Hydraulic System Component Description

Section 04-01-03

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines, which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

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Scope of This Publication

Component Descriptions provides a description of various major components in the hydraulic system.

Customer Responsibilities and Warranty Advisories

The P&H wheel loaders are warranted in accordance with the warranty policy provided with the machine. The recommended operating and maintenance procedures set forth shall be followed to ensure warranty coverage is not jeopardized. Failure to comply with recommended operating and maintenance procedures may void machine warranty.

Any questions or problems relating to warranty policy or administration should be directed to Komatsu Service Center. Include the model and serial number, in-service date of the machine, and hour meter reading. **We especially draw your attention to the following safety advisors.**

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Safety

This publication contains special instructions that pertain to safety, operation, maintenance, and repair of the machine. Listed below are the signal words and symbols that precede these instructions and their meanings:

⚠ DANGER

- **The danger label indicates a hazardous situation, which if not avoided, will result in death or serious injury.**

⚠ WARNING

- **The warning label indicates a hazardous situation, which if not avoided, could result in death or serious injury.**

⚠ CAUTION

- **The caution label, used with the safety alert symbol indicates a hazardous situation, which if not avoided, could result in minor or moderate injury (includes the safety alert symbol ⚠).**

CAUTION

- **The caution label (without safety alert symbol) is used to address practices not related to personal injury only equipment damage.**

NOTICE

The NOTICE graphic is to indicate areas of importance to the reader that are not related to personal injury or machine damage.

Safety, Warnings and Cautions

⚠ WARNING

CRUSH HAZARD

- **Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.**
- **Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.**

- **Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.**

<u>CRUSH, SHOCK, OR OTHER HAZARDS</u>

- **Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.**

⚠ CAUTION

<u>STRUCK-BY OR STRUCK AGAINST HAZARDS</u>

- **Struck-by or struck against hazards exist if the hydraulic reservoir manual air release valve is installed incorrectly. Incorrect installation can cause the reservoir to appear to be depressured when it is actually pressured. The handle on the release valve may appear to be correctly positioned, but actually be pointing in the wrong direction. Always check the pressure registered on the reservoir gauge in the “Air Box”, located on top of the Low Voltage Control Cabinet, to ensure the pressure is released. Working on the reservoir or removing reservoir fill cap without depressurizing the reservoir can cause a struck-by or struck against hazard resulting in serious injury.**

<u>SKIN INJECTION HAZARD</u>

- **Skin injection hazard exists when priming pumps. High hydraulic pressure is present when priming pumps. Injection of hydraulic fluid into the skin is possible when high hydraulic pressure is present. Use all necessary Personal Protective Equipment (PPE), such as face shield, eye protection, long sleeves, etc., to avoid injury when priming pumps. Failure to wear all necessary PPE can cause in skin injection resulting in serious injury.**

Hydraulic Reservoir

Service Facilities of the Hydraulic Reservoir

The following instructions apply to the Models L-1350, L-1850, and L-2350 unless individually specified. When individually specified refer only to the instructions which apply to the appropriate machine model.

The hydraulic reservoir is mounted on the rear frame, near the pivot area, on the right side of the machine.

1) Fluid Level Sight Glass, **2)** Side Access Panel

Figure 1. Hydraulic reservoir typical

Fluid Level Sight Gauge

The hydraulic reservoir is equipped with a sight gauge for checking the fluid in the reservoir. Refer to illustration "Hydraulic reservoir fluid level". This gauge should be checked daily as part of the operator's daily walk-around inspection. If the level is low, the source of the leak should be determined and repaired. The reservoir should be filled to ¾ up to the sight gauge (with machine on flat ground, lift arms down and bucket flat on the ground). DO NOT fill to the top of reservoir sight glass.

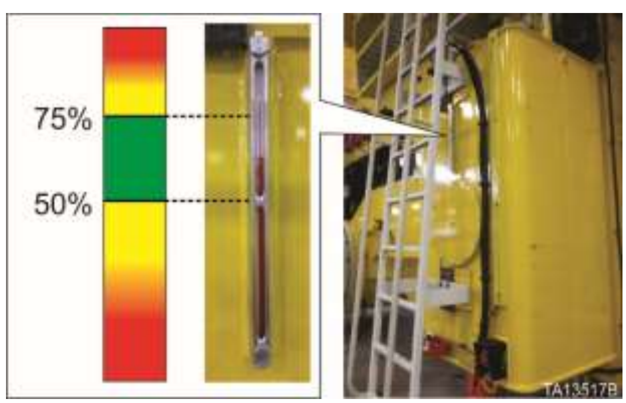
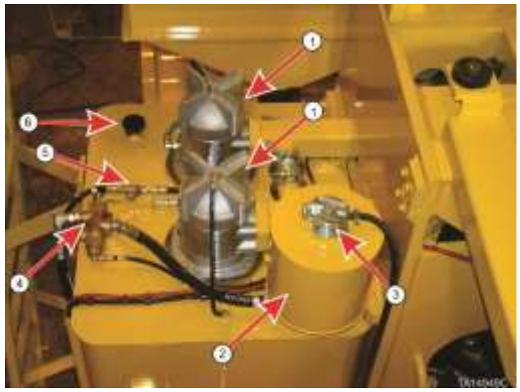


Figure 2. Hydraulic reservoir fluid level

Reservoir Return Filters

The hydraulic reservoir has two filters L-1350, L-1850 or three filters L-2350 which filters the oil returning to the hydraulic reservoir. They filter particles that are 10 micron and larger. The filter housings are located on top of the hydraulic reservoir.



1) Return Filter Housing, **2)** Surge Reservoir, **3)** Relief Cap, **4)** Automatic Air Release Valve, **5)** Manual Air Release Valve, **6)** Filler Cap

Figure 3. Typical top view of hydraulic reservoir L-1350, L-1850

1) Return Filter Housings, **2)** Relief Valve, **3)** Surge Reservoir, **4)** Automatic Air Release Valve, **5)** Manual Reservoir Vent Valve**, 6)** Filler Cap

Figure 4. Typical top view L-2350 hydraulic reservoir

Reservoir Manual Air Pressure Release Valve

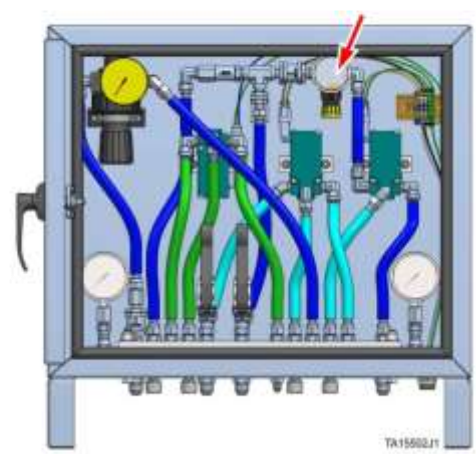
A manual valve on top of the reservoir is used to de-pressurize the reservoir. When the valve handle is placed in the down position, the reservoir is pressurized. When the handle is in the up position, the reservoir is de-pressurized.

⚠ CAUTION

Struck-by or struck against hazards exist if the hydraulic reservoir manual air release valve is installed incorrectly. Incorrect installation can cause the reservoir to appear to be depressured when it is actually pressured. The handle on the release valve may appear to be correctly positioned, but actually be pointing in the wrong direction. Always check the pressure registered on the reservoir gauge in the "Air Box", located on top of the Low Voltage Control Cabinet, to ensure the pressure is released. Working on the reservoir or removing reservoir fill cap without depressurizing the reservoir can cause a struck-by or struck against hazard resulting in serious injury.

Figure 5. Air bleed valve in pressurized position (reservoir pressurized)

Mounted on top of the low voltage control cabinet



Hydraulic reservoir regulator/gauge

Figure 6. Compressed air box

Reservoir Drain Valve

A drain valve is provided on the bottom of the hydraulic reservoir for draining the reservoir. Refer to illustration, “Hydraulic reservoir typical”. Ensure the reservoir air pressure is released by using the Manual Air Release Valve before connecting drain hose to the drain valve.

Figure 7. Hydraulic reservoir drain valve

Filling the Reservoir through the Central Service System

There are two methods of filling the hydraulic reservoir. The central service system can be used, or the reservoir has a filler cap on top that can be used to fill the reservoir. If the filler cap on top of the reservoir is used, the hydraulic fluid should be filtered to 10 microns prior to entering the reservoir. Follow Safety Preparations for either method.

Figure 8. Central service system

The preferred method for filling the hydraulic reservoir is to use the remote quick coupling fitting on the optional Central Service System. This will reduce the chances of contamination by routing the fluid through a return filter before entering the reservoir. If your machine is not equipped with the Central Service System, refer to text “Filling the Reservoir through the Filler Cap”. The Central Service System is mounted in a protective box, on the left rear frame.

Safety Preparations

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

a. Stop the wheel loader on flat level ground.

b. Set bucket flat and level on the ground.

c. Place wheel chocks in front and behind each wheel.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.

d. Set the parking brakes.

e. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

f. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.

Figure 9. GEN 2 Battery Isolation Box – Battery isolation switch in OFF position with locks in place

NOTICE

The GEN 2 battery and engine starter isolation box is shown in this document. GEN 1 machines will have a different type of switch and box. The lock out/tag out requirements are the same.

g. Release the air from the hydraulic reservoir by using the hydraulic reservoir air valve (ball valve) on top of the reservoir. The supply line from main air system will be blocked and reservoir air will vent out the hose that runs down the outside of the hydraulic reservoir.

- Turn the handle to the up position as shown

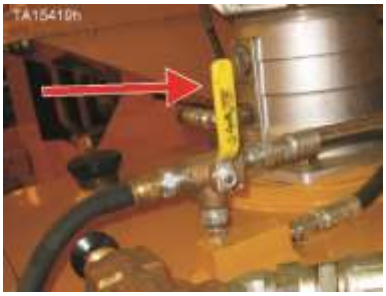


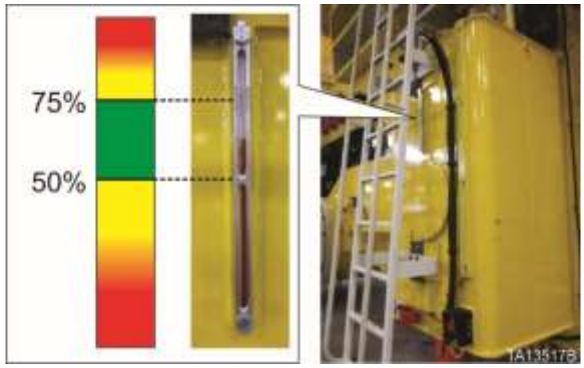
Figure 10. Hydraulic reservoir air valve handle UP

h. Release the air from the various air storage reservoirs by opening all of the air bleed valves.

Three valves on right side of rear frame under hydraulic reservoir	
One valve on right side of front frame near hoist cylinder ball cap	
	

Figure 11. Air reservoir bleed valves in open position

i. Perform typical filling procedure per equipment usage procedures, local rules and regulations.
   - The reservoir should be filled to 3/4 up the fluid sight gauge with oil at ambient temperature (with bucket resting on the ground). DO NOT fill to the top of the reservoir sight glass.



Component	Model	Capacity	
Hydraulic Reservoir	L-1350	375 gallons	1,419 liters
	L-1850	375 gallons	1,419 liters
	L-2350	382 gallons	1,446 liters

Table 1. Hydraulic reservoir capacity

j. Replace the protective cap when finished.

k. Follow all lockout tag out rules, local rules, and local regulations to return the machine back to service.

Filling the Reservoir through the Fill Neck (Fill Port)

The hydraulic reservoir can be filled through the filler cap, located on top of the hydraulic reservoir. BE SURE to clean away any dust or debris which might enter the system before removing the cap.

NOTICE

Fluid should NEVER be pumped from an open drum or container directly into the hydraulic reservoir without suitable filtration. A transfer pump should be used to pump fluid from the storage vessel through a suitable 10 micron filter, compatible with the fluid and through a clean hose.

Safety Preparations

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

a. Stop the wheel loader on flat level ground.

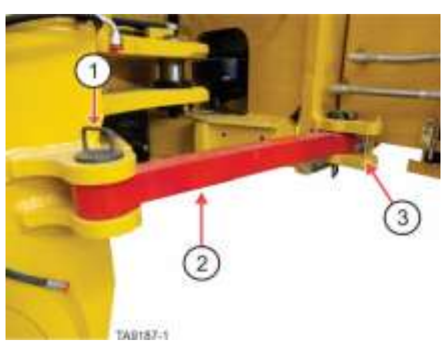
b. Set bucket flat and level on the ground.

c. Move the frame lock to the locked position so that the frame cannot be steered.

d. Place wheel chocks in front and behind each wheel.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position, **3)** Retaining pin bracket for un-locked position

Figure 12. Frame lock in locked position

e. Set the parking brakes.

f. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

g. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.

Figure 13. GEN 2 Battery Isolation Box – Battery isolation switch in OFF position with locks in place

NOTICE

The GEN 2 battery and engine starter isolation box is shown in this document. GEN 1 machines will have a different type of switch and box. The lock out/tag out requirements are the same.

h. Release the air from the hydraulic reservoir by using the hydraulic reservoir air valve (ball valve) on top of the reservoir. The supply line from main air system will be blocked and reservoir air will vent out the hose that runs down the outside of the hydraulic reservoir.

- Turn the handle to the up position as shown

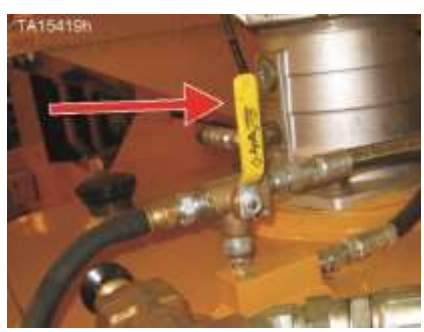


Figure 14. Hydraulic reservoir air valve handle UP

i. Release the air from the various air storage reservoirs by opening all of the air bleed valves.

Three valves on right side of rear frame under hydraulic reservoir	
One valve on right side of front frame near hoist cylinder ball cap	
	

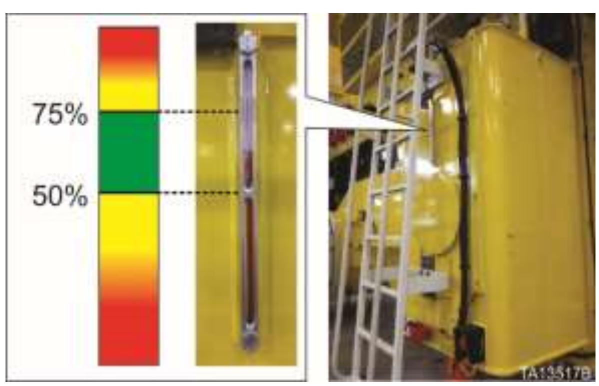
Figure 15. Open air reservoir bleed valves

j. Remove the filler cap.

Filler Cap on fill neck (fill port)

k. Perform typical filling procedure per equipment usage procedures, local rules and regulations.

- The reservoir should be filled to 3/4 up the fluid sight gauge with oil at ambient temperature (with bucket resting on the ground). DO NOT fill to the top of the reservoir sight glass.



Component	Model	Capacity	
Hydraulic Reservoir	L-1350	375 gallons	1,419 liters
	L-1850	375 gallons	1,419 liters
	L-2350	382 gallons	1,446 liters

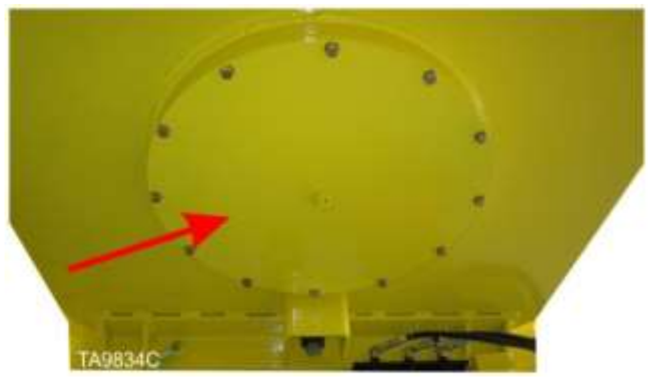
l. Replace the filler cap when completed.

m. Follow all lockout tag out rules, local rules, and local regulations to return the machine back to service.

Reservoir Access Panels

Removable panels are provided on the side and bottom of the hydraulic reservoir for cleaning the inside of the reservoir.

Side view
1) Fluid Level Sight Glass, **2)** Side Access Panel



Bottom view
Access Panel

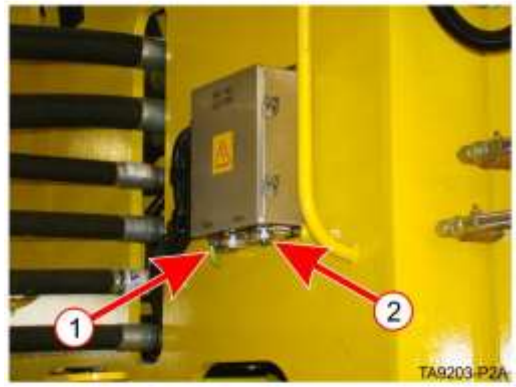
Figure 16. Hydraulic reservoir typical

Hydraulic Reservoir Heaters (Optional)

Two 4000-watt, 240-volt immersion heaters are optionally provided for heating the hydraulic oil. The heaters are installed into the side of the hydraulic reservoir. Refer to illustration "Hydraulic reservoir heaters (optional)". The heaters operate only on external power.

Heating elements are mounted inside of hydraulic reservoir

Figure 17. Hydraulic reservoir heaters (optional)



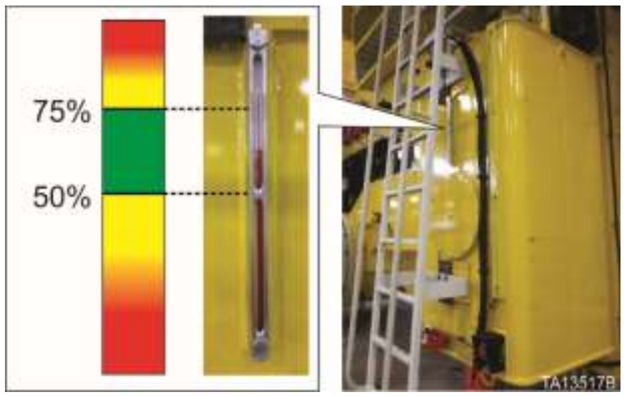
(located at pivot area left side of machine)
1) Component Heater Receptacle-Recp 1
2) Engine Oil/Coolant Preheater Connections

Figure 18. Component heater connections typical all loaders (optional)

Service Requirements and Recommendations

Daily Inspection

Check the fluid level sight gauge on the side of the hydraulic reservoir to ensure the fluid level is to the ¾ full mark on the gauge. Check for visible fluid leaks.



Oil Analysis

Oil samples must be taken for analysis every 500 hours of operation to meet Komatsu warranty requirements. A quick connect fitting for collecting oil samples is optionally provided on the hydraulic reservoir side access panel (illustration “Hydraulic oil sampling quick connect fitting”). If contaminates exceed the amount listed under CLEANLINESS TARGETS located in the Preventive Maintenance section of the Service Manual, the system should be completely flushed and new fluid and filters installed. If this level of contamination occurs on consecutive tests, component failure may be imminent, and the machine should be scheduled for repair. Refer to LUBRICATING OIL ANALYSIS located in the section of the Service Manual entitled “PREVENTIVE MAINTENANCE REQUIREMENTS AND RECOMMENDATIONS LUBRICATION AND SERVICE” for additional information on establishing an on-going oil analysis program.

CAUTION

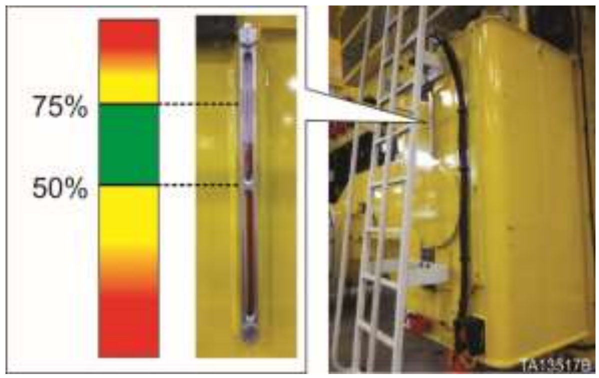
Use caution to prevent contamination from entering the hydraulic reservoir when collecting oil samples.

Figure 19. Hydraulic oil sampling quick connect fitting

Reservoir Drain and Refill

Drain, flush reservoir, and replace hydraulic fluid when oil analysis indicates the need. Ensure the hydraulic reservoir air pressure has been released before draining or filling the reservoir.

The reservoir should be filled to 3/4 up the fluid sight gauge with oil at ambient temperature (with bucket resting on the ground). Do not fill to the top of the reservoir sight glass.



Component	Model	Capacity	
Hydraulic Reservoir	L-1350	375 gallons	1,419 liters
	L-1850	375 gallons	1,419 liters
	L-2350	382 gallons	1,446 liters

Pumps

NOTICE

The left and right sides of the loader are determined when standing behind it or sitting in the operator's seat — not from standing in front and facing it. Engine left and right banks are determined by viewing engine from the flywheel end.

The rear frame contains the engine, generator, hydraulic pump drive (gearbox), hydraulic reservoir, and many other hydraulic components.

Pumps				**Flow at 1800 rpm**		**Total Flow**	
Pump Usage	Pump Qty	CC	cu in	Flow (l/min)	Flow (gpm)	l/min	gpm
Hoist/Bucket	3	260.00	15.86	468.0	123.6	1404.0	370.8
Circulation	1	227.12	13.86	408.8	108.0	408.8	108.0
Steering	2	95.00	5.72	171.0	44.6	342.0	89.1
Blower/fan	2	95.00	5.72	171.0	44.6	342.0	89.1
Accessory	1	45.00	2.75	81.0	21.4	81.0	21.4
Gear box	1	35.56	2.17	64.0	16.9	64.0	16.9
Option Aux Oil	1	45.00	2.75	81.0	21.4	81.0	21.4

Table 2. Hydraulic pump service and flow on L-1350 loader (at 1800 RPM)

Pumps				**Flow at 1800 rpm**		**Total Flow**	
Pump Usage	Pump Qty	CC	cu in	Flow (l/min)	flow (gpm)	l/min	gpm
Hoist/Bucket	4	260.00	15.86	468.0	123.6	1872.0	494.3
Circulation	1	227.12	13.86	408.8	108.0	408.8	108.0
Steering	2	95.00	5.72	171.0	44.6	342.0	89.1
Blower/fan	2	95.00	5.72	171.0	44.6	342.0	89.1
Accessory	1	45.00	2.75	81.0	21.4	81.0	21.4
Gear box	1	35.56	2.17	64.0	16.9	64.0	16.9
Opt Aux Oil	1	45.00	2.75	81.0	21.4	81.0	21.4

Table 3. Hydraulic pump service and flow on L-1850 loader (at 1800 RPM) with Tier1 or 2 engine

Pumps				Flow at 1800 rpm		Total Flow	
Pump Usage	Pump Qty	CC	cu in	Flow (l/min)	flow (gpm)	l/min	gpm
Hoist/Bucket	4	260.00	15.86	468.0	123.6	1872.0	494.3
Circulation	1	227.12	13.86	408.8	108.0	408.8	108.0
Steering	2	95.00	5.72	171.0	44.6	342.0	89.1
Blower	1	95.00	5.72	171.0	44.6	342.0	89.1
Fan	2	130	7.93	234.0	61.8	468.0	123.6
Accessory	1	45.00	2.75	81.0	21.4	81.0	21.4
Gear box	1	35.56	2.17	64.0	16.9	64.0	16.9
Opt Aux Oil	1	45.00	2.75	81.0	21.4	81.0	21.4

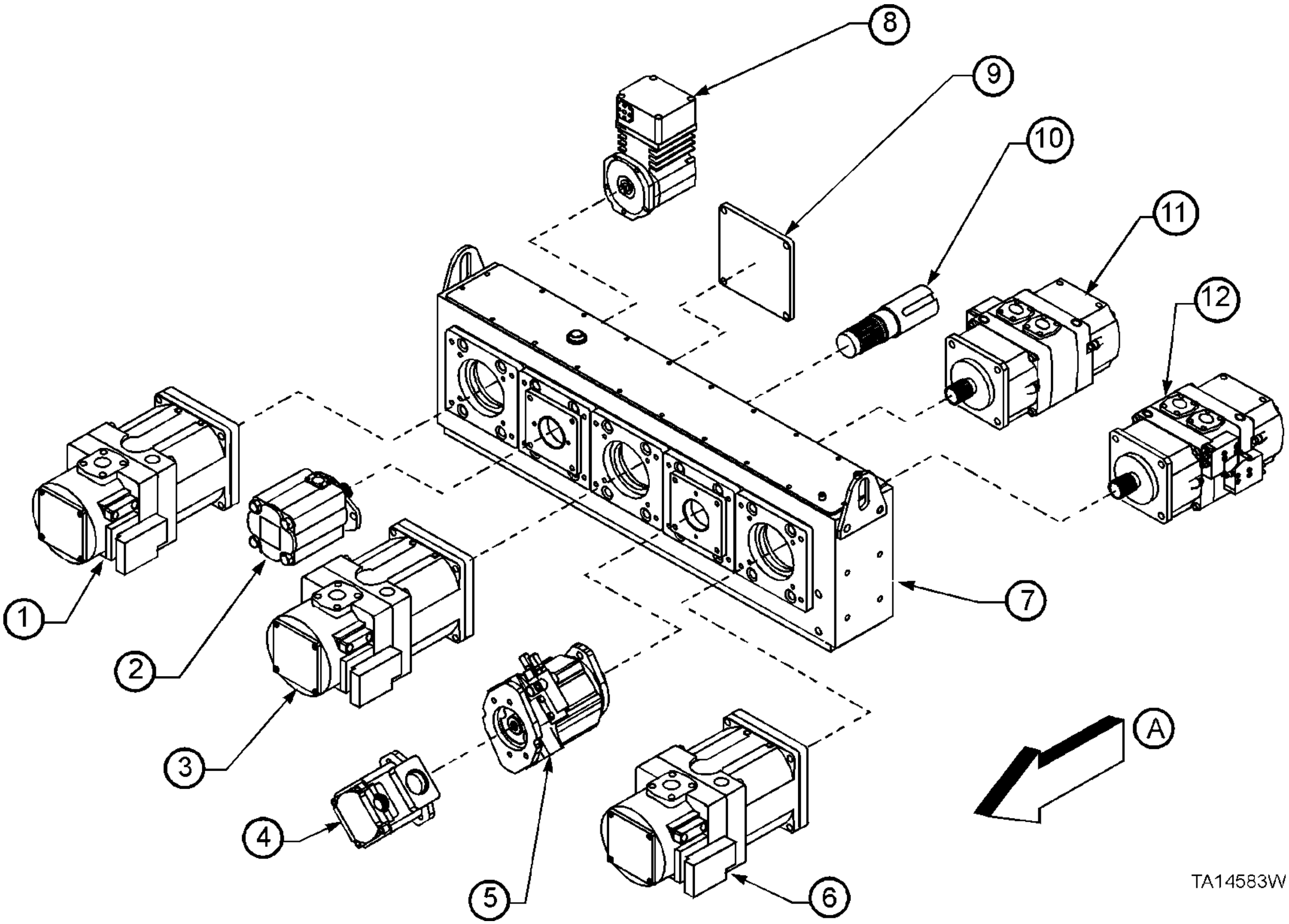
Table 4. Hydraulic pump service and flow on L-1850 loader (at 1800 RPM) with Tier4 engine

Pumps				Flow at 1800 rpm		Total Flow	
Pump Usage	Pump Qty	CC	cu in	Flow (l/min)	flow (gpm)	l/min	gpm
Hoist/Bucket	4	260.00	15.86	468.0	123.6	1872.0	494.3
Circulation	1	227.12	13.86	408.8	108.0	408.8	108.0
Steering	2	130	7.93	234.0	61.8	468.0	123.6
Blower/fan	2	95.00	5.72	171.0	44.6	342.0	89.1
Accessory	1	45.00	2.75	81.0	21.4	81.0	21.4
Gear box	1	35.56	2.17	64.0	16.9	64.0	16.9
Opt Aux Oil	1	45.00	2.75	81.0	21.4	81.0	21.4

Table 5. Hydraulic pump service and flow on L-2350 loader (at 1800 RPM)

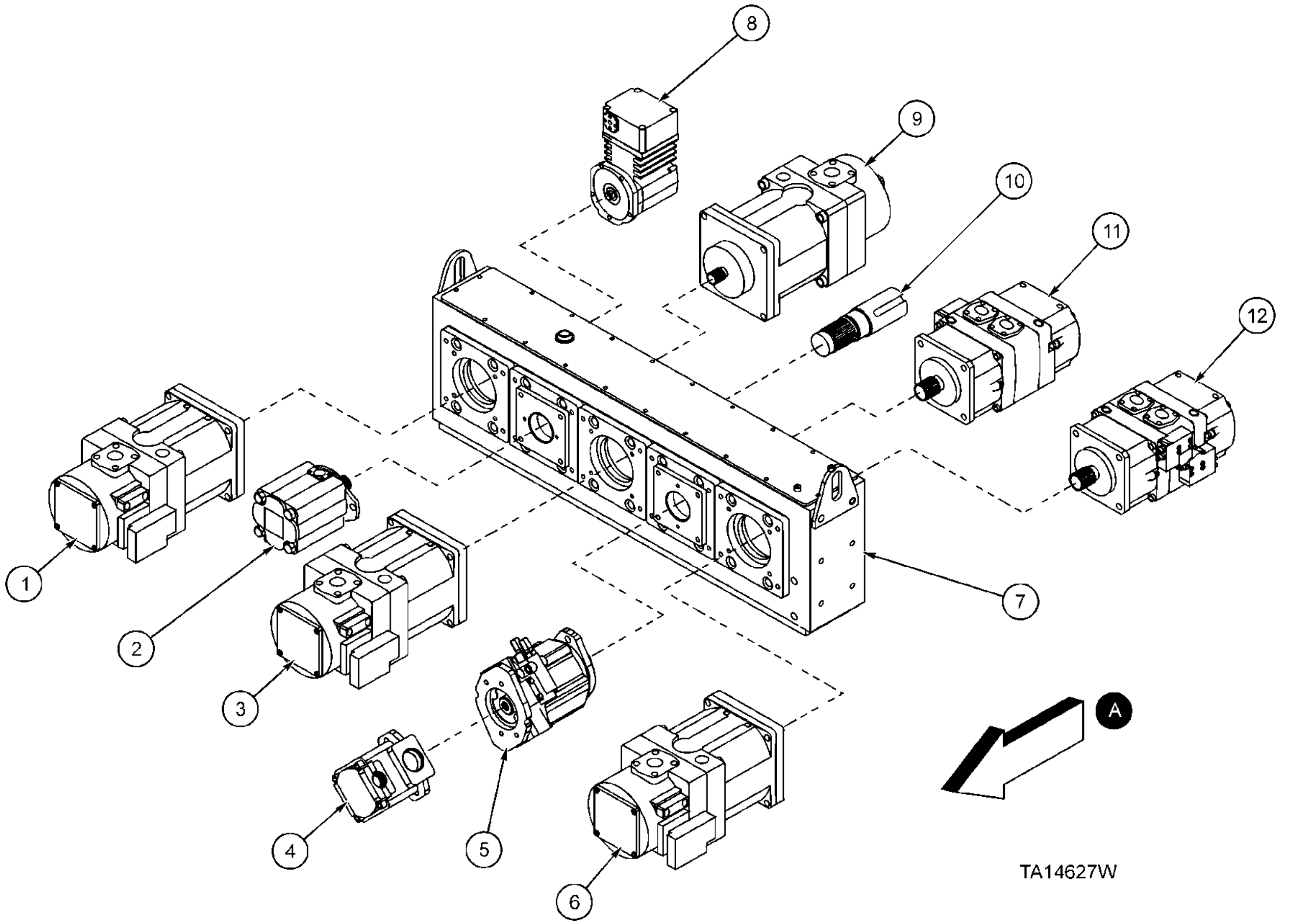
Model	Main	Fast Hoist	Steering	Blower	Fan	Accessory	Circulation
L-1350 Gen 2	2	1	2 (tandem)	Tandem		1	1
L-1350 Gen 3	3	1	2 (tandem)	Tandem		1	1
L-1850 8 Blade	3	1	2 (tandem)	Tandem		1	1
L-1850 11 Blade	3	1	2 (tandem)	1	1	1	1
L-1850 Tier4 Engine	3	1	2 (tandem)	1	2	1	1
L-2350 8 Blade	3	1	2 (one mounted on fast hoist pump)	Tandem		1	1
L-2350 11 Blade	3	1	2 (one mounted on fast hoist pump)	1	1	1	1

Table 6. Hydraulic pump arrangement



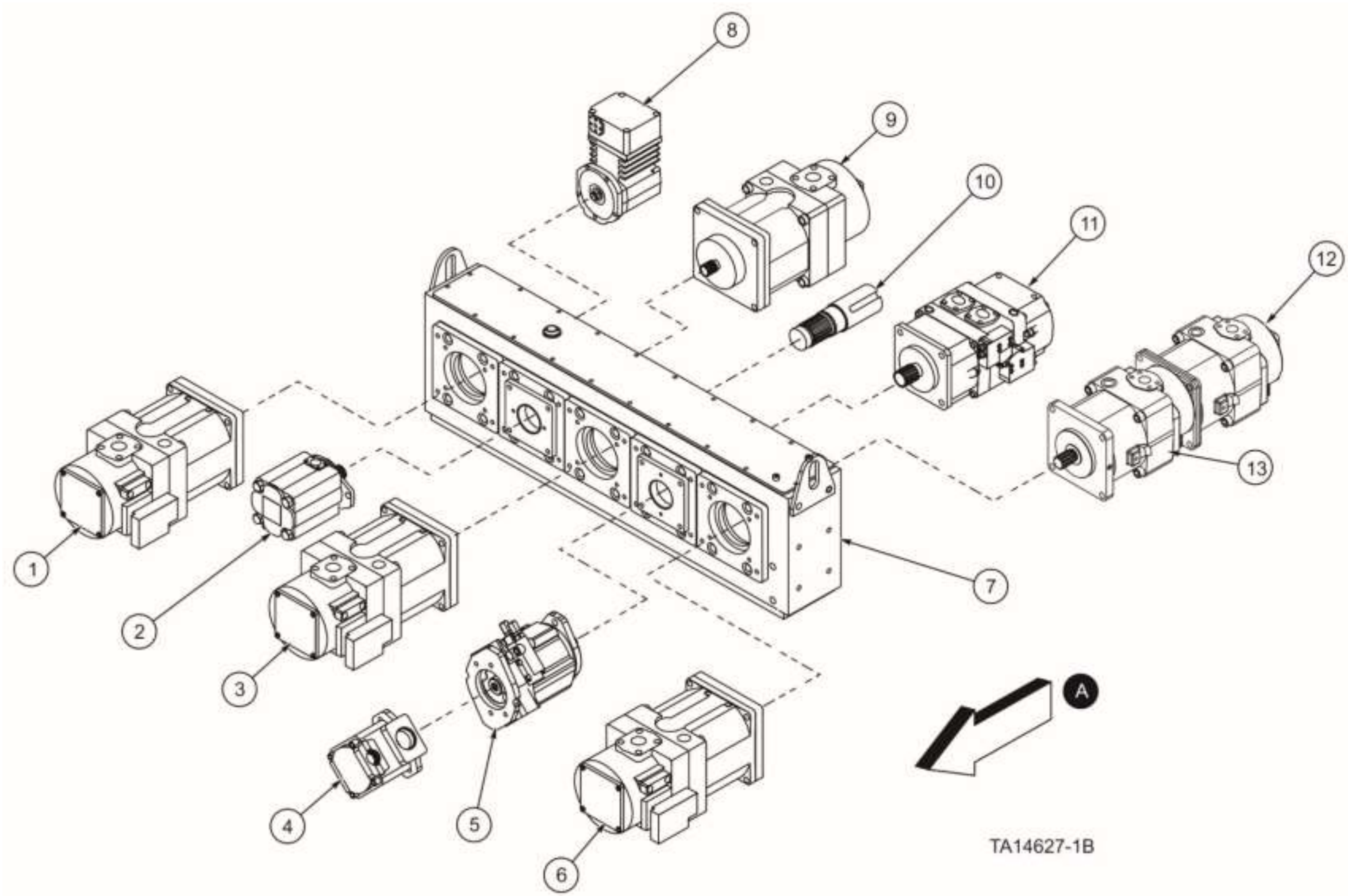
A) To Front Of Loader, **1)** Main Pump, **2)** Hydraulic Oil Cooling Circuit, **3)** Main Pump, **4)** Gearbox Lube, **5)** Accessory Pump, **6)** Main Pump, **7)** Hydraulic Pump Gearbox, **8)** Air Compressor, **9)** Cover Plate, **10)** Drive Shaft Powered by Generator, **11)** Steering, **12)** Engine Fan/Blower

Figure 20. L-1350 Hydraulic pump arrangement (typical pump types are illustrated)



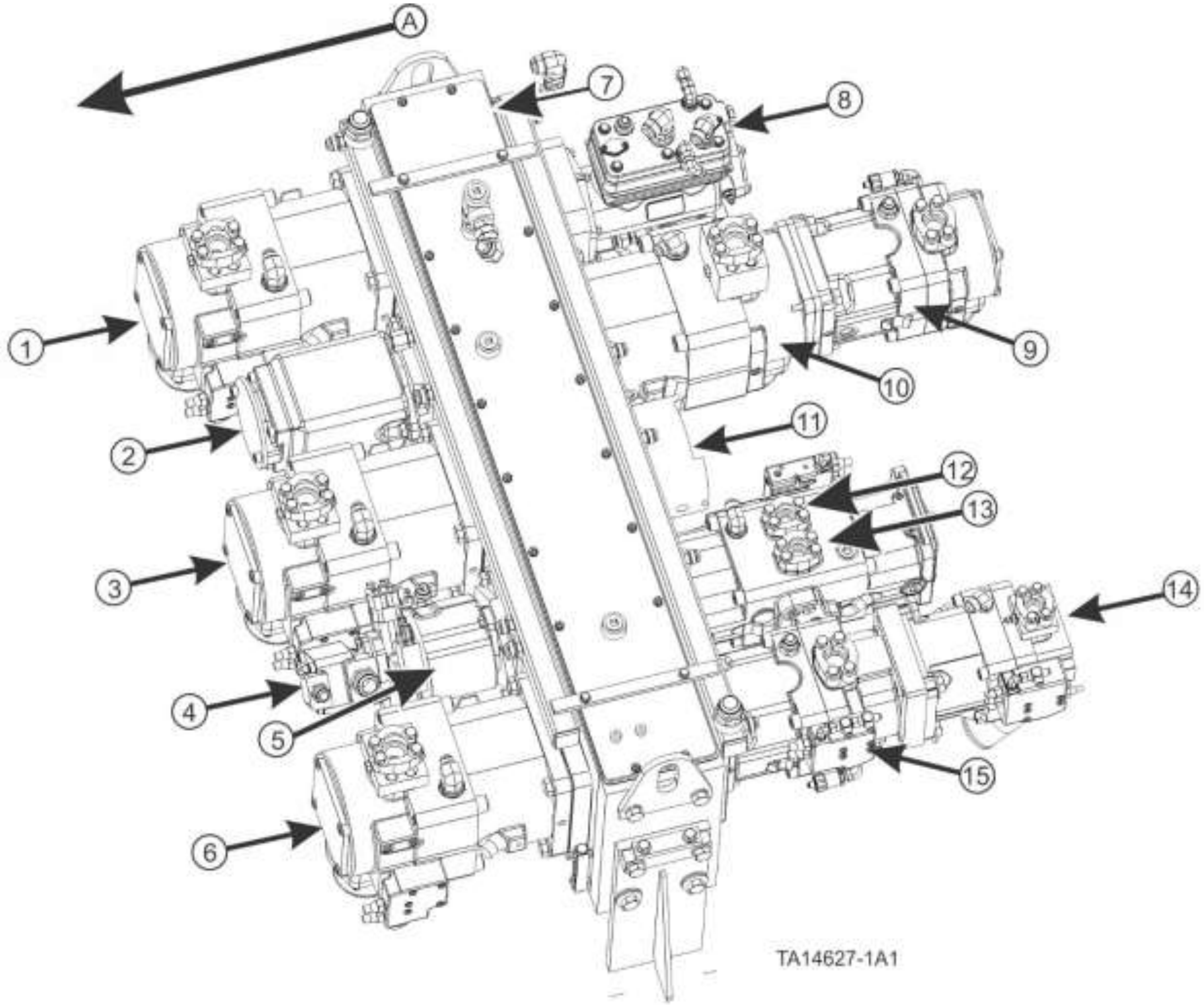
A) To Front Of Loader, **1)** Main Pump, **2)** Hydraulic Oil Cooling Circuit, **3)** Main Pump, **4)** Gearbox Lube, **5)** Accessory Pump, **6)** Main Pump, **7)** Hydraulic Pump Gearbox, **8)** Air Compressor, **9)** Main Pump, **10)** Drive Shaft Powered by Generator, **11)** Steering, **12)** Engine Fan/Blower

Figure 21. L-1850 Hydraulic pump arrangement for 8 blade engine fan (typical pump types are illustrated)



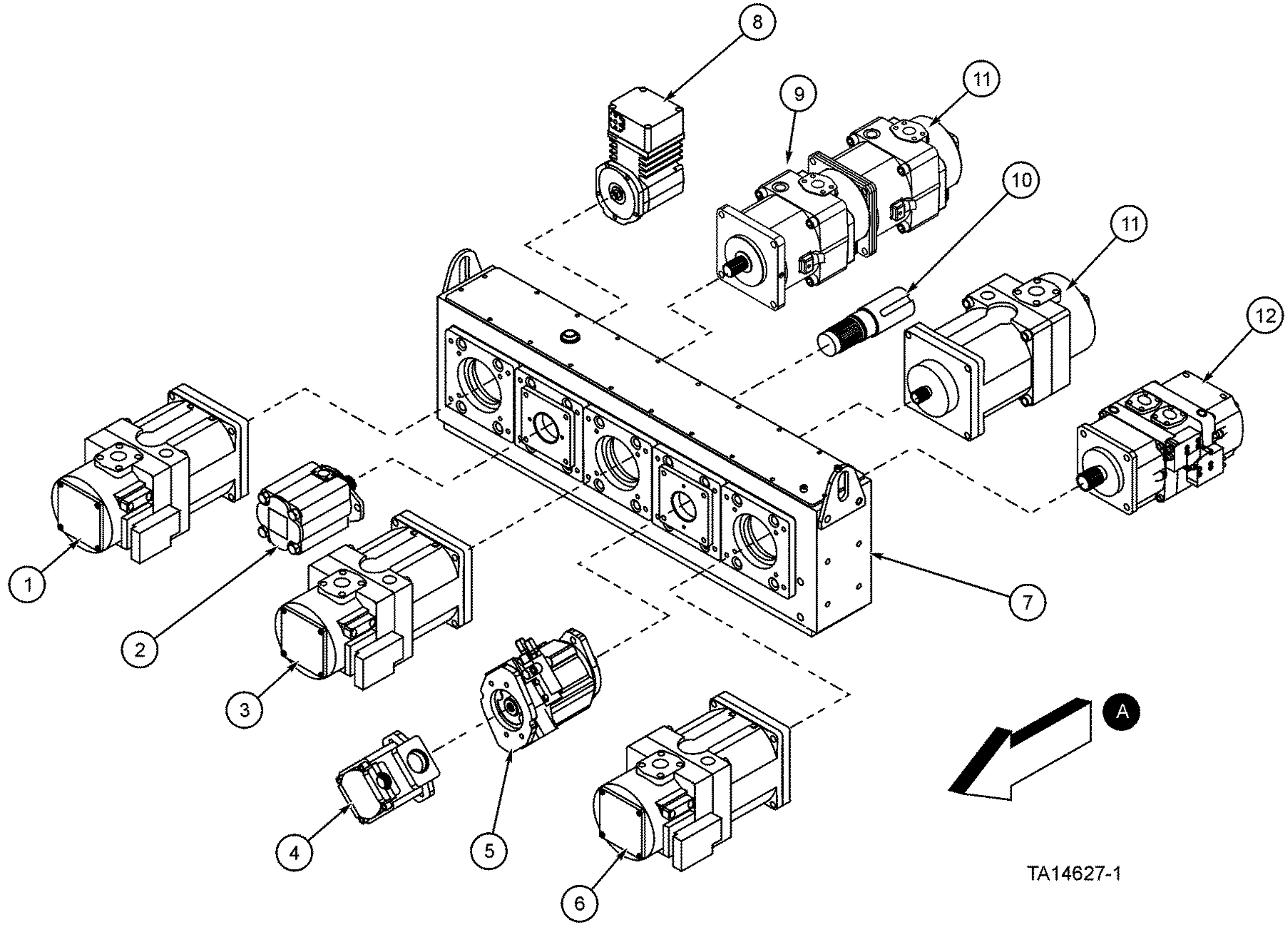
A) To Front Of Loader, 1) Main Pump, **2)** Hydraulic Oil Cooling Circuit, **3)** Main Pump, **4)** Gearbox Lube, **5)** Accessory Pump, **6)** Main Pump, **7)** Hydraulic Pump Gearbox, **8)** Air Compressor, **9)** Main Pump, **10)** Drive Shaft Powered by Generator, **11)** Steering, **12)** Engine Blower, **13)** Engine Fan

Figure 22. L-1850 Hydraulic pump arrangement for 11 blade engine fan (typical pump types are illustrated)



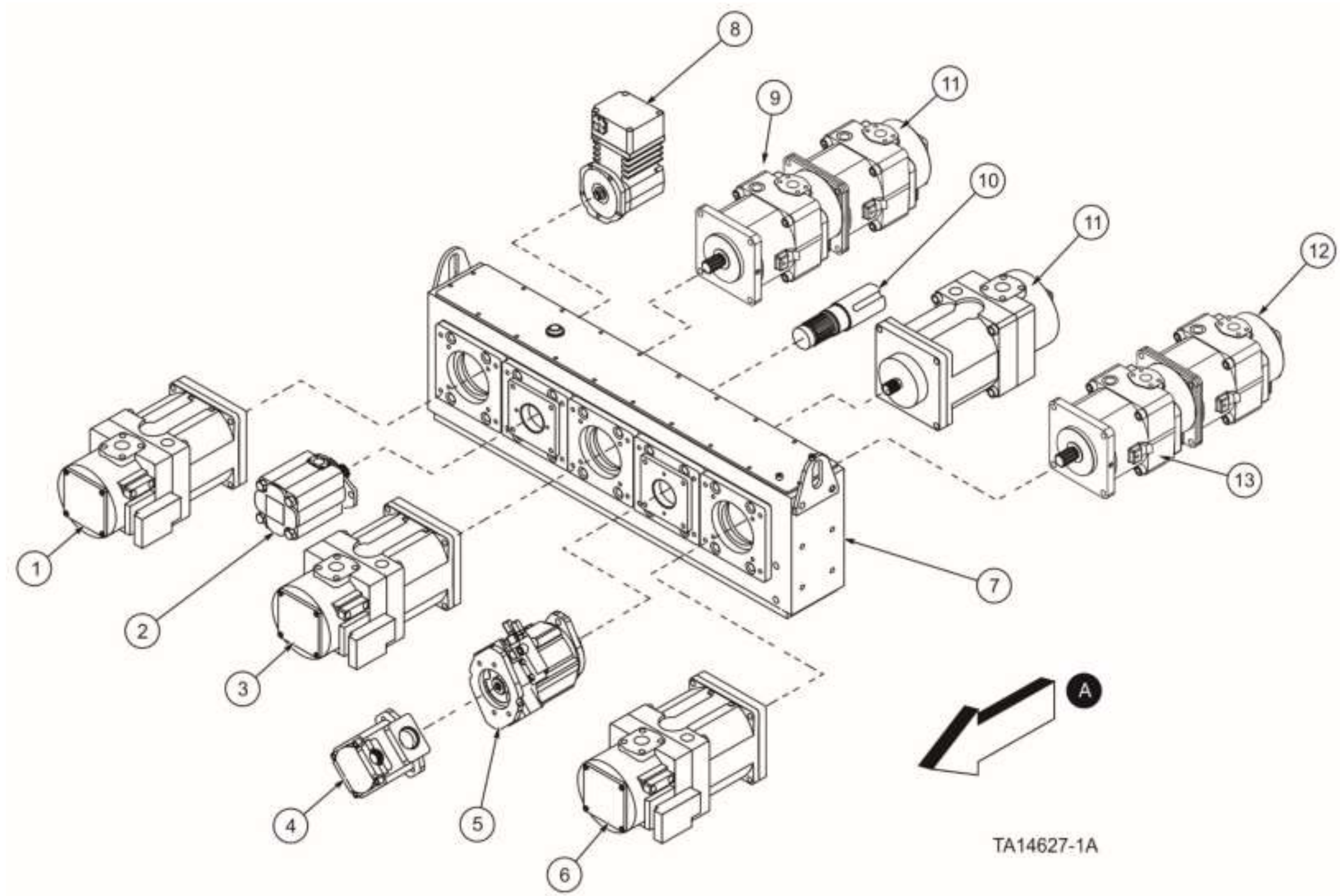
A) To Front Of Loader, 1) Bucket/Hoist Pump#2, **2)** Hydraulic Oil Cooler Pump, **3)** Fast Hoist Pump, **4)** Gearbox Lube Pump, **5)** Accessory Pump, **6)** Bucket/Hoist Pump #1, **7)** Hydraulic Pump Gearbox, **8)** Air Compressor, **9)** Engine Fan Pump#2, **10)** Bucket/Hoist Pump#3, **11)** Drive Shaft Powered by Generator, **12)** Steering Pump B, **13)** Steering Pump A, **14)** Engine Air Blower Pump, **15)** Engine Fan Pump#1

Figure 23. L-1850 Hydraulic pump arrangement for 11 blade Tier 4 engine fan (typical pump types are illustrated)



A) To Front Of Loader, **1)** Main Pump, **2)** Hydraulic Oil Cooling Circuit, **3)** Main Pump, **4)** Gearbox Lube, **5)** Accessory Pump, **6)** Main Pump, **7)** Hydraulic Pump Gearbox, **8)** Air Compressor, **9)** Main Pump, **10)** Drive Shaft Powered by Generator, **11)** Steering, **12)** Engine Fan/Blower

Figure 24. L-2350 Hydraulic pump arrangement for 8 blade engine fan (typical pump types are illustrated)



A) To Front Of Loader, **1)** Main Pump, **2)** Hydraulic Oil Cooling Circuit, **3)** Main Pump, **4)** Gearbox Lube, **5)** Accessory Pump, **6)** Main Pump, **7)** Hydraulic Pump Gearbox, **8)** Air Compressor, **9)** Main Pump, **10)** Drive Shaft Powered by Generator, **11)** Steering, **12)** Engine Blower, **12)** Engine Fan

Figure 25. L-2350 Hydraulic pump arrangement for 11 blade engine fan (typical pump types are illustrated)

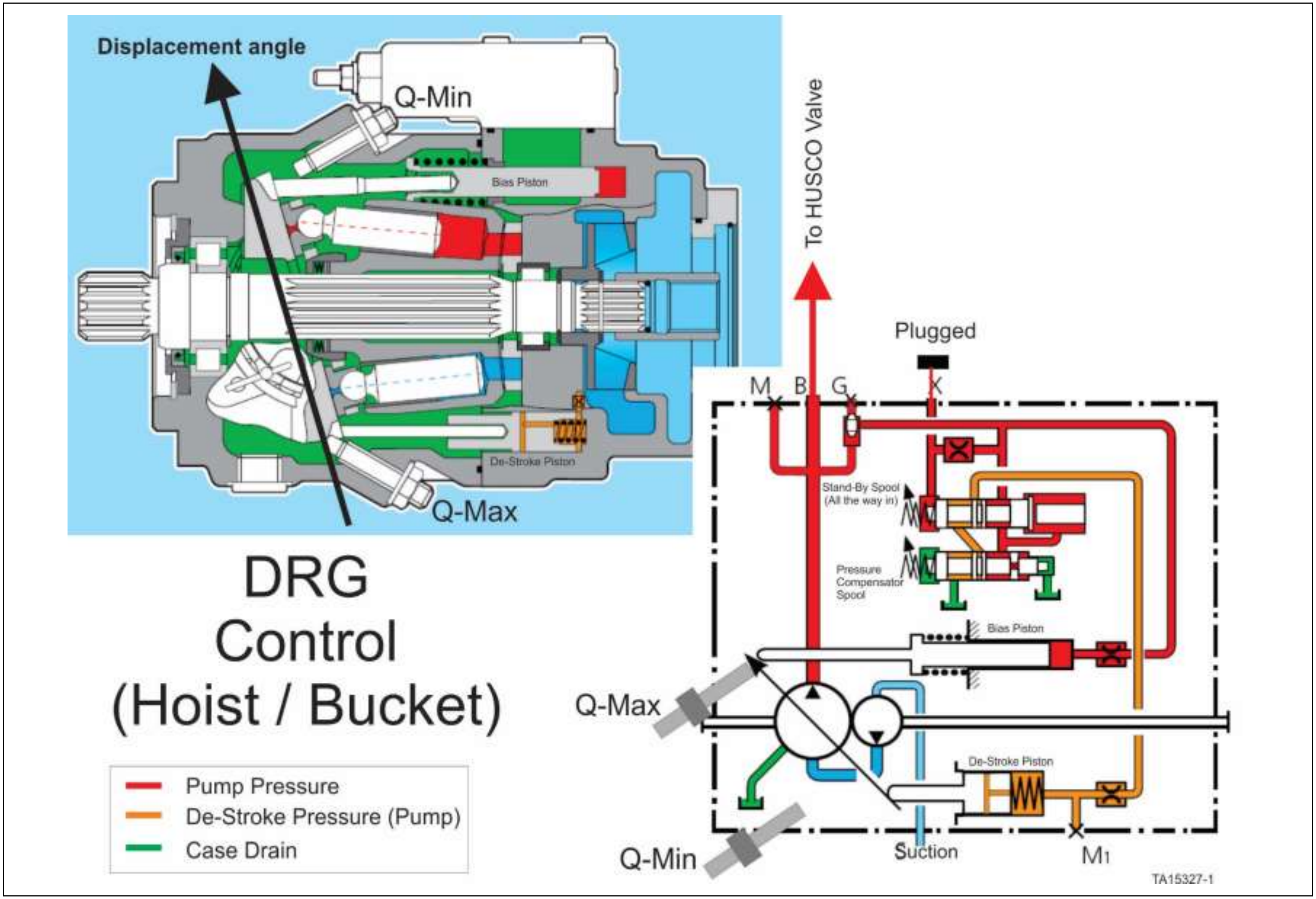


Figure 26. DRG hoist and bucket

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DRG (Hoist Bucket)

The bias piston and spring hold the pump in its maximum displacement angle. When the pump begins to rotate, flow is pushed toward the open center HUSCO valves and back to reservoir.

As a hoist or bucket function is commanded, the flow from the pump is directed to either the hoist, or bucket cylinder. The resistance of the cylinder's movement results in a pressure felt all the way back to the pump and its control valve assembly.

The pump control valve assembly has two control spools. One is referred to as stand-by; the other is called the pressure compensator.

On the hoist and bucket pumps, the "LS" port is plugged creating a hydraulic lock on the stand-by spool. The setting screw is turned in completely, eliminating any possibility of moving. The pressure compensator spool has pump pressure trying to move the spool against an adjustable spring. The setting of the spring determines at what pressure the spool shifts and directs pump pressure to the de-stroking piston, forcing the pump to minimum displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. As pressure drops, the pressure compensator spool returns to the closed position, allowing the bias piston to push the pump to maximum displacement again.

Both the min and max angles of the pump swash plate are adjustable by moving the mechanical stops (Q-MIN Q-MAX) in or out. These are factory set and under normal conditions should not be adjusted.

NOTICE

Contact Komatsu for adjustment procedure for Q-MIN/Q-MAX.

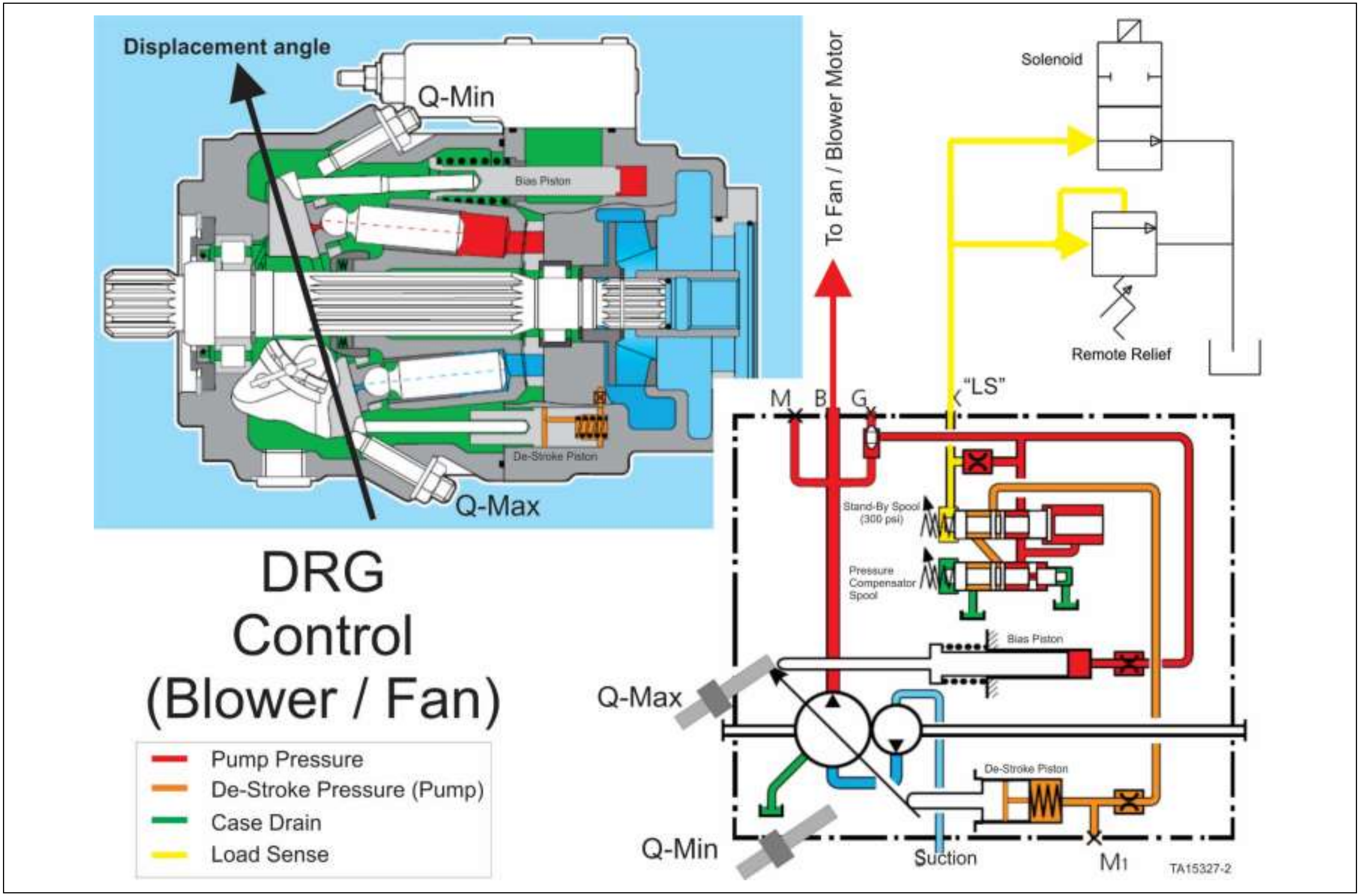

Figure 27. DRG fan blower

DRG Control (Fan and Blower)

The bias piston and spring hold the pump in its maximum displacement angle. When the pump begins to rotate, flow is pushed toward the motor causing it to rotate.

The pressure or resistance of flow is determined by the speed at which the motor is rotating the fan blades. Higher speed results in higher pressure.

The pump control valve assembly has two control spools. One is referred to as stand-by, the other is called the pressure compensator.

On the fan and blower pumps, the "LS" port is connected to a remote relief allowing for easier maintenance adjustments. The stand-by spool spring is adjusted per the specification chart, so when the LS port is vented to hydraulic reservoir, pump pressure will build until it overcomes the spring at the specific value. Once moved, this spool will direct pump pressure to the de-stroking piston, forcing the pump to minimum displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. As pump pressure drops, the stand-by spool will return to the closed position allowing the bias piston to push the pump to maximum displacement again.

The remote relief acts as an addition to the stand-by spring. The stand-by spring is set to the value in the specification chart and as pump pressure increases, so does the pressure in the load sense line through an orifice internal to the control valve assembly. When pressure in the load sense line is less than the remote relief setting, the stand-by spool remains centered keeping the pump at maximum displacement. As pressure increases to the remote relief setting, the spring end of the stand-by spool is relieved creating a differential in pressure from one side of the spool to the other. Once the differential is greater than the stand-by spring setting, the spool will shift and direct pump pressure to the de-stroking piston, forcing the pump to a lesser displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. As pressure drops, the stand-by spool will return to the closed position allowing the bias piston to push the pump to maximum displacement again. Because of this additive effect, pump pressure will always be stand-by spring pressure plus load sense pressure.

The pressure compensator spool has pump pressure trying to move the spool against an adjustable spring. The setting of the spring determines at what pressure the spool shifts and directs pump pressure to the de-stroking piston, forcing the pump to a lesser displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. As pressure drops, the pressure compensator will return to the closed position allowing the bias piston to push the pump to maximum displacement again.

Both the min and max angles of the swash plate are adjustable by moving the mechanical stops (Q-MIN Q-MAX) in or out (these are factory set and under normal conditions should not be adjusted).

NOTICE

Contact Komatsu for adjustment procedure for Q-MIN/Q-MAX.

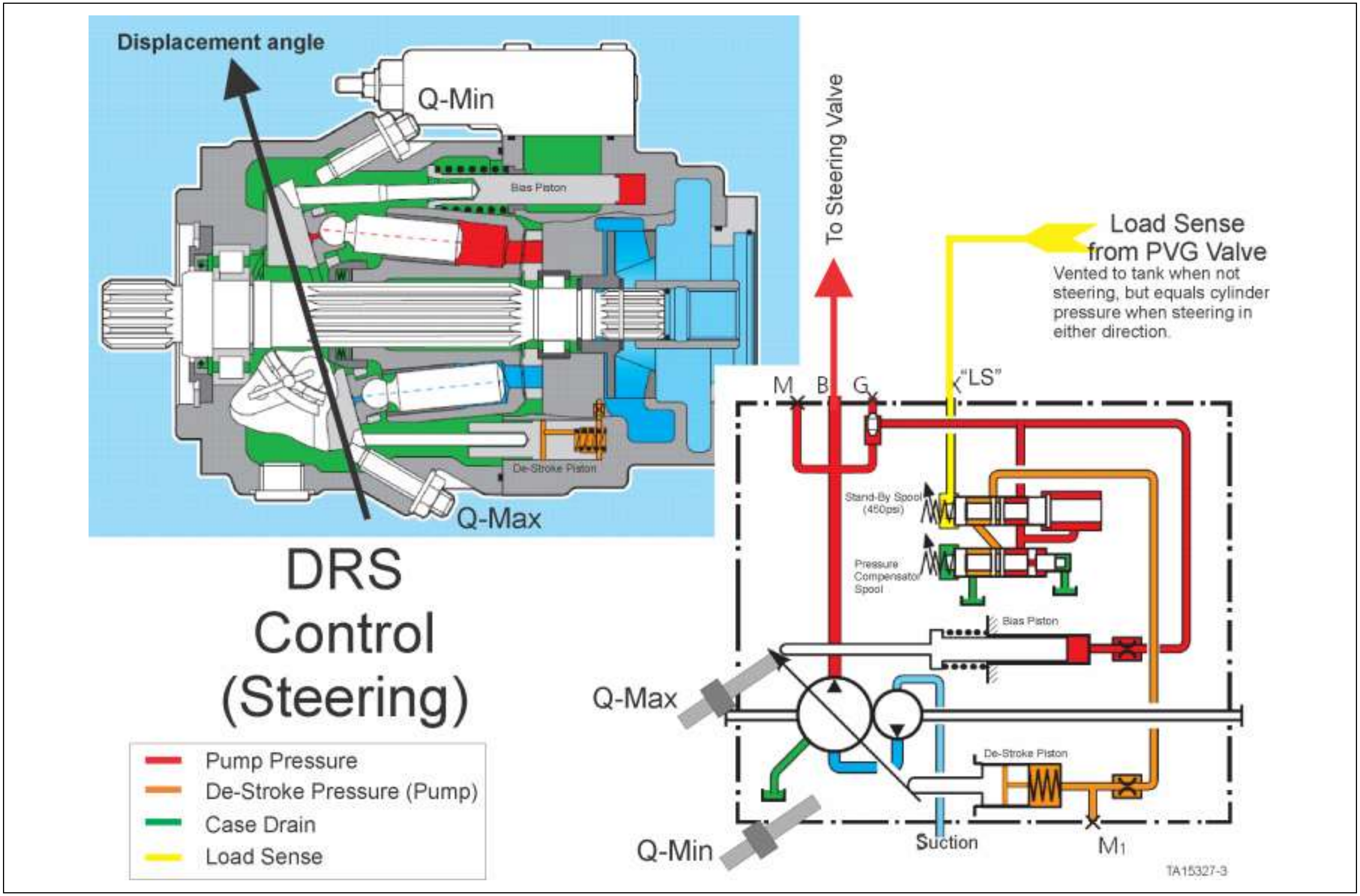

Figure 28. DRS (Steering)

DRS Control (Steering)

The bias piston and spring hold the pump swash plate in its maximum displacement angle (Q-MAX). When the pump begins to rotate, oil flow is directed toward the closed center steering valve. The pressure or resistance of flow is determined by the pressure created by the resistance of the steering cylinder motion. The pump control valve assembly has two control spools. One is referred to as stand-by, the other is called the pressure compensator. On the steering pumps, the “LS” (Load Sense) port is connected to the “LS” port of the PVG valve, which when not steering, vents this pressure to reservoir, but when steering is actuated, “LS” senses the actual pressure in the steering cylinders.

No Steering Commanded

The stand-by spool spring is adjusted so when the LS port is vented to reservoir, the pumps pressure will build until it overcomes the spring at 450 psi (31 bar). Once moved, this spool will direct pump pressure to the de-stroking piston forcing the pump to a lesser displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. If pressure drops below the spring setting, the stand-by spool returns to the closed position allowing the bias piston to push the pump to maximum displacement again.

Steering in Either Direction

The “LS pressure adds to the setting of the stand-by spring. As steering is commanded, the resistance to cylinder movement results in an increase in “LS” pressure that adds to the setting on the stand-by spring, allowing the flow to remain full at a higher pressure. This balancing act allows the pump to produce flow at a rate that results in a pressure 450 psi (31 bar) higher than the pressure in the cylinder. Any excess pressure will force the stand-by spool to shift and direct pump pressure to the de-stroking piston, forcing the pump to minimum displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. If pressure drops, the stand-by spool returns to the closed position allowing the bias piston to push the pump to maximum displacement again. Because of this additive effect, pump pressure will always be the combined pressure of the stand-by spring and load sense pressure.

Maximum Steering Pressure

The pressure compensator spool has pump pressure trying to move the spool against an adjustable spring. The setting of the spring determines at what pressure the spool shifts and directs pump pressure to the de-stroking piston, forcing the pump to a lesser displacement angle. Pump pressure is also felt on the bias piston, but the larger area of the de-stroking piston allows it to exert more force. As pressure drops, the pressure compensator returns to the closed position, allowing the bias piston to again push the pump to maximum displacement. Both the min and max angles of the swash plate are adjustable by moving the mechanical stops (Q-MIN Q-MAX) in or out (these are factory set and under normal conditions should not be adjusted).

NOTICE

Contact Komatsu for adjustment procedure for Q-MIN/Q-MAX.

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Hydraulic System Post Service Requirements

CAUTION

Failure to properly prime EACH PUMP every time the system is opened for service or repair, or if the hydraulic reservoir is drained and filled, may result in a pump failure due to a dry start condition during machine start-up. Always bleed fluid until air bubbles cease. This situation may also adversely affect the warranty.

⚠ CAUTION

Skin injection hazard exists when priming pumps. High hydraulic pressure is present when priming pumps. Injection of hydraulic fluid into the skin is possible when high hydraulic pressure is present. Use all necessary Personal Protective Equipment (PPE), such as face shield, eye protection, long sleeves, etc., to avoid injury when priming pumps. Failure to wear all necessary PPE can cause in skin injection resulting in serious injury.

Hydraulic Pump Priming

After the hydraulic system is opened, regardless of the type or amount of service or repair, or the hydraulic reservoir has been drained and fluid added, it is **critically important** that the hydraulic pumps (located at the hydraulic pump drive gearbox in the front of the rear frame) be primed prior to starting the machine. Use the following procedures to ensure the hydraulic pumps are free of air before operation.

Safety Preparations

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

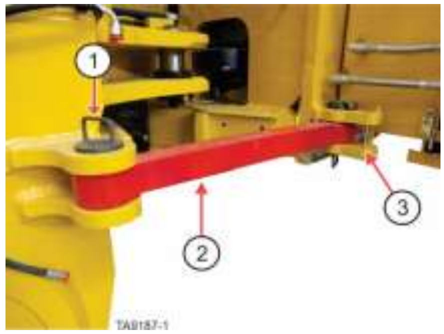
a. Stop the wheel loader on flat level ground.

b. Move the frame lock to the locked position so that the frame cannot be steered.

c. Place wheel chocks in front and behind each wheel.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,
3) Retaining pin bracket for un-locked position

Frame lock in locked position

d. Set bucket flat and level on the ground.

e. Set the parking brakes.

f. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

g. Turn the engine isolation switch to the off position and install lock on the switch.

Figure 29. GEN 2 Battery Isolation Box – Battery isolation switch in OFF position with locks in place

NOTICE

The GEN 2 battery and engine starter isolation box is shown in this document. GEN 1 machines will have a different type of switch and box. The lock out/tag out requirements are the same.

⚠ WARNING

Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.

h. Use the hydraulic pressure bleed down valves located in the front frame underneath the Husco valves to bleed any stored pressure in the hoist and bucket cylinders.

i. Turn each valve slowly counterclockwise as shown below and allow the pressure to bleed down.

j. Open the valve completely and leave it open during this procedure.

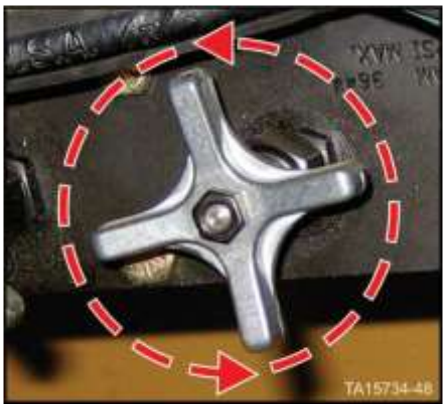


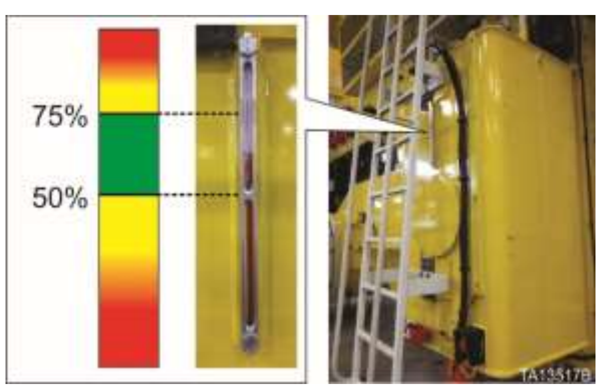
Figure 30. Pressure bleed down valves

k. Turn the key switch on and boot the LINCS system.

Piston Pumps

- **L-1350 (Gen 2):** BH1 (Bucket/Hoist), BH2 (Bucket/Hoist), FHP (Fast Hoist), FP (Fan), BP (Blower), and AP (Accessory). Repeat procedure for each pump.
- **L-1350 (Gen 3) L-1850, L-2350:** BH1 (Bucket/Hoist), BH2 (Hoist), BH3 (Bucket/Hoist), BH4 (Bucket/Hoist), FP (Fan), BP (Blower), and AP (Accessory). Repeat procedure for each pump.

1. Hydraulic reservoir oil level sight glass must read ¾ full when the lift arms and bucket are flat on the ground. Check sight gauge on side of reservoir.



2. The manual air release valve, located on top of the hydraulic reservoir, must be in the pressurized position (reservoir is pressurized).

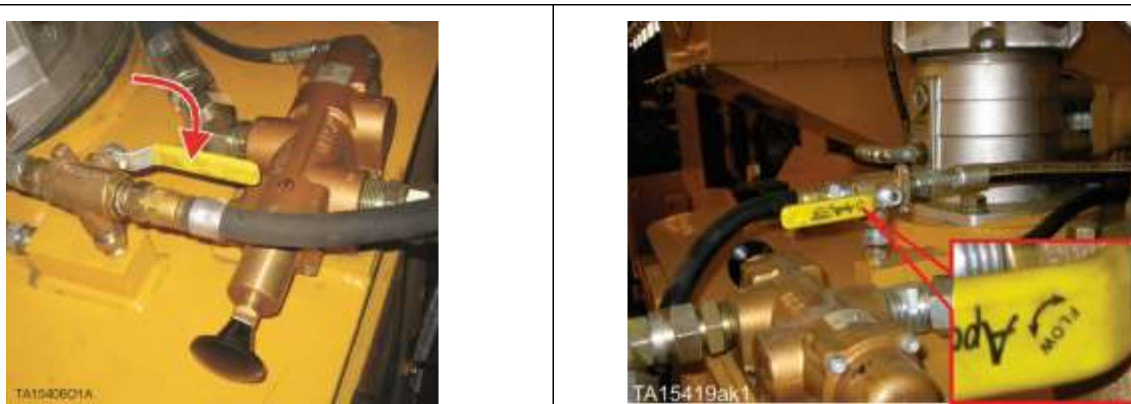


Figure 31. Air bleed valve in pressurized position (reservoir pressurized)

3. Compressed air system pressure must be greater than 60 psi (4.13 bar). Pressurize through shop air connection at distribution reservoir or remote drain (as applicable).

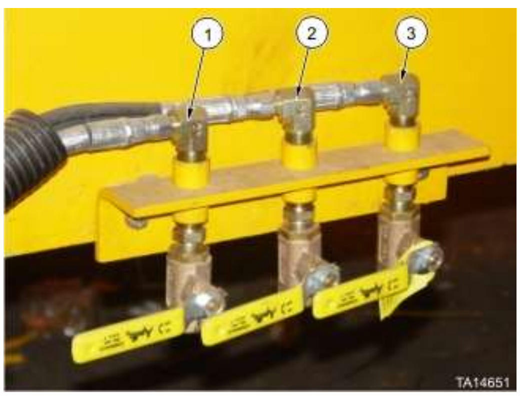
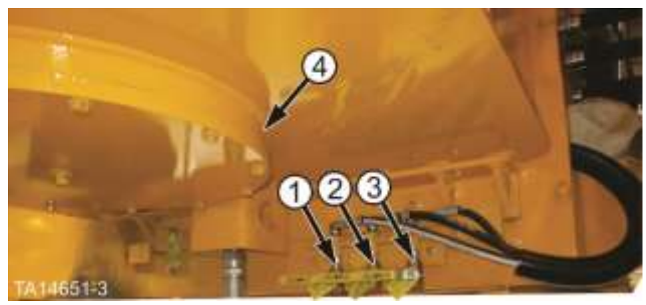
 **Located beneath electrical cabinet**	 **Located beneath hydraulic reservoir**
1) Distribution Reservoir Drain Valve **2)** Front Brake Reservoir Drain Valve **3)** Rear Brake Reservoir Valve	**1)** Distribution Reservoir Drain Valve **2)** Front Brake Reservoir Drain Valve **3)** Rear Brake Reservoir Valve **4)** Hydraulic Tank Reservoir Access Panel

Figure 32. Remote drain kit (typical installation)

4. Pressurize the hydraulic reservoir to 4-6 psi (0.27-0.41 bar). Verify pressure by looking at hydraulic reservoir pressure by using the LINCS system or by looking at the gauge on the hydraulic reservoir air regulator valve, located inside the air system box on top of the LVCC.

NOTICE

Piston pumps require bleeding on the pressure side and case drain side of the pump. It may require three or more gallons of oil to be drained to assure all air is bled out of the pump.

5. Loosen the case drain line on top of the pump. Refer to illustration “Piston pump bleed port locations”. Allow oil to flow from loosened connection into a container until bubbles cease.

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7. Tighten case drain line.

8. Locate the pressure test fitting connector on the outlet of each pump. Refer to illustration “Piston pump bleed port locations”. Attach a female coupling and a length of hose vented into a suitable container. Disconnect coupling and hose when oil flow is free of air.

NOTICE

It may require three or more gallons of oil to be drained, to assure, that all of the air is bled out of the pump.

1) Pressure Side Bleed Port Quick Connect, **2)** Case Drain Port

Figure 33. Piston pump bleed port locations

Vane Pumps

- **L-1350, L-1850, L-2350:** CP (Hydraulic Oil Circulation Pump)

1. Hydraulic reservoir level sight glass must read ¾ full, when the lift arms and bucket are flat on the ground. Check sight gauge on side of reservoir.

2. Be sure the manual air release valve, located on top of the hydraulic reservoir, is closed.

3. Compressed air system pressure must be greater than 60 psi (4.13 bar). It can be pressurized through a shop air connection at distribution reservoir or remote drain (as applicable).

4. Pressurize the hydraulic reservoir to 4-6 psi (0.27-0.41 bar). Verify pressure by looking at hydraulic reservoir pressure by using the LINCS system or by looking at the gauge on the hydraulic reservoir air regulator valve, located inside the air box on the electrical cabinet.

5. Locate the pressure test fitting connector on the outlet of each pump. Attach a female coupling and a length of hose vented into a suitable container. Disconnect coupling and hose when oil flow is free of air.

Filter Leak Check

Following replacement of the hydraulic filters, it is **critically important** to check them for leaks with the engine running at high throttle before returning the loader to service.

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Gearbox

Hydraulic Pump Drive (Gearbox) Service

It is essential to perform proper gearbox servicing and to monitor the lubricating fluid wear particle count to achieve long life of the hydraulic pump gearbox.

Use Specified Lubricating Fluid

The lubricating oil is used to perform the basic functions of lubrication, cooling, cleansing, and diagnostics. Using the proper fluid is critical in the service life of the hydraulic pump drive gearbox. Komatsu recommends the use of quality fluid with a good additive package, high viscosity index, and most importantly, the correct viscosity, as specified on table “LUBRICATION AND FLUID SPECIFICATIONS located at the end of this manual section.

The hydraulic pump drive gearbox runs between 1800 at 1980 rpm when loaded normally. The gearbox is hydro dynamically lubricated, which means that the mating components create a constant film under pressure, preventing metal-to-metal contact. Due to the high speed, fluid viscosity must be at the optimum level, so that as the gears pass through the fluid, the voids are readily filled. If the viscosity is too high, the voids would not be filled, causing metal-to-metal contact between the gears which results in component failure. If the viscosity drops too low, due to an incorrect fluid viscosity choice or poor fluid viscosity index additive package, a boundary lubrication condition occurs (the lubrication film becomes too thin to provide separation between the mating surfaces).

With high-speed applications, foaming and shearing of the fluid are common problems. Quality fluids contain an additive package that includes an anti-foam agent and a high shear stability. Another important additive is VI improver, which increases the viscosity index of the fluid, allowing it to operate over a greater range of temperatures.

Proper viscosity is also critical because the fluid must be pumpable. All P&H wheel loader gearboxes are fitted with a circulating vane pump, which moves the fluid throughout the gearbox. This pump assists in lubricating the gearbox, as well as circulating the fluid through an oil cooler and filter. The fluid acts as a heat transfer medium, transferring the heat created by the rotating components to the oil cooler where the heat is dissipated. This process allows the gearbox system to run cooler and more efficiently. The circulating fluid also conveys collected contaminants in the system to the filter for removal.

Lastly, the fluid is a diagnostic tool. Through regular fluid sampling, trends of the wear materials generated in the system may be monitored by analysis. With this analysis, repairs can be made before a complete failure occurs. Refer to text “LUBRICATING OIL ANALYSIS”, located in Section 02 of the Service Manual, for information on establishing an on-going lubricating oil analysis program.

NOTICE

A lubricating oil analysis program with samples collected every 500 hours is mandatory to meet Komatsu warranty requirements. Gearbox oil change intervals are based on oil analysis wear trend data and the parameters listed in table “CLEANLINESS TARGETS”, located in Section 02 of the Service Manual.

- **The hydraulic pump gearbox is factory equipped with SAE 75W-140 synthetic gear oil. It is recommended that this oil be used for subsequent refilling and servicing of the gearbox.**

- **Should other than the factory installed synthetic oil be used, quality 80W-90 gear oil is recommended. Recommended lubricants for the hydraulic pump gearbox are listed in table "LUBRICATION AND FLUID SPECIFICATIONS", located at the end of this manual section.**

Hydraulic Pump Drive (Gearbox) Service Intervals

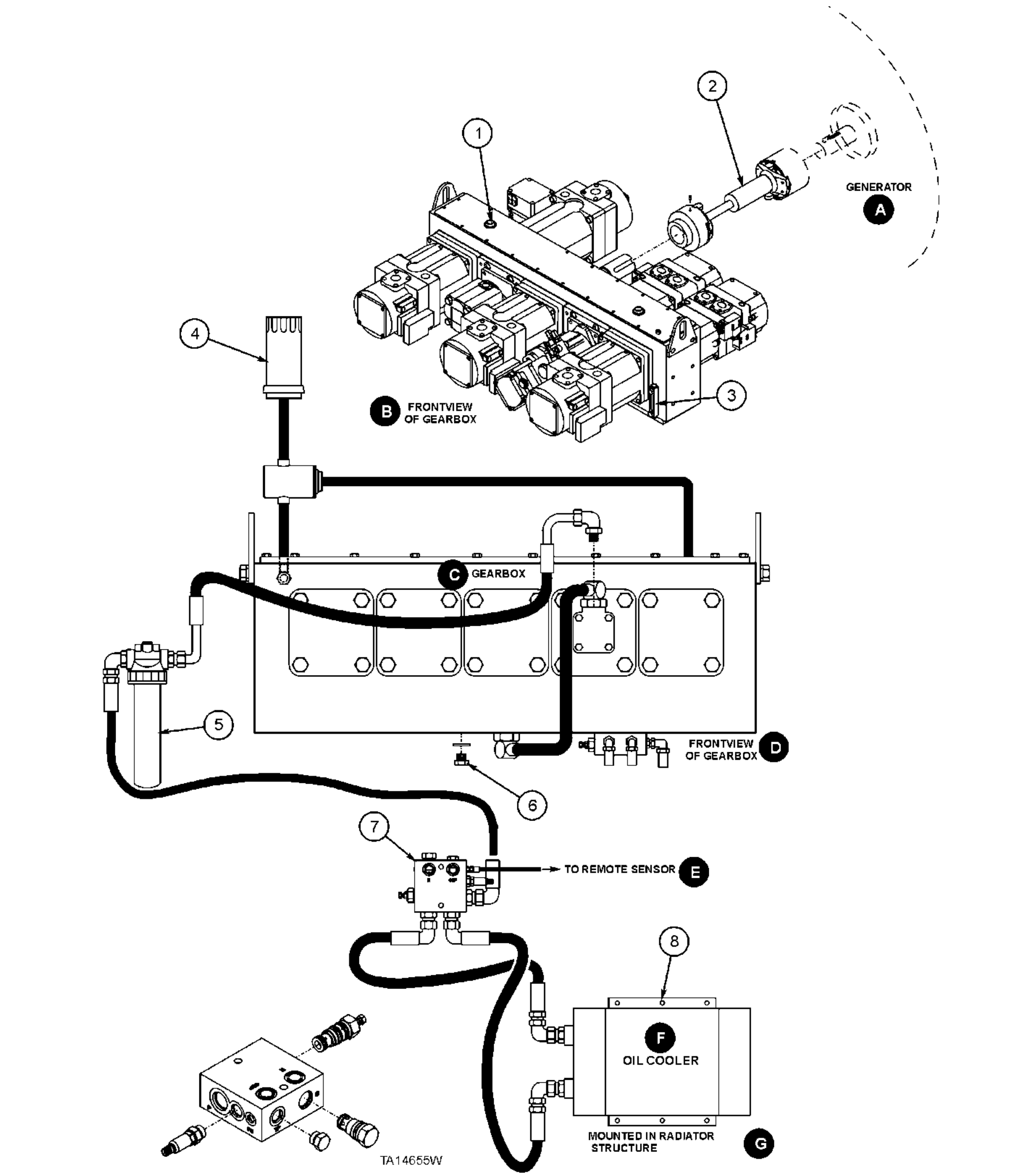
In accordance with the P. M. recommendations:

a. **Lubricant Level Inspection Daily:** The hydraulic pump gearbox should be inspected for proper oil level daily. A sight glass is provided on the front of the gearbox for checking the oil level. Refer to "Hydraulic pump gearbox service points (typical gearbox and pump layout shown)" for component location. If the gearbox oil level is low, repair the leak and fill the gearbox to the proper level with the proper oil before operating the loader.

b. **Lubricating Oil Analysis Every 500 Hours:** Oil samples for lubricating oil analysis must be taken every 500 hours to meet Komatsu warranty requirements. If solid particle contamination (chromium or iron) reaches 100 ppm on two or more consecutive tests, component failure is imminent and teardown/rebuild should be considered.

NOTICE

The U-joints on the hydraulic pump gearbox driveshaft are permanently sealed and do not require periodic lubrication.



1. Fill Plug	**5.** Oil Filter
2. Drive Shaft	**6.** Drain Plug
3. Fluid Level Sight Glass	**7.** Control Valve
4. Air Breather Filter	**8.** Oil Cooler

A) Generator, **B)** Front View Of Gearbox, **C)** Gearbox, **D)** Front View Of Gearbox, **E)** To Remote Sensor, **F)** Oil Cooler, **G)** Oil Cooler Is Located Inside Radiator Assembly.

Figure 34. Hydraulic pump gearbox service points (typical gearbox and pump layout shown)

Hydraulic pump gearbox oil filter

Figure 35. Hydraulic pump gearbox oil filter

c. **Oil Filter Replacement Every 1500 Hours:** The oil filter should be replaced every 1500 hours of operation. The filter is mounted on the wall on the inside of the rear frame, close to the gearbox. Refer to illustration “Hydraulic pump gearbox service points (typical gearbox and pump layout shown)” and “Hydraulic pump gearbox oil filter” for component location.

CAUTION

DO NOT over torque the filter housing retaining nut on the filter assembly. A maximum of 30 ft. lbs. (40 Nm) is recommended on the knurled nut.

d. **Draining, Flushing and Refilling:** The gearbox and oil cooler should be flushed and filled with new synthetic oil when the need for replacement is indicated by oil analysis and the CLEANLINESS TARGETS (located in Section 02 of the Service Manual entitled “PREVENTIVE MAINTENANCE REQUIREMENTS AND RECOMMENDATIONS LUBRICATION AND SERVICE”). **DO NOT overfill. If the gearbox is overfilled, oil may saturate the air filter, requiring it to be replaced immediately.** Refer to illustration “Hydraulic pump gearbox service points (typical gearbox and pump layout shown)” for location of drain and fill plugs.

NOTICE

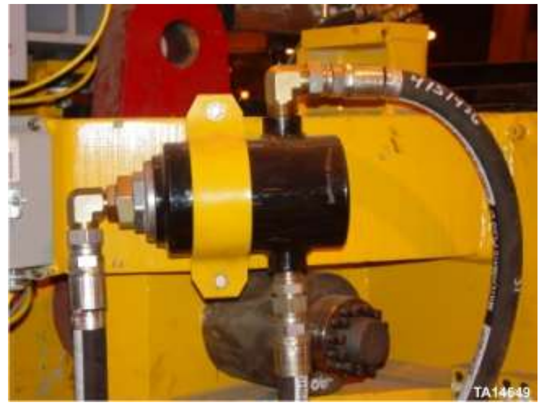
The hydraulic pump gearbox, oil cooler and filter holds 7 gallons [27 liters] of oil.

e. **Gearbox Air Breather Filter Replacement:** The air breather filter should be replaced every 1500 hours of operation. The air breather filter is typically mounted behind the operator’s cab. Refer to illustration “Hydraulic pump gearbox breather filter and strainer”.

NOTICE

The hydraulic pump drive gearbox breather filter is mounted on the right side of the machine, under the grating, behind the operator’s cab. Refer to illustration “Hydraulic pump gearbox breather filter and strainer”.

f. **Gearbox Breather Strainer Cleaning:** The gearbox breather strainer should be cleaned at the same time the filters are changed. This strainer is the same strainer used in the planetary drive filtration system (if present).



Typical gearbox breather strainer

1) Typical Mounting Location (behind cab)

Figure 36. Hydraulic pump gearbox breather filter and strainer

Hydraulic Pump Drive (Gearbox) Lubricant Pump Circuit

The hydraulic pumps are driven by a gearbox assembly, which is mechanically powered via a driveshaft, by the generator. A 17 gpm (64.4 lpm) vane pump, pumps the hydraulic gearbox internal lubricating oil through a canister-type filter. The oil then travels to the gearbox oil cooler control valve mounted on the bottom of the hydraulic pump gearbox. The oil enters the control valve at port “P” where it is monitored by a 200 psi (13.7 bar) pressure limiting sequence valve and a 100 psi (6.9 bar) oil cooler bypass check valve. The flow then leaves the control valve at port “CP” and travels through the oil cooler, returning to the control valve at Port “CR”. This oil passes through the control valve and into an internal distribution manifold. Oil flows into each of the bearing areas from a common distribution tube. The splined adapters are fitted with a piston ring on its outside diameter that mates with a bore in the bearing housing. This blocks the flow of oil around the shaft except what passes along the spline root areas. Flow is great enough to fill the cavity between the pump and drive adapter to a point above the drive adapter where a drain hole in the bearing housing allows overflow through the bearing area into the sump. The spline, being totally saturated, is called a “wet spline”.

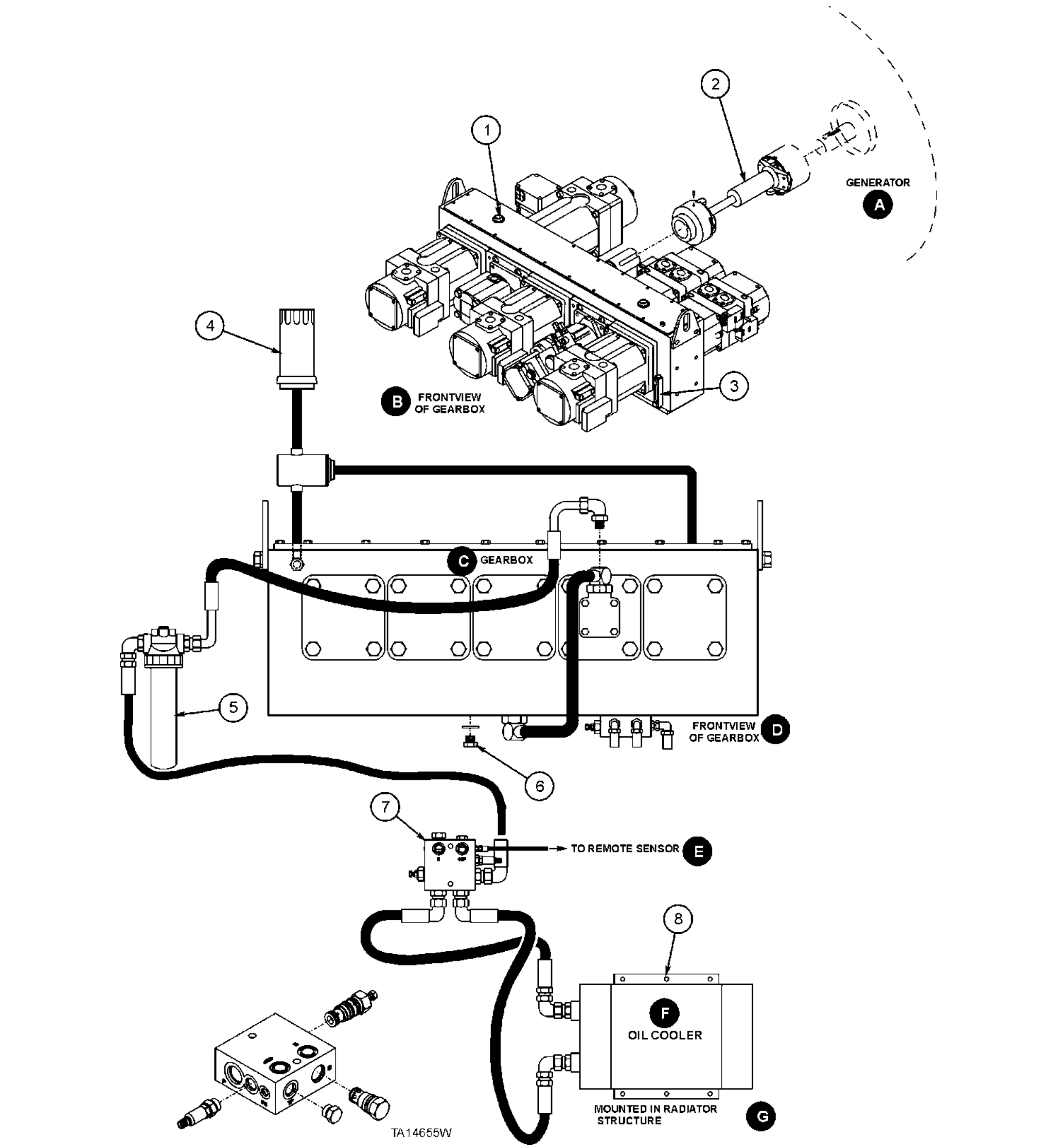
A pressure transducer is remotely mounted and a temperature sending unit is attached to the valve, monitors performance. These two devices provide warning information by illuminating the amber warning light on the operator’s console and sounding an audible alarm. A warning screen indicating gearbox overheating will appear on the LINCS computer monitor.

CAUTION

If removing and replacing gearbox lube pump, make special note of seal orientation. The seal is reversed to prevent cross-contamination of gearbox lubricant and hydraulic oil.

NOTICE

Remove all paint, rust, and debris from mating surfaces of all bolts 3/4" or larger and torque per specifications listed in “Capscrew and Bolt-Nut Torque Specifications”.



1. Fill Plug
2. Drive Shaft
3. Fluid Level Sight Glass
4. Air Breather Filter
5. Oil Filter
6. Drain Plug
7. Control Valve
8. Oil Cooler

A) Generator, **B)** Front View Of Gearbox, **C)** Gearbox, **D)** Front View Of Gearbox, **E)** To Remote Sensor, **F)** Oil Cooler, **G)** Mounted In Radiator Structure.

Figure 37. Hydraulic pump drive (gearbox) service points (typical gearbox and pump layout shown)

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Main Hoist and Bucket Control Valves (HUSCO)

The main bucket and hoist control valves (HUSCO valves) are located in the front frame.

L-1350/L-1850/L-2350: From left to right they are HUSCO #1 (H1), HUSCO #2 (H2) and HUSCO #3 (H3). Refer to illustration “L-1350/L-1850/L-2350 Hoist and bucket control valves (HUSCO valves)”.

These valves are of the open center design, returning pump flow to reservoir until an operation is commanded.

The HUSCO Valves #1 and #2 have two sections: bucket, and hoist, with the bucket first in the circuit giving it priority over the hoist circuit. The HUSCO Valve #3 has a single section used solely for hoist. Since HUSCO Valve #3 is independently supplied, slow hoisting can be performed while the bucket is being operated.

The control spool in each section is spring centered, open center in the neutral position. Pilot lines connected to both sides of the spool, which, when pressurized by operating the pilot control valve, move the spool out of the spring centered position. This restricts pump flow normally going to the reservoir and redirects it across a load check valve to perform the pilot commanded operation. Since the amount of spool travel is proportional to the pressure in the pilot line, flow which controls speed, is infinitely variable.

When the hoist joystick control is in the neutral (hold) position, pilot oil from both sides of the spool is vented back to the hydraulic reservoir, allowing the spools in the valve to center.

HUSCO valves have main relief valves, port relief valves, and load check valves. Refer to the Specifications sheet located in Section 01 of the Service Manual for model specific pressure settings.

The port relief valves protect the cylinders from pressure spikes and voids. The main relief valves protect the pumps from damage. The load check valves assure that pump pressure will be greater than cylinder pressure before cylinder movement occurs. This prevents a drop-in cylinder pressure when the spool initially shifts.

HUSCO #1 and #2 have an additional circuit relief. The dump circuit has a secondary operational pressure setting controlled by a Solenoid (SOL SD) and an 800-psi (55 bar) relief valve mounted externally. These relief valves are externally adjustable. HUSCO valves #1 and #2 also have four anti-void check valves, one for each circuit. The anti-void check valves are integrated into the relief valves. Should a void occur, these check valves will allow fluid returning to the hydraulic reservoir to be used to fill the void.

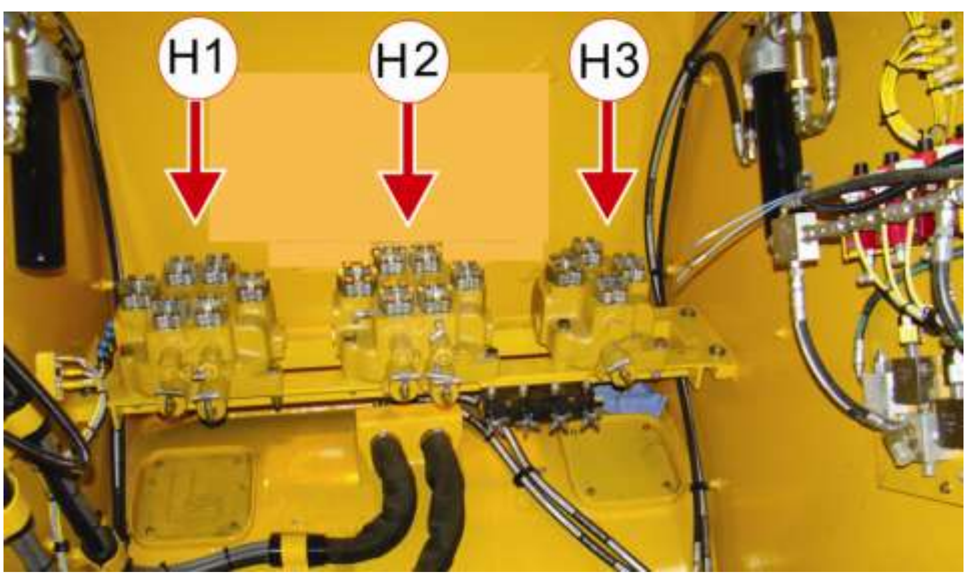
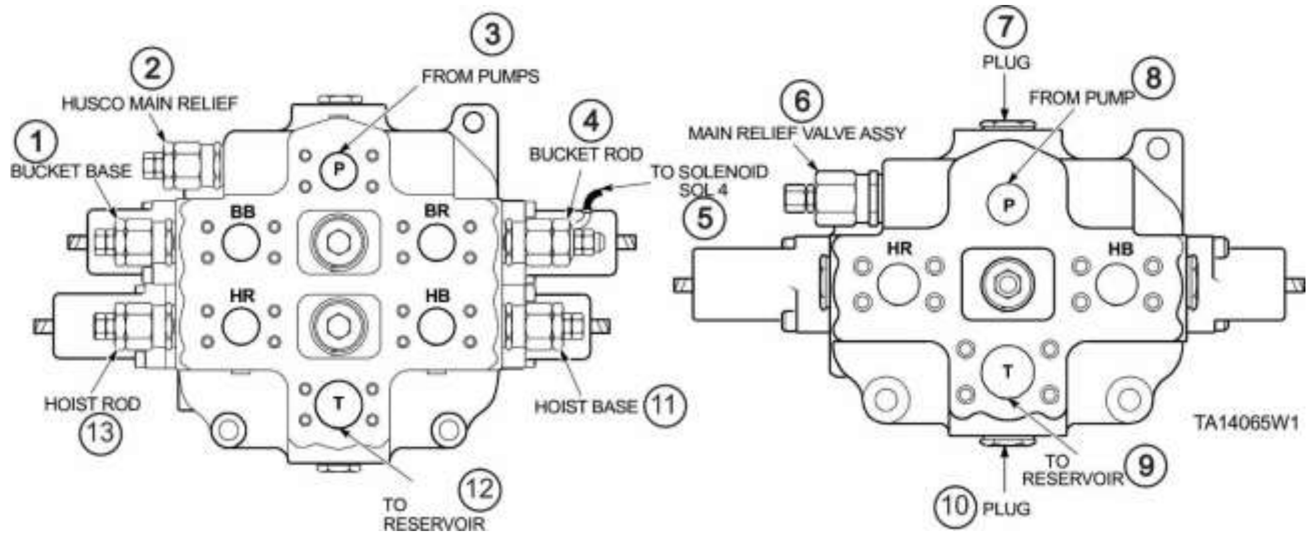


Figure 38. L-1350/L-1850/L-2350 Hoist and bucket control valves (HUSCO valves)



1) Bucket Base, **2)** HUSCO Main Relief, **3)** From Pumps, **4)** Bucket Rod, **5)** To Solenoid Sol 4, **6)** Main Relief Valve Assembly, **7)** Plug, **8)** From Pump, **9)** To Reservoir, **10)** Plug, **11)** Hoist Base, **12)** To Reservoir, **13)** Hoist Rod

Figure 39. HUSCO valves

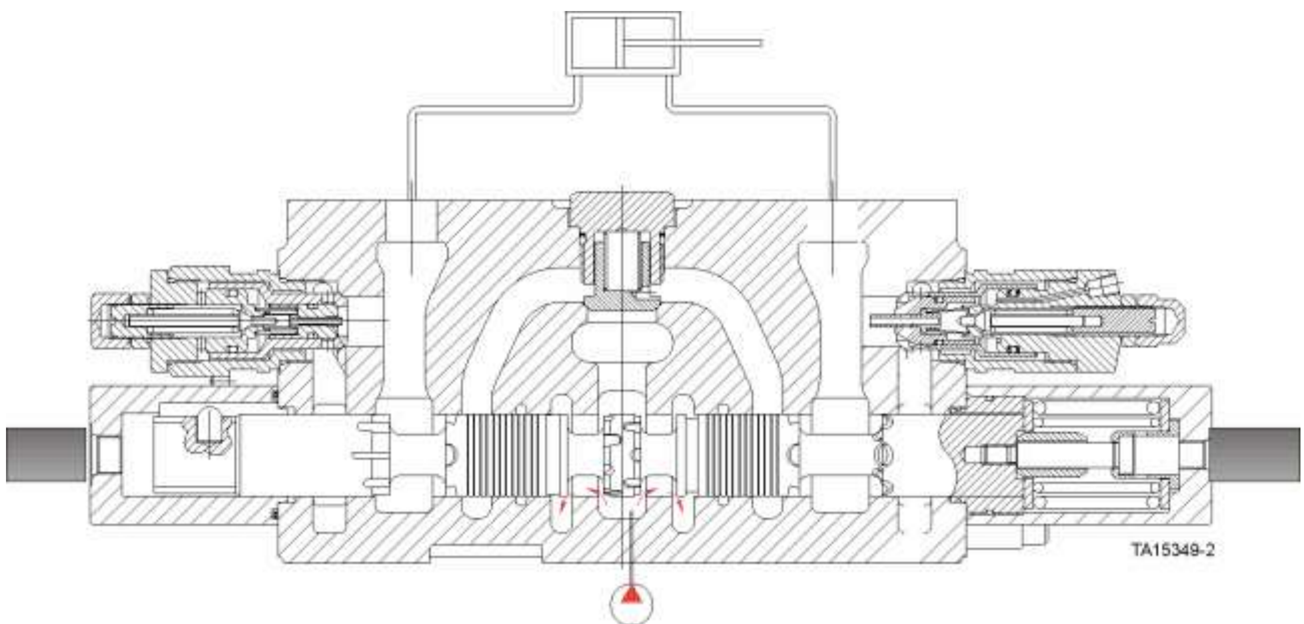


Figure 40. Bucket neutral

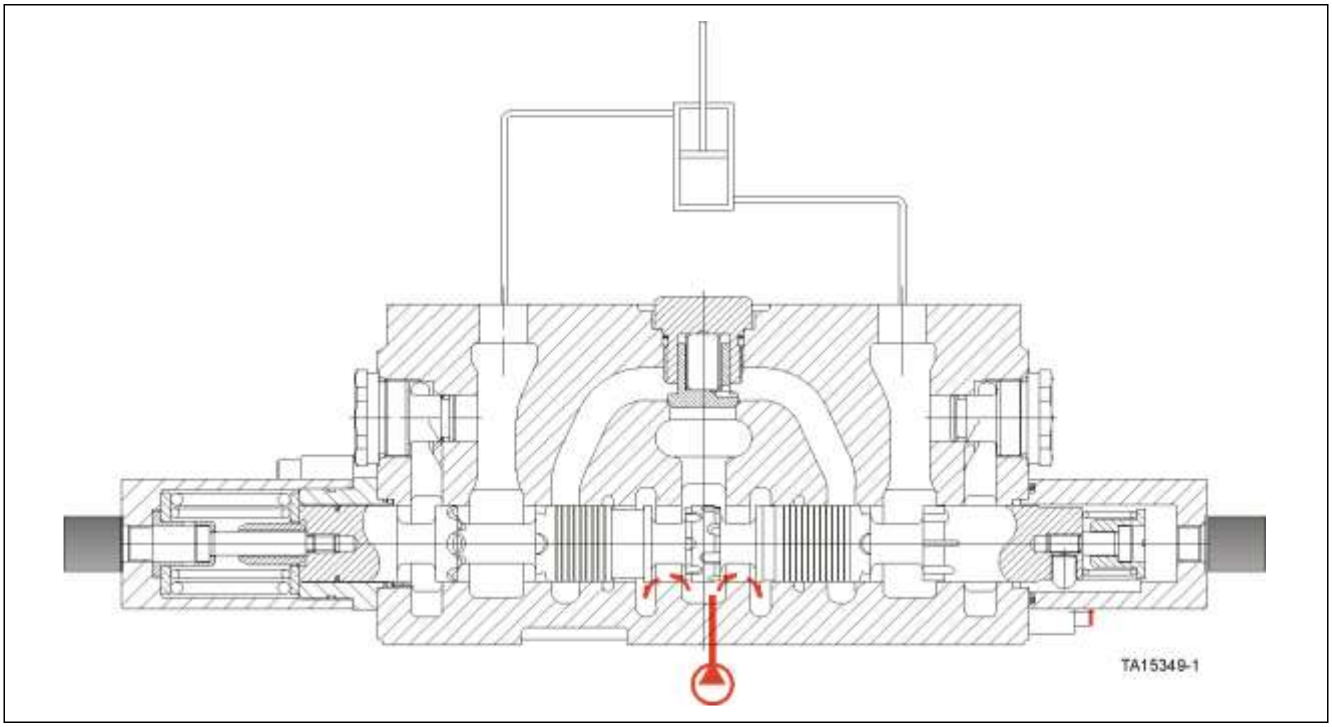


Figure 41. Hoist neutral

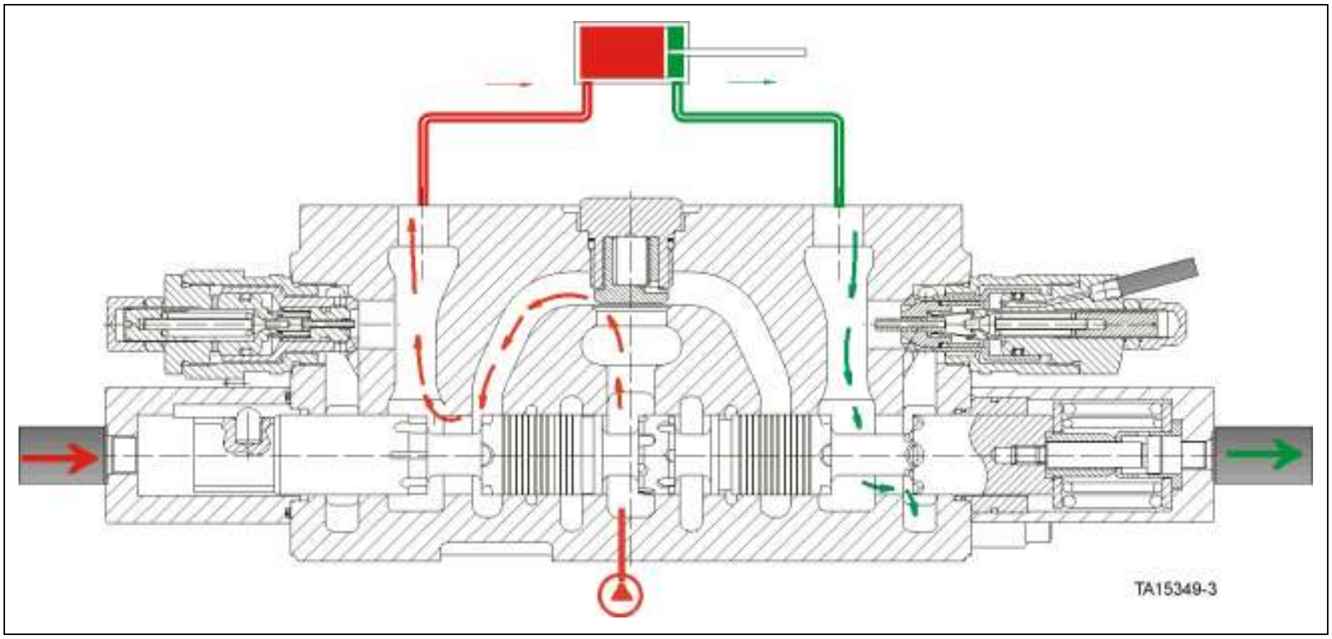


Figure 42. Bucket rollback

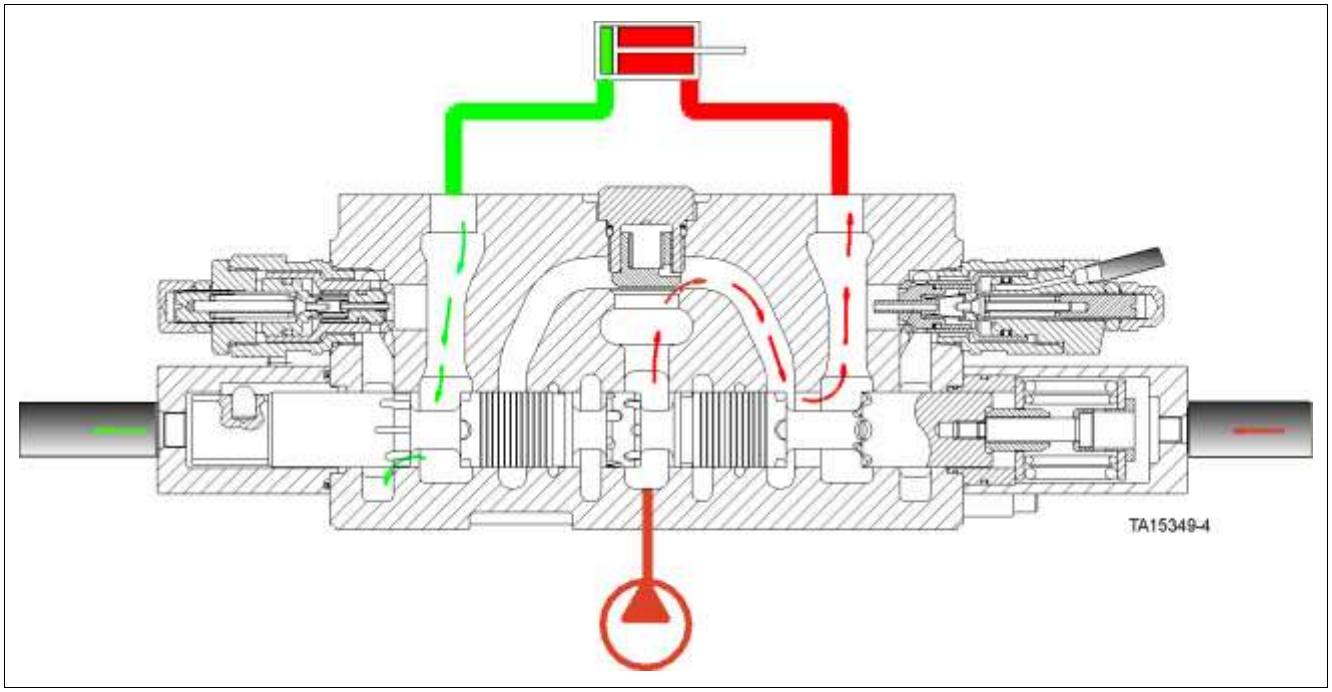


Figure 43. Bucket dump

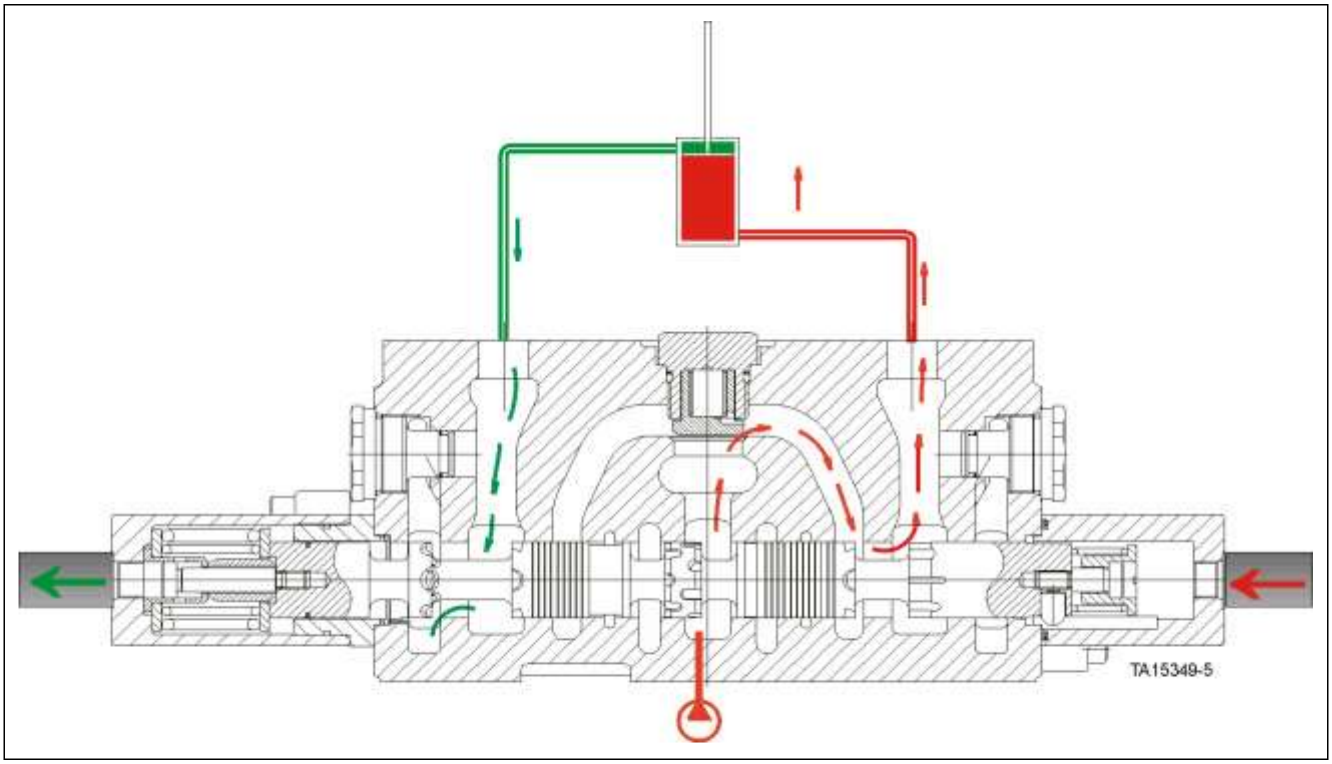


Figure 44. Hoist

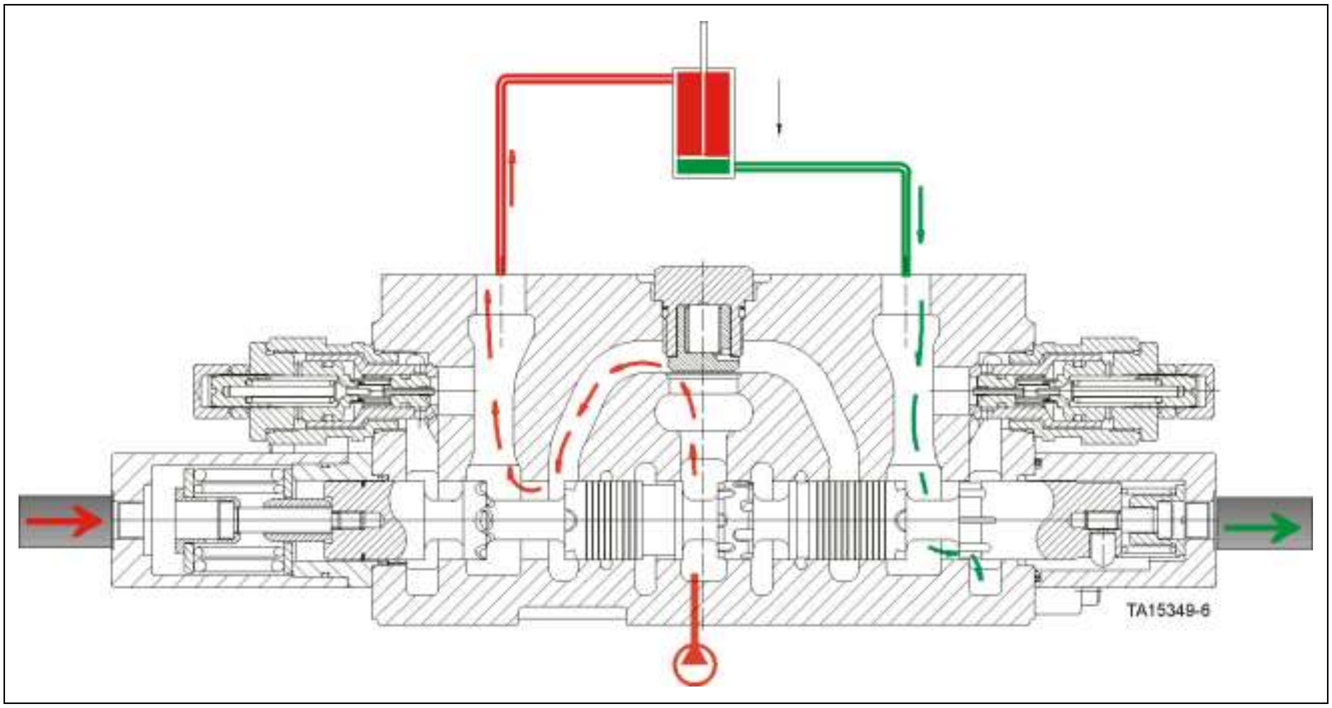


Figure 45. Power down

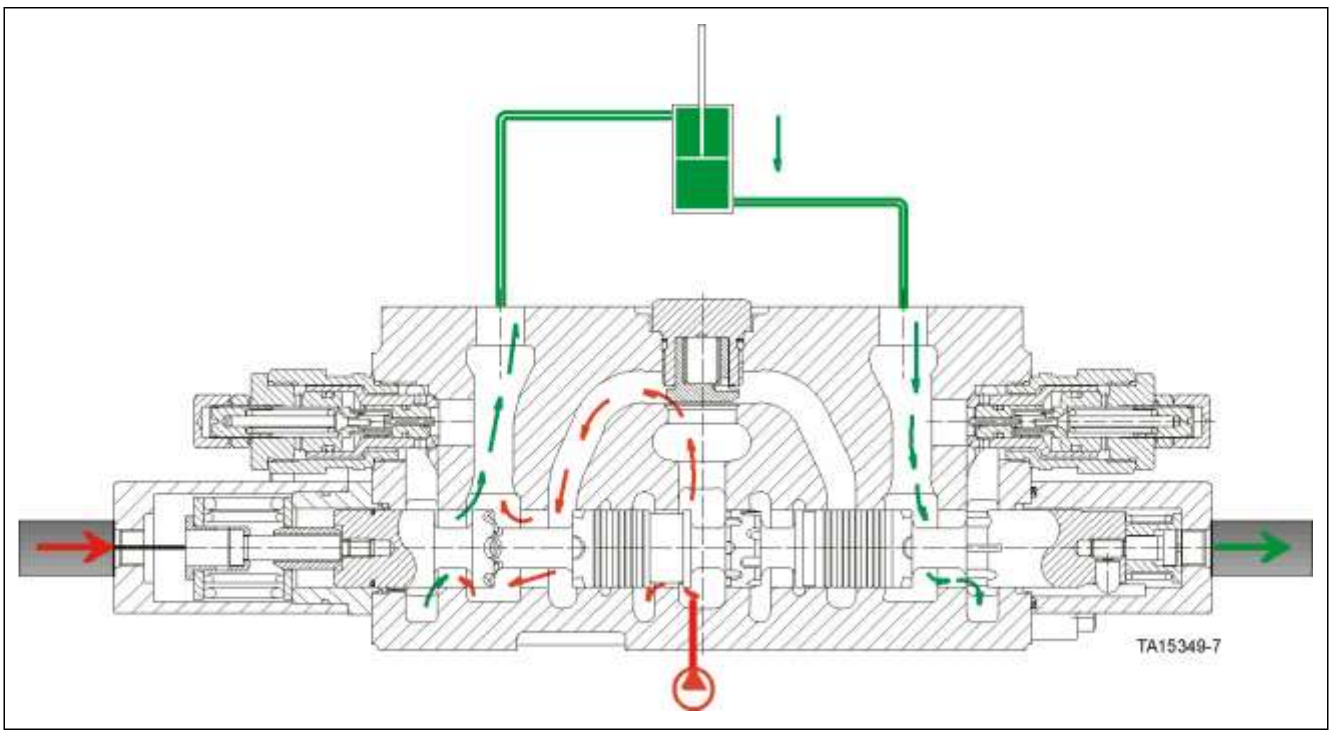


Figure 46. Float

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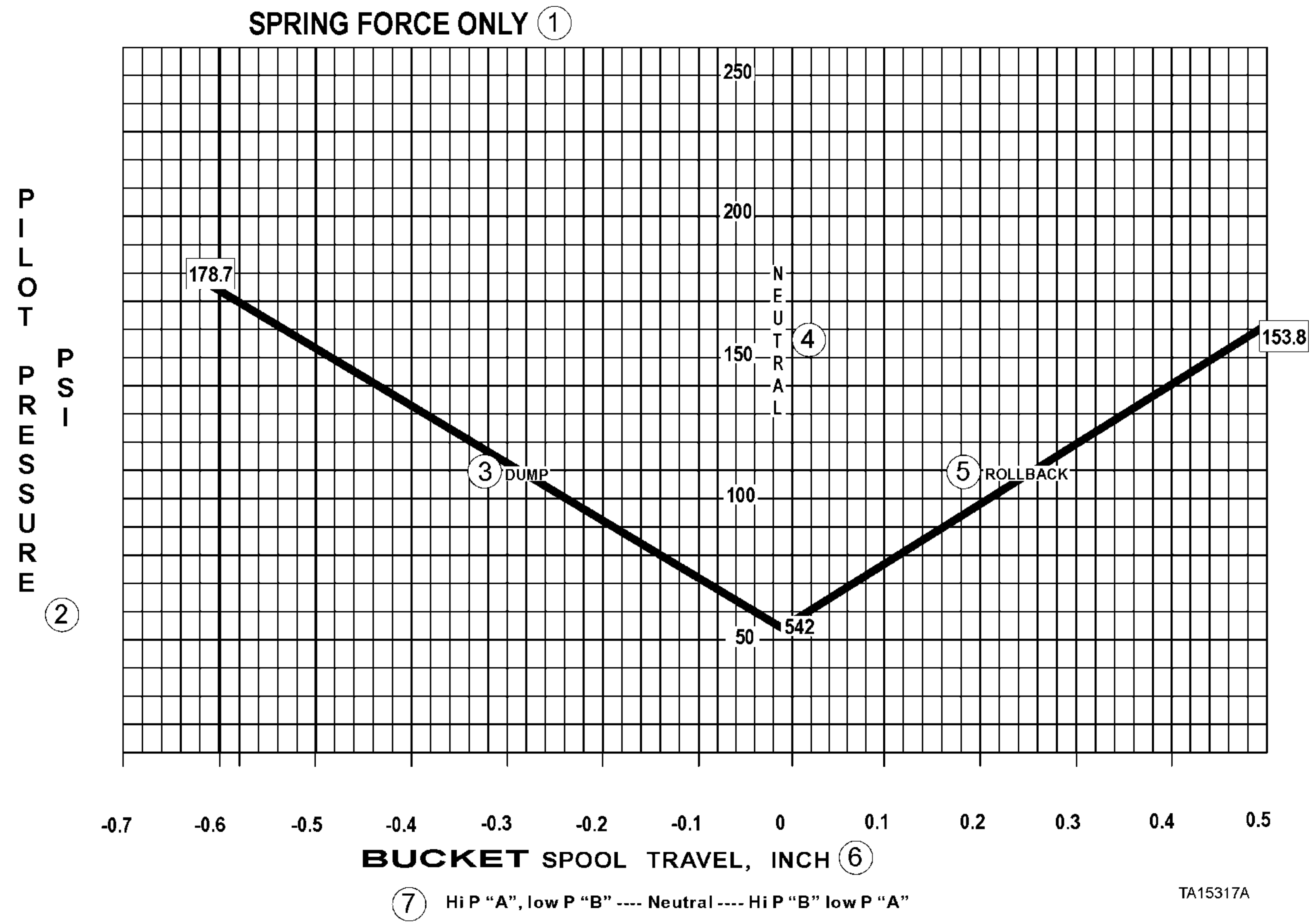
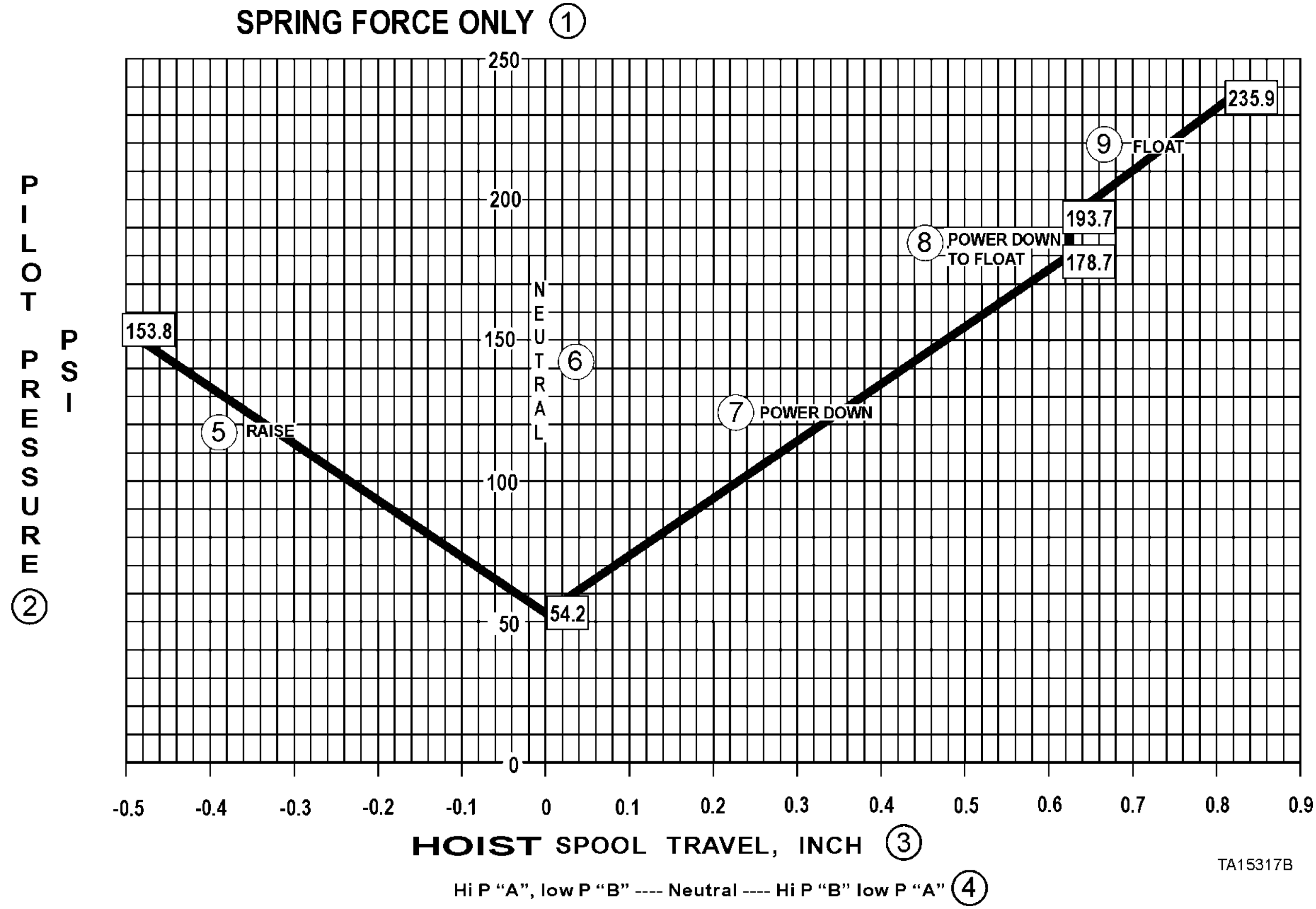


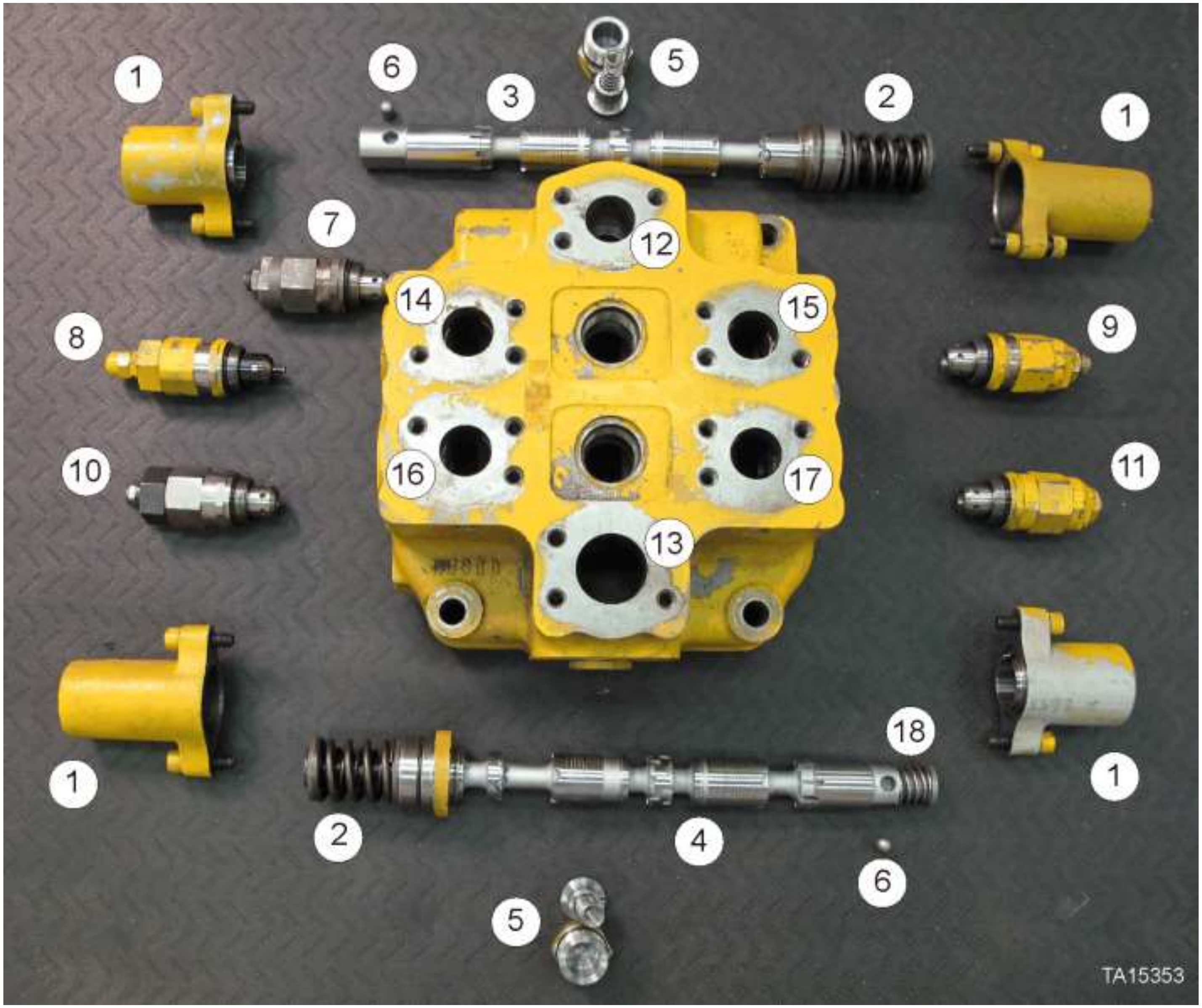
1) Spring force only, **2)** Pilot pressure psi, **3)** Dump, **4)** Neutral, **5)** Rollback
6) Bucket spool travel, inch, **7)** Hi P "A", Low P "B" Neutral Hi P "B" Low P "A"

Figure 47. Spool chart 1



1) Spring force only, **2)** Pilot pressure psi, **3)** Hoist spool travel, inch, **4)** Hi P "A", Low P "B" Neutral Hi P "B" Low P "A"
5) Raise, **6)** Neutral, **7)** Power down, **8)** Power down to float, **9)** Float

Figure 48. Spool chart 2



1) End Cap
2) Centering Spring
3) Bucket Spool
4) Hoist Spool
5) Load Check Valve
6) Anti-Rotation Pin
7) Main Relief
8) Bucket Relief
9) Bucket Relief Vented
10) Hoist Rod Relief
11) Hoist Base Relief
12) Inlet
13) Return
14) Bucket Base
15) Bucket Rod
16) Hoist Rod
17) Hoist Base
18) Float Spring

Figure 49. Double spool HUSCO valve (exploded view)

1) End Cap
2) Centering Spring
3) Hoist Spool
4) Float Spring

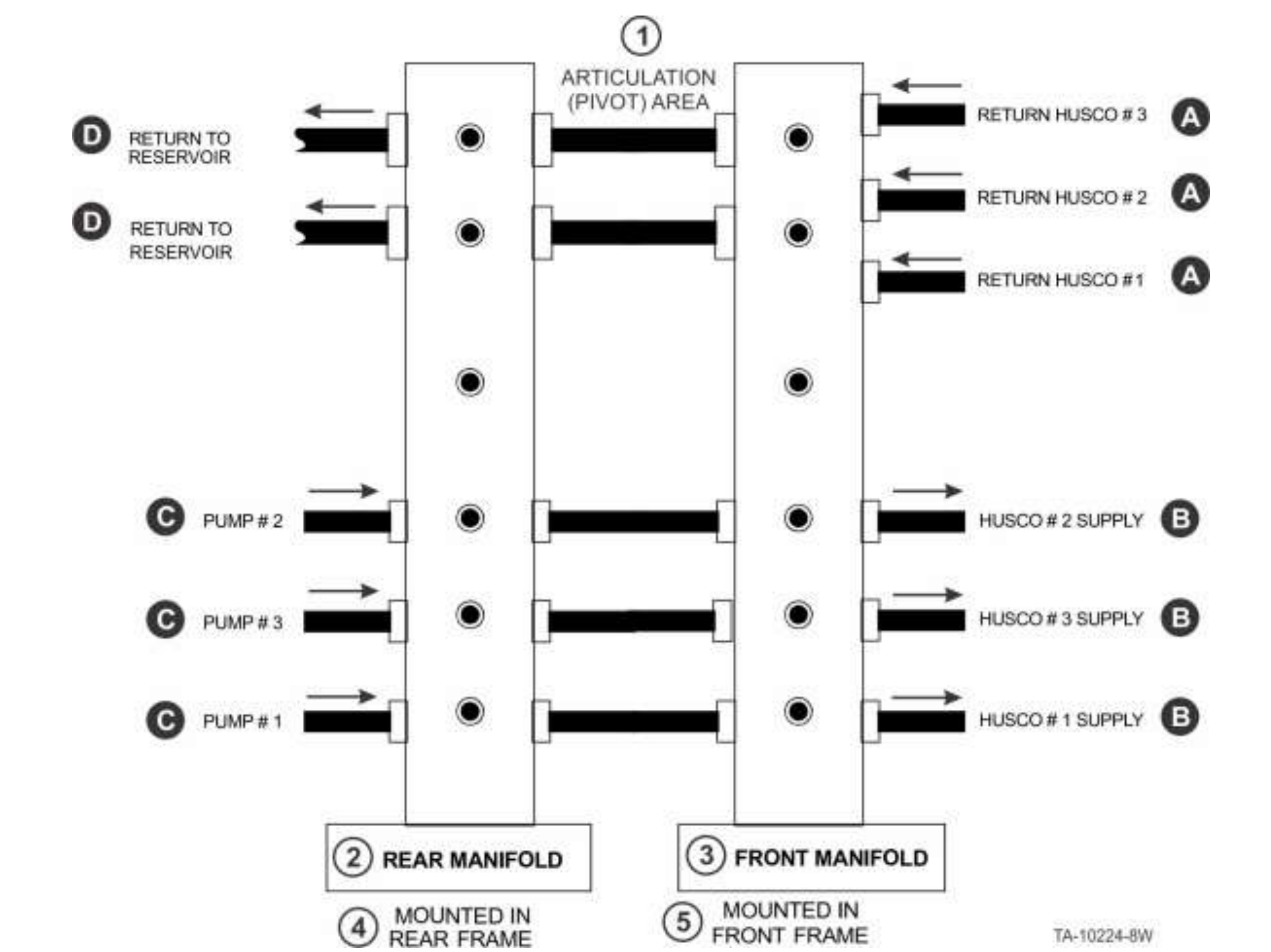
Float Function NOT used on: L-1350, L-1850, L-2350

5) Anti Rotation Pin
6) Main Relief
7) Plug (Circuit Relief)
8) Load Check Valve
9) Inlet
10) Return
11) Hoist Base
12) Hoist Rod

Figure 50. Single spool HUSCO valve (exploded view)

Multi-Port Distribution Manifolds

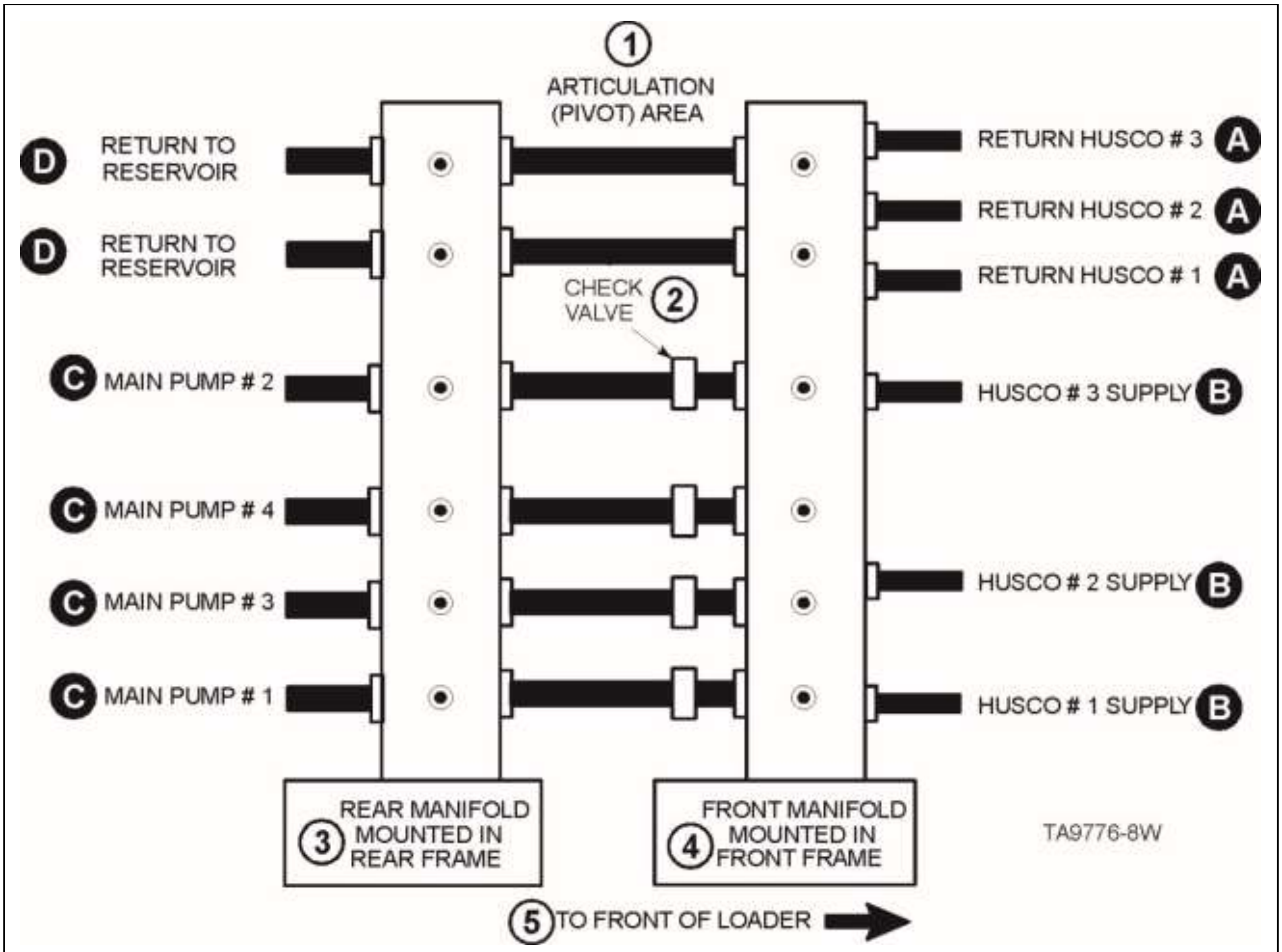
Multi-port distribution manifolds (Christmas trees) are mounted in the rear frame and in the front frame. Depending on machine model, one of the distribution manifolds consolidates high pressure pump oil flow and return oil flow across the articulation area. Typically, three high pressure pump hoses and two return hoses are connected between the distribution manifolds. Hose routing to and from the manifolds is shown in illustrations "MULTI-PORT DISTRIBUTION MANIFOLDS" below (select model as applicable). The hoses between the manifolds span the articulation area of the machine.



1) Articulation (pivot) area, **2)** Rear manifold, 3) Front manifold, **4)** Mounted in rear frame, **5)** Mounted in front frame

A) Return HUSCO #, **B)** HUSCO# Supply, **C)** Pump#, **D)** Return to reservoir

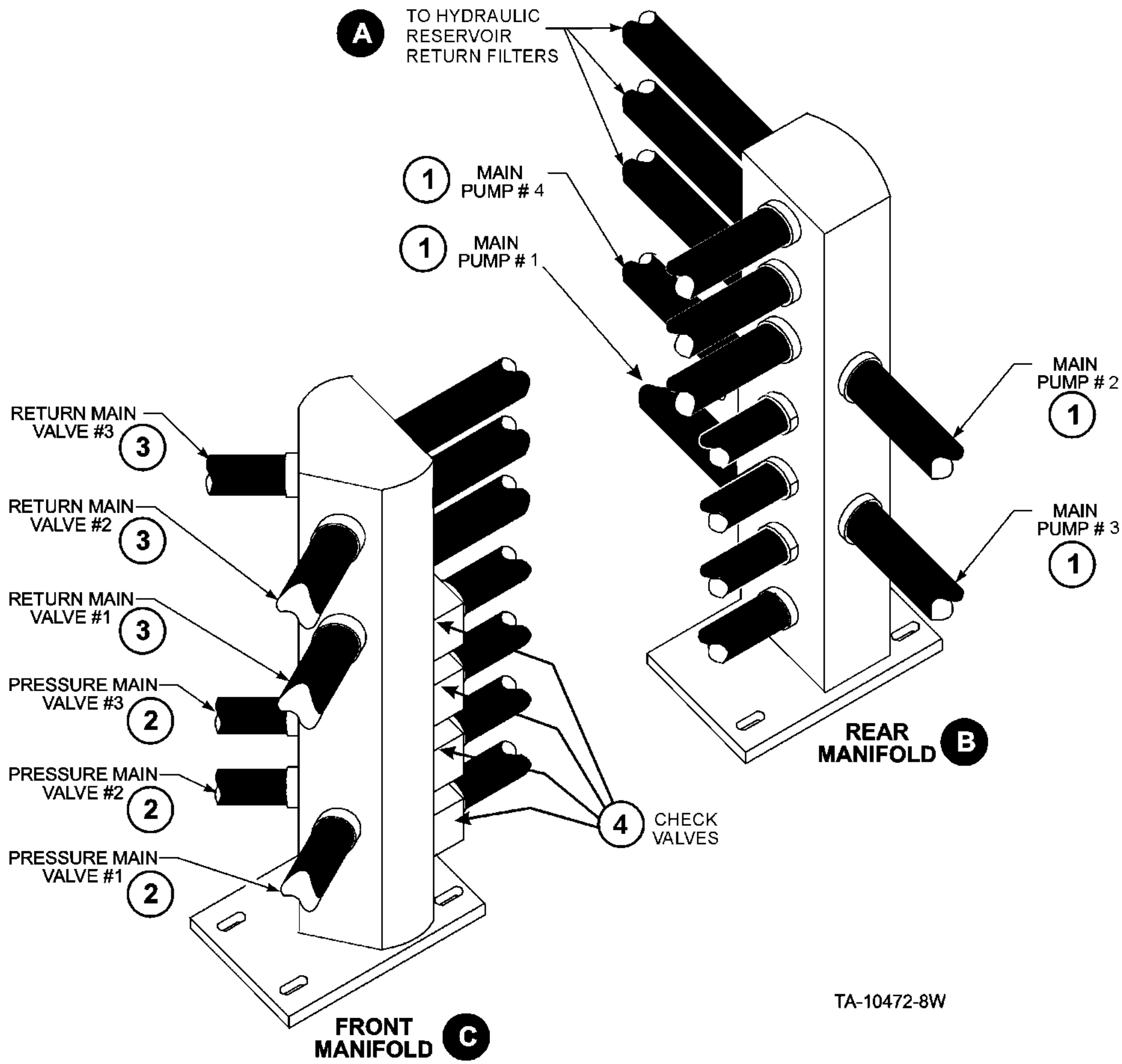
Figure 51. L-1350 Multi-port distribution manifolds



1) Articulation (pivot) area, **2)** Check valve, **3)** Rear manifold mounted in rear frame, **4)** Front manifold mounted in front frame, **5)** To front of loader

A) Return HUSCO #, **B)** HUSCO # Supply, **C)** Main pump#, **D)** Return to reservoir

Figure 52. L-1850 Multi-port distribution manifolds



1) Main pump#, **2)** Pressure main valve#, **3)** Return main valve#, **4)** Check valves
A) To hydraulic reservoir return filters, **B)** Rear manifold, **C)** Front manifold

Figure 53. L-2350 Multi-port distribution manifolds

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Hoist and Bucket Hydraulic Circuit Manual Bleed Valve Assembly

The valves on the Hoist and Bucket Hydraulic Circuit Manual Bleed Valve Assembly are needle valves that require very little torque to close. EXCESSIVE torque will damage the valves. The valve assembly relieves the hydraulic pressure from the hoist and bucket circuits. When the hydraulic system is being worked on, the pressure should be relieved from the hoist and bucket cylinders by opening all the valves on the assembly. When these valves are opened, the lift arms will lower (if elevated), and the bucket may move. Use caution and make sure the area is clear of personnel before operating the valve assembly. Do not operate the valve assembly when the machine is running.

⚠ WARNING

Struck-by or crush hazard exists when using the Manual Bleed Valve Assembly to relieve pressure from the hoist and bucket circuits. Operating the manual bleed valve may cause the lift arms and bucket to descend rapidly. All personnel shall be made to stand clear of the lift arms and bucket areas before the Manual Bleed Valve Assembly is used to relieve hoist and bucket circuit pressure. Before performing any procedure on any hydraulic component within the hoist and bucket circuit, the valves shall be used to relieve residual system pressure from the hoist and bucket circuit. The Hoist and Bucket Hydraulic Circuit Manual Bleed Valve Assembly shall not be operated when the engine is running. Failure to clear the bucket and lift arm areas of personnel prior to operating the valve assembly or to relieve pressure from the hoist and bucket circuit before working on any hydraulic component can cause a struck-by or crush hazard resulting in serious injury or death.

Before any procedure is started on the main hydraulic valves, use the Manual Bleed Valve assembly located on inside the front frame, near the main hoist and bucket valves, to bleed any stored pressure in the hoist and bucket hydraulic circuit. Slowly turn each valve counterclockwise and allow time for the pressure to bleed down. Close the valves before starting the engine.

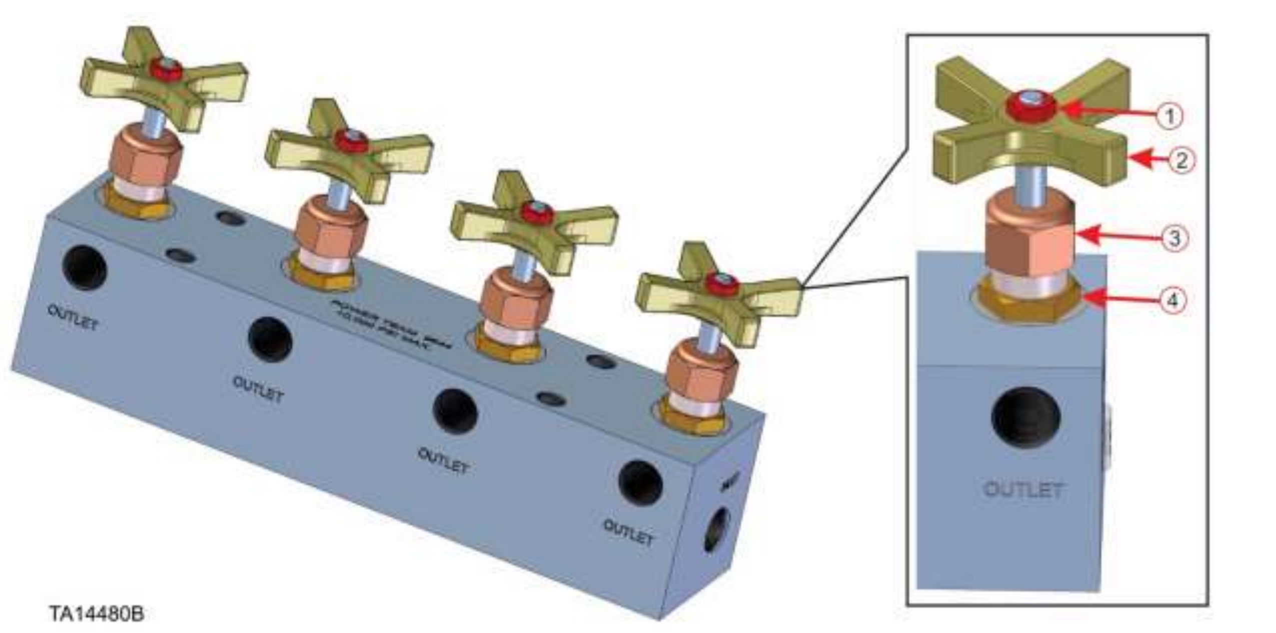
NOTICE

Using the Manual Bleed Valve Assembly is the only acceptable way to lower the lift arms and bucket when the engine is not running.

Typically located inside the front of the front frame-under hoist and bucket valves

Figure 54. Manual bleed valve assembly (hoist/bucket circuit bleed down)

If maintenance of a valve or replacement of the valve assembly becomes necessary, once the work is completed check the torque values as provided in Figure “Manual bleed valve assembly (hoist/bucket cylinder bleed down) nut torque values”.



1) Torque 1/4 “ nut that holds valve handle onto stem to 14 ft. lbs. (19 N•m) Valve handle is keyed and can be held to torque nut, **2)** When closing the valve, Hand Tighten Only. Do not force closed. There is no torque value available, **3)** Torque Packing nut to 100 to 115 in. lbs. (11.3 to 13 N•m), **4)** Torque valve nut 70 to 90 ft. lbs. (95 to 122 N•m).

Figure 55. Manual bleed valve assembly (hoist/bucket cylinder bleed down) nut torque values

Float Valves

The Float Valves are located at the bottom of each hoist cylinder (refer to illustration “Float valve assembly”). Two normally closed valves connect the base to the rod side of the cylinder. Pressure from Solenoid (SOL FD) will shift the spool and allow oil to flow from the base side of the cylinder to the rod side. This transfer of fluid allows the lift arms to float down at a quicker rate than the HUSCO Valve could perform alone.

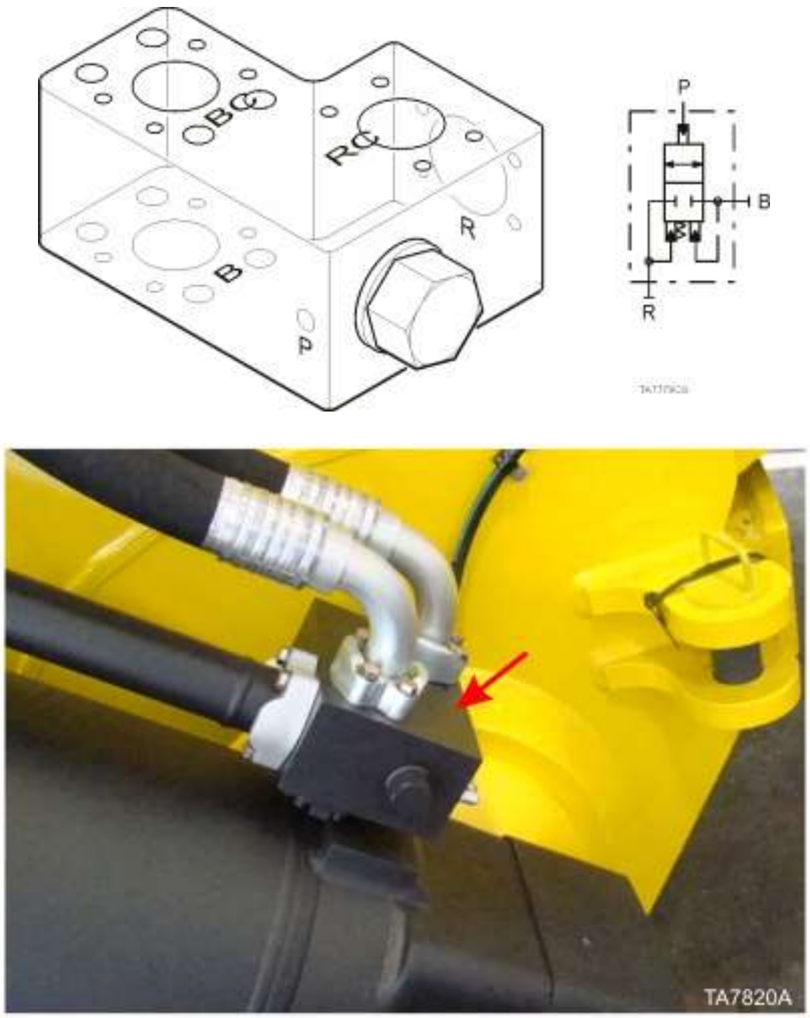


Figure 56. Float valve assembly

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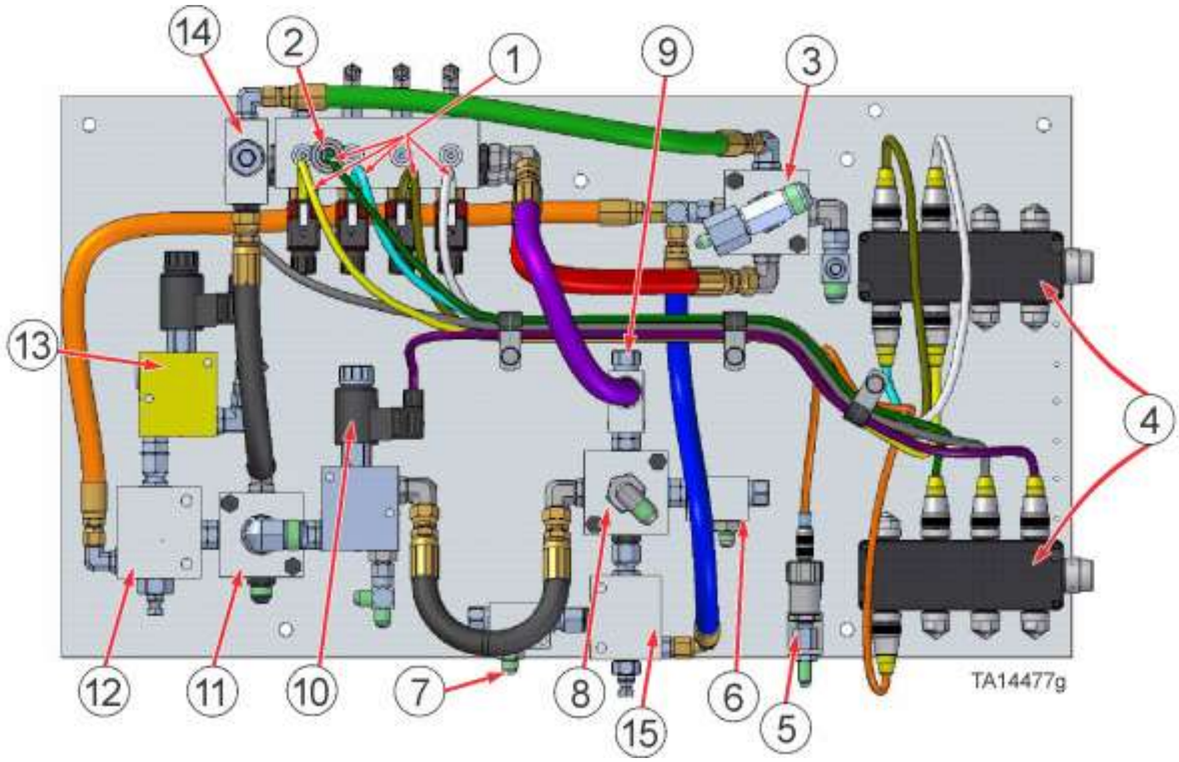
Pilot Circuits

Front Frame Hydraulic Panel

The Front Frame Hydraulic Panel contains solenoids, valves, breakout boxes, and other various pieces of equipment. The central location of these pieces of equipment makes maintenance faster and easier. For more details, refer to the illustration for “Front Frame Hydraulic Panel” below.



1. Pilot valve assembly	**8.** Five (5) port manifold
2. Pilot pressure transducer (1500 psi)(104 bar)	**9.** Flow Control, pilot supply - 2. 5 gpm (9.46 lpm)
3. Five (5) port manifold	**10.** Solenoid valve, float (SOL. FD)
4. Breakout boxes Turck	**11.** Five (5) port manifold
5. Pressure transmitter, 5000 psi (345 bar) load weigh	**12.** Relief valve, secondary dump
6. Flow Control, Auto lube - 2. 5 gpm (9.46 lpm)	**13.** Solenoid valve, secondary dump (SOL. SD)
7. Flow Control, planetary drive filtration - 2. 5 gpm (9.46 lpm)	**14.** Pilot Pressure, relief valve

Figure 57. Front frame hydraulic panel (TYPICAL)

Front Frame Hydraulic Panel Functions

The following text explains various functions of the Front Frame Hydraulic Panel, located inside the front frame of the machine. There is no significance for colors; as they are only used to differentiate between different functions of equipment.

Gray

The accessory pump supplies oil to the front frame where it is connected to a distribution manifold. This distribution manifold has three (3) 2.5-gpm [9.5 lpm] flow controls attached. Each of which, limit the maximum outlet flow preventing a circuit failure from affecting the whole supply system pressure. The oil is supplied to the following circuits:

1. Pilot
2. Auto Lube
3. Front planetary drive filtration (motor).
4. Float Solenoid no flow control is installed in this circuit.

Blue

Pilot Supply oil is derived from one of the 2.5-gpm flow controls. Pressure in this circuit is limited to 450-psi (31 bar) by relief valve. Until one of the proportional solenoids energizes, the 2.5-gpm [9.5 lpm] oil flow returns back to the reservoir creating a constant pressure in the supply.

Yellow

As a function is actuated, the corresponding proportional solenoid will energize allowing pilot oil to flow across the solenoid and out to the main valve spools. The amount of outlet pressure is determined by the duty cycle of the solenoid (Pulse Width Modulation - PWM). The duty cycle is a result of LINCS calculation of the necessary pilot pressure, based on the operator's command. The higher the pressure the further the main spools shift, the faster the cylinders travel.

Each proportional valve output is directed to the end caps of the main valve spools. Most functions utilize two main valves so the lines connect to both. Hoist up uses all three.

For troubleshooting, all four of the output lines connect together through individual check valves to create a single sense line that terminates at a pressure transducer. The check valves prevent pressure from one circuit back feeding into the other. A .025" orifice is installed between the pilot pressure transducer line and the hydraulic reservoir. The size is small enough not to affect pressure readings when a function is activated, but as the command is returned to neutral residual pressure felt at the transducer will be bled back to the hydraulic reservoir. This bleeding action also creates some additional flow in the lines between the proportional solenoid and the main valves, reducing the effect of oil viscosity changes due to cold oil.

Green

There are two return paths to the hydraulic reservoir for the pilot control system. One, is a general-purpose return, the other is a low-back pressure path that has no transient pressure spike capabilities. This low-back pressure return is necessary for the proportional solenoids and relief valves that have a vent line on the spring end. Deviation from this plumbing will result in the relief setting being affected by return pressure.

Pink

There are two vent-able relief's in the main valves; both exist in the bucket rod circuit (bucket dump). The vent line from these reliefs is connected to a solenoid that when de-energized, passes the oil to an 800-psi (55 bar) relief whose return is back to the hydraulic reservoir. When the solenoid is de-energized the return from the 800-psi (55 bar) relief is opened to the reservoir reducing the operating pressure of the relief's in the main valves to 800-psi (55 bar). The solenoid will normally be energized any time the lift arms are below the horizontal position of +5 degrees.

Red

To bleed any residual pressure from the cylinders, a hose is connected from the cylinder ports of the main valve to bleed down the manifold. Opening the needle valves allows the pressure to be vented to the hydraulic reservoir.

A single hose is connected from the hoist cylinder base pressure port of the main valve to a pressure transducer. This transducer monitors hoist base pressure that is used for load weigh calculations.

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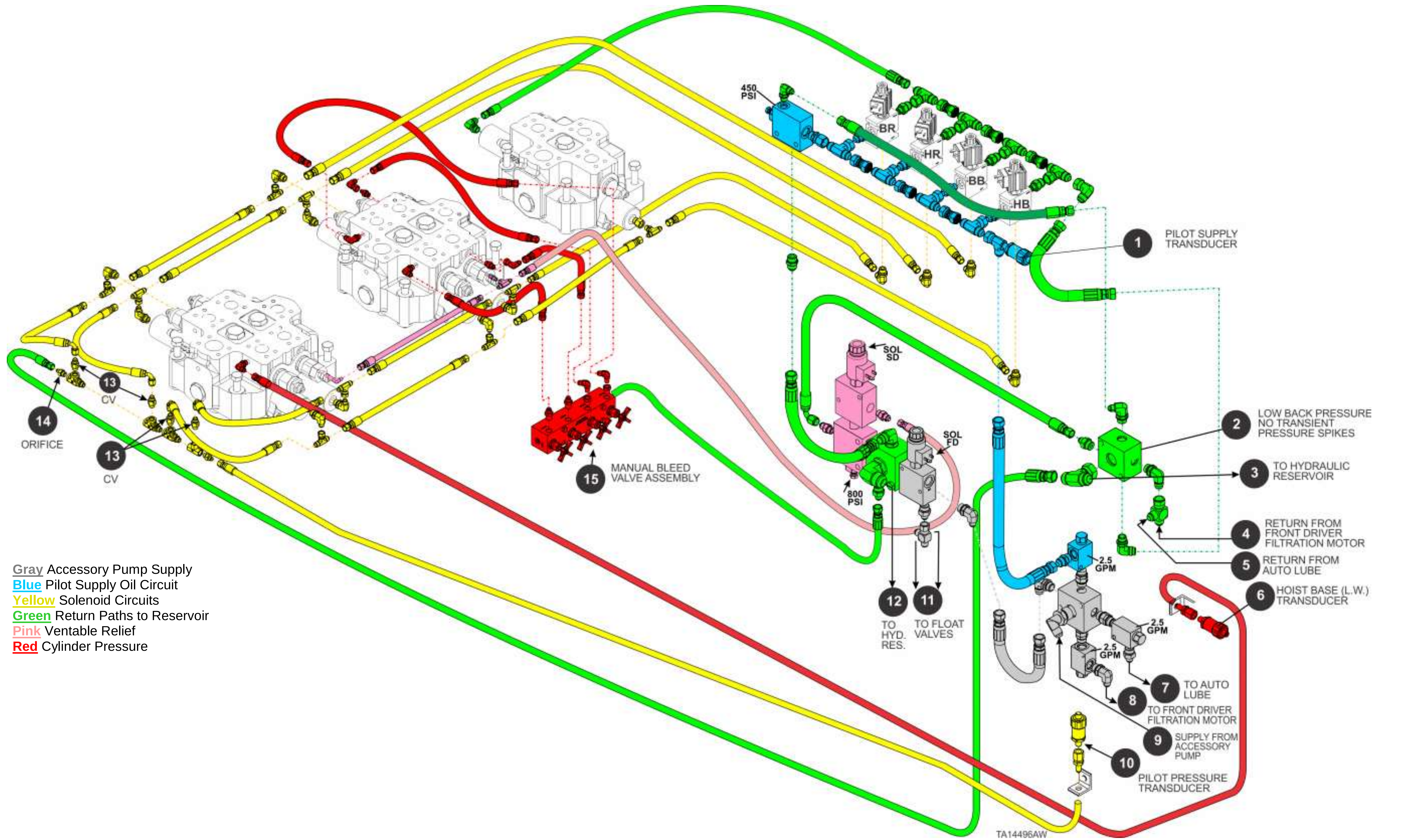

1) Pilot Supply Transducer, **2)** Low Back Pressure No Transient Pressure Spikes, **3)** To Hydraulic Reservoir, **4)** Return From Front Planetary Drive Filtration Motor, **5)** Return From Auto Lube, **6)** Hoist Base (L W) Transducer, **7)** To Auto Lube, **8)** To Front Planetary Drive, **9)** Supply From Accessory Pump, **10)** Pilot Pressure Transducer, **11)** To Float Valves, **12)** To Hydraulic Reservoir, **13)** Check Valve, **14)** Orifice, **15)** Manual Bleed Valve Assembly

Figure 58. Front frame hydraulic panel functions (TYPICAL)

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Steering Main Valves

Components used in the Steering circuit:

- Steering Position Sensor
- VCU
- Steering Interface Card
- Park Brake Switch
- Joystick
- Steering Pumps
- Pressure Transducers
- Hoses
- Steering Valve (DANFOSS)
- PVG pilot control valve
- Cylinders
- Relief Valves
- Anti-Cavitation Valves
- Return Filters
- Steering Crossover Relief Valve Assy. (L-2350 only)

Steering Proportional Valve (DANFOSS-PVG Valve) L-1350/L-1850/2350

The steering system is electric over hydraulic. The steering system is setup as a closed loop - low pressure system when the steering is in the neutral steer state. This system uses variable piston pumps. The L-1350 and L-1850 wheel loaders steering system has a tandem piston pump. The L-2350 wheel loader has two independent piston pumps. During the neutral steer state, the steering pumps swash plate is at a minimal position that only produces enough flow for standby pressure. The standby pressure should be greater than 300 psi (21 bar) but less than 450 psi (31 bar) in the steering system. As a steer command is given, the swash angle of the pump will increase causing the output flow of the pump to increase. The pressure of the steering system will increase until the turning resistance of the machine is overcome. If the machine is physically stuck, maximum pump pressure may be achieved without any steering angle change (steering resistance greater than steering force).

Hydraulic oil flows from the hydraulic reservoir to the inlet of the Steering pumps. The flow and pressure from the Steering pumps are regulated by the DRS system of control. The DRS system of control is load sensing. When a steering command is given, a load sense pilot command is given to the pump from the PVG 32 pilot valve (this valve will be covered later). The load sense pilot causes the pump swash plate angle to increase and additional flow to be directed out of the steering pump. Pump pressure will be dependent on the steering resistance or the maximum pressure setting of the pressure compensator on the pump. Hydraulic oil is pressurized in the pumps and flows out to check valves that are located on the steering manifold block. In the steering manifold block, the oil flows from the two are combined. The oil flows out of the manifold block to the HP port on the main flow amplifier valve (DANFOSS).

The pressurized oil flows into the HP (High Pressure) port and is directed to the Priority spool. The Priority spool has been disabled from operation in this steering system by fully screwing “IN” the main relief valve. Oil flows across the priority spool and is given two possible paths. A very small amount of oil passes through orifices on the priority spool, which is passed to the P (Pilot) output port on the DANFOSS valve. The majority of the flow is stopped at the load check valve. Oil flow across the load check valve will be discussed during an actual steering event.

The P port on the DANFOSS valve is connected to the P (Pilot) port on the PVG 32 Pilot Control Valve. The P port on the PVG 32 uses a two-valve combination of a pressure relief valve and a pressure reducing valve (vented sequence valve) to regulate pressure. The P port pressure is controlled by oil flowing through an orifice, to a pressure relief valve (set at 4,000 psi, 276 bar). The sequence valve vent line (spring side) is connected between the 4000 psi (276 bar) relief and the orifice. When the pressure is greater than 4,000 psi (276 bar), the sequence valve opens and dumps P port pressure back to reservoir. This oil has a direct connection to the directional spool (three position closed center). The pressure relief valve controls maximum inlet pressure to the PVG 32 valve. Another pressure reducing valve further controls the pilot to a set 200 psi (13.7 bar). This is the pilot oil that will be used by the four solenoid valves for control of the directional spool internal to the PVG 32 valve.

NOTICE

The following example describes a left-steer command. The right-steer command operates the same, except “right” should be substituted for “left”.

When a left steer command is given, two of the four solenoids will open. One of the solenoids directs the 200 psi (13.7 bar) pilot oil to the end of the directional spool. The other solenoid valve allows the oil on the other end of the directional spool to be returned to the hydraulic reservoir through the T port (Hydraulic Reservoir “Reservoir”). This allows the directional spool to start moving.

As the directional spool in the PVG 32 moves, some of the main pilot oil is directed across the spool and is outputted through the B (Left) pilot oil port. This oil is directed to the L (Left) pilot oil port on the DANFOSS valve. The same time B port is receiving oil, some of the oil is also directed through an orifice and to a shuttle valve. The shuttle valve passes the oil to another orifice and then to the LS (Load Sense) port. The LS port is connected to the LS port on the steering pump compensator valves located on each steering pump. With load sense oil flowing to the load sense port on the pumps, the swash plate on each pump will increase in angle. This causes the output flow of the pumps to increase.

NOTICE

The Main Relief valve in the DANFOSS Steering valve is screwed completely in. Steering pump pressure is controlled by the pressure compensator valve found on each steering pump.

The pilot oil received at the L port on DANFOSS valve is directed to one end of the directional spool (three position closed center). The direction spool will start to move. As this spool moves, some of the pilot oil flows through the directional spool and is used to shift the flow amplifier spool. The quantity of oil sent to the flow amplifier spool depends on the amount of the steering command from the operator.

In the flow amplifier spool, the pilot oil from the L port is combined with the main pump flow. This oil then passes through the Flow Amplifier Spool and is then directed to the directional spool.

L-1350 and L-1850 without a Steering Cylinder Crossover Relief Valve Assembly

At the directional spool, the oil is sent out to CL (cylinder left) port, to the steering cylinders. The cylinders are connected in a crossed plumbed configuration. The right-hand cylinder’s base port is connected to the left cylinder’s rod port. And the right-hand cylinder’s rod port is connected to the left cylinder’s base port. Thus, in a left turn the base of the right-hand cylinder is extending while the left-hand cylinder is retracting. The cylinders are double acting and the return oil is directed back to DANFOSS valve to the CR (cylinder right) port.

NOTICE

Both cylinder ports (CL and CR) have shock and suction valves in parallel with ports. The shock and suction valves serve as cylinder protection only and do not normally operate. The overload relief is set at 4000 psi (275.8 bar). The anti-cavitation valves also provide oil if voids develop in the cylinder because of outside forces.

The returning oil from the steering cylinders is directed across the directional spool through a 75 psi (5.17 bar) back pressure valve and then exits the DANFOSS valve at the HT (Hydraulic Reservoir “Reservoir”) port.

From the HT port the oil flows back to the hydraulic reservoir return manifold.

The oil passes through the return manifold and is then passed through the return filters that are located inside the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

L-2350 with a Steering Cylinder Crossover Relief Valve Assembly

At the directional spool, the oil is sent out to the crossover relief valve assembly. This assembly has two relief valves that provide additional protection for the steering cylinders. The relief valves are set at 4300 psi (296.5 bar). These relief valves, when active, allow the oil to flow from the side of the cylinder with high pressure to the side of cylinder with low pressure. During normal operation, the oil flowing from the steering valve simply passes through the crossover assembly and flows to the steering cylinder ports.

The cylinders are connected in a crossed plumbed configuration. The right-hand cylinder’s base port is connected to the left cylinder’s rod port. And the right-hand cylinder’s rod port is connected to the left cylinder’s base port. Thus, in a left turn the base of the right-hand cylinder is extending while the left-hand cylinder is retracting. The cylinders are double acting and the return oil is directed back to the steering cross over relief valve. The oil flows through the crossover relief valve and is directed to the DANFOSS valve to the CR (cylinder right) port.

NOTICE

Both of the cylinder ports (CL and CR) have shock and suction valves in parallel with ports. The shock and suction valves serve as cylinder protection only and do not normally operate. The overload relief is set at 4000 psi (275.8 bar). The anti-cavitation valves also provide oil if voids develop in the cylinder because of outside forces.

The returning oil from the steering cylinders is directed across the directional spool through a 75 psi (5.17 bar) back pressure valve and then exits the DANFOSS valve at the HT (Hydraulic Reservoir “Reservoir”) port.

From the HT port the oil flows back to the hydraulic reservoir return manifold.

The oil passes through the return manifold and is then passed through the return filters that are located inside the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

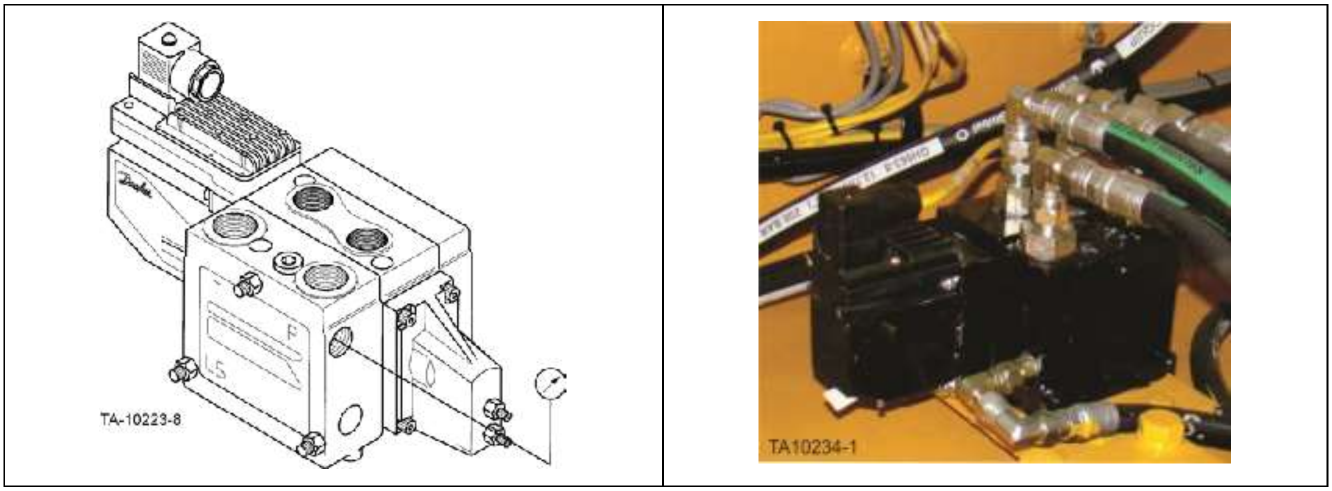
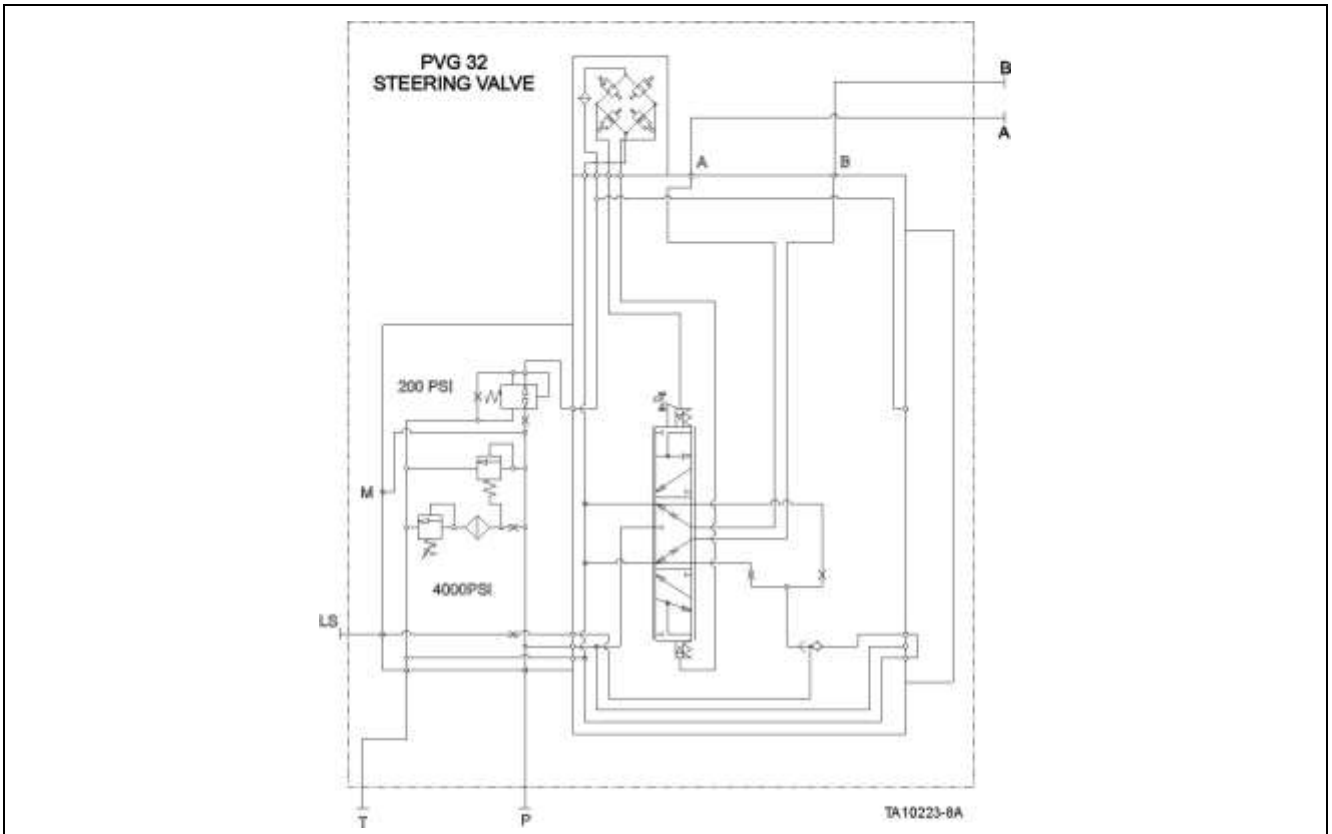
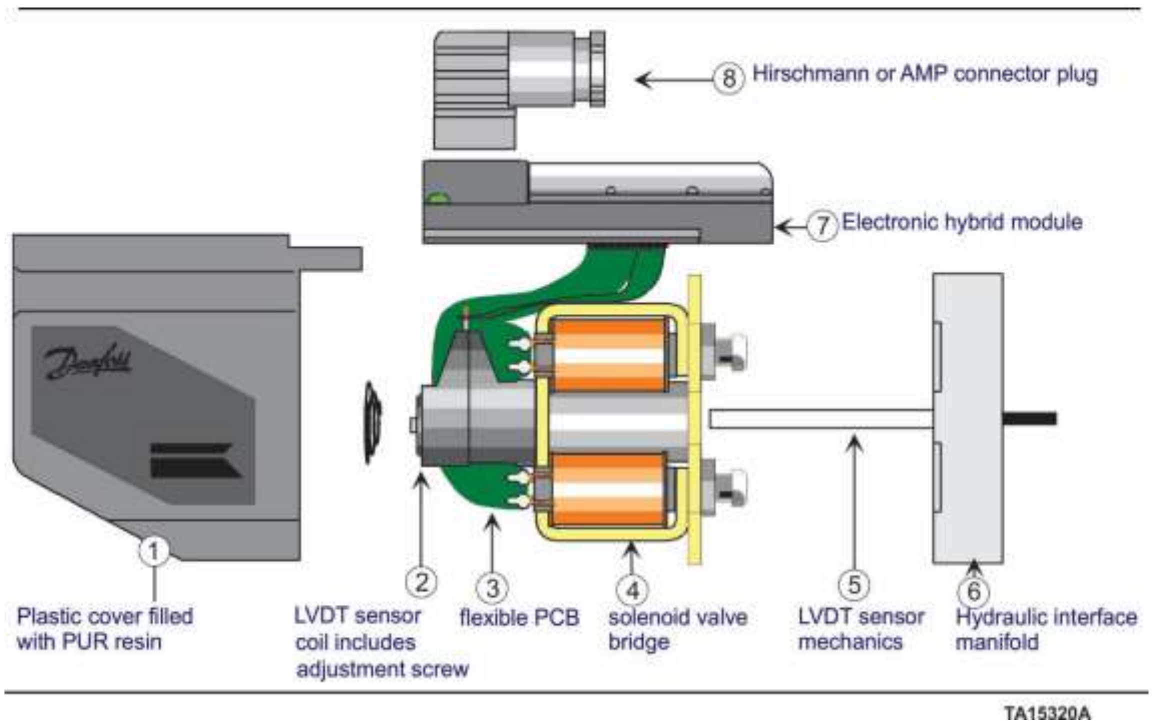


Figure 59. Steering proportional valve DANFOSS PVG valve



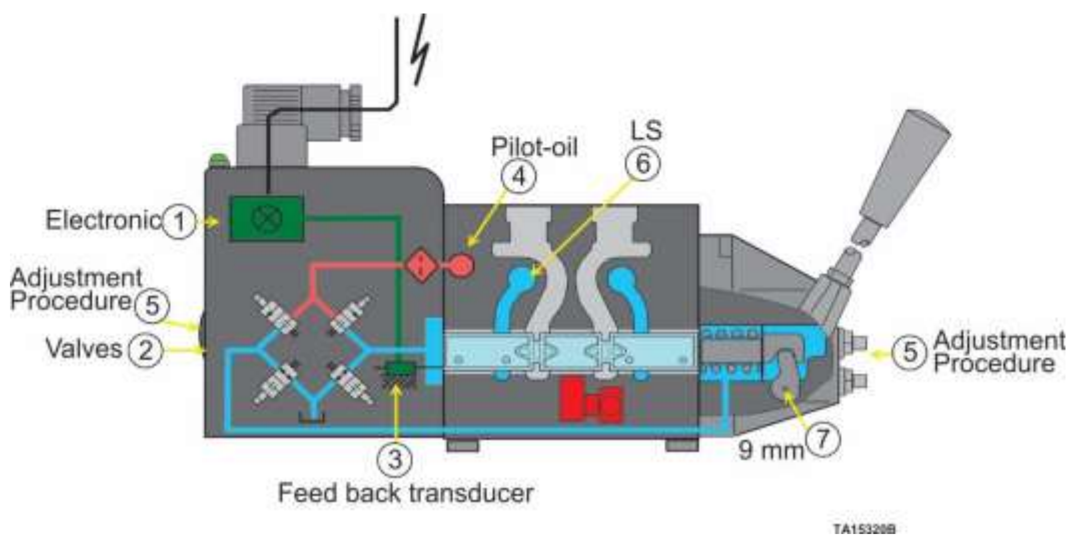
PVG 32 Steering Valve

Figure 60. Steering proportional valve diagram DANFOSS PVG valve



1) Plastic Cover Filled With PUR Resin, **2)** LVDT Sensor Coil Includes Adjustment Screw, **3)** Flexible PCB, **4)** Solenoid Valve Bridge, **5)** LVDT Sensor Mechanics, **6)** Hydraulic Interface Manifold, **7)** Electronic Hybrid Module, **8)** Hirschmann or AMP Connector

Figure 61. Electrical actuator assembly



1) Electronic, **2)** Valves, **3)** Feed Back Transducer, **4)** Pilot-Oil, **5)** Adjustment Procedure, **6)** LS, **7)** 9 mm

Figure 62. PVE function integrated electronics

Closed loop control of the main spool

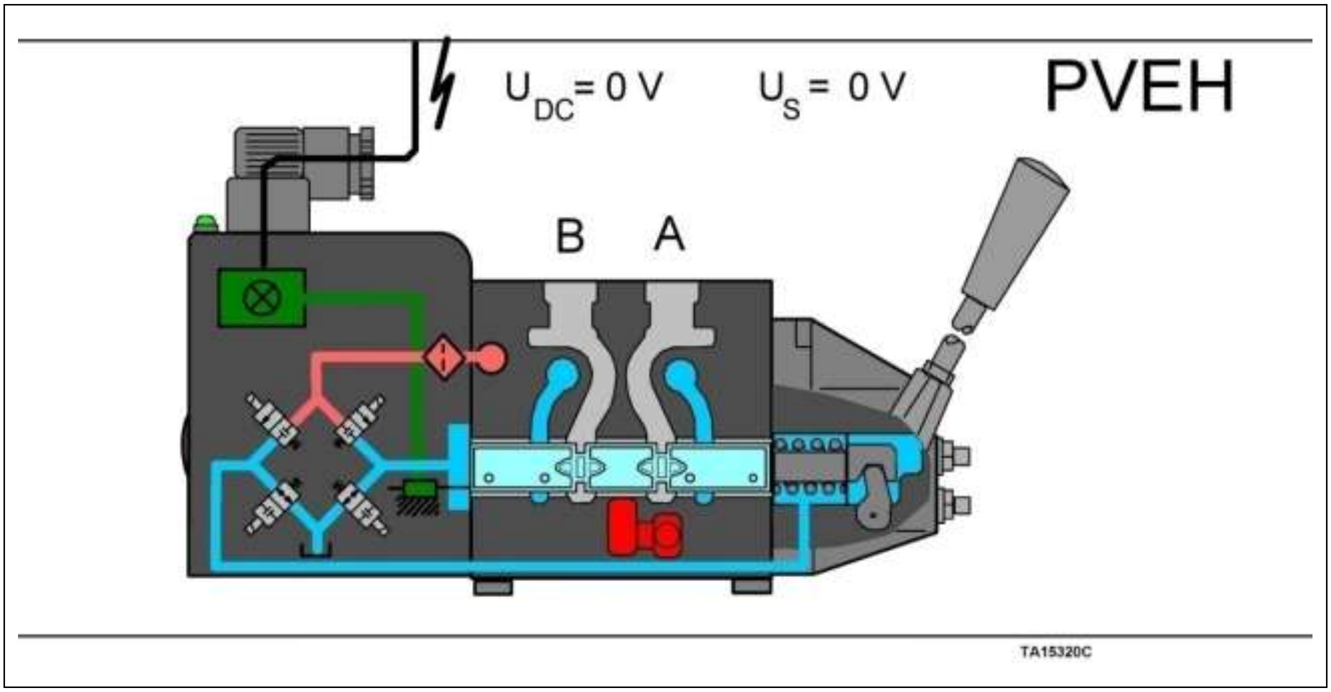
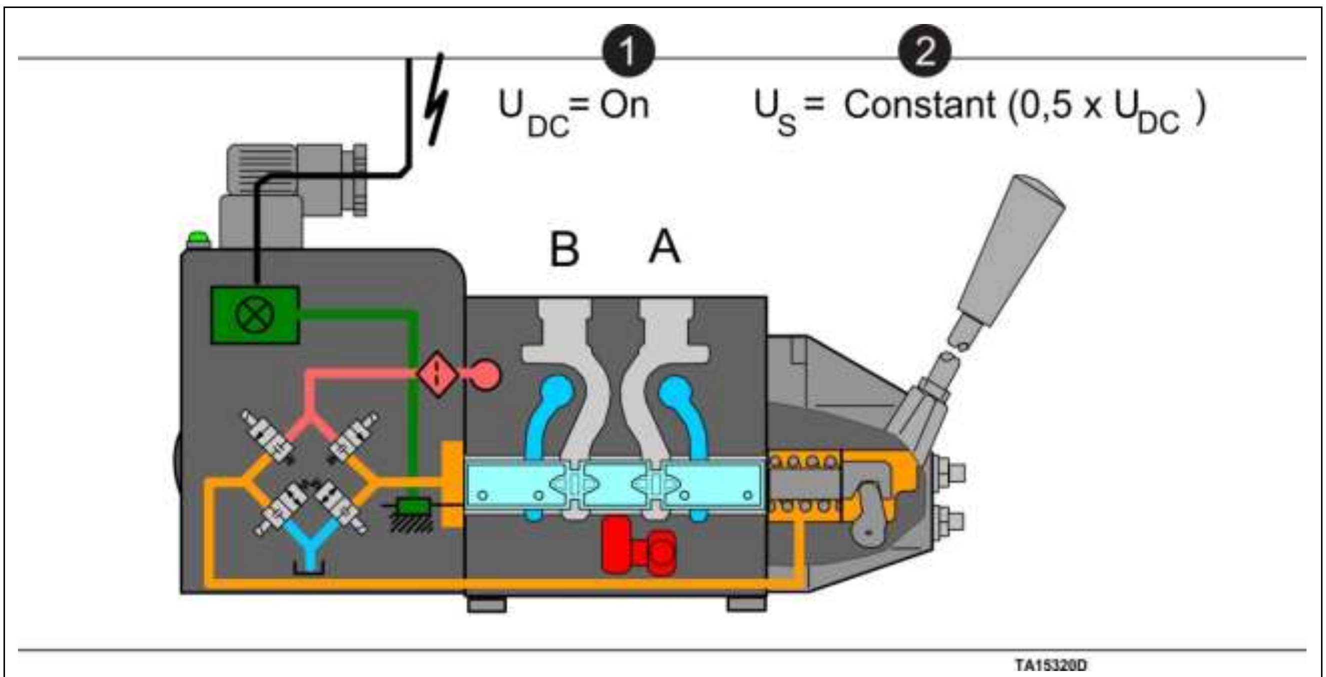


Figure 63. PVE activation principle (1 of 4)

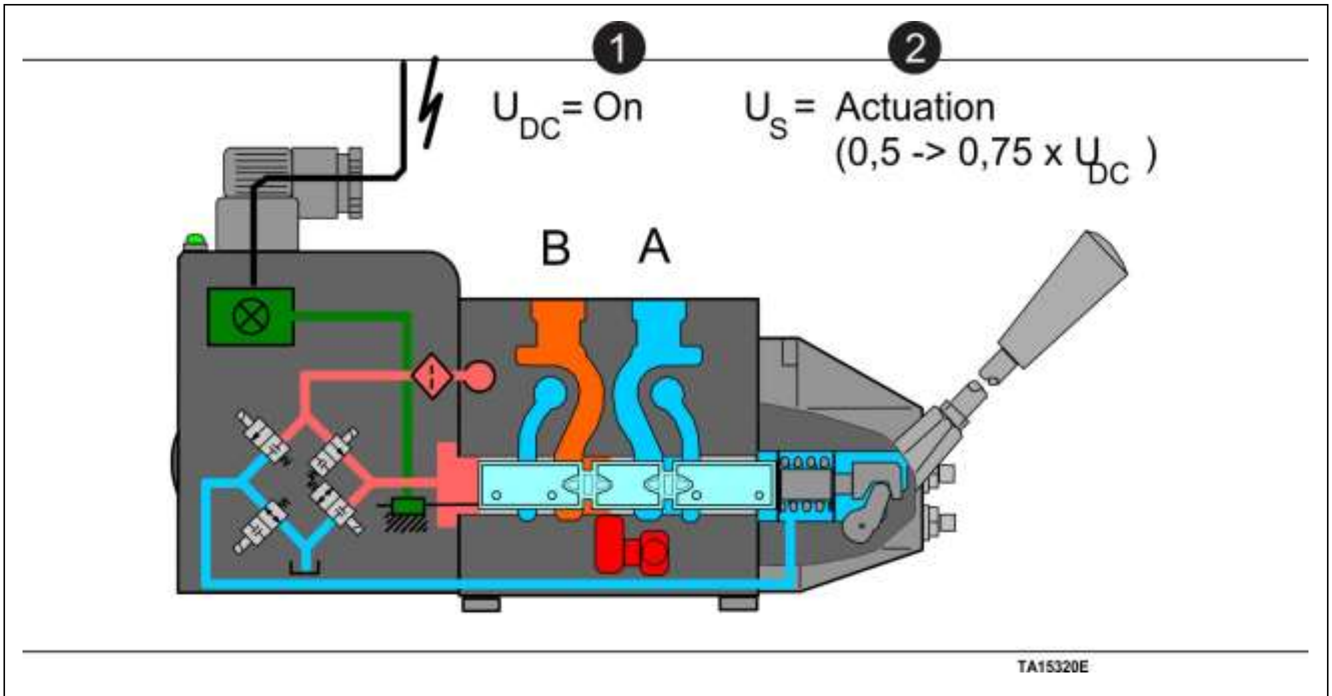
Electrical power disconnected. Spring center to neutral



1) On, **2)** Constant

Figure 64. PVE activation principle (2 of 4)

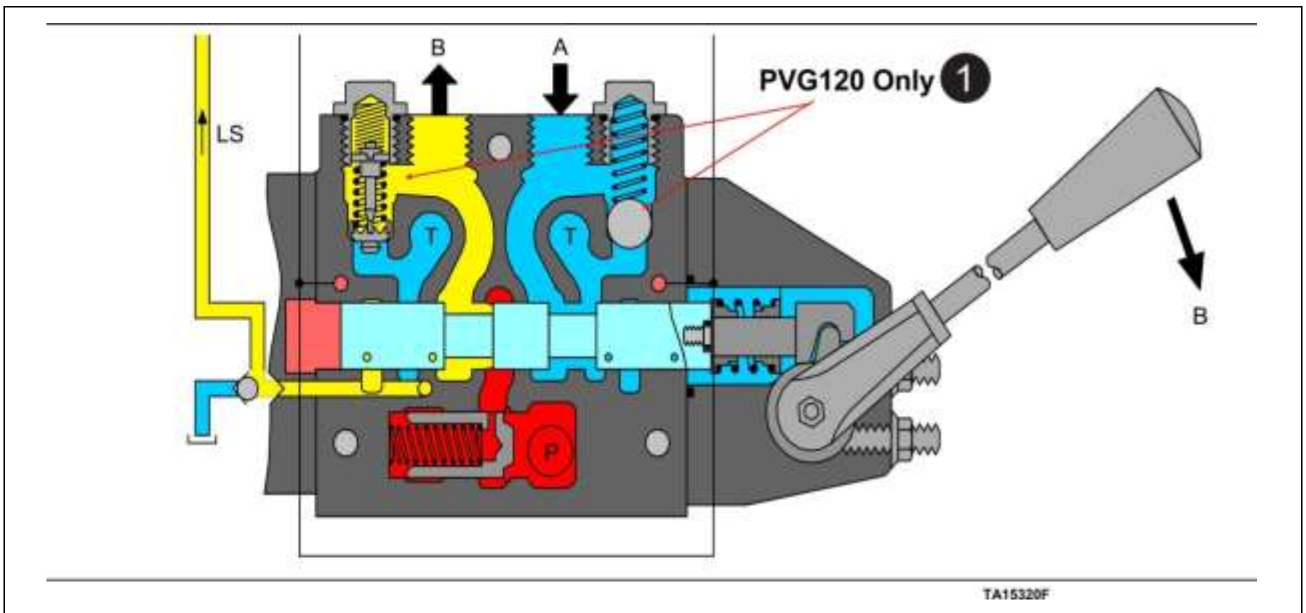
Electrical power connected. Neutral signal from joystick. Spool held in neutral by pilot pressure.



1) On, **2)** Actuation

Figure 65. PVE activation principle (3 of 4)

As joystick signal requests flow to B port, spool moved in B direction by pilot pressure.



1) PVG 120 only

Figure 66. PVE activation principle (4 of 4)

Fault Monitoring Description	
Input signal monitoring	The input voltage is continuously monitored. The acceptable signal range is between 15% and 85% of the supply voltage. If signal voltage goes outside of this range, the system will switch into an error state.
Transducer supervision	If one of the wires going to the LVDT sensor, or a wire inside the sensor is broken or shorted, the system will switch into an error state.
Supervision of the closed loop	The spool position must always correspond to the position requested by the input signal. If the spool is 15% farther from neutral (providing more flow) than requested, the system detects an error and will switch into an error state.

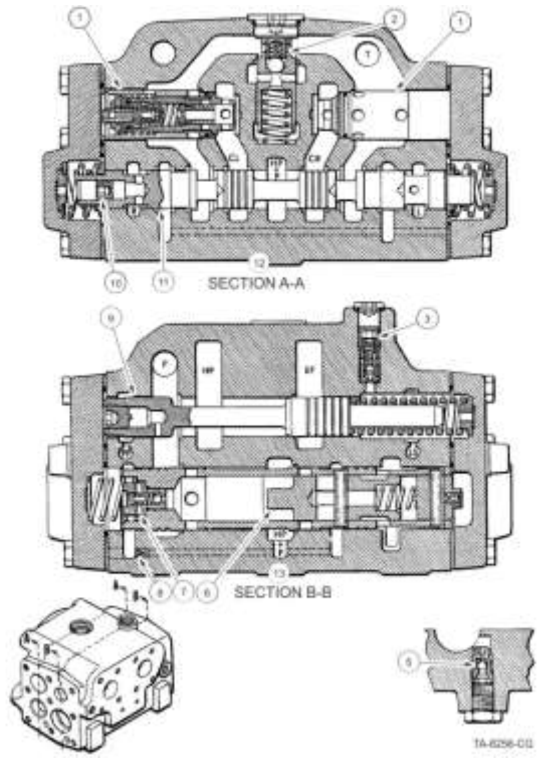
Steering Flow Amplifier Valve (DANFOSS Flow Amplifier)

The Steering Flow Amplifier Valve (DANFOSS Flow Amplifier) is located on the rear steering cylinder cross member between the steering cylinders. This valve will be referred to as the DANFOSS Flow Amplifier for the remainder of the procedures. This control works in conjunction with the DANFOSS PVG Valve and the steering joystick to provide steering control. The DANFOSS PVG Valve actuates by the movement of the joystick and provides a metering pilot oil supply to actuate the DANFOSS Flow Amplifier. The DANFOSS Flow Amplifier supplies a proportional (10:1) flow of oil to the steering cylinders. The metering pilot oil supply is then combined with the pump flow for a resulting (11:1) ratio of oil traveling to the cylinders.

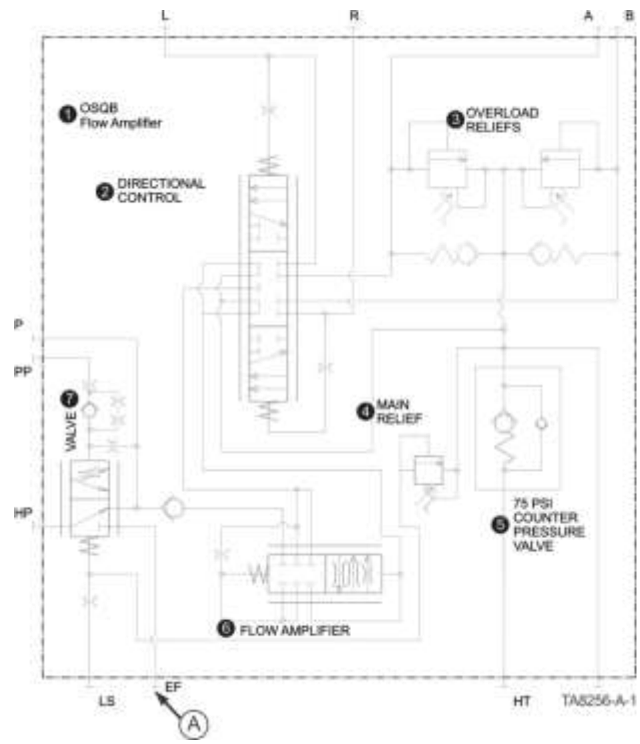
Figure 67. DANFOSS flow amplifier

The DANFOSS Flow Amplifier has built-in directional and pressure control/amplifier valves that prevent the transfer of positive and negative forces (overrun and kickback).

The dual shock and suction valves act as shock absorbers for the steering cylinders. Should one steering cylinder’s pressure go above the overload relief setting, the dual relief valves will allow oil pressure to transfer to the other cylinder or back to the hydraulic reservoir through the 75 psi (5.17 bar) counter pressure valve.



1. Overload Reliefs
2. 75 psi (5.17 bar) Counter Pressure Valve
3. Man Relief Valve
4. Not Used
5. “LS” and “PP” Orifice
6. Amplifier Spool
7. Check Valve
8. Orifice Screw
9. Priority Valve
10. Throttle Check Valve
11. Directional Spool
12. Section A-A
13. Section B-B



1. OSQB Flow Amplifier
2. Directional Control
3. Overload Relief
4. Main Relief
5. 75 psi Counter Pressure Valve
6. Flow Amplifier
7. Valve

A (port EF). Capped

Figure 68. DANFOSS flow amplifier section view

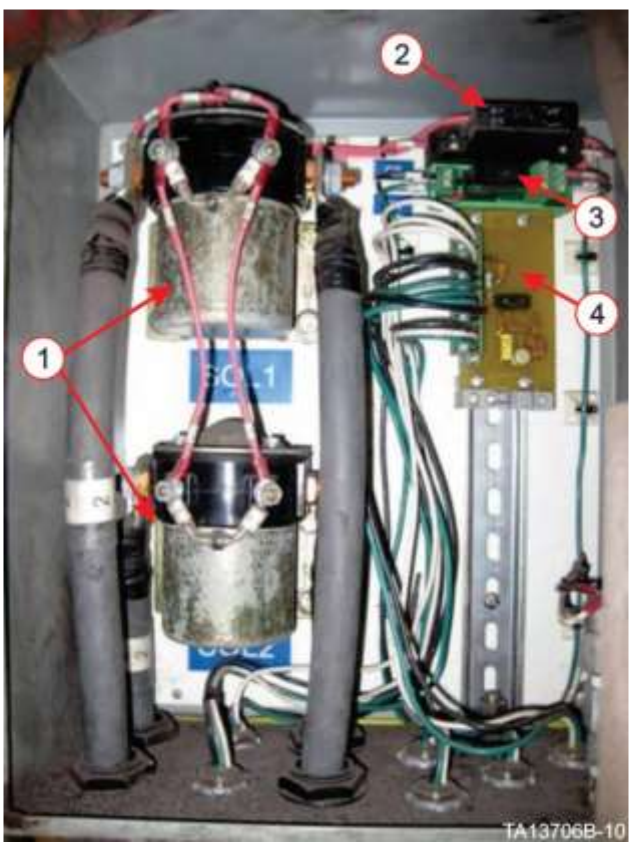
Auxiliary Steering System (Optional)

The Auxiliary Steering System employs the use of up to two 24 volt, nine horsepower motor-driven pumps with the vehicle's four batteries as the 24 volt power source.

(typical pump(s) located in front, right, inside of rear frame)

Figure 69. Auxiliary steering pump

These pumps are controlled by a 30 psi [2 bar] pressure switch which monitors pump pressure. The switch is located in the auxiliary steering junction box.



1) Motor Solenoids
2) Motor Solenoid Circuit Breaker
3) Relay
4) Steering Interface Card Assembly

Figure 70. Auxiliary steering junction box (located in front, right, inside of rear frame)

The normal pressure drop measured at this point is approximately 350 psi [24 bar] with the machine throttle at HI idle. The auxiliary pumps will activate if the system pressure drops to below 30 psi (2 bar), the machine is moving and a steering command has been given. The response time to activate the Auxiliary Steering System is momentary. Consequently, there should be no loss of control.

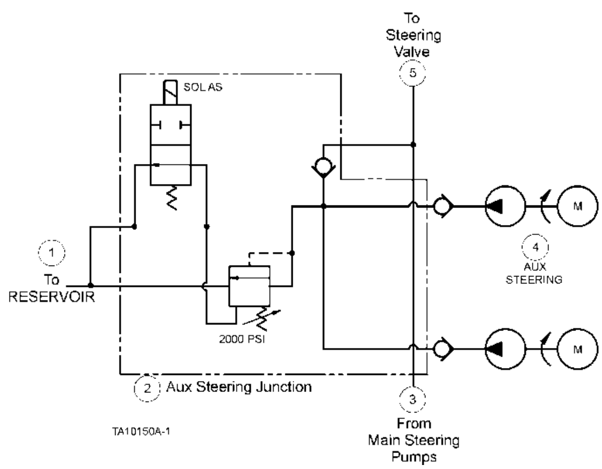
These pumps supply fluid across a one-way check valve into the system normally supplied by the steering pump. The check valve prevents the fluid from flowing backwards through the normal steering pumps.

Control of the Electric Pumps: If a failure of the main steering pumps occurs, the auxiliary steering motors provide steering oil when a steer command is given. When a steering command is generated, the steering motors and Solenoid AS are energized. Oil flows from the pumps to the steering manifold. From the manifold, all the steering functions are the same as the descriptions above. The maximum system pressure is controlled by the auxiliary steering relief to 2000 psi (138 bar).

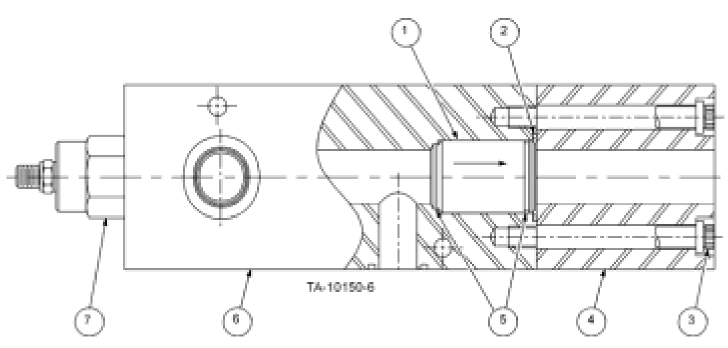
The LINCS computer system activates the red warning light, an audible alarm sounds, and a text message indicating the activation of auxiliary steering appears on the cab computer monitor.

CAUTION

Auxiliary steering is an Auxiliary (back up) system. It should only be used to bring the machine to a stop. It should NEVER be used in material handling operations.



1) To Reservoir, **2)** Aux Steering Junction, **3)** From Main Steering Pumps, **4)** Aux. Steering, **5)** To Steering Valve



1) Check Valve, **2)** O-Ring, **3)** Capscrew, **4)** Housing, **5)** O-Ring, **6)** Housing, **7)** Relief Valve

Figure 71. L-1350, L-1850, and L-2350 steering junction valve assembly

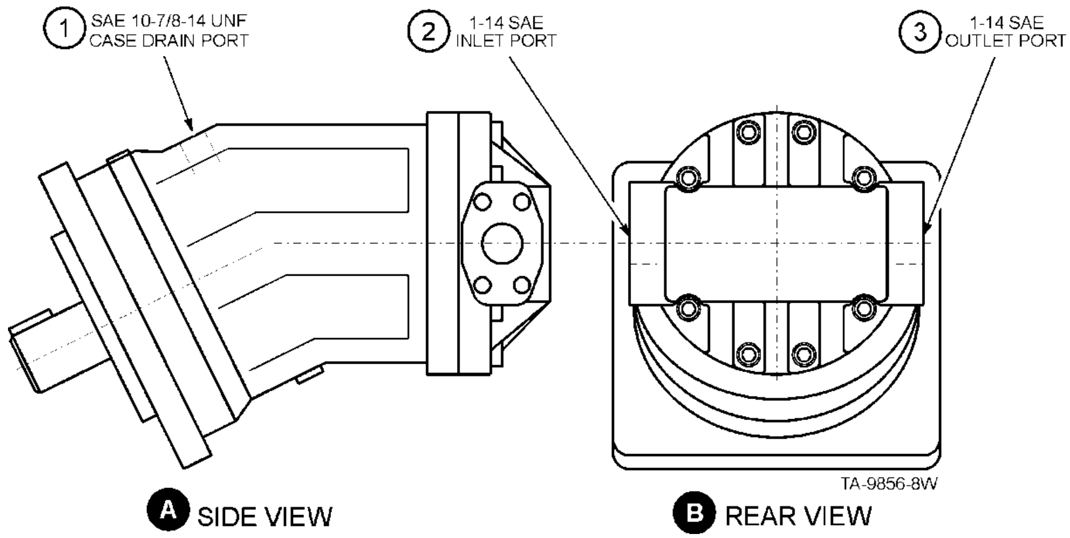
Hydraulic Motors

Engine Fan Motor

The engine fan motor is a piston-type motor (refer to illustration "Radiator fan hydraulic motor"). The motor is mounted on a bracket that is attached to a crossmember. The fan motor speed sensor gear and fan are mounted on the motor's keyed shaft. A speed sensor probe reads the motor's rpm from the rotating gear. The motor's speed can be read by accessing the maintenance menu by using the channel browser function of the LINCS computer system.

NOTICE

Motor repair and overhaul instructions are provided in the REXROTH product information. Refer to the PARTS MANUAL for service parts for the assembly.



A) Side View, **B)** Rear View
1) SAE 10-7/8-14 UNF Case Drain Port, **2)** 1-14 SAE Inlet Port, **3)** 1-14 SAE Outlet Port

Figure 72. Radiator fan hydraulic motor

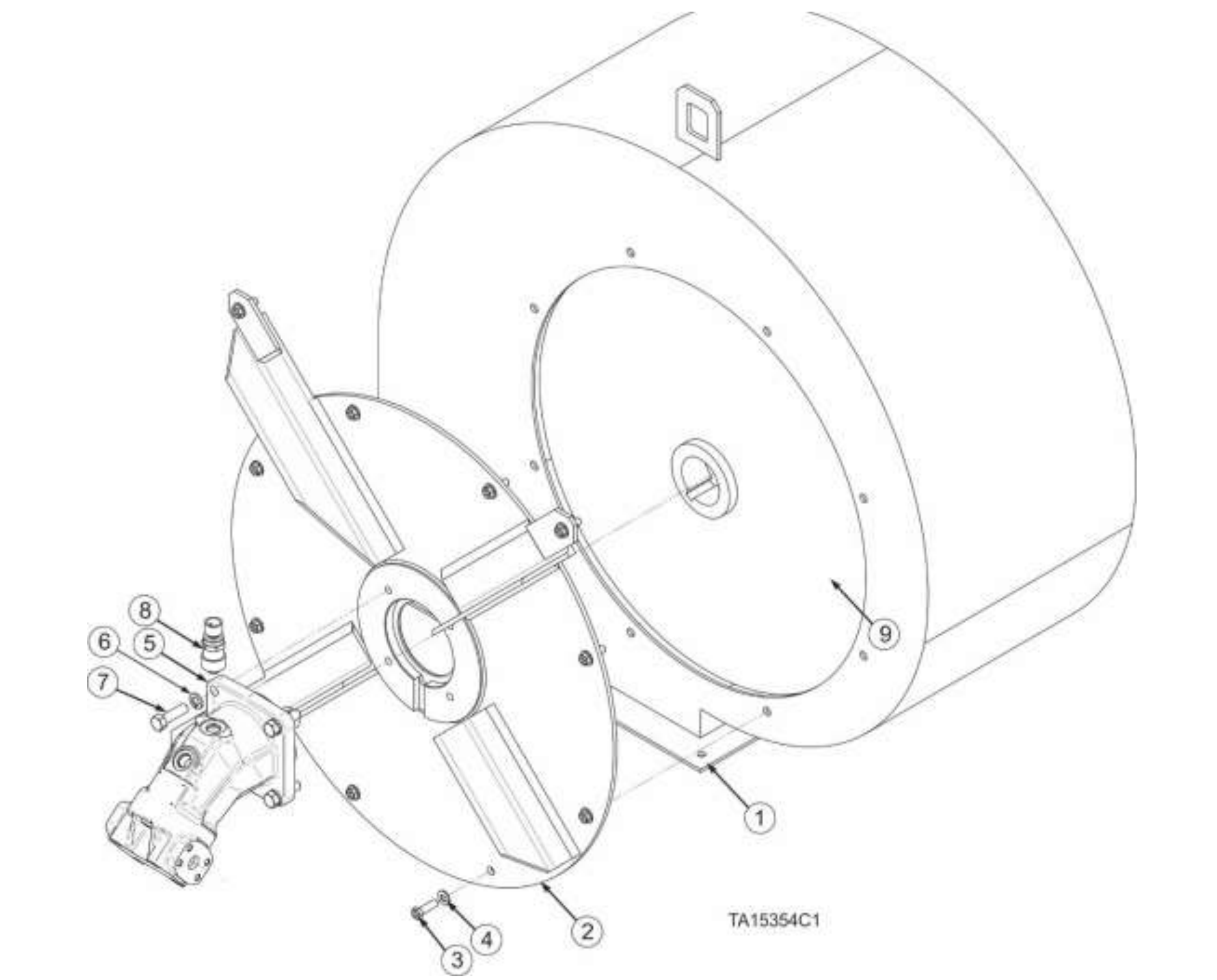
Blower Motor

The blower fan motor is a constant displacement piston type motor. The motor is mounted on the blower housing that is located behind the operator cab. The fan motor has an internal speed sensor ring with a speed sensor located on the top of the motor. The blower fan speed is variable between approximately 900 rpm to 3000 rpm. The blower fan wheel is mounted on the motor shaft by a split taper hub. The blower fan provides cooling air to:

- SR generator
- SR traction motors (4 total, one on each wheel)
- Electrical Converter Cabinet
- Cab pressurization

The fan speed is variable and is controlled by the LINCS system. Whenever any of the electrical components listed above has a temperature rise above a set point or the machine is in electrical braking for more than 10 seconds, the speed of the blower will increase. This provides additional cooling to the individual components while increasing hydraulic load to help electrical braking.

The speed sensor is used to monitor the blower rpm for the proper adjustment of the pump. The speed can be read by accessing the maintenance menu by using the channel browser function of the LINCS computer system



1) Blower Wheel Housing, **2)** Motor Mount Structure, **3)** Bolt, **4)** Washer, **5)** Motor, **6)** Washer, **7)** Bolt, **8)** Speed Sensor, **9)** Blower Wheel

Figure 73. Blower motor assembly typical

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Planetary Drive Oil Filtration System

The planetary drive oil filtration system consists of two hydraulically driven motors that receive their hydraulic power from the accessory pump that is mounted on the hydraulic pump drive (HPD gearbox). Each motor runs tandem pumps that circulate lubricant through an individual planetary drive.

1. Rear Strainer (2) 1 For Each Planetary Drive), **2)** Rear Canister Filter (2) (1) For Each Planetary Drive), **3)** Pump/Motor (2) (1 Rear, 1 Inside Front Frame), **4)** Fuel Reservoir (1)

Figure 74. Planetary drive filtration system components (rear system shown)

Filtration System Operation

Each of the four planetary drives (drivers) has its own closed loop oil filtration system. Each filtration system is comprised of the following components:

- Strainer
- Pump
- Check Valve
- Filter
- Flow Sensor

A single hydraulic motor is used to power two (2) pumps (one pump per planetary drive) for each axle. The motor and pumps are arranged in such a way that hydraulic oil and driver oil cross contamination cannot occur.

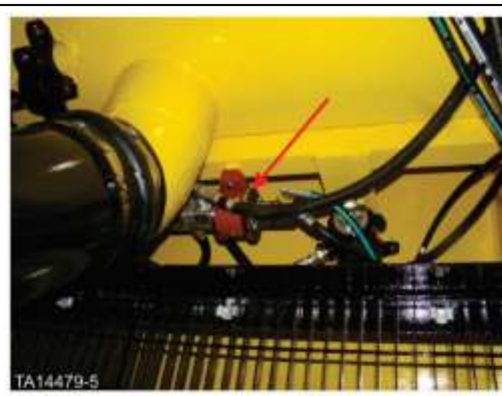
The filtration strainers, filters, and pump for the rear planetary drives are mounted behind the rear axle (under the machine against the fuel reservoir), on each side of the machine.

Figure 75. Rear planetary drive filtration system component mounting locations

The filtration strainers, filters, and pump for the front planetary drives are mounted inside the front frame.

Filters located inside front frame

Strainers located inside front frame



Pump/Motor located inside front frame

Figure 76. Front planetary drive filtration system component mounting locations

Fluid Flow through a Driver Filtration System

- When the engine goes to high throttle, the pump motors receive hydraulic oil.
- The motor turns the pump, causing oil to be drawn from the primary gear side through a fitting in the motor end bell.
- The oil is pulled through a strainer.
- Oil then flows through the pump.
- Oil flows through a check valve that prevents accumulated particles from back flowing into the pump while the machine is off.
- From the check valve the oil flows through a 10 micron absolute media oil filter.
- After being filtered, the oil flows through a flow sensor. The flow sensor detects oil flow is occurring. The switch state of the flow sensor is monitored by LINCS.
- From the oil filter, the oil is returned to the internal gear area of the planetary drive through another fitting in the motor end bell.

NOTICE

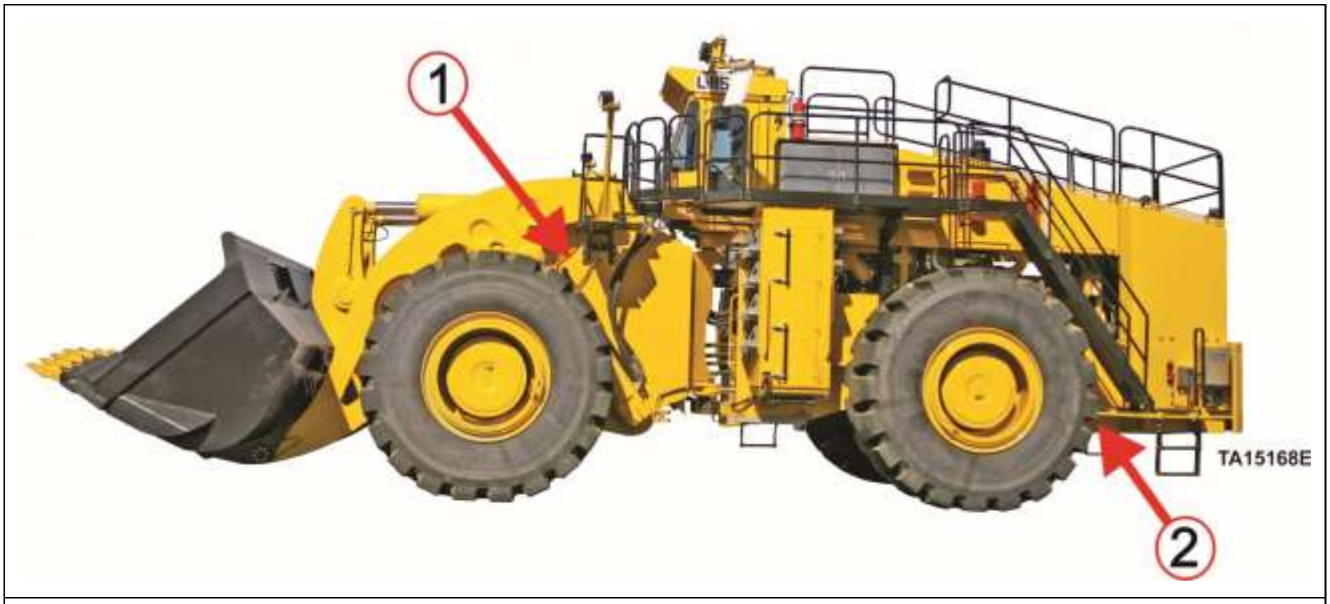
During the warranty period, notify your distributor immediately should large chips or an unusual amount of metallic residue accumulate in the strainers and filters or on the magnetic fill plug.

NOTICE

Refer to specific machine model hydraulic schematic for a schematic of the planetary drive oil filtration system. Hydraulic schematics are located in the Parts Manual.

CAUTION

Should a LINCS warning situation occur, remove the machine from service, and correct the problem immediately, or serious damage could result.



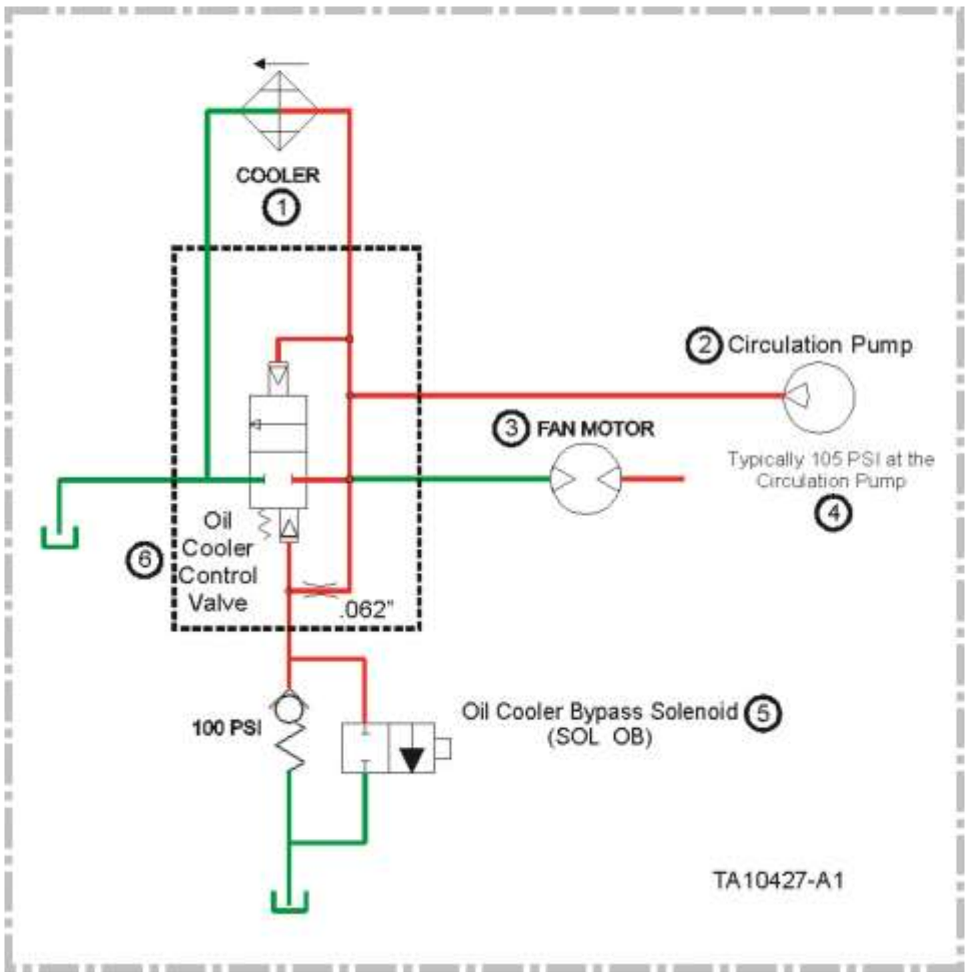
1) Planetary Drive Oil Filtration System Front, **2)** Planetary Drive Oil Filtration System Rear

Figure 77. Planetary drive filtration system component locations

Oil Cooler Control Valve

The oil cooler control valve is a spring biased pilot controlled logic valve that controls the flow path. Oil can flow directly through the valve out to the oil cooler, which is mounted adjacent to the radiator, or bypass the oil cooler by flowing across the logic valve and back to the hydraulic reservoir. The route of the oil is dependent upon temperature and viscosity. On the inlet to this valve is a pilot port that is connected by a hose to the cap end of the valve. This pilot port provides controlling pressure to the logic element and provides flow to the oil cooler pilot valve at Port “P”.

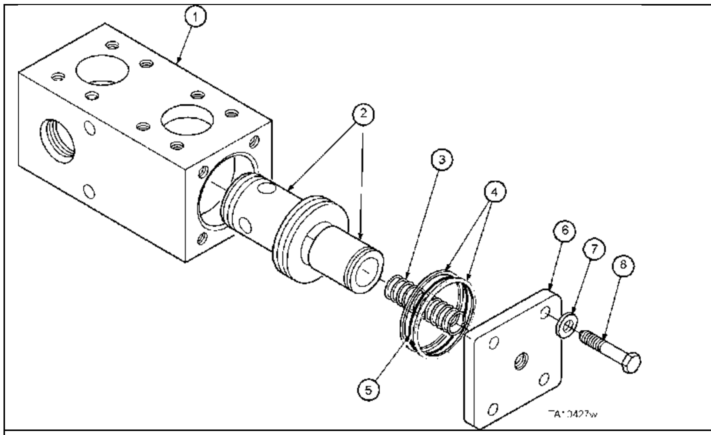
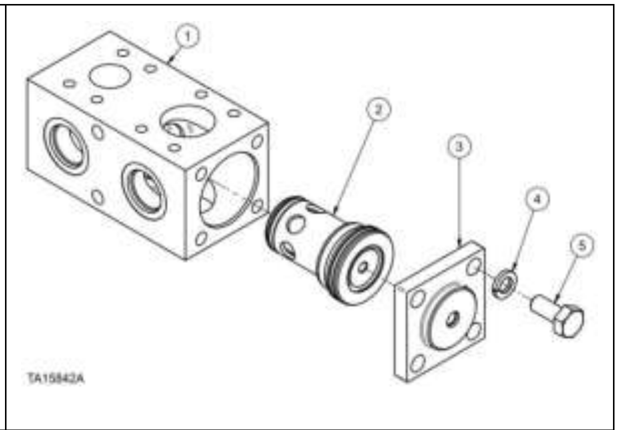
The Oil Cooler Pilot Valve controls the operation of the oil cooler control valve. As oil enters Port “P” of the oil cooler pilot valve, it has two parallel paths to flow. One path is across a 100-psi (6.9 bar) check valve and the other is across a normally closed solenoid valve. Both paths exit Port “T”.



1) Cooler, **2)** Circulation Pump, **3)** Fan Motor, **4)** Typically 105 psi (7.2 bar) at the Circulation Pump, **5)** Oil Cooler Bypass Solenoid, **6)** Oil Cooler Control Valve

Figure 78. Oil cooler control valve schematic all models

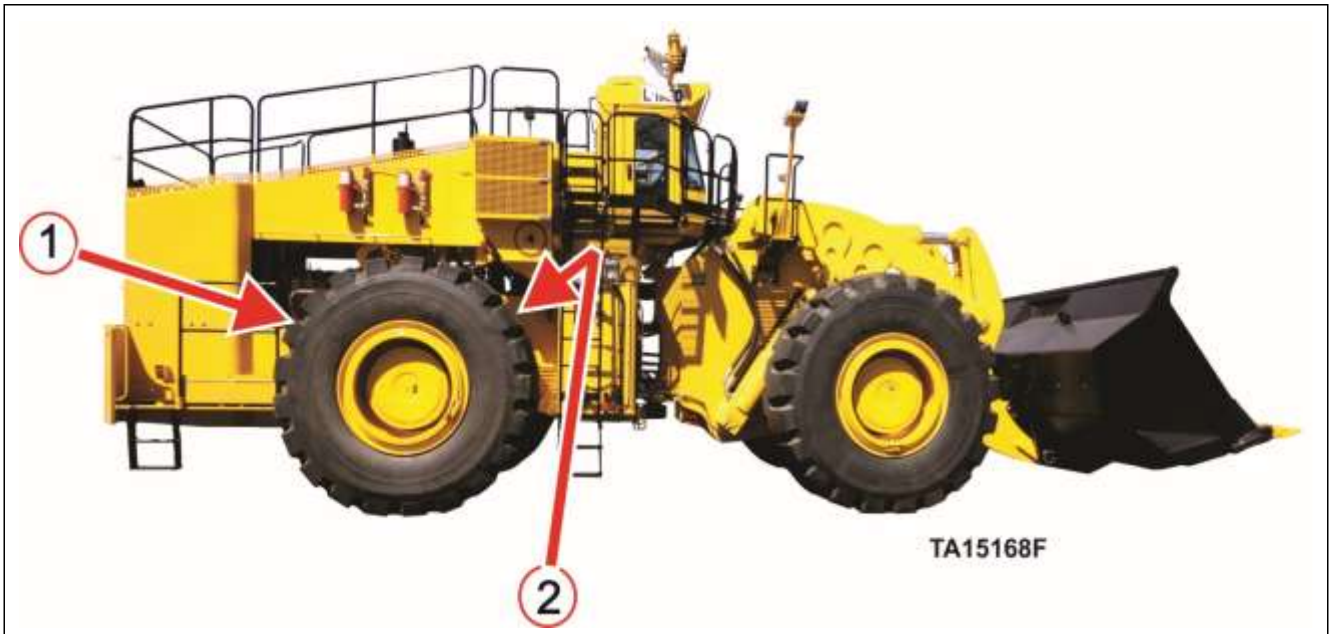
An oil cooler bypass solenoid is plumbed around the 100-psi (6.9 bar) check valve. This solenoid is energized if the hydraulic oil is cold (<140º F degrees). This bypass, when energized, causes most of the hydraulic oil to return to the hydraulic reservoir without going through the oil cooler.

	
1) Housing, **2)** Cartridge Assembly, **3)** Spring, **4)** Backup Ring, **5)** O-Ring, **6)** End Cap, **7)** Lockwasher, **8)** Bolt	**1)** Housing, **2)** Cartridge Assembly, **3)** End Cap, **4)** Lockwasher, **5)** Bolt **Note: Internal spring not shown**
Early Production	**Current Production**

NOTICE

The cartridge assembly from early production valve assemblies is not interchangeable with current production valve assemblies.

Figure 79. Oil cooler control valve assembly



1) Oil Cooler Control Valve Location, 2). Oil Cooler Bypass Solenoid Valve Location

Figure 80. Oil cooling system component locations

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Auxiliary Oil Cooler (Optional) Fan Speed Control

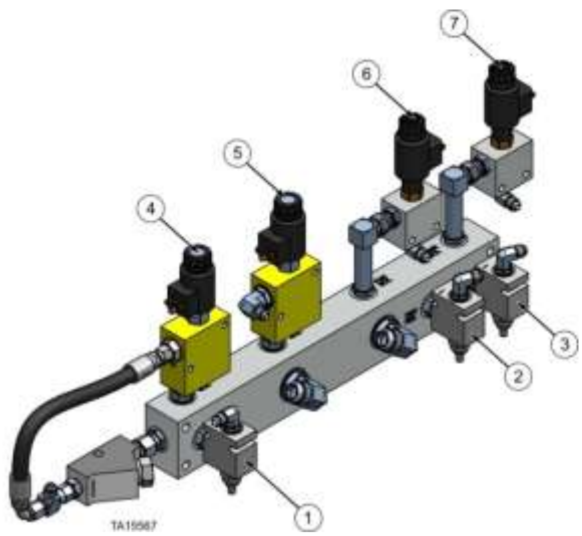
The auxiliary oil cooler fan is commanded “ON” when the hydraulic oil temperature rises above the “upper” temperature set point. The set point is sensed in the hydraulic reservoir by a temperature sensor.

SET POINTS: Upper 150° F (65.6° C) Lower 145° F (62.8° C)

The auxiliary oil cooler fan remains “ON” until the hydraulic reservoir oil temperature drops to the lower set point where it will return to “OFF” mode again.

L-1350/L-1850/L-2350: The auxiliary oil cooler fan is a two-speed system, where the fan rolls at a low speed (down to 0 rpm) during its “OFF” mode, and rotates at high speed during its “ON” mode.

Fan speed can be adjusted to high speed if additional cooling is required during extremely hot conditions. It can only be adjusted by Maintenance level or higher authorization. Temporarily forcing the fan to high speed is also useful in blowing accumulations of dust and dirt from the coils.



1) Auxiliary Oil Cooler Remote Relief
2) Radiator Fan Remote Relief
3) Blower Remote Relief
4) Oil Cooler Bypass Solenoid
5) Auxiliary Oil Cooler Proportional Valve
6) Radiator Fan Proportional Valve
7) Blower Proportional Valve

Figure 81. Proportional and relief manifold assembly

Hydraulic System Thermal Control

Under “normal” conditions, the hydraulic cooling system will keep the hydraulic oil temperature below approximately 158° F (70° C). Any one or more of the following reasons may contribute to an increase in the system temperature.

- Incorrectly adjusted relief valve.
- Incorrectly adjusted pump compensator.
- Incorrectly adjusted main fan pump compensator.
- Incorrect hydraulic fluid type and/or viscosity.
- Excessive dust and/or dirt plugging air path through oil cooler core.
- Foreign debris plugging interior oil cooler core.
- Incorrect fan speed setting.
- Operation of the machine above system limits for extended periods. These limits may be:
    - Operation above rated altitude.
    - Excessive bucket load weight.
    - Excessive hydraulic system stalling or holding circuits against system stops and/or relief valves.
    - Operation in an ambient temperature above rated temperature. Actual temperature where loader is working must be reviewed, not the “regional” ambient temperature.

CAUTION

Where “normal” operation consists of occasional, short excursions over the rated ambient temperature, the loader must have all other possible system faults eliminated. The duty cycle of the loader should be reduced to such a level that the cooling system maintains hydraulic oil temperature at a constant level, preferably at or below 158° F (70° C). It is paramount that all other system components are clean and correctly adjusted to help offset the increased ambient temperature. Operation of the loader under these conditions, with other defects in the hydraulic cooling system, will quickly cause rapid temperature rise and may result in catastrophic temperature related failures.

Figure 82. Auxiliary oil cooler typical location

Position Sensors

The machine control software system (LINCS®) uses encoders to determine component angles.

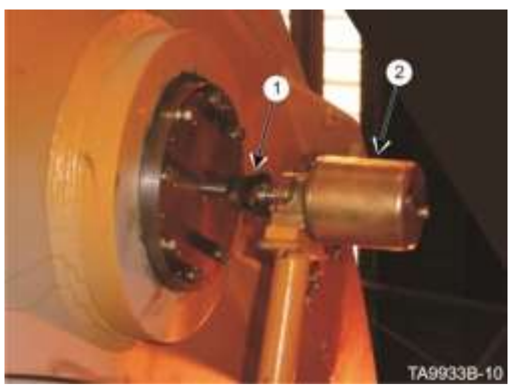
- Bucket - from complete rollback through full dump
- Lift arms - from completely lowered through fully raised
- Steering - frame articulation) from steered fully left through steered fully right

Encoders may be attached to the component by either direct shaft attachment (thought a coupling) or by rod linkage.

Automatic Bucket Leveling Circuit

Bucket angle and lift arm heights are continuously monitored by using encoders. The LINCS® computer system uses the bucket angle signal and the bucket height signal to automatically level the bucket from any position when the lift arms are lowered by pressing the "return to dig" control switch.

The bucket level encoder is mounted on a support on the torque tube structure and is connected to the bell crank pivot retaining capture plate. The bucket height encoder is mounted on a support stand outside the right lift arm. Each encoder is driven by a driveshaft, which is connected to either the right lift arm or bell crank. The bucket angle and bucket heights are displayed on the main LINCS Main Operator Screen. The bucket height signal is also used by the LINCS computer to stop hoisting when a limit has been set by using the Alternate Height switch. The Alternate Height switch is used for loading vehicles of uniform height. When the bucket height switch is turned ON, the bucket will automatically stop at the same height each time the hoist joystick is used to raise the lift arms. If the Alternate Height switch is turned OFF, the lift arms will rise to full height.



1) Driveshaft, **2)** Cover

Bucket height rotary transducer mounted right side, in front of operator's cab-typical installation

Figure 83. Automatic bucket leveling circuit rotary encoder

Setting up Rotary Position Sensors

The Generation 2 machines lift arm, bell crank, and steer position sensors give an output of 4 to 20mA.

- From 0˚ to 1˚ the integral LED is on.
- The output increases linearly from 4mA at 0˚ to 20mA at 120˚.
- From >120˚ to 360˚ the output is 20mA. The output steps down to 4mA at >360˚. The shaft can rotate continuously: it has no stops.

Setup is the same for all Generation 2 machines.

Lift Arm Sensor

- Position the bucket at full rollback. Lower the lift arms until the hoist cylinders are fully retracted.
- Loosen the coupling set screw on the lift arm side.
- Rotate the sensor shaft for 3VDC between the signal and ground terminals.
- Tighten the set screw.

This should give the following results.

	Cylinders Fully Retracted	Cylinders Fully Extended	CW Rotation of Sensor Shaft
L1350	3V	9.07V	15˚ to 106˚
L1850	3V	~8.8V*	15˚ to ~102˚*
L2350	3V	8.8V	15˚ to 102˚

* The precise cylinder stroke is not known at this time

Bell Crank Sensor

- Set the bucket on the ground in the level position.
- Loosen the coupling set screw on the bell crank side.
- Rotate the sensor shaft for 6VDC between the signal and ground terminals.
- Tighten the set screw.

The signal voltage extremes will vary for the various size loaders and for high lift versus standard.

Steer Position Sensor

- Set the steering angle at zero and install the safety link.
- Loosen the sets screws at the sensor housing shaft.
- Rotate the sensor housing shaft for 6VDC between the signal and ground terminals.
- Tighten the set screws.

This should give the following results.

Steer Position	Signal Voltage
Right	>2V <6V
0˚	6V
Left	>6V <10V

The signal voltage will depend on the amount of rotation of the sensor shaft. That is controlled by the linkage and steering angle.

Lubrication Specifications

CAUTION

Be sure all lubrication/oil is suitable for the climate at your location. See your oil vendor to assure the oil will flow at minimum temperature experienced. Using lubricants other than what is specified by the manufacturer (including viscosity differences) can cause severe damage to components

Hydraulic Oil Lubrication Requirements

General Requirements

Hydraulic oils used in P&H wheel loaders must be category HV oils with improved viscosity/temperature properties, and zinc additives for wear in addition to those modifiers to inhibit oxidation, foam, rust, and corrosion.

ISO Viscosity Grade

ISO viscosity grade of hydraulic oil must be as follows:

Hydraulic System Operating Temperature Range*	ISO Viscosity Grade
45°C to 60°C (113°F to 140°F)	32
49°C to 74°C (120°F to 165°F)	46
57°C to 85°C (135°F to 185°F)	68

* Arctic conditions are defined as an ambient temperature consistently below 0°F (-18°C). These conditions represent a specialized field where extensive use is made of heating equipment before starting, and/or use specially developed oils for arctic conditions, such as synthetics.

Hydraulic Oil Properties

Properties of oil must comply with the following table:

Property	Value		
	ISO 32 Grade	**ISO 46 Grade**	**ISO 68 Grade**
Kinematic Viscosity at 40°C (cSt), min	28.8-35.2	41.4-50.6	61.2-74.8
Kinematic Viscosity at 100°C (cSt), min	5.0	6.1	7.8
Viscosity Index, minimum	150	140	140
Pour point, maximum [1]	-30°C	-30°C	-25°C
FZG Gear Scuffing (ISO 14635-1) Failure Load Stage, min.	10	10	10
Vane Pump Testing (DIN 51389-2) mass loss in mg, ring/vane, max.	120/30	120/30	120/30
Copper Corrosion (DIN EN ISO 2160 – 3 hrs@100°C), max	2		
Foaming (ISO 6247) maximum (ml/ml)	150/0		
Rust protection (DIN ISO 7120, Proc. A)	Passed		

1 Oil with different pour point may be used, provided the pour point is 5°C lower than the minimum ambient temperature.

Special Conditions

Special operating conditions or limited hydraulic oil availability may necessitate the use of oils having properties that fall outside this specification. Approval for use of these oils will be considered on a case-by-case basis. The use of non-recommended oils or the mixing of incompatible oils may damage components and void the warranty. Refer to the following information for a list of approved oils.

Approved Oils

Hydraulic oils listed in the following table are granted approval for use in loaders, within the specifications and conditions stated for each. Oils may be submitted for approval by providing the associated product data sheet to the Joy Mining Products engineering department. Oils submitted for approval will be considered on a case-by-case basis. Some may be required to go through a performance trial period prior to approval that is at the user's risk. Length of trial period will be determined by engineering review of the oil properties. The use of non-recommended oils or the mixing of incompatible oils may damage components and void the warranty. Approvals may be revoked at any time without notice.

Properties of the oil and conditions for use must comply with the following table:

Source	Description	Nominal Operating Temp (deg.C)[1]	ISO Viscosity Grade	Kinematic Viscosity at 40°C (cSt)	Kinematic Viscosity at 100°C (cSt)	Viscosity Index	Flash Point (deg.C)	Pour Point (deg.C)	Denison Spec	Rexroth Spec	Conditions / Notes
BP	Bartran HV	57-85	68	70.5	10.8	142	208	-39		Yes	approval based on history of use
BP	HLP-HM	45-65	46	46.0	6.8	95	215	-27	HF-0	RE90220	
BP	HLP-HM	55-75	68	68.0	8.8	95	226	-24	HF-0	RE90220	approval based on history of use
Caltex	Rando HD	45-65	46	44.0	6.8	110	238	-33	HF-0	---	approval based on history of use
Castrol	Hyspin AWH-M	45-70	46	46	8.32	150	215	-42	HF-0	RE90220	
Fuchs	Renolin B HVI Plus	47-73	46	46	8.1	149	186	-45	HF-0	---	approval based on history of use
Mobil	DTE 10 Excel	38-62	32	32.7	6.6	164	250	-54	HF-0	RE90220-01	
Mobil	DTE 10 Excel	46-72	46	45.6	8.5	164	232	-45	HF-0	RE90220-01	Ref.Joy p/n 4123226
Mobil	DTE 10 Excel	57-84	68	68.4	11.2	156	240	-39	HF-0	RE90220-01	
Mobil	DTE 20 (25)	45-65	46	44.2	6.7	98	232	-27	HF-0,-1,-2	---	
Mobil	Mobilfluid 424	51-77	---	55.0	9.3	145	198	-42	HF-0,-1,-2	Approved	Ref. Joy p/n 4123226
Shell	Tellus S3 M	46-67	46	46	6.8	105	220	-33	HF-0,-1,-2	---	approval based on history of use
Shell	Tellus S68	54-77	68	68	8.7	97	222	-30	HF-0,-1,-2	Yes	approval based on history of use
Shell	Tellus S100	63-86	100	100	11.2	96	234	-24	---	Yes	approval based on history of use
Shell	Tellus 68	54-77	68	68	8.7	98	225	-27	HF-0,-1,-2	Yes	approval based on history of use

1. Approval based on oil operating temperatures within range shown.

Table 7. Approved hydraulic oils

Hydraulic Pump Drive (HPD) (PTO) Gearbox

Model	Component	Capacity		Lubrication
L1350/L1850/L2350	Hydraulic Pump Drive Gearbox[2]	7 gallons	27 liters	SAE 75W-140W synthetic gear oil or SAE 80W-90W gear oil.
1 ARCTIC CONDITIONS represent a specialized field where extensive use is made of heating equipment before starting. 2 Refer to Section 3 of this manual. The hydraulic pump drive gearbox is factory equipped with synthetic oil.				

Table 8. HPD gearbox fluid specifications

Automatic Lubrication System

**Type of Grease	**Minimum Ambient Temperature	**Grease Grade
Pumpable auto lube grease fortified with extremely high pressure and anti-wear properties for slow speed, high shock application The grease is required to have minimum 3% to maximum 5% MoS_2 “Molybdenum Disulfide” additive.	+70ºF (+20°C) and above	NLGI #2 grease
	+50ºF (+10°C) and above	NLGI #1 grease
	+10ºF(-12°C) to 50ºF(+10°C),	NLGI #0 grease
	-30ºF(-34°C) to +10ºF(-12°C)	NLGI #00 grease

CAUTION

**** The values listed for grade and temperature in the table GREASE SPECIFICATIONS are only general guidelines for grease grade. Grease specifications can vary widely, depending on the location where the grease was blended and local conditions. Each grease meeting the 3-5% Molybdenum Disulfide requirement should also have the Lincoln Ventmeter number verified to make sure it meets system requirements. Use of incorrect grease that does not meet the Ventmeter specification may cause pump problems and the injectors may not cycle and refill properly.**

Depending on the characteristics of the grease it is possible that a thicker NLGI grade of grease may be used at lower temperatures than shown in the table GREASE SPECIFICATIONS as long as the grease meets the Lincoln Ventmeter specifications.

NOTICE

LINCOLN VENTMETER SPECIFICATION

At a temperature that is 10°F (5°C) below the minimum ambient temperature to which the machine will be exposed, the Lincoln Ventmeter reading should be:

Injector Type	Ventmeter Reading
SL-1 injectors	500 psi (34.5 bar) or less
SL-V and SL-V XL injectors	900 psi (62.0 bar) or less

For Example:

- The minimum mine temperature is 0°F (-17.8°C).

Mine Site Temperature	Minus	10°F (5°C)	Equals	Target Temperature
0°F (-17.8°C)	minus	10°F (5°C)	=	-10°F (-23.3°C)

Examples:

Grease/Grade	Ventmeter Reading	Target Temperature	Acceptability
Brand XYZ	900 psi (62 bar)	15°F (-9.4°C)	Unacceptable
Brand ABC	400 psi (27.6 bar)	-10°F (-23.3°C).	Acceptable

The Lincoln Ventmeter test is typically performed by Lincoln and/or the grease manufacturer, by using a Ventmeter tool as shown.

All Machines	Lincoln Automatic Lubrication Pump	15 oz.	444 ml.	10W30 motor oil

Table 9. Auto lube pump lubrication and grease specifications

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Abbreviations

The circuit schematics and some illustrations in this publication use the abbreviations shown below.

BD	=	Bucket Dump (ROD)	BR	=	Bucket Rod Pilot
RB	=	Bucket Roll (base)	HP	=	High Pressure
H	=	Hoist (base)	HR	=	Hoist Rod Pilot
PD	=	Power Down	HT	=	Hydraulic Reservoir (tank)
FAS	=	Float Auxiliary Supply	L	=	Left
BB	=	Bucket Base Pilot	LS	=	Load Sense
EF	=	Extra Flow (NA)	P	=	Pressure
FPS	=	Float Pilot Supply	PP	=	Pilot Pressure
HB	=	Hoist Base Pilot	PVS	=	Pilot Control Valve Supply
A	=	Right Pilot (steer)	R	=	Right
B	=	Left Pilot (steer)	T	=	Tank

Figure 84. Hydraulic abbreviations as used in illustrations and schematics in this publication

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Capscrew and Bolt-Nut Torque Specifications

There are some exceptions to the torques provided on the following pages. Reduced torques are specified in the planetary drive rebuild manual, for the capscrews holding the planetary drive covers, due to a copper sealing washer under the head of the capscrew.

The torque specifications on this chart apply only to Grade 8 bolts, black or gold colored, and 12PT black-colored alloy steel capscrews. 12PT capscrews with gold-colored zinc chromate plating are excluded from these specifications and the zinc chromate 12PT capscrews should not be used on loaders or dozers. (except for planetary drive covers)

These torque values are for normal routine operations. If doing component rebuilds or any other abnormal machine component assembly/disassembly, please contact the factory for these values for specific instances.

		
Does not apply X	12PT Alloy Capscrew ✓	Grade 8 Bolt ✓

NOTICE

Please note the additional tables for exceptions to the torque values for items such as Lift Arm Ballcaps, Super Nuts and steering pin bolts with drilled grease passages.

Please direct any questions to Komatsu Product Support.

Capscrew and Bolt-Nut Torque Specifications Chart

Standard SAE G8 and Alloy Steel and Hex Socket Capscrews

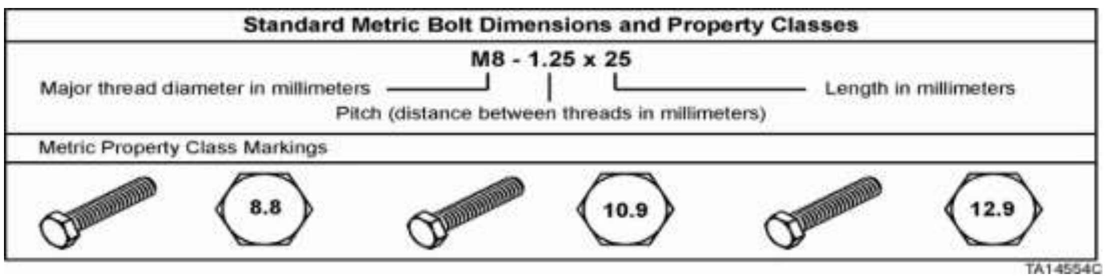
Size	Thread	GRADE 8 Fasteners		Alloy Steel 12PT. and Hex Socket Capscrews	
		USA Units lb-ft	Metric Units N-m	USA Units lb-ft	Metric Units N-m
		**Lubed	**Lubed	**Lubed	**Lubed
1/4 (0.25)	20 UNC	9	13	12	16
	28 UNF	10	14	14	19
5/16 (0.3125)	18 UNC	18	25	24	33
	24 UNF	20	27	27	37
3/8 (0.375)	16 UNC	33	45	45	61
	24 UNF	37	50	50	68
7/16 (0.4375) (* See Note below)	14 UNC	52	71	70	95
	20 UNF	58	79	79	107
1/2 (0.5) (* See Note below)	13 UNC	80	109	108	146
	20 UNF	90	122	122	165
5/8 (0.625)	11 UNC	159	216	203	275
	18 UNF	180	244	230	312
3/4 (0.75)	10 UNC	282	383	361	490
	16 UNF	315	427	403	546
1 (1.0) (*** See Note below)	8 UNC	682	925	872	1182
	14 UNS	764	1,036	977	1325
1-1/8 (1.125)	7 UNC	966	1310	1235	1674
	12 UNF	1083	1468	1385	1878
1-1/4 (1.25) (**** See Note below)	7 UNC	1,363	1,848	1744	2365
	12 UNF	1,509	2,046	1930	2617
1-1/2 (1.5)	6 UNC	2,371	3,215	3033	4113
	12 UNF	2,668	3,618	3413	4628

*** See Special Torque Specifications for ROPS super nut.**
**** See page 4 for specifications for "LUBED" – engine oil on threads and shoulder.**
***** See Special Torque Specifications for 950/1150 steering pins.**

***** This bolt is UNS (with 14 threads per inch), it is NOT UNF. It is a unique thread count bolt.**
****** See Special Torque Specifications for loader lift arms and 1350/1850/2350 steering pins.**

Standard Metric Bolts and Grades (SAE J1701M)

Size (mm)	Pitch (mm)	Property Class 8.8		Property Class 10.9		Property Class 12.9	
		USA Units lb-ft	Metric Units N-m	USA Units lb-ft	Metric Units N-m	USA Units lb-ft	Metric Units N-m
		** Lubed	** Lubed	** Lubed	** Lubed	** Lubed	** Lubed
6	1.00	6	8	8	11	10	13
7	1.00	10	13	14	19	16	22
8	1.25	14	19	20	27	24	32
10	1.50	28	38	40	54	47	63
12	1.75	49	66	70	94	81	110
14	2.00	77	105	111	150	130	176
16	2.00	121	164	173	235	202	274
18	2.50	167	226	239	324	279	378
20	2.50	244	331	337	458	394	535
24	3.00	422	572	584	791	682	925



Capscrew and Bolt-Nut Torque Specifications

Special Torque Specifications

Alloy Steel 12PT. Capscrew for Wheel Loader Lift Arm Ballcaps

Size	Type	Thread	USA Units lb-ft	Metric Units N-m	Application
			**Lubed	**Lubed	
1-1/4 (1.250)	12PT. capscrew F-C on head	7 UNC	1900	2577	LHD, L-950, L-1150, L-1350, L-1850, and L-2350 (Lift arm ball caps only)
1-1/4 (1.250)	12PT. capscrew B-7 on head	12 UNF	1320	1790	L-1000-L-1100 (Lift arm ball caps only)

Steering Pins (Hex Head Bolt)

Size	Type	Thread	USA Units lb-ft	Metric Lubed N-m	Application
			** Lubed	** Lubed	
1 (1.0)	Bolt (drilled center)	8UNC	425	576	LHD, L-950, D-950, L-1150 (Steering Pins)
1-1/4 (1.250)	Bolt (drilled center)	7UNC	850	1152	L-1350, L-1850, L-2350 (Steering Pins)

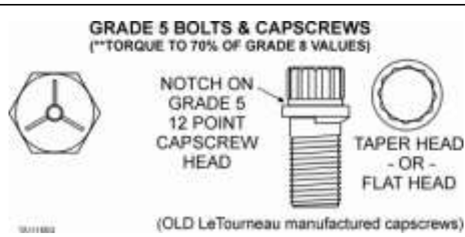
Aluminum 12pt. Capscrews used for Motor Pinion Balancing

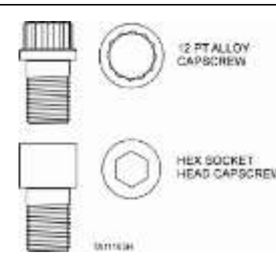
Size	Type	Thread	USA Units (lb-ft)		Metric Units (N-m)	
			Dry	**Lubed	Dry	**Lubed
¾ (0.75)	Aluminum	16 UNF	114	86	155	117
¾ (0.75)	Aluminum 2024-T4	16 UNF	150	113	203	153
15/16 (.9375)	Aluminum 6061 T6	12 NF	217	163	294	221
15/16 (.9375)	Aluminum 2024-T4	12 NF (2 START)	285	214	387	290

2-Thread (2-Start) Steel 12PT. Capscrews

Size	Type	Thread	USA Units lb-ft	Metric Units N-m
			** Lubed	** Lubed
3/8 (.3750)	12PT.	24 NF	25	34
9/16 (.5625)	12PT.	18 NF	87	119
15/16 (.9375)	12PT.	14 NF	428	584
1-5/16 (1.325)	12PT.	12 NF	1216	1660

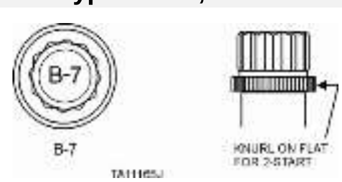
Bolt and Capscrew Markings on Head





Typical Markings on Alloy Capscrew Heads

Typical B-7, 2-Start



** See "Key Items" for specifications for "LUBED" – engine oil on threads and shoulder.

Capscrew and Bolt-Nut Torque Specifications

Key Items

- "LUBED" is defined as having the threads and under the head lubricated with engine oil. Engine oil is defined as SAE 30 or 40 weight oil, including multi viscosity grades 5W-30 through 15W-40. No other lubricant (such as anti-seize, MolyKote, copper coat, grease, etc.) is permitted unless specifically called out in a Komatsu procedure.

****LUBED = Lubricated with engine oil on threads and under head**

(SAE 30 or 40 weight oil, including multi viscosity grades 5W-30 through 15W-40)

NOTE: No other lubricant (such as anti-seize, never seize, MolyKote, copper coat, grease, etc.) is permitted unless specifically called out in a Komatsu procedure.

- All capscrews and bolts should be started by hand until a minimum of three (3) threads are engaged prior to any air impact equipment being used.
- If a procedure in a Rebuild Manual, Repair and Overhaul or Operating and Service Manual calls for the use of Loctite® threadlocker on the threads, the torque specification for "lubed" should be used. The threads on both the fastener and mating part should be thoroughly cleaned with a proper solvent prior to use of Loctite®. The Loctite® thread sealant should only be used on the threads - not the head.
- Certain applications in components such as drivers or lift arm ball caps may specify a FERRY brand of capscrew. Use only FERRY brand capscrews in these applications.
- Komatsu, recommends that any old 12PT. Komatsu-fabricated (fabrication was stopped many years ago) capscrew (refer to illustration under BOLT AND CAPSCREW MARKINGS ON HEAD) be replaced at the time of repair with alloy capscrews. If new capscrews are not available, then the Komatsu-fabricated capscrews should only be torqued to Grade 5 specifications (70% of Grade 8 value - lubed).
- The torque specifications on the charts on page 2 only apply to Grade 8 bolts, metric bolts and 12PT. black-colored alloy steel capscrews. Capscrews with gold-colored zinc chromate plating are excluded from these specifications and these capscrews should not be used on loaders or dozers except for driver covers.

		
Does not apply X	**12PT Alloy Capscrew ✓**	**Grade 8 Bolt ✓**

- CLEANING: It is mandatory to remove all paint, rust and debris from all mating surfaces, surfaces under the head of the bolt or capscrew and threads prior to installation and torquing of all bolts and capscrews.

	
Arrow indicates location to be cleaned	**Cleaning paint and rust prior to torquing**

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