



SHEPPARD

a **WABCO** company

M-SERIES POWER STEERING GEAR SERVICE MANUAL

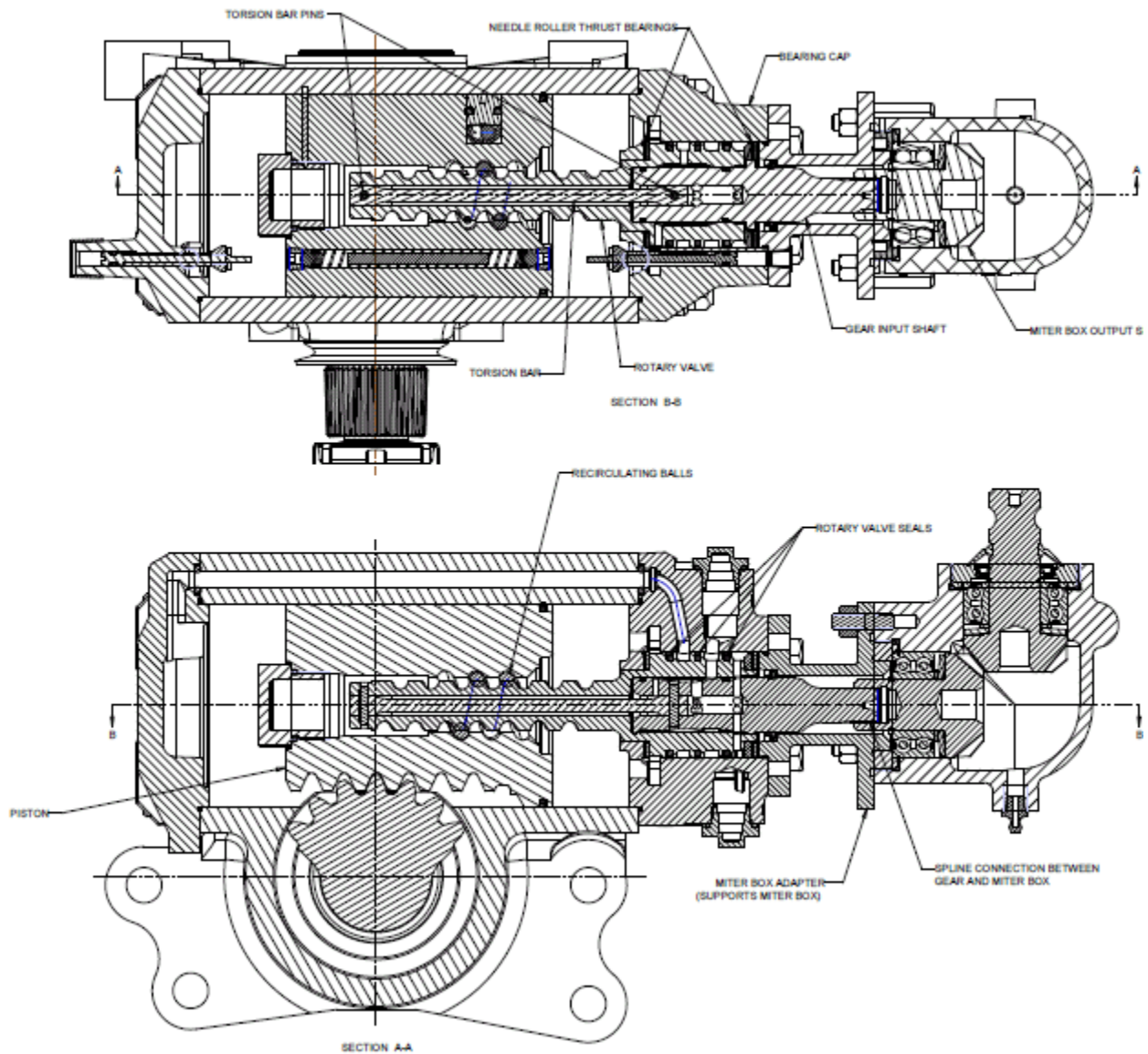



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SAFETY NOTICE


 Before you begin any maintenance, troubleshooting or repairs, please read this manual carefully. The procedures outlined in this manual have been assembled to provide service technicians the best possible information available on troubleshooting and repairing Sheppard M-Series Steering Gears at the time of this publication. Sheppard D-Series and 92-Series Steering Gears are covered in separate service manuals. To ensure safe and reliable operation, the service and repair procedures must be followed carefully. This manual has been written using the ANSI Z535.6-2011 Standard as a guide.


THIS MANUAL CONTAINS SAFETY ALERT SYMBOLS  AND SIGNAL WORDS TO IDENTIFY PERSONAL INJURY OR PROPERTY DAMAGE. BE ALERT TO 

 **WARNING**  **CAUTION** AND  **NOTICE** - THE INFORMATION FOLLOWING A SAFETY SIGNAL WORD OR SAFETY ALERT SYMBOL WILL SAVE YOU FROM INJURY OR UNNECESSARY REPAIR.

 This Safety Alert Symbol is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

 **DANGER** Indicates a hazardous situation that, if not avoided, WILL result in death or serious injury.

 **WARNING** Indicates a hazardous situation that, if not avoided, COULD result in death or serious injury.

 **CAUTION** Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

 **NOTICE** Indicates information considered important, but not hazard related. It identifies possible property damage.

SECURE FOR SERVICE

The term "Secure for Service" is used throughout this manual to identify when the vehicle should be put in a condition where maintenance can be performed safely, with minimal risk of personal injury or property damage. Local shop safety practices apply and may include, but are not limited to:

- Wear Personal Protective Equipment (PPE) such as eye protection and chemical resistant gloves
- Set the Parking Brake
- Chock the wheels
- Remove the ignition key
- Disconnect the battery
- Have the means to properly contain and dispose of fluids

If at any time you have questions or comments, contact the Sheppard Field Service Hotline at 800-274-7437.

INTRODUCTION

This service manual covers only repairs to Sheppard M-Series steering gears. The vehicle manufacturer's service manual should be used for removal and installation instructions of the steering gear, power steering pump, and all other steering system components.

All information, pictures, illustrations and specifications in this manual are the latest available at the time of printing. We reserve the right to make changes without notice. If you are not certain you have the current revision of this manual, or if you have questions about any procedures, please call our Field Service Hotline at 800-274-7437 before you begin repairs.

The R. H. Sheppard Company was founded in 1937 by Mr. R. H. Sheppard when he purchased a one story factory on East Middle Street in Hanover, PA. The rights to produce the existing product lines of the Kintzing wire cloth loom, floor polisher and gas engine generator were also purchased. These products provided the basis of the manufacturing facility and a place where the diesel engines could be developed. As various uses were found for the diesel engines and business prospered, the other lines were phased out.

From that one story factory on Middle Street, the company purchased the factory on Philadelphia Street in 1940 and the foundry in 1943. These plants were expanded over the years to their present sizes. In 1981, construction began on the first bay of Plant 5, which has been expanded to include three bays, totaling 52,000 square feet. The Technical Center was completed in 1988 to provide full function testing of all of our products and to help in the solving of our customers' engineering problems. With the completion of the new foundry in 1990, our foundry capacity was doubled. The latest addition to the company has been the facility in Wytheville, VA, which covers 64,000 square feet. This facility provides support for the Hanover manufacturing facility, as well as producing the sway bar product line for Kenworth. The first diesels were produced experimentally as early as 1933, after Mr. Sheppard graduated from Dickinson College. In all, twenty basic models of engines were developed and marketed throughout the world. These engines were used to power generator-sets, pumps, life boats, rescue craft, refrigerated railroad cars, and farm tractors. The diesel engines were the first love of Mr. Sheppard, and he searched for a long-term use for thirty years. The engines were produced from the 1930's to 1963.



The first power steering gear was applied to the SD-4 tractor in 1953, and soon would find its way to heavy duty trucks. In the years between the end of tractor production and the total commitment to power steering in 1963, the company produced one of the first ice vending machines that would store bags of ice and automatically dispense them as a soda machine does today. Although the ice machine was never a significant product for the company, it should be mentioned.



In 1963, R. H. Sheppard totally committed the company's manufacturing and engineering resources to the production of power steering. Over the years, the company has been issued more than two dozen patents on steering, from both R. H. and Peter Sheppard. This continued commitment - to produce the highest quality steering components possible - led to the introduction of the M-series family of gears in 1986. The M-series includes five basic models, with several hundred variations of those models in our system.

Our products are used throughout the U.S. and Canada, as well as ten foreign countries around the world. Whether the product is power steering for the transportation industry, econovances for cleaner, more efficient engines, sway bars for suspensions or certified castings - our focus and our success has been to provide the highest quality products and the best service possible.

STEERING GEAR IDENTIFICATION

BASIC MODEL NUMBER

The basic model number is cast into the center of the main housing, and identifies the basic family the steering gear belongs to. Examples are:

- M80
- M83
- M90
- M100
- M110

STEERING GEAR MODEL AND SERIAL NUMBER

Letters and numbers are stamped or pin-printed into the housing at the edge of the sector shaft bore, to identify the steering gear sub-model and serial number. When these numbers are combined with the basic model number (cast into the housing), they give you the complete steering gear model and serial number. Examples are:

- SAW1 10A03034 (M80SAW1)
- PAM22 07B05553 (M83PAM22)
- SAD17 04G05490 (M90SAD17)
- PMX3 R09L0332 (M100PMX3R)
- PJZ34 09E07748 (M110PJZ34)

NOTE: No matter how the steering gear is mounted to the chassis, the model and serial number will be stamped into the housing on the side which is visible.

AUTO

The word AUTO cast into the housing next to the basic model number means the steering gear has Automatic Relief Plungers. If AUTO is not present the steering gear has Manual Relief Plungers. See the appropriate section of this manual on how to set the relief plungers.

WHAT IT ALL MEANS

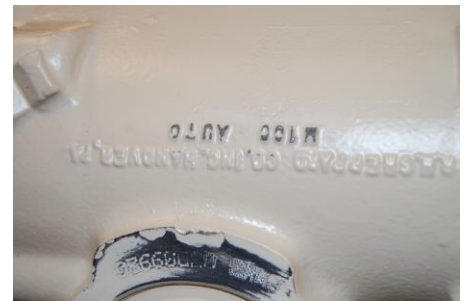
Example: M100PMX3R

- M-Represents the Series of the steering gear, the M-Series. Other Series are D-Series and 92-Series.
- 100-Indicates the diameter of the piston in millimeters. There are also 80, 83, 90 and 110. The larger the piston the more powerful the steering gear.
- P-Stands for Power or Primary steering gear. It will be the one connected to the steering wheel and be the Master gear for multiple steering gear systems. S in this position means Slave or Secondary steering gear on heavy or multiple axle chassis. It will not be connected to the steering wheel and receives its pressure from the Primary or Master steering gear.
- MX-Is the next set of letters in sequence assigned when this particular model was created. It also means this steering gear is designed for a specific application, as are all Sheppard steering gears. An MX is not interchangeable with an SS, MT, QS, DQ. Contact your vehicle dealer or Sheppard Field Service for questions on steering gear applications.
- 3-Indicates the steering gear has Automatic Relief Plungers. Other designators are: 1-Indicates Manual Relief Plungers,
- 2-Indicates a special application, two digits mean the steering gear came from Sheppard with a Pitman Arm attached.
- R-Shows the steering gear was remanufactured by Sheppard.

“A” with a number-Indicates the steering gear was built with a special mounting bracket (M110PBT1A2).



**PITMAN ARM AND COLUMN
REMOVED**



**BASIC MODEL NUMBER (M100)
(INVERTED)**



REMOVE PAINT



PMX3

THE SERIAL NUMBER

Example: R08C1672

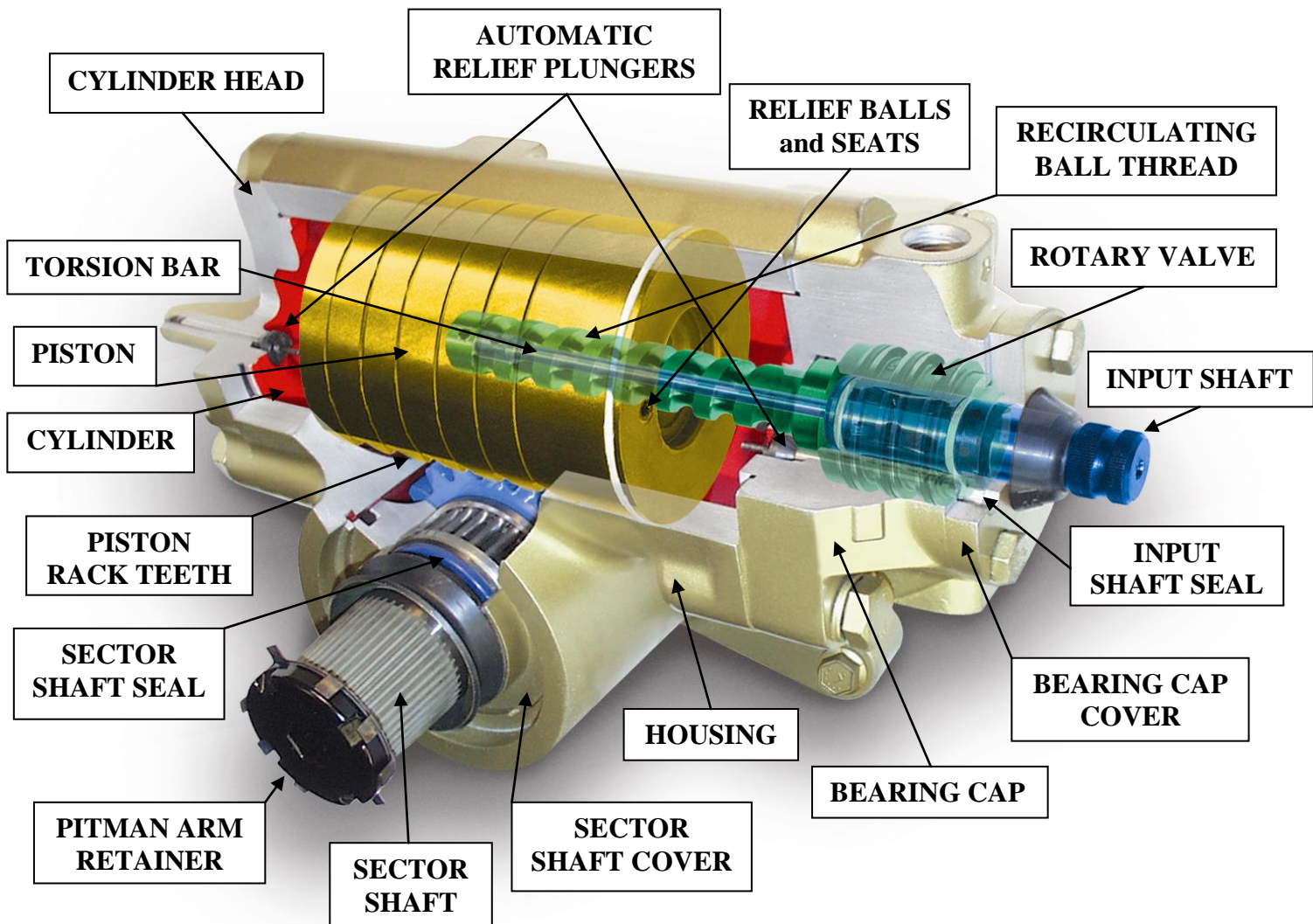
- R-Shows the steering gear was remanufactured by Sheppard.
- 08-Year the steering gear was built.
- C-Month of the year the steering gear was built (March 2008).
- 1672-Sequential serial number for gears built that month.

If you ever need assistance with a steering problem, it is important you have the complete model number and serial number.



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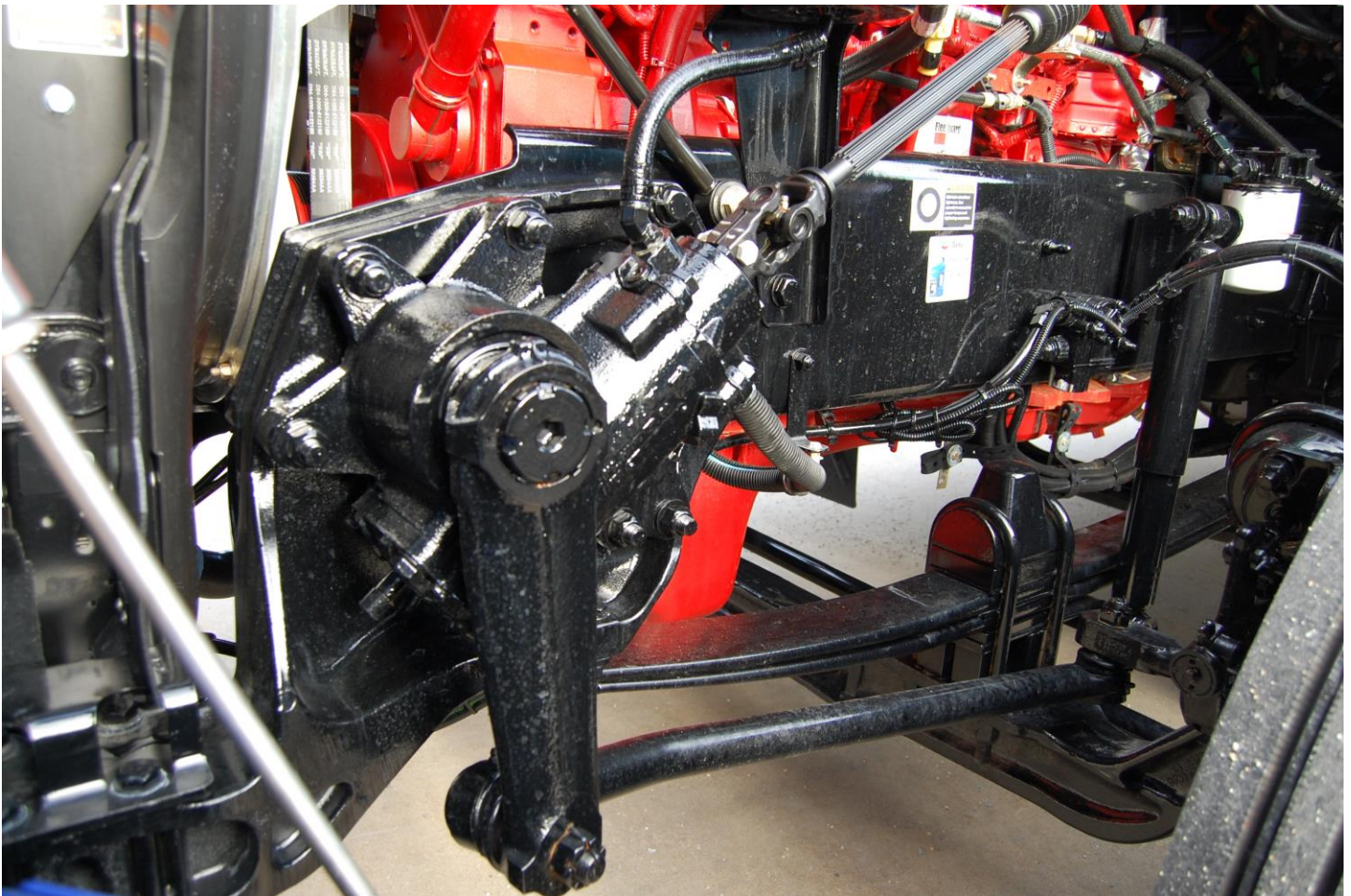


M-SERIES POWER STEERING GEAR

GLOSSARY OF TERMS

1. **Back-Driving Slave Gear** – Used to steer additional axle(s). Receives hydraulic assist pressure from a master gear. The pitman arm is linked to the master gear and the input shaft is driven by the piston. The input shaft is connected to and used to actuate an additional steering gear on another axle.
2. **Back Pressure** – Circulating pressure of the steering system when the steering wheel is not being turned.
3. **Ball Return Retainer Plug** – Plug in the side of the piston that holds the recirculating balls and ball guides in place inside the piston. NOT SERVICABLE
4. **Base Mounted Gear** – The steering gear is mounted to the frame or bracket using the mounting holes in the housing opposite the sector shaft cover.
5. **Bearing Cap** – End cap that contains the input shaft and rotary valve.
6. **Bearing Cap Cover** – Small round cover with 4 small bolts and a hole for access to a relief plunger, on the end of the bearing cap. It contains the input seal, salt seal, and on newer models the retaining washer.
7. **Bleeder Screw** – 1/8" Allen set screw located in a 3/4" plug on the top of the housing (if the steering gear is mounted with the sector bore up, or directly in the end cap of some slave gears).
8. **Cylinder Bore** – Long part of housing which contains the piston.
9. **Cylinder Head** – End cap on the housing which does not have the input shaft. It contains a relief plunger, but not on slave steering gears.
10. **Crab Bracket** – The metal bracket mounted to the bearing cap on some vehicles which holds a bearing the steering column passes through.
11. **Draglink** – The connection between the pitman arm on the steering gear and the steer arm on the wheel hub.
12. **Flow** – The movement of fluid or the speed it is moving. Expressed in Gallons Per Minute (GPM).
13. **Housing** – The main body of the steering gear which all parts bolt to or are held by.
14. **Intermediate Shaft** – The section of the steering column which extends between the cab and the steering gear, normally 2 sections with one sliding inside the other.
15. **Input Shaft** – Shaft the steering column universal joint connects to. Part of the control valve which directs fluid to either end of the piston.
16. **Miter** – An independent or attached gear set which changes the direction of the steering column to the input shaft of the steering gear. NOT SERVICABLE.
17. **Miter T Box** - An independent or attached gear set which changes the direction of two steering columns to the input shaft of the steering gear. NOT SERVICABLE.
18. **Mounting Bracket** – A metal piece which allows the steering gear to be adapted to the frame of a vehicle.
19. **Mounting Feet** – The legs or pads cast into the housing which allows the steering gear to be mounted to a vehicle by means of nuts and bolts.
20. **Piston** – Located in the cylinder bore of the housing. Redirects mechanical and hydraulic input force to mechanical output force that moves the sector shaft and pitman arm. NOT SERVICABLE.
21. **Piston Ring** – Teflon seal ring around most (not all) pistons. NOT SERVICABLE.
22. **Pitman Arm** – The lever which mounts on the splined end of the sector shaft and connects to the draglink.
23. **Pressure** – Hydraulic force created by the pump used to help move the piston in the steering gear. Measured in Pounds per Square Inch (PSI).
24. **Pressure Relief Valve (PRV)** – Used on some (not all) steering gears when the pump maximum pressure is higher than what the steering gear is designed to operate at. Housed in the bearing cap and identified by a large 1 1/4" nut on the bearing cap.
25. **Pump** – The device which supplies fluid under pressure to the steering gear.
26. **Rack Teeth** – The area on the piston which engages the sector shaft teeth.
27. **Recirculating Balls** – 24 steel balls used as bearings which provide the connection between the rotary valve and piston.
28. **Recirculating Ball Thread** – The area on the rotary valve and inside the piston where 24 steel recirculating balls travel.
29. **Relief Check Ball and Seat** – Located in each end of the piston and held in place by a long spring between the two balls. Used to relieve system pressure when dislodged by the relief plunger at the end of steering travel.
30. **Relief Plunger** – A long pin located in each end cap of the steering gear (not on slave gears). It may be mechanical or automatic and should be adjusted to relieve hydraulic assist pressure before the axle stop contacts the axle.
31. **Rotary Valve** – Internal valve located in the bearing cap of the steering gear which directs fluid to either end of the piston. It is actuated by turning the input shaft by the steering wheel, through the steering column and universal connection.
32. **Sector Shaft** – The output shaft of the steering gear which is the connection between the piston and pitman arm.
33. **Sector Shaft Seals** – 2 piece pressure seals located between the bearing and outside of the housing on each end of the sector shaft. One is in the housing and one is in the sector cover.
34. **Sector Bore** – Area of the housing which contains the sector shaft.
35. **Sector Cover** – Steel cover which houses a bearing and sector shaft seal. It may be solid and cover the end of the sector shaft, or the shaft may pass through the center of it (depending on the steering gear design). May be held in place by bolts, or a large snap ring, or by 3 clips retained by two bolts in each clip.

36. **Slave Gear** – A steering gear not directly connected to the steering wheel used to assist a master (or primary) steering gear. It is powered by hydraulic pressure sent from the master gear.
37. **Slave Ports** – Threaded openings which may be found in the cylinder head, bearing cap, or sector bore used for the hose fittings which connect the pressure lines to the slave gear(s).
38. **Steer Arm** – Arm on the wheel hub the draglink connects to.
39. **Steer Axle** – Any axle that controls the direction of the vehicle when the steering wheel is turned.
40. **Steering Column** – The linkage assembly which connects the steering wheel to the steering gear input.
41. **Steering Gear** – Mechanical/hydraulic device used to convert the rotary motion of the steering wheel into a linear motion for the pitman arm.
42. **Steering Wheel** – The round object the driver turns with his hands to guide the vehicle left and right.
43. **Tab-Lock Retainer** – Allen head bolt assembly used to provide the initial torque for installing the pitman arm. Uses alignment tabs that fit into the pitman arm and retraining tabs which fold into the bolt head and prevent it from backing off after being torqued.
44. **Thrust Bearing** – Needle roller bearings on both ends of the rotary valve in the bearing cap.
45. **Thrust Bearing Shim** – Shims located next to the thrust bearings in the bearing cap which provide a smooth hardened steel surface for the bearings to ride against.
46. **Thrust Washer** – Washer on end of the rotary valve which determines valve end play in the bearing cap.
47. **Torsion Bar** – Bar which connects the input shaft to the rotary valve and returns the valve to a neutral position.
48. **Universal Joint** – The part of the steering column which allows the sections to connect at different angles.
49. **Valve Seals** – 3 grooved seals on the outside of the rotary valve each with a rubber energizing ring. NOT SERVICABLE.



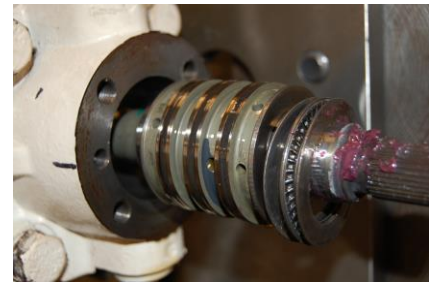
STEERING GEAR OPERATING PRINCIPLES

1. The INPUT SHAFT is connected to the steering column universal joint, and is centered within the ROTARY VALVE in the neutral position by the TORSION BAR. It is an open centered valve which allows fluid to flow directly through the steering gear and back to the reservoir at low pressure when the engine is running and no force is applied to the input shaft. The ROTARY VALVE is supported both top and bottom in the BEARING CAP by a series of THRUST BEARINGS, SHIMS, and a THRUST WASHER which are constantly bathed in steering fluid.
2. The INPUT SHAFT HIGH PRESSURE SEAL and SALT SEAL are located in the BEARING CAP COVER. No greasing of the seals is required. A FACE SEAL (dust boot) is installed over the INPUT SHAFT as extra protection for the seals.
3. The ROTARY VALVE SHAFT BALL THREAD rotates within the piston on 24 STEEL RECIRCULATING BALLS.
4. The SECTOR SHAFT rotates on two ROLLER BEARINGS which are constantly lubricated by the steering fluid. The SECTOR SHAFT PRESSURE SEALS are located next to each bearing.
5. The SECTOR SHAFT TEETH engage the PISTON RACK TEETH machined into one side of the PISTON. The PITMAN ARM is mounted on the tapered splines of the SECTOR SHAFT. The arm will get tighter on the splines the harder it is worked. The PITMAN ARM RETAINER applies the initial pressure to the arm to seat it onto the shaft, and then acts as a safety device to prevent the arm from coming loose if it was not properly torqued.
6. RELIEF PLUNGERS are located in both the BEARING CAP and CYLINDER HEAD and may be either manual or automatic depending on the steering gear model. They must be correctly adjusted to obtain full turn angle (wheel cut) of the steering and still prevent the axle stops from hitting the axle under full steering pump pressure.
7. Turning the steering wheel turns the steering column and rotates the INPUT SHAFT. This overcomes the resistance of the TORSION BAR which opens the ROTARY VALVE to allow as much pressure as is needed from the pump to push the PISTON through the CYLINDER BORE. (The more resistance encountered in trying to steer the wheels, the more the valve opens and more pressure from the pump is applied to the piston.)
8. At the same time, the ROTARY VALVE opens a passage back to the reservoir for the fluid in the opposite side cylinder cavity, allowing it to drain, and closes off the flow of fluid from the pump going directly to the reservoir.
9. Fluid pressure and flow will push the pressure side RELIEF BALL off its BALL SEAT, and along with the RELIEF SPRING pressure, force the opposite side RELIEF BALL onto its BALL SEAT (sealing off any internal leakage through the piston).
10. When the wheels are steered to the full turn angle the PISTON will move through the CYLINDER BORE until the RELIEF PLUNGER contacts the RELIEF BALL and pushes it off its seat, opening the flow path for fluid back to the reservoir and dumping steering system pressure. This ensures there is not enough power assist to keep turning and drive the axle stop into the axle. The process reverses for steering the opposite direction.

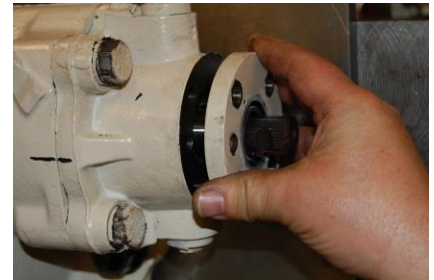
When the engine is running, there is a constant flow of oil at low pressure through the steering gear until a force is applied to the steering wheel. This constant oil flow provides instant steering response and absorbs road shocks for smooth operation.

NOTE: If there is a loss of power steering pump pressure while driving, the steering gear is designed to provide a mechanical back-up so the vehicle may be safely steered to the side of the road.

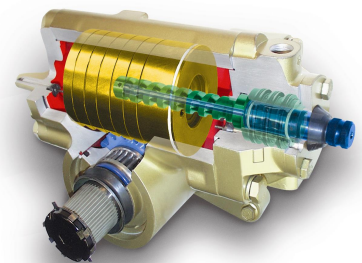
Steering gears may be built with an integral PRESSURE RELIEF VALVE if the power steering pump has no relief, or the pump delivers higher pressure than the gear



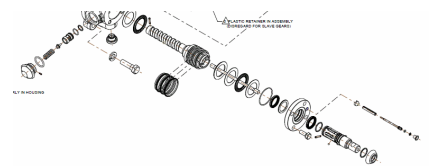
ROTARY VALVE ASSEMBLY



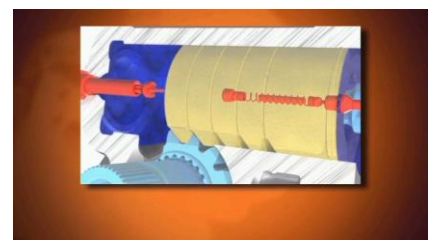
BEARING CAP COVER



INTERNAL COMPONENTS



INPUT AND ROTARY VALVE ASSEMBLY



END OF TRAVEL RELIEF

is rated. This valve protects the steering gear against excessive pressure and reduces system temperature by avoiding high pressure by-pass and recirculation within the pump.

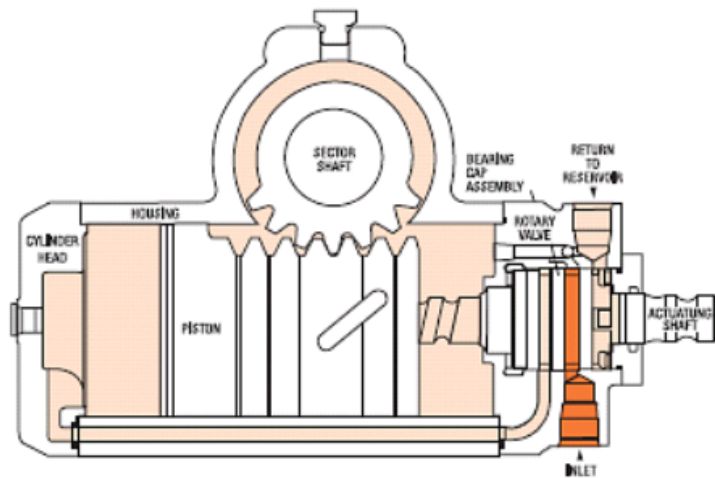
Sheppard steering gears are designed to provide long service life and simple repair. The sector shaft to piston rack never requires center point adjustment. The relief plungers, once set initially, do not require adjustment unless axle stop settings or tire size is changed. With routine care and limited maintenance, Sheppard M-Series Steering Gears will provide many miles of reliable performance.



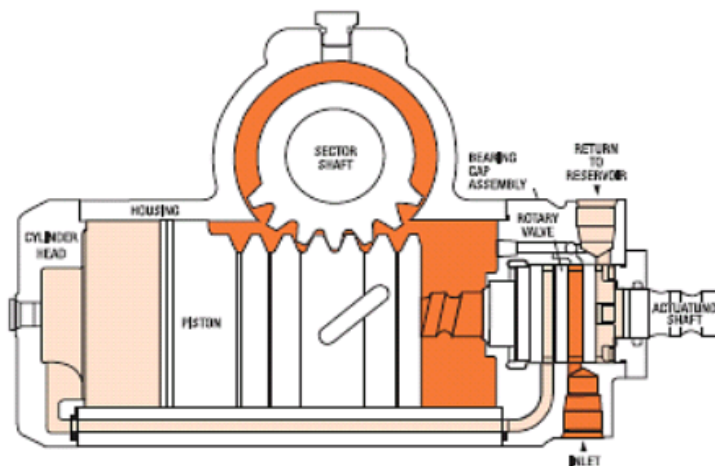
PRESSURE RELIEF VALVE (PRV)



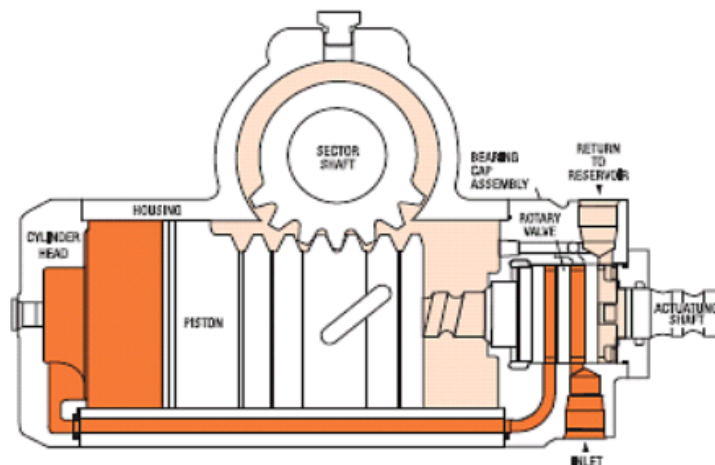
OIL FLOW THROUGH THE STEERING GEAR



Here the steering gear is in the neutral position with no force being applied to the steering wheel in either direction. There is equal-low pressure at both ends of the piston and fluid is flowing through the bearing cap and right back to the reservoir. This provides a hydraulic cushion to help damper road shocks, and an instant reaction when hydraulic force is needed to help move the piston under load.



In this example, when the steering wheel is turned to the left, the rotary valve opens allowing fluid to pressurize the bearing cap end of the piston, and the sector shaft bore. At the same time, the valve is closing off the return to the reservoir. The more force required to turn the steering, the more the valve directs fluid to the piston instead of the reservoir. When maximum force is needed to turn the steering, all pump output is directed by the valve to the piston and none escapes to the reservoir.



Turning the steering wheel to the right directs fluid to the cylinder head end of the piston. It also begins closing off the flow back to the reservoir, and allows the bearing cap end to drain to the reservoir.

DUAL STEERING GEAR SYSTEMS

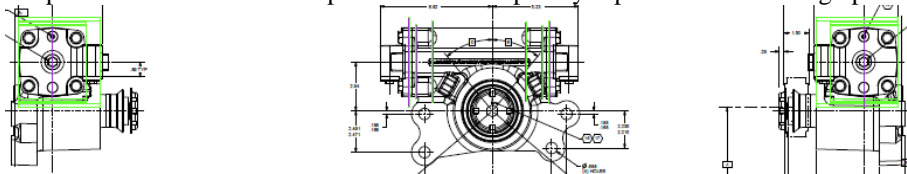
Two or more steering gears are sometimes used where steer axle weights exceed 16,000 lbs gross axle weight rating. Multiple gears, or gears and hydraulic assist cylinders, are used to balance the steering forces across the axle(s) and save space, instead of using a massive single steering gear.

Slave (secondary) steering gears are driven or operated by hydraulic pressure sent from the master (primary) steering gear connected to the steering wheel. The pressure pushes the slave gear piston (or cylinder piston) to provide power assistance. As the steering wheel is turned, the valve opens in the master gear allowing pump pressure to build on one side of the master gear piston, which also pressurizes the line going to one side of the slave gear piston. When the steering wheel is let go, the valve returns to center and closes off the pressure going to the gears.

Relief plungers are only installed in master steering gears, and will relieve system pressure for the entire system at the end of steering travel. Power steering pumps must be sized appropriately to provide enough flow for the additional gears, but not so much that it causes excessive backpressure on the master gear control valve. Normally, the gears are all mechanically linked together through the pitman arms, axle steer arms, tie rods, and draglinks to obtain correct consistent steer angles.

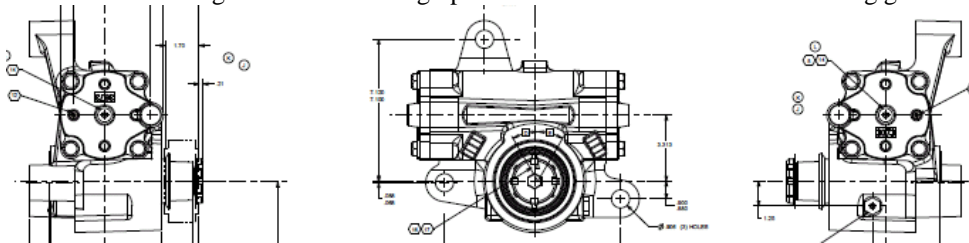
IMPORTANT: A special procedure (found in this manual) is used to bleed dual systems. It is critical this procedure be followed if the system has been repaired or serviced.

M-Series Cooling Slave - A 4 line slave gear having a high pressure line on each end of the steering gear and has a port cast into the length of the housing. Fluid returning to the reservoir from the master gear is routed through this port to use the slave gear as a heat sink to reduce steering system temperatures. This line is low pressure and completely separated from the high pressure ends of the gear.



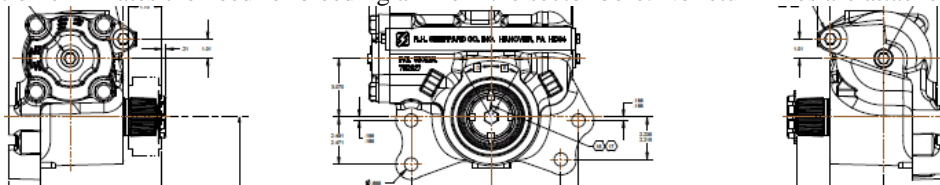
M80SAW1 (COOLING SLAVE)

M-Series Standard Slave - A 2 line slave gear which has a high pressure line on each end of the steering gear and no return lines.



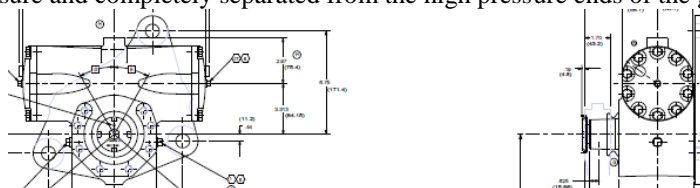
M90SAD1 (STANDARD SLAVE)

D-Series Slave - A 2 line slave gear that has a high pressure line connected to the cylinder head, and one to the sector shaft bore of the housing. This configuration eliminates the need for bleeding air from the sector bore. No return lines are attached.



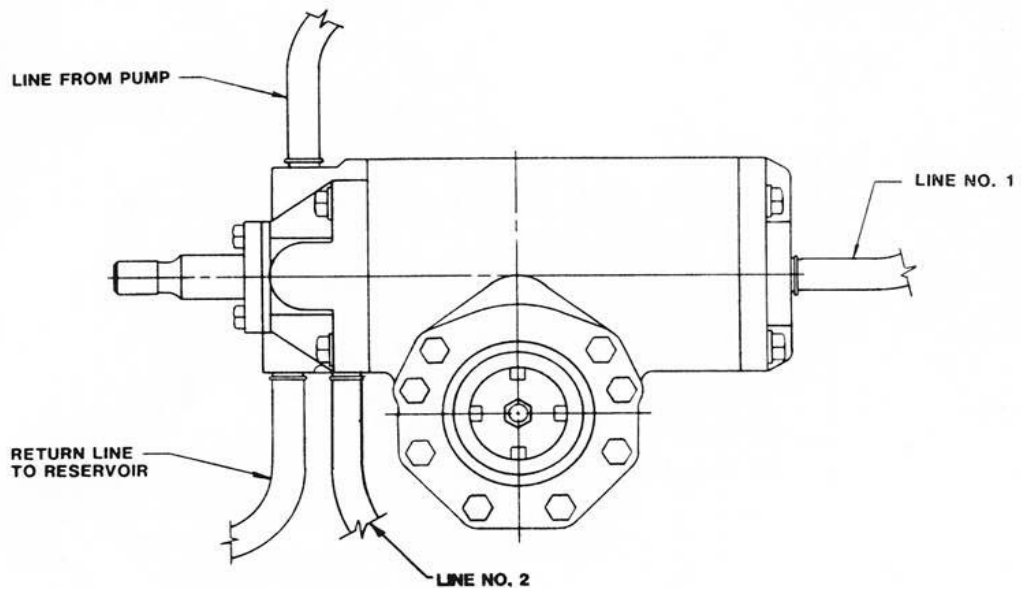
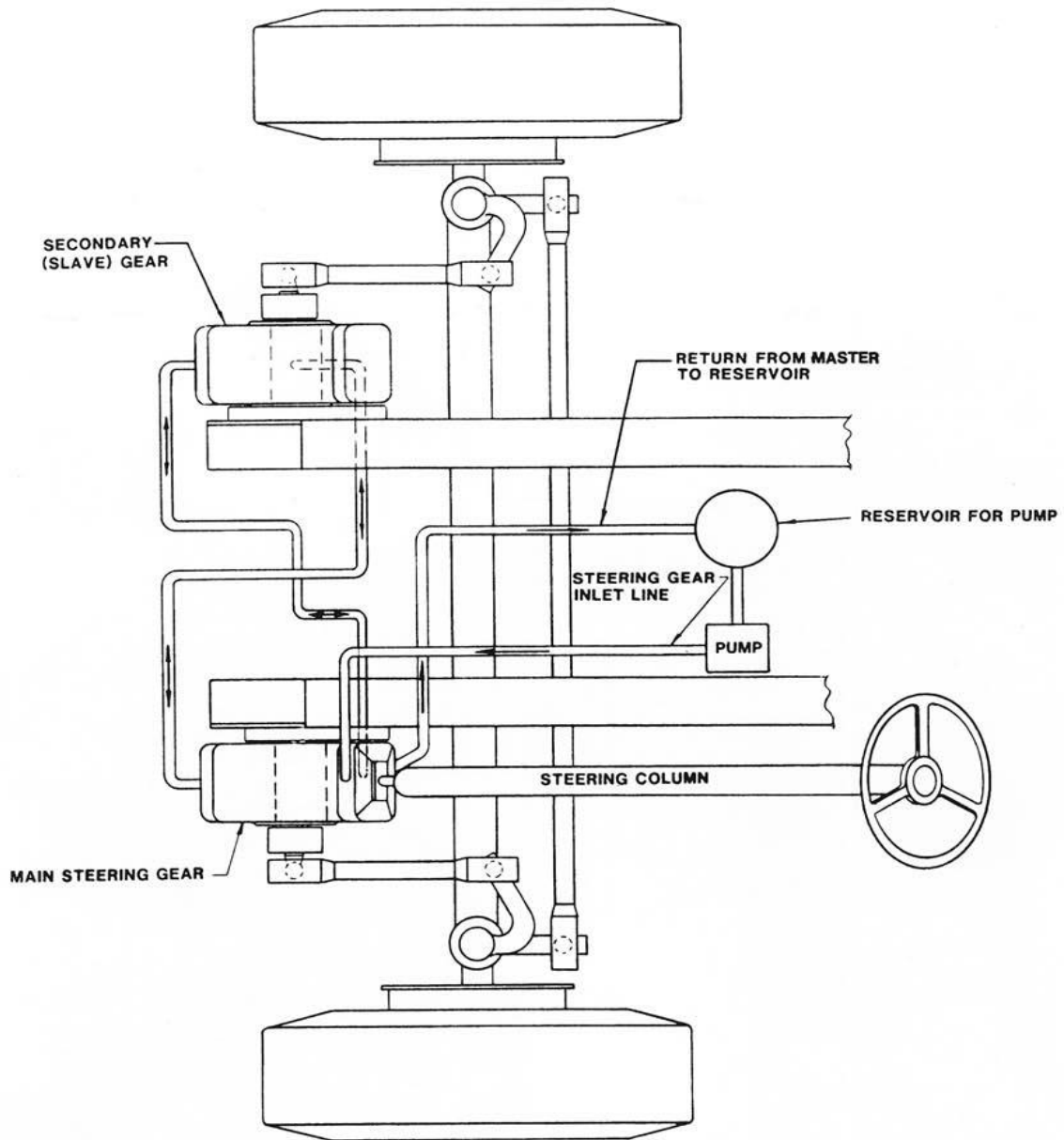
HD94SG1 (D-SERIES SLAVE)

92-Series Slave - A 4 line slave gear having a high pressure line on each end of the steering gear and has the fluid returning to the reservoir from the master gear routed through the sector shaft bore to use the slave gear as a heat sink to reduce steering system temperatures. This line is low pressure and completely separated from the high pressure ends of the gear.

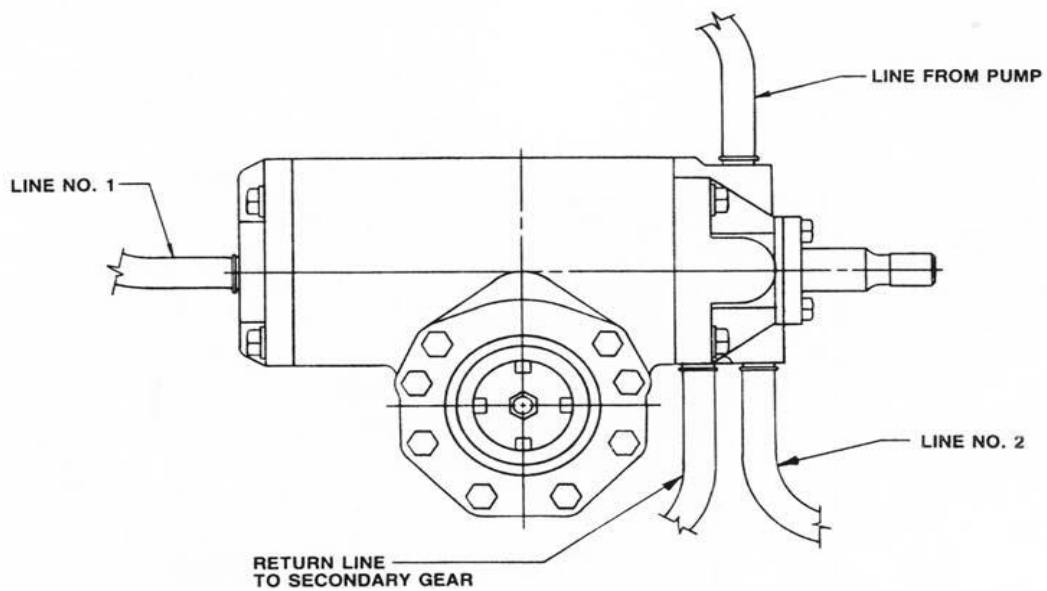
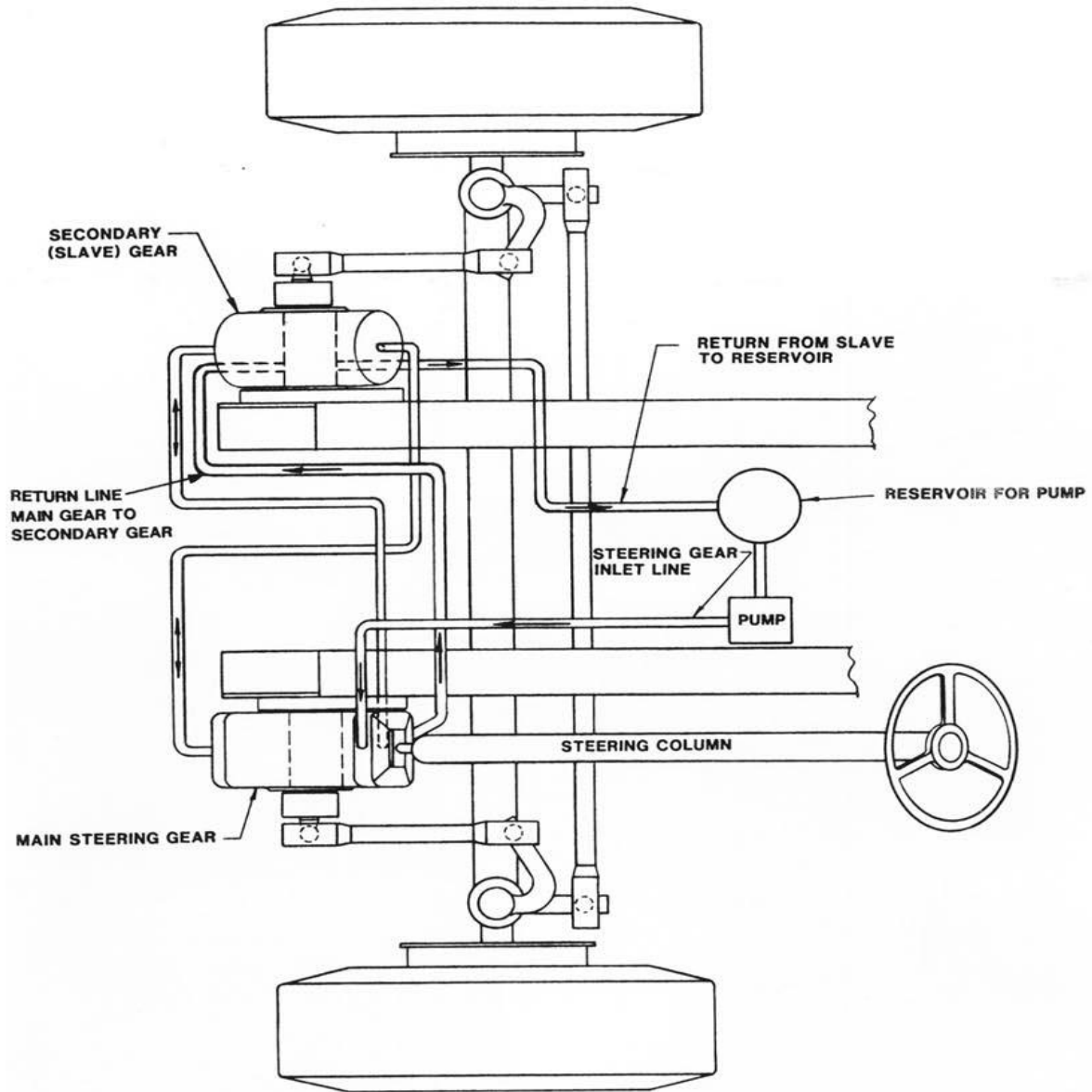


292SEZ6 (92-SERIES SLAVE)

STANDARD SLAVE SYSTEM



COOLING SLAVE SYSTEM



SPECIFICATIONS

Each vehicle manufacturer specifies the maximum system operating pressure and pump flow for their various steering installations. Some pumps may have to provide fluid to accessories such as fan drives, fifth wheel lifts, hydraulic booms, or PTOs. Always consult the vehicle manufacturer's specifications for the correct pump relief pressure and flow for the vehicle you are working on.



WARNING

DO NOT INCREASE THE MAXIMUM SYSTEM PRESSURE WITHOUT CONSULTING THE VEHICLE MANUFACTURER. SERIOUS PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT!

Before any steering gear or pump is replaced for poor performance, consult the DIAGNOSIS AND TROUBLESHOOTING section of this manual and complete the TROUBLESHOOTING CHECKLIST. Many times gears and pumps are replaced needlessly due to misdiagnosis of a problem. Steering gears returned under warranty which are tested and found to have no defects will not be reimbursed. If you have any questions about your troubleshooting diagnosis, contact your vehicle manufacturer's tech line, or the Sheppard Field Service Hotline at 1-800-274-7437.

	MD83	HD94	M100	M110	SD110	XD120
Front Axle Range	6-10k lbs (2700-4500 kg)	10-14.6k lbs (4500-6600 kg)	10-14.6k lbs (4500-6600 kg)	14.6-18k lbs (6600-8200 kg)	14.6-18k lbs (6600-8200 kg)	18-23k lbs (8200-10400 kg)
Output Torque @ Rated Pressure & 90% Efficiency	35,058 in-lbf (3961 Nm)	45,436 in-lbf (5134 Nm)	46,345 in-lbf (5236 Nm)	59,300 in-lbf (6700 Nm)	59,760 in-lbf (6752 Nm)	78,825 in-lbf (8906 Nm)
Rated Pressure	2,683 psi (185 bar)	2,683 psi (185 bar)	2,350 psi (162 bar)	2,175 psi (150 bar)	2,756 psi (190 bar)	2,175 psi (150 bar)
Minimum Pump Flow @1.5 HWT/s	2.4 GPM (9.1 LPM)	3.0 GPM (11.4 LPM)	3.0 GPM (11.4 LPM)	3.5 GPM (13.2 LPM)	3.9 GPM (14.8 LPM)	4.8 GPM (18.2 LPM)
Pump Flow Range Single Steering Gear	2.4-3.4 GPM (9.1-12.9 LPM)	3.0-4.0 GPM (11.4-15.1 LPM)	3.0-4.0 GPM (11.4-15.1 LPM)	3.5-4.5 GPM (13.2-17.0 LPM)	3.9-4.9 GPM (14.8-18.5 LPM)	4.8-5.8 GPM (18.2-22.0 LPM)
Ratio	16.9:1	16.9:1	18.9:1	23.0:1	16.9:1	23.0:1
Gear Travel	95°	95°	95°	100°	95°	96°
Normal System Operating Temperature	-40 to 220 °F (-40 to 104 °C)	-40 to 220 °F (-40 to 104 °C)	-40 to 220 °F (-40 to 104 °C)	-40 to 220 °F (-40 to 104 °C)	-40 to 220 °F (-40 to 104 °C)	-40 to 220 °F (-40 to 104 °C)
Not-To-Exceed Temperature	250 °F (121 °C)	250 °F (121 °C)	250 °F (121 °C)	250 °F (121 °C)	250 °F (121 °C)	250 °F (121 °C)
Output Shaft Diameter	2.00 in (50.8 mm)	2.00 in (50.8 mm)	2.00 in (50.8 mm)	2.25 in (57.2 mm)	2.25 in (57.2 mm)	2.50 in (63.5 mm)
Approximate Dry Weight	60 lbs (27.2 kg)	70 lbs (31.8 kg)	75 lbs (34.0 kg)	110 lbs (49.9 kg)	85 lbs (38.6 kg)	150 lbs (68.0 kg)
Pump Flow Range Dual Steering Gears @1.0 HWT/s & 90% Efficiency						
w/ MD83 Slave	4.0-5.5 GPM (15.1-20.8 LPM)	4.5-6.0 GPM (17.0-22.7 LPM)	4.6-6.1 GPM (17.4-23.1 LPM)	5.0-6.5 GPM (18.9-24.6 LPM)	5.3-6.8 GPM (20.1-25.7 LPM)	6.0-7.5 GPM (22.7-28.4 LPM)
w/ HD94 Slave	N/A	5.0-6.5 GPM (18.9-24.6 LPM)	5.1-6.6 GPM (19.3-25.0 LPM)	5.5-7.0 GPM (20.8-26.5 LPM)	5.5-7.0 GPM (20.8-26.5 LPM)	6.5-8.0 GPM (24.6-30.3 LPM)
w/ M100 Slave	N/A	N/A	5.3-6.8 GPM (20.1-25.7 LPM)	5.6-7.1 GPM (21.2-26.9 LPM)	N/A	6.6-8.1 GPM (25.0-30.7 LPM)
w/ M110 Slave	N/A	N/A	N/A	6.0-7.5 GPM (22.7-28.4 LPM)	N/A	7.0-8.5 GPM (26.5-32.2 LPM)
w/ SD110 Slave	N/A	N/A	N/A	6.5-8.0 GPM (24.6-30.3 LPM)	6.5-8.0 GPM (24.6-30.3 LPM)	7.3-8.8 GPM (27.6-33.3 LPM)
w/ XD120 Slave	N/A	N/A	N/A	N/A	N/A	8.0-9.5 GPM (30.3-36.0 LPM)
Output Torque Range @ Rated Pressure of Master Gear & 90% Efficiency						
w/ MD83 Slave	70,116 in-lbf (7922 Nm)	80,497 in-lbf (9095 Nm)	77,052 in-lbf (8706 Nm)	87,720 in-lbf (9911 Nm)	95,772 in-lbf (10821 Nm)	107,245 in-lbf (12117 Nm)
w/ HD94 Slave	N/A	90,878 in-lbf (10268 Nm)	86,144 in-lbf (9733 Nm)	96,133 in-lbf (10862 Nm)	106,435 in-lbf (12026 Nm)	115,661 in-lbf (13068 Nm)
w/ M100 Slave	N/A	N/A	92,690 in-lbf (10473 Nm)	102,194 in-lbf (11546 Nm)	N/A	121,719 in-lbf (13752 Nm)
w/ M110 Slave	N/A	N/A	N/A	118,600 in-lbf (13400 Nm)	N/A	138,125 in-lbf (15606 Nm)
w/ SD110 Slave	N/A	N/A	N/A	106,462 in-lbf (12029 Nm)	119,520 in-lbf (13504 Nm)	125,987 in-lbf (14235 Nm)
w/ XD120 Slave	N/A	N/A	N/A	N/A	N/A	157,650 in-lbf (17812 Nm)

PRE-DELIVERY INSPECTION (PDI) FOR SHEPPARD STEERING SYSTEMS

THESE ARE ONLY **GUIDELINES** PROVIDED BY SHEPPARD. THEY ARE NOT INTENDED TO REPLACE THE DIRECTIVES OF THE VEHICLE MANUFACTURER AND ARE NOT REIMBURSEABLE BY SHEPPARD.

1. Ensure the vehicle is at normal operating temperature.
2. Start the engine and check the fluid level in the power steering reservoir. It should be between the minimum and maximum markings. If fluid is needed, refer to the vehicle manufacturer's guidelines on what fluid is to be used.
3. Inspect the system for any fluid leaks. Ensure all hose fittings and clamps are tight.
4. Inspect the hose routing for any kinks in the hose, or clamps that are too tight and crush the hose. Any restriction must be corrected. Ensure no lines contact any moving parts of the engine or chassis. Shut the engine off.
5. Raise the steer tires just off the ground and inspect the steering column, draglink, and all steering links. Ensure they have been properly greased and all boots are in place.

⚠ WARNING

Ensure all cotter pins are in place for the castle nuts.

⚠ WARNING

6. Make sure the pinch bolt is in place and tight on the universal joint connecting the steering column to the steering gear input shaft.

⚠ WARNING

7. Ensure 2 tabs are bent over and locking the pitman arm retainer on the steering gear.

8. Ensure the rubber sector shaft cover is securely attached. The unpainted end of the sector shaft should not be exposed, if it is exposed, a new cover can be found in the Sector Shaft Seal Kit for the model gear you have.

9. Turn the steering full left and full right. **(This will set automatic relief plungers in the steering gear if it has AUTO plungers.)**

⚠ WARNING

10. **MAKE SURE THE AXLE STOPS CONTACT THE AXLE**

IN BOTH DIRECTIONS! If they do not, there is a mechanical problem; the pitman arm may be mistimed, steering gear may not be centered, draglink/other steer link may be adjusted wrong, or the wrong part number could be installed. There could also be interference on the chassis stopping the movement of the steering.

11. Ensure the axle stops are set per the vehicle manufacturer's specifications. They should be set either to a specific degree of steering travel, or to a minimum clearance at the tire and pitman arm.
12. Set the steer tires on the ground and start the engine. Turn the steering full left and full right with normal steering effort-do not pull hard on the steering wheel. There should be a small gap between the axle stop and the axle. The axle stop should not hit the axle and make the power steering pump go into relief. You should hear the steering gear relieve pressure in both directions just before the axle stops contact the axle.
13. If there is a large gap between the axle stops and the axle: the relief plungers in the end of the steering gear are relieving too early. Adjust the plungers by backing them out with a screwdriver. **If they will not adjust contact Sheppard Field Service at 1-800-274-7437.**
14. If there is no gap between the axle stops and the axle and the pump is going into relief but the steering gear is not: the relief plungers in the end of the steering gear are not relieving. Adjust the plungers by screwing them in with a screwdriver. **If they will not adjust contact Sheppard Field Service at 1-800-274-7437.**

⚠ WARNING

THE STEERING GEAR RELIEF PLUNGERS MUST BE ADJUSTED CORRECTLY. FAILURE TO SET THEM COULD RESULT IN DRIVER COMPLAINTS OF LIMITED STEERING TRAVEL, STEERING SYSTEM DAMAGE OR A COMPLETE LOSS OF STEERING.

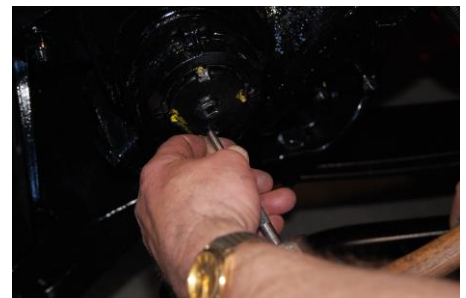
15. Return the vehicle to service. Any problems noted should be reported to the vehicle manufacturer.



INSPECT THE LINES FOR KINKS



CHECK COLUMN AND PINCH BOLTS



ENSURE LOCK TABS ARE BENT IN



CHECK THE AXLE STOP GAPS

PREVENTIVE MAINTENANCE

The power steering system fluid and filter must be changed on a regular schedule to keep the system operating at peak efficiency and reduce the risk of seal failures. The use of the vehicle manufacturer's recommended fluid, filter and change interval will ensure the system runs clean, and help reduce system operating temperatures. Consult your vehicle owner's manual for the change schedule and parts to use.

PARTS REQUIRED:

Drain Pan New Filter New Fluid 7/8" Combination Wrench Wrench for Reservoir Cover
Floor Jack

⚠ WARNING FOLLOW THE VEHICLE MANUFACTURER'S GUIDELINES FOR SECURING THE VEHICLE FOR SERVICE!

PROCEDURE

1. Secure the vehicle for service.
2. Raise the steer tires off the ground and place a drain pan below the steering gear.
3. Wipe off the area around all hose connections, reservoir fill cap, and filter cover.
4. Disconnect all lines from the steering gear ensuring each one is marked for reconnection to the proper fitting. If this is a master gear in a multi-gear system, disconnect all the lines to the master gear. Drain all fluid from the system.
5. Turn the steer tires full right and full left several times to purge as much fluid as possible from the steering gear(s).

⚠ CAUTION The reservoir cover or filter element may be under spring pressure.

6. Remove the reservoir cover and note the position of the spring (if equipped) for reassembly.
7. Remove the filter from the reservoir and discard it.
8. Wipe out the inside of the reservoir with a clean, lint-free towel. Ensure the reservoir is completely clean! Contamination too small for the filter to catch will build up in the fluid and reservoir and accelerate the wear on the seals. Wiping out the reservoir is the best way to get rid of it.
9. Re-connect all lines to the steering gear.
10. Install the new filter element and reservoir cover. Use a new cover seal when available.
11. Fill the reservoir with new fluid to within 1" of the top of the reservoir. (When the engine starts the level will drop quickly.) Tighten the reservoir cap.

NOTICE Do not allow the reservoir to run dry as pump damage may occur.

12. Start the engine and let it idle. Fill the reservoir level back up to Full Cold.
13. Turn the steering all the way full left then to full right. Hold pressure on the wheel at the end of travel for about 5 seconds in order to purge any air through the relief system in the steering gear. Repeat this process several times. Shut the engine off.
14. Fill the reservoir level back up to the Full Cold mark.
15. Clean the area, remove the drain pan, lower the vehicle and remove the jack.
16. Start the engine again and turn the steering full left and full right. If it does not steer smoothly, follow the Bleeding Procedure in this manual. Check for leaks.
17. Record the date the fluid and filter were changed and return the vehicle to service.

NOTE: Mixing fluids can cause a chemical reaction which can attack parts of the steering system-particularly seals, and is not recommended. If switching from Automatic Transmission Fluid to Engine Oil (or and other fluid change) the system should be fully drained and filter changed as outlined here.

Always ensure the reservoir level is topped off with the same fluid the steering system is currently using. Do not mix different types of fluids!



REPLACE THE FILTER



WIPE OUT THE RESERVOIR



FILL THE RESERVOIR



CHECK FOR LEAKS

SEAL KITS

Seal kits are available for all Sheppard steering gears through the vehicle manufacturer's dealer network. They can not be purchased directly from Sheppard. The seal kits are for repair of external fluid leaks only – there are no kits which contain any of the piston seals or valve seals. If the steering gear exhibits excessive internal wear or leakage, it should be replaced with a genuine Sheppard Remanufactured steering gear.

NOTE: Steering gears built prior to July 1990 have an obsolete input shaft seal. There is no longer a seal kit available to repair a leaking input seal on that series of gears. If the input seal leaks the entire steering gear must be replaced with an updated model.



WARNING

ANY SWAPPING OF, OR MODIFICATIONS TO THE BEARING CAP COVER TO MAKE IT ACCEPT NEWER SEALS MAY CAUSE PERSONAL INJURY OR STEERING GEAR FAILURE!

The most updated list of our seal kits can be found on our website www.rhsheppard.com under SERVICE, then SERVICE BULLETINS.

ACCEPTABLE FLUIDS

The type of fluid to use in the power steering system is determined by the vehicle manufacturer. Refer to the service or owner's manual for the specified fluid. It is important to keep the fluid clean and changed according to the vehicle manufacturer's guidelines. Neglected system fluid will cause accelerated wear of internal components and seal leaks.

The following fluids have been reviewed by Sheppard and found to be acceptable for use in Sheppard M-Series steering gears:

Automatic Transmission Fluid Dexron III	Shell Rotella T30W
Automatic Transmission Fluid Type "E" or "F"	Shell Rotella T SAE 30
Castrol ATF Heavy Duty	Shell Rotella T 15W40
Castrol Dexron 6 ATF	Shell Tellus T46 Oil
Castrol Enduron S - 15W40 Synthetic	Shell Tellus 68
Castrol Hypuron 15W40	SRS Wiolan H-540
Castrol MP Dexron III / Mercon	Texaco Havoline 10W40
Castrol Tecton S - 15W40	Texaco Havoline Automatic Transmission Fluid Mercon / Dexron III
Castrol Tecton Extra - 15W40	Texaco Texamatic 7045E Automatic Transmission Fluid
Castrol TransSynd	Texaco URSA Premium TDX 15W40
Chevron Delo 400 Multigrade 15W40	Texaco URSA Super Plus 15W40
Chevron Automatic Transmission Fluid Dexron III / Mercon	Union 10W40
Chevron Rykon Premium MV 5W20	Union 15W40
Chevron RPM Heavy Duty Motor Oils 15W40	Unocal 46 Power Steering Fluids
Chevron Synthetic Automatic Heavy Duty Transmission Fluid	Unocal Guardol 15W40 Motor Oil
Chevron 10W40 Supreme	US Oil Wide Range Automatic Transmission Fluid
Cummins Premium Blue 2000 15W40	Valvoline All Fleet Plus - 15W40
ELF Lubricants XT2388 / Dexron III	Valvoline AW 32 HVI Oil
Exxon Auto H32 Hydraulic Fluid	Valvoline Premium Blue - 15W40
Exxon Firexx HF-DU68	Valvoline Synthetic Premium Blue - 5W40
Fleetrite PSF (CH990625)	
Ford Spec. M2C138CJ	
Mack EON Premium Plus	
Mobil 1 0W30 Tri-Synthetic	
Mobil 1 15W50 Motor Oil	
Mobil ATF 210	
Mobil Delvac 1300 Super - 15W40	
Mobil Quintolubric 822-220	
Mobile SHC 525 Hydraulic Oil	
Mobil Super 10W40 Motor Oil	
Mobil Super 15W40 Motor Oil	
Q8 Hindemith LT	
Shell Global Code 51204 PSF 20631	
Shell Rimula Premium 15W40	

DIAGNOSIS AND TROUBLESHOOTING

Rule #1 - DO NOT REMOVE THE STEERING GEAR! You can't figure out what the problem with the truck is, if the steering gear or pump is laying on a workbench beside it!

This manual is designed to try and give the mechanic all the knowledge we can to help him (or her) correct any problems with a Sheppard power steering gear. Used properly, this section will assist you in solving steering problems quickly, and without changing parts until you get it right. It does not have all the answers, but hopefully it has the ones you need. If this manual does not help, let us know! As always, you are welcome to call the Sheppard Field Service Hotline at 800-274-7437 to discuss any problems. If we don't have the answer, we will call on all the resources our company has to find you an answer (a correct answer). That includes our Tech Center, Product Engineering, Manufacturing Engineering, Remanufacturing, our assembly personnel, management, component suppliers, our colleagues at the OEM level, and Mr. Peter Sheppard (our company President).

Use the Problem Diagnosis Guide to help pinpoint the source of the problem. A clear understanding of what the complaint is, is critical to figuring out how to solve it. Talk to the driver and drive the vehicle yourself if possible. Use the Troubleshooting Procedure to systematically test the steering system. Having a Pressure and Flow Tester is the most important tool you can have along with the knowledge of how to use it. Having the Troubleshooting Checklist completed prior to contacting us with any questions is a big help. We put it inside the back cover of this manual to make it easy to make copies.

Remember; the steering gear is only a small part of the total steering system, and it all has to work together to get the vehicle down the road. You can trace the whole steering system starting from where the driver's hands contact the steering wheel, to where every tire contacts the road.



PROBLEM	POSSIBLE CAUSE	REPAIR
Oil leak around sector shaft	<p>A. Sector shaft seal hard and brittle from excessive heat. Source may be excessive system backpressure due to a restriction, relief plungers not adjusted correctly, excessive pump flow, steering system overloaded from excessive weight, incorrect fluid or water contamination.</p> <p>B. Seal torn. Seal incorrectly installed or repaired, seal not greased when installed, seal torn by installation tool.</p> <p>C. Seal or shaft worn excessively. Due to normal wear and tear, or possible particle contamination caused by fluid and filter not being changed per the vehicle manufacturer's guidelines.</p> <p>D. Dirt or debris in seal groove or on seal creating path for oil leak.</p> <p>E. Missing or loose cover on end of sector shaft allowed contaminants to damage seal and shaft.</p> <p>F. Seal installed backwards. The black lip should face the bearing.</p>	Replace seals with sector shaft seal kit. Sector shaft may require replacement if worn excessively. Correct source of cause. Ensure all parts are very clean during assembly.
Oil leak at sector cover	<p>A. Sector shaft seal leaking.</p> <p>B. Sector cover o-ring or housing L-seal leaking due to wear from a rough sealing surface, debris contamination, hard from excessive heat, improper installation, dirt in seal groove.</p>	Replace seals with sector shaft seal kit, correct source of cause.
Oil leak around input shaft	<p>A. Input shaft pressure seal hard and brittle from excessive heat. Source may be excessive system backpressure due to a restriction, relief plungers not adjusted correctly, excessive pump flow, steering system overloaded from excessive weight, incorrect fluid or water contamination.</p> <p>B. Seal torn. Seal incorrectly installed or repaired, seal not greased when installed, seal torn by installation tool.</p> <p>C. Seal or shaft worn excessively. Due to normal wear and tear, or possible particle contamination caused by fluid and filter not being changed per the vehicle manufacturer's guidelines.</p> <p>D. Dirt or debris in seal groove or on seal creating path for oil leak.</p> <p>E. Seal installed backwards or wrong seal. The seal lip of the pressure seal should face the fluid and have a GOLD SPRING on the seal. The seal lip of the dirt/salt seal should face the steering column and have a SILVER SPRING, unless it is the old style seal with no spring.</p>	Replace seals with input shaft seal kit, correct source of cause. The input shaft itself is not serviceable. If it is severely worn, the entire steering gear must be replaced.
Oil leak from bearing cap cover.	A. Bearing cap cover o-ring is worn, pinched or hard. Hardness indicates excessive heat.	Replace all bearing cap seals using an input shaft seal kit.
Oil leak from bearing cap relief plunger hole.	A. O-ring on relief plunger hard or torn. Could be hard from heat or torn from adjusting.	A. Replace relief plunger o-ring. If it is an autoplugger, replace with an autoplugger repair kit. Use an end cap seal kit to obtain the o-ring needed for a

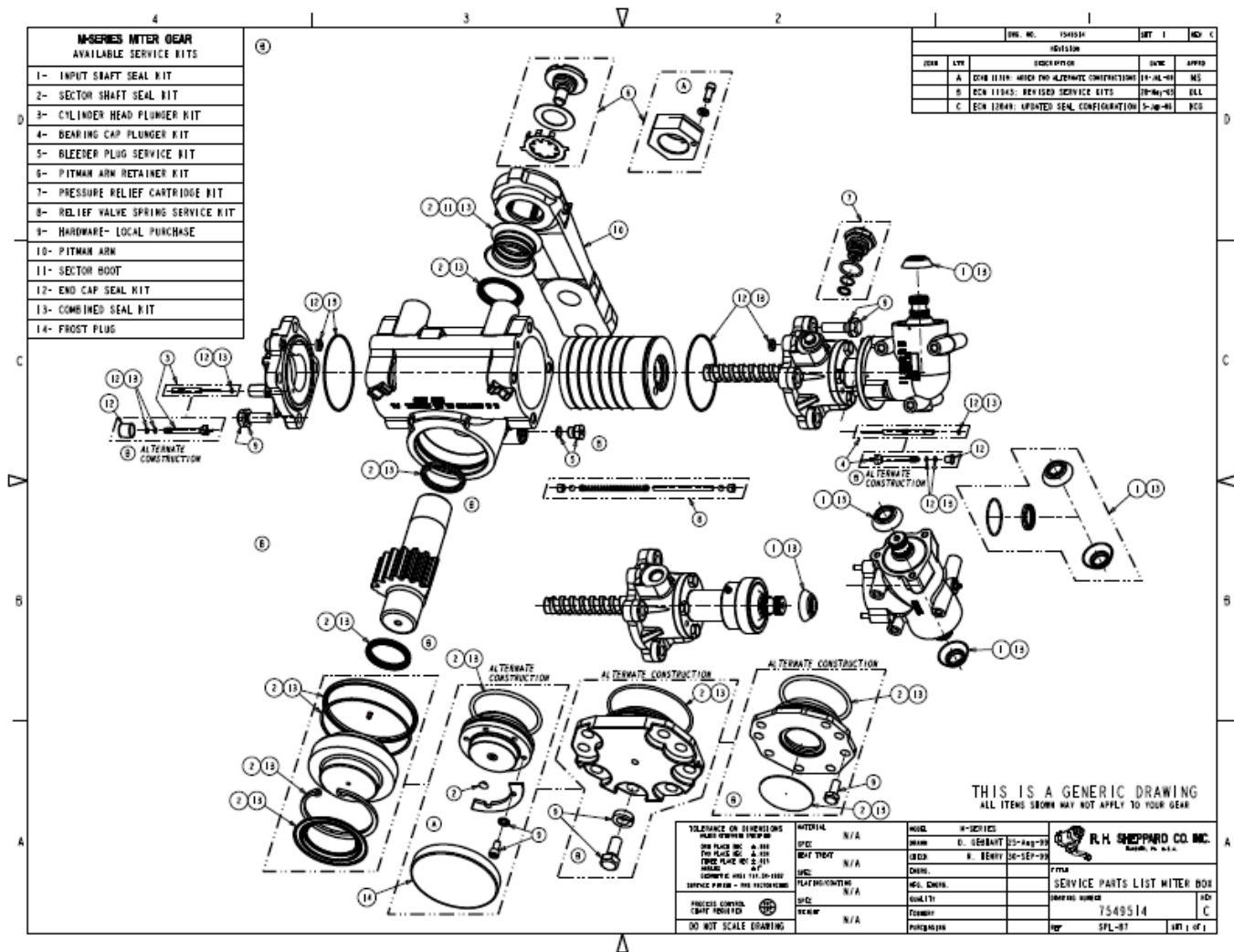
	<p>B. Ensure the bore is smooth and not damaged from someone using the wrong tool to adjust the plunger.</p> <p>C. Bearing cap cover o-ring could be leaking and the fluid coming out the relief plunger hole. Verify if the leak is coming out around the plunger, or if it is coming from the cover joint and filling up the hole.</p>	<p>manual relief plunger (which can also be used on the autoplunger).</p> <p>B. If the relief plunger bore is damaged, replace the steering gear-the area is not repairable without extensive machining, and bearing caps are not available as service parts.</p> <p>C. If the bearing cap cover o-ring is leaking, replace with an input shaft seal kit</p>
Oil leak from cylinder head relief plunger hole.	<p>A. O-ring on relief plunger hard or torn. Could be hard from heat or torn from adjusting.</p> <p>B. Ensure the bore is smooth and not damaged from someone using the wrong tool to adjust the plunger.</p>	<p>A. Replace relief plunger o-ring. If it is an autoplunger, replace with an autoplunger repair kit. Use an end cap seal kit to obtain the o-ring needed for a manual relief plunger (which can also be used on the autoplunger).</p> <p>B. If the relief plunger bore is damaged, replace the steering gear-the area is not repairable without extensive machining, and cylinder heads are not available as service parts.</p>
Oil leak from bearing cap to housing joint.	<p>A. Tetra seal hard and not providing sealing compression.</p> <p>B. Bearing cap square ring (or o-ring) hard from heat or pinched. Pinched rings can be caused by improper installation, or over-pressurizing the steering gear. Excessive pressure will cause the bearing cap to breathe or flex and nibble or pinch the ring. This can be caused by improper setting of the relief plungers, or failure of the pump pressure regulating valve.</p>	<p>Replace both seals using an end cap seal kit. Ensure the relief plungers relieve system pressure prior to the axle stops hitting the axle. Verify the pump is performing to spec.</p>
Oil leak from cylinder head to housing joint.	<p>A. Tetra seal hard and not providing sealing compression.</p> <p>B. Cylinder head square ring (or o-ring) hard from heat or pinched. Pinched rings can be caused by improper installation, or over-pressurizing the steering gear. Excessive pressure will cause the cylinder head to breathe or flex and nibble/pinch the ring. This can be caused by improper setting of the relief plungers, or failure of the pump pressure regulating valve.</p>	<p>Replace both seals using an end cap seal kit. Ensure the relief plungers relieve system pressure prior to the axle stops hitting the axle. Verify the pump is performing to spec.</p>
Fluid milky or white in appearance.	<p>Water added to system by mistake or entering through faulty reservoir cap.</p>	<p>Completely flush system, install new filter. Clean vent system if applicable and replace the reservoir cap. Most systems vent through the reservoir cap.</p>
Oil being forced out of reservoir vent or oil is foaming.	<p>A. Restriction in the system causing excessive backpressure. Filter may be clogged, hose may have a flapper inside at the fitting, and hose may be coming apart inside.</p> <p>B. Air in system. Bleed the system and check for leaks on the suction side of the pump, or a crack in the pump.</p> <p>C. Oil overheating. Could be caused by excessive system backpressure, excessive ambient temperatures, wrong fluid being used, or the relief plungers are not set properly.</p>	<p>Perform pressure and flow test.</p> <p>A. Check system backpressure and repair as necessary.</p> <p>B. Use a soap bubble solution to check for leaks on the pump. Check hose fitting o-rings for tears.</p> <p>C. Check fluid quality. Reset the relief plungers.</p> <p>D. Check the filter design. Filter must not allow fluid to pass through and cause turbulence in the reservoir.</p>
Loss of power steering fluid and engine oil level rising.	<p>Power steering pump shaft seal is leaking.</p>	<p>Replace the pump.</p>

<p>Power steering system fluid smells burnt or is discolored. System is operating above 230 degrees F.</p>	<p>A. System operating temperatures are too high. B. Fluid and filter has not been changed according to the vehicle manufacturer's recommendation.</p>	<p>Perform pressure and flow test. A. Check for excessive system backpressure. Reset the relief plungers. Change the fluid and filter. Ensure the front axle is not being overloaded. B. Change filter and fluid per the vehicle manufacturer's guidelines.</p>
<p>Steer tires do not turn far enough when the vehicle is on the ground.</p>	<p>A. Axle stops are screwed out too far limiting wheel travel. B. Steering gear is going into relief too soon and there is a large gap between the axle stop and the axle with the vehicle on the ground.</p>	<p>A. Adjust the axle stops to the vehicle manufacturer's spec, or to a minimum of 1" clearance between the tire and any hard part, plus a minimum of 1/2" clearance between the pitman arm and any hard part. B. After the steering stops are set, adjust the relief plungers to relieve system pressure just prior to the axle stops hitting the axle with the vehicle sitting on the ground.</p>
<p>Steering does not turn far enough when the steer tires are off the ground.</p>	<p>A. Axle stops may be screwed out too far. B. The pitman arm is mistimed to the sector shaft. C. The piston may not be centered in the steering gear when the wheels are pointing straight ahead. D. The sector shaft is mistimed to the piston rack.</p>	<p>A. Adjust the axle stops to the vehicle manufacturer's spec, or to a minimum of 1" clearance between the tire and any hard part, plus a minimum of 1/2" clearance between the pitman arm and any hard part. B. Check the timing marks on the pitman arm and sector shaft-they should be aligned mark to mark. If aligning the marks dead on does not work, call Sheppard. Some manufacturers intentionally misalign the timing marks. C. Disconnect the draglink and turn the steering all the way to the left. Count the number of steering wheel revolutions it takes to go all the way to the right. Divide the number by 2 and turn the steering back to the center that amount of wheel turns. The piston is now centered. The pitman arm should be pointing close to straight down. With the steer tires pointing straight ahead connect the draglink (adjust it if necessary). Ensure the axle stops are correctly set and adjust the relief plungers. D. Remove the sector shaft and align the timing mark on the center tooth between the timing marks on the 2 center teeth of the piston rack.</p>
<p>No power steering on cold start-engine must be revved before power assist comes in.</p>	<p>Power steering pump vanes are not extending.</p>	<p>Contact the pump manufacturer.</p>
<p>Hard steering both directions all the time.</p>	<p>A. Pump pressure or flow is too low. B. Binding steering column universal joint, firewall bushing, slider shaft or support bearing. C. Binding steer axle king pins or linkage. D. Excessive steering gear internal leakage. E. Collapsed or kinked pump suction line. F. Miter box (if equipped) has internal failure. G. Weight on steer axle exceeds axle weight rating.</p>	<p>Perform pressure and flow test. A. Replace pump. B. Repair column. C. Repair king pins or linkage. D. Replace steering gear. E. Replace suction line to pump. F. Replace miter. G. Reduce weight over axle. H. Air tires to spec. I. Consult vehicle manufacturer. J. Consult vehicle manufacturer.</p>

	<p>H. Steer tire pressure too low.</p> <p>I. Steering gear is spec'd too small for the application.</p> <p>J. Pitman arm is too long for the application.</p> <p>K. Steering column or linkage is rubbing against something.</p> <p>L. Steering system out of fluid or fluid is low.</p> <p>M. Steer axle alignment out of spec.</p>	<p>K. Eliminate interference.</p> <p>L. Fill the reservoir and repair any leaks.</p> <p>M. Perform chassis alignment.</p>
Hard steering either direction-sometimes (intermittent)	<p>A. Pump pressure regulator sticking.</p> <p>B. Steering column slider shaft binding.</p> <p>C. Steering column u-joint binding.</p> <p>D. Air in system.</p> <p>E. Debris under relief check ball in piston.</p> <p>F. Excessive internal leakage.</p> <p>G. Steering system fluid is low.</p>	<p>Perform pressure and flow test.</p> <p>A. Replace pump.</p> <p>B. Grease or replace steering column.</p> <p>C. Replace u-joint.</p> <p>D. Bleed air from system.</p> <p>E. Change fluid and filter, wipe out reservoir. Remove cylinder head and ball seat using a 3/16" allen wrench. 2 balls, spring and rod will come out. Clean the passage with air and reassemble.</p> <p>F. Replace the steering gear-not serviceable.</p> <p>G. Fill the reservoir and check for leaks.</p>
Hard steering in only one direction.	<p>A. Steering column u-joint binding.</p> <p>B. Air in system.</p> <p>C. Debris under relief check ball in piston.</p> <p>D. Excessive internal leakage.</p> <p>E. Steering system fluid is low.</p> <p>F. Steer axle alignment out of spec.</p>	<p>Perform pressure and flow test.</p> <p>A. Replace u-joint.</p> <p>B. Bleed air from system.</p> <p>C. Change fluid and filter, wipe out reservoir. Remove cylinder head and ball seat using a 3/16" allen wrench. 2 balls, spring and rod will come out. Clean the passage with air and reassemble.</p> <p>D. Replace steering gear-not serviceable.</p> <p>E. Fill the reservoir and check for leaks.</p> <p>F. Perform chassis alignment.</p>
Hard steering only when loaded.	<p>A. Pump is weak.</p> <p>B. Excessive weight on steer axle/vehicle is overloaded.</p> <p>C. Dry 5th wheel.</p> <p>D. Chassis alignment out of spec.</p>	<p>Perform pressure and flow test.</p> <p>A. Replace pump.</p> <p>B. Reduce axle load.</p> <p>C. Lubricate 5th wheel.</p> <p>D. Perform chassis alignment.</p>
Hard steering only when unloaded.	Chassis alignment out of spec.	Perform chassis alignment.
High system backpressure	<p>A. Pump flow is excessive.</p> <p>B. Clogged filter.</p> <p>C. Line is kinked or blocked.</p> <p>D. Blockage in steering gear.</p> <p>E. Valve in steering gear is sticking and not returning to the center/neutral position.</p>	<p>Perform pressure and flow test.</p> <p>A. Replace with correct flow pump.</p> <p>B. Replace filter and fluid, clean reservoir.</p> <p>C. Check/replace lines.</p> <p>D. Replace steering gear-valve is not serviceable.</p> <p>E. Note pressure at idle, then turn steering wheel 1/8 turn and let go. Pressure should rise then fall to where is started at. If it stays in pressure, remove the steering column from the input shaft and check again by turning the input shaft. If it still stays in pressure replace the steering gear, if it returns normally, repair/replace the steering column.</p>
Steering does not return to center on its own.	<p>A. Excessive drag on the input shaft.</p> <p>B. Binding in the king pins or steer axle linkage.</p>	<p>Perform pressure and flow test.</p> <p>A. Steer hard to one side, remove steering column from input shaft and</p>

	<p>C. Not enough caster in the axle alignment. D. Excessive system backpressure. E. Pump flow is too low or too high.</p>	<p>drive ahead. If wheels return column is at fault. B. Lube/repair pins or links. Set steer tires on turn plates, disconnect draglink and push tire until the axle stop hits. Release tire-if it does not return to center axle is binding or caster is insufficient. C. Perform chassis alignment. D. Find source of restriction. E. Replace pump with correct part.</p>
Wander or darting	<p>A. Excessive drag on the input shaft. B. Binding in the king pins or steer axle linkage. C. Not enough caster in the axle alignment. D. Excessive system backpressure. E. Pump flow is too low or too high. F. Dry 5th wheel. G. Chassis out of alignment. H. Air in steering system. I. Loose steering gear or chassis components. J. Vehicle overloaded. K. Vehicle ride height is incorrect. L. Tire pressures too low.</p>	<p>Perform pressure and flow test. A. Steer hard to one side, remove steering column from input shaft and drive ahead. If wheels return column is at fault. B. Lube/repair pins or links. Set steer tires on turn plates, disconnect draglink and push tire until the axle stop hits. Release tire-if it does not return to center axle is binding or caster is insufficient. C. Perform chassis alignment. D. Find source of restriction. E. Replace pump with correct part. F. Lubricate 5th wheel. G. Perform chassis alignment. H. Bleed the air from the steering. I. Check/tighten loose components. J. Reduce load. K. Adjust ride height to correct setting. L. Correct tire pressures.</p>
Excessive play in steering wheel	<p>A. Steering column u-joint worn. B. Steering column worn at slider shaft. C. Pinch bolt loose at column u-joint allowing splines to skip. D. Pitman arm splines to skipping. E. Draglink or cross tube socket ends worn. F. Steering gear loose on frame. G. Suspension bushings worn. H. Thrust bearing or shim damaged/missing from bearing cap. I. Steering wheel loose on splines.</p>	<p>A. Replace u-joint. B. Replace steering column. C. Tighten pinch bolt. If splines are worn, steering gear and u-joint must both be replaced. D. Retorque retainer. If splines are worn, the sector shaft and pitman arm must both be replaced. E. Replace worn ends. F. Tighten mounting bolts. Ensure holes are not elongated. G. Replace bushings. H. Damaged parts indicate impact damage and the steering gear must be replaced. Replace missing shim. I. Tighten steering wheel nut, ensure splines are true.</p>
Steering feels rough	<p>A. Steering column or u-joint worn out or needs lubricated. B. Steering gear contaminated with dirt or debris. C. Thrust bearing in bearing cap damaged. D. King pins or steering linkage worn.</p>	<p>A. Remove column and check u-joints for smooth operation. Check slider shaft for polishing and proper lubrication. B. Change filter and fluid and flush system with clean fluid. Wipe out reservoir. C. Remove bearing cap cover and check thrust bearings, shims and cover for damage. If damaged, replace entire steering gear due to impact. D. Lube/repair pins or links. Set steer tires on turn plates, disconnect draglink and push tire until the axle stop hits.</p>

		Release tire-if it does not return to center axle is binding or caster is insufficient.
Steering is lumpy (hard, easy, hard, easy)	A. Steering column u-joints are out of phase. They must be timed so the hard and easy spots even out for smooth steering.	A. Remove slider shaft from steering column and reposition 90 degrees.
Steering turns by itself	A. Hoses are hooked up incorrectly. B. Steering column is putting pressure against the steering gear input shaft. C. Steering gear rotary valve or seals damaged.	A. Verify hose routing. The large port on the bearing cap which is closest to the sector shaft is ALWAYS the pump pressure line. B/C. Remove column from steering gear and turn input shaft with socket and ratchet. If the gear still self steers replace it due to a damaged rotary valve, otherwise repair the steering column.
Catch or bind in steering then free	A. Pump flow is too low. B. Air in system. C. Loose steering gear or steer axle mounting bolts. D. Rotary valve seal is sticking.	Perform pressure and flow test. A. Replace pump. Fluid is not flowing fast enough to push the piston. B. Bleed the system only when turning right. C. Tighten mounting bolts to vehicle mfr specs. D. Replace the rotary valve seals.



TROUBLESHOOTING PROCEDURE

⚠ WARNING FOLLOW GOOD SHOP PRACTICE WHEN TROUBLESHOOTING. ENSURE THE VEHICLE IS SECURED FOR SERVICE, ALL SAFETY PRACTICES FOLLOWED, AND PERSONAL PROTECTIVE EQUIPMENT IS WORN AT ALL TIMES.

NOTICE

Do not remove the steering gear from the vehicle!

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 or binding 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

- **Talk to the driver** – Refer to the list of technical terms in this manual to obtain a clear understanding of what the complaint is.
- **Drive the vehicle** – If possible, have the driver show what the problem is that he is experiencing, drive the vehicle together to duplicate the condition. Does the truck pull to one side or the other? Does the steering wheel want to jerk out of your hands? Is it hard to steer and if so, under what conditions? Does the wheel not want to come back to center after a turn? Does it turn easy for a turn then get hard? Both directions?
- **Ask lots of questions** – Does the problem occur only when loaded or unloaded? Does the problem happen when turning only to the left, only to the right, or in both directions? Is the problem affected by vehicle speed or engine RPM's? Does it only happen when backing the vehicle? Has the steering gear been replaced recently, and if it has, why was it replaced, for the same problem? Have any other steering system components been replaced or shown problems; pump, lines, filter, reservoir, king pins, draglink, etc. How often are the power steering fluid and filter changed? Is it on a regular maintenance cycle?
- **Steering gear was just replaced** – Find out if the relief plungers were adjusted and how they were adjusted. Ask if the steering system had the air bled from it and what procedure was used – particularly on a dual steering gear equipped vehicle (the procedure is very specific).

Step 2: Visually Inspect the Vehicle

- **Check the fluid for proper level.** Does it smell burnt? The system could be overheating for any number of reasons which will need to be determined. Is it foaming with lots of air bubbles in it? If so, check for leaks on the suction side of the pump – hose fitting o-rings, loose hose clamps, etc.
- **Check for a dry fifth wheel** – The drag from lack of lubrication will tend to steer the vehicle.
- **Check tires** for mismatch, improper inflation, and uneven wear patterns.
- **Check for uneven loading of the vehicle** – Added equipment (booms, winches, snow plows, and spreaders) or special body configurations should be checked for their effect on steering angles and effort. Check if the suspension was modified with the addition of a different axle (truck was made all wheel drive and the suspension was lifted).
- **Check the suspension** – Inspect for worn spring shackles, patterns of excessive wear, out of alignment rear axles which will tend to steer the



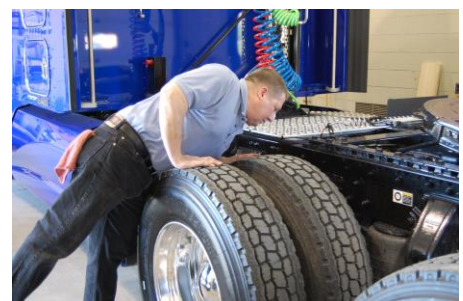
CHECK THE FLUID LEVEL



IS FLUID FOAMING OR BURNT



LUBRICATE FIFTH WHEEL



CHECK DRIVE AXLE ALIGNMENT

front of the vehicle. Look for components shifting as the axle is steered including the steering gear. See if the tires are making contact with any other parts (such as the pitman arm or draglink). Inspect the axle stops; ensure they are in place and not bent. See if they are hitting the axle hard.

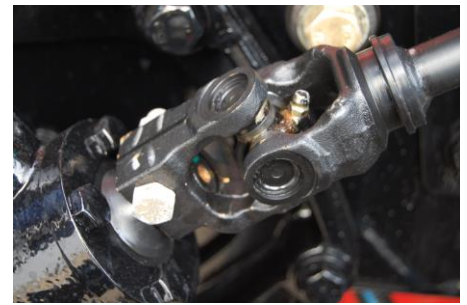
- **Check the steering column** – Ensure the column is not hitting anything as it rotates and the universal on the input shaft does not hit the bearing cap cover bolts. Look for the steering wheel rubbing against the column cover, and the column rubbing as it passes through the cab floor.
- **Check the hoses** – Ensure the hoses are in good condition and properly routed. Improperly installed hose fitting can cause a “flapper” or loose piece of rubber inside the hose. This condition can cause high system backpressure or starve the pump from fluid. Note: The inlet and return ports on the bearing cap are staggered when viewed from the side. The inlet port will always be the one closest to the sector shaft.

Step 3: Inspect the Mechanical Components

- **Check the steering column** - Remove the universal joint from the input shaft of the steering gear and inspect the sliding intermediate shaft for signs of polishing, galling, or binding. Ensure it is properly lubricated. Inspect each universal joint for sticking and proper lubrication. Ensure the universal joints are properly phased – improper phasing will cause “lumpy” steering, or a hard-easy-hard-easy feel to the steering. If the steering gear has a bracket mounted on the bearing cap with a carrier bearing in it, ensure the bearing rotates freely, and is aligned properly in the bracket. The bearing tends to put a side load against the steering column and cause “self steer” if not properly aligned.
- **Compare the input torque taken at the steering wheel to the input torque taken directly on the input shaft of the steering gear.** The correct size 12 point socket will fit over the input shaft so that an inch pound torque wrench may be used. Normal torque at the steering wheel will be approximately 55-75 inch pounds.
- **Check the pitman arm** – Ensure the arm does not contact any other parts. Check for “toggle” which occurs when the pitman arm and draglink are almost in line with each other. There must be sufficient angle between the two to ensure smooth steering. If toggle occurs, adjust the axle stops to reduce the turning radius and gain a better angle between the pitman arm and draglink.
- **Check for steering gear centering** – Ensure the piston is centered in the gear if full steering to one side cannot be reached. Disconnect the draglink and turn the steering wheel to full left, then turn it full right. Count the number of steering wheel revolutions it takes. Divide the number by 2 and steer back to center that number of turns. This centers the piston in the cylinder of the steering gear. The timing mark on the end of the sector shaft should be pointing to the center of the steering gear. The pitman arm timing mark should line up with the timing mark on the sector shaft when the pitman arm is hanging straight down (or very close to it) on most applications.
- **Check the steer axle for binding** – Raise the steer tires off the ground and steer the axle through its full turn radius. Check it with the engine running and with the engine off. Feel for any binding or hard spots, and ensure the axle stops contact the axle in both directions. Set the vehicle on a set of bearing plates (the type used for front end alignments). Disconnect the draglink from the pitman arm. Grab the tire and turn it until the axle stop hits the axle then let go. The tires should try to return to the straight ahead (or close to) position. If they do not, look for binding linkage connections or king pins. Reconnect all links prior to hydraulic testing.

Step 4: Test the Hydraulic Power Assist System

NOTE: If the steering gear is under warranty, DO NOT REMOVE IT UNTIL ALL HYDRAULIC TESTS ARE COMPLETED, AND YOU GET A RETURNED GOODS AUTHORIZATION (RGA) NUMBER FROM SHEPPARD. Warranty may be denied if this procedure is not followed.



CHECK THE COLUMN



INSPECT FOR LEAKS AND KINKS



CHECK U-JOINTS AND SLIDER



USE TURN PLATES



ESSENTIAL TOOLS

Keep in mind; **FLOW** – Determines how fast you can steer, and **PRESSURE** – Determines whether you have enough power to steer.

- With not enough flow from the pump you should be able to turn the steering slowly, but it will bind if you try to turn it fast. Too much flow and the steering could be too easy, or the vehicle could be difficult to control (darting and wandering).
- With not enough pressure, the steering will be hard to turn. The steering pressure will equal the maximum pump pressure. Too much pressure can cause the steering gear housing to crack or break, the relief balls to get jammed into the relief spring inside the steering gear piston, hoses to rupture, and other steering components to bend or break.
- It is critical to have the correct pump flow and pressure the vehicle was designed for.

Heat, is the enemy of any steering system. The higher the system temperature, the less efficient the system will operate. Excessive heat causes steering gear seals to fail because they get hard and cannot maintain their seal. Pump internal leakage increases as temperatures increase, which adds even more heat to the system. Hoses become hard and brittle as heat increases causing the inner hose lining to break apart which can get stuck in the steering gear causing it to fail. System temperatures should never be allowed to exceed 230F.

To properly test the steering system, use a 0-3000 psi pressure gage, 1-10 gpm flow meter, and shut-off valve installed between the pump and steering gear. A thermometer placed directly into the power steering reservoir is also needed, and must be capable of reading up to 250F. The Sheppard Pressure and Flow Test Kit #5517641 pictured here is available directly from Sheppard by calling 717-633-4102 or the Field Service Hotline at 800-274-7437.



HEAT SHOULD NOT EXCEED 250F



PRESSURE & FLOW TESTER

WARNING OIL UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE SEVERE INJURY. NEVER USE YOUR HANDS TO CHECK FOR LEAKS.

WARNING USE CAUTION WHEN CLOSING THE TESTER SHUT-OFF VALVE. DO NOT EXCEED 3000 PSI ON THE GAGE. A STUCK PRESSURE RELIEF VALVE IN THE PUMP CAN CAUSE PRESSURE TO CLIMB UNTIL A HOSE OR SEAL BURSTS.

NOTICE All tests MUST be performed with the weight of the vehicle on the ground. DO NOT apply the service brakes while steering! The parking brake should be set and the rear wheels chocked. The vehicle should be sitting on a solid level surface, clean and dry (preferably a brushed concrete floor).

The testing is to duplicate driving conditions as much as possible, and vehicles are not driven with the steer tires off the ground! Place a drain pan under the steering gear and install the pressure and flow tester. Start the vehicle and top off the fluid level.

Make a copy of the Troubleshooting Checklist found inside the back cover of this manual. For the latest version of the checklist, go to www.rhsheppard.com under SERVICE, then SERVICE BULLETINS. You may be asked to fax the completed checklist to Sheppard.

TROUBLESHOOTING CHECKLIST

1. Record the date and dealer information.
2. Describe the steering complaint: be as detailed as possible. When does the problem happen, turning only to the left or only to the right? Only when loaded? Only in the morning when it's cold? Only at the end of the day?
3. Complete the vehicle and steering system information portion of the form. The steering gear sub-model and serial numbers are stamped or pin printed into the side of the housing. Examples: PMX3 06H12345, or

SHEPPARD
Quality engineered products. Unlimited capabilities.

POWER STEERING TROUBLESHOOTING CHECKLIST

Before proceeding with the following tests, check all mechanical and external conditions before hydraulic testing. Do not measure the steering gear or pump until that specific test is completed and an authorization number has been received from Sheppard.

Date: _____
 Dealer Name & Location: _____
 Dealer Contact Name: _____
 Contact Phone Number: _____
 Servicing Tech Name: _____

Sheppard Returned Goods Authorization Number: _____

Description of Steering Complaint: _____

Vehicle Model: _____
 Mileage: _____
 Engine Model: _____
 Steering Gear Model: _____
 Slave Gear Model (if equipped): _____
 Pump Manufacturer: _____
 Front Axle Weight Rating: _____

Vehicle Application: _____
 Serial No.: _____
 Pump Part # _____
 Front Axle Manufacturer: _____

HYDRAULIC TESTS: Refer to RH Sheppard service information available on-line at www.rhsheppard.com and in the Sheppard steering gear Service Manual. Do not remove the steering gear's internal pressure and flow tester in the pressure line from the pump in the gear as outlined in the Diagnosis and Troubleshooting Section. Record the following information:

Engine Idle RPM _____ Engine Max RPM _____
 Oil Temperature _____ Degree F (Tests should be run at about 180F)
 System Body Pressure @ Idle _____ PSI Body Pressure @ Max RPM _____ PSI
 Maximum System Pressure (Pump Relief Setting) at Idle _____ PSI at Max RPM _____ PSI
 Flow @ Idle with Body Pressure Only _____ GPM
 Flow @ Max RPM Body Pressure Only _____ GPM
 Flow @ Idle With 1500 PSI Load Applied _____ GPM
 Flow @ Max RPM With 1500 PSI Load Applied _____ GPM
 Drive Steering Gear Stay in Pressure when the Steering Wheel is released? YES _____ NO _____
 Static Steer Turning Pressure RIGHT Turn _____ PSI LEFT Turn _____ PSI
 Relief Flange Trip Pressure RIGHT Turn _____ PSI Pressure Drops Down to _____ PSI
 Relief Flange Trip Pressure LEFT Turn _____ PSI Pressure Drops Down to _____ PSI
 Steering Gear Internal Leakage RIGHT Turn _____ PSI _____ GPM
 Steering Gear Internal Leakage LEFT Turn _____ PSI _____ GPM
 Static Steer Turning Input: Right RIGHT Turn _____ In. Lbs. LEFT Turn _____ In. Lbs.

Sheppard Field Service Hotline: 1-800-274-7437
 Call the Hotline for authorization and receive checklist parts steering gear my license.
 Warranty may be denied without a completed checklist.

Revised 6/2009

TROUBLESHOOTING CHECKLIST



MODEL AND SERIAL NUMBER

SAD15 07B12345. The Model Number will be cast into the side of the housing. Examples: M100, or M90. If the word AUTO appears or if the sub model number has a 3 right after the letters, the gear has Automatic Relief Plungers. If it has a 1 right after the letters, the gear has Manual Relief Plungers.

4. **Install the Pressure and Flow tester in the pressure line between the pump and the steering gear.** Place a drain pan under the steering gear. Start the vehicle and make sure the flow meter moves in the direction indicated by the arrow on the flow meter. Ensure the pressure gage does not stick; it should rise when the steering wheel is turned, and drop to 0 when the engine is shut off. Top off the fluid level at this time.
5. **Record Engine Idle and Maximum RPM.** If the engine idles too slowly, the pump will not turn fast enough to give the proper flow and hard steering will result, especially on engines which have a 1:1 pump drive ratio (like Cummins).
6. **Record the Oil Temperature.** Use a thermometer placed in the fluid in the reservoir. Testing is to be completed at 180F. Close the shut-off valve on the tester until 1500 psi shows on the gage and the temp is at 180F. At 180F, open the valve fully. Some problems, such as intermittent binding or catching in the steering, can only be found if the testing is completed at 200F. Ensure you record the correct temperature when testing.

NOTICE

DO NOT EXCEED 230F. Pump and seal failures will begin to occur at this temperature!

7. **Record the System Backpressure at Idle and at Full RPM.** This is the circulating pressure of the system without moving the steering wheel. This test reveals any restrictions in the system such as; clogged hoses or “flappers”, soft pump suction hoses which collapse with increased flow, clogged filter, kinked hoses, clogged reservoir, debris stuck in the steering gear passages. It can also reveal a pump which is putting out more flow than the system can handle. Pressure should be less than 50 psi for a single steering gear, and less than 150 psi for dual steering gear systems. Excessive backpressure causes high steering system temperatures, more wear on the pump, and does not allow the valve in the steering gear to operate smoothly. Hard steering may be the result as well as shorter seal and component life due to the increased heat.
8. **Record Maximum Pump Pressure at Idle and Max RPM.**

⚠ WARNING

USE EXTREME CAUTION WHEN COMPLETING THIS TEST. DO NOT EXCEED 3000 PSI ON THE GAGE. CLOSE THE VALVE SLOWLY UNTIL THE FLOW METER SHOWS 0 FLOW. DO NOT KEEP THE VALVE CLOSED LONGER THAN 3 SECONDS OR THE PUMP MAY BE DAMAGED.

- Some pump relief valves will work fine at idle then stick at max rpm. Check the pressure rating marked on the pump to see what the maximum should be. Most pumps are rated for 1800, 2175, 2350 or 2650 psi. The pump should hold max pressure when the shut-off valve is closed for the full 3 seconds and not start dropping off. If the pump will not build the correct pressure it should be replaced, and the new pump checked the same as the old one. Ensure it is the correct pump for the vehicle VIN.
9. **Record Flow at Idle with Backpressure Only.** This test is with the shut-off valve wide open, engine idling, no touching the steering wheel. If the flow is too low, the faster you turn the steering wheel, the harder it will be to turn. If the flow is too high, it will cause high system backpressure and excessive heat resulting in component failures.
 10. **Record Flow at Max RPM with Backpressure Only.** This test is with the shut-off valve wide open, engine at maximum RPM, no touching the steering wheel. Flow should not increase more than about 2 gpm from idle. Some pumps will barely increase in flow.
 11. **Record Flow at Idle with 1500 PSI Load Applied.** With the engine idling, close the tester shut-off valve until 1500 psi shows on the gage. Record how much flow is showing on the flow meter. This test is designed to duplicate the load the pump sees when the vehicle is tuning at slow or no speed which is



(M100) PMX3 03D09920



PERFORM TESTS AT 180F



CHECK PRESSURES IN PSI



RECORD ALL FLOWS IN GPM



CHECK FLOWS AT IDLE AND MAX ENGINE RPM

when the steering works the hardest. If the flow is still good, chances are the pump is ok.

12. **Record Flow at Max RPM with 1500 PSI Load Applied.** With the engine at maximum rpm, close the tester shut-off valve until 1500 psi shows on the gage. Record how much flow is showing on the flow meter. This test will show the maximum flow the pump can deliver. If the flow is still good and the max pressure reading was correct, the pump is ok.

At this point in the testing, all checks on the pump are complete. If the pump is bad, you know it by now. If the pump checks good proceed with the remainder of the tests.

13. **Does the Valve Stay in Pressure When the Steering Wheel is Released-Yes or No?** With the engine idling, look at the pressure gage and note what it reads. Turn the steering wheel one eighth (1/8) turn and let go of it. The pressure should drop back to where it started. If it does not, disconnect all steering column shafts from the input shaft of the steering gear. Turn the input shaft again 1/8 turn with a pair of pliers or vice grips and note if the pressure returns to where it started. Steering columns can sometimes put a side load against the input shaft and prevent it from returning to neutral. This can create a high system backpressure reading and also excessive heat.
14. **Record Static Steer Turning Pressure Right and Left.** The vehicle must be sitting on the ground on a smooth, dry surface (brushed concrete is the standard surface for testing). With the engine at idle and the parking brake set, turn the steering wheel all the way to the right and all the way to the left a couple times. Do not step on the brakes! Record the highest pressure turning in each direction before it hits the end of travel. The pressure should spike and drop off at the end of travel (if it does not the relief plungers need to be adjusted). This static steer pressure should not be as high as the Maximum Pump Pressure. If it is, the steering is being overloaded either by too much weight on the steer axle, or excessive binding of a component(s) in the steering system.
15. **Record the Relief Plunger Trip Pressures Right and Left.** Turn the steering wheel all the way to the right and record the very highest pressure reached when you hit the end of travel, then record what the pressure drops to as you PULL HARD on the steering wheel. Repeat for the left turn. There is no certain pressure or range to look for. You DO NOT want to see the pressure go to Maximum Pump Pressure and stay there. This would indicate the relief plunger needs adjusted or is broken off.
16. **Record the Steering Gear Internal Leakage in PSI (pressure) and GPM (flow).** If the steering gear is built with a pressure relief valve (PRV), it must be removed and replaced with the 3331812K Test Plug for testing purposes only. If the PRV is not replaced with the test plug, the PRV will open during the test and show excessive internal leakage. The PRV looks like a 1 1/2" nut on the side of the steering gear bearing cap. Simply unscrew it and replace it with the test plug. Do not over tighten the plug.
 - a. Place a 1" steel block (or equivalent) between the axle stop bolt and the axle on the left front wheel. (A 4X4" wood block cut to fit between the frame or spring, and the wheel rim of the steer tire also works well. The wheels should be kept close to center when the block is being held.)
 - b. While holding the block in place have the wheels turned slowly to a full left, squeezing the block between the axle stop bolt and the axle. Pull hard on the steering wheel to ensure the valve in the steering gear is completely open to allow all pump flow to one side of the steering gear piston. This will also close the return path to the reservoir. When properly done, the steering system should achieve maximum pump pressure, and flow should be less than one gallon per minute. Note the pressure and flow readings with the block in place.
 - c.

WARNING Take care when squeezing the block between the axle stop and the axle. The block can be ejected and personal injury could result.



FLOW W/ 1500 PSI LOAD APPLIED



TYPICAL STEERING PUMP



CHECK ALL PRESSURES WITH THE TIRES ON THE GROUND!



PRV IN BEARING CAP



PRV ON LEFT, 3331812K TEST PLUG ON RIGHT



AXLE STOP W/ TYPICAL GAP

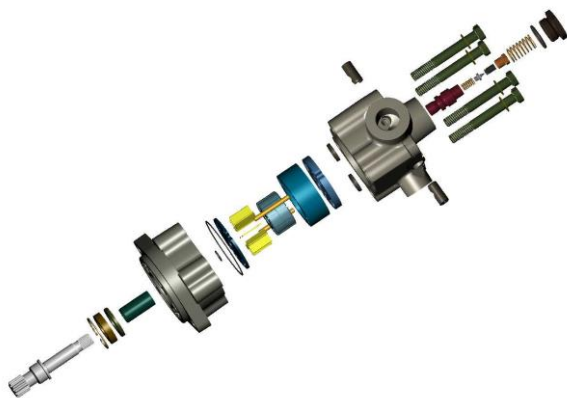
- d. Repeat for a right turn, placing the block between the axle stop bolt and axle on the right side of the vehicle.
- e. If excessive internal leakage was noted in one or both directions (flow greater than 1 gpm), the steering gear should be replaced.

NOTE: If this test is being performed on a dual steering gear system (master and slave gear, or master gear with an assist cylinder) or multiple steering gear system, and excessive internal leakage is noted, remove and cap the pressure lines coming off the master gear which lead to the slave gear or cylinder. **DO NOT** couple the hoses together as this will only create a flow path back to the reservoir. Disconnect the draglink for the slave gear or disconnect one end of the assist cylinder. Repeat steps a through d. If the internal leakage drops below 1 gpm, the problem is in the slave gear or assist cylinder. If the internal leakage is still above 1 gpm, the problem is in the master steering gear. An internal leakage of 1 gpm is allowed for each steering gear or cylinder. (A steering system using 3 steering gears would be allowed 3 gpm total of internal leakage.)

17. **Record the Static Steer Turning Input Effort.** Measure the input effort with a dial or beam type inch pound torque wrench at the center nut of the steering wheel (most are 1 1/4"). Click type (crack bar) and digital torque wrenches should not be used. Turn the steering wheel smoothly all the way left and all the way right, not too fast but not too slow. Look for the highest torque reached before hitting the end of travel. The reading may stay steady or slowly rise. It should not be "lumpy", as in go up and down and up and down as you steer from side to side. If it does, there is a problem with the phasing of the universal joints in the steering column. They should be phased or timed so that the high and low spots of all the joints make for smooth steering side to side.

- a. Most line haul tractors, medium duty trucks, and motor homes will steer from about 55-70 in lbs.
- b. Most vocational trucks, cranes, off-highway vehicles, and very heavy applications will steer from about 70-100 in lbs.

18. **Shut off the engine and remove the pressure and flow test kit.** Replace the test plug (if used) with the PRV. Do not over tighten. Reconnect all lines and linkages previously disconnected. Check and correct the fluid level, and remove the drain pan.



TYPICAL POWER STEERING PUMP



1" BAR USED TO CHECK INTERNAL LEAKAGE



MAX PUMP PRESSURE AND NO FLOW = 0 INTERNAL LEAKAGE



CHECKING INPUT EFFORT



POWER STEERING PUMP

STEERING GEAR REPLACEMENT AND ADJUSTMENT

Sheppard Power Steering Gears are manufactured and tested for proper operation prior to shipment. Every effort has been made to ensure they will provide you with many miles of trouble-free, safe operation. To protect your investment and comply with your warranty, it is important that these instructions be closely followed.

TOOLS REQUIRED:

Drain Pan	Rags	2-7/8" Combination Wrenches	1/2" Drive Ratchet Handle	5/8", 1/2" Drive Socket
11/16" Combination Wrench		1/2" or 3/4" Drive Air Impact	0-100 ft/lb 1/2" Drive Torque Wrench	
Medium Hammer		Center Punch	0-600 ft/lb Torque Wrench	Flat Screwdriver
5/8" or 3/4" Allen Drive Socket		Appropriate size Sockets and Wrenches for the Steering Gear Mounting Bolts and Draglink Nut		

⚠ CAUTION

STEERING GEARS ARE HEAVY AND AWKWARD TO HANDLE. IT IS EASY TO GET FINGERS PINCHED OR DROP THE GEAR WHEN HANDLING IT. MAINTAIN A CLEAN WORK AREA AND PLAN AHEAD HOW YOU ARE GOING TO REMOVE AND STORE THE OLD GEAR, AND INSTALL THE NEW ONE. GOOD PRIOR PLANNING WILL MAKE THE JOB MUCH EASIER!

1. Anytime a power steering gear or power steering pump is replaced, the oil and oil filter in the power steering system should be changed. All lines and fittings should be flushed of any possible contaminants. Use the type of fluid specified by the vehicle manufacturer or 15W40 Engine Oil if none is specified.
2. 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.
3. Remove the steering column universal joint from the steering gear input shaft and secure the column out of the way. Now is a good time to inspect the column and u-joints for looseness or binding.
4. If the new steering gear has a pitman arm already installed, remove the cotter pin from the castle nut on the draglink, and the draglink from the pitman arm. Secure the draglink out of the way, or;
5. Remove the pitman arm using the guidelines in this manual. The draglink does not have to be removed from the pitman arm.
6. Disconnect and cap all the hoses from the steering gear. Do not allow contaminants to enter the hoses. If the hoses are leaking or hard and brittle, replace them.
7. Transfer the hose fittings from the old steering gear to the new one. Replacing the o-rings is recommended.
8. Clean the steering gear of grease and oil before removing it.
9. Hold the gear securely while the frame mounting bolts are removed, and remove the steering gear.
10. Ensure the mounting bolts are the correct length for the replacement steering gear. (As models are updated, sometimes the thickness of the gear mounting pads can change.)
11. Inspect the frame rail for straightness. A wavy or distorted frame will cause the steering gear to bind once mounted.
12. Install the steering gear on the vehicle. Care should be taken to ensure the mounting bracket or steering gear is not distorted when the bolts are drawn up. This condition could cause binding in the gear. Torque the bolts in an alternating pattern to the vehicle manufacturer's specs.
13. Install the steering column or intermediate shaft to the steering gear input shaft, ensuring the clamp bolt is torqued to the vehicle manufacturer's specification.
14. If required, install the pitman arm using the guidelines in this manual. Take care not to move the arm more than 2 inches in either direction unless the draglink has been installed. Over-traveling the piston will prematurely set AUTO relief plungers.
15. Install the draglink on the pitman arm if required (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 is performed.
16. Attach all hoses to the gear or gears. Ensure they are in good condition and routed with no kinks in the line or clamps pinching them. Refer to the Dual Steering Gear Systems section of this manual for proper routing of dual steer systems. On M-Series gears, the inlet and outlet ports are staggered. The inlet port is always the one closest to the output shaft.

NOTE: 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, the pitman arm may be mistimed.

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

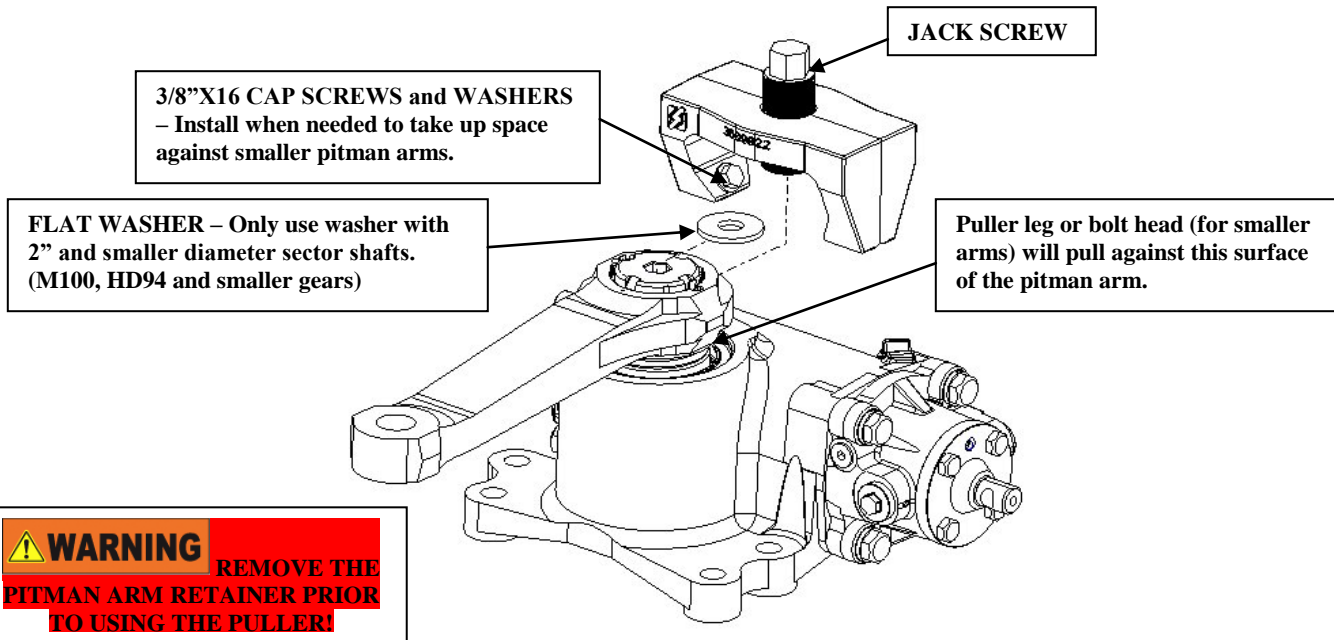
NOTICE

18. Set the AUTO relief plungers or adjust the manual relief plungers to obtain proper wheel cut.
19. Bleed the gear or gears using the guidelines in this manual.
20. Double-check all fasteners, fittings, hose routings, and check for leaks. Top off the fluid and return the vehicle to service.
21. Sheppard recommends the power steering system fluid and filter be changed according to the vehicle manufacturer's guidelines. Regular preventive maintenance is essential to the life of the steering system.

If you have questions at any time contact our Field Service Hotline at 1-800-274-7437!

PITMAN ARM REMOVAL and INSTALLATION

SHEPPARD PITMAN ARM PULLER 3591842K (3596372K is similar)



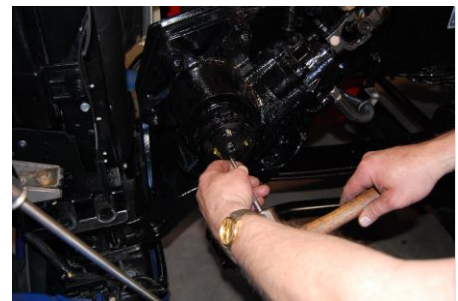
WARNING THE PITMAN ARM WILL BE EXTREMELY TIGHT! USE ONLY LIGHT HAMMER BLOWS WHEN TAPPING ON THE ARM TO REMOVE IT! NEVER APPLY HEAT TO THE PITMAN ARM OR STEERING GEAR AS DAMAGE TO THE PITMAN ARM, SECTOR SHAFT, OR SEALS MAY RESULT!

CAUTION The pitman arm removes with great force and a loud bang may occur when the arm pulls free from the sector shaft. Exercise extreme caution when using this removal tool. Always wear safety glasses or a face shield.

NOTICE The pitman arm is easiest to remove while the steering gear is still mounted to the vehicle (in most applications). The 3/8" bolts and large flat washer are used when pulling smaller arms.

REMOVAL

1. Park the vehicle and secure it for service per the manufacturer's directions.
2. Disconnect the drag link from the pitman arm per the manufacturer's directions.
3. Use a punch to bend the restraining tabs out of the notches in the pitman arm retainer.
4. Do not bend the tabs out of the 2 slots machined into the pitman arm.
5. Using the appropriate Allen socket and impact wrench, remove the retainer. If the retainer is not damaged, it may be reused.
6. Note the timing mark on the end of the sector shaft. It should be aligned with a timing mark on the pitman arm. Some arms have several timing marks-ensure you know which mark to align when the arm is reinstalled.
7. Apply a dab of chassis grease to the end of the sector shaft and to the threads of the puller jackscrew.
8. Use the large flat washer on the end of the sector shaft and apply a coat of grease to it if sector shaft is 2" or smaller. Slide the puller over the end of the pitman arm far enough that the jackscrew will be centered on the end of the sector shaft and washer. You may have to tap the puller with the hammer to get it properly positioned on the arm. Ensure the jackscrew is centered and makes contact down in the recess of the sector shaft counter bore.
9. If pulling a narrow arm, screw the 3/8" bolts into the puller legs from the inside, so the bolt heads make contact with the pitman arm. You can grind the bolt heads if necessary to get a proper fit, or add washers to the bolts for added support (to minimize bending).



BEND OUT LOCK TABS



REMOVE THE RETAINER

CAUTION The jackscrew must be centered squarely on the end of the sector shaft. Damage to the puller will result if it is not aligned properly.

- Tighten the jackscrew with the impact wrench and remove the pitman arm. Tapping on the arm with a hammer at the same time will aide in loosening the arm.

INSTALLATION

CAUTION Proper pitman arm installation is critical to the safe operation of the vehicle. Correct torque values are essential to keep the arm from coming loose. Always follow these procedures when installing the pitman arm.

WARNING IF THE PITMAN ARM RETAINER IS NOT TORQUED CORRECTLY DURING INSTALLATION, THE PITMAN ARM CAN COME LOOSE AND CAUSE PERSONAL INJURY AND MECHANICAL DAMAGE. ANYTIME A PITMAN ARM IS FOUND LOOSE, REPLACE BOTH THE PITMAN ARM AND THE SECTOR SHAFT.

NOTICE Mount the steering gear to the vehicle frame prior to tightening the pitman arm retainer.

- Clean the splines of the sector shaft and pitman arm. The splines should be free of any dirt, grease or oil prior to installing the arm.
- Slide the pitman arm onto the sector shaft. Align the correct timing marks. Ensure the splines are fully seated in the roots. If you do not know which timing mark to use, contact Sheppard Field Service.
- Coat the threads of the pitman arm retainer, and both sides of the friction washer with anti-seize.
- Screw the retainer into the sector shaft. Ensure the alignment tabs on the tab washer fall into the notches of the arm.

WARNING THE RETAINER MUST BE TORQUED TO THE VALUE STAMPED INTO THE FACE OF THE RETAINER. FAILURE TO DO SO MAY CAUSE PERSONAL INJURY OR MECHANICAL DAMAGE.

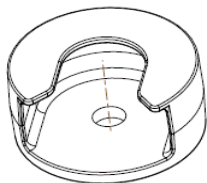
M80 AND M83 -	225 FOOT POUNDS
M90 AND M100 -	350 FOOT POUNDS
M110 -	450 OR 550 FOOT POUNDS

- Use a 5/8" or 3/4" Allen drive bit to tighten the retainer to the specified torque. Continue torquing the retainer until 2 of the locking tabs align with the notches in the face of the retainer. (It is acceptable to exceed the specified torque in order to get the lock tabs to align.)

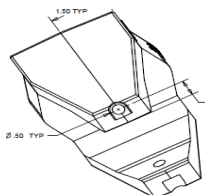
WARNING DO NOT BACK OFF THE RETAINER TO ALIGN THE TABS. A LOOSE PITMAN ARM AND LOSS OF STEERING CONTROL MAY RESULT.

- Use a punch and hammer to bend the locking tabs into the notches of the retainer. Apply torque putty to the tabs for visual reference.

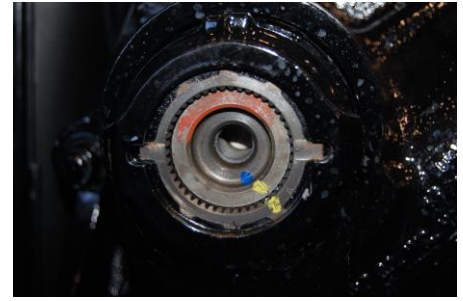
WARNING DO NOT RETORQUE THE RETAINER! IT MAY CAUSE A LOOSE PITMAN ARM BY BOTTOMING OUT THE RETAINER BOLT



3574864 PULLER



3591842K PULLER



NOTE THE TIMING MARKS



REMOVE THE PITMAN ARM



ALIGN MARKS AND INSTALL ARM



TORQUE THE RETAINER



BEND LOCK TABS INTO SLOTS

AXLE STOP ADJUSTMENT

Axle stop positioning should be checked during the Pre Delivery Inspection and as part of the vehicle's preventive maintenance program. The stops determine the vehicle's maximum steering angle and can be adjusted using the stop bolt and jam nut on the back of each steer tire hub on most vehicles. Some vehicles use a different stop arrangement such as a stop piece which contacts the pitman arm on some independent suspensions.

NOTICE

The following information is a guideline to provide **MAXIMUM** turn angle in each direction. It may provide a tighter turn radius in one direction over the other. If you prefer to have the same number of steering wheel turns in each direction, set the axle stops accordingly. Refer to the vehicle manufacturer for exact turn angle specifications for your vehicle.

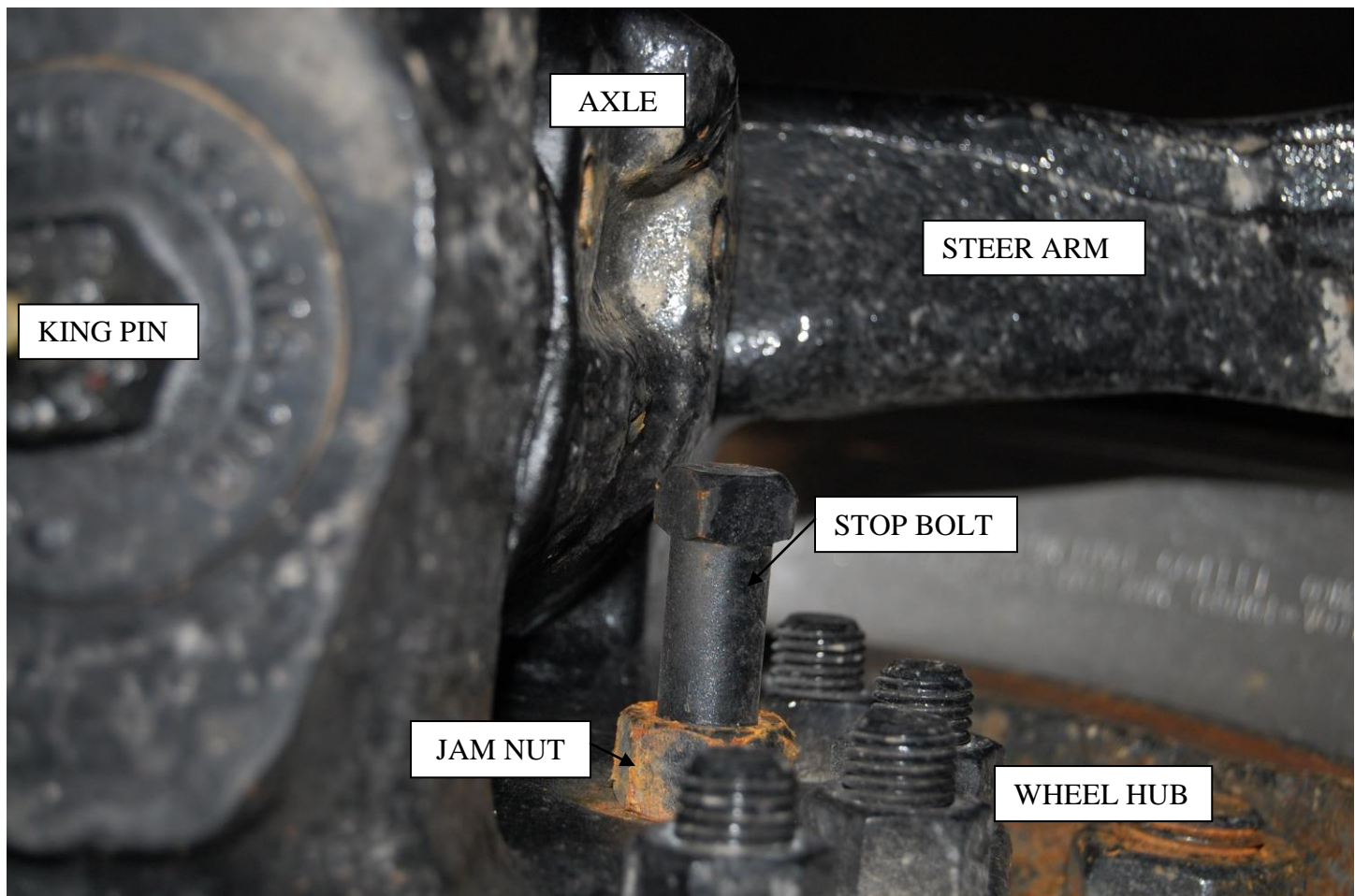
1. Park the vehicle on a clean, dry, solid surface - preferably concrete.
2. Secure the vehicle for service.
3. Raise the steer axle until the steer tires are just off the ground.

⚠ WARNING MAINTAIN AT LEAST 1" OF CLEARANCE BETWEEN THE STEER TIRES AND ANY HARD PART ON THE CHASSIS. CONTACT WITH THE TIRE MAY RESULT IN STEERING COMPONENT AND TIRE DAMAGE. MAINTAIN AT LEAST 1/4" OF CLEARANCE BETWEEN THE PITMAN ARM (OR ANY OTHER STEERING LINKAGE) AND ANY OTHER HARD PART OF THE CHASSIS.

4. Turn the wheels full right and check the distance between the tires and chassis, pitman arm and draglink. (Figure 1)
5. Adjust the axle stop to maintain a minimum 1" clearance. Also check the clearances between the end of the pitman arm, the steer arm, the tie rods, and cross tubes. A minimum of 1/4" should be maintained at these points. This is the maximum wheel cut available. (Figures 2, 3 and 4)
6. Turn the wheels full left and repeat the process for the left turn.

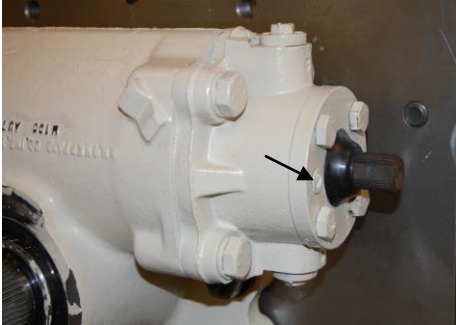
NOTE: Adjust the axle stop on the right wheel for the right turn, and the left wheel for the left turn.

7. Ensure the jam nuts are tight on both axle stops and return the vehicle to service.



RELIEF PLUNGERS

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 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 and may be in a hole in the cover, or in the hole in the end of a boss sticking out from the cover. The hole may be covered with a plastic plug or cap. Both the auto and manual plungers have a slotted head for a screwdriver and look alike. They both may be located either on the frame side or the tire side of the centerline of the steering gear.



BEARING CAP PLUNGER



CYLINDER HEAD PLUNGER



MANUAL AND AUTO PLUNGERS

The plungers 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.

NOTICE

After a steering gear is built and tested by Sheppard, the relief plungers are set all the way in. When the gear is installed on a vehicle, it will have **MINIMUM STEERING TRAVEL** until the relief plungers are properly set. This applies to new and remanufactured steering gears, with manual or auto relief plungers.



CAUTION

FAILURE TO SET OR ADJUST THE RELIEF PLUNGERS MAY RESULT IN DAMAGE TO THE STEERING SYSTEM AND CHASSIS. PLUNGERS MUST BE SET OR ADJUSTED ON ALL REPLACEMENT STEERING GEARS!

AUTO PLUNGERS

1. Automatic plunger gears are identified by the word AUTO in raised letters cast into the side of the steering gear housing.
2. Raise the steer tires off the ground.
3. Start the engine and let it run at idle speed. Ensure the axle stops are set at the vehicle manufacturer's spec. If no spec is available, set the stops for maximum wheel cut with a minimum of 1" clearance between the tire and any part of the chassis. Ensure the pitman arm has clearance to any hard part.



CAUTION

ENSURE THE PITMAN ARM AND DRAGLINK DO NOT FORM A STRAIGHT LINE AT FULL TURN ANGLE. THIS CONDITION IS CALLED "TOGGLE" AND WILL PREVENT THE STEER TIRES FROM RETURNING TO CENTER.

4. Set the AUTO 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 AUTO plunger assembly and push it back to its set position. **The stops MUST contact the axle.**
5. Set the vehicle back on the ground. 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 AUTO plungers must be reset. Normally you will see a small gap between the axle stop and the axle.

NOTICE

If the axle stops contact the axle (with the wheels on the ground) and load the power steering pump or begin twisting the chassis, the auto plungers have been pushed out too far and **MUST BE RESET.**



M100 AUTO STEERING GEAR



ENSURE AXLE STOPS ARE SET



JACK UP STEER AXLE AND TURN FROM STOP TO STOP

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 should be used:

SINGLE GEAR SYSTEMS

If the gear is mounted with the bulge in the housing for the sector shaft hanging below the piston cylinder:

1. With the weight of the vehicle on the ground, start the engine and let it run at idle speed.
2. Turn the steering wheel from stop to stop 3 times. Hold the wheel in pressure for about 5 seconds when you reach the end of travel in each direction. Center the steering, bleeding complete.

If the gear is mounted with the bulge in the housing for the sector shaft sitting above the piston cylinder:

3. Locate the bleeder plug on the sector housing. It will look like a bolt head that a 3/4" wrench would fit. There may be a piece of tape on it covering the 1/8" Allen set screw in the center of it. Remove the tape to expose the set screw.

NOTICE

Many newer model gears do not have the bleeder plug, even if they are mounted in this manner. Instead, there is a bleed passage cast into the housing which allows the air to be carried to the bearing cap. Bleed this type gear using steps 1 and 2.

4. Do not remove the bleeder screw from the plug! There is a check ball behind it which likes to get lost.
5. With the weight of the vehicle on the ground, start the engine and let it run at idle speed.
6. With a helper, turn the steering wheel to full left. Open the set screw in the bleeder plug 4 turns. With the bleeder still open, turn the wheels all the way to the right. When you get all the way to the right, shut the bleeder. Turn the wheels all the way back to the left and repeat the procedure 4 more times. **THE BLEEDER SHOULD ONLY BE OPEN AS YOU ARE TURNING RIGHT!** If it is open when turning left, air will be forced back into the system.
7. Center the steering, bleeding is complete.

NOTICE

Do not allow the reservoir to run dry at any time. Bleeding is complete when the steering operates smoothly from stop to stop, turning in both directions.

DUAL GEAR SYSTEMS

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 pressure on the steering wheel 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. You may need a jack under the steer axle to take some weight off the steer tires for them to turn. Keep holding pressure on the steering wheel for 15 seconds after the slave gear stops moving.
3. Now turn the steering wheel all the way to the right until the axle stop contacts the axle and hold pressure on the steering wheel until the pitman arm on the slave gear moves its full travel. Keep holding pressure on the



SELF-BLEEDING GEAR (SECTOR BORE IS BELOW CYLINDER)



GEAR WITH BLEEDER (SECTOR BORE IS ABOVE CYLINDER)



BLEEDER PLUG (WITH TAPE REMOVED). BLEED ONLY WHEN TURNING RIGHT!



DUAL GEAR SYSTEM SLAVE GEAR

- steering wheel for 15 seconds after the slave gear stops moving.
- Repeat the procedure 3 more times or until there is no air in the system and the slave gear moves freely.

NOTE: Pressure must be kept on the steering wheel to keep the valve open sending fluid to the slave gear. When pressure is released the valve returns to neutral and no pump pressure is sent to the steering gears.

- Turn the steering wheel until the pitman arm on the slave gear lines up with the draglink and install the draglink. **Do not move the pitman arm on the slave gear by hand. Air may be drawn into the system.**
- Cycle the steering from stop to stop. If a catch is noted, look for bleeder plugs on the steering gears. If the gear is mounted with the bulge in the housing for the sector shaft sitting above the piston cylinder, 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, open the bleeder only when the piston is moving toward the bleeder.

If you have questions at any time, contact our Field Service Hotline at 1-800-274-7437.



HD94 SLAVE GEAR



PITMAN ARM PULLER, PRESSURE & FLOW TESTER AND PRV TEST PLUG *ORDER FORM*

Call for Current Pricing

Part		Cost (USD)	Quantity
FOR ALL MODELS - EXCEPT SHEPPARD XD120 and 592: #3591842K, ZRX3591842K, 2603813C91, or NSN 5120-01-578-6906 (RECOMMENDED PULLER FOR MOST APPLICATIONS) 9 lbs. Measures 8.5" x 5" x 4" Tariff Class 8708.99 Product Made in USA		\$CALL includes S&H	
ONLY FOR SHEPPARD XD120 and 592: #3596372K, ZRX3596372K 9 lbs. Measures 8.5" x 5" x 4" Tariff Class 8708.99 Product Made in USA		\$CALL includes S&H	
FOR USE ON SHEPPARD M100, M90, M83, M80, HD94, MD83, 392, 292 and older gears: #3574864, ZRX3574864 9 lbs. Measures 7" x 6" x 7" Tariff Class 8708.99 Product Made in USA		\$CALL includes S&H	
PRESSURE AND FLOW TEST KIT: #5517641, 2603145C91, NSN 2530-01-613-5022 10 lbs. Measures 20" x 11" x 7" Tariff Class 9026.20 Product Made in USA		\$CALL includes S&H	
PRESSURE RELIEF VALVE (PRV) TEST PLUG #3331812K, 3887112C91, or NSN 4820-01-613-6442 1 lb. Measures Tariff Class 8708.94 Product Made in USA		\$CALL Includes S&H	

TO PLACE A VISA OR MASTERCARD ORDER, FAX THIS FORM TO 717-633-4127 OR CALL SHEPPARD REMAN
AT 800-371-5268/717-633-4107 BETWEEN 7AM – 4PM MONDAY THRU FRIDAY
(All Sales Final/No Returns)

Name & Phone: _____

Ship To: _____

CREDIT CARD INFORMATION:

Account #: _____

Security # _____ Expiration Date: _____

Name on Card: _____

TOTAL CHARGED: \$ _____ **DATE:** _____

INPUT SHAFT SEAL REPLACEMENT

FOR ALL M AND D-SERIES STEERING GEARS BUILT AFTER JULY 1990

NOTICE

If your M-Series steering gear was built prior to July 1990 it will have white Teflon rings for seals in the bearing cap cover and on the input shaft. IT IS OBSOLETE. The steering gear should be replaced with a genuine Sheppard remanufactured steering gear.

WARNING

DO NOT REPLACE THE BEARING CAP COVER WITH A NEW ONE, OR ONE FROM ANOTHER STEERING GEAR. THE GEAR CAN BIND UP, OR BECOME TOO LOOSE AND CAUSE A HAZARDOUS DRIVING CONDITION. (Does not apply to Slave (secondary) gears.)

TOOLS REQUIRED:

Drain Pan 15/16", 1/2" Drive Socket 1/4" Flat Screwdriver Seal Pick Rags 16mm, 1/2" Drive Socket
Small Ball Peen Hammer 5/8", 1/2" Drive Socket 1/2" Drive Ratchet Handle 11/16" Combination Wrench Seal Driver Kit
0-100 ft/lb (minimum) 1/2" Drive Torque Wrench

NOTICE

Not all seals are used in every model steering gear. This is a universal kit. On most vehicles, seal replacement can be completed with the steering gear on the vehicle. Do not remove it unless necessary.

1. Remove the steering column lower u-joint from the steering gear input shaft using the 5/8" socket and 11/16" wrench. Place the drain pan below the steering gear. Depending on how the gear is mounted, some fluid may be lost.
2. Remove the rubber boot from the input shaft with the screwdriver.

NOTICE

CLEAN THE AREA AROUND THE INPUT SHAFT!

CAUTION

DO NOT TURN THE INPUT SHAFT WITH THE BEARING CAP COVER REMOVED! THE LOWER THRUST BEARING OR SHIM MAY SLIDE OUT OF PLACE AND BECOME JAMMED DURING REASSEMBLY. TURNING THE SHAFT OR MIXING OF COMPONENTS CAN CAUSE DAMAGE TO THE INPUT SHAFT, ROTARY VALVE, THRUST BEARINGS AND BEARING CAP.

3. Remove the four bolts on the bearing cap cover with the 16mm socket and remove the cover by prying it off evenly with the screwdriver. Do not remove the larger bearing cap bolts!

CAUTION

THE TOP THRUST WASHER SHIM MAY STICK TO THE COVER. IF IT DOES, REINSTALL THE WASHER ON TOP OF THE THRUST BEARING IN THE BEARING CAP.

NOTICE

If the input shaft is rust pitted or badly worn, the steering gear will have to be replaced. The input shaft itself is not serviceable.

4. Pry the outside salt seal from the cover with the screwdriver and discard it. Newer style salt seals have a silver spring and look just like the high pressure seal. The older style salt seal is the very thin single lip seal. You must replace like for like.
5. Flip the cover over and remove the cover washer (if installed) with a screwdriver and save for reuse.
6. Using a driver or socket, tap the input (high pressure) seal out of the cover and discard it.
7. Remove the o-ring from the bottom of the cover and discard it.
8. Using a seal driver or 1" socket, drive the new input seal with the **GOLD SPRING** into the cover **with the seal lip facing the housing side of the cover, toward the thrust bearings**. A press or vice may also be used. **Use ONLY the GOLD SPRING SEAL as the pressure seal.**
9. Use the salt seal that matches the size of the old one and tap it into the steering column side of the cover with the seal driver or 1" socket. Ensure the seal lip or **SILVER SPRING** is facing the top side of the cover, toward the steering column.



REMOVE COVER AND REINSTALL SHIM



REMOVE SALT SEAL



REMOVE COVER WASHER (IF INSTALLED)



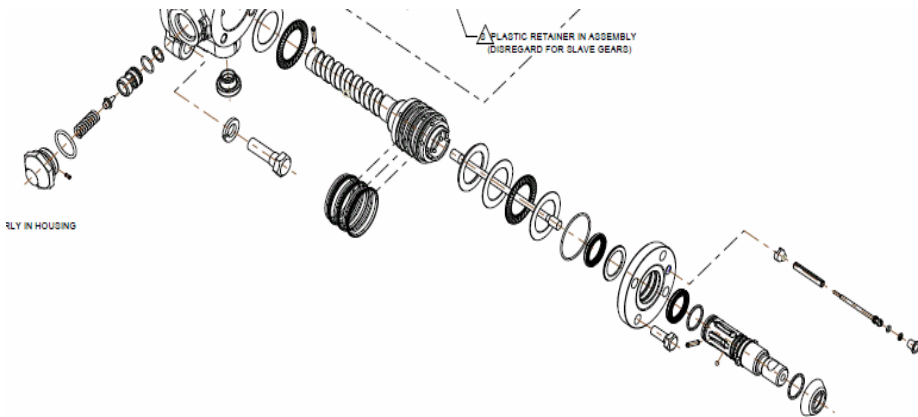
DRIVE THE INPUT SEAL OUT

NOTICE

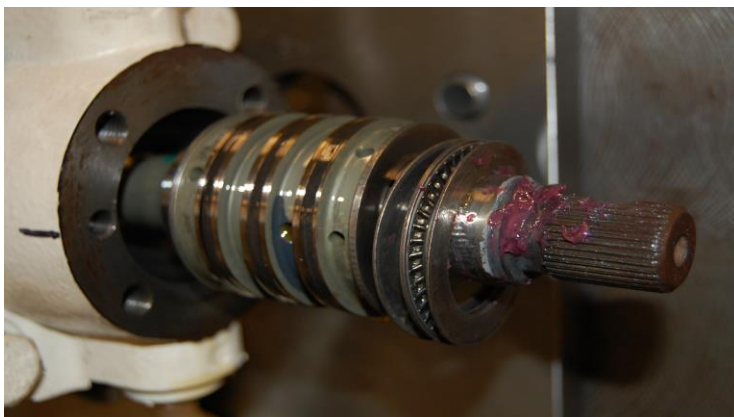
The input seal and salt seal are installed in the cover back to back, with the seal lips facing AWAY from each other.

10. Install the new o-ring onto the housing side of the cover. Ensure it is not twisted.
11. Tap the cover washer back into the cover (if equipped).
12. Using #2 chassis grease, fill the area between the seals. No further greasing is required or recommended. If the cover has a grease fitting, remove it and fill the hole with silicone sealant.
13. Tape the splines of the input shaft to prevent seal damage and lube the o-ring, seal lips and input shaft with a light coat of grease. Install the cover onto the bearing cap making sure not to roll the lip of the high pressure seal. Ensure the small hole in the cover is aligned with the relief plunger hole in the bearing cap. Torque the bolts to 53-64 ft/lbs.
14. Choose the correct size face seal (rubber boot) and install it over the input shaft. Ensure it is pushed down below the bottom of the splines and makes good contact with the cover.
15. Remove the tape from the input shaft and reinstall the steering column lower yoke. Torque the pinch bolt to manufacturer's specification. Fill the power steering reservoir to the proper level, start the vehicle and check for leaks. Return vehicle to service.

BOLTS	Size	Grade	FT/LBS	(NM)	Socket
Bearing Cap Cover	M10 X 1.5	10.9	53-64	(72-87)	16mm



EXPANDED INPUT/ROTARY VALVE ASSEMBLY



INPUT/ROTARY VALVE ASSEMBLY



**INPUT SEAL GOLD SPRING
FACES OUT!**



**SALT SEAL SILVER SPRING
FACES OUT!**



**REINSTALL COVER WASHER
AND O-RING**



MUST GREASE THE SEALS!!!!



**INSTALL COVER AND TORQUE
THE BOLTS TO 53-64 FT**

SECTOR SHAFT SEAL REPLACEMENT

TOOLS REQUIRED:

Drain Pan	Rags	5/8" or 3/4", 1/2" Drive Allen Socket	15/16" Impact Socket	Seal Pick
Silicone Sealer	Impact Wrench	1/2" Drive Ratchet Handle	1/8" Punch	Very Large Snap Ring Pliers
13mm 1/2" Drive Socket		Medium sized Hammer	600 ft/lb (min) Torque Wrench	
18mm 1/2" Drive Socket		1/4" Flat Screwdriver	Sheppard Pitman Arm Puller 3591842K or equivalent	

NOTICE

NOT ALL SEALS ARE USED IN EVERY MODEL STEERING GEAR. THIS IS A UNIVERSAL KIT. DO NOT REMOVE THE STEERING GEAR FROM THE CHASSIS. THE REPAIR CAN BE DONE IN PLACE ON MOST VEHICLES.

1. Park the vehicle on a clean dry surface, shut off the engine and set the parking brake. Place a drain pan under the steering gear.

NOTICE

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

2. Bend the locking tabs away from the pitman arm retainer using the punch and hammer. Remove the retainer using a 5/8" or 3/4" Allen Drive Socket. Remove the pitman arm with the puller, using the 15/16" impact socket and impact wrench. **Note which timing marks are aligned (there could be more than one mark on the pitman arm). Only a Sheppard pitman arm puller or a jaw-type puller should be used to remove the pitman arm.**



WARNING

Do not attempt to remove the arm by using a wedge between the pitman arm and housing. Housing damage may result and make it very difficult to remove the cover. Do not apply heat to the pitman arm!

3. Remove the V-boot from the sector shaft. Remove the snap ring protective cover, if equipped, by carefully prying the plastic seal from the housing with a screwdriver. Take care to not damage the housing during removal. Clean any RTV sealant from the snap ring area.
4. Remove the stick on plastic dust cover or plastic screw-in cover, or metal hub cap from the back side of the housing if equipped.
5. Remove the snap ring using a suitable size pair of snap ring pliers or "walk it out" with a pair of flat bladed screwdrivers. Remove the retaining clips and bolts (with 13mm socket), if equipped, or the bolt on cover (with 18mm socket) as required.



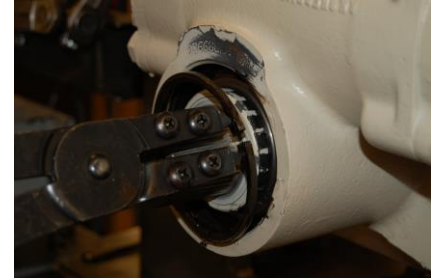
WARNING

USE EXTREME CAUTION WHEN REMOVING THE SNAP RING AS PERSONAL INJURY MAY RESULT.

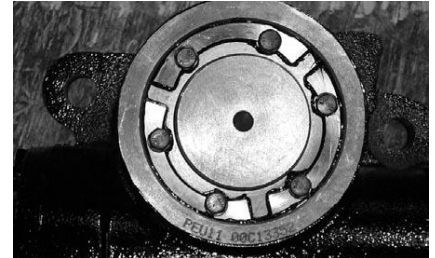
6. Carefully clean any paint or corrosion from the housing to allow the cover to slide freely out of the housing. A slide hammer may be used to remove the sector shaft and cover, or loosely install the pitman arm and retainer to use it as a handle to pull the shaft and cover out. The cover and shaft can also be driven out of the housing from the opposite side if the steering gear is removed from the vehicle.
7. Remove the sector cover from the sector shaft.
8. Remove the sector shaft seals from the housing and cover using the seal pick. Carefully pry the pressed in excluder from the cover or housing with the screwdriver, taking care not to damage the housing surface.
9. Remove the O-ring from the sector shaft cover, or the 2 piece L-seal from the housing.
10. Thoroughly clean all parts with a suitable degreaser. Ensure there is no dirt or debris in any of the seal grooves. The smallest dirt particle or brush hair can cause a leak to start!
11. Install a new sector shaft seal in the sector cover and a new sector shaft seal in the housing. Install the sector shaft seals so the black side (pressure seal) faces the



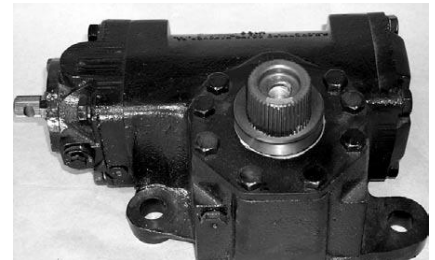
SNAP RING PROTECTIVE COVER



REMOVE SNAP RING



OR BOLTS AND CLIPS



OR BOLTED COVER



PITMAN ARM USED AS A HANDLE TO PULL SHAFT

inside of the steering gear. The black sides will face each other when installed. The seals are two-pieces which fit together. The pieces must stay together when installed in the groove. Lubricate the seals with clean chassis lube after installation.

NOTICE

It will be necessary to bend the seals to install them. Set one side of the seal in the groove, and walk it in using your fingers. When the seal is in place it may be necessary to work the seal with your fingers or a blunt seal pick to properly seat the seal. When using a 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. The seal should look perfectly round when installed.

NOTICE

All snap ring style gears will utilize the thicker o-ring supplied or the 2 piece L-seal. Bolted or clip-style covers use the thin o-ring.

12. Install the new o-ring on the sector shaft cover taking care to not twist it during installation or, install the new 2 piece L-seal into the housing by first inserting the black pressure seal into the housing with the L side facing the outside of the housing. Then insert the flat backup ring into the L side of the pressure seal. When assembled, the backup ring will be on the side of the L-seal facing the outside of the housing. Apply a coat of clean chassis lube to the o-ring or L-seal prior to installing the cover into the housing.
13. Install the new excluder seal into the face of the sector cover or housing (if applicable) by tapping it into place with the hammer.
14. Install the sector shaft into the housing. Take care to position the timing mark on the sector shaft tooth between the 2 timing marks on the piston teeth. **Failure to align the timing marks will result in incorrect turn radius.**
15. Cover the sector shaft splines with tape and install the cover over the sector shaft. Use a hammer and piece of wood to drive the cover on.



CAUTION

Use only enough force to install the cover. Excessive force on the cover could damage the sector shaft cover or bearing and steering gear damage may result. The cover must be installed to flush or below the snap ring groove in the housing on snap ring and clip retained covers.

16. Install the snap ring or install the cover retaining bolts (or retaining clips with bolts) in bolt on cover designs. Torque the cover bolts to 72-87 ft/lbs and clip bolts to 31-38 ft/lbs.



WARNING

THE SNAP RING CAN EASILY SLIP OFF THE PLIERS WHEN PLACING IN THE HOUSING. USE EXTREME CAUTION WHEN INSTALLING THE SNAP RING AS PERSONAL INJURY MAY RESULT.



WARNING

THE SNAP RING MUST BE FULLY SEATED IN THE GROOVE. AN IMPROPERLY SEATED SNAP RING MAY COME OUT WITHOUT WARNING! LOSS OF STEERING CONTROL OR DAMAGE MAY RESULT.

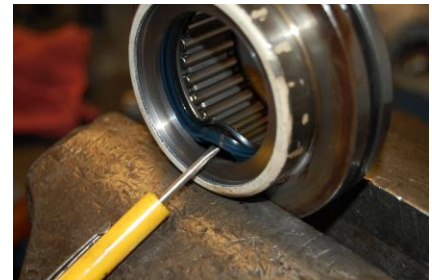
17. Install the snap ring protective cover into the housing over the snap ring by lightly tapping on the outside diameter of the cover until it bottoms in the bore. It may be necessary to tap on the body of the cover with a punch and hammer to fully seat the cover.
18. Pack the V-boot with clean chassis lube and slide the V-boot over the sector shaft splines until the lip contacts the sector shaft cover. On models with a groove cut into the sector shaft under the splines, use the boot which has 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. Clean all excess grease from the sector shaft splines.
19. Attach the new frame side dust cover by cleaning the housing with a solvent and applying the new disk over the end of the sector shaft. Use a bead of silicone sealer on the edge of the disk. Also use a bead of silicone inside the edge of the



REMOVE COVER FROM SHAFT



PRY OUT EXCLUDER SEAL



REPLACE PRESSURE SEAL



INSTALL NEW SEAL-BLACK LIP FACES THE BEARING!



SEALS MUST BE PERFECTLY ROUND-NO FLAT SPOTS!!



TAP IN NEW EXCLUDER AND REPLACE O-RING

housing before installing the hub cap on models which use it.

- Install the pitman arm by aligning the timing mark on the arm to the timing mark on the end of the sector shaft. Ensure the splines of the arm and shaft are clean and dry.

WARNING DO NOT USE ANTISEIZE ON THE SPLINES!

NOTICE

On most vehicles, when the pitman arm is installed properly and the wheels are pointing straight ahead, the pitman arm will hang straight down (or just slightly off). If it does not - verify the piston is centered in the steering gear and the sector shaft is timed correctly to the piston.

- Screw the pitman arm retainer into the sector shaft, making sure the tabs on the washer sit into the groves machined into the pitman arm. (Use anti seize on the retainer threads and the washers.) Torque the retainer to the value stamped in the face of the retainer. Keep applying torque until the locking tabs on the washer align with the slots in the retainer. Bend 2 locking tabs into the retainer.

WARNING DO NOT BACK OFF WHEN TIGHTENING THE RETAINER! PROPER INSTALLATION OF THE PITMAN ARM IS CRITICAL! IMPROPER INSTALLATION OF THE ARM MAY CAUSE PERSONAL INJURY AND EQUIPMENT DAMAGE AT A LATER DATE!

- Fill the system with an approved fluid. Start the engine, check and correct the fluid level. Check for leaks. Bleed air from the system if necessary. Return the vehicle to service.

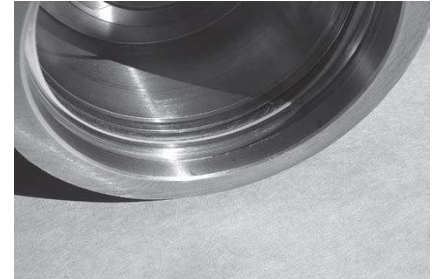
SECTOR COVER TYPE	BOLT SIZE	GRADE	Torque FT/LB	Torque NM	Socket
Bolt-On Sector Cover	M12 X 1.75	9.8	72-87	(97-118)	18mm
Clip-Style Sector Cover	M8 X 1.25	12.9	31-38	(42-52)	13mm



TIMING MARKS ON THE 2 CENTER TEETH OF THE PISTON RACK



REPLACE HOUSING SEAL- BLACK LIP FACES BEARING!



REPLACE HOUSING L-SEAL (IF EQUIPPED)



GREASE THE SHAFT!



ALIGN THE TIMING MARKS!



INSTALL THE COVER AND SNAP RING (OR CLIPS & BOLTS)



INSTALL NEW RUBBER DISC

END CAP SEAL REPLACEMENT

TOOLS REQUIRED:

Drain Pan	Rags	1/8" and 1/4" Flat Screwdriver	Vice Grip Locking Pliers
Seal Pick	Small Ball Peen Hammer	11/16" Combination Wrench	2-7/8" Combination Wrenches
5/8", 1/2" Drive Socket	1/2" Drive Ratchet Handle	0-300 ft/lb (minimum) 1/2" Drive Torque Wrench	
16,18,21 or 24mm, 1/2" Drive Socket			

NOTICE

NOT ALL SEALS ARE USED IN EVERY MODEL STEERING GEAR. THIS IS A UNIVERSAL KIT. DO NOT REMOVE THE STEERING GEAR FROM THE CHASSIS. THE REPAIR CAN BE DONE IN PLACE ON MOST VEHICLES.

NOTICE

Auto Plunger steering gears may require part number 18212821K if the plunger is damaged during disassembly or reassembly.

BEARING CAP

1. Match mark the bearing cap and housing for reassembly. Remove the lower u-joint from the steering gear input shaft using the 5/8" socket and 11/16" wrench and secure it out of the way. Remove all hoses and fittings from the bearing cap using the 7/8" wrench.
2. Using the 16,18,21 or 24mm socket remove the four large bolts from the bearing cap. **DO NOT REMOVE THE SMALLER BEARING CAP COVER AROUND THE INPUT SHAFT.** Turn the input shaft and raise the bearing cap off the housing until it stops so the seals can be accessed.
3. Using a seal pick, remove the square ring or o-ring, and the small tetra seal from the bearing cap and discard. Thoroughly clean the seal grooves with a suitable solvent.

NOTICE

Any small pieces of dirt or brush hairs in the seal groove will cause a leak!

4. Carefully stretch the square ring or o-ring over the bearing cap assembly (take care not to over stretch the seal). Walk away from it for about 15 minutes to let the seal shrink back to its original size. With the seal over the bearing cap, push the square ring or o-ring into the seal groove of the bearing cap. Use a light coating of clean chassis lube to hold the seal into the seal groove.
5. Lightly coat the new tetra seal with clean chassis lube and install it in the smaller groove of the bearing cap. **The new style seal is an orange silicone with a white nylon backup ring surrounding it.** It is a direct replacement for the old black seal. The solid orange side goes into the cover.
6. **IF IT HAS BEEN LEAKING**, remove the relief plunger and replace the o-ring supplied in the kit. Manual plungers can be unscrewed using a flat bladed screwdriver. AUTO Plungers must be disassembled (flange nut removed from the plunger) and the plunger pushed out of the bearing cap. Replace the o-ring, coat with clean chassis lube and install the plunger back into the bearing cap. Apply lock-tite to the plunger threads and tighten the flange nut against the spring pin.

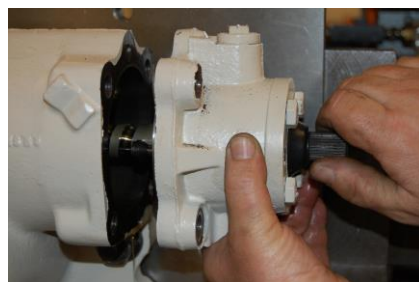
NOTICE

You will need to check and correct the relief plunger settings after repairs are completed.

7. Turn the input shaft into the steering gear making sure to align the marks on the housing and bearing cap. Take care not to pinch the seals during assembly. **Ensure the relief plunger is aligned with the check ball in the end of the piston.**
8. Install the four attaching bolts and torque to specs.
9. Attach the steering column and torque the pinch bolt to the vehicle manufacturer's specs. Reconnect the hoses and fill the reservoir with the vehicle manufacturer's recommended fluid. Start the vehicle. Check and correct the fluid level in the system.



REMOVE BEARING CAP BOLTS



TURN INPUT UNTIL IT STOPS



REMOVE THE TETRA SEAL AND SQUARE RING



STRETCH NEW SQUARE RING OVER THE BEARING CAP

10. Check and correct relief plunger settings as required. Bleed any air from the system if necessary and return the vehicle to service.

CYLINDER HEAD

1. Match mark the cylinder head and housing for alignment. Remove the four large bolts from the cylinder head using a 16,18,21 or 24mm socket and remove the cylinder head.
2. Remove the square ring and tetra seal from the cylinder head with the seal pick and discard.
3. Remove the relief plunger and replace the o-ring supplied in the kit. Manual plungers can be unscrewed using a flat bladed screwdriver. AUTO Plungers must be disassembled (flange nut removed from the plunger) and the plunger pushed out of the cylinder head. Replace the o-ring, coat with clean chassis lube and install the plunger back into the cylinder head. Apply Lock-Tite to the plunger threads and tighten the flange nut against the spring pin.

NOTICE

You will need to check and correct the relief plunger settings after repairs are completed.

4. Clean the cylinder head using a suitable solvent. Install the square ring or o-ring in the groove of the cylinder head and install the tetra seal in the small groove of the cylinder head. **The new style seal is an orange silicone with a white nylon backup ring surrounding it.** It is a direct replacement for the old black seal. Apply a light coat of clean chassis lube to hold the seals in place during installation. The solid orange side goes into the cover.
5. Install the cylinder head onto the housing, taking care to align the marks made during disassembly. **Ensure the relief plunger is aligned with the check ball in the end of the piston.**
6. Torque the bolts to the required spec. Top off the fluid, start the vehicle and check for leaks. Return the vehicle to service.

Bearing Cap Bolts	Bolt Size	Grade	Torque FT/LBS	Torque NM	Socket Size
M80	M10 X 1.5	10.9	53-64	(72-87)	16mm
M90	M12 X 1.75	8.8	72-87	(97-118)	18mm
M100	M14 X 2.0	8.8	114-140	(154-190)	21mm
M110	M16 X 2.0	10.9	230-277	(312-376)	24mm
Cylinder Head Bolts					
M80	M10 X 1.5	10.9	53-64	(72-87)	16mm
M83	M10 X 1.5	10.9	53-64	(72-87)	16mm
M90	M12 X 1.75	8.8	72-87	(97-118)	18mm
M100	M14 X 2.0	8.8	114-140	(154-190)	21mm
M110	M10 X 1.5	10.9	53-64	(72-87)	16mm



INSTALL NEW TETRA SEAL



REPLACE THE AUTO PLUNGER O-RING IF NECESSARY



TORQUE THE BOLTS!



REMOVE THE CYLINDER HEAD



REPLACE THE SEALS



INSTALL AND TORQUE BOLTS



RESET BOTH AUTO PLUNGERS IF THE O-RINGS WERE REPLACED

RELIEF PLUNGER REPAIR

TOOLS REQUIRED:

Drain Pan	Rags	1/8" and 1/4" Flat Screwdriver	Vice Grip Locking Pliers
Seal Pick	Small Ball Peen Hammer	11/16" Combination Wrench	2-7/8" Combination Wrenches
5/8", 1/2" Drive Socket		1/2" Drive Ratchet Handle	
16,18,21 or 24mm, 1/2" Drive Socket		0-300 ft/lb (minimum) 1/2" Drive Torque Wrench	

NOTICE

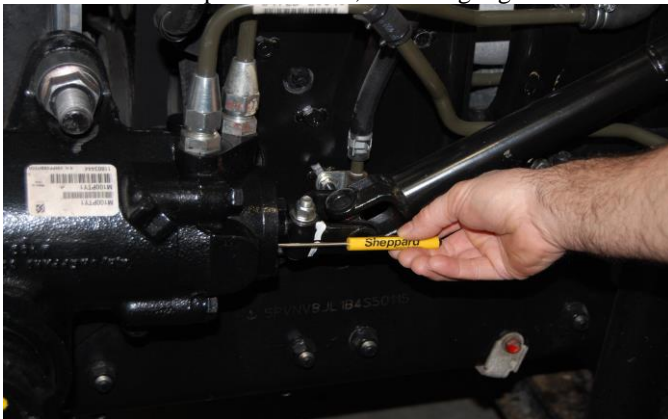
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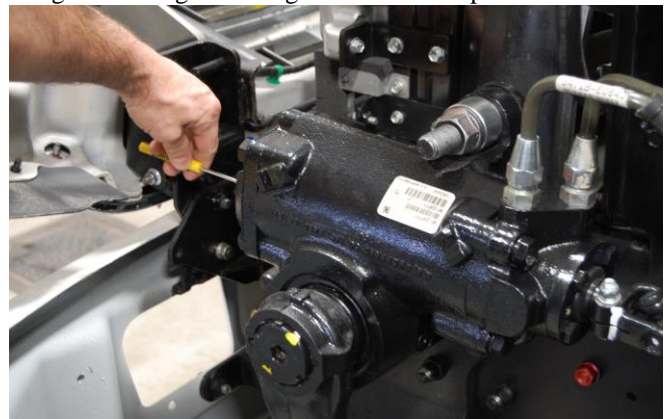
Both Manual and Automatic Relief Plungers appear the same- they both have a slotted screw head! (TOP PLUNGER IS MANUAL, BOTTOM IS AUTO PLUNGER)

Auto Plunger steering gears require an Autoplunger Repair Kit as well as an End Cap Seal Kit. Manual Plunger steering gears can be repaired with only the End Cap Seal Kit and the appropriate replacement manual plunger, if the plunger requires replacement.

MANUAL RELIEF PLUNGER REPAIR: Simply unscrew the plunger with the 1/8" flat screwdriver. Count the number of turns the plunger comes out, so that it can be screwed back in to the same position. Replace the o-ring with a similar style new o-ring which comes in the End Cap Seal Kit. Lubricate the o-ring with grease prior to installing the plunger. Clean the plunger hole with a suitable solvent and inspect it for rust, burrs or gouges which could damage the o-ring. A damaged bore is not repairable.



BEARING CAP PLUNGER



CYLINDER HEAD PLUNGER

NOTICE

If the relief plunger is bent or broken it must be replaced and the cylinder bore inspected for damage.

AUTOMATIC RELIEF PLUNGER REPAIR

BEARING CAP PLUNGER

1. Match mark the bearing cap and housing for reassembly. Remove the lower u-joint from the steering gear input shaft using the 5/8" socket and 11/16" wrench and secure it out of the way.
2. Using the 16,18,21 or 24mm socket remove the four large bolts from the bearing cap. **DO NOT REMOVE THE SMALLER BEARING CAP COVER AROUND THE INPUT SHAFT.** Turn the input shaft and raise the bearing cap off the housing until it stops so the plunger can be accessed.
3. Hold the cone shaped nut on the end of the plunger with a pair of vise grip pliers, 10 mm wrench, or small adjustable wrench. Unscrew the plunger pin from the nut using a flat bladed screwdriver.
4. Push the plunger pin out of the bearing cap (it could be very tight). Replace the o-ring with a new one (supplied in the End Cap Seal Kit), or replace the entire assembly using the 18212821K Auto Plunger Repair Kit.
5. Inspect the plunger bore. It must be clean and free of any scratches or gouge marks. If it is damaged, the plunger o-ring will not seal. The bore is not repairable. Reaming it will over-size it and cause a leak.
6. Coat the o-ring with clean chassis lube and insert the plunger pin back into the bearing cap. Apply lock-tite to the plunger threads and tighten the flange nut against the spring pin.

NOTICE

Seals may be replaced at this time.

7. Turn the input shaft into the steering gear making sure to align the marks on the housing and bearing cap. Take care not to pinch the seals during assembly. **Ensure the relief plunger aligns with the check ball in the end of the piston.**
8. Install the four attaching bolts and torque to specs.
9. Attach the steering column and torque the pinch bolt to the vehicle manufacturer's specs. Reconnect the hoses and fill the reservoir with the vehicle manufacturer's recommended fluid. Start the vehicle. Check and correct the fluid level in the system.
10. Check and correct relief plunger settings as required. Bleed any air from the system if necessary and return the vehicle to service.

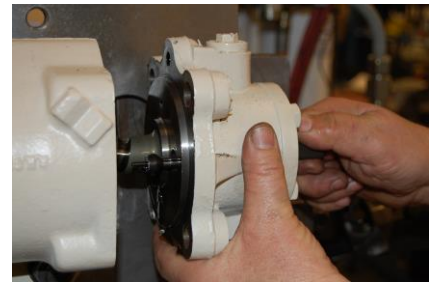
CYLINDER HEAD PLUNGER

1. Match mark the cylinder head and housing for alignment. Remove the four large bolts from the cylinder head using a 16,18,21 or 24mm socket and remove the cylinder head. Place it in a vice on your workbench.
2. Hold the cone shaped nut on the end of the plunger with a pair of vise grip pliers, 10 mm wrench, or small adjustable wrench. Unscrew the plunger pin from the nut using a flat bladed screwdriver.
3. Push the plunger pin out of the bearing cap (it could be very tight). Replace the o-ring with a new one (supplied in the End Cap Seal Kit), or replace the entire assembly using the 18212821K Auto Plunger Repair Kit.
4. Inspect the plunger bore. It must be clean and free of any scratches or gouge marks. If it is damaged, the plunger o-ring will not seal. The bore is not repairable. Reaming it will over-size it and cause it to leak.
5. Coat the o-ring with clean chassis lube and insert the plunger pin back into the bearing cap. Apply lock-tite to the plunger threads and tighten the flange nut against the spring pin. Clean the cylinder head with a suitable solvent.

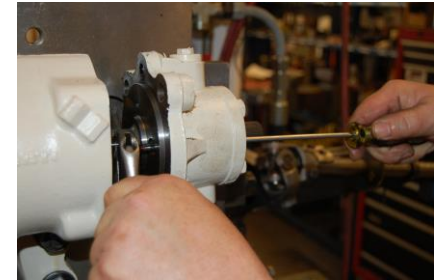
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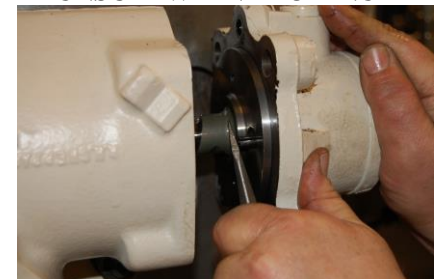
7. Install the cylinder head onto the housing, taking care to align the marks made during disassembly. **Ensure the relief plunger is aligned with the check ball in the end of the piston.**
8. Torque the bolts to the required spec. Top off the fluid, start the vehicle and check for leaks. Return the vehicle to service.



TURN UNTIL IT STOPS



UNSCREW PIN FROM NUT



PUSH PLUNGER PIN OUT



GREASE THE NEW O-RING!



DRIVE THE PLUNGER PIN IN

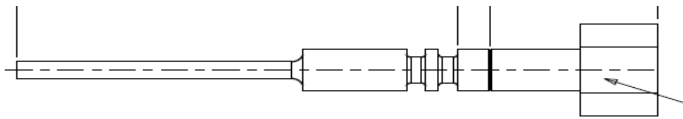


TORQUE THE BOLTS

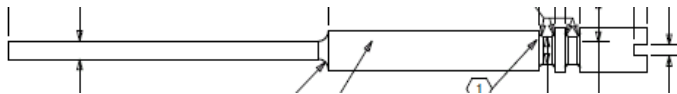
NOTICE

You must check and correct the relief plunger settings.
Use the guidelines in this manual.

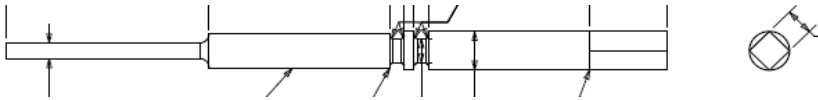
Bearing Cap Bolts	Bolt Size	Grade	Torque FT/LBS	Torque NM	Socket Size
M80	M10 X 1.5	10.9	53-64	(72-87)	16mm
M90	M12 X 1.75	8.8	72-87	(97-118)	18mm
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Cylinder Head Bolts					
M80	M10 X 1.5	10.9	53-64	(72-87)	16mm
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M110	M10 X 1.5	10.9	53-64	(72-87)	16mm



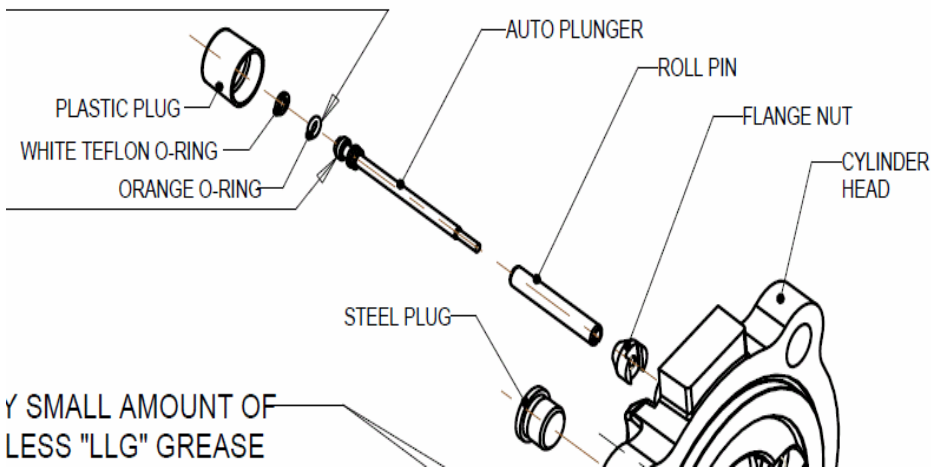
CYLINDER HEAD PLUNGER W/ 1/2" NUT (PETERBILT)



TYPICAL MANUAL RELIEF PLUNGER



BEARING CAP PLUNGER FOR INTEGRAL MITER GEARS



Y SMALL AMOUNT OF LESS "LLG" GREASE

AUTOMATIC RELIEF PLUNGER ASSEMBLY



REMOVE THE CYLINDER HEAD



REMOVE CONE NUT FROM PIN



DRIVE PLUNGER PIN OUT



INSPECT AND CLEAN BORE



GREASE THE O-RING AND REASSEMBLE



INSTALL AND TORQUE BOLTS

PRESSURE RELIEF VALVE (PRV)

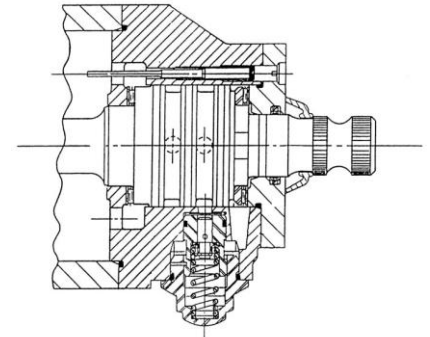
An integral pressure relief valve (PRV) is used on some steering gears and is located on the side of the bearing cap. The valve limits the maximum pressure inside the steering gear. It is used in steering systems where the supply pump is rated for a higher output pressure than the steering gear is capable of operating at. This type system normally uses the pump to supply fluid to other components such as a hydraulic fan drive, fifth wheel lift, or other chassis hydraulics.

When the maximum PRV pressure is reached, the valve opens and relieves excess pressure internally through the steering gear bearing cap, back to the reservoir. The PRV can be removed for cleaning and inspection. It can also be replaced if found to be relieving at a pressure lower than it is specified for. Contact Sheppard Field Service for the part number of the replacement PRV.

WARNING THE PRESSURE RELIEF VALVE CARTRIDGE SHOULD NOT BE DISASSEMBLED OR ADJUSTED FOR HIGHER PRESSURE. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT!

The PRV cartridge is torqued to 35 ft. lbs.

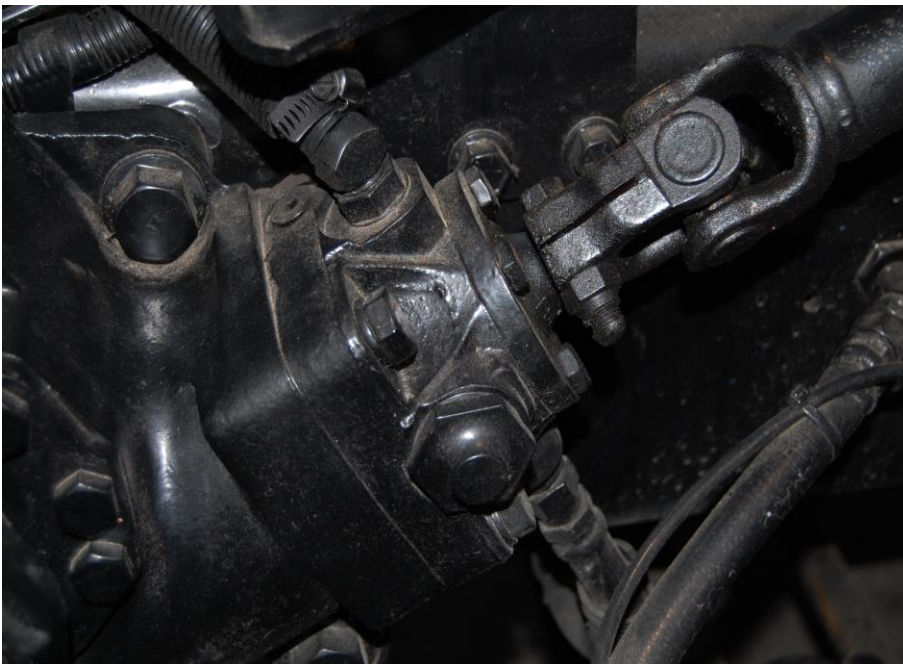
NOTICE AN INTERNAL LEAKAGE TEST CANNOT BE ACCURATELY PERFORMED ON A STEERING SYSTEM WHICH HAS A PRV. THE PRV MUST BE REMOVED FROM THE BEARING CAP AND A PRV TEST PLUG PART #3331812K MUST BE INSTALLED IN PLACE OF IT. FAILURE TO DO SO WILL RESULT IN A FALSE READING OF HIGH INTERNAL LEAKAGE.



PRV IN BEARING CAP



LEFT-PRV, RIGHT 3331812K TEST PLUG



M100 WITH PRESSURE RELIEF VALVE (PRV)

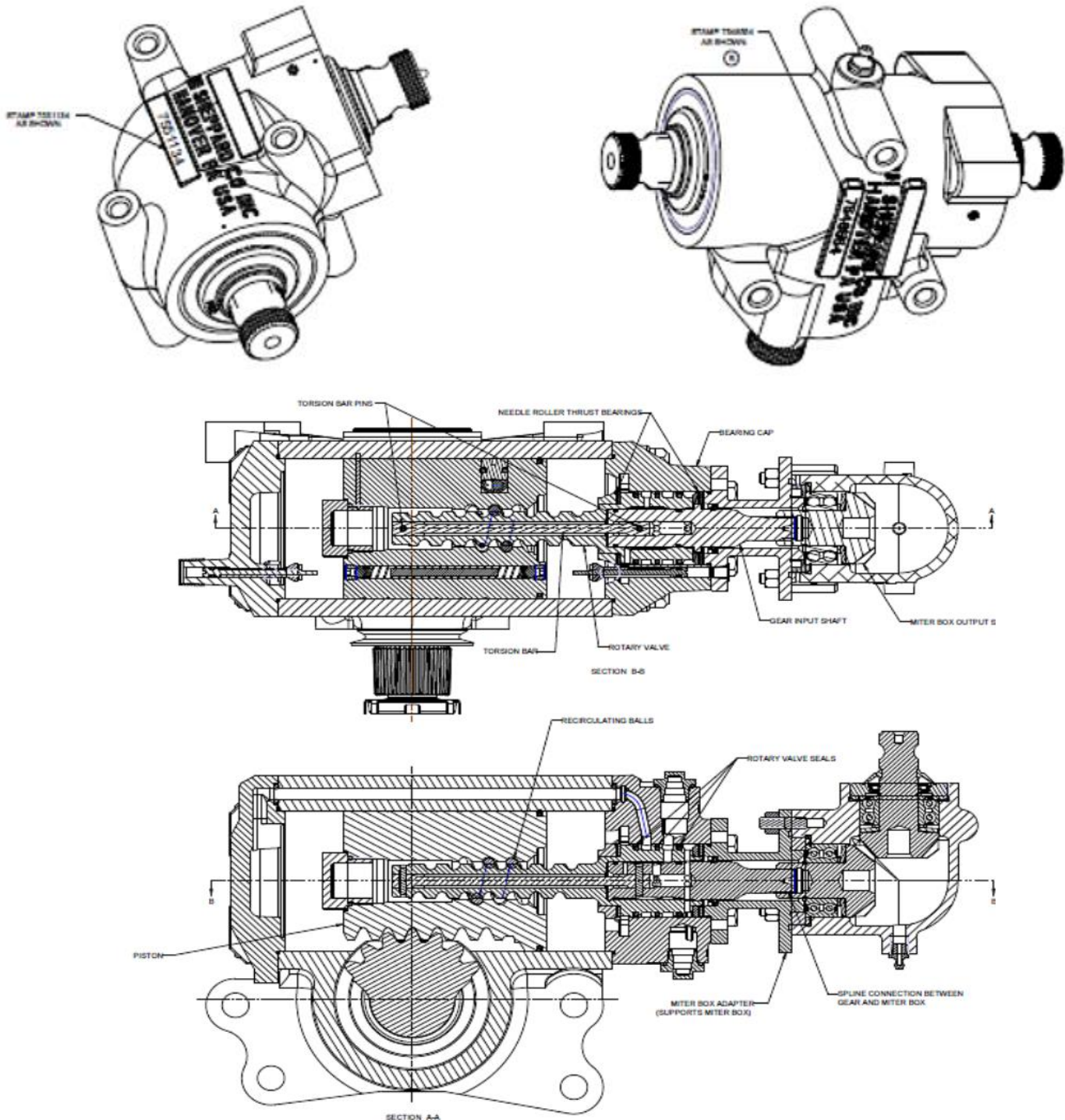


TEST PLUG INSTALLED

MITER BOXES

The R. H. Sheppard Co. also offers miter boxes for a variety of applications. They can be stand-alone pieces or integral to the steering gear. They are used for changing the direction of the steering column input to the steering gear, and offer a smoother, more reliable alternative to universal joints. They come in a variety of configurations and can also be engineered for a specific application.

Miter boxes are not repairable and have no serviceable parts except for the grease fitting (where applicable).



TORQUES AND TOOLS REQUIRED **FOR REPAIRING ALL M-SERIES** **SHEPPARD STEERING GEARS**

APPLICATION	BOLT SIZE	GRADE	FT/LBS	(NM)	SOCKET
Bearing Cap Cover Bolts- All M-Series	M10 X 1.5	10.9	53-64	(72-87)	16mm
Bearing Cap Bolts -					
M80	M10 X 1.5	10.9	53-64	(72-87)	16mm
M90	M12 X 1.75	8.8	72-87	(97-118)	18mm
M100	M14 X 2.0	8.8	114-140	(154-190)	21mm
M110	M16 X 2.0	10.9	230-277	(312-376)	24mm
Cylinder Head Bolts-					
M80	M10 X 1.5	10.9	53-64	(72-87)	16mm
M83	M10 X 1.5	10.9	53-64	(72-87)	16mm
M90	M12 X 1.75	8.8	72-87	(97-118)	18mm
M100	M14 X 2.0	8.8	114-140	(154-190)	21mm
M110	M10 X 1.5	10.9	53-64	(72-87)	16mm
All M100 Bolt-On Sector Cover Bolts	M12 X 1.75	9.8	72-87	(97-118)	18mm
All Clip-Style M110 Sector Cover Bolts	M8 X 1.25	12.9	31-38	(42-52)	13mm

INPUT SHAFT SEAL REPLACEMENT

TOOLS REQUIRED:

15/16", 1/2" Drive Socket	1/4" Flat Screwdriver	Seal Pick	Rags
1", 1/2" Drive Socket	Small Ball Peen Hammer	5/8", 1/2" Drive Socket	
1/2" Drive Ratchet Handle	11/16" Combination Wrench	Drain Pan	
16mm, 1/2" Drive Socket	0-100 ft/lb (minimum) 1/2" Drive Torque Wrench		

SECTOR SHAFT SEAL REPLACEMENT

TOOLS REQUIRED:

Drain Pan	5/8" or 3/4", 1/2" Drive Allen Socket	15/16" Impact Socket	Seal Pick
Silicone Sealer	Impact Wrench	1/2" Drive Ratchet Handle	
1/8" Punch	Very Large Snap Ring Pliers	13mm 1/2" Drive Socket	Rags
Medium sized Hammer	0-600 ft/lb Torque Wrench	18mm 1/2" Drive Socket	
1/4" Flat Screwdriver	Sheppard Pitman Arm Puller 3589922K or equivalent		

END CAP SEAL REPLACEMENT

TOOLS REQUIRED:

Drain Pan	1/8" and 1/4" Flat Screwdriver	16,18,21 or 24mm, 1/2" Drive Socket
Rags	Small Ball Peen Hammer	11/16" Combination Wrench
Seal Pick	1/2" Drive Ratchet Handle	2-7/8" Combination Wrenches
5/8", 1/2" Drive Socket		
Vice Grip Locking Pliers	0-300 ft/lb (minimum) 1/2" Drive Torque Wrench	



POWER STEERING TROUBLESHOOTING CHECKLIST

Before proceeding with the following tests, check all mechanical and external conditions before hydraulic testing. Do not remove the steering gear or pump until hydraulic tests are completed and an authorization number has been received from Sheppard.

Date: _____
 Dealer Name & Location: _____
 Dealer Contact Name: _____
 Contact Phone Number: _____
 Servicing Tech Name: _____

Sheppard Returned Goods
 Authorization Number:

Description of Steering Complaint:

Vehicle Model _____
 Mileage _____ VIN _____
 Engine Model _____ Vehicle Application _____
 Steering Gear Model _____ Serial No. _____
 Slave Gear Model (if equipped) _____ Serial No. _____
 Pump Manufacturer _____ Pump Part # _____
 Front Axle Weight Rating _____ Front Axle Manufacturer _____

HYDRAULIC TESTS: Refer to RH Sheppard service information available on line at: www.rhsheppard.com and in the Sheppard steering gear Service Manuals. Do not remove the steering gear! Install a pressure and flow tester in the pressure line from the pump to the gear as outlined in the Diagnosis and Troubleshooting Section. Record the following information:

Engine Idle RPM _____ Engine Max RPM _____
 Oil Temperature _____ Degrees F (Tests should be run at about 180F)
 System Backpressure @ Idle _____ PSI Backpressure @ Max RPM _____ PSI
 Maximum System Pressure (Pump Relief Setting) at idle _____ PSI at Max RPM _____ PSI
 Flow @ Idle with Backpressure Only _____ GPM
 Flow @ Max RPM Backpressure Only _____ GPM
 Flow @ Idle With 1500 PSI Load Applied _____ GPM
 Flow @ Max RPM With 1500 PSI Load Applied _____ GPM
 Does Steering Gear Stay in Pressure when the Steering Wheel is released? YES _____ NO _____
 Static Steer Turning Pressure RIGHT Turn _____ PSI LEFT Turn _____ PSI
 Relief Plunger Trip Pressure RIGHT Turn _____ PSI Pressure Drops Down to _____ PSI
 Relief Plunger Trip Pressure LEFT Turn _____ PSI Pressure Drops Down to _____ PSI
 Steering Gear Internal Leakage RIGHT Turn _____ PSI _____ GPM
 Steering Gear Internal Leakage LEFT Turn _____ PSI _____ GPM
 Static Steer Turning Input Effort RIGHT Turn _____ In. Lbs LEFT Turn _____ In. Lbs.

Sheppard Field Service Hotline: 1-800-274-7437

**Call the Hotline for pre-authorization and review of checklist prior to steering gear replacement.
Warranty may be denied without a completed checklist.**



For any questions concerning this service manual or any Sheppard product, contact our Field Service Hotline at 1-800-274-7437, or refer to our website: www.rhsheppard.com.

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 FAX: 717-633-4125