Steering Troubleshooting Guide

Table of Contents

Sub-Headings

Steering

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TRW Automotive® Steering and Suspension Systems Linkage Service Manual, © TRW Inc., 1997.

TRW Automotive® Steering and Suspension Systems Chart Your Way to Easy Steering, Steering System Troubleshooting Guide, © TRW Inc., 1993, Publication Number WA 3-96 10M.

TRW Automotive® Steering and Suspension Systems TAS Steering Gear Service Manual, TAS 40, 55, 65 and 85 Series, © TRW Inc., 1998, Publication Number WA-TRW1108, Rev 7/98.

TRW Automotive® Steering and Suspension Systems Power Steering Pump Service Manual, PS Series, © TRW Inc., 1994, Publication Number PS SM WA 5M 5/97.

TRW Automotive® Steering and Suspension Systems TAS Poppets, PS Series, © TRW Inc., 1996, Publication Number WA/3-96.

TRW Automotive® Steering and Suspension Systems Service Bulletin #COL-105, Intermediate Column Installation, ©TRW Inc., March 1994.

TRW Automotive® Steering and Suspension Systems Service Bulletin #TAS-108, Steering System Maintenance Schedule, © TRW Inc., February 1993.

TRW Automotive® Steering and Suspension Systems Service Bulletin #TAS-103, Lubrication of TAS Gears, © TRW Inc., February 1993.

Safety

The purpose of this safety summary is twofold. First, it is to help ensure the safety and health of individuals performing service and maintenance on, or operation of, this Blue Bird product. Second, it is to help ensure the protection of equipment. Before performing any service, maintenance or operating procedure on this product, individuals should read and adhere to the applicable warnings, cautions and notes located throughout this Blue Bird Service Manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not correctly adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify, or otherwise give additional insight for a given subject, product or procedure. Please note that on occasion, notes too may advise of potential safety issues.

Specifications

Item	Measurement	Specification
Power Steering Pump		
Pump	Displacement/Rev	22 cc/rev (1.34 in^3/rev)
Pump	Flow	4.23 gpm (16 lpm)
Pump	Pressure (max)	2,175 psi (150 bar)
Relief Valve Seat Assembly	Torque	7-15 lb-ft (9—20 Nm)
Plug	Torque	15-25 lb-ft (20—34 Nm)
Pressure Point (Outlet)	Torque	37 lb-ft max (50 Nm)
Steering Gear		
Auxiliary Cylinder Plug	Torque	25—35 lb-ft (34—48 Nm)
Auto Bleed Plug	Torque	38—58 lb-ft (52—79 Nm)
Poppet Sealing Nut	Torque	33—37 lb-ft (45—50 Nm)
Poppet Fixed Stop Screw	Torque	38—58 lb-ft (52—79 Nm)
Relief Valve Cap	Torque	25—35 lb-ft (34—48 Nm)
Sector Shaft Adjusting Screw Jam Nut	Torque	40—45 lb-ft (54—61 Nm)
Drag Rod Assembly Vertical Joint	Adjustment	38.16—39.47 in
Drag Rod Assembly Vertical Joint (60.20 in)	Adjustment	57.45—62.84 in
Drag Link Clamp Nut	Torque	50—60 lb-ft (67.8—81.3 Nm)

Routine Maintenance and Adjustment

Caution

Never high-pressure wash or steam clean a power steering pump while off the vehicle. Doing so could force contaminants inside the pump and cause it to malfunction.

Regularly check the fluid and the fluid level in the power steering reservoir. Encourage drivers to report any malfunctions or accidents that could have damaged the steering components.

Caution

Do not attempt to weld any broken steering component. Replace the component with original equipment only. Do not cold-straighten, hot straighten or bend any steering system component.

Always clean off around the reservoir filler cap before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system. Investigate and correct any external leaks, no matter how minor. Replace reservoir filters according to requirements.

Lubrication Guidelines (Sliding Seal)

Normal Service — Lubricate socket every oil change or more frequently when the vehicle is subjected to harsh environments. Flush with grease until you see clean grease.

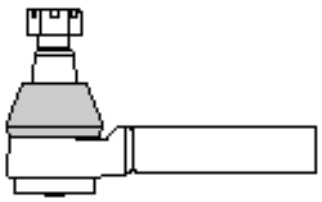

Figure 1—Sliding Seal

Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure pitman arm timing marks are aligned properly to prevent internal bottoming of the steering gear.

Keep tires inflated to correct pressure.

Never use a torch to remove pitman arm.

Investigate and immediately correct the cause of any play, rattle or shimmy in any part of the steering system.

Make sure the steering column is aligned properly.

Maintain grease pack behind the output shaft dirt and water seal as a general maintenance procedure at least twice a year (Spring and Fall). Grease fitting is provided in housing trunnion. Use only NLGI Grade 2 multi-purpose chassis lube, and use only a hand-operated grease gun on fitting. Add grease until it begins to extrude past the sector shaft dirt and water seal.

Filling and Air Bleeding the System

Caution

Make sure poppets are set correctly before beginning this procedure.

1. Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time.

Caution

Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.

2. Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.
3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dipstick.

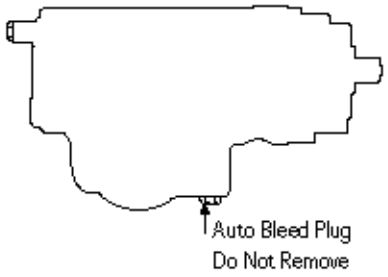

Figure 2—Auto Bleed Plug Location

4. Automatic bleed systems should now be free from trapped air. **Figure 2**.

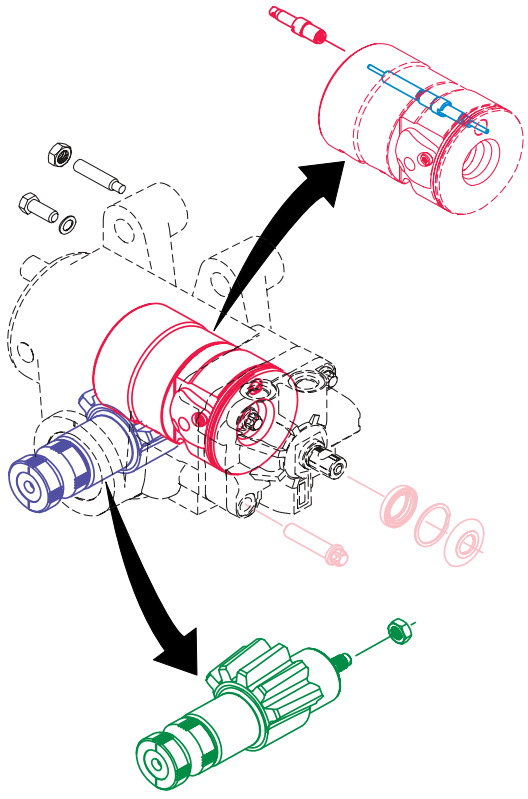

Figure 3—TAS Gear

Input Shaft Seal Replacement

1. This procedure uses the vehicle's power steering pump to force out the input shaft seal. To use this procedure, the power steering pump should have a minimum of 1,500 psi avail available.
2. Disconnect return line from the steering gear and plug the line. Also, cap the return port of the gear with a high-pressure fitting.
3. Remove the steering column from the gear input shaft.
4. Remove the dirt and water seal from the steering gear. Save this seal to match the new seal to the correct size. Refer to **Figure 3.**
5. Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring. Be careful not to scratch the bore with the screwdriver.
6. Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.
7. Tie or wrap a shop towel around the input shaft area and place a dip pan under the vehicle to catch the oil.
8. Add fluid as necessary, to the full line on the dipstick. Do not mix fluid types.

Warning

Any mixture of fluid types, or use of any unapproved fluid could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

9. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).
10. Remove the shop towel. Disconnect the steering column, and remove the input shaft seal.
11. Check the seal area of the valve housing for any seal fragments. Remove any that are found.
12. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. Determine and fix the cause of excessive heat in the vehicle.
13. Put clean grease on the inside diameter of the new input shaft seal, and place it over the input shaft. With the small diameter of tool against the seal, tap the tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

Caution

Do not use a socket to install this seal because you will not be able to control seal installation depth, possibly causing a leak.

14. Insert new retaining ring into the groove.
15. Pack the end of the valve housing bore around the input shaft with grease. Choose the correct size dirt and water seal by comparing the choices to the old seal, or by measuring the major diameter of the input shaft serrations. Apply more grease to the new dirt and water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.
16. Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.
17. Reconnect the return line to the steering gear return port.
18. Bleed air from system.

Sector Shaft Adjustment

A sector shaft leak or a leak at the vent hole (weep hole) of the sector shaft side cover will require removal and repair or replacement of the steering gear.

Caution

Never plug a leaking vent hole (weep hole). This could cause the steering gear to hydraulically lock.

This adjustment can only be completed on the vehicle if the adjusting screw jam nut is accessible. This nut is located on the side cover.

1. With the engine on, rotate the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the housing. The line on the sector shaft should be at a 90° angle from the input shaft. The sector shaft is now on its "center of travel". Turn the vehicle off.
2. Remove the drag link from the pitman arm.

Caution

To avoid resetting the poppets, do not rotate the input shaft more than 1 ½ turns from the "center of travel" position while the drag link is disconnected.

3. From the "center of travel" position, grasp the pitman arm and gently try to rotate it back and forth. If looseness or lash is felt at this point, the sector shaft is out of adjustment.
4. Loosen the jam nut.
5. If no lash was detected in Step 3, turn the shaft adjusting screw counterclockwise until you feel last at the output shaft. Refer to **Figure 3**.
6. Slowly turn the shaft adjusting screw clockwise until you feel no last at the output shaft without using more than 10 lb-ft (14 Nm) of torque. From this position, turn the screw clockwise 1/8 to 3/16 of a turn more. Hold the adjusting screw in place, and tighten the jam nut. Final jam nut torque is 43 lb-ft (58 Nm).
7. Turn the steering wheel ¼ turn each side of center, then back to center and recheck the pitman arm for lash. You should feel no lash. If there is lash, repeat Steps 4, 6 and 7.
8. Reconnect the drag link to the pitman arm.

Caution

Maintain grease in the sector shaft bearing through the grease fitting in the housing, using only a hand-operated grease gun. Add grease until it begins to extrude past the dirt and water seal. Do not use a power grease gun because it will supply grease too fast; this could adversely affect the high-pressure seal and contaminate the hydraulic fluid.

Initial Poppet Setting

Caution

The axle stops and all steering linkage must be set according to Blue Bird specifications, and the pitman arm must be correctly aligned on the sector shaft for poppets to be set correctly.

For this procedure to work correctly, you must have:

- A new gear received from Blue Bird's aftermarket system or a used gear on which poppet seats have been replaced or reset during gear disassembly procedures.
- A fixed stop screw installed in the housing, or a poppet adjusting screw installed so that it duplicates the fixed stop screw length.

1. With the engine at idle and the vehicle unloaded, turn the steering wheel to full travel in one direction until axle stop contact is made. Maximum input torque to be applied during this procedure is 40 lb rim pull (178 Nm) on a 20-inch (508 mm) diameter steering wheel.

Note

If you encounter excess rim pull effort, allow the vehicle to roll forward or jack up the vehicle at the front axle.

2. Follow the same procedure while turning the steering in the other

direction. The poppets are now positioned to trip and reduce pressure as the steered wheels approach the axle stops in either direction.

Poppet Readjustment

Refer to Part Number 1469261 for Blue Bird poppet adjusting kit.

The poppets will need to be reset if any of the following occur:

- Changing to larger tires
- Reducing turn radius for any reason
- If the steer axle u-bolts are bent or broken
- If the pitman arm is mistimed
- Axle stop bolts damaged
- Steering gear is mounted on a different vehicle

The resetting procedure will work in most causes with at least 1-¾ hand wheel turns from each side of center. If you are making a large reduction in turning radius and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section.

1. Set the axle stops to Blue Bird's turning radius or clearance specifications.
2. Start the engine and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.
3. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut. Refer to **Figure 3**.
4. Your steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already part of the steering gear, back the nut off the adjusting screw until it is flush with the end of the adjusting screw.
5. Make sure the engine is off and the road wheels are in a straight-ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of the housing.
6. If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.
7. Turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 7/32" Allen wrench. Tighten the sealing nut against the housing.

Caution

If the drive end of the screw is below the face of the nut, the poppet seat flange will brake when engine is started.

8. Refill the system reservoir with approved hydraulic fluid.

Caution

Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.

9. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.
10. Start the engine and let it run at idle speed.
11. Note which output shaft timing mark is nearest the housing piston bore.
12. Turn the steering wheel to the right until axle stop contact is made.
13. Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" diameter steering wheel) after the axle stop is contact.
14. Turn the steering wheel to the left (end of timing mark away from adjusting screw) until the other axle stop is contacted.
15. Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" diameter steering wheel).
16. Release the steering wheel and shut off the engine.

17. Loosen the sealing nut and back out the adjusting screw until 1" is past the nut. Torque sealing nut to 15 lb-ft.

Caution

Do not hold the steering wheel at full turn for more than 10 seconds at a time. The heat build-up at pump relief pressure may damage components.

18. Start the engine and let it idle.
19. Turn the steering wheel to the right (end of timing mark toward adjusting screw), until axle stop is made.
20. Hold the steering wheel in this position (with up to 40 lb rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing Steps 18-20.
21. With steering wheel held tightly at full turn, loosen the jam nut and hold it in place with a wrench.
22. Turn the adjusting screw in (clockwise) using finger-pressure only (don't use a ratchet), until the Allen wrench stops. Do not attempt to turn it in further. Pause the turning-in process each time the driver releases the steering wheel; continue turning only while the wheel is held at full turn.
23. Back off the adjusting screw 3 ¼ turns and tighten the sealing nut. Torque sealing nut to 35 lb-ft.
24. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

Warning

The length of the adjusting screw beyond the nut must be no more than 1 1/16" for proper thread alignment.

Note

The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Lubrication of TAS Gears

Caution

Do not use an automatic or power grease gun on this fitting. The high rate of flow from such devices could force grease inside the high-pressure seal. This could contaminate the hydraulic system and promote seal leakage.

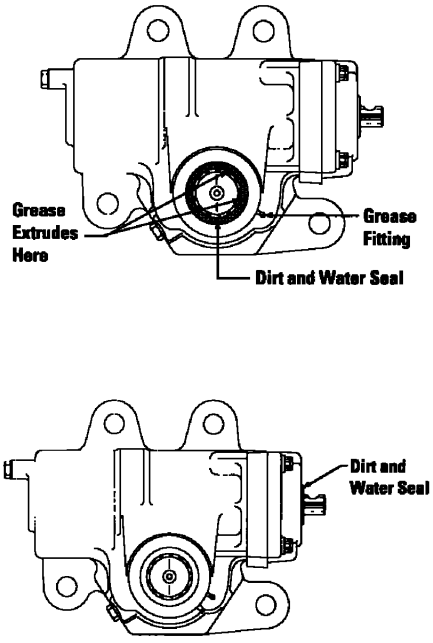

Figure 4—Lubrication Points

1. Locate the grease fitting on the trunnion side of the steering gear near the output shaft. Use a hand-type grease gun to force grease (NLGI Grade 2 or 3 multi-purpose EP chassis lube) through the fitting until you can see it past the external dirt and water seal. **Figure 4**.
2. Clean old grease from the dirt and water seal near the input shaft, and the cavity behind the seal with a lint-free cloth. Repack the area using clean, high temperature industrial grease (Mobil Temp* 1 or 2 equivalent). Reseat the dirt and water seal in its groove vehicle the serration and against the valve housing.

Axle Stop Adjustment

Adjustment of axle stops should be made after tow-in has been set on the front axle.

1. With front tires on turn angle plates, center left front tire in the straight-ahead position using alignment equipment. Set turn angle plates to zero.
2. The right hand axle stop should be adjusted so that for a full right hand turn, the turn angle plate under the left hand tire reads 45□ 1□. The left hand axle stop should be adjusted so that for a full left hand turn, the turn angle plate under the right hand tire reads approximately 36□. Lock axle stop jam nuts after adjusting.
3. Remove turn angle plates. Verify that axle stops contact axle pad at full right hand and left hand turns. It may be necessary to relieve tire flex by rolling bus forward or backward in order to make stops contact. There must be at least 0.125-inch clearance between pitman arm, drag rod, and front axle tie rod and all potential interference points.

Approved Hydraulic Fluids

- Automatic Transmission Fluid Dextron II
- Automatic Transmission Fluid Type "E" or "F"
- Chevron 10W-40 Motor Oil
- Chevron Custom 10W-40 Motor Oil
- Chevron Torque 5 Fluid
- Exxon Nuto H32 Hydraulic Fluid
- Fleetrite PSF (Can #990625C2)
- Ford Spec M2C138CJ
- Mack EO-K2 Engine Oil
- Mobil ATf 210
- Mobil Super 10W-40 Motor Oil
- Premium Blue 2000 – SAE 15W-40
- Texaco 10W-40 Motor Oil
- Texaco TL-1833 Power Steering Fluid
- Union 10W-40 Motor Oil
- Union 15W-40 Motor Oil
- Unocal Guardol 15W-40 Motor Oil

Note

The steering system should be kept filled with one of the above fluids.

Warning

Completely flush the steering system with one of the recommended fluids above only. Do not mix oil types. Any mixture or any unapproved oil could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

Maintenance

Maintenance Schedule	
Hydraulic System	
Area	**Frequency**
Check Oil Level	Monthly
Change Oil	Annually or every 100,000 miles
Change Oil Filter (25 micrometer)	Annually or every 100,000 miles
Inspect hoses and fittings	Lubrication Interval Twice per year
Mechanical System	
Component	Frequency
Adjust Sector Shaft Preload	As required
Replace trunnion bearing grease	Chassis lubrication interval or monthly

Replace input shaft seal grease	Twice per year
Check bolt torque (mounting bolts, pinch bolts at pitman arm and input shaft, mounting bracket if used)	Annually or every 100,000 miles
Lubricate column and U-joint	12 months or 12,000 miles
Lubricate Steering Linkage	6 months or 6,000 miles
Check tire inflation levels	Weekly
Alignment	As required by tire wear patterns
Check shock absorbers	12 months of 12,000 miles

Table 1—Maintenance Schedule

Theory of Operation

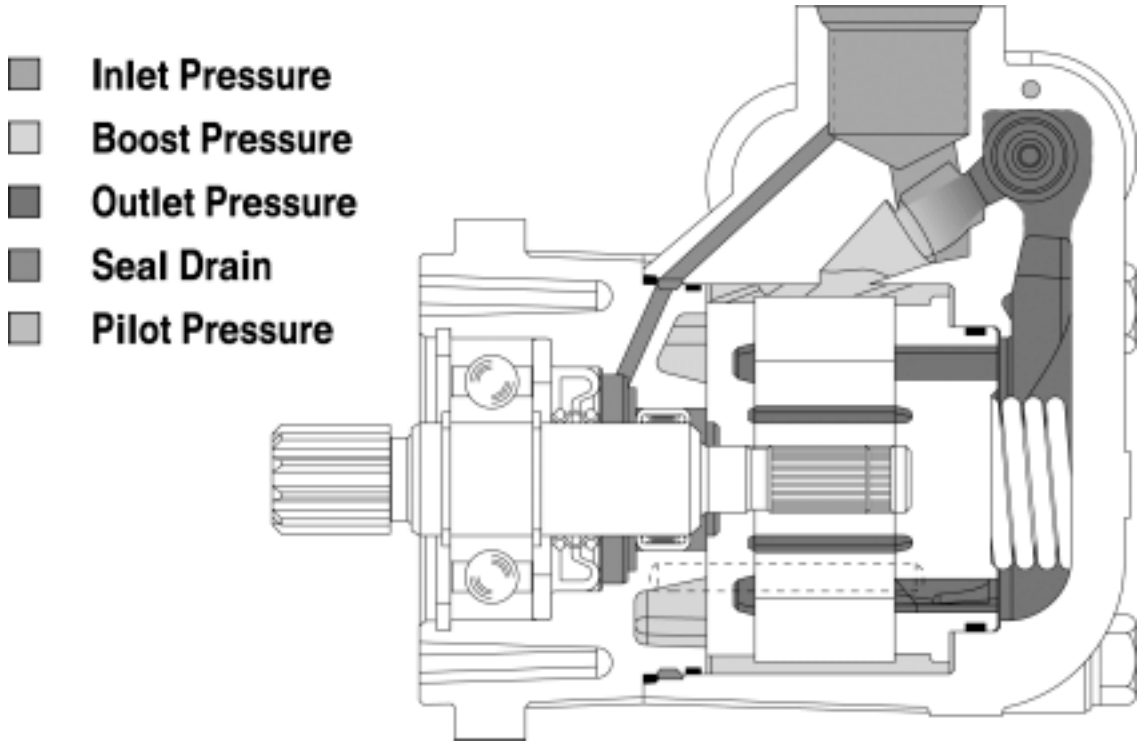

Figure 5—Oil Flow Illustration

The power steering pump is the heart of the hydraulic steering system. It converts the rotational energy supplied by the engine into hydraulic energy, flow, and pressure for use by the steering gear. Pressure is created by a restriction in the circuit.

The power steering pump functions by creating a partial vacuum at the inlet, which causes atmospheric pressure to force fluid into the pump from the reservoir. The pump then pushes this fluid into the system for use. The fluid is used to power the steering gear. Pump output flow relates to steering gear speed and pump output pressure relates to steering gear force (work).

Steering Gear

When the driver turns the steering wheel, they transmit force from the steering wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the re-circulating ball mechanism, tries to move the rack piston axially through the gear-housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal geometry of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

Most gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage. These valves are automatically set to axle stops after installation in vehicle at first full right and left turn.

The relief valve limits maximum supply pressure to protect the power steering gear, but it does not reduce pressure as the steered wheels approach the axle stops.

The steering gear, which is mounted with the output shaft above the rack piston bore, is equipped with an automatic bleed system.

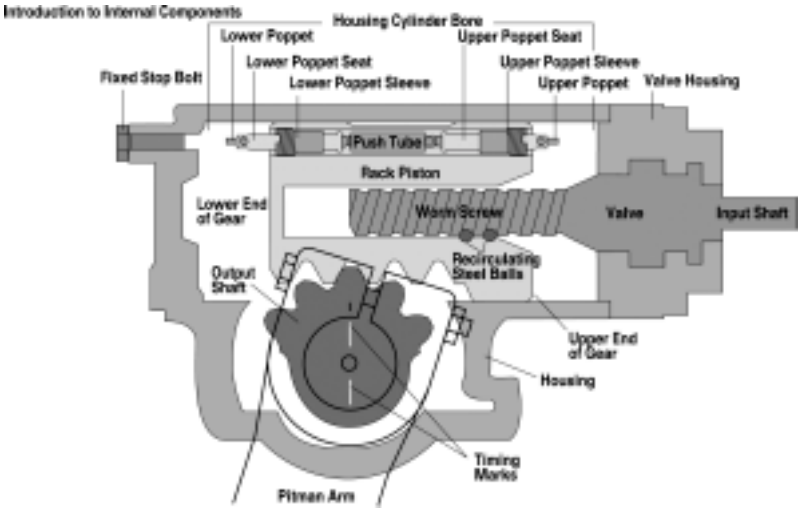

Figure 6—Internal Components

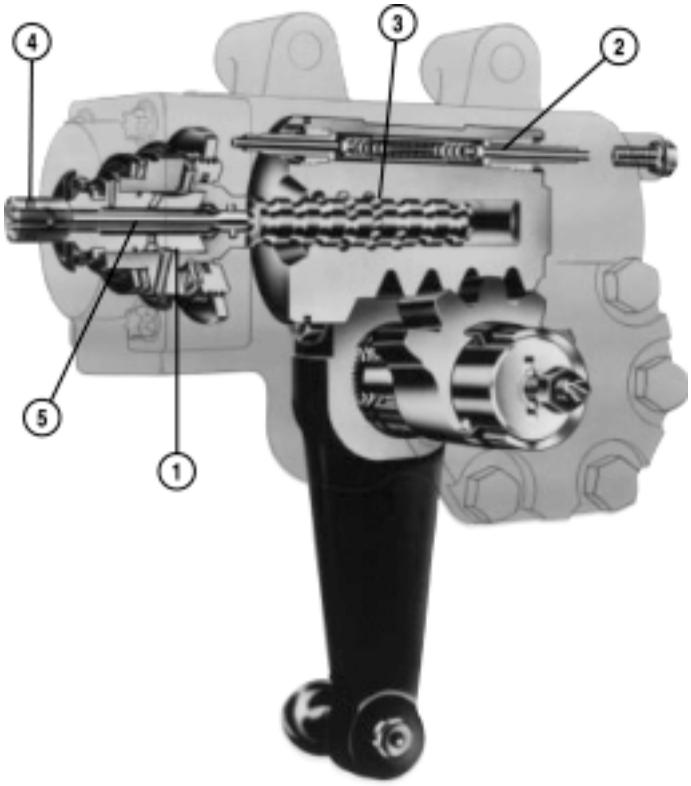

Figure 7—Components

Rotary Valve (1) — This device provides responsive steering control.
Poppets (2) (optional) — These unloading valves are automatically set to furnish power steering pump protection and reduce pressure to unload steering linkage at vehicle axle stop settings.
Recirculating Balls (3) — Combine high mechanical efficiency with smooth operation.
Dirt and Water Seals (4) — Lip type seals on both input and output shafts.
Torsion Bar (5) — Provides positive valve centering with definitive "feel of the road".

- Relief valves furnish pump protection by limiting maximum pressure (optional).
- Balanced area cylinder so back pressures cannot affect steering stability.
- High temperature seals were developed to withstand temperatures of 250° F.
- Manual steering capability provides for steering control in the event of hydraulic failure.
- Auxiliary porting available for auxiliary cylinder control.
- Seal protectors provide protection from harsh environment conditions.

Steering Gear Valve Poppets

Rotating input shaft causes rack piston to move.

Lower poppet in rack piston contacts fixed stop bolt or adjusting screw.

Upper poppet in rack position contacts valve housing.

Contact of poppet and screw or valve housing pushes poppet away from its seat. Gap between poppet and seat allows fluid to pass through the rack piston, reducing pressure.

Poppet should contact screw or valve housing just before axle contacts axle stop.

Automatic Adjustment (Poppets)

New steering gear poppet components look like this before setting. At this point, they are ready for automatic adjustment. **Figure 8.**

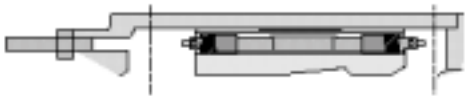

Figure 8: Axle Stop Settings

The amount of gear travel is determined on each vehicle by the axle stop settings. End of gear travel is marked in these diagrams by dotted lines. The rack piston will stop when it reaches these points because the axle stops will not allow the road wheels to travel further. **Figure 8.**

Figure 9—First Full Turn

On the first full turn after installation on a vehicle, the poppet seat will make contact internally, and be pushed into the sleeve. Since the rack piston has traveled to its farthest point for the vehicle, the poppet seat, in its new set position, has also reached its farthest point of travel. **Figure 9**.

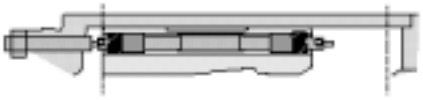

Figure 10—Second Full Turn

In the second full turn, the remaining poppet seat will be pushed in the amount required for that vehicle. Since the poppet seat and sleeve assemblies are a pressed fit, both poppet seats will now remain in this set position until they are reset using the procedure that follows. **Figure 10.**

Figure 11—Adjusted

Notice that the poppets were adjusted along with the poppet seat. In all subsequent turns, the poppet will be pushed off the seat to reduce pressure, and the poppet seat should never again make contact with the housing or the fixed stop screw. **Figure 11**.

When the poppet makes contact, pressure is reduced which also reduces the power assist felt at the steering wheel. Axle to axle stop contact can still be achieved, but with manual steering only.

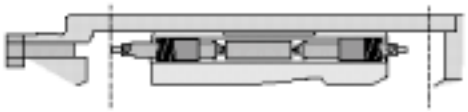

Figure 12—Axle Stops Reset

Axle stops have been reset in this diagram. They have been moved in, indicating that wheel cut has been reduced. **Figure 12**.

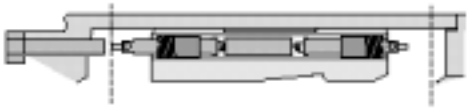

Figure 13—Adjusting Screw

Ad adjusting screw is installed in the gear for the resetting process so the poppet components can be forced together to push on one another. Once the poppet components are pushed together, they will stay that way. The adjusting screw will also remain as part of the gear. Do not try to reuse the fixed stop screw after resetting poppets. **Figure 13**.

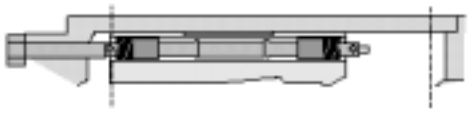

Figure 14—Right Turn

Turning to the right, the steering gear will force the lower poppet seat against the adjusting screw. The lower poppet seat then contacts the push tube and forces it against the upper poppet seat. This will force the upper poppet seat out so it can be set automatically on the next turn. **Figure 14**.

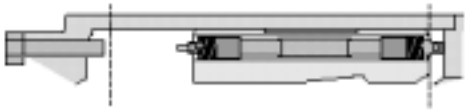

Figure 15—Upper Poppet Seat

This turn sets the upper poppet seat in just the same way as it was set when the gear was new. Notice that since the poppet components are still forced together, the upper poppet seat is now forcing the push tube against the lower poppet seat to push it out. **Figure 15**.

Figure 16—Adjusting Screw Backed Out

The adjusting screw is backed out of the way, so the poppet seat will not contact it on the next turn. **Figure 16**.

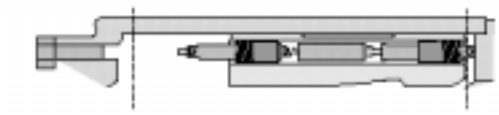

Figure 17—Setting Position

Holding the wheel at full turn places the poppet seat in the proper position for setting. **Figure 17**.

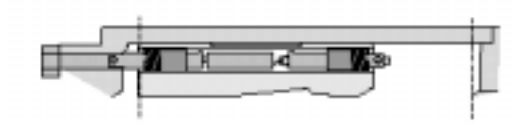

Figure 18—Adjusting Screw Turned In

The adjusting screw is then turned in to meet the lower poppet seat and backed-out 3 ¼ turns. **Figure 18**.

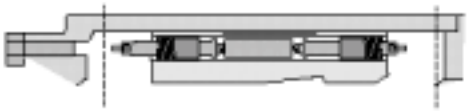

Figure 19—Adjusting Screw Stays in Position

The adjusting screw remains in this position, and acts as the contact point for the lower poppet until poppets need to be reset again. **Figure 19**.

System Components

Power Steering Pump

The power steering pump is a balanced, positive displacement, sliding van type, two line pump with an internal pilot operated flow control and relief valve. The components of this description are broken down and explained below:

The pump will output a fixed volume for each revolution of the input shaft. This fixed volume is determined by the internal contour of the cam ring.

This describes the type of pumping element. The PS pumping element consists of three components.

The rotor that holds the vanes and is driven by the engine with the pump input shaft.

The vanes that slide back and forth in slots in the rotor while following the internal contour that defines the amount of fluid that is output with each revolution of the rotor.

The PS pump requires an inlet line to supply oil to the pump and an outlet line to take the oil supplied by the pump to the steering gear. All excess (bypass) oil is diverted internally in the pump housing back to the inlet of the pumping element. Other systems may have a third line which takes this excess oil back to the reservoir.

The pump has a pilot operated valve built into the pump housing that will control the amount of oil that is output to the steering gear. This allows the output flow to remain within specification for almost any input speed variation.

The pump has a pilot operated relief valve built into the flow control valve spool, which will limit the maximum press the pump can produce. When the pressure limit has been reached, the relief section will cause the flow control to bypass more oil internal to the pump, limiting the outlet pressure.

Steering Gear

Integral hydraulic power steering means that the gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute or liters per minute) directed to a cylinder cavity. The control valve controls flow through the steering gear.

The pressure (measured in pounds per square inch, or bar) required for the gear to steer the vehicle, is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the appropriate cylinder cavity in the steering gear (and in the auxiliary cylinder if it is a dual steering system) at the proper flow rate and pressure.

The higher pressure a steering gear can withstand, the more work it can perform. The maximum operating pressure is 2,175 psi (150 bar); maximum flow rate is 8 gal/min (30.3 L/min).

The gear can steer a vehicle within its front-end weight rating through a turn at low speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear.

The recommended minimum flow at 1-½ steering wheel turns per second is as follows:

3.0 gal/min (11.4 L/min)

If the steering gear valve is controlling an auxiliary cylinder, increased minimum flow is required (generally at least 75%) based on the size of the auxiliary cylinder and the vehicle's steering geometry.

Maximum internal leakage is 1 gal/min.

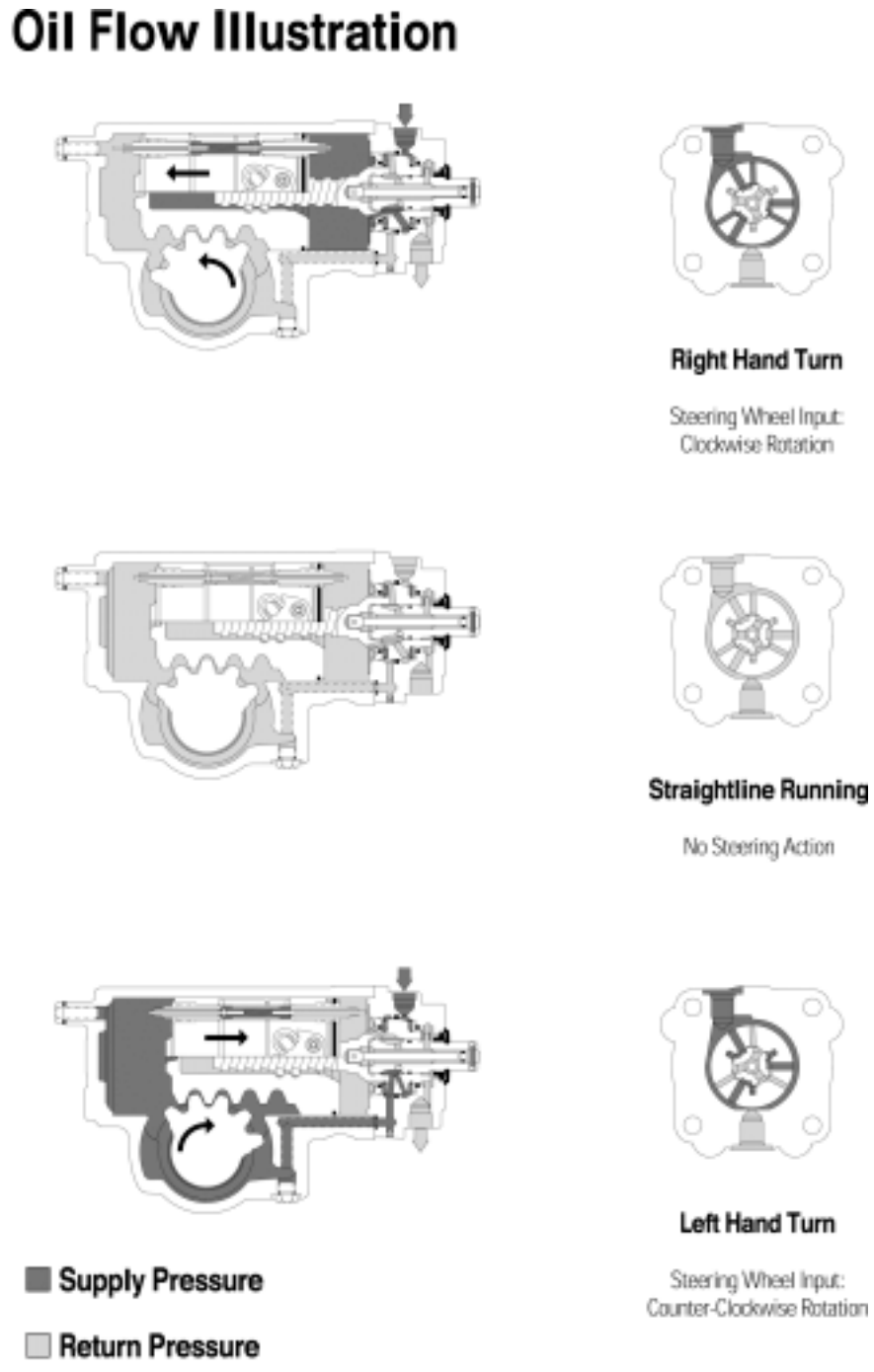

Figure 20—Oil Flow

Steering Gear Poppet Components

The steering gear poppet consists of the following components:

- Two poppet seat and sleeve assemblies
- Two poppets
- Spring
- Nylon Spacer Rod
- Push Tube

Setting poppets means pushing the poppet seat into the poppet sleeve. This backs off the poppet so it will contact the screw of valve housing just before axle contacts axle stop.

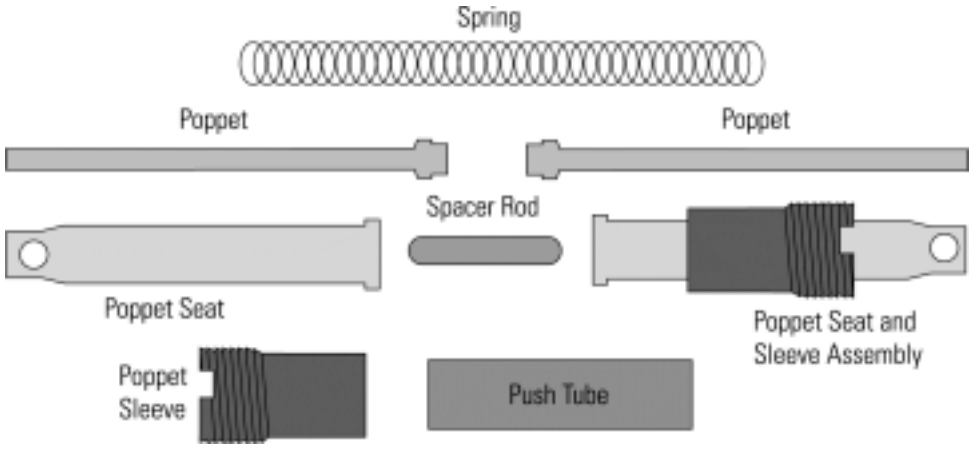

Figure 21—Ball Socket

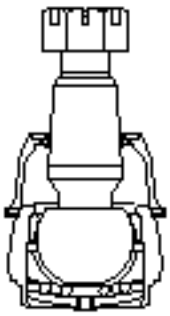

Figure 22—Ball Socket

Each 8000 Series ball socket features a hardened steel spherical ball stud captured between a hardened steel upper bearing and a spring pre-loaded thermoplastic lower bearing. Ball stud radial and axial movement is extremely limited by constant compression of the dual bearings around the ball. 8000 Series vertical ball sockets are used on medium and heavy-duty trucks, as well as off highway vehicles. The 8000 series sockets combine the full ball, dual seat design with the low-end movement. **Figure 22**.

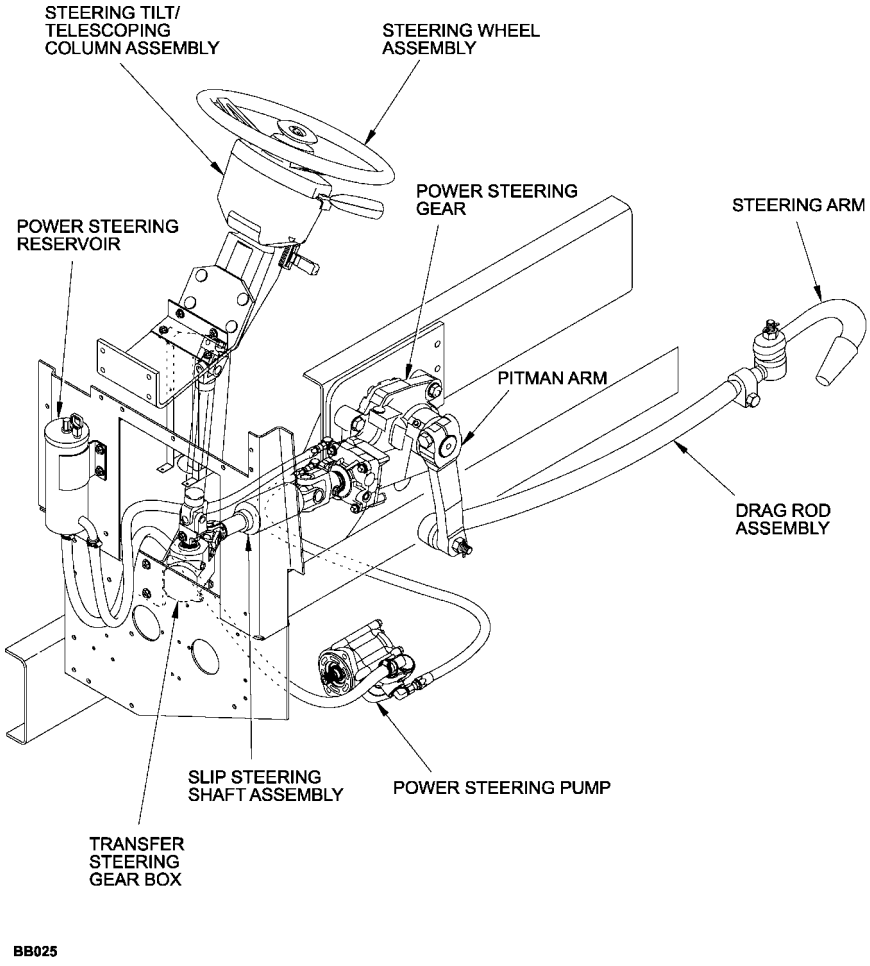

Figure 23—Component Location

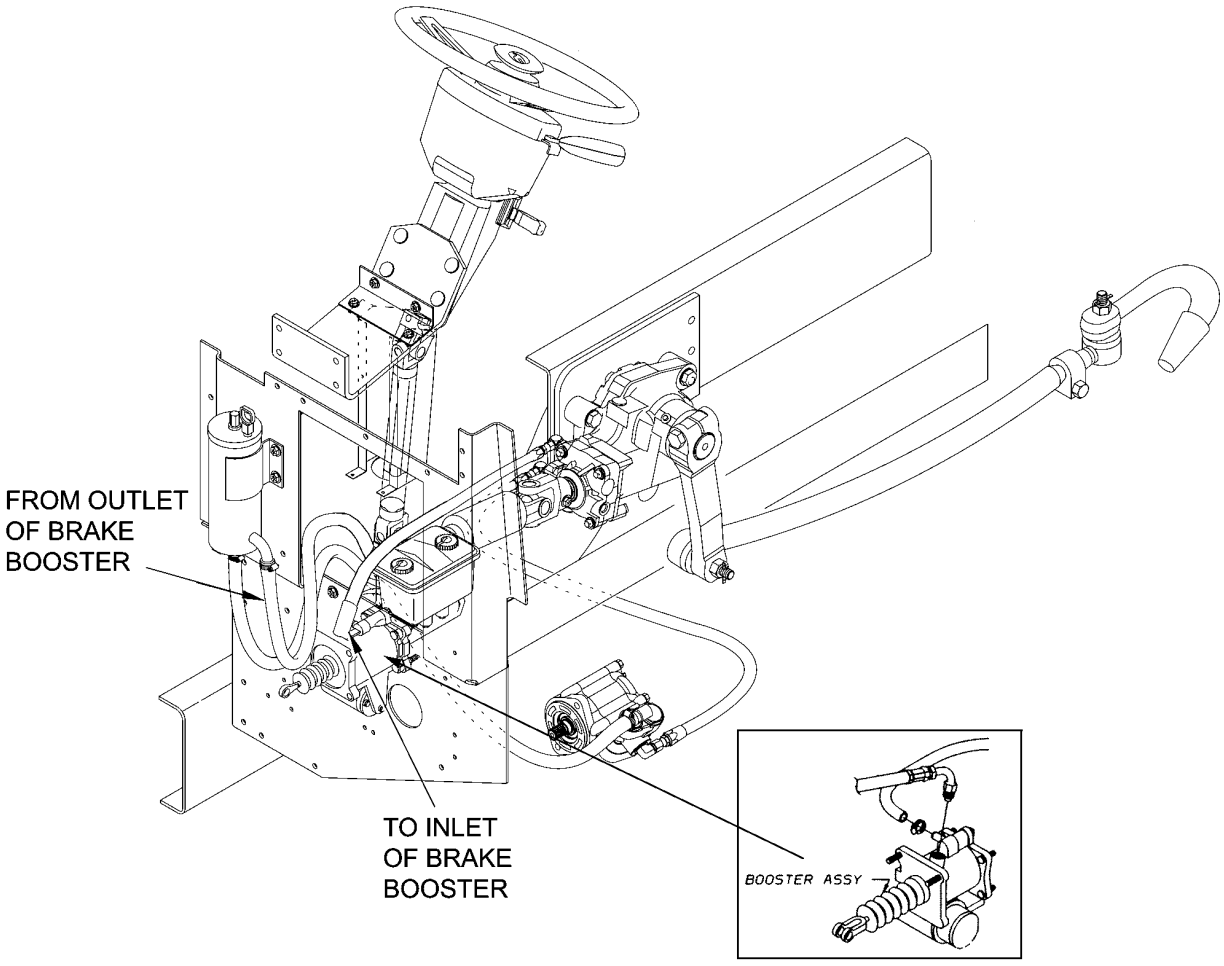

Figure 24—Component Location

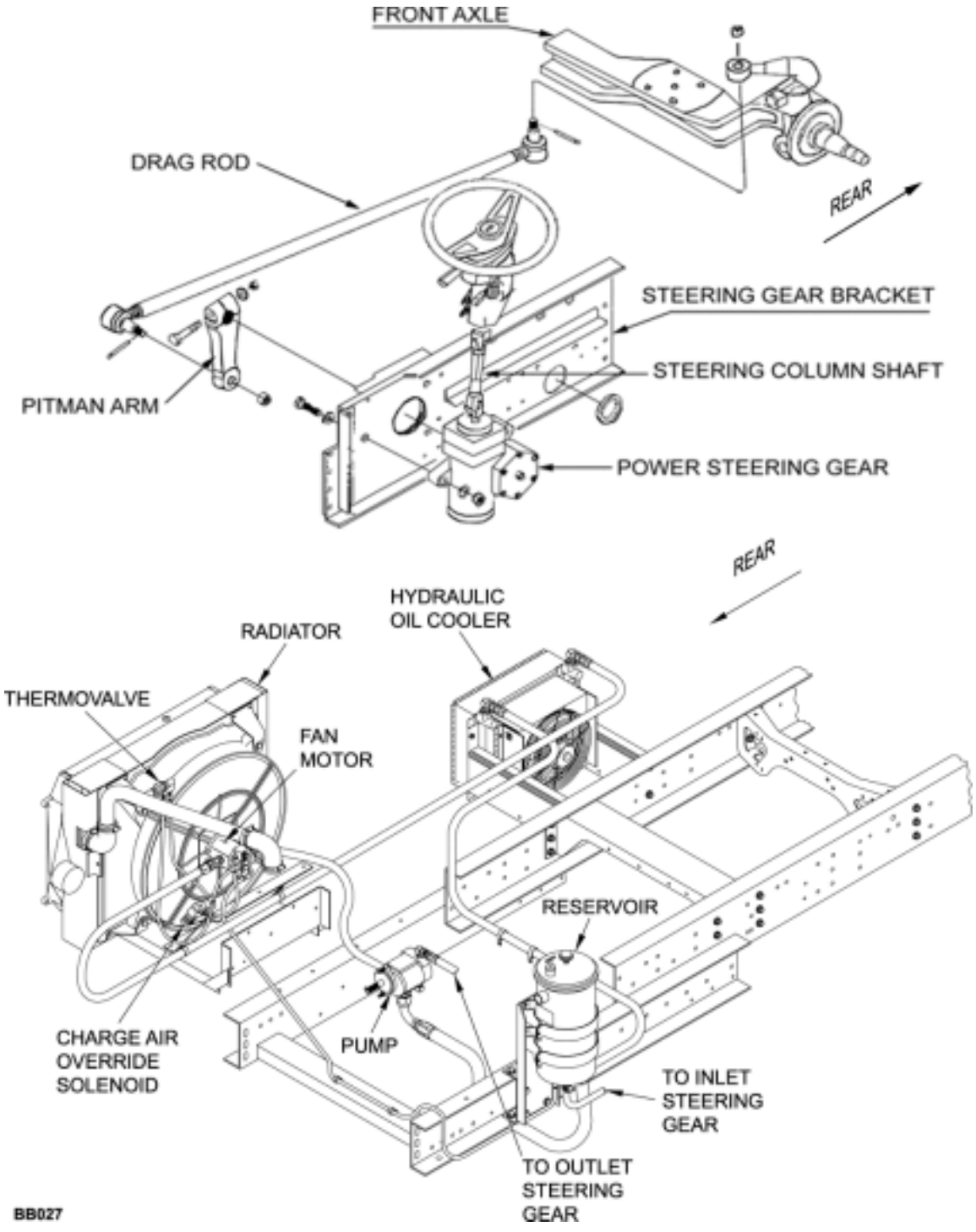

Figure 25—Component Location

Troubleshooting and Diagnostics

Note

Refer to Hydraulic Fan Drive Troubleshooting as it pertains to oil supply. Troubleshooting for the Rear Engine steering system is the same as the Front Engine, except for the hydraulic oil supply. The power steering pump is not dedicated for the steering circuit on the Rear Engine. The pressure relief valve and a flow divider valve will be discussed in the Hydraulic Fan Drive Section.

Warning

While performing these tests, take the necessary precautions when working with internal vehicle components, hot hydraulic fluid and pressure.

Power Steering System Analyzer (PSSA)

A Power Steering System Analyzer (PSSA) is a combination of a flow meter, shut off valve, and pressure gauge. This tool will allow you to measure flow and pressure, and provide a load on the pump in the hydraulic lines of the steering system. This tool is required to correctly analyze a steering system, and it is recommended that you do not begin troubleshooting a steering system without a PSSA.

The steering circuit is a pressure on demand hydraulic system. Full system pressure will not build up unless you use a cutoff valve which is incorporated in the PSSA or you prevent operation of the poppet by using a spacer block, as described in the Measured Internal Leakage Test #9.

Understanding the Complaint

Steering systems for heavy-duty vehicles are made up of many components from the steering wheel to the road wheel. The purpose of the steering system is to give the driver directional control of the vehicle.

When a driver feels the steering control over his/her vehicle is not as it should be, it is up to you to decide if there is a problem, and if so, figure out what is causing it. It is always easier to fix something if you really understand the complaint. Some ways you can do this are:

Talk to the driver and ask lots of "what", "when", "where" and "how" questions. Make sure you can feel or see the problem. Have the driver show you exactly what he or she means. Walk around the vehicle; look for anything that may be an obvious cause of the problem.

Flow Charts

Flow charts are a quick and easy way to find the cause of a steering system problem. There is a flow chart for each of the 10 most common driver complaints.
Start the flow charts at the BEGIN box. If there is a QUESTION, next answer it either YES or NO, and follow the arrows to the next step. When you get to CAUSE/TEST box (or string of boxes), you will begin testing the vehicle to confirm the cause of the complaint. A string of CAUSE/TEST boxes means there are several possible causes. You will have to do the tests to find out which one is the cause for the vehicle on which you are working. These boxes are arranged in order of likelihood of being the cause of the complaint. It is important to do them in order. The test number in the CAUSE/TEST box will tell you to which test to go. Find the right test number and follow the test procedure. When you are

done with the test, go back to the flow chart and go on to the next step.

If you identify a problem through a test procedure, it is important that you retest the vehicle to make sure the complaint condition has been corrected.

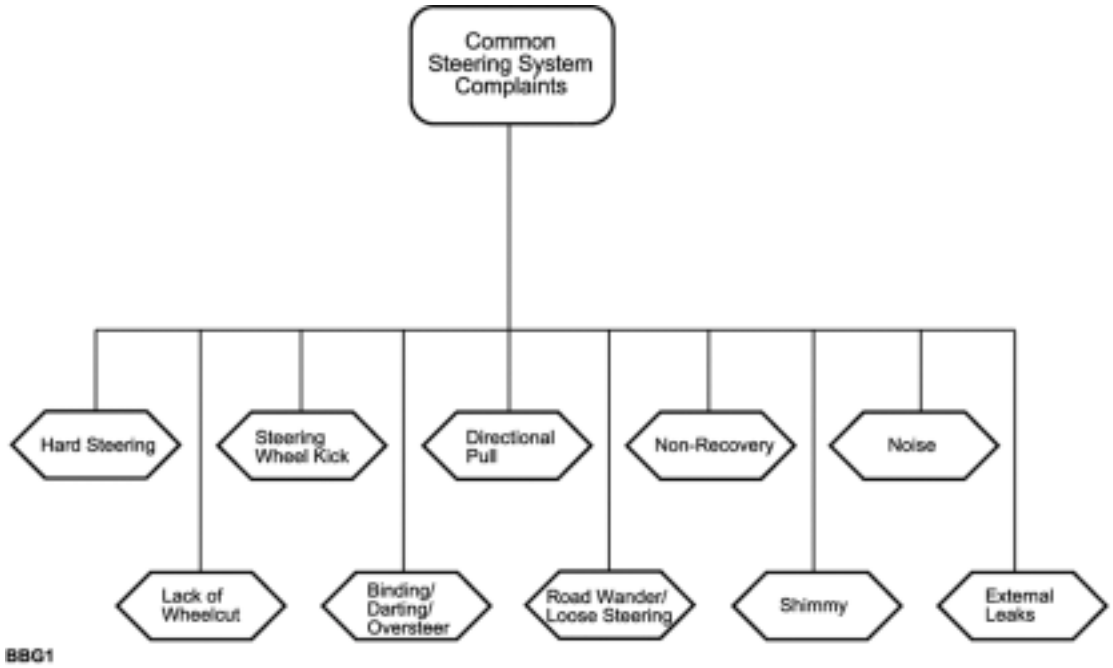

Figure 26—Steering Complaints

Definitions of 10 Most Common Complaints

1. Hard Steering

Hard Steering is when steering effort at the steering wheel is more than 200 inch pounds (typically 18-22 lbs at the rim of the steering wheel). Steering is still possible, but there is not enough power assist.

Common phrases used to describe Hard Steering:

- Won't turn
- Hangs-up
- Locks-up
- No assist
- Shuts down
- Won't turn unless moving

2. Lack of Turning Radius

Common phrases used to describe Lack of Turning Radius:

- Too great of turning radius required
- Turning radius restricted
- Not enough turns lock to lock

3. Steering Wheel Kick

Steering Wheel Kick is when the road wheels hit a bump to which the steering wheel reacts. The kick is usually dampened out quickly.

Common phrases used to describe Steering Wheel Kick:

- Kickback
- Backlash
- Bump Steer

4. Binding/Darting/Oversteer

Binding is a change or increase in steering wheel effort. Binding will usually not require the effort levels described in Hard Steering, unless it is severe. Darting and oversteer are words that mean the driver suddenly gets more turning than he/she wants.

5. Directional Pull

Common phrases used to describe Directional Pull:

- Steering pulls to the right (or left)
- Bus pulls to the right (or left)
- A constant force is required to keep the bus going straight

6. Road Wander/Loose Steering

Common phrases used to describe Road Wander or Loose Steering:

- Lash in Steering
- Lost motion in steering
- Continual corrections are needed at the steering wheel to keep the vehicle from wandering

7. Non-Recovery

Common phrases used to describe Non-Recovery:

- Wheels don't return to straight ahead

8. Shimmy

A severe shimmy condition can be felt at the steering wheel. Typically, once something triggers a shimmy condition to occur, it is sustained until the drive does something (such as slow down) to dampen out the condition.

Common phrases used to describe Shimmy:

- Shake at steering wheel

9. Noise

Common phrases used to describe Noise:

- Steering is noisy
- Clicking or clunking sound is heard when steering

10.External Leakage

Common phrases used to describe External Leaks if they are not obvious:

- Loss of steering fluid
- Continual adding of fluid in reservoir required

Hard Steering

Hard steering is when steering effort at the steering wheel is more than 200 inch pounds (typically 18-22 lbs at the rim of the steering wheel). Steering is still possible, but there is not enough power assist. Different models of steering gears have differently designed effort levels. The diameter of the steering wheel will also affect the rim pull required. Be sure the proper size steering wheel is installed. Common phrases used to describe Hard Steering:

- Won't turn
- Hangs up
- Locks up
- No assist
- Shuts Down
- Won't turn unless moving

Explanation of Flow Chart Terms

Is the condition present during cold start only?

Does the hard steering occur during initial start up? This would be after the vehicle has been sitting long enough to allow the total system, including the fluid, to cool enough to be the same as the outside (ambient) temperature.

All American Steering Troubleshooting

Is the condition sensitive to steering wheel speed?
Do you notice a difference in steering effort when turning the wheel fast only, or slow only?

Is the condition intermittent? Does the hard steering happen randomly? If the problem occurs sometimes but not always, and it does not seem to be related to the steering wheel position, steering direction, or manner of steering, it is intermittent. Examples of what is not an intermittent condition are if hard steering is noticed in a right turn but not a left turn, or if the problem occurs when steering fast but not slow.

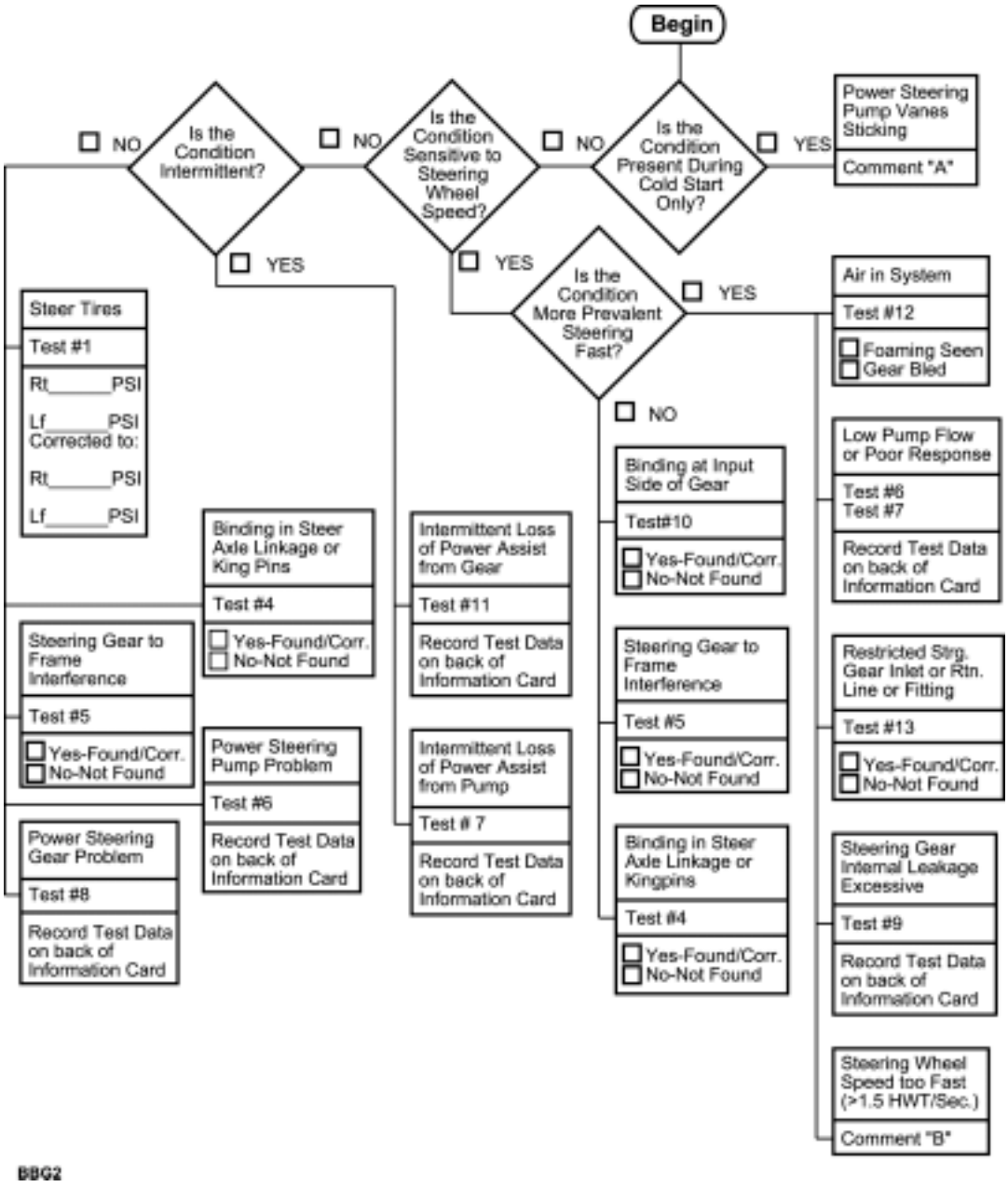

Figure 27—Hard Steering

#1 Tire Check

Figure 28—Tire Check

Figure 29—Check Pressure

1. Look for:

- Tire damage (**Figure 28**)
- Uneven or extreme tread wear
- Mismatched tires

2. Check tire pressure. **Figure 29**.

#2 Steer Axle and Linkage Binding Test

Figure 30—Disconnect Drag Link

1. With vehicle steer tires on radius plates (turntables) or equivalent, disconnect the drag link or pitman arm from the steering gear (and linkage from assist cylinder if there is one on the vehicle). **Figure 30**.

Caution

Do not steer the gear with linkage removed. Poppets may come out of adjustment.

Figure 31—Pull Tire to Axle Stop

2. By hand, pull the tire to one axle stop and release (engine off). The tire should self-return to near straight ahead. **Figure 31**.
3. Repeat the test in the opposite direction.
4. If tire does not self-return to near straight ahead, a problem is likely in steer axle king pin bushings/bearings or linkage.

#3 Steering Gear Mounting Test

Figure 32—Inspect for Binding

1. Look for anything between the steering gear and frame that could cause a binding problem. For example: hoses or brackets that have been routed, or are interfering between the steering gear and frame, frame flanges or spring mounting points. Mounting pads lower than steering gear housing, lack of clearance between frame and steering gear valve housing adapter, sector shaft adjusting screw and nut mismatched with access adjustment hole in frame. **Figure 32**.

Figure 33—Check for Distortion

2. If the steering gear has been mounted to the frame in a way that causes the gear to distort (not be flat), it may cause a steering problem. The use of spacers is alright as long as the gear is mounted securely, and the gear is not distorted when mounting bolts are tightened. Checking to see if distortion is present on the vehicle may require the following test (**Figure 33**).
3. With vehicle parked and turned off, steer the wheel slowly, checking for a binding-type of feel at the steering wheel. When binding is felt, loosen one mounting bolt and steer the vehicle again. Continue to loosen one mounting bolt at a time and check for improvement in the binding condition. If improvement is made by loosening the bolts, determine by inspection what interference or condition is causing the gear to distort and correct the problem

#4 Power Steering Pump Test

Figure 34—Check Temperature

Figure 35—PSSA

1. Install thermocouple in reservoir. Install Power Steering System Analyzer (PSSA) in pressure line with shut-off valve fully open. **Figure 35**. Park the vehicle outside. Record ambient temperature. **Figure 34**. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30 and 40 minutes. Do not allow the temperature to exceed 250°.

Warning

If the oil temperature goes over 250° F, or 150° F above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended

temperatures, the heat problem may be the root cause of the complaint.

2. Run the engine at idle speed.

Warning

When closing the PSSA, shut off valve slowly. Check the pressure gauge. For the safety of personnel and to prevent damage to the vehicle, do not allow the system to exceed 2500 psi.

Caution

Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up.

3. Measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noise, as the valve is being opened and closed as shown in **Figures 36—40**.

Figure 36—Flow and Pressure

Figure 37—Flow and Pressure

Figure 38—Flow and Pressure

Figure 39—Flow and Pressure

Figure 40—Flow and Pressure

Oil Temperature _____ DEG
Engine Idle Speed _____ RPM

Idle Speed		
	Pressure (psi)	Flow (GPM)
Load Valve Open		
	500	
	1000	
	1500	
Load Valve Closed		

4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed as shown in **Figures: 36—40**.

Oil Temperature _____ DEG
Engine Governed Speed _____ RPM

	Governed Speed	
	Pressure (psi)	Flow (GPM)
Load Valve Open		
	500	
	1000	
	1500	
Load Valve Closed		

5. Determine the recommended flow range and maximum allowable system pressure for the steering system being used by referring to your service manual.
6. Compare the minimum and maximum flows, and the relief pressure you need measured to gear and pump specifications.
7. If the minimum measured pump flow is less than the minimum recommended flow for the steering gear used, the pump may not be putting out enough flow for an adequate steering speed. If the maximum system pressure is lower than that specified for the pump (check your manual), it might not be developing enough pressure to steer. If either case exists, the pump needs to be repaired or replaced.

#5 Intermittent Loss of Power Assist from Pump Test

Figure 41—Check Temperature

Figure 42—PSSA

1. Install thermocouple in reservoir. **Figure 41**. Install PSSA in pressure line with shut-off valve fully open. **Figure 42**. Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30 and 40 minutes. Do not allow the temperature to exceed 250°.

Warning

If the temperature goes over 250° F, or 150° F above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously impacted. Damage to hoses, seals and other components may result if operated at

extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

Caution

Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up.

2. (Do not allow the pressure to exceed 2500 psi). With the engine at idle, note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading you above noted.
3. With the load valve open, run the engine to governed speed and note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading noted above.
4. Conduct this pump response test once at idle and three times at engine governed RPM. If the flow rate does not return immediately, the pump is malfunctioning, which can result in momentary loss of power assist.

#6 Steering Gear Check

Figure 43—PSSA

Figure 44—Check Temperature

1. Install thermocouple in reservoir. **Figure 44**. Install PSSA in pressure line with shut off valve fully open. **Figure 43**. Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30 and 40 minutes. Do not allow the temperature to exceed 250°.

Note

Steering systems that have a pump relief valve and an integral steering gear relief valve typically will have the pump relief valve setting approximately 300 PSI or more above the gear's relief valve setting. Refer to table for correct relief pressure levels.

Engine	Relief valve Setting (initial)	Relief Valve Setting (final)
Cummins 5.9	2320 psi	2620 psi
Cummins 8.3	2175 psi	2475 psi
CAT 3126	2175 psi	2475 psi

Figure 45—Steer Vehicle

2. Try to locate the problem by steering the vehicle while parked. Steer in a slow, smooth motion back and forth between axle stops (you may need to load the vehicle). **Figure 45**. Hard Steering means 18-22 pounds of force (Figure 45) at the rim of the steering wheel that occurs somewhere between the normal poppet trip points. If the poppets are set correctly, hard steering at the poppet trip points will be normally within approximately 1/3 steering wheel turn from axle stop contact points.

Figure 46—Force Reading

3. When hard steering is noticed, note pressure and flow reading of PSSA.
4. If the flow is under a GPM and pressure is the same as relief pressure measured in the earlier pump test (Test #6) for a gear without a relief valve, or pressure without regard to flow is as specified for a gear with an integral relief valve, the steering gear is performing correctly.
5. If flow is over 1 GPM and pressure is far below relief pressure measured in the earlier pump test (Test #6) for a gear without a relief valve, or below the correct relief pressure setting for a gear with an integral relief valve, proceed to Step 4.
6. If the steering gear has an integral relief valve, proceed to Step 5. If the gear does not have an integral relief valve, the steering gear has excessive internal leakage and needs to be repaired or replaced. (See Step 7.)
7. Remove the integral relief valve components (refer to steering gear service manual for procedure) and install a relief valve plug, special tool J37130, in its place.

Figure 47—PSSA

8. Again, steer the vehicle back and forth and determine if hard steering is felt. If so, note pressure and flow reading of the PSSA. **Figure 47**.
9. If hard steering can no longer be produced, the relief valve removed from the gear earlier was not operating properly and should be replaced with one specified for the gear you are working on.
10. If hard steering is again noticed, with a noted flow of over 1 GPM and pressure level is far below pump relief as measured during the pump test, the relief valve you removed is OK, but the steering gear has excessive internal leakage and needs to be repaired or replaced.
11. One possible source of excessive internal leakage in steering gears is shuttling poppets. This is only true of gears with automatic poppets, and only if the service poppet adjusting screw and sealing jam nut kit has been installed in

the end opposite the input shaft. This condition can occur if during the installation of the service kit, the installation instructions were not followed carefully, and the adjusting screw was turned into the housing too far. This will cause the interference fit poppet mechanisms to be continually cycled back and forth, thereby losing their interference fit and set positions within the gear as the vehicle is steered lock to lock.

12. To test for shuttling poppets, determine if the hard steering is always noticed at the same wheel cut position rather than at the same steering pressure. As an example, if hard steering occurs 1 ½ steering wheel rotations right of straight ahead at a pressure of 600 psi when you first feel it, try to determine the following:
13. Begin steering maneuvers from different positions (such as ½, 1 and 1 ½ steering wheel rotations left of straight ahead). From each starting point, turn right until the hard steering occurs. If the hard steering is always found at the same 1 ½ turns right of straight ahead but at different pressures, it is most likely shuttling poppets. If it occurs at the same pressure level but at different wheel cut positions, some other internal leak path within the gar causes it. If there is a poppet shuttling problem, the steering gear needs to be replaced or rebuilt with new automatic poppet components.

#7 Measured Internal Leakage Test

Figure 48—Check Temperature

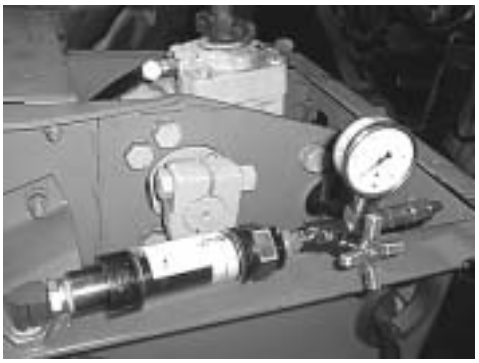

Figure 49—PSSA

1. Install thermocouple in reservoir. **Figure 48**. Install PSSA in pressure line with shut-off valve fully open. **Figure 49**.

Warning

This test can be dangerous if not performed correctly. Keep your fingers clear of the axle stops and spacer block during this test. Make sure the spacer block contacts the axle block squarely. Contact this is not square could break the axle stops or dangerously throw or eject the spacer block.

Figure 50—Axle Stop

Figure 51—Axle Stop

Note

Be sure you reinstall the relief valve and valve cap with new o-ring, back onto the gear after leakage test.

2. To test the steering gear for internal leakage, you must first prevent operation of the gear's internal unloading (poppet) valves or relief valve (or both, in some gears). This will allow full pump relief pressure to develop. To prevent operation of the poppets, place an unhardened steel spacer block, about one inch thick and long enough to keep your fingers clear, between the axle stop at one wheel. **Figures 50 and 51**. To prevent operation of the relief valve, remove the relief valve cap, o-ring and two-piece relief valve, if equipped, from valve housing. Discard the O-ring. Install the relief valve plug, special tool J37130 in its place.

Caution

When running this test, do not hold the steering wheel in the full turn position for longer than 5 to 10 seconds at a time to avoid damaging the pump.

Warning

Keep your fingers clear of the axle stops and spacer block during this test. Make sure the spacer block contacts the axle stop squarely. Contact that is not square could break the axle stops, dangerously throw, or eject the spacer block.

3. With the fluid temperature between 125° and 135°, turn the steering wheel until the axle stops bottom on the spacer block.

Figure 52—Force Reading

4. Apply 20 pounds of force (**Figure 52**) to the rim of the steering wheel during this test to be sure that the steering gear control valve is fully closed. The pressure gauge should now read pump relief pressure, as noted during the pump pressure test (Test #6). You can now read steering gear internal leakage on the flow meter.
5. Repeat this test for the opposite direction of turn.
6. If internal leakage is greater than 1.0 gpm, repair or replace the gear.

Note

When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.

#8 Steering Column Binding Test

1. With the vehicle parked, the engine off and the steer axle jacked-up, slowly steer the vehicle until the binding position is located.

Figure 53—Remove Steering Column

2. With the steering gear at this position, remove the steering column assembly from the steering gear. Record the correct position of the column and steering gear for re-assembly after test. **Figure 53**.

Figure 54—Check for Binding

3. Rotate the steering gear input shaft no more than ¼ turn each direction and check if binding is still present. **Figure 54**. If binding is not felt, correct the steering column problem.

#9 Intermittent Loss of Power Assist from Gear Test

Figure 55: Check Temperature

Figure 56: PSSA

1. Install thermocouple in reservoir. **Figure 55**. Install PSSA in pressure line with shut-off valve fully open. **Figure 56**. Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start at 10, 20, 30 and 40 minutes. Do not allow the temperature to exceed 250°.

Caution

If the temperature goes over 250° F, or 150° F above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

2. If the test was stopped because of extreme fluid temperature, there may be several causes including: restricted hoses or fittings, faulty filter in reservoir, excess oil flow, winter fronts, improper components installed, application of non-approved will-fit components. Tests #13 and #6 may help you finding the cause. If the steering system continues to exceed the maximum recommended operational temperatures, it may be necessary to install an auxiliary oil cooler to maintain the proper steering system oil temperatures.

Note

Utilization of winter fronts or other methods of restricting the radiator air flow are not recommended. If vehicle is equipped with winter front or other method of restricting the cooling system air flow, it may be necessary to conduct the 40 minute temperature test (Test #6, Step 1) with and

without the cooling system restricted to determine worst case temperature.

Figure 57—Turn Wheel

Figure 58—PSSA

3. Let the engine idle and then begin steering the vehicle while parked. Steer smoothly from stop to stop with the palm of your hand back and forth several times between the normal poppet trip points to allow the intermittent hard steering to occur. **Figure 57**. If hard steering occurs, write down the pressure level and flow rate at the time of the hard steering. **Figure 58**. If the flow is above 1 GPM and pressure is far below the normal steering pressure level at the time of hard steering, repair or replacement of the steering gear will be necessary. If the flow is not above 1 GPM, perform Test #6.

#10 Air in Hydraulic System Check

Figure 59—Inspect Reservoir

1. Inspect reservoir for foaming or air bubbles. **Figure 59**. If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings on the inlet side of the pump. Look for oil level changes engine off versus engine on. If fluid level increases when the vehicle is shut off, there is an air pocked trapped in the steering gear. The increase may not be noticeable, depending on the size of the pocket.
2. Bleed the steering gear. (See Routine Maintenance and Adjustment, Filling and Air Bleeding the System.)
3. Repeat the bleeding operation three times, and recheck oil level in reservoir to make sure there is enough oil for the system to operate properly.

#11 Restricted Hydraulic Line Check

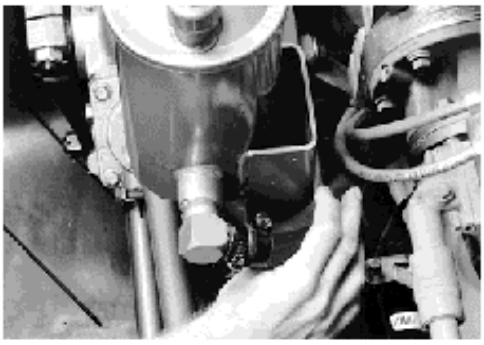

Figure 60—Check for Kinks

1. Look at the suction line that goes to the pump (if there is one) to check for kinks or any other obstructions or irregularities on the inside of the hose. **Figure 60**.

Figure 61—Check Temperature

Figure 62—PSSA

2. With the PSSA and temperature gauge installed (**Figure 61** and **Figure 62**), load valve fully open and oil at 125° to 135°, determine a test engine speed (RPM) that causes pump to delivery 3, 4, 5 or 6 GPM (whichever is easier) and record this speed.
3. Remove the PSSA and install a low pressure gauge (200-300 PSI maximum with approximately 10 PSI per division) in the pressure line to the steering gear at the pump end. Install a temperature gauge in the power steering reservoir.

Caution

Do not allow system pressure to exceed the rating of the gauge during the following procedure or damage to the gauge will result. Extremely high restrictions may be indicated with the PSSA gauge as installed with load valve fully open.

Note

Be sure that the steering gear input shaft is not being restrained from re-centering because this will cause a false steering gear pressure drop. If there is any question, conduct this test with the steering column removed.

Figure 63—Check Temperature

4. Bringing the power steering fluid temperature to 125° to 135° at engine idle, with no steering force applied to the steering wheel. **Figure 63**.
5. At the test engine speed selected from Step 2 above, measure and record the gauge reading and shut off the engine. This measures total system pressure.
6. Remove the pressure and return lines from the steering gear and connect them together with a fitting that will not restrict the flow. **Figure 64**.
7. Start the engine, and run at the RPM identified in Step 2 with the fluid temperature between 125° to 135°.
8. Measure and record gauge reading and shut off engine. This is hydraulic line/reservoir pressure.

Figure 64—Remove Lines

9. The difference between the total system pressure gauge reading and the hydraulic line/reservoir pressure gauge reading is the steering gear pressure drop. For a TAS65 steering gear, at a flow of 3, 4, 5 or 6 GPM, the drop should not be greater than 30, 40, 55 or 70 PSI respectively. The line/reservoir pressure drop for a flow of 3, 4, 5 or 6 GPM should not be greater than 20, 20, 25 or 25 PSI respectively.

Note

Some power steering pumps have a temporary state during which the pumping element vanes do not extend. Usually increasing engine speed briefly will correct the problem. The maximum speed of steer with power assist for a power steering gear is limited by pump flow and internal leakage. Recommended minimum flow for a new TAS65 steering gear is 3.0 gallons per minute, and is based on a steering speed capability of 1.5 steering wheel turns per second.

Reduced Turning Radius Tests

Common Phrases Used:

- Too great of turning radius required
- Turning radius restricted
- Not enough turns lock to lock

Axle Stops Don't Allow Enough Wheel Cut	Test #14
Misaligned Pitman Arm to Output Shaft	Test #15
Misadjusted Draglink	Test #16
Misadjusted Poppet	Test #17

Figure 65—Turning Radius

#14 Axle Stop Setting Check

Figure 66—Radius Plates

1. Put vehicle steer tires on radius plates (turntables). Check to make sure axle stops are set to manufacturer's specifications. **Figure 66**.

#15 Pitman Arm and Output Shaft Alignment Check

Figure 67—Output Shaft

1. Look to make sure the output shaft timing mark is lined up with the pitman arm timing mark. Some pitman arms have more than one mark, so make sure the right one is used. **Figure 67**.

#16 Misadjusted Drag Link Check

Figure 68—Drag Link

1. The length of the drag link must be correct for the steering system. Check the length after you make sure the pitman arm/shaft timing marks are aligned, the gear is at its center position and the road wheels are straight ahead. **Figure 68**.
2. AAFE 38.16—39.47 inch
3. AARE 57.45—62.84 inch

#17 Poppet Setting Procedure

If you are working on a newly-installed TAS steering gear, refer to Initial Poppet Setting.

Steering Wheel Kick Tests

Steering Wheel Kick is when the road wheels hit a bump to which the steering wheel reacts. The kick is usually dampened out quickly. Common phrases used to describe Steering Wheel Kick:

- Kickback
- Backlash
- Bump Steer

Air in System	Test #12	_ Foaming Seen _ Gear Bled
Looseness in Mechanical System	Test #18 Test #19	_ Yes- Found/Corrected _ No- Not Found
Worn or Missing Shock Absorbers	Test #20	_ OK _ Not OK
Low Pump Flow	Test #6 Test #7	Record Test Data on Back of Information Card
Linkage Geometry	Comment "C"	

Figure 69—Kick Tests

#6 Power Steering Pump Test

Perform power steering pump test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#7 Intermittent Loss of Power Assist from Pump Test

Perform intermittent loss of power assist from pump test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#12 Air in Hydraulic System Check

Perform air in hydraulic system check. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#18 Lash in Steering System Check

Two people are needed for this test. One person will turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels. **Figure 70, Figure 71** and **Figure 72.**

Figure 70—Inspect

Figure 71—Inspect

Figure 72—Inspect

Figure 73—Inspect

Figure 74—Inspect

Figure 75—Inspect

- Steering wheel to steering column
- U-joints, or slip-joint and/or miter boxes
- Steering column to steering gear input shaft
- Steering gear input shaft to steering gear output shaft
- Pitman arm to output shaft
- Drag link to pitman arm connection
- Drag link ends (sockets) and adjustable areas
- Axle arm to drag link connection
- King pin axle connections (bushings)
- Tie rod arms to tie rod connection
- Tie rod ends (sockets) and adjustable areas
- Steering spindle
- Wheel bearings
- Lug nuts
- Spring to spring pin connectors
- Front axle
- Front axle U-bolts
- Spring hanger brackets/rear shackles

Note

Cracked on broken components can cause symptoms similar to loose components but may be more difficult to find.

Be sure to check rear drive axles for any looseness.

#19 Steering Gear Adjustment Check

Check and adjust per service manual if necessary.

#20 Shock Absorber Check

Look to see if shocks have been removed. Also look for external oil leak on shocks. Make sure existing shocks are not worn out.

Comments

Vehicle linkages are designed to minimize the effect at the steering wheel during normal steered axle/suspension movements. Be sure that linkage used is as specified by Blue Bird Corporation.

Binding/Darting/ Oversteer Tests

Binding is a change or increase in steering wheel effort. Binding will usually not require the effort levels described in Hard Steering unless it is severe. Darting and oversteer are words that mean the driver suddenly gets more turning than he wants.

Is cyclic binding felt at the steering wheel? While steering in a slow, smooth manner, is a torque variation encountered which repeats fro a given amount of steering wheel rotation? An example would be a hard spot or "lump" felt at the steering wheel once every revolution at the same spot.

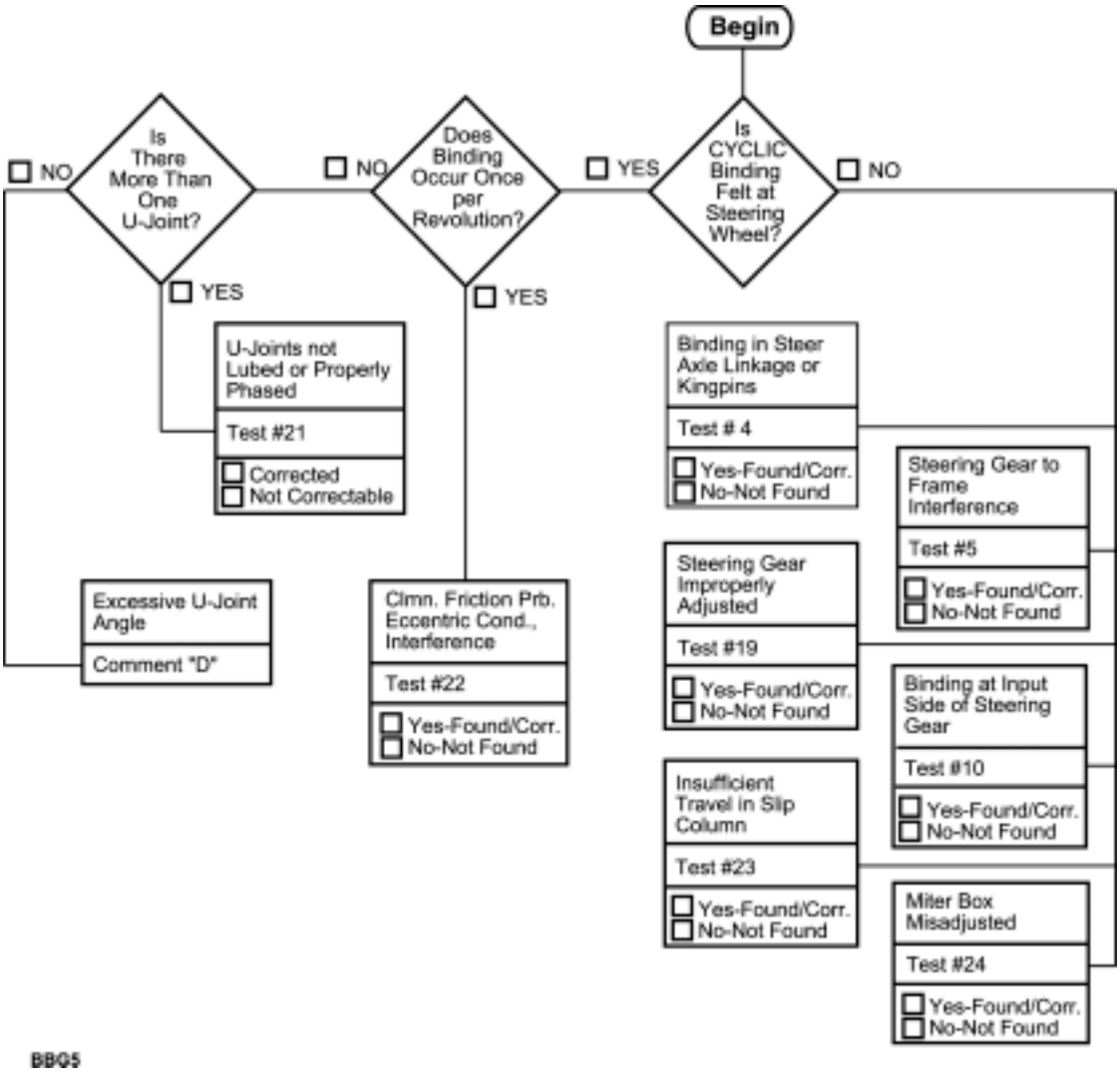

Figure 76—Binding/Darting/Oversteer

#4 Steer Axle and Linkage Binding Test

Perform steer axle linkage and binding test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#5 Steering Gear Mounting Test

Perform steering gear mounting test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#10 Steering Column Binding Test

Perform steering column binding test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#19 Steering Gear Adjustment Check

Perform steering gear adjustment test. (See Troubleshooting and Diagnostics Steering wheel Kick Tests.)

#21 U-Joint Phasing and Lubrication Check

Perform a u-joint phasing and lubrication check test. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

1. Make sure u-joints are properly lubricated.

Figure 77—U-joint

Figure 78—U-joint

2. Steering column assemblies with more than one universal joint (cardian type) can cause a cyclic binding feel or torque variation at the steering wheel if the u-joints are not in phase with each other. Optimum phasing of two u-joint system is achieved by placing the yoke at each end of the intermediate shaft in line with the plane of the corresponding u-joint angle. **Figure 77 and Figure 78**. If a steering column assembly with multiple U-joints is taken apart, it must be reinstalled with the timing marks for slip mechanisms aligned. This is true for both the cross-type and the splined-type two-piece intermediate shaft.

#22 Steering Column Interference Test

Figure 79—Steering Column

1. Position column assembly at the location where interference is noticed, and look for something interfering or rubbing on the rotating column assembly, such as brackets, bolts, floorboard, boot, horn wire, turn signal, etc. **Figure 79**.

#23 Slip Column Travel Test

Figure 80—Slip Column

1. Check the slip column by looking to make sure there is a proper allowance when in use. **Figure 80**.
2. Look for wear or galling. **Figure 80**.
3. Check slip column for too much slip force.

#24 Miter Box Misadjusted (AAFE only) Test

Figure 81—Miter Box

1. Check and adjust per manufacturer's instructions.

Comments

A single u-joint operating at angle will cause a cyclic torque variation at the steering wheel. The amount of torque variation increases with the amount of operating angle. A secondary binding movement that side loads the input shaft also increases with increased u-joint angles. U-joint operating angles of 15 degrees or less will minimize the torque variation felt at the steering wheel.

Directional Pull

Common phrases used to describe Directional Pull:

- Steering pulls to the right (or left)
- Vehicle pulls to the right (or left)
- A constant force is required to keep the truck going straight

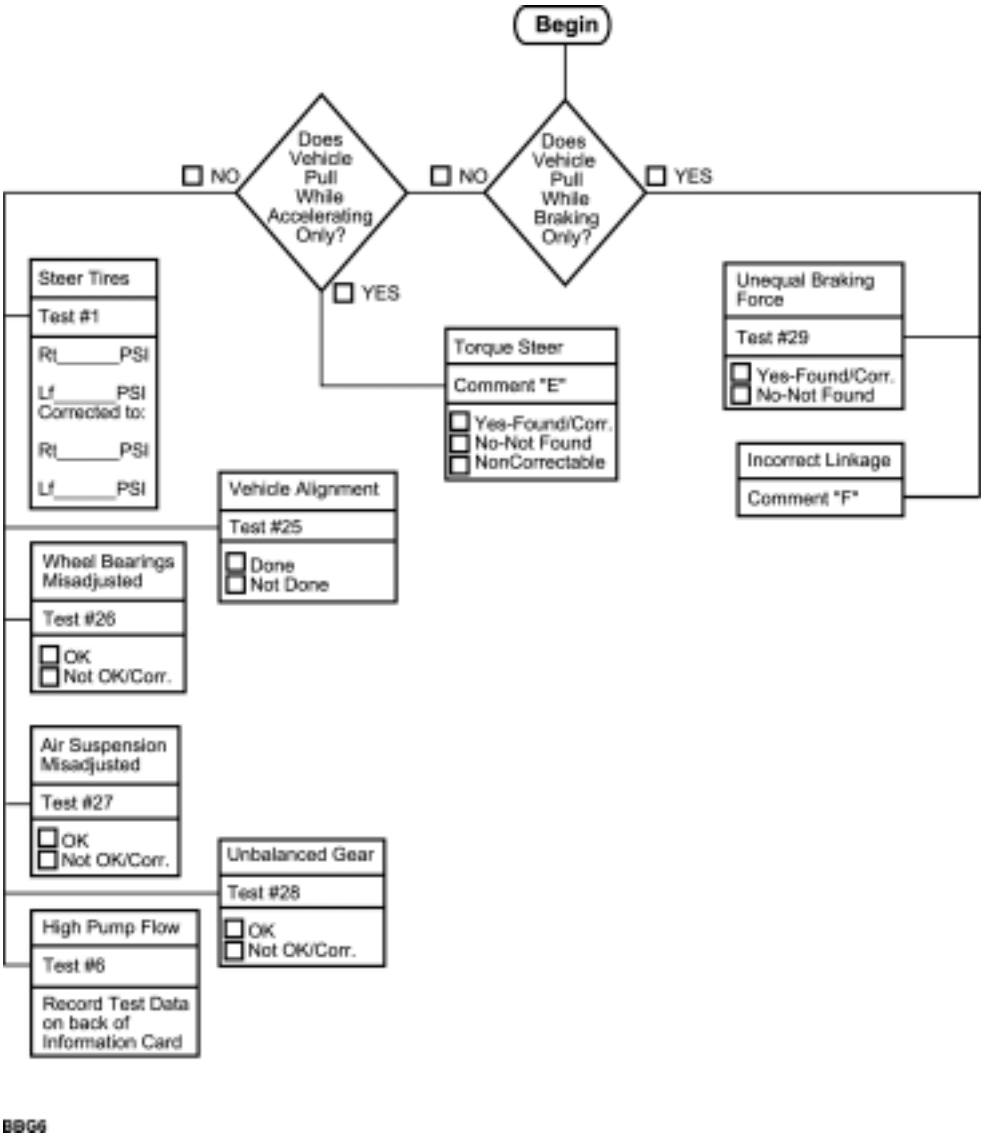

Figure 82—Directional Pull

#1 Tire Check

Perform tire check test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#6 Power Steering Pump Test

Perform power steering pump test. (See Troubleshooting and Diagnostic Hard Steering Tests.)

#25 Alignment Check

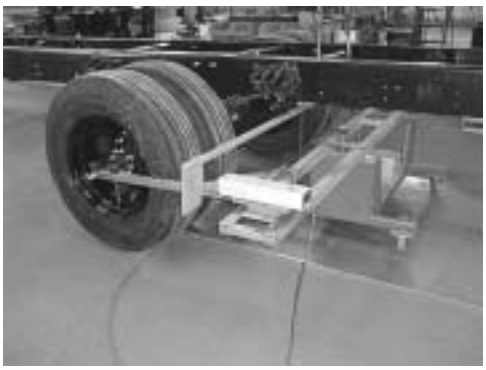

Figure 83—Alignment

1. Check alignment of steered axle and rear drive axles and trailer axles (if problem only exists with trailer). Refer to section on Front Axle. **Figure 83**.

#26 Wheel Bearing Check

Figure 84—Wheel Bearing

1. Verify that adjustment is per manufacturer's specification. **Figure 84**.

#27 Air Suspension Adjustment Check

Figure 85—Check and Set

1. Check and set to specifications. **Figure 85**.

#28 Gear Control Valve Imbalance Check

1. Install a low pressure gauge (200-300 PSI maximum with approximately 10 PSI per division) in the pressure line from pump to gear.

Caution

Do not allow system pressure to exceed the rating of the gauge in the following procedure or damage to the gauge will result.

2. At engine idle, slightly turn the steering column by hand in one direction until a pressure rise is observed at the gauge.
3. Stop steering and gently allow the steering column to re-center.
4. Next, slightly turn the steering column by hand in the opposite direction while observing the gauge and determine if pressure initially rises of falls wit initiation of a turn.
5. Repeat test a few times in each direction.
6. If a consistent fall in pressure is associated with the initiation of a turn in one direction, the steering gear's control valve is unbalanced and needs to be replaced.

#29 Unequal Brake Force Check

Figure 86—Inspect

1. Visually inspect brake assemblies for oil/grease on braking surfaces, and overall condition of brake surfaces. **Figure 86**.
2. Adjust or replace brakes, if necessary.

Comments

Deflections in the suspension and linkage, front and rear, due to high engine generated torque levels can cause a steering effect.

This most often occurs at lower vehicle speeds while accelerating.

The location of the axle arm ball center is important during spring wind-up conditions such as severe braking. A steering arm different from that specified by the manufacturer could cause a steering effect while braking.

Road Wander/Loose Steering Tests

Common phrases used to describe Road Wander or Loose Steering:

- Lash in Steering
- Lost motion in steering
- Constant correction is needed at the steering wheel to keep the vehicle from wandering

Steer Tires	Test #1	Rt ___PSI Lf ___ PSI Corrected to: Rt ___ PSI Lf ___ PSI
Rear Steer	Comment "G"	
Vehicle Alignment	Test #25	_ Done _ Not Done
Looseness in Mechanical System	Test #18 Test #19 Test #24 Test #26	_ Yes-Found/Corrected _ No-Not Found

Figure 87—Road Wander/Loose Steering

#1 Tire Check
Perform tire check test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#18 Lash in Steering System Check
Perform lash in steering system check. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

#19 Steering Gear Adjustment Check
Perform steering gear adjustment check. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

#24 Miter Box Misadjusted (AAFE only) Test
Perform miter box misadjusted test. (See Troubleshooting and Diagnostics Binding/Darting/Oversteer Tests.)

#25 Alignment Check
Perform alignment check. (See Troubleshooting and Diagnostics Directional Pull Test.)

#26 Wheel Bearing Check
Perform wheel-bearing check. (See Troubleshooting and Diagnostics Directional Pull Test.)

Comments

Soft or loosely supported suspensions may allow the rear driving axles to become non-square with the centerline of the chassis during load shifting or trailer roll which will tend to produce a steering effect.

Non-Recovery Tests

Common Phrases Used to Describe Non-Recovery:

- Wheels don't return to straight ahead

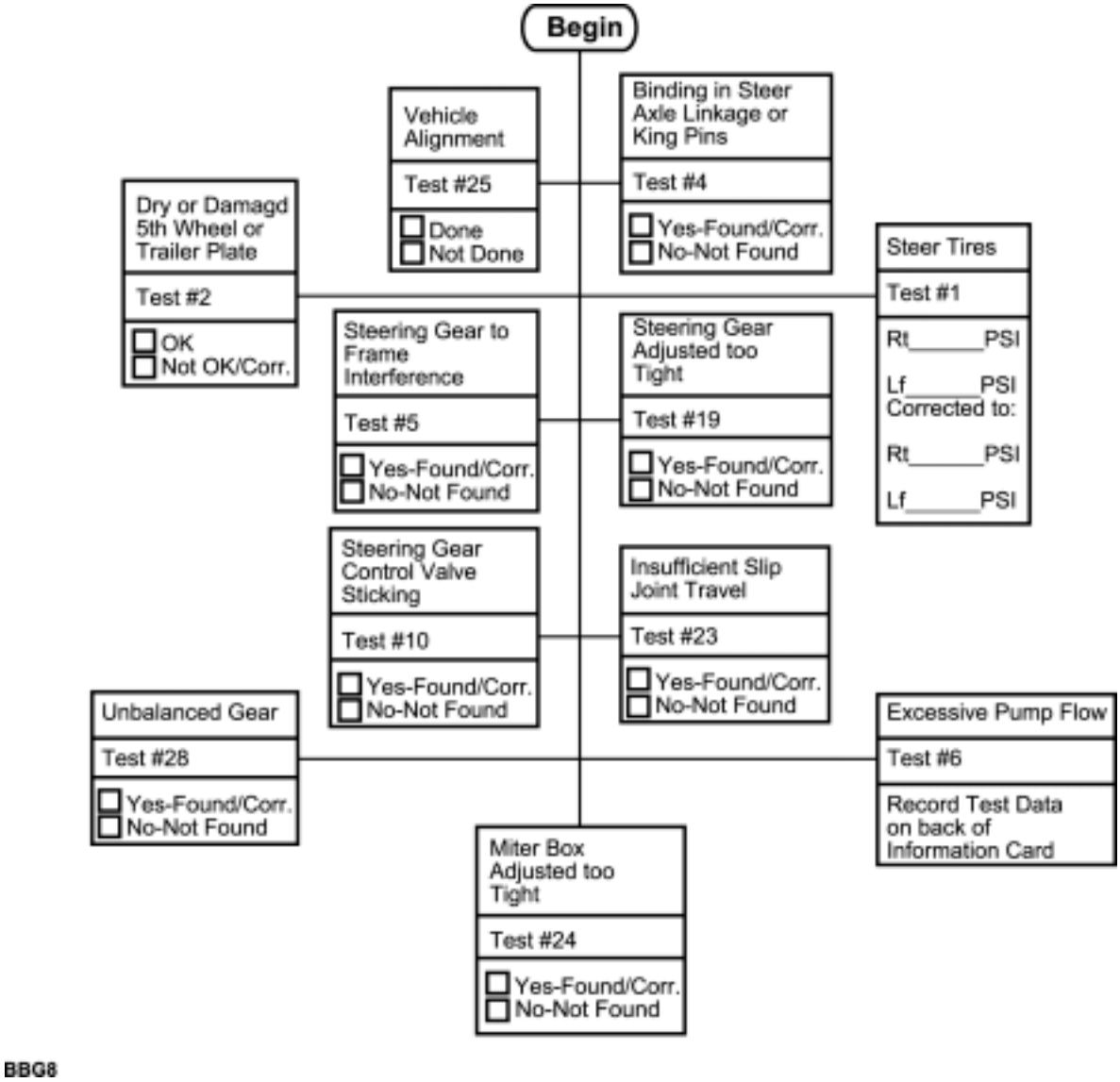

Figure 88—Non-Recovery Tests

#1 Tire Check

Perform tire check test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#4 Steer Axle and Linkage Binding Test

Perform steer axle linkage and binding test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#10 Steering Column Binding Test
Perform steering column binding test. (Se Troubleshooting and Diagnostics Hard Steering Tests.)

#19 Steering Gear Adjustment Check
Perform steering gear adjustment check. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

#23 Slip Column Travel Test
Perform slip column travel test. (See Troubleshooting and Diagnostics Binding/Darting/Oversteer Tests.)

#24 Miter Box Misadjusted (if equipped) Test
Perform miter box misadjusted test. (See Troubleshooting and Diagnostics Binding/Darting/Oversteer Tests.)

#25 Alignment Check
Perform alignment check. (See Troubleshooting and Diagnostic Directional Pull Tests.)

#28 Gear Control Valve Imbalance Check
Perform gear control valve imbalance check. (See Troubleshooting and Diagnostics Directional Pull Test.)

#5 Steering Gear Mounting Test
Perform steering gear mounting test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#6 Power Steering Pump Test
Perform power steering pump test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

Shimmy Tests

A severe Shimmy condition can be felt at the steering wheel. Typically, once something triggers a shimmy condition to occur, it is sustained until the driver does something (such as slow down) to dampen out the condition. A common phrase used to describe shimmy is "a shake at steering wheel".

Tire, Wheel, Brake Balance or Run Out	Test #30	_ OK _ Not OK/Corrected
Air in System	Test #12	_ Foaming Seen _ Gear Bled
Looseness in Mechanical System	Test #18 Test #19 Test #24 Test #26	_ Yes-Found/Corrected _ No-Not Found
Vehicle Alignment	Test #25	_ Done _ Not Done

Figure 89—Shimmy Tests

#12 Air in Hydraulic System Check
Perform air in hydraulic system check. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#18 Lash in Steering System Check
Perform lash in steering system check. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

#19 Steering Gear Adjustment Check
Perform steering gear adjustment check. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

#24 Miter Box Misadjusted (if equipped) Test
Perform miter box misadjusted test. (See Troubleshooting and Diagnostics Binding/Darting/Oversteer Tests)

#25 Alignment Check
Perform alignment check. (See Troubleshooting and Diagnostics Directional Pull Test)

#26 Wheel Bearing Check
Perform wheel-bearing check. (See Troubleshooting and Diagnostics Directional Pull Test.)

#30 Road Wheel Rotating Assembly Check

Have wheel assemblies balanced and checked for lateral and radial run out per manufacturer's specifications. Preferred method for checking balance is with wheels still on the vehicle. Balance includes total rotating assembly.

Noise Tests

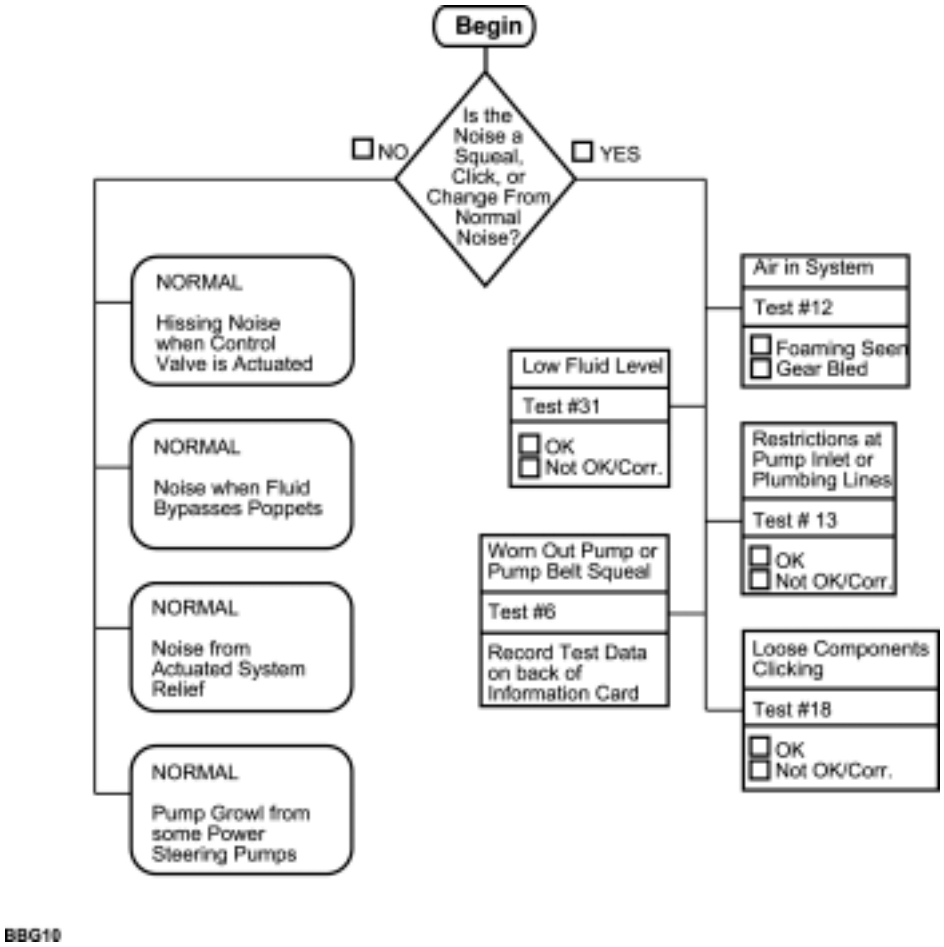

Figure 90—Noise Test

Common Phrases Used to Describe Noise

- Steering is noisy
- Clicking or clunking sound is heard when steering
- Moaning or crunching at steering gear

#6 Power Steering Pump Test

Perform power steering pump test. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#12 Air in Hydraulic System Check

Perform air in hydraulic system check. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#13 Restricted Hydraulic Line Check

Perform restricted hydraulic line check. (See Troubleshooting and Diagnostics Hard Steering Tests.)

#18 Lash in Steering System Check

Perform lash in steering system check. (See Troubleshooting and Diagnostics Steering Wheel Kick Tests.)

#31 Power Steering Fluid Level Check

Check reservoir and make sure there is enough fluid. **Figure 91**.

Figure 91—Check Reservoir

External Leakage

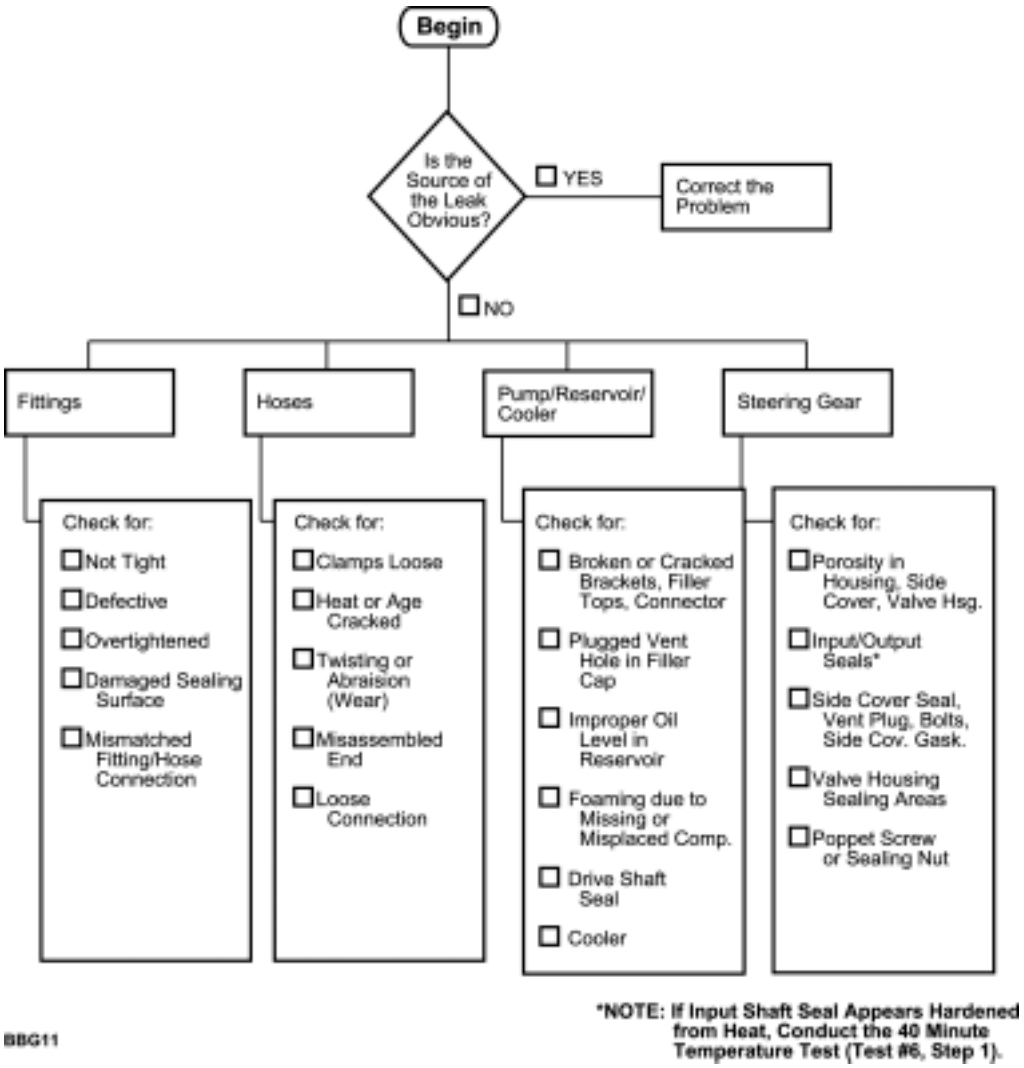

Figure 92—External Leakage

Note

If Input Shaft Seal appears hardened from heat, conduct the 40-minute temperature test (Test #6, Step 1).

Comments

The actual source of external leakage may be difficult to locate because of visual obstruction of components, fan blast, road grime and the fact that fluid tends to run and drip from the lowest point, which may not be close to the leakage source. Some leakage may only occur with the engine off while other leakage may require pressure to cause it to occur. The system may have to be cleaned and dried to find the source. The source of the leak needs to be found before removing or changing parts.

Common phrases used to describe External Leaks:

- Continual adding of fluid in reservoir required
- Oil on components
- Oil puddle under vehicle after being parked
- Leaks at gear box
- Loss of steering fluid

Steering Component Replacement

Steering Gear

If the steering gear has to be removed for service, it is recommended to replace the steering gear with a new or re-manufactured component.

Perform the following after the steering gear has been installed.

1. Adjust sector shaft. Refer to Routine Maintenance and Adjustment (Sector Shaft Adjustment).
2. Lubricate steering gear. Refer to Routine Maintenance and Adjustment (Lubrication of TAS Gears).
3. Air bleed the system. Refer to Routine Maintenance and Adjustment (Filling and Air Bleeding the System).
4. Adjust axle stops. Refer to Routine Maintenance and Adjustment (Axle Stop Adjustment).
5. Set poppets to initial setting. Refer to Routine Maintenance and Adjustment (Initial Poppet Setting).

Caution

Turn the steering gear input shaft with the steering linkage (pitman arm, drag rod, cross tube, etc) disconnected could disrupt poppet adjustment, resulting in hydraulic system failure and steering linkage damage.

Steering Pump

If the steering pump has to be removed for service, it is recommended to replace the steering gear with a new or a re-manufactured component.

Steering Linkage (Drag Links, Tie Rods, Pitman Arm, Sockets, Seals)

- Check for unusual tire wear patterns
- Visually inspect linkage components for missing hardware, broken clamps, gouges on tubes (from rubbing parts) and bent linkage. Check for a bent steering arm
- If you can see the end of the socket threads through the slot in the tube, the drag link or tie rod must be adjusted or replaced. Either it is the wrong size, or the misadjustment was used to compensate for another problem on the vehicle. Toe in adjusted to compensate for vent tie rod arms and relocated steering gear (with the use of spacers, etc.)
- Missing or damaged grease fittings must be replaced
- Any form of tear in grease boots or improper sealing requires seal replacement
- Check for wear on the socket throat, and excessive lash in the socket assembly
- Check socket connection for missing cotter pins

If you are not authorized, or do not have the proper equipment to repair the steering linkage, see an authorized Blue Bird repair shop.

Steering Column

Figure 93—Steering Column

1. Disconnect battery power
2. Tag and disconnect electrical connectors from steering column
3. Match mark steering column universal joint at end of steering column
4. Remove cap screw, washer and nut from steering column universal joint
5. Loosen universal joint from steering shaft. Figure 93.
6. Remove steering column mounting cap screws
7. Remove steering column
8. Check universal joints for play and looseness
9. Replace parts as necessary
10. Position steering column in vehicle. Align splines on steering column universal joint with splines on shaft
11. Install steering column mounting cap screws
12. Install cap screw, washer and nut in steering column universal joint
13. Connect electrical connectors on steering column, remove tags
14. Connect battery power
15. Start vehicle, operate steering system and check for proper steering operation

Ninety-Degree Gearbox

Figure 94—Ninety-Degree Gearbox

1. Match mark universal joints on top and rear of ninety-degree gearbox to their respective gearbox shafts. Figure 94.
2. Remove cap screws, nut and washers from top and rear universal joints.
3. Disconnect universal joints from top and rear of ninety-degree gearbox.
4. Remove four mounting cap screws, washers and nuts.
5. Remove ninety-degree gearbox from vehicle.
6. Check universal joints for play and looseness.
7. Replace parts as necessary.
8. Position ninety-degree gearbox in vehicle.
9. Align splines on ninety-degree gearbox universal joints with splines on shafts.
10. Install four mounting cap screws, washers and nuts.
11. Install cap screws, nuts and washers in top and rear universal joints.
12. Start vehicle, operate steering system and check for proper steering operation.

Steering Driveshaft

1. Match mark universal joints on both ends of steering driveshaft to their respective shafts.
2. Remove cap screws, nuts and washers from steering driveshaft universal joints.
3. Disconnect front and rear universal joint

4. Remove steering driveshaft.
5. Inspect front and rear universal joints for play and looseness.
6. Replace parts as necessary.
7. Position steering driveshaft in vehicle.
8. Align splines on ninety-degree gearbox universal joints with splines on shafts.
9. Align splines on both ends of steering driveshaft with splines on their respective shafts.
10. Install cap screws, nuts and washers in steering driveshaft universal joints.
11. Start vehicle, operate steering system and check for proper steering operation.