2010 STEERING

Power Steering - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Power Steering Fluid Cooler Hose Bracket Bolt	9 N.m	80 lb in
Power Steering Fluid Reservoir Bracket Bolt, V6	9 N.m	80 lb in
Power Steering Gear Inlet Hose Bracket Bolts	9 N.m	80 lb in
Power Steering Gear Inlet Hose Fitting	34 N.m	25 lb ft
Power Steering Gear Outlet Hose Bracket Bolts	9 N.m	80 lb in
Power Steering Gear Outlet Hose Fitting	34 N.m	25 lb ft
Power Steering Pump Auxiliary Bracket Bolt, V6	20 N.m	15 lb ft
Power Steering Pump Bracket Bolt, V6	58 N.m	43 lb ft
Power Steering Pump Bracket Bolt, V8	50 N.m	37 lb ft
Power Steering Pump Bolt, V6	22 N.m	16 lb ft
Power Steering Pump Bolt, V8	25 N.m	18 lb ft
Steering Gear Bolts		
• First Pass	50 N.m	37 lb ft
• Second Pass	120°	
Steering Gear Pinion Bolt	50 N.m	37 lb ft
Steering Linkage Inner Tie Rod	75 N.m	55 lb ft
Steering Linkage Inner Tie Rod Nut	75 N.m	55 lb ft
Steering Linkage Outer Tie Rod Nut		
• First Pass	30 N.m	22 lb ft
• Second Pass	120°	

POWER STEERING PUMP SPECIFICATIONS

Engine Code	Engine Size	High Flow		Pressure Relief	
		LPM	GPM	kPa	PSI
LLT	3.6L	8.0	2.11	11197-11997	1624-1740
L99 LS3	6.2L	6.49-7.99	1.71-2.11	11260-12090	1633-1754

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

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Application	Type of Material	GM Part Number	
		United States	Canada
Power Steering Fluid	DEXRON® VI ATF	88861003	88861004
Inner Tie Rod Thread Locking Adhesive	Loctite® 271	89021297	10953488

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - POWER STEERING SYSTEM

IMPORTANT: Review the system description and operation in order to familiarize yourself with the system functions. Refer to Power Steering System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power steering system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for leaking power steering components. If necessary, refer to **Power Steering Fluid Leaks (w/o Hydroboost)**.
- Verify the power steering reservoir for the proper operating specification. Refer to **Checking and Adding Power Steering Fluid**.
- Inspect the power steering fluid for the following indications of contamination:
  - Milky fluid - water
  - Brown fluid - burnt
  - Debris in fluid - plastic or dirt
- If necessary, flush the power steering system. Refer to **Power Steering System Flushing**.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Power Steering Fluid Leaks (w/o Hydroboost)**
- **Rattle, Clunk, or Shudder Noise from the Power Steering System**
- **Whine or Growl Noise from the Power Steering System**
- **Poor Return of Steering Wheel**
- **Steering Effort Hard in One or Both Directions**
- **Steering Effort Too Easy in One or Both Directions**

POWER STEERING SYSTEM TEST

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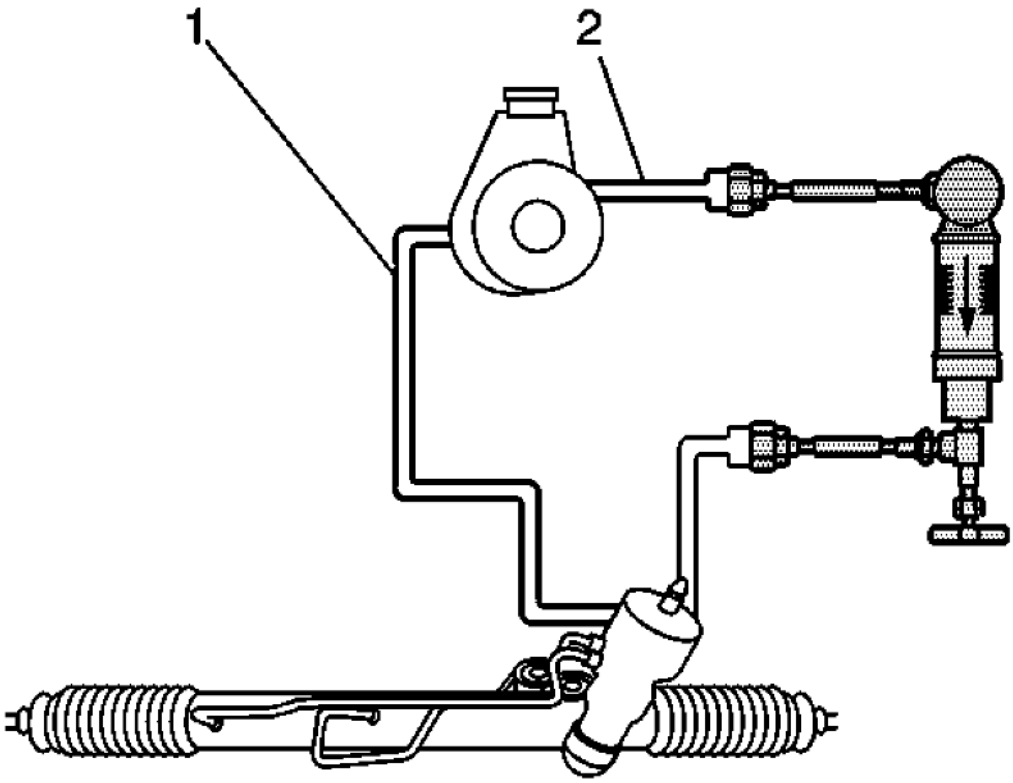


Fig. 1: Identifying Power Steering Hoses
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Power Steering Return Hose
2	Power Steering Pressure Hose

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5: This step tests the system for restrictions.
7: This step tests the following components for the following conditions:
- The pump for internal leaks
- The power steering pipes for kinks

8: This step tests the ability of the pump to regulate flow at maximum pressure.
10: This step tests the ability of the pump to regulate flow under normal operating conditions.

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12: This step tests the internal components of the pump and the gear.

Step	Action	Value(s)	Yes	No
DEFINITION: The Power Steering System Test Procedure will perform the following functions: • Test the operation of the hydraulic power steering system. • Test the operation of the power steering pump and power steering gear. • Identify restrictions in the system.				
1	Inspect the power steering fluid for the following indications of contamination: • Milky fluid - water • Brown fluid - burnt • Debris in fluid - plastic or dirt Is the fluid free of contamination?	-	Go to **Step 3**	Go to **Step 2**
2	Flush the power steering system. Refer to **Power Steering System Flushing**. Did you complete the procedure?	-	Go to **Step 3**	-
3	**NOTE:** **In order to accurately diagnose the system, the malfunction must be present during the test procedure.** Attempt to duplicate the condition.Is the condition present?	-	Go to **Step 4**	System OK
4	1. Turn the ignition switch to the OFF position. 2. Place a drain pan under the vehicle in order to catch any power steering fluid. 3. Disconnect the power steering pressure pipe/hose from the power steering pump or the power steering gear as necessary. 4. Install the **J-44721:** Power Steering System Analyzer. 5. Fill the power steering system. Refer to **Checking and Adding Power Steering Fluid**. Did you complete the installation?	-	Go to **Step 5**	-
	1. Fully open the **J-44721:** Power Steering System Analyzer valve.			

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5	2. Start the engine. **CAUTION:** **Do not hold the steering wheel in the full turn position longer than 5 seconds, as damage to the steering pump may result.** 3. Turn the steering wheel and BRIEFLY hold the steering wheel against the steering stop in order to release any trapped air from the system. 4. Inspect and ensure that all of the power steering pipe/hose connections are not leaking. 5. Making sure the steering wheel is OFF the steering stop, observe the pressure reading. Is the pressure reading greater than the specified value?	1379 kPa (200 psi)	Go to **Step 6**	Go to **Step 7**
6	**NOTE:** **A restriction may be present in the power steering system. Turn OFF the engine IMMEDIATELY.** Locate and repair the restriction.Did you complete the repair?	-	Go to **Step 15**	-
7	1. Allow the engine to run until the engine reaches full operating temperature. 2. Record the pressure reading and flow reading. 3. Partially close the **J-44721:** Power Steering System Analyzer valve until the system pressure reaches the specified value, then record the FLOW reading. 4. Subtract second flow reading from the first flow reading. Is the flow DECREASE greater than 3.8 L (1 gal) per minute?	4827 kPa (700 psi)	Go to **Step 11**	Go to **Step 8**
	NOTE: **Do not leave the valve closed for more than 5 seconds, or internal pump damage could accrue.** Fully close then open the **J-44721:** Power			

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8	Steering System Analyzer valve 3 times. Record all of the high pressure readings. Refer to **Power Steering Pump Specifications** for power steering system pressure relief specifications.Are the 3 high pressure readings within specifications?	-	Go to **Step 9**	Go to **Step 13**
9	Are the three high pressure readings within 245 kPa (50 psi) of each other?	-	Go to **Step 10**	Go to **Step 13**
10	1. Increase the engine speed to approximately 1,500 RPM. 2. Record the flow reading. Refer to **Power Steering Pump Specifications** for power steering system pressure specifications. Is the actual flow reading within specifications?	-	Go to **Step 11**	Go to **Step 13**
11	Is the difference between the actual flow reading and the maximum flow specification more than 3.8 L (1 gal) per minute?	-	Go to **Step 13**	Go to **Step 12**
12	Turn the steering wheel from steering stop to steering stop and record the FLOW readings at each stop. Is the flow LOWER than 3.8 L (1 gal) per minute?	-	Go to **Step 15**	Go to **Step 14**
13	Replace the power steering pump. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**. Did you complete the replacement?	-	Go to **Step 15**	-
14	The power steering gear is leaking across the piston or bypassing the valve circuit. Replace the power steering gear. Refer to **Steering Gear Replacement**. Did you complete the replacement?	-	Go to **Step 15**	-
15	Test the power steering system for the original condition. Does the original condition still exist?	-	Go to **Step 5**	Go to **Step 16**
16	1. Disconnect and remove the **J-44721:** Power Steering System Analyzer from the vehicle. 2. Connect the vehicle power steering pipes/hoses. 3. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**. Did you complete the procedure?	-	System OK	-

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POWER STEERING FLUID LEAKS (W/O HYDROBOOST)

NOTE:

- **If fluid is found on a manual steering gear or on an electronic power steering gear, do not replace steering gear. Vehicles equipped with these systems do not use hydraulic power steering fluid. The fluid may be assembly fluid or another system fluid.**
- **Clean the components and identify the sources of the leaks before attempting to repair or replace any power steering components. Clearly mark all locations of leaks with paint, marker, or equivalent for warranty identification and engineering root cause analysis.**

Some customers may comment on a fluid LEAK or NOISY power steering pump. Upon inspection, the technician may find power steering fluid leaking from the hydraulic power steering system. Use the following inspection procedure in order to diagnose the source of the leak and take appropriate action to correct the condition.

1. Inspect the fluid level in the power steering fluid reservoir. If the fluid level is NOT low, a careful analysis of the condition is necessary to confirm that the type of fluid is actually power steering fluid.
2. Visually inspect the power steering system and components where the fluid has accumulated.
3. Completely clean off all residual fluid from the power steering components.
4. Add fluorescent dye compatible with the power steering fluid.
5. Start the vehicle and allow the power steering system to reach the normal operating temperature.
6. Turn the steering wheel to the stops in each direction while bumping the steering wheel against the stops 3-4 times. This will build maximum steering system pressure and help identify the source of the leak if present.
7. Turn vehicle engine OFF.
8. Shine a black light on the area where the residual fluid accumulated. Identify the sources of the leaks.
9. Mark all locations of leaks with paint, marker, or equivalent.
10. Repair or replace all affected components.

RATTLE, CLUNK, OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM

Step	Action	Yes	No
1	Did you review the Power Steering System General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**.
2	Verify that a rattle, clunk or shudder noise is present. Is a rattle, clunk or shudder noise present?	Go to **Step 3**	System OK
3	Inspect the power steering hoses for correct routing and clearance. Is the routing or clearance of the power steering hoses incorrect?	Go to **Step 11**	Go to **Step 4**
	Inspect the power steering pump drive belt for cracking		

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4	or excessive wear. Refer to one of the following: • **Symptoms - Engine Mechanical** for 3.6L engines • **Symptoms - Engine Mechanical** for 6.2L engines Is the drive belt cracked or excessively worn?	Go to **Step 12**	Go to **Step 5**
5	Inspect the power steering pump pulley for damage. Is the power steering pump pulley damaged?	Go to **Step 13**	Go to **Step 6**
6	Inspect the power steering pump for the proper installation. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**. Is the power steering pump installation incorrect?	Go to **Step 14**	Go to **Step 7**
7	Inspect the power steering gear for the proper installation. Refer to **Steering Gear Replacement**. Is the power steering gear installation incorrect?	Go to **Step 15**	Go to **Step 8**
8	Inspect the front suspension. Is the front suspension worn?	Go to **Step 16**	Go to **Step 9**
9	Inspect the intermediate shaft. Is the intermediate shaft worn?	Go to **Step 17**	Go to **Step 10**
10	Inspect the steering column for the proper installation. Refer to **Steering Column Replacement** . Is the steering column installation incorrect?	Go to **Step 18**	Go to **Step 2**
11	Adjust or replace the hoses. Refer to the appropriate procedures: • **Fluid Cooler Outlet Hose Replacement** • **Power Steering Fluid Reservoir Outlet Hose Replacement (V6)** • **Power Steering Gear Inlet Pipe/Hose Replacement** • **Power Steering Gear Outlet Pipe/Hose Replacement** Did you complete the repair?	Go to **Step 19**	-
12	Replace the drive belt. Refer to one of the following: • **Drive Belt Replacement** for 3.6L engines • **Drive Belt Replacement - Accessory** for 6.2L engines		-

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	Did you complete the repair?	Go to **Step 19**	
13	Replace the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (V6)** or **Power Steering Pump Pulley Replacement (V8)**. Did you complete the repair?	Go to **Step 19**	-
14	Install the power steering pump correctly. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**. Did you complete the repair?	Go to **Step 19**	-
15	Install the power steering gear correctly. Refer to **Steering Gear Replacement**. Did you complete the repair?	Go to **Step 19**	-
16	Replace the worn suspension components. Did you complete the repair?	Go to **Step 19**	-
17	Replace the intermediate shaft. Refer to **Intermediate Steering Shaft Replacement** . Did you complete the repair?	Go to **Step 19**	-
18	Install the steering column correctly. Refer to **Steering Column Replacement** . Did you complete the repair?	Go to **Step 19**	-
19	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

WHINE OR GROWL NOISE FROM THE POWER STEERING SYSTEM

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to **Step 3**	System OK
3	Inspect the power steering fluid for the following indications of contamination: • Milky fluid - water • Brown Fluid - burnt • Debris in fluid - plastic or dirt Is the fluid free of contamination?	Go to **Step 5**	Go to **Step 4**
4	Flush the power steering system. Refer to **Power Steering System Flushing**. Did you complete the procedure?	Go to **Step 11**	Go to **Step 5**
	Using the **J-39570:** Chassis Ear, inspect the power		

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5	steering gear for a whine or growl noise. Is the noise present at the power steering gear?	Go to **Step 8**	Go to **Step 6**
6	Using the **J-39570:** Chassis Ear, inspect the power steering pump for a whine or growl noise. Is the noise present at the power steering pump?	Go to **Step 9**	Go to **Step 7**
7	Using the **J-39570:** Chassis Ear, inspect the power steering hoses for a whine or growl noise. Is the noise present at the power steering hoses?	Go to **Step 10**	Go to **Step 2**
8	Replace the power steering gear. Refer to **Steering Gear Replacement**. Did you complete the repair?	Go to **Step 11**	-
9	Replace the power steering pump. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**. Did you complete the repair?	Go to **Step 11**	-
10	Adjust the routing of the power steering hoses. Did you complete the repair?	Go to **Step 11**	-
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

POOR RETURN OF STEERING WHEEL

Step	Action	Yes	No
DEFINITION: After completing a turn, extra steering input is required for the steering wheel to return to center.			
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Power Steering System Description and Operation**
2	Verify that poor return of the steering wheel is present. Does the system operate normally?	System OK	Go to **Step 3**
3	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Lubricate the tie rod ends and ball joints, if applicable. 3. Inspect the suspension system for worn or damaged components. 4. Repair as necessary. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 4**
4	1. Rotate the steering wheel ONE revolution in both directions. 2. Rotate the steering wheel back to the original position.		

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	Was the steering wheel abnormally difficult to rotate in either direction?	Go to **Step 5**	Go to **Step 10**
5	**IMPORTANT:** **Position the wheels straight ahead. Do NOT rotate the steering wheel more than one complete revolution from center.** 1. Disconnect the intermediate shaft from the steering column. 2. Note the position of the steering wheel and rotate the steering wheel ONE revolution in both directions. 3. Rotate the steering wheel back to the original position. Was the steering wheel abnormally difficult to rotate in either direction?	Go to **Step 11**	Go to **Step 6**
6	Inspect the intermediate shaft for stiff or loose joints. Repair or replace as necessary. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 7**
7	1. Remove the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** . 2. Disconnect both outer tie rod ends from the steering knuckles. 3. Use your hands in order to move the tie rod end studs. 4. If abnormally difficult to move, replace the tie rod end. If equipped with recirculating ball steering, ensure that idler and pitman arm joints are not to stiff. Repair as necessary. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 8**
8	1. Use your hands to rotate the steering knuckle inboard and outboard in order to inspect for a binding strut bearings, ball joints, or axle. 2. Repair or replace any abnormally stiff or loose components. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 9**
9	Inspect for binding in the steering gear. If a binding is present, repair or replace the steering gear. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 10**
	Inspect the wheel alignment and adjust as necessary.		

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10	Refer to **Wheel Alignment Measurement** . Did you find and complete the repair?	Go to **Step 12**	-
11	Inspect the steering column for a binding. If a binding is present, repair or replace the steering column as necessary. Did you find and complete the repair?	Go to **Step 12**	-
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

STEERING EFFORT TOO EASY IN ONE OR BOTH DIRECTIONS

Step	Action	Yes	No
1	Did you review the Power Steering System Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that the steering effort is too easy in one or both directions. Does the system operate normally?	System OK	Go to **Step 3**
3	Perform the power steering test procedure. Refer to **Power Steering System Test**. Did you complete the procedure?	Go to **Step 4**	-
4	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

STEERING EFFORT HARD IN ONE OR BOTH DIRECTIONS

Step	Action	Yes	No
1	Did you review the Power Steering System General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that the steering effort is hard in one or both directions. Does the system operate normally?	System OK	Go to **Step 3**
3	Perform the power steering test procedure. Refer to **Power Steering System Test**. Did you complete the procedure?	Go to **Step 4**	-
4	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

REPAIR INSTRUCTIONS

STEERING LINKAGE INNER TIE ROD INSPECTION

Special Tools

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J-8001: Dial Indicator Set

For equivalent regional tools, refer to **Special Tools**.

NOTE: **This inspection procedure does not supersede local government required inspections that have more stringent requirements.**

1. Turn the ignition key to the ON position with the engine OFF.
2. With the aid of an assistant, turn the steering wheel to the full stop position and hold the steering wheel in that position until the test is complete. The tie rod being tested should be inside the steering gear housing seated against the steering stop.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. If there is not a good location for the **J-8001:** Dial Indicator pointer at the steering gear housing, install a large worm gear hose clamp to the steering gear housing over the larger steering gear boot clamp and align the clamp so that the screw can be a location for the **J-8001:** Dial Indicator pointer.

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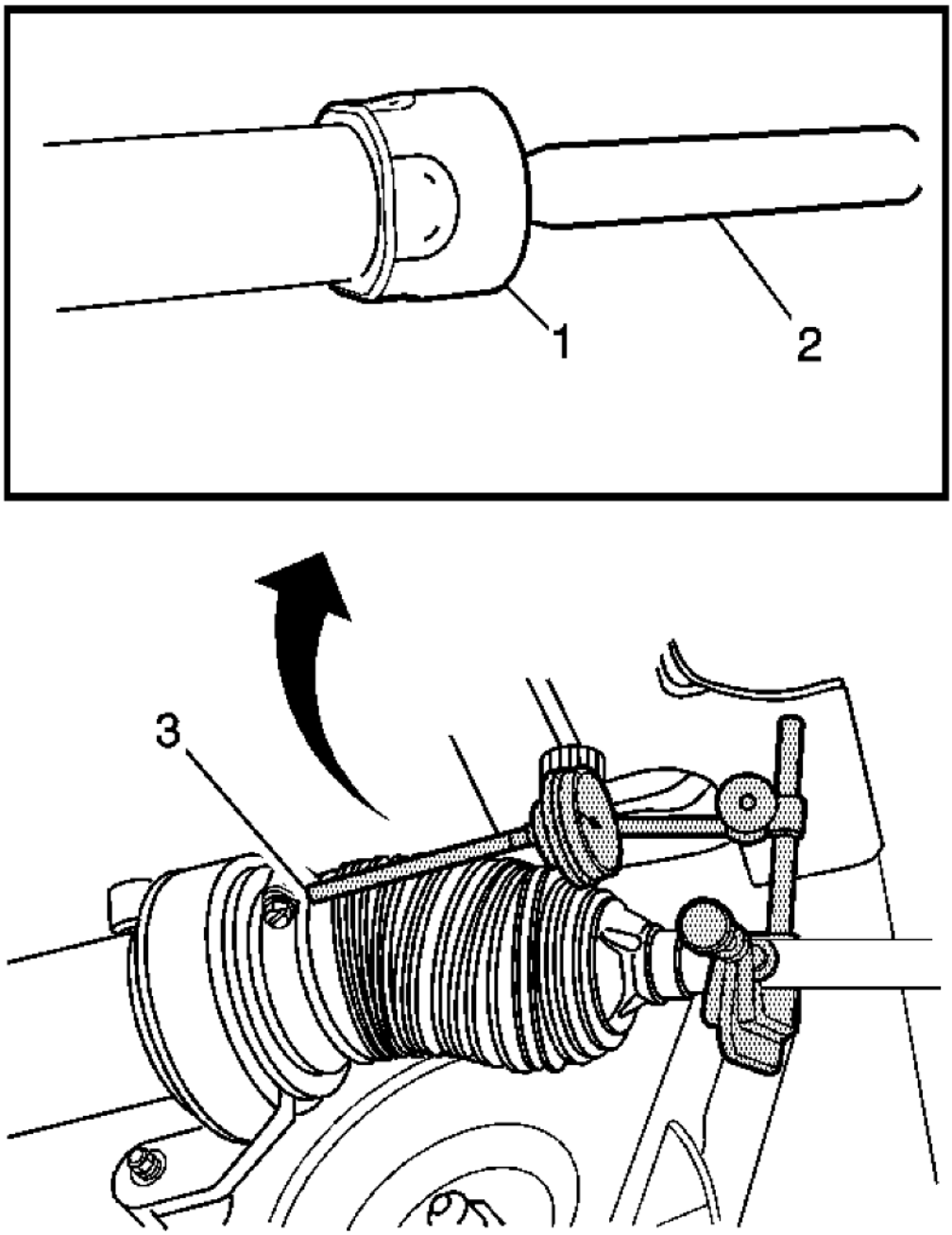


Fig. 2: Measuring Lash Between Inner Tie Rod & Steering Gear Housing
Courtesy of GENERAL MOTORS CORP.

5. Install the **J-8001:** Dial Indicator between the inner tie rod (2) and the steering gear housing or the worm

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gear clamp in such a way as to measure the lash between the inner tie rod and the steering gear housing.

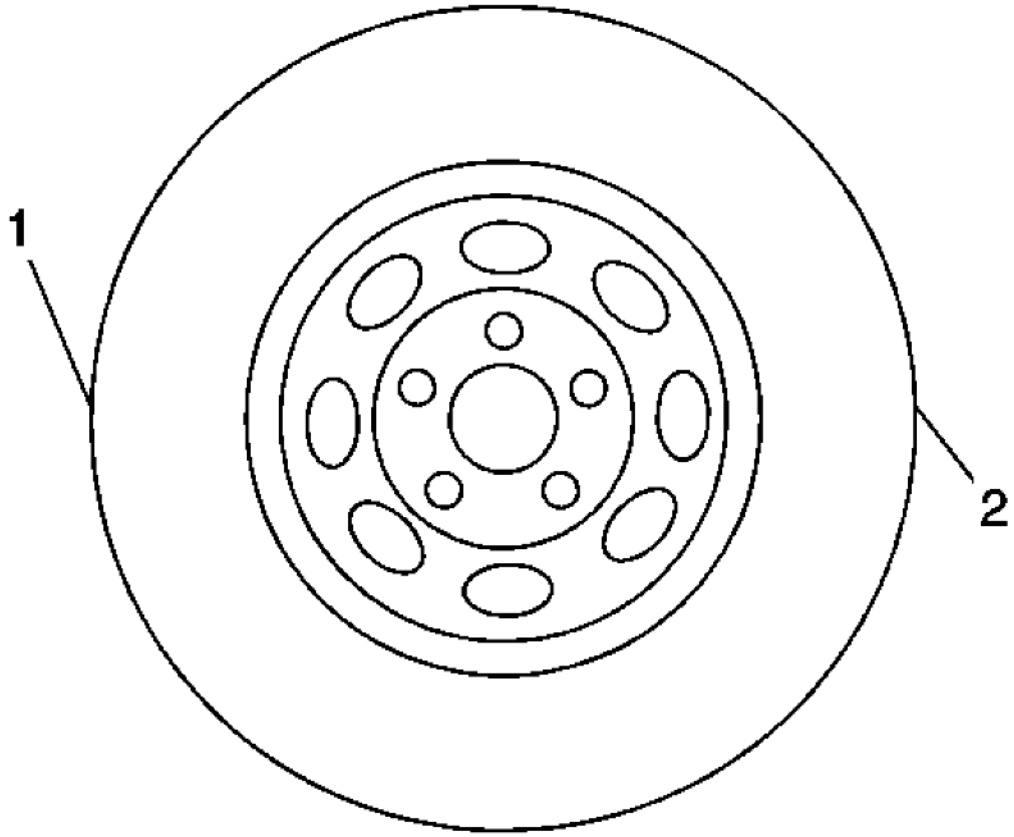


Fig. 3: Identifying Grasping Positions
Courtesy of GENERAL MOTORS CORP.

NOTE: Only move the tire enough to feel any lash between the inner tie rod and the inner tie rod housing without moving the steering gear rack.

6. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire in order to remove any lash.
7. Zero the **J-8001:** Dial Indicator.
8. On the same side of the tire previously pushed in, gently pull out and measure the lash.
9. Record the measurement seen on the **J-8001:** Dial Indicator.
10. If the measured value exceeds 0.5 mm (0.02 in), replace the inner tie rod. Refer to **Steering Linkage Inner Tie Rod Replacement**.

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11. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD INSPECTION

Special Tools

J-8001: Dial Indicator Set

For equivalent regional tools, refer to **Special Tools**.

NOTE: This inspection procedure does not supersede local government required inspections that have more stringent requirements.

1. Inspect the outer tie rod end seal. If the outer tie rod end seal is torn, replace the outer tie rod end. Refer to **Steering Linkage Outer Tie Rod Replacement**.
2. Raise the side of the vehicle being inspected with a floor jack while maintaining contact between the opposite wheel and the shop floor. Support the lower control arm with a floor jack stand as far outboard as possible and remove the floor jack. Refer to **Lifting and Jacking the Vehicle** .

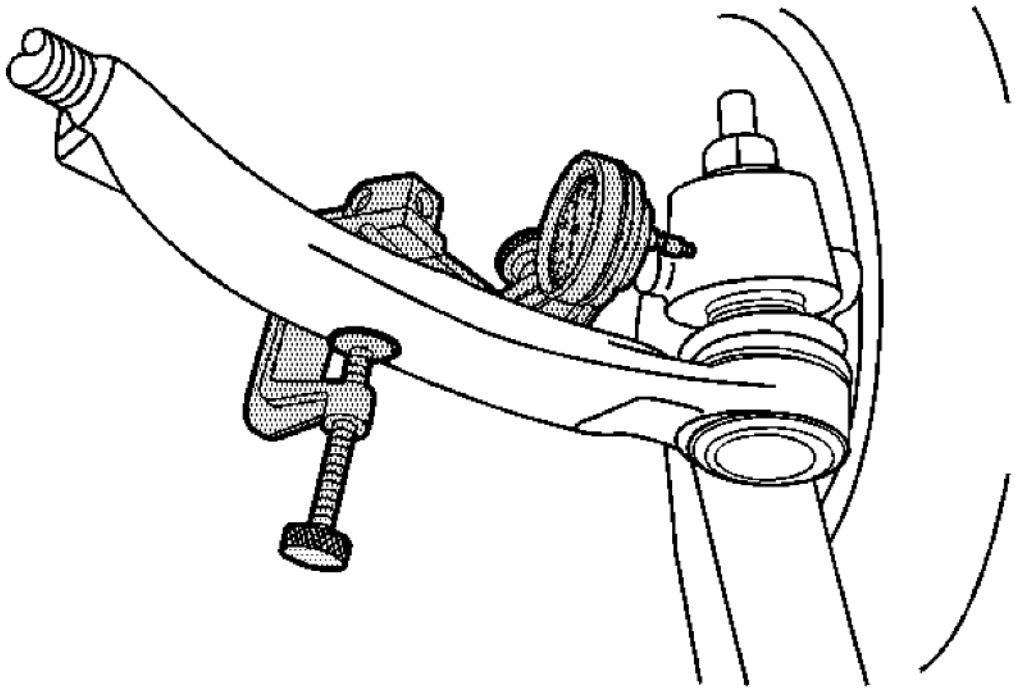


Fig. 4: Measuring Outer Tie Rod Lash

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Courtesy of GENERAL MOTORS CORP.

3. Install the **J-8001:** Dial Indicator between the outer tie rod end and the steering knuckle as shown in the graphic. Note that the tire and wheel assembly is shown removed only for clarification of the **J-8001:** Dial Indicator position.

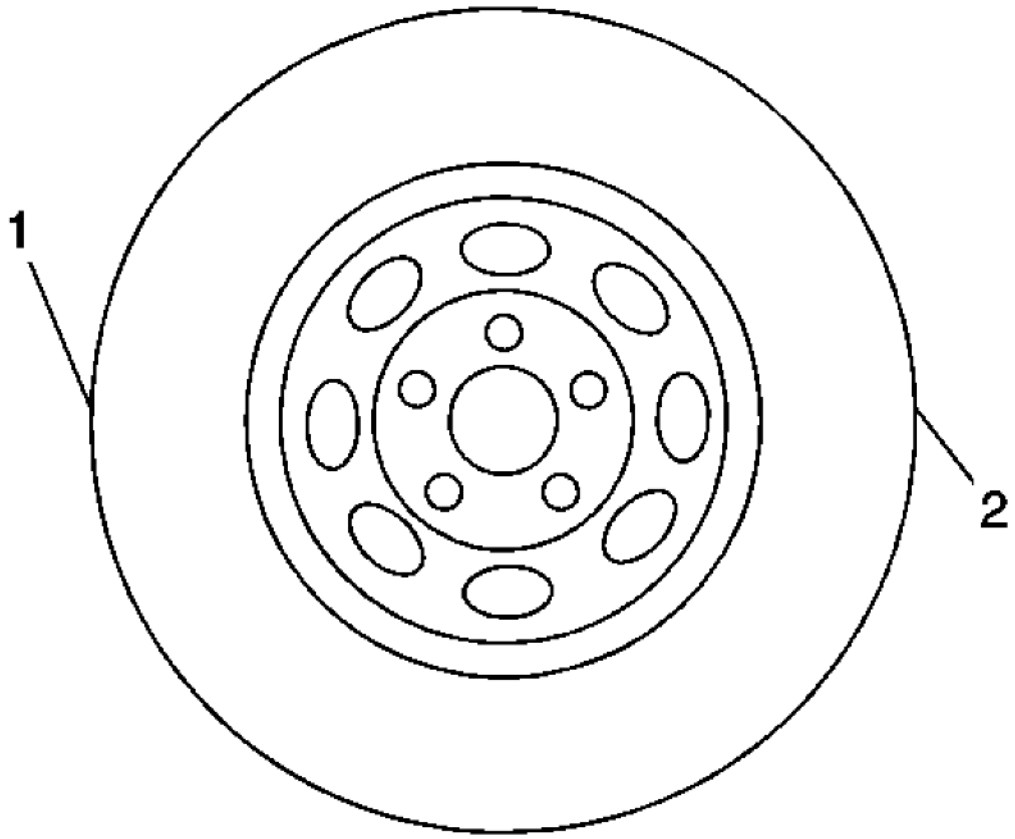


Fig. 5: Identifying Grasping Positions
Courtesy of GENERAL MOTORS CORP.

4. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire to remove any lash.
5. Zero the **J-8001:** Dial Indicator.
6. On the same side of the tire previously pushed inwards, gently pull outwards and measure the lash.
7. Record the measurement seen on the **J-8001:** Dial Indicator.
8. If the measured value exceeds 0.5 mm (0.02 in) then replace the outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.

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9. Repeat the procedure for the other side.

POWER STEERING SYSTEM BLEEDING

Special Tools

- **J-23738-A:** Vacuum Pump
- **J-43485:** Power Steering Bleeder Adapter

For equivalent regional tools, refer to **Special Tools**.

CAUTION: If the power steering system has been serviced, an accurate fluid level reading cannot be obtained unless air is bled from the steering system. The air in the fluid may cause pump cavitation noise and may cause pump damage over a period of time.

NOTE:

- **Use clean, new power steering fluid only. Refer to Adhesives, Fluids, Lubricants, and Sealers.**
- **Hoses touching the frame, body or engine may cause system noise. Ensure the hoses do not touch any other part of the vehicle.**
- **Loose connections may not leak, but could allow air into the steering system. Ensure all hose connections are tight.**
- **Maintain the power steering fluid level throughout the bleeding procedure.**
- **Introducing too much air into the power steering system will increase the amount of time required to bleed the system.**
- **Do not turn the steering wheel until instructed to do so.**

1. Apply the park brake.
2. Using a floor jack and jack stands, raise the front of the vehicle until the center of the front wheels are approximately 61 cm (24 in) off the ground. Refer to **Lifting and Jacking the Vehicle** .

CAUTION: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

3. Fill the power steering fluid reservoir with fluid to the bottom of the filler neck.
4. Connect the **J-43485:** adapter to the **J-23738-A:** pump.
5. Hold the **J-43485:** adapter on the top of the reservoir filler neck.
6. Apply a vacuum of 51 kPa (15 in Hg, 7 psi).
7. Set the **J-23738-A:** pump down. The vacuum will hold the **J-43485:** adapter in place.
8. Wait 5 minutes. Monitor the vacuum gauge.

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NOTE: The vacuum gauge needle will fluctuate while the steering wheel is moving.

9. With the key in the ON position and with the engine OFF, have an assistant turn the steering wheel from stop to stop 10 times. Maintain a vacuum of 51 kPa (15 in Hg, 7 psi) while the assistant holds the steering wheel at each steering stop for 5 seconds.
10. Relieve the vacuum in the **J-23738-A:** pump.
11. Remove the **J-43485:** adapter from the reservoir filler neck.
12. Ensure the power steering fluid level is correct. Refer to **Checking and Adding Power Steering Fluid**.
13. With the reservoir cap off, start the engine. Slowly rotate the steering wheel from stop to stop 10 times. Hold the steering wheel at each stop for 2 seconds.
14. Turn the engine OFF.
15. Ensure the power steering fluid level is correct.
16. Lower the vehicle.
17. Ensure the power steering fluid level is correct.

NOTE: The vehicle may exhibit some steering shudder while turning the steering wheel with the vehicle stationary and the brakes applied. This condition will dissipate with time and vehicle usage. Drive the vehicle. If you notice the shudder condition is improving, release the vehicle to the customer and explain that the shudder condition will dissipate after some driving.

18. Turn the steering wheel from stop to stop. Inspect the power steering system for leaks and noise.

CHECKING AND ADDING POWER STEERING FLUID

1. Run the engine until the power steering fluid reaches about 80°C (170°F).
2. Turn the engine OFF.
3. If the power steering fluid reservoir is covered by a shield or a cover, remove the shield or the cover, as applicable.
4. Clean the power steering fluid reservoir and the reservoir cap.
5. Remove the reservoir cap.

NOTE: Inspect the power steering pump fluid level at regular intervals.

6. Inspect the power steering fluid level in the reservoir or on the cap stick, as applicable. Ensure that the fluid level is at the HOT/FULL/MAX mark on the cap stick or on the reservoir, as applicable.

CAUTION: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

7. Add power steering fluid if necessary. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

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8. Install the reservoir cap.
9. If you removed a shield or a cover, install the shield or the cover, as applicable.

POWER STEERING SYSTEM FLUSHING

NOTE: Do not reuse any drained power steering fluid regardless of appearance or condition.

1. Raise the vehicle until the front wheels are off the ground. Refer to **Lifting and Jacking the Vehicle** .
2. Place a large drain pan under the vehicle in order to collect the draining fluid.
3. Remove the fluid return hose at the power steering fluid reservoir or the pump inlet connection, as applicable.
4. Plug the reservoir return hose inlet connection on the power steering fluid reservoir or the pump, as applicable.

NOTE: This step may require 4 L (4 qt) of power steering fluid until the draining fluid appears clear.

5. Have an assistant maintain the minimum fluid level in the reservoir using clean, new power steering fluid. Refer to **Checking and Adding Power Steering Fluid**.
6. With the key in the ON position and with the engine OFF, turn the steering wheel fully to the left and to the right. Continue until the fluid from the return hose runs clear.
7. Remove the plug and install the fluid return hose to the power steering fluid reservoir or the pump inlet connection, as applicable.
8. Bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Inspect the power steering fluid for the following indications of contamination:
   - Milky fluid - water
   - Brown fluid - burnt
   - Plastic debris or dirt chunks
10. If the fluid is contaminated, repeat steps 3-9.
11. Remove the drain pan.
12. Lower the vehicle.

POWER STEERING FLUID RESERVOIR REPLACEMENT (V6)

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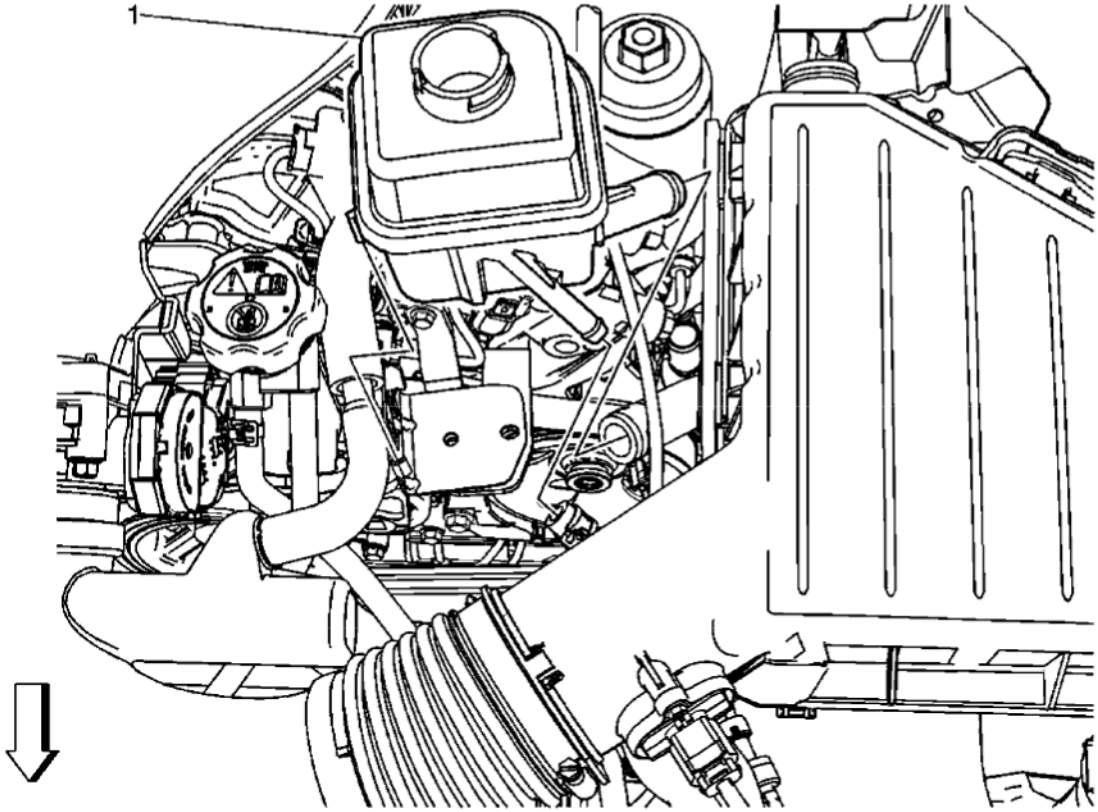


Fig. 6: Power Steering Fluid Reservoir (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
CAUTION: **Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.** **Preliminary Procedures** 1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** . 2. Place drain pans under the vehicle. 3. Remove as much power steering fluid from the reservoir as possible. 4. Disconnect the power steering fluid reservoir outlet hose from the power steering fluid reservoir. Cap the power steering fluid reservoir outlet hose. 5. Disconnect the power steering fluid cooler outlet hose from the power steering fluid reservoir. Cap the power steering fluid cooler outlet hose.	
	Power Steering Fluid Reservoir **Procedure**

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1	1. Release the clip and slide the power steering fluid reservoir off of the power steering fluid reservoir bracket. 2. Fill the power steering fluid reservoir. Refer to **Checking and Adding Power Steering Fluid**. 3. Clean any excess power steering fluid from the vehicle.

POWER STEERING FLUID RESERVOIR REPLACEMENT (V8)

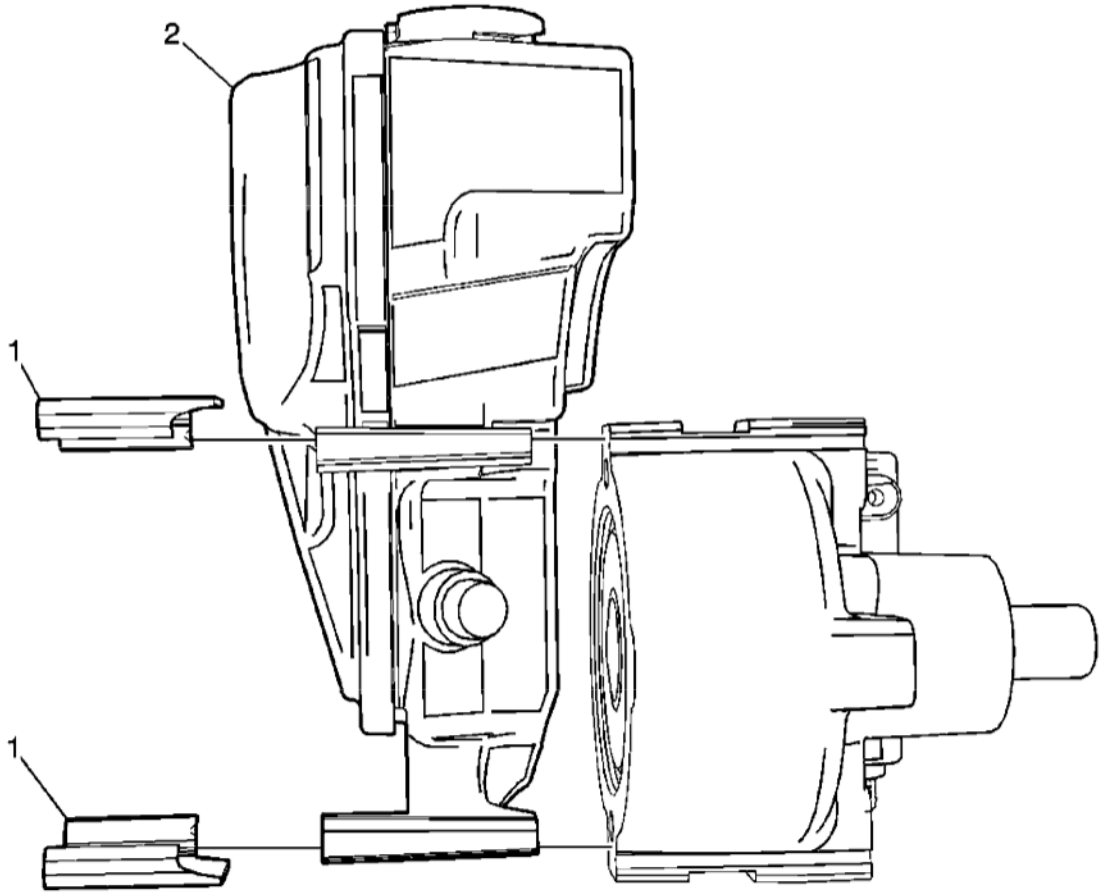


Fig. 7: Power Steering Fluid Reservoir (V8)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the power steering pump. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**.	
1	Power Steering Fluid Reservoir Retainer
2	Power Steering Fluid Reservoir **Procedure:**

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	Install a NEW reservoir O-ring seal.

POWER STEERING FLUID RESERVOIR BRACKET REPLACEMENT (V6)

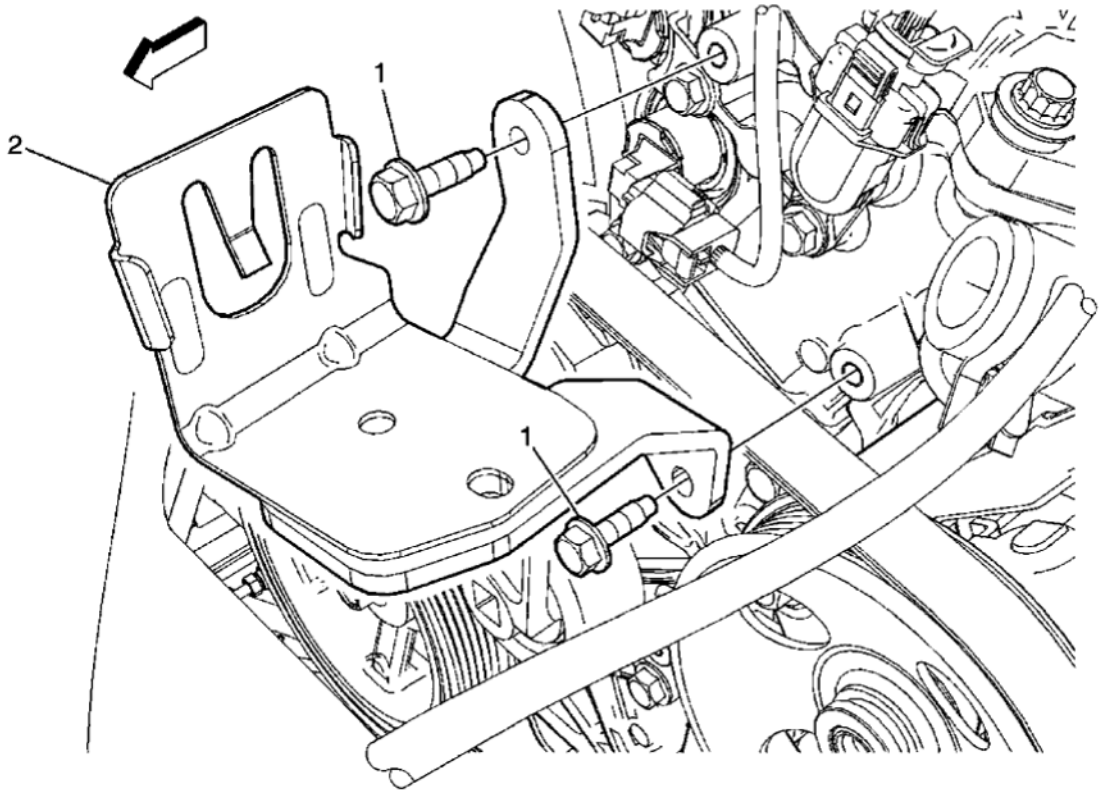


Fig. 8: Power Steering Fluid Reservoir Bracket (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)**.	
1	Power Steering Fluid Reservoir Bracket Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 9 N.m (80 lb in)
2	Power Steering Fluid Reservoir Bracket

POWER STEERING PUMP PULLEY REPLACEMENT (V6)

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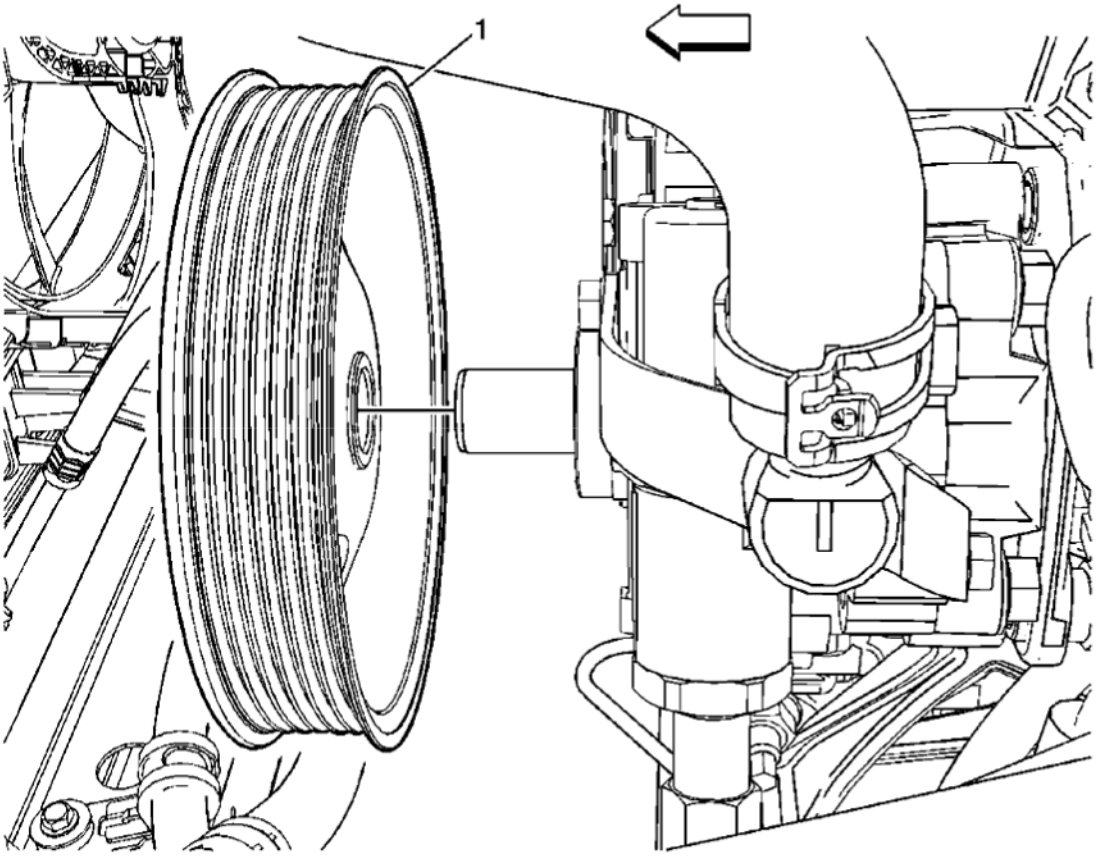


Fig. 9: Power Steering Pump Pulley (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** . 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 3. Remove the accessory drive belt from the power steering pump pulley only. Refer to **Drive Belt Replacement** .	
1	Power Steering Pump Pulley **Procedure** 1. Use the **J-25034-C:** Pulley Remover in order to remove the pulley. 2. Use the **J-25033-C:** Pulley Installer in order to install the pulley. **Tip:** Ensure the axial tolerance of the pulley on the pump shaft is within 0.25 mm (0.010 in).

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	Special Tools • **J-25034-C:** Pulley Remover • **J-25033-C:** Pulley Installer For equivalent regional tools, refer to **Special Tools**.

POWER STEERING PUMP PULLEY REPLACEMENT (V8)

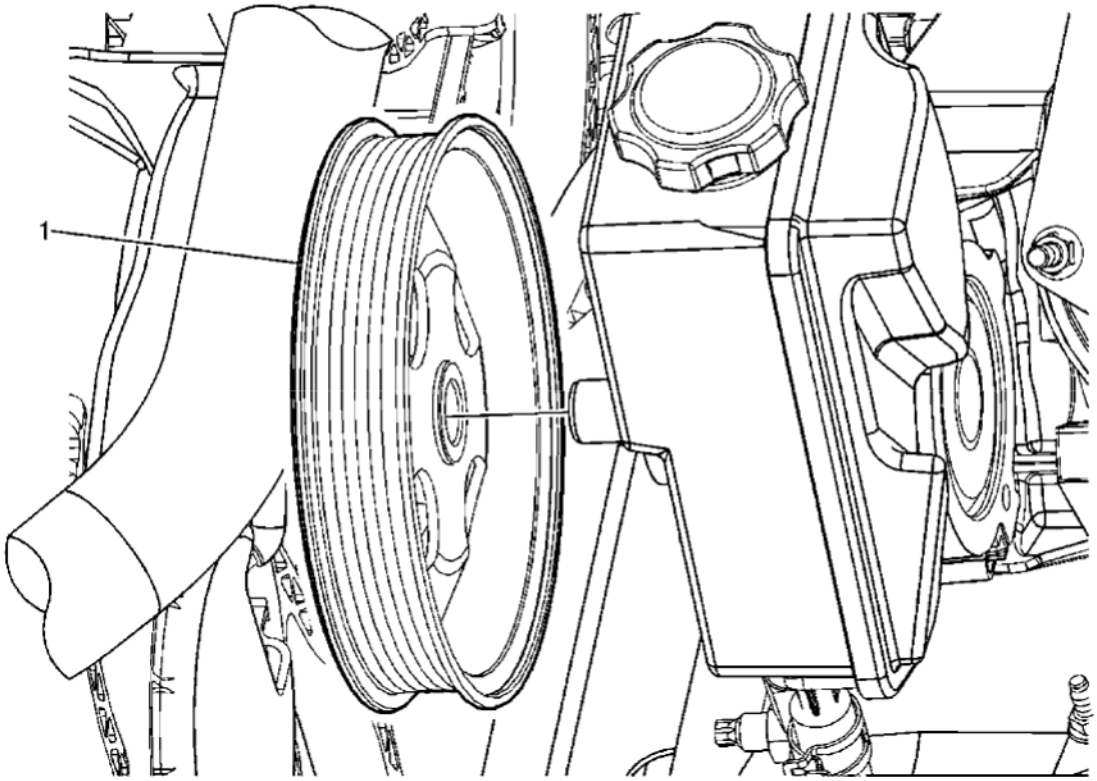


Fig. 10: Power Steering Pump Pulley (V8)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the engine cover. Refer to **Engine Cover Replacement** . 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 3. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** . 4. Remove the accessory drive belt from the power steering pump pulley only. Refer to **Drive Belt**	

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Replacement - Accessory .	
1	Power Steering Pump Pulley **Procedure** 1. Use the **J-25034-C:** Pulley Remover in order to remove the pulley. 2. Use the **J-25033-C:** Pulley Installer in order to install the pulley. **Tip:** Ensure the axial tolerance of the pulley on the pump shaft is within 0.25 mm (0.010 in). **Special Tools** • **J-25034-C:** Pulley Remover • **J-25033-C:** Pulley Installer For equivalent regional tools, refer to **Special Tools**.

POWER STEERING PUMP REPLACEMENT (V6)

Removal Procedure

1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Cover the air conditioning compressor in order to prevent power steering fluid from dripping on the air conditioning compressor.
3. Place drain pans under the vehicle.

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

NOTE: Introducing too much air into the power steering system will increase the amount of time required to bleed the system.

4. Remove the power steering fluid reservoir outlet hose from the vehicle. Refer to **Power Steering Fluid Reservoir Outlet Hose Replacement (V6)**.
5. Disconnect the power steering gear inlet hose from the power steering pump. Cap the power steering gear inlet hose. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
6. If you are removing and installing the same power steering pump, plug the power steering pump outlet port.
7. Remove the power steering pump pulley from the vehicle. Refer to **Power Steering Pump Pulley Replacement (V6)** or **Power Steering Pump Pulley Replacement (V8)**.

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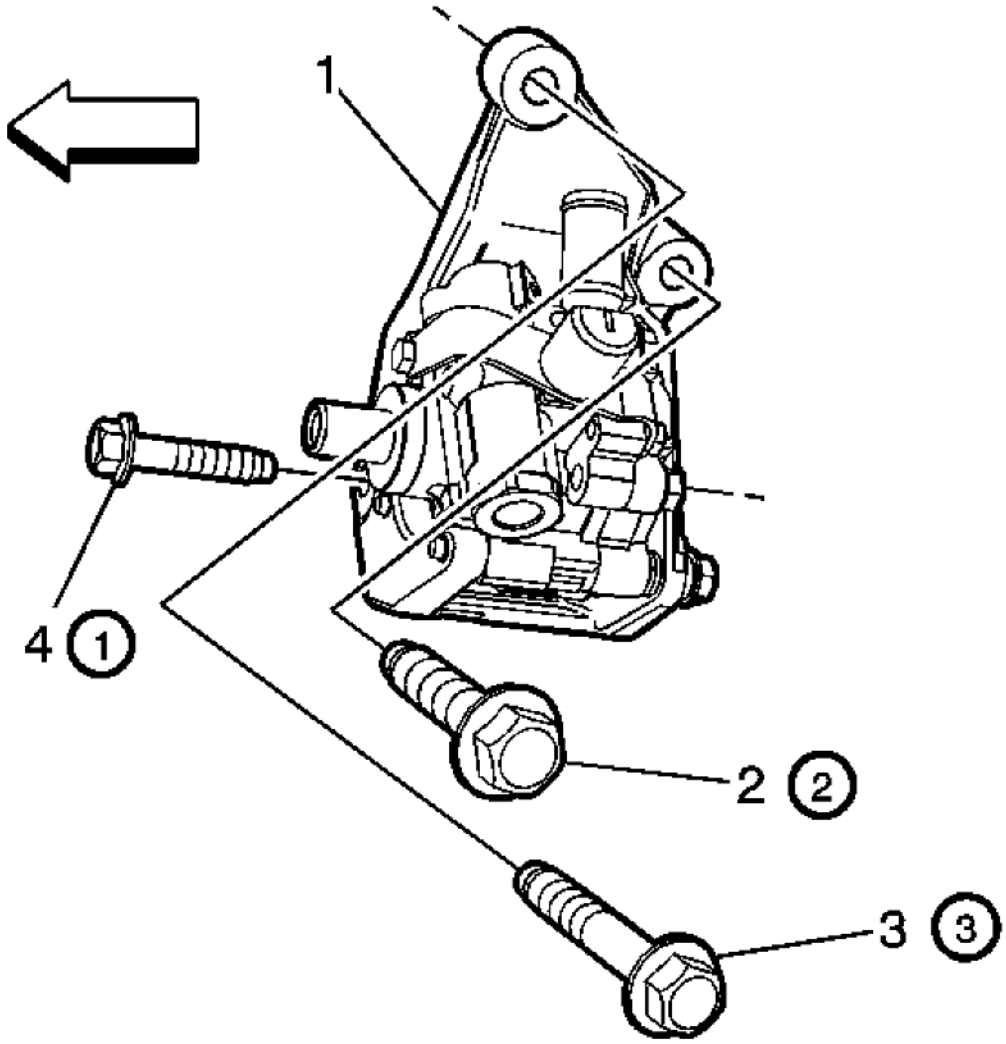


Fig. 11: Power Steering Pump Bracket & Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

8. Remove the 3 power steering pump bracket bolts (2, 3, 4).
9. Remove the power steering pump and the bracket (1) as an assembly from the vehicle.
10. If equipped, remove the bolt and the pump auxiliary bracket from the pump.
11. If you will be installing a NEW power steering pump, remove the power steering pump from the bracket. Refer to **Power Steering Pump Bracket Replacement (V6)** or **Power Steering Pump Bracket Replacement (V8)**.

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Installation Procedure

1. If you are installing a NEW power steering pump, install the power steering pump to the power steering pump bracket. Refer to **Power Steering Pump Bracket Replacement (V6)** or **Power Steering Pump Bracket Replacement (V8)**.

   CAUTION: Refer to Fastener Caution .

2. If equipped, install the pump auxiliary bracket. Install the power steering pump auxiliary bracket bolt and tighten to 20 N.m (15 lb ft).
3. Ensure there is a plug in the power steering pump outlet port.

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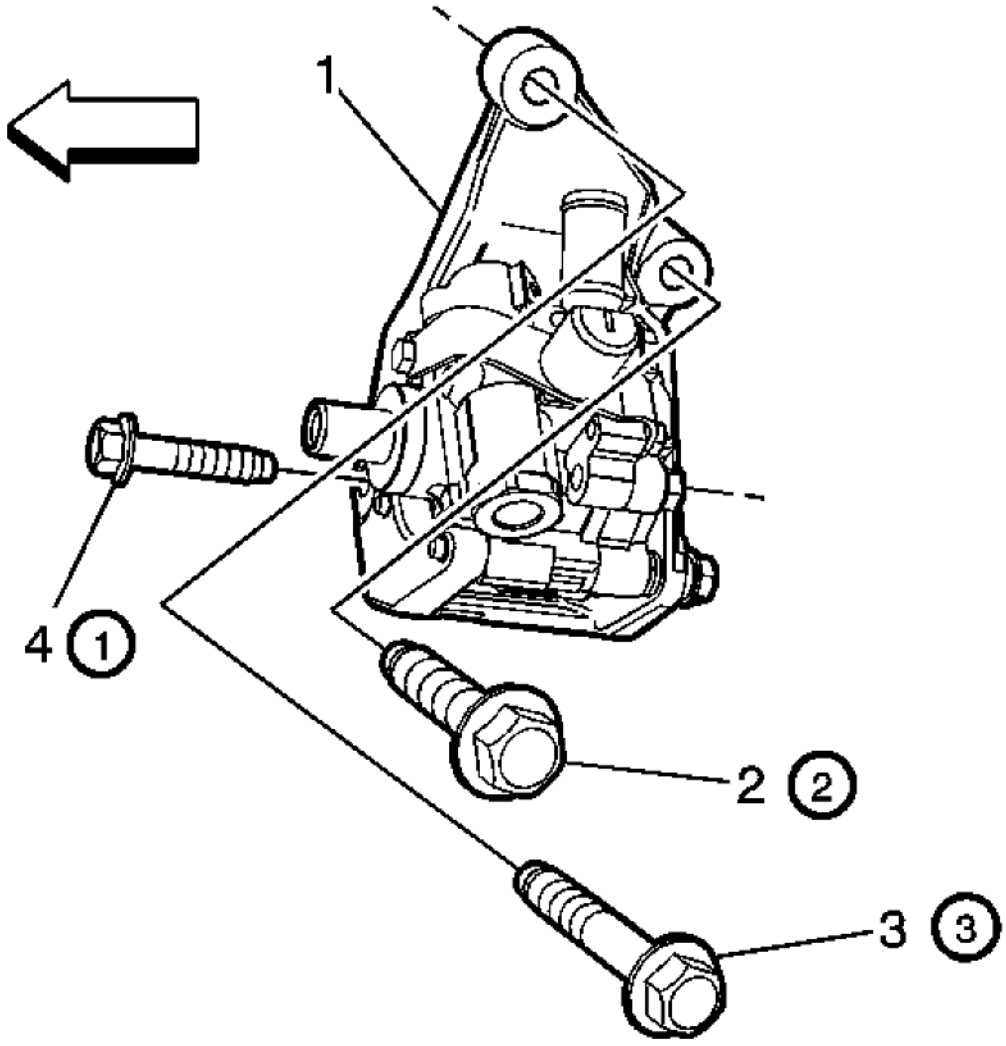


Fig. 12: Power Steering Pump Bracket & Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Position the power steering pump and the bracket (1) as an assembly in the vehicle.
5. Install the 3 power steering pump bracket bolts (1, 2, 3). Tighten the power steering pump bracket bolts in sequence to 58 N.m (43 lb ft).
6. Install the power steering fluid reservoir outlet hose to the vehicle. Refer to **Power Steering Fluid Reservoir Outlet Hose Replacement (V6)**.
7. Fill the power steering fluid reservoir. Refer to **Checking and Adding Power Steering Fluid**.
8. Remove the cap from the power steering gear inlet hose. When fluid starts to flow from the hose, cap the

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hose with your thumb. Ensure the O-ring seal is on the hose and is in good condition.

9. Remove the plug from the power steering pump outlet port and quickly connect the power steering gear inlet hose to the power steering pump. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
10. Clean any excess power steering fluid from the vehicle.
11. Install the power steering pump pulley to the power steering pump. Refer to **Power Steering Pump Pulley Replacement (V6)** or **Power Steering Pump Pulley Replacement (V8)**.
12. Remove the cover from the air conditioning compressor.
13. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
14. Remove the drain pans.
15. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

POWER STEERING PUMP REPLACEMENT (V8)

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Cover the generator in order to prevent power steering fluid from dripping on the generator.
3. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (V6)** or **Power Steering Pump Pulley Replacement (V8)**.
4. Place drain pans under the vehicle.
5. If you will be installing a NEW power steering pump, remove as much power steering fluid from the reservoir as possible.

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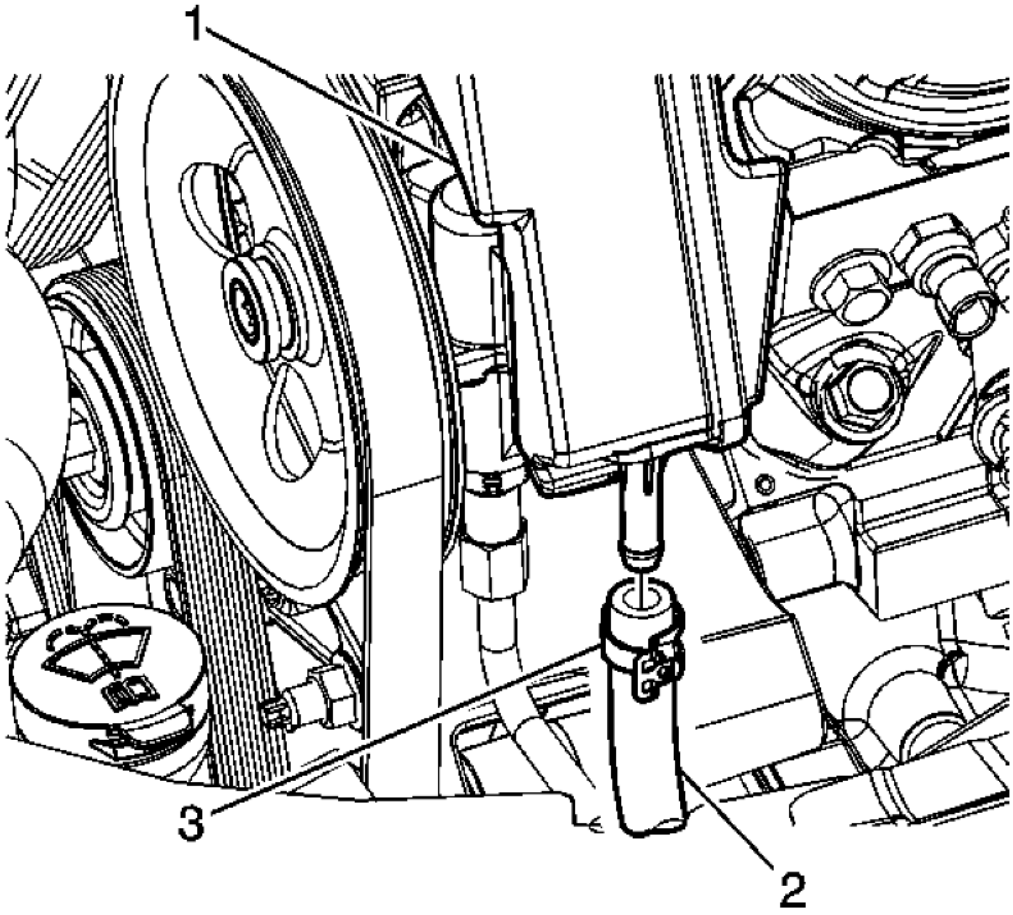


Fig. 13: Power Steering Fluid Cooler Outlet Hose & Power Steering Fluid Reservoir
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

NOTE: Introducing too much air into the power steering system will increase the amount of time required to bleed the system.

6. Disconnect the power steering fluid cooler outlet hose (2) from the power steering fluid reservoir (1). Plug the power steering fluid cooler outlet hose.
7. If you are removing and installing the same power steering pump, plug the power steering fluid reservoir

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inlet port.

8. Disconnect the power steering gear inlet hose from the power steering pump. Cap the power steering gear inlet hose. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
9. If you are removing and installing the same power steering pump, plug the power steering pump outlet port.

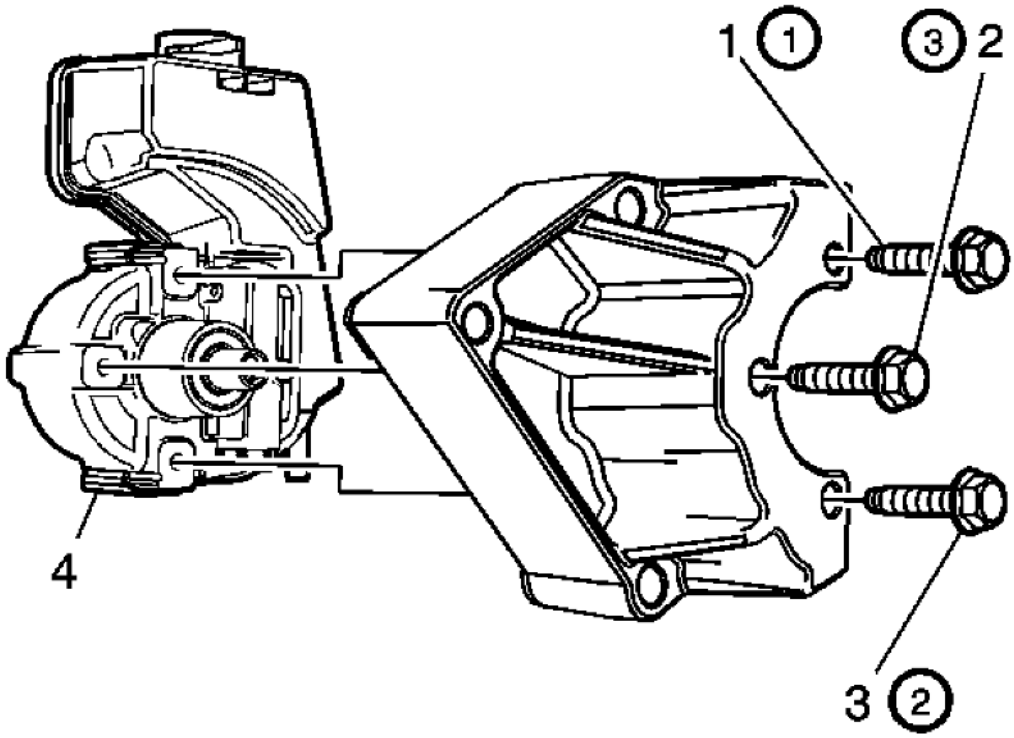


Fig. 14: Power Steering Pump & Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Remove the 3 power steering pump bolts (1, 2, 3).
11. Slide the power steering pump (4) off of the power steering pump bracket. Remove the power steering pump and the reservoir as an assembly from the vehicle.
12. If you will be installing a NEW power steering pump, remove the power steering fluid reservoir from the power steering pump. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)**.

Installation Procedure

1. If you are installing a NEW power steering pump, install the power steering fluid reservoir to the power

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steering pump. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)**.

2. Ensure there is a plug in the power steering pump outlet port.

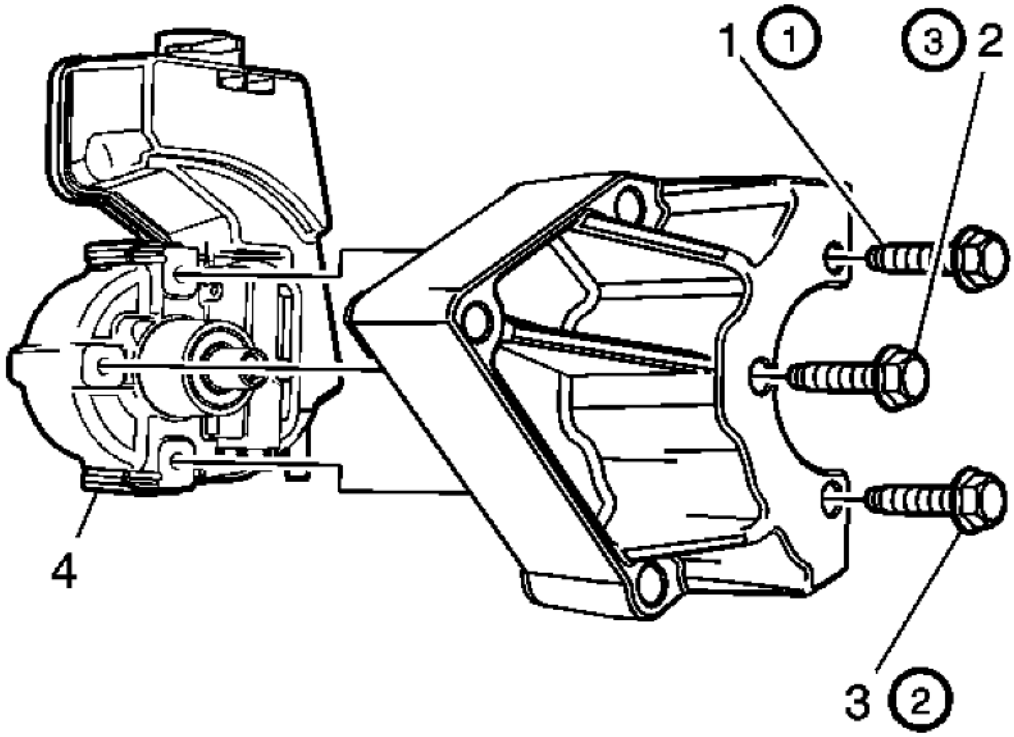


Fig. 15: Power Steering Pump & Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

3. Position the power steering pump (4) and the reservoir as an assembly on the power steering pump bracket.

CAUTION: Refer to Fastener Caution .

4. Install the 3 power steering pump bolts (1, 2, 3). Tighten the power steering pump bolts in sequence to 25 N.m (18 lb ft).

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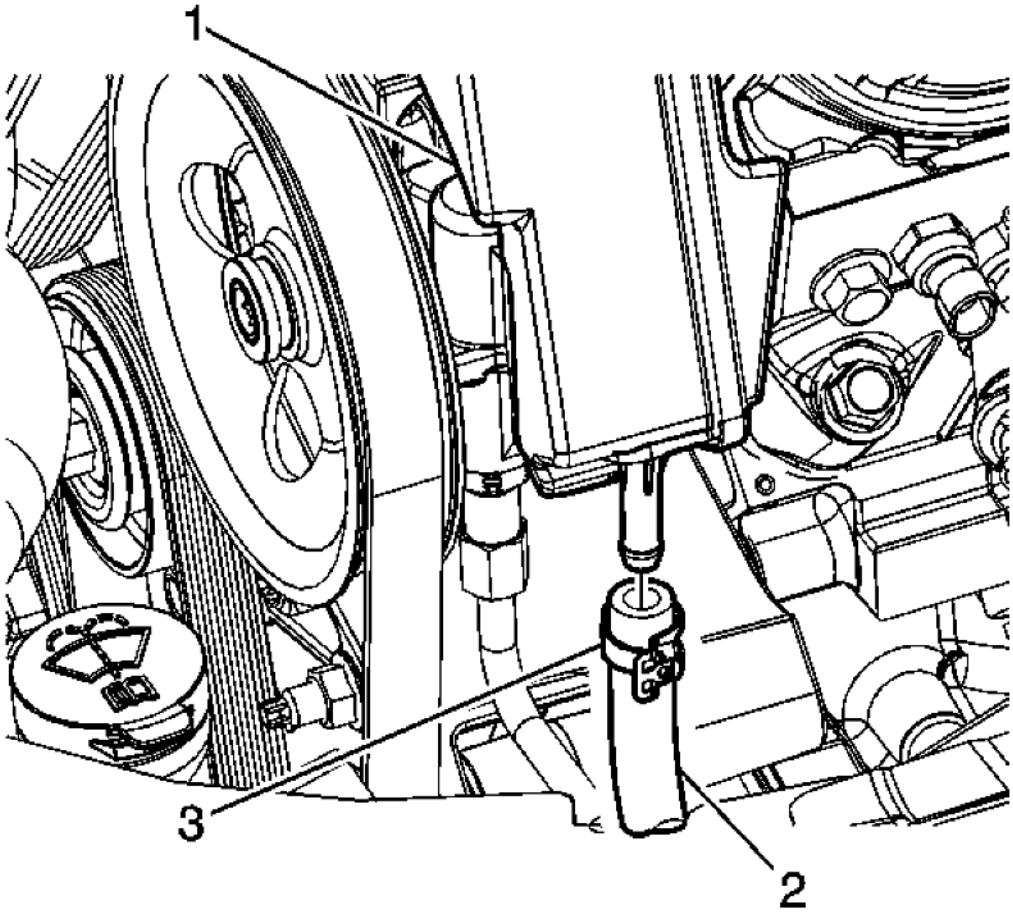


Fig. 16: Power Steering Fluid Cooler Outlet Hose & Power Steering Fluid Reservoir
Courtesy of GENERAL MOTORS CORP.

5. Remove the plug from the power steering fluid cooler outlet hose (2). Remove the plug from the power steering fluid reservoir inlet port and quickly connect the power steering fluid cooler outlet hose to the power steering fluid reservoir.
6. Fill the power steering fluid reservoir. Refer to **Checking and Adding Power Steering Fluid**.
7. Remove the cap from the power steering gear inlet hose. When fluid starts to flow from the hose, cap the hose with your thumb. Ensure the O-ring seal is on the hose and is in good condition.
8. Remove the plug from the power steering pump outlet port and quickly connect the power steering gear inlet hose to the power steering pump. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
9. Clean any excess power steering fluid from the vehicle.
10. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (V6)** or **Power Steering Pump Pulley Replacement (V8)**.

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11. Remove the cover from the generator.
12. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
13. Remove the drain pans.
14. Install the engine cover. Refer to **Engine Cover Replacement** .

POWER STEERING PUMP BRACKET REPLACEMENT (V6)

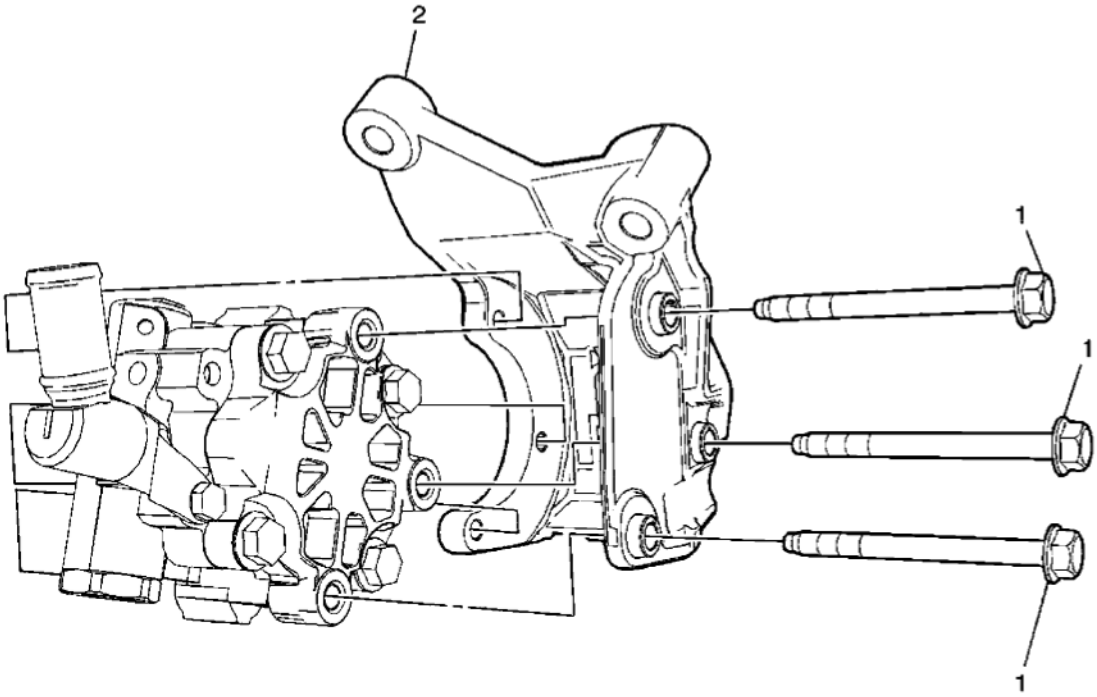


Fig. 17: Power Steering Pump Bracket (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** . 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 3. Disconnect the accessory drive belt from the power steering pump pulley only. Refer to **Drive Belt Replacement** . 4. Disconnect the power steering pump bracket from the engine block. DO NOT disconnect the power steering hoses. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**.	
1	Power Steering Pump Bolt (Qty: 3) **CAUTION:**

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	Refer to Fastener Caution . **Tighten:** 22 N.m (16 lb ft)
2	Power Steering Pump Bracket

POWER STEERING PUMP BRACKET REPLACEMENT (V8)

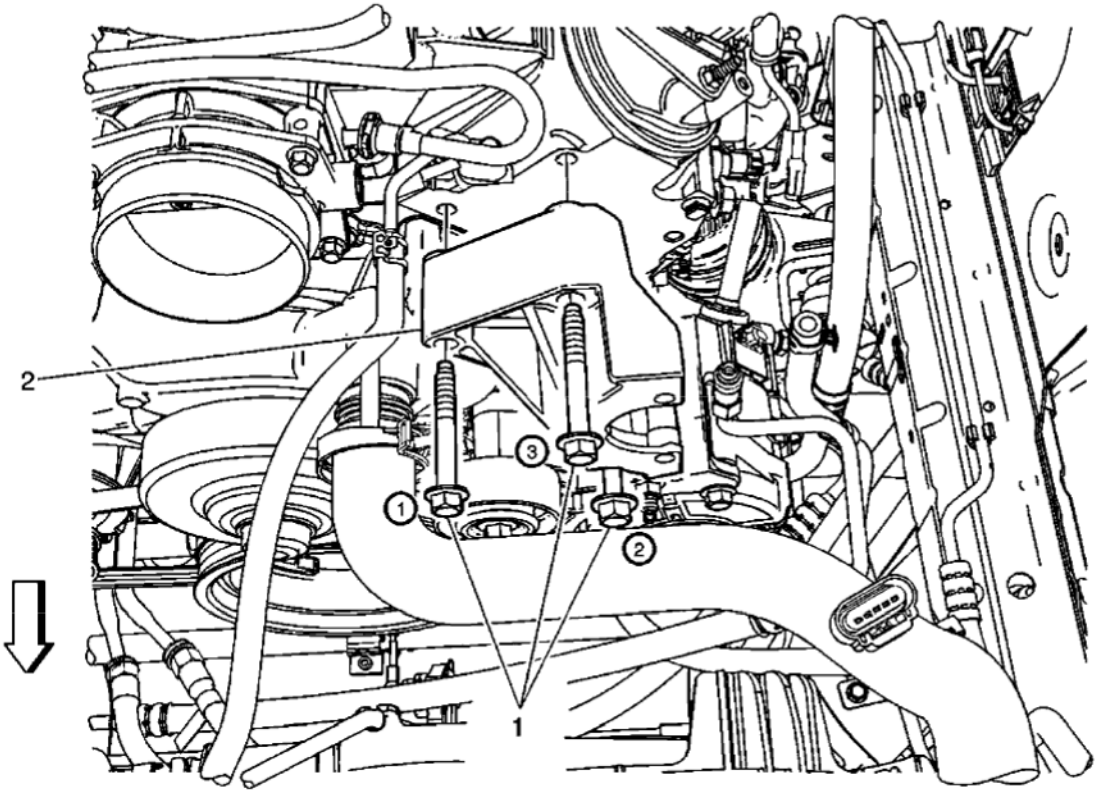


Fig. 18: Power Steering Pump Bracket (V8)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the engine cover. Refer to **Engine Cover Replacement** . 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 3. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** . 4. Disconnect the accessory drive belt from the power steering pump pulley only. Refer to **Drive Belt Replacement - Accessory** . 5. Disconnect the power steering pump from the power steering pump bracket. Access the power steering pump bolts through the holes in the pulley. DO NOT disconnect the power steering hoses.	

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	Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)**.
1	Power Steering Pump Bracket Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure:** Tighten the bolts in sequence. **Tighten:** 50 N.m (37 lb ft)
2	Power Steering Pump Bracket

STEERING LINKAGE OUTER TIE ROD REPLACEMENT

Special Tools

J-38892: Ball Joint Separator

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

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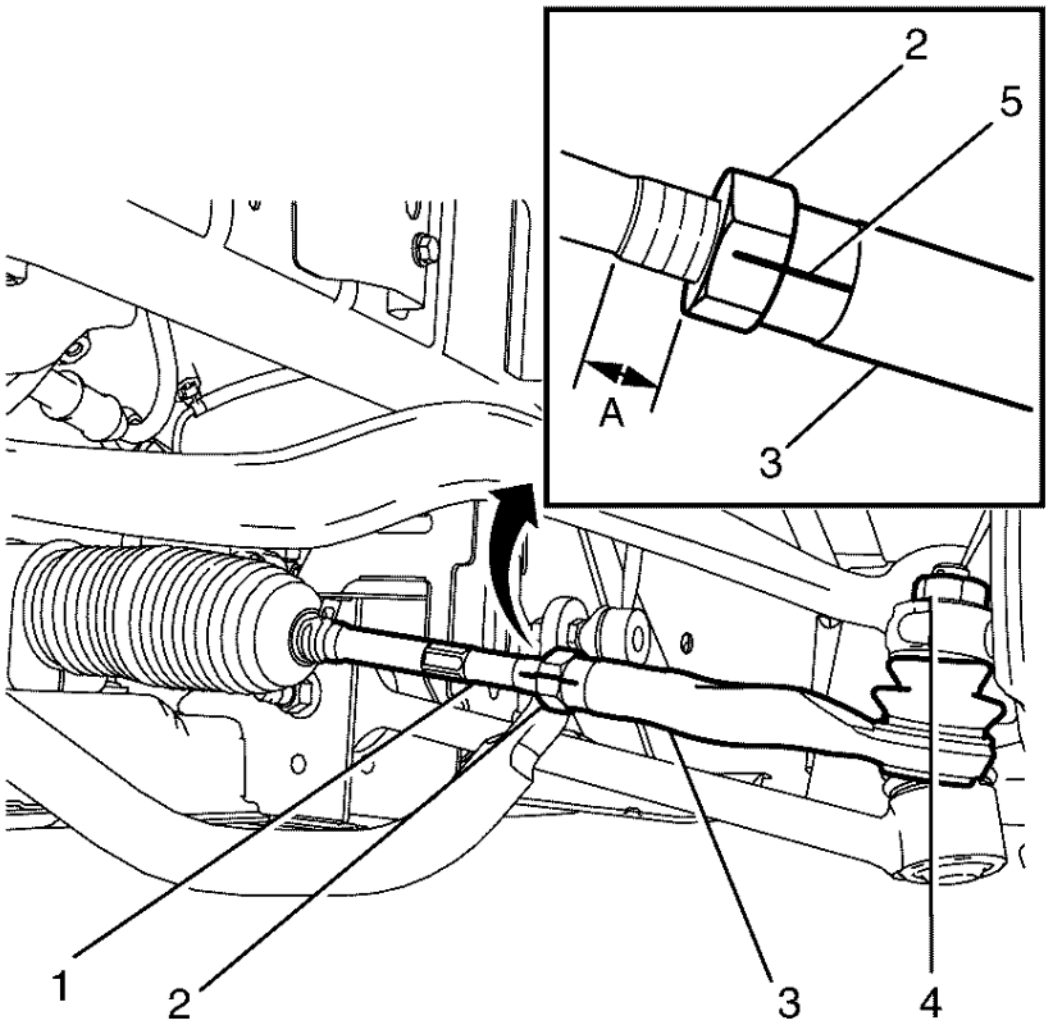


Fig. 19: Identifying Tie Rod End & Lock Nut
Courtesy of GENERAL MOTORS CORP.

2. Use paint in order to place match marks (5) on the steering linkage inner tie rod nut (2) and on the steering linkage outer tie rod (3).
3. Measure and record the distance of the thread (A) in relation to the inner tie rod nut.
4. Loosen the inner tie rod nut half a turn.

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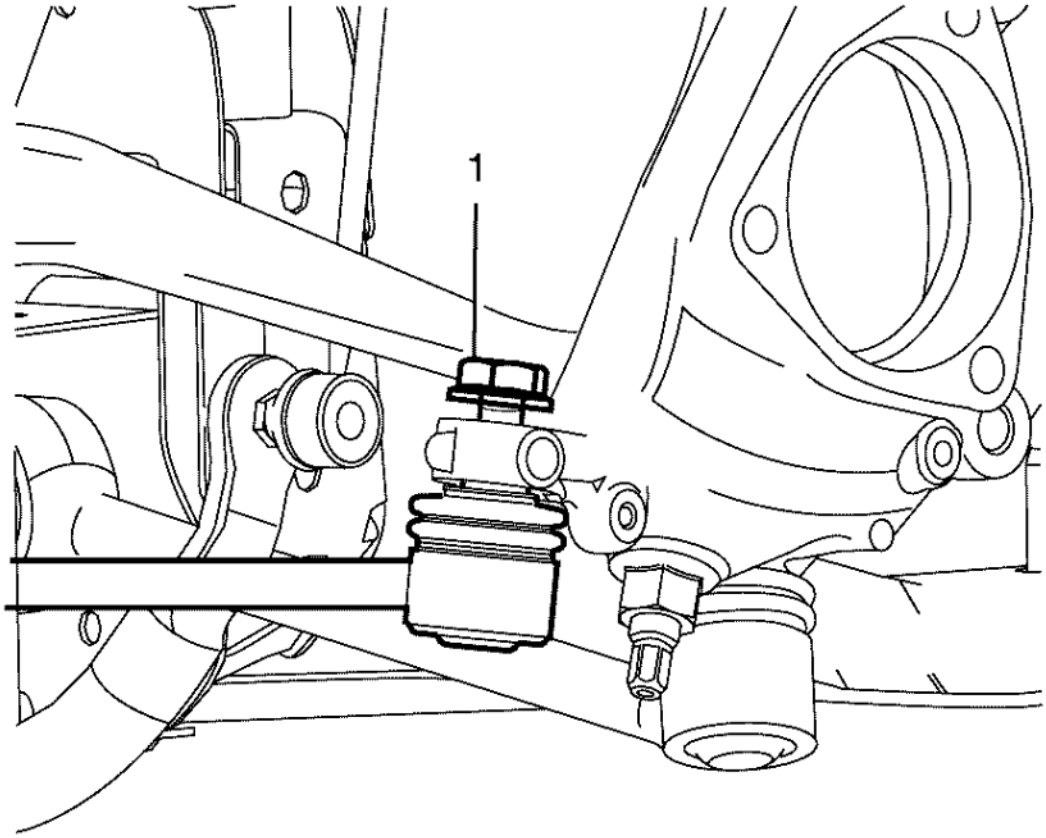


Fig. 20: Identifying Outer Tie Rod Nut
Courtesy of GENERAL MOTORS CORP.

5. Loosen the outer tie rod nut (1) to the top of the stud.

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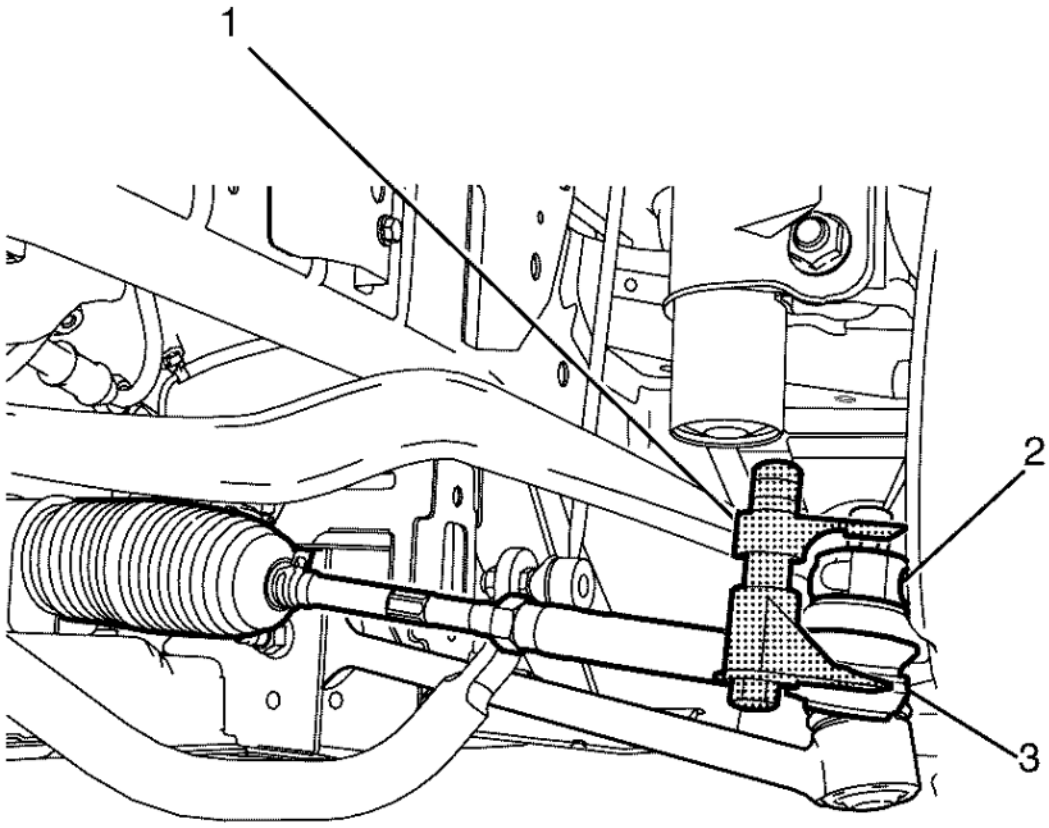


Fig. 21: Disengaging Outer Tie Rod From Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

6. Use the **J-38892:** Separator (1) in order to disengage the outer tie rod from the steering knuckle (2).

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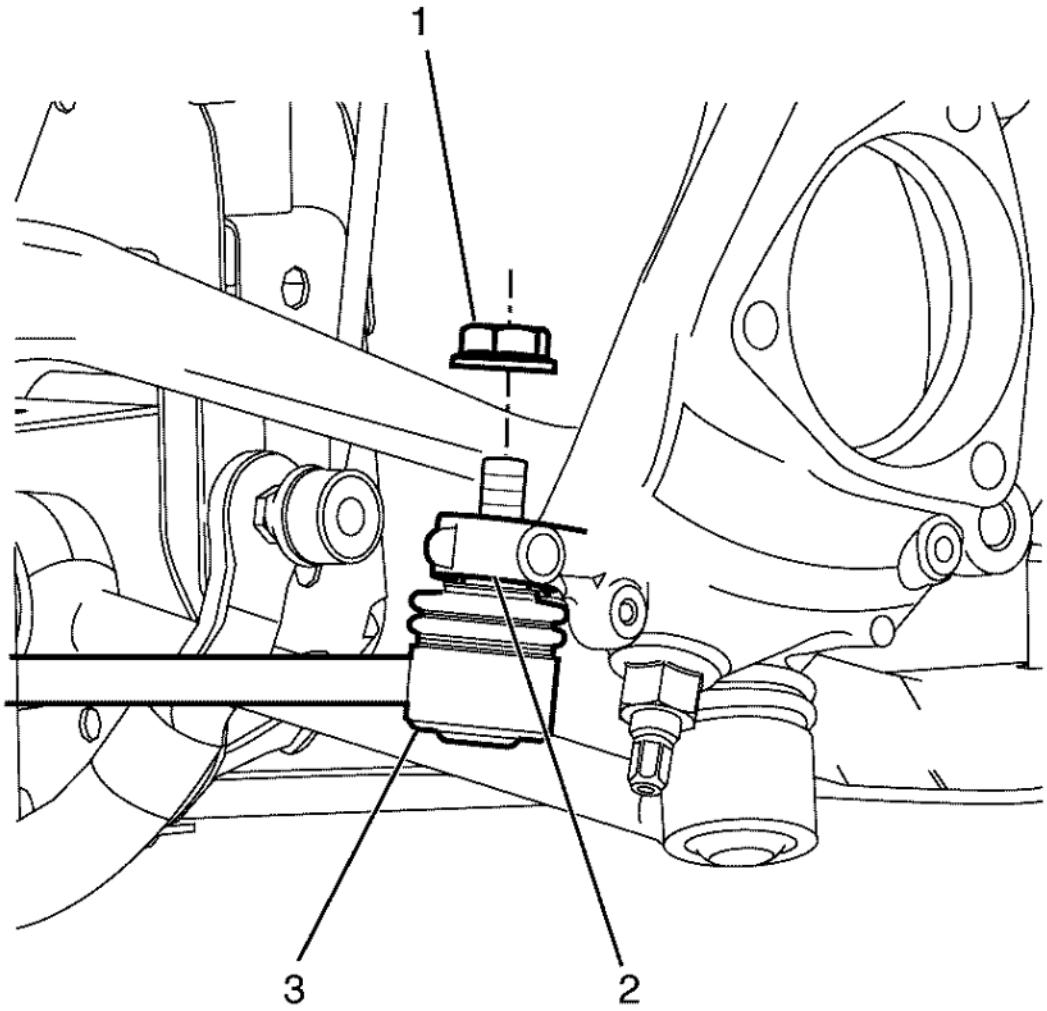


Fig. 22: Outer Tie Rod & Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

7. Remove and discard the outer tie rod nut (1).
8. Separate the outer tie rod (3) from the steering knuckle (2).

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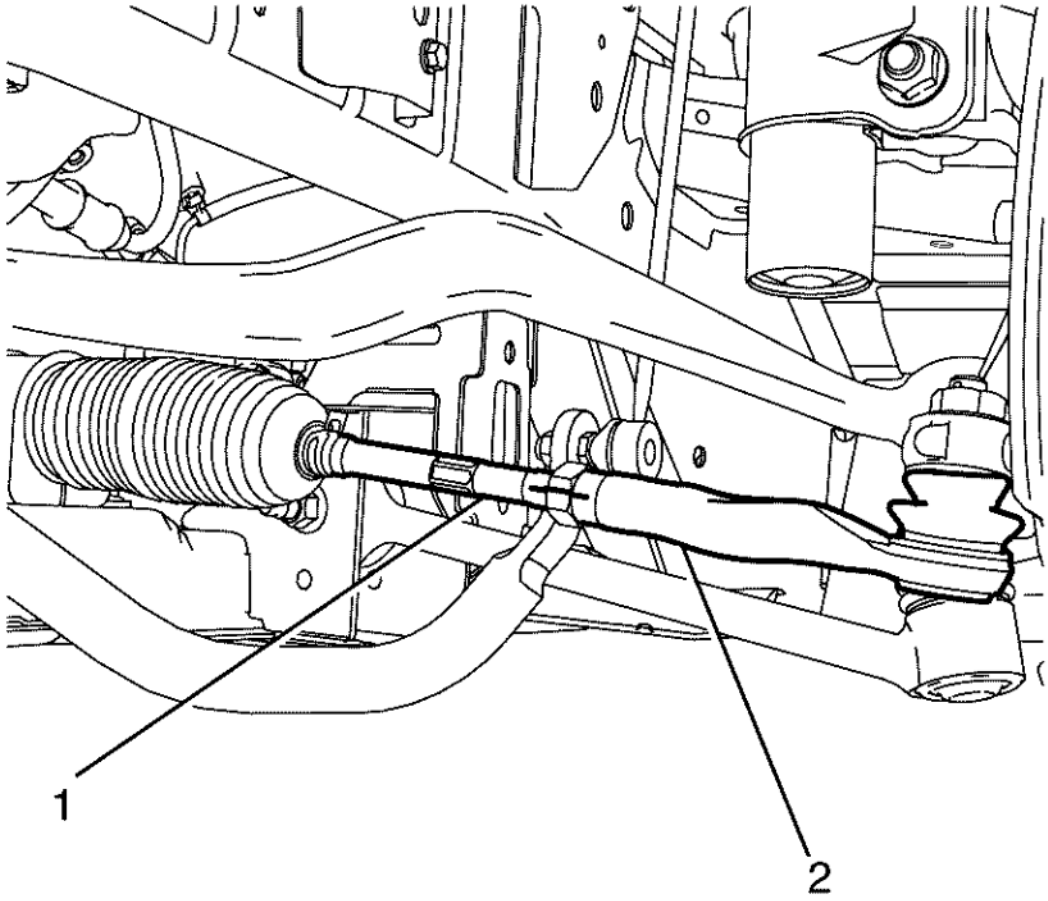


Fig. 23: Outer & Inner Tie Rods
Courtesy of GENERAL MOTORS CORP.

9. Remove the outer tie rod (2) from the inner tie rod (1). Count and record the number of turns necessary in order to remove the outer tie rod.

Installation Procedure

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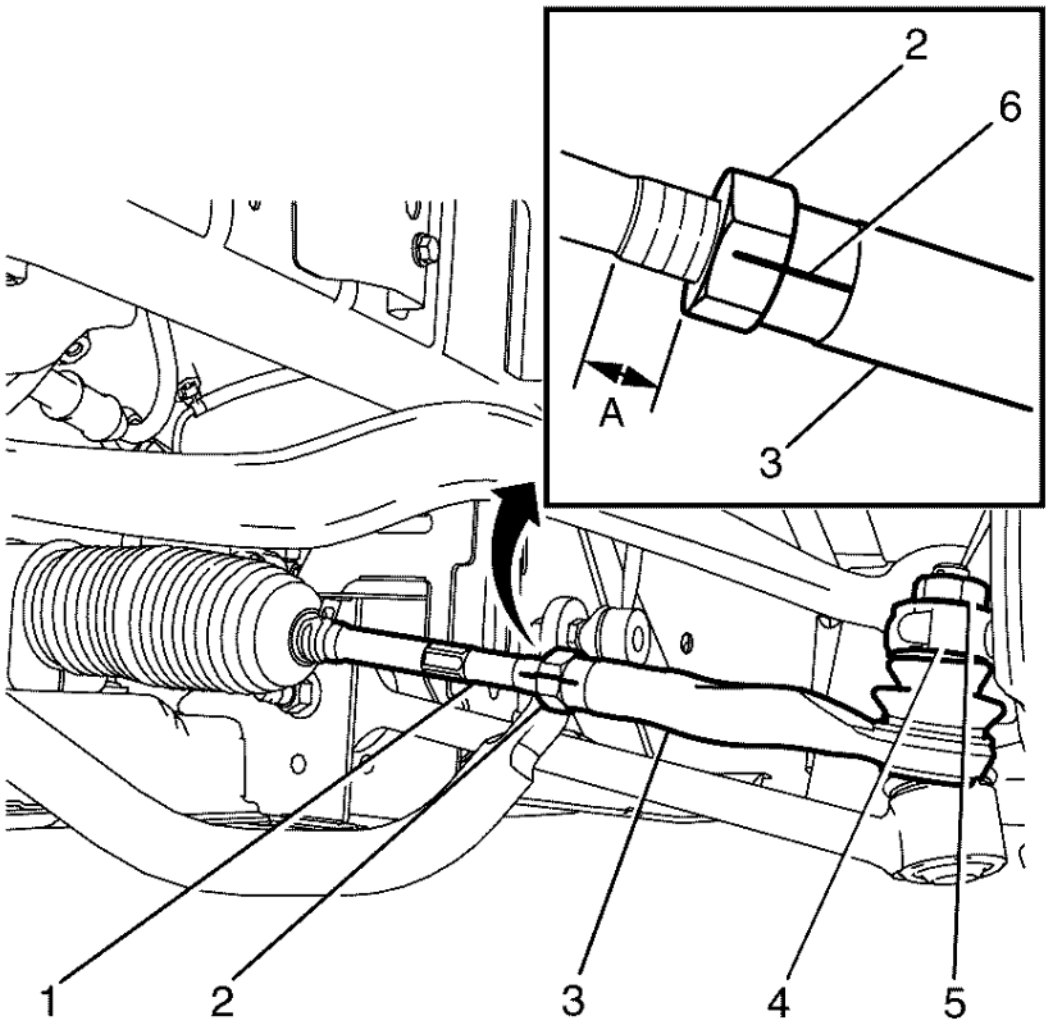


Fig. 24: Tie Rod Components
Courtesy of GENERAL MOTORS CORP.

1. Install the outer tie rod (3) to the inner tie rod (1). Use the same number of turns as recorded during the removal procedure.

NOTE: Do not tighten the inner tie rod nut (2) yet.

2. Ensure the distance (A) is the same as recorded during the removal procedure.
3. Connect the outer tie rod to the steering knuckle (4).

CAUTION: Refer to Fastener Caution .

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4. Install the NEW outer tie rod nut (5) and tighten to 30 N.m (22 lb ft).
5. Tighten the outer tie rod nut an additional 120 degrees.
6. Align the match marks (6).
7. Install the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .
9. Tighten the inner tie rod nut to 75 N.m (55 lb ft).

STEERING GEAR BOOT REPLACEMENT

Special Tools

J-22610: Keystone Clamp Pliers

Removal Procedure

1. Remove the steering linkage outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.

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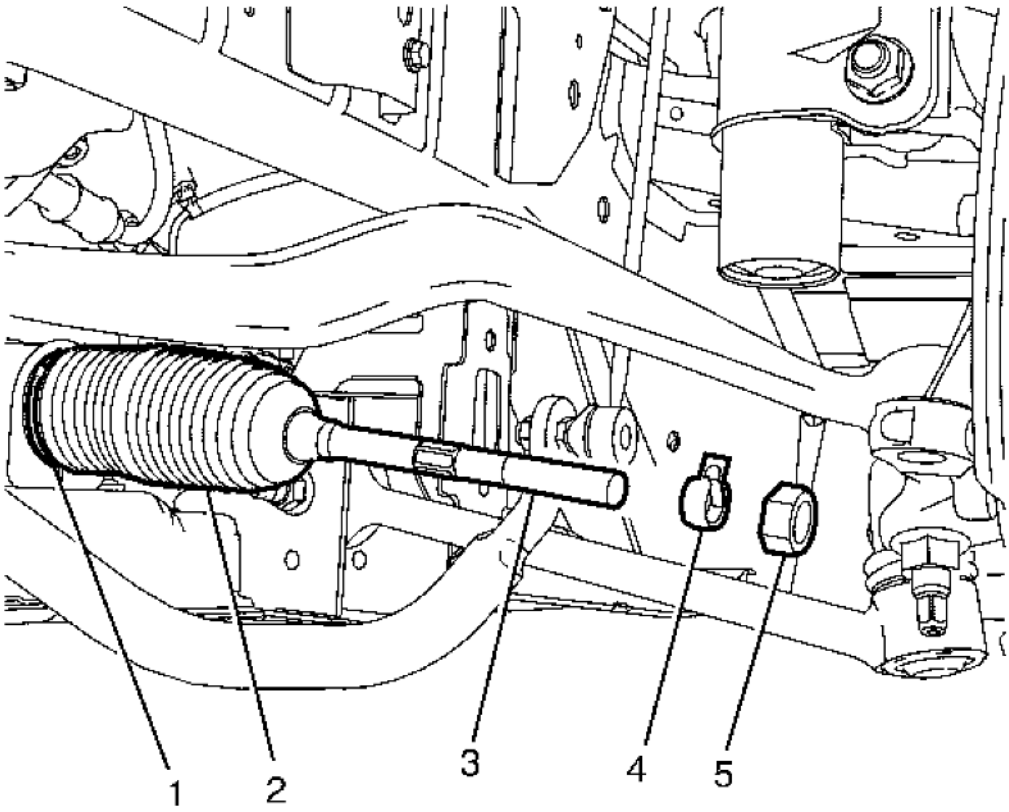


Fig. 25: Tie Rod & Boot Components
Courtesy of GENERAL MOTORS CORP.

NOTE: Note the number of turns necessary in order to remove the inner tie rod nut (5).

2. Remove the inner tie rod nut from the inner tie rod (3).

NOTE: The outer boot retaining clamp (4) is a single use part.

3. Remove the outer boot retaining clamp.

   Discard the clamp.

NOTE: The inner boot clamp (1) is a single use part.

4. Remove the inner boot clamp.

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Discard the clamp.

5. Remove the boot (2) from the inner tie rod.

Installation Procedure

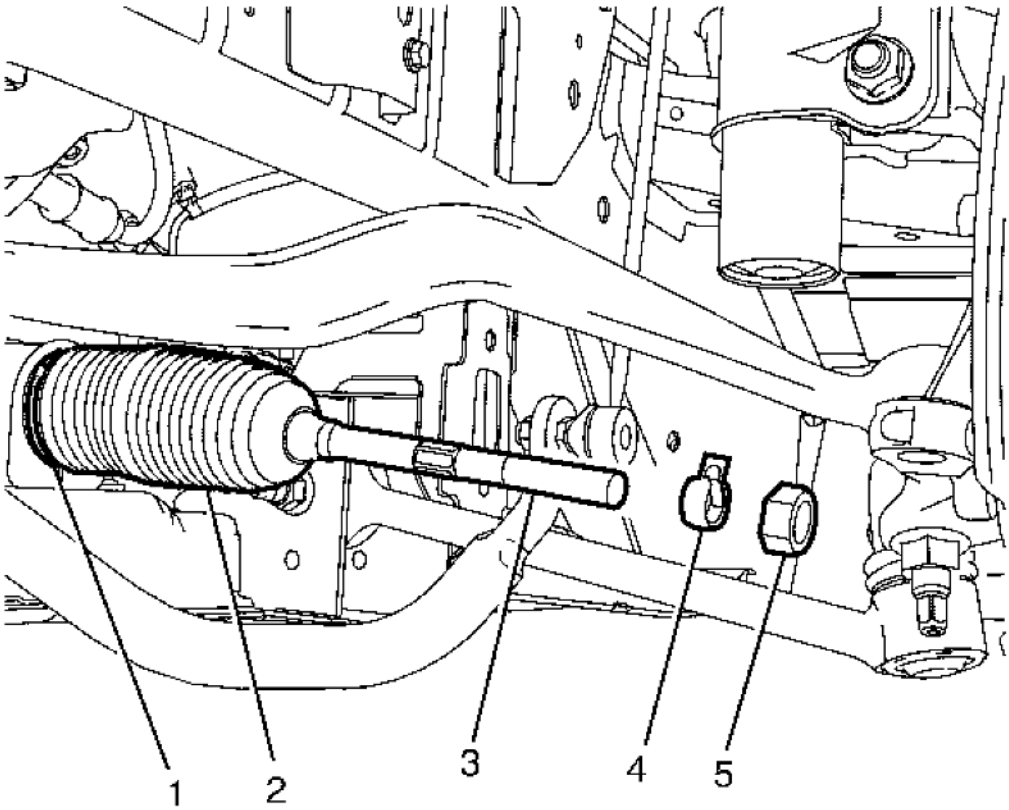


Fig. 26: Tie Rod & Boot Components
Courtesy of GENERAL MOTORS CORP.

1. Install the boot (2) to the inner tie rod (3).
2. Install the NEW inner boot clamp (1).
3. Crimp the inner boot clamp with the **J-22610:** Pliers or equivalent.
4. Install the NEW outer boot retaining clamp (4).

NOTE: Install the inner tie rod nut (5) with the same number of turns as recorded during removal.

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5. Install the inner tie rod nut (5) to the inner tie rod.
6. Install the outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.

FLUID COOLER OUTLET HOSE REPLACEMENT

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** for the V6 engine or to **Air Cleaner Assembly Replacement** for the V8 engine.
2. If equipped with the V6 engine, cover the air conditioning compressor in order to prevent power steering fluid from dripping on the air conditioning compressor.

   If equipped with the V8 engine, cover the generator in order to prevent power steering fluid from dripping on the generator.

3. Place drain pans under the vehicle.

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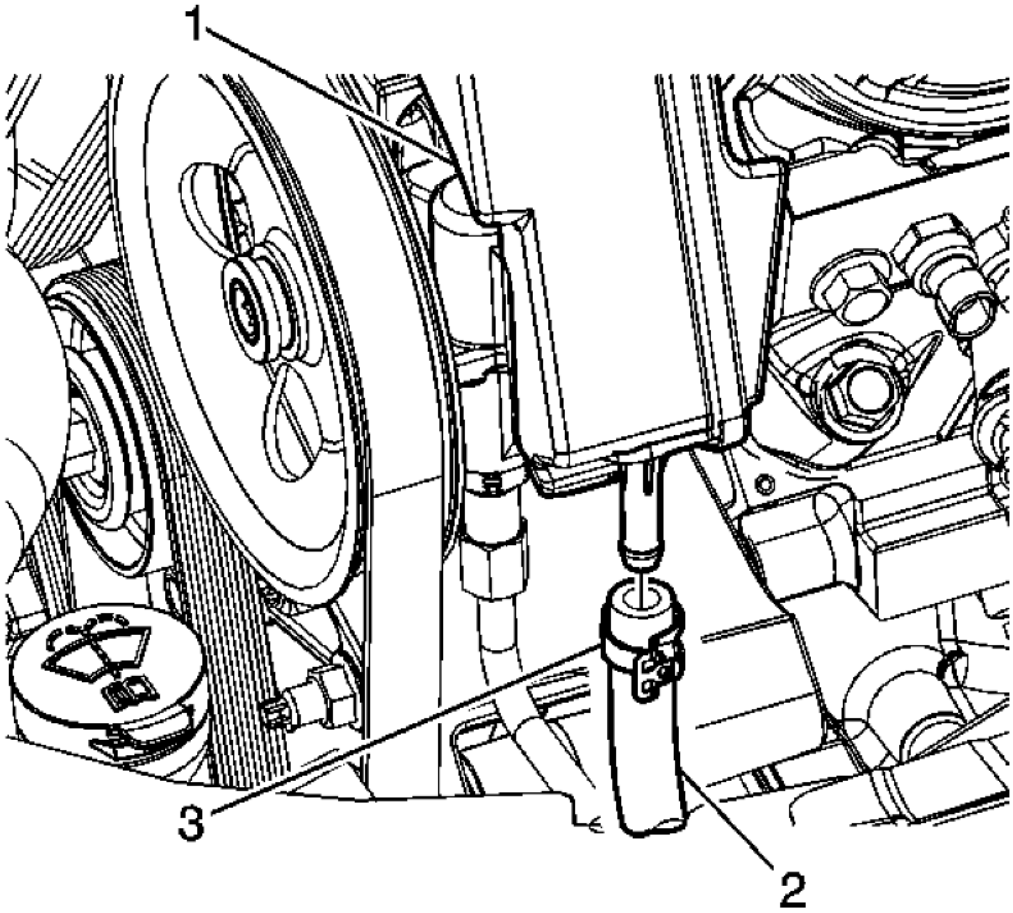


Fig. 27: Power Steering Fluid Cooler Outlet Hose & Power Steering Fluid Reservoir
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

NOTE: Introducing too much air into the power steering system will increase the amount of time required to bleed the system. Maintain the fluid level during this procedure.

4. Disconnect the power steering fluid cooler outlet hose (2) from the power steering fluid reservoir (1). Cap the power steering fluid reservoir inlet port. Plug the power steering fluid cooler outlet hose.

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5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

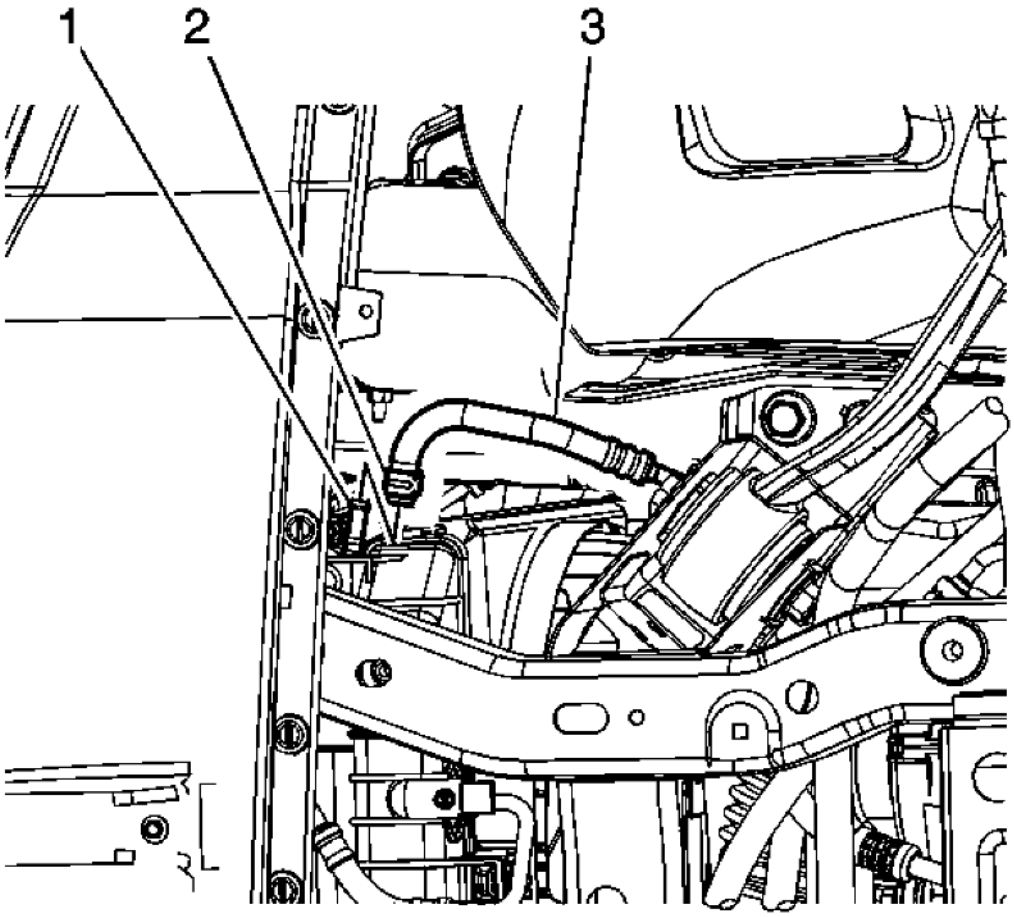


Fig. 28: Power Steering Fluid Cooler Outlet Hose & Port
Courtesy of GENERAL MOTORS CORP.

CAUTION: Caution should be taken when trying to remove the power steering oil cooler hoses from the power steering oil cooler. Applying excessive force or pulling on the port could cause the port to break off and warrant a complete replacement of the assembly.

6. Disconnect the power steering fluid cooler outlet hose (3) from the power steering fluid cooler outlet port (1) on the air conditioning condenser. Cap the power steering fluid cooler outlet port.
7. Remove the bolt and separate the bracket from the front frame.
8. Remove the power steering fluid cooler outlet hose from the vehicle.

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Installation Procedure

1. Plug the cooler end of the power steering fluid cooler outlet hose.
2. Position the power steering fluid cooler outlet hose on the front frame.

CAUTION: Refer to Fastener Caution .

3. Install the bracket to the front frame with the bolt and tighten to 9 N.m (80 lb in).

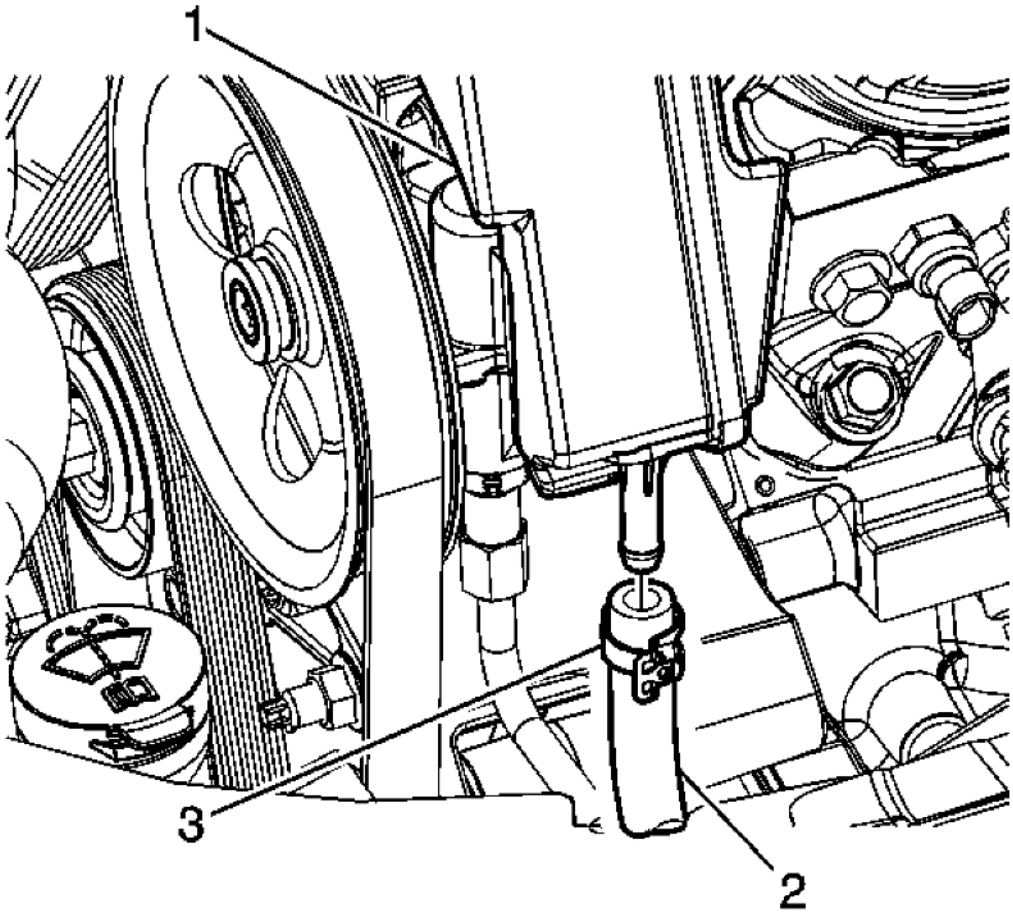


Fig. 29: Power Steering Fluid Cooler Outlet Hose & Power Steering Fluid Reservoir
Courtesy of GENERAL MOTORS CORP.

4. Remove the cap from the power steering fluid reservoir (1) inlet port. Remove the plug from the power

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steering fluid cooler outlet hose (2). Connect the power steering fluid cooler outlet hose to the power steering fluid reservoir.

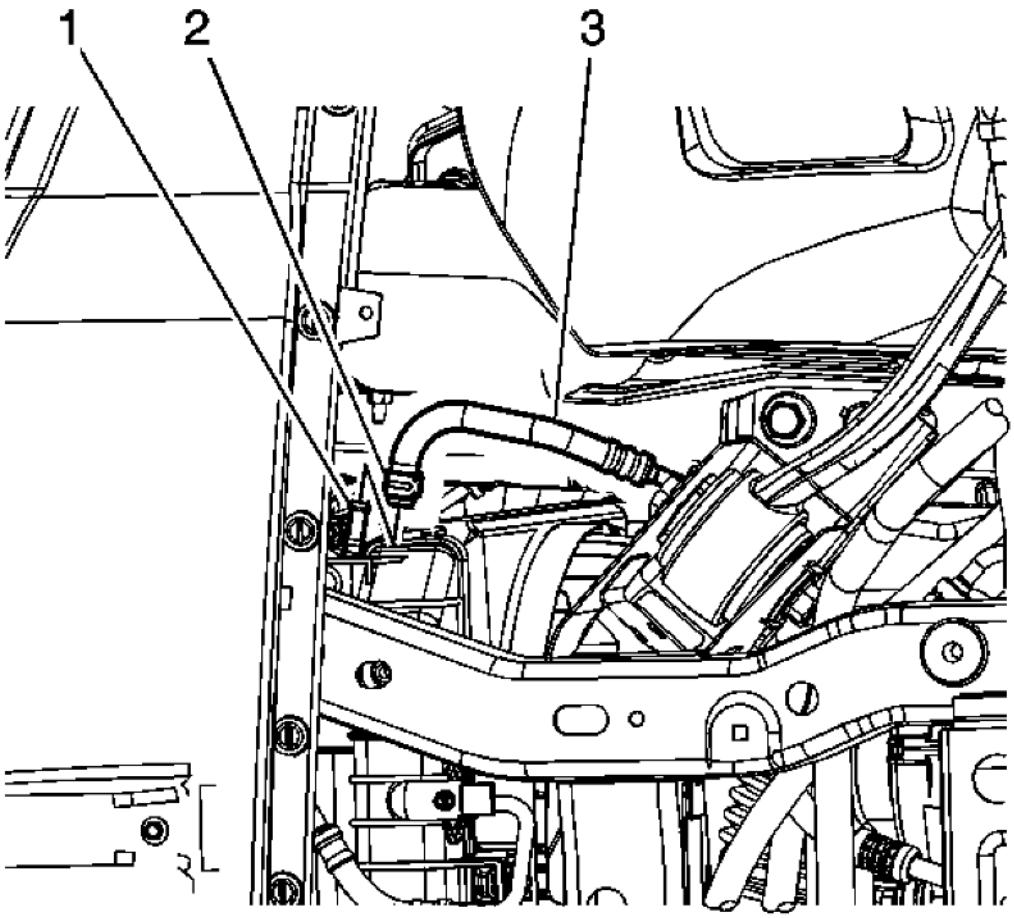


Fig. 30: Power Steering Fluid Cooler Outlet Hose & Port
Courtesy of GENERAL MOTORS CORP.

5. Remove the plug from the power steering fluid cooler outlet hose (3). When fluid starts to flow from the hose, cap the hose with your thumb.
6. Remove the cap from the power steering fluid cooler outlet port (1) and quickly connect the power steering fluid cooler outlet hose to the power steering fluid cooler outlet port.
7. Remove the drain pans.
8. Lower the vehicle.
9. Clean any excess power steering fluid from the vehicle.
10. Remove the cover from either the air conditioning compressor or the generator, as applicable.

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11. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** for the V6 engine or to **Air Cleaner Assembly Replacement** for the V8 engine.
12. Bleed the power steering system. Refer to **Power Steering System Bleeding**.

POWER STEERING FLUID RESERVOIR OUTLET HOSE REPLACEMENT (V6)

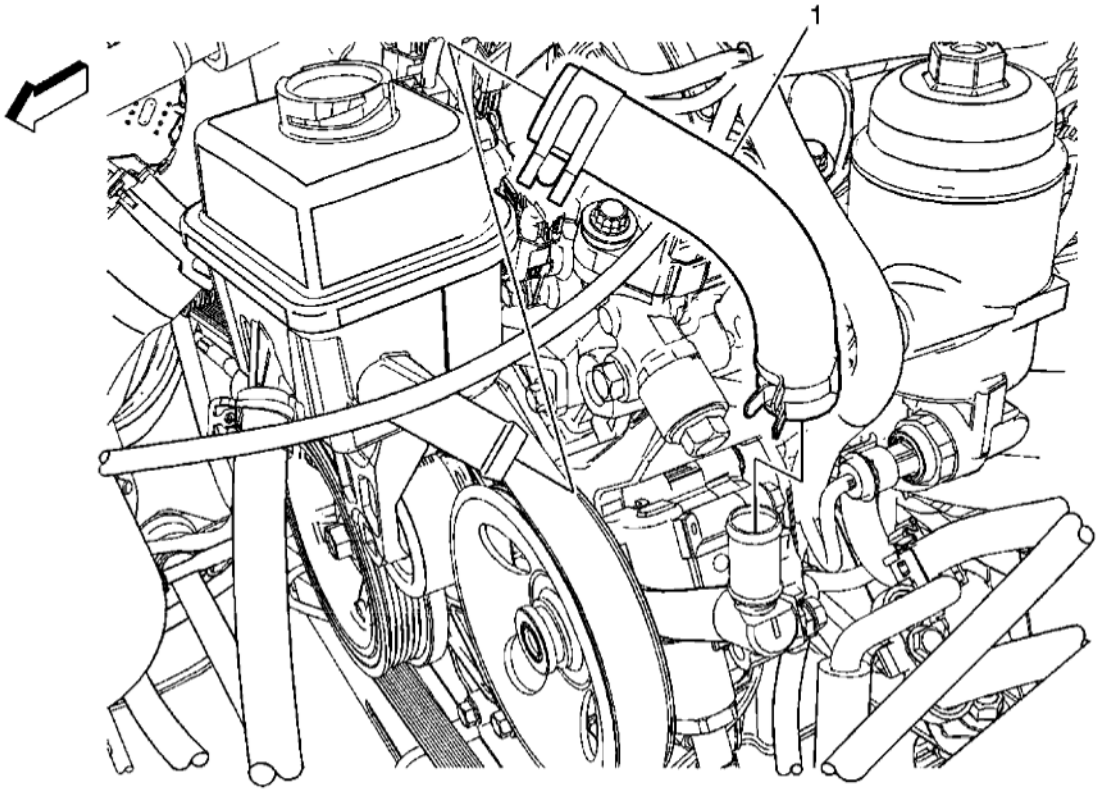


Fig. 31: Power Steering Fluid Reservoir Outlet Hose (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

CAUTION:
Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

Preliminary Procedures

1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Cover the air conditioning compressor in order to prevent power steering fluid from dripping on the air conditioning compressor.

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4. Place drain pans under the vehicle. 5. Remove as much power steering fluid from the reservoir as possible.	
1	Power Steering Fluid Reservoir Outlet Hose **Procedure** 1. Disconnect the power steering fluid reservoir outlet hose from the power steering pump. Cap the power steering pump inlet port. 2. Disconnect the power steering fluid reservoir outlet hose from the power steering fluid reservoir. Cap the power steering pump outlet port. 3. Fill the power steering fluid reservoir. Refer to **Checking and Adding Power Steering Fluid**. 4. Clean any excess power steering fluid from the vehicle.

POWER STEERING GEAR INLET PIPE/HOSE REPLACEMENT

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** for the V6 engine or to **Air Cleaner Assembly Replacement** for the V8 engine.
2. If equipped with the V6 engine, cover the air conditioning compressor in order to prevent power steering fluid from dripping on the air conditioning compressor.

   If equipped with the V8 engine, cover the generator in order to prevent power steering fluid from dripping on the generator.

3. Place drain pans under the vehicle.

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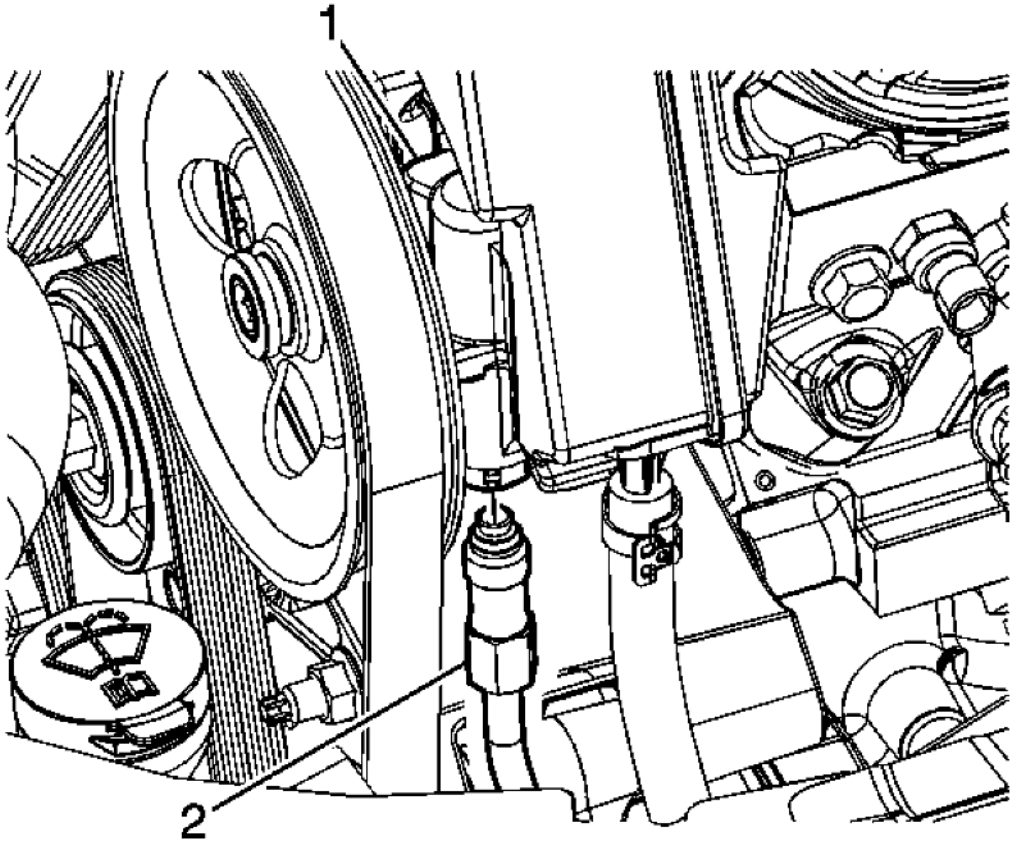


Fig. 32: Power Steering Gear Inlet Hose & Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

NOTE: Introducing too much air into the power steering system will increase the amount of time required to bleed the system. Maintain the fluid level during this procedure.

4. Disconnect the power steering gear inlet hose (2) from the power steering pump (1). Plug the power steering pump outlet port. Cap the power steering gear inlet hose.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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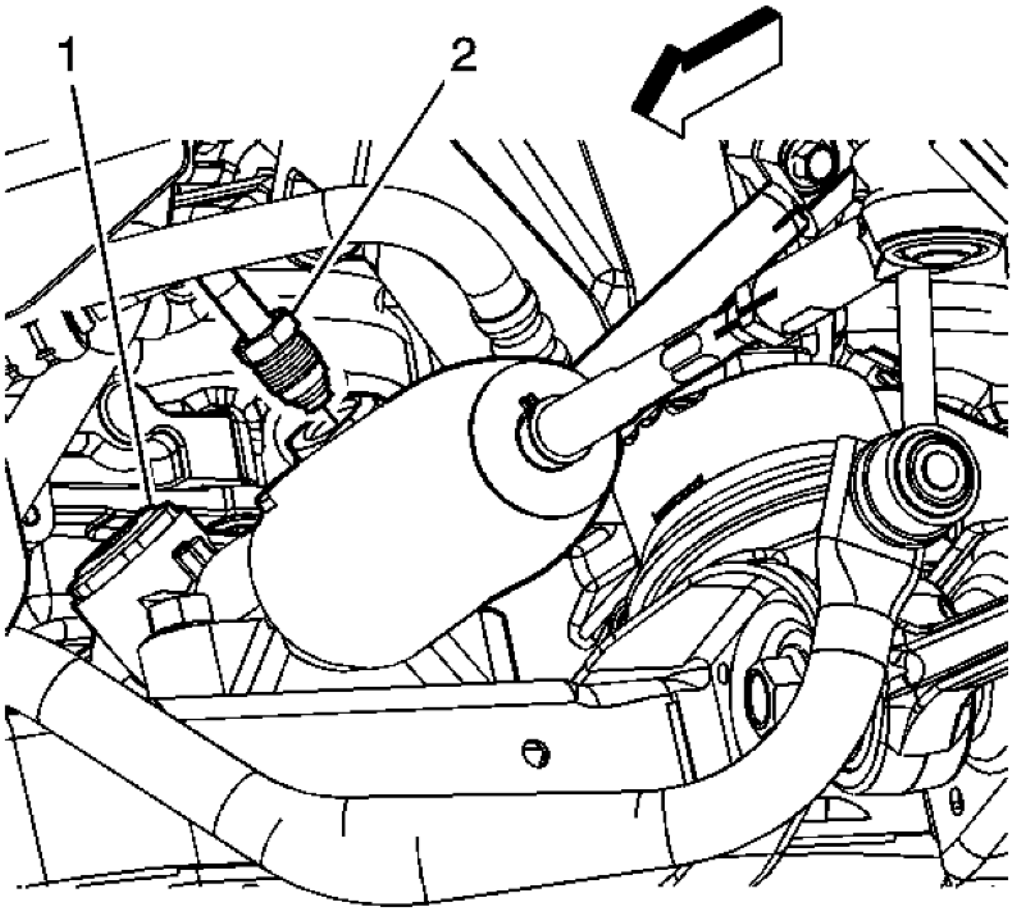


Fig. 33: Power Steering Gear Inlet Hose & Power Steering Gear
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the power steering gear inlet hose (2) from the power steering gear (1). Plug the power steering gear inlet port.
7. Remove the 2 bolts from the 2 brackets.
8. Remove the power steering gear inlet hose from the vehicle.

Installation Procedure

1. Cap the power steering gear end of the power steering gear inlet hose.
2. Position the power steering gear inlet hose on the front frame.

CAUTION: Refer to Fastener Caution .

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3. Install the 2 bolts to the 2 brackets and tighten to 9 N.m (80 lb in).

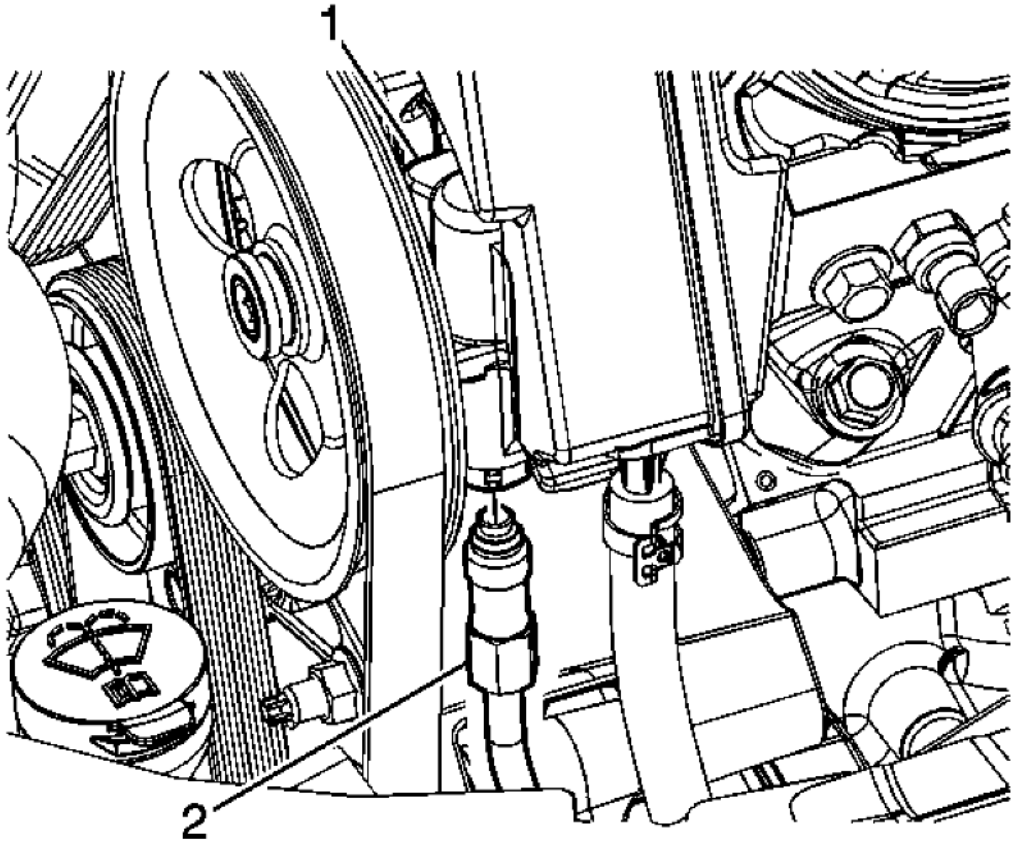


Fig. 34: Power Steering Gear Inlet Hose & Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

4. Remove the cap from the power steering gear inlet hose (2). Ensure the O-ring seal is on the hose and is in good condition.
5. Remove the plug from the power steering pump outlet port and quickly connect the power steering gear inlet hose to the power steering pump. Tighten the power steering gear inlet hose fitting to 34 N.m (25 lb ft).

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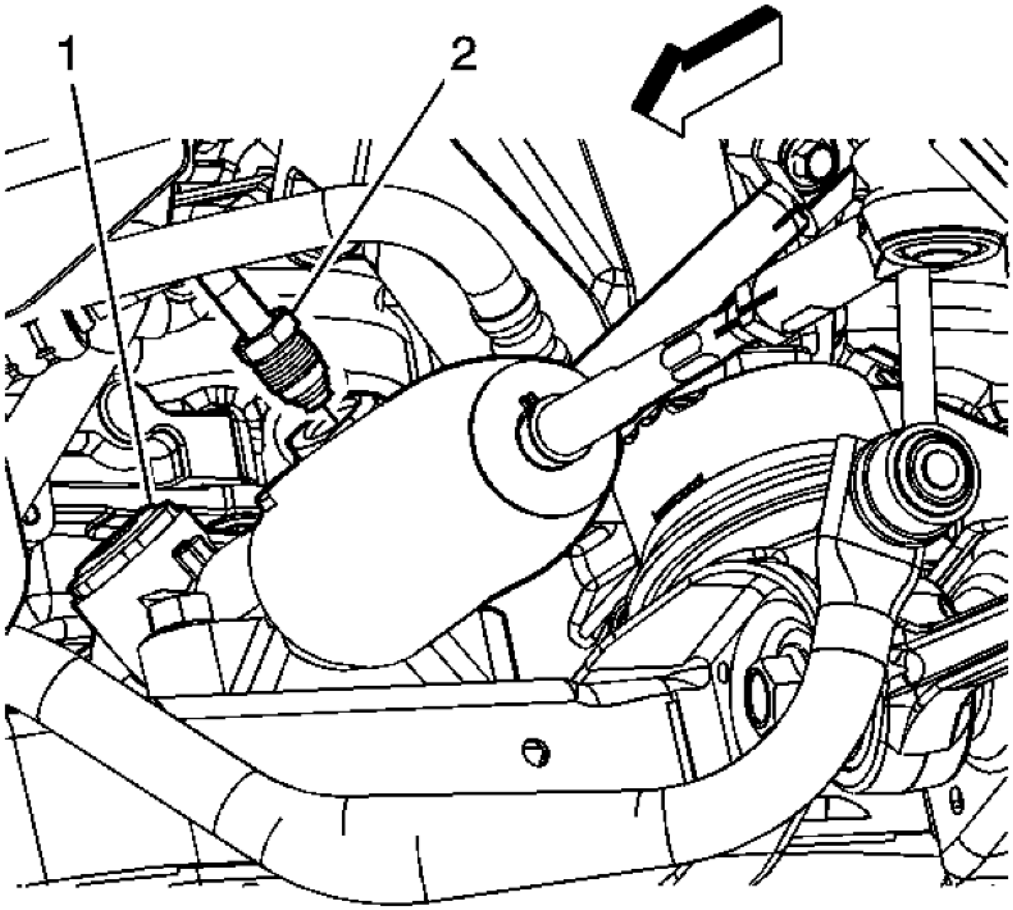


Fig. 35: Power Steering Gear Inlet Hose & Power Steering Gear
Courtesy of GENERAL MOTORS CORP.

6. Remove the cap from the power steering gear inlet hose (2). When fluid starts to flow from the hose, cap the hose with your finger. Ensure the O-ring seal is on the hose and is in good condition.
7. Remove the plug from the steering gear (1). Connect the power steering gear inlet hose to the steering gear. Tighten the power steering gear inlet hose fitting to 34 N.m (25 lb ft).
8. Clean any excess power steering fluid from the vehicle.
9. Remove the cover from either the air conditioning compressor or the generator, as applicable.
10. Remove the drain pans.
11. Lower the vehicle.
12. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** for the V6 engine or to **Air Cleaner Assembly Replacement** for the V8 engine.

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13. Bleed the power steering system. Refer to **Power Steering System Bleeding**.

POWER STEERING GEAR OUTLET PIPE/HOSE REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place drain pans under the vehicle.

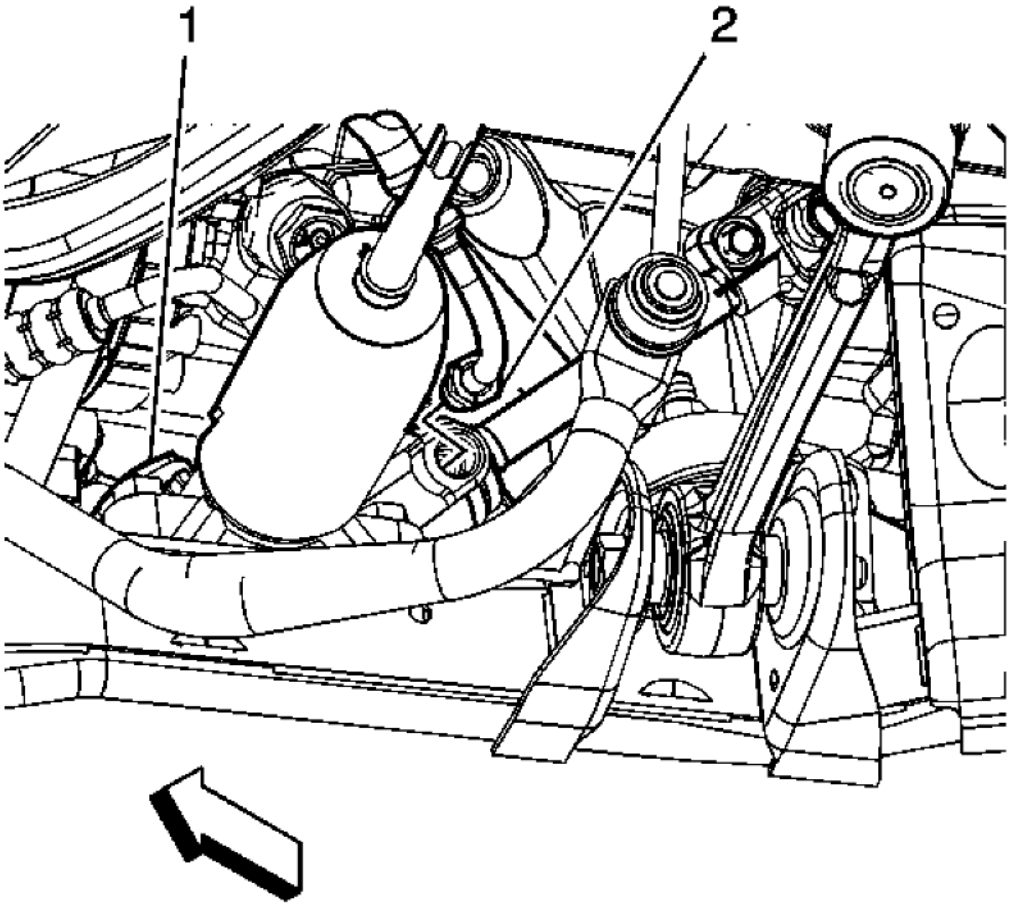


Fig. 36: Power Steering Gear Outlet Hose & Steering Gear
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of

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power steering fluid and damage to the system.

NOTE: Introducing too much air into the power steering system will increase the amount of time required to bleed the system. Maintain the fluid level during this procedure.

3. Disconnect the power steering gear outlet hose (2) from the steering gear (1). Plug the steering gear outlet port. Cap the power steering gear outlet hose.

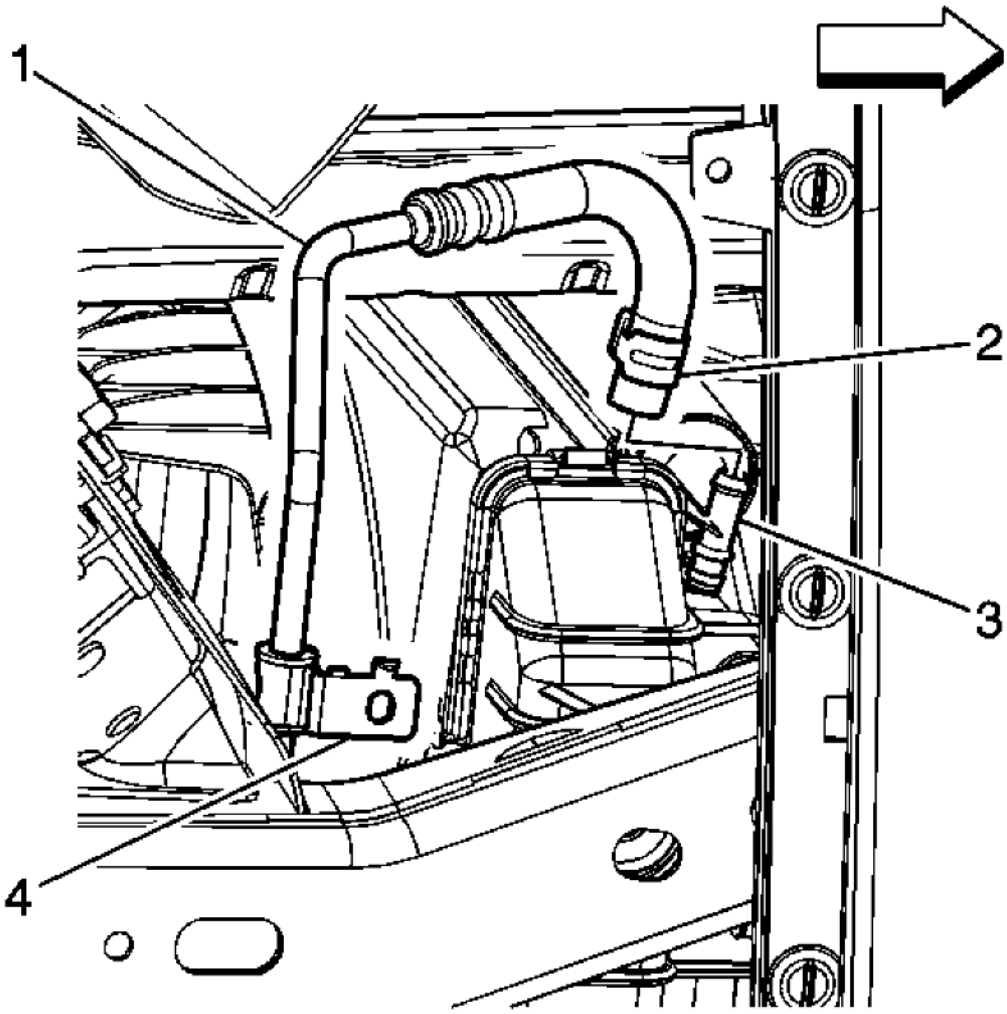


Fig. 37: Power Steering Gear Outlet Hose Components
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Caution should be taken when trying to remove the power steering oil cooler hoses from the power steering oil cooler. Applying excessive force or pulling on the port could cause the port to break off and warrant a complete replacement of the assembly.

4. Disconnect the power steering gear outlet hose (1) from the power steering fluid cooler inlet port (3) on the air conditioning condenser. Cap the power steering fluid cooler inlet port.
5. Remove the 3 bolts from the 3 brackets (4) on the power steering gear outlet hose.
6. Remove the power steering gear outlet hose from the vehicle.

Installation Procedure

1. Cap the power steering gear end of the power steering gear outlet hose.
2. Position the power steering gear outlet hose on the front frame.

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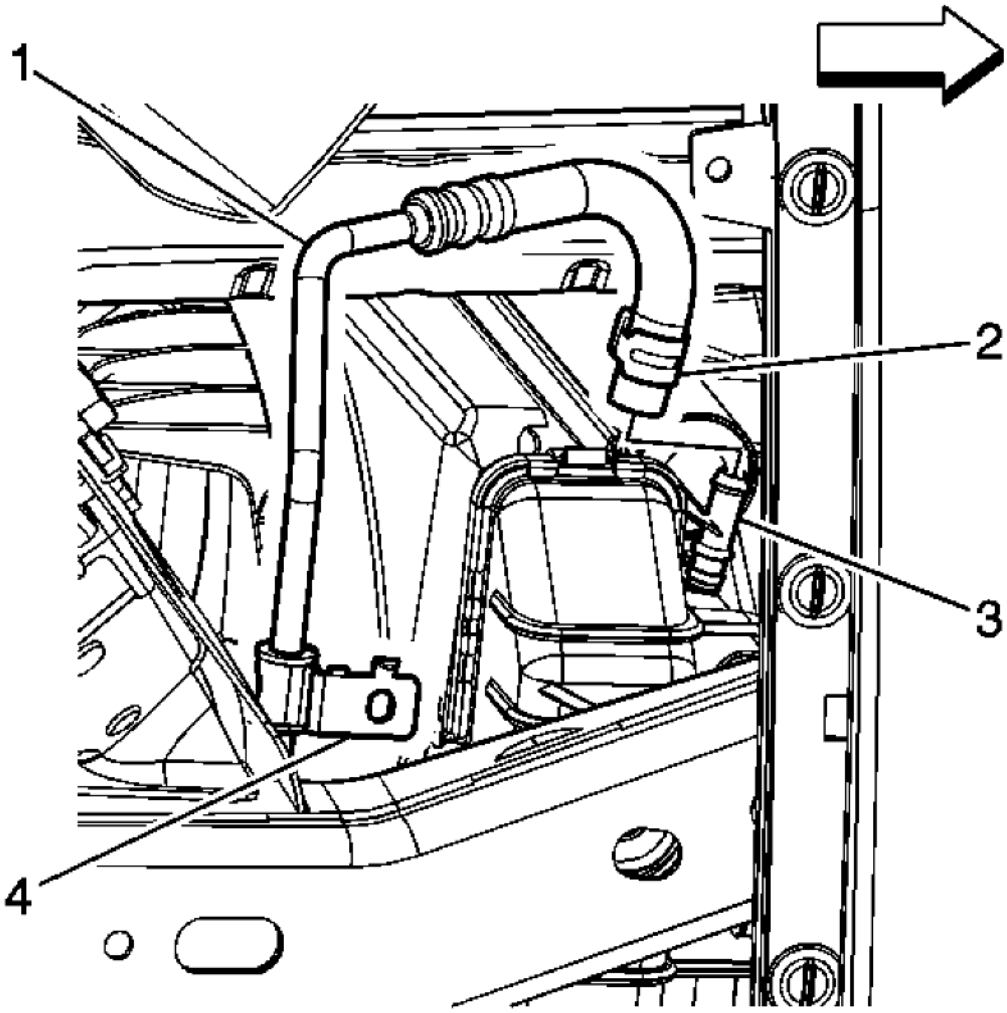


Fig. 38: Power Steering Gear Outlet Hose Components
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the 3 bolts to the 3 brackets (4) on the power steering gear outlet hose (1). Tighten the bolts to 9 N.m (80 lb in).
4. Remove the cap from the power steering fluid cooler inlet port (3). Connect the power steering gear outlet hose to the power steering fluid cooler inlet port.

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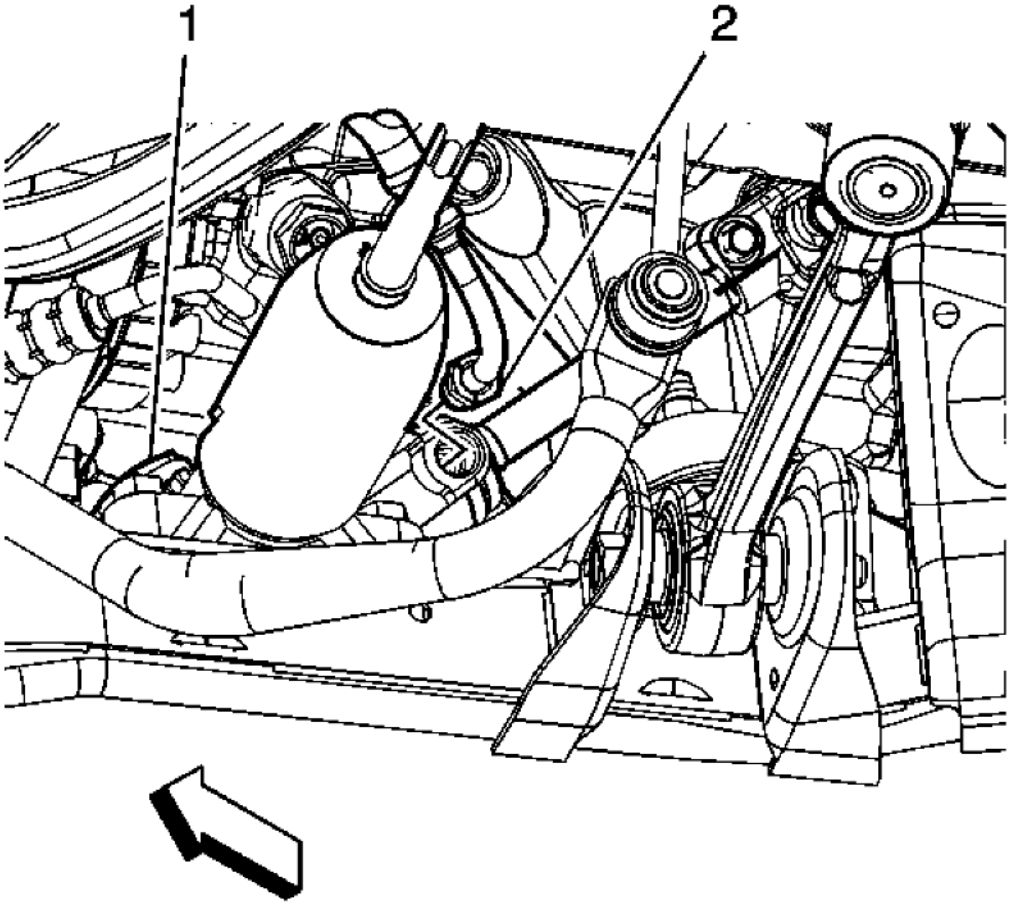


Fig. 39: Power Steering Gear Outlet Hose & Steering Gear
Courtesy of GENERAL MOTORS CORP.

5. Remove the cap from the power steering gear outlet hose (2). When fluid begins to flow from the hose, cover the end of the hose with your finger. Ensure the O-ring seal is on the hose and is in good condition.
6. Remove the plug from the steering gear outlet port and quickly connect the power steering gear outlet hose to the steering gear. Tighten the fitting to 34 N.m (25 lb ft).
7. Clean any excess power steering fluid from the vehicle.
8. Remove the drain pans.
9. Lower the vehicle.
10. Bleed the power steering system. Refer to **Power Steering System Bleeding**.

STEERING GEAR REPLACEMENT

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Removal Procedure

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. LOCK the steering column and verify the front wheels are in the straight ahead position.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
4. Place drain pans under the vehicle.

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

NOTE: Introducing too much air into the power steering system will increase the amount of time required to bleed the system. Maintain the fluid level during this procedure.

5. Disconnect the power steering gear inlet hose from the steering gear. Plug the steering gear inlet port. Cap the power steering gear inlet hose. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
6. Disconnect the power steering gear outlet hose from the steering gear. Plug the steering gear outlet port. Cap the power steering gear outlet hose. Refer to **Power Steering Gear Outlet Pipe/Hose Replacement**.
7. Disconnect the 2 outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
8. Disconnect the intermediate steering shaft from the steering gear pinion shaft. Refer to **Intermediate Steering Shaft Replacement** .
9. On the driver's side, disconnect the front wheel speed sensor connector.

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10. On the driver's side, disconnect the front lower control front arm from the steering knuckle. Refer to **Front Lower Control Front Arm Replacement** .
11. On the driver's side, push the front suspension toward the rear of the vehicle.

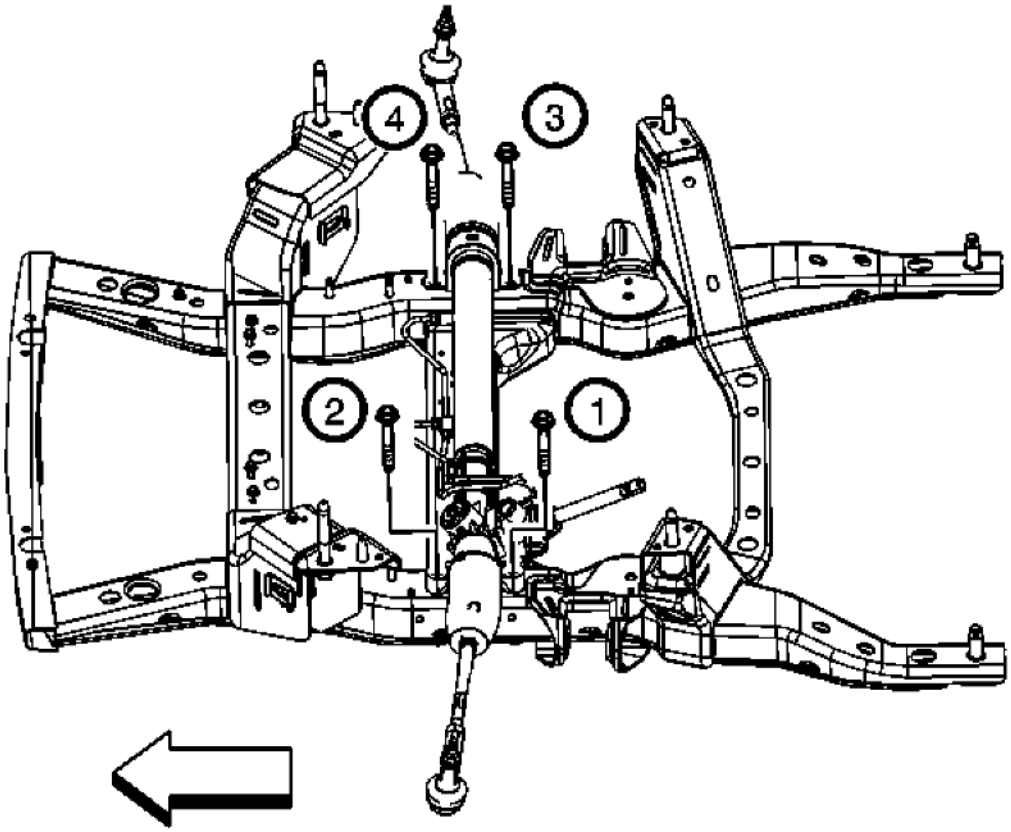


Fig. 40: Steering Gear Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

12. Remove the 4 bolts (1, 2, 3, 4) from the steering gear.
13. On the driver's side, remove the steering gear from the vehicle through the front wheel house.

Installation Procedure

1. Verify the steering gear is in the straight ahead position.
2. Position the steering gear on the front frame.

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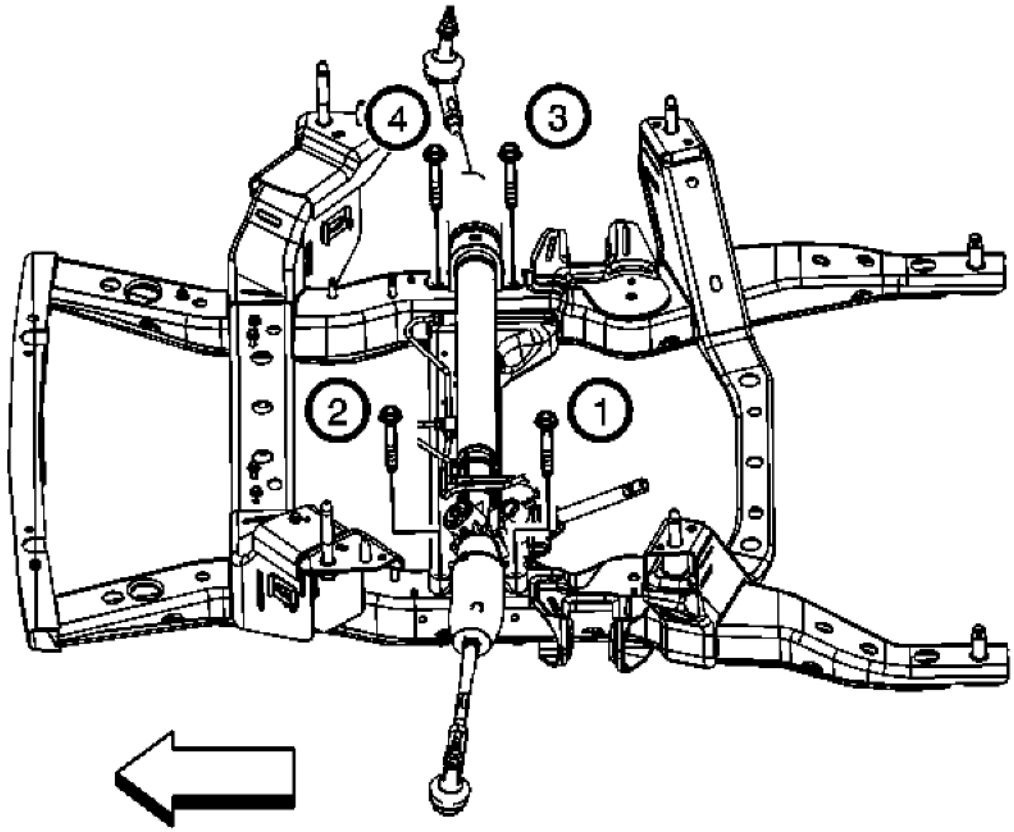


Fig. 41: Steering Gear Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Install the bolts in sequence. Do not tighten the bolts to the specification yet.

3. Install, but do not tighten, the 4 bolts (1, 2, 3, 4) in order to retain the steering gear to the front frame.

CAUTION: Refer to Fastener Caution .

NOTE: Tighten the bolts in sequence.

4. Tighten the 4 bolts in sequence to 50 N.m (37 lb ft).
5. Tighten the 4 bolts in sequence an additional 120 degrees.

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6. Connect the front lower control front arm to the steering knuckle. Refer to **Front Lower Control Front Arm Replacement** .
7. Connect the front wheel speed sensor connector.
8. Connect the intermediate steering shaft to the steering gear pinion shaft. Refer to **Intermediate Steering Shaft Replacement** .
9. Connect the 2 outer tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
10. Remove the cap from the power steering gear outlet hose. When fluid begins to flow from the hose, cover the end of the hose with your finger. Ensure the O-ring seal is on the hose and is in good condition.
11. Remove the plug from the steering gear outlet port and quickly connect the power steering gear outlet hose to the steering gear. Refer to **Power Steering Gear Outlet Pipe/Hose Replacement**.
12. Remove the cap from the power steering gear inlet hose. When fluid starts to flow from the hose, cap the hose with your finger. Ensure the O-ring seal is on the hose and is in good condition.
13. Remove the plug from the steering gear. Connect the power steering gear inlet hose to the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
14. Clean any excess power steering fluid from the vehicle.
15. Remove the drain pans.
16. Install the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
17. Fill the power steering fluid reservoir. Refer to **Checking and Adding Power Steering Fluid**.
18. With the key in the ON position and with the engine OFF, turn the steering wheel from stop to stop 12 times.
19. Apply the park brake.
20. Using jack stands, support the front of the vehicle and position the center of the front wheels approximately 61 cm (24 in) off the ground.
21. Lower the rear of the vehicle to the ground.
22. Bleed the power steering system. Refer to **Power Steering System Bleeding**.
23. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .
24. Lower the vehicle.

STEERING LINKAGE INNER TIE ROD REPLACEMENT

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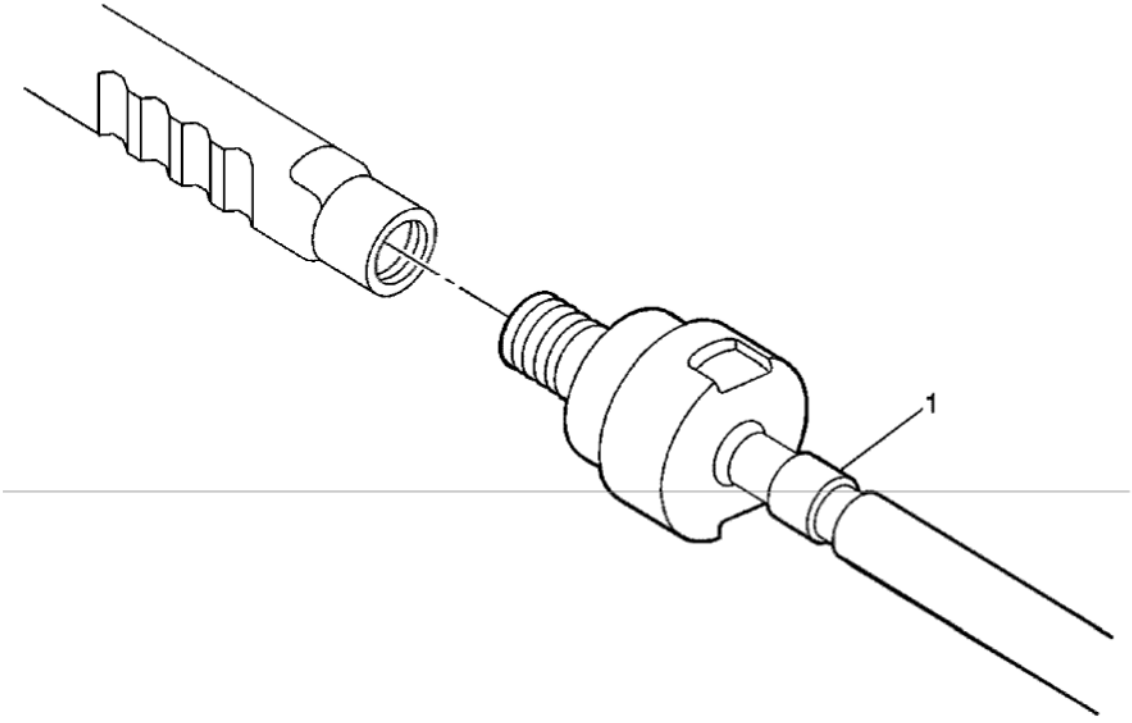


Fig. 42: Steering Linkage Inner Tie Rod
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the steering gear boot. Refer to **Steering Gear Boot Replacement**. 2. Inspect the rack and the inner tie rod for corrosion or contamination on the area covered by the boot. If none is evident, continue with the repair. If corrosion or contamination are evident, replace the steering gear. Refer to **Steering Gear Replacement**.	
1	Steering Linkage Inner Tie Rod **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Use a wrench on the flat areas on the end of the rack in order to hold the rack still. Use a wrench on the flat areas of the inner tie rod housing in order to remove the inner tie rod. 2. Clean the threads on the inner tie rod and on the rack. Remove all traces of adhesive. 3. Evenly apply thread locking adhesive to the threads on the inner tie rod. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

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	4. While holding the rack with a wrench, use a crow foot wrench and a torque wrench in order to install the inner tie rod. 5. After installing the steering linkage inner tie rod, measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** . **Tighten:** 89 N.m (66 lb ft)

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION

The hydraulic power steering pump is a constant displacement vane-type pump that provides hydraulic pressure and flow for the power steering gear. The hydraulic power steering pumps are either belt-driven or direct-drive, cam-driven.

The power steering fluid reservoir holds the power steering fluid and may be integral with the power steering pump or remotely located. The following locations are typical locations for the remote reservoir:

- Mounted to the front of the dash panel
- Mounted to the inner fender
- Mounted to a bracket on the engine

The 2 basic types of power steering gears are listed below:

- A recirculating ball system
- A rack and pinion system

In the recirculating ball system, a worm gear converts steering wheel movement to movement of a sector shaft. A pitman arm attached to the bottom of the sector shaft actually moves one tie rod and an intermediate rod move the other tie rod.

In the rack and pinion system, the rack and the pinion are the 2 components that convert steering wheel rotation to lateral movement. The steering shaft is attached to the pinion in the steering gear. The pinion rotates with the steering wheel. Gear teeth on the pinion mesh with the gear teeth on the rack. The rotating pinion moves the rack from side to side. The lateral action of the rack pushes and pulls the tie rods in order to change the direction of the vehicle's front wheels.

The power steering pressure hose connects the power steering pump union fitting to the power steering gear and allows pressurized power steering fluid to flow from the pump to the gear.

The power steering return hose returns fluid from the power steering gear back to the power steering fluid reservoir. The power steering return line may contain an integral fin-type or line-type power steering fluid cooler.

In a typical power steering system, a pump generates hydraulic pressure, causing fluid to flow, via the pressure hose, to the steering gear valve assembly. The steering gear valve assembly regulates the incoming fluid to the

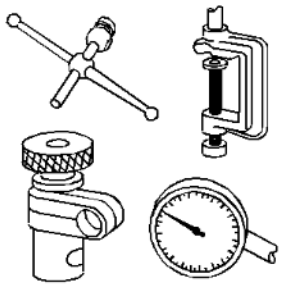
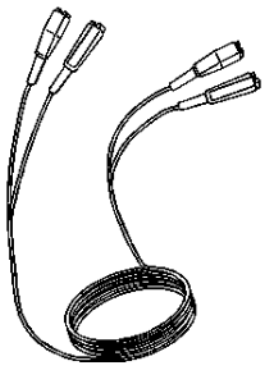
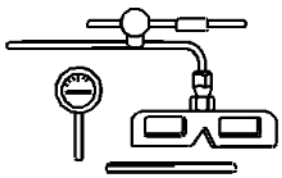
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right and left chambers in order to assist in right and left turns.

Turning the steering wheel activates the valve assembly, which applies greater fluid pressure and flow to 1 side of the steering gear piston, and lower pressure and flow to the other side of the piston. The pressure assists the movement of the gear piston. Tie rods transfer this force to the front wheels, which turn the vehicle right or left.

SPECIAL TOOLS AND EQUIPMENT

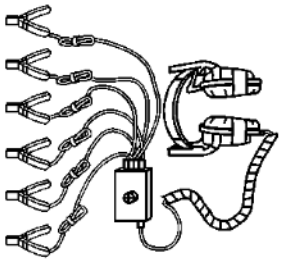
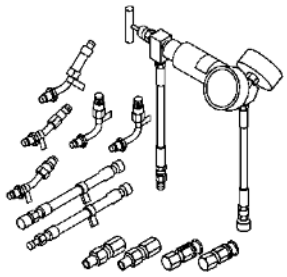
SPECIAL TOOLS

Illustration	Tool Number/ Description
	J-8001 Dial Indicator Set
	J-22610 Keystone Clamp Pliers
	J-23738-A J-35555 Vacuum Pump

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	J-25033-C Pulley Installer
	J-25034-C Pulley Remover
	J-38892 Ball Joint Separator
	J-39570 Chassis Ear

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	J-43485 Power Steering Bleeder Adapter
	J-44721 Power Steering Analyzer

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2010 STEERING

Steering Wheel and Column - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Steering Column Bolts	22 N.m	16 lb ft
Steering Column Shroud Bolts	2.5 N.m	22 lb in
Steering Gear Pinion Bolt	50 N.m	37 lb ft
Steering Wheel Bolt	30 N.m	22 lb ft
Upper Intermediate Steering Shaft Bolt	36 N.m	26.5 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Steering Gear Pinion Bolt Thread Locking Adhesive	Blue Loctite® 242	12345382	10953489
Upper Intermediate Steering Shaft Bolt Thread Locking Adhesive	Blue Loctite® 242	12345382	10953489

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - STEERING WHEEL AND COLUMN

Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel and Column Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel and column.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Steering Column Tilt Function Inoperative**
- **Ignition Key Cannot Be Removed from the Ignition Lock Cylinder**

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- **Ignition Key Cannot Turn or Sticks in Any Position**
- **Noise in Steering Column**
- **High Shift Effort**
- **Looseness in Steering Column**

STEERING COLUMN TILT FUNCTION INOPERATIVE

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that the steering column tilt function is inoperative. Does the steering column tilt function operate normally?	System OK	Go to **Step 3**
3	Verify that the following components are not seized or corroded: • Tilt pivot pins • Tilt head lock shoes Are the components seized or corroded?	Go to **Step 7**	Go to **Step 4**
4	Inspect the tilt pivot pins for binding. Are the tilt pivot pins binding?	Go to **Step 8**	Go to **Step 5**
5	Inspect for a weak or broken steering column tilt spring. Is the steering column tilt spring weak or broken?	Go to **Step 9**	Go to **Step 6**
6	Inspect the steering column wiring harness routing for tightness. Was the steering column wiring harness routed correctly?	Go to **Step 11**	Go to **Step 10**
7	Replace the steering column. Refer to **Steering Column Replacement**. Did you complete the repair?	Go to **Step 11**	-
8	If serviceable, replace the pivot pins. If not serviceable replace the steering column. Refer to **Steering Column Replacement**. Did you complete the repair?	Go to **Step 11**	-
9	Replace the tilt spring. Did you complete the repair?	Go to **Step 11**	-
10	Route the steering column wiring harness to the correct location. Did you correctly rout the wiring harness?	Go to **Step 11**	-

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11	Operate the steering column tilt function in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

NOISE IN STEERING COLUMN

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and perform the necessary inspections?	Go to **Step 2**	Go to **Steering Wheel and Column Description and Operation**
2	Verify that noise is present in the steering column during operation. Is noise present in the steering column during operation?	Go to **Step 3**	System OK
3	Inspect the steering column mounting features for the following conditions: • Steering column mounting fasteners for looseness • Steering column mounting features are sheared Are the steering column mounting features loose?	Go to **Step 9**	Go to **Step 4**
4	Inspect the SIR/SRS coil for noise. Is the SIR/SRS coil noisy?	Go to **Step 10**	Go to **Step 5**
5	Inspect the lock plate retaining ring for correct installation. Is the lock plate retaining ring installed incorrectly?	Go to **Step 11**	Go to **Step 6**
6	Inspect the steering column upper and lower bearings for the following conditions: • Damage • Lubrication • Wear • Proper seating Are the bearings in need of repair or replacement?	Go to **Step 12**	Go to **Step 7**
7	Does the tilt joint need to be lubricated?	Go to **Step 13**	Go to **Step 8**
8	**IMPORTANT:** **This is best evaluated while driving the vehicle, turning the steering and applying the brake pedal.** Inspect the steering column intermediate shaft for		

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	noise.Is the steering column intermediate shaft noisy?	Go to **Step 14**	Go to **Step 15**
9	**IMPORTANT:** **If the steering column mounting feature is damaged or sheared, the steering column will need to be replaced. Refer to Steering Column Replacement.** Tighten the steering column mounting fastener to specifications. Refer to **Fastener Tightening Specifications**.Did you complete the repair?	Go to **Step 15**	-
10	Replace the SIR/SRS coil. Refer to **Steering Wheel Inflatable Restraint Module Coil Replacement** . Did you complete the repair?	Go to **Step 15**	-
11	Install the lock plate retaining ring correctly. Did you complete the repair?	Go to **Step 15**	-
12	**IMPORTANT:** **If the steering column upper and/or lower bearings are not serviceable, the steering column will need to be replaced. Refer to Steering Column Replacement.** Replace the upper and/or lower bearings, if serviceable.Did you complete the replacement?	Go to **Step 15**	-
13	Lubricate the tilt joint. Did you complete the repair?	Go to **Step 15**	-
14	Replace the appropriate steering intermediate shaft component. Did you complete the repair?	Go to **Step 15**	-
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

HIGH SHIFT EFFORT

Step	Action	Yes	No
DEFINITION: Abnormally high shift effort is required to shift the transmission out of the Park (P) position.			
1	Did you review the Steering Wheel and Column Description and Operation?	Go to **Step 2**	Go to **Steering Wheel and Column Description and Operation**
2	Verify that a high column shift effort is required in order to shift out of the PARK position. Does the column shifter operate normally?	System OK	Go to **Step 3**
3	Inspect for worn or worn or damaged automatic transmission range selector shift cable. Is the transmission range selector shift cable worn or damaged?	Go to **Step 6**	Go to **Step 4**

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4	Inspect the automatic transmission range selector shift cable for binding or mis-adjustment. Is the automatic transmission range selector shift cable binding or mis-adjusted?	Go to **Step 7**	Go to **Step 5**
5	Inspect the column linear shift assembly for damage. Is the column linear shift assembly damaged?	Go to **Step 8**	Go to **Step 9**
6	Replace the automatic transmission range selector shift cable. Did you complete the repair?	Go to **Step 9**	-
7	Adjust the automatic transmission range selector shift cable. Did you complete the repair?	Go to **Step 9**	-
8	**IMPORTANT:** **If the column linear shift assembly is not serviceable, then the steering column will need to be replaced. Refer to Steering Column Replacement.** Replace the column linear shift assembly, if serviceable.Did you complete the replacement?	Go to **Step 9**	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

LOOSENESS IN STEERING COLUMN

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Steering Wheel and Column Description and Operation**
2	Verify that the steering column is loose. Is the steering column loose?	Go to **Step 3**	System OK
3	Inspect the steering column mounting features for the following conditions. • Steering column mounting fasteners for looseness • Steering column mounting features are sheared Are the steering column mounting features loose?	Go to **Step 5**	Go to **Step 4**
4	Inspect the upper and/or lower bearings for looseness. Are any of the bearings worn or loose?	Go to **Step 6**	Go to **Step 7**
	IMPORTANT: **If the steering column mounting feature is damaged or sheared, the steering column will need to be**		

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	replaced. Refer to Steering Column Replacement.		
5	Tighten the steering column mounting fastener to specifications. Refer to **Fastener Tightening Specifications**.Did you complete the repair?	Go to **Step 7**	-
6	**IMPORTANT:** **If the steering column upper and/or lower bearings are not serviceable, the steering column will need to be replaced. Refer to Steering Column Replacement.** Replace the upper and/or lower bearings, if serviceable.Did you complete the repair?	Go to **Step 7**	-
7	Operate the steering column in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

REPAIR INSTRUCTIONS

INTERMEDIATE STEERING SHAFT REPLACEMENT

Removal Procedure

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. LOCK the steering column and verify the front wheels are in the straight ahead position.
2. Ensure the tilt and telescope lever is in the locked position with the steering column tilted to the highest position and telescoped to the maximum rearward position.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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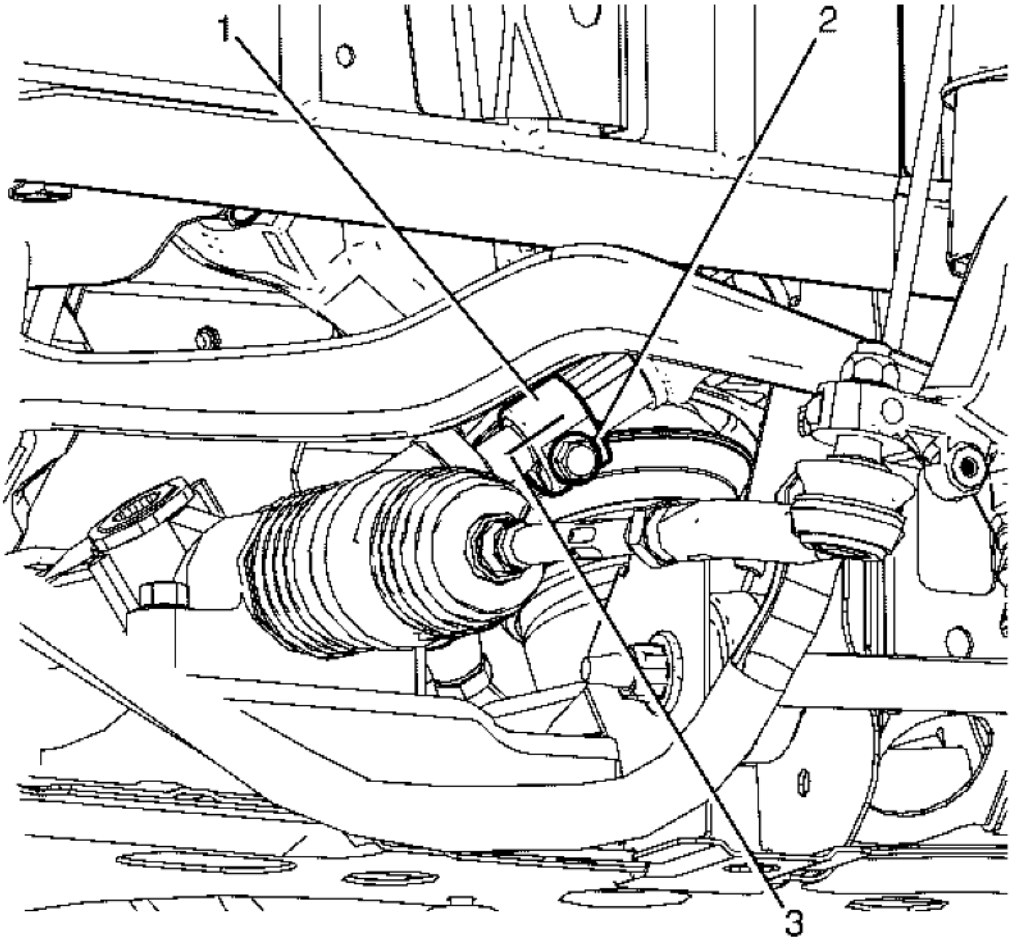


Fig. 1: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

4. Working under the vehicle, use paint in order to place match marks on the intermediate steering shaft (1) and on the steering gear pinion shaft (3).
5. Remove the steering gear pinion bolt (2).
6. Remove the thread locking patch and clean the threads on the steering gear pinion bolt.
7. Disconnect the intermediate steering shaft from the steering gear pinion shaft.

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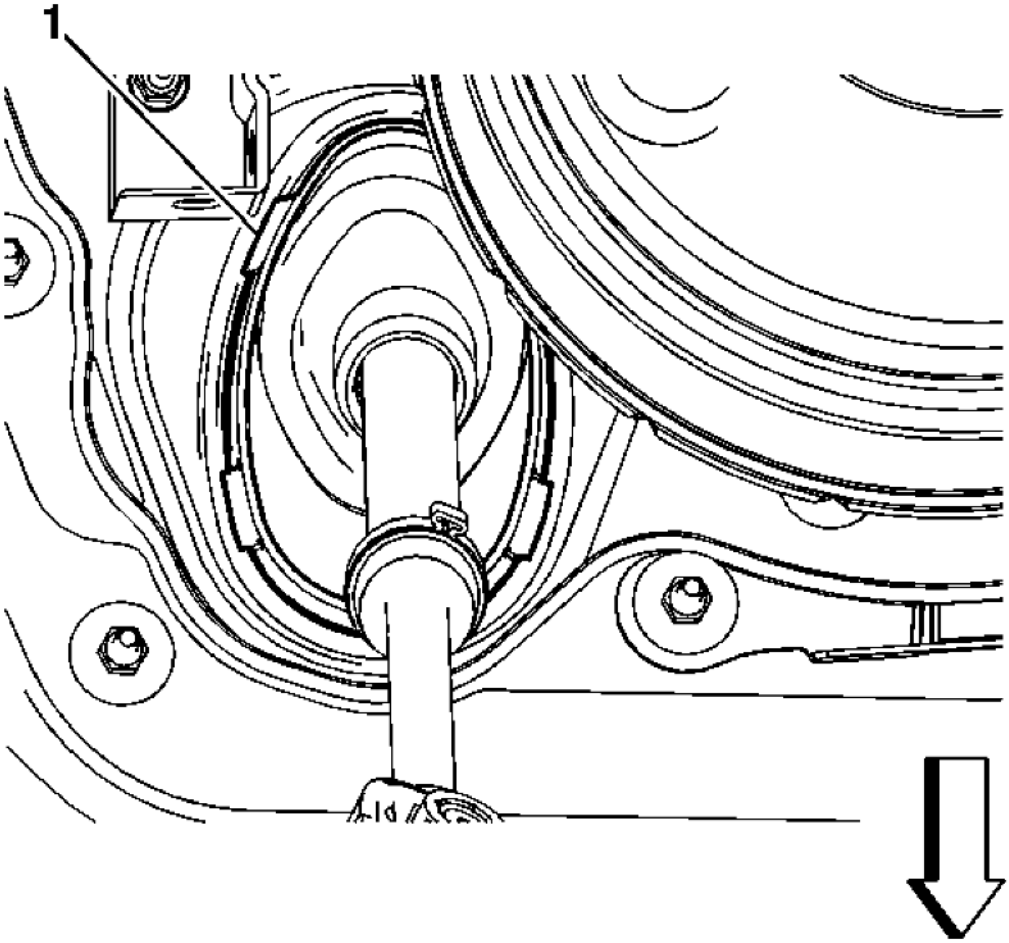


Fig. 2: Intermediate Shaft Seal Tabs
Courtesy of GENERAL MOTORS CORP.

8. Working under the vehicle, disengage the 4 tabs (1) on the intermediate shaft seal.

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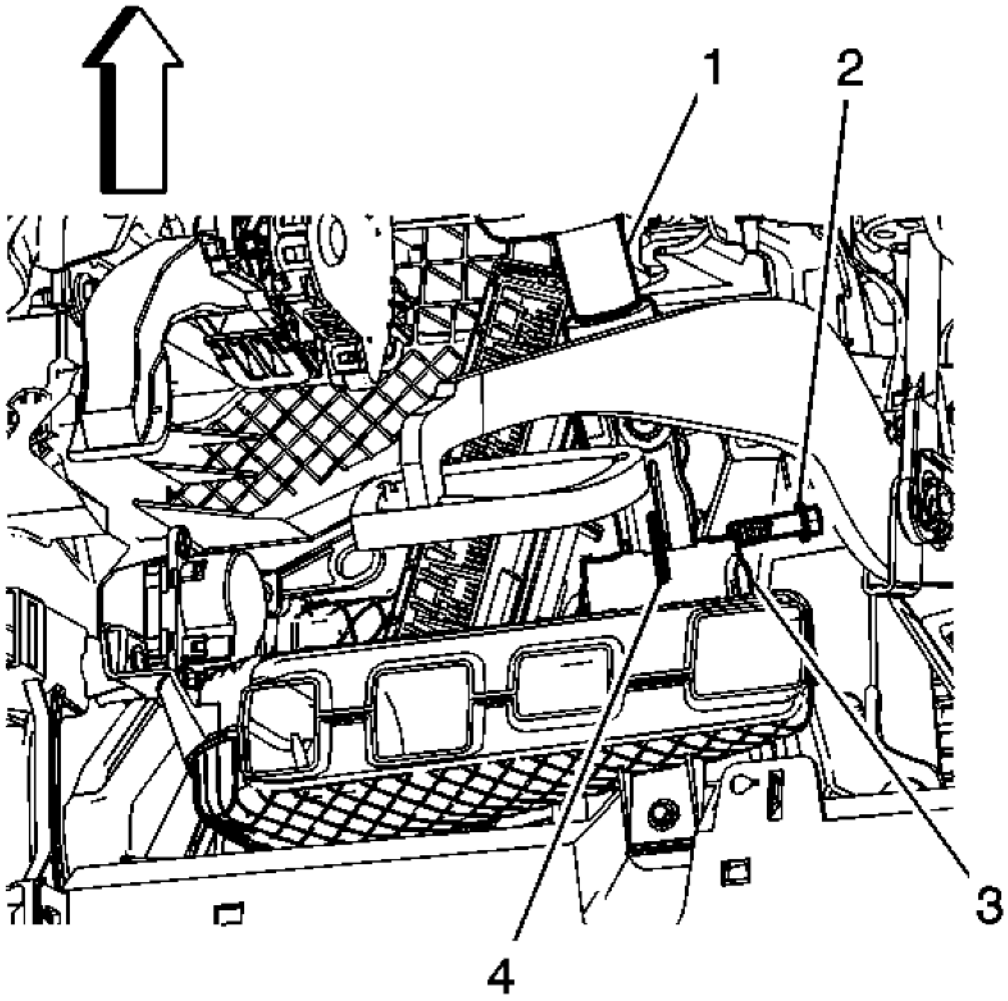


Fig. 3: Steering Column Shaft & Intermediate Steering Shaft Match Marks
Courtesy of GENERAL MOTORS CORP.

9. Working under the instrument panel, use paint in order to place match marks (4) on the steering column shaft (1) and on the intermediate steering shaft (3).
10. Remove the upper intermediate shaft bolt (2).
11. Remove the thread locking patch and clean the threads on the upper intermediate shaft bolt.
12. Disconnect the intermediate steering shaft from the steering column shaft.

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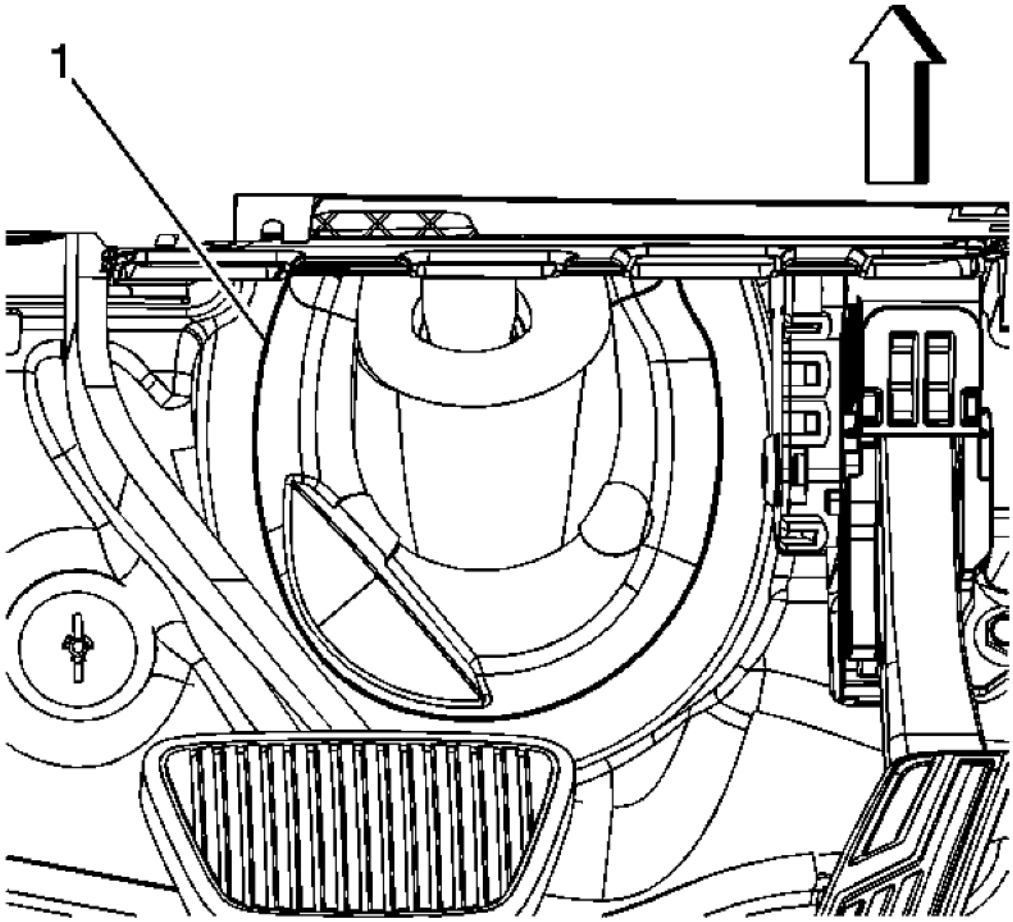


Fig. 4: Intermediate Shaft Seal
Courtesy of GENERAL MOTORS CORP.

13. Working under the instrument panel, remove the intermediate shaft seal (1) from the dash panel.
14. Remove the intermediate steering shaft and the seal as an assembly from the vehicle.

Installation Procedure

1. If you are replacing the intermediate steering shaft, copy the match marks from the old shaft to the new shaft.
2. Ensure the tilt and telescope lever is in the locked position with the steering column tilted to the highest position and telescoped to the maximum rearward position.
3. Position the intermediate steering shaft and intermediate shaft seal assembly in the vehicle on the driver's floor.

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4. Position the intermediate steering shaft in the dash panel opening.

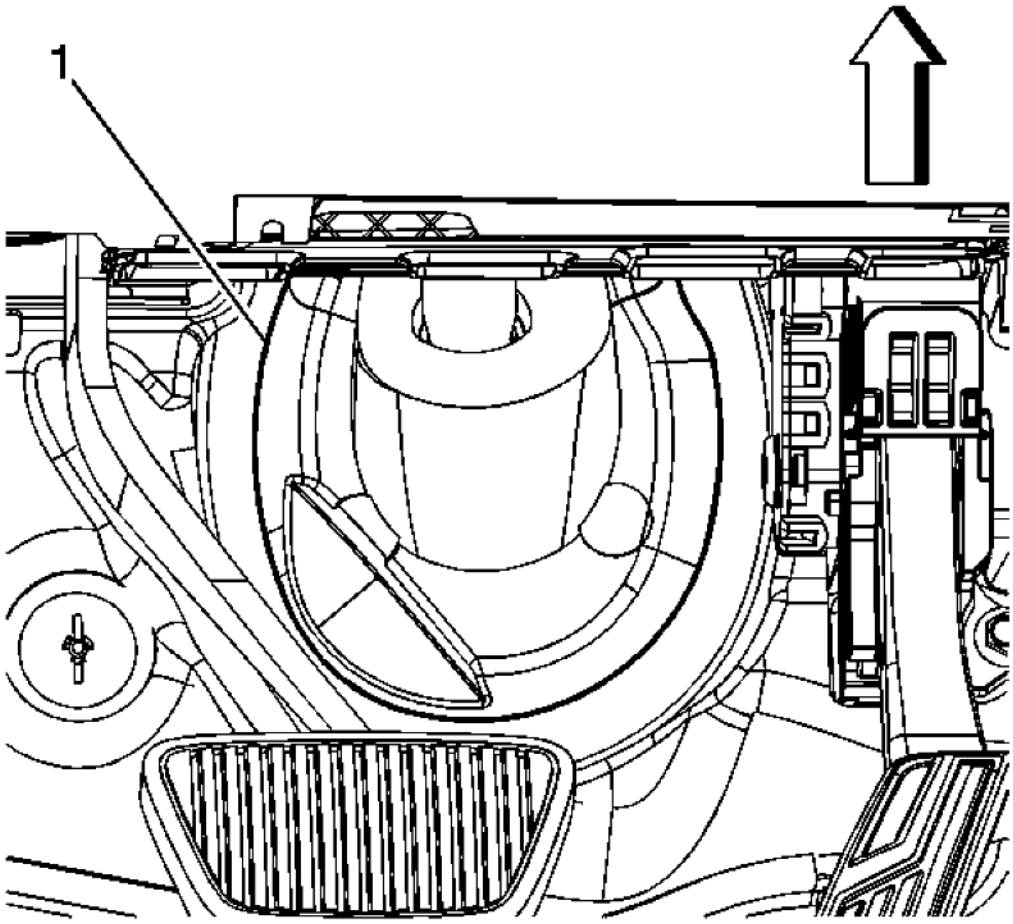


Fig. 5: Intermediate Shaft Seal
Courtesy of GENERAL MOTORS CORP.

5. Working under the instrument panel, install the intermediate shaft seal (1) to the dash panel. Apply pressure to the seal in order to engage the 4 tabs.

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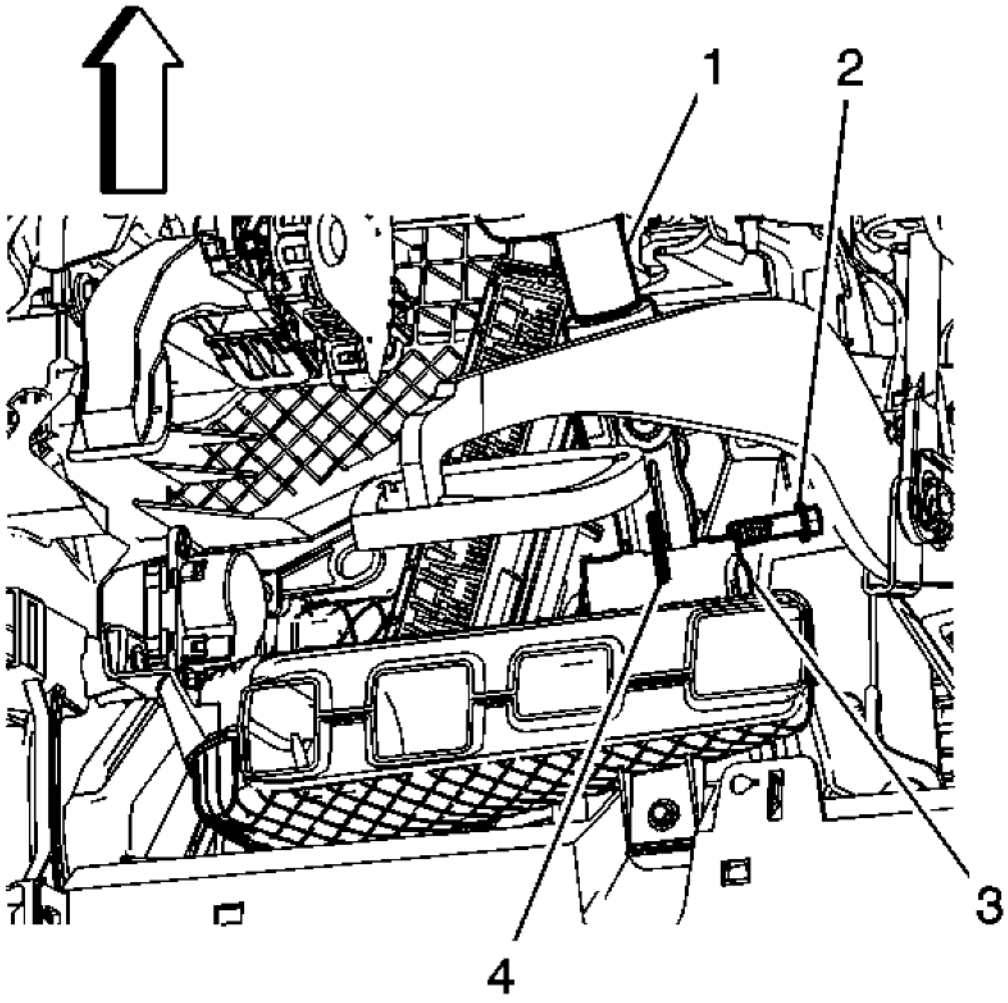


Fig. 6: Steering Column Shaft & Intermediate Steering Shaft Match Marks
Courtesy of GENERAL MOTORS CORP.

6. Working under the instrument panel, align the match marks (4) and connect the intermediate steering shaft (3) to the steering column shaft (1).
7. Apply thread locking adhesive to the upper intermediate steering shaft bolt (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

CAUTION: Refer to Fastener Caution .

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8. Install the upper intermediate steering shaft bolt and tighten to 36 N.m (26.5 lb ft).

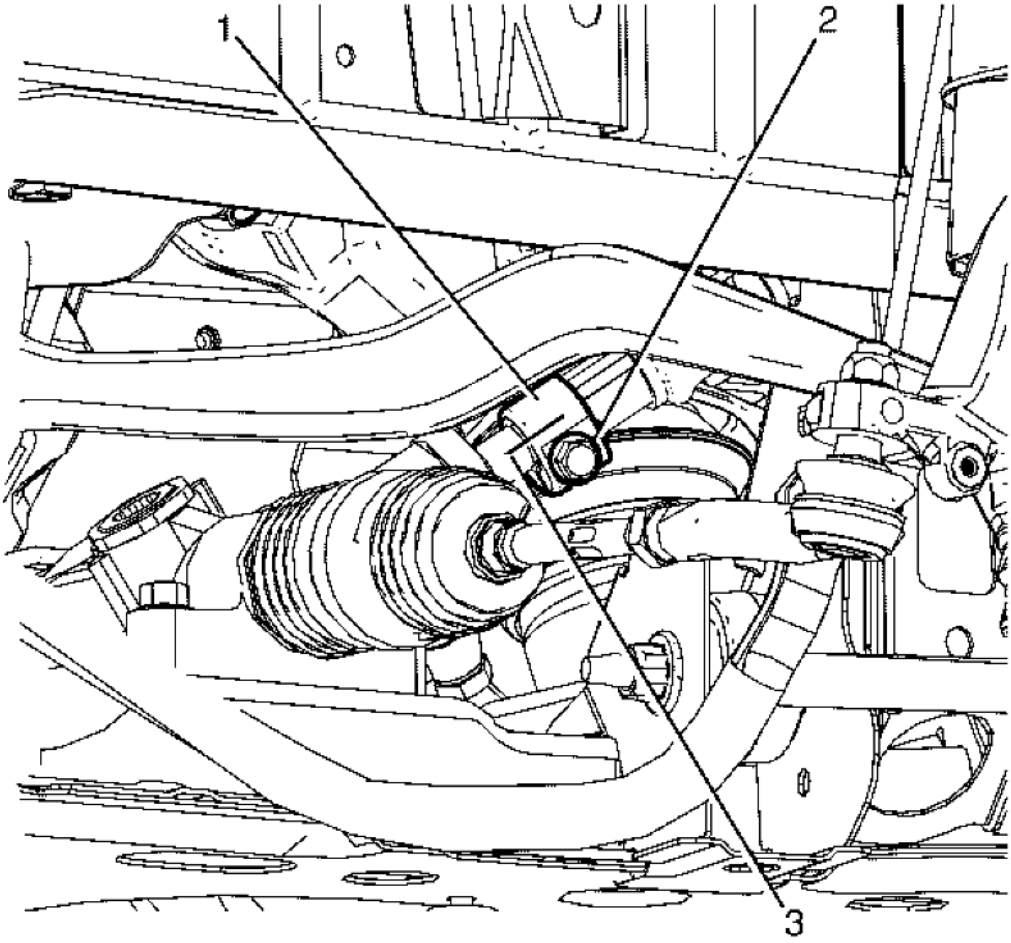


Fig. 7: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

9. Working under the vehicle, align the match marks and connect the intermediate steering shaft (1) to the steering gear pinion shaft (3).
10. Apply thread locking adhesive to the steering gear pinion bolt (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
11. Install the steering gear pinion bolt and tighten to 50 N.m (37 lb ft).

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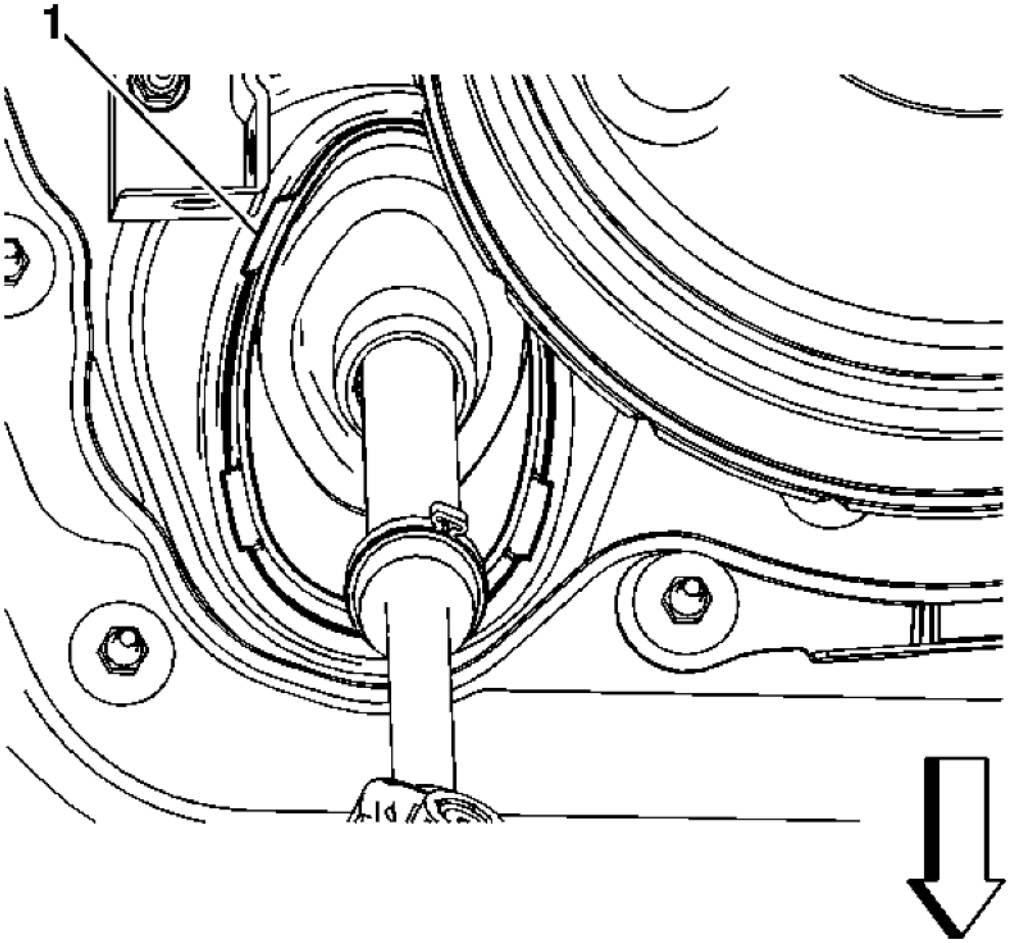


Fig. 8: Intermediate Shaft Seal Tabs
Courtesy of GENERAL MOTORS CORP.

12. Working under the vehicle, ensure the 4 tabs (1) on the intermediate shaft seal engage the dash panel.
13. Lower the vehicle.

STEERING COLUMN ACCIDENT DAMAGE INSPECTION

Inspection Procedure

1. Remove the turn signal switch bracket. Refer to **Turn Signal Switch Bracket Replacement**.

NOTE: **Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, where the steering column has been impacted, or**

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where the supplemental inflatable restraint systems deployed, may have a damaged or misaligned steering column.

2. Remove the steering column from the vehicle. Refer to **Steering Column Replacement**.
3. Rotate the steering column shaft. Verify the shaft turns freely and without interference.

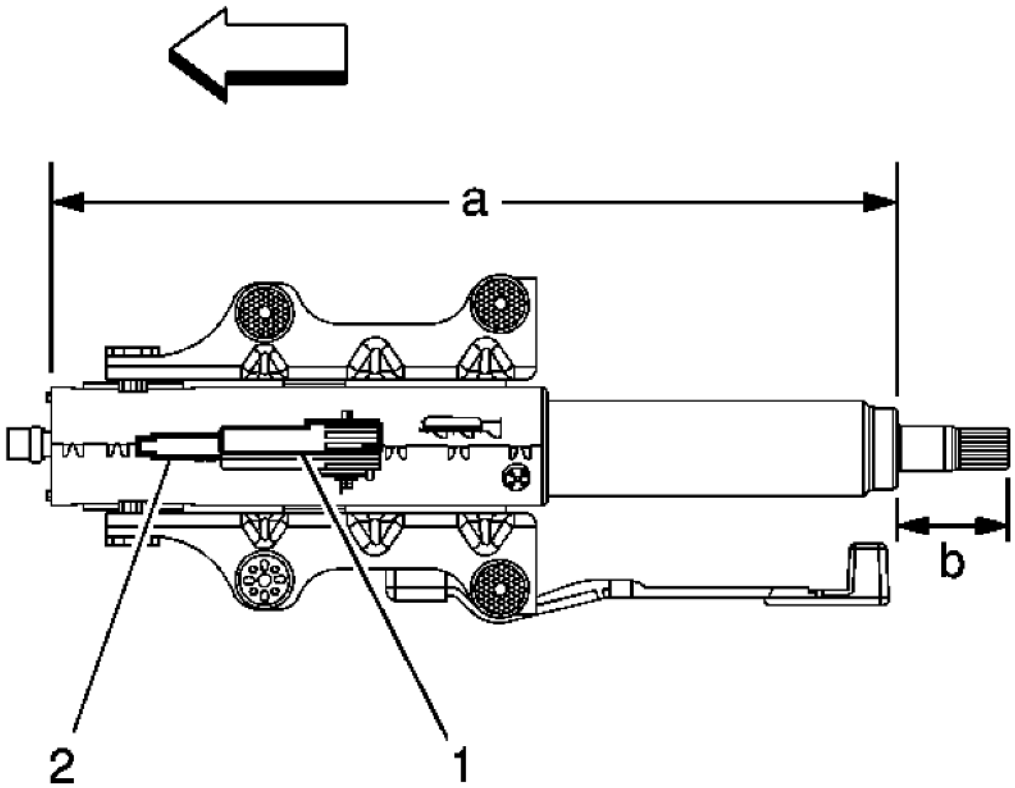


Fig. 9: Steering Column Components
Courtesy of GENERAL MOTORS CORP.

4. Verify the E/A strap retainer (1) is firmly seated on the jacket.
5. Verify there is no visual damage to the E/A strap (2).
6. Measure the length of the upper shaft (b) from the end of the upper jacket to the tip. The length of the upper shaft must not be less than 57 mm (2.2 in).
7. Measure the length of the upper and lower jacket assembly (a). The length of the upper and lower jacket assembly must not be less than 441 mm (17.4 in).
8. If the steering column does not meet the specifications, the steering column is damaged. Discard the damaged steering column. Install a NEW steering column.

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If the steering column meets the specifications, install the steering column. Refer to **Steering Column Replacement**.

9. Install the turn signal switch bracket. Refer to **Turn Signal Switch Bracket Replacement**.

STEERING COLUMN SHROUD REPLACEMENT

Removal Procedure

1. Lower the tilt and telescope lever. Keep the lever in the released position.

   Telescope the steering column to the maximum rearward position.

   Tilt the steering column to the lowest position.

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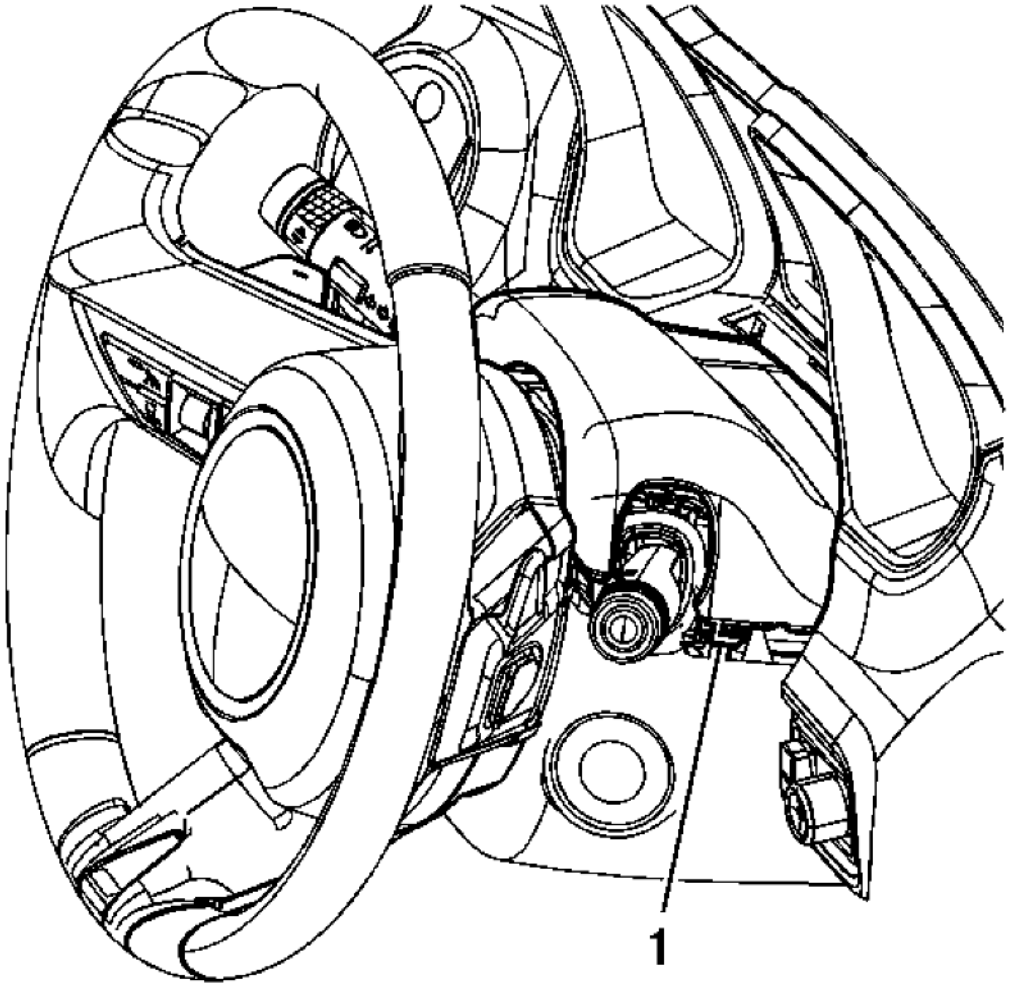


Fig. 10: Right Side Upper Steering Column Shroud Tab
Courtesy of GENERAL MOTORS CORP.

2. Release the 1 tab (1) that secures the right side of the upper steering column shroud to the steering column.

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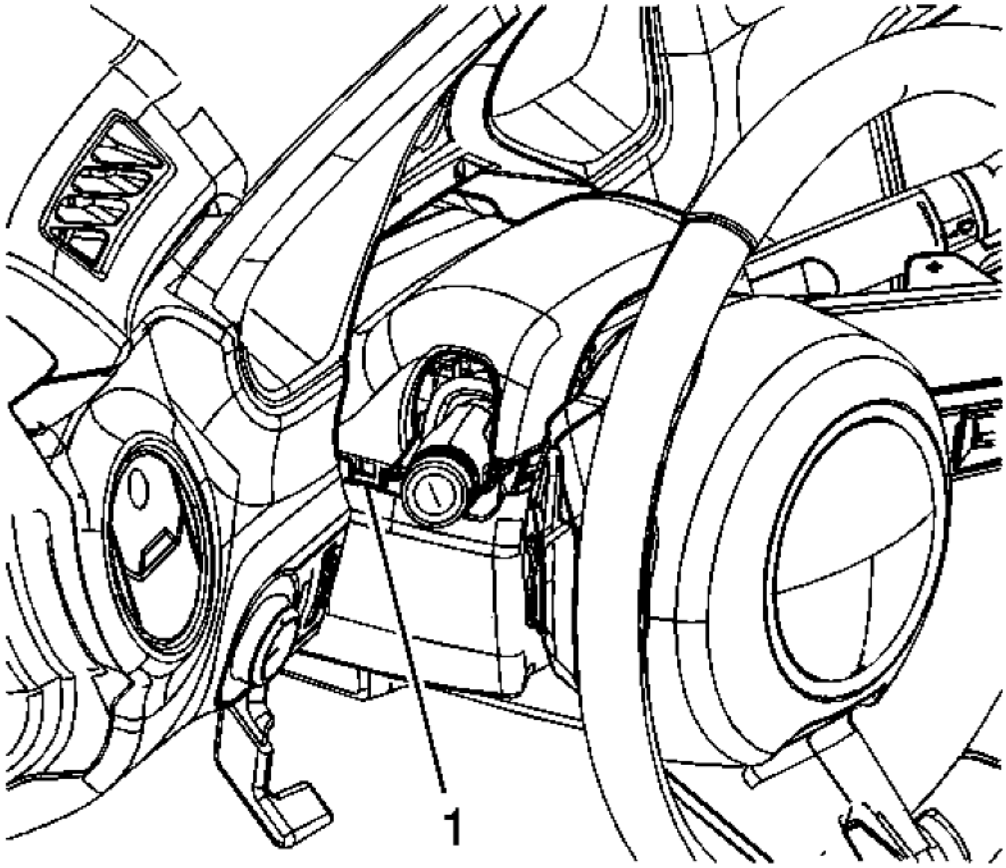


Fig. 11: Left Side Upper Steering Column Shroud Tab
Courtesy of GENERAL MOTORS CORP.

3. Release the 1 tab (1) that secures the left side of the upper steering column shroud to the steering column.

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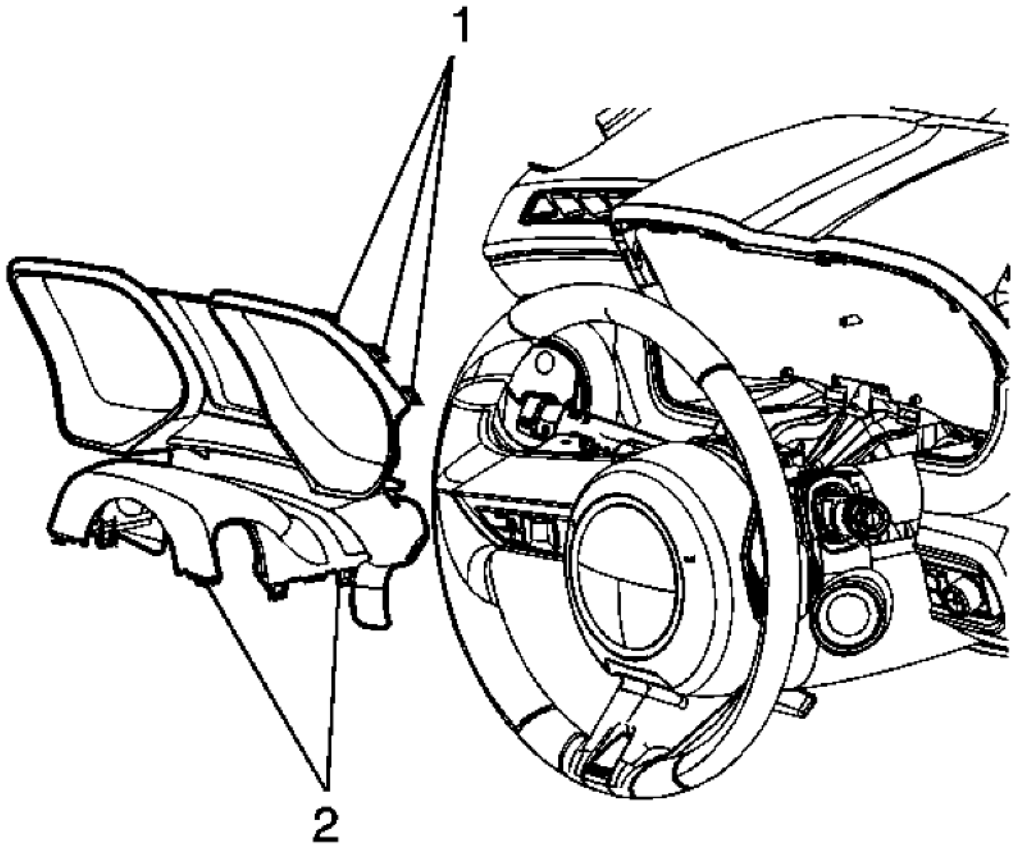


Fig. 12: Right Side Upper Steering Column Shroud Tabs
Courtesy of GENERAL MOTORS CORP.

4. Release the 2 tabs (2) that secure the right side of the upper steering column shroud to the steering column.
5. Release the 2 tabs that secure the left side of the upper steering column shroud to the steering column.
6. Use a flat bladed plastic trim tool in order to release the retaining tabs (1) securing the instrument panel cluster trim plate to the instrument panel.
7. Remove the upper steering column shroud and the instrument panel cluster trim plate as an assembly from the instrument panel.

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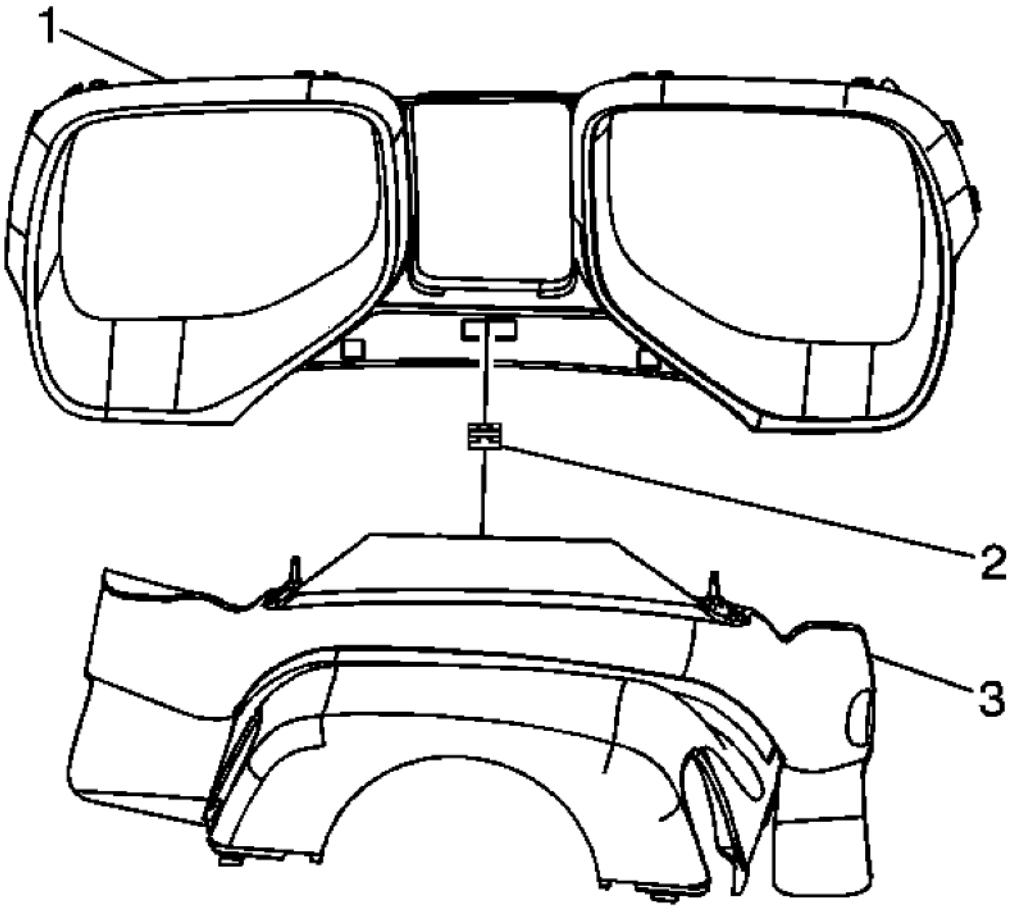


Fig. 13: Upper Steering Column Shroud & Instrument Panel Cluster Trim Plate
Courtesy of GENERAL MOTORS CORP.

8. Use a flat bladed plastic trim tool in order to release the clip (2) and the 2 retainers.

   Remove the upper steering column shroud (3) from the instrument panel cluster trim plate (1).

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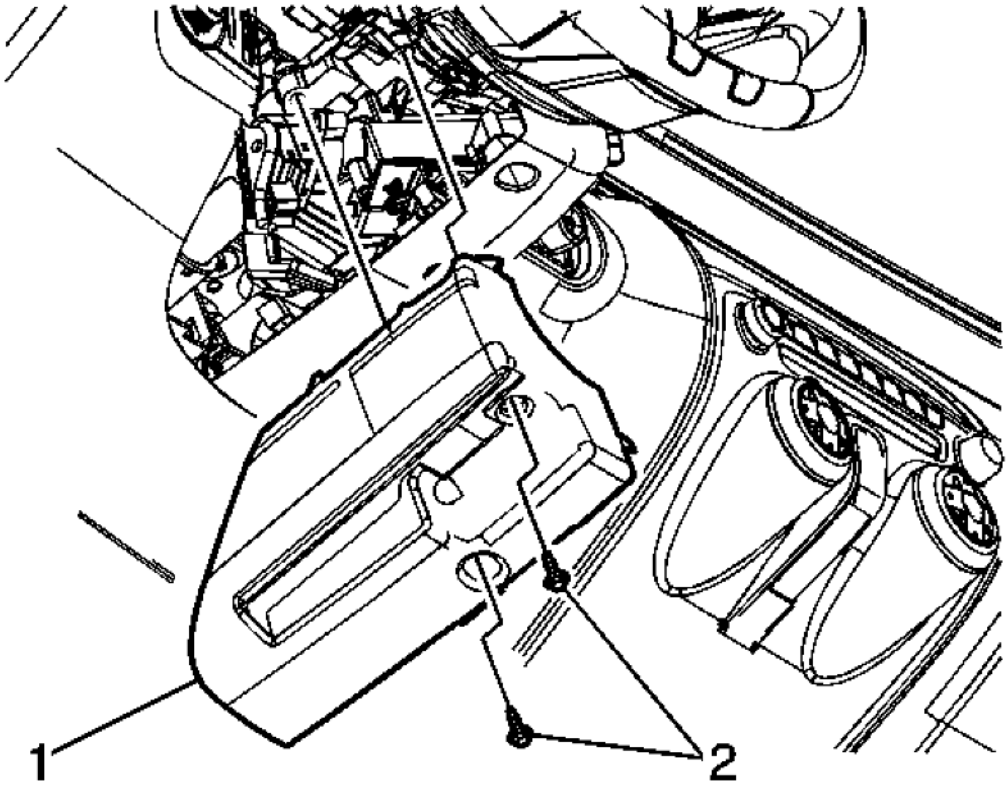


Fig. 14: Lower Left Steering Column Shroud & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the 2 bolts (2) from the lower left steering column shroud (1).
10. Disengage the 4 tabs and remove the lower left steering column shroud from the steering column.

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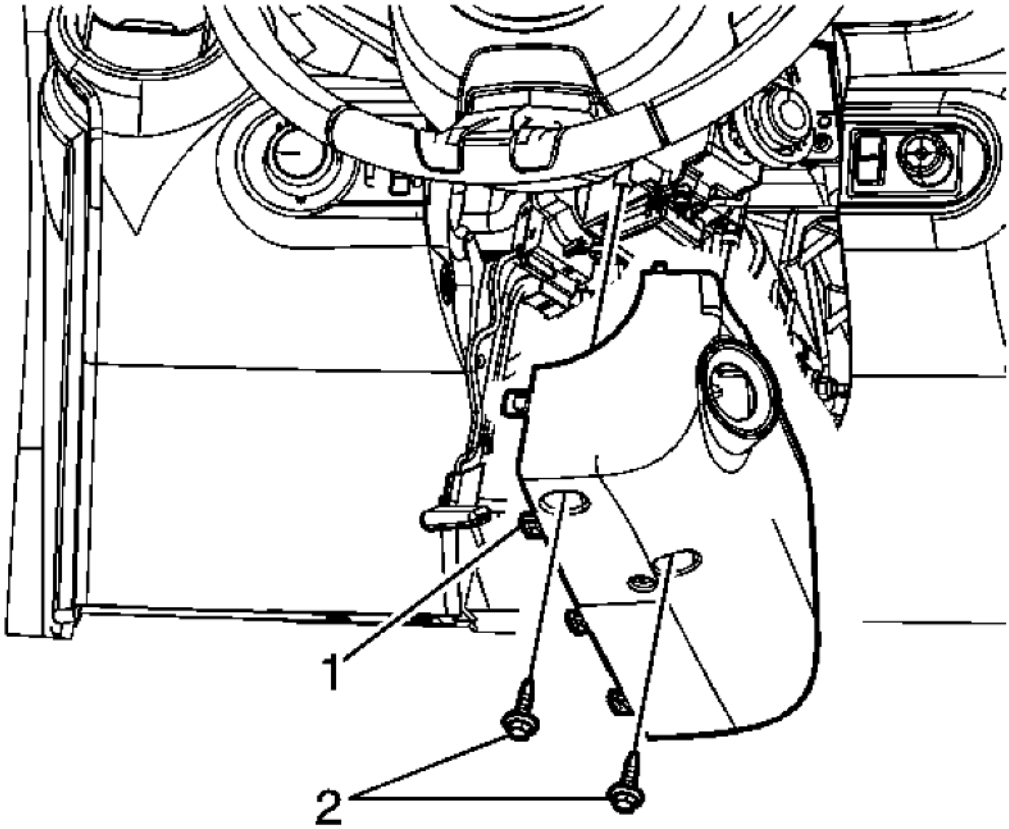


Fig. 15: Lower Right Steering Column Shroud & Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the 2 bolts (2) from the lower right steering column shroud (1).
12. Disengage the instrument panel harness retainer from the lower right steering column shroud.
13. Remove the lower right steering column shroud from the vehicle.

Installation Procedure

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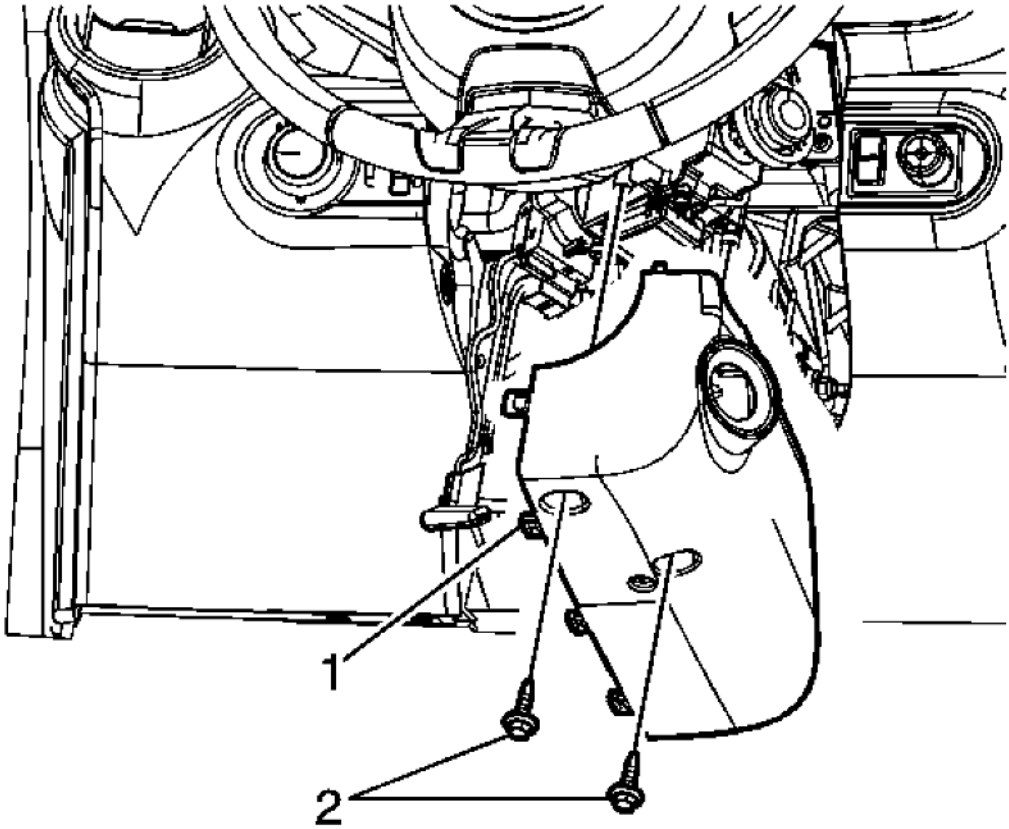


Fig. 16: Lower Right Steering Column Shroud & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Secure the instrument panel harness retainer to the lower right steering column shroud (1).

   CAUTION: Refer to Fastener Caution .

2. Install the lower right steering column shroud to the steering column with the 2 bolts (2) and tighten to 2.5 N.m (22 lb in)..

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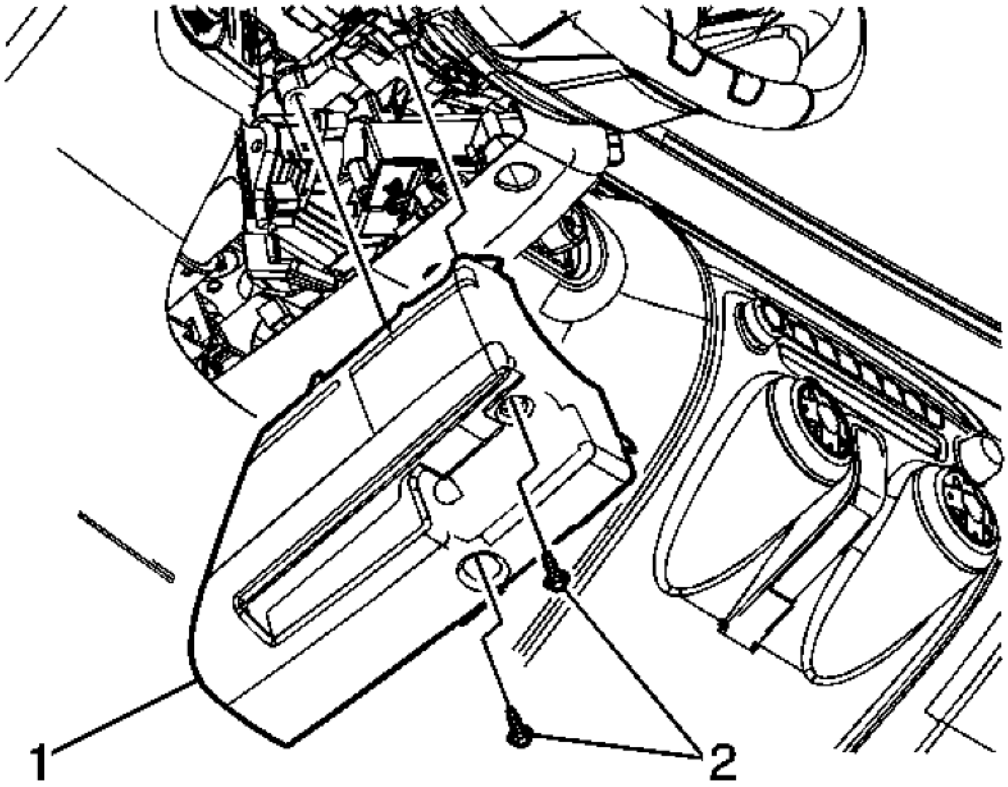


Fig. 17: Lower Left Steering Column Shroud & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Route the tilt and telescope lever through the opening in the lower left steering column shroud (1).

   Install the lower left steering column shroud to the steering column and engage the 4 tabs.

4. Install the 2 bolts (2) to the lower left steering column shroud.

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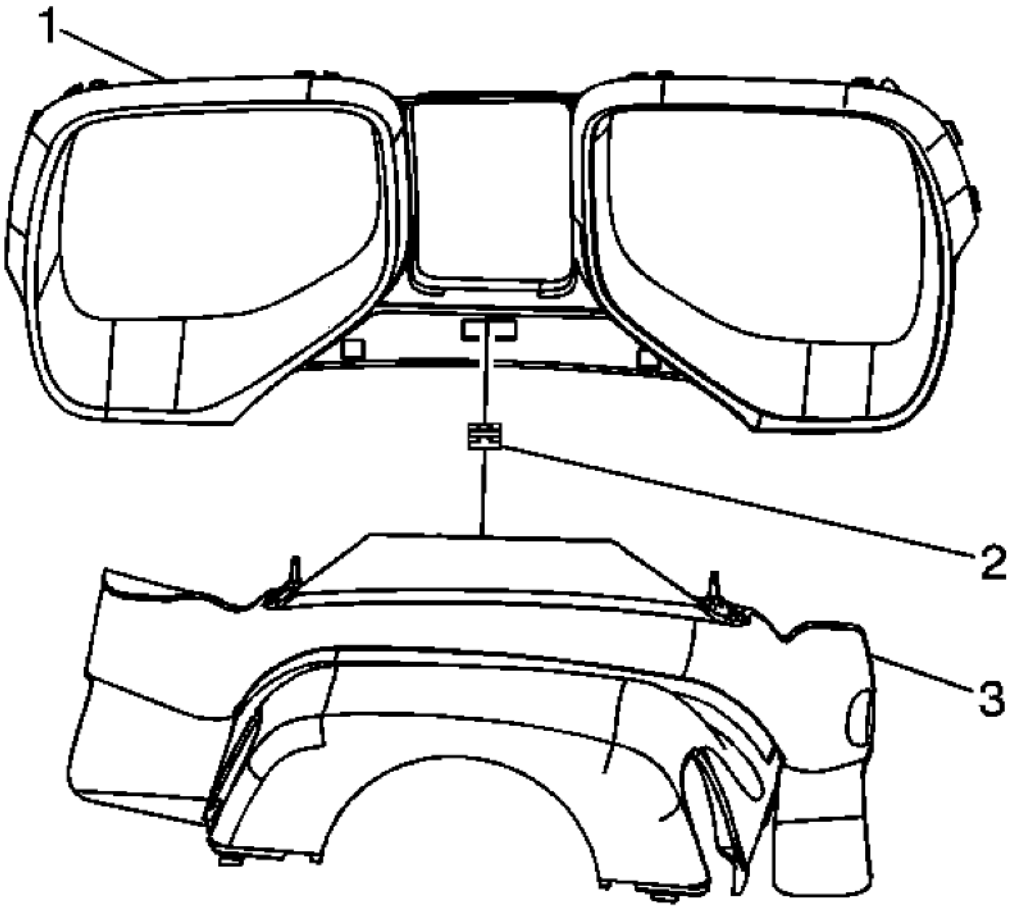


Fig. 18: Upper Steering Column Shroud & Instrument Panel Cluster Trim Plate
Courtesy of GENERAL MOTORS CORP.

5. Install the instrument panel cluster trim plate (1) to the instrument panel assembly.
6. Install the upper steering column shroud (3) to the instrument panel cluster trim plate with the clip (2) and the 2 retainers.
7. Install the left side of the upper steering column shroud to the steering column with the 2 tabs.
8. Install the right side of the upper steering column shroud to the steering column with the 2 tabs.

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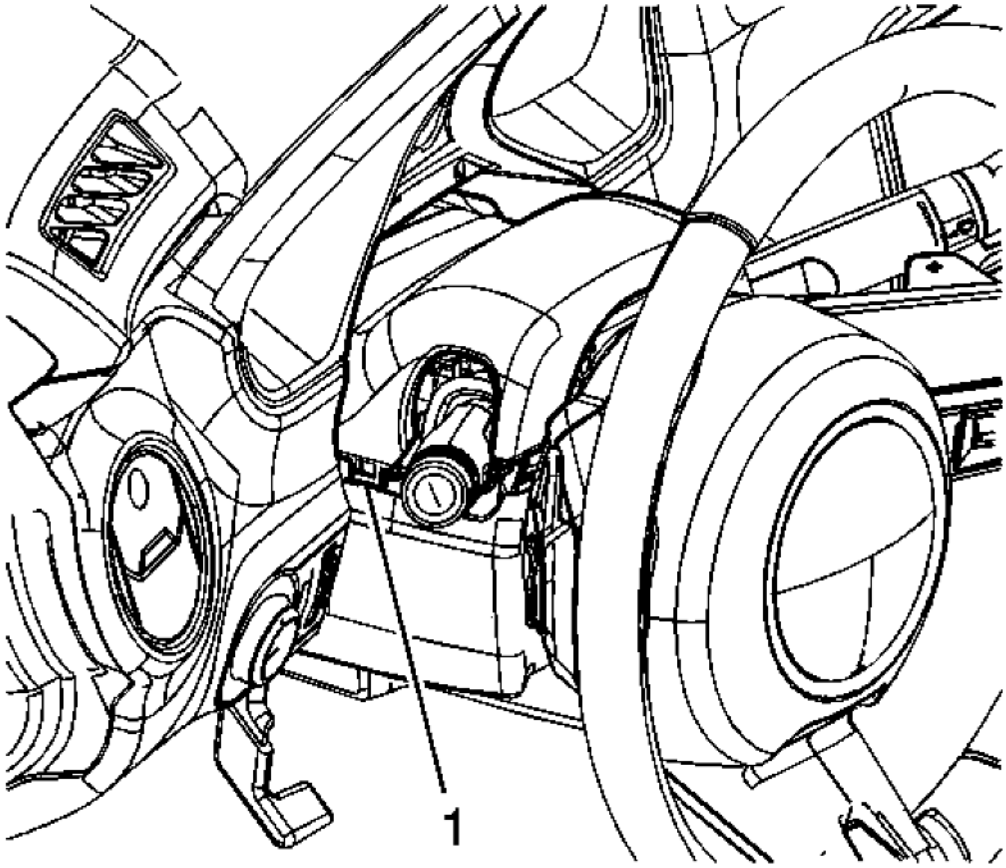


Fig. 19: Left Side Upper Steering Column Shroud Tab
Courtesy of GENERAL MOTORS CORP.

9. Install the left side of the upper steering column shroud to the steering column with the 1 tab (1).

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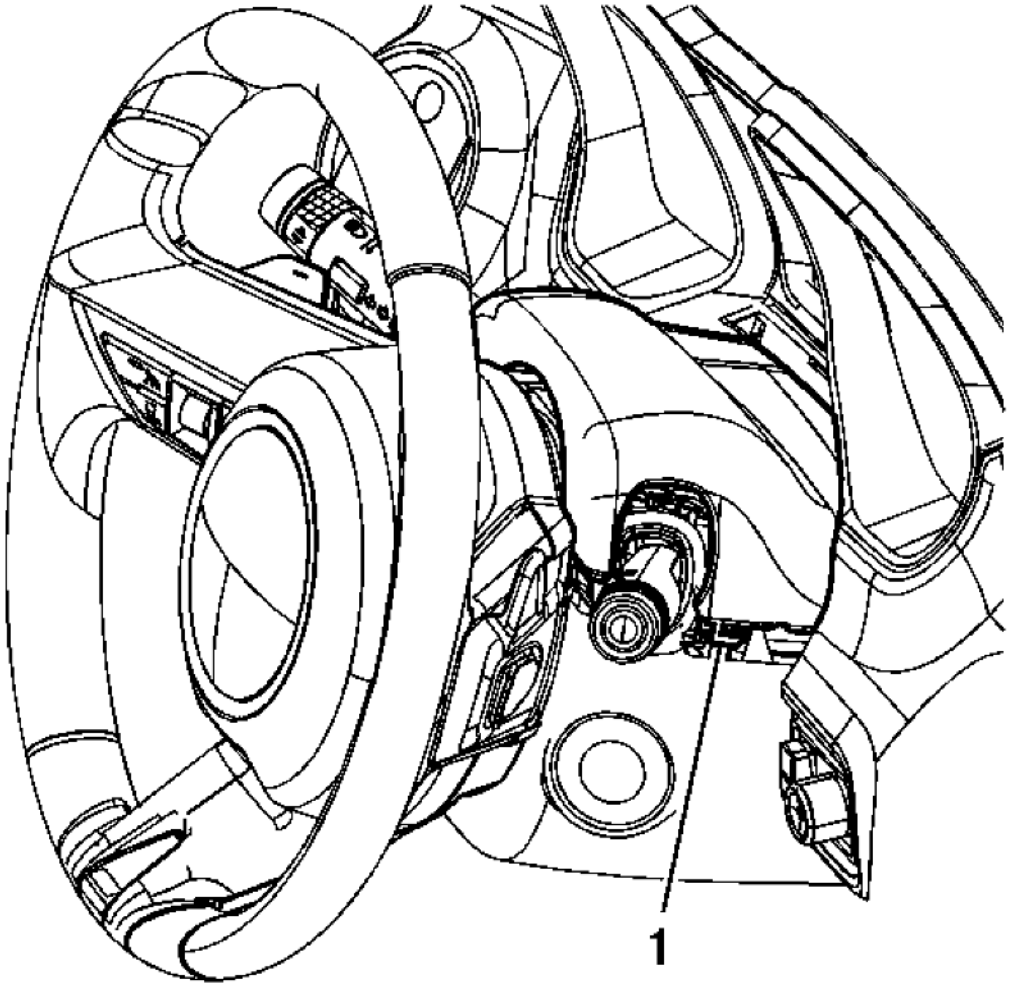


Fig. 20: Right Side Of Upper Steering Column Shroud Tab
Courtesy of GENERAL MOTORS CORP.

10. Install the right side of the upper steering column shroud to the steering column with the 1 tab (1).
11. Raise the tilt and telescope lever to the secured position.

TURN SIGNAL SWITCH BRACKET REPLACEMENT

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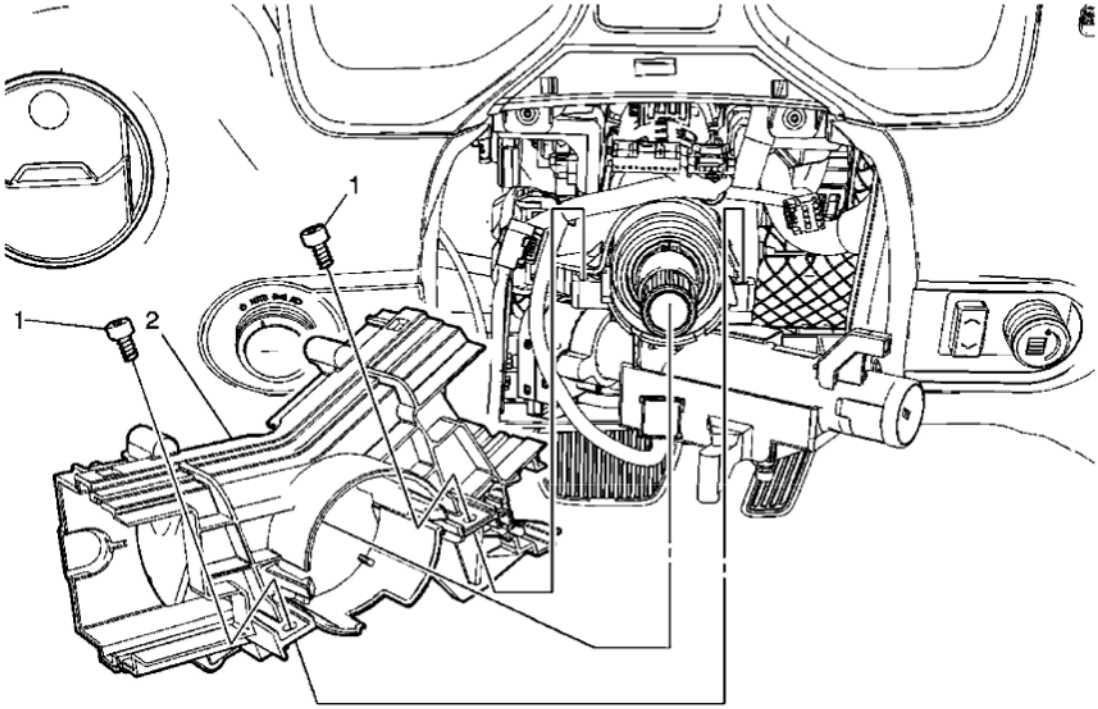


Fig. 21: Turn Signal Switch Bracket
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the inflatable restraint steering wheel module coil. Refer to **Steering Wheel Inflatable Restraint Module Coil Replacement** .	
1	Turn Signal Switch Bracket Fastener (Qty: 2)
2	Turn Signal Switch Bracket **Procedure** 1. Disconnect any electrical connectors as necessary. 2. Transfer any parts as necessary. Refer to **Turn Signal Multifunction Switch Replacement** and to **Windshield Wiper and Washer Switch Replacement** .

TURN SIGNAL MULTIFUNCTION SWITCH REPLACEMENT

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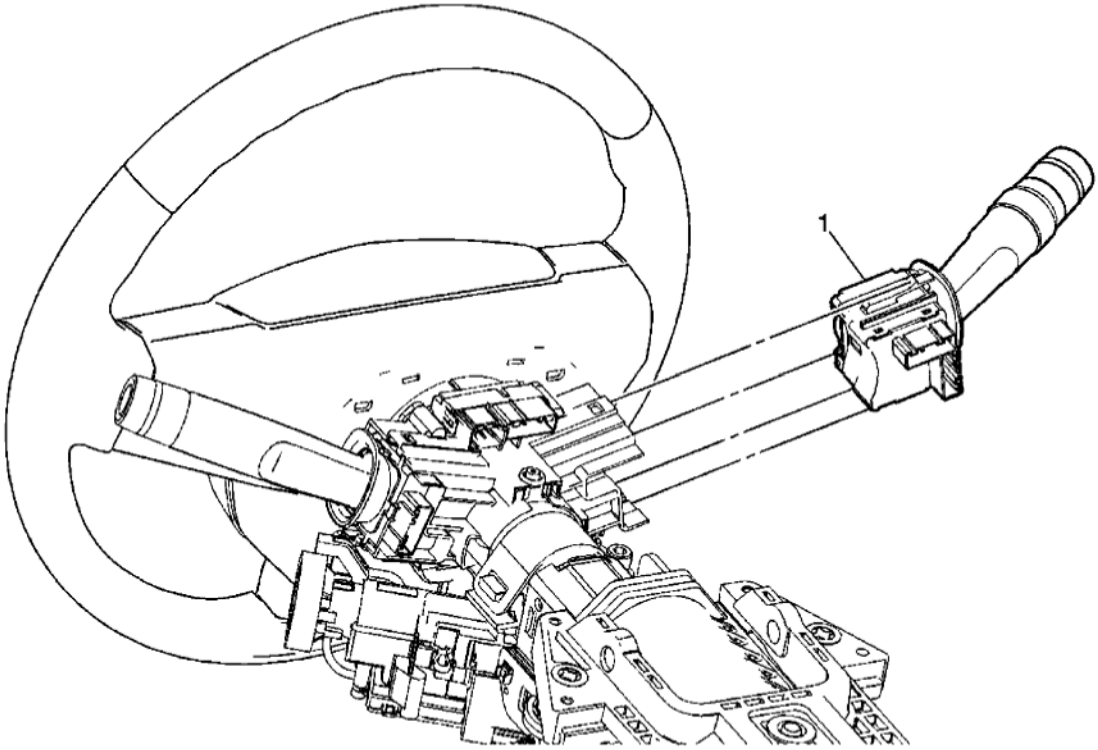


Fig. 22: Turn Signal Multifunction Switch
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the steering column shroud. Refer to **Steering Column Shroud Replacement**.	
1	Turn Signal Multifunction Switch **Procedure** 1. Disconnect any electrical connectors as needed. 2. Release the plastic retaining tabs and remove the turn signal multifunction switch from the turn signal switch bracket.

STEERING WHEEL REPLACEMENT

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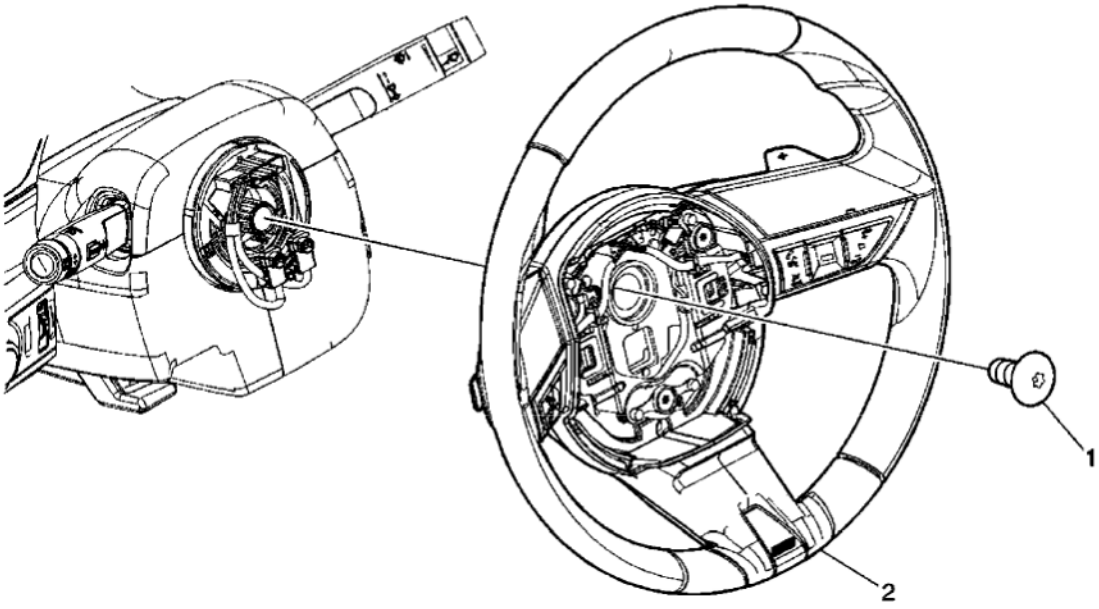


Fig. 23: Steering Wheel
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the steering wheel inflatable restraint module airbag. Refer to **Steering Wheel Inflatable Restraint Module Airbag Replacement** . 2. Use paint in order to place match marks on the steering wheel and on the steering column shaft.	
1	Steering Wheel Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 30 N.m (22 lb ft)
2	Steering Wheel **Procedure** 1. Disconnect all electrical connectors as needed. 2. Remove the steering wheel. 3. Copy the match marks from the old steering wheel to the new steering wheel. 4. Transfer any parts as needed.

STEERING WHEEL SPOKE CONTROL SWITCH BEZEL REPLACEMENT

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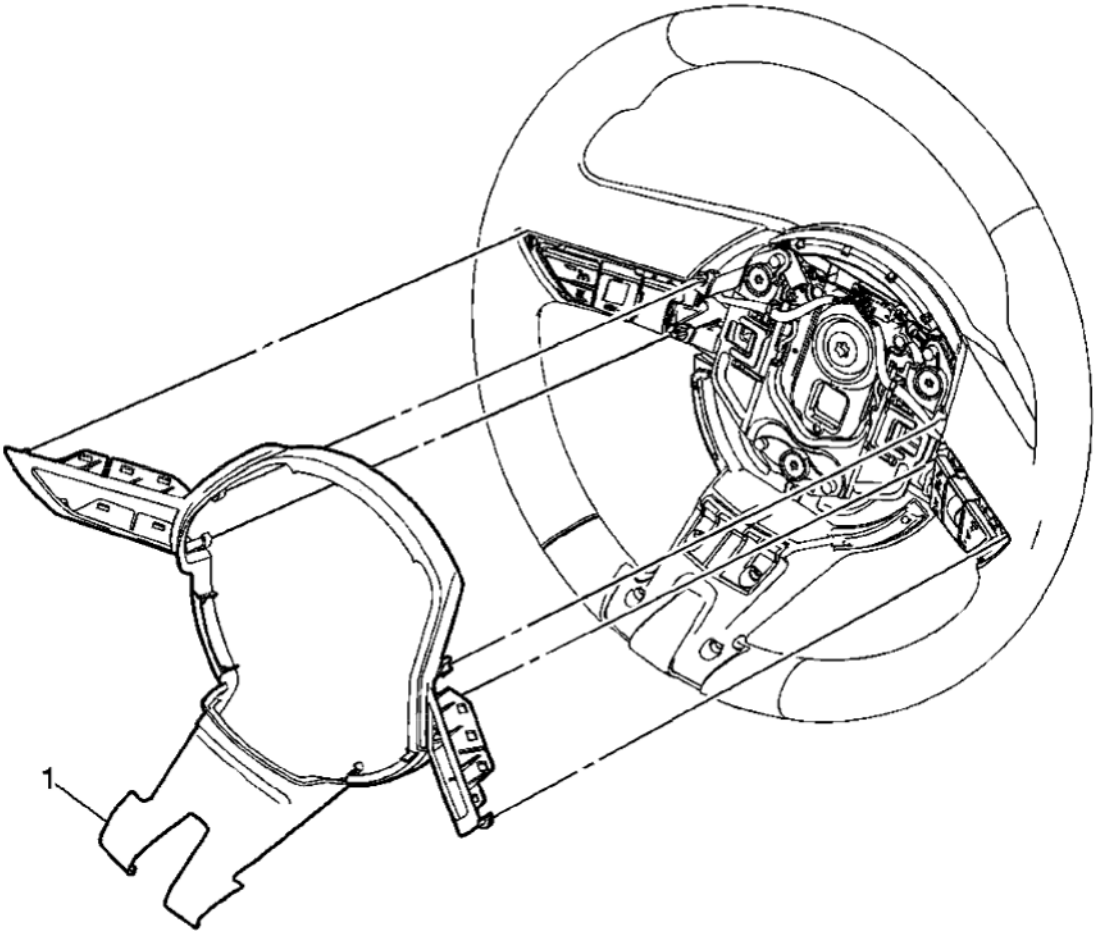


Fig. 24: Steering Wheel Spoke Control Switch Bezel
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the inflatable restraint steering wheel module. Refer to **Steering Wheel Inflatable Restraint Module Airbag Replacement** .	
1	Steering Wheel Spoke Control Switch Bezel **Procedure:** Using the appropriate tool, release the retainers to remove the bezel.

STEERING COLUMN REPLACEMENT

Removal Procedure

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column

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will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. LOCK the steering column and verify the front wheels are in the straight ahead position.
2. Remove the steering column shroud. Refer to **Steering Column Shroud Replacement**.
3. Ensure the tilt and telescope lever is in the locked position with the steering column tilted to the highest position and telescoped to the maximum rearward position.
4. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
5. Disconnect any electrical connectors as necessary.

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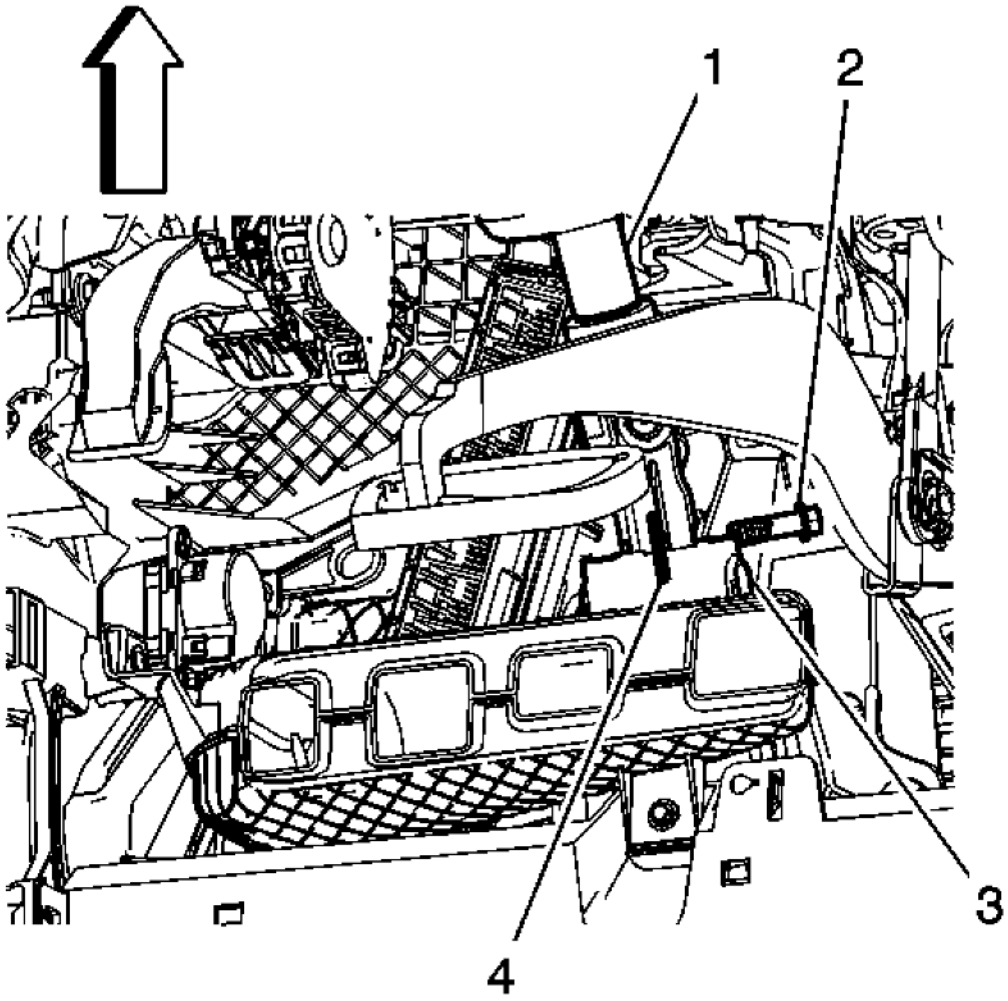


Fig. 25: Steering Column Shaft & Intermediate Steering Shaft Match Marks
Courtesy of GENERAL MOTORS CORP.

6. Use paint in order to place match marks (4) on the steering column shaft (3) and on the intermediate steering shaft (1).
7. Remove the upper intermediate steering shaft bolt (2).
8. Separate the upper intermediate steering shaft from the steering column. Do not pull the intermediate steering shaft lower seal.
9. Support the steering column.

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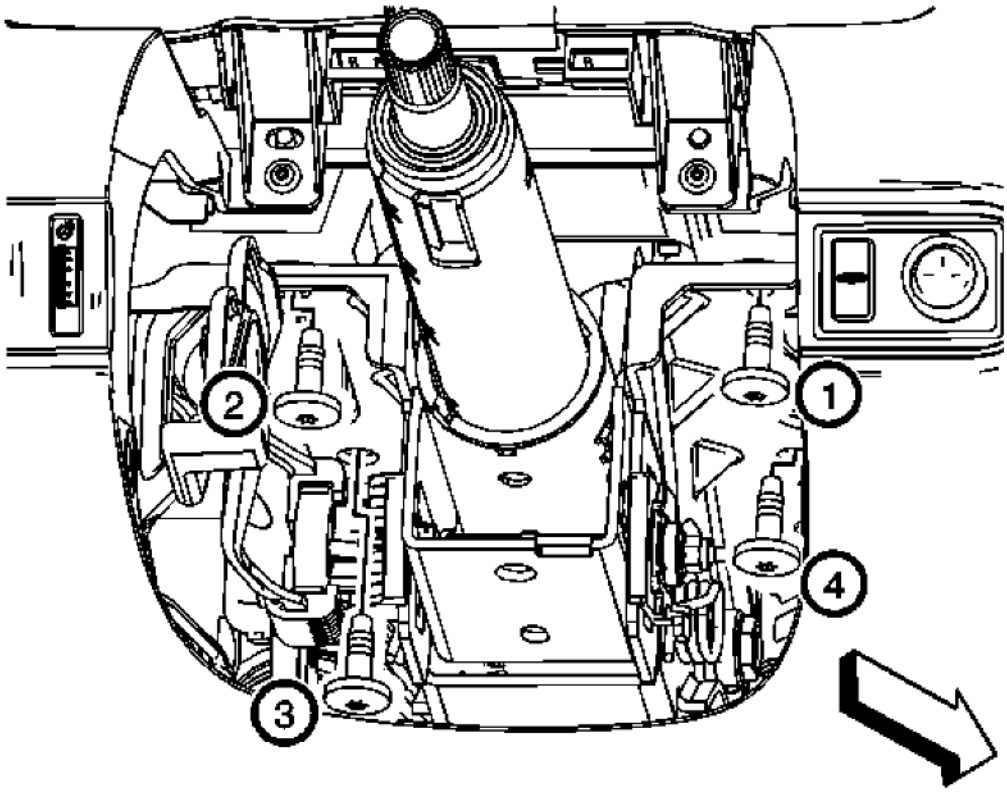


Fig. 26: Steering Column Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Remove the 4 steering column bolts (1, 2, 3, 4).

CAUTION: Once the steering column is removed from the vehicle, the column is extremely susceptible to damage. Dropping the column assembly on the end could collapse the steering shaft or loosen the plastic injections, which maintain column rigidity. Leaning on the column assembly could cause the jacket to bend or deform. Any of the above damage could impair the columns collapsible design. Do NOT hammer on the end of the shaft, because hammering could loosen the plastic injections, which maintain column rigidity. If you need to remove the steering wheel, refer to the Steering Wheel Replacement procedure in this section.

11. Remove the steering column from the vehicle.
12. Transfer components as necessary.

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Installation Procedure

1. If you are replacing the steering column, copy the match marks from the old column to the new column.
2. Ensure the tilt and telescope lever is in the locked position with the steering column tilted to the highest position and telescoped to the maximum rearward position.
3. Position the steering column in the vehicle.

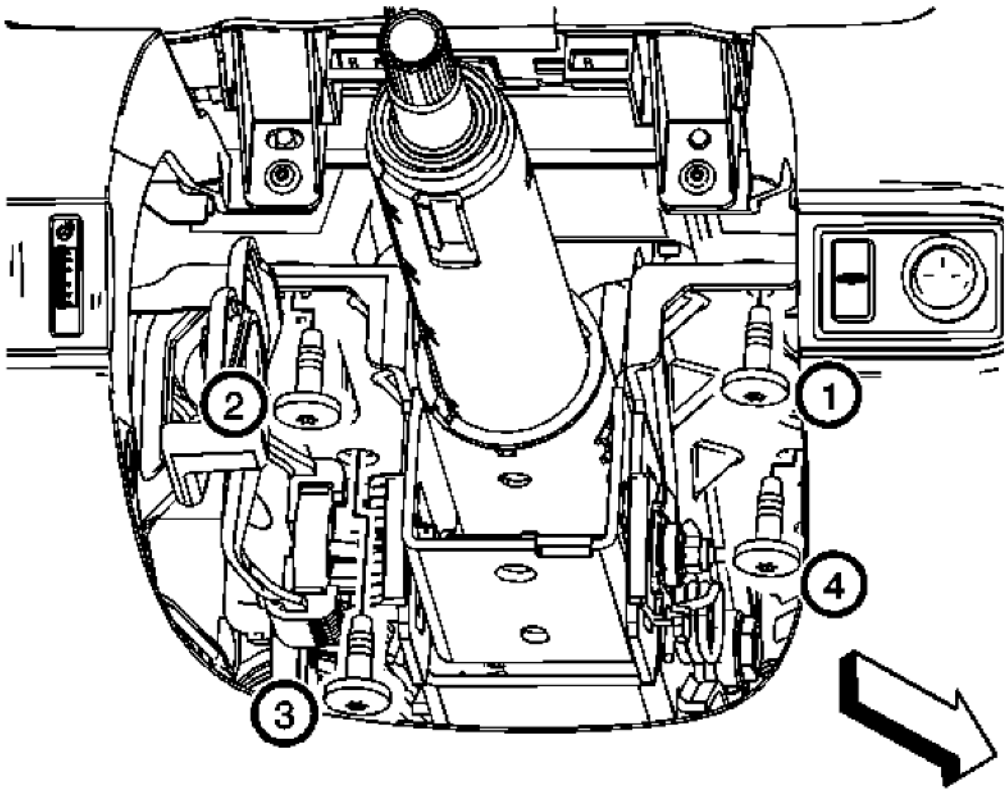


Fig. 27: Steering Column Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Support the steering column and install, but DO NOT tighten, the 4 steering column bolts (1, 2, 3, 4).

CAUTION: Refer to Fastener Caution .

NOTE: Tighten the bolts in sequence.

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5. Tighten the steering column bolts in sequence to 22 N.m (16 lb ft).

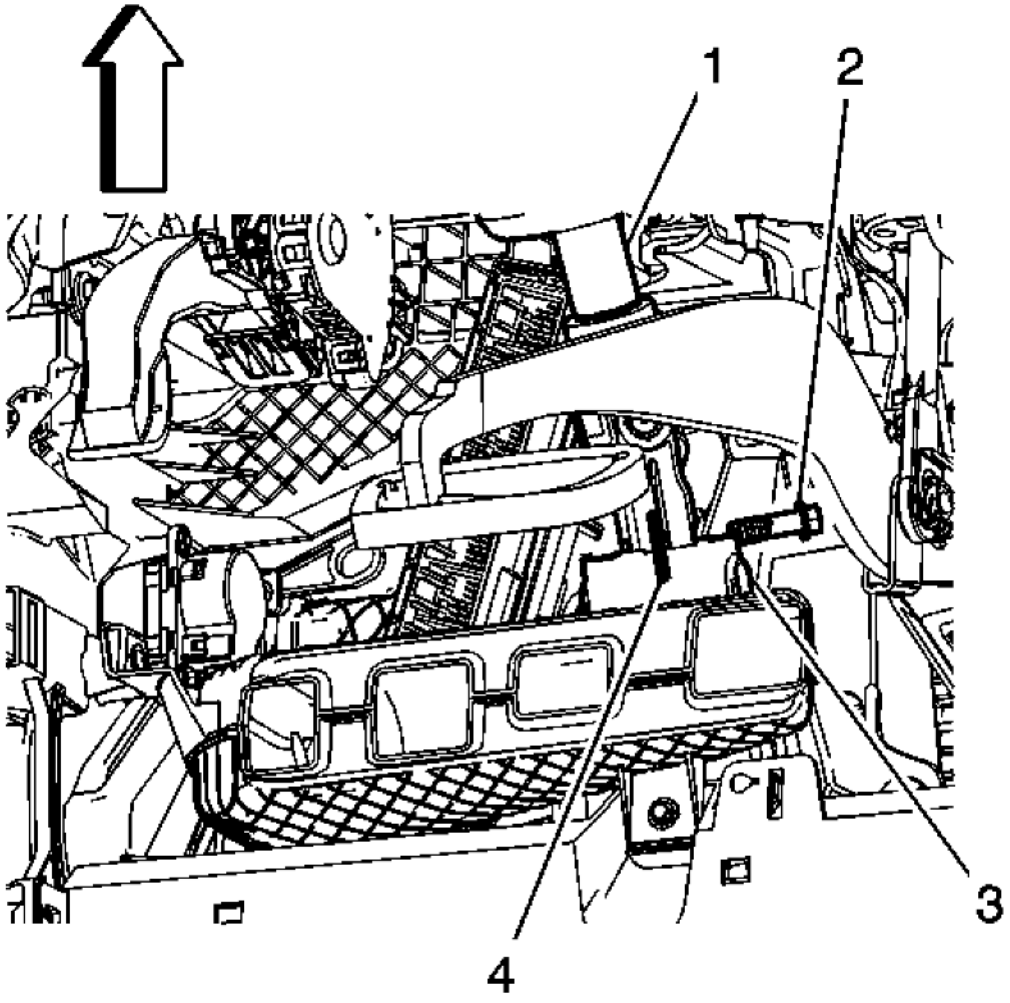


Fig. 28: Steering Column Shaft & Intermediate Steering Shaft Match Marks
Courtesy of GENERAL MOTORS CORP.

6. Align the match marks (4) and install the upper intermediate steering shaft (1) to the steering column shaft (3).
7. Ensure the intermediate steering shaft upper seal is seated correctly.
8. Install the upper intermediate steering shaft bolt (2) and tighten to 36 N.m (26.5 lb ft).
9. Connect all electrical connectors as necessary.
10. Install the steering column shroud. Refer to **Steering Column Shroud Replacement**.

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11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

STEERING ANGLE SENSOR REPLACEMENT

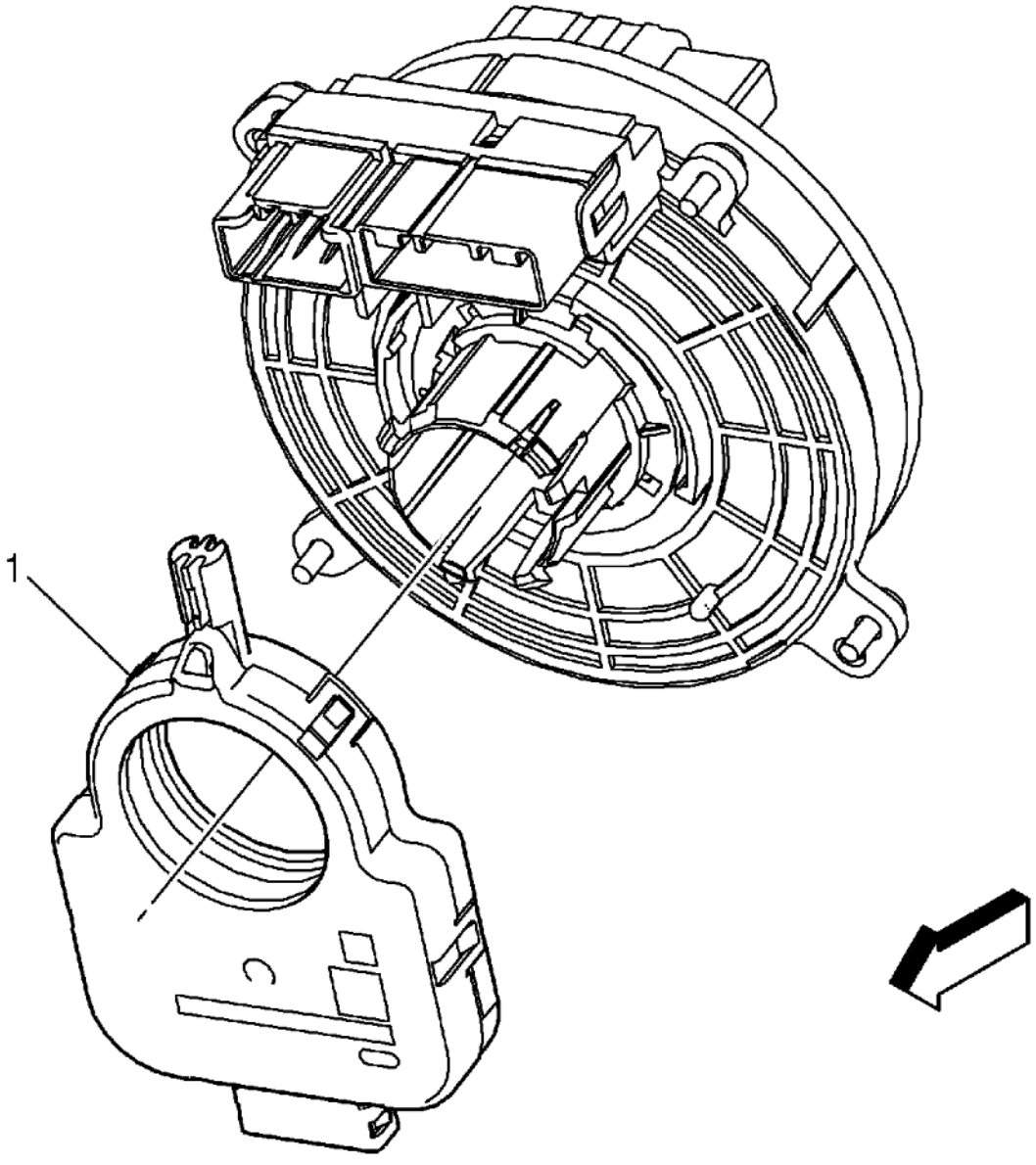


Fig. 29: Steering Angle Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the steering wheel inflatable restraint module coil. Refer to **Steering Wheel Inflatable Restraint Module Coil Replacement** .	
	Steering Angle Sensor

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1	**Procedure** 1. Press in the clip on the steering wheel inflatable restraint module coil in order to remove the sensor. 2. After installation, center the steering angle sensor. Refer to **Steering Angle Sensor Centering** .

DESCRIPTION AND OPERATION

STEERING WHEEL AND COLUMN DESCRIPTION AND OPERATION

The steering wheel and column has 4 primary functions:

- Heated Steering Wheel
- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Heated Steering Wheel

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering wheel control module supplies ground to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel. The heated steering wheel temperature is monitored through an internal temperature sensor. When the steering wheel reaches operating temperature the module will cycle the voltage on and off to maintain the operating temperature.

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security, Found on Some Vehicle Models

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch-location varies
- The steering column lock-content varies
- The ignition cylinder-location varies
- The theft deterrent module-location varies

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Driver Convenience

The steering wheel and column may also have driver controls attached for convenience and comfort. The following controls may be mounted on or near the steering wheel or column.

- The turn signal switch
- The hazard switch
- The headlamp dimmer switch
- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The manual/power tilt or tilt/telescoping functions
- The power pedal adjustment control switch
- The navigation/OnStar® features
- The HVAC controls

Driver Safety

The steering wheel and column has safety features to protect the driver. The following components may be mounted on or near the steering column:

Energy-Absorbing Steering Column

The energy-absorbing steering column compresses in the event of a front-end collision, which reduces the chance of injury to the driver. The energy-absorbing feature, collapsible steering shaft, and break away mounting features help reduce the injury in the event of an accident. In addition to these features, the following driver safety features may be on the steering column. To inspect the steering column for damage, refer to **Steering Column Accident Damage Inspection**.

Electronic Park Lock (EPL)/Ignition Lock Cylinder Control Actuator

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an ignition lock cylinder control actuator system in the steering column. The ignition lock cylinder control actuator purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The column ignition lock system consists of an ignition lock cylinder control actuator, and a park position switch that is located in the automatic transmission shift lock control switch. The ignition lock cylinder control actuator contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Linear Shift Assembly

If the vehicle is equipped with a column mounted gear shift, it has a linear shift assembly on the steering

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column. The linear shift assembly has a cable that runs from the linear shift assembly to the ignition lock cylinder case. The purpose of this cable is to prevent the ignition key from being turned to the OFF position when the transmission is in gear and the vehicle may still be moving. The linear shift assembly cable contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

SIR Coil and Module

For additional information on the operation of the SIR coil and module, refer to **SIR System Description and Operation** .

Automatic Transmission Shift Lock Actuator

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components: the automatic transmission shift lock control solenoid, the automatic transmission shift lock control switch, the body control module (BCM), the powertrain control module (PCM)/engine control module (ECM). With the ignition in the ON position, voltage is supplied to automatic transmission shift lock control switch. Voltage flows through the normally closed contacts of the automatic transmission shift lock control switch to the automatic transmission shift lock control solenoid. When the BCM receives a class 2 message from the PCM/ECM indicating the transmission is in the park position the BCM then grounds the automatic transmission shift lock solenoid control circuit. This energizes the automatic transmission shift lock control solenoid causing the transmission shift lever to be physically locked in the PARK position. When the brake pedal is pressed the contacts in the automatic transmission shift lock control switch open, de-energizing the automatic transmission shift lock control solenoid. This allows the shift lever to be move out of the PARK position.

Steering Wheel Angle Sensor or Steering Wheel Position Sensor

The steering wheel position sensor is located somewhere along the steering shaft assembly. The sensor measures the position of the steering wheel and the speed at which it is rotated. A signal representing this measurement is provided to the vehicle stability enhancement system (VSES) module. The VSES module uses this signal, along with several others representing different vehicle conditions, to monitor the driving behavior of the vehicle and ensure that it stays in control. If the VSES module determines that the vehicle is out of control it provides signals to the powertrain control module (PCM) and the ABS module. These output signals are used to modulate the transmission torque and brake pressure of each of the vehicles wheels in order to regain control of the vehicle.

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