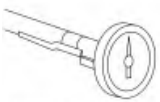


Power Steering

Materials

Name	Specification
Automatic Transmission Fluid (ATF)/Power Steering Fluid Leak Detection Dye 164-R3701 (Rotunda)	-
Motorcraft® MERCON® LV Automatic Transmission Fluid XT-10-QLVC	WSS-M2C938-A MERCON® LV,

Special Tool(s)

 ST1300A	100W/12 Volt DC UV Lamp 164-R0751
 ST1396A	Dial Thermometer 0-220°F 023-R0007 or equivalent
 ST2670A	Evacuation Cap, Power Steering 211-265 or equivalent
 ST1477A	Power Steering Analyzer (OTC 5079) or equivalent
 ST1176A	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 -

Principles of Operation

Hydraulic Steering Assist Without Electronic Steering Assist

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 into the HydroMax (if equipped). The HydroMax uses the power steering pressure to provide hydraulic pressure assist to the hydraulic brakes. The fluid exits the HydroMax to the

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.

Hydraulic Steering Assist With Electronic Steering Assist

Vehicles equipped with an electronic steering actuator operate in the same manner as described above with the addition of the steering actuator positioned between the steering gear and the steering column. The steering actuator provides supplemental steering assist for features such as PTBA and Lane Departure Warning (LDW). The electronic steering actuator is composed of an integrated electrical motor and PSCM. The motor operation and level of steering assist provided is controlled by the PSCM.

For additional information on the electronic steering actuator system,

REFER to: Power Steering - Vehicles With: Electronic Steering Actuator - System Operation and Component Description (211-02 Power Steering, Description and Operation).

Material

Item	Specification
Material: Automatic Transmission Fluid (ATF)/Power Steering Fluid Leak Detection Dye / 164-R3701 (Rotunda)	â€”
Material: Motorcraft® MERCON® LV Automatic Transmission Fluid / XT-10-QLVC (WSS-M2C938-A) (MERCON® LV,)	MERCON® LV

Preliminary Inspection

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage or leaks.

Visual Inspection Check

- Fluid level
 - Tire pressure
 - Tires
 - Drive belt
 - Drive belt tensioner
 - Steering column alignment
 - Tie-rod ends
 - Suspension components
 - Steering column shaft U-joints
 - Intermediate shaft bolts
 - Power steering reservoir baffle
 - Power steering reservoir screen
 - Power steering pressure lines, fittings or O-rings
 - Power steering return hoses and clamps
 - Steering gear
 - Power steering pump
 - Power steering fluid cooler (if equipped)
 - Electronic Steering Actuator (ESA) (if equipped)
3. Inspect the power steering fluid for the following conditions:
 - Aeration or foam Purge the power steering system.
REFER to: Power Steering System Purging (211-02 Power Steering, General Procedures).
 - Overheating or contamination: Flush the power steering system.
REFER to: Power Steering System Flushing (211-02 Power Steering, General Procedures).
 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. Automatic Transmission Fluid (WSS-M2C938-A; MERCON® LV)

- wipe off any visible signs of fluid or residue build up.

5. NOTICE: Do not hold the steering wheel at the stops for more than 5 seconds. Damage to the power steering pump may occur.

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

- Visually inspect the power steering hydraulic line and 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.
 - If a leak is detected at a constant tension spring clamp, verify the hose is not damaged and is fully installed on the hose fitting. Make sure 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.
- Visually inspect the power steering components for leaks.
 - If a leak is detected in the power steering pressure line or return hose, install a new power steering pressure line or hose.
 - If a leak is detected in the steering gear turn tubes, repair or install new turn tubes.
 - If a leak is detected in the power steering pump, install a new power steering pump.
REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
or REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation).
 - If a leak is detected in the steering gear, repair or install a new steering gear.
REFER to: Steering Gear (211-02 Power Steering, Removal and Installation).
or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
 - If a leak is detected in the power steering cooler, install a new cooler.
REFER to: Power Steering Fluid Cooler (211-02 Power Steering, Removal and Installation).
or REFER to: Power Steering Fluid Cooler - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
- For information on power steering leak detection, refer to Component Tests in this section.
- If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding.
- 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 or 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

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.
REFER to: Diagnostic Methods (100-00 General Information, Description and Operation).

Condition	Possible Sources	Action
Steering has lack of assist or inconsistent assist	Refer to the Pinpoint Test	GO to Pinpoint Test A
Excessive steering wheel play	Refer to the Pinpoint Test	GO to Pinpoint Test B
Steering system drift, pull or wander	Refer to the Pinpoint Test	GO to Pinpoint Test C
Poor returnability, binding or sticky steering	Refer to the Pinpoint Test	GO to Pinpoint Test H

Symptom Chart – NVH

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.
REFER to: Diagnostic Methods (100-00 General Information, Description and Operation).

NVH symptoms should be identified using the diagnostic tools available. For a list of these tools, an explanation of their uses and a glossary of common terms,

REFER to: Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Description and Operation).

. 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 to: Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
for the next likely system and continue diagnosis.

Condition	Possible Sources	Action
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 coupling joints damaged or worn	INSTALL a new steering column shaft. REFER to: Steering Column Lower Shaft (211-04 Steering Column, Removal and Installation). or REFER to: Steering Column Upper Shaft (211-04 Steering Column, Removal and Installation).
	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 if equipped, or mounting bolts loose or damaged	TIGHTEN the bolts to specification or INSTALL new bolts as necessary. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
	Steering column shaft coupling bolts are loose	TIGHTEN the bolts to specification. or REFER to: Steering Column Upper Shaft (211-04 Steering Column, Removal and Installation).
	Steering column damaged or worn	REPAIR or INSTALL a new steering column as necessary. REFER to: Steering Column (211-04 Steering Column, Removal and Installation).

Condition	Possible Sources	Action
Front End Noise - During Acceleration (Tip-In) Or Deceleration (Tip-Out) May Occur With Braking	NOTE: Noises when accelerating or decelerating involve parts which move during an acceleration tip-in (pressing foot on gas pedal) or parts which move during deceleration tip-out (when taking foot off gas pedal). These noises are not typically associated with the steering gear. • Steering shaft slip joints or lower input shaft (requires lubrication) • Roll restrictor • Powertrain mounts • Exhaust heat shield (tinny rattle) • Exhaust isolators and brackets • Subframe mounts • Engine to chassis wiring, tubes, brackets (loose or out of position)	GO to Pinpoint Test F
Front End Noise - During Braking	NOTE: If the noise occurs during braking and during tip-in or tip-out, this is not typically a steering gear related noise. • Caliper anchors, calipers or brake pads • Top strut mount or bearings (if equipped) • Lower control arm attachment to sub frame bushings and bolts • Engine to chassis wiring, tubes or brackets (loose or out of position) • Powertrain mounts or engine roll restrictor mounts • Exhaust isolators or brackets • Steering shaft slip joints • Subframe mounts	GO to Pinpoint Test F
Front End Noise - Driving Straight On Smooth Roads	NOTE: Front end noises while driving straight involve parts which rotate continuously while the road wheels are rotating. Typically not a steering gear. NOTE: Wheel hub bearings can produce noise after achieving 56 km/h (35 mph) while driving straight if they are worn. • Rotating Sources: • Axle shafts • Carrier bearing (noise is typically felt through the console) • Drive shafts • Transfer case assembly (if equipped) • Wheel hub and wheel bearings (typically higher speeds) • Wind Sources: • Air dams • Heat shields • Radiator ducts or shields • Wheel well splash shields	GO to Pinpoint Test G

Condition	Possible Sources	Action
Front End Noise - Over Bumps, Rough Roads, Dips, Depressions Or When Entering A Driveway	NOTE: <i>Noises over bumps and rough roads involve parts which move and contact during up and down motion.</i> • Jounce bumper • Stabilizer bar insulators or links • Front shock brackets or strut mounts • Loose steering gear tie rods • Loose steering gear bolts • Loose front brake calipers or pins • Loose lower control arm-to-subframe bolts or bushings • Loose ball joint • Loose exhaust heat shield, isolators or brackets • Subframe to body attachments points • Upper or lower steering shaft • Internal or external steering gear stops	GO to Pinpoint Test D
Front End Noise - Turning At Slow Speeds Or During Parking Lot Maneuvers	NOTE: <i>Exterior front end noises when turning at slow speeds involve parts which move, rotate or make contact during a partial or full turn.</i> • Springs, shocks, struts and bearings or bushings (most common) • Tires • Steering gear internal stops (full turn) • External steering stops (full turn) • Steering tie rods (loose) • Loose steering gear mounts or bolts • Stabilizer bar links and insulators • Integrated front wheel ends (4x4 only) • Front control arms and bushings • Subframe or crossmember condition, mounts or fasteners • Engine or transmission mounts	GO to Pinpoint Test D
High speed shake or shimmy “œ” occurs at high speeds	Worn or damaged steering linkage components	GO to Steering Linkage Component Test in this section.
Noise When Turning - Noticed More In The Interior	NOTE: <i>Interior cabin noises involve parts moving or contacting during a steering wheel turn or interior parts moving or contacting during steering column tilt or telescopic operations.</i> • Steering column shrouds • Steering shafts and steering shaft joints • Steering shaft boots or seals • Clockspring (when lubricant on the clockspring is dry or drying) • Steering column tilt or telescoping motor (if equipped) • Shifter cables (if equipped) • Adaptive front steering motor (if equipped)	GO to Pinpoint Test E
Power steering hiss or whistle	Steering column shaft coupling-to-steering gear is binding or misaligned	REPAIR or INSTALL a new steering column shaft as necessary. REFER to: Steering Column (211-04 Steering Column, Removal and Installation).
	Grounded or loose steering column boot at the dash panel	REPAIR as necessary.

Condition	Possible Sources	Action
	Damaged or worn steering gear input shaft and valve	REPAIR or INSTALL a new steering gear as necessary. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
	Restricted power steering lines or hoses	GO to Pinpoint Test A
	Hydro-Boost brake booster	- START the engine. - 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. - CARRY OUT the Power Steering Leak Test Component Test. - REPAIR any leaks found. - If no leaks are found, INSTALL a new Hydro-Boost brake booster. REFER to: Brake Booster - Vehicles With: Hydro-Boost, (206-07 Power Brake Actuation, Removal and Installation).
Power steering pump moan or 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 or 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 (211-02 Power Steering, General Procedures). - If a pump moan still exists, INSTALL a new power steering pump. REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation). or REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
	Blockage in the power steering fluid reservoir filter or return ports caused by power steering fluid contamination	NOTE: <i>It may be necessary to remove the power steering fluid reservoir to flush contamination trapped in the reservoir filter/screen or to remove blockage in the return ports.</i> CHECK the power steering fluid reservoir filter or return ports for contaminants or blockage. FLUSH the power steering system as necessary. REFER to: Power Steering System Flushing (211-02 Power Steering, General Procedures).
	Power steering line or hose grounded to chassis	INSPECT the power steering lines or hoses. REPAIR as necessary.

Condition	Possible Sources	Action
	Power steering pump brackets loose or misaligned	CHECK bolts, brackets and bracket alignment. TIGHTEN bolts to specification. REPAIR or INSTALL new brackets as necessary. REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation). or REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
Power steering pump noise (steering wheel turned fully to stop)	Power steering fluid flow into the bypass valve of the pump valve housing, with fluid temperature below 54Â°C (130Â°F)	Acceptable condition.
Power steering pump noisy	Blockage in the power steering fluid reservoir filter or return ports caused by power steering fluid contamination	NOTE: <i>It may be necessary to remove the power steering fluid reservoir to flush contamination trapped in the reservoir filter/screen or to remove blockage in the return ports.</i> CHECK the power steering fluid reservoir filter or return ports for contaminants or blockage. FLUSH the power steering system as necessary. REFER to: Power Steering System Flushing (211-02 Power Steering, General Procedures).
	Power steering pump	INSTALL a new power steering pump as necessary. REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation). or REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
Power steering pump whine noise	Aerated fluid	CHECK for a leak in the system. REFER to Power Steering Fluid Leak Test Component Test. PURGE the air from the system. REFER to: Power Steering System Purging (211-02 Power Steering, General Procedures).
	Blockage in the power steering fluid reservoir filter or return ports caused by power steering fluid contamination	NOTE: <i>It may be necessary to remove the power steering fluid reservoir to flush contamination trapped in the reservoir filter/screen or to remove blockage in the return ports.</i> CHECK the power steering fluid reservoir filter or return ports for contaminants or blockage. FLUSH the power steering system as necessary. REFER to: Power Steering System Flushing (211-02 Power Steering, General Procedures).
	Damaged power steering pump	INSTALL a new power steering pump as necessary. REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation). or REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
Steering column rattle	Loose bolts or attaching brackets	TIGHTEN the bolts to specification. REFER to: Steering Column (211-04 Steering Column, Removal and Installation).

Condition	Possible Sources	Action
	Loose, worn or insufficiently lubricated column bearings	LUBRICATE bearings or INSTALL new steering column bearings or steering column as necessary. REFER to: Steering Column (211-04 Steering Column, Removal and Installation).
	Steering column shaft coupling compressed or extended	INSPECT the rubber spider coupling for damage. INSTALL a new intermediate shaft as necessary. REFER to: Steering Column Lower Shaft (211-04 Steering Column, Removal and Installation). or REFER to: Steering Column Upper Shaft (211-04 Steering Column, Removal and Installation).
Steering column squeak, cracks 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.
Steering column ticking or creaking noise	Steering column lower bearing	VERIFY the noise is coming from the lower bearing and INSTALL a new steering column as necessary. REFER to: Steering Column (211-04 Steering Column, Removal and Installation).
Steering gear clunk “œ” 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: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, & (211-02 Power Steering, Removal and Installation).
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 (211-02 Power Steering, General Procedures). - If noise persists after system flush, INSTALL a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, & (211-02 Power Steering, Removal and Installation).
	Steering gear rotary seal	NOTE: Use the chassis ears to verify 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: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, & (211-02 Power Steering, Removal and Installation).
	Stone shield (if equipped)	VERIFY the stone shield is correctly installed and it is not making contact with the steering shaft. REPOSITION stone shield or INSTALL a new stone shield as necessary.

Condition	Possible Sources	Action
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 (211-02 Power Steering, General Procedures).
	Steering gear or power steering hoses	GO to Steering Gear Grunt or 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. PURGE the air from the system. REFER to: Power Steering System Purging (211-02 Power Steering, General Procedures).
Steering system cold start noise	Blockage in the power steering fluid reservoir filter screen or return ports caused by power steering fluid contamination	NOTE: Some noise during an extremely cold start (-12.2°C [-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 filter/screen or to remove blockage in the return ports. CHECK the power steering fluid reservoir filter or return ports for contaminants or blockage. FLUSH the power steering system as necessary. REFER to: Power Steering System Flushing (211-02 Power Steering, General Procedures).
	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 (211-02 Power Steering, General Procedures).

Pinpoint Tests

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

Diagnostic Overview

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.

Possible Causes

- Contaminated power steering fluid
- Steering gear
- Power steering pump
- Restricted power steering lines or hoses
- Electronic steering actuator (if equipped)

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

A1 CHECK FOR OPTIONAL VEHICLE EQUIPMENT

- Determine if the vehicle is equipped with an electronic steering actuator.

Is the vehicle is equipped with an electronic steering actuator?

Yes	GO to A2
No	GO to A4

A2 CHECK THE PSCM (POWER STEERING CONTROL MODULE) FOR DIAGNOSTIC TROUBLE CODES (DTCs)

- Ignition ON.
- Using a diagnostic scan tool, carry out the PSCM self-test.

Are there any Diagnostic Trouble Codes (DTCs) present in the PSCM?

Yes	☐ Click here to access Guided Routine (EPAS).
No	If the PSCM does not respond to the diagnostic scan tool, REFER to the Symptom Chart in the Interactive Diagnostics. ☐ Click here to access Guided Routine (EPAS). If the PSCM does respond to the diagnostic scan tool and there are no Diagnostic Trouble Codes (DTCs) present in the PSCM, GO to A3

A3 ISOLATE THE ELECTRONIC STEERING ACTUATOR

NOTE: Disabling the electronic steering actuator reduces steering assist by approximately 15%.

NOTE: Setting the ignition to ON with the EPAS motor fuse removed sets Diagnostic Trouble Codes (DTCs) in the PSCM and other modules. Make sure to clear all Diagnostic Trouble Codes (DTCs) once diagnostics are complete.

- Ignition OFF.
- Locate and remove the EPAS motor fuse in the BJB.
- Test drive the vehicle and evaluate for a lack of assist or inconsistent assist.

Is a lack of assist or inconsistent assist present?

Yes	GO to A4
No	INSTALL a new electronic steering actuator. REFER to: Electronic Steering Actuator (211-02 Power Steering, Removal and Installation).

A4 CHECK FOR POWER STEERING FLUID CONTAMINATION

- Check the power steering fluid for contamination.

Is the power steering fluid free of any contamination?

Yes	GO to A5
No	FLUSH the power steering system. REFER to: Power Steering System Flushing (211-02 Power Steering, General Procedures). TEST the system for normal operation. If the assist concern is still present, PURGE the power steering system. REFER to: Power Steering System Purging (211-02 Power Steering, General Procedures). TEST the system for normal operation. If the assist concern is still present, GO to A5

A5 CHECK THE STEERING ASSIST WITH THE ENGINE SPEED RAISED

- **NOTICE: Do not hold the steering wheel at the stops for more than 5 seconds. Damage to the power steering pump may occur.**

Set the engine speed to 2,100 rpm and turn the steering wheel fully to the left and right.

Is steering assist fully restored to normal with the engine speed raised?

Yes	INSTALL a new power steering pump. REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation). or REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation).
No	GO to A6

A6 CHECK FOR A CHANGE IN ASSIST ON LEFT AND RIGHT TURNS

- With the engine running 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 power steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With Hydro-Boost, g (211-02 Power Steering, Removal and Installation).
No	GO to A7

A7 CHECK THE STEERING LINES AND HOSES FOR RESTRICTIONS

- Inspect the steering lines and hoses for damage, kinks or restrictions.

Are the steering lines and hoses free from any damage, kinks or restrictions?

Yes	GO to A8
No	INSTALL new lines or hoses as necessary. TEST the system for normal operation.

A8 MONITOR THE ENGINE SPEED CHANGES

NOTICE: Do not hold the steering wheel at the stops for more than 5 seconds. Damage to the power steering pump may occur.

NOTE: Make sure the vehicle is on a flat dry surface, all accessories are in the OFF position and the steering system is at normal operating temperature.

- Connect the diagnostic tool.
- Start the engine.
- With the engine running at idle, raise the power steering fluid temperature to 74Â°- 80Â°C (165Â°-176Â°F) by rotating the steering wheel fully to the left and to the right several time.
- Using a diagnostic scan tool, monitor the Engine 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 speed change (even temporarily) by more than 30 RPM when turning the steering wheel?

Yes	INSTALL a new power steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation). Using a diagnostic scan tool, CARRY OUT the Network Test. CLEAR any steering related Diagnostic Trouble Codes (DTCs) from the reporting module.
No	INSTALL a new power steering pump. REFER to: Power Steering Pump - 6.2L V8 (211-02 Power Steering, Removal and Installation). or REFER to: Power Steering Pump - 6.7L Power Stroke Diesel (211-02 Power Steering, Removal and Installation). Using a diagnostic scan tool, CARRY OUT the Network Test. CLEAR any steering related Diagnostic Trouble Codes (DTCs) from the reporting module.

Pinpoint Test B: Excessive Steering Wheel Play

Diagnostic Overview

Possible Causes

- Steering gear
- Steering column shaft or U-joints
- Steering linkage
- Electronic steering actuator (if equipped)

PINPOINT TEST B : EXCESSIVE STEERING WHEEL PLAY

B1 CHECK FOR OPTIONAL VEHICLE EQUIPMENT

- Determine if the vehicle is equipped with an electronic steering actuator.

Is the vehicle is equipped with an electronic steering actuator?

Yes	GO to B2
No	GO to B3

B2 CHECK THE PSCM (POWER STEERING CONTROL MODULE) FOR DIAGNOSTIC TROUBLE CODES (DTCs)

- Ignition ON.
- Using a diagnostic scan tool, carry out the PSCM self-test.

Are there any Diagnostic Trouble Codes (DTCs) present in the PSCM?

Yes	□ Click here to access Guided Routine (EPAS).
No	If the PSCM does not respond to the diagnostic scan tool, REFER to the Symptom Chart in the Interactive Diagnostics. □ Click here to access Guided Routine (EPAS). If the PSCM does respond to the diagnostic scan tool and there are no Diagnostic Trouble Codes (DTCs) present in the PSCM, GO to B3

B3 CHECK THE STEERING LINKAGE

- Carry out the Steering Linkage Component Test in this section.

Is the steering linkage OK?

Yes	GO to B4
No	INSTALL new steering linkage components as necessary.

B4 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 power steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
No	TIGHTEN the steering column shaft fasteners or INSTALL a new steering column shaft. REFER to: Steering Column Lower Shaft (211-04 Steering Column, Removal and Installation). or REFER to: Steering Column Upper Shaft (211-04 Steering Column, Removal and Installation).

Pinpoint Test C: Steering System Drift, Pull or Wander

Diagnostic Overview

Possible Causes

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

PINPOINT TEST C : STEERING SYSTEM DRIFT, PULL OR WANDER

C1 CHECK FOR OPTIONAL VEHICLE EQUIPMENT

- Determine if the vehicle is equipped with an electronic steering actuator.

Is the vehicle is equipped with an electronic steering actuator?

Yes	☐ Click here to access Guided Routine (EPAS).
No	GO to C2

C2 VERIFY THE CONDITION TO BE RESOLVED IS NOT NOISE

- Attempt to replicate the customer concern.

Is this a noise concern?

Yes	DO NOT use this test. REFER to the Symptom Chart for the appropriate pinpoint test.
No	GO to C3

C3 VERIFY THE CONDITION TO BE RESOLVED IS NOT A BINDING OR STICKY STEERING CONDITION

- Attempt to replicate the customer concern.

Is this a binding or sticky steering concern?

Yes	DO NOT use this test. REFER to the Symptom Chart for the appropriate pinpoint test.
No	GO to C4

C4 VERIFY THE CONDITION TO BE RESOLVED IS NOT A STEERING WHEEL IS OFF CENTER CONDITION

- Attempt to replicate the customer concern.

Is this a steering returnability concern?

Yes	DO NOT use this test. REFER to the Symptom Chart for the appropriate pinpoint test.
No	GO to C5

C5 VEHICLE PULL OR DRIFT EVALUATION

- Test drive the vehicle in the following manner:
 - Drive straight on a constant right road crown, at a speed greater than 40 km/h (25 mph), with your hands on the steering wheel for more than 45 seconds.
 - Drive straight on a constant left road crown, at a speed greater than 40 km/h (25 mph), with your hands on the steering wheel for more than 45 seconds.
 - Drive straight on a road with constant minimal road crown, at a speed greater than 40 km/h (25 mph), with your hands on the steering wheel for more than 45 seconds.
- If the vehicle pulls left on a left crown, pulls right on a right crown and does not pull on flat (no crown) roads when driven as instructed above, the vehicle is performing as designed.

Is the vehicle performing as designed?

Yes	RETURN the vehicle to the customer and EXPLAIN the drift and pull compensation operation to the customer.
No	GO to C6

C6 CHECK THE STEERING WHEEL INSTALLATION

- Verify the steering wheel connection is not bent or twisted and the steering wheel has been correctly installed. Refer to Section 211-04.

Is the steering wheel connection undamaged and has the steering wheel been correctly installed?

Yes	For vehicles equipped with adaptive steering, GO to C7 For vehicles not equipped with adaptive steering, GO to C9
No	REINSTALL or INSTALL new component(s) as necessary. REFER to: Steering Wheel (211-04 Steering Column, Removal and Installation). or REFER to: Steering Wheel - Vehicles With: Adaptive Steering (211-04 Steering Column, Removal and Installation). DRIVE the vehicle to VERIFY the repair.

C7 CHECK THE SECM (STEERING EFFORT CONTROL MODULE) FOR DIAGNOSTIC TROUBLE CODES (DTCs)

- Ignition ON.
- Using a diagnostic scan tool, carry out the SECM self-test.

Are there any Diagnostic Trouble Codes (DTCs) present in the SECM?

Yes	DIAGNOSE all SECM Diagnostic Trouble Codes (DTCs). □ Click here to access Guided Routine (SECM).
No	GO to C8

C8 RESET THE STEERING WHEEL ANGLE SENSOR TRIM AND THE STEERING MOTOR ANGLE TRIM

- Using alignment equipment and the manufacturer's instructions, reset the front toe. Refer to Section 204-00.
- Using a diagnostic scan tool, carry out the Steering Wheel Angle Sensor Trim routine.
- Using a diagnostic scan tool, carry out the Steering Motor Angle Trim routine.
- Test drive the vehicle in the following manner:
 - Drive straight on a constant right road crown, at a speed greater than 40 km/h (25 mph), with your hands on the steering wheel for more than 45 seconds.
 - Drive straight on a constant left road crown, at a speed greater than 40 km/h (25 mph), with your hands on the steering wheel for more than 45 seconds.
 - Drive straight on a road with constant minimal road crown, at a speed greater than 40 km/h (25 mph), with your hands on the steering wheel for more than 45 seconds.

Is the drift, pull, wander or clear vision concern still present?

Yes	GO to C9
No	The concern has been repaired and was most likely caused by an un-trimmed steering wheel sensor, steering motor sensor or front toe out of adjustment.

C9 CHECK FOR UNEVENLY LOADED VEHICLE

- Visually inspect the vehicle for an uneven loading condition.

Is the vehicle unevenly loaded?

Yes	ADVISE the customer of uneven loading condition.
No	GO to C10

C10 CHECK THE TIRE PRESSURES AND CONDITIONS

- Check the tire pressures. Refer to the VC label.
- Check the tires for uneven or abnormal wear.
REFER to: Wheels and Tires (204-04A Wheels and Tires, Diagnosis and Testing).

Are the tire pressures and tire conditions OK?

Yes	GO to C11
No	ADJUST the tire pressures to the specified pressure or INSTALL new tires as necessary.

C11 ISOLATE TIRE DRIFT OR PULL CONDITION

- With the transmission in NEUTRAL, position the vehicle on a hoist.
REFER to: Jacking and Lifting - Overview (100-02 Jacking and Lifting, Description and Operation).
- Cross the front wheel and tire assemblies from left-to-right.
REFER to: Wheel and Tire - Vehicles With: Single Rear Wheels (204-04A Wheels and Tires, Removal and Installation).
or REFER to: Wheel and Tire - Vehicles With: Dual Rear Wheels (204-04A Wheels and Tires, Removal and Installation).
- Test drive the vehicle.

Is the drift, pull or wander concern still present?

Yes	If the vehicle drifts or pulls in the same direction, GO to C12 If the vehicle drifts or pulls in the opposite direction, tire forces are causing the drift, pull or wander condition. REFER to: Wheels and Tires (204-04A Wheels and Tires, Diagnosis and Testing).
No	The concern has been corrected. Tire forces were causing the drift, pull or wander concern.

C12 CHECK FOR BRAKE DRAG

- With the transmission in NEUTRAL, position the vehicle on a hoist.
REFER to: Jacking and Lifting - Overview (100-02 Jacking and Lifting, Description and Operation).
- Spin all 4 wheel and tire assemblies by hand and check for brake drag.

Do the wheels spin freely?

Yes	GO to C13
No	DIAGNOSE the brake drag condition. REFER to: Brake System (206-00 Brake System - General Information, Diagnosis and Testing).

C13 CHECK THE WHEEL ALIGNMENT

- Using alignment equipment and the manufacturer's instructions, check the wheel alignment.

Is the wheel alignment within specifications?

Yes	GO to C14
No	ADJUST the alignment as necessary. REFER to: Suspension System (204-00 Suspension System - General Information, Diagnosis and Testing).

C14 CHECK THE STEERING GEAR MOUNT FASTENERS

- With the transmission in NEUTRAL, position the vehicle on a hoist.
REFER to: Jacking and Lifting - Overview (100-02 Jacking and Lifting, Description and Operation).
- Check the steering gear for loose fasteners.

Are the fasteners in good condition and tightened to specifications?

Yes	GO to C15
No	INSTALL new fasteners (if necessary) and TIGHTEN to specifications. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).

C15 CHECK THE STEERING GEAR

- Carry out the Steering Gear Valve Component Test in this section.

Is the steering gear valve OK?

Yes	GO to C16
No	INSTALL a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).

C16 CHECK THE STEERING COLUMN SHAFT

- Verify the steering column shaft rotates freely and is not grounded against other vehicle components.

Does the steering shaft rotate freely and is it free from grounding against other components?

Yes	GO to C17
No	REPAIR or INSTALL new component(s) as necessary. REFER to: Steering Column (211-04 Steering Column, Removal and Installation). DRIVE the vehicle to VERIFY the repair.

C17 INSPECT THE STEERING COLUMN SHAFT U-JOINTS

WARNING: Do not reuse steering column shaft bolts. This may result in fastener failure and steering column shaft detachment or loss of steering control. Failure to follow this instruction may result in serious injury to vehicle occupant(s).

NOTICE: Do not allow the steering column to rotate while the steering column shaft is disconnected or damage to the clockspring may result. If there is evidence the steering column shaft has rotated, the clockspring must be removed and re-centered.

- Disconnect the upper steering column shaft from the steering column.
 - Discard the bolt.
- Using a suitable holding device, hold the steering wheel in the straight-ahead position.
- Inspect the steering column shaft U-joints for looseness or wear.

Are the steering column shaft U-joints okay?

Yes	CONNECT the upper steering column shaft to the steering column. INSTALL a new bolt and tighten to specifications. REFER to: Steering Column Upper Shaft (211-04 Steering Column, Removal and Installation).
No	INSTALL a new steering column. REFER to: Steering Column (211-04 Steering Column, Removal and Installation).

Pinpoint Test D: Front End Noise - Turning At Slow Speeds, During Parking Lot Maneuvers, Over Bumps, Rough Roads, Dips, Depressions Or When Entering A Driveway

Diagnostic Overview

Noises over bumps and rough roads involve parts which move and contact during up and down motion.

Exterior front end noises when turning at slow speeds involve parts which move, rotate or make contact during a partial or full turn.

Possible Causes

- Jounce bumper
- Springs, shocks, struts and bearings or bushings (most common)
- Front shock brackets or strut mounts
- Tires
- Stabilizer bar insulators or links
- Steering gear internal stops (full turn)
- External steering stops (full turn)
- Steering tie rods (loose)
- Loose steering gear mounts or bolts
- Loose steering gear bolts
- Loose front brake calipers or pins
- Loose lower control arm-to-subframe bolts or bushings
- Loose ball joint
- Loose exhaust heat shield, isolators or brackets
- Stabilizer bar links and insulators
- Integrated front wheel ends (4x4 only)
- Front control arms and bushings
- Engine or transmission mounts
- Upper or lower steering shaft

PINPOINT TEST D : FRONT END NOISE - TURNING AT SLOW SPEEDS, DURING PARKING LOT MANEUVERS, OVER BUMPS, ROUGH ROADS, DIPS, DEPRESSIONS OR WHEN ENTERING A DRIVEWAY

D1 CHECK FOR NOISE AT FULL STEERING LOCK

- Test drive the vehicle.
 - With the steering wheel at full lock (end of travel) to the left, attempt to recreate the customer concern.
 - With the steering wheel at full lock (end of travel) to the right, attempt to recreate the customer concern.

Is the noise condition present when turning at full lock?

Yes	Compare to a like vehicle. If similar, this is a normal condition - return the vehicle to the customer.
No	GO to D2

D2 INSPECTION FOR NOISE SOURCE

- Inspect the following components for a potential concern (loose, damaged, worn, broken, rubbing).
 - Tires
 - Engine or transmission mounts
 - Front brake caliper, caliper pins and brake discs
 - Front control arms and bushings
 - Integrated front wheel ends (4x4 only)
 - Loose ball joint
 - Loose exhaust head shield, isolators and brackets
 - Loose lower control arm-to-subframe bolts
 - Loose steering gear mounts and bolts
 - Springs, shocks, struts, strut bearings, bushings and jounce bumpers
 - Stabilizer bar links and isolators
 - Steering stops
 - Subframe or crossmember condition, mounts and fasteners
 - Tie-rod ends
 - Upper and lower steering column shaft

Are any of the listed parts worn, damaged or impaired?

Yes	INSTALL new or REPAIR the affected components. REFER to the appropriate section in the Workshop Manual.
No	GO to D3

D3 VERIFY GENERAL NOISE LOCATION USING CHASSIS EARS (LEFT OR RIGHT SIDE OF VEHICLE)

- Using a listening device, such as Chassis Ears:
 - Install the listening device on the left and right front strut towers.
 - Prepare the vehicle for a road test.
 - Using an assistant, attempt to duplicate the noise while listening to the device.

Is the noise louder on the left side?

Yes	GO to D4
No	If the right side is louder, GO to D5 If neither the left or the right side is louder, GO to D6

D4 EVALUATION FOR LEFT SIDE NOISE

- Using a listening device, such as Chassis Ears:
- Attach probe 1 to the left strut tower.
 - If loudest, inspect the strut tower area and attachments for looseness and wear.
- Attach probe 2 to the left coil spring.
 - If loudest, inspect the upper strut bearing assembly for looseness and wear.
- Attach probe 3 to the left lower control arm-to-subframe attachment point.
 - If loudest, inspect the control arm and bushings, subframe and bushings, sway bar bushings and links (common), and associated bolts for looseness, wear.
- Attach probe 4 to the steering gear housing.
 - If loudest, inspect the inner and outer tie rods, mounting bushings, bolts and input shaft for looseness and wear. Place hands on steering shaft boot to verify if noise or vibration is transferring into steering gear (common). Verify whether other nearby components are transferring noise vibration into steering gear (common).
- Using an assistant, test drive the vehicle and listen to the 4 probes.

Do any of these probes reveal the noise under consideration?

Yes	Referring to the possible noise source listed with each probe: If probe 1 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 2 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 3 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 4 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If all component inspections are OK and the steering gear is the primary noise source, INSTALL a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
No	If the noise is not revealed to be on the left side through the above 4 probes, RE-EVALUATE the noise condition with customer. If the noise is still not revealed to be on the left side, GO to D5

D5 EVALUATION FOR RIGHT SIDE NOISE

- Using a listening device, such as Chassis Ears:
- Attach probe 1 to right strut tower.
 - If loudest, inspect the strut tower area and attachments for looseness and wear.
- Attach probe 2 to the right coil spring.
 - If loudest, inspect the upper strut bearing assembly for looseness and wear.
- Attach probe 3 to the right lower control arm-to-subframe attachment point.
 - If loudest, inspect the control arm and bushings, subframe and bushings, sway bar bushings and links (common), and associated bolts for looseness, wear.
- Attach probe 4 to the steering gear housing.
 - If loudest, inspect the inner and outer tie rods, mounting bushings, bolts and input shaft for looseness and wear. Place hands on steering shaft boot to verify if noise or vibration is transferring into steering gear (common). Verify whether other nearby components are transferring noise vibration into steering gear (common).
- Using an assistant, test drive the vehicle and listen to the 4 probes.

Do any of these probes reveal the noise under consideration?

Yes	Referring to the possible noise source listed with each probe: If probe 1 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 2 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 3 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 4 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If all component inspections are OK and the steering gear is the primary noise source, INSTALL a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
No	If the noise is not revealed to be on the right side through the above 4 probes, RE-EVALUATE the noise condition with customer. If the noise is still not revealed to be on the right side, GO to D6

D6 EVALUATION FOR NOISE IN CENTER

- Using a listening device, such as Chassis Ears:
 - Attach probe 1 to the center of the subframe (or engine crossmember for body-on-frame vehicles).
 - If loudest, inspect the subframe, subframe mounts and any attaching hardware (sway-bar bushing mounts) for correct torque specifications, damage, wear or witness marks. Inspect the engine and transmission mounts for road debris, correct torque specification, damage or wear.
 - Attach probe 2 to the bulkhead.
 - If loudest, inspect the bulkhead for damage or loose components (brackets, tubes, wiring harnesses, bushings).
 - **NOTE:** *The steering gear is central to steering system and noises may be transferred to it from other nearby components.*
- Attach probe 3 to the center of the steering gear housing.
- If loudest, inspect the steering gear inner and outer tie-rods, mounting bushings, wiring harnesses and related components. Inspect the input shaft, boot and slip-joint lubrication. Place hands on the steering shaft boot (at dash) and check for a vibration or noise transferring into the steering gear.
- Using an assistant, test drive the vehicle and listen to the 3 probes.

Do any of these probes reveal the noise under consideration?

Yes	Referring to the possible noise source listed with each probe: If probe 1 is the loudest, REPAIR or INSTALL new components listed with probe 1 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 2 is the loudest, REPAIR or INSTALL new components listed with probe 2 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If probe 3 is the loudest, REPAIR or INSTALL new components listed with probe 3 as necessary. If the issue still exists, EVALUATE the next loudest probe channel. If all component inspections are OK and the steering gear is the primary noise source, INSTALL a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).
No	If the noise is not revealed to be in the center area through the above 3 probes, RE-EVALUATE the noise condition with the customer or, for further evaluation of the noise, REFER to: Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Pinpoint Test E: Noise When Turning - Noticed More In The Interior

Diagnostic Overview

Interior cabin noises involve parts moving or contacting during a steering wheel turn or interior parts moving or contacting during steering column tilt or telescopic operations.

Possible Sources

- Steering column shrouds
- Steering shafts and steering shaft joints
- Steering shaft boots or seals
- Clockspring (when lubricant on the clockspring is dry or drying)
- Steering column tilt or telescoping motor (if equipped)
- Shifter cables (if equipped)

PINPOINT TEST E : NOISE WHEN TURNING - NOTICED MORE IN THE INTERIOR

E1 DETERMINE THE SOURCE OF THE INTERIOR NOISE WHILE DRIVING

- While an assistant drives, use a stethoscope (or similar tool) to determine if the noise is coming from the steering column area or other interior components.

Is the noise coming from the steering column?

Yes	GO to E2
No	RE-EVALUATE the customer concern or, for further NVH diagnosis, REFER to: Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

E2 CHECK THE STEERING COLUMN SHROUDS

- Remove the steering column shrouds.
REFER to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
- With the vehicle stationary, rotate the steering wheel to the left and right steering stops.

Is the noise present while turning the steering wheel?

Yes	GO to E3
No	The steering column shrouds may be the noise source. INSPECT the shrouds for witness marks, proper alignment and damage. REPAIR or INSTALL new as necessary. REFER to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).

E3 VISUAL INSPECTION FOR FRONT END INTERIOR NOISE SOURCE

- With the steering column shrouds removed, visually inspect and check operation of the following components and systems while turning the steering wheel:
 - Adaptive steering components (if equipped)
 - Column shift components - shifter, cables and mounting bracket bolts (if equipped)
 - Steering column mounting bolts
 - Steering column shaft boot
 - Steering column U-joints (upper and lower)
 - Steering wheel and clockspring
 - Steering shaft flex joint
 - Steering shaft pinch bolt joints or collar
 - Telescoping steering shaft
 - Tilt and telescopic motors (if equipped)
 - Top steering collar, mid column and lower bearing
 - Turn signal cancellation assembly
- Inspect for impaired components, damaged, loose, excessively noisy or excessively worn components.

Are the listed components OK?

Yes	Components may pass a visual inspection but could still be making internal noises. REFER to the list of components in the pinpoint test step and, using a stethoscope, IDENTIFY components with internal noise. REPAIR or INSTALL new components as necessary.
No	REPAIR or INSTALL new any components as necessary.

Pinpoint Test F: Front End Noise - During Braking, During Acceleration (Tip-In) Or Deceleration (Tip-Out) May Occur With Braking

Diagnostic Overview

Noises when accelerating or decelerating involve parts which move during an acceleration tip-in (pressing foot on gas pedal) or parts which move during deceleration tip-out (when taking foot off gas pedal). These noises are **not** typically associated with the steering gear.

If the noise occurs during braking **and** during tip-in or tip-out, this is not typically a steering gear related noise.

Possible Causes

- Steering shaft slip joints or lower input shaft (requires lubrication)
- Roll restrictor
- Powertrain mounts
- Exhaust heat shield (tinny rattle)
- Exhaust isolators and brackets
- Subframe mounts
- Engine to chassis wiring, tubes, brackets (loose or out of position)
- Caliper anchors, calipers or brake pads
- Top strut mount or bearings (if equipped)
- Lower control arm attachment to sub frame bushings and bolts
- Engine to chassis wiring, tubes or brackets (loose or out of position)
- Steering shaft slip joints

PINPOINT TEST F : FRONT END NOISE - DURING BRAKING, DURING ACCELERATION (TIP-IN) OR DECELERATION (TIP-OUT) MAY OCCUR WITH BRAKING

F1 FRONT END NOISE EVALUATION

- Test drive the vehicle, determine if the noise occurs only during braking or if the noise occurs during braking, acceleration and deceleration.

Does the noise **ONLY** occur during vehicle braking?

Yes	DIAGNOSE the braking system, REFER to: Brake System (206-00 Brake System - General Information, Diagnosis and Testing).
No	GO to F2

F2 SERVICE BAY ACTIVE UNDER HOOD FRONT END NOISE INSPECTION

NOTE: Noise sources can be identified by stethoscope or hands-on during vehicle rocking. Tip-in and tip-out noises are not usually steering gear related.

- Prepare the vehicle for testing in a quiet area on level ground.
 - Steer the front wheels into the straight-ahead position.
 - Shift the transmission into PARK (automatic transmission) or THIRD (manual transmission).
 - Shut the engine off.
 - Release the parking brake.
 - Open the hood.
- Rock the vehicle backwards and forwards by pushing on the front bumper and attempt to locate the source of the noise.
 - Rocking the vehicle causes the engine mounts to flex, resulting in the movement of several components.
- Possible noise sources could be, but are not limited to:
 - Axle shafts
 - All coolant tubes, air conditioning tubes and wiring harnesses
 - Drive shafts
 - Exhaust hangers and other related exhaust components
 - Roll restrictor
 - Steering column shaft slip joint
 - Subframe mounts
 - Transmission or engine mounts

Was the noise identified and located during this test?

Yes	REPAIR or INSTALL new components as necessary.
No	GO to F3

F3 VISUAL INSPECTION FOR FRONT END NOISE SOURCE

- With the transmission in NEUTRAL, position the vehicle on a hoist.
REFER to: Jacking and Lifting - Overview (100-02 Jacking and Lifting, Description and Operation).
- Inspect the following components for a potential concern (loose, damaged, worn, broken):
 - Engine mounts
 - Transmission mounts
 - Roll restrictors
 - Exhaust heat shield (tinny rattle)
 - Steering gear heat shield
 - Exhaust isolators and bracket
 - Steering column shaft slip joints (dry condition)
 - Subframe mounts
 - Engine to chassis wiring, tubes or brackets (loose or out of position)
 - Drive shafts
 - Mid-shaft bearing (if equipped)

Are all of the listed components OK?

Yes	Components may pass a visual inspection but could still be making internal noises. Noise may only be identified during a test drive. REFER to the list of components in the pinpoint test step and, using a Chassis Ears or similar tool, pinpoint the noise source. REPAIR or INSTALL new components as necessary. For additional NVH information, REFER to: Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
No	REPAIR or INSTALL new components as necessary.

Diagnostic Overview

Front end noises while driving straight involve parts which rotate continuously while the road wheels are rotating. Typically **not** a steering gear.

Wheel hub bearings can produce noise after achieving 56 km/h (35 mph) while driving straight if they are worn.

Possible Rotating Sources

- Axle shafts
- Carrier bearing (noise is typically felt through the console)
- Drive shafts
- Transfer case assembly (if equipped)
- Wheel hub and wheel bearings (typically higher speeds)

Possible Wind Sources

- Air dams
- Heat shields
- Radiator ducts or shields
- Wheel well splash shields

PINPOINT TEST G : FRONT END NOISE - DRIVING STRAIGHT ON SMOOTH ROADS

G1 CHECK TIRE CONDITION

- Check tires for wear, damage, uneven tread or miss-matched tires (miss-matched tires are especially important on AWD and 4x4 systems).
- Verify all 4 tires are matching size and brand.

Are the tires free from wear, damage, uneven tread or miss-matching issues?

Yes	GO to G2
No	INSTALL new tires as necessary. REFER to: Wheel and Tire (204-04A Wheels and Tires, Disassembly and Assembly).

G2 CHECK FOR NOISE CHANGE DURING BUMPS AND VARYING SPEEDS

- Test drive the vehicle and confirm the noise.
 - Make sure to drive over bumps and vary the vehicle speed during the test.

Was the noise affected by bumps?

Yes	GO to Pinpoint Test D
No	GO to G3

G3 VISUAL INSPECTION FOR NOISE SOURCE

- The following components can cause noise issues while rotating. Inspect the following components for looseness, wear and damage:
 - Axle shafts
 - Axle shaft U-joints
 - Drive shafts and pinion bearings
 - Drive shaft center support bearing (RWD only)
 - Integrated wheel ends and associated vacuum system (4x4 only)
 - Transfer case assembly (if equipped)
 - Wheel hubs and bearings
- The following components can cause noise issues while being disturbed
 - Air dams
 - Heat shields
 - Radiator ducts or shields
 - Tubes and hoses
 - Wheel well linings and splash shields
 - Wiring harnesses
 - Other components not retained

Are all of the listed components OK?

Yes	GO to G4
No	REPAIR or INSTALL new components as necessary.

G4 VEHICLE ON-HOIST INSPECTION

- With the transmission in NEUTRAL, position the vehicle on a hoist. Refer to Section 100-02 in the Workshop Manual.
- Raise the vehicle until the wheels can spin freely.
- Start the engine.
- Disable the AdvanceTrac or traction control system (if equipped).
- Bring the vehicle up to speed where the reported noise can be heard.
- Listen for the noise.

Was the noise able to be replicated with the vehicle on the hoist?

Yes	Using a listening device, such as Chassis Ears, LOCATE the causal component. REPAIR or INSTALL new as necessary.
No	GO to G5

G5 ROAD TEST NOISE VERIFICATION

- Using a listening device, such as Chassis Ears:
 - Attach probe 1 to the back side of the left front wheel knuckle or spindle.
 - Attach probe 2 to the back side of the right front wheel knuckle or spindle.
- Using an assistant to test drive the vehicle, attempt to duplicate the noise while listening to the device.

Is the reported noise also heard through probe 1 or 2?

Yes	The noise may be caused by the wheel bearing or related components. INSPECT and REPAIR or INSTALL new as necessary (brake components, integrated wheel ends, etc.).
No	REFER to the list of possible sources in step G3 for further evaluation of noise sources or, to continue NVH diagnostics, REFER to: Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Pinpoint Test H: Poor Returnability, Binding or Sticky Steering

Diagnostic Overview

Possible Causes

- Binding steering column shaft
- Binding steering column U-joints
- Binding steering column bearing(s)
- Binding dash boot seal
- Suspension components
- Steering gear
- Electronic steering actuator (if equipped)

PINPOINT TEST H : POOR RETURNABILITY, BINDING OR STICKY STEERING

H1 CHECK FOR OPTIONAL VEHICLE EQUIPMENT

- Determine if the vehicle is equipped with an electronic steering actuator.

Is the vehicle is equipped with an electronic steering actuator?

Yes	☐ Click here to access Guided Routine (EPAS).
No	GO to H2

H2 ISOLATE THE STEERING COLUMN

WARNING: Do not reuse steering column shaft bolts. This may result in fastener failure and steering column shaft detachment or loss of steering control. Failure to follow this instruction may result in serious injury to vehicle occupant(s).

NOTICE: Do not allow the steering column to rotate more than 360 degrees while the steering column shaft is disconnected or damage to the clockspring may result. If there is evidence the steering column shaft has rotated, the clockspring must be removed and re-centered.

- Disconnect the upper steering column shaft from the steering column.
 - Discard the bolt.
- Rotate the steering wheel 360 degrees to the right, re-center the steering wheel, then rotate the steering wheel 360 degrees to the left and re-center.
- Using a suitable holding device, hold the steering wheel in the straight-ahead position.

Is a binding condition still present?

Yes	INSPECT the steering column and steering column U-joints for a binding condition or rubbing against other vehicle components. REPAIR or INSTALL new as necessary.
No	GO to H3

H3 ISOLATE THE STEERING SHAFTS

WARNING: Do not reuse steering column shaft bolts. This may result in fastener failure and steering column shaft detachment or loss of steering control. Failure to follow this instruction may result in serious injury to vehicle occupant(s).

- Disconnect the lower steering column shaft from the steering gear.
 - Discard the bolt.
- Check the steering linkage and steering gear for binding, sticking, tight spots and uneven operation by slowly moving the front wheels through their full turn radius.

Is a binding condition still present?

Yes	GO to H4
No	INSPECT the steering column upper and lower shafts for a binding condition or rubbing against other vehicle components. REPAIR or INSTALL a new shaft as necessary. REFER to: Steering Column Lower Shaft (211-04 Steering Column, Removal and Installation). or REFER to: Steering Column Upper Shaft (211-04 Steering Column, Removal and Installation).

H4 ISOLATE THE STEERING GEAR

WARNING: Do not reuse steering column shaft bolts. This may result in fastener failure and steering column shaft detachment or loss of steering control. Failure to follow this instruction may result in serious injury to vehicle occupant(s).

- Disconnect the sector shaft arm from the steering gear.
 - Discard the nut.
- Check the steering linkage for binding, sticking, tight spots and uneven operation by slowly moving the front wheels through their full turn radius.

Is a binding condition still present?

Yes	INSPECT the steering linkages and wheel knuckles for a binding condition. REPAIR or INSTALL new as necessary.
No	INSTALL a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation). or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).

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.

1. Remove the power steering pump reservoir cap and check the power steering fluid level. If necessary, add the specified power steering fluid. Automatic Transmission Fluid (WSS-M2C938-A;MERCON® LV)
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 more than 5 seconds. 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. **NOTICE: Do not hold the steering wheel at the stops for more than 5 seconds. Damage to the power steering pump may occur.**

Start the engine. 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.

10. Stop the engine and inspect the system including the Hydro-Boost (if equipped), for traces of UV dye using the 100W/12 Volt DC UV Lamp. Repair as necessary.

Pump Flow and Pressure Test

WARNING: Do not touch the flowmeter during the test procedure or for several minutes after use. The flowmeter may become hot during use and can burn unprotected skin. Failure to follow this instruction may result in serious personal injury.

NOTE: For power steering pump flow, pressure and relief pressure specifications, refer to General Specifications/Power Steering Pump in this section.

1. **NOTICE: Make sure the connection point does not interfere with any of the engine accessory drive components or drive belts. Damage to the analyzer or accessory drive components may occur.**

Install the power steering analyzer at the high-pressure port of the power steering pump. Make sure the power steering analyzer gate valve is fully open.

2. Place the Dial Thermometer 0-220°F in the power steering pump reservoir.
3. Check the power steering fluid level. If necessary, add specified power steering fluid.
4. Install a digital tachometer.
5. **NOTICE: Do not hold the steering wheel against the stops for more than 5 seconds. Damage to the power steering pump may 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. With the steering wheel in the straight-ahead position, set the engine at idle. Record the flow rate and pressure readings.
 - If the flow rate is below the flow rate specification, continue with the test procedure.
 - If the pressure reading is above the pressure specification, check the power steering hoses for kinks and restrictions.
7. Partially close the gate valve to obtain 5171 kPa (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. **NOTICE: Do not allow the gate valve to remain closed for more than 5 seconds. Damage to the power steering pump may occur.**

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, then install a new power steering pump.

9. Set engine speed to 2,100 rpm. Record the flow rate.
 - If the flow rate varies more than 3.785L/min (1 gal/min) from the initial flow rate reading, install a new power steering pump.

10. **NOTICE: Do not hold the steering wheel against the stops for more than 5 seconds. Damage to the power steering pump may occur.**

Turn the vehicle wheels to full left turn stop.

- Evaluate and record the pressure

11. **NOTICE: Do not hold the steering wheel against the stops for more than 5 seconds. Damage to the power steering pump may occur.**

Turn the vehicle wheels to full right turn stop.

- Evaluate and record the pressure

Properly working poppets do not allow the pump to see relief pressure at or near full turn steer stops. The maximum pressure at the stops is approximately 2,100 psi.

12. 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 repairing the steering gear.

Steering Gear Valve Test

1. With the transmission in NEUTRAL, position the vehicle on a hoist.
REFER to: Jacking and Lifting - Overview (100-02 Jacking and Lifting, Description and Operation).

- 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: Steering Gear (211-02 Power Steering, Removal and Installation).
or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).

Steering Gear Grunt or 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 more than 5 seconds. Damage to the power steering pump may occur.**

Rotate the steering wheel to the RH stop, then turn the steering wheel 90 degrees back to the left. 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 (211-02 Power Steering, General Procedures).
If a loud grunt or strong shudder still exists, check the power steering lines and hoses for restrictions or damage and repair as necessary. If the lines and hoses are OK, install a new steering gear. REFER to: Steering Gear (211-02 Power Steering, Removal and Installation).
or REFER to: Steering Gear - Vehicles With: Hydro-Boost, (211-02 Power Steering, Removal and Installation).

Steering Linkage Test

1. With the transmission in NEUTRAL, position the vehicle on a hoist.
REFER to: Jacking and Lifting - Overview (100-02 Jacking and Lifting, Description and Operation).
 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, a new tie-rod must be installed.
REFER to: Tie Rod End (211-03 Steering Linkage, Removal and Installation).
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