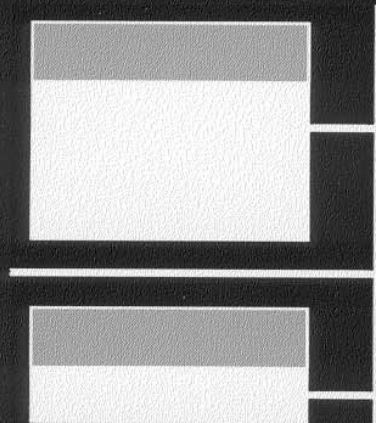
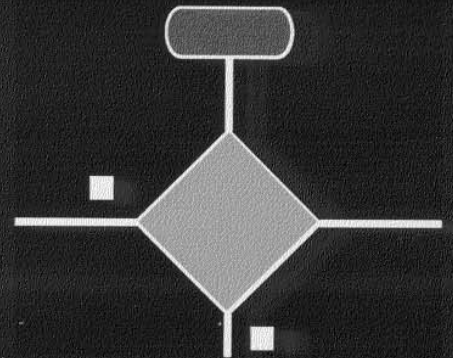
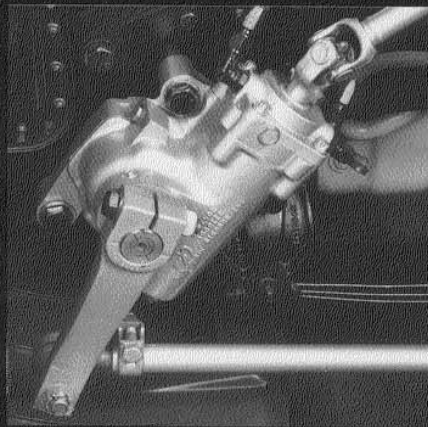


TRW Automotive
Steering & Suspension Systems



Chart Your Way to Easy Steering



Steering System Troubleshooting Guide



Chart Your Way to Easy Steering

Steering System Troubleshooting Guide

Notice

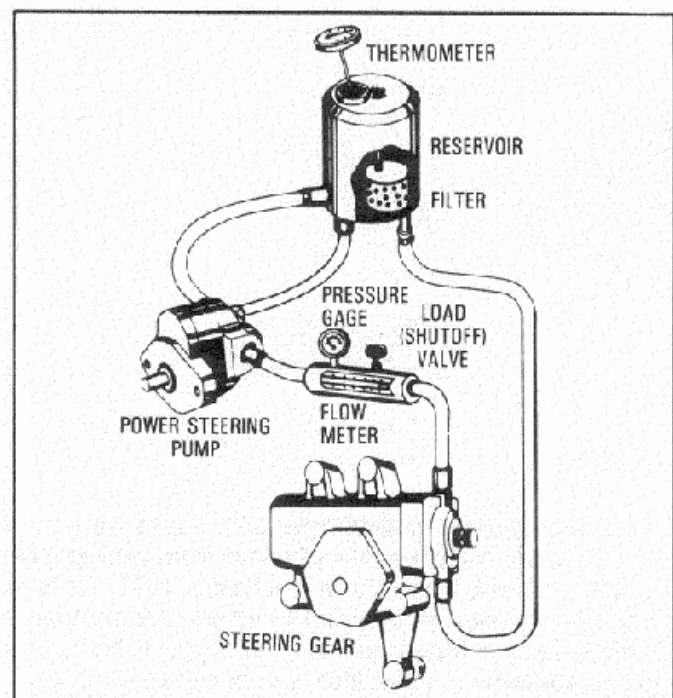
This guide and the accompanying videotapes were prepared for the purpose of providing general advice concerning the diagnosis and correction of commercial vehicle steering related problems. These materials are intended for use by properly trained, professional mechanics, NOT "Do-it-Yourselfers". These materials should be used in conjunction with service manuals provided by 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.

Definitions

- NOTE:** A NOTE gives key information to make a procedure easier or quicker to follow.
- CAUTION:** A CAUTION refers to those procedures that must be followed to avoid damage to a steering component or the gear.
- WARNING:** A WARNING REFERS TO THOSE PROCEDURES THAT MUST BE FOLLOWED FOR THE SAFETY OF THE DRIVER AND THE PERSON INSPECTING OR REPAIRING THE GEAR.

PSSA - (Power Steering System Analyzer)

Some of the tests in this manual require the use of a **Power Steering System Analyzer**. A Power Steering System Analyzer is a combination of a flow meter, shut off valve, and pressure gage. This tool will allow you to measure flow and pressure, and provide a load on the pump in the hydraulic lines of the steering system. This tool is required to correctly analyze a steering system, and TRW recommends that you **DON'T BEGIN TROUBLESHOOTING A STEERING SYSTEM WITHOUT A PSSA**.



WARNING: THROUGHOUT THIS TROUBLESHOOTING GUIDE, TEST PROCEDURES ARE RECOMMENDED TO HELP LOCATE THE CAUSE OF EACH COMPLAINT. WHILE PERFORMING THESE TESTS, TRW ADVISES THAT YOU TAKE NECESSARY PRECAUTIONS WHEN WORKING WITH INTERNAL VEHICLE COMPONENTS, AND HOT HYDRAULIC FLUID.

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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 vehicle is not like it should be, it is up to you to decide if there is a problem, and if so, figure out what is causing it. It is always easier to fix something if you really understand the complaint. Some ways you 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 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 a section for each of the 10 most common driver complaints. Once you have a good understanding of what the complaint is, choose the section of the book that best matches the problem. Because there are different ways to say the same thing, our definitions of the 10 complaints used in this book are on pages 3 and 4, and also in the glossary at the end of the manual.

Flow Charts

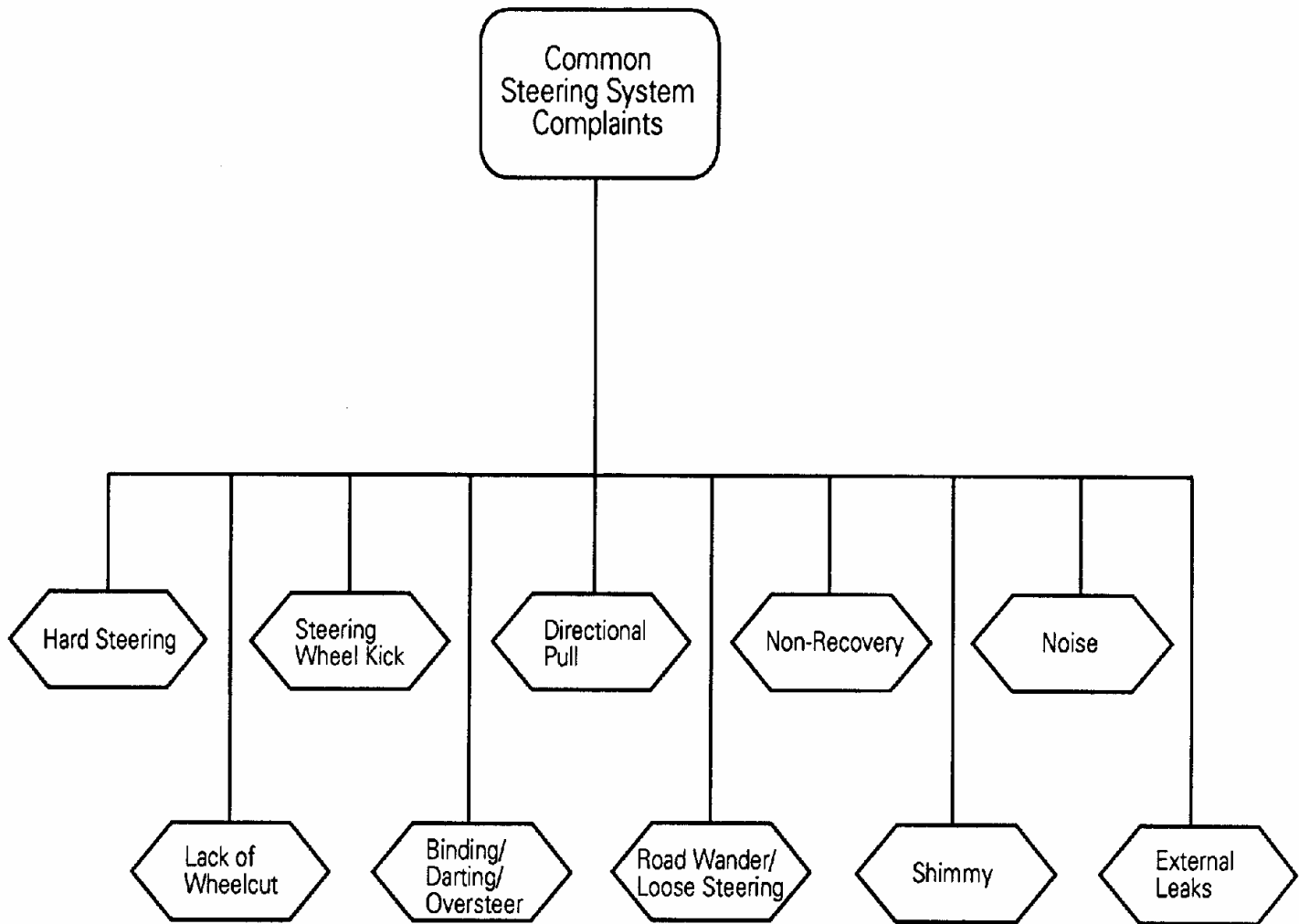
Flow charts are a quick and easy way to find the cause of a steering system problem. There is a flow chart for each of the 10 most common driver complaints at the beginning of each section.

Start the flow charts at the **BEGIN** box. If there is a **QUESTION** next, answer it either YES or NO, and follow the arrows to the next step. When you get to a **CAUSE/TEST** box (or string of boxes) you will begin testing the truck to confirm the cause of the complaint. A string of **CAUSE/TEST** boxes means there are several possible causes; you'll have to do the tests to find out which one is the cause for the vehicle you are working on. These boxes are arranged in order of likelihood of being the cause of the complaint; it is important to do them in order. The test number in the lower part of the **CAUSE/TEST** box will tell you which test to go to in the pages following the flow chart; find the right test number and follow the test procedure. When you're done with that test, go back to the flow chart, and go on to the next step.

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

Warranty

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



Definitions of 10 Most Common Complaints

1. Hard Steering

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

Common phrases used to describe Hard Steering:

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

2. Lack of Wheelcut

Common phrases used to describe Lack of Wheelcut:

- 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 to describe Steering Wheel Kick:

- Kickback
- Backlash
- Bump steer

4. Binding/Darting/Oversteer

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

5. Directional Pull

Common phrases used to describe Directional Pull:

- 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 to describe Road Wander or Loose Steering:

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

7. Non-Recovery

Common phrases used to describe Non-Recovery:

- Wheels don't return to straight ahead

8. Shimmy

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

Common phrases used to describe Shimmy:

- Shake at steering wheel

9. Noise

Common phrases used to describe Noise:

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

10. External Leakage

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

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

Notes

Hard Steering

1

Definition and Common Phrases Used

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

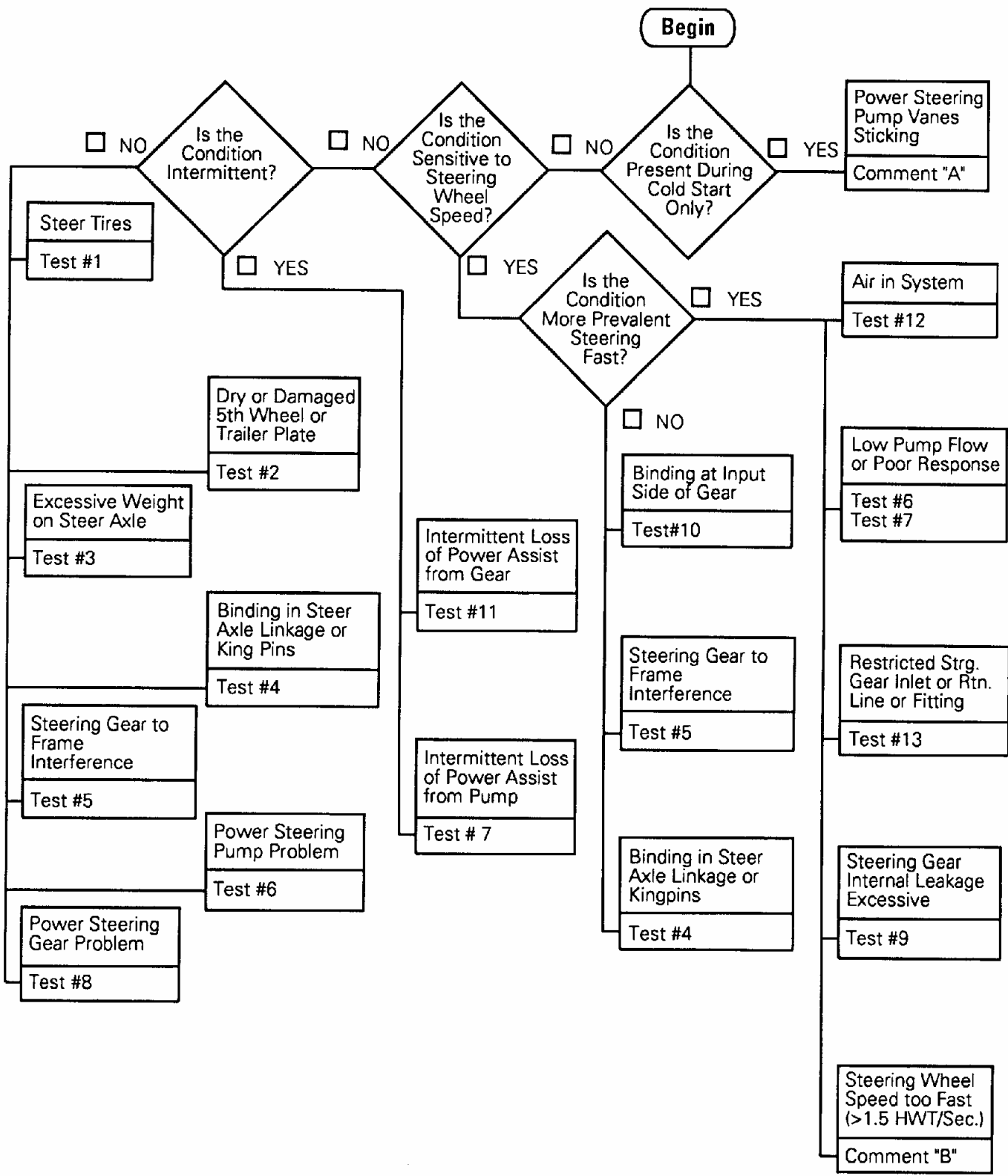
- Won't turn
- Locks-up
- Shuts-down
- Hangs-up
- No assist
- Won't turn unless moving

Explanation of Flow Chart Terms

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

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

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



Hard Steering Tests

Test Procedure

#1 Tire Check

1. Look for:
 - Tire damage. FIGURE 1.1
 - Uneven or extreme tread wear
 - Mismatched tires
2. Check tire pressure.



Figure 1.1



#2 Fifth Wheel and Trailer Plate Check

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

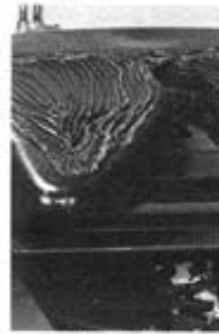


Figure 2.1



#3 Steer Axle Weight Test

1. Have steer axle weighed at load condition which produces complaint and compare to specifications. FIGURE 3.1.



Figure 3.1

#4 Steer Axle and Linkage Binding Test

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 4.1.

CAUTION: Do not steer the gear with linkage removed as mis-adjustment 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 4.2.
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 4.1



Figure 4.2

Hard Steering Tests (Continued)

Test Procedure

#5 Steering Gear Mounting Test

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 5.1. Mounting pads lower than steering gear housing, lack of clearance between frame and steering gear valve housing adaptor, sector shaft adjusting screw and nut mismatched with access adjustment hole in frame.
2. If the steering gear has been mounted to the frame in a way that causes the gear to distort (not be flat), it may cause a steering problem. The use of spacers is alright as long as the gear is mounted securely, and the gear is not distorted when mounting bolts are tightened. FIGURE 5.2. Checking to see if distortion is present on the vehicle may require the following test:
3. With vehicle parked and turned off, steer the wheel slowly checking for a binding-type of feel at the steering wheel. When binding is felt loosen one mounting bolt, and steer the vehicle again. Continue to loosen one mounting bolt at a time and check for improvement in the binding condition. If improvement is made by loosening the bolts, determine by inspection what interference or condition is causing the gear to distort and correct the problem.

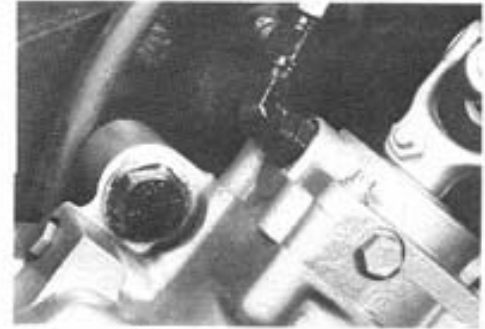


Figure 5.1

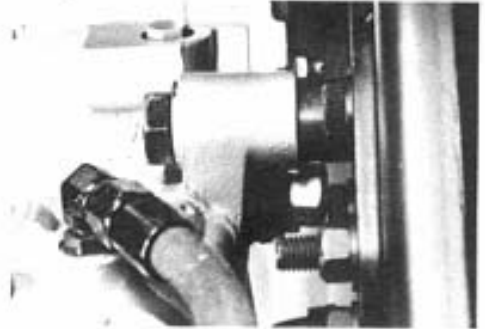


Figure 5.2



Figure 6.1

#6 Power Steering Pump Test

1. Install temperature gage 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°

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

2. Run the engine at idle speed.

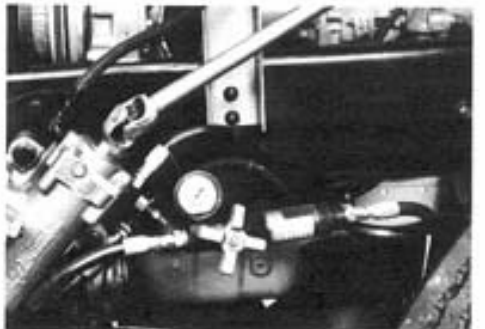


Figure 6.2

Hard Steering Tests (Continued)

Test Procedure

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 2500 psi 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 by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Idle Speed _____ RPM

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

4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed: FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Governed Speed _____ RPM

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

5. Determine the recommended flow range and maximum allowable system pressure for the steering system being used by referring to your service manual.
6. Compare the minimum and maximum flows, and the relief pressure you measured to gear and pump specifications.
7. If the minimum measured pump flow is less than the minimum recommended flow for the steering gear used, the pump may not be putting out enough flow

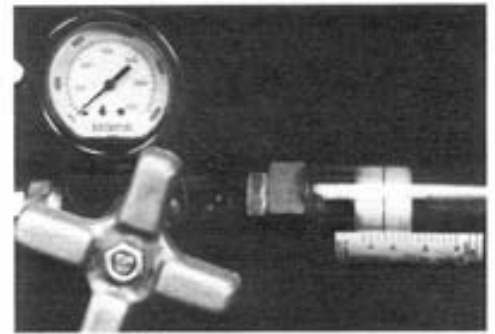


Figure 6.3

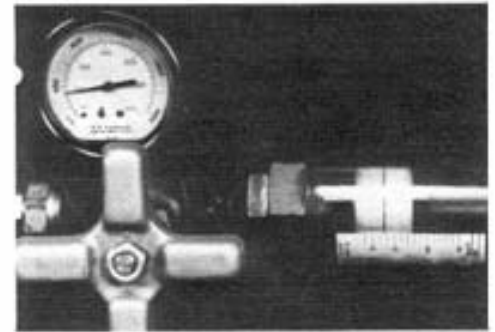


Figure 6.4

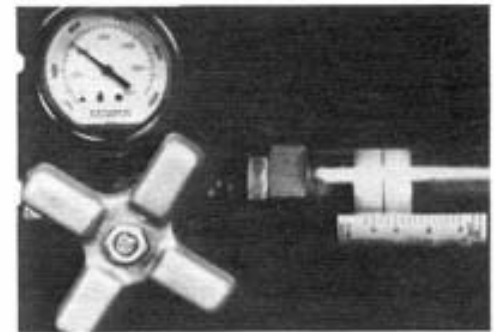


Figure 6.5

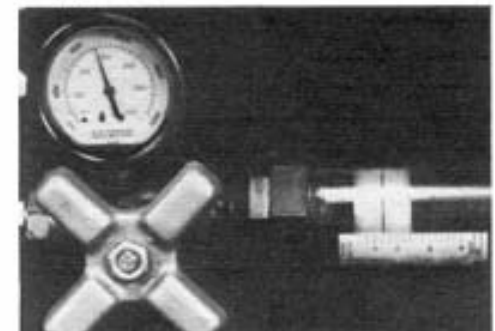


Figure 6.6

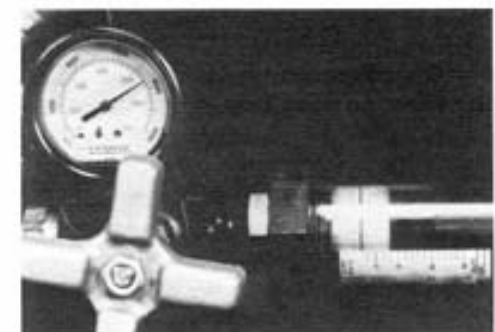


Figure 6.7

Hard Steering Tests (Continued)

Test Procedure

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.



Figure 7.1

#7 Intermittent Loss of Power Assist from Pump Test

1. Install temperature gage in reservoir. FIGURE 7.1. Install PSSA in pressure line with shut-off valve fully open. FIGURE 7.2. 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°

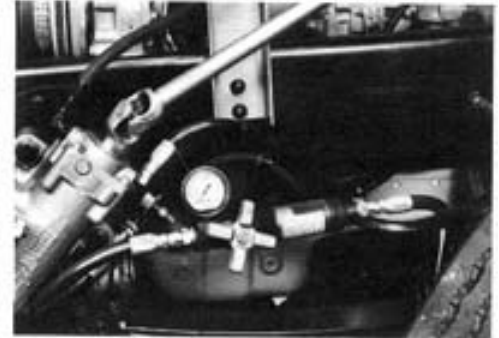


Figure 7.2

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

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

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

Hard Steering Tests (Continued)

Test Procedure

#8 Steering Gear Check

1. Install temperature gage in reservoir. FIGURE 8.1. Install PSSA in pressure line with shut-off valve fully open. FIGURE 8.2. 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°

NOTE: Steering systems that have a pump relief valve and an integral steering gear relief valve typically will have the pump relief valve setting approximately 300 PSI or more above the gear's relief valve setting. Check vehicle manufacturer's specifications for correct relief pressure levels.

2. Try to locate the problem by steering the vehicle while parked. Steer in a slow, smooth motion back and forth between axle stops (you may need to load the vehicle). FIGURE 8.3. Hard Steering means 18-22 pounds of force at the rim of the steering wheel that occurs somewhere between the normal poppet trip points. If the poppets are set correctly, hard steering at the poppet trip points will be normal within approximately 1/3 steering wheel turn from axle stop contact points.
3. When hard steering is noticed, note pressure and flow reading of PSSA. FIGURE 8.4.

If flow is under 1 GPM and pressure is the same as relief pressure measured in the earlier pump test (Test #6) for a gear without a relief valve, or pressure without regard to flow is as specified for a gear with an integral relief valve, the steering gear is performing correctly.

If flow is over 1 GPM and pressure is far below relief pressure measured in the earlier pump test (Test #6) for a gear without a relief valve, or below the correct relief pressure setting for a gear with an integral relief valve, proceed to step 4.

4. If the steering gear has an integral relief valve, proceed to step 5. If the gear does not have an integral relief valve, the steering gear has excessive internal leakage and needs to be repaired or replaced (see step 7).
5. Remove the integral relief valve components (refer to steering gear service manual for procedure) and install a relief valve plug, special tool J37130, in its place.



Figure 8.1

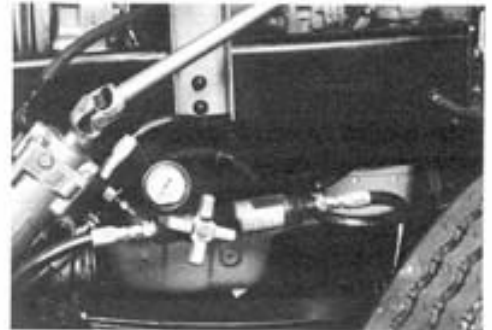


Figure 8.2



Figure 8.3



Figure 8.4

Hard Steering Tests (Continued)

Test Procedure

6. Again steer the vehicle back and forth and determine if hard steering is felt. If so, note pressure and flow reading of the PSSA. FIGURE 8.5.

If hard steering can no longer be produced, the relief valve removed from the gear earlier was not operating properly and should be replaced with one specified for the gear you are working on.

If hard steering is again noticed, with a noted flow of over 1 GPM and pressure level is far below pump relief as measured during the pump test, the relief valve you removed is OK but the steering gear has excessive internal leakage and needs to be repaired or replaced.

7. One possible source of excessive internal leakage in steering gears is shuttling poppets. This is only true of gears with automatic poppets, and only if the service poppet adjusting screw and sealing jam nut kit has been installed in the end opposite the input shaft. This condition can occur if during the installation of the service kit, the installation instructions were not followed carefully, and the adjusting screw was turned into the housing too far. This will cause the interference fit poppet mechanisms to be continually cycled back and forth, thereby losing their interference fit and set positions within the gear as the vehicle is steered lock to lock.

To test for shuttling poppets, determine if the hard steering is always noticed at the same wheel cut position rather than at the same steering pressure. As an example, if hard steering occurs 1-1/2 steering wheel rotations right of straight ahead at a pressure of 600 PSI when you first feel it, try to determine the following:

Begin steering maneuvers from different positions (such as 1/2, 1 and 1-1/2 steering wheel rotations left of straight ahead). From each starting point, turn right until the hard steering occurs. If the hard steering is always found at the same 1-1/2 turns right of straight ahead but at different pressures, it is most likely shuttling poppets. If it occurs at the same pressure level but at different wheel cut positions it is caused by some other internal leak path within the gear. If there is a poppet shuttling problem, the steering gear needs to be replaced or rebuilt with new automatic poppet components.

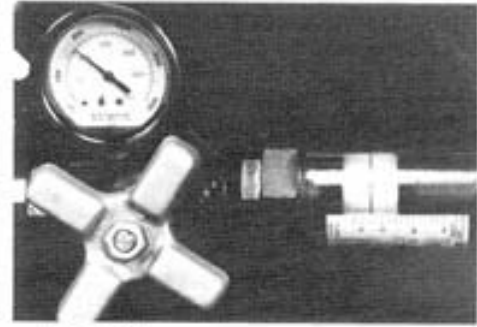


Figure 8.5

Hard Steering Tests (Continued)

Test Procedure

#9 Measured Internal Leakage Test

1. Install temperature gage in reservoir. FIGURE 9.1. Install FSSA in pressure line with shut-off valve fully open. FIGURE 9.2.

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 (FIGURE 9.3), between the axle stop at one wheel. FIGURE 9.4. To prevent operation of the relief valve, remove the relief valve cap, o-ring and two piece relief valve, if equipped, from valve housing. Discard the o-ring. Install the relief valve plug, special tool 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 and 135°, turn the steering wheel until the axle stops bottom on 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 9.5. The pressure gage should now read pump relief pressure, as noted during the pump pressure test (Test #6). You can now read steering gear internal leakage on the flow meter.
5. Repeat this test for the opposite direction of turn

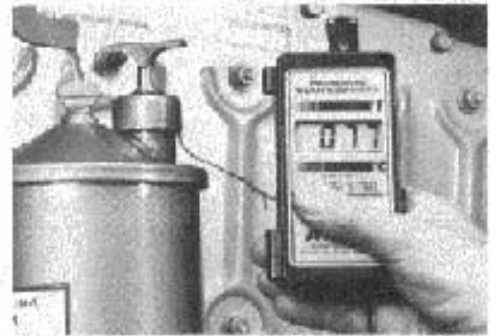


Figure 9.1

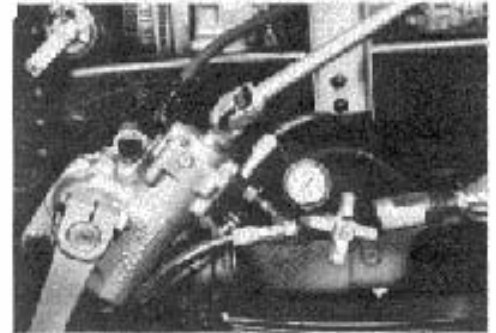


Figure 9.2



Figure 9.3



Figure 9.4



Figure 9.5

Hard Steering Tests (Continued)

Test Procedure

6. If internal leakage is greater than 1.0 gpm and there is no auxiliary hydraulic cylinder in the system, repair or replace the gear. If the internal leakage is greater than 2 gpm, and there is an auxiliary hydraulic cylinder in the system, controlled by the TAS gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic lines at the TAS unit's auxiliary ports. Plug those ports with suitable pressure plugs or caps. Connect the disconnected lines together if a rotary auxiliary cylinder is in the system. Plug the disconnected lines if a linear auxiliary cylinder is in the system. FIGURE 9.6. Disconnect the linear cylinder from the steering linkage making sure it will clear the steered axle. FIGURE 9.7. Repeat the internal leakage test. If the internal leakage is less than 1.0 gpm, repair or replace the auxiliary cylinder. If the internal leakage is greater than 1.0 gpm, repair or replace the TAS gear.

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

#10 Steering Column Binding Test

1. With the vehicle parked, the engine off, and the steer axle jacked-up, slowly steer the vehicle until the binding position is located.
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 10.1.
3. Rotate the steering gear input shaft no more than 1/4 turn each direction and check if binding is still present. FIGURE 10.2. If binding is not felt, correct the steering column problem.

#11 Intermittent Loss of Power Assist from Gear Test

1. Install temperature gage in reservoir. FIGURE 11.1. Install PSSA in pressure line with shut-off valve fully open. FIGURE 11.2. 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°.

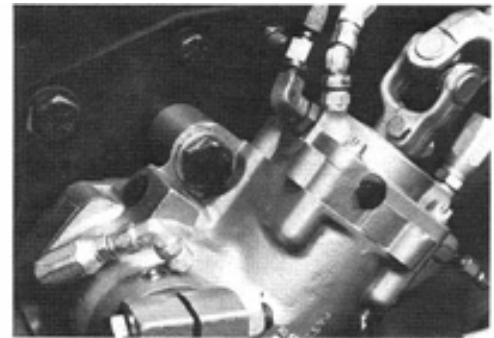


Figure 9.6

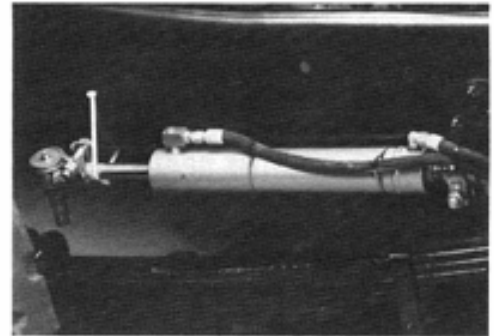


Figure 9.7



Figure 10.1

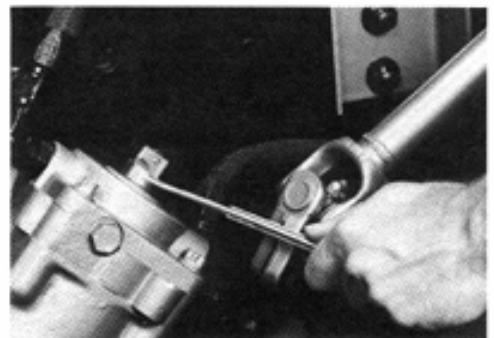


Figure 10.2



Figure 11.1

Hard Steering Tests (Continued)

Test Procedure

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

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

NOTE: TRW Commercial Steering Division does not recommend or support the utilization of winter fronts or other methods of restricting the radiator air flow. If vehicle is equipped with winter front or other method of restricting the cooling system air flow, it may be necessary to conduct the 40 minute temperature test (Test #6, step 1) with and without the cooling system restricted to determine worst case temperature.

3. Let the engine idle and then begin steering the vehicle while parked. Steer smoothly from stop to stop with the palm of your hand back and forth several times between the normal poppet trip points to allow the intermittent hard steering to occur. FIGURE 11.3. If hard steering occurs, write down the pressure level and flow rate at the time of the hard steering. FIGURE 11.4. If the flow is above 1 GPM and pressure is far below the normal steering pressure level at the time of hard steering, repair or replacement of the steering gear will be necessary. If the flow is not above 1 GPM, perform Test #6.

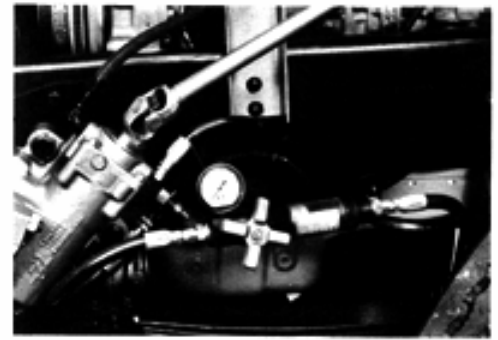


Figure 11.2



Figure 11.3

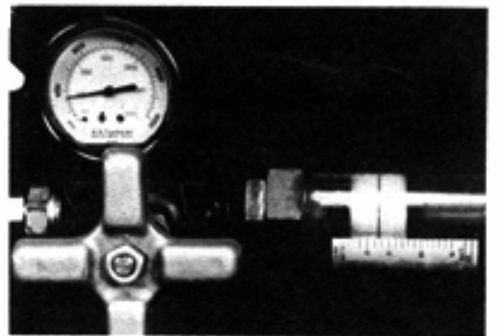


Figure 11.4



Figure 12.1

#12 Air in Hydraulic System Check

1. Inspect reservoir for foaming or air bubbles. FIGURE 12.1. If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings on the inlet side of the pump. Look for oil level changes engine off versus engine on. If fluid level increases when the vehicle is shut off, there is an air pocket trapped in the steering gear. The increase may not be noticeable, depending on the size of the pocket.

Hard Steering Tests (Continued)

Test Procedure

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 13.1



Figure 13.2

#13 Restricted Hydraulic Line Check

1. Look at the suction line that goes to the pump (if there is one) to check for kinking or any other obstructions or irregularities on the inside of the hose. FIGURE 13.1.
2. With the PSSA and temperature gage installed (FIGURES 13.2 - 13.3), load valve fully open, and oil at 125 to 135 °, determine a test engine speed (RPM) that causes pump to deliver 3, 4, 5 or 6 GPM (whichever is easier) and note this speed.
3. Remove the PSSA and install a low pressure gage (200-300 PSI maximum with approximately 10 PSI per division) in the pressure line to the steering gear at the pump end. FIGURE 13.4. Install a temperature gage in the power steering reservoir.

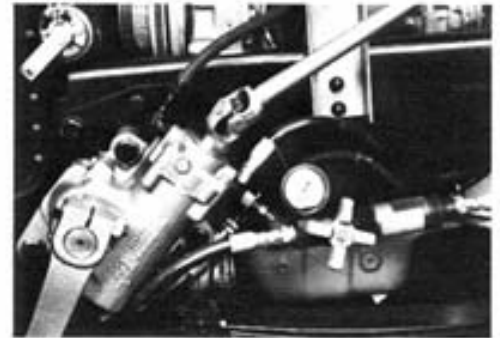


Figure 13.3

CAUTION: Do not allow system pressure to exceed the rating of the gage during the following procedure or damage to the gage will result. Extremely high restrictions may be indicated with the PSSA gage 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.

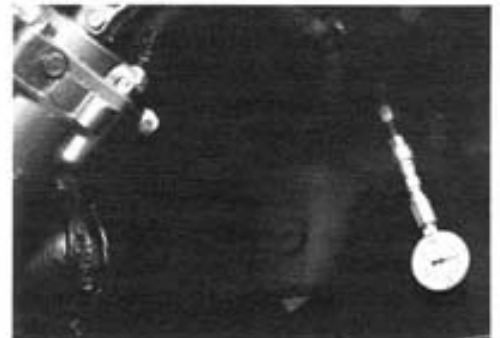


Figure 13.4

4. Bring the power steering fluid temperature to 125 - 135 ° at engine idle, with no steering force applied to the steering wheel. FIGURE 13.5.
5. At the test engine speed selected from step 2 above, measure and record the gage reading and shut off the engine. This measures total system pressure



Figure 13.5

Hard Steering Tests (Continued)

Test Procedure

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 13.6.
7. Start the engine, and run at the RPM identified in step 2 with the fluid temperature between 125-135 °.
8. Measure and record gage reading and shut off engine. This is hydraulic line/reservoir pressure.
9. The difference between the total system pressure gage reading and the hydraulic line/reservoir pressure gage reading is the steering gear pressure drop. For a TAS65 steering gear, at a flow of 3, 4, 5 or 6 GPM, the drop should not be greater than 30, 40, 55 or 70 PSI respectively. The line/reservoir pressure drop for a flow of 3, 4, 5 or 6 GPM should not be greater than 20, 20, 25 or 25 PSI respectively.

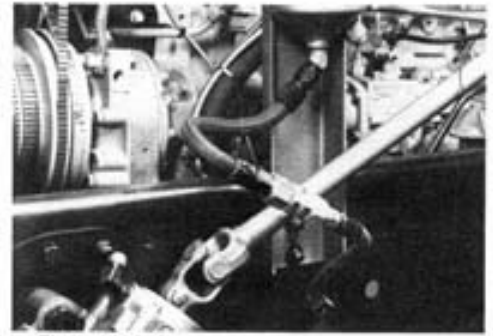


Figure 13.6

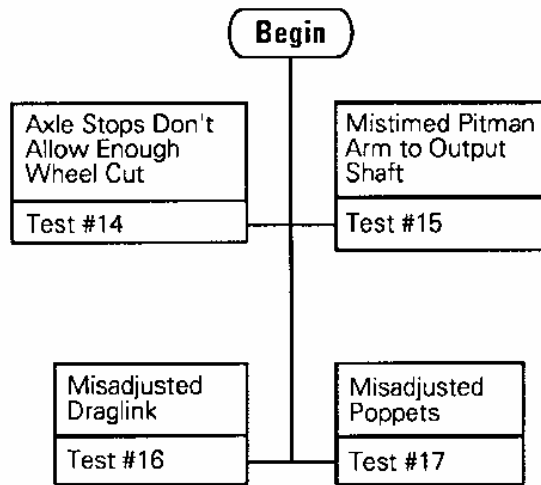
Comments

- 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.
- B** The maximum speed of steer with power assist for a power steering gear is limited by the pump flow and internal leakage. Recommended minimum flow for a new TAS65 steering gear is 3.0 gallons per minute, and is based on a steering speed capability of 1.5 steering wheel turns per second.

Notes

Common Phrases Used

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



Reduced Wheelcut Tests

Test Procedure

#14 Axle Stops Setting Check

1. Put vehicle steer tires on radius plates (turntables). Check to make sure axle stops are set to manufacturer's specifications. FIGURE 14.1.



Figure 14.1

#15 Pitman Arm and Output Shaft Alignment Check

1. Look to make sure the output shaft timing mark is lined up with the pitman arm timing mark. Some pitman arms have more than one mark, so make sure the right one is used. FIGURE 15.1.

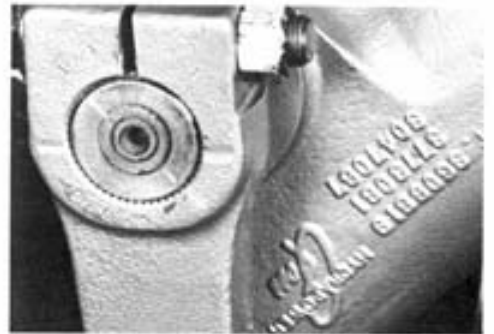


Figure 15.1

#16 Misadjusted Drag Link Check

1. The length of the drag link must be correct for the steering system. Check the length after you make sure the pitman arm/shaft timing marks are aligned, the gear is at its center position, and the road wheels are straight ahead. FIGURE 16.1.



Figure 16.1

#17 Poppet Setting Procedure

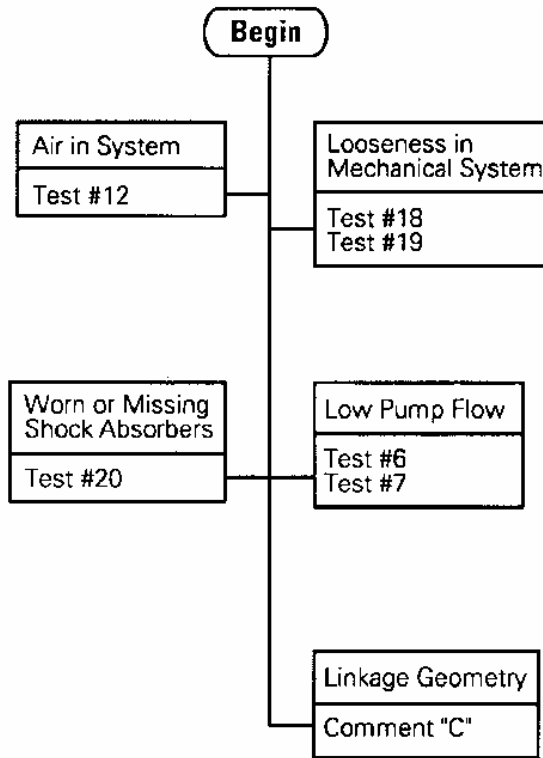
1. If you are working on a newly-installed TAS steering gear, refer to the service manual to correctly set the poppets.
2. To set poppets using the adjustable service kit refer to your steering gear service manual.

Notes

Definition and Common Phrases Used

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 to describe Steering Wheel Kick:

- Kickback
- Backlash
- Bump steer



Steering Wheel Kick Tests

Test Procedure

#6 Power Steering Pump Test

1. Install temperature gage 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°.

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

2. 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 2500 psi 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 by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Idle Speed _____ RPM

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

4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed: FIGURES 6.3 - 6.7.



Figure 6.1

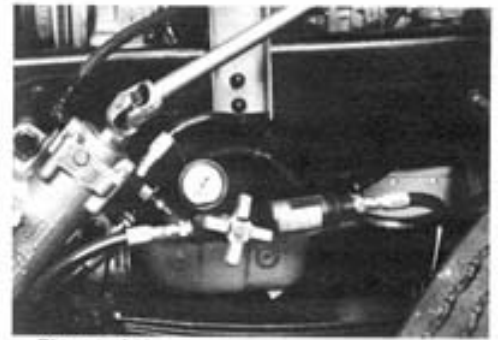


Figure 6.2

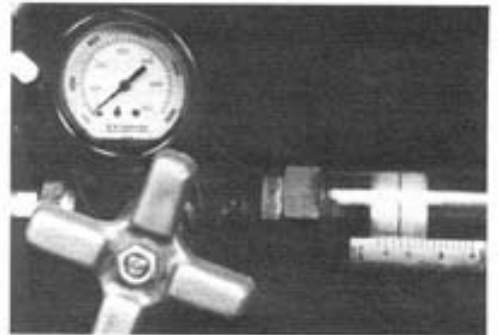


Figure 6.3

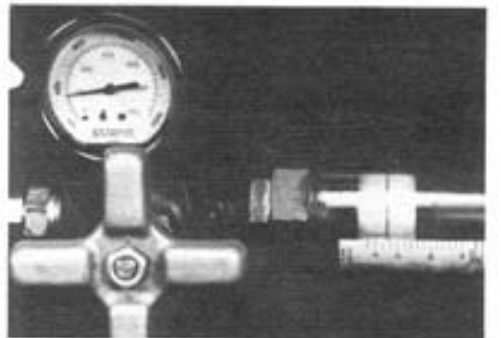


Figure 6.4

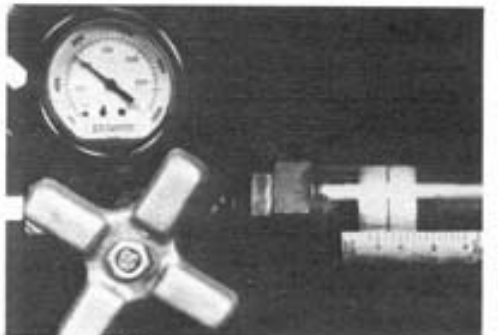


Figure 6.5

Steering Wheel Kick Tests (Continued)

Test Procedure

Oil Temperature _____ DEG
Engine Governed Speed _____ RPM

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

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

#7 Intermittent Loss of Power Assist from Pump Test

1. Install temperature gage in reservoir. FIGURE 7.1. Install PSSA in pressure line with shut-off valve fully open. FIGURE 7.2. 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°.

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

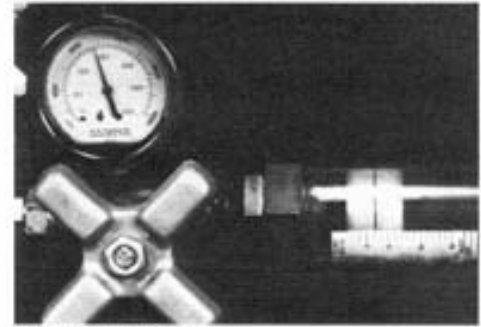


Figure 6.6

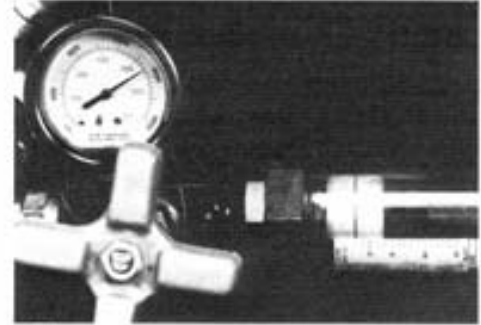


Figure 6.7



Figure 7.1



Figure 7.2

Steering Wheel Kick Tests (Continued)

Test Procedure

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

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

#12 Air in Hydraulic System Check

1. Inspect reservoir for foaming or air bubbles. FIGURE 12.1. If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings on the inlet side of the pump. Look for oil level changes engine off versus engine on. If fluid level increases when the vehicle is shut off, there is an air 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.

#18 Lash in Steering System Check

1. Two people are needed for this test. One person will turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels: FIGURES 18.1 - 18.5.

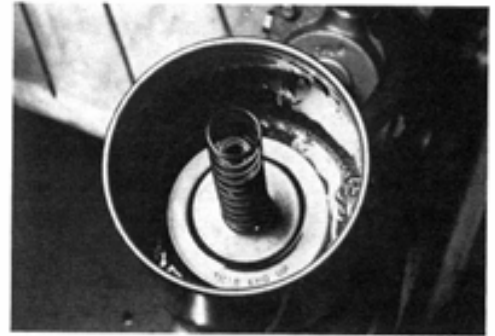


Figure 12.1

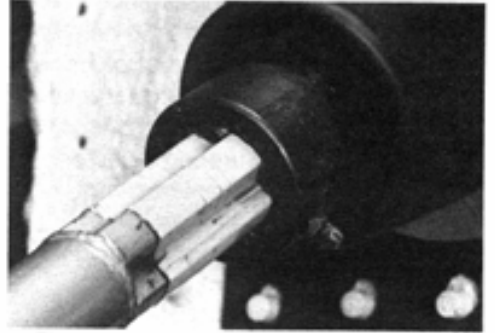


Figure 18.1

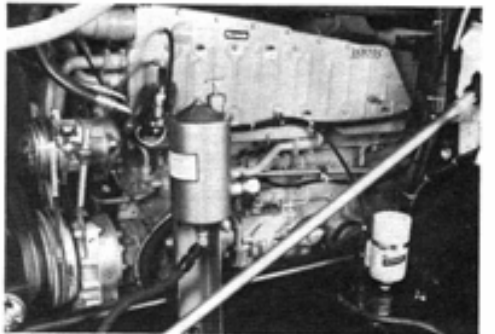


Figure 18.2

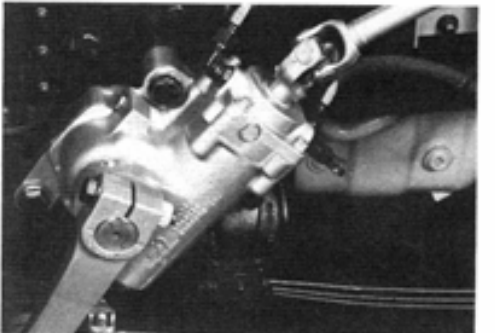


Figure 18.3



Figure 18.4

Steering Wheel Kick Tests (Continued)

Test Procedure

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

NOTE: Cracked 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. FIGURE 18.6.

#19 Steering Gear Adjustment Check

1. Check and adjust per service manual if necessary.

#20 Shock Absorber Check

1. Look to see if shocks have been removed. Also look for external oil leak on shocks. Make sure existing shocks are not worn out. FIGURE 20.1.

Comments

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



Figure 18.5



Figure 18.6

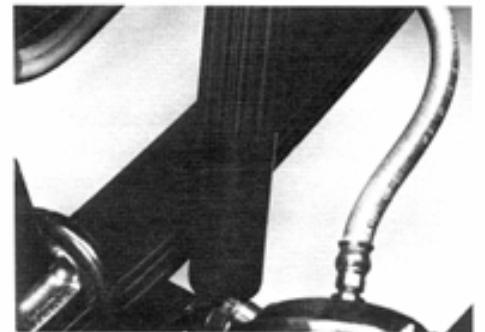


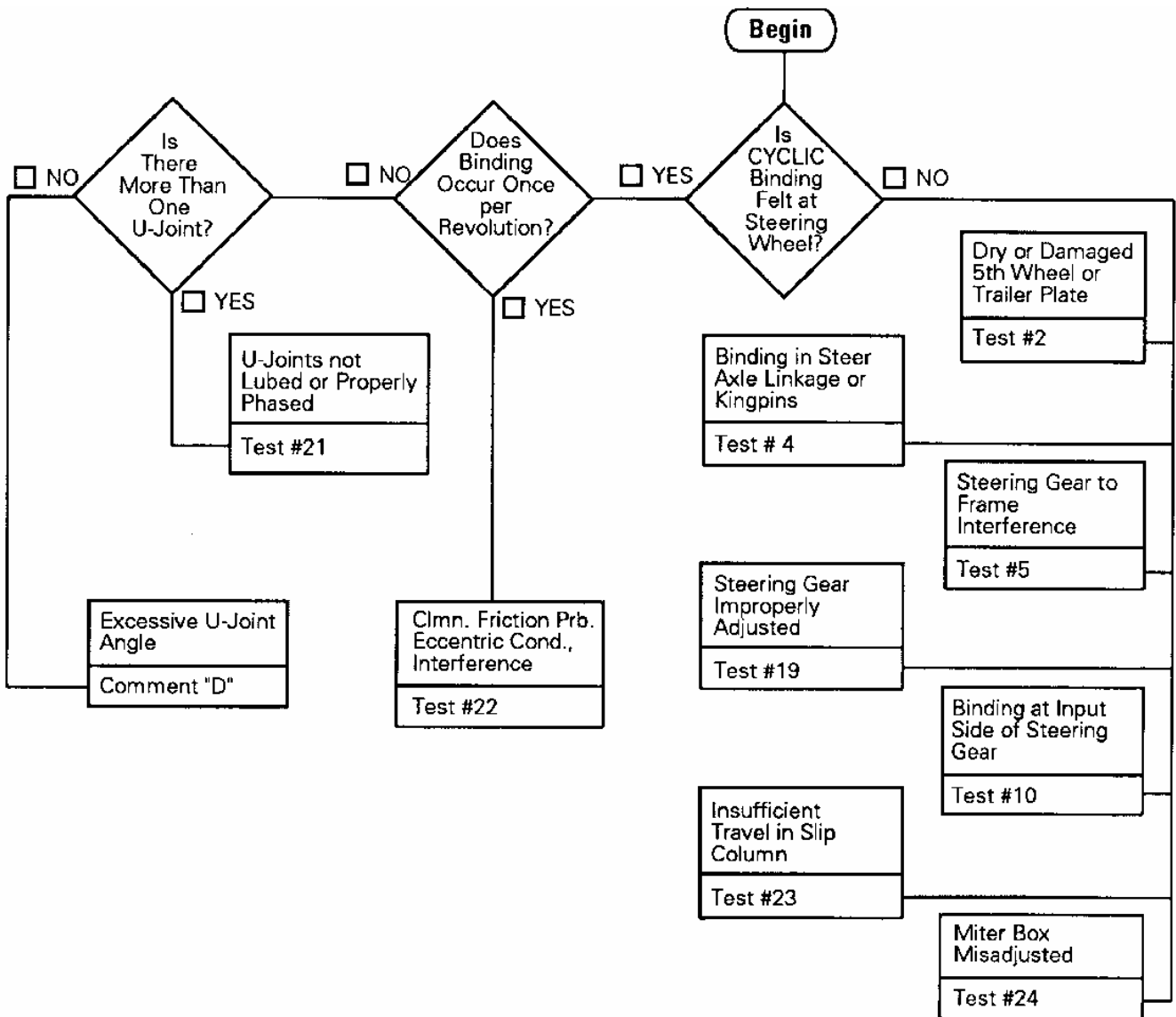
Figure 20.1

Definition

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

Explanation of Flow Chart Terms

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



Binding/Darting/Oversteer Tests

Test Procedure

#2 Fifth Wheel and Trailer Plate Check

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

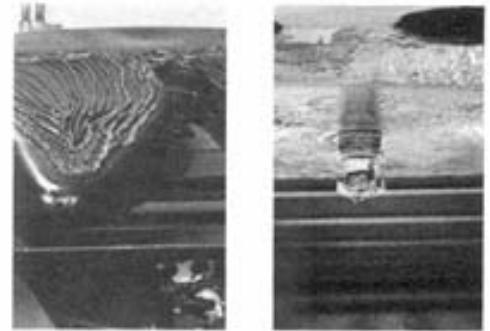


Figure 2.1

#4 Steer Axle and Linkage Binding Test

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 4.1.

CAUTION: Do not steer the gear with linkage removed as mis-adjustment 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 4.2.
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 4.1



Figure 4.2

#5 Steering Gear Mounting Test

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. FIGURE 5.1. Frame flanges or spring mounting points, mounting pads lower than steering gear housing, lack of clearance between frame and steering gear valve housing adaptor, sector shaft adjusting screw and nut mismatched with access adjustment hole in frame.
2. If the steering gear has been mounted to the frame in a way that causes the gear to distort (not be flat), it may cause a steering problem. The use of spacers is alright as long as the gear is mounted securely, and the gear is not distorted when mounting bolts are tightened FIGURE 5.2. Checking to see if distortion is present on the vehicle may require the following test:



Figure 5.1

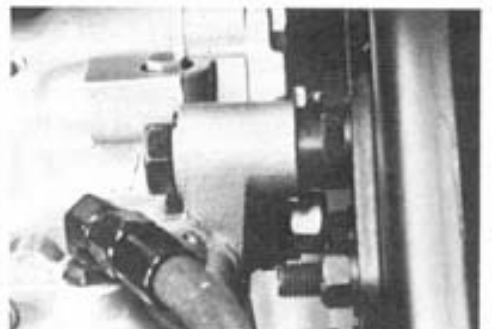


Figure 5.2

Binding/Darting/Oversteer Tests (Continued)

Test Procedure

3. With vehicle parked and turned off, steer the wheel slowly checking for a binding-type of feel at the steering wheel. When binding is felt loosen one mounting bolt, and steer the vehicle again. Continue to loosen one mounting bolt at a time and check for improvement in the binding condition. If improvement is made by loosening the bolts, determine by inspection what interference or condition is causing the gear to distort and correct the problem.

#10 Steering Column Binding Test

1. With the vehicle parked, the engine off, and the steer axle jacked-up, slowly steer the vehicle until the binding position is located.
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 10.1.
3. Rotate the steering gear input shaft no more than 1/4 turn each direction and check if binding is still present. FIGURE 10.2. If binding is not felt, correct the steering column problem.

#19 Steering Gear Adjustment Check

1. Check and adjust per service manual if necessary.

#21 U-Joint Phasing and Lubrication Check

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. Optimum phasing of a two u-joint system is achieved by placing the yoke at each end of the intermediate shaft in line with the plane of the corresponding u-joint angle. FIGURES 21.1 - 21.2. 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 10.1

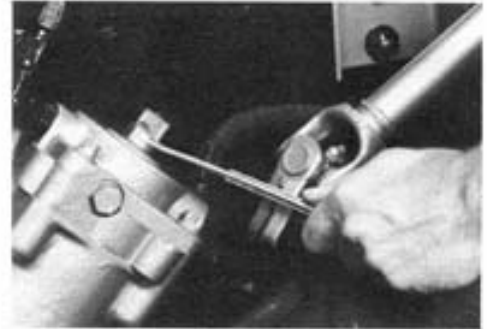


Figure 10.2



Figure 21.1



Figure 21.2

Binding/Darting/Oversteer Tests (Continued)

Test Procedure

#22 Steering Column Interference Test

1. Position column assembly at the location where interference is noticed, and look for something interfering or rubbing on the rotating column assembly such as brackets, bolts, floorboard, boot, horn wire, turn signal, etc. FIGURE 22.1.



Figure 22.1

#23 Slip Column Travel Test

1. Check the slip column by looking to make sure there is proper travel allowance when in use. FIGURE 23.1.
2. Look for wear or galling. FIGURE 23.2.
3. Check slip column for too much slip force.

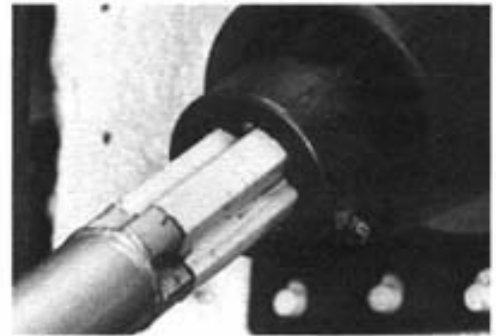


Figure 23.1

#24 Miter Box Misadjusted (if equipped) Test

1. Check and adjust per manufacturer's instructions. FIGURE 24.1.



Figure 23.2

Comments

- 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 binding movement that side loads the input shaft also increases with increased u-joint angles. U-joint operating angles of 15 degrees or less will minimize the torque variation felt at the steering wheel.



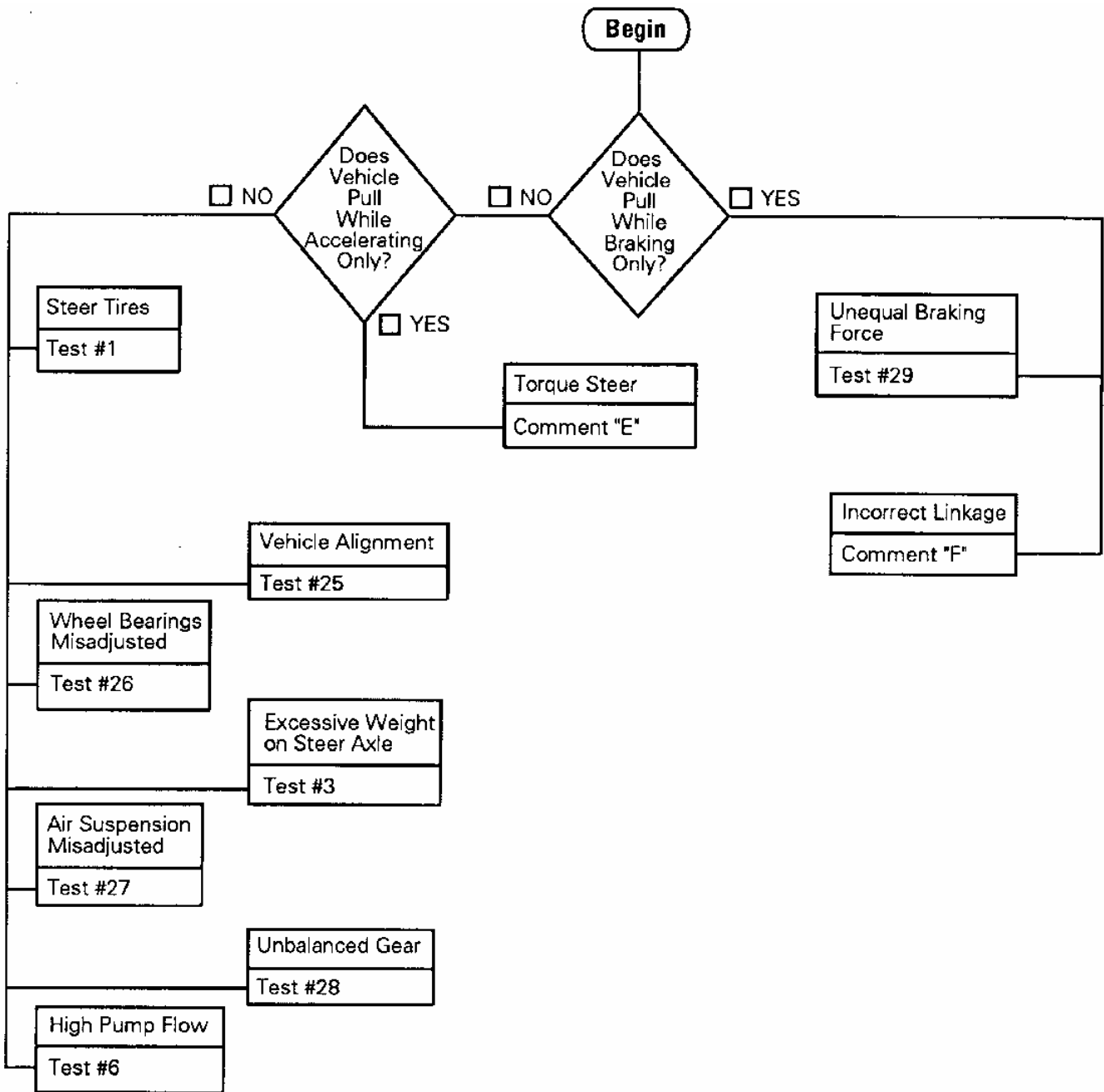
Figure 24.1

Notes

Common Phrases Used

Common phrases used to describe Directional Pull:

- 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.



Directional Pull Tests

Test Procedure

#1 Tire Check

1. Look for:
 - Tire damage. FIGURE 1.1.
 - Uneven or extreme tread wear
 - Mismatched tires
2. Check tire pressure.

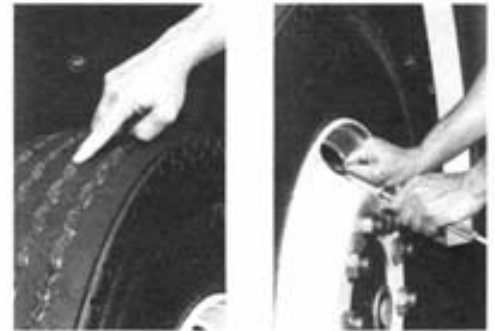


Figure 1.1

#3 Steer Axle Weight Test

1. Have steer axle weighed at load condition which produces complaint and compare to specifications. FIGURE 3.1.



Figure 3.1

#6 Power Steering Pump Test

1. Install temperature gage 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°.



Figure 6.1

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

2. 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 2500 psi for safety of personnel and to prevent damage to the vehicle.



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.

3. 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. FIGURES 6.3 - 6.7.

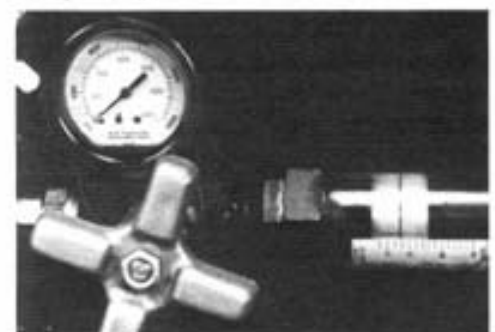


Figure 6.3

Directional Pull Tests (Continued)

Test Procedure

Oil Temperature _____ DEG.
 Engine Idle Speed _____ RPM

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

- 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: FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Governed Speed _____ RPM

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

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

#25 Alignment Check

- Check alignment of steered axle and rear drive axles, and trailer axles (if problem only exists with trailer). FIGURE 25.1.

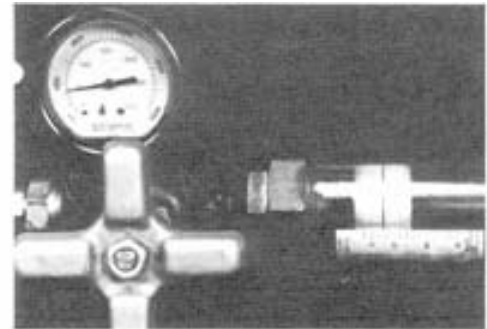


Figure 6.4

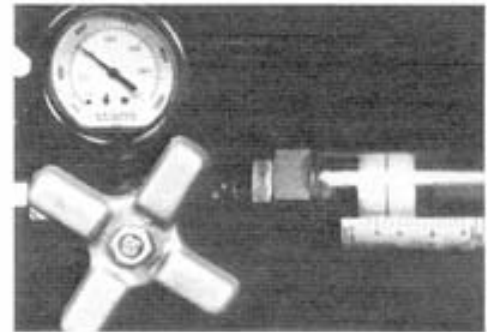


Figure 6.5

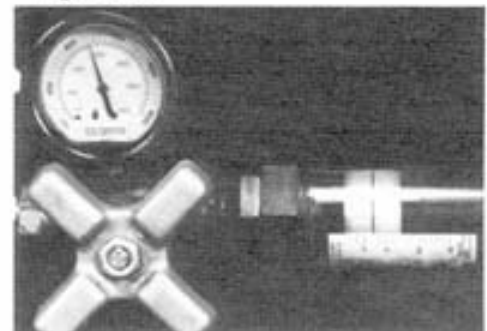


Figure 6.6

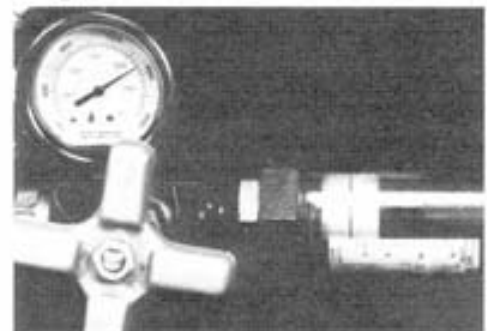


Figure 6.7

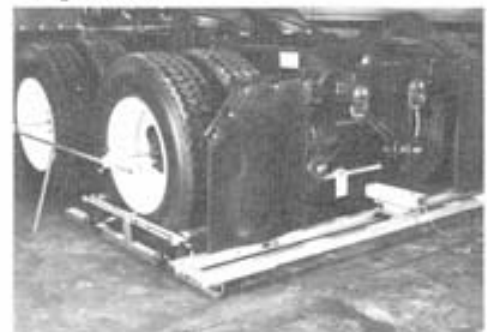


Figure 25.1

Directional Pull Tests (Continued)

Test Procedure

#26 Wheel Bearing Check

1. Verify that adjustment is per manufacturer's specification. FIGURE 26.1.



Figure 26.1

#27 Air Suspension Adjustment Check

1. Check and set to manufacturer's specifications. FIGURE 27.1.

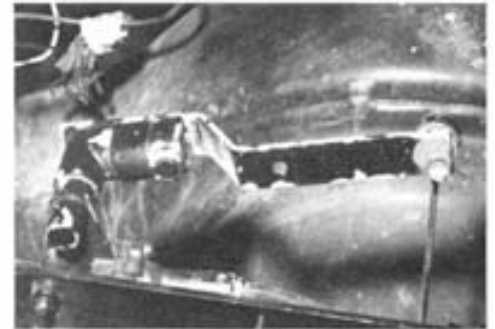


Figure 27.1

#28 Gear Control Valve Imbalance Check

1. Install a low pressure gage (200-300 PSI maximum with approximately 10 PSI per division) in the pressure line from pump to gear. FIGURE 28.1.

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

2. At engine idle, slightly turn the steering column by hand in one direction until a pressure rise is observed at the gage. FIGURE 28.2.
3. Stop steering and gently allow the steering column to recenter.
4. Next slightly turn the steering column by hand in the opposite direction while observing the gage 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 28.1

#29 Unequal Brake Force Check

1. Visually inspect brake assemblies for oil/grease on braking surfaces, and overall condition of brake surfaces. FIGURE 29.1.
2. Adjust or replace brakes if necessary.



Figure 28.2



Figure 29.1

Directional Pull Tests (Continued)

Test #Procedure

Comments

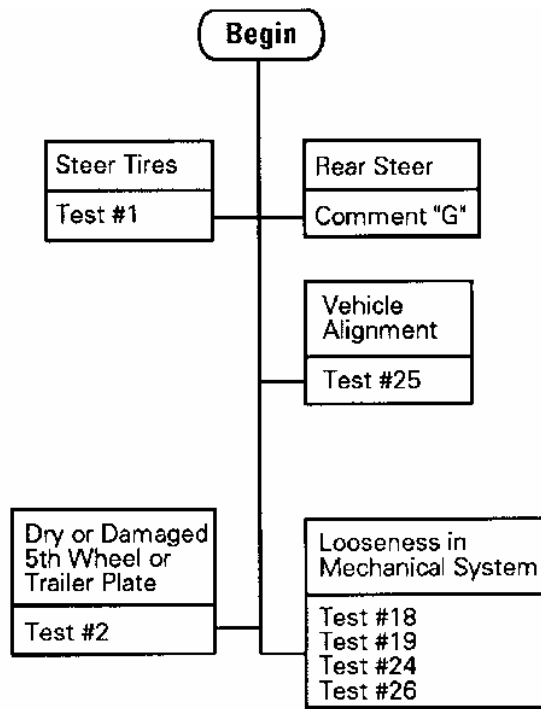
- E** Deflections in the suspension and linkage, front and rear, due to high engine generated torque levels can cause a steering effect. This most often occurs at lower vehicle speeds while accelerating.

- 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.

Common Phrases Used

Common phrases used to describe Road Wander or Loose Steering:

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



Road Wander/Loose Steering Tests

Test Procedure

#1 Tire Check

1. Look for:
 - Tire damage. FIGURE 1.1.
 - Uneven or extreme tread wear
 - Mismatched tires
2. Check tire pressure.



Figure 1.1



#2 Fifth Wheel and Trailer Plate Check

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

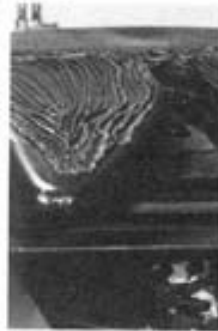


Figure 2.1



#18 Lash in Steering System Check

1. Two people are needed for this test. One person will turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels: FIGURES 18.1 - 18.5.

- 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 to spring pin connectors
- Front axle
- 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. FIGURE 18.6.

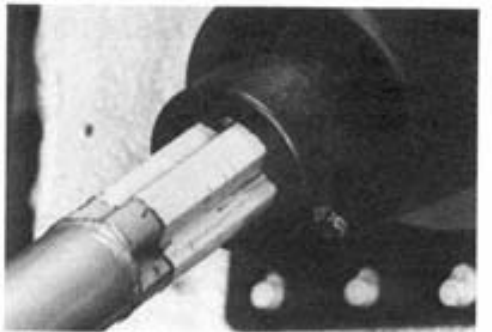


Figure 18.1



Figure 18.2



Figure 18.3

Road Wander/Loose Steering Tests (Continued)

Test Procedure

#19 Steering Gear Adjustment Check

1. Check and adjust per service manual if necessary.

#24 Miter Box Misadjusted (if equipped) Test

1. Check and adjust per manufacturer's instructions. FIGURE 24.1.

#25 Alignment Check

1. Check alignment of steered axle and rear drive axles, and trailer axles (if problem only exists with trailer). FIGURE 25.1.

#26 Wheel Bearing Check

1. Verify that adjustment is per manufacturer's specification. FIGURE 26.1.

Comments

- 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.

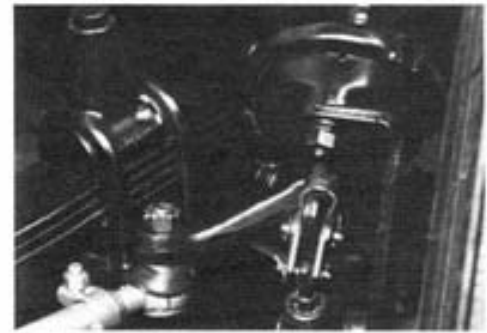


Figure 18.4

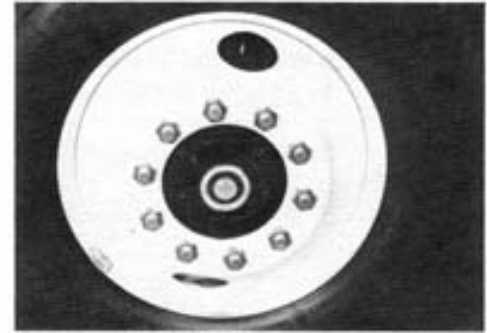


Figure 18.5



Figure 18.6



Figure 24.1

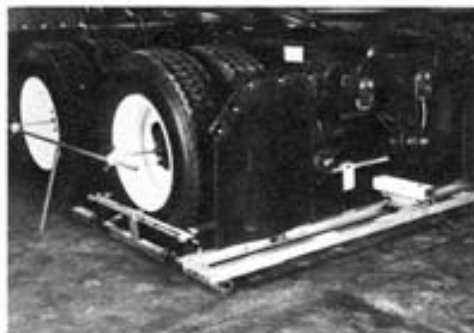


Figure 25.1

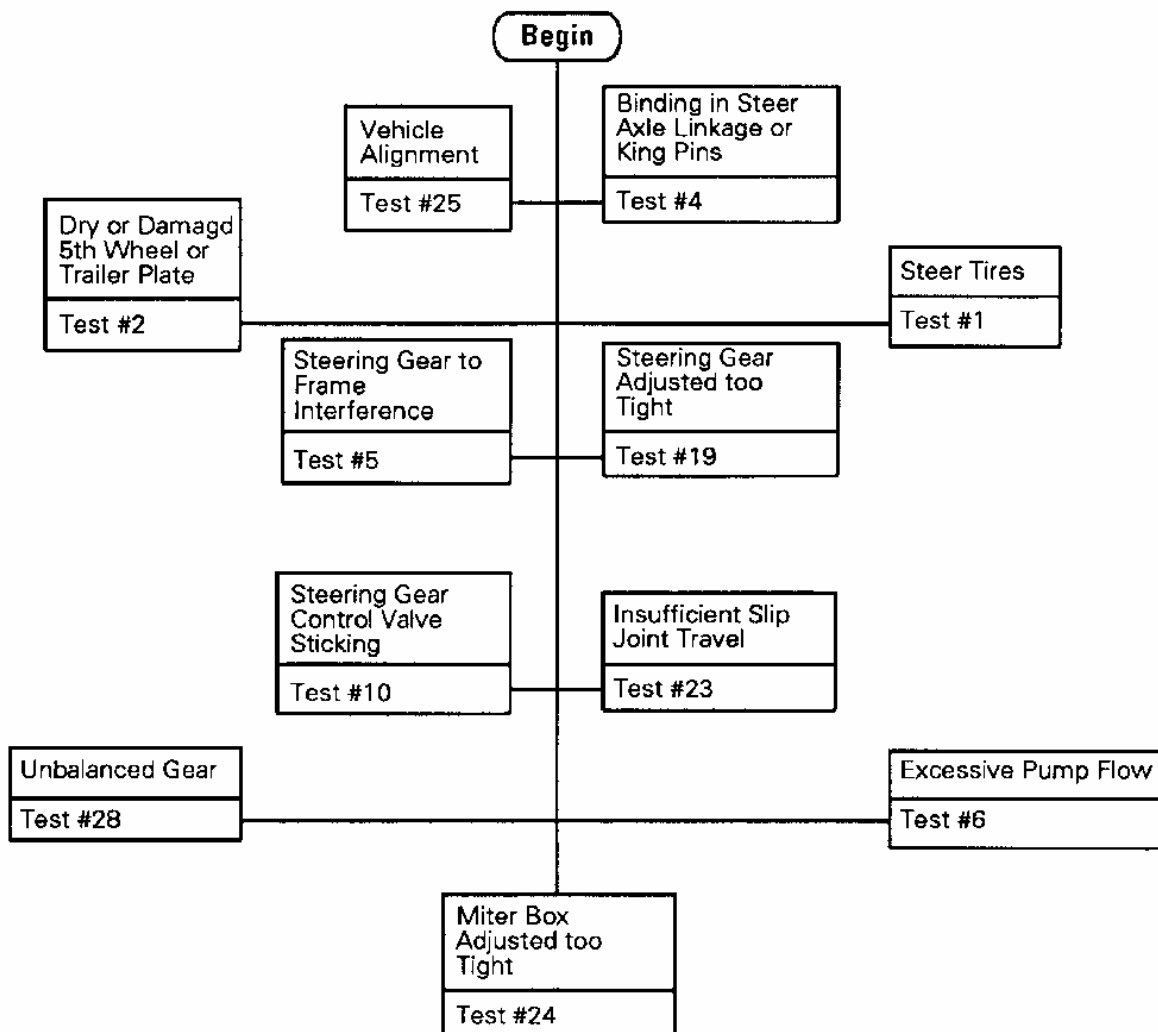


Figure 26.1

Common Phrases Used

Common phrases used to describe Non-Recovery:

- Wheels don't return to straight ahead.



Non-Recovery Tests

Test Procedure

#1 Tire Check

1. Look for:
 - Tire damage. FIGURE 1.1.
 - Uneven or extreme tread wear
 - Mismatched tires
2. Check tire pressure.



Figure 1.1



#2 Fifth Wheel and Trailer Plate Check

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



Figure 2.1

#4 Steer Axle and Linkage Binding Test

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 4.1.

CAUTION: Do not steer the gear with linkage removed as mis-adjustment 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 4.2.
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 4.1



Figure 4.2

#5 Steering Gear Mounting Test

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. FIGURE 5.1. Frame flanges or spring mounting points, mounting pads lower than steering gear housing, lack of clearance between frame and steering gear valve housing adaptor, sector shaft adjusting screw and nut mismatched with access adjustment hole in frame.



Figure 5.1

Non-Recovery Tests (Continued)

Test Procedure

2. If the steering gear has been mounted to the frame in a way that causes the gear to distort (not be flat), it may cause a steering problem. The use of spacers is alright as long as the gear is mounted securely, and the gear is not distorted when mounting bolts are tightened. FIGURE 5.2. Checking to see if distortion is present on the vehicle may require the following test:
3. With vehicle parked and turned off, steer the wheel slowly checking for a binding-type of feel at the steering wheel. When binding is felt loosen one mounting bolt, and steer the vehicle again. Continue to loosen one mounting bolt at a time and check for improvement in the binding condition. If improvement is made by loosening the bolts, determine by inspection what interference or condition is causing the gear to distort and correct the problem.

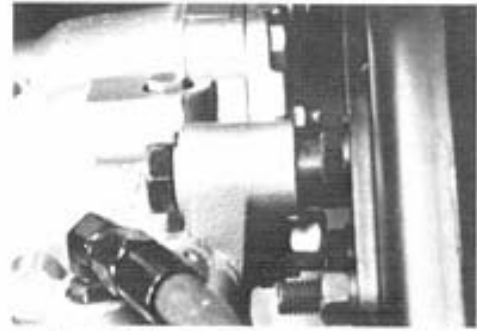


Figure 5.2



Figure 6.1

#6 Power Steering Pump Test

1. Install temperature gage 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°.

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

2. 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 2500 psi 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.

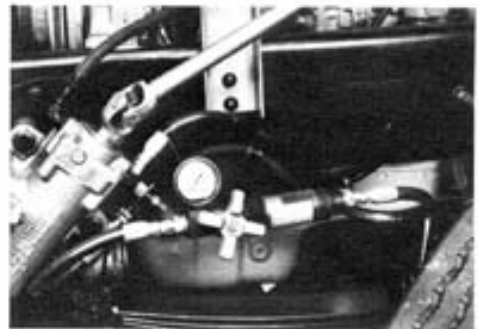


Figure 6.2

Non-Recovery Tests (Continued)

Test Procedure

3. 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. FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Idle Speed _____ RPM

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

4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed: FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Governed Speed _____ RPM

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

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

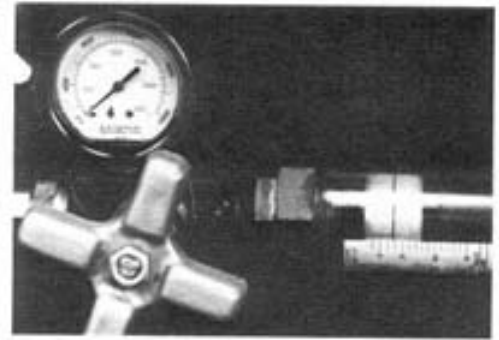


Figure 6.3

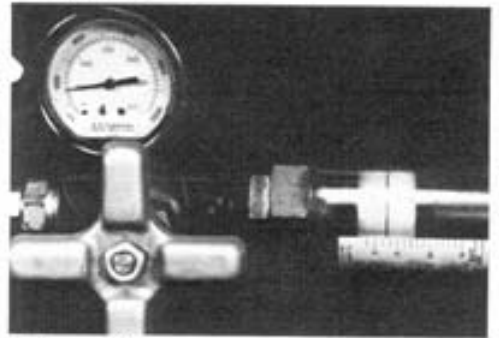


Figure 6.4

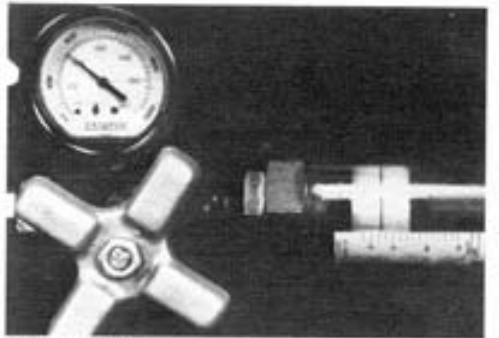


Figure 6.5

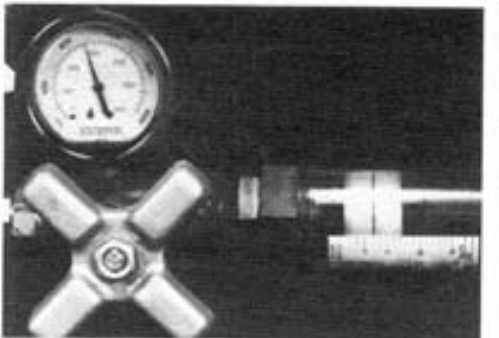


Figure 6.6

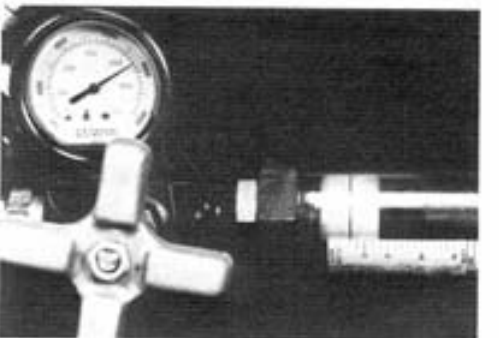


Figure 6.7

Non-Recovery Tests (Continued)

Test Procedure

#10 Steering Column Binding Test

1. With the vehicle parked, the engine off, and the steer axle jacked-up, slowly steer the vehicle until the binding position is located.
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 10.1.
3. Rotate the steering gear input shaft no more than 1/4 turn each direction and check if binding is still present. FIGURE 10.2. If binding is not felt, correct the steering column problem.



Figure 10.1

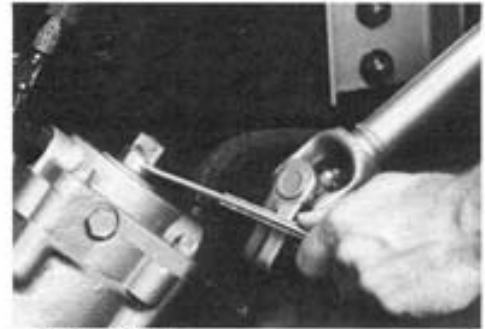


Figure 10.2

#19 Steering Gear Adjustment Check

1. Check and adjust per service manual if necessary.

#23 Slip Column Travel Test

1. Check the slip column by looking to make sure there is proper travel allowance when in use. FIGURE 23.1.
2. Look for wear or galling. FIGURE 23.2.
3. Check slip column for too much slip force.

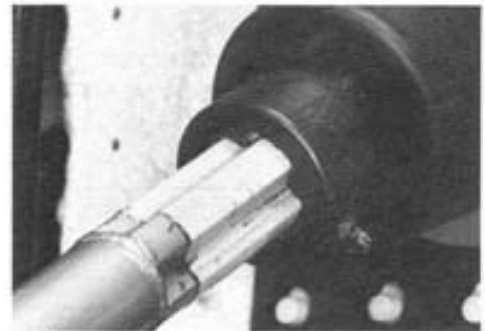


Figure 23.1

#24 Miter Box Misadjusted (if equipped) Test

1. Check and adjust per manufacturer's instructions. FIGURE 24.1.



Figure 23.2



Figure 24.1

Non-Recovery Tests (Continued)

Test Procedure

#25 Alignment Check

1. Check alignment of steered axle and rear drive axles, and trailer axles (if problem only exists with trailer). FIGURE 25.1.

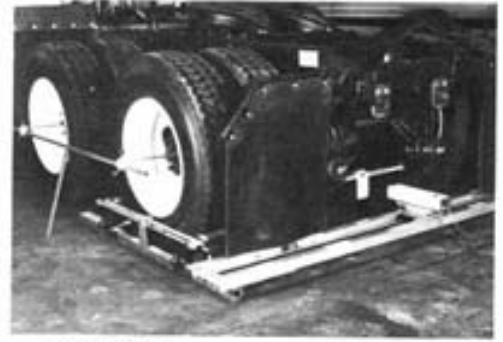


Figure 25.1

#28 Gear Control Valve Imbalance Check

1. Install a low pressure gage (200-300 PSI maximum with approximately 10 PSI per division) in the pressure line from pump to gear. FIGURE 28.1.

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

2. At engine idle, slightly turn the steering column by hand one direction until a pressure rise is observed at the gage. FIGURE 28.2.
3. Stop steering and gently allow the steering column to recenter.
4. Next slightly turn the steering column by hand the opposite direction while observing the gage 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.

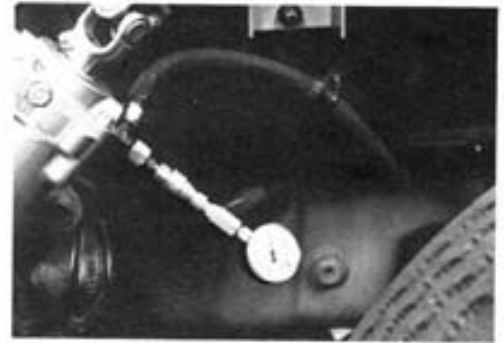


Figure 28.1



Figure 28.2

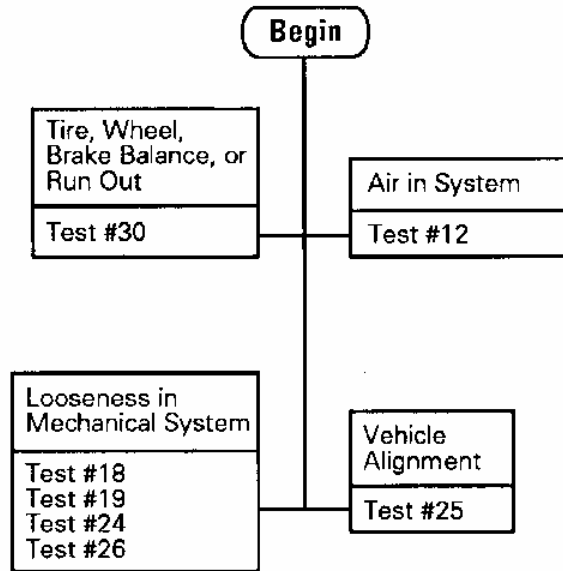
Notes

Definition and Common Phrases Used

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 to describe Shimmy:

- Shake at steering wheel



Shimmy Tests

Test Procedure

#12 Air in Hydraulic System Check

1. Inspect reservoir for foaming or air bubbles. FIGURE 12.1. If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings on the inlet side of the pump. Look for oil level changes engine off versus engine on. If fluid level increases when the vehicle is shut off, there is an air 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.

#18 Lash in Steering System Check

1. Two people are needed for this test. One person will turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels: FIGURES 18.1 - 18.5.

- 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 to spring pin connectors
- Front axle
- 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.



Figure 12.1



Figure 18.1

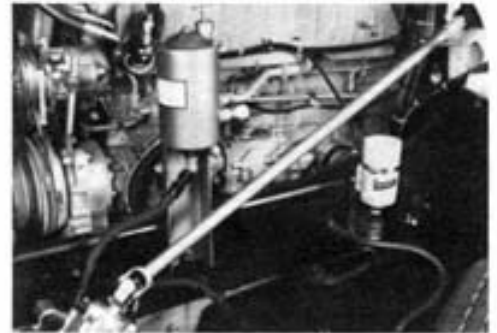


Figure 18.2



Figure 18.3



Figure 18.4

Shimmy Tests (Continued)

Test Procedure

NOTE: Be sure to check rear drive axles for any looseness. FIGURE 18.6.

#19 Steering Gear Adjustment Check

1. Check and adjust per service manual if necessary.

#24 Miter Box Misadjusted (if equipped) Test

1. Check and adjust per manufacturer's instructions. FIGURE 24.1.

#25 Alignment Check

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

#26 Wheel Bearing Check

1. Verify that adjustment is per manufacturer's specification. FIGURE 26.1.

#30 Road Wheel Rotating Assembly Check

1. 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. FIGURE 30.1.



Figure 18.5



Figure 18.6



Figure 24.1



Figure 26.1

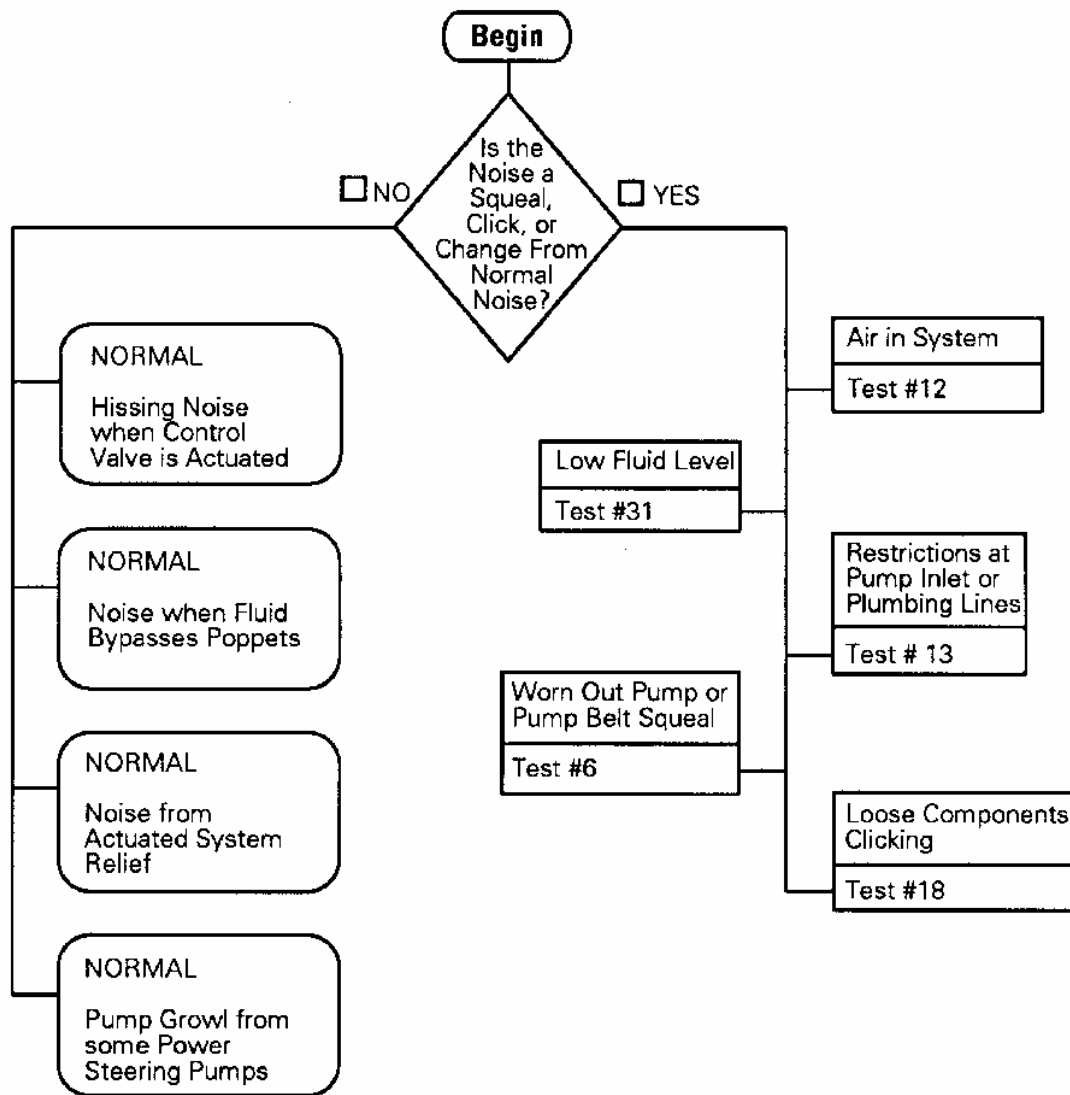


Figure 30.1

Common Phrases Used

Common phrases used to describe Noise:

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



Noise Tests

Test Procedure

#6 Power Steering Pump Test

1. Install temperature gage 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°.

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

2. 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 2500 psi 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 by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. FIGURES 6.3 - 6.7.

Oil Temperature _____ DEG.
 Engine Idle Speed _____ RPM

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

4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed: FIGURES 6.3 - 6.7.



Figure 6.1

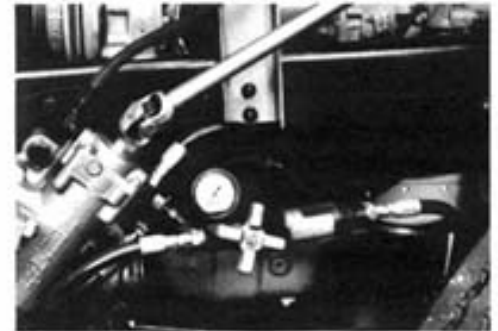


Figure 6.2

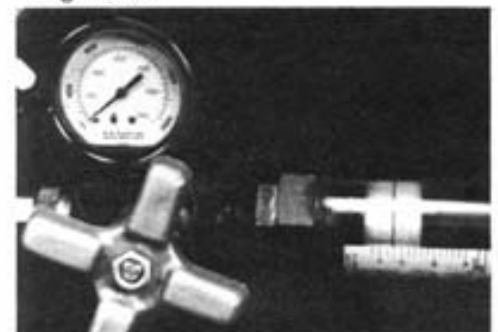


Figure 6.3

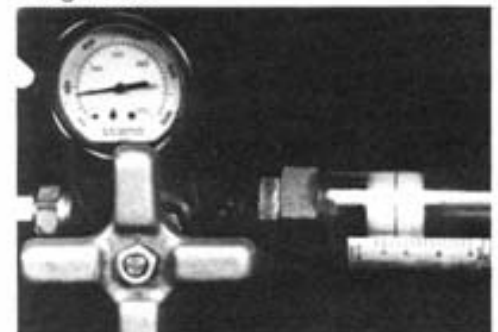


Figure 6.4

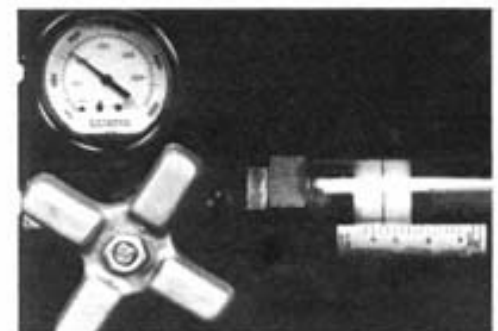


Figure 6.5

Noise Tests (Continued)

Test Procedure

Oil Temperature _____ DEG.
Engine Governed Speed _____ RPM

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

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

#12 Air in Hydraulic System Check

1. Inspect reservoir for foaming or air bubbles. FIGURE 12.1. If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings on the inlet side of the pump. Look for oil level changes engine off versus engine on. If fluid level increases when the vehicle is shut off, there is an air 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.

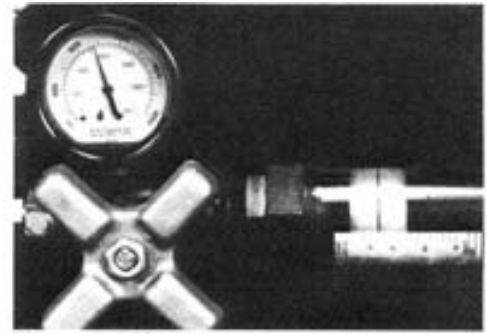


Figure 6.6

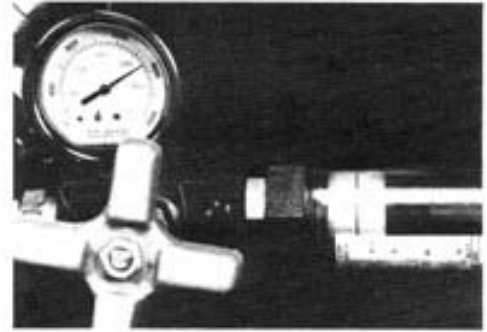


Figure 6.7



Figure 12.1

Noise Tests (Continued)

Test Procedure

#13 Restricted Hydraulic Line Check

1. Look at the suction line that goes to the pump (if there is one) to check for kinking or any other obstructions or irregularities on the inside of the hose. FIGURE 13.1.
2. With the PSSA and temperature gage installed (FIGURES 13.2 - 13.3), load valve fully open, and oil at 125 to 135 degrees, determine a test engine speed (RPM) that causes pump to deliver either 3, 4, 5 or 6 GPM (whichever is easier) and note this speed.
3. Remove the PSSA and install a low pressure gage (200-300 PSI maximum with approximately 10 PSI per division) in the pressure line to the steering gear at the pump end. FIGURE 13.4. Install a temperature gage in the power steering reservoir. FIGURE 13.5.

CAUTION: Do not allow system pressure to exceed the rating of the gage during the following procedure or damage to the gage will result. Extremely high restrictions may be indicated with the PSSA gage 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 to 135 ° at engine idle, with no steering force applied to the steering wheel. FIGURE 13.5.
5. At the test engine speed selected from step 2 above, measure and record the gage 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 13.6.
7. Start the engine, and run at the RPM identified in step 2 with the fluid temperature between 125-135 °.
8. Measure and record gage reading and shut off engine. This is hydraulic line/reservoir pressure.
9. The difference between the total system pressure gage reading and the hydraulic line/reservoir pressure gage reading is the steering gear pressure drop. For a TAS65 steering gear, at a flow of 3, 4, 5 or 6 GPM, drop should not be greater than 30, 40, 55 or 70 PSI respectively. The line/reservoir pressure drop for a flow of 3, 4, 5 or 6 GPM should not be greater than 20, 20, 25 or 25 PSI respectively.



Figure 13.1



Figure 13.2



Figure 13.3



Figure 13.4



Figure 13.5

Noise Tests (Continued)

Test Procedure

#18 Lash in Steering System Check

1. Two people are needed for this test. One person will turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels: FIGURES 18.1 - 18.5.

- 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 to spring pin connectors
- Front axle
- 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. FIGURE 18.6.



Figure 13.6

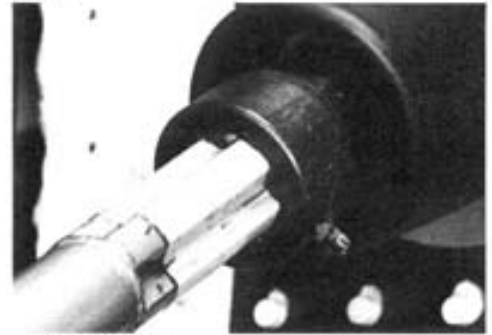


Figure 18.1

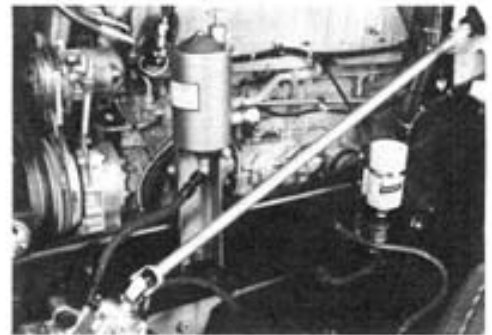


Figure 18.2



Figure 18.3



Figure 18.4

Noise Tests (Continued)

Test Procedure

#31 Power Steering Fluid Level Check

1. Check reservoir and make sure there is enough fluid.
FIGURE 31.1.



Figure 18.5



Figure 18.6

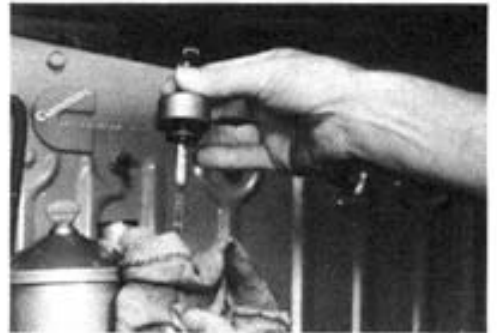


Figure 31.1

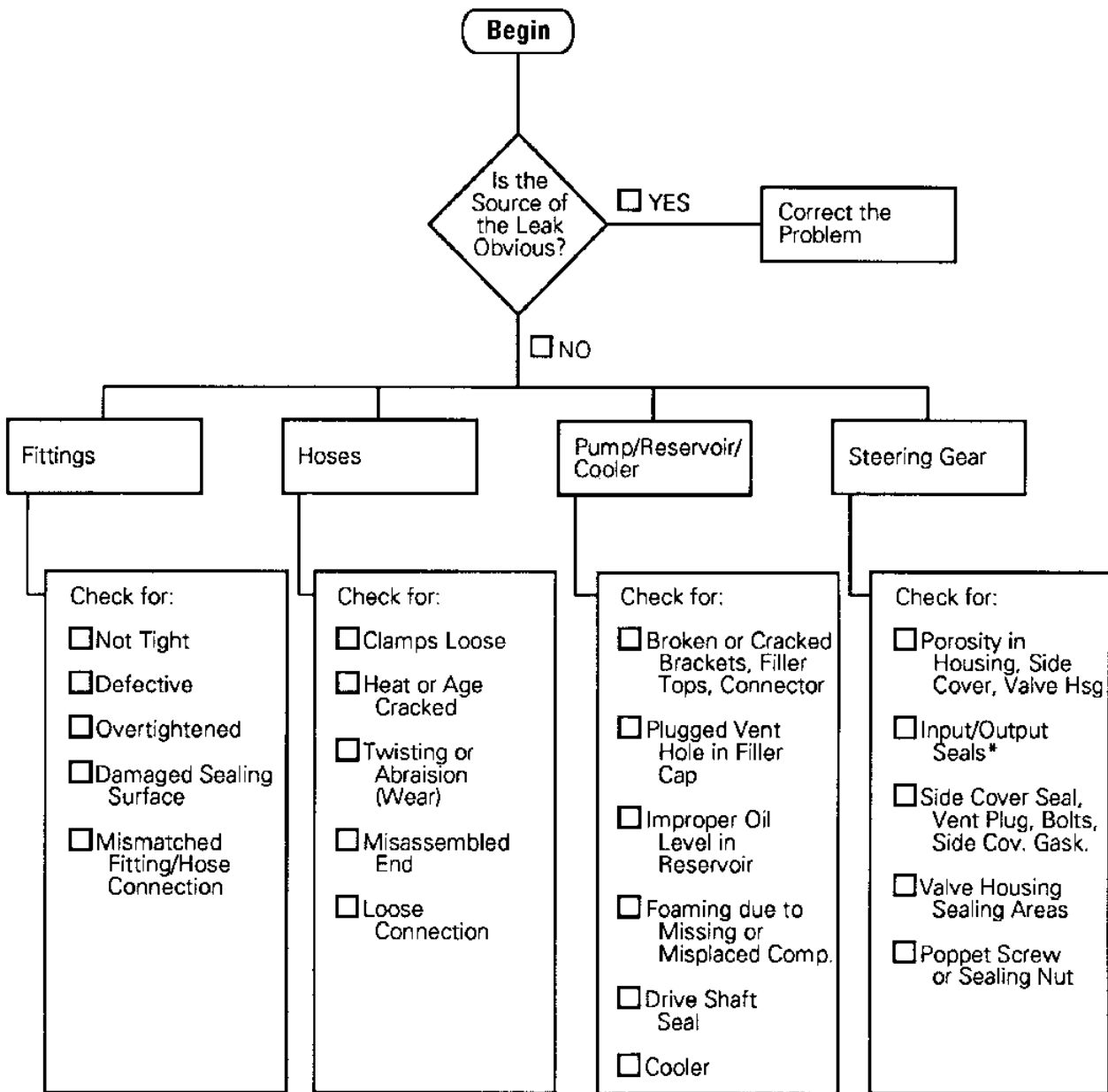
Notes

Comments and Common Phrases Used

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

Common phrases used to describe External Leaks:

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



***NOTE: If Input Shaft Seal Appears Hardened from Heat, Conduct the 40 Minute Temperature Test (Test #6, Step 1).**

Glossary of Terms

Ambient .. Surrounding on all sides. The temperature around the vehicle.

Binding .. Hindered from free operation. 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.

Cyclic .. Happening or appearing at regular intervals.

Cyclic Binding .. While steering in a slow, smooth manner, is a torque variation encountered which repeats for a given amount of steering wheel rotation. An example would be a hard spot or "lump" felt at the steering wheel once per revolution.

Darting .. To move suddenly or rapidly. Darting is when the driver suddenly gets more turning than he wants from his vehicle.

Distort .. Twist out of original shape.

Hard Steering .. 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.

Oversteer .. The tendency of a vehicle to steer into a sharper turn than intended.

PSSA .. Power Steering System Analyzer. A Power Steering System Analyzer is a combination of a flow meter, shut off valve, and pressure gage. This tool will allow you to measure flow and pressure, and provide a load on the pump in the hydraulic lines of the steering system.

Shimmy .. Abnormal shake or vibration. 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.

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

Notes



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