



D-SERIES INTEGRAL POWER STEERING GEAR MANUAL

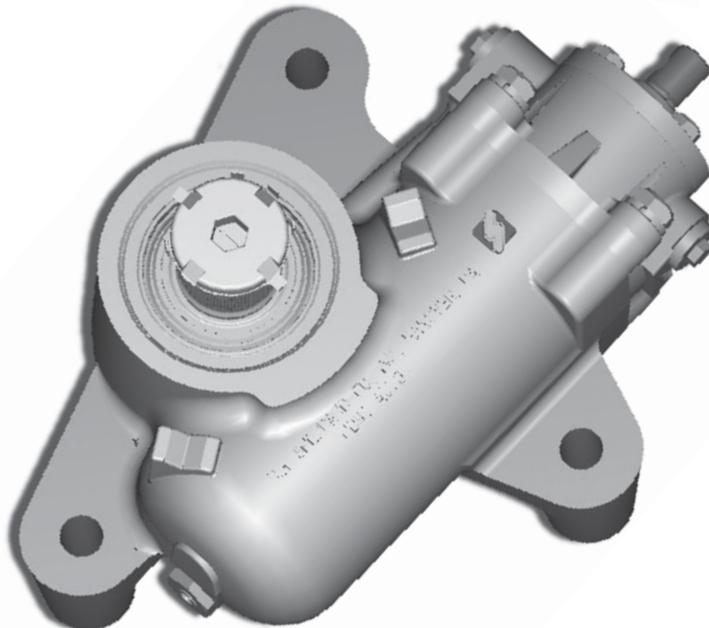
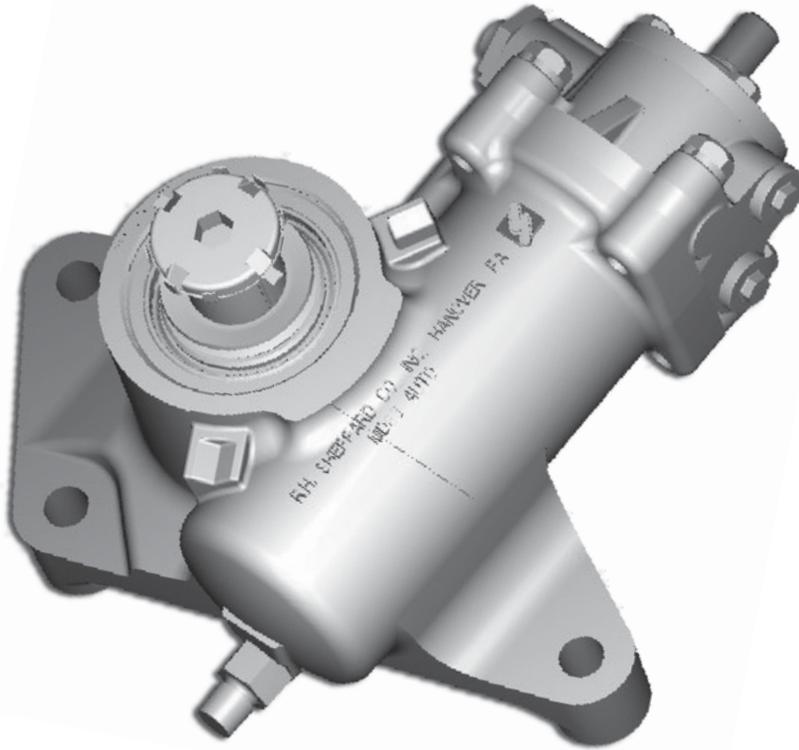


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Questions or Problems?

Call Sheppard Field Service at 800-2RH-SHEP (274-7437)
or refer to the Service Section at www.rhsheppard.com.

POWER STEERING

The Sheppard D-Series Integral Power Steering Gear is a full-time hydraulic steering gear unit. When compared to earlier Sheppard units and to other steering gears on the market, the D-Series gear has a number of competitive advantages.

- **Two Applications** (Figure 1) – A heavy duty unit is designed for 12,000- to 14,600-pound front axles, and a medium duty unit for 6,000- to 10,000-pound front axles.

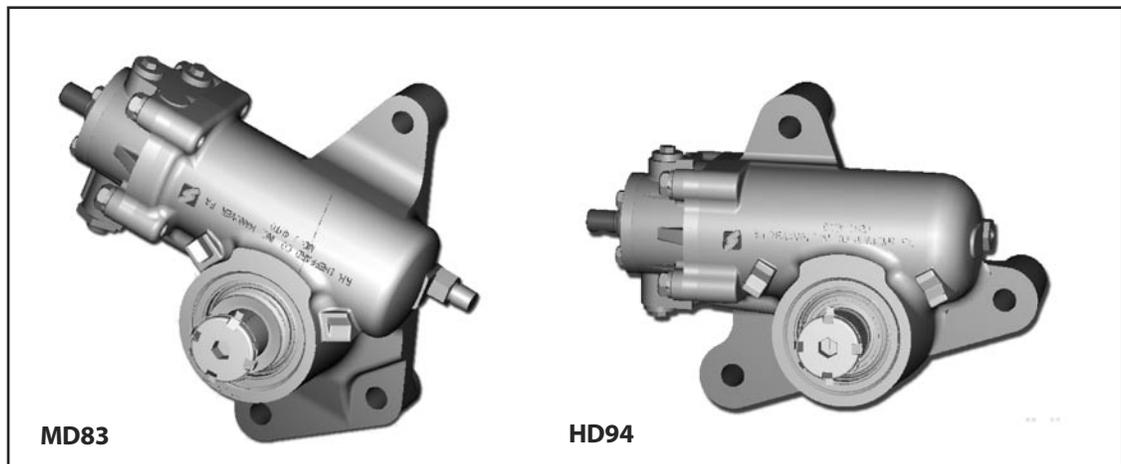


Figure 1. HD and MD Steering Gears.

- **Better Road Feel** – The gear feels stiffer on-center, yet takes no more effort to park than a standard gear. The time lag between steering input and response is greatly reduced.
- **Improved Overall Performance** – The D-Series gear's 16.9 ratio is the fastest on the market for quicker steering response and less driver effort. The HD is 11.4% more responsive than the current M100 gear.
- **Less Vibration** – Hydraulics are smoother to damp shudder and shake.
- **Lighter Weight** -- Stronger ductile iron reduces wall thickness and weight by about 10 pounds.
- **Improved Maneuverability** – The piston and sector shaft mating redesign makes the HD about 1.5 inches shorter than previous Sheppard models for closer mounting to the frame rail, so wheel cut angles can be sharper. The autoplugger is recessed into the cylinder end to shorten overall length.
- **Quieter** – The patent-pending 8-slot valve produces less than 70 decibels, which is below the driver's audible range from within the cab.
- **Longer Life** – The HD model uses a standard M90 bearing cap, and the sector shaft seal and cover have been redesigned for longer seal life. The blind bore cylinder head reduces potential leaks and saves space. The piston rack and sector shaft has a new, more robust gear tooth design. The cylinder autoplugger is inside a removable cartridge for ease of maintenance.

Operating Principles

When the engine is running, a constant low-pressure oil flow through the steering gear gives instant response and absorbs road shock to help eliminate steering wheel kick. Pressure is equal throughout the steering gear, except in two situations:

- When the engine or supply pump is not running, any towing or moving the vehicle should be done carefully because the steering may be much slower to respond to correction.
- In addition, in the unlikely event of sudden pressure loss, the system reverts to mechanical back-up steering so that the vehicle may be safely steered to the side of the road.

Special Warranty Procedure

Before replacing a Sheppard steering gear for ANY reason, please contact the RH Sheppard Service Hotline at 800-2RH-SHEP (274-7437). RHS experts will provide troubleshooting assistance and, if necessary, an authorization (RGA) number. This RGA should be noted on the warranty claim AND on the steering gear being returned. Claims for steering gears replaced without prior authorization from RHS may be denied.

COMPONENT INSTALLATION AND REMOVAL



Warranty and Installation Tips

Sheppard power steering gears are manufactured and tested for proper operation prior to shipment. Every effort has been made to ensure that the product will deliver many miles of trouble-free, safe operation. To protect your customer's investment and comply with the warranty, it is important that these instructions be closely followed.

- Any time a power steering gear or power steering pump is replaced, the oil and oil filter in the power steering system must be changed (see the Maintenance section of this manual on page 31). All lines and fittings must be flushed of any possible contaminants. Use the type of fluid specified by the vehicle manufacturer or 15W40 engine oil if none is specified.

NOTE: Sheppard recommends the power steering system fluid and filter be changed at every engine oil change. Today's systems typically have smaller reservoirs and operate at much higher temperatures than in the past. Regular preventive maintenance is essential to extended steering system life.

- If a power steering pump has been replaced, it should be tested to ensure that its pressure and oil flow are the same as originally specified by the vehicle manufacturer.
- When installing the steering gear on the vehicle, take care to ensure the mounting bracket or steering gear is not distorted when the bolts are tightened. Distortion could cause binding in the gear.
- Transfer the hose fittings from the old steering gear to the new one. Replace the O-rings.
- Attach all hoses to the gear or gears. Ensure they are in good condition and routed with no kinks in the line. Refer to the next section (page 5) for proper routing of dual steer systems. On D-Series gears, the inlet and outlet ports are staggered. The inlet port is always the one closest to the output shaft.
- Install the steering column or intermediate shaft to the steering gear input shaft. Ensure the clamp bolt is torqued to the vehicle manufacturer's specification.
- Install the pitman arm using the guidelines found in this manual. Take care not to move the arm more than 2 inches in either direction until the draglink has been installed. Over-traveling the piston will prematurely set automatic relief plungers.
- Install the draglink on the pitman arm (except slave gears) and torque the fastener to the vehicle manufacturer's specification. Slave gears should not have the draglink installed until the bleeding procedure.

NOTE: The pitman arm may be mistimed if you cannot turn the steering all the way until the stops contact the axle in each direction with the steer tires off the ground.

- Fill the power steering system with an approved fluid. Start the engine and let it idle. **DO NOT ALLOW THE RESERVOIR TO RUN DRY!**

IMPORTANT! Set the automatic relief plungers to obtain proper wheel cut. Use the procedures on page 18.

- Bleed the gear or gears using the guidelines found in this manual.
- Double-check all fasteners, fittings, and hose routings. Check for leaks. Top off the power steering system and return the vehicle to service.

Routing D-Series Dual Gear Hoses and Lines

Two or more integral steering gears (“master” and “slave” units) are sometimes used where front axle weights exceed 16,000-pounds. Dual steering systems balance the steering gear output across two or more steering arms and conserve under-hood space.

Pressure from the master gear on the vehicle’s left side powers the secondary or slave unit (Figure 2) on the vehicle’s right side. Hydraulic pressure and flow move the slave gear in the opposite direction of the master gear. Another difference between the two units is that hydraulic relief plungers are not used in the slave gear. Master gear relief plungers will relieve hydraulic pressure for both gears when properly adjusted.

The dual system is mechanically linked to the front-end components by a draglink and steer arm on the right hand spindle on the axle. However, only hydraulic connections, with no physical mechanical components, exist between the master and slave units (Figure 3).

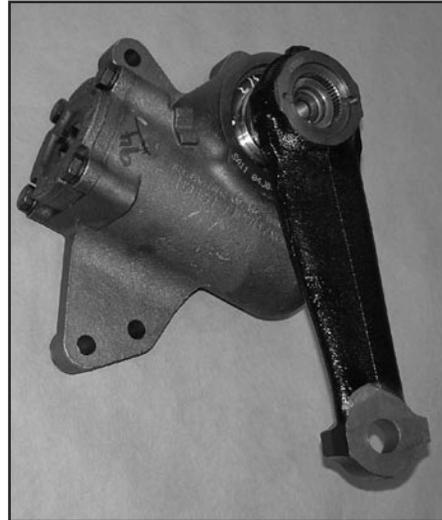


Figure 2. HD94 Slave Gear.

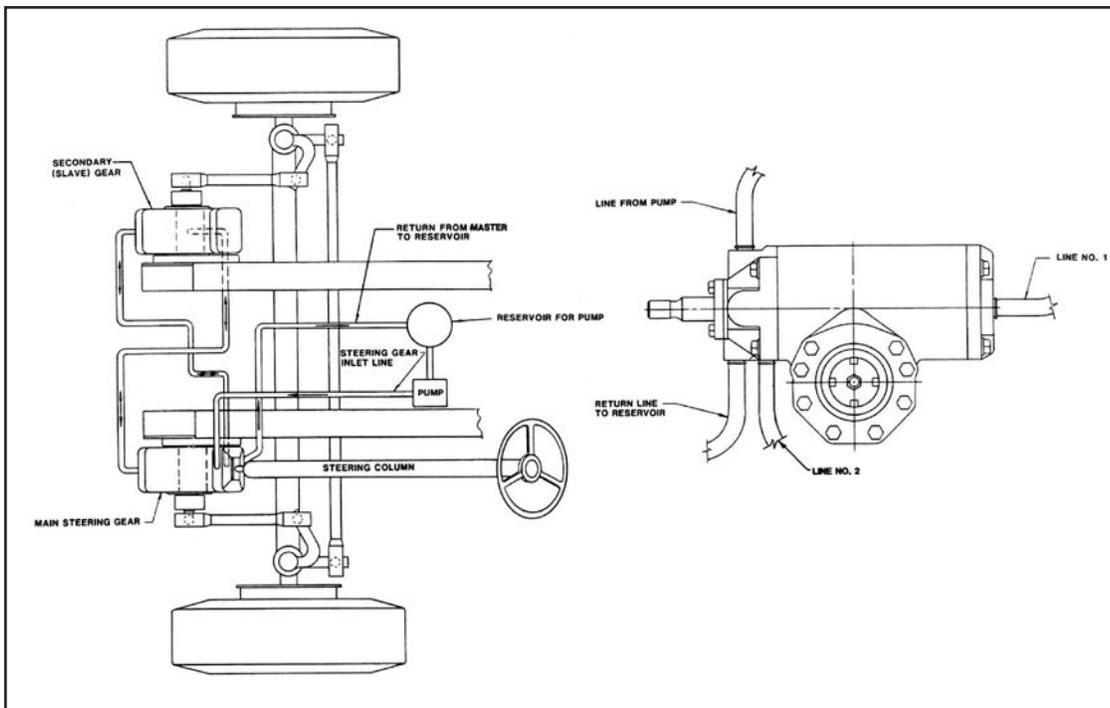


Figure 3. Standard Slave Routing. This system requires only cross-over pressure lines between master and slave, requiring no additional line.

COMPONENT INSTALLATION AND REMOVAL



Installing Replacement Input and Sector Shaft Seals

See the Seal Replacement section on page 10 for procedure sequence. The steering gear is not removed from the vehicle for these procedures. However, the steering gear must be partially disassembled to replace the sector shaft seals. Take care to mark the sector shaft timing if the shaft is replaced.

If you have questions at any time, the Sheppard service manual can be found at www.rhsheppard.com, or call the Field Service Hotline at 800-2RH-SHEP (274-7437).

Pitman Arm Installation

! **WARNING:** Proper pitman arm installation is crucial to the safe operation of the vehicle. Correct torque values are very important! Always follow these procedures when installing the pitman arm.

! **DANGER:** If the pitman arm is not applied as specified, it can cause an accident.
● Any time a pitman arm is found loose, replace the pitman arm and the sector shaft.

Tools Required

- ✓ Appropriate size Allen drive bit
 - ✓ Torque wrench
 - ✓ Hammer
 - ✓ Punch
 - ✓ Anti-seize compound
-

Procedure:

NOTE: Mount the steering gear on the frame to make pitman arm installation easier.

1. To install the pitman arm:
 - a. Install the arm onto the sector shaft, taking care to align the timing marks (Figure 4).
 - b. Install the pitman arm retainer into the sector shaft, taking care to align the tabs in the notches of the arm (Figure 5).
 - c. Apply anti-seize compound:
 - i. To the retainer threads.
 - ii. To both sides of the friction washer if the retainer is new.

CAUTION: In step 2 below, take note of the torque value on the face of the retainer. Always torque the retainer to the specified value.

2. Torque the retainer to the specified value.

DANGER: Do not back off the torque value to align the tabs! A loose pitman arm or loss of steering control could result.

3. Continue torquing the retainer past the specified value until two of the notches in the retainer align with the tabs of the washer (Figure 6).
4. Use the punch and hammer to bend the restraining tabs of the washer into the notches of the retainer (Figure 7).
5. Apply torque putty to the tabs for future reference.

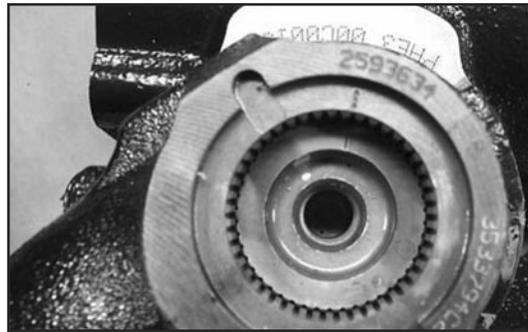


Figure 4. Aligned Timing Marks.



Figure 5. Aligned Tabs.



Figure 6. Aligning with Washer Tabs.



Figure 7. Bending Retainer Tabs.

COMPONENT INSTALLATION AND REMOVAL



Pitman Arm Removal

The pitman arm may need removal on some vehicles before removing the steering gear. Proper technique in removing the pitman arm will avoid damage to the steering gear, pitman arm, and retainer.

Tools Required

- ✓ Hammer
- ✓ Tapered punch
- ✓ Appropriate size Allen drive socket – 5/8" or 3/4"
- ✓ Sheppard pitman arm puller – Kent Moore part number ZTSE4439 or three-jaw puller
- ✓ Impact wrench

Information Required

- ✓ Vehicle manufacturer's procedures for lifting and blocking

! **DANGER:** Damage to the pitman arm or sector shaft can cause an accident at a later date. Never weld the pitman arm or sector shaft!

! **WARNING:** The pitman arm will be extremely tight. Do not use a hammer or apply heat to the arm. Otherwise, the sector shaft, pitman arm, or seals can be damaged, leading to later failure.

1. Park the vehicle on a clean, dry, solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Block the wheels.
 - c. Place the transmission in neutral.
 - d. Tilt the hood or cab.

! **CAUTION:** The pitman arm has alignment tabs (Figure 8), while the retainer has restraining tabs. In step 2 below, do not bend the alignment tabs out of the pitman arm.

2. Use the punch to bend the restraining tabs out of the pitman arm retainer (Figure 9).



Figure 8. Alignment Tabs.



Figure 9. Bending Restraining Tabs.

NOTE: In step 3 below, lubricate the retainer face. Otherwise, pitman arm removal will be difficult.

3. Lubricate the face of the retainer with clean chassis lube.
4. To remove the pitman arm:
 - a. Slide the pitman arm puller over the pitman arm. NOTE: It will be necessary to remove the sector shaft cover bolts to slide the puller over the arm if the gear has a bolt-on cover.
 - b. Take care to align the hole in the puller with the Allen socket in the retainer.
 - c. Insert the Allen drive socket through the puller and into the retainer socket.
 - d. Use an impact wrench to back off the retainer. The retainer will act as a jackscrew to remove the pitman arm.

SEAL REPLACEMENT



Input Shaft Seal Replacement

Do not remove the steering gear for this repair.

Tools Required

- ✓ Appropriate size sockets and drivers to remove U-joint pinch bolt and bearing cap mounting bolts
- ✓ Drain pan
- ✓ 5/8" and 11/16" combination wrenches
- ✓ 0-150 ft/lb torque wrench (minimum)
- ✓ Screwdriver
- ✓ 1" socket and short extension (1/2" drive)
- ✓ Small hammer
- ✓ Arbor press (recommended)

Parts Required

- ✓ Input shaft seal kit
- ✓ Specified fluid

! CAUTION: During the procedures below, do not turn the input shaft during repairs. Damage to the steering gear will result.

Disassembly:

1. Park the vehicle on a clean, dry, solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Block the wheels.
 - c. Place the transmission in neutral.
 - d. Tilt the hood or cab using the procedure in the vehicle manufacturer's service manual.
2. Remove the steering column lower yoke from the steering gear input shaft.

IMPORTANT! Clean the area around the input shaft!

- ! WARNING:** Do not turn the input shaft with the bearing cap cover removed!
- Turning the shaft or mixing of components will cause damage to the input shaft, rotary valve, thrust bearings, and bearing cap.
3. Remove the four bolts on the bearing cap cover and remove the cover.

- ! CAUTION:** The thrust washer may stick to the cover. If it does, reinstall the washer on top of the thrust bearing in the bearing cap (Figure 10).
4. Remove the salt seal from the cover, and the cover washer (Figure 11).
 5. Using an appropriate sized socket or seal driver, tap the input (high pressure) seal out of the cover and discard it.
 6. Remove the O-ring from the bottom of the cover and discard it.
 7. With a socket or seal driver in a press or vise, press in the new input seal with the gold spring facing the bottom of the cover and reinstall the cover washer.
 8. Locate the appropriate size salt seal and press it into the cover. Ensure the seal lip or silver spring is facing the top of the cover.
 9. Install the new O-ring in the bottom of the cover (Figure 12).
 10. Using #2 chassis grease, fill the area between the seals. No further greasing is required or recommended.
 11. Lube the O-ring and seal lips with a light coat of grease.
 12. Wrap the input shaft splines with tape to avoid damaging the new seals (Figure 13).
 13. Install the cover onto the bearing cap, making sure not to roll the lip of the high-pressure seal.
 14. Ensure the small hole in the cover is aligned with the relief plunger hole in the bearing cap.
 15. Torque the bolts to 60 ft/lbs.



Figure 10. Reinstalling Thrust Washer.



Figure 11. Discarding Salt Seal.



Figure 12. Installing Bearing Cap Cover O-ring.



Figure 13. Taped Splines.

SEAL REPLACEMENT



16. Install the correct size rubber boot over the input shaft. Ensure it is pushed down below the bottom of the splines and makes good contact with the cover.
17. Remove the tape from the input shaft.
18. Reinstall the steering column lower yoke.
19. Torque the pinch bolt to manufacturer's specification.
20. Fill the power steering reservoir to the proper level.
21. Start the truck.
22. Check for leaks.

Sector Shaft Seal Replacement

The steering gear is not removed from the vehicle for this procedure. However, the steering gear must be partially disassembled to replace the sector shaft seals. Take care to mark the sector shaft timing if the shaft is replaced.

Tools Required

- ✓ Drain pan
 - ✓ Hammer
 - ✓ Punch
 - ✓ Appropriate size Allen drive socket
 - ✓ Sheppard pitman arm puller (Kent Moore #ZTSE-4439)
 - ✓ Sockets and ratchet
 - ✓ Large snap ring pliers
 - ✓ Seal driver
-

Procedure:

NOTE: The steering gear must be removed from the vehicle for sector seal replacement if the steering gear is mounted inside the frame rail, or where the pitman arm is between the steering gear and the frame rail.

1. Park the vehicle on a clean, dry, solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Chock the wheels.
 - c. Tilt the hood or cab to gain access to the steering gear.

! **CAUTION:** In step 2 below, do not attempt to remove the arm by using a wedge ● between the pitman arm and housing. Housing damage will result! Do not apply heat to the pitman arm!

NOTE: In step 2 below, use only a Sheppard pitman arm puller (Kent-Moore #ZTSE-4439) or a three-jaw puller to remove the pitman arm on snap ring design housings (Figure 14).

2. Remove the pitman arm retainer and pitman arm following instructions in this manual.
3. Remove the V-boot from the sector shaft.
4. Remove the snap ring protective cover, if equipped, by carefully prying the plastic seal from the housing. Take care to not damage the housing during removal.
5. Clean any RTV sealant from the snap ring area.
6. Remove the adhesive plastic dust cover from the back side of the housing, if equipped.
7. Carefully clean any paint or corrosion from the housing to allow the cover to slide freely out of the housing.

! DANGER: In step 8 below, take care when removing the snap ring. The snap ring can slip off of the pliers when removed from the housing, resulting in personal injury.

8. Remove the snap ring using a suitable size pair of snap ring pliers or slide it out of its groove with a pair of flat-bladed screwdrivers.

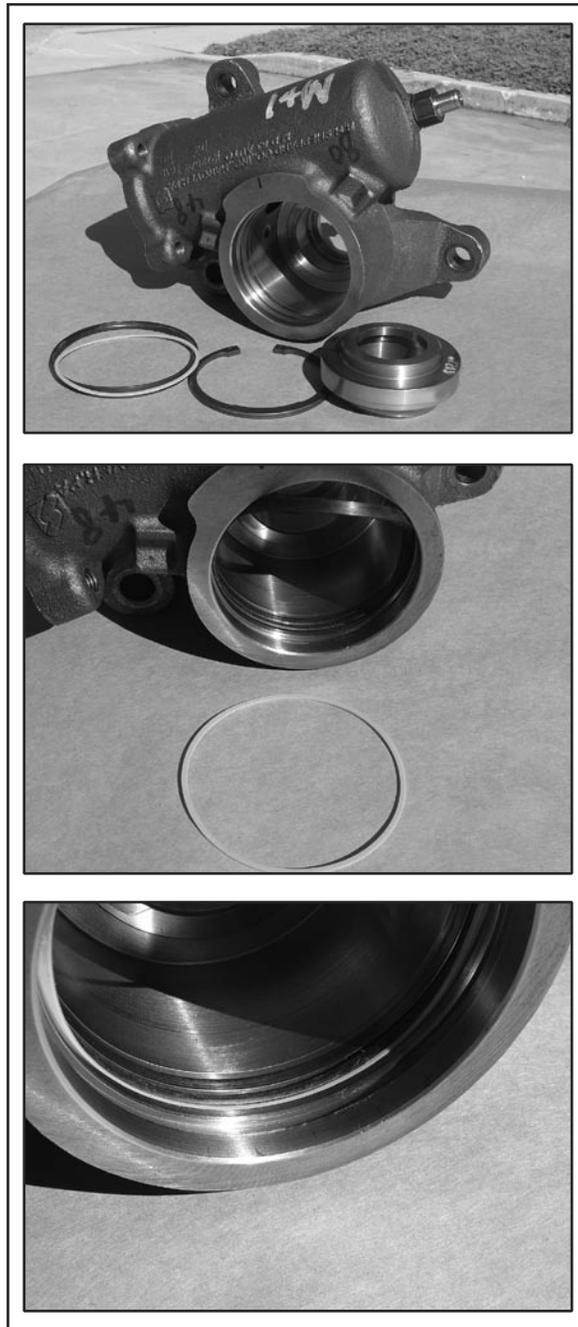


Figure 14. MD83 Showing Housing, L-Seal, New Cover, and Backup Ring.

SEAL REPLACEMENT



! CAUTION: In step 9 below, do not turn the steering wheel while removing the cover! Increased pressure from turning can cause the cover to be forced out, causing personal injury.

9. To remove the sector shaft cover:
 - a. Use system pressure as follows:
 - i. Start the engine.
 - ii. Allow the circulating system pressure to push the sector shaft cover out of the housing.
 - iii. Shut off the engine when the cover exits the housing.
 - b. Use a slide hammer.
 - c. Drive the cover and shaft out of the housing from the opposite side if the steering gear is removed from the vehicle.

10. Remove:

- a. The shaft and cover from the steering gear housing.
- b. The seals from the housing and cover using a seal pick.

! CAUTION:

- In step 10c below, take care not to damage the seal bore.
 - c. Carefully pry the pressed-in excluder from the cover.

11. Remove the two-piece L-seal from the housing.

! CAUTION: In step 12 below, the sector shaft oil seals are two-piece seals that must be bent to install them. To properly seat the seal once it is in place, it may be necessary to work the seal with your fingers or a blunt seal pick. When using a blunt seal pick to seat the seal, push only on the body of the seal and not on the seal lip. Damage to the seal lip will cause an oil leak.

NOTE: In step 12 below, install the sector shaft seals so the black side of the seal faces the inside of the steering gear.

12. Install one new sector shaft seal in both:

- a. The sector cover
- b. The housing

13. Lubricate the seals with clean chassis lube after installation.

! CAUTION:

- During installation of O-rings or seals, take care not to twist them.

14. Install the new two-piece L-seal.

- a. Insert the black pressure seal into the housing with the L side facing out.
- b. Insert the flat backup ring (Figure 14) into the L side of the pressure seal. When assembled, the backup ring will be on the side of the L-seal facing out.
- c. Apply a coat of clean chassis lube to the O-ring or L-seal prior to installing the cover into the housing.

! **CAUTION:** In step 15 below, take care to align the timing mark on the sector shaft ● with the timing marks on the piston. Failure to align the timing marks will result in an incorrect turn radius.

15. Install the sector shaft into the housing.

! **CAUTION:** In step 16 below, light hammer blows will be required to install the ● cover. Use only sufficient force to install the cover. Excessive force on the cover could damage the sector shaft cover or bearing, damaging the steering gear. The cover must be installed flush with or below the snap ring groove in the housing.

16. Install the cover over the sector shaft.

! **DANGER:** In step 17 below, the snap ring can slip off the pliers when removed ● from the housing. Take care when installing the snap ring as personal injury can result. The snap ring must be fully seated in its groove. Improperly seated snap rings can come out without warning! Loss of steering control, an oil leak, or personal injury may result.

17. Install the snap ring using a suitable size snap ring pliers.

18. If equipped with an excluder seal:

- a. Pack the seal lip with clean chassis lube.
- b. Using a suitable size seal driver and hammer, install the seal over the sector shaft splines into the seal groove of the cover.

19. Install the snap ring protective cover into the housing over the snap ring by lightly tapping on the outside diameter of the cover until it bottoms in the bore. It may be necessary to tap on the body of the seal with a drift punch and hammer to fully seat the cover.

20. To install the V-boot:

- a. Pack the V-boot with clean chassis lube.
- b. Slide the V-boot over the sector shaft splines until the lip contacts the sector shaft cover.
- c. On models with a groove cut into the sector shaft under the splines, use the boot with one lip larger than the other. The larger lip should be facing the pitman arm. Slide the boot on until it snaps into the groove.
- d. Clean all excess grease from the sector shaft splines.

21. Attach the new frame side dust cover:

NOTE: Failure to replace and correctly seal the frame side dust cover will cause a leak at the sector shaft seal.

- a. Clean the housing with solvent.
- b. Apply a small bead of RTV silicone on the edge of the disk.
- c. Apply the new disk over the sector shaft bore.

SEAL REPLACEMENT



- ! **WARNING:** In step 22 below, proper installation of the pitman arm is crucial.
- Improper installation of the arm can cause an accident at a later date.

22. Install the pitman arm following the procedures in this manual.
23. Fill the system with approved fluid (page 31).
24. Start the engine.
25. Check and correct the fluid level.
26. Check for leaks.
27. Bleed the system if necessary as shown in this manual.
28. Return the vehicle to service.

End Cap Seal Replacement

1. Park the vehicle on a clean, dry solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Chock the wheels.
 - c. Tilt the hood or cab to gain access to the steering gear.

2. Place a drain pan under the steering gear.

NOTE: Steering gears with automatic plungers may require plunger kit part number 18212821K if the plunger is damaged during disassembly or reassembly.

3. For the slave gear cylinder head:
 - a. Mark the cylinder head and housing for alignment.
 - b. Remove the four large bolts from the cylinder head using a suitable size socket.
 - c. Remove the cylinder head.
 - d. Remove the square ring from the cylinder head and discard.
 - e. Replace the O-ring supplied in the kit.
 - f. Coat the O-ring with clean chassis lube.
 - g. Clean the cylinder head using a suitable solvent.
 - h. Install the square ring or O-ring in the cylinder head groove.
 - i. Apply a light coat of clean chassis lube to hold the seals in place during installation.

- ! **CAUTION:** In step 3j below, take care to align the marks made during disassembly in step 3a.

- j. Install the cylinder head onto the housing.
4. For the bearing cap:
 - a. Mark the bearing cap and housing for reassembly.
 - b. Remove the lower U-joint and face seal from the steering gear input shaft.

! CAUTION: In step 4c below, do not remove the bearing cap cover around the input shaft.

- c. Remove:
 - i. Hoses
 - ii. Fittings
 - iii. Four large bolts from the bearing cap
- d. To access the seal, turn the input shaft to raise the bearing cap off the housing.
- e. To install the new square ring or O-ring and tetra seal:
 - i. Using a seal pick, remove the square ring or O-ring and tetra seal from the bearing cap and discard.
 - ii. Warm the square ring or O-ring in hot water to allow it to stretch more easily.

NOTE: In step 4-e-iii below, take care not to over-stretch the seal.

- iii. Carefully stretch the square ring or O-ring over the bearing cap assembly.
- iv. With the seal over the bearing cap, push the square ring or O-ring into the seal groove of the bearing cap.
- v. Apply clean chassis lube to hold the seal into the seal groove.
- vi. Install the tetra seal in the smaller groove of the bearing cap.
- vii. Lightly coat the tetra seal with clean chassis lube.

NOTE: Automatic plungers must be disassembled by removing the flange nut from the plunger and pushing the plunger out of the cylinder head or cartridge.

- f. Remove the relief plunger.
- g. Replace the O-ring supplied in the kit.
- h. Coat the O-ring with clean chassis lube.
- i. Apply thread locking compound to the plunger threads.
- j. Install the plunger back into the bearing cap.
- k. Tighten the flange nut against the spring pin.

NOTE: Check and correct the relief plunger settings after repair.

! CAUTION: In step 4l below, take care to align the marks on the housing and bearing cap. Take care not to pinch the seals during assembly.

- l. Turn the input shaft into the steering gear.
 - m. Install the four attaching bolts and torque to specifications.
 - n. Install the U-joint following the vehicle manufacturer's guidelines.
5. Start the vehicle.
6. Check and correct the fluid level in the system.

RELIEF PLUNGERS AND AXLE STOPS

Relief Plungers

Relief plungers (Figure 15) prevent the power steering pump from operating at maximum relief pressure at the end of steering travel. When properly adjusted, the relief plungers reduce system temperature and excessive stress on the mechanical components of the steering system by preventing the axle stops from contacting the axle under full pump pressure. A relief plunger is placed in each end of all Sheppard steering gears (with the exception of slave gears) to unload steering system pressure prior to the axle stops contacting the axle. One plunger is located in a small hole in the bearing cap cover next to the input shaft. The other plunger is on the opposite end of the steering gear in a cartridge screwed into the housing.

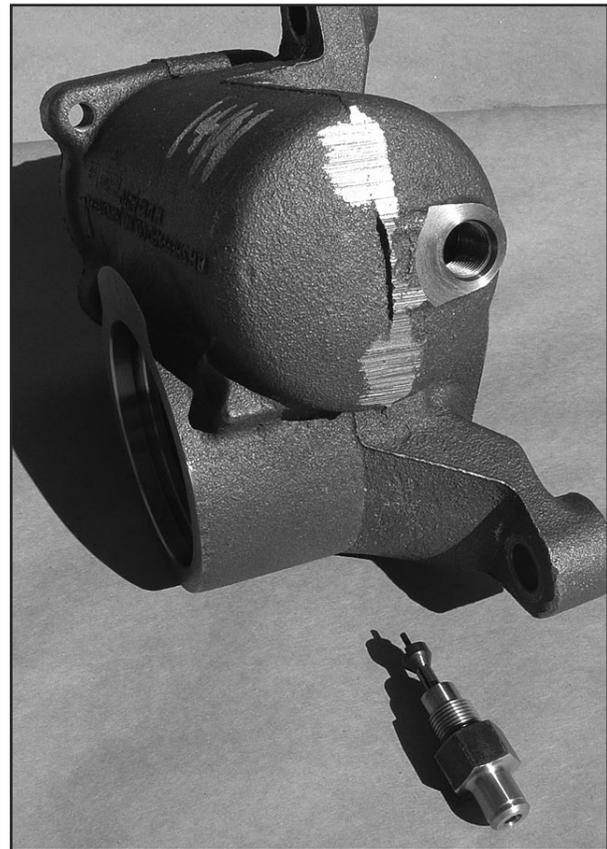


Figure 15. Relief Plunger and Cartridge.

CAUTION: Failure to set or adjust the relief plungers could result in damage to the steering system. Plungers **MUST** be set or adjusted whenever a steering gear is replaced.

Automatic Plungers

Automatic plunger gears are identified in two ways (Figure 16):

- The word AUTO in raised letters is cast into the side of the steering gear housing.
- Plastic caps on each end of the gear cover the plunger hole.

Procedure:

1. Raise the steer tires off the ground.
2. Start the engine and let it run at idle speed.
3. Ensure the axle stops are set for maximum wheel cut with a minimum of 1" clearance between the tire and any part of the chassis.
4. Set the automatic plungers by turning the steering wheels from side to side until the axle stops contact the axle. This allows the piston in the steering gear to contact the automatic plunger assembly and push it back to its set position. The stops **MUST** contact the axle.
5. Lower the vehicle so the full weight is on the front tires.



Figure 16. Identifying Automatic Plungers.

6. Turn the steering wheel completely from stop to stop. The chassis should not flex when the steering reaches the end of travel. If it does, the automatic plungers must be reset. Normally, there is a small gap between the axle stop and the axle.
7. Reset the automatic plungers by tapping them in with a 1/4" punch and hammer until you feel the plunger bottom out in the bore (Figure 17). Be careful not to score the plunger bore. Scoring the bore will cause a leak that cannot be repaired. After the automatic plungers are installed, set them by repeating steps 1 - 6.



Figure 17. Resetting Automatic Plungers.

RELIEF PLUNGERS AND AXLE STOPS



Repairing Automatic Plungers

Under normal use, Sheppard automatic plungers need no regular maintenance. The automatic plunger is serviceable only as a kit and is only required if a leak is present. Sheppard plunger kit part number 18212821K will fit both the cylinder head and bearing cap end of the steering gear.

Tools Required

- ✓ Drain pan
 - ✓ Metric sockets and ratchet
 - ✓ Slotted screwdriver bit with suitable socket and ratchet
 - ✓ 1/4" drift punch
 - ✓ 1/8" pin punch
 - ✓ 1/4" pin punch
 - ✓ 1/4" center punch
 - ✓ 10mm open end wrench
 - ✓ Hammer
-

Repairing Cylinder Head

1. Park the vehicle on a clean, dry, solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Block the wheels.
 - c. Place the transmission in neutral.
 - d. Tilt the hood or cab to access the front tires.
2. Verify that the steering gear has automatic plungers.
 - a. Look for the letters "AUTO" cast into the housing.
 - b. Look for plastic caps on the plunger hole.
3. Place a drain pan under the steering gear.
4. Remove the auto plunger cartridge.
5. To service the cylinder head auto plunger:
 - a. Place the cartridge in a vise.
 - b. Remove the plastic plug from the automatic plunger hole.

! **CAUTION:** In step 5c below, keep the 1/4" punch straight in the bore and do not hit the plunger too hard. Otherwise, the steering gear or automatic plunger assembly will be damaged.

- c. Using a 1/4" punch and hammer, drive the automatic plunger assembly in until it bottoms in the bore. The spring pin, flange, and plunger body should now be accessible for repair.

- d. Carefully insert the screwdriver bit into the plunger bore to engage the slotted head of the plunger body (Figure 18).

! CAUTION: In step 5e below, do not
 ● allow the screwdriver bit to slip off the plunger body. Otherwise, the bore can be damaged.

NOTE: The automatic plunger flange is held in place with thread locking compound installed at the factory. Approximately 15-20 inch/pounds of torque are required to remove the flange.

- e. Using the 10mm open-end wrench to hold the flange across the flat sides, carefully turn the flange to remove the flange from the plunger body.
 - f. Discard the flange.
6. Using a 1/8" pin punch, remove the plunger body from the spring pin and discard. It may be necessary to tap the plunger body to remove it from the spring pin.
 7. To install a new plunger assembly:
 - a. Coat the plunger assembly O-ring with a light coat of grease.

! CAUTION: Check the plunger bore for nicks or gouges before installing the
 ● plunger assembly. Take care not to introduce dirt or contaminants in the plunger bore when reassembling.

- b. Install the plunger body through the spring pin.
- c. Use the screwdriver bit and ratchet to hold the plunger body.

! CAUTION: In step 7d below, the flange must contact the spring pin. Otherwise,
 ● steering gear damage or a leak can result.

NOTE: The plunger body has thread-locking compound and will require approximately 15-20 inch/pounds of torque to overcome it.

- d. Screw the flange onto the plunger body using the 10mm open-end wrench until the flange contacts the spring pin.
8. Install the cartridge into the cylinder head and torque to 30-50 ft/lbs.
 9. To complete the service:
 - a. Fill the reservoir with an approved fluid.
 - b. Start the engine.
 - c. Check and correct the fluid level.



Figure 18. Servicing Plunger Body.

RELIEF PLUNGERS AND AXLE STOPS



- d. Check for leaks.
- e. Set the automatic plungers following the procedure on page 18.
- f. Lower and fasten the hood or cab following the procedures in the vehicle manufacturer's service manual.

Repairing Input End Bearing Cap Automatic Plunger

Parts Required

- ✓ Auto plunger repair kit 18212821K

Tools Required

- ✓ Drain pan
- ✓ Metric sockets and ratchet
- ✓ Slotted screwdriver bit with suitable socket and ratchet
- ✓ 1/4" drift punch
- ✓ 1/8" pin punch
- ✓ 1/4" pin punch
- ✓ 1/4" center punch
- ✓ 10mm open end wrench
- ✓ Hammer

Procedure:

1. Park the vehicle on a clean, dry, solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Block the wheels.
 - c. Place the transmission in neutral.
 - d. Tilt the hood or cab to access the front tires.
2. Place a drain pan under the steering gear.
3. Mark the bearing cap and housing for re-assembly.
4. Remove the universal joint from the input shaft of the steering gear.
5. Remove the plastic plug from the plunger hole.

❗ **WARNING:** In step 6 below, failure to keep the 1/4" punch straight in the bore or hitting the plunger too hard can result in damage to the steering gear or automatic plunger assembly.

6. Using the 1/4" punch and hammer, drive the automatic plunger in until it bottoms.
7. Remove the four attaching bolts from the bearing cap using an appropriate size socket and ratchet.

❗ **CAUTION:** In step 8 below, do not force the shaft when turning it out of the housing. Binding of the shaft and steering gear damage can result.

8. Separate the bearing cap assembly from the housing by turning the input shaft out of the housing. Turn the shaft until it stops.
9. Carefully insert the screwdriver bit into the plunger bore to engage the slotted head of the plunger body.

! **CAUTION:** In step 10 below, do not allow the screwdriver bit to slip off the plunger body as damage to the bore can result.

NOTE: The auto plunger flange is held in place with thread locking compound and the threads are staked at the factory. It will require approximately 15-20 inch/pounds of torque to remove the flange.

10. Using the 10mm open-end wrench to hold the flange across the flat sides, carefully turn the flange to remove the flange from the plunger body.
11. Discard the flange.
12. Remove the plunger body from the spring pin and discard. It may be necessary to tap the plunger body to remove it from the spring pin. Use of a 1/8" pin punch is recommended.
13. Coat the O-ring of the plunger assembly with a light coat of grease.
14. Install the plunger body through the spring pin.

! **CAUTION:** Check the plunger bore for nicks or gouges before installing the plunger assembly. Take care not to introduce dirt or contaminants in the plunger bore when reassembling.

! **CAUTION:** The flange must contact the spring pin. Otherwise, steering gear damage or a leak can result.

NOTE: The plunger body has locking compound on the threads and will require approximately 15-20 inch/pounds of torque to overcome it.

15. Use the screwdriver bit and ratchet to hold the plunger body. Screw the flange onto the plunger body using the 10mm open-end wrench until the flange contacts the spring pin.
16. Remove the block.
17. Install the bearing cap assembly onto the housing taking care to align the reassembly marks made earlier.
18. Install the plug in the plunger hole. Torque the attaching bolts to specifications.
19. Install the universal joint onto the steering gear input shaft following the procedures in the vehicle manufacturer's service manual.
20. Fill the reservoir with an approved fluid.
21. Start the engine.
22. Check and correct the fluid level.
23. Check for leaks.
24. Set the automatic plungers as described above.
25. Lower and fasten the hood or cab following the procedures in the vehicle manufacturer's service manual.

RELIEF PLUNGERS AND AXLE STOPS



Axle Stop Adjustment

Axle stop positioning should be checked during pre-delivery because such positioning will determine the vehicle's maximum wheel cut. Stops can be adjusted using the adjustable bolt and lock nut on each spindle.

NOTE: The following procedure is a guide. Refer to the OEM specifications for specific vehicle wheel cuts.

Tools Required

- ✓ Hydraulic jack
 - ✓ Wrenches to fit stop bolts
-

Procedure:

1. Park the vehicle on a clean, dry, solid surface, preferably concrete.
 - a. Set the parking brake.
 - b. Chock the wheels.
 - c. Tilt the hood or cab to access the front tires.
2. Raise the front of the vehicle until the tires clear the surface.

! **WARNING:** In step 3 below, do not exceed the minimum clearance of 1". Never allow the tire to contact the chassis. Otherwise, tire or steering component damage will result.

3. Turn the wheels:
 - a. To a full right turn.
 - i. Note the position of the tire relative to the steering gear or draglink.
 - ii. Adjust the stop bolt on the spindle until a minimum clearance of 1" is maintained between the tire and the chassis. This is the maximum wheel cut available.
 - b. To a full left turn. Repeat adjustment.
4. Make sure the jam nuts are tight on both axle stop bolts.
5. To complete the service:
 - a. Lower the vehicle.
 - b. Lower and fasten the hood or cab following the procedure in the vehicle manufacturer's service manual.
 - c. Remove the chocks.

Bleeding Air from Steering Gears

Most single steering gears can be bled simply by turning the steering wheel all the way from stop to stop after the gear has been installed, lines connected, system filled with fluid, and relief plungers set. Some gears, however, require bleeding through a bleeder screw or, in the case of dual gear systems, a special procedure. The following guidelines can be used.

NOTE: Two technicians are needed for this procedure.

Single Gear Systems

! CAUTION:

- Do not allow the reservoir to run dry at any time.

Procedure:

1. If the gear is mounted with the bulge in the housing for the sector shaft hanging below the piston cylinder:
 - a. With the weight of the vehicle on the ground, start the engine and let it run at idle speed.
 - b. Turn the steering wheel lock to lock 3 times.
 - c. Hold the wheel in pressure for about 5 seconds when you reach the lock position in each direction.
 - d. Center the steering.
 - e. Bleeding is complete.
2. If the gear is mounted with the bulge in the housing for the sector shaft sitting above the piston cylinder:
 - a. Locate the bleeder plug on the sector housing (Figure 19). It resembles a 3/4" bolt head.
 - i. Locate a piece of tape covering a 1/8" allen set screw in the center of the head.
 - ii. Remove the tape to expose the set screw.



Figure 19. Bleeder Plug with Set Screw.

- ### **! CAUTION:**
- Do not remove the bleeder screw from the plug. A check ball behind the screw may easily be lost.

- ### **! CAUTION:**
- The bleeder should only be open when turning the steer tires to the right. If it is open when turning left, air will be forced back into the system.

RELIEF PLUNGERS AND AXLE STOPS



- b. With the weight of the vehicle on the ground, start the engine and let it run at idle speed.
 - c. Technician #1 turns the steering wheel to full left.
 - d. Technician #2 opens the set screw in the bleeder plug 4 turns.
 - e. With the bleeder still open, technician #1 turns the wheels to full right. At the full right turn position, technician #2 shuts the bleeder.
 - f. Turn the wheels all the way to the left and repeat the procedure 2 more times.
3. Center the steering.
 4. Bleeding is complete.

Dual Gear Systems

! CAUTION:

- Do not allow the reservoir to run dry at any time.

Procedure:

1. With the weight of the vehicle on the ground, start the engine and let it run at idle speed. The draglink should be connected to the pitman arm on the main gear but not connected to the slave gear.
2. Turn the steering wheel all the way to the left until the axle stop contacts the axle and hold it until the pitman arm on the slave gear moves its full travel. It should move in the opposite direction of the pitman arm on the main gear.
3. Turn the steering wheel full right until the axle stop contacts the axle.
4. Hold it until the pitman arm on the slave gear moves its full travel.
5. Repeat the procedure 3 more times or until there is no air in the system and the slave gear moves freely.

NOTE: Do not move the pitman arm on the slave gear by hand. Air may be drawn into the system.

6. Turn the steering wheel until the pitman arm on the slave gear lines up with the draglink and install the draglink.
7. Cycle the steering from stop to stop. If the steering catches or sticks, some air is in the system and additional bleeding is needed. Follow the procedure outlined for bleeding a single gear with the bulge in the housing for the sector shaft sitting above the piston cylinder. If both gears have bleeder plugs, bleed only when turning the steering wheel to the right.

Bleeding is complete when the steering operates smoothly from lock to lock in both directions.

To properly diagnose steering complaints, it is important to understand the complete steering system. Many factors outside of the steering system will affect steering performance: suspension misalignment, looseness in front-end components, mismatched tires, a dry fifth wheel, and more.

General Diagnosis

Often, a steering gear is replaced needlessly because an orderly diagnostic procedure is not followed. Begin your diagnosis using the following outline as a guide.

Step 1: Define the Complaint

- ✓ Interview the driver – Refer to the list of technical terms at the end of this manual to obtain a clear understanding of what the driver is saying.
- ✓ Drive the vehicle – If possible, the driver should show the technician the problem he is experiencing, driving the vehicle together to duplicate the condition.

Step 2: Visually Inspect the Vehicle

- ✓ Check for a dry fifth wheel – The drag from lack of lubrication will tend to steer the vehicle.
- ✓ Check tires for mismatch, improper inflation, or uneven wear patterns.
- ✓ Check for poor loading practices – Special body or equipment installations should be checked for their effect on steering angles and effort.
- ✓ Check for suspension sagging or shifting. Out-of-line rear axles will tend to steer the front end of the vehicle.

Step 3: Inspect Mechanical Components

- ✓ Check all front axle components for wear, looseness, or seizing.
- ✓ Inspect the steering column for drag. More than 10 inch/pounds of drag measured with the column suspended at the angle of operation is excessive.
- ✓ Check the steering gear mounting to be sure that it is tight. A steering gear that is shifting on the frame will cause poor steering performance and may eventually lead to a catastrophic failure of the housing.

Step 4: Check the Hydraulic Supply System

- ✓ Follow the procedures as outlined in the hydraulic diagnosis section below. Oil pressure and flow must be within the vehicle manufacturer's specifications.

Troubleshooting and Testing

Before proceeding with diagnostic tests and repair procedures, check all mechanical and external conditions. **The checklist form on the last page can be photocopied. It follows the troubleshooting outline.**

Testing The Hydraulic System

The Sheppard Heavy Duty Power Steering Test Kit Part #5517641 (Figure 20) is an excellent tool for troubleshooting power steering systems and can be ordered from Sheppard.

This tester is a self contained, direct reading device to check system flow, pressure, or both at the same time. It can detect worn components, check flow and pressure control settings, or monitor overall system performance.



Figure 20. Sheppard Power Steering Tester.

Low Cost – Easy to Use

Only one hose is disconnected, either at the pump output or at the pressure input to the power steering gear housing. This tester:

- Installs between the pump and steering gear.
- Isolates the pump from the gear with a shutoff valve.
- Reads pressure and flow at the same time.
- Includes a 0-3000 psi pressure gauge.
- Includes a 1-10 gpm flow meter.
- Is complete with hoses and standard swivel fitting.

Hydraulic Diagnosis

Before any steering gear repairs are made, complete the hydraulic supply evaluation and make any repairs. Many times steering gears have been replaced needlessly because a hydraulic supply system evaluation had not been completed.

Vehicle manufacturers specify the maximum operating pressure for their various steering systems. Always refer to the vehicle manufacturer's specifications for the correct pump relief settings. Sheppard D-series steering gears operate at system pressures up to 2790 psi depending on the chassis the gear is installed on. Some applications operate at lower pressures; consult the vehicle OEM for the power steering pump pressure rating. Steering system pump flow should be in the 2.5-6.0 gpm range. Optimum performance will be about 4 gpm for single gear applications and 5.5 gpm for dual gear applications.

NOTE: All tests must be performed with the vehicle parked on a clean, dry, solid surface, with the engine running and the full weight of the vehicle on the front wheels.

Procedure:

1. Make a copy of the troubleshooting test sheet.
2. Connect the pressure and flow tester in series with the pressure line of the pump.
3. Start the engine.
4. Check the system oil level. Make sure the oil is flowing in the proper direction as indicated by the arrow on the flow meter.
5. Place a thermometer in the reservoir.
6. Run the engine at idle speed.
7. Slowly close the shut off valve until you have a pressure reading of 1000 psi.
 - a. Maintain this pressure until system temperature reaches 180 degrees Fahrenheit.
 - b. Open the shutoff valve all the way when the temperature is 180 degrees.
8. Check system backpressure:
 - a. Normal system backpressure will be between 0 and 100 psi with the engine idling and the steering wheel stationary. Dual systems will normally read slightly higher.
 - b. Backpressure should be checked at normal operating temperature.

! WARNING: In step 9 below, a bad pressure relief valve may not relieve pump pressure. Closing the shutoff valve may cause severe pump damage or high-pressure hoses to rupture. Watch the pressure gauge closely. If pressure rises rapidly or goes above 2800 psi, stop the test! Do not close the valve all the way.

! CAUTION: After closing the shutoff valve in step 9a below, open the valve as quickly as possible to avoid heat build-up or possible damage to the steering pump.

NOTE: Some steering pumps are not equipped with integral relief valves. Close the shutoff valve slowly.

9. Check the pump maximum relief pressure:
 - a. With the engine running at specified idle speed, slowly turn the shutoff valve until it is closed.
 - b. Read the pressure at which the pressure relief valve opens. This pressure reading should equal the maximum pump pressure specified by the vehicle manufacturer.

10. Check system flow by measuring oil flow under the following conditions, recording your findings on the troubleshooting checklist.
 - a. Flow at idle with back pressure only
 - b. Flow at idle under a 1500 psi load applied with the shutoff valve
 - c. Flow at full governed rpm with back pressure only
 - d. Flow at full governed rpm under a 1500 psi load applied with the shutoff valve

11. Check for aerated oil:
 - a. Visually check for air in the steering system oil. The oil should be clear.
 - b. Any signs of frothing indicate air in the system and steering performance will be affected.
 - c. Carefully check for leakage on the suction side of the steering pump.
 - d. Drain, refill, and bleed the system.
 - e. Set the relief plungers using the procedure on page 18.

12. Check dry park pressure and input effort:
 - a. Measure and record the pressure required to steer the vehicle from full left to full right while parked. Input effort is measured at the steering wheel retaining nut.
 - b. Use a dial type inch/pound torque wrench to check static steering input effort. Normal input effort will be less than 100 inch/pounds.

Fluid and Filter Change

Fluid and filter change keeps the system fluid clean. The use of high quality fluids (see list below) and filters will assure the removal of contaminants and dissipate heat.

NOTE: Sheppard recommends the power steering system fluid and filter be changed at every engine oil change. Today's systems typically have smaller reservoirs and operate at much higher temperatures than in the past. Regular preventive maintenance is essential to extended steering system life.

Fluid Recommendations

Power steering fluid lubricates moving parts and removes the heat that reduces efficiency and increases wear. Sheppard lists all approved fluids on their website (www.rhsheppard.com) and approves these fluids in the D-Series steering gear:

- Automatic Transmission Fluid Dexron II or Type "E" or "F"
- Chevron 10W40
- Chevron Customer 10W40 Motor Oil
- Cummins Premium Blue 2000 15W40
- Drydene XHD 15W40
- Drydene MP Dexron II/ Mercon ATF
- Exxon Auto H32 Hydraulic Fluid
- Fleetrite PSF (Can #990625C2)
- Ford Spec. M2C138CJ
- Mack EO-K2 Engine Oil
- Mobil 1 15W50 Motor Oil
- Mobil ATF 210
- Mobil Super 10W40 Motor Oil
- Mobil Super 15W40 Motor Oil
- Shell Rotella T30W
- Shell Rotella T SAE 30
- Texaco 10W40
- Texaco Code 1831 Power Steering Fluid 11872
- Texaco Code 1854 Mercon / Dexron III
- Union 10W40
- Union 15W40
- Unocal 46 Power Steering Fluids
- Unocal Guardol 15W40 Motor Oil
- Valvoline All-Climate 10W40 Motor Oil

Tools Required

- ✓ Drain pan
- ✓ Shop towels
- ✓ 10" adjustable wrench
- ✓ Hydraulic jack of a suitable size
- ✓ Screwdriver

Parts Required

- ✓ Specified steering fluid
- ✓ Specified filter

Procedure:

1. Park the vehicle on a clean, dry, solid surface, preferably a concrete pad.
 - a. Set the parking brake.
 - b. Block the rear wheels.
 - c. Place the transmission in neutral.
2. Using the hydraulic jack, raise the front end of the vehicle until the tires have cleared the surface.
3. Tilt the hood or raise the cab using the procedure in the vehicle manufacturer's service manual.
4. Drain the fluid:
 - a. Place the drain pan under the steering gear to catch the fluid.
 - b. Remove the pressure and return lines from the steering gear to drain fluid.

NOTE: In step 5 below, discard only the filter element. The other parts retain the filter in the reservoir assembly.

5. To remove the filter:
 - a. Wipe off the area around the reservoir cap with a clean towel.
 - b. Remove the bolt from canister type reservoirs.
 - c. Remove the cover.
 - d. Remove the filter from the canister and discard. If a spin-on filter is used, remove the filter and discard using the filter wrench.
 - e. Wipe the inside of the reservoir canister clean with a clean shop towel.
 - f. With the hoses disconnected:
 - i. Make sure the drain pan will catch the oil from the steering gear.
 - ii. Slowly turn the steering wheel from full left to full right three or more times to purge oil from the steering gear.

6. Attach the pressure and return lines to the steering gear and tighten to specifications.
7. Install a new filter element in the reservoir according to the directions on the filter element and the vehicle manufacturer's service manual.
8. To clean and service the reservoir cap:
 - a. Clean the reservoir cap with an approved solvent.
 - b. Install a new gasket.
 - c. For vehicles with a spin-on filter element, replace the filter using procedures in the vehicle manufacturer's service manual.
9. Fill the reservoir with new steering fluid to within 1" of the top of the reservoir canister.
10. Install the reservoir cover and tighten the bolt to the vehicle manufacturer's specification.

! CAUTION: In steps 11 and 12 below, do not allow the reservoir to empty during start up. Pump damage may result.

11. Start the vehicle.

12. With the engine idling:

- a. Check the fluid level and fill as needed.
- b. Bleed the system following the guidelines contained in this manual.

! WARNING: In step 12c below, do not check for leaks by hand. Hydraulic oil under pressure can penetrate the skin and cause severe injury.

- c. Visually check all fittings and hoses for external leaks.

13. To complete the service:

- a. Shut the engine off.
- b. Remove the drain pan.
- c. Lower the vehicle until the full weight of the tires is on the surface.
- d. Remove the jack.
- e. Lower and fasten the cab or hood using the procedures in the vehicle manufacturer's manual.

Final Adjustments

Sheppard Power Steering gears have no external adjustments for sector shaft or valve shaft pre-load. Make sure all linkages and system components are within the vehicle manufacturer's specifications.

- **TORQUE:** Check all fastener torque values when installing the steering gear (Table 1). Consult the vehicle manufacturer's service manual for torque values from steering gear to frame, pinch bolt, and draglink.
- ! **DANGER:** Improper pitman arm installation could lead to an accident or serious personal injury!
- **PITMAN ARM:** Pitman arm application torque is critical. Follow the pitman arm installation instructions in this manual.
- **SET RELIEF PLUNGERS:** Verify the type of relief plungers in your steering gear. Refer to procedures beginning on page 18 to properly set the relief plungers.
- **BLEED THE SYSTEM:** Follow the guidelines on pages 25-26 for proper bleeding of both single and dual gear systems.

Table 1. Torque Values

APPLICATION	SIZE	GRADE	FT/LBS	(N/M)
Bearing Cap Cover: All D-Series	M10 x 1.5	10.9	53-64	(72-87)
Bearing Cap Bolts: MD or HD	M14 x 2.0	9.8	114-140	(154-190)
Cylinder Head: HD Slave	M14 x 2.0	9.8	114-124	(154-190)

The following are terms (in alphabetical order) that technicians should know when discussing heavy vehicle power steering.

Back Pressure – Circulating pressure of the steering system.

Base Mounted Gear – The steering gear is mounted to the frame rail or bracket utilizing the eight mounting holes opposite the sector shaft cover.

Bearing Cap – End cap of the steering gear that houses the actuating shaft and valve.

Bearing Cap Cover – Small cover on the end of the bearing cap of the steering gear. The bearing cap cover houses the input shaft oil and salt seals.

Bleed Screw – 1/8" allen screw located in the sector shaft bore of the steering gear.

Cavitation – Bubbles that form in the oil which keep the pump from supplying pressure and volume.

Contamination – Dirt or other foreign material in a fluid.

Cylinder Bore – Long bore of the steering gear where the steering gear piston is housed.

Cylinder Head – The end cap of the steering gear bolted on the housing opposite the actuating shaft end of the gear.

Displacement – The volume of fluid that can pass through a pump or cylinder in a single revolution or stroke.

Feedback – Transferred energy from the output of a device to its input.

Flow – The amount of fluid that passes a certain point in a unit of time. The volume of flow is usually expressed in gallons per minute for liquids.

Fluid Flow – The stream or movement of a fluid, or the rate of its movement.

Piston – Changes the hydraulic force to mechanical force in the steering gear cylinder bore.

Plunger – Relief valves in the steering gear to limit steering gear piston travel. Plungers are automatic and are adjustable.

Pressure Relief Valve – Optional pressure relief valve integral to the steering gear to limit system operating pressure. Identified by a large hex nut on the side of the bearing cap.

Pump – A device that converts mechanical force and motion into hydraulic fluid power.

Rack Teeth – The area on the piston that engages the sector shaft teeth.

Recirculation Ball Thread – The area of the rotary valve on which the 24 steel balls travel.

Relief Valve – A pressure control valve used to limit system pressure.

Rotary Valve – Internal valve in the bearing cap of the steering gear. It is actuated by the steering wheel through the yoke connection of the steering column.

Sector Shaft – The shaft on which the pitman arm is attached.

Sector Shaft Bore – Area of the steering gear that houses the sector shaft.

Slave Gear – Right hand gear in a dual system application.

Slave Ports – Threaded openings in the cylinder head, bearing cap, and sector shaft bore to install the pressure lines to operate the slave gear.

Tab-Lock Retainer – Bolt assembly used to provide initial torque when installing the pitman arm. Uses alignment tabs that fit into the pitman arm and restraining tabs to be locked into the head of the retainer.

TROUBLESHOOTING



Here are the causes and solutions for the most common steering gear problems.

NOTE: For safety reasons, the R. H. Sheppard Co. no longer recommends that power steering gears be dismantled and repaired. If any problem listed below would require dismantling the gear, instead replace it with a new or remanufactured one.

<i>Possible Causes</i>	<i>Solutions</i>
OIL LEAKS	
<ol style="list-style-type: none"> 1. At output shaft 2. At actuating shaft 3. At supply pump driveshaft 	<ol style="list-style-type: none"> 1. Replace damaged sector shaft seal and sector shaft if necessary. 2. Replace worn or damaged oil shaft seal. 3. <ol style="list-style-type: none"> a. Replace damaged seal. b. Check for high operating temperatures that may damage seal. c. Replace pump if shaft bushing is loose or damaged.
LUBRICANT APPEARANCE	
<ol style="list-style-type: none"> 1. Lubricant milky or white, caused by water entry through reservoir venting system 2. Lubrication oil discolored <ol style="list-style-type: none"> a. Operating temperatures too high b. Change intervals too long c. Incorrect lubricant used 	<ol style="list-style-type: none"> 1. Clean vent system or replace cap assembly, then flush system. 2. <ol style="list-style-type: none"> a. Correct cause of overheating. b. Change oil more often. c. Drain, flush, and refill with recommended fluid.
OIL FORCED OUT OF RESERVOIR OR FOAMING	
<ol style="list-style-type: none"> 1. Clogged oil filter 2. Air in system 3. Relief plungers not adjusted properly, creating high operating temperatures 4. Air leak in suction side of supply pump 5. Pump cavitating 6. Oil overheating 	<ol style="list-style-type: none"> 1. Change oil and filter – Change more often. 2. <ol style="list-style-type: none"> a. Bleed air from system. b. Check for air leak on suction side of supply pump. 3. Adjust relief plungers (see page 18). 4. Refer to pump servicing instructions. 5. Check for restriction in pump supply. 6. Check for restriction in steering gear return.
ENGINE OIL IN POWER STEERING RESERVOIR (GEAR DRIVEN PUMP)	
<ol style="list-style-type: none"> 1. Faulty seal at pump drive shaft 2. Faulty seal at accessory shaft driving supply pump 	<ol style="list-style-type: none"> 1. Repair pump. 2. Repair shaft.
HIGH OPERATING TEMPERATURES	
<ol style="list-style-type: none"> 1. Oil flow restriction 2. Oil flow too high (high pump temperature) 	<ol style="list-style-type: none"> 1. Check back pressure. 2. Check maximum oil flow.
NO POWER STEERING ON COLD STARTING	
Hydraulic supply pump vanes not extending (vane pump only)	Increase engine speed momentarily to extend vanes and start pump action. Usually does not happen often and does not last long. Not a cause for pump repair or replacement.

Possible Causes

Solutions

EXCESSIVE PUMP PRESSURE WITH STEERING GEAR IN NEUTRAL POSITION	
1. Pinched oil return line – High back pressure 2. Binding steering column	1. Relocate line. 2. Repair steering column.
WHEEL CUTS RESTRICTED	
Relief plungers not adjusted properly	Adjust relief plungers.
ERRATIC STEERING OR MECHANICAL STEERING ONLY	
1. Insufficient volume of oil 2. Sticking pressure relief valve	1. Refer to pump servicing instructions. 2. Replace relief valve as required.
HARD STEERING	
1. Faulty supply pump 2. Steering out of alignment 3. High operating temperature	1. Check pump flow. 2. Align front end. 3. Locate and correct cause of overheating.
WHEEL TURNS HARD IN ONE OR BOTH DIRECTIONS	
1. Bind in steering column 2. Dirt or foreign matter trapped in piston relief 3. Bent or damaged king pins and tie rods 4. Front end load too great 5. Low oil level in steering system 6. Air in system 7. Caster degree incorrect	1. Check column drag. 2. Check piston relief. 3. Replace king pins and tie rods. 4. Lighten load. Notify customer of overloading. 5. Fill oil reservoir as required. Check for leaks. 6. Bleed system and check for cause. 7. Correct to specifications.
NO ATTEMPT TO RETURN TO STRAIGHT AHEAD FROM TURNS (MAY ALSO BE HARD STEERING COMPLAINT)	
1. No positive caster 2. Steering gear mounting distorted 3. Linkage ball sockets seized or binding 4. King pins seized or binding 5. Oil flow rate incorrect	1. Set caster to 3° to 5° positive. 2. Shim mounting pads to eliminate piston-to-bore interference. Use correct bolt length on the base mount gears. 3. Check and repair or replace. 4. Repair or replace. 5. Check and correct supply pump.
DARTING, WANDERING (OVERSTEERING)	
1. Oil flow too high 2. Air trapped in steering gear 3. Looseness, worn front end parts 4. Front end alignment not correct 5. Overloading 6. Rear axle not parallel 7. Tight tie rod ends, draglink sockets	1. Supply pump not to specifications. 2. Bleed system. 3. Check and repair as required. 4. Align front end caster. 5. Reduce loads. Notify customer of overloading. 6. Repair as required. 7. Check rotational torque. Replace if necessary.

Possible Causes

Solutions

EXCESSIVE BACKLASH OR FREEPLAY	
<ol style="list-style-type: none"> 1. Worn U-joint or U-joint yoke loose on actuating shaft 2. Pitman arm ball worn "egg-shaped" (if equipped) 3. Worn or damaged pitman arm splines 4. Loose bracket frame to bracket or bracket to gear 5. Rack on piston damaged 6. Damaged sector shaft/splines 	<ol style="list-style-type: none"> 1. Replace damaged parts. 2. Replace pitman arm assembly where riveted ball is used. 3. Replace pitman arm and sector shaft. 4. Remove and clean frame and bracket. Assure bracket is not bearing on frame radius or worn by looseness. Reinstall bracket, torquing bolts to proper rating. If necessary, replace bracket. 5. Replace steering gear. 6. Replace steering gear.
STEERING INPUT NOT SMOOTH	
<ol style="list-style-type: none"> 1. Worn U-joint 2. Lack of lubrication 3. U-joints not phased properly 4. Low oil flow 5. Overload on front axle 6. Pump cavitating 7. Overheating 	<ol style="list-style-type: none"> 1. Replace as required. 2. Lubricate per vehicle manufacturer's recommendations. 3. Re-phase columns (see Note). 4. <ol style="list-style-type: none"> a. Idle speed too low – adjust idle b. Drive belts slipping – tighten belts c. Supply pump not to specifications – replace 5. Verify front axle weight. Notify customer of overloading. 6. Correct pump supply. 7. Correct cause of overheating.

NOTE: U-joint operating angle must be 20° to 25°. Read inch/pound torque differences while steering from lock-to-lock. Variation of more than 15 inch/pound means improper phasing. To correct phasing, rotate the intermediate shaft one spline at a time until torque is the same through 360 degrees.

TROUBLESHOOTING AND TESTING

Before proceeding with diagnostic tests and repair procedures, check all mechanical and external conditions. This checklist form, which can be removed and photocopied, follows the troubleshooting outline below.

Date: _____

Servicing Dealer Location: _____

Customer Name: _____



Description of Steering Complaint:

Vehicle Model _____ Mileage _____ VIN _____

Steering Gear Model: _____ Serial No. _____

Slave Gear Model (if equipped) _____ Serial No. _____

Pump Manufacturer _____ Front Axle Weight _____

Hydraulic Tests

Do not remove the steering gear! Install the Sheppard pressure and flow tester in series with the pressure line of the pump. Record the following information:

Stabilized Oil Temperature: _____

System Backpressure @ Idle _____ Backpressure @ Full RPM _____

Maximum System Pressure (Pump Relief Setting) _____ psi

Flow @ Idle with Backpressure Only _____ GPM

Flow @ Full Governed RPM with Backpressure Only _____ GPM

Flow @ Idle with 1500 psi Load Applied _____ GPM

Flow @ Full Governed RPM with 1500 psi Load Applied _____ GPM

Static Steer Pressure Right Turn _____ psi Left Turn _____ psi

Static Steer Input Right Turn _____ in/lb Left Turn _____ in/lb

For questions about diagnosis, call Sheppard Field Service at 800-274-SHEP (274-7437).