




SAFETY NOTICE


 **STOP!** Before you begin, please read this manual carefully. The repair procedures outlined in this manual are for repairing the Sheppard Integral Power Steering Gear. To ensure safe and reliable operation, these service and repair procedures must be followed carefully.



THIS MANUAL CONTAINS A NUMBER OF SAFETY SIGNAL WORDS LIKE: DANGER, WARNING, CAUTION, IMPORTANT, or NOTE. The information following a safety signal word is very important.

When you see the word  **DANGER** it means the information will help you avoid an extreme hazard that could kill or cause a very serious injury every time.

When you see the word  **WARNING** it means there is a hazard that is not as serious as DANGER but the hazard could cause injury or death if you do not follow the proper rules or procedures.

When you see the  **CAUTION** it means the information that follows will help avoid damage to the steering gear.

The signal words IMPORTANT or NOTE are used to draw attention to ways of doing your job better or right.

This section of the manual is designed to help the mechanic troubleshoot steering complaints. Used properly the section will assist you in completing a proper and less time consuming diagnosis and repair.

You will find sub sections covering diagnosis, troubleshooting, definitions and terms for complaints. To properly repair the problem you must have a clear understanding of the driver's complaint. The Glossary of Terms and Definitions will help pin point the problem quickly.

Locate the complaint in the troubleshooting section and complete all the necessary tests as outlined in the proper section of this manual. Complete the troubleshooting checklist and record your findings.

If after completing the diagnosis and repairs found in the Diagnosis and Troubleshooting section of this manual, you are unsure of your findings, contact the Field Service Department of the R. H. Sheppard Co., Inc. at 717-633-4111. When contacting the R. H. Sheppard Co. with a problem be sure to have your completed troubleshooting checklist available.

Do not remove the gear until you have completed all procedures to solve your problems. Remember the steering gear is only one part of a total steering system. Many factors outside the steering gear will affect steering performance.

IMPORTANT: 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. Factors such as misalignment, looseness in front end components, mismatched tires and dry fifth wheel, to name a few, will affect steering.

A trouble shooting checklist is provided in the Miscellaneous Section of this manual. This form can be removed and photo copied. This checklist will follow the diagnosis outline below.

GENERAL DIAGNOSIS

Many times a steering gear is removed and disassembled needlessly because an orderly diagnostic procedure is not followed.

A glossary of common terms is provided at the end of this section of the manual. This glossary is intended to help you better understand the problem.

Begin your diagnosis using the following outline as a guide.

I. DEFINE THE COMPLAINT

- a. Talk to and question the driver - Refer to the glossary to obtain a clear understanding of what the driver is saying.
- b. Drive the vehicle - If possible have the driver show you what he is experiencing. Drive the vehicle together to duplicate the condition.

II. PERFORM A VISUAL INSPECTION OF THE VEHICLE

- a. Check for dry fifth wheel - Lack of lubrication will tend to steer the vehicle.
- b. Check tires for mismatch, improper inflation or uneven wear patterns.
- c. Check for poor loading practices - Special body or equipment installations should be checked for their effect on steering performance.
- d. Check for suspension sagging or shifting - Out of line rear axles will tend to steer the front end of the vehicle.

III. INSPECT MECHANICAL COMPONENTS

- a. Check all front axle components for wear, looseness or seizing.
- b. Inspect steering column for drag - more than 10 inch pounds of drag measured with the column suspended at the angle of operation is excessive.
- c. Check steering gear mounting to be sure that it is tight. A steering gear that is shifting on the frame will affect steering performance.

IV. CHECK THE HYDRAULIC SUPPLY SYSTEM

- a. Follow the procedures as outlined in the hydraulic diagnosis section of this manual. Oil pressure and flow must be within the vehicle manufacturer's specifications.

HYDRAULIC DIAGNOSIS

The Sheppard M-Series integral power steering gear is a reactionary part of the power steering system. By reactionary we mean that its operation is dependent on the proper supply of oil pressure and flow from the hydraulic supply pump.

When the steering wheel is turned, oil flow is applied to one end of the steering gear piston causing pressure to build. This pressure causes the piston to move. As the piston moves it is displaced by a volume of oil under pressure. The speed the piston moves is dependent on the amount of oil flow or,

Flow = Speed of steering.

Maximum system relief pressure limits the amount of steering gear output available to steer your specific vehicle or,

Pressure = The amount of work the steering gear can do.

Keeping the basic formula of “Flow = Steering Wheel Speed” and “Pressure = Work” in mind will help you diagnose steering problems.

Oil pressure and flow requirements are set during the design of the steering system. When diagnosing steering problems, oil pressure and flow must meet design specifications. Pressure and flow specifications vary. Follow the vehicle manufacturer’s recommendations.

System back pressure and operating temperature must be considered during the diagnosis of the steering system. High system back pressure will create heat.

High system oil temperatures reduce overall efficiency of the steering pump and steering gear.

Various types of pressure and flow meters are available to diagnose power steering problems. A pressure gauge rated at 3000 PSI and a flow meter with a capacity of 10 GPM are needed to check oil pressure and flow.

A shutoff valve placed downstream from the pressure gauge allows the hydraulic supply pump to be isolated from the gear to check pump relief pressure. A simple thermometer placed in the reservoir will show system temperature.

Pictured below is the Sheppard Heavy Duty Power Steering Test Kit Part #5517641. This is an excellent tool for troubleshooting power steering systems and can be ordered using the form in the Miscellaneous section of this manual.



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

LOW COST - EASY TO USE

Only one hose connection is broken, either at the pump output or at the pressure input to the power steering gear housing.

- * Installs between pump and steering gear
- * Shutoff valve isolates pump from gear
- * Pressure and flow can be read at the same time
- * 0-3000 P.S.I. pressure gauge
- * 1-10 G.P.M. flow meter
- * Complete with hoses & standard swivel fitting

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

Using a pressure and flow test kit, proceed with the evaluation of the hydraulic system. Record your findings on the trouble shooting checklist.

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

1. Connect the pressure and flow tester in series with the pressure line of the pump. Make a copy of the trouble shooting test sheet.
2. Start the engine and check system oil level. Make sure the oil is flowing in the proper direction as indicated by the arrow on the flow meter.
3. Place a thermometer in the reservoir.
4. Run the engine at idle speed. Slowly close the shut off valve until you have a pressure reading of 1000 PSI. Maintain this pressure until system temperature reaches 180 degrees Fahrenheit. Open the shutoff valve all the way when the temperature is 180 degrees.
5. Check System Backpressure:
Normal system back pressure will be between 0 and 100 PSI with the engine idling and the steering wheel stationary. Dual systems will normally read slightly higher. Back pressure should be checked at normal operating temperature.
6. Pump Maximum Relief Pressure:
With the engine running at specified idle speed, slowly turn the shutoff valve until it is closed and read the pressure at which the pressure relief valve opens. (Open the shutoff valve as quickly as possible to avoid heat build-up or possible damage to the steering pump.) This pressure reading should equal the maximum pump pressure specified by the vehicle manufacturer. Check specifications.



WARNING A BAD PRESSURE RELIEF VALVE MAY NOT RELIEVE PUMP PRESSURE. CLOSING THE SHUTOFF VALVE MAY CAUSE SEVERE PUMP DAMAGE OR HIGH-PRESSURE HOSES TO RUPTURE. WATCH THE PRESSURE GAUGE CLOSELY. IF PRESSURE RISES RAPIDLY OR GOES ABOVE 2500 PSI. STOP! DO NOT CLOSE THE VALVE ALL THE WAY.

SOME STEERING PUMPS ARE NOT EQUIPPED WITH INTEGRAL RELIEF VALVES. CLOSE THE SHUTOFF VALVE SLOWLY AND WATCH THE PRESSURE. IF SYSTEM PRESSURE GOES ABOVE 2500 PSI DO NOT CONTINUE TO CLOSE THE SHUTOFF VALVE. PUMP DAMAGE OR PERSONAL INJURY MAY RESULT.

7. Flow Test:
Measure oil flow under the following conditions. Record your findings on the Trouble Shooting Checklist.
Flow at idle with back pressure only
Flow at idle under a 1500 PSI load applied with the shutoff valve
Flow at full governed RPM with back pressure only
Flow at full governed RPM under a 1500 PSI load applied with the shutoff valve
8. Aerated Oil:
Visually check for air mixed with the oil in the steering system. The oil should be clear. Any signs of frothing indicates air in the system and steering performance will be affected. Carefully check for leakage on the suction side of the steering pump. Drain, refill, and bleed the system. Follow the procedure for setting relief plungers in the “Common Procedures” section of this manual.
Before any steering gear repairs are made complete the hydraulic supply evaluation and make any repairs. Many times steering gears have been repaired or replaced needlessly because a hydraulic supply system evaluation had not been made.
Additional references to pressure and flow testing will be made in the diagnosis charts in the “General Diagnosis” section of this manual.
9. Dry park Pressure and Input Effort:
Measure and record the pressure required to steer the vehicle from full left to full right while parked. Input effort is measured at the steering wheel retaining nut. Use a dial type inch pound torque wrench to check static steering input effort. Normal Input effort will be less than 100 inch pounds.

OIL FLOW AND PRESSURE RECOMMENDATIONS

The Sheppard M-Series power steering gears are designed to operate at a maximum pressure of 2175 PSI. Each vehicle Manufacturer specifies the maximum operating pressure at which their various steering installations are to be operated. Always refer to your Vehicle Manufacturer's specifications for the correct pump relief settings for the vehicle you are working on.



WARNING

DO NOT INCREASE THE MAXIMUM OPERATING PRESSURE WITHOUT CONSULTING THE VEHICLE MANUFACTURER. SERIOUS DAMAGES MAY OCCUR.

Oil flow and pressure for the Sheppard M-Series steering gears are outlined below by model number. Refer to the gear identification section of this manual to determine the model of steering gear you are working on. Oil flow requirements remain the same for all similar models and do not change from installation to installation. Follow the Vehicle Manufacturer's recommendation.

M-SERIES STEERING GEARS

	M80P	M90P	M100P	M110P
RATED PRESSURE	2175 PSI	2175 PSI	2175 PSI	2175 PSI
MIN. PUMP FLOW (SINGLE)	2.1 GPM	2.5 GPM	3.0 GPM	3.5 GPM
PUMP FLOW RANGE (SINGLE)	2.5-6.0 GPM	2.5-6.0 GPM	3.0-6.0 GPM	3.5-6.0GPM
PUMP FLOW RANGE (DUAL SYSTEM)	N/A	4.6-6.0 GPM	5.1-6.0 GPM	5.6-6.0 GPM
RATIO	16.8-1	18.9-1	18.9-1	23-1
OUTPUT SHAFT DIAMETER	1.75 IN.	2.0 IN.	2.0 IN.	2.25 IN.

Before any steering gear repairs are made complete the entire troubleshooting checklist provided in this manual. Many times steering gears are removed or replaced needlessly. Remember, once the steering gear is removed there is only one thing that can be determined -its weight!!!

If you have completed the troubleshooting checklist and are unsure of your diagnosis contact your Vehicle Manufacture representative, or the Field Service Department of the R. H. Sheppard Co., Inc. at 800-274-7437.

1. **Rotary Valve** - Internal valve in the bearing cap of the steering gear. It is actuated by the steering wheel through the yoke connection of the steering column.
2. **Back Pressure** - Circulating pressure of the steering system.
3. **Base Mounted Gear** - The steering gear is mounted to the frame rail or bracket utilizing the eight mounting holes opposite the sector shaft cover.
4. **Bearing Cap** - End cap of the steering gear that houses the actuating shaft and valve.
5. **Bearing Cap Cover** - Small cover on the end of the bearing cap of the steering gear. The bearing cap cover houses the input shaft oil and salt seal.
6. **Bleeder Screw** - 1/8" allen screw located in the sector shaft bore of the steering gear.
7. **Cavitation** - Bubbles that form in the oil which keep the pump from supplying pressure and volume.
8. **Contamination** - Dirt or other foreign material in a fluid.
9. **Cylinder Bore** - Long bore of the steering gear where the steering gear piston is housed.
10. **Cylinder Head** - The end cap of the steering gear bolted on the housing opposite the actuating shaft end of the gear.
11. **Displacement** - The volume of fluid that can pass through a pump or cylinder in a single revolution or stroke.
12. **Feedback** - A transfer energy from the output of a device to it's input.
13. **Fluid Flow** - The stream or movement of a fluid, or the rate of it's movement.
14. **Piston** - Is found in the cylinder bore. Changes the hydraulic force to mechanical force in the steering gear.
15. **Plunger** - Relief valves in the steering gear to limit steering gear piston travel. Plungers are adjustable and can be either manual or automatic adjusting.
16. **Pressure Relief Valve** - Optional pressure relief valve integral to the steering gear to limit system operating pressure. Identified by a large hex nut on the side of the bearing cap.
17. **Pump** - A device that converts mechanical force and motion into hydraulic fluid power.
18. **Rack Teeth** - The area on the piston that engages the sector shaft teeth.
19. **Recirculation Ball Thread** - The area of the rotary valve on which the 24 steel balls travel.
20. **Relief Valve** - A pressure control valve used to limit system pressure.
21. **Sector Shaft** - The shaft the pitman arm is attached to.
22. **Sector Shaft Bore** - Area of the steering gear that houses the sector shaft.
23. **Slave Gear** - Right hand gear in a dual system application.
24. **Slave Ports** - Threaded openings in the cylinder head, bearing cap and sector shaft bore to install the pressure lines to operate the slave gear.
25. **Tab - Lock Retainer** - Bolt assembly used to provide initial torque when installing the pitman arm. Uses alignment tabs that fit into the pitman arm and restraining tabs to be locked into the head of the retainer.
26. **Flow** - The amount of fluid that passes a certain point in a unit of time. The volume of flow is usually expressed in gallons per minute for liquids.

TROUBLESHOOTING GUIDE

This section is designed to give you causes and possible remedies for the most common problems.

Symptom	Possible cause	Remedy
Oil leaking at output shaft of steering gear.	Damaged sector shaft seal	Replace sector shaft seal and sector shaft if necessary
Oil leaking at actuating shaft of steering gear	Worn or damaged oil seal	Replace actuating shaft seal
Oil leaking at supply pump drive shaft	Damaged oil seal Oil seal heat damaged Loose or damaged bushing on pump drive shaft	Replace oil seal Check operating temperature Repair pump per pump service instruction
Lubricant milky or white in appearance	Water entry through reservoir venting system	Clean vent system or replace cap assembly Flush System
Oil forced out of reservoir or foaming	Clogged oil filter	Change oil and oil filter Change more often
	Air in system	Bleed air from system Check for air leak on suction side of supply pump
	Relief plungers of steering gear not adjusted properly creating high operating temperatures	Adjust relief plungers (See Common Procedures)
	Air leak in suction side of supply pump	Refer to pump servicing instructions
	Pump cavitating	Check for restriction in pump supply
	Oil overheating	Check for restriction in steering gear return
Engine oil in power steering reservoir (Gear driven pump)	Faulty seal at pump drive shaft	Repair pump
	Faulty seal at accessory shaft driving supply pump	Repair accessory drive
Lubrication oil discolored	Operating temperatures too high	Check and correct cause of overheating
	Change intervals too long Incorrect lubricant used	Change oil more often Drain, flush and refill with recommended fluid
High operating temperatures	Oil flow restriction	Check back pressure
	Oil flow too high	Check maximum oil flow

Symptom	Possible cause	Remedy
No power steering on cold starting	Hydraulic supply pump vanes not extending (Vane type pump only)	Increase engine speed momentarily to extend vanes and start pump action. Usually does not happen often and does not last long. Not a cause for pump repair or replacement.
Excessive pump pressure with steering gear in neutral position.	Pinched oil return line High back pressure	Relocate line
	Binding steering column	Repair steering column
Wheel cuts restricted	Relief plungers not adjusted properly	Adjust relief plungers
Erratic steering or mechanical steering only	Insufficient volume of oil	Refer to pump servicing instructions
	Sticking pressure relief valve in steering gear	Replace relief valve as required
Hard Steering	Faulty supply pump	Check pump flow
	Steering out of alignment	Align front end
	High operating temperature	Locate and correct cause of overheating
Wheel turns hard in one or both directions	Bind in steering column	Check column drag
	Dirt or foreign matter trapped in piston relief	Check piston relief
	Bent or damaged king pins and tie rods	Repair or replace king pins and tie rods Refer to servicing instructions
	Front end load too great	Lighten load
	Low oil level in steering system	Fill oil reservoir as required
	Air in system	Bleed system and check for cause of air
	Caster degree incorrect	Correct to Specifications
Wheel turns hard in one direction	Metal or foreign material in relief ball seat in piston of steering gear	Remove and clean relief valve seats or replace damaged parts
No attempt to return to straight ahead from turns (may also be hard steering complaint)	No positive caster	Set caster to 3° to 5° positive caster

Symptom	Possible cause	Remedy
	Steering gear mounting distorted	Shim mounting pads to correct piston to bore interference. Make sure correct bolt length is used on the base mount gears.
	Linkage ball sockets seized or binding	Check and repair or replace
	King pins seized or binding	Repair or replace
	Oil flow rate incorrect	Check and correct supply pump
Darting, wandering (oversteering)	Oil flow too high	Supply pump not to specifications
	Air trapped in steering gear	Bleed system
	Looseness, worn front end parts	Check and repair as required
	Front end alignment not correct	Align front end caster
	Overloading	Reduce loads
	Rear axle not parallel	Check & repair as required
	Tight tie rod ends & drag link sockets	Check rotational torque & replace if necessary
Excessive backlash/freeplay	Worn universal joint	Replace universal joint
	Pitman arm ball worn "egg-shaped" (if equipped)	Replace pitman arm assembly where riveted ball is used.
	Loose bracket frame to bracket or bracket to gear	Remove bracket, clean frame and bracket. Check radius of frame making sure bracket is not bearing on radius surface. Check bracket for wear from being loose. Replace bracket and tighten to recommended torque rating by size and grade of bolts. If necessary, replace bracket.
	Rack on piston damaged	Replace steering gear
	Damaged sector shaft/splines	Replace steering gear
	Worn or damaged pitman arm splines	Replace pitman arm and sector shaft
	Universal joint yoke loose on actuating shaft	Repair or replace damaged parts.

Symptom	Possible cause	Remedy
Steering input not smooth	Worn universal joint	Check and replace as required
	Lack of lubrication	Lubricate per vehicle manufacturer's recommendations
	Universal joints not phased properly	Re-phase columns*
	Low oil flow	Idle speed too low Drive belts slipping Supply pump not to specifications
	Overload on front axle	Verify front axle weight. Do not exceed rating of front axle.
	Pump cavitating	Correct pump supply
	Overheating	Correct cause of overheating

NOTE: Universal joints are designed to operate best when the angle between the drive and driven shaft is a maximum of 20 to 25 degrees. Angles greater than this may upset steering performance.

IMPORTANT: Actuating shaft thread wear generally comes from improper lubrication or excessive manual steering. Manual steering results from low pump pressure or flow or an overloaded front axle.

*To check phasing of the universal joints in the steering column, use an inch-pound graduated dial type torque wrench. With a socket on the steering wheel retaining nut, read the difference in the torque while steering from lock-to-lock. Variation of more than 15 in.-lb. means improper phasing. Take the reading with the vehicle stationary and the engine running at idle.

Phasing can usually be corrected by rotating the two-piece intermediate shaft one spline at a time until the torque reading remains the same throughout the 360 degree rotation of the steering wheel.