




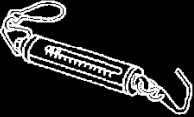
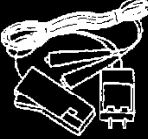
## Steering: Testing and Inspection

### Initial Inspection

#### Steering System

 ST1398-A	Dial Thermometer 0-220°F 023-R0007 or Equivalent
 ST1177-A	Hand Held Automotive Meter 105-R0053 or Equivalent
 ST1477-A	Power Steering Analyzer 211-F001 (014-00207) or Equivalent

#### Special Tools

 ST1689-A	Spring Scale 211-034 (T74P-3504-Y)
 ST1398-A	Tach Adapter 418-F102 (007-00061) or Equivalent

#### Special Tool(s)

#### Inspection and Verification

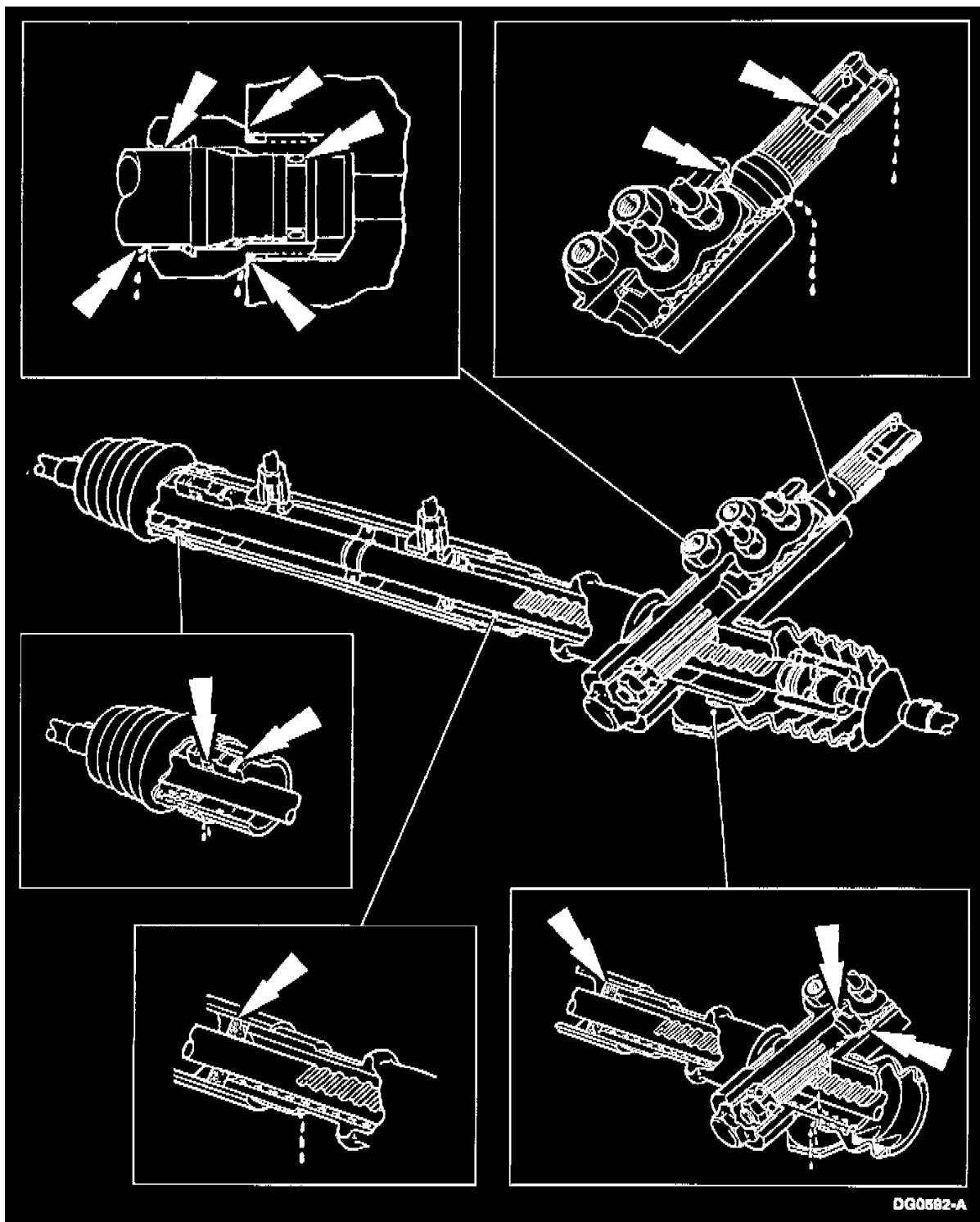
**CAUTION:** Do not hold the steering wheel at the stops for an extended amount of time. Damage to the power steering pump will result.

**NOTE:** Make the following preliminary checks before repairing the steering system:

1. Verify the customer concern by operating the steering system.
2. Inspect the tires
  - ^ Check the tire pressure; refer to the Vehicle Certification (VC) label.
  - ^ Verify that all tires are sized to specification.
  - ^ Check the tires for damage and uneven wear.
3. Belt and Tensioner Check
  - ^ Refer to diagnosis and testing of the accessory drive system
4. Fluid Level Check
  - ^ Verify that the power steering fluid level is within the appropriate hot or cold range on the dipstick. Add Motorcraft MERCON Multi-Purpose ATF XT-2-QDX or MERCON equivalent.

5. Air Bleeding

- ^ Verify that there is no air in the power steering system. Run the engine until it reaches normal operating temperature. Turn the steering wheel to the left and right several times without hitting the stops. If any air bubbles are present, refer to Purging-CII Power Steering Pump or Purging Power Steering Pump-CIII.



External Leak Check-Typical Power Rack-and-Pinion Steering Gear

**External Leak Check-Typical Power Rack-and-Pinion Steering Gear**

6. External Leak Check

- ^ With the ignition switch at OFF, wipe off the power steering pump, power steering hose assembly, power steering return hoses, power steering fluid cooler, and steering gear.
- ^ With the engine running, turn the steering wheel from stop to stop several times. Do not hold steering wheel at stops. Check for leaks. Repair as necessary if leaks are observed.

7. Turning Effort Check

### Mechanical

- Loose tie-rod ends
- Loose suspension components
- Loose steering column shaft universal joints
- Loose column intermediate shaft bolts
- Steering gear
- Binding or misaligned steering column
- Power steering pump
- Bent or pinched power steering hoses

8. Visually inspect for obvious signs of mechanical damage.
9. If an obvious cause for an observed or reported malfunction is found, correct the cause (if possible) before proceeding to the next step
10. If the fault is not visually evident, determine the symptom. GO to Symptom Chart. See: Diagnosis By Symptom/Symptom Chart

## Pump Flow and Pressure Test

### Pump Flow and Pressure Test

**WARNING: Do not touch the flowmeter during the test procedure, or severe burns and serious injury may occur.**

1. **CAUTION:** Make sure that the connection point will not interfere with any of the engine accessory drive components or drive belts.

Install special tool 211-F001 (014-00207) at the high pressure port of the power steering pump. Make sure the gate valve on the special tool is fully open.

^ On some vehicles, the power steering pump high pressure port is inaccessible and the special tool should then be installed either at the steering gear or at a point in the high pressure line between the power steering pump and the steering gear.

2. Place special tool 023-R0007 in the power steering pump reservoir.
3. Check the power steering fluid level. If necessary add power steering fluid.
  - ^ Use Motorcraft MERCON Multi-Purpose ATF XT-2-QDX or MERCON equivalent.
4. Install special tool 418-F012 (007-00061) and special tool 105-R0053.
5. **CAUTION:** Do not hold the steering wheel against the stops for more than three to five seconds at a time. Damage to the power steering pump will occur.

Start the engine. Place the transmission in neutral. Set the parking brake. Raise the power steering fluid temperature to **74 - 80°C (165 - 175°F)** by rotating the steering wheel fully to the left and right several times.

6. Set the engine speed to **1500 rpm**. Record the flow rate and pressure readings.
  - ^ If the flow rate is below the flow rate specification, a new power steering pump may need to be installed. Continue with the test procedure.
  - ^ If the pressure reading is above the maximum pressure specification. check power steering hoses for kinks and restrictions
7. Partially close the gate valve to obtain 750 psi. Set the engine speed at idle. Record the flow rate.
  - ^ If the flow is less than the specified flow rate, install a new power steering pump.
8. **CAUTION:** Do not allow the gate valve to remain closed for more than 5 seconds.

Completely close and partially open the gate valve 3 times. Record the pressure relief valve actuation pressure reading.

^ If the pressure does not meet the relief pressure specification, install a new power steering pump.

9. Set engine speed to **1500 rpm**. Record the flow rate.
  - ^ If the flow rate varies more than **3.785 liters/minute (1 gallon/minute)** from the initial flow rate reading. install a new power steering pump.
10. **CAUTION:** Do not hold the steering wheel against the stops for more than three to five seconds at a time. Damage to the power steering pump will occur.

Set the engine speed at idle. Turn (or have an assistant turn) the steering wheel to the left and right stops. Record flow rate anti pressure readings at the stops

^ The pressure reading at both stops should be nearly the same as the maximum pump relief pressure.

^ The flow rate should drop below **1.9 liters/minute (0.5 gallons/minute)**.

^ If the pressure does not reach the maximum pump relief pressure or the flow rate does not drop below the specified value, excessive internal leakage is occurring. Install a new steering gear as necessary.

11. Turn (or have an assistant turn) the steering wheel slightly in both directions and release quickly while watching the pressure gauge
  - ^ The pressure reading should move from the normal back pressure reading and snap back as the steering wheel is released
  - ^ If the pressure returns slowly or sticks, the rotary valve in the steering gear is sticking or the steering column is binding. Check the steering column and linkages before servicing the steering gear.

## Steering Gear Valve

### Steering Gear Valve

1. With the vehicle in motion, place the transmission in NEUTRAL and turn the engine OFF.
  - ^ If the vehicle does not pull with the engine OFF, install a new steering gear.
2. If the vehicle pulls with the engine OFF, cross-switch the front wheels.
3. If the vehicle pulls to the opposite side, cross-switch the front and rear wheels on the same side.
4. If the vehicle pull direction does not change, check the front suspension components, wheel alignment and frame alignment.

## Steering Linkage

### Steering Linkage

1. **NOTE:** Excessive vertical motion of the studs relative to the sockets may indicate excessive wear.

With the parking brake applied, perform the following:

- ^ Have an assistant rotate the steering wheel back and forth **360 degrees** and watch for relative motion of the studs in the steering linkage ball sockets.
  - ^ Watch for loose steering gear mounting.
2. Another method is to raise the front wheels off the ground, grasp the wheel at the front and rear and watch for excessive play or binding in the joints while trying to steer the wheels.
  3. Install new or tighten any worn, damaged, or loose steering components.

## Tie Rod Articulation Torque

### Tie-Rod Articulation Torque

1. **NOTE:** This check may be done with the steering gear on or off the vehicle.

Disconnect the tie-rod end from the front wheel spindle.

2. Move the front wheel spindle tie-rod back and forth three times.
3. Hook special tool 211-034 (T74P-3504-Y) over the tie-rod end of the threaded portion of the front wheel spindle tie-rod and measure the force required to move the front wheel spindle tie-rod.
4. If the force required to move the front wheel spindle tie-rod does not meet the specifications, install a new front wheel spindle tie-rod.

## Turning Effort Test

### Turning Effort Test

**NOTE:** Make sure that the front wheels are correctly aligned and the tire pressure is correct before checking turning effort.

1. Park the vehicle on dry concrete and set the parking brake.
2. Insert special tool 023-R0007 into the power steering pump reservoir.
3. **CAUTION:** Do not hold the steering wheel against the stops for more than three to five seconds at a time. Damage to the power steering pump will occur.

Idle the engine for two to three minutes. Turn the steering wheel from stop to stop several times to warm the fluid to **50 - 60°C (122 - 140°F)**.

4. With the engine running, attach special tool 211-034 (T74P-3504-Y) to the rim of the steering wheel.
5. Using special tool 211-034 (T74P-3504-Y), measure the pull required to turn the steering wheel one complete revolution in each direction.

## Symptom Definitions

### Steering System Symptom Definitions

#### Drift/Pull

Pull is a tugging sensation, felt by the hands on the steering wheel, that must be overcome to keep the vehicle going straight.

Drift describes what a vehicle with this condition does with hands off the steering wheel.

- ^ A vehicle-related drift/pull, on a flat road will cause a consistent deviation from the straight-ahead path and require constant steering input in the opposite direction to counteract the effect.
- ^ Drift/pull may be induced by conditions external to the vehicle (i.e., wind, road camber).

#### Excessive Steering Wheel Play

Excessive steering wheel play is a condition in which there is too much steering wheel movement before the wheels move. A small amount of steering wheel free play is considered normal.

#### Feedback

Feedback is a roughness felt in the steering wheel when the vehicle is driven over rough pavement.

#### Hard Steering or Lack of Assist

Hard steering or lack of assist is experienced when the steering wheel effort exceeds specifications. Hard steering can remain constant through the full turn or occur near the end of a turn. It is important to know the difference between hard steering/lack of assist and binding.

Hard steering or lack of assist can result from either hydraulic or mechanical conditions. It is extremely important to know if this concern occurs during driving, during very heavy or static parking maneuvers.

**Nibble**

Sometimes confused with shimmy, nibble is a condition resulting from tire interaction with various road surfaces and observed by the driver as small rotational oscillations of the steering wheel.

**Poor Returnability/Sticky Steering**

Poor returnability and sticky steering is used to describe the poor return of the steering wheel to center after a turn or after a steering correction is completed.

**Shimmy**

Shimmy, as observed by the driver, is large, consistent, rotational oscillations of the steering wheel resulting from large, side-to-side (lateral) tire/wheel movements.

Shimmy is usually experienced near **64 km/h (40 mph)**, and can begin or be amplified when the tire contacts pot holes or irregularities in the road surface.

**Wander**

Wander is the tendency of the vehicle to require frequent, random left and right steering wheel corrections to maintain a straight path down a level road.

**Symptom Chart**

Symptom Chart

<b>Condition</b>	<b>Possible Sources</b>	<b>Action</b>
<ul style="list-style-type: none"> <li>• <b>Hard Steering or Lack of Assist</b></li> </ul>	<ul style="list-style-type: none"> <li>• Seized lower steering column shaft U-joints.</li> <li>• Damaged, fractured steering column bearing(s).</li> <li>• Power steering pump.</li> <li>• Suspension components.</li> <li>• Steering gear internal leakage.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>INSTALL</b> a new lower steering column shaft.</li> <li>• <b>REPAIR</b> the steering column.</li> <li>• <b>GO</b> to Pump Flow and Pressure Test Component Test</li> <li>• <b>REFER</b> to Wheels and Tires for suspension system diagnosis and testing.</li> <li>• <b>GO</b> to Pump Flow and Pressure Test Component Test</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Excessive Steering Pump Noise</b></li> </ul>	<ul style="list-style-type: none"> <li>• Power steering pump.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>GO</b> to Pump Flow and Pressure Test Component Test</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Excessive Steering Wheel Play</b></li> </ul>	<ul style="list-style-type: none"> <li>• Damaged, loose, or worn tie-rod end</li> <li>• Loose, worn or damaged front wheel spindle tie-rod</li> <li>• Damaged/worn steering gear.</li> <li>• Loose, worn or damaged steering column bearing(s).</li> <li>• Loose, worn or damaged lower steering column shaft U-joint(s).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>GO</b> to the Steering Linkage Component Test.</li> <li>• <b>GO</b> to the Tie-Rod Articulation Torque Component Test.</li> <li>• <b>INSTALL</b> a new steering gear.</li> <li>• <b>INSTALL</b> new steering column bearing(s).</li> <li>• <b>INSTALL</b> a new lower steering column shaft.</li> </ul>

Condition	Possible Sources	Action
<ul style="list-style-type: none"> <li>• Wander</li> </ul>	<ul style="list-style-type: none"> <li>• Unevenly loaded or overloaded vehicle.</li> <li>• Loose, worn or damaged front wheel spindle tie-rod.</li> <li>• Loose, worn or damaged tie-rod ends.</li> <li>• Loose or damaged steering gear mounting bolts.</li> <li>• Loose lower steering column shaft U-joint bolts.</li> <li>• Loose, worn or damaged lower steering column shaft U-joints.</li> <li>• Loose, worn or damaged steering column bearing(s).</li> <li>• Suspension components.</li> </ul>	<ul style="list-style-type: none"> <li>• INFORM the customer of incorrect vehicle loading.</li> <li>• GO to the Tie-Rod Articulation Torque Component Test.</li> <li>• GO to the Steering Linkage Component Test.</li> <li>• INSTALL new or TIGHTEN the bolts.</li> <li>• TIGHTEN the bolts.</li> <li>• INSTALL a new lower steering column shaft.</li> <li>• INSTALL new steering column bearing(s).</li> <li>• REFER to Suspension for suspension system diagnosis and testing.</li> </ul>
<ul style="list-style-type: none"> <li>• Drift/Pull</li> </ul>	<ul style="list-style-type: none"> <li>• Unevenly loaded or overloaded vehicle.</li> <li>• Wheel alignment.</li> <li>• Loose, worn or damaged front wheel spindle tie-rod.</li> <li>• Loose, worn or damaged tie-rod ends.</li> <li>• Suspension components.</li> <li>• The steering gear valve effort out of balance.</li> <li>• Check the brake system for proper operation.</li> <li>• Improper frame/underbody alignment.</li> </ul>	<ul style="list-style-type: none"> <li>• INFORM the customer of incorrect vehicle loading.</li> <li>• ADJUST as required.</li> <li>• GO to the Tie-Rod Articulation Torque Component Test.</li> <li>• GO to the Steering Linkage Component Test.</li> <li>• REFER to Suspension for suspension system diagnosis and testing.</li> <li>• GO to Steering Gear Valve Component Test</li> <li>• REFER to Suspension</li> <li>• CORRECT as required. REFER to Frame Dimension Manual.</li> </ul>
<ul style="list-style-type: none"> <li>• Feedback</li> </ul>	<ul style="list-style-type: none"> <li>• Loose, worn or damaged front wheel spindle tie-rod.</li> <li>• Loose, worn or damaged tie-rod ends.</li> <li>• Loose or damaged steering gear insulators or bolts.</li> <li>• Loose lower steering column shaft U-joint bolts.</li> <li>• Loose suspension bushings, fasteners or ball joints.</li> <li>• Worn or damaged steering column bearing(s).</li> </ul>	<ul style="list-style-type: none"> <li>• GO to the Tie-Rod Articulation Torque Component Test.</li> <li>• GO to the Steering Linkage Component Test.</li> <li>• INSTALL new or TIGHTEN the retaining bolts.</li> <li>• TIGHTEN the bolts.</li> <li>• INSTALL new suspension components as necessary.</li> <li>• INSTALL new steering column bearing(s).</li> </ul>

<b>Condition</b>	<b>Possible Sources</b>	<b>Action</b>
<ul style="list-style-type: none"><li>• <b>Poor Returnability/Sticky Steering</b></li></ul>	<ul style="list-style-type: none"><li>• Binding lower steering column shaft U-joints.</li><li>• Loose, worn or damaged front wheel spindle tie-rod.</li><li>• Loose, worn or damaged tie-rod ends.</li><li>• Suspension components.</li><li>• Binding steering column bearing(s).</li></ul>	<ul style="list-style-type: none"><li>• <b>INSTALL</b> a new lower steering column shaft.</li><li>• <b>GO</b> to the Tie-Rod Articulation Torque Component Test.</li><li>• <b>GO</b> to the Steering Linkage Component Test.</li><li>• <b>REFER</b> to Suspension. for suspension system diagnosis and testing.</li><li>• <b>INSTALL</b> new steering column bearing(s).</li></ul>
<ul style="list-style-type: none"><li>• <b>Shimmy</b></li></ul>	<ul style="list-style-type: none"><li>• Loose, worn or damaged tie-rod end.</li><li>• Loose, worn or damaged front wheel spindle tie-rod.</li><li>• Suspension components.</li></ul>	<ul style="list-style-type: none"><li>• <b>GO</b> to the Steering Linkage Component Test.</li><li>• <b>GO</b> to the Tie-Rod Articulation Torque Component Test.</li><li>• <b>REFER</b> to Suspension. for suspension system diagnosis and testing.</li></ul>