

# Steering Diagnostics Service Manual

CHART YOUR WAY TO EASY STEERING





 <b>WARNING</b>	A warning describes hazards or unsafe practices which could result in severe personal injury or death.
 <b>CAUTION</b>	A caution describes hazards or unsafe practices which could result in personal injury or product or property damage.
<b>NOTE</b>	A note gives key information to make following a procedure easier or quicker.

## Notice

This guide was prepared for the purpose of providing general advice concerning the diagnosis and correction of commercial vehicle steering related problems. This guide is intended for the use of properly trained, professional mechanics, NOT "Do-it-Yourselfers". Also, this guide should be used in conjunction with service manuals provided by both the vehicle and component manufacturers. Diagnosis and correction of commercial vehicle steering related problems should only be handled by properly trained, professional mechanics who have the proper equipment, tools, instructions and know-how to perform the work properly and safely.

## Power Steering System Analyzer (PSSA) Gauge

Some of the tests in this manual require the use of a PSSA. This device is a combination flow meter, shut-off valve, and pressure gauge. This tool will allow you to measure flow and pressure, and provide a load on the pump through the hydraulic lines of the steering system. This tool is required to correctly analyze a steering system. TRW recommends that you **DO NOT BEGIN TROUBLESHOOTING A STEERING SYSTEM WITHOUT THE USE OF A PSSA**. If you are not sure how to use a PSSA, you may refer to the video available through our website at: [www.trucksteering.com](http://www.trucksteering.com). This video compliments the tests in this book which require the use of the PSSA.

 <b>WARNING</b>
Throughout this troubleshooting guide, test procedures are recommended to help locate the cause of each complaint. While performing these tests, TRW advises that you <b>TAKE NECESSARY PRECAUTIONS</b> when working with internal vehicle components and hot hydraulic fluids.

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# Introduction

## Understanding the Complaint

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

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

- Talk to the driver and ask a lot of questions like “what, when, where, and how”
- Make sure you can feel or see the problem. Have the driver show you exactly what he/she means.
- Walk around the truck, looking for anything that may be an obvious cause of the problem.

To make your job easier and faster this manual has both the flow charts and test procedures/comments, each in their own section. Once you have a good understanding of what the complaint is, choose the flow chart that best matches the symptoms described to you. Because there are different ways to say the same thing, we have provided our definitions of the 10 most common complaints in this book. Use these to determine which section of the manual would be helpful to begin diagnosing the steering system.

## Reading the flow charts:

Start the chart at the **BEGIN** box. Follow the lines to the next box answer the question or perform the test to verify the cause of the complaint, then proceed to the next step. These boxes are arranged in order of likelihood of being the cause of the driver's complaint. **It is important to complete the tests, in order, and follow the flow of the chart.** Locate correct test number in the TEST PROCEDURES section, and follow the test procedure. When you are done with the test, note the results and correct the root cause. If condition still exists, keep going through the chart (if necessary, to correct the problem). The results of some tests will need to be recorded. Use the TEST RESULTS section to record these values.

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

## Warranty

If you have identified that a steering component on your vehicle needs to be replaced, this does not always mean it is warrantable. Please read your manufacturer's warranty carefully before submitting a steering component for warranty consideration.

# Definitions

## 1. Hard Steering

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

Common phrases used:

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

## 2. Reduced Wheelcut

Common phrases used:

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

## 3. Steering Wheel Kick

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

Common phrases used:

- Kickback
- Backlash
- Bump steer

## 4. Binding, Darting and Oversteer

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

## 5. Directional Pull

Common phrases used:

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

## 6. Road Wander/Loose Steering

Common phrases used:

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

## 7. Non-Recovery

Common phrases used:

- Wheels don't return to straight ahead

## 8. Shimmy

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

Common phrases used:

- Shake at steering wheel

## 9. Noise

Common phrases used:

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

## 10. External Leakage

Common phrases used:

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

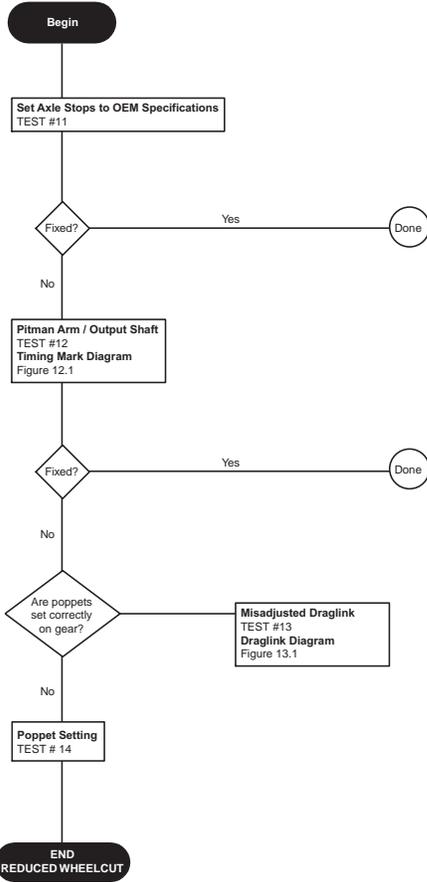
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## Section 2      **Flow Chart Diagrams**

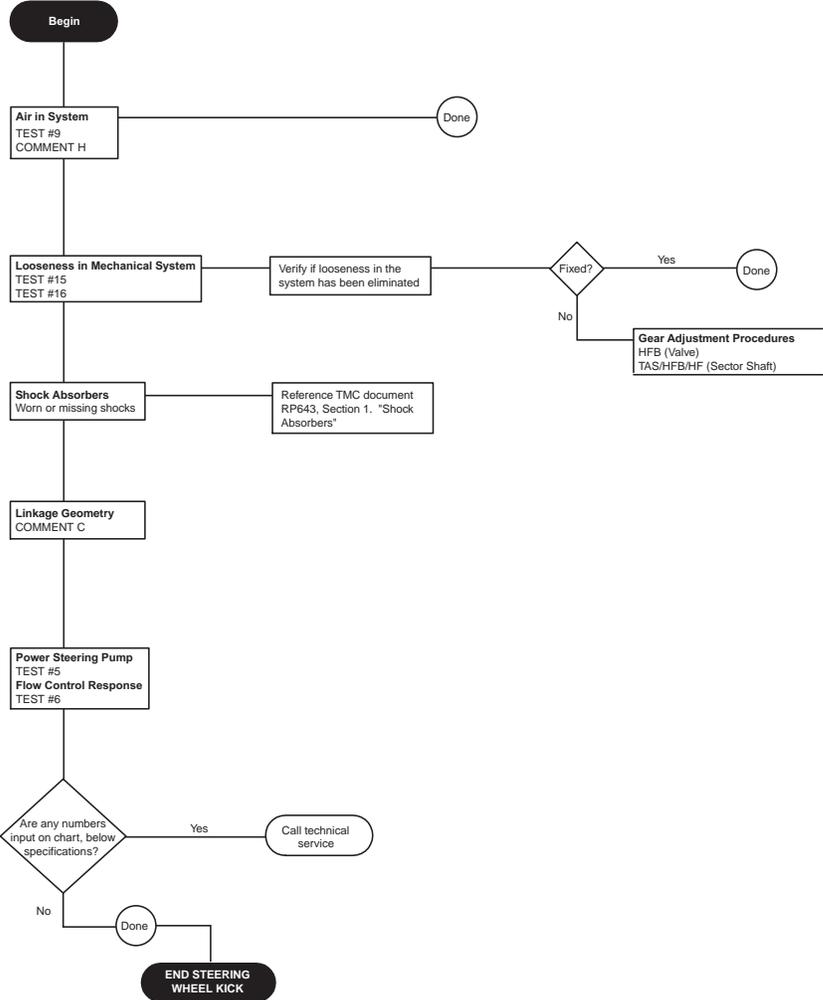
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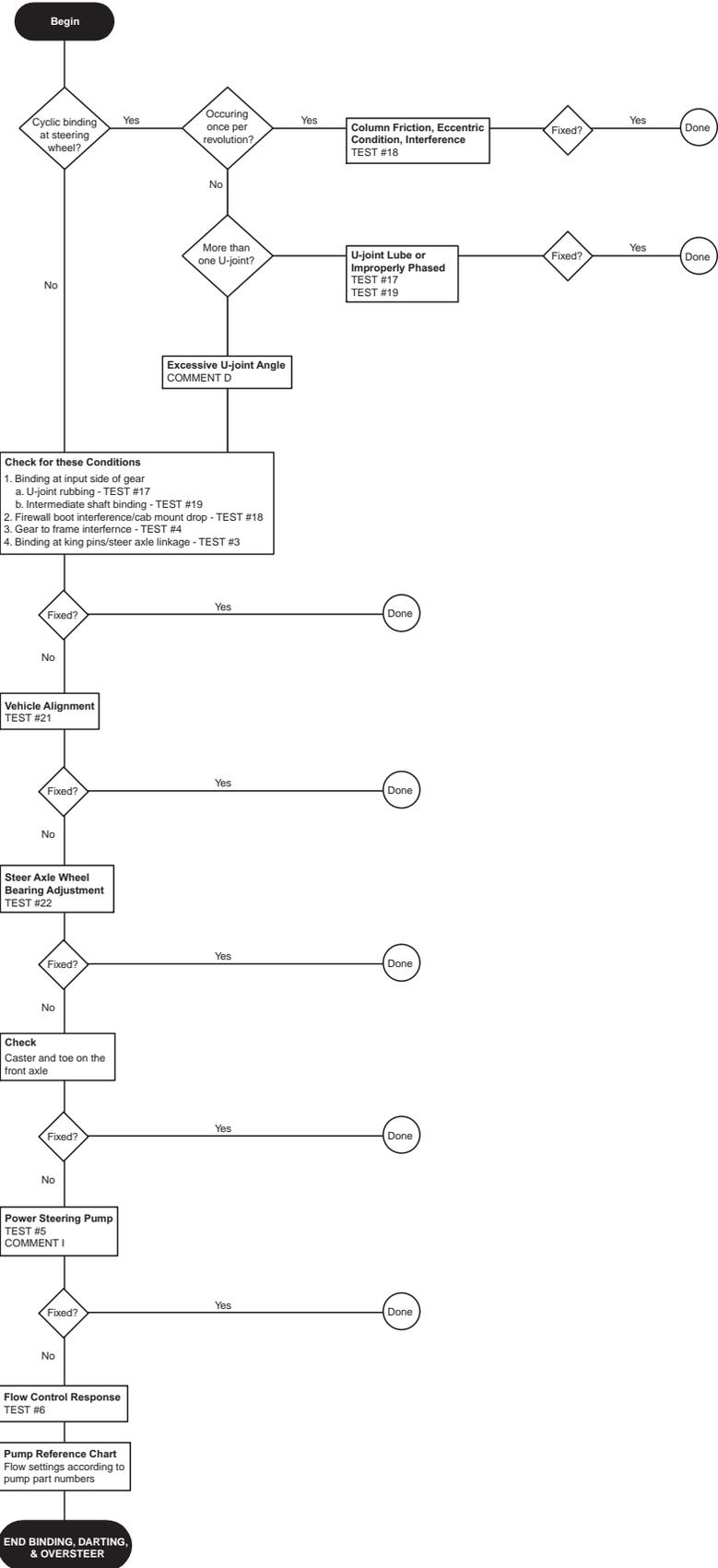
# Reduced Wheelcut



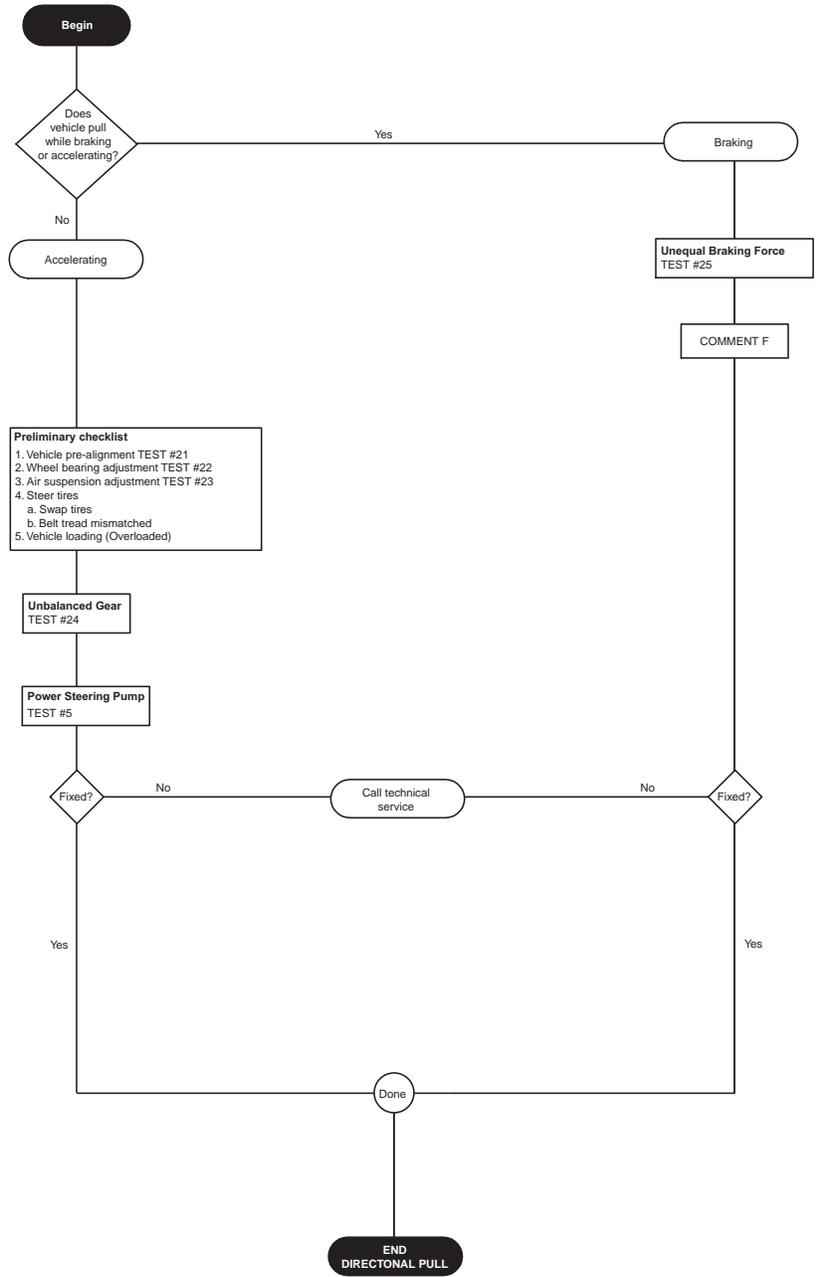
# Steering Wheel Kick



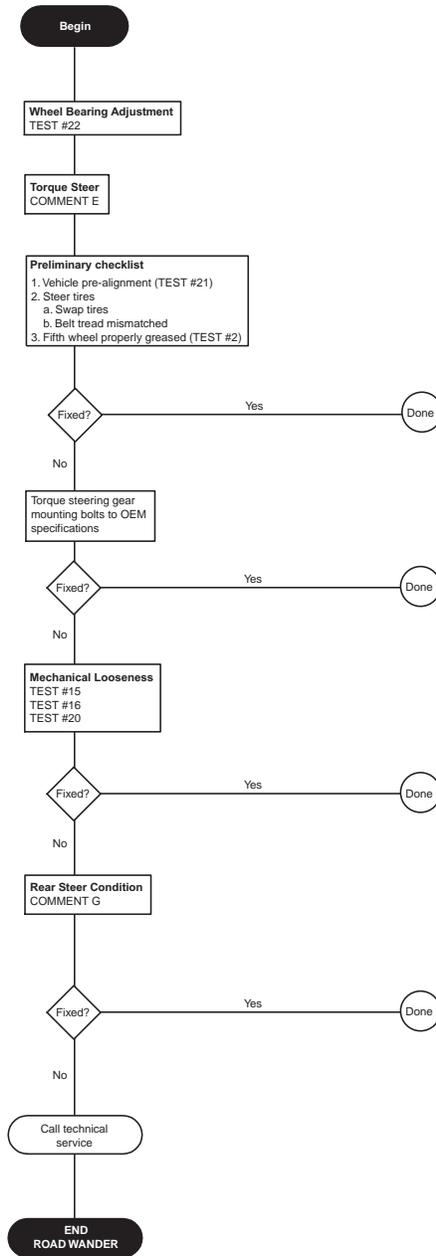
# Binding, Darting, and Oversteer



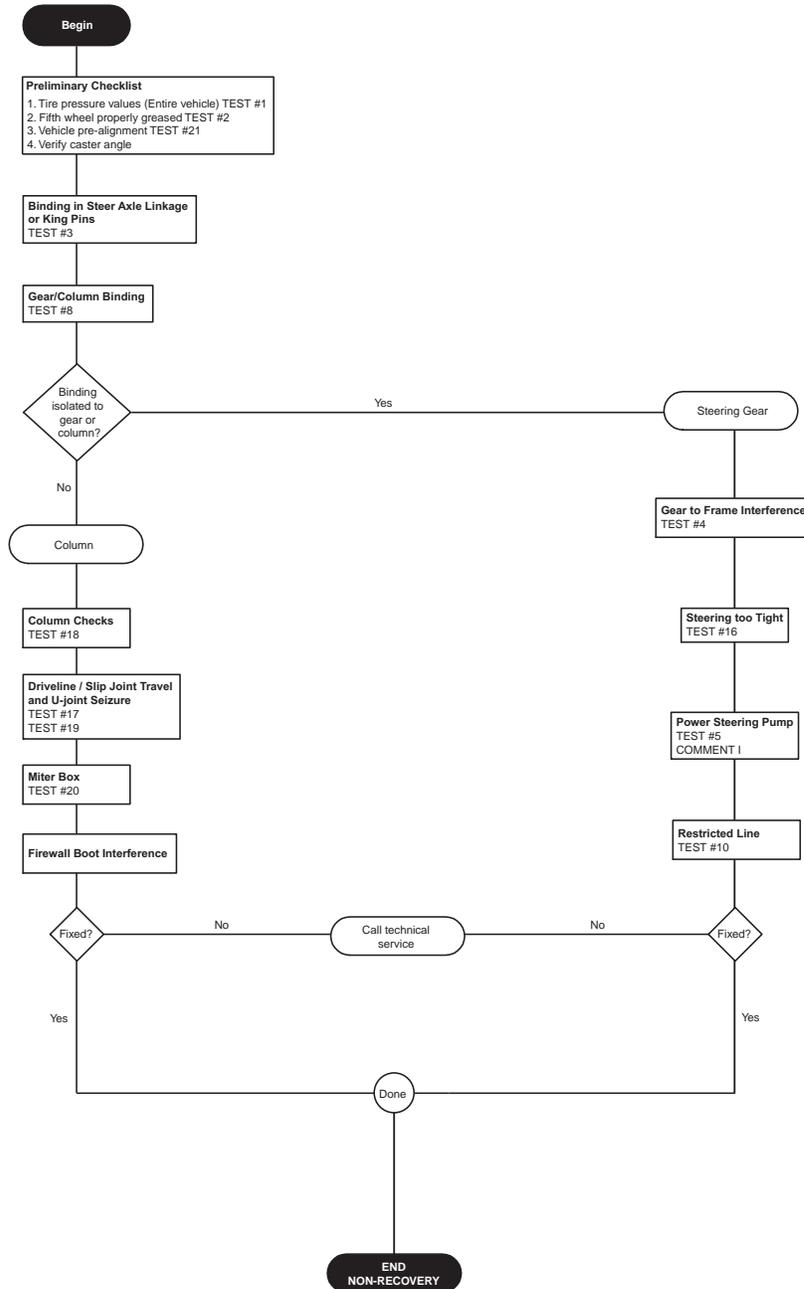
# Directional Pull

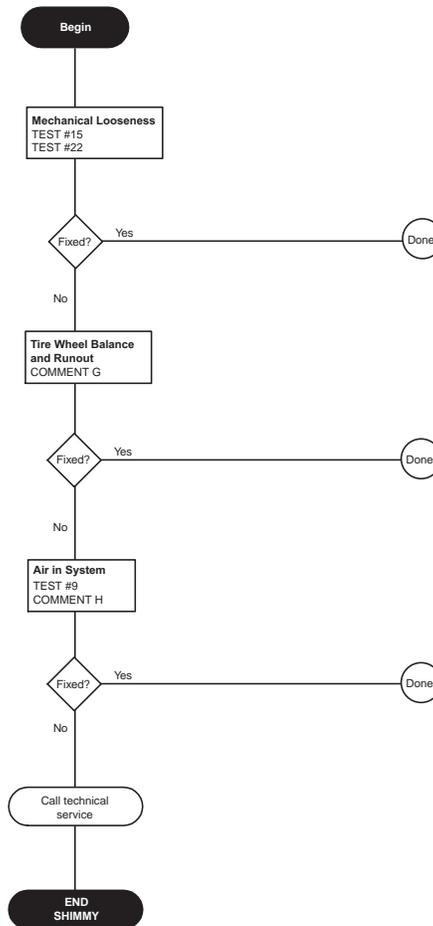


# Road Wander/Loose Steering

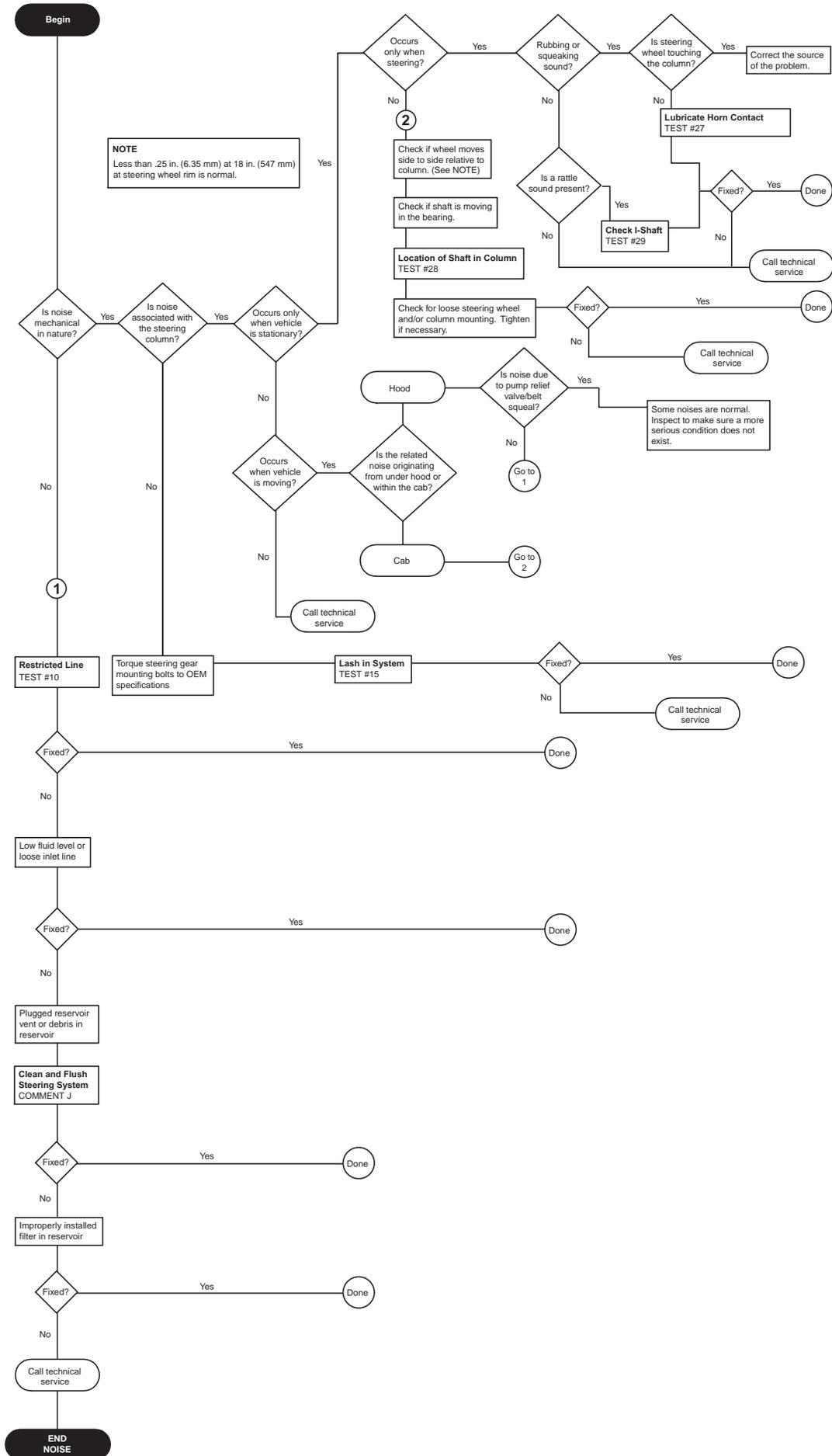


# Non-Recovery

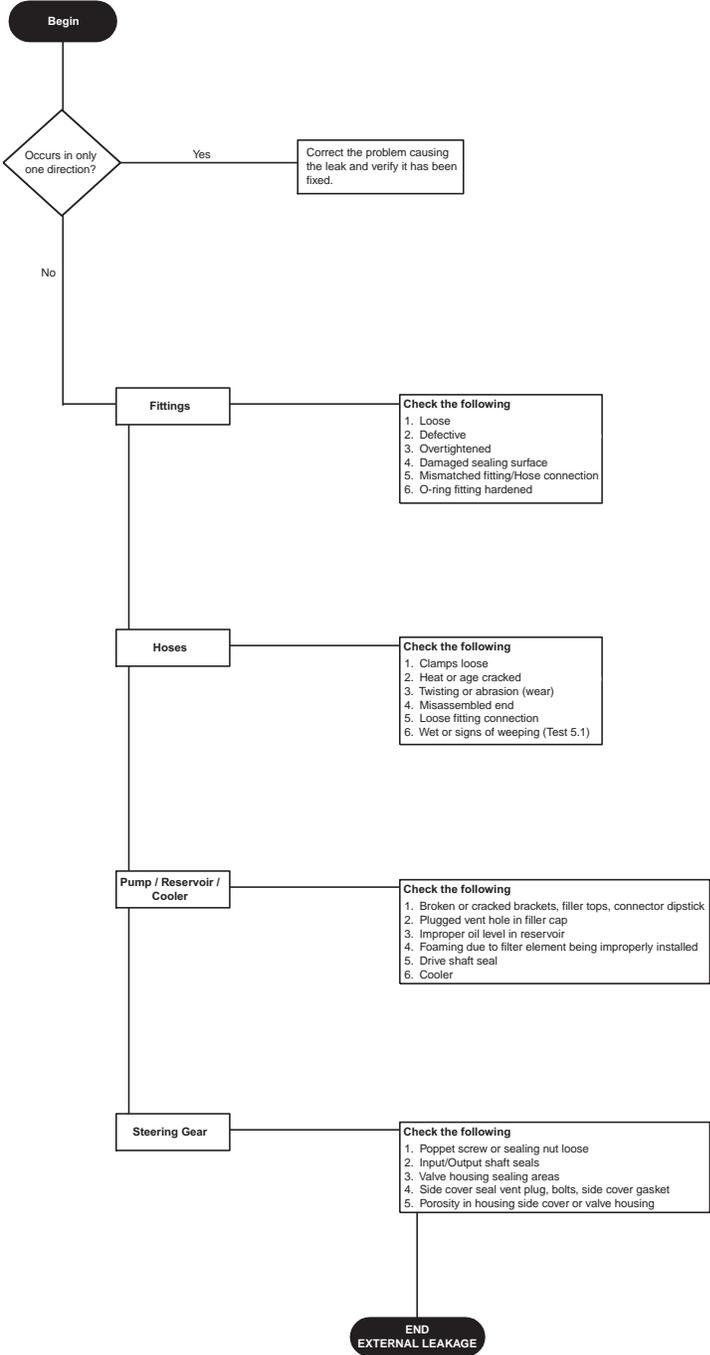




# Noise



# External Leakage



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## Section 3

## Test Procedures

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### Test #1

#### Steer Tire Check

1. Look for: Tire damage, Uneven or extreme tread wear, mismatched tires or other wear indicators that would cause the problem. *Figure 1.1.*
2. Check tire pressures on steer axle tires. *Figure 1.2.*

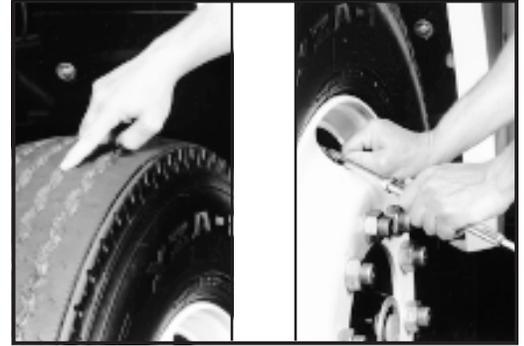


Figure 1.1

Figure 1.2

### Test #2

#### Fifth Wheel and Trailer Plate

1. Look for dry fifth-wheel or trailer plate. *Figure 2.1.*
2. Look for damage to fifth-wheel or trailer plate. *Figure 2.2.*
3. Inspect fifth-wheel for looseness.

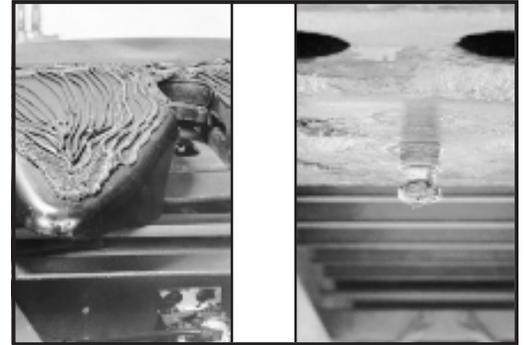


Figure 2.1

Figure 2.2

### Test #3

#### Steer Axle and Linkage Binding

1. With vehicle steer tires on radius plates (turntables) or equivalent, disconnect the drag link or pitman arm from the steering gear, (and linkage from assist cylinder if there is one on the vehicle). *Figure 3.1.*

**CAUTION** Do not steer the gear with linkage removed, as misadjustment of automatic poppets may result.

2. By hand, pull the tire to one axle stop and release (engine off). The tire should self-return to near straight ahead. *Figure 3.2.*
3. Repeat the test in the opposite direction.
4. If tire does not self-return to near straight ahead, a problem is likely in steer axle king pin bushings/bearings or linkage.



Figure 3.1



Figure 3.2

## Test #4

### Steering Gear Mounting

1. Look for anything between the steering gear and frame that could cause a binding problem. For example: hoses or brackets that have been routed, or are interfering between the steering gear and frame, frame flanges or spring mounting points. *Figure 4.1.* Mounting pads lower than steering gear housing, lack of clearance between frame and steering gear valve housing adapter, sector shaft adjusting screw and nut contact with access adjustment hole in frame. If interference is found, correct the problem.
2. If the steering gear has been mounted to the frame in a way that causes the gear to distort (not be flat), it may cause a steering problem. *Figure 4.2.* Checking to see if distortion is present on the vehicle may require the following test:
3. With vehicle parked and engine running, steer the wheel slowly checking for a binding-type of feel at the steering wheel. When binding is felt (stop engine loosen one mounting bolt restart engine) and steer the vehicle again. Continue to loosen one mounting bolt at a time, shutting off engine each time, and check for improvement in the binding condition. If improvement is made by loosening the bolts, determine by inspection the condition causing the gear to distort and correct the problem. Distortion of .030" (.80 mm) or less is acceptable. If greater than .030" (.80 mm) surface flatness, condition must be corrected.



Figure 4.1

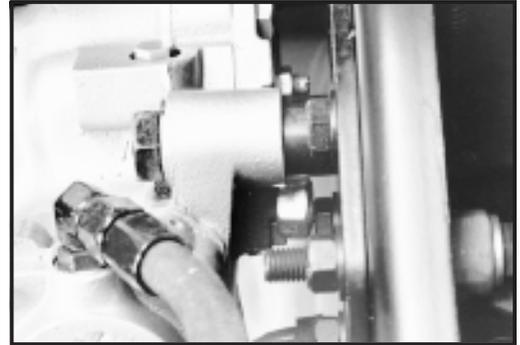


Figure 4.2

## Test #5

### Power Steering Pump Test

IMPORTANT: Read the following instructions below before completing **Table 5**, located in the "TEST RESULTS" section.

Verify Engine Idle speed per your OEM specifications.

1. Install temperature gauge in reservoir. *Figure 5.1*. Install PSSA in pressure line with shut-off valve fully open. *Figure 5.2*.
2. Run the engine at 1000 rpm.

**CAUTION** When closing the PSSA shut off valve, do so slowly and keep an eye on the pressure gauge. Do not allow the system to exceed 3000 psi (207 bar) for safety of personnel and to prevent damage to the vehicle.

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

3. Measure and record the following flow and pressure readings (see chart) by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. *Figures 5.3-5.7*.
4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed.
5. Determine the recommended flow range and maximum allowable system pressure for the steering system being used by referring to your service manual.
6. Compare the minimum and maximum flows (and the relief pressure you measured) to gear and pump specifications.
7. If the minimum measured pump flow is less than the minimum recommended flow for the steering gear used (see **Steering Gear Flow Requirements** chart), the pump may not be putting out enough flow for an adequate steering speed. If the maximum system pressure is lower than that specified for the pump (check your manual), it may not be developing enough pressure to steer. If either case exists, the pump needs to be repaired or replaced.

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

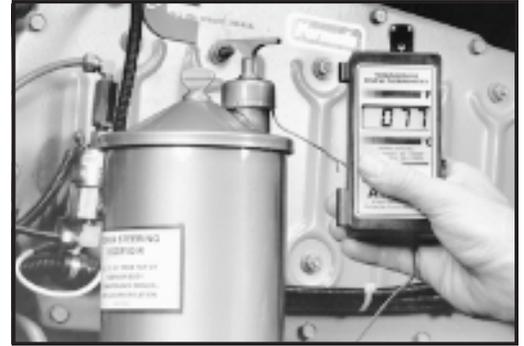


Figure 5.1

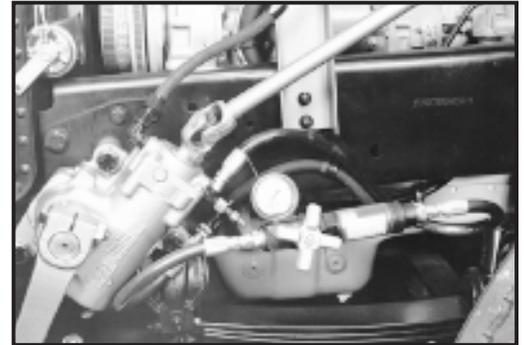


Figure 5.2

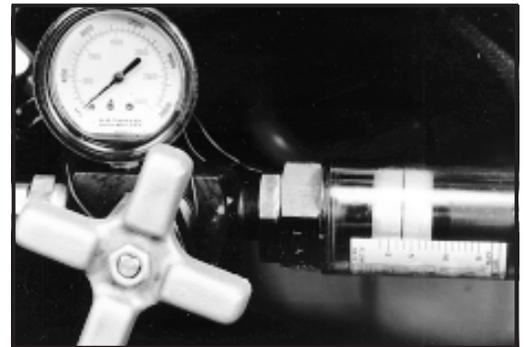


Figure 5.3

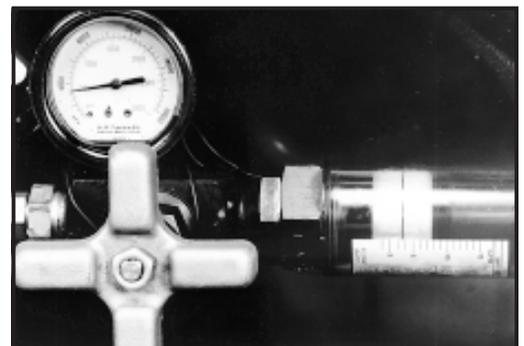


Figure 5.4

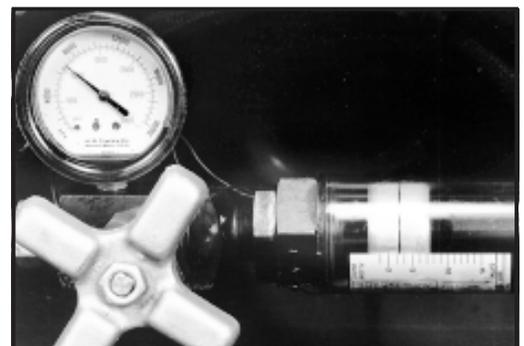


Figure 5.5

## Test #5.1

### 40 Minute Power Steering Pump Test

**IMPORTANT:** Read the following instructions below before completing **Table 5.1** in the "Test Results" section.

Verify Engine Idle speed per your OEM specifications

1. Install temperature gauge in reservoir. *Figure 5.1*. Install PSSA in pressure line with shut-off valve fully open. *Figure 5.2*. Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30 and 40 minutes. Do not allow the temperature to exceed 250° F (121° C).

#### NOTE

If the temperature goes over 250° F (121° C) , or 150° F (66° C) above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

2. Run the engine at idle speed.

#### CAUTION

**When closing the PSSA shut off valve, do so slowly and keep an eye on the pressure gage. Do not allow the system to exceed 3000 psi (207 BAR) for safety of personnel and to prevent damage to the vehicle.**

#### CAUTION

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

3. Measure and record the following flow and pressure readings (see chart) by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. *Figures 5.3-5.7*.
4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed.
5. Determine the recommended flow range and maximum allowable system pressure for the steering system being used by referring to your service manual.
6. Compare the minimum and maximum flows, and the relief pressure you measured to gear and pump specifications.
7. If the minimum measured pump flow is less than the minimum recommended flow for the steering gear used (see **Steering Gear Flow Requirements** chart), the pump may not be putting out enough flow for an adequate steering speed. If the maximum

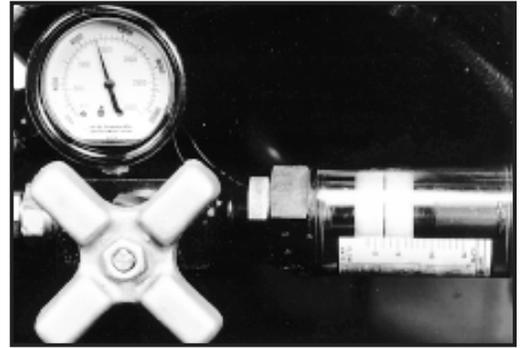


Figure 5.6

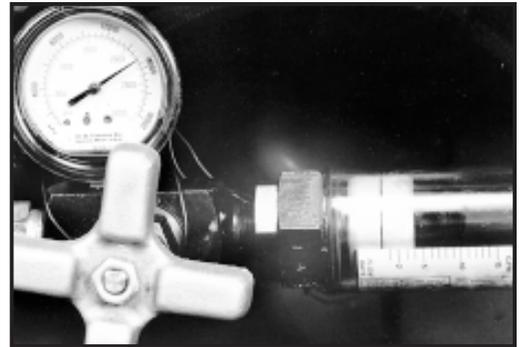


Figure 5.7

system pressure is lower than that specified for the pump (refer to your OEM service manual), it may not be developing enough pressure to steer. If either case exists, the pump needs to be repaired or replaced.

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

### Test #6 Pump Flow Control Response

IMPORTANT: Read the following instructions below before completing **Table 6**, in the "Test Results" section

1. Install temperature gauge in reservoir. *Figure 6.1*. Install PSSA in pressure line with shut-off valve fully open. *Figure 6.2*.

**NOTE** If the temperature goes over 250° F (121° C) , or 150° F (66° C) above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

**CAUTION** Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up. (Do not allow the pressure to exceed 3000 psi (207 bar).

2. With the engine at idle, note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading you noted above.
3. With the load valve open run the engine to governed speed and note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading noted above.
4. Conduct this pump response test three times at idle and three times at 1500 RPM. If the flow rate does not return immediately, the pump is malfunctioning, which can result in momentary loss of power assist.

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

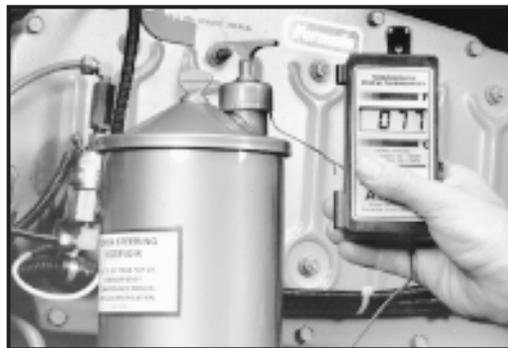


Figure 6.1

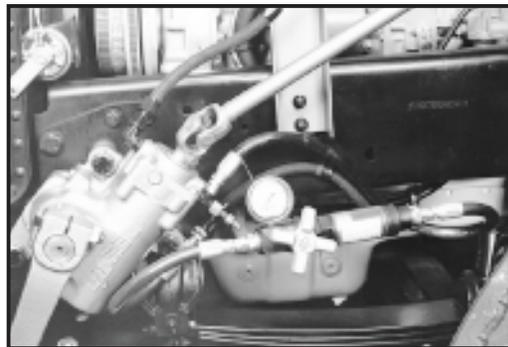


Figure 6.2

## Test #6.1

### 40 Minute Pump Flow Control Response

Read the following instructions below before completing **Table 6.1** in the "Test Results" section

1. Install temperature gauge in reservoir. *Figure 6.1*. Install PSSA in pressure line with shut-off valve fully open. *Figure 6.2*. Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30, and 40 minutes. Do not allow the temperature to exceed 250° (121°C)

#### NOTE

If the temperature goes over 250° F (121° C) , or 150° F (66° C) above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

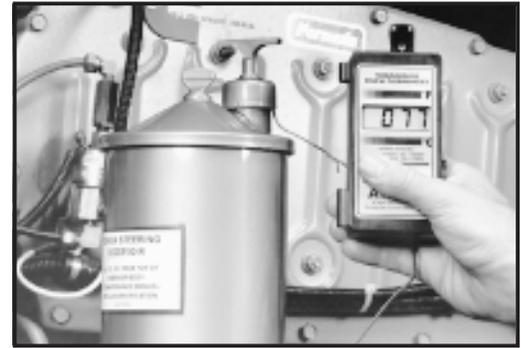


Figure 6.1

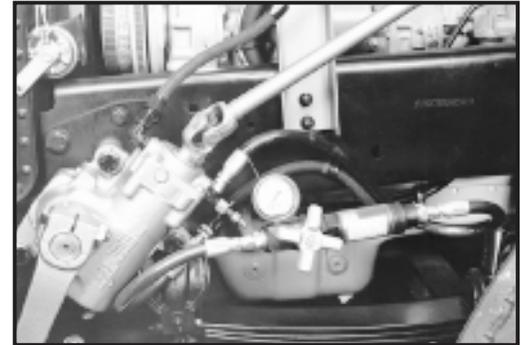


Figure 6.2

#### CAUTION

**Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up. (Do not allow the pressure to exceed 3000 psi (207 bar).)**

2. With the engine at idle, note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading you noted above.
3. With the load valve open run the engine to governed speed and note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading noted above.
4. Conduct this pump response test three times at idle and three times at 1500 RPM. If the flow rate does not return immediately, the pump is malfunctioning, which can result in momentary loss of power assist

#### NOTE

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

## Test #7

### Measured Internal Leakage

1. Install temperature gauge in reservoir. *Figure 7.1.* Install PSSA in pressure line with shut-off valve fully open. *Figure 7.2.*

**WARNING** THIS TEST CAN BE DANGEROUS IF NOT PERFORMED CORRECTLY. KEEP YOUR FINGERS CLEAR OF THE AXLE STOPS AND SPACER BLOCK DURING THIS TEST. MAKE SURE THAT THE SPACER BLOCK CONTACTS THE AXLE STOP SQUARELY. CONTACT THAT IS NOT SQUARE COULD BREAK THE AXLE STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.

2. To test the steering gear for internal leakage, you must first prevent operation of the gear's internal unloading (poppet) valves or relief valve (or both, in some gears). This will allow full pump relief pressure to develop. To prevent operation of the poppets, place an unhardened steel spacer block, about one inch thick and long enough to keep your fingers clear between the axle stop at one wheel. *Figures 7.3-7.4.* To prevent operation of the relief valve, remove the relief valve cap, o-ring and two piece relief valve, if equipped, from valve housing. Install the relief valve plug, special tool number J37130 in its place.

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

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

**WARNING** KEEP YOUR FINGERS CLEAR OF THE AXLE STOPS AND SPACER BLOCK DURING THIS TEST. MAKE SURE THAT THE SPACER BLOCK CONTACTS THE AXLE STOP SQUARELY. CONTACT THAT IS NOT SQUARE COULD BREAK THE AXLE STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.

3. With the fluid temperature between 125-135° F (52-57° C), turn the steering wheel until the axle stop bolt contacts the spacer block.
4. Apply 20 pounds of force to the rim of the steering wheel during this test to be sure that the steering gear control valve is fully closed. *Figure 7.5.* The pressure gauge should now read pump relief pressure, as noted during the Flow Control Response Test (Test #6). You can now read steering gear internal leakage on the flow meter.
5. Repeat this test for the opposite direction of turn.
6. If internal leakage is greater than 1 gpm (3.8 lpm) and there is no auxiliary hydraulic linear or rotary cylinder in the system, repair or replace the gear. If the internal leakage is greater than 2 gpm (7.6 lpm), and there is an auxiliary hydraulic linear or rotary cylinder in the system, controlled by the gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic

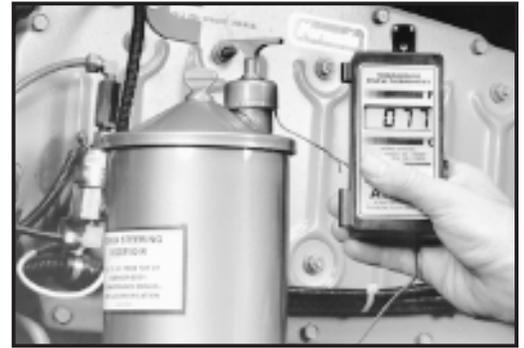


Figure 7.1

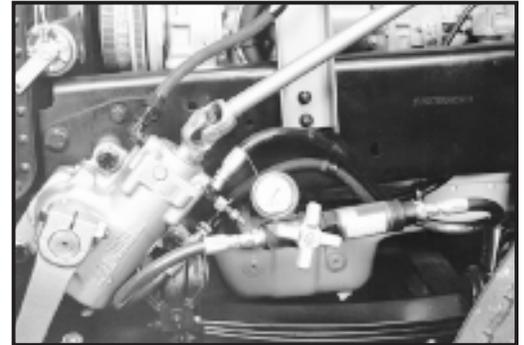


Figure 7.2



Figure 7.3

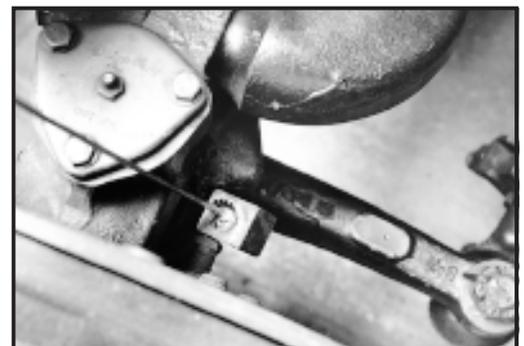


Figure 7.4



Figure 7.5

lines at the gear auxiliary ports. Plug the steering gear ports with suitable steel or high pressure plugs or caps.

In the event that a rotary cylinder is used in the system, connect the disconnected lines together with a suitable union fitting. In the case of a linear cylinder, first plug the disconnected lines and then disconnect the cylinder from the steering linkage, making sure it will clear the steered axle. *Figures 7.6-7.7.*

Repeat the internal leakage test. If the internal leakage is less than 1 gpm (3.8 lpm), repair or replace the auxiliary cylinder. If the internal leakage is greater than 1 gpm (3.8 lpm), repair or replace the gear.

<b>NOTE</b>	When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.
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### Test #8 Steering Column Binding

1. With the vehicle parked, the engine off, and the steer axle jacked up, slowly steer the vehicle until the binding position is located.
2. With the steering gear at this position, remove the steering column assembly from the steering gear. Note the correct position of the column and steering gear for reassembly after test. *Figure 8.1*
3. Rotate the steering gear input shaft no more than 1/4 turn each direction and check if binding is still present. *Figure 8.2* If binding is not felt, correct the steering column problem.

### Test #9 Air in Hydraulic System

1. Inspect reservoir for foaming or air bubbles. *Figure 9.1* If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings. Look for oil level changes engine off versus engine on, if fluid level increases when the vehicle is shut off, there is an air pocket trapped in the steering gear. The increase may not be noticeable, depending on the size of the pocket.
2. Bleed the steering gear (if there is a manual bleed screw at the top of the gear). With system at normal operating temperature and engine at proper idle speed and running, open the bleed screw and wait until clean, clear oil begins to flow from the gear. Close the bleed screw and steer the vehicle completely from stop to stop.
3. Repeat the bleeding operation three times, and recheck oil level in reservoir to make sure there is enough oil for the system to operate properly.



Figure 7.6

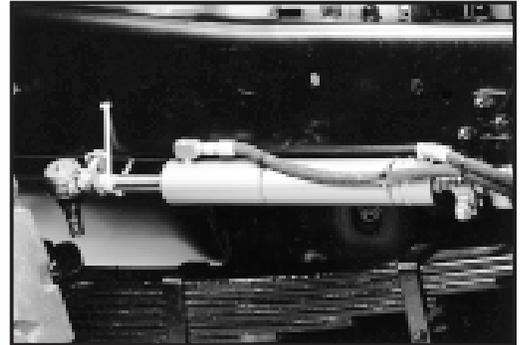


Figure 7.7

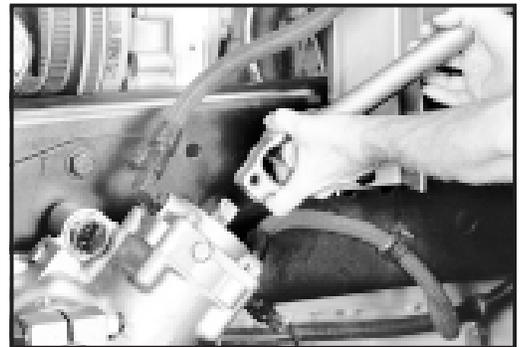


Figure 8.1

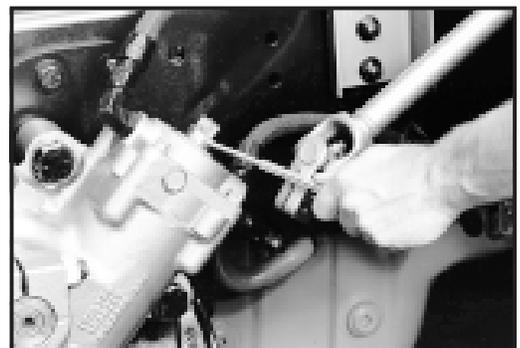


Figure 8.2



Figure 9.1

## Test #10 Restricted Hydraulic Line

Read the following instructions below before completing **Table 10**, in the "Test Results" section

1. Look at the supply line that goes to the pump to check for kinking or any other obstructions or irregularities on the inside of the hose. *Figure 10.1.*
2. Install PSSA with load valve fully open. *Figures 10.2-10.3.* Insert temperature gauge into reservoir. With oil between 125-135 °F (52-57 °C), determine a test engine speed (RPM) that causes pump to deliver 3, 4, 5 or 6 gpm (11, 15, 19, or 23 lpm) (whichever is easier) and note this speed.
3. Remove the PSSA and install a low pressure gauge (200-300 psi (14-21 bar)) maximum with approximately 10 psi (.70 bar) per division) in the pressure line to the steering gear at the pump end. Install a temperature gauge in the power steering reservoir.

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

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

4. Bring the power steering fluid temperature to 125-135 °F (52-57 °C), at engine idle, with no steering force applied to the steering wheel. *Figure 10.4.*
5. At the test engine speed selected from step 2 above, measure and record the gauge reading and shut off the engine. This measures total system pressure.
6. Remove the pressure and return lines from the steering gear and connect them together with a fitting that will not restrict the flow. *Figure 10.5.*
7. Start the engine, and run at the RPM identified in step 2 with the fluid temperature between 125-135 °F (52-57 °C).
8. Measure and record gauge reading and shut off engine. This is hydraulic line/reservoir pressure.
9. The difference between the total system pressure gauge reading and the hydraulic line/reservoir pressure gauge reading is the steering gear pressure drop. For a TRW steering gear, at a flow of 3, 4, 5 or 6 gpm (11, 15, 19, or 23 lpm), the drop should not be greater than 30, 40, 55 or 70 psi (2.0, 2.8, 3.8, 4.8 bar) respectively. The line/reservoir pressure drop for a flow of 3, 4, 5 or 6 gpm (11, 15, 19, or 23 lpm) should not be greater than 20, 20, 25 or 25 psi (1.4, 1.4, 1.7, 1.7 bar) respectively.

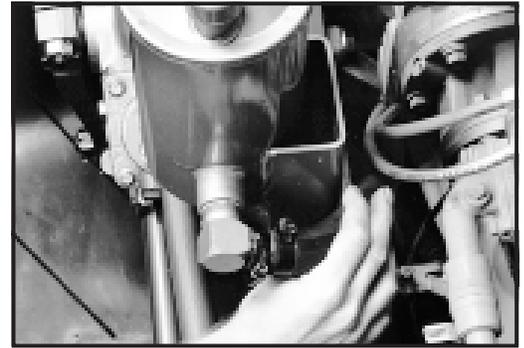


Figure 10.1

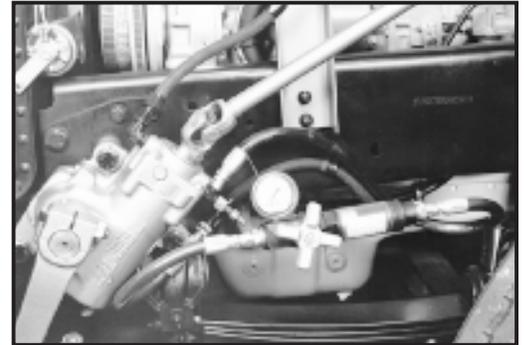


Figure 10.2

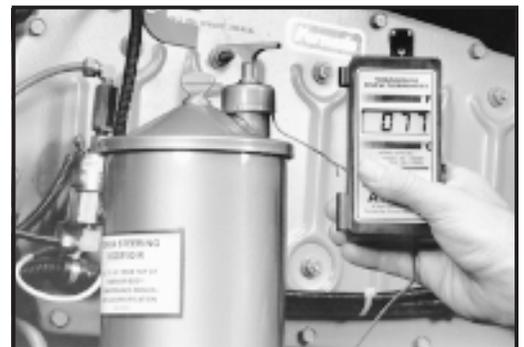


Figure 10.3



Figure 10.4

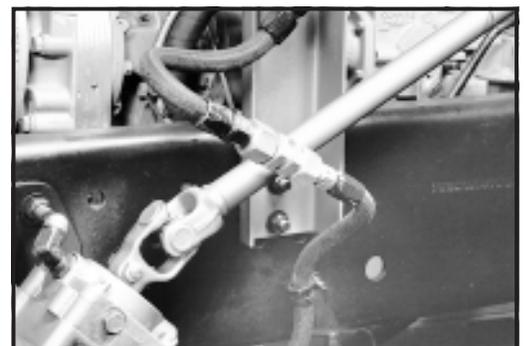


Figure 10.5

**Test #11**  
**Axle Stop Setting**

Put vehicle steer tires on radius plates (turntables). Check to make sure axle stops are set to manufacturer's specifications. *Figure 11.1.*



Figure 11.1

**Test #12**  
**Pitman Arm and Output Shaft Alignment**

Look to make sure the output shaft timing mark is lined up with the pitman arm timing mark. Some pitman arms have more than one mark, so make sure the right one is used. *Figure 12.1.*



Figure 12.1

**Test #13**  
**Misadjusted Drag Link**

The length of the drag link must be correct for the steering system. Check the length after you make sure the pitman arm/ shaft timing marks are aligned, the gear is at its center position, and the road wheels are straight ahead. *Figure 13.1.*

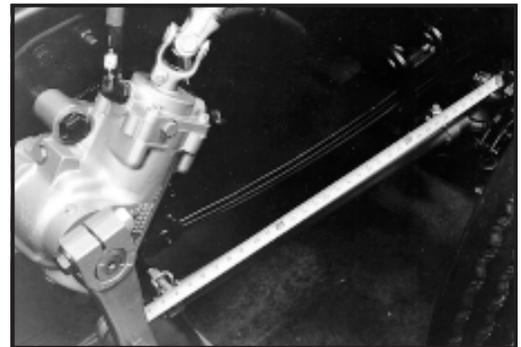


Figure 13.1

**Test #14**  
**Poppet Setting Procedure**

1. If you are working on a newly-installed TAS steering gear, refer to the service manual to correctly set the poppets. If you are working on a steering gear, other than a TAS series, refer to the OEM's service manual for correct poppet setting instructions.
2. To set poppets on a TAS series gear using the adjustable service kit, refer to your steering gear service manual.

## Test #15 Lash in Steering System

Two people are needed for this test. One person will slowly turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels: *Figures 15.1-15.5.*

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

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

**NOTE** Be sure to check rear drive axles for any looseness and inspect tires for signs of abnormal wear.

## Test #16 Steering Gear Adjustment

Check and adjust according to the appropriate service manual for your steering gear if necessary

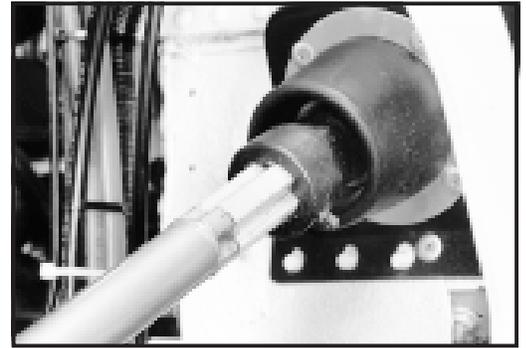


Figure 15.1

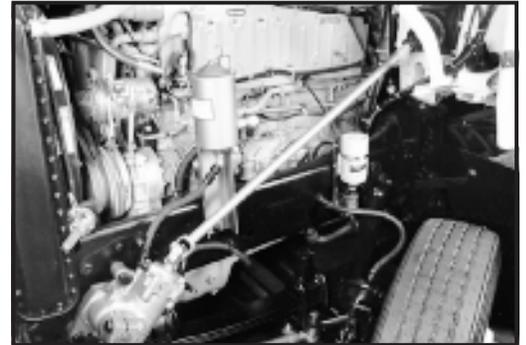


Figure 15.2



Figure 15.3

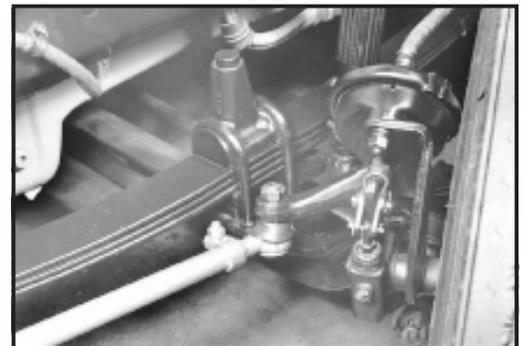


Figure 15.4



Figure 15.5

### Test #17

#### U-Joint Phasing and Lubrication

1. Make sure u-joints are properly lubricated.
2. Steering column assemblies with more than one universal joint (cardan type) can cause a cyclic binding feel or torque variation at the steering wheel if the u-joints are not in phase with each other. *Figure 17.1-17.2.* If a steering column assembly with multiple u-joints is taken apart, it must be reinstalled with the timing marks for slip mechanisms aligned. This is true for both the cross-type and the splined-type two-piece intermediate shaft.



Figure 17.1

### Test #18

#### Steering Column Interference

Position steering wheel at the location where steering wheel interference is noticed, and look for something interfering or rubbing on the rotating column assembly such as brackets, bolts, floorboard, boot, etc.

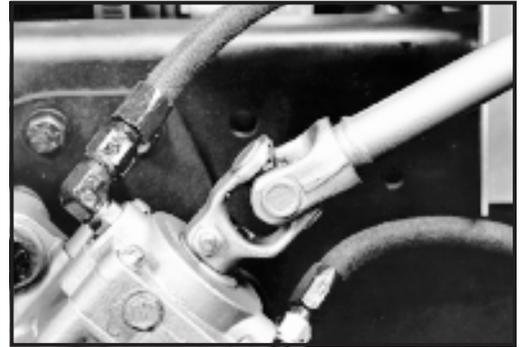


Figure 17.2

### Test #19

#### Intermediate Column Interference

1. Check the slip column by looking to make sure there is proper travel allowance when in use. *Figure 19.1.*
2. Look for wear or galling. *Figure 19.2.*
3. Check slip column for too much slip force

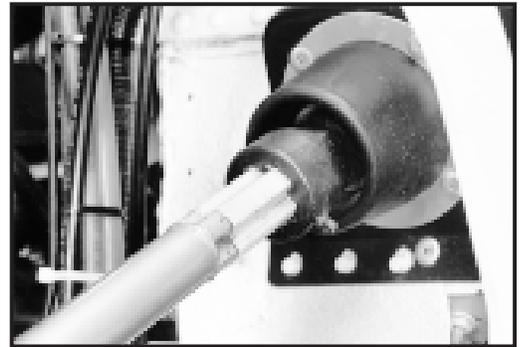


Figure 19.1



Figure 19.2

**Test #20**  
**Miter Box Misadjusted (if equipped)**

Check and adjust per manufacturer's instructions. *Figure 20.1.*



Figure 20.1

**Test #21**  
**Vehicle Alignment**

Check alignment of steered axle and rear drive axles, and trailer axles (if problem only exists with trailer). *Figure 21.1.*

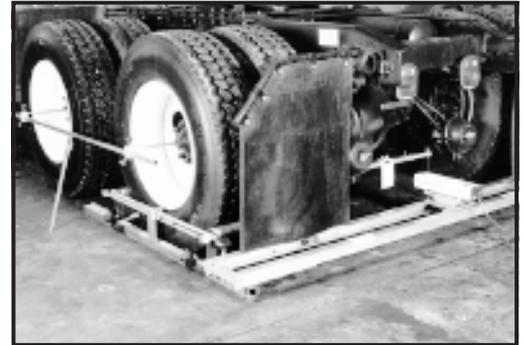


Figure 21.1

**Test #22**  
**Wheel Bearing Adjustment**

Verify that adjustment is made according to manufacturer's specification. *Figure 22.1.*

**Test #23**  
**Air Suspension Adjustment**

Check and set to manufacturer's specifications

**Test #24**  
**Gear Imbalance**

1. Install a low pressure gauge (200-300 psi (14-21 bar) maximum with approximately 10 psi (.70 bar) per division) in the pressure line from pump to gear. *Figure 24.1.*

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

2. At engine idle, slightly turn the steering wheel one direction until a pressure rise is observed at the gauge. *Figure 24.2.*
3. Stop steering and gently allow the steering wheel to recenter.
4. Next slightly turn the steering wheel the opposite direction while observing the gauge and determine if pressure initially rises or falls with initiation of a turn.
5. Repeat test a few times in each direction.
6. If a consistent fall in pressure is associated with the initiation of a turn in one direction, the steering gear's control valve is unbalanced and needs to be replaced.



Figure 22.1

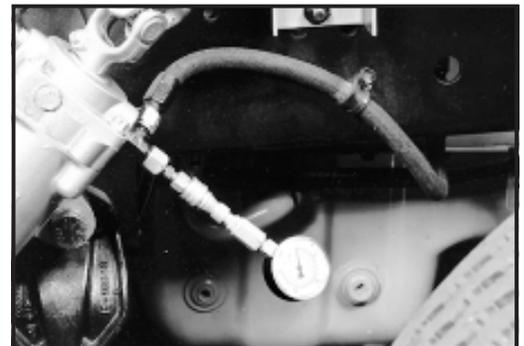


Figure 24.1

**Test #25**  
**Unequal Brake Force**

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



Figure 24.2

**Test #26****Tire Balance / Runout**

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

**TEST #27****Steering Column Noise**

If column does not include a clockspring, remove steering wheel and add dielectric grease to the horn contact. The grease TRW uses is Model No. K-5/X Semifluid CA, product code 134613, from Century Lubricants. If noise continues, check steering wheel and shroud (not applicable to columns with clockspring).

**TEST #28****Steering Column Bearing**

Check upper bearing gaskets. Gaskets should cover bearing.

**TEST #29****Intermediate Column Lash**

Check intermediate column (I-Shaft) for torsional lash in U-Joints of slip section. Replace intermediate column if necessary.

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**Section 4**

**Comments**

Comment A - H ..... 36  
Comment I - K ..... 37

**Comment A**

Some power steering pumps have a temporary state during which the pumping element vanes do not extend. Usually increasing engine speed briefly will correct the problem.

**Comment B**

The maximum speed of steer with power assist for a power steering gear is limited by the pump flow and internal leakage. Example: Recommended minimum flow for a new TAS65 steering gear is 3.0 gpm (11.4 lpm), and is based on a maximum steering speed capability of 1.5 steering wheel turns per second.

**Comment C**

Vehicle linkages are designed to minimize the affect at the steering gear and steering wheel during normal steered axle/suspension movements. Be sure that linkage used is as specified by vehicle manufacturer.

**Comment D**

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

**Comment E**

Deflections in the suspension and linkage, front and rear, due to high engine generated torque levels can cause a steering effect. This most often occurs at lower vehicle speeds while accelerating.

**Comment F**

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

**Comment G**

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

**Comment H**

Power steering pump cavitation

Pump cavitation is defined as a "wining" or noisy power steering pump. Usually, pump cavitation is most noticed during engine start-up at low temperature extremes. However, other conditions can cause the power steering pump to continually cavitate and cause internal pump damage, and ultimately, failure. These conditions are:

1. Twisted, loose, or cracked inlet line
2. Inlet line blockage due to:
  - a. Contamination - dirt and foreign material
  - b. Damaged filters
  - c. Reservoir components
  - d. Inner hose liner separation
3. Displaced (improper or improperly installed) filters
4. Reservoir cap "vent" plugged

**Comment I**

## Excessive Flow

TRW steering gears are rated for 8 gpm maximum power steering pump flow. Although the gears have the capability to handle this maximum flow, it is not always a system need or requirement. When using combinations of dual gears or a single gear with a hydraulic linear cylinder, supply flows for both components should be considered (See Steering Gear Flow Requirements). Single gear applications have a recommended flow at engine idle. For acceptable steering speed performance, again, refer to the Steering Gear Flow Requirements. Increasing the engine idle flow by more than 50% of the recommended flow can cause power steering system overheating, vehicle directional control problems (Darting), and steer axle returnability (Non-recovery). If you measure idle flows above the 50% limit, consult your OEM for guidance and recommendations.

**Comment J**

## Flushing and Air Bleeding the System

**IMPORTANT:** Clean the area around the reservoir, steering gear and pump thoroughly before beginning this procedure.

1. Set parking brake on vehicle and block rear wheels.
2. Raise the front end off the ground
3. Take vehicle out of gear and put into neutral position
4. Raise hood and place a drip pan under the steering gear
5. Remove both the pressure and return lines from the steering gear
6. Remove filter from the power steering fluid reservoir and discard

**IMPORTANT:** Discard only the filter, other components may be required to hold filter element in place inside the reservoir.

7. Clean the inside of the reservoir
8. Turn steering wheel from full left to full right 3-4 times. This will purge the oil from the steering gear.
9. Reconnect pressure and return lines to the steering gear and tighten
10. Install new filter element into the reservoir
11. Clean reservoir filler cap with an approved solvent. Inspect gasket and replace if necessary.
12. Fill reservoir with approved replacement fluid and reinstall the filler cap
13. Start engine for 10 seconds, stop, and check reservoir fluid level and top off if necessary. You may need to repeat this procedure 3 or 4 times.
14. Upon completion of filling the reservoir, start the engine and let it idle. At engine idle, steer full right and full left once and return to straight ahead. Stop engine and check power steering reservoir level and top off if required.
15. Restart engine and steer full turns each direction 3 or 4 times.
16. Stop engine and recheck reservoir fluid level and adjust to correct level, if needed.
17. Inspect system for leaks and correct if necessary
18. Bleed air from the system if required (Refer to your steering gear service manual for recommended air bleeding procedures.)
19. Remove drip pan and lower vehicle. Remove blocks from wheels and release vehicle for normal service.

**Comment K**

## Identifying "Burnt Oil"

Sometimes the power steering reservoir oil supply will become hotter than the normal operating temperature and overheat. This condition may result in an intermittent loss of power assist and also cause deterioration of the power steering hoses and component seals. TRW recommends that the power steering hoses be examined for deterioration due to overheated oil, which can be identified by wet hoses, and determine the condition of the reservoir fluid by looking for signs of "burnt oil."

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**Section 5      Test Results**

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Test 6 - Flow Control Response Test ..... 41

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## Test 5.0 - Power Steering Pump Test

Relief Pressure: \_\_\_\_\_ PSI/BAR

Engine(RPM)	No Load	1000PSI
Idle		
1500		

**Table 5.0**

## Test 5.1 - 40 Minute Power Steering Pump Test

Ambient	
Start	
10 Minutes	
20 Minutes	
30 Minutes	
40 Minutes	
Unit of Measure	°F or °C

Relief Pressure: \_\_\_\_\_ PSI/BAR

Engine(RPM)	No Load	1000PSI
Idle		
1500		

**Table 5.1**

## Test 6.0 - Pump Flow Control Response Test

Unit of Measure	PSI or BAR
Pump Relief #1 (Idle)	
Pump Relief #2 (Idle)	
Pump Relief #3 (Idle)	

Unit of Measure	PSI or BAR
Pump Relief #1 (1500 RPM)	
Pump Relief #2 (1500 RPM)	
Pump Relief #3 (1500 RPM)	

Table 6.0

## Test 6.1 - 40 Minute Pump Flow Control Response Test

Ambient	
Start	
10 Minutes	
20 Minutes	
30 Minutes	
40 Minutes	
Unit of Measure	°F or °C

Unit of Measure	PSI or BAR
Pump Relief #1 (Idle)	
Pump Relief #2 (Idle)	
Pump Relief #3 (Idle)	

Unit of Measure	PSI or BAR
Pump Relief #1 (1500 RPM)	
Pump Relief #2 (1500 RPM)	
Pump Relief #3 (1500 RPM)	

Table 6.1

## Test 10.0 - Restricted Hydraulic Line Test

With PSSA @ 125 - 135 F (52 - 57 C)	RPM	GPM or LPM
With pressure gauge at pressure line to steering gear at pump end	RPM	GPM or LPM
Remove pressure and return lines and measure pressure with gauge at pump outlet	RPM	PSI or BAR

**Table 10.0**

# Steering Gear Flow Requirements

## Single Gear

Gear	GPM	LPM
TAS40, THP/PCF45, HFB52	2.2	8.3
TAS55, THP/PCF60	2.6	9.8
TAS65 or HFB64	3.0	11.4
TAS85 or HFB70	3.6	13.6
RCS40	2.2	8.3
RCS55	2.6	9.8
RCS65	3.0	11.4
RCS85	3.6	13.6

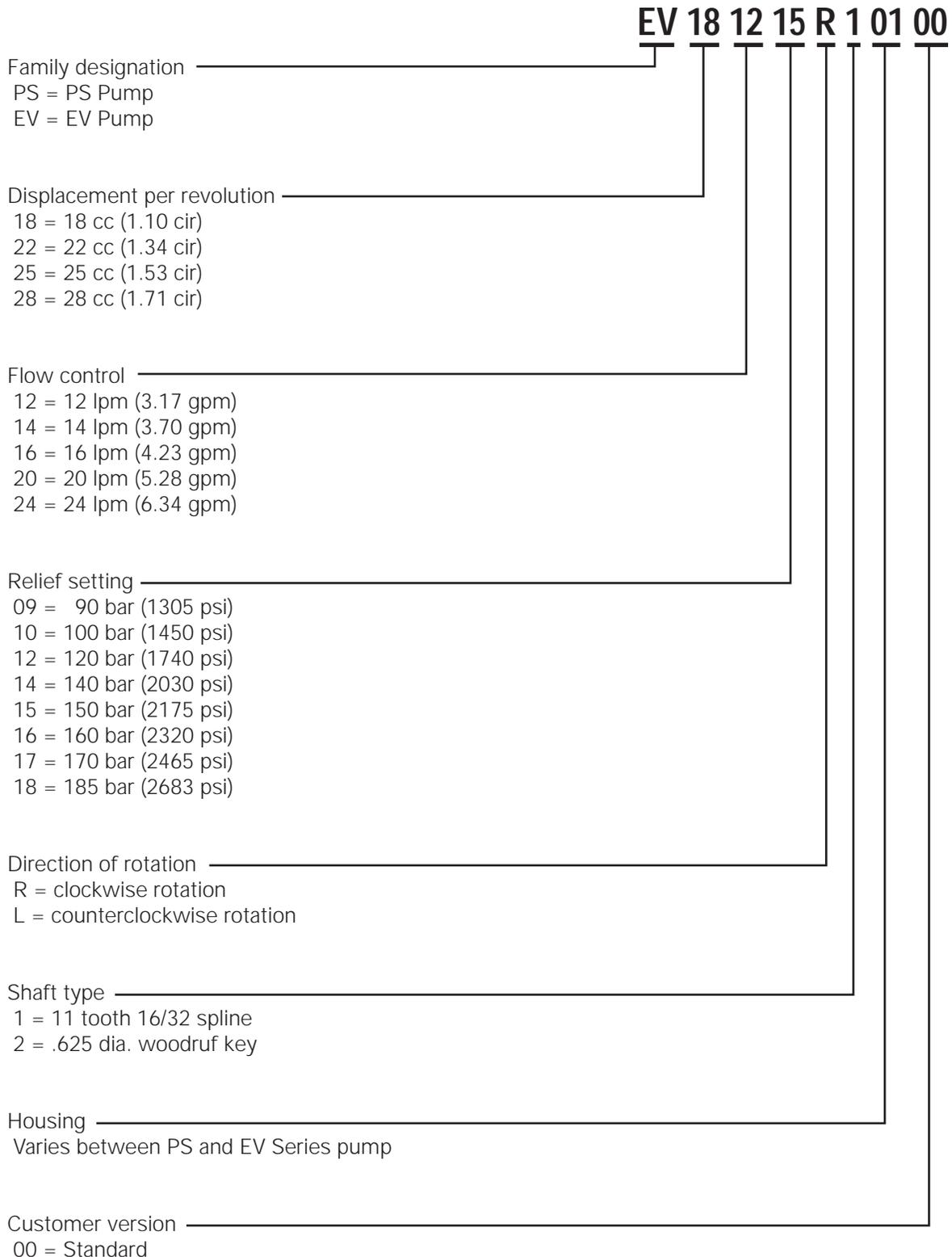
## Dual Gear

Gear	GPM	LPM
TAS65 w/ RCS65	6.0	22.7
TAS65 w/ Linear Cylinder	6.5	24.6
TAS85 w/ RCS85	7.0	26.5
TAS85 w/ RCS65	6.5	24.6
TAS85 w/ Linear Cylinder	6.5	24.6
HFB70 w/ RCB70	7.0	26.5
HFB70 w/ RCB64	6.5	24.6
HFB70 w/ Linear Cylinder	6.5	24.6

# Pump Part Number Reference Guide

Check the part number on your TRW power steering pump and note the pump relief setting shown in the example below. (See illustration on where to find the pump part number). If the values that you have recorded are within +/- 100 psi (+/- 7 bar) your pump is functioning properly. If the values recorded are below the negative tolerance, your pump is malfunctioning and should be replaced.

For TRW power steering pumps, the relief setting will be the 5th and 6th numbers in the pump part number.







**TRW Automotive**  
Commercial Steering Systems  
800 Heath Street  
Lafayette, IN 47904  
Tel 765.423.5377  
Fax 765.429.1868  
<http://www.trucksteering.com>  
<http://trucksteering.trw.com>