General Information

A new Checklist for Troubleshooting Power Steering System Performance, form SD-94, has been developed to include the new high-pressure power steering gears as well as the power steering pumps. Use form SD-94, dated 9/17/04, and the following troubleshooting procedures when troubleshooting the power steering system.

You are required to fill out the applicable sections of form SD-94 when submitting a warranty claim on a power steering gear. It is recommended that you fill out the applicable sections of form SD-94 when submitting a warranty claim on a power steering pump. See **Fig. 1** and **Fig. 2** for a sample of form SD-94.

Form SD-94 can be downloaded from the internet through www.AccessFreightliner.com.

- Key in your user name and password.
- Click on Applications.
- Click on ServicePro®.
- Cancel the Vehicle Identification window.
- Click on Service Solutions.
- Click on Symptoms Search.
- At the bottom of the screen, enter 2005 in the Enter Solution Number field.
- Click on the SD-94 attachment.

Dealers can order form SD-94 through the TAO electronic mail system.

- At the TAO Mail Menu, key in B for bulletin boards.
- Tab down to Pub-Forms-FTL and key in L for list.
- At Freightliner Manuals Order Form, key in U.

If you don't have access to the TAO electronic mail system, contact Publishing Distribution at 503-745-7343.

Troubleshooting Procedures

Steps 1 through 3 are typically related to routine maintenance procedures. Some of these inspections and procedures can be found in the Pretrip Inspection and Daily Maintenance chapter in the *FLD Conventional Driver's Manual*; some of these inspections and procedures can be found in the *Heavy-Duty Trucks Maintenance Manual*.

1. Check the tire pressure and load.

   1.1 Check that the front tires are inflated to the correct pressure, and the tire pressure is equal on both sides. Correct the pressure if needed.

   Low pressure causes increased steering effort due to friction with the road surface. Unequal tire pressure causes unequal friction between the tire and the road. This can cause pulling to one side. Check the tires for damage or abnormal wear.

   1.2 Check that the rear tires are inflated to the correct pressure, and the tire pressure is equal on both sides. Correct the pressure if needed.

   1.3 Check that the tire sizes are correctly matched, and whether duplex or oversized tires (that were not originally specified for the vehicle) have been installed.

   Extra tire width causes increased steering effort due to extra friction with the road surface. If the axle stops were turned out to reduce wheel cut due to a change in tires, the power steering gear poppets/plungers will need to be adjusted.

   1.4 Determine whether the vehicle is operated at or over the rated load.

   Increased load causes greater steering effort. Make sure the vehicle is being operated within rated capacities.

2. Check the lubrication and condition of the fifth wheel, if so equipped.

   Check to see if the fifth wheel is adequately lubricated. A dry fifth wheel plate makes it difficult to change direction. Check the plate surface for burrs, gouges, and irregularities.

3. Check for loose and binding components. Check whether any steering components need maintenance or adjustment.

   3.1 Check for proper lubrication of the drag link, tie rods, and knuckle pins. Apply lubrication as needed.

Troubleshooting Procedures

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Checklist for Troubleshooting Power Steering System Performance

To be used with the troubleshooting and diagnostic checks.

Date _____ Work order No. _____

Evaluation performed by _____ ◻ Dealership ◻ Fleet ◻ Independent

Vehicle Identification
Vehicle model _____ Serial No. _____ Date in service _____
Mileage _____ Mileage when steering complaint first occurred _____
Vehicle application _____ Normal steering axle load _____

Steering System Description
Steering pump mfr. _____ Model No. _____
Steering gear mfr. _____ Model No. _____ Date code _____
Slave steering gear mfr. (optional) _____ Model No. _____ Date code _____
Reservoir capacity: ◻ 2 quarts (1.9 liters) ◻ 4 quarts (3.8 liters)
Type of fluid: ◻ ATF ◻ Other: _____

List complaint: _____
_____
_____

The numbers below correspond to the steps in the troubleshooting procedures, Subject 300. Refer to Subject 300 for definitions, explanations, and instructions.

1. **Check tire pressure and load:**
   - Front tire pressure correct and even on both sides? ◻ Yes ◻ No
   - Rear tire pressure correct and even on both sides? ◻ Yes ◻ No
   - Oversized front tires? ◻ Yes ◻ No
   - Operated at excessive load? ◻ Yes ◻ No

2. **Check fifth wheel lube and condition:** ◻ N/A ◻ OK ◻ Not OK

3. **Check for loose and binding components:**
   - Lubrication of drag link, tie rods, and knuckle pins? ◻ Yes ◻ No
   - Steering driveline U-joints bind? ◻ Yes ◻ No
   - Sector shaft adjustment OK? ◻ Yes ◻ No
   - Front tire self−return OK? ◻ Yes ◻ No
   - Fasteners and components worn or loose? ◻ Yes ◻ No

4. **Power steering temperature and hydraulic checks:**
   - 4.2. Check for correct fluid level. ◻ Fluid OK ◻ Added fluid
   - 4.5. Record initial fluid temperature. ◻ °F ◻ °C _____

5. **Power steering hydraulic system:**

Install a Power Steering System Analyzer (PSSA) between the pump high-pressure line and the steering gear. Run the engine at idle and use the load valve to raise the fluid temperature to 180°F (82°C).

- 5.1. Record total system back pressure. ◻ psi ◻ kPa _____
  See troubleshooting and diagnostic checks if greater than 100 psi (689 kPa).

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Fig. 1, Checklist for Troubleshooting Power Steering System Performance, Front Page

5.2. Check for erratic pump response while momentarily closing and opening the load valve. ◻ OK ◻ Not OK

5.3. Pump relief pressure. ◻ psi ◻ kPa _____

5.4. Pump relief valve operated correctly at idle. ◻ OK ◻ Not OK

5.5. Pump relief valve operated correctly at 1500 rpm. ◻ OK ◻ Not OK

5.6. Partially close the load valve until the pressure gauge reads approximately 1800 psi (12 410 kPa) or 2300 psi (15 858 kPa) for high-pressure steering gears. Record flow rate with engine at idle and with the appropriate load applied. ◻ gpm ◻ L/min ____

5.7. Record flow rate with engine at 1500 rpm and no load applied. ◻ gpm ◻ L/min ____

5.8. Run engine at governed speed until fluid temperature stabilizes. Record the maximum fluid temperature. Do not exceed 250°F (121°C). ◻ °F ◻ °C _____

5.9. Steering gear internal leakage:
Primary gear: 1.0 gpm (3.8 L/min) max ◻ gpm ◻ L/min Left _____ Right _____
(optional) Slave gear or ram: 1.0 gpm (3.8 L/min) max Left _____ Right _____

6. Steering gear poppet adjustment:
6.1. Check that pitman arm and sector shaft timing marks are aligned. ◻ Yes ◻ No
6.2. Poppet relief pressure. ◻ psi ◻ kPa Left _____ Right _____

7. Abnormal power steering noise:
7.1. If not already done, check for proper fluid level. ◻ Fluid OK ◻ Too low ◻ Too high
7.2. Check fluid condition. ◻ Fluid OK ◻ Discolored ◻ Foamy ◻ Other _____
7.3. Hissing at less than full turn. ◻ Yes ◻ No

8. Check for leaks and restrictions, and test the system back pressure:
8.1. Check for kinked or collapsed hoses. ◻ Yes ◻ No
8.1. Check for leaking fittings. ◻ Yes ◻ No
8.1. Check for leaking seals. ◻ Yes ◻ No

8.2. Install a low−pressure gauge− 200 to 300 psi (1379 to 2068 kPa)—in the appropriate locations within the power steering system to determine the following values.

8.3. Fill out the fields below using instructions found in substep 8.3 of the diagnostic checks.

Pump outlet	P2: _____	P2 max: 100 psi (689 kPa)	◻ OK	◻ Not OK
		140 psi* (965 kPa)	◻ OK	◻ Not OK
Gear inlet	G1: _____	P2 − G1 max: 12 psi	◻ OK	◻ Not OK
Gear outlet	G2: _____	G1 − G2 max 55 psi	◻ OK	◻ Not OK
Booster inlet*	B1: _____	G2* − B1 max: 12 psi	◻ OK	◻ Not OK
Booster outlet*	B2: _____	B1* − B2 max: 40 psi	◻ OK	◻ Not OK
Reservoir inlet	R1: _____	B2* − R1 max: 12 psi	◻ OK	◻ Not OK
Reservoir outlet	R2: _____	G2 − R1 max: 12 psi	◻ OK	◻ Not OK
Pump inlet	P1: _____	R1 − R2 max: 4 − 8 psi	◻ OK	◻ Not OK
		R2 − P1 max: 12 psi	◻ OK	◻ Not OK

*For vehicles with hydraulic brakes.

List repairs and add comments:_____

_____

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Fig. 2, Checklist for Troubleshooting Power Steering System Performance, Back Page

Troubleshooting Procedures

Chock the rearmost tires. With the engine shut down, turn the steering wheel and check for looseness or binding. Make sure all components are free to move, but are not excessively loose.

3.2 Check the COE steering column bearings for binding. Lubricate them if needed.

3.3 Check the steering driveline U-joints for looseness or binding. Lubricate them if needed.

3.4 Check for correct steering phasing where applicable. The U-joints should line up. Reset the phasing if needed.

NOTE: On older COEs, the steering U-joints do not line up.

3.5 Check the sector shaft adjustment.

- With the vehicle on the ground and the front tires pointed straight ahead, turn the steering wheel until slight motion is observed at the front wheels.
- Align a reference mark on the steering wheel to a rule, then slowly turn the steering wheel in the opposite direction until motion is again detected at the wheels.
- Measure the lash (free play) at the rim of the steering wheel.

  Excessive lash exists if steering wheel movement exceeds 2-1/2 inches (64 mm) with a 20-inch (508-mm) steering wheel, or 2-1/4 inches (57 mm) with an 18-inch (457-mm) steering wheel.

3.6 Check that the front wheels self-return without binding.

- With the engine off, chock the rearmost tires and place the front tires on radius plates (turntables).
- Disconnect the drag link from the steering arm.
- By hand, pull the tire to one axle stop and release. The tire should self-return to almost straight ahead.
- Repeat in the opposite direction.
- If the tire does not return to near straight ahead, check for binding or a lack of lubrication in the steering axle kingpin bushings or tie rod linkage.
- Connect the drag link and tighten the castle nut, then install a new cotter pin.

3.7 Inspect all suspension fasteners and components for wear and looseness.

4. Prepare the power steering system for temperature and hydraulic checks.

NOTE: The hydraulic power steering system is tested with a Power Steering System Analyzer (PSSA), and with the hydraulic fluid at operating temperature. The part number for the PSSA is J-26487. The part number for the adapter kit is J-28593. The PSSA and adapter kit are available from SPX Kent-Moore. See **Fig. 3**.

A PSSA is a combination of a flow meter, a shutoff valve, and a pressure gauge. The PSSA will allow you to measure flow and pressure, and provide a load on the pump in the hydraulic lines of the steering system.

4.1 Park the vehicle outside to reduce noise and exhaust in the shop.

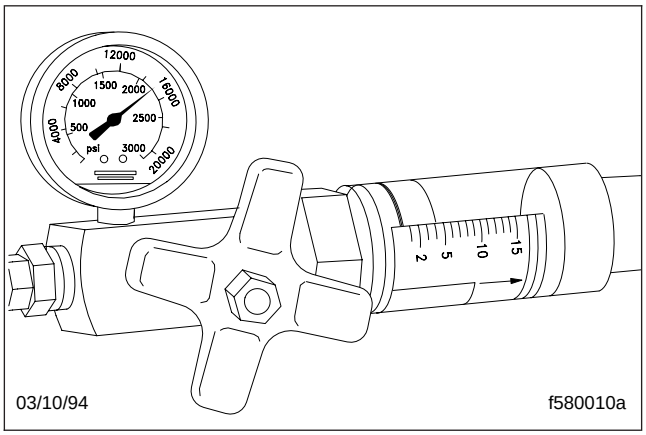


Fig. 3, Power Steering System Analyzer

4.2 Record on form SD-94 whether the fluid level was okay or if fluid was added.

4.3 Install the PSSA between the pump high-pressure line and the steering gear.

4.4 Fill and bleed the steering system as needed.

4.5 Determine the initial power steering fluid temperature.

- Place a temperature gauge in the fluid reservoir.
- Record the initial temperature on form SD-94, and leave the temperature gauge in the reservoir to monitor the fluid temperature throughout these tests.

NOTE: Power steering system checks must be done with the power steering fluid at operating temperature, approximately 180°F (82°C). Maintain this temperature throughout the following tests.

CAUTION

Do not leave the load valve fully closed for longer than five seconds. Doing so could damage the power steering system.

4.6 If not already done, raise the power steering fluid temperature to normal operating temperature.

- Run the engine at idle.
- Partially close the load valve on the PSSA until the pressure gauge reads 1000 psi (6895 kPa).
- Open the valve when the fluid temperature reaches about 180°F (82°C).

5. Test the power steering hydraulic system.

5.1 Check the total system back pressure.

- Run the engine at idle.
- Make sure the PSSA load valve is fully open.
- Read the pressure gauge on the PSSA.
- Record the total system back pressure on form SD-94.

NOTE: If the total system back pressure is greater than 100 psi (689 kPa) on a vehicle with air brakes, or 140 psi (965 kPa) on a vehicle with hydraulic brakes, back pressure is excessive. Go to step 8 to find the restriction in the system.

CAUTION

Do not leave the load valve closed for longer than five seconds during the following test. Doing so could damage the power steering system.

5.2 Check for erratic pump response.

- Slowly close the load valve.
- When the valve is completely closed, read the pressure gauge.
- Open the valve.

  If the pressure rises rapidly, appears to be uncontrolled, or rises above the typical relief pressure, open the load valve immediately. See **Table 1** or **Table 2** for relief pressures.
- Indicate on form SD-94 whether the pump response was erratic or not.

  If the response was erratic, replace the pressure relief valve in the pump or the power steering pump as required. For instructions, see **Group 46** in the *Heavy-Duty Trucks Service Manual*. After replacing the pressure relief valve, repeat substeps 5.1 and 5.2. Make sure the temperature is at about 180°F (82°C). If the pressure was consistent, go to substep 5.3.

5.3 Check the pump relief pressure.

- Slowly close the load valve.
- When the valve is completely closed, read the pressure gauge.
- Open the valve.

Troubleshooting Procedures

Minimum Measured Pump Flow and Relief Pressure at Engine Idle		
Gear Make and Model*	**Flow at 1800 psi (12 500 kPa)**	**Typical Relief Pressure**
TRW TAS40 or HFB52	1.8 gpm (6.8 L/min)	2175 ± 100 psi (15 000 ± 700 kPa)
TRW TAS55	2.2 gpm (8.3 L/min)	
TRW TAS65 or HFB64	2.6 gpm (9.8 L/min)	
TRW TAS85 or HFB70	3.2 gpm (12.1 L/min)	
TRW TAS65 With RCS65	5.6 gpm (21.1 L/min)	
TRW TAS65 With Linear Cylinder	6.1 gpm (23.1 L/min)	
TRW TAS85 With RCS65	6.6 gpm (25.0 L/min)	
TRW TAS85 With Linear Cylinder	6.1 gpm (23.1 L/min)	
HFB70 With RCB70	6.6 gpm (25.0 L/min)	
HFB70 With RCB64	6.1 gpm (23.1 L/min)	
HFB70 With Linear Cylinder	6.1 gpm (23.1 L/min)	
Sheppard MD83	2.1 gpm (8.1 L/min)	
Sheppard M100	3.0 gpm (11.4 L/min)	
Sheppard M110 With Slave 110 and Dual TRW Right-Side Rams	5.6 gpm (21.2 L/min)	

* On vehicles with TRW TAS steering gears and hydraulic brakes, the typical relief pressure is 2375 ± 100 psi (16 000 ± 700 kPa).

Table 1, Minimum Measured Pump Flow and Relief Pressure at Engine Idle

Minimum Measured Pump Flow and Relief Pressure for High-Pressure Gears at Engine Idle		
Gear Make and Model	**Flow at 2300 psi (16 000 kPa)**	**Typical Relief Pressure**
TRW THP45	1.5 gpm (5.7 L/min)	2683 ± 100 psi (15 000 ± 700 kPa)
TRW THP60 or PCF60	2.3 gpm (8.7 L/min)	
TRW THP60 With Linear Cylinder	5.8 gpm (22.0 L/min)	
TRW THP60 With RCH45	6.3 gpm (23.8 L/min)	

Table 2, Minimum Measured Pump Flow and Relief Pressure for High-Pressure Gears at Engine Idle

- Record the relief pressure on form SD-94.

If the pump relief pressure matches the relief pressure in **Table 1** or **Table 2**, it is acceptable. Go to the next substep.

If the pump relief pressure does not match the relief pressure in **Table 1** or **Table 2**, refer to the pump manufacturer's service literature to verify the exact relief pressure for the power steering pump being diagnosed.

If the pump relief pressure does not match the relief pressure in **Table 1** or **Table 2** or the pump manufacturer's specifications, replace the pressure valve if not done previously, or replace the power steering pump. After replacing the pressure relief valve in the pump, repeat substeps 5.1 and 5.2.

If the pump relief pressure does not match the relief pressure in **Table 1** or **Table 2** and the relief valve was previously replaced, replace the pump. For instructions, see

Group 46 in the *Heavy-Duty Trucks Service Manual*. After replacing the pump, evaluate the pump's performance by repeating step 5.

5.4 Test the pump relief valve reaction at idle.

- Run the engine at idle.
- Note the flow rate with the load valve open.
- Close the load valve until the pump relief pressure is reached. The flow rate should drop to zero.
- Smoothly and quickly open the load valve and note the flow rate. Repeat this action three times. It should return to the flow rate noted above.
- Record on form SD-94 whether the relief valve operated correctly or not.

If the flow rate returns smoothly and quickly, the relief valve is acceptable. Go to the next substep.

If the flow rate does not return smoothly and quickly, the pump relief valve is not working correctly. Replace the relief valve if not done previously, or replace the power steering pump.

5.5 Test the pump relief valve reaction at 1500 rpm.

- Run the engine at 1500 rpm.
- Note the flow rate with the load valve open.
- Close the load valve until the pump relief pressure is reached.
- Smoothly and quickly open the load valve and note the flow rate. Repeat this action three times. It should return to the flow rate noted above.
- Record on form SD-94 whether the relief valve operated correctly at 1500 rpm.

If the flow rate returns immediately, the relief valve is acceptable. Go to the next step.

If the flow rate does not return immediately, the pump relief valve is not working correctly. Replace the relief valve if not done previously.

5.6 Test the flow of the pump at idle with a load applied.

- Run the engine at idle.
- Slowly close the load valve until the pressure gauge reads 1800 psi (12 410 kPa).
- Read the flow gauge and record the flow rate on form SD-94.

NOTE: For high-pressure steering gears, use 2300 psi (15 858 kPa) as the test load pressure. See **Table 1** or **Table 2** for minimum flow rate.

- Open the load valve.

5.7 Test the maximum flow of the pump with no load applied.

- Run the engine at 1500 rpm.
- Read the flow gauge and record the maximum flow on form SD-94.

If the flow rate is below the minimum as indicated in **Table 1** or **Table 2**, repair or replace the pump. For instructions, see **Group 46** in the *Heavy-Duty Trucks Service Manual*.

If the flow rate is above 8 gpm (30 L/min), replace the flow control and relief valve in the pump, or replace the power steering pump as required. For instructions, see **Group 46** in the *Heavy-Duty Trucks Service Manual*.

CAUTION

Do not allow the temperature to exceed 250°F (121°C) during the following test. If this temperature is exceeded, stop the test and record the last noted temperature on form SD-94.

5.8 Record the maximum fluid temperature.

- Run the engine at governed speed.

Troubleshooting Procedures

- Observe the power steering fluid temperature until it stabilizes.
- Record on form SD-94 the maximum power steering fluid temperature.

  If the temperature does not exceed 250°F (121°C) during the test, excessive system heat is probably not the cause of the complaint.

  If at any time during the test the temperature exceeded 250°F (121°C), the system is operating at excessive temperature levels, and steering system performance and life may be affected. Damage to hoses, seals, and other components may result if the vehicle is operated at excessive steering system temperatures.

  Excessive steering system backpressure or excessive pump flow may be the cause of the over temperature problem. Go to step 8 if you suspect a restriction in the system.

  If excessive heat continues to be a problem, a cooler may need to be added to the system.

⚠ WARNING

Keep fingers clear of the stop bolt and spacer block during the following test. Make sure that the spacer block contacts the axle stop squarely. Contact that is not square could break the stop bolts or eject the spacer block, which could cause serious personal injury.

⚠ CAUTION

While running the following test, do not hold the steering wheel in the full-turn position for more than five seconds. Doing so could damage the pump.

NOTE: The following substeps check for excessive internal leakage in the steering gear(s). Make sure the fluid temperature is approximately 180°F (82°C) and the vehicle is stationary with the front wheels pointing forward.

5.9 Test the steering gear internal leakage.

- Run the engine at idle with the load valve open.
- Place an unhardened steel spacer, 1-inch (25-mm) thick, between the axle and the stop bolt at one side of the axle. See **Fig. 4**.

  The spacer should have an extension or handle long enough to keep fingers clear of the axle stop area. A brazing rod or welding rod works well for this purpose.

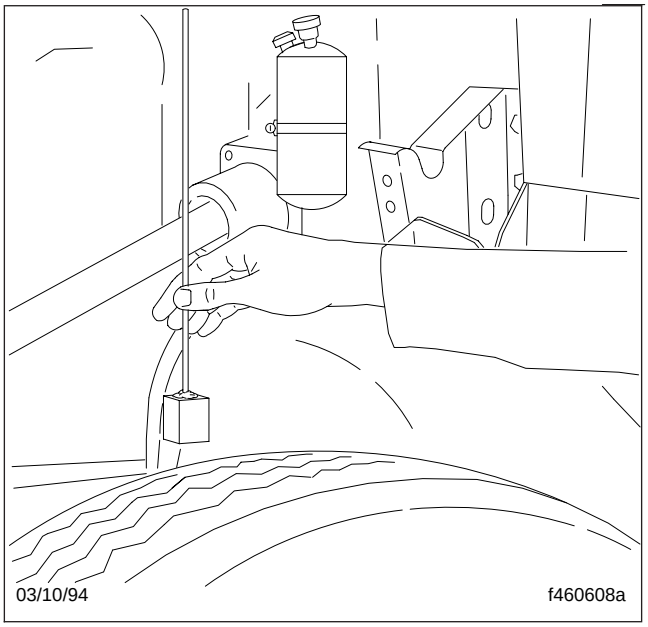


Fig. 4, Position the Steel Spacer

- Have someone turn the steering wheel until the stop bolt contacts the spacer block. See **Fig. 5**.
- Apply a 20-pound (89-newton) force on the steering wheel.
- Read the internal leakage rate on the flow meter. Record this value on form SD-94.

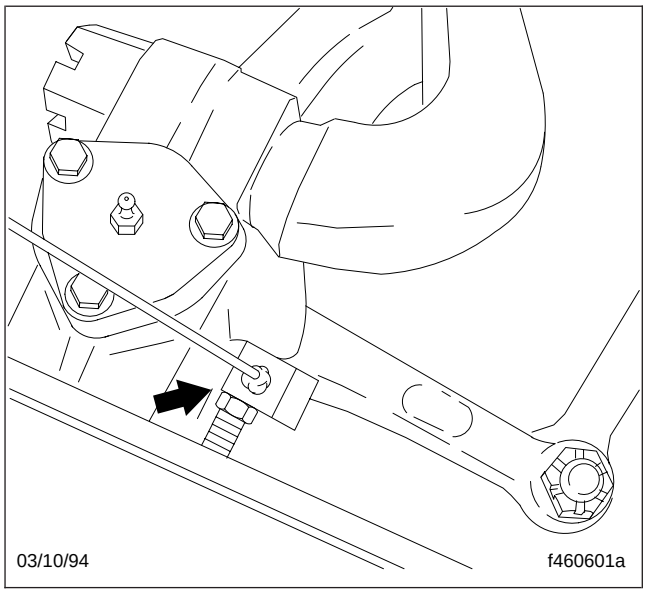


Fig. 5, Steel Spacer Contacting the Axle Stop

- Repeat substep 5.9 (beginning with placing the spacer between the axle and the axle stop) for the opposite turn.

  The maximum permissible internal leakage for a single gear is 1.0 gpm (3.8 L/min). If leakage is greater in either turning direction, replace the steering gear components as needed.

  For systems with two or more steering gears and/or linear cylinders, the total acceptable internal leakage is 1.0 gpm (3.8 L/min) for each steering gear/ram in the system. For example, for a dual-gear system (two steering gears) the total acceptable internal leakage is 2.0 gpm (7.6 L/min).

  If the leakage is more than 2.0 gpm (7.6 L/min) on a dual-gear system, isolate the auxiliary cylinder from the system.

- Disconnect the auxiliary cylinder hydraulic lines at the main gear auxiliary ports.
- Plug the main steering gear ports with suitable steel or high-pressure plugs or caps.
- Direct the disconnected lines into a drain pan.
- Repeat the internal leakage test.

  If the internal leakage is less than 1 gpm (3.8 L/min), repair or replace the auxiliary gear or linear cylinder. If the internal leakage is greater than 1 gpm (3.8 L/min), repair or replace the main gear.

- Remove the plugs and connect the hoses.
- Fill the power steering reservoir to the proper level.

6. Check the steering gear poppet relief valve and stop bolt adjustment.

   NOTE: Poppets limit the steering assist when the front wheels approach the stop bolts. Improper adjustment can apply excessive force to the steering linkage or loss of assist as the steering wheel approaches either full-left or full-right turns.

   6.1 Check the steering system for adequate turn angle.

   - Make sure the stop bolt settings limit the steering travel so there is 1/2-inch (13-mm) clearance from all stationary components, and 3/4-inch (19-mm) clearance from all moving components.
   - Make sure the pitman arm is situated on the steering gear sector shaft correctly.

⚠ CAUTION

If power steering pump relief pressure is reached while the steering wheel is at full lock, release the steering wheel from this position. Do not allow the pump relief pressure to be maintained for longer than five seconds or damage to the pump may result.

   6.2 Check the poppet relief pressure.

Troubleshooting Procedures

- Set up a system for hydraulic checks as done in step 4.
- Make sure the fluid temperature is at approximately 180°F (82°C) and the vehicle is stationary on the ground with the front wheels pointing forward.
- Run the engine at idle with the load valve open.
- Turn the steering wheel to either full-lock position.
- Note the pressure gauge reading.
- Repeat the previous three instructions for the opposite turn.
- Record the poppet relief pressure on form SD-94 for both turns.

The pressure should drop slightly before the steering stops are contacted. If the pressure increases (from contact with the steering stops), the poppets/plungers must be manually reset. For poppet reset instructions, see the *Heavy-Duty Trucks Service Manual*.

If the pressure is relieved and assist is lost when the wheel is too far from the axle stop, adjust the automatic poppet valve following the instructions in the next substep.

6.3 Adjust the poppet valves.

- Turn the steering wheel to the full-lock position.
- Apply a 20-pound (89-newton) force on the steering wheel while in the full-lock position.
- Repeat the previous two instructions for the opposite turn.

If the poppets (TRW gears only) have been adjusted or reset properly, and after subsequent vehicle operations loss of assist continues to occur when the wheel is too far from the axle stop, the poppets have become loose due to previous incorrect poppet adjustment and must be replaced. After poppet replacement and adjustment, test again for correct poppet relief function and record the pressure on form SD-94.

7. Check for abnormal power steering noise.

NOTE: Noise from the power steering system does not necessarily mean there is a problem. Some noises are normal and are the result of proper operation.

7.1 If not already done, check for proper fluid level. Record the results on form SD-94.

7.2 Check the condition of the power steering fluid and record the condition on form SD-94.

7.3 Check if a hissing sound is heard at less than full turn. If a hissing sound is heard, check the steering gear poppet and the axle stop adjustment and record the result on form SD-94. For adjustment instructions, see step 6.

See **Table 3** and **Table 4** for possible causes and remedies for common noises associated with the power steering system and power steering pump.

8. Check for leaks and restrictions, and test the system back pressure.

8.1 Check for leaks and restrictions.

- Run the engine at idle.
- Inspect all hoses and fittings for signs of kinked or collapsed hoses, or leaking fittings.
- Inspect all external seals.
- Repair all leaking fittings and replace parts as needed.
- Replace any leaking seals.
- Inspect the seal bores and sealing surfaces for scrapes or burrs. Make sure the seals are installed correctly using the recommended tools as instructed in the *Heavy-Duty Trucks Service Manual*.

Power Steering System Noise	
Possible Cause	**Remedy**
Growling or other abnormal steering noise	Check the fluid level. Check for air bubbles and foam. Check for hose and fitting leaks. Add fluid if needed. If there is air in the fluid, check for inlet tube and hose leaks. Correct all leaks.
A change from the usual pump sound	Check the power steering fluid reservoir. Check for air bubbles and foam in the fluid. If there is air in the fluid, check for inlet tube and hose leaks. Correct all leaks.
Clicking noise during a turn	Check for loose steering components. Check the front suspension for insufficient spring pin shims. Tighten any loose steering components. Add front spring pin shims if needed.
Hissing when the steering wheel is at or near full turn	Fluid flowing past a poppet valve makes a hissing noise. This is normal. No action is needed.

Table 3, Power Steering System Noise

Power Steering Pump Noise	
Possible Cause	**Remedy**
The intake line is plugged.	Drain the system. Clear the intake line if needed. Fill the system.
There is an air leak at the pump connections, the fittings, the reservoir connections, or the shaft seal.	Check all the connections by pouring power steering fluid over them, and listen for a reduction in sound. Tighten all the connections as needed. If the problem persists, remove the pump, disassemble it, and replace the shaft seal.
The pump input shaft is misaligned.	Remove and disassemble the pump. Replace the shaft seal and bearing.

Table 4, Power Steering Pump Noise

- Indicate on form SD-94 if there were any kinked or collapsed hoses, or leaking fittings or seals.

If you replaced the steering gear input shaft seal and found it to be excessively hard, test the system operating temperature, substep 5.8, if not already done.

⚠ CAUTION

Do not move the steering wheel or allow the system pressure to exceed the rating of the gauge during the following test, or damage to the gauge could occur.

8.2 Test the system back pressure.

- Install a low-pressure gauge—200 to 300 psi (1379 to 2068 kPa) maximum—between the pressure line and the pump.
- Run the engine at idle and check for correct fluid level. If necessary, add fluid. If bubbles or foam appear in the reservoir, check the hose fittings for looseness or leaks.
- With the engine at idle, read the total system back pressure on the pressure gauge. Record the value on form SD-94.
- If the total system back pressure is greater than 100 psi (689 kPa), or 140 psi (965 kPa) for a vehicle with hydraulic brakes, go to the next substep. If the pressure between the pressure line and pump is less, restriction is not a problem.

8.3 Determine the restriction of the individual components by subtracting the values shown in **Table 5**. Record the values on form SD-94.

Troubleshooting Procedures

The component at fault can be identified by checking pressure at key locations in the steering system. With the engine at idle, use the low-pressure gauge and hose connection adaptors necessary to measure pressure at all locations identified in **Fig. 6**. Each time the gauge moves to a new location, make sure that the fluid level is correct and air is removed from the system by running the engine at idle and checking the fluid level.

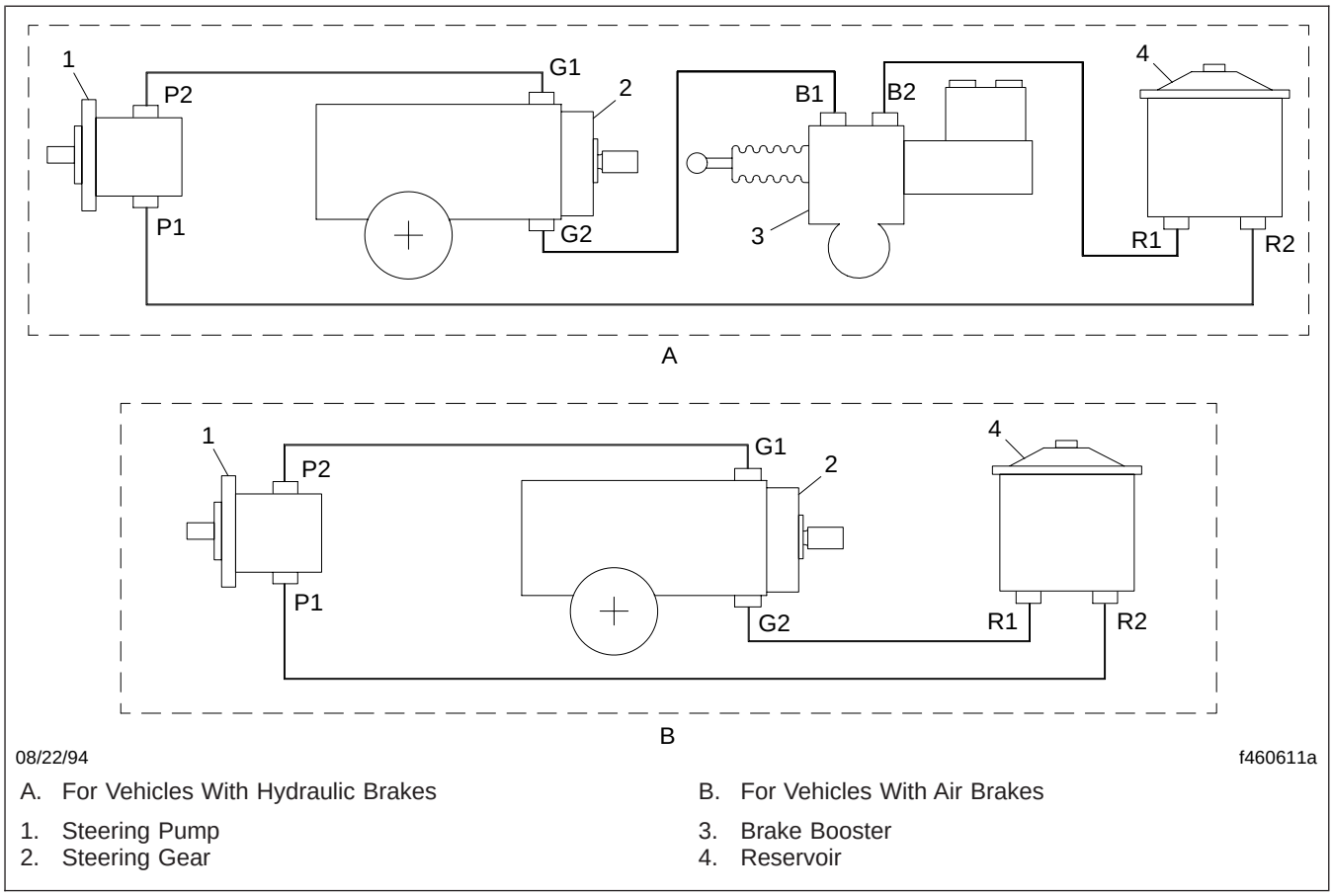
- Install the low-pressure gauge between the pump outlet and the pump-to-gear hose. Record this value as P2.
- Install the low-pressure gauge between the pump-to-gear hose and the steering gear inlet port. Record this value as G1.
- Install the low-pressure gauge between the steering gear outlet port and the gear-to-reservoir hose. Record this value as G2.
- Install the low-pressure gauge between the gear-to-reservoir hose and the reservoir inlet port. Record this value as R1.
- Install the low-pressure gauge between the reservoir outlet port and the reservoir-to-pump hose. Record this value as R2.
- Record the total system back pressure as determined in substep 8.2 as P1.

  NOTE: For a vehicle with hydraulic brakes, perform similar procedures as those in substep 8.3. Record the pressure at the booster inlet as B1, and at the booster outlet as B2.

  If any component exceeds the maximum allowable restriction listed for each component, refer to the applicable action to take in **Table 5**.

Total System and Component Restrictions		
Total System and Component Pressure-Check Location	**Maximum Allowable Restriction**	**Action to Take**
P2 = total system (pump outlet)	Hydraulic brakes: 140 psi (965 kPa) Air brakes: 100 psi (689 kPa)	Check pressure at the key locations.
P2–G1 = hose: pump-to-gear	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G1–G2 = steering gear	55 psi (379 kPa)	The gear rotary valve is damaged. Replace the gear. See instructions elsewhere in this group.
G2–B1 = hose: gear-to-booster	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
G2–R1 = hose: gear-to-reservoir	12 psi (83 kPa)	Check for a kinked or plugged hose. Replace the hose if necessary.
B1–B2 = booster	40 psi (276 kPa)	Check the internal booster filter for contaminants. Check for contaminants causing binding or blockage of poppet and check valves within the booster.
B2–R1 = hose: booster-to-reservoir	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.
R1–R2 = reservoir	2 qt: 4 psi (28 kPa)	Replace the filter. Check for internal blockage.
R2–P1 = hose: pump supply	12 psi (83 kPa)	Check for a kinked, collapsed, or plugged hose. Replace the hose if necessary.

Table 5, Total System and Component Restrictions



A. For Vehicles With Hydraulic Brakes

1. Steering Pump
2. Steering Gear

B. For Vehicles With Air Brakes

3. Brake Booster
4. Reservoir

Fig. 6, Plumbing Diagrams