Steering System

Special Tool(s)

 ST1300-A	100W/12 Volt DC UV Lamp 164-R0751
 ST1396-A	Dial Thermometer 0-220°F 023-R0007 or equivalent
 ST2670-A	Evacuation Cap, Power Steering 211-265 or equivalent
 ST1176-A	Vacuum Pump Kit 416-D002 (D95L-7559-A) or equivalent
 ST2834-A	Vehicle Communication Module (VCM) and Integrated Diagnostic System (IDS) software with appropriate hardware, or equivalent scan tool

Material

Item	Specification
Dye-Lite® ATF/Power Steering Fluid Leak Detection Dye 164-R3701 (Rotunda)	—
MERCON® V Automatic Transmission Fluid XT-5-QM (or XT-5-QMC) (US); CXT-5-LM12 (Canada)	MERCON® V

Principles of Operation

Power Steering

The power steering system uses a vane-type pump to move the fluid from the reservoir to the steering gear and through the rest of the steering hydraulic system. The power steering pump is mounted to the engine and driven

by the engine accessory drive belt. Power steering fluid flows into the pump from the reservoir. The power steering fluid is trapped between the pump vanes and moved to the high-pressure side of the pump, creating a flow of fluid. The restriction of this flow by the steering gear creates the pressure that provides the steering assist. A combined pressure relief/flow valve is built into the pump to control the maximum pressure and flow provided to the steering system. This action prevents damage to the system and provides the correct level of assist during all engine speeds. While under pressure, the power steering fluid flows through the high-pressure power steering line to the steering gear. The fluid exits the gear and flows through the return line, cooler and finally to the reservoir. The reservoir slows the fluid, allows air to escape and filters the fluid before returning it to the pump.

Inspection and Verification

1. Verify the customer concern.

2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
• Fluid level • Tire pressure • Tires • Drive belt • Drive belt tensioner (if equipped) • Steering column alignment • Tie-rod ends • Suspension components • Steering column shaft U-joints • Steering column shaft bolts • Power steering reservoir screen or filter • Pressure lines, fittings or O-rings • Power steering return hoses and clamps • Steering gear • Power steering pump • Power steering fluid cooler (if equipped) • Power Steering Pressure (PSP) switch

3. Inspect the power steering fluid for the following conditions:
   - Aeration or foam: Purge the power steering system. Refer to Power Steering System Purging in this section.
   - Overheating or contamination: Flush the power steering system. Refer to Power Steering System Flushing in this section.

4. **NOTE:** It may be necessary to add power steering fluid to achieve the correct level.

   Check the fluid level and clean the power steering components.
   With the ignition OFF:
   - check the power steering fluid level and add fluid as necessary.
   - wipe off any visible signs of fluid or residue build up.
   - ***NOTICE:*** **Do not hold the steering wheel at the stops for an extended amount of time. Damage to the power steering pump may occur.**

     Start the engine and turn the steering wheel from stop-to-stop several times.

5. Visually inspect the power steering hydraulic line/hose connections for damage or leaks.

- If a leak is detected at a threaded fitting or clamp plate joint, tighten to specification. If the leak is still evident, visually inspect the O-rings or Teflon® seals. Install new O-rings or Teflon® seals as necessary.

Refer to Section 211-02 .

- If a leak is detected at a constant tension spring clamp, verify that the hose is not damaged and fully installed on the hose fitting. Make sure that the constant tension spring clamp is positioned 2 mm (0.078 in) from the end of the hose. If the leak remains, install a new constant tension spring clamp.
- If a leak is detected at a screw clamp joint, verify that the hose is not damaged and fully installed on the hose fitting and the clamp is positioned 2 mm (0.078 in) from the end of the hose before tightening the screw clamp. If the leak remains, install a new screw clamp. Refer to Section 211-02 .
- If a leak is detected at the Power Steering Pressure (PSP) switch, install a new switch as necessary.

6. Visually inspect the power steering components for leaks.

- If a leak is detected in the pressure or return line, install a new line. Refer to Section 211-02 .
- If a leak is detected in the power steering pump, install a new power steering pump. Refer to Section 211-02 .
- **NOTE:** On vehicles with rack-and-pinion steering gear, it may be necessary to remove the bellows boot clamp from the steering gear bellows boot to inspect for internal steering gear leaks.

  If a leak is detected in the steering gear, repair or install a new steering gear. Refer to Section 211-02 .
- If a leak is detected in the power steering reservoir, install a new reservoir. Refer to Section 211-02 .

7. For information on power steering leak detection, refer to Component Tests in this section.

8. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding.

9. If the cause is not visually evident, verify the symptom and GO to Symptom Chart - Steering System or GO to Symptom Chart - NVH .

Steering System Symptom Definitions

Drift/Pull

Pull is described as 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 the hands off the steering wheel.

- A vehicle-related drift/pull on a flat road can cause a consistent deviation from the straight-ahead path and require constant steering input in the opposite direction to counteract the effect.
- Drift/pull can be induced by conditions external to the vehicle, such as wind or 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.

Lack of Assist or Inconsistent Assist

Lack of assist or inconsistent assist is experienced when the steering wheel effort is higher than normal. 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 poor returnability/sticky steering.

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 or during high-effort parking maneuvers.

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 steering correction is completed.

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 — Steering System

Symptom Chart — Steering System

Condition	Possible Sources	Action
• Steering has lack of assist or inconsistent assist	• Contaminated power steering fluid • Steering gear • Power steering pump • Restricted power steering lines/hoses	• GO to Pinpoint Test A .
• Excessive steering wheel play	• Steering gear • Steering column shaft/U-joints • Steering linkage	• GO to Pinpoint Test B .
• Steering system drift/pull/wander	• Steering column shaft/U-joints • Steering gear mounts • Steering gear valve	• GO to Pinpoint Test C .
• Poor returnability/sticky steering	• Binding steering column shaft/U-joints • Suspension components • Binding steering column bearing(s) • Binding dash boot seal • Steering gear	• INSTALL a new steering column shaft. REFER to Section 211-04 . • To continue the suspension diagnosis, REFER to Section 204-00 . • INSTALL a new steering column. REFER to Section 211-04 . • INSTALL a new dash boot seal. REFER to Section 211-04 . • The steering gear cannot be adjusted. INSTALL a new steering gear as necessary. REFER to Section 211-02 .

Symptom Chart — NVH

Symptom Chart — NVH

NOTE: NVH symptoms should be identified using the diagnostic tools that are available. For a list of these tools, an explanation of their uses and a glossary of common terms, refer to Section 100-04 . Since it is possible any one of multiple systems may be the cause of a symptom, it may be necessary to use a process of elimination type of diagnostic approach to pinpoint the responsible system. If this is not the causal system for the symptom, refer back to Section 100-04 for the next likely system and continue diagnosis.

Condition	Possible Sources	Action
• Steering system cold start noise	• Blockage in the power steering fluid	• **NOTE:** Some noise during an extremely cold start (-12.2℃ [-

	reservoir caused by power steering fluid contamination	10°F]) is normal and should improve as the steering system warms up (usually within 60 seconds). • **NOTE:** It may be necessary to remove the power steering fluid reservoir to flush contamination trapped in the reservoir screen. CHECK the power steering fluid reservoir for contamination. FLUSH the power steering system as necessary. REFER to Power Steering System Flushing in this section.
	• Air in the steering hydraulic system (aerated fluid)	• CHECK for leaks in the system. REFER to Power Steering Leak Test Component Test in this section. PURGE the air from the system. REFER to Power Steering System Purging in this section.
• Steering grunt or shudder — occurs when turning into or out of a turn at low speeds (temperature sensitive)	• Air in the steering hydraulic system (aerated fluid)	• CHECK for leaks in the system. REFER to Power Steering Leak Test Component Test. PURGE the air from the system. REFER to Power Steering System Purging in this section.
	• Steering gear or power steering hoses	• GO to Steering Gear Grunt/Shudder Component Test in this section.
• Steering system clonk — hydraulic knocking sound	• Air in the steering hydraulic system (aerated fluid)	• **NOTE:** Some amount of clonk noise is considered acceptable. If in doubt of the acceptability, compare to another vehicle. CHECK for leaks in the system. REFER to Power Steering Leak Test Component Test in this section. PURGE the air from the system. REFER to Power Steering System Purging in this section.
• Power steering pump moan — loud humming noise occurs when the steering wheel is rotated to the stop position. Produces a 120-600 Hz frequency that changes with rpm	• Low fluid and/or air in the steering hydraulic system (aerated fluid)	• CHECK for leaks in the system. REFER to Power Steering Fluid Leak Test Component Test. PURGE the air from the system. REFER to Power Steering System Purging in this section. If a pump moan still exists, INSTALL a new power steering pump. REFER to Section 211-02.
	• Power steering fluid reservoir or screen is blocked or damaged	• **NOTE:** It may be necessary to remove the power steering fluid reservoir to flush contamination trapped in the reservoir screen. CHECK the power steering fluid reservoir for contamination. FLUSH the power steering system as necessary. REFER to Power Steering System

		Flushing in this section.
	• Power steering line/hose grounded to chassis	• INSPECT the power steering lines/hoses. REPAIR as necessary.
	• Power steering pump bolts loose	• TIGHTEN bolts to specification. REPAIR or INSTALL new brackets as necessary. REFER to Section 211-02.
	• Steering gear isolators	• INSPECT the isolators for wear or damage. REPAIR as necessary.
• Steering gear clunk — occurs only while cornering over a bump (can be temperature sensitive)	• Steering gear	• INSPECT the steering gear for loose mounting bolts. TIGHTEN to specification as necessary. REFER to Section 211-02.
• Feedback (rattle, chuckle or knocking noise in the steering gear) — roughness is felt in the steering wheel when the vehicle is driven over rough surfaces	• Steering column shaft/U-joints damaged or worn	• INSTALL a new steering column shaft. REFER to Section 211-04.
	• Loose, damaged or worn tie-rod ends	• INSPECT and INSTALL new tie-rod ends as necessary. GO to Steering Linkage Component Test in this section.
	• Steering gear insulators or mounting bolts loose or damaged	• TIGHTEN the bolts to specification or INSTALL new bolts as necessary. REFER to Section 211-02.
	• Steering column shaft bolts are loose	• TIGHTEN the bolts to specification. REFER to Section 211-04.
	• Steering column damaged or worn	• REPAIR or INSTALL a new steering column as necessary. REFER to Section 211-04.
• Power steering hiss or whistle	• Steering column shaft-to-steering gear is binding or misaligned	• REPAIR or INSTALL a new steering column shaft as necessary. REFER to Section 211-04.
	• Grounded or loose steering column boot at the dash panel	• REPAIR as necessary.
	• Damaged or worn steering gear input shaft and valve	• REPAIR or INSTALL a new steering gear as necessary. REFER to Section 211-02.
	• Restricted power steering lines/hoses	• INSTALL new power steering lines/hoses as necessary. REFER to Section 211-02.
• Steering column rattle	• Loose bolts or attaching brackets	• TIGHTEN the bolts to specification.
	• Loose, worn or insufficiently lubricated column bearings	• LUBRICATE bearings or INSTALL new steering column bearings or steering column as necessary. REFER to Section 211-04.
	• Steering shaft	• INSTALL new insulators.

	insulators damaged or worn	REFER to Section 211-04 .
	• Steering column shaft compressed or extended	• INSPECT the rubber spider coupling for damage. INSTALL a new steering column shaft. REFER to Section 211-04 .
• Steering gear squeak	• Incorrect power steering fluid in system	• If incorrect power steering fluid is suspected, FLUSH the power steering system. REFER to Power Steering System Flushing in this section. If noise persists after system flush, INSTALL a new steering gear. REFER to Section 211-02 .
	• Steering gear rotary seal	• **NOTE:** VERIFY that the steering gear is the source of the noise. It may be necessary to replicate the customer operating conditions (fluid temperature, turning rate of steering wheel) to get the squeak to reoccur. INSTALL a new steering gear as necessary. REFER to Section 211-02 .
	• Stone shield (if equipped)	• MAKE SURE that the stone shield is correctly installed and that it is not making contact with the steering shaft. REPOSITION stone shield or INSTALL a new stone shield as necessary.
• Steering column squeak, clicks or grinds	• Loose or misaligned steering column shrouds	• TIGHTEN or ALIGN the steering column shrouds.
	• Steering wheel rubbing against steering column shrouds	• REPOSITION the steering column shrouds.
	• Upper or lower steering column bearing	• INSTALL a new steering column or steering column bearings as necessary.
• Power steering pump noisy	• Power steering pump	• INSTALL a new power steering pump as necessary. REFER to Section 211-02 .
• Power steering pump noise (steering wheel turned fully to stop/lock)	• Power steering fluid flow into the bypass valve of the pump valve housing, with fluid temperature below 54℃ (130℉)	• Acceptable condition.
• Power steering pump whine noise	• Aerated fluid	• CHECK for a leak in the system. REFER to Power Steering Fluid Leak Test Component Test in this section. PURGE the air from the system. REFER to Power Steering System Purging in this section.
	• Damaged power steering pump	• INSTALL a new power steering pump as necessary. REFER to

		Section 211-02 .
• High speed shake or shimmy — occurs at high speeds	• Worn or damaged steering linkage components	• GO to Steering Linkage Component Test in this section.

Pinpoint Tests

Pinpoint Test A: Steering Has Lack of Assist or Inconsistent Assist

NOTE: Hard steering or lack of assist is experienced when the steering wheel effort is higher than normal. Hard steering can remain constant through the full turn, occur near the end of a turn or differ right to left.

This pinpoint test is intended to diagnose the following:

- Power steering fluid contamination
- Steering gear
- Power steering pump
- Power steering hoses

PINPOINT TEST A: STEERING HAS LACK OF ASSIST OR INCONSISTENT ASSIST

Test Step	Result / Action to Take
A1 CHECK FOR POWER STEERING FLUID CONTAMINATION	
• Check the power steering fluid for contamination. • **Is the power steering fluid contaminated?**	**Yes** FLUSH the power steering system. REFER to Power Steering System Flushing in this section. CHECK the system for normal operation. If assist concern still exists, GO to A2 . **No** GO to A2 .
A2 CHECK THE STEERING ASSIST WITH THE ENGINE RPM RAISED	
• ***NOTICE:*** **Do not hold the steering wheel at the stops for an extended amount of time. Damage to the power steering pump may occur.** • Set the engine at 2,100 rpm and turn the steering wheel fully to the left and right. • **Is steering assist fully restored to normal with the engine rpm raised?**	**Yes** INSTALL a new power steering pump. REFER to Section 211-02 . **No** GO to A3 .
A3 CHECK FOR A CHANGE OF ASSIST ON LEFT AND RIGHT TURNS	
• With the engine at idle, turn the steering wheel fully to the left and to the right. • **Does the steering assist change when turning from right to left?**	**Yes** INSTALL a new steering gear. REFER to Section 211-02 . **No** GO to A4 .
A4 CHECK THE STEERING LINES AND HOSES FOR RESTRICTIONS	
• Inspect the steering lines and hoses for damage, kinks or restrictions. • **Are the steering lines or hoses damaged,**	**Yes** INSTALL new lines or hoses as necessary.

kinked or restricted?	**No** GO to A5 .
A5 MONITOR THE ENGINE RPM CHANGES ***NOTICE:* Do not hold the steering wheel at the stops for an extended amount of time. Damage to the power steering pump may occur.** **NOTE:** Make sure that the vehicle is on a flat dry surface, all accessories are in the OFF position and that the steering system is at normal operating temperature. • Connect the scan tool. • Start the engine. • With the engine at idle, raise the power steering fluid temperature to 74-80℃ (165-176℉) by rotating the steering wheel fully to the left and right several times. • Enter the following diagnostic mode on the scan tool: DataLogger — PCM. • Monitor the Engine Revolutions Per Minute (RPM) PID while turning the steering wheel quickly to the left stop position and then to the right stop position. • Note the engine rpm during the turns. • **Does the engine rpm change (even temporarily) more than 30 rpm when turning the steering wheel?**	**Yes** INSTALL a new steering gear. REFER to Section 211-02 . **No** INSTALL a new power steering pump. REFER to Section 211-02 .

Pinpoint Test B: Excessive Steering Wheel Play

This pinpoint test is intended to diagnose the following:

- Steering linkage
- Steering column shaft U-joints
- Steering gear

PINPOINT TEST B: EXCESSIVE STEERING WHEEL PLAY

Test Step	Result / Action to Take
B1 CHECK THE STEERING LINKAGE • Carry out the Steering Linkage Component Test in this section. • **Is the steering linkage OK?**	**Yes** GO to B2 . **No** INSTALL new steering linkage components as necessary. Refer to the appropriate section in Group 211 for the procedure.
B2 CHECK THE STEERING COLUMN SHAFT • Inspect the steering column shaft U-joints and fasteners for looseness. • **Are the U-joints and fasteners OK?**	**Yes** INSTALL a new steering gear as necessary. REFER to Section 211-02 . **No** TIGHTEN the steering column shaft fasteners or INSTALL a new steering column shaft. REFER to Section 211-04 .

Pinpoint Test C: Steering System Drift/Pull/Wander

This pinpoint test is intended to diagnose the following:

- Steering gear
- Steering column shaft
- Steering column shaft U-joints
- Steering gear mounts

PINPOINT TEST C: STEERING SYSTEM DRIFT/PULL/WANDER

Test Step	Result / Action to Take
C1 CHECK THE STEERING COLUMN SHAFT **NOTE:** Be sure to keep the clockspring centered when disconnecting the intermediate shaft. Refer to the appropriate section in Group 501 for the procedure. • Check the steering column and shaft for grounding. • Disconnect the steering column shaft at the steering column. • Inspect the steering column shaft U-joints for looseness or wear. • **Are the steering column shaft U-joints OK?**	**Yes** GO to C2. **No** INSTALL a new steering column shaft as necessary. REFER to Section 211-04.
C2 CHECK THE STEERING GEAR MOUNTING • Check the steering gear mounts for looseness or wear. • **Are the steering gear mounts OK?**	**Yes** GO to C3. **No** INSTALL a new steering gear as necessary. REFER to Section 211-02.
C3 CHECK THE STEERING GEAR • Carry out the Steering Gear Valve Component Test in this section. • **Is the steering gear valve OK?**	**Yes** REFER to Section 204-00 to diagnose suspension system drift/pull/wander. **No** REPAIR or INSTALL a new steering gear as necessary. REFER to Section 211-02.

Component Tests

Power Steering Fluid Leak Test

NOTE: This test should only be carried out if a leak in the system has not been detected during a thorough visual inspection. Refer to Inspection and Verification in this section.

1. Remove the power steering pump reservoir cap and check the power steering fluid level. If necessary, add the specified power steering fluid.

2. Tightly install the Power Steering Evacuation Cap onto the reservoir and connect the Vacuum Pump Kit to the Evacuation Cap.

3. Using the Vacuum Pump Kit, apply 68-85 kPa (20-25 in-Hg) of vacuum to the power steering system.

4. Observe the vacuum gauge for 30 seconds. If the vacuum gauge reading drops more than 3 kPa (0.88 in-Hg), a leak is present.

5. Remove the Vacuum Pump Kit.

6. Start the engine and insert the Dial Thermometer into the Evacuation Cap.

7. ***NOTICE:*** **Do not hold the steering wheel at the stops for an extended amount of time. Damage to the power steering pump may occur.**

   With the engine at idle, raise the power steering fluid temperature to 74-80°C (165-176°F) by rotating the steering wheel fully to the left and right several times.

8. Stop the engine and visually inspect the system for leaks.
   - If a leak is evident, repair as necessary.
   - If a leak is not evident, add the specified UV fluorescent tracer dye to the power steering fluid. Use 14.78 ml (1/2 oz) of dye solution for every 1.89L (2 qt) of power steering fluid.

9. Start the engine.

10. ***NOTICE:*** **Do not hold the steering wheel at the stops for an extended amount of time. Damage to the power steering pump may occur.**

    With the engine at idle, raise the power steering fluid temperature to 74-80°C (165-176°F) by rotating the steering wheel fully to the left and right several times.

11. Stop the engine and inspect the system for traces of UV dye using the 100W/12 Volt DC UV Lamp. Repair as necessary.

Steering Gear Valve Test

1. With the vehicle in NEUTRAL, position it on a hoist. Refer to Section 100-02 .
   - Raise the vehicle until the front wheels are off the ground.

2. **NOTE:** Do not hold the steering wheel while carrying out this step.

   Start the engine.
   - If the steering wheel rotates in either direction (with no hand input), install a new steering gear. Refer to Section 211-02 .

Steering Gear Grunt/Shudder Test

1. Place a Dial Thermometer in the power steering fluid reservoir.

2. With the engine cold, start the engine and set engine idle speed to 1,200 rpm.

3. ***NOTICE:*** **Do not hold the steering wheel against the stops for an extended amount of time. Damage to the power steering pump may occur.**

   Rotate the steering wheel to the RH stop, then turn the steering wheel 90 degrees back from that position. Slowly turn the steering wheel back and forth approximately one-twelfth of a full turn.

4. Turn the steering wheel another 90 degrees. Slowly turn the steering wheel back and forth approximately one-twelfth of a full turn.

5. Repeat the test with the power steering fluid at different temperatures until the temperature reaches 74-80°C (165-176°F).

6. If a light grunt is heard or a low (50-200 Hz) shudder is present, this is a normal steering system condition.

7. If a loud grunt is heard or a strong shudder is felt, purge the power steering system. Refer to Power Steering System Purging in this section. If a loud grunt or strong shudder still exists, check the power steering lines/hoses for restrictions or damage and repair as necessary. Refer to Section 211-02 . If the lines/hoses are OK, install a new steering gear. Refer to Section 211-02 .

Steering Linkage Test

1. With the vehicle in NEUTRAL, position it on a hoist. Refer to Section 100-02 .

2. Using hand force only, check the inner and outer tie rods for vertical and lateral movement in the tie-rod ball studs/sockets.
    - If there is any lateral or vertical movement in the tie-rod ball studs/sockets (inner or outer), a new tie rod must be installed. Refer to the appropriate section in Group 211 for the procedure.