave setting at low pressure for initial flushing operation.

5. **Steering Priority Spool:** Remove, clean all parts, ensure all orifices are clean and reinstall.

6. Remove the screened fittings from the **L** (left) and **R** (right) steering control unit ports and flush to remove any accumulated contamination particles.

Front-end attachment cleaning procedure

NOTE: The cleaning procedure below should also be utilized when transferring a previously used attachment to a new truck with a clean hydraulic system to prevent contaminating the new system.

1. Ensure absolute cleanliness in all work procedures.

2. Flush cylinders and refill with filtered oil.

3. Clean hoses and tubes.

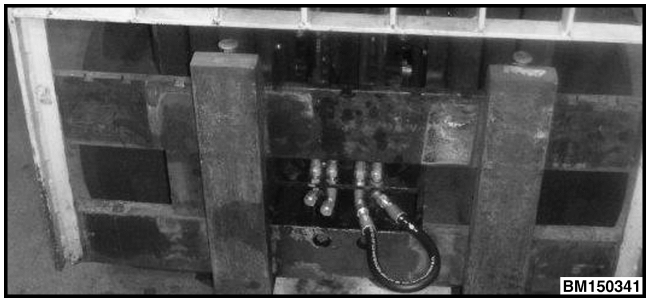
System flushing procedure

Once the hydraulic system has been overhauled and all components cleaned and installed, the hydraulic reservoir needs to be refilled with filtered oil. The filter caddy is then used to clean the reservoir oil until a predetermined level of oil cleanliness is achieved. This operation is not possible without a filter caddy. The caddy ensures that the reservoir and reservoir oil are clean before the pump is turned.

Next, the pump needs to be bled or the case filled with filtered oil. Only then can the hydraulic system be put into operation. The most critical part of the start-up procedure is when the hydraulic pump is turned for the first time.

NOTE: Wand positioning is an important part of maximizing the cleaning speed of the filter caddy. In order to ensure proper cleaning of the reservoir fluid, position the ends of both the inlet and the outlet hose or tube as far apart as possible.

1. Loop the steering, auxiliary, and tilt circuits to exclude the cylinders during the initial flushing operation. This will allow the fluid to flow through continuously to clear the air from the system and keep from recontaminating the cylinders just cleaned. See Figure 122.
   - Steering lines should be looped at the steer axle end.
   - Tilt lines should be looped at tilt cylinder end.
   - Auxiliary lines should be looped at the carriage end.



NOTE: THIS IMAGE IS AN EXAMPLE OF WHAT THE LOOPING PROCEDURE WILL LOOK LIKE.

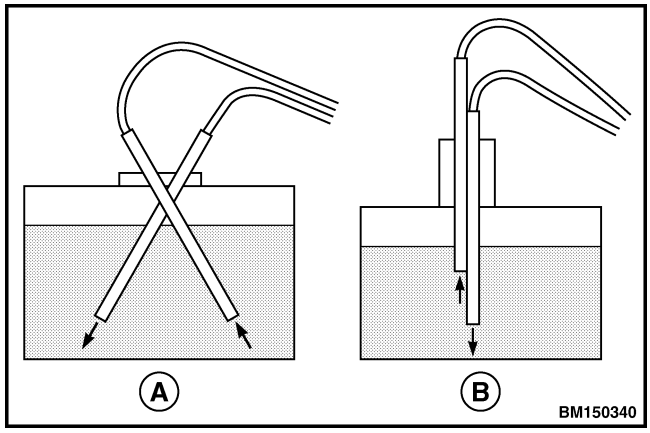
Figure 122. Hydraulic hose looping

2. Clean the top of the filter housing, cap, and surrounding reservoir surface to avoid adding any additional contaminants to the hydraulic reservoir.

3. Remove the filter housing cap, filter element, and element basket to allow full access to the reservoir.

4. Fill the reservoir with filtered oil using the filter caddy or a barrel pump to transfer oil from the storage barrel.

5. Position the filter station wands inside the reservoir per the following guideline:
   - The best situation occurs when the reservoir has a large but short opening. That way the wands can be crossed and separated to create turbulence throughout the reservoir and filter the fluid faster. When the reservoir opening is smaller and has a long or narrow opening, the wands have to be offset at different heights, see Figure 123. In this orientation, the flow and cleaning speed will be slower than the widely separated tubes.



A. CROSSED CONFIGURATION
B. OFFSET CONFIGURATION

Figure 123. Filter station wand configuration

Filter caddy start-up

After setup is complete, the filter caddy is now ready for start-up and cleaning of the reservoir fluid.

- Run the reservoir cleaning process for the time outlined in Table 4. Different filter machines have different flow rates, requiring different run times to achieve the required cleanliness.

System start-up and flushing

Once components are clean and the fluid in the reservoir has been flushed clean the system is ready to start.

1. Install the filter element bowl, a new filter element, and filter housing cap.

2. On pumps with a flooded inlet (pump inlet is below the reservoir fluid level) carefully loosen the intake line to allow the trapped air to escape. This ensures that the line is full of fluid so the pump will have immediate lubrication.

3. On units fitted with variable displacement pumps with an external case drain line, fill the pump case with filtered hydraulic fluid through the highest case drain port and reconnect the case drain line. Failure to do so will result in damage to the pump through inadequate lubrication at start-up.

4. Confirm the reservoir is above the minimum level.

5. Ensure all hydraulic controls are in neutral so there is no load on the system.

6. Start the system and run unloaded at lowest possible speed.
   - On lift trucks equipped with a fixed displacement system, allow the system to run unloaded for 10 minutes to flush any remaining particles still in the main valve circuit back to the filter. Inspect for leaks and check reservoir level.

NOTE: Perform Step 7 on lift trucks equipped with a variable displacement pump (VDP).

7. Bleed the LS (load sensing) pilot line by carefully loosening the pilot line fitting at the pump to allow trapped air to escape.
   - On lift trucks equipped with a VDP, the pump will not flow unless there is a demand from the control levers. Fully actuate and hold the last auxiliary lever (third or fourth lever). Allow the system to run unloaded for ten minutes to flush any remaining particles still in the main valve circuit back to the filter. Inspect for leaks and check reservoir level.

8. With the circuits still looped (cylinders not connected), progressively operate each hydraulic function in the following order to flush out any remaining particles and majority of the air in each circuit. First at low speed (low pressure), then at high speed (high flow).
   - Auxiliary 3- Set auxiliary speed at ten for highest flow rate on EH valves.
   - Auxiliary 4- Set auxiliary speed at ten for highest flow rate on EH valves.
   - Tilt
   - Lift
   - Steering

9. Shut off system, remove circuit loops and connect cylinders.

10. With the cylinders now connected, operate the individual hydraulic functions in the same sequence as above for at least five complete stroke cycles each until all air is expelled and all actuators operate smoothly. Stroke cylinders slowly taking care not to develop high pressure at the end of stroke which can cause dieseling.

11. With system at operating temperature, 50°C (120°F), check and adjust all relief valve settings to specification and set the auxiliary speed setting to match auxiliary requirements. See the **Capacities and Specifications Manual** for your lift truck model.

12. Functionally test all circuits under load.

13. Check reservoir fluid level, fill to correct level with filtered fluid.

14. Take an oil sample from the designated test port and send off for analysis.

15. Return lift truck to service.

16. After fifty hours of operation, take an oil sample from the designated test port and send off for analysis to verify the system is operating at the target cleanliness level.

Reservoir fluid cleaning times

Cleaning times can be affected by various factors. The reasons for this include:

- The filter caddy is cavitating.
- The return wand is not submerged in fluid and is generating air bubbles.
- The filter tower has not been purged.
- Too much fluid turbulence in reservoir.
- The oil is too cold.
- The oil is heavily contaminated with water and particles.

The following table has been developed to provide an estimate of the cleaning times required with the filter caddy.

Table 4. Reservoir Flushing Times

Reservoir Flushing Time - Minutes			
Hydraulic Reservoir Capacity	OF7 Hand Held Filter Caddy 15 liter/min (4 gal/min) Flow Capacity	OFCD Portable Filter Caddy 53 liter/min (14 gal/min) Flow Capacity	Target ISO Cleanliness
Less than 42 liter (11 gal)	40	10	@ Start-Up after reservoir flush = ISO 18/15/12 @ Stabilization at 50 operating hours = ISO 20/17/14 10
42 to 80 liter (11 to 21 gal)	80	20	

NOTE: See Hydraulic Cleanliness Service Gram for further information on the filter caddies.

DEALING WITH DIFFERENT FLUID TYPES

DANGER

The filter caddy is designed for the transfer and filtering of hydraulic and lubrication oils only! It is not to be used for highly volatile fluids such as gasoline or paint thinners. Failure to follow this warning may lead to death or serious injury.

Cleaning procedure after switching fluids (cross contamination flushing)

1. Prepare an empty waste oil container (five gallon bucket), as well as a top-off container (five gallon container) for fluid removed from the hydraulic system.

2. Insert suction wand into reservoir and place return wand into the waste container.

3. Replace existing particle filter with those of the fluid in the machine (if the filter caddy has HCE-102 Tractor Hydraulic Oil filters and machine uses HCE-140 Hydraulic Oil, then install filters used with HCE-140 oil).

4. Run the filter caddy until the waste container is filled with about four gallons of fluid.

5. Remove return wand from waste container, wipe it clean, and insert into reservoir.

6. Position wands in the correct orientation and begin reservoir filtration until desired cleanliness level has been achieved.

7. Cycle machine hydraulic functions.

8. Resume reservoir filtration.

Filter caddy maintenance

See the filter caddy **Operating Manual** for detailed instructions.

No maintenance operations should be carried out while the unit is running. Before starting any other maintenance operations, ensure that the system is shut down and disconnected from the electrical power source. System pressure can be contained in the unit for some time after it has been disconnected.

Servicing the strainer

Under normal operating conditions, the strainer should be removed from the line, cleaned and re-installed after every one hundred hours of operation. The strainer should be cleaned more often however, if the fluid is heavily contaminated.

DC motor

The motor should be inspected at regular intervals (every five hundred hours of operation or every three months, whichever occurs first). Keep the motor clean and the ventilation openings clear.

HYDRAULIC OIL SAMPLING 202001-071

HYDRAULIC OIL SAMPLING METHOD

Objective

Document a structured oil sampling method for taking fluid samples from field vehicles.

Maximize Data Density in the sample.

- Determine level of wear particles.
- Understand status of additive deletion.
- Determine cleanliness and dryness of fluid.

Establish physical and chemical properties of oil, contamination, and mechanical wear. Oil life and service intervals are determined by degradation due to oxidation and additive depletion.

General guidelines

WARNING

The lift truck must be put on blocks for some types of maintenance and repair. See How to put a lift truck on blocks, in the Periodic Maintenance 8000SRM2305 **manual.**

The surface must be solid, even, and level when the lift truck is put on blocks. Make sure any blocks used to support the lift truck are solid, one-piece units.

WARNING

When operating the lift truck with the hood open, be aware of the fan, pulleys and belts. Failure to recognize these moving components could lead to serious injury.

WARNING

At operating temperature, the hydraulic oil is HOT. DO NOT permit the hot oil to touch the skin and cause a burn.

Due to the extreme sensitivity to external contamination of an oil sample, the utmost care and diligence must be exercised while performing oil sampling. The measured cleanliness of a hydraulic fluid sample depends on how and where (in the hydraulic system) the sample is extracted. Follow the procedure carefully and consistently each time a sample is taken.

1. Refer to Hydraulic Cleanliness Service Gram number (JH00064R05H) for kits specifically designated for Hydraulic Oil Analysis.

2. Use the same analysis laboratory for all similar fluid samples in order to maintain consistent results for each sample program. There are differences in results from laboratory to laboratory, no matter how reputable.

3. Consistent use of the same laboratory will provide a historical record of sample results. Trending of these results provides the ability to identify significant changes in oil condition.

4. Analysis Reports should include the following information:
   - Spectrographic analysis - Wear Metals
   - Viscosity
   - FT-IR spectroscopy - Additive condition, oxidation, TAN, fluid mixing
   - Particle counts per ISO 4406-1999
   - Water Content (% or PPM (parts per million))

5. Follow the described method for sampling in all cases to avoid contamination of the sample.

6. Minimize Data Variability.
   - Consistent sampling process produces uniform, consistent, and representative information.
   - DO NOT allow contaminant to enter the sample from outside the oil.
   - Use the same location for each sample. Not all sample locations will produce the same data.

7. The recommended frequency for hydraulic fluid samples is:
   - Every 500 hours and just prior to all oil and filter changes. Once the effects of the operating conditions have on the oil are understood, it may be possible to extend the sampling frequency.
   - High operating temperatures and severe operating conditions shorten the life of oil. For machines operating in severe duty applications with high hydraulic oil temperatures or operating in highly contaminated environments, we recommend taking oil samples every 500 hours.
   - Within one operational hour of major system service, then at 100 hours, and every 500 hours thereafter.
   - Significant changes in the system fluid condition reported by the analysis will dictate a repeat sample to validate results prior to taking corrective actions.

8. Document all hydraulic component failures or hydraulic system service performed that might have introduced contamination or new oil into the system since the last oil sample was taken.

Synopsis

1. Analysis Reports

   Spectrographic analysis

   - Used to finely measure parts per million by weight (PPM) of various elements contained in sampled oil. The process measures the concentration of wear metals, contaminant metals and additive metals in a lubricant.
     - It can identify the concentration of individual metal or alloy of a particle. Its size limit is about 8 microns or smaller, so it is blind to the larger particles that can often signal pending failure.
     - Spectrographic limits are an instrument limitation. The size limitation depends on the particle types and instrumentation used.
     - Spectrographic Analysis and Particle Count Analysis form an efficient partnership in identifying the concentration of small and large particles in the oil and the total fluid contamination level.

   Viscosity

   - The most important physical property of oil, viscosity determination provides a specific number to compare to the recommended oil in service. An abnormal viscosity (± 15%) is usually indicative of a problem. Standard ISO VG 46 hydraulic oil should have a viscosity between 41 and 51.

   Fourier Transform Infrared (FT-IR) Spectrometer

   - Measures the chemical composition of a lubricant.
     - Every compound has a unique infrared signature. Using a FT-IR Spectrometer, the key signature points in a spectrum of a specific lubricant are monitored. These signatures are usually common contaminants and degradation by-products unique for a particular lubricant.
     - Molecular analysis of hydraulic fluids by FT-IR spectroscopy produces direct information on molecular species on interest, including additives, fluid breakdown products and external contamination. The infrared spectrum of used oil is compared to a baseline spectrum of new oil. Levels of oxidation, nitration and sulfate by-products are reported along with soot, water and glycol.

Particle Counts

- Measures the size and quantity of particles in a lubricant. Use whenever Hyster provides recommended lubricant cleanliness levels and for any system where oil cleanliness is directly related to longer lubricant life, decreased equipment wear or improved equipment performance.

  - The analysis report will show the actual number of particles by size category and by the ISO code per ISO 4406-1999. The ISO code reports 3 particle size categories: ≥ 4 microns / ≥ 6 microns / ≥ 14 microns
  - Use whenever Hyster provides recommended lubricant cleanliness levels and for any system where oil cleanliness is directly related to longer lubricant life, decreased equipment wear or improved equipment performance.

Water Content

- The Karl Fischer Test quantifies the amount of water in lubricant.

  - Results are reported as % water or PPM (1% = 10,000 PPM).
  - Water seriously damages the lubricating properties of oil and promotes component corrosion, Increased water concentrations indicate possible condensation, coolant leaks, or leaks around the seals.

2. All equipment or components of equipment requiring oil will vary in performance and wear rates from one application to another, depending on the nature and extent of their use, their exposure to adverse operating conditions, their age, how often the oil was changed, etc. Unless a sharp increase in an important element is detected, it is inadvisable to rely on a single test. Repeated sampling on a regular schedule is required to establish trending which will enable the technician to identify significant changes in the system.

3. It is important to know the target fluid cleanliness level specified for the system. Unless otherwise stated, Hyster hydraulic systems have a target cleanliness of ISO 20/17/14. See the **Periodic Maintenance** 8000SRM2305 manual.

4. Although the 3 code ISO system is used for all manufacturing cleanliness requirements, for hydraulic oil samples taken in the field, only the last two ISO particle counts need to be monitored. As an example, 20/17/14 is stated as simply --/17/14. Unless otherwise stated in the **Periodic Maintenance** 8000SRM2305 manual, target oil cleanliness levels for field oil samples are ISO --/15/12 for initial fill oil, and ISO --/17/14 for oil in service.

   As previously stated, the Particle Count test is used in partnership with the Spectrographic Analysis to monitor the total contamination levels in the oil. Trending the concentration of small and large particles indicates the severity of system wear.

Hydraulic oil analysis report guidelines

Unless otherwise stated in the **Periodic Maintenance** 8000SRM2305 manual, see Table 5 for the hydraulic oil cleanliness guidelines and Table 6 for the water content guidelines.

Table 5. Hydraulic Oil Cleanliness Guidelines

Oil type	Initial fill oil	Target cleanliness for hydraulic oil in service	Maximum particle counts for oil in service
ISO VG 46	ISO --/15/12	ISO --/17/14	ISO --/18/15
ISO VG 46	ISO --/15/12	ISO --/17/14	ISO --/18/15

Table 6. Hydraulic oil water content guidelines

Water content	Status	Recommended action
≤ 0.05% (≤ 500 PPM)	Normal	None Required

Table 6. Hydraulic oil water content guidelines (Continued)

Water content	Status	Recommended action
> 0.05% to < 0.1% (>500 to <1000 PPM)	Alert	Use filter caddy to remove water.
≥ 0.1% (≥ 1000 PPM)	Immediate Action Required	Use filter caddy to remove water or replace fluid. Determine and eliminate source of water ingression.

Sampling conditions

1. All samples should be taken with the system at normal operating temperature; the hydraulic fluid at 50°C (120°F) or greater. Operate all hydraulic functions repeatedly just prior to taking a sample.
2. The system must be running when taking a sample.
3. Thoroughly flush sampling valves and sampling devices.
4. Maintain sample bottles in a clean environment.
5. Sample at proper frequency.
6. Record operating hours on machine and oil hours.
7. Record oil brand and type.
8. Send samples immediately to laboratory.

Equipment

NOTE: Refer to Hydraulic Cleanliness Service Gram number (JH00064R05H) for kits specifically designated for Hydraulic Oil Analysis.

1. A factory installed zero-leak quick-disconnect fitting (Hyster P/N 2061646) is installed on the control valve of 1-8 ton capacity products at the recommended sampling location.
   - Sampling port conversion kits for other units without factory installed sample ports may be available from the **Hyster Parts Distribution Center**.
   - Oil sampling directly from the reservoir with a sampling pump is an alternative but results may be unreliable due to oil flow stratification and inconsistent probe location.
2. Utilize hydraulic sampling valve kit available from **Hyster Parts Distribution Center**. It includes a connection line, fitting and a valve to open and close flow through the quick disconnect fittings.
3. Utilize hydraulic oil analysis kits available from **Hyster Parts Distribution Center**.

SAMPLING PROCEDURE

Hydraulic oil sampling

CAUTION

Wear safety glasses when collecting oil samples.

1. Operate lift truck long enough to bring oil up to operating temperature and evenly distribute contaminants throughout the system. Operate all hydraulic functions for a minimum of three cycles. Run the system at elevated speeds and steer lock to lock, lift to full height and lower fully, tilt full forward and full back, and cycle any attachment for at least one minute each. Assure oil temperature in sump has reached at least 50°C (120°F) prior to initiating the following procedure.
   - **Internal Combustion Engine (ICE) Truck** - run the engine at high idle speed.
2. To avoid contaminating the sample:
   - Clean your hands or wear clean nitrile gloves.
   - Leave sample container closed until just before you are ready to take sample.
   - When cap is off bottle, hold bottle in your hand with the opening facing down, and do not set the cap or open bottle down on a workbench, truck surface, or in your pocket.
   - Do not touch sample bottle with sampling line.

- Try to sample in an enclosed area - doors closed to reduce drafts that may carry contaminants. Do not take a sample in an area where someone is grinding, cutting, sweeping, or creating dust of any kind.
- Return fluid back into the system by running it into dipstick tube. Do not run fluid into a waste pan when flushing the sample tube.

3. When taking oil sample:
   - **ICE Truck** - run the engine at high idle speed.
   - Open the valve and flush the sampling line by following oil back into the sump through the dipstick tube for at least one minute.

4. To take the sample; open the sample bottle, hold the nozzle over the sample bottle **without touching the nozzle on the sample bottle** and collect 50 to 100 ml (2 to 4 oz) of oil. Close the valve and immediately seal the sample container. Leave some head space in the bottle to facilitate agitation at the analysis laboratory.

Sample labeling

Sample labels should include the following minimum information:

- Date and time of sample
- System sampled, e.g. hydraulic system
- Equipment reference, e.g. truck serial number
- Operating hours on machine and hours on oil
- Fluid manufacturer and type (example - Shell Spirax®)

Results documentation

1. Send samples immediately for analysis.

2. Send samples to the same laboratory for analysis to maintain consistent results for trending comparison.

3. Laboratory analysis reports should be retained in the Analysis Laboratories on-line database and vehicle service log for future reference.