

Steering

Power Steering - CTS Coupe & Wagon

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Power Steering Fluid Cooler Bracket-to-Cooler Hose Bolt (LFW, LFX)	10 N.m	89 lb in
Power Steering Fluid Cooler Bracket-to-Cooler Outlet Hose Bolt (LSA)	9 N.m	80 lb in
Power Steering Fluid Cooler Bracket-to-Impact Bar Bolt or Screw	15 N.m	11 lb in
Power Steering Fluid Cooler Bracket-to-Impact Bar Nut	15 N.m	11 lb ft
Power Steering Fluid Reservoir Inlet Hose Bolt or Screw (LSA)	9 N.m	80 lb in
Power Steering Gear Inlet and Outlet Pipe Retainer Bolt (AWD)	10 N.m	89 lb in
Power Steering Gear Inlet Pipe/Hose Bracket Bolt	9 N.m	80 lb in
Power Steering Gear Inlet Hose-to-Pump Fitting (LFW, LFX)	34 N.m	25 lb ft
Power Steering Gear Inlet Hose-to-Pump Fitting (LSA)	38 N.m	28 lb ft
Power Steering Gear Inlet Hose Latch Plate Bolt	22.5 N.m	17 lb ft
Power Steering Gear Outlet Hose Bracket Bolt	9 N.m	80 lb in
Power Steering Gear Solenoid Bolt	3 N.m	27 lb in
Power Steering Inner Tie Rod End	100 N.m	74 lb ft
Power Steering Pump-to-Bracket Bolt	25 N.m	18 lb ft
Power Steering Pump Bracket-to-Block Bolt (LFW, LFX)	22 N.m	17 lb ft
Power Steering Pump Bracket-to-Block Bolt (LSA)	22 N.m	17 lb ft
Remote Power Steering Fluid Reservoir-to-Bracket Bolt (LFW, LFX)	10 N.m	89 lb in
Remote Power Steering Fluid Reservoir-to-Bracket Bolt (LSA)	25 N.m	18 lb ft
Remote Power Steering Fluid Reservoir Bracket-to-Block Nut or Bolt (LFW, LFX)	40 N.m	30 lb ft
Steering Gear Bolt (AWD)		
• First Pass	60 N.m	44 lb ft
• Second Pass	80°	
Steering Gear Nut or Bolt (RWD)	85 N.m	63 lb ft

Steering Linkage Inner Tie Rod Nut	65 N.m	48 lb ft
Steering Linkage Outer Tie Rod Nut		
• First Pass	35 N.m	26 lb ft
• Second Pass	110°	

POWER STEERING PUMP SPECIFICATIONS

Power Steering Pump Specifications

Engine Code	Engine Size	High Flow		Pressure Relief	
		LPM	GPM	kPa	PSI
LFW, LFX, LSA (AWD)	3.0L, 3.6L, 6.2L	11.2	3.0	11200/12000	1624/1740
LFW, LFX, LSA (RWD)	3.0L, 3.6L, 6.2L	10.25	2.7	11200/12000	1624/1740

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Power Steering Fluid	GM Power Steering Fluid	89021184	89021186

SCHEMATIC WIRING DIAGRAMS

POWER STEERING WIRING SCHEMATICS

Power Steering System

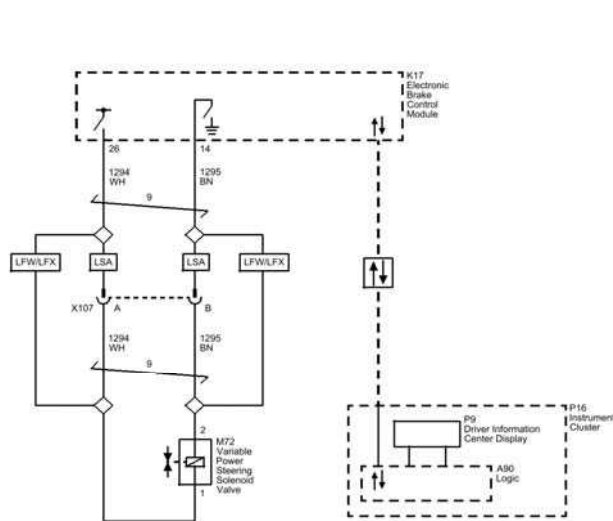


Fig. 1: Power Steering System

Courtesy of GENERAL MOTORS COMPANY

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**.
- 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**
- **Rattle, Clunk, or Shudder Noise from the Power Steering System (LFW, LFX), Rattle, Clunk, or Shudder Noise from the Power Steering System (LSA)**
- **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

Rack and Pinion System

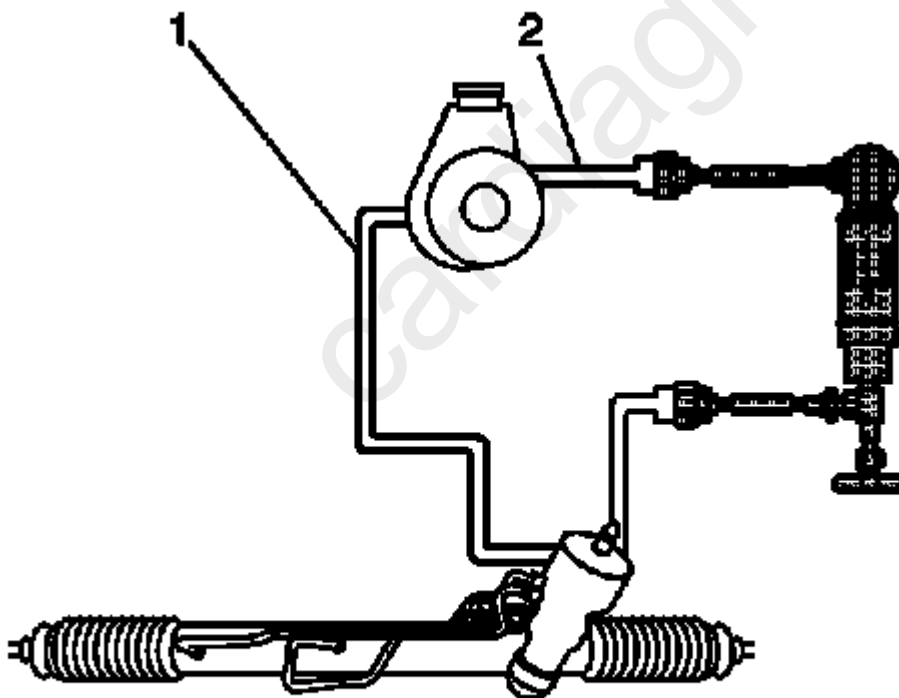


Fig. 2: Testing Rack and Pinion System Pressures

Courtesy of GENERAL MOTORS COMPANY

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.

12

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

Power Steering System Test

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 <u>Power Steering System Flushing</u> . 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 <u>Checking and Adding Power Steering Fluid</u> . Did you complete the installation?	-	Go to Step 5	-
5	1. Fully open the J-44721 Power Steering System Analyzer valve. 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	1379 kPa (200 psi)		

	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?		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
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 Steering System Analyzer valve 3 times. Record all of the high pressure readings. Refer to <u>Power Steering Pump Specifications</u> 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 <u>Power Steering Pump Specifications</u> 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 <u>Power Steering Pump Replacement (LSA), Power Steering Pump Replacement (LFW, LFX).</u> 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 <u>Steering Gear Replacement (RHD), Steering Gear Replacement (LHD With AWD), Steering Gear Replacement (LHD With RWD).</u> 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 <u>Power Steering System Bleeding.</u> Did you complete the procedure?	-	System OK	-

POWER STEERING FLUID LEAKS

Special Tools

GE-28431-6 Fluorescent Dye

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

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. Refer to **Checking and Adding Power Steering Fluid**. 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.

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

3. Use a clean towel or a rag in order to completely clean off all residual fluid from the power steering components.
4. Add 30 cc (1 oz) of **GE-28431-6** dye to the power steering fluid.
5. Start the vehicle and warm the steering system by turning to the left steering stop and to the right steering stop 10 times with the weight of the vehicle on the front tires.
6. Turn vehicle engine OFF.
7. Shine a black light on the area where the residual fluid accumulated. Identify the sources of the leaks.
8. Mark all locations of leaks with paint, marker, or equivalent.
9. Repair or replace all affected components.

RATTLE, CLUNK, OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM (LFW, LFX)**Rattle, Clunk, or Shudder Noise from the Power Steering System (LFW, LFX)**

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 <u>Symptoms - Power Steering System</u>
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 proper routing and clearance.		

	Is the routing or clearance of a power steering hose incorrect?	Go to Step 11	Go to Step 4
4	Inspect the engine drive belt for cracking or excessive wear. Refer to <u>Drive Belt Falls Off and Excessive Wear Diagnosis</u> . 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 <u>Power Steering Pump Replacement (LFW, LFX)</u> . Is the power steering pump installation incorrect?	Go to Step 14	Go to Step 7
7	Inspect the steering gear for the proper installation. Refer to <u>Steering Gear Replacement (RHD)</u> , <u>Steering Gear Replacement (LHD With AWD)</u> , <u>Steering Gear Replacement (LHD With RWD)</u> . Is the steering gear installation incorrect?	Go to Step 15	Go to Step 8
8	Inspect in the inner tie rods and the outer tie rods for looseness. Refer to <u>Steering Linkage Inner Tie Rod Inspection</u> , and to <u>Steering Linkage Outer Tie Rod Inspection</u> . Are the inner tie rods or the outer tie rods loose?	Go to Step 16	Go to Step 9
9	Inspect the front suspension. Refer to <u>Noise Diagnosis - Front Suspension</u> . Is the front suspension worn?	Go to Step 17	Go to Step 10
10	Inspect the intermediate steering shafts for wear. Are any of the intermediate steering shafts worn?	Go to Step 18	Go to Step 3
11	Adjust or replace the hose that is causing the noise. Refer to the appropriate procedure: • <u>Power Steering Fluid Reservoir Inlet Hose Replacement (LFW, LFX)</u> • <u>Power Steering Fluid Reservoir Outlet Hose Replacement (LFW, LFX)</u> • <u>Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX, MX0)</u>, <u>Power Steering Gear Inlet Pipe/Hose Replacement (RHD)</u>, <u>Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX, MX7)</u> • <u>Power Steering Gear Outlet Pipe/Hose Replacement (RHD)</u>, <u>Power Steering Gear Outlet Pipe/Hose Replacement (AWD)</u>, <u>Power Steering Gear Outlet Pipe/Hose Replacement (LHD With LFW, LFX, RWD)</u>		

	Did you complete the repair?	Go to Step 19	-
12	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the repair?	Go to Step 19	-
13	Replace the power steering pump pulley. Refer to <u>Power Steering Pump Pulley Replacement (LFW, LFX)</u> . Did you complete the repair?	Go to Step 19	-
14	Install the power steering pump correctly. Refer to <u>Power Steering Pump Replacement (LFW, LFX)</u> . Did you complete the repair?	Go to Step 19	-
15	Install the power steering gear correctly. Refer to <u>Steering Gear Replacement (RHD)</u> , <u>Steering Gear Replacement (LHD With AWD)</u> , <u>Steering Gear Replacement (LHD With RWD)</u> . Did you complete the repair?	Go to Step 19	-
16	Replace either the worn inner tie rod or the worn outer tie rod. Refer to <u>Steering Linkage Inner Tie Rod Replacement (All Wheel Drive)</u> , <u>Steering Linkage Inner Tie Rod Replacement (Rear Wheel Drive)</u> , or to <u>Steering Linkage Outer Tie Rod Replacement (RWD)</u> , <u>Steering Linkage Outer Tie Rod Replacement (AWD)</u> . Did you complete the repair?	Go to Step 19	-
17	Replace the worn front suspension component. Did you complete the repair?	Go to Step 19	-
18	Replace the worn intermediate steering shaft that is causing the noise. Refer to the appropriate procedure: • <u>Upper Intermediate Steering Shaft Replacement</u> • <u>Intermediate Steering Shaft Replacement</u> • <u>Lower Intermediate Steering Shaft Replacement</u> 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

RATTLE, CLUNK, OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM (LSA)

Rattle, Clunk, or Shudder Noise from the Power Steering System (LSA)

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 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 proper routing and clearance. Is the routing or clearance of a power steering hose incorrect?	Go to Step 11	Go to Step 4
4	Inspect the engine drive belt for cracking or excessive wear. Refer to <u>Drive Belt Falls Off and Excessive Wear Diagnosis</u> . 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 <u>Power Steering Pump Replacement (LSA)</u> . Is the power steering pump installation incorrect?	Go to Step 14	Go to Step 7
7	Inspect the steering gear for the proper installation. Refer to <u>Steering Gear Replacement (RHD)</u> , <u>Steering Gear Replacement (LHD With RWD)</u> . Is the steering gear installation incorrect?	Go to Step 15	Go to Step 8
8	Inspect in the inner tie rods and the outer tie rods for looseness. Refer to <u>Steering Linkage Inner Tie Rod Inspection</u> , and to <u>Steering Linkage Outer Tie Rod Inspection</u> . Are the inner tie rods or the outer tie rods loose?	Go to Step 16	Go to Step 9
9	Inspect the front suspension. Refer to <u>Noise Diagnosis - Front Suspension</u> . Is the front suspension worn?	Go to Step 17	Go to Step 10
10	Inspect the intermediate steering shafts for wear. Are any of the intermediate steering shafts worn?	Go to Step 18	Go to Step 3
11	Adjust or replace the hose that is causing the noise. Refer to the appropriate procedure: • <u>Power Steering Fluid Reservoir Inlet Hose Replacement (LSA)</u> • <u>Power Steering Fluid Reservoir Outlet Hose Replacement (LSA)</u> • <u>Power Steering Gear Inlet Pipe/Hose Replacement (LSA)</u>, • <u>Power Steering Gear Outlet Pipe/Hose Replacement (RHD) Power Steering Gear Outlet Pipe/Hose Replacement (LSA)</u>		

	Did you complete the repair?	Go to Step 19	-
12	Replace the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> . Did you complete the repair?	Go to Step 19	-
13	Replace the power steering pump pulley. Refer to <u>Power Steering Pump Pulley Replacement (LSA)</u> . Did you complete the repair?	Go to Step 19	-
14	Install the power steering pump correctly. Refer to <u>Power Steering Pump Replacement (LSA)</u> . Did you complete the repair?	Go to Step 19	-
15	Install the power steering gear correctly. Refer to <u>Steering Gear Replacement (RHD)</u> , <u>Steering Gear Replacement (LHD With RWD)</u> . Did you complete the repair?	Go to Step 19	-
16	Replace either the worn inner tie rod or the worn outer tie rod. Refer to <u>Steering Linkage Inner Tie Rod Replacement (Rear Wheel Drive)</u> , or to <u>Steering Linkage Outer Tie Rod Replacement (RWD)</u> . Did you complete the repair?	Go to Step 19	-
17	Replace the worn front suspension component. Did you complete the repair?	Go to Step 19	-
18	Replace the worn intermediate steering shaft that is causing the noise. Refer to the appropriate procedure: • <u>Upper Intermediate Steering Shaft Replacement</u> • <u>Intermediate Steering Shaft Replacement</u> • <u>Lower Intermediate Steering Shaft Replacement</u> 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

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 <u>Symptoms - Power Steering System</u>
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 <u>Power Steering System Flushing</u>. Did you complete the procedure?	Go to Step 11	Go to Step 5
5	Using the J-39570 Chassis Ear , inspect the power 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 <u>Steering Gear Replacement (RHD)</u>, <u>Steering Gear Replacement (LHD With AWD)</u>, <u>Steering Gear Replacement (LHD With RWD)</u>. Did you complete the repair?	Go to Step 11	-
9	Replace the power steering pump. Refer to <u>Power Steering Pump Replacement (LSA)</u>, <u>Power Steering Pump Replacement (LFW, LFX)</u>. 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

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 Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Power Steering System</u>
	Verify that poor return of the steering wheel is		

2	present. Does the system operate normally?	System OK	Go to Step 3
3	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 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. Was the steering wheel abnormally difficult to rotate in either direction?	Go to Step 5	Go to Step 10
5	NOTE: 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 <u>Tire and Wheel Removal and Installation</u> . 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 too 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
10	Inspect the wheel alignment and adjust as necessary. Refer to <u>Wheel Alignment Measurement</u> . 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

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 <u>Symptoms - Power Steering System</u>
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 <u>Power Steering System Test</u> . 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

Steering Effort Hard in One or Both Directions

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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

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.

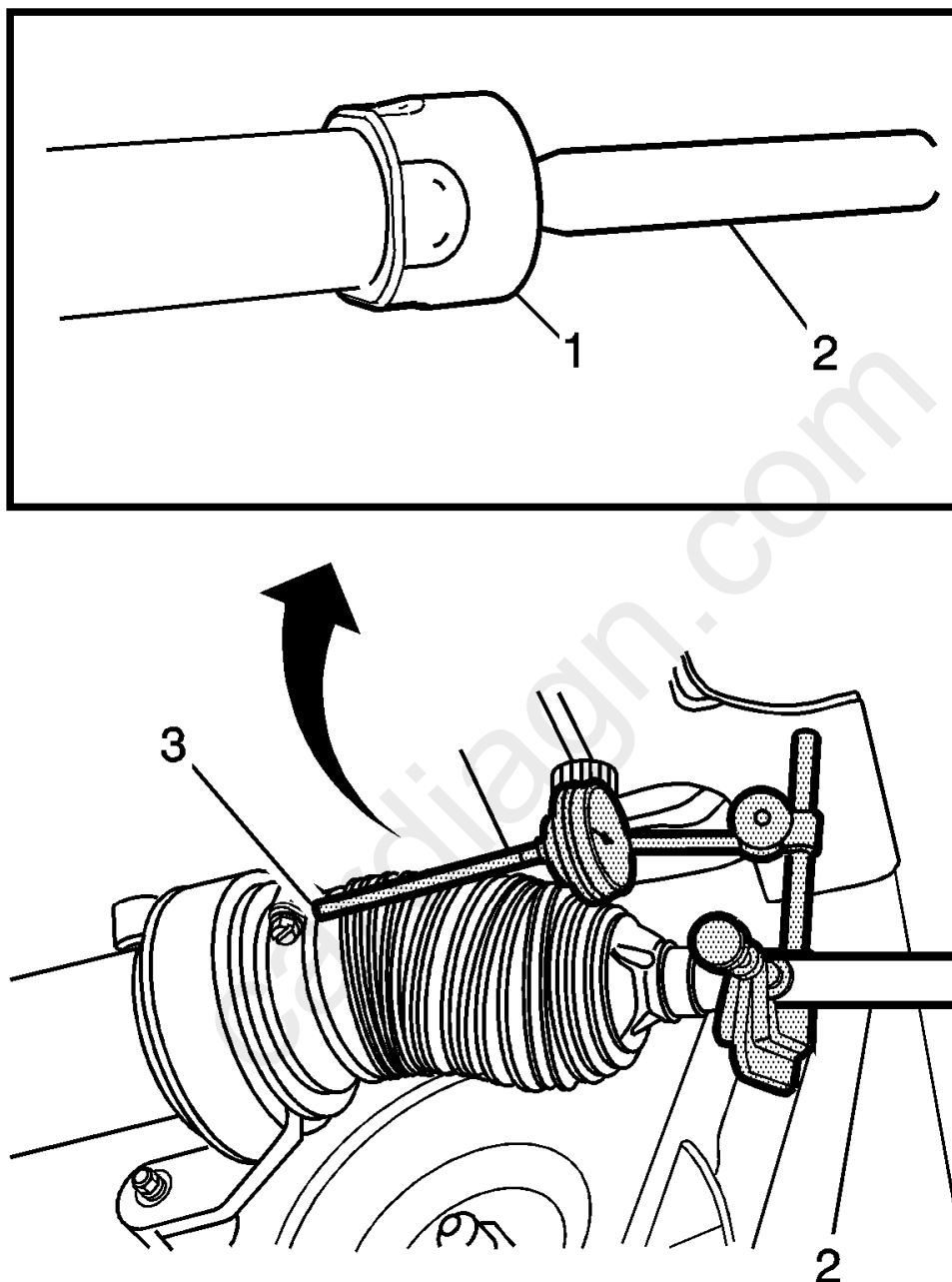


Fig. 3: Measuring Lash Between Inner Tie Rod & Steering Gear Housing
Courtesy of GENERAL MOTORS COMPANY

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

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

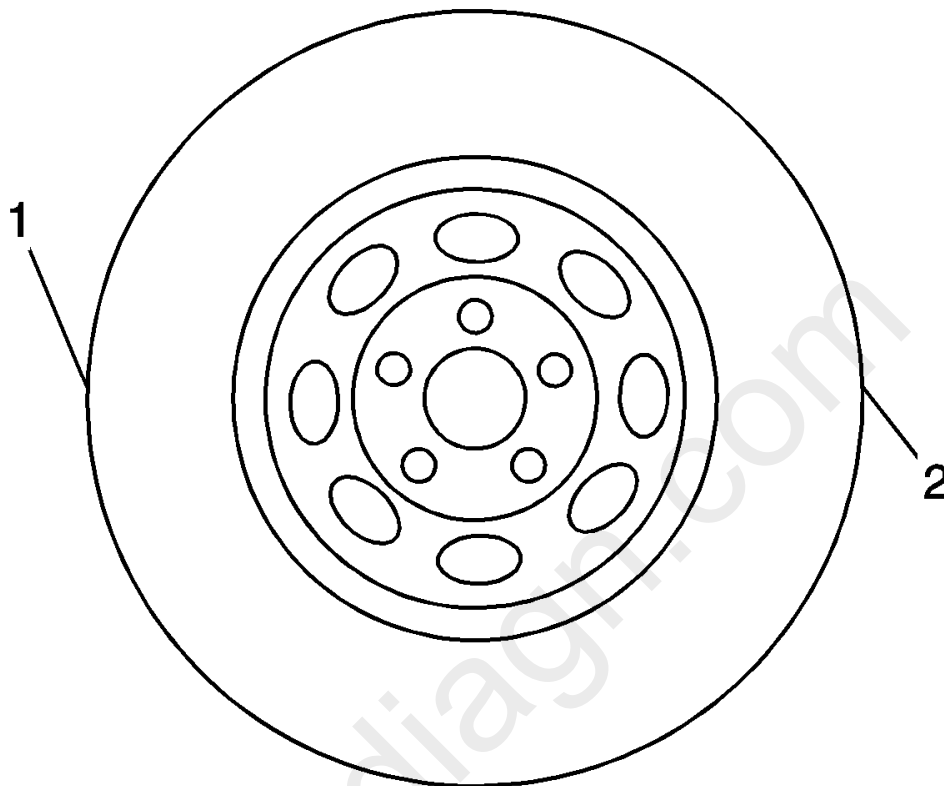


Fig. 4: Identifying Tire Grasping Positions
Courtesy of GENERAL MOTORS COMPANY

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 (All Wheel Drive)**, **Steering Linkage Inner Tie Rod Replacement (Rear Wheel Drive)**.
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 (RWD)**, **Steering Linkage Outer Tie Rod Replacement (AWD)**.
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**.

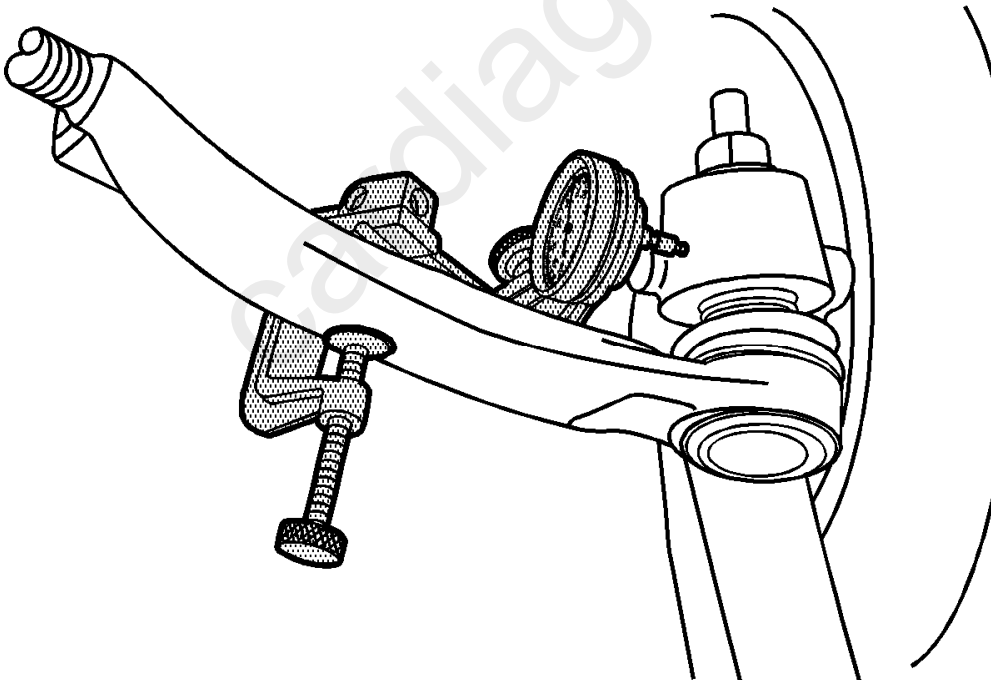


Fig. 5: Measuring Outer Tie Rod Lash
Courtesy of GENERAL MOTORS COMPANY

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.

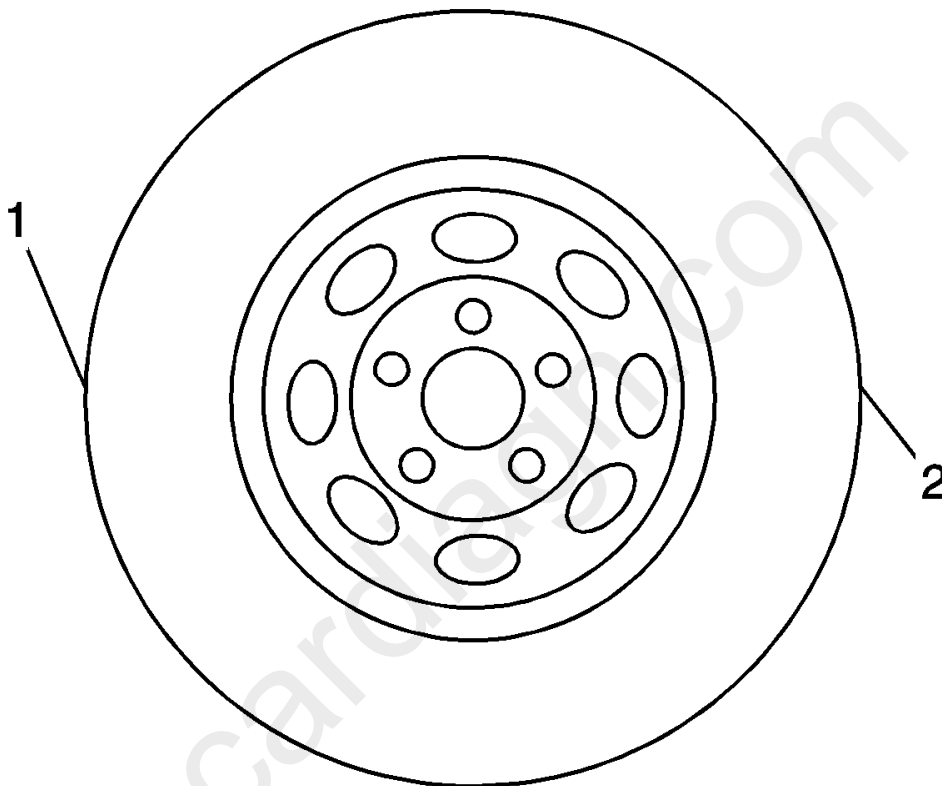


Fig. 6: Identifying Tire Grasping Positions
Courtesy of GENERAL MOTORS COMPANY

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 (RWD)**, **Steering Linkage Outer Tie Rod Replacement (AWD)**.
9. Repeat the procedure for the other side.

POWER STEERING SYSTEM BLEEDING

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.

1. Fill the power steering fluid reservoir with fluid to the minimum system level, the FULL COLD level, or the middle of the hash mark on the cap stick fluid level indicator, as applicable.
2. Raise the vehicle until the front wheels are off the ground. Refer to Lifting and Jacking the Vehicle.
3. With the key in the ON position and with the engine OFF, turn the steering wheel from stop to stop 12 times.

If the vehicle is equipped with longer length power steering hoses, turn the steering wheel from stop to stop 15 to 20 times.

4. Verify the power steering fluid level. Refer to Checking and Adding Power Steering Fluid.
5. Start the engine. Rotate the steering wheel from left to right. Inspect the power steering system for signs of cavitation or fluid aeration, like pump noise or whining.
6. Verify the fluid level. Repeat the bleed procedure, if necessary.
7. Lower the vehicle.

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**.
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 (LFW, LFX)

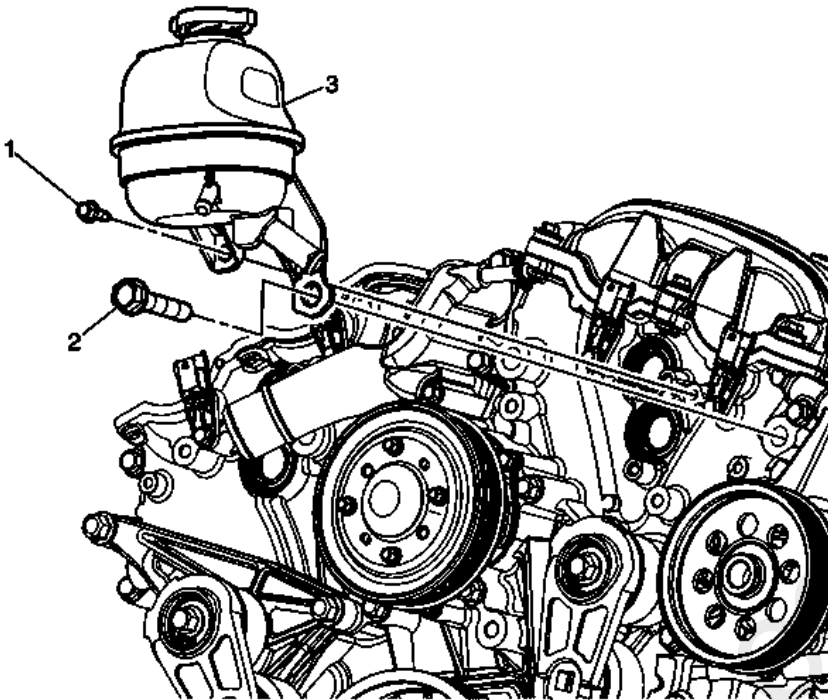


Fig. 7: Remote Power Steering Fluid Reservoir (LFW, LFX)
 Courtesy of GENERAL MOTORS COMPANY

Power Steering Fluid Reservoir Replacement (LFW, LFX)

Callout	Component Name
Preliminary Procedure 1. Remove the front air deflector. Refer to <u>Front Air Deflector Replacement</u> . 2. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (All Wheel Drive)</u> , <u>Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)</u> . 3. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 4. Place drain pans under the vehicle. 5. Remove as much power steering fluid from the reservoir as possible.	
1	Power Steering Fluid Reservoir Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
	Power Steering Fluid Reservoir Fastener TIP: If the vehicle is not equipped with a power brake booster auxiliary pump, this will be a

2	bolt. TIP: If the vehicle is equipped with a power brake booster auxiliary pump, this will be a nut on a stud. Tighten 40 N.m (30 lb ft)
3	Power Steering Fluid Reservoir Procedure 1. Disconnect the power steering fluid reservoir outlet hose. 2. Disconnect the power steering reservoir inlet hose. 3. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>. 4. Clean any excess power steering fluid from the vehicle.

POWER STEERING FLUID RESERVOIR REPLACEMENT (LSA)

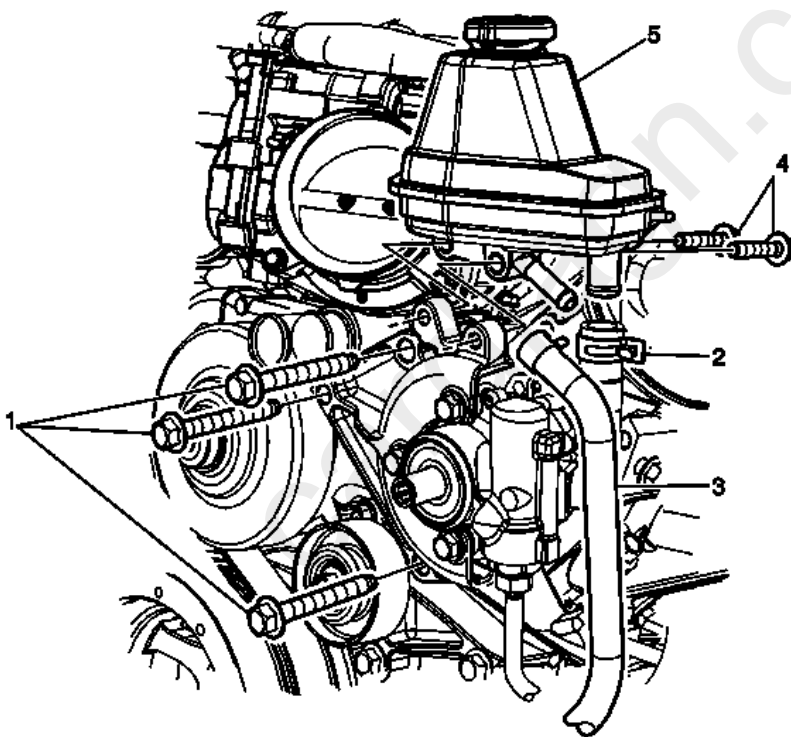


Fig. 8: Identifying Power Steering Fluid Reservoir (LSA)
 Courtesy of GENERAL MOTORS COMPANY

Power Steering Fluid Reservoir Replacement (LSA)

Callout	Component Name
Preliminary Procedures	
1.	Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> .

2. Remove the air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .
3. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
4. Siphon the fluid from the power steering fluid reservoir.
5. Place a drain pan under the vehicle.
6. Remove the power steering pulley. Refer to **Power Steering Pump Pulley Replacement (LSA)**.

1	Power Steering Pump Bracket Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Loosen the bolts as much as necessary in order to access the reservoir bolts. Tighten 22 N.m (17 lb ft)
2	Clamp (Qty: 2)
3	Power Steering Fluid Reservoir Inlet Hose
4	Power Steering Fluid Reservoir Bolt (Qty: 2) Tighten 25 N.m (18 lb ft)
5	Power Steering Fluid Reservoir Procedure Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>.

POWER STEERING PUMP PULLEY REPLACEMENT (LFW, LFX)

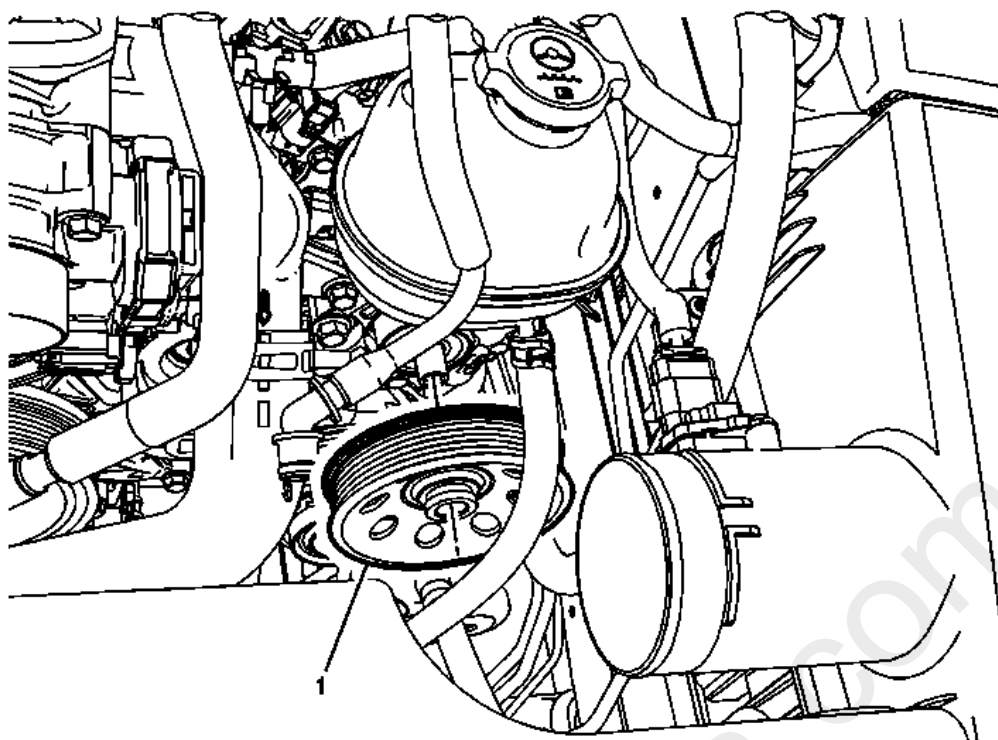


Fig. 9: Power Steering Pump Pulley (LFW, LFX)

Courtesy of GENERAL MOTORS COMPANY

Power Steering Pump Pulley Replacement (LFW, LFX)

Callout	Component Name
Preliminary Procedures 1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. If equipped, remove the power brake booster auxiliary pump. Refer to <u>Power Brake Booster Auxiliary Pump Replacement</u> . 3. Disconnect the drive belt from the power steering pump pulley only. Refer to <u>Drive Belt Replacement</u> .	
1	Power Steering Pump Pulley Procedure 1. Use the J-25034-C remover in order to remove the power steering pump pulley. 2. Use the J-25033-C installer in order to install the power steering pump pulley. 3. Ensure the axial tolerance of the power steering pulley on the power steering pump shaft is within 0.25 mm (0.010 in). Special Tools • J-25033-C Pulley Installer

- J-25034-C Pulley Remover

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

POWER STEERING PUMP PULLEY REPLACEMENT (LSA)

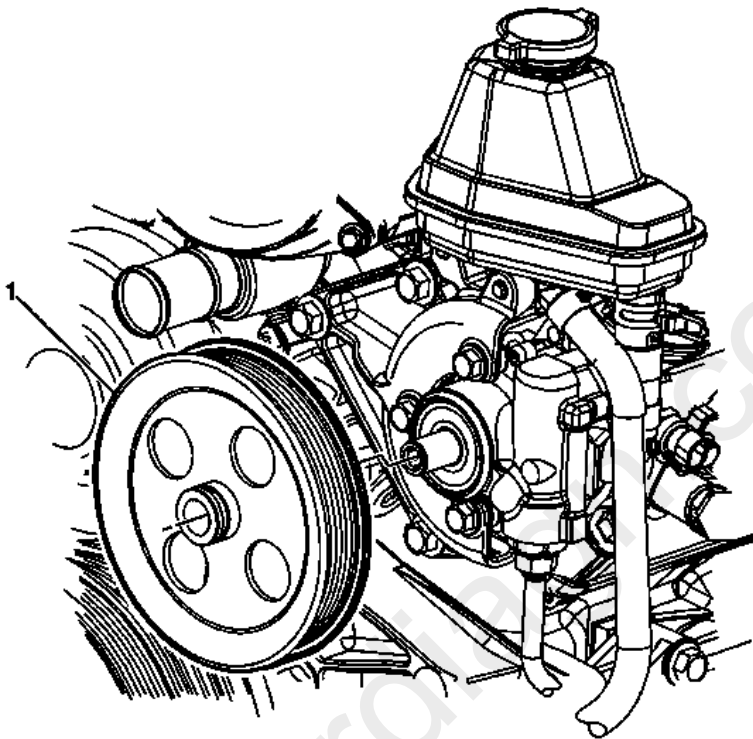


Fig. 10: Identifying Power Steering Pump Pulley (LSA)
Courtesy of GENERAL MOTORS COMPANY

Power Steering Pump Pulley Replacement (LSA)

Callout	Component Name
Preliminary Procedure	
1. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 2. Remove the air cleaner resonator outlet duct. Refer to <u>Air Cleaner Resonator Outlet Duct Replacement</u> . 3. Remove the power steering belt from the power steering pulley only. Refer to <u>Drive Belt Replacement - Accessory</u> .	
	Power Steering Pump Pulley
Procedure	
1. Use the J 25034-C Pulley Remover in order to remove the pulley.	

1

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 25033-C** Pulley Installer
- **J 25034-C** Pulley Remover

POWER STEERING PUMP REPLACEMENT (LFW, LFX)

Removal Procedure

1. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
2. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
3. Place drain pans under the vehicle.
4. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
5. Remove as much power steering fluid from the power steering fluid reservoir as possible.
6. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**.

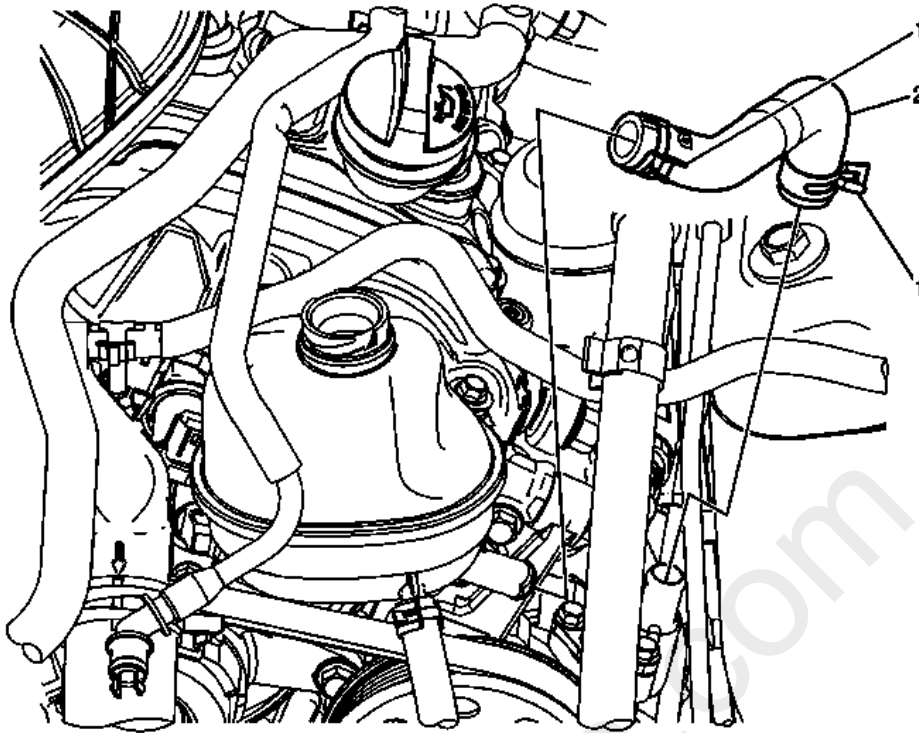


Fig. 11: Power Steering Fluid Reservoir Outlet Hose (V6)
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the hose clamp (1) and disconnect the power steering fluid reservoir outlet hose (2) from the power steering pump.
8. Disconnect the power steering gear inlet hose from the power steering pump. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX)**, **Power Steering Gear Inlet Pipe/Hose Replacement (RHD)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX)**.

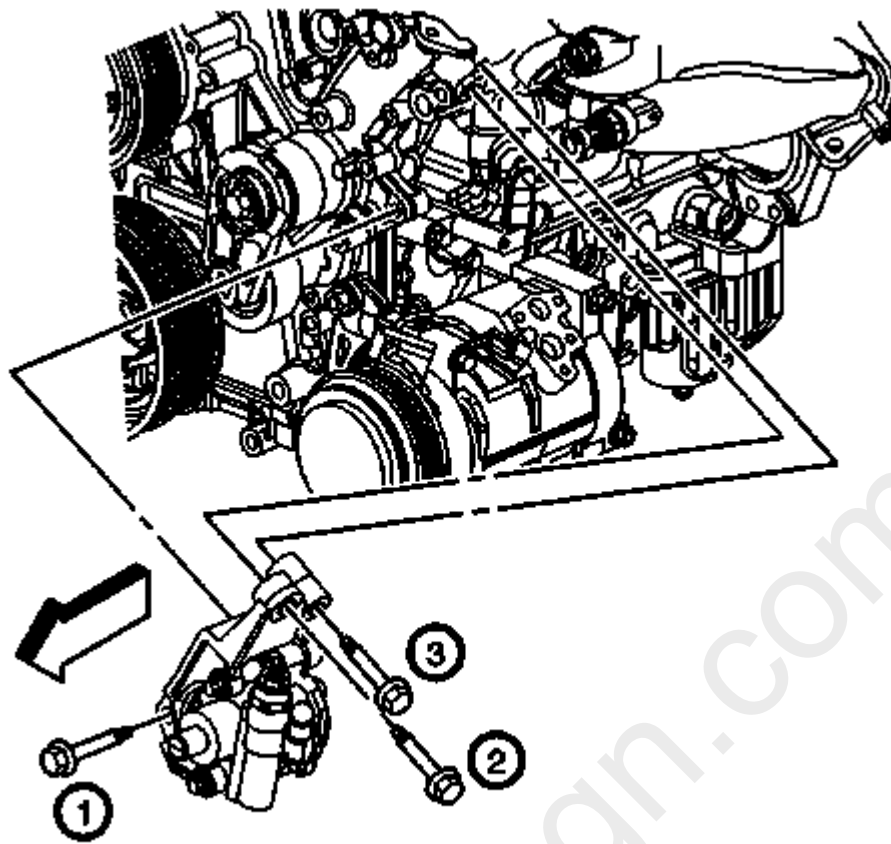


Fig. 12: View Of Power Steering Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the power steering pump bracket bolts (1, 2, 3).
10. Remove the power steering pump and the bracket as an assembly from the vehicle.
11. If necessary, transfer the power steering pump bracket. Refer to **Power Steering Pump Bracket Replacement**.

Installation Procedure

1. Position the power steering pump and the bracket in the vehicle.

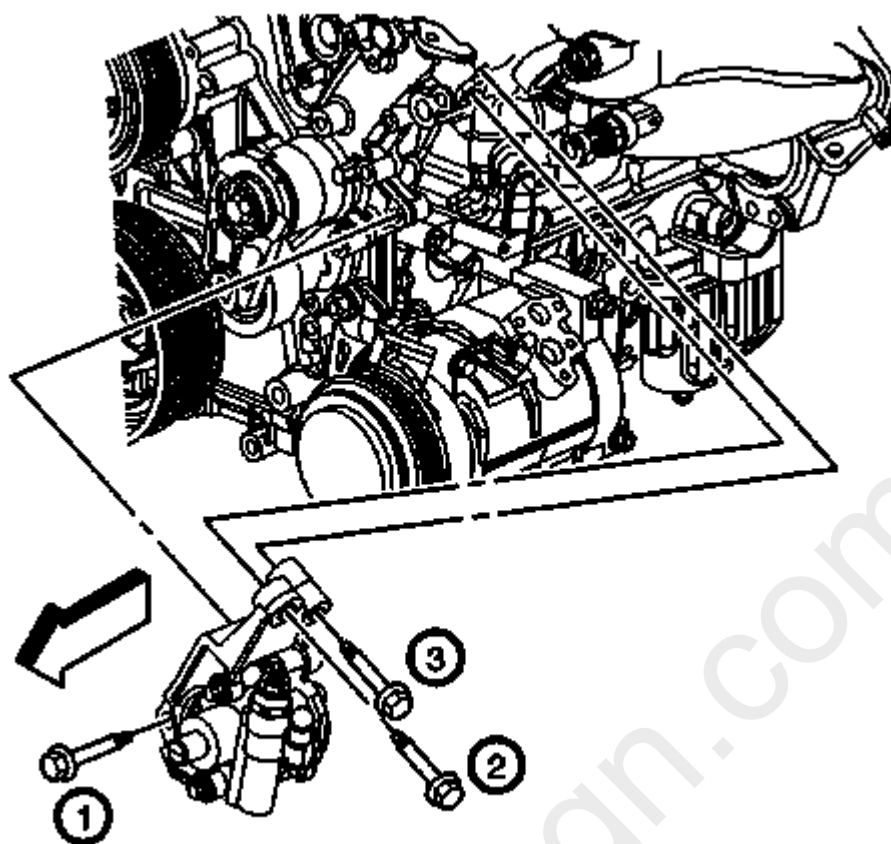


Fig. 13: View Of Power Steering Bracket Bolts
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Start all fasteners by hand before finalizing any torques.

2. Install the power steering pump bracket bolts (1, 2, 3).

CAUTION: Refer to Fastener Caution .

NOTE: Torque the power steering pump bolts in the sequence shown.

3. Tighten the power steering pump bracket bolts to 50 N.m (37 lb ft).
4. Connect the power steering gear inlet hose to the power steering pump. Refer to Power Steering Gear Inlet Pipe/Hose Replacement (LSA), Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX), Power Steering Gear Inlet Pipe/Hose Replacement (RHD), Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX).

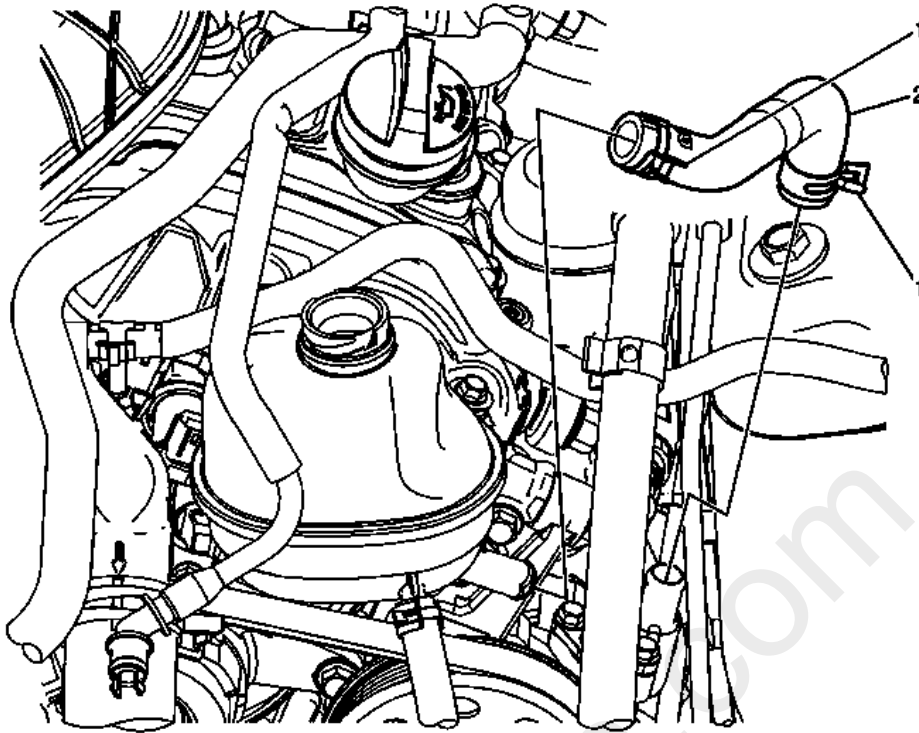


Fig. 14: Power Steering Fluid Reservoir Outlet Hose (V6)

Courtesy of GENERAL MOTORS COMPANY

5. Connect the power steering fluid reservoir outlet hose (2) to the power steering pump. Secure the hose with the clamp (1).
6. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**.
7. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
8. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Clean any excess fluid from the vehicle.
10. Remove the drain pans.
11. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
12. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

POWER STEERING PUMP REPLACEMENT (LSA)

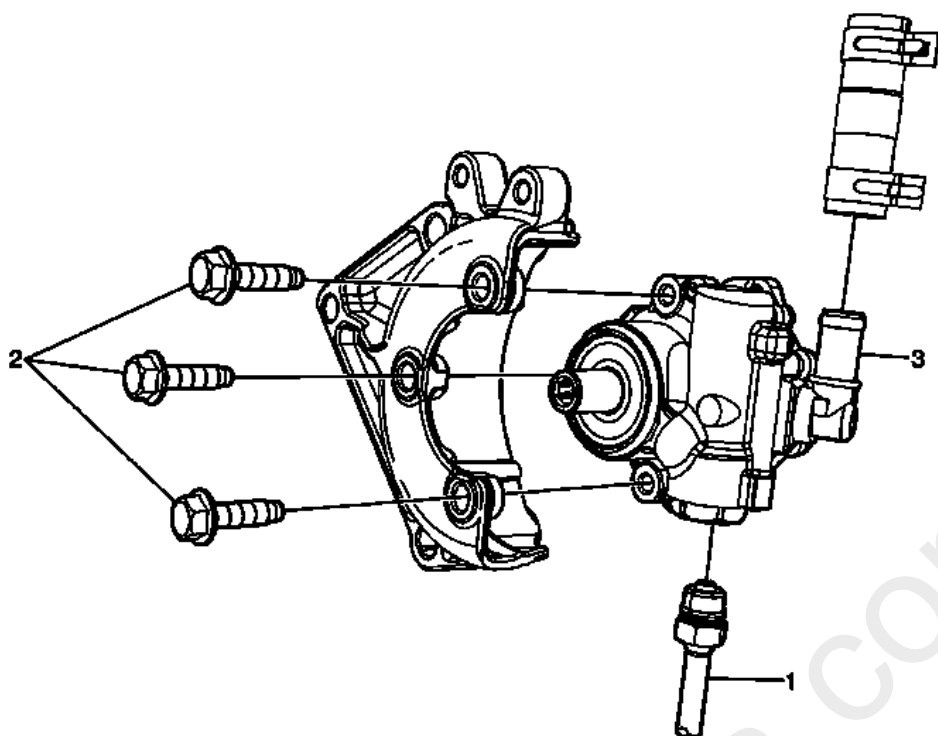


Fig. 15: Identifying Power Steering Pump (LSA)
 Courtesy of GENERAL MOTORS COMPANY

Power Steering Pump Replacement (LSA)

Callout	Component Name
Preliminary Procedures 1. Remove the power steering pump pulley. Refer to <u>Power Steering Pump Pulley Replacement (LSA)</u>. 2. Place a drain pan under the vehicle. 3. Remove the remote power steering fluid reservoir. Refer to <u>Power Steering Fluid Reservoir Replacement (LSA)</u>.	
1	Power Steering Gear Inlet Hose Fitting CAUTION: Refer to <u>Fastener Caution</u> . Tighten 38 N.m (28 lb ft)
2	Power Steering Pump Bolt (Qty: 3) Tighten 25 N.m 18 lb ft
	Power Steering Pump

	Procedure
3	1. Loosen the hose clamp and transfer the power steering fluid reservoir outlet hose to the new pump. 2. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>.

POWER STEERING PUMP BRACKET REPLACEMENT

Removal Procedure

1. Remove the power steering pump. Refer to **Power Steering Pump Replacement (LSA)**, **Power Steering Pump Replacement (LFW, LFX)**.

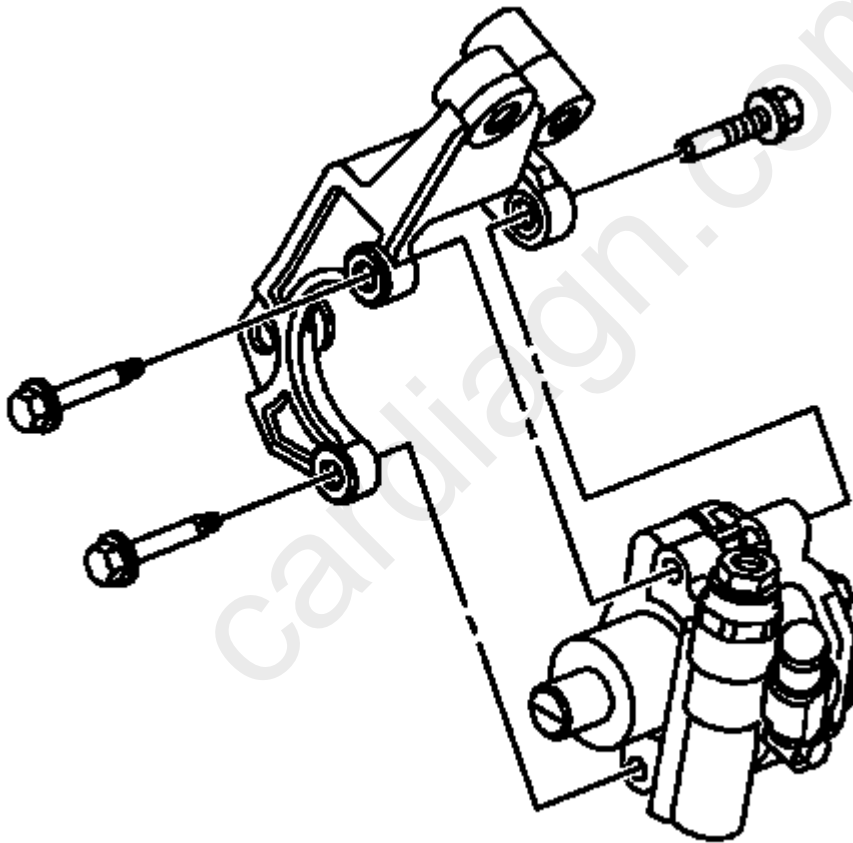


Fig. 16: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Remove the power steering pump bolts.
3. Separate the power steering pump from the power steering pump bracket.

Installation Procedure

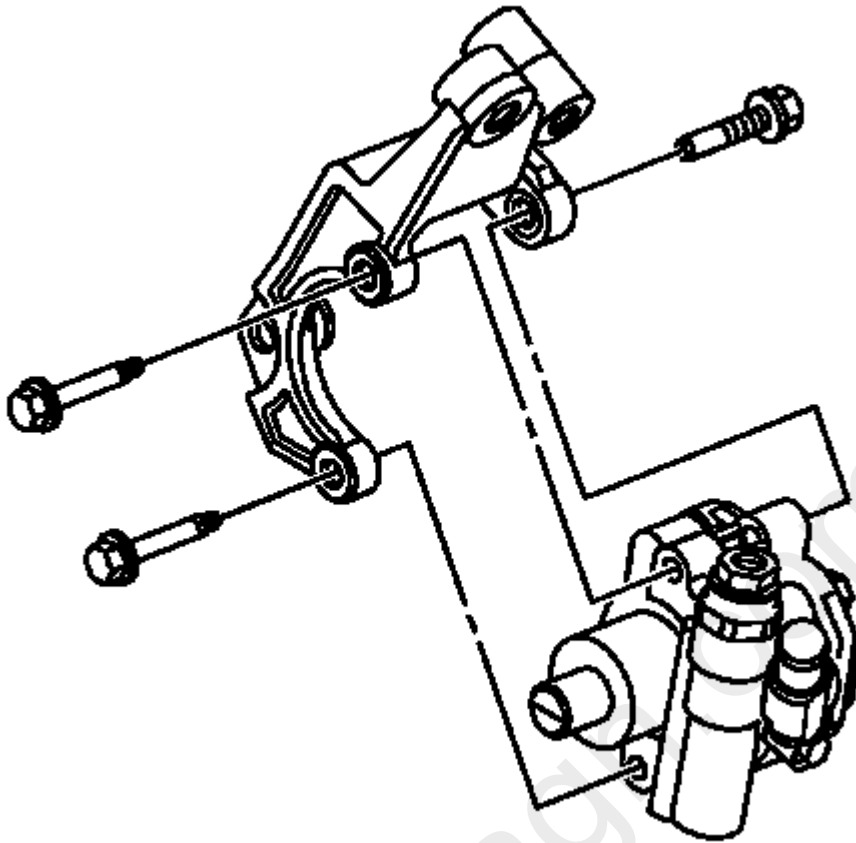


Fig. 17: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Align the power steering pump to the power steering pump bracket.

CAUTION: Refer to Fastener Caution .

2. Install the power steering pump bolts.

Tighten

Tighten the bolts to 25 N.m (18 lb ft).

3. Install the power steering pump. Refer to **Power Steering Pump Replacement (LSA)**, **Power Steering Pump Replacement (LFW, LFX)**.

STEERING LINKAGE OUTER TIE ROD REPLACEMENT (AWD)

Special Tools

J-24319-B Steering Linkage and Tie Rod Puller

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

Removal Procedure

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

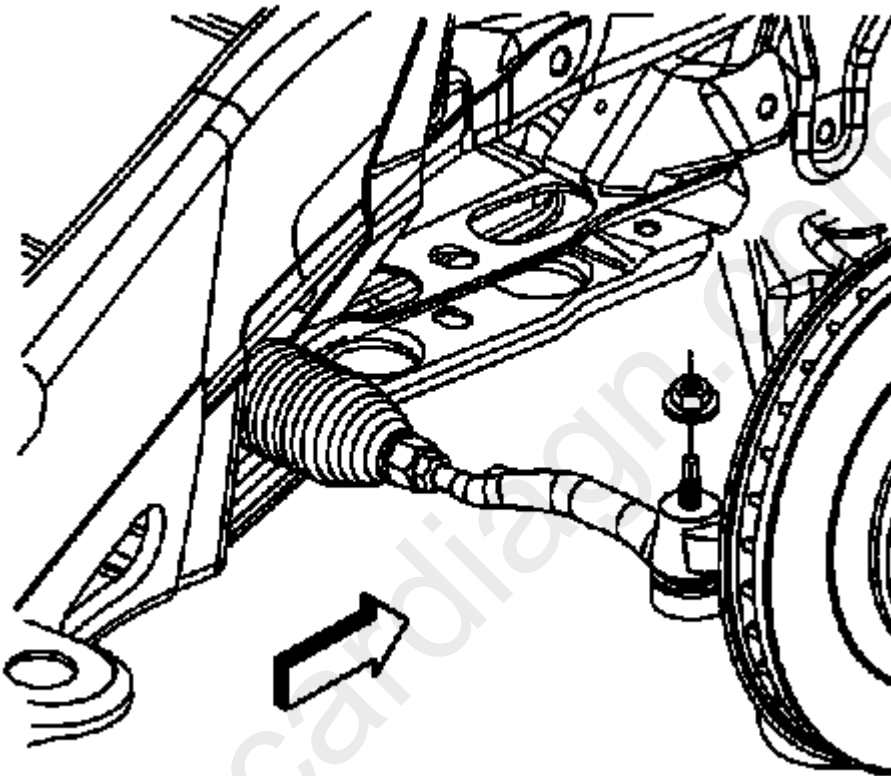


Fig. 18: View Of Tie Rod Retaining Nut
Courtesy of GENERAL MOTORS COMPANY

2. Remove the steering linkage outer tie rod nut.

Discard the nut.

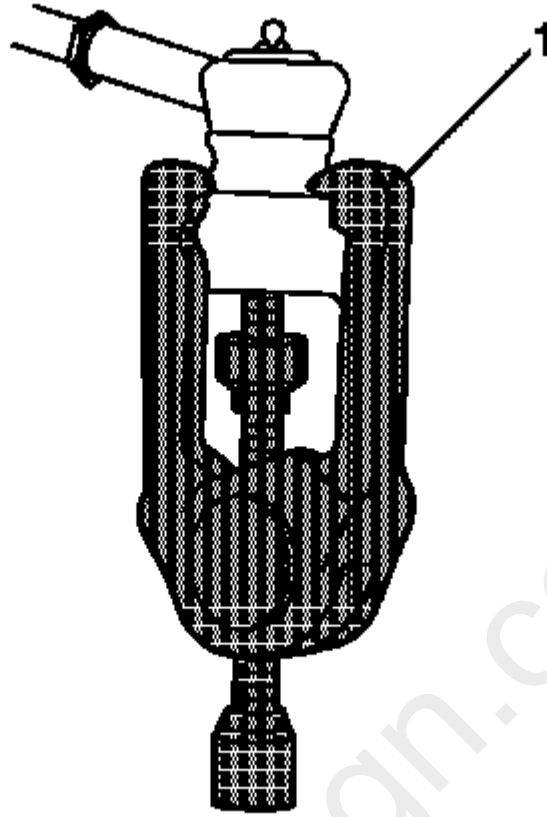


Fig. 19: Removing Outer Tie Rod Assembly From Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the steering linkage outer tie rod from the steering knuckle using the **J-24319-B** Puller.

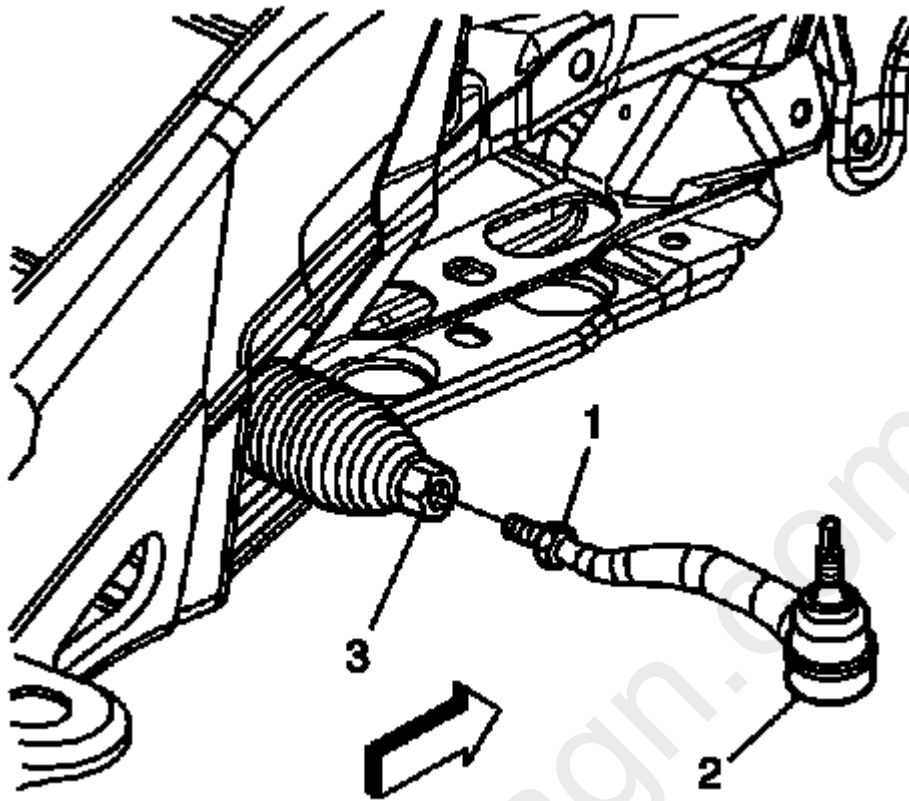


Fig. 20: View Of Outer Tie Rod, Inner Tie Rod & Jam Nut
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the steering linkage inner tie rod nut (1).

NOTE: **Note the number of complete turns necessary in order to remove the steering linkage outer tie rod (2).**

5. Remove the steering linkage outer tie rod from the steering linkage inner tie rod (3).
6. Remove the steering linkage inner tie rod nut from the steering linkage outer tie rod.

Discard the nut.

Installation Procedure

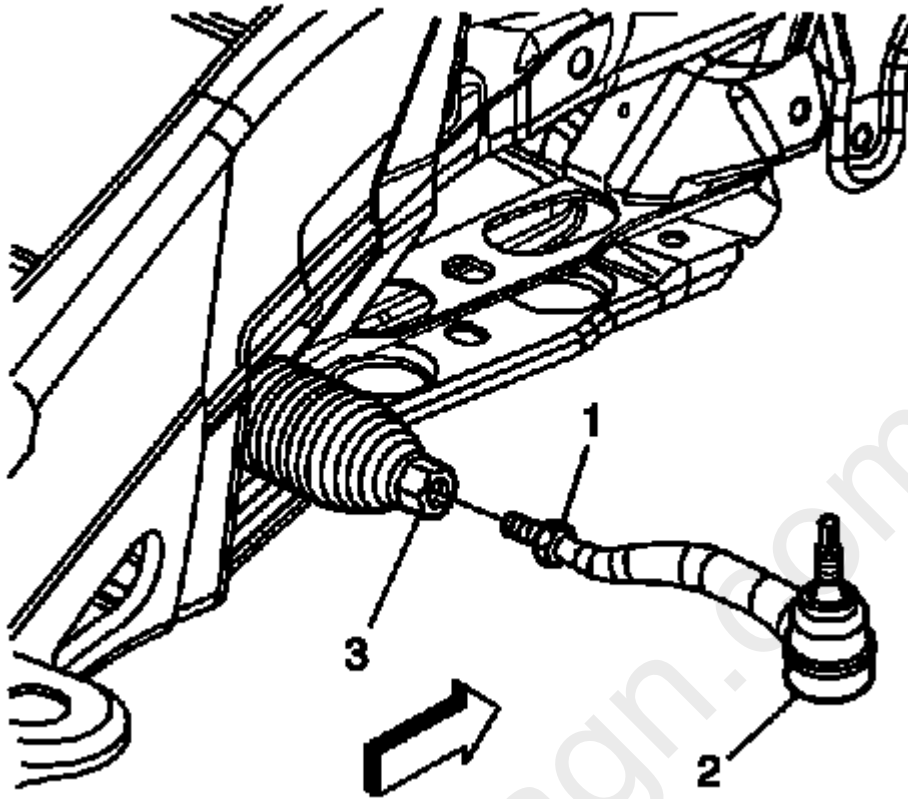


Fig. 21: View Of Outer Tie Rod, Inner Tie Rod & Jam Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW steering linkage inner tie rod nut (1) to the steering linkage outer tie rod (2).

NOTE: Install the steering linkage outer tie rod the same number of complete turns as noted in the removal.

2. Install the steering linkage outer tie rod to the steering linkage inner tie rod (3).

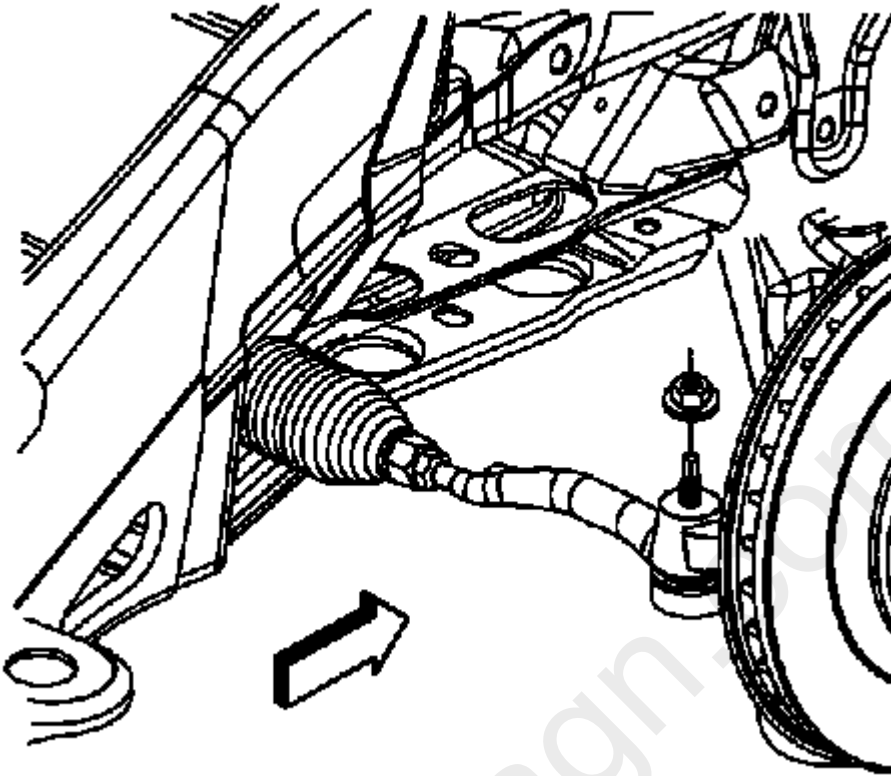


Fig. 22: View Of Tie Rod Retaining Nut
Courtesy of GENERAL MOTORS COMPANY

3. Install the steering linkage outer tie rod to the steering knuckle.

CAUTION: Refer to Fastener Caution .

4. Install a NEW steering linkage outer tie rod nut and tighten to 35 N.m (26 lb ft).
5. Tighten the steering linkage outer tie rod nut an additional 110 degrees.
6. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
7. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .
8. Tighten the steering linkage inner tie rod nut to 65 N.m (48 lb ft).

STEERING LINKAGE OUTER TIE ROD REPLACEMENT (RWD)

Special Tools

J-24319-B Steering Linkage and Tie Rod Puller

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

Removal Procedure

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

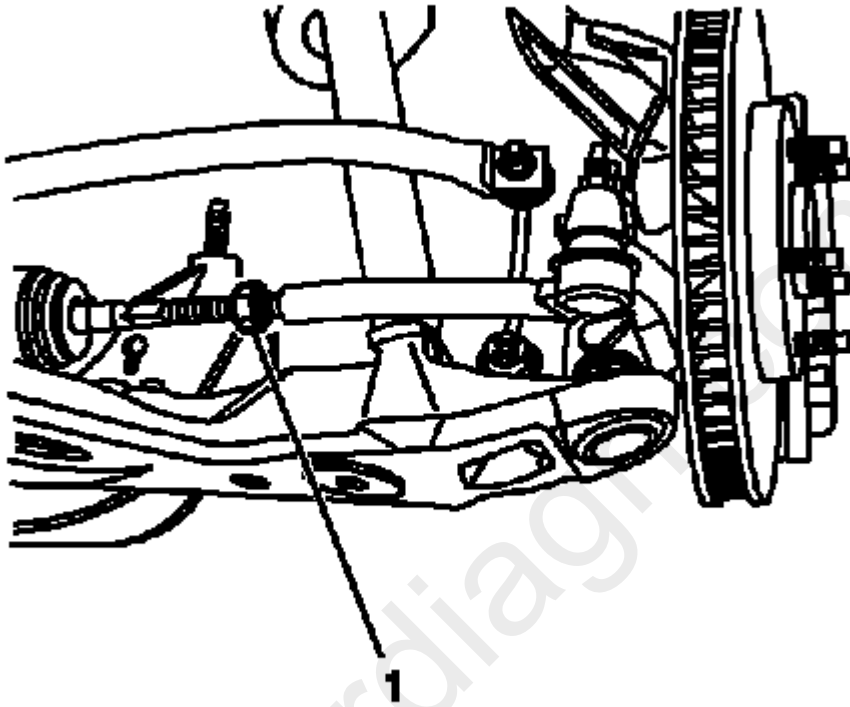


Fig. 23: View Of Outer Tie Rod Jam Nut
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the steering linkage inner tie rod nut (1).

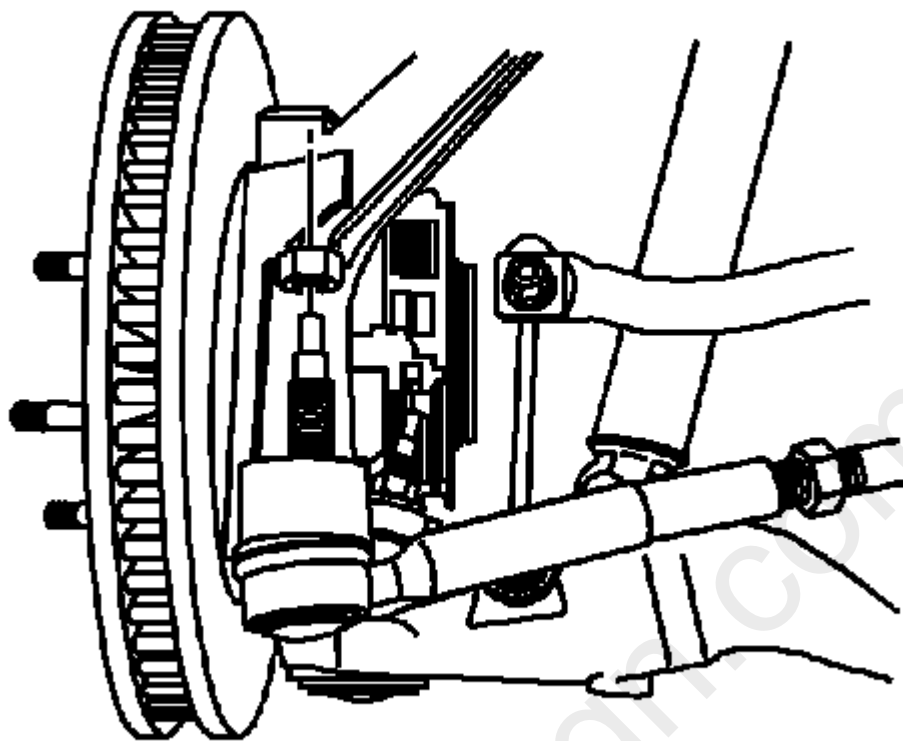


Fig. 24: View Of Outer Tie Rod-To-Steering Knuckle And Retaining Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove the steering linkage outer tie rod nut.

Discard the nut.

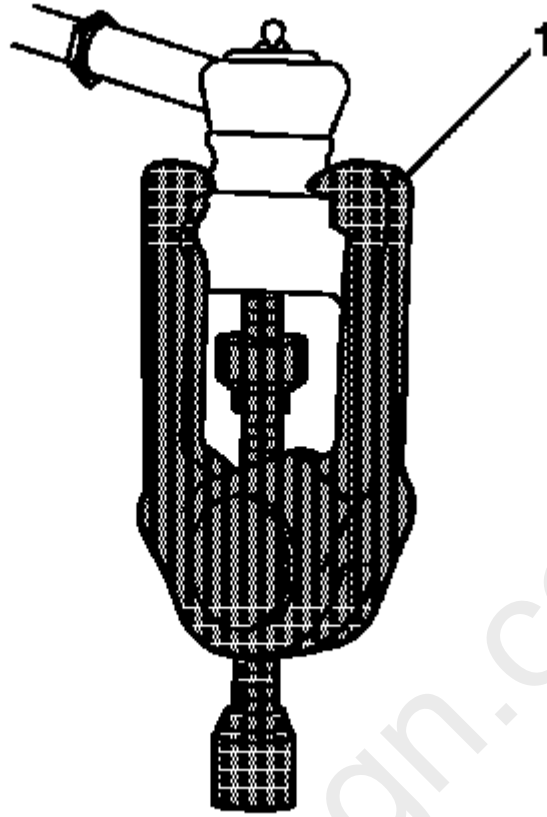


Fig. 25: Removing Outer Tie Rod Assembly From Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the steering linkage outer tie rod from the steering knuckle using the **J-24319-B** Puller.

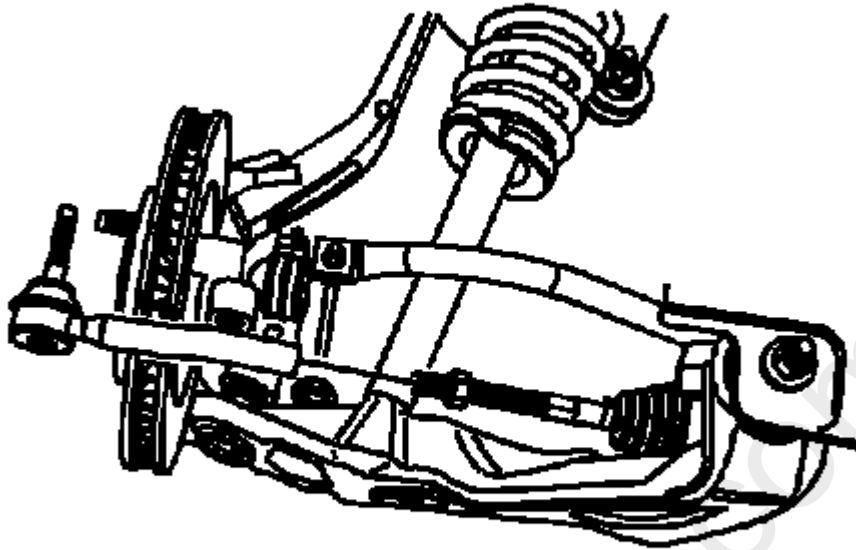


Fig. 26: View Of Outer Tie Rod & Inner Tie Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number of complete turns necessary in order to remove the steering linkage outer tie rod.

5. Remove the steering linkage outer tie rod from the steering linkage inner tie rod.

Installation Procedure

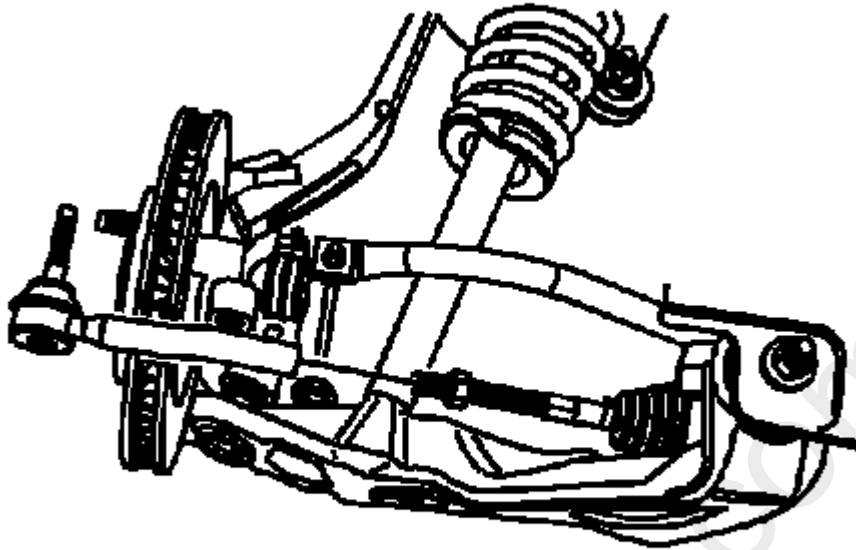


Fig. 27: View Of Outer Tie Rod & Inner Tie Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the steering linkage outer tie rod the same number of complete turns as noted in the removal.

1. Install the steering linkage outer tie rod to the steering linkage inner tie rod.

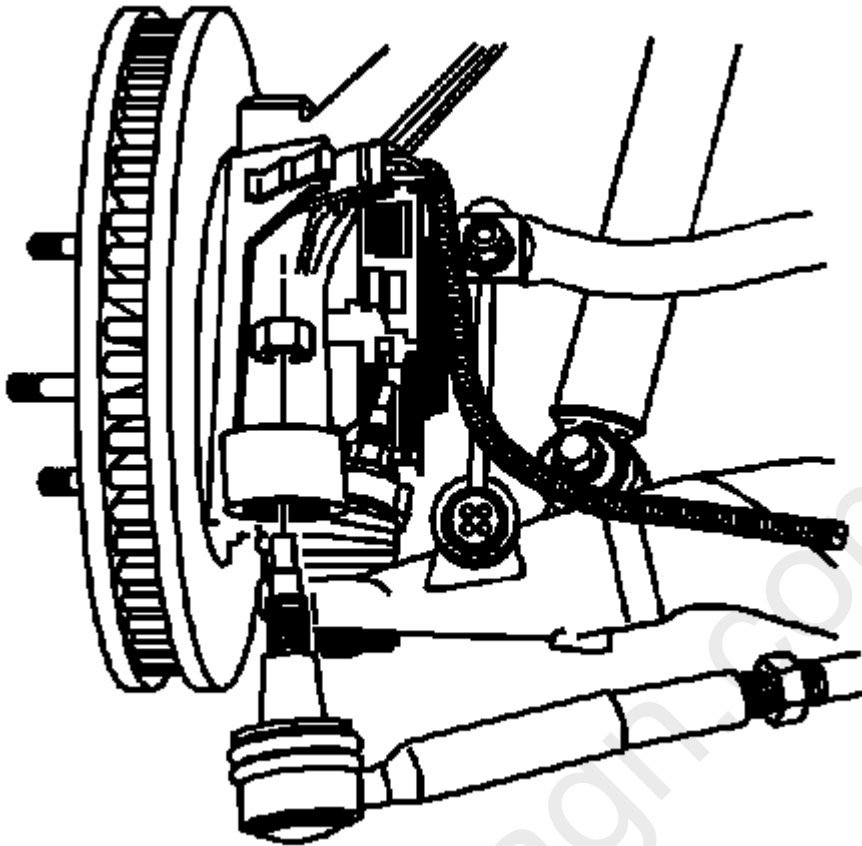


Fig. 28: View Of Outer Tie Rod & Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

2. Install the steering linkage outer tie rod to the steering knuckle.

CAUTION: Refer to Fastener Caution .

3. Install a NEW steering linkage outer tie rod nut and tighten to 35 N.m (26 lb ft).
4. Tighten the steering linkage outer tie rod nut an additional 110 degrees.
5. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
6. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .
7. Tighten the steering linkage inner tie rod nut to 65 N.m (48 lb ft).

STEERING GEAR BOOT REPLACEMENT (RWD)

Removal Procedure

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

(RWD).

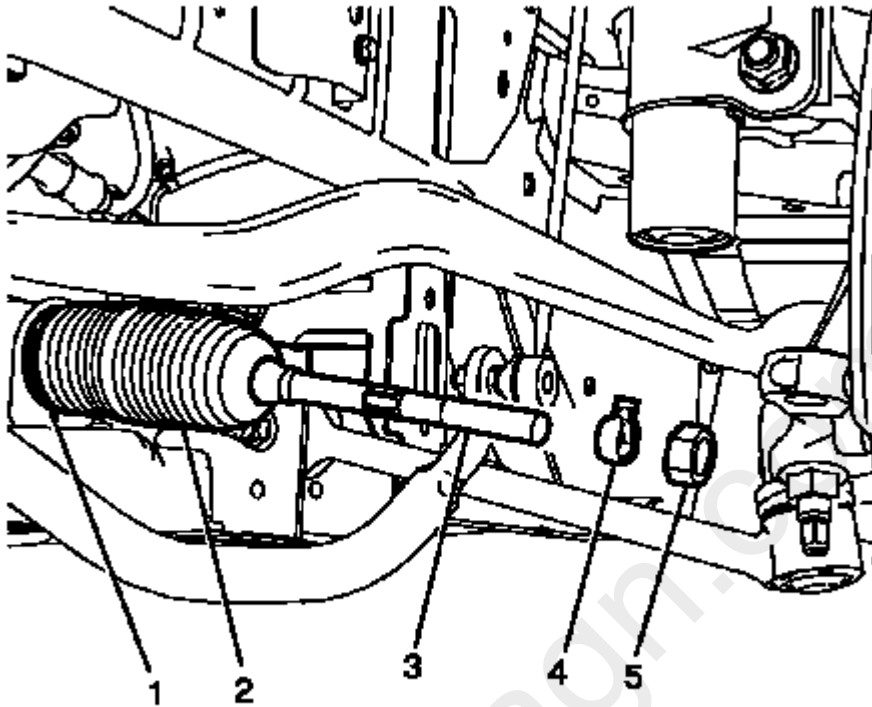


Fig. 29: View Of Tie Rod & End Lock Nut
Courtesy of GENERAL MOTORS COMPANY

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.

Discard the clamp.

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

Installation Procedure

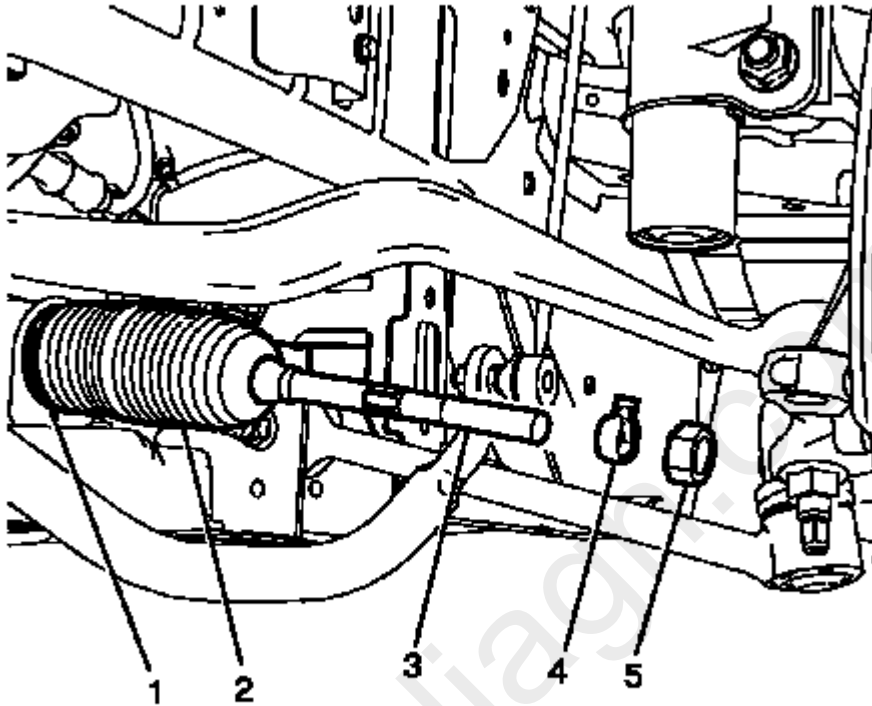


Fig. 30: View Of Tie Rod & End Lock Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install the boot (2) to the inner tie rod (3).
2. Install the NEW inner boot clamp (1).
3. 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.

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

STEERING GEAR BOOT REPLACEMENT (AWD)

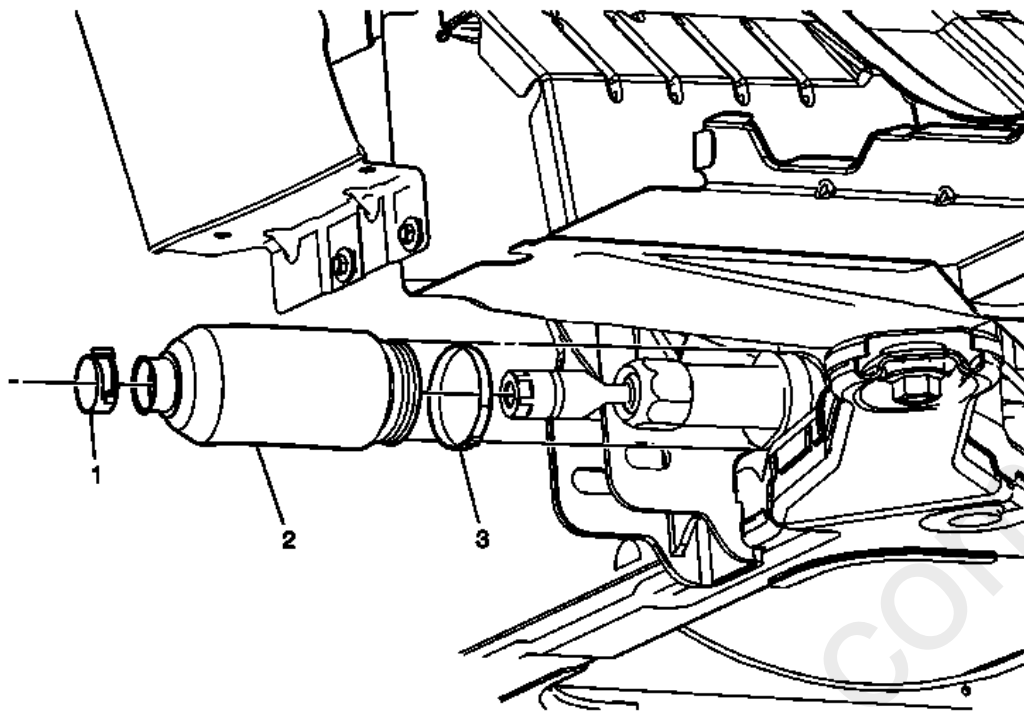


Fig. 31: Steering Gear Boot (All Wheel Drive)
 Courtesy of GENERAL MOTORS COMPANY

Steering Gear Boot Replacement (AWD)

Callout	Component Name
Preliminary Procedure	
Remove the outer tie rod. Refer to <u>Steering Linkage Outer Tie Rod Replacement (AWD)</u> .	
1	Outer Boot Clamp
2	Steering Gear Boot
3	Inner Boot Clamp

POWER STEERING COOLER PIPE/HOSE REPLACEMENT (LHD WITH LFW, LFX)

Removal Procedure

1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .
2. Remove as much power steering fluid from the power steering fluid reservoir as possible.
3. Remove the front air deflector. Refer to Front Air Deflector Replacement .
4. Remove the front compartment lower noise shield. Refer to Front Compartment Lower Noise Shield Replacement (All Wheel Drive) , Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive) .
5. Place drain pans under the vehicle as necessary.

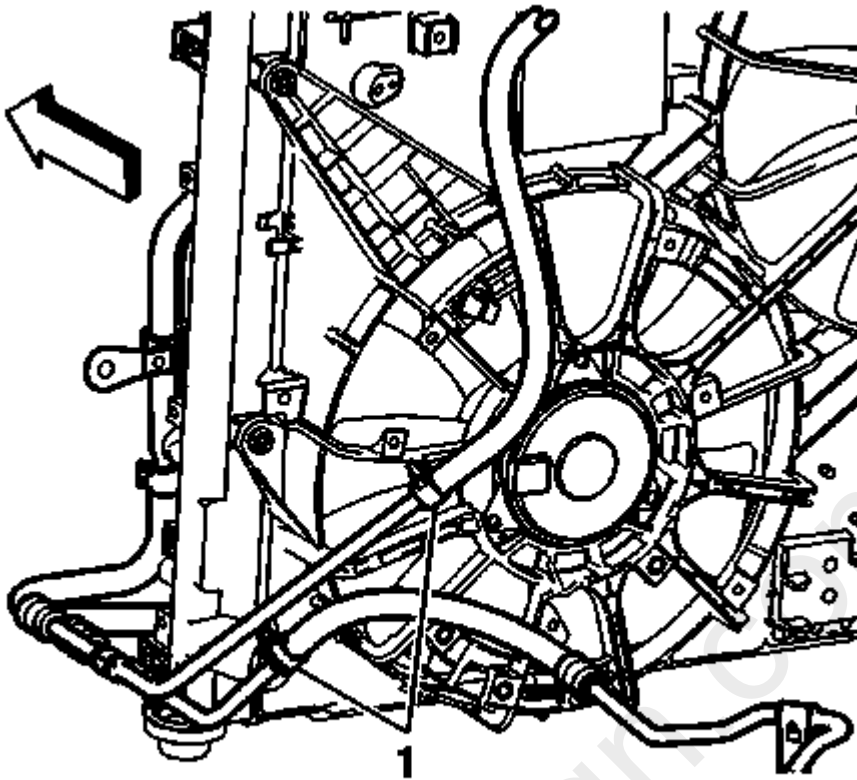


Fig. 32: Identifying Power Steering Hoses
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the hose clamps (1) and disconnect the power steering fluid reservoir inlet hose and the power steering gear outlet hose from the power steering cooler hose.

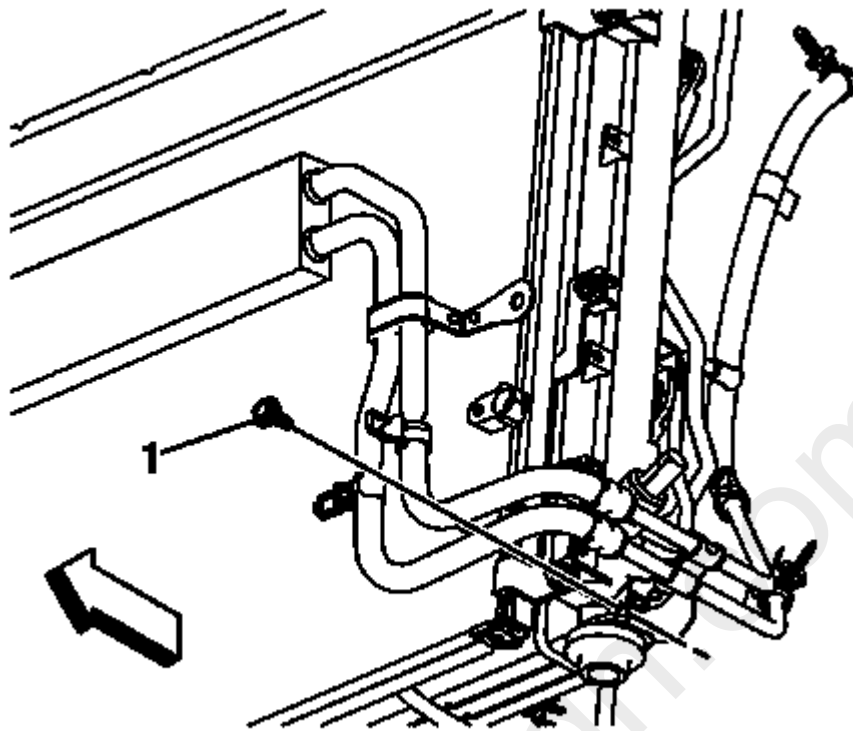


Fig. 33: Identifying Power Steering Fluid Cooler Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power steering fluid cooler bracket bolt (1).

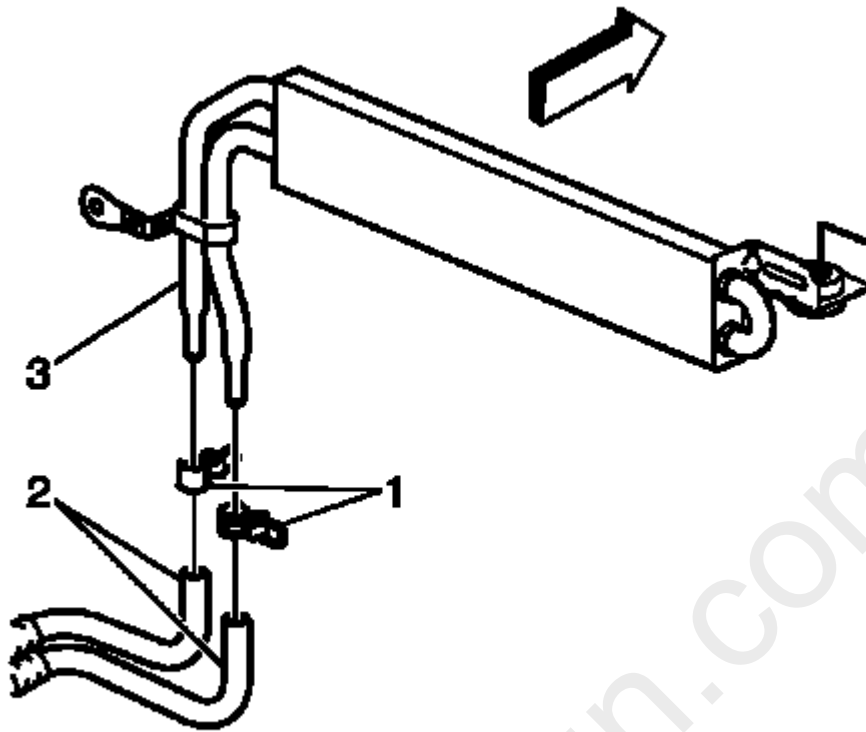


Fig. 34: Identifying Power Steering Cooler Hose Clamps & Hoses
Courtesy of GENERAL MOTORS COMPANY

8. Loosen the hose clamps (1) and disconnect the power steering cooler hoses (2) from the power steering fluid cooler (3).
9. Remove the power steering cooler hose from the vehicle.

Installation Procedure

1. Position the power steering cooler hose in the vehicle.

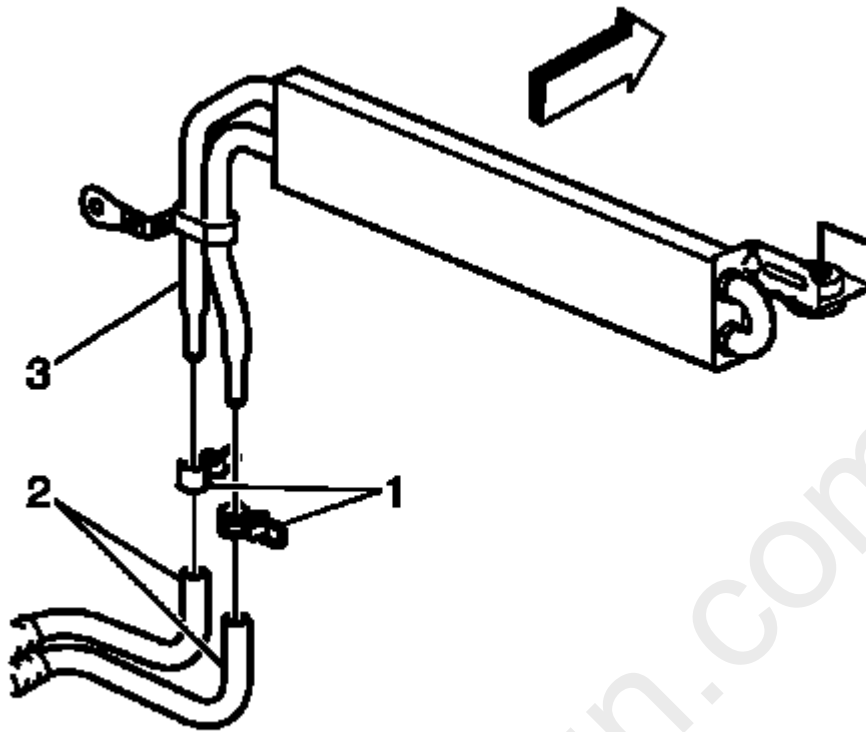


Fig. 35: Identifying Power Steering Cooler Hose Clamps & Hoses
Courtesy of GENERAL MOTORS COMPANY

2. Connect the power steering cooler hoses (2) to the power steering fluid cooler (3). Secure the hoses with the clamps (1)

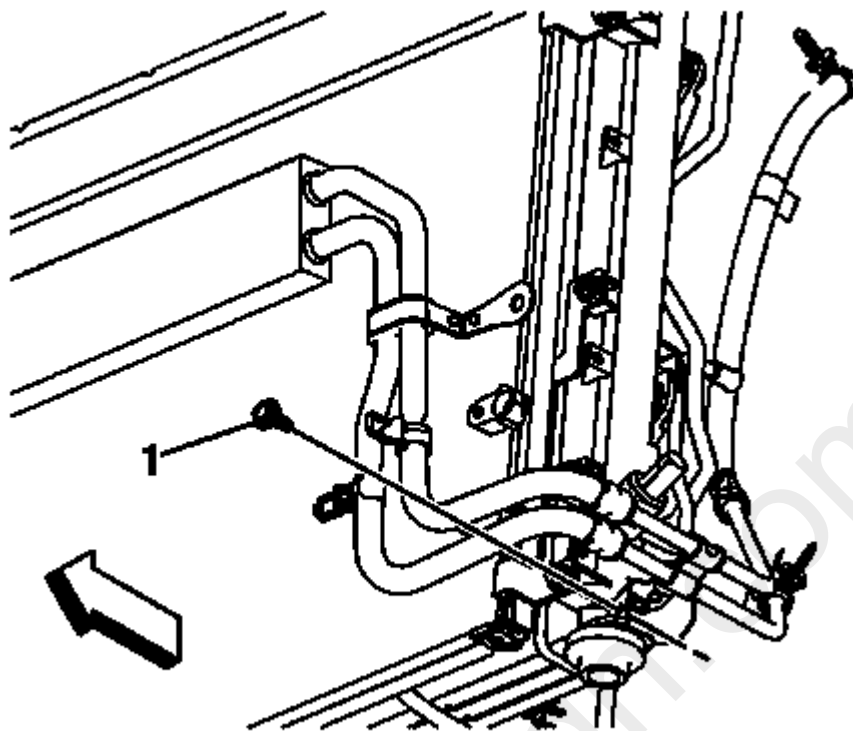


Fig. 36: Identifying Power Steering Fluid Cooler Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the power steering fluid cooler bracket bolt (1) and tighten to 10 N.m (89 lb in).

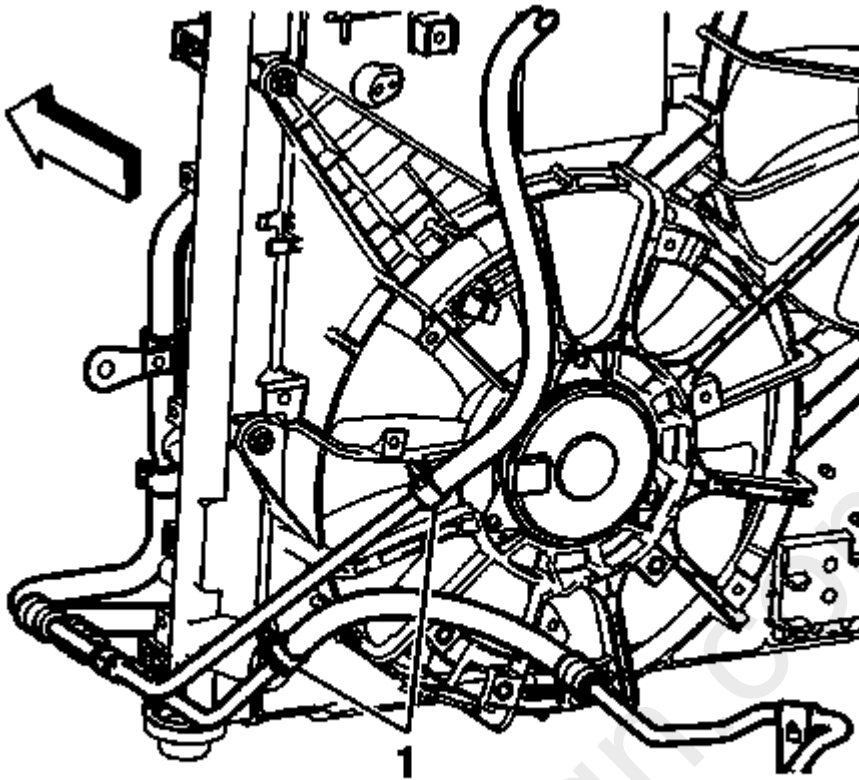


Fig. 37: Identifying Power Steering Hoses
Courtesy of GENERAL MOTORS COMPANY

4. Connect the power steering fluid reservoir inlet hose and the power steering gear outlet hose to the power steering cooler hose. Secure the hoses with the clamps (1).
5. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
6. Clean any excess power steering fluid from the vehicle.
7. Remove the drain pans.
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
9. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
10. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

POWER STEERING COOLER PIPE/HOSE REPLACEMENT (RHD)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove as much power steering fluid from the power steering fluid reservoir as possible.

3. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
4. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
5. Place drain pans under the vehicle as necessary.

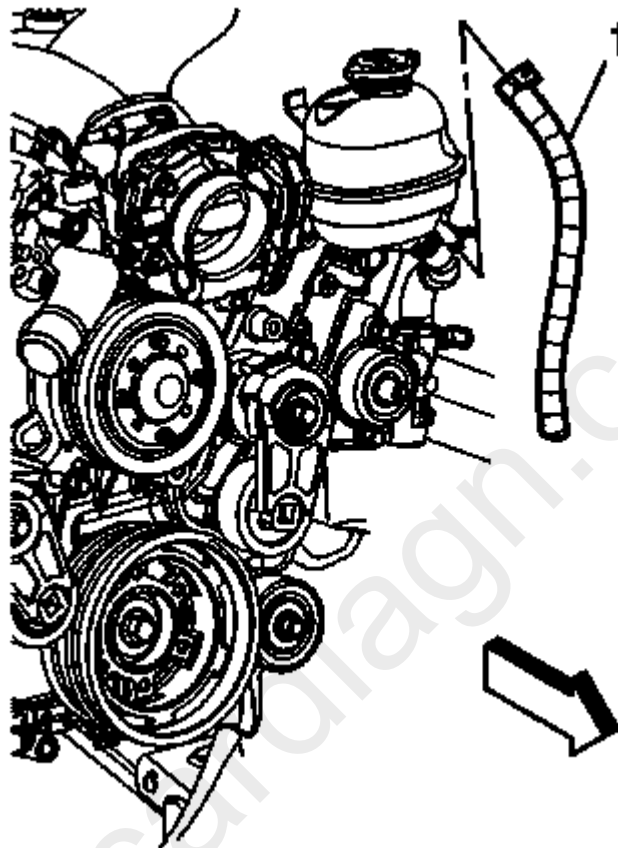


Fig. 38: Identifying Power Steering Cooler Hose
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the hose clamp and disconnect the power steering cooler hose (1) from the power steering fluid reservoir.

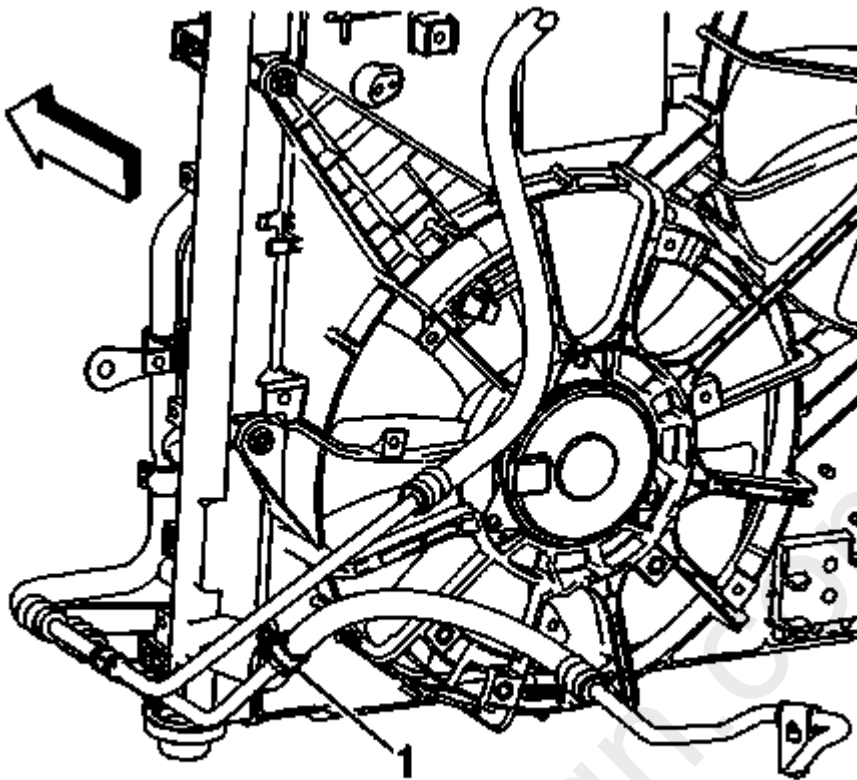


Fig. 39: Identifying Power Steering Gear Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the hose clamp (1) and disconnect the power steering gear outlet hose from the power steering cooler hose.

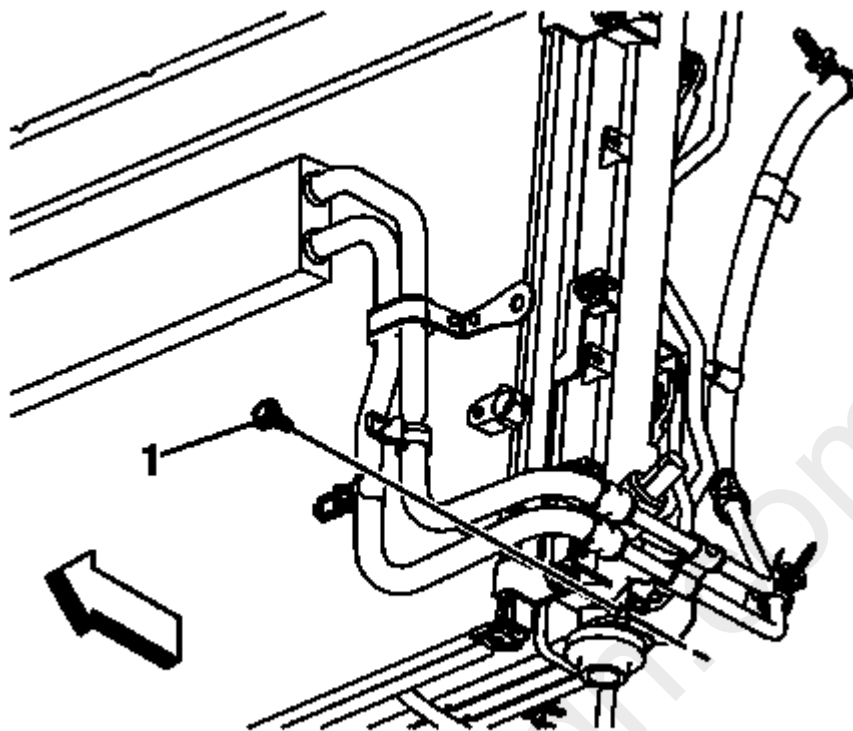


Fig. 40: Identifying Power Steering Fluid Cooler Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power steering fluid cooler bracket bolt (1).

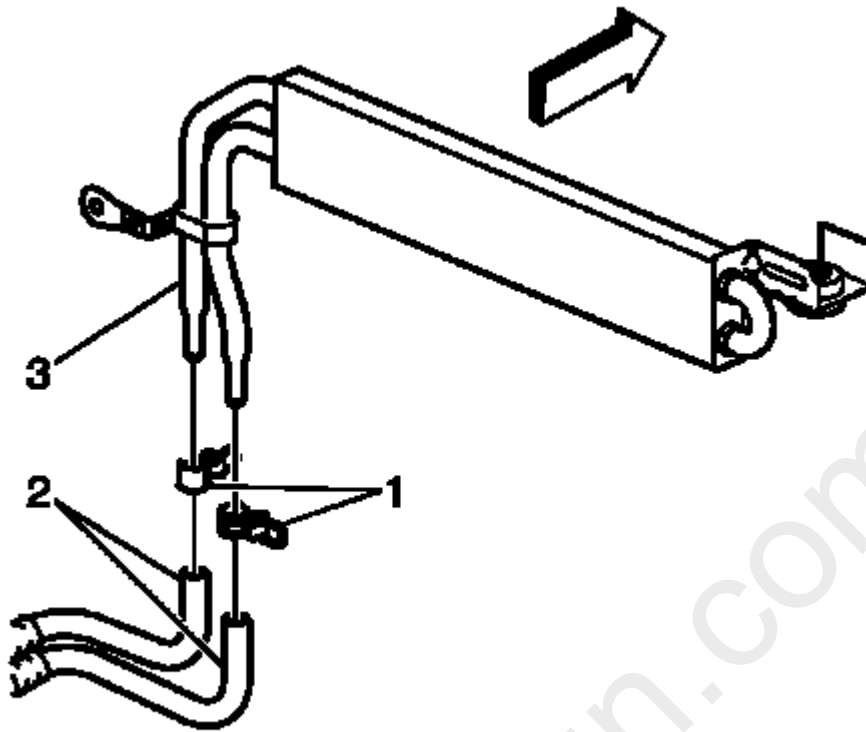


Fig. 41: Identifying Power Steering Cooler Hose Clamps & Hoses
Courtesy of GENERAL MOTORS COMPANY

9. Loosen the hose clamps (1) and disconnect the power steering cooler hoses (2) from the power steering fluid cooler (3).
10. Remove the power steering cooler hose from the vehicle.

Installation Procedure

1. Position the power steering cooler hose in the vehicle.

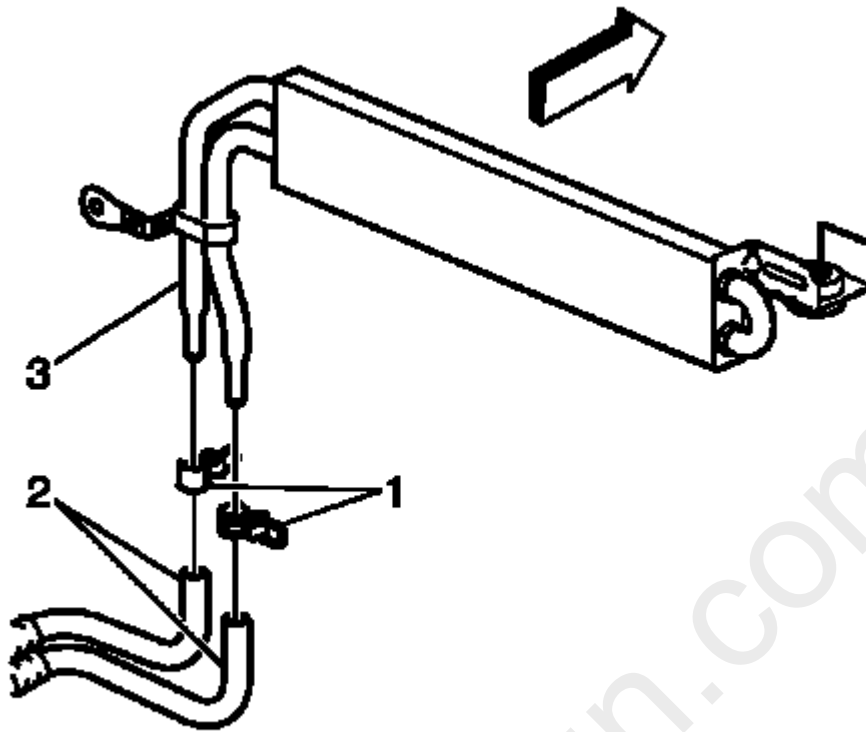


Fig. 42: Identifying Power Steering Cooler Hose Clamps & Hoses
Courtesy of GENERAL MOTORS COMPANY

2. Connect the power steering cooler hoses (2) to the power steering fluid cooler (3). Secure the hoses with the clamps (1).

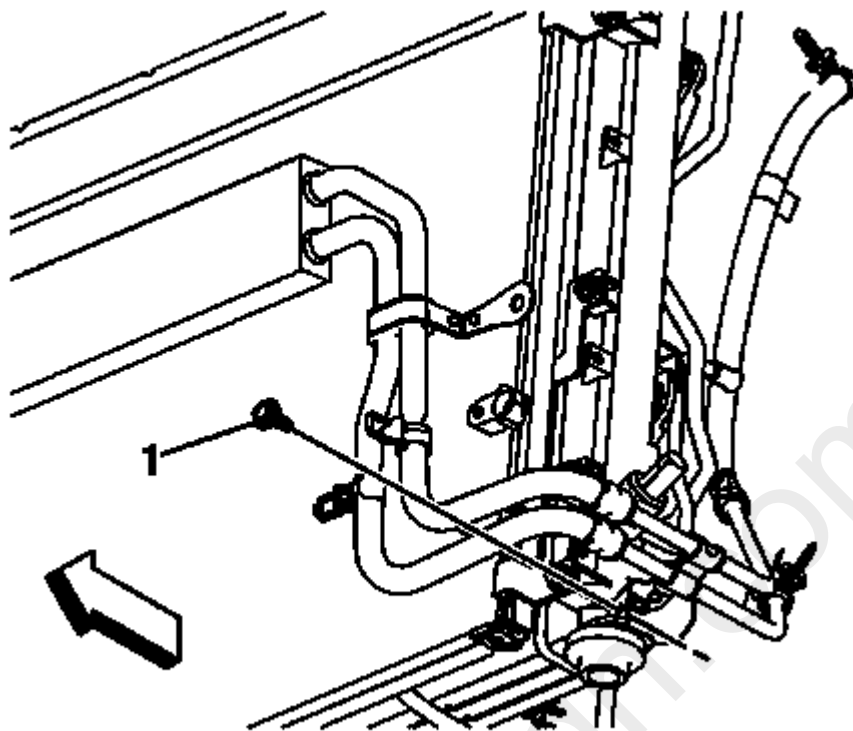


Fig. 43: Identifying Power Steering Fluid Cooler Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the power steering fluid cooler bracket bolt (1) and tighten to 10 N.m (89 lb in).

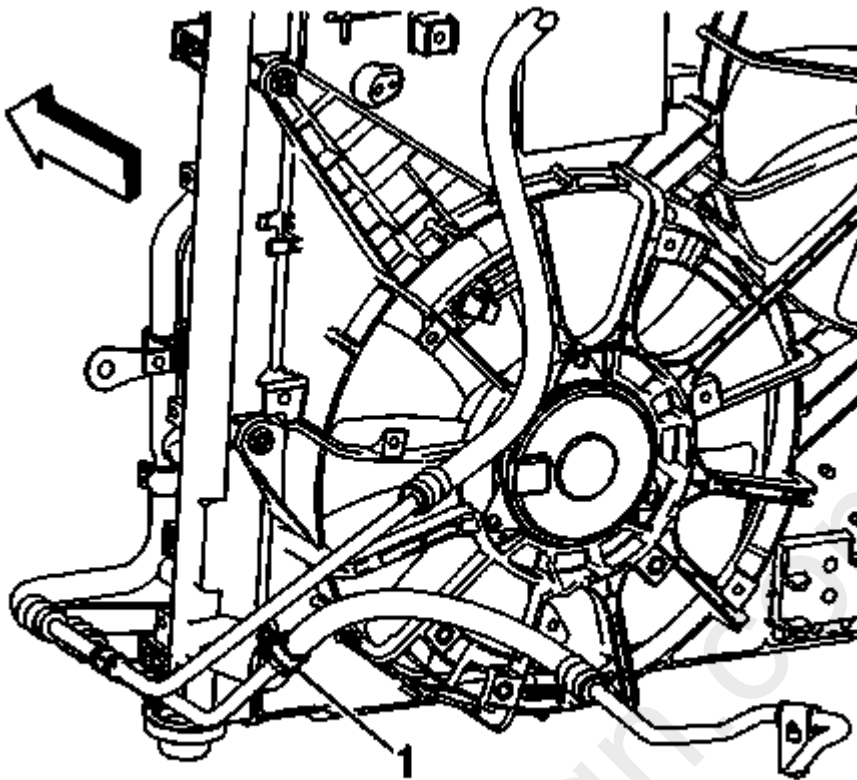


Fig. 44: Identifying Power Steering Gear Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Connect the power steering gear outlet hose to the power steering cooler hose. Secure the hose with the clamp (1).

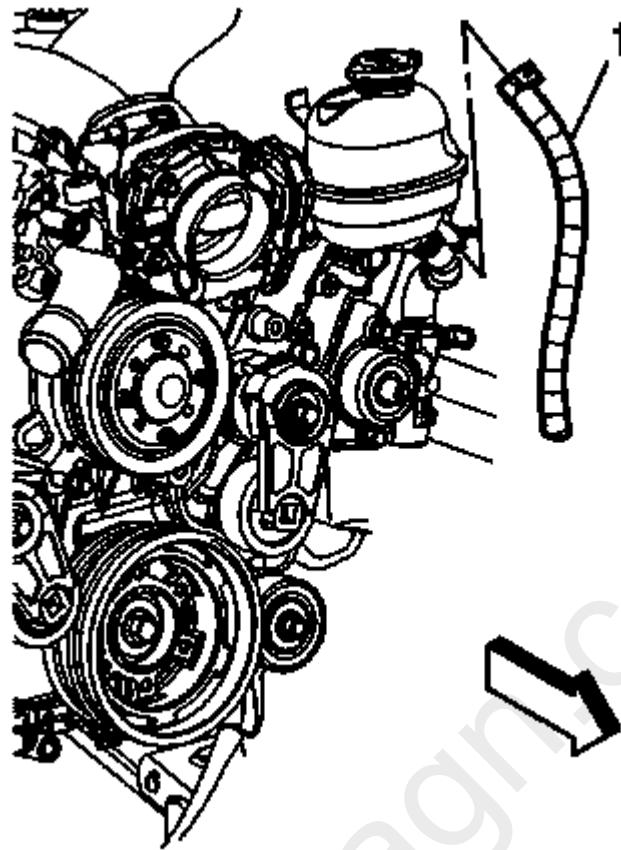


Fig. 45: Identifying Power Steering Cooler Hose
Courtesy of GENERAL MOTORS COMPANY

5. Connect the power steering cooler hose (1) to the power steering fluid reservoir. Secure the hose with the clamp.
6. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
7. Clean any excess power steering fluid from the vehicle.
8. Remove the drain pans.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
10. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
11. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

FLUID COOLER OUTLET HOSE REPLACEMENT (LSA)

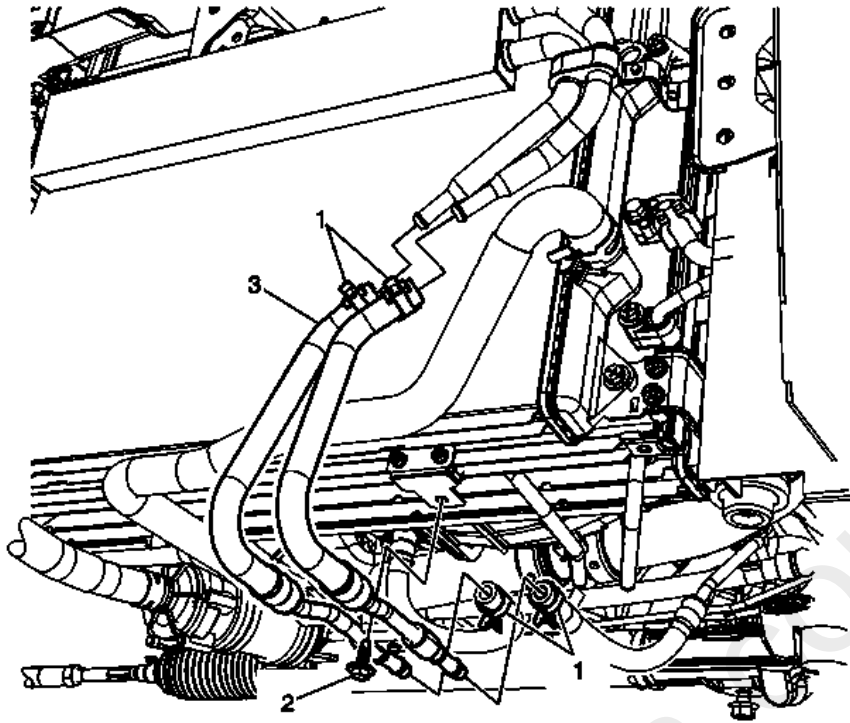


Fig. 46: Identifying Fluid Cooler Outlet Hose (LSA)

Courtesy of GENERAL MOTORS COMPANY

Fluid Cooler Outlet Hose Replacement (LSA)

Callout	Component Name
Preliminary Procedure	
1. Remove the front intake manifold cover. Refer to <u>Intake Manifold Cover Replacement - Front</u> . 2. Siphon the fluid from the power steering fluid reservoir. 3. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> . 4. Place a drain pan below the vehicle.	
1	Clamp (Qty: 4)
2	Power Steering Fluid Cooler Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
3	Power Steering Fluid Cooler Outlet Hose Procedure Fill and Bleed the power steering system. Refer to <u>Power Steering System Bleeding</u> .

POWER STEERING FLUID COOLER REPLACEMENT (LFW, LFX)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove as much power steering fluid from the power steering fluid reservoir as possible.
3. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
4. Place drain pans under the vehicle as necessary.

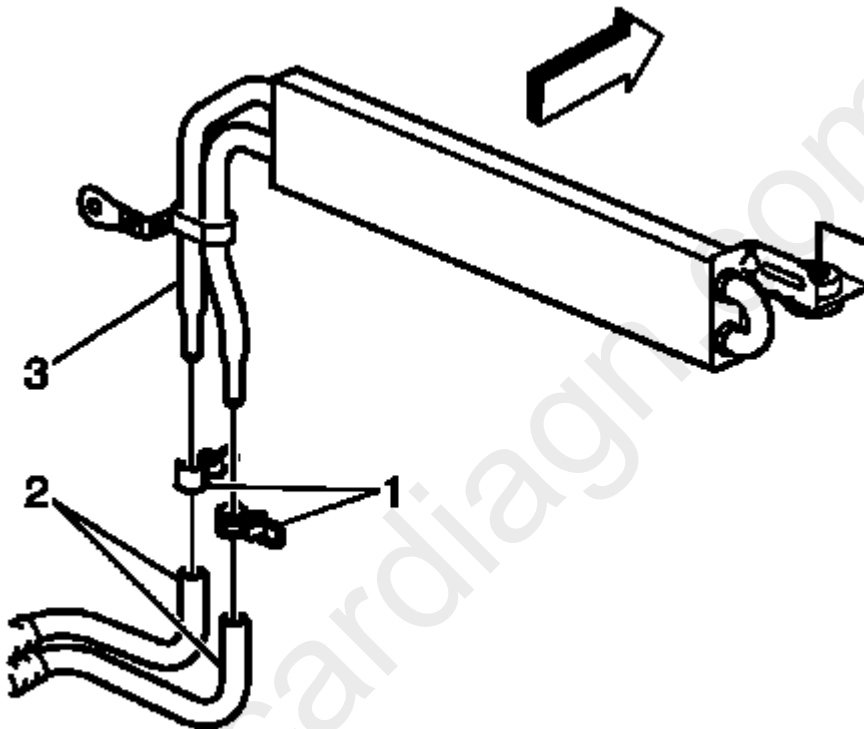


Fig. 47: Identifying Power Steering Cooler Hose Clamps & Hoses
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the hose clamps (1) and disconnect the power steering cooler hoses (2) from the power steering fluid cooler (3).
6. Loosen the front bumper fascia enough in order to pull the front bumper fascia forward and access the power steering fluid cooler bracket bolt. Refer to **Front Bumper Fascia Replacement** .

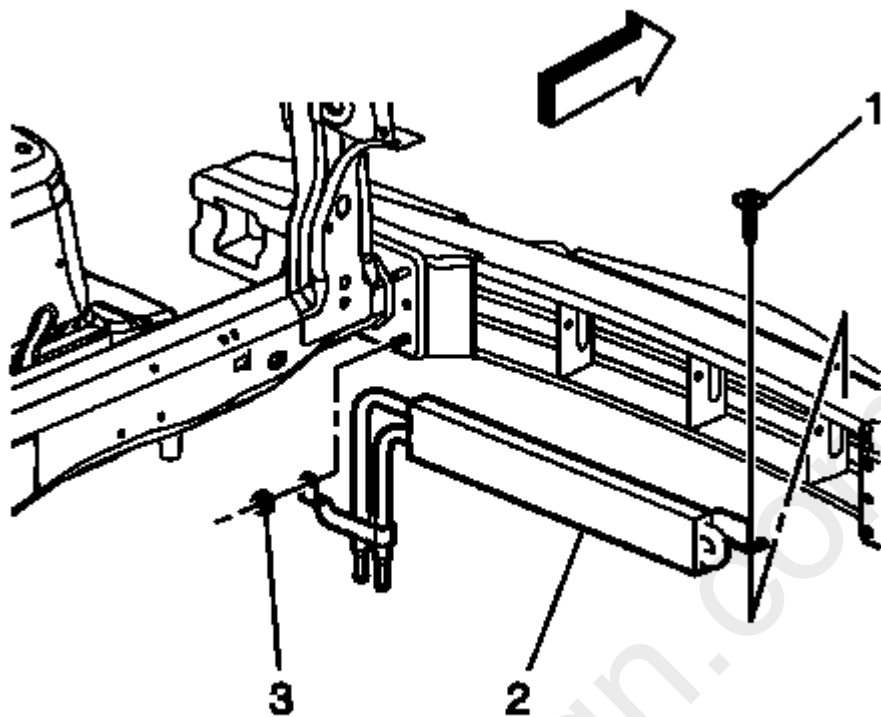
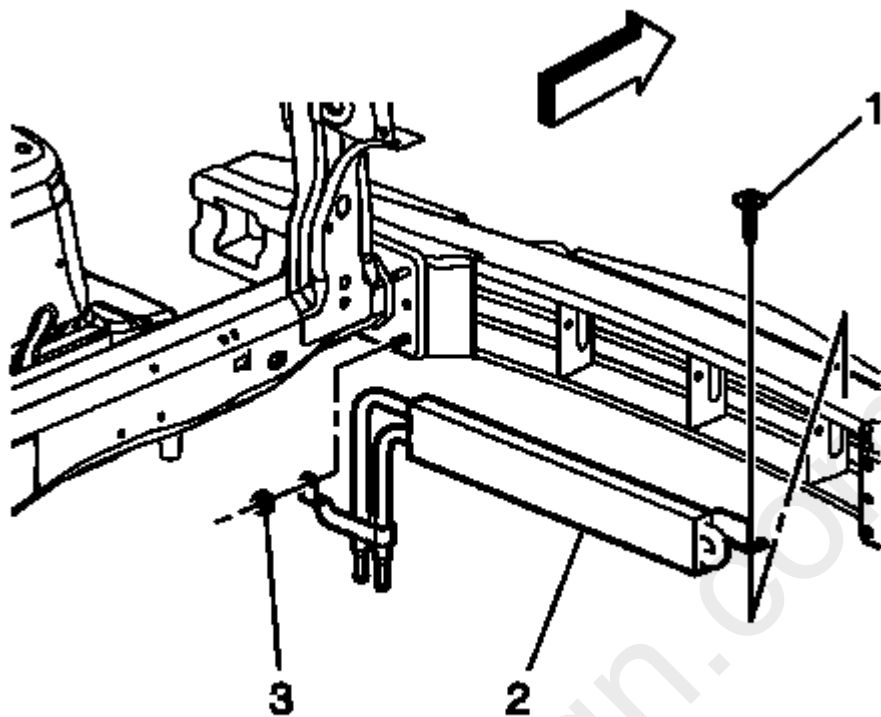


Fig. 48: View of Fascia and Power Steering Fluid Cooler Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power steering fluid cooler bracket bolt (1).
8. Remove the power steering fluid cooler bracket nut (3).
9. Remove the power steering fluid cooler (2) from the vehicle.

Installation Procedure



1. Position the power steering fluid cooler (2) in the vehicle.

2. Install the power steering fluid cooler bracket bolt (1) and tighten to 15 N.m (11 lb ft).
3. Install the power steering fluid cooler bracket nut (3) and tighten to 15 N.m (11 lb ft).
4. Secure the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

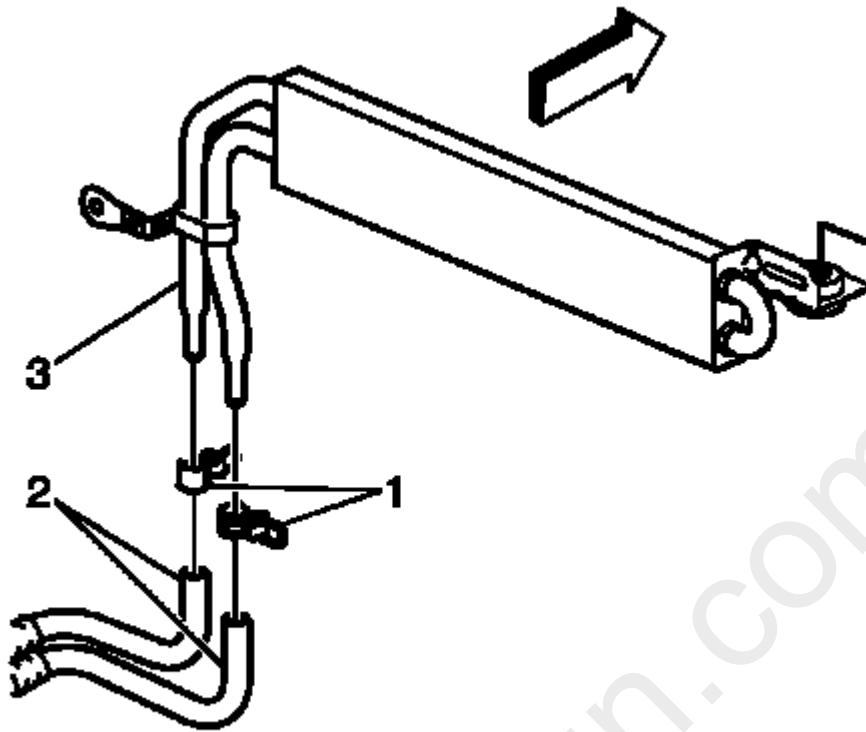


Fig. 50: Identifying Power Steering Cooler Hose Clamps & Hoses
Courtesy of GENERAL MOTORS COMPANY

5. Connect the power steering cooler hoses (2) to the power steering fluid cooler (3). Secure the hoses with the clamps (1).
6. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
7. Clean any excess power steering fluid from the vehicle.
8. Remove the drain pans.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
10. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

POWER STEERING FLUID COOLER REPLACEMENT (LSA)

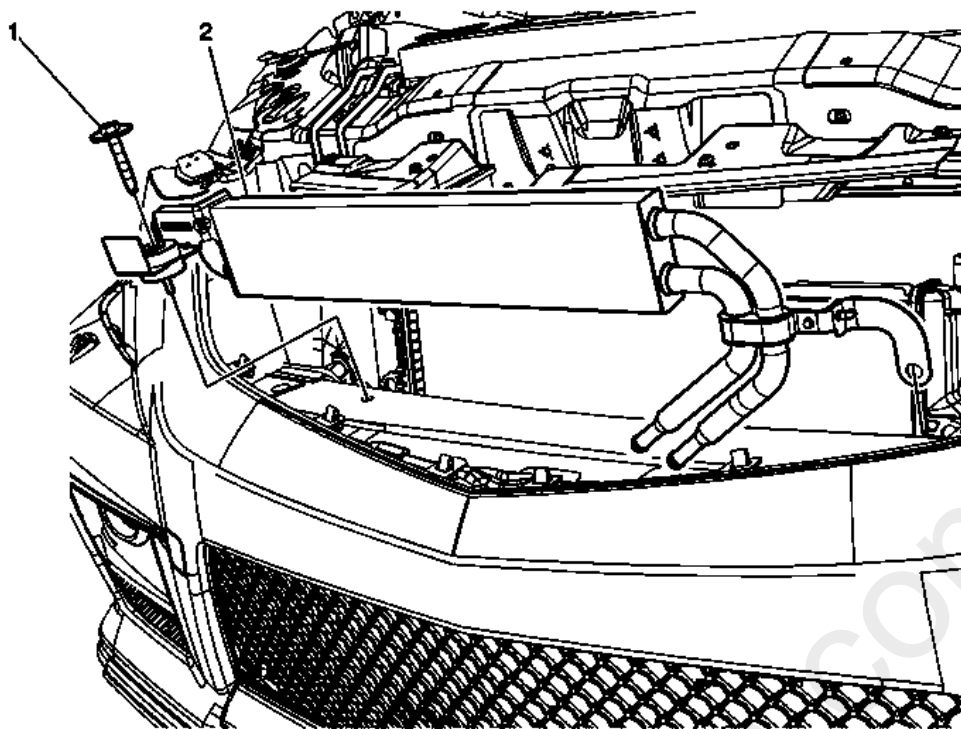


Fig. 51: Identifying Power Steering Fluid Cooler (LSA)

Courtesy of GENERAL MOTORS COMPANY

Power Steering Fluid Cooler Replacement (LSA)

Callout	Component Name
Preliminary Procedure 1. Remove the front bumper energy absorber. Refer to <u>Front Bumper Fascia Energy Absorber Replacement (BRT)</u> , <u>Front Bumper Fascia Energy Absorber Replacement (Standard)</u> . 2. Place a drain pan under the vehicle. 3. Remove the front intake manifold cover. Refer to <u>Intake Manifold Cover Replacement - Front</u> . 4. Siphon the fluid from the power steering fluid reservoir.	
1	Power Steering Fluid Cooler Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 15 N.m (11 lb ft)
	Power Steering Fluid Cooler Procedure

2

1. Loosen the hose clamps and remove the cooler outlet hoses from the cooler.
2. Remove the nut holding the power steering fluid cooler to the front bumper impact bar. Refer to **Front Bumper Impact Bar Replacement** .
3. Separate the cooler from the impact bar.
4. Fill and Bleed the power steering system. Refer to **Power Steering System Bleeding**.

POWER STEERING FLUID RESERVOIR INLET HOSE REPLACEMENT (LFW, LFX)

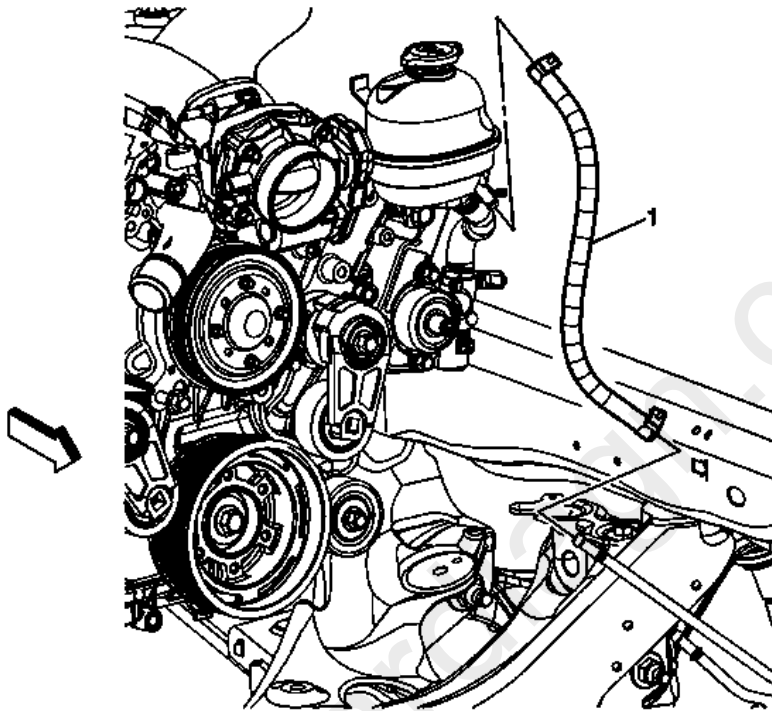


Fig. 52: Power Steering Fluid Reservoir Inlet Hose Replacement
Courtesy of GENERAL MOTORS COMPANY

Power Steering Fluid Reservoir Inlet Hose Replacement (LFW, LFX)

Callout	Component Name
Procedure	
1. Remove the front air deflector. Refer to <u>Front Air Deflector Replacement</u> . 2. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (All Wheel Drive)</u> , <u>Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)</u> . 3. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
	Power Steering Reservoir Inlet Hose
	Procedure

1

1. Disconnect the power steering reservoir inlet hose from the power steering cooler hose.
2. Disconnect the power steering reservoir inlet hose from the remote power steering fluid reservoir.
3. After repairs, fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
 - Before repairs, remove as much power steering fluid from the remote power steering fluid reservoir as possible.
 - Before repairs, place drain pans under the vehicle as needed.
 - After repairs, clean any excess fluid from the vehicle and remove the drain pans.

POWER STEERING FLUID RESERVOIR INLET HOSE REPLACEMENT (LSA)

Removal Procedure

1. Remove the front compartment sight shields. Refer to **Front Compartment Sight Shields Replacement** .
2. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
4. Remove the air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .
5. Place a drain pan under the vehicle.
6. Siphon the fluid from the power steering fluid reservoir.
7. Loosen the clamp and remove the reservoir inlet hose from the reservoir.
8. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
9. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
10. Remove the front compartment lower noise shield if necessary. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .

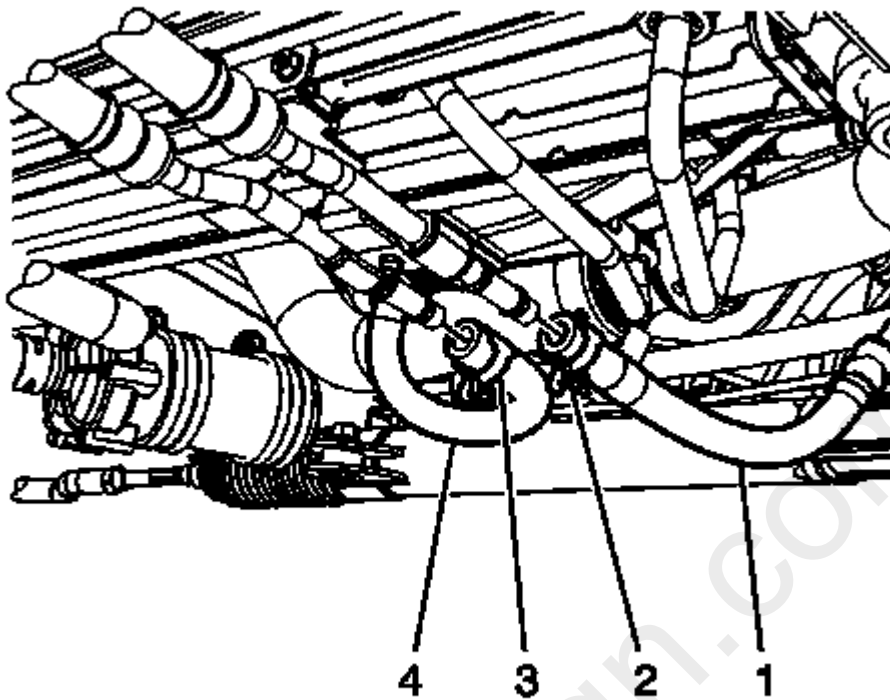


Fig. 53: Identifying Reservoir Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

11. Loosen the clamp (3) and remove the reservoir inlet hose (4) from the cooler hose.

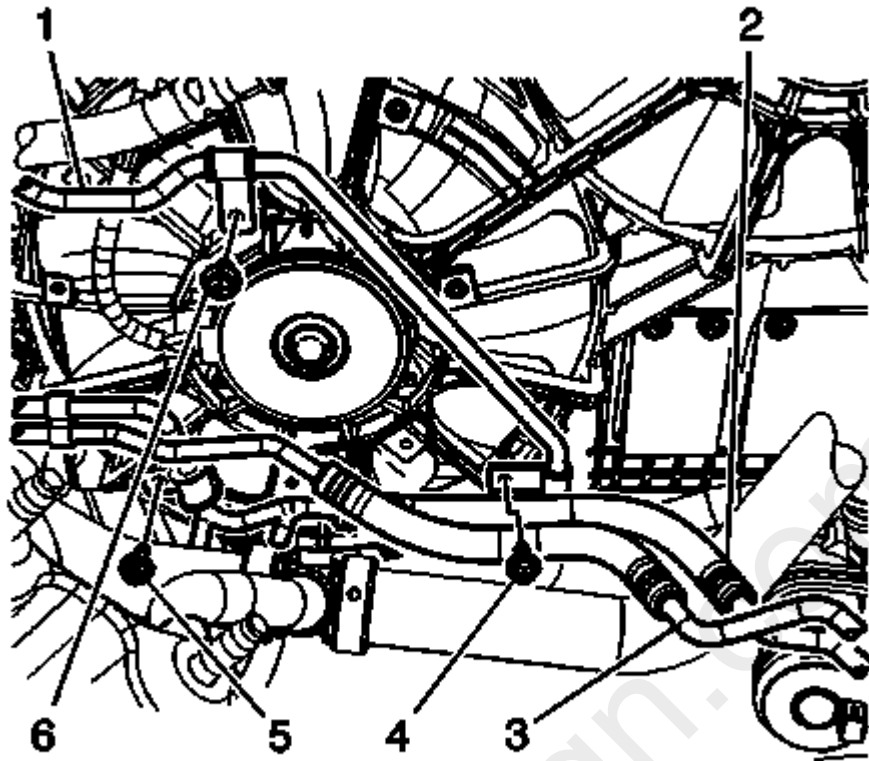


Fig. 54: Identifying Reservoir Inlet Hose & Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Remove the 2 fasteners (4 and 6) from the reservoir inlet hose (1).
13. Remove the reservoir inlet hose from the vehicle.

Installation Procedure

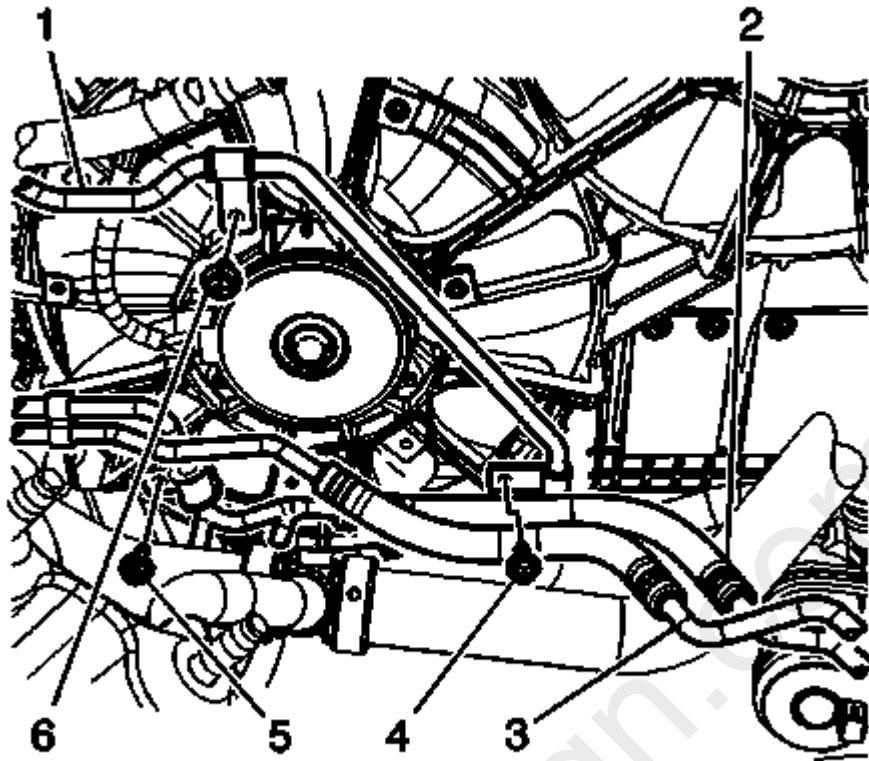


Fig. 55: Identifying Reservoir Inlet Hose & Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Position the reservoir inlet hose (1) in the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the 2 fasteners (4 and 6) to the reservoir inlet hose and tighten to 9 N.m (80 lb in).

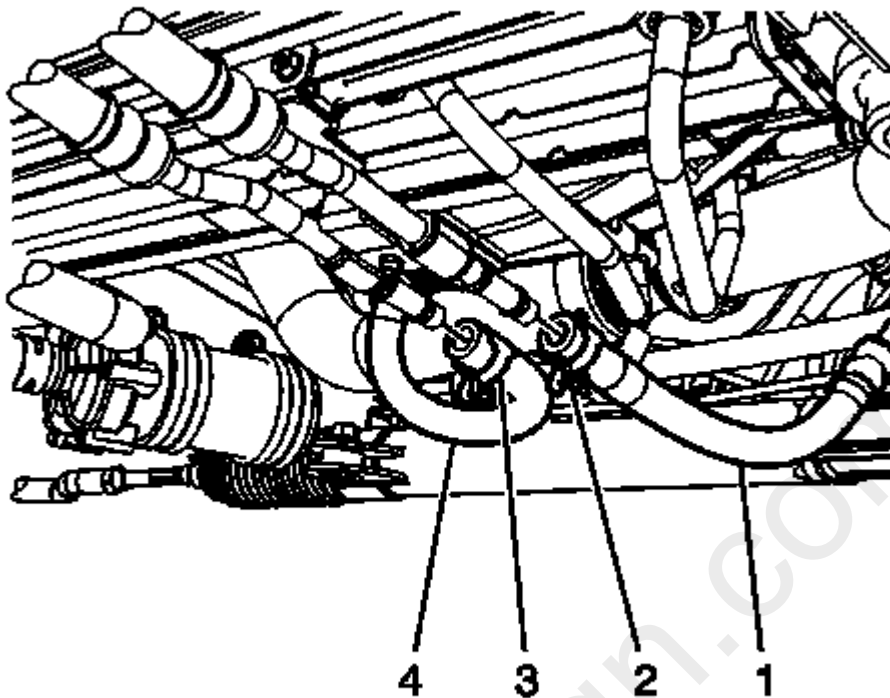


Fig. 56: Identifying Reservoir Inlet Hose & Clamp
 Courtesy of GENERAL MOTORS COMPANY

3. Install the reservoir inlet hose (4) to the cooler hose with the clamp (3).
4. If you removed the front compartment lower noise shield, install the shield. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
5. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
6. Install the reservoir inlet hose to the reservoir with the clamp.
7. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
8. Remove the drain pan.
9. Lower the vehicle.
10. Install the air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement**
11. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
12. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
13. Install the front compartment sight shields. Refer to **Front Compartment Sight Shields Replacement** .

POWER STEERING FLUID RESERVOIR OUTLET HOSE REPLACEMENT (LFW, LFX)

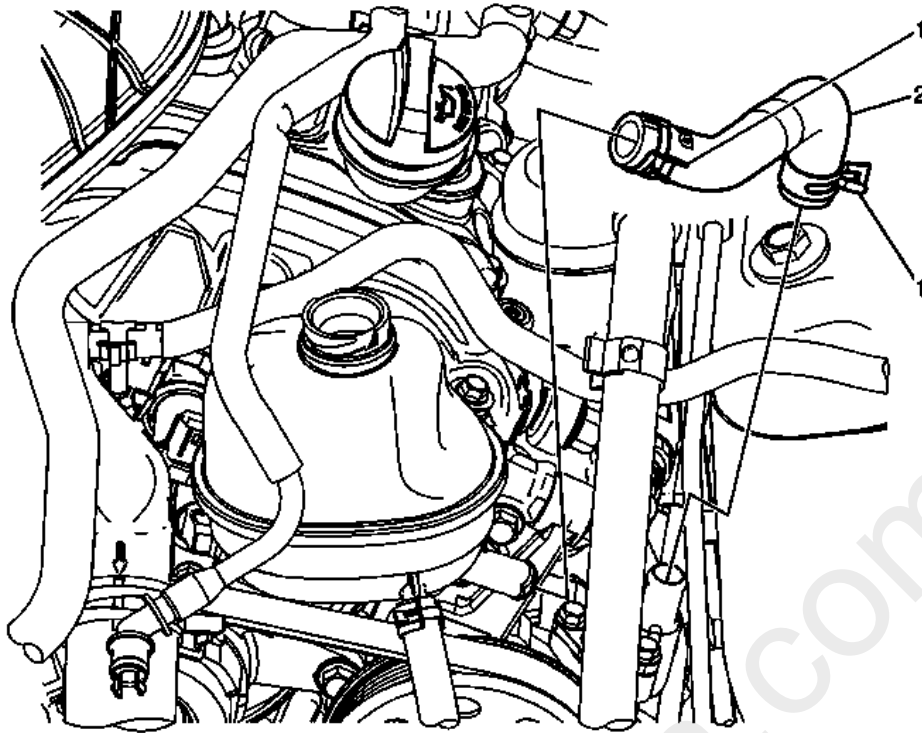


Fig. 57: Power Steering Fluid Reservoir Outlet Hose (LFW, LFX)
Courtesy of GENERAL MOTORS COMPANY

Power Steering Fluid Reservoir Outlet Hose Replacement (LFW, LFX)

Callout	Component Name
Preliminary Procedures	
1. Remove the front air deflector. Refer to <u>Front Air Deflector Replacement</u> . 2. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (All Wheel Drive)</u> , <u>Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)</u> . 3. Place drain pans under the vehicle. 4. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 5. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 6. Cover the air conditioning compressor in order to prevent power steering fluid from dripping on the air conditioning compressor. 7. Remove as much power steering fluid from the reservoir as possible.	
1	Power Steering Fluid Reservoir Outlet Hose Clamp (Qty: 2)
2	Power Steering Fluid Reservoir Outlet Hose
	Procedure
	1. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>.

2. Clean any excess power steering fluid from the vehicle.

POWER STEERING FLUID RESERVOIR OUTLET HOSE REPLACEMENT (LSA)

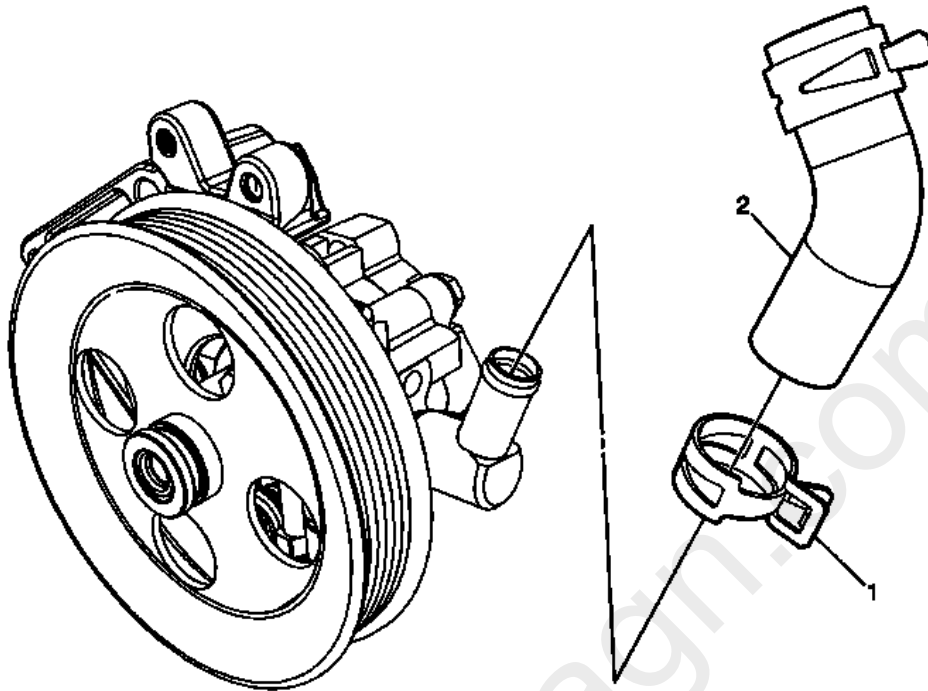


Fig. 58: Identifying Power Steering Fluid Reservoir Outlet Hose (LSA)

Courtesy of GENERAL MOTORS COMPANY

Power Steering Fluid Reservoir Outlet Hose Replacement (LSA)

Callout	Component Name
Preliminary Procedure	
1. Remove the front intake manifold cover. Refer to <u>Intake Manifold Cover Replacement - Front</u> . 2. Place a drain pan under the vehicle. 3. Siphon the fluid from the power steering fluid reservoir. 4. Remove the power steering fluid reservoir. Refer to <u>Power Steering Fluid Reservoir Replacement (LSA)</u>.	
1	Clamp
2	Power Steering Reservoir Outlet Pipe/Hose
Procedure Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u> .	

POWER STEERING GEAR INLET PIPE/HOSE REPLACEMENT (LFW, LFX)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove as much power steering fluid from the power steering fluid reservoir as possible.
3. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**.
4. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
5. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
6. Place drain pans under the vehicle as necessary.

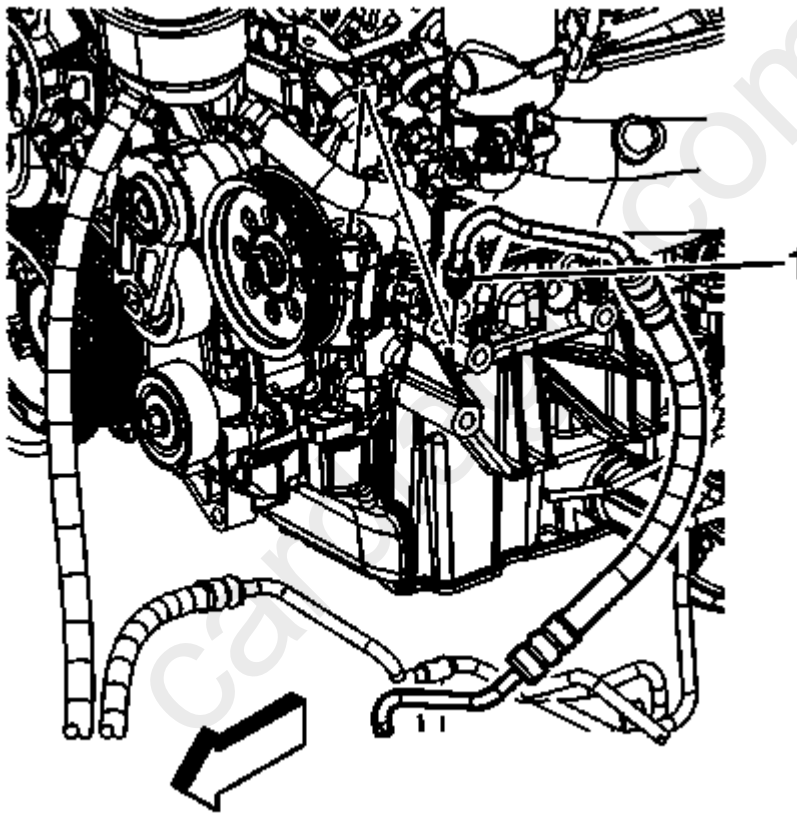


Fig. 59: View of Power Steering Gear Inlet Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the power steering gear inlet hose fitting (1) from the power steering pump.

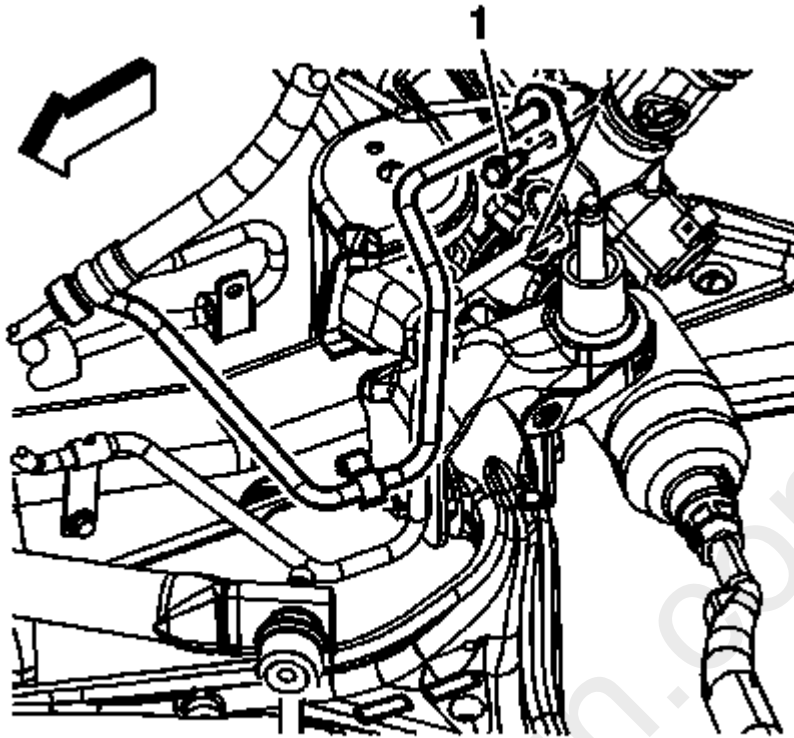


Fig. 60: View of Power Steering Gear Inlet Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power steering gear inlet hose latch plate bolt (1).

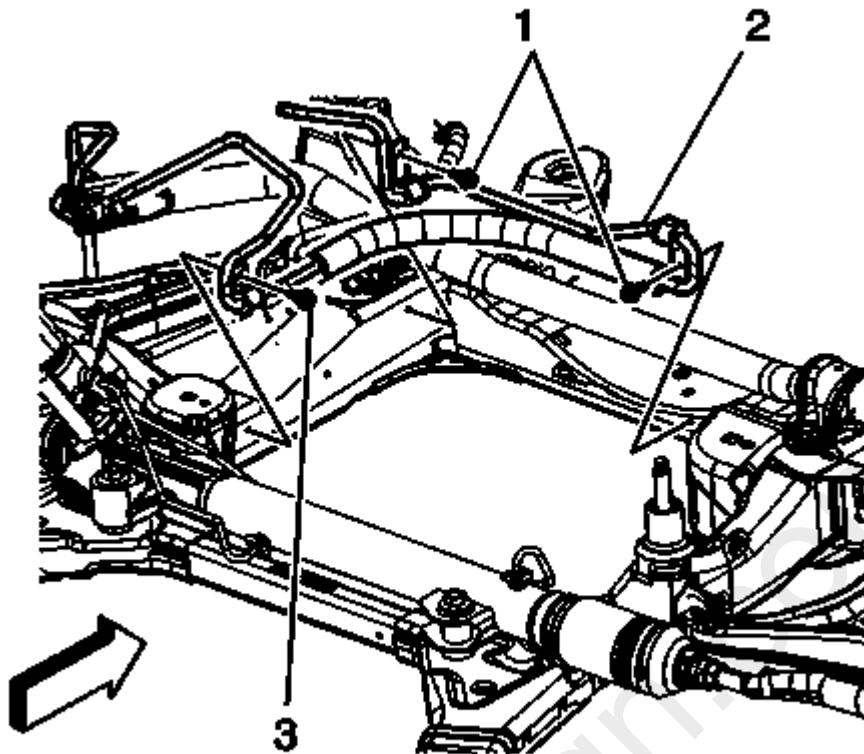


Fig. 61: View of Power Steering Gear Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Remove the power steering gear inlet and outlet pipe retainer bolts (1, 3).
10. Remove the power steering gear inlet hose (2) from the vehicle.

Installation Procedure

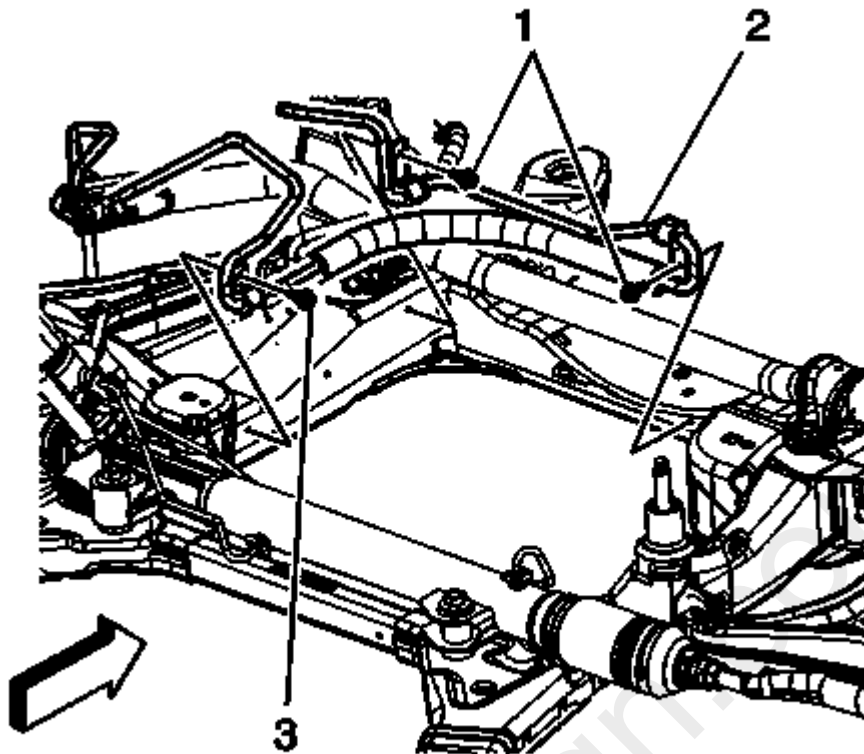


Fig. 62: View of Power Steering Gear Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the power steering gear inlet hose (2) in the vehicle.

NOTE: Start all fasteners by hand before finalizing any torques.

2. Install the power steering gear inlet and outlet pipe retainer bolts (1, 3).

CAUTION: Refer to Fastener Caution .

3. Tighten the power steering gear inlet and outlet pipe retainer bolts to 10 N.m (89 lb in).

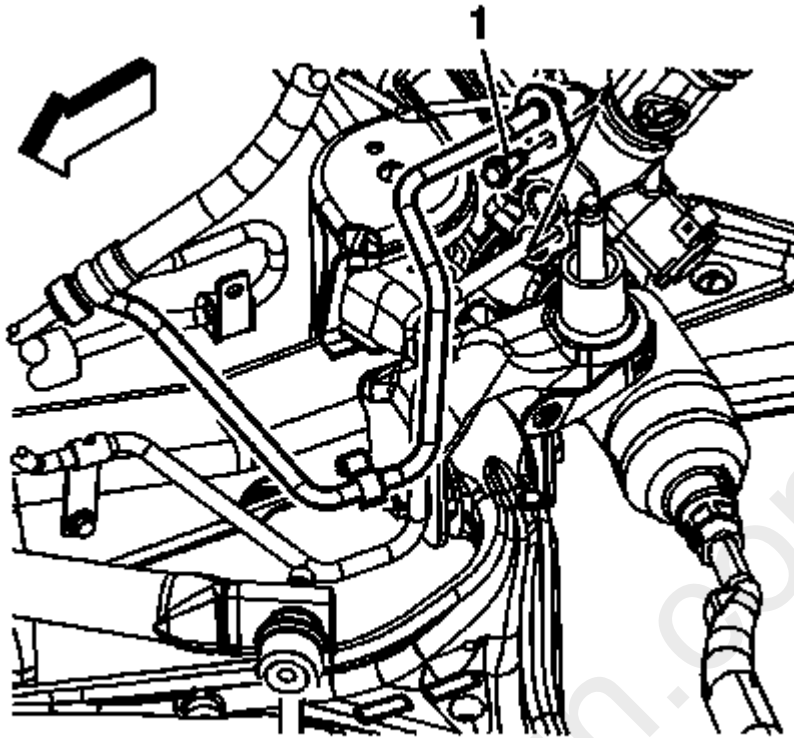


Fig. 63: View of Power Steering Gear Inlet Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the power steering gear inlet hose latch plate bolt (1).
5. Tighten the power steering gear inlet hose latch plate bolt to 22.5 N.m (17 lb ft).

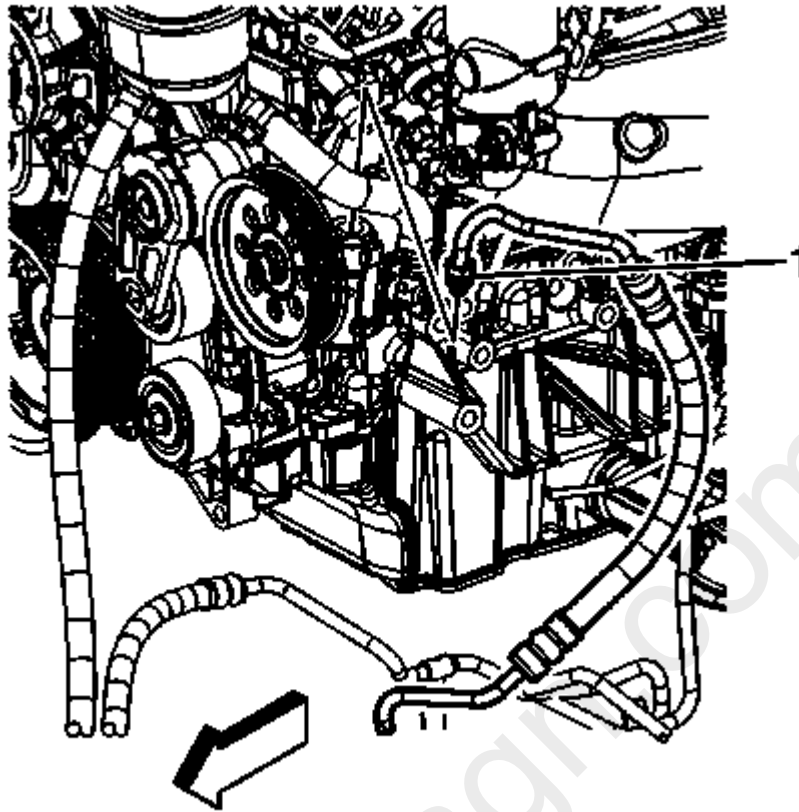


Fig. 64: View of Power Steering Gear Inlet Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Connect the power steering gear inlet hose fitting (1) to the power steering pump. Tighten the fitting to 34 N.m (25 lb ft).
7. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**.
8. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Clean any excess power steering fluid from the vehicle.
10. Remove the drain pans.
11. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
12. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
13. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

POWER STEERING GEAR INLET PIPE/HOSE REPLACEMENT (RHD)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove as much power steering fluid from the power steering fluid reservoir as possible.
3. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX), Power Steering Pump Pulley Replacement (LSA)**.
4. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
5. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
6. Place drain pans under the vehicle as necessary.

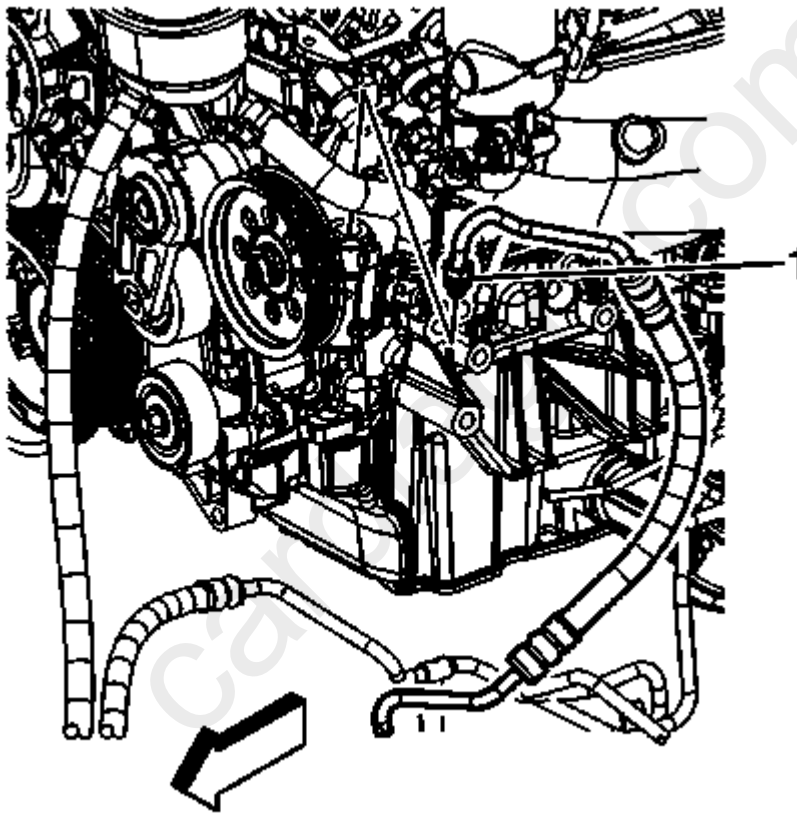


Fig. 65: View of Power Steering Gear Inlet Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the power steering gear inlet hose fitting (1) from the power steering pump.

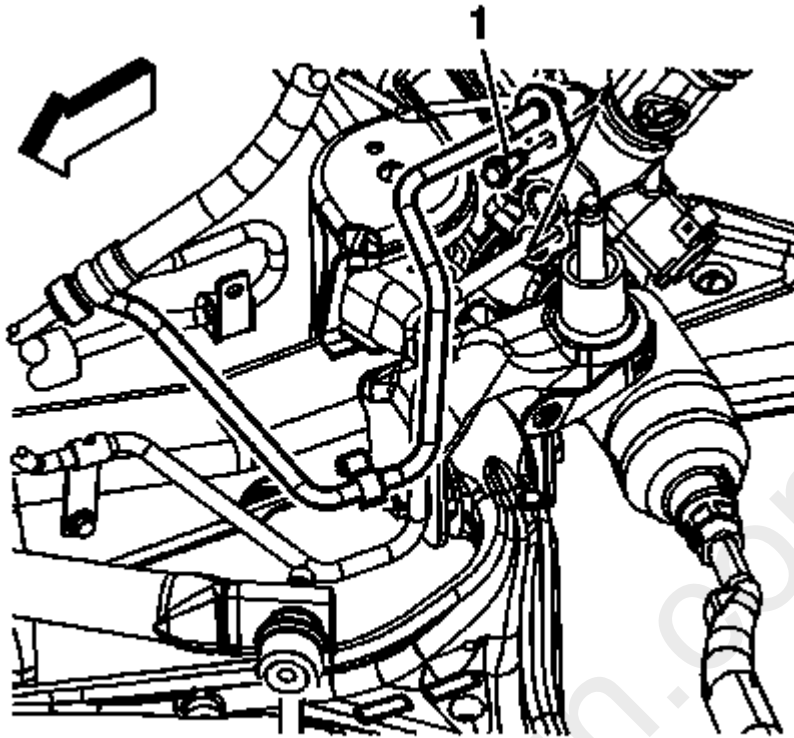


Fig. 66: View of Power Steering Gear Inlet Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power steering gear inlet hose latch plate bolt (1).

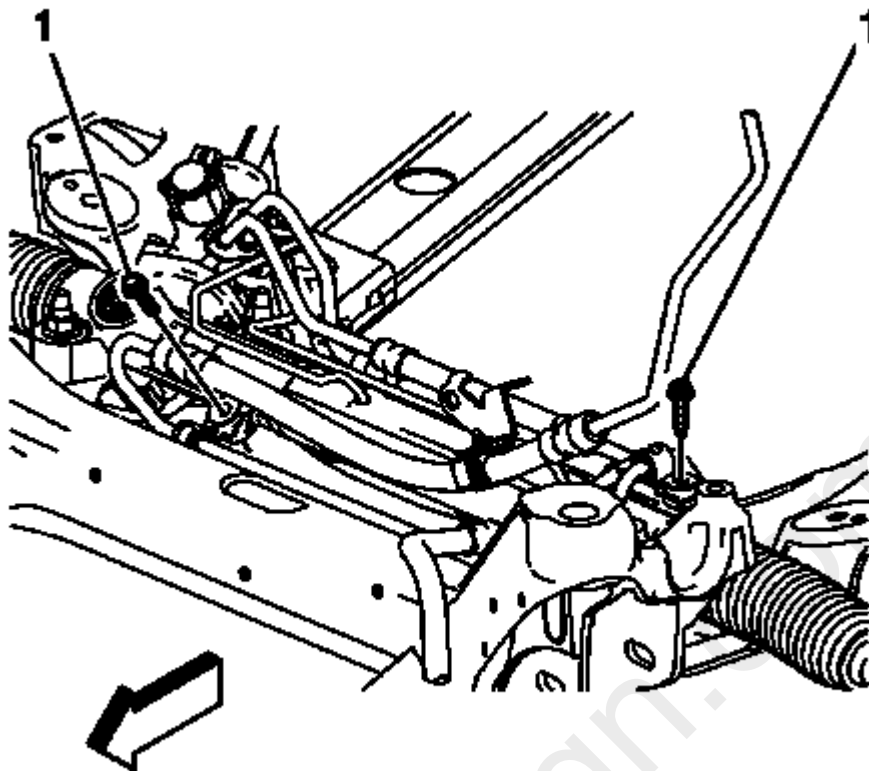


Fig. 67: Identifying Power Steering Gear Inlet Hose Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the power steering gear inlet hose bracket bolts (1).
10. Remove the power steering gear inlet hose from the vehicle.

Installation Procedure

1. Position the power steering gear inlet hose in the vehicle.

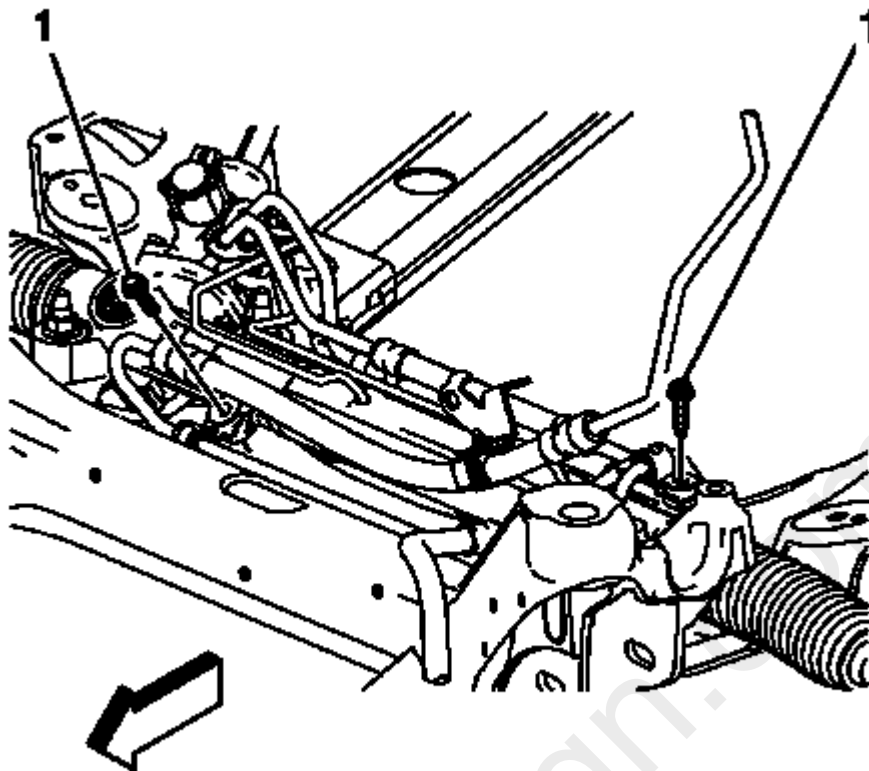


Fig. 68: Identifying Power Steering Gear Inlet Hose Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Start all fasteners by hand before finalizing any torques.

2. Install the power steering gear inlet hose bracket bolts (1).
3. Tighten the power steering gear inlet hose bracket bolts to 9 N.m (80 lb in).

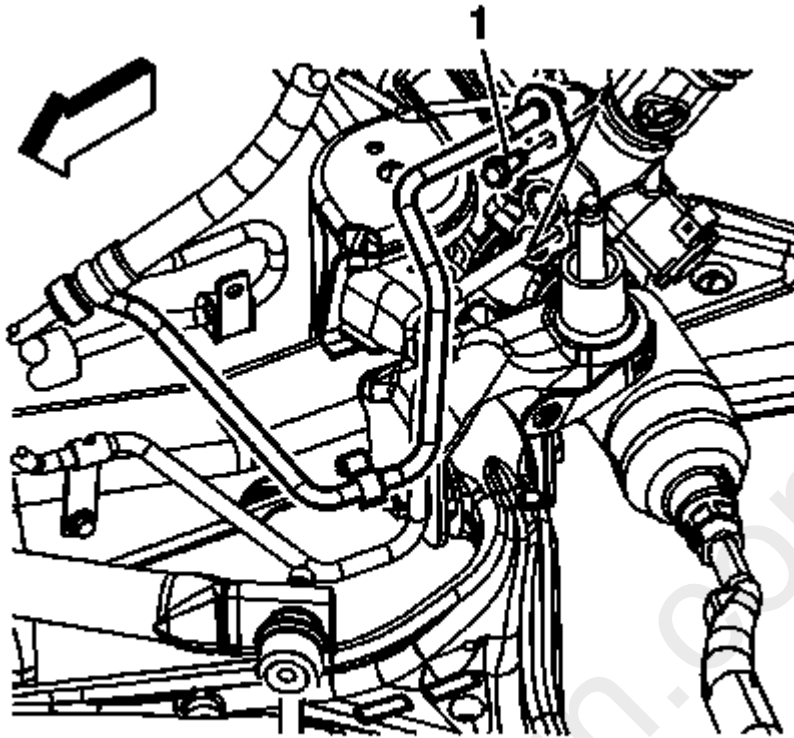


Fig. 69: View of Power Steering Gear Inlet Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the power steering gear inlet hose latch plate bolt (1).
5. Tighten the power steering gear inlet hose latch plate bolt to 22.5 N.m (17 lb ft).

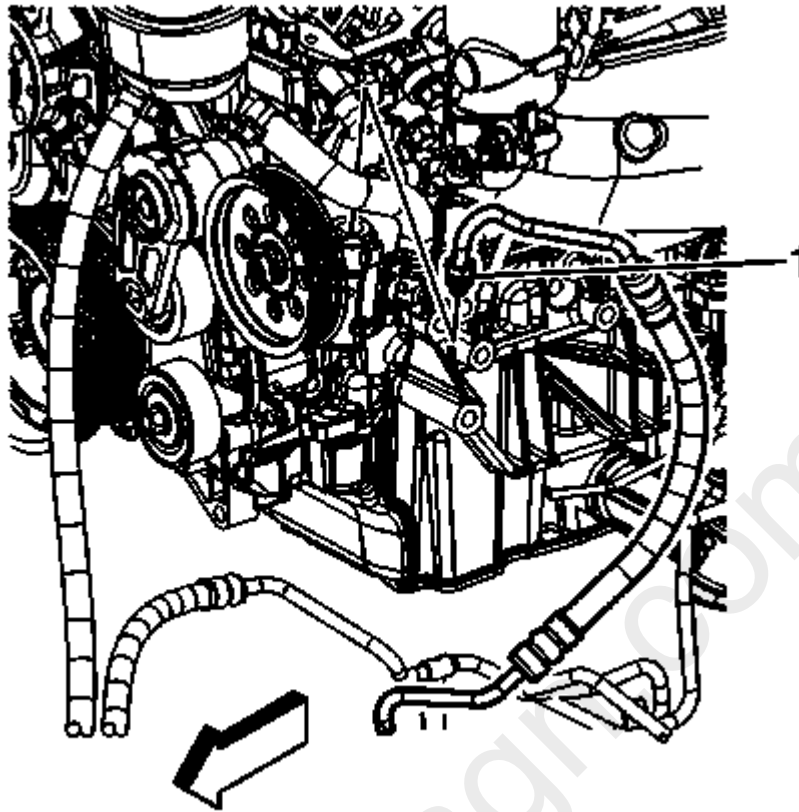


Fig. 70: View of Power Steering Gear Inlet Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Connect the power steering gear inlet hose fitting (1) to the power steering pump. Tighten the fitting to 34 N.m (25 lb ft).
7. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**, **Power Steering Pump Pulley Replacement (LSA)**.
8. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Clean any excess power steering fluid from the vehicle.
10. Remove the drain pans.
11. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
12. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
13. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

POWER STEERING GEAR INLET PIPE/HOSE REPLACEMENT (LHD WITH LFW, LFX)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove as much power steering fluid from the power steering fluid reservoir as possible.
3. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**.
4. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
5. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
6. Place drain pans under the vehicle as necessary.

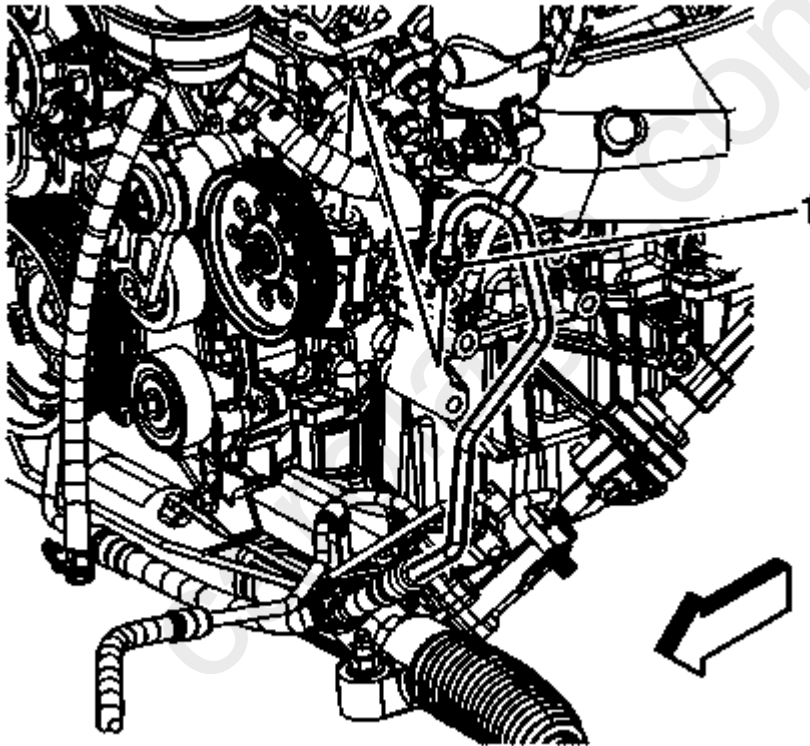


Fig. 71: View of Power Steering Gear Inlet Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the power steering gear inlet hose fitting (1) from the power steering pump.

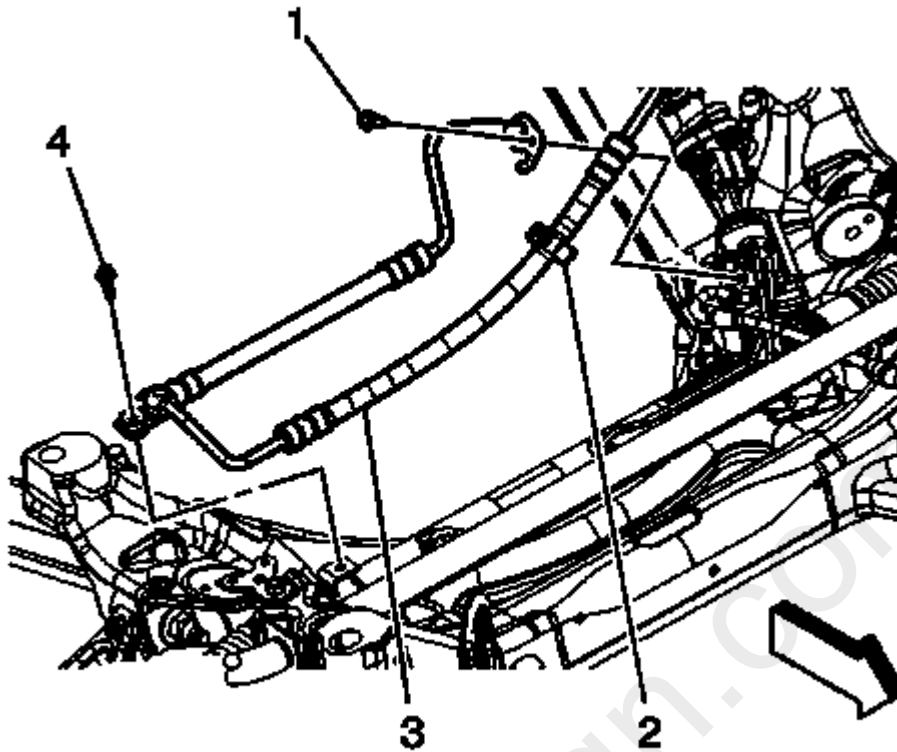


Fig. 72: View of Power Steering Gear Inlet Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power steering gear inlet hose latch plate bolt (1).
9. Disconnect the power steering gear inlet hose plastic retainer (2) from the power steering gear inlet hose clip bracket.
10. Remove the power steering gear inlet pipe bracket bolt (4).
11. Disconnect the power steering gear solenoid electrical connector.
12. Remove the power steering gear inlet hose (3) from the vehicle.

Installation Procedure

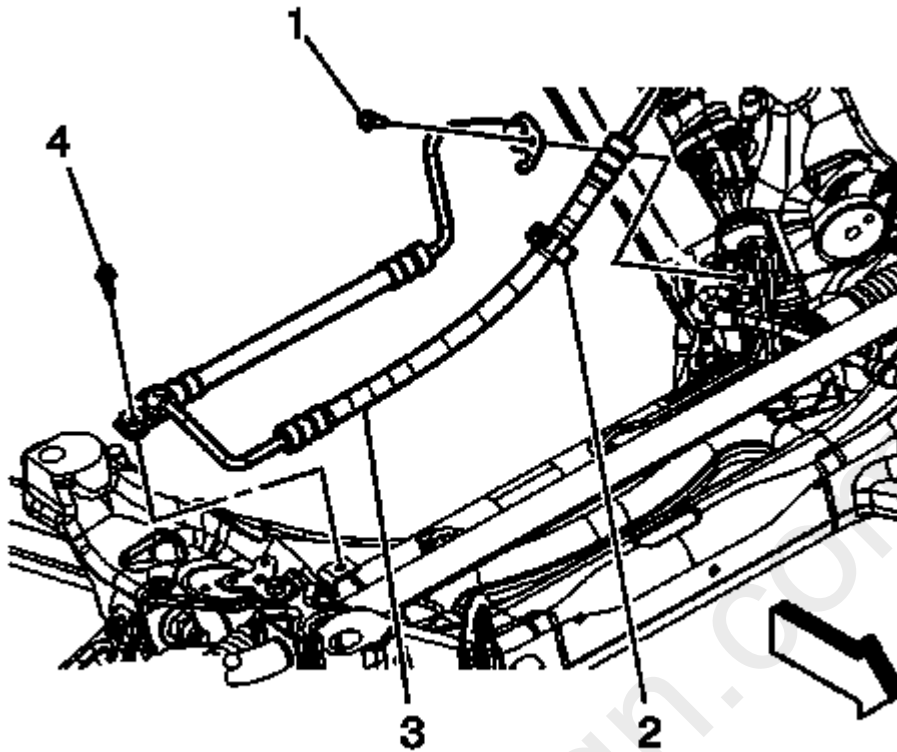


Fig. 73: View of Power Steering Gear Inlet Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the power steering gear inlet hose (3) in the vehicle.
2. Connect the power steering gear solenoid electrical connector.

NOTE: **Start all fasteners by hand before finalizing any torques.**

3. Install the power steering gear inlet pipe bracket bolt (4).

CAUTION: Refer to Fastener Caution .

4. Tighten the power steering gear inlet pipe bracket bolt to 9 N.m (80 lb in).
5. Connect the power steering gear inlet hose plastic retainer (2) to the power steering gear inlet hose clip bracket.
6. Install the power steering gear inlet hose latch plate bolt (1).
7. Tighten the power steering gear inlet hose latch plate bolt to 22.5 N.m (17 lb ft).

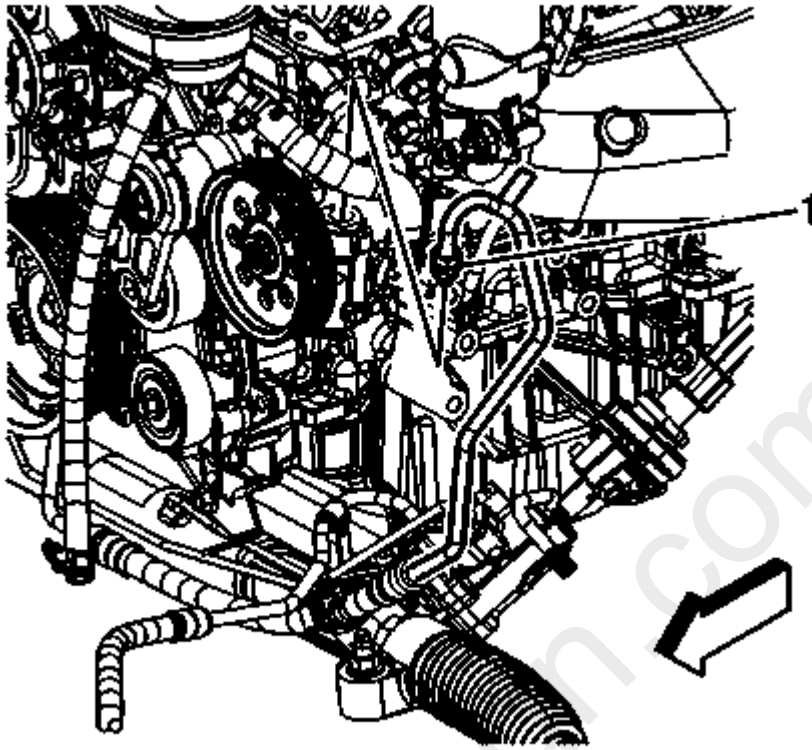


Fig. 74: View of Power Steering Gear Inlet Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Connect the power steering gear inlet hose fitting (1) to the power steering pump. Tighten the fitting to 34 N.m (25 lb ft).
9. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LFW, LFX)**.
10. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
11. Clean any excess power steering fluid from the vehicle.
12. Remove the drain pans.
13. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
14. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
15. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

POWER STEERING GEAR INLET PIPE/HOSE REPLACEMENT (LSA)

Removal Procedure

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 air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .
4. Place a drain pan under the vehicle.
5. Siphon the fluid from the power steering fluid reservoir.
6. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (LSA)**.

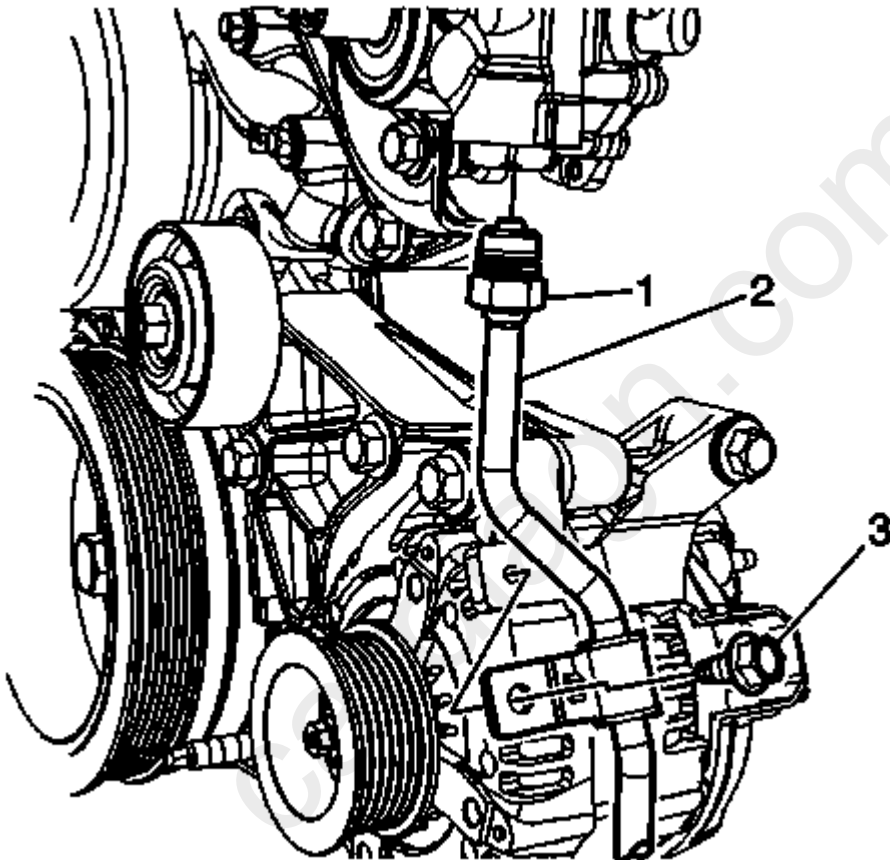


Fig. 75: Identifying Power Steering Gear Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power steering gear inlet hose bolt (3) from the generator.
8. Loosen the fitting (1) and remove the gear inlet hose (2) from the power steering pump.
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
10. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
11. Remove the front compartment lower noise shield if necessary. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
12. Remove the left engine splash shield. Refer to **Engine Splash Shield Replacement** .

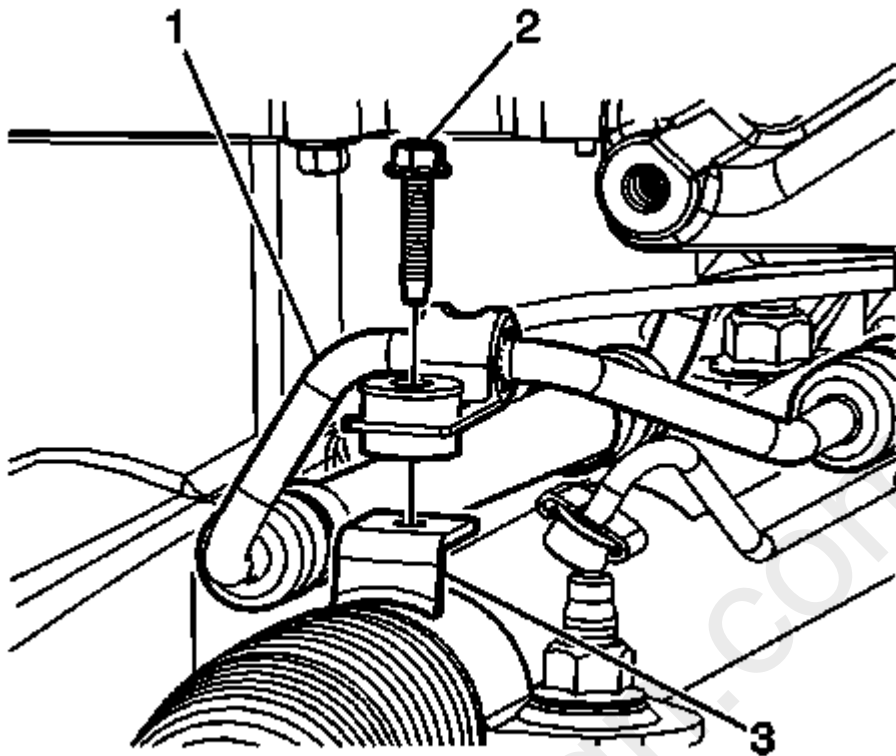


Fig. 76: Identifying Power Steering Gear Flange Components
Courtesy of GENERAL MOTORS COMPANY

13. Remove the bolt (2) from the power steering gear flange (3) and separate the gear inlet hose (1) from the steering gear flange.

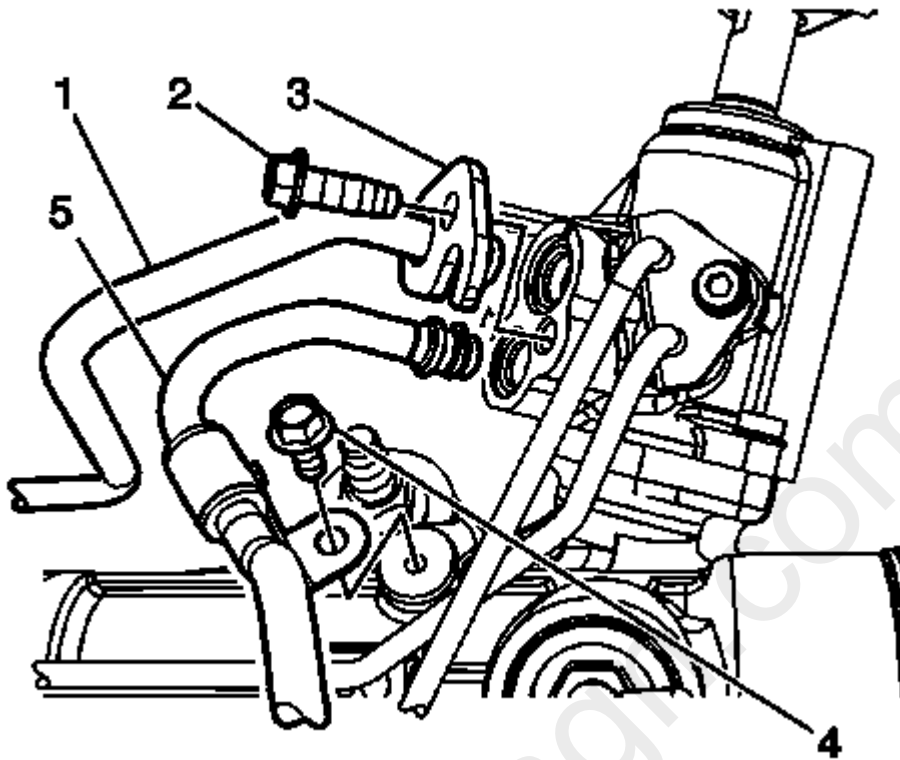


Fig. 77: Identifying Gear Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

14. Remove the bolt (2) from the gear inlet hose latch plate (3).
15. Reposition the plate.
16. Remove the gear inlet hose (1) from the steering gear.
17. Remove the gear inlet hose from the vehicle.
18. Remove the O-ring seal from the gear inlet hose-to-steering gear fitting.

Discard the O-ring seal.

Installation Procedure

1. Install a NEW O-ring seal to the gear inlet hose-to-steering gear fitting.
2. Position the power steering gear inlet hose in the vehicle.

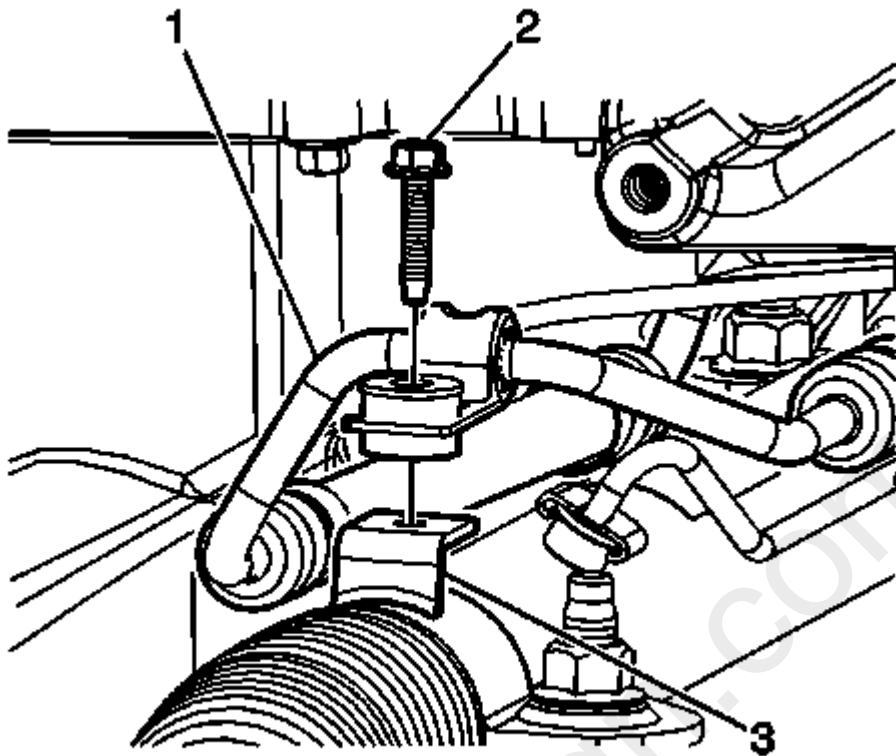


Fig. 78: Identifying Power Steering Gear Flange Components
Courtesy of GENERAL MOTORS COMPANY

3. Install, but do not tighten, the bolt (2) in order to retain the gear inlet hose (1) to the steering gear flange (3).

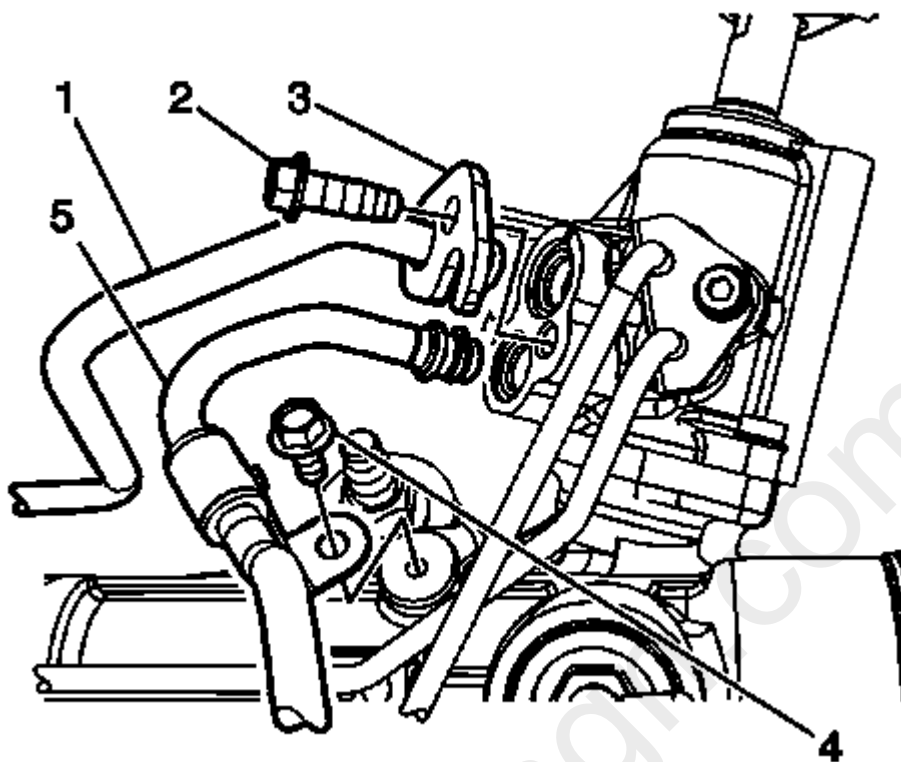


Fig. 79: Identifying Gear Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

4. Install the gear inlet hose (1) to the steering gear.
5. Lower the vehicle in order to access the power steering pump.

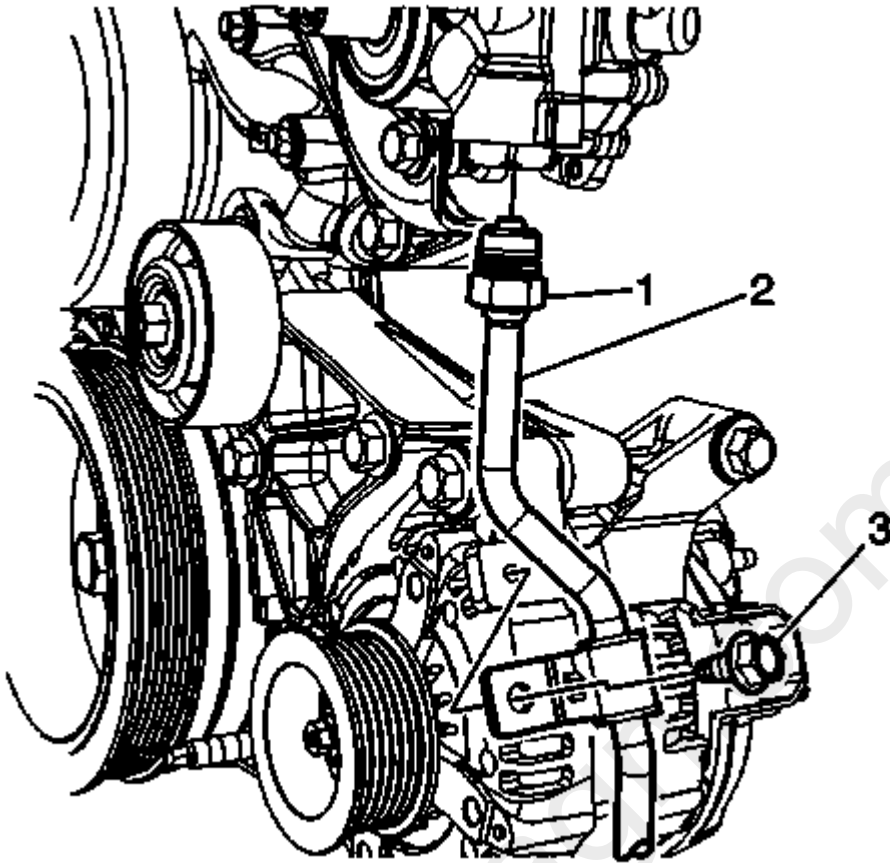


Fig. 80: Identifying Power Steering Gear Inlet Hose Components
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Fully seat the gear inlet hose to the power steering pump.

6. Install the power steering gear inlet hose (2) to the power steering pump. Tighten the fitting to 38 N.m (28 lb ft).
7. Install the steering gear inlet hose bolt to the generator and tighten to 9 N.m (80 lb in).
8. Tighten the steering gear inlet hose bolt to the steering gear flange to 9 N.m (80 lb in).
9. Reposition the latch plate onto the gear inlet and outlet hose fittings.
10. Install the latch plate bolt and tighten to 22.5 N.m 17 lb ft.
11. Install the left engine splash shield. Refer to Engine Splash Shield Replacement .
12. If you removed the front compartment lower noise shield, install the shield. Refer to Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive) .
13. Install the front air deflector. Refer to Front Air Deflector Replacement .
14. Install the power steering pump pulley. Refer to Power Steering Pump Pulley Replacement (LSA).

15. Install the air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .
16. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
17. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
18. Remove the drain pan.
19. Lower the vehicle.
20. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

POWER STEERING GEAR OUTLET PIPE/HOSE REPLACEMENT (AWD)

Removal Procedure

1. Remove the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
2. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
3. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** .
4. Place drain pans under the vehicle as needed.

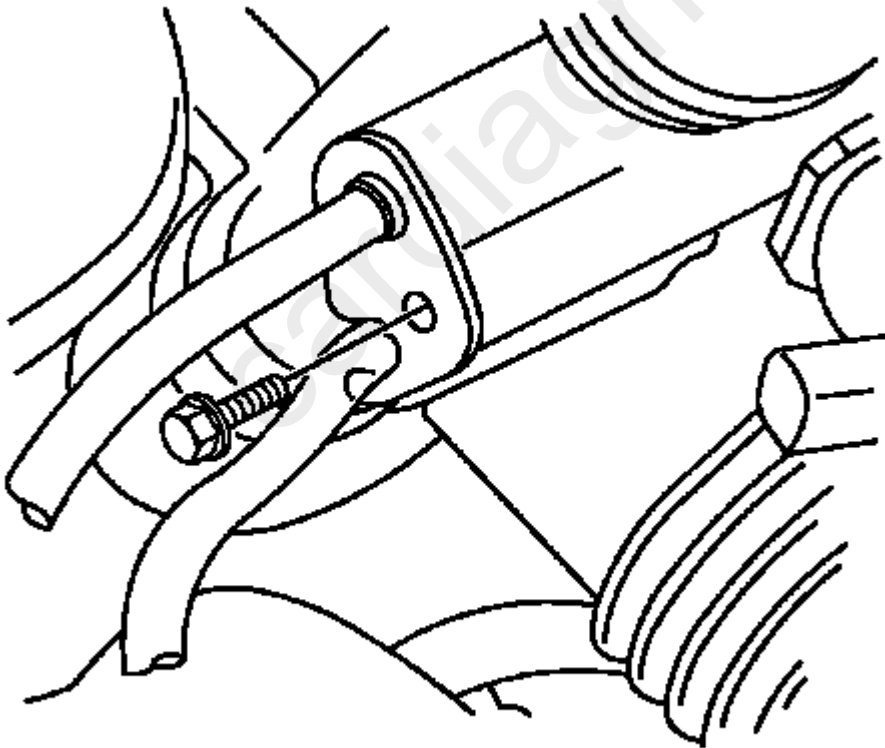


Fig. 81: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power steering gear inlet hose latch plate bolt.

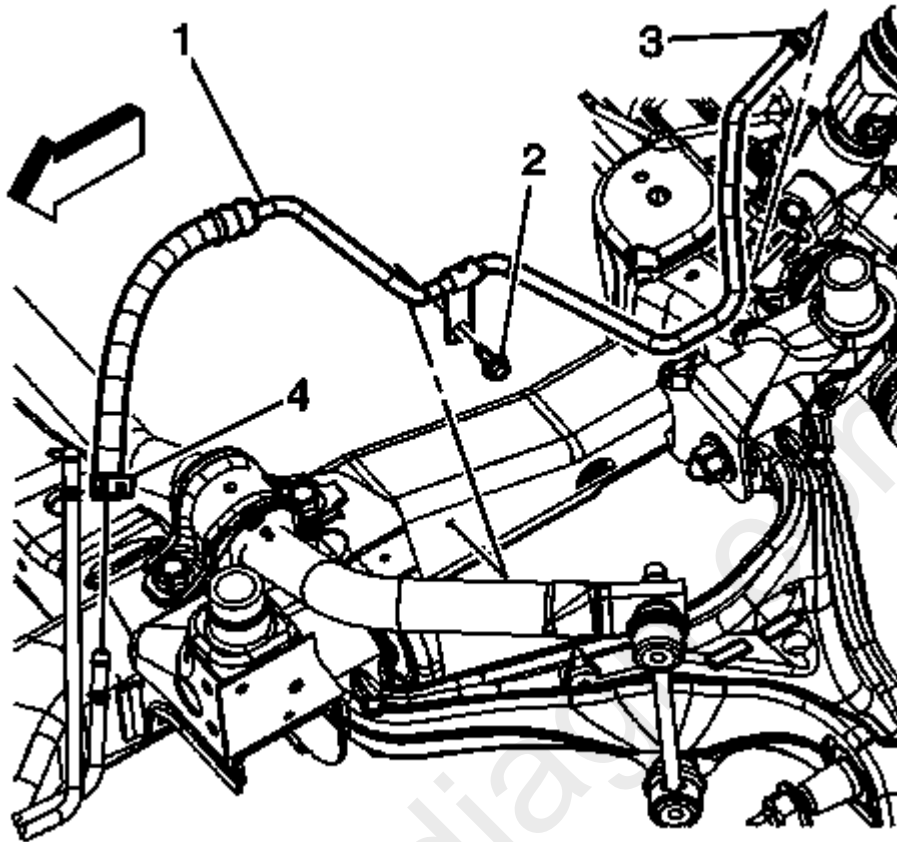


Fig. 82: View of Steering Gear Pipe Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the power steering gear inlet and outlet pipe retainer bolt (2).
7. Disconnect the power steering gear outlet hose (4) from the power steering cooler hose.
8. Remove the power steering gear outlet hose fitting (3) from the steering gear.
9. Remove the power steering gear outlet hose (1) from the vehicle.

Installation Procedure

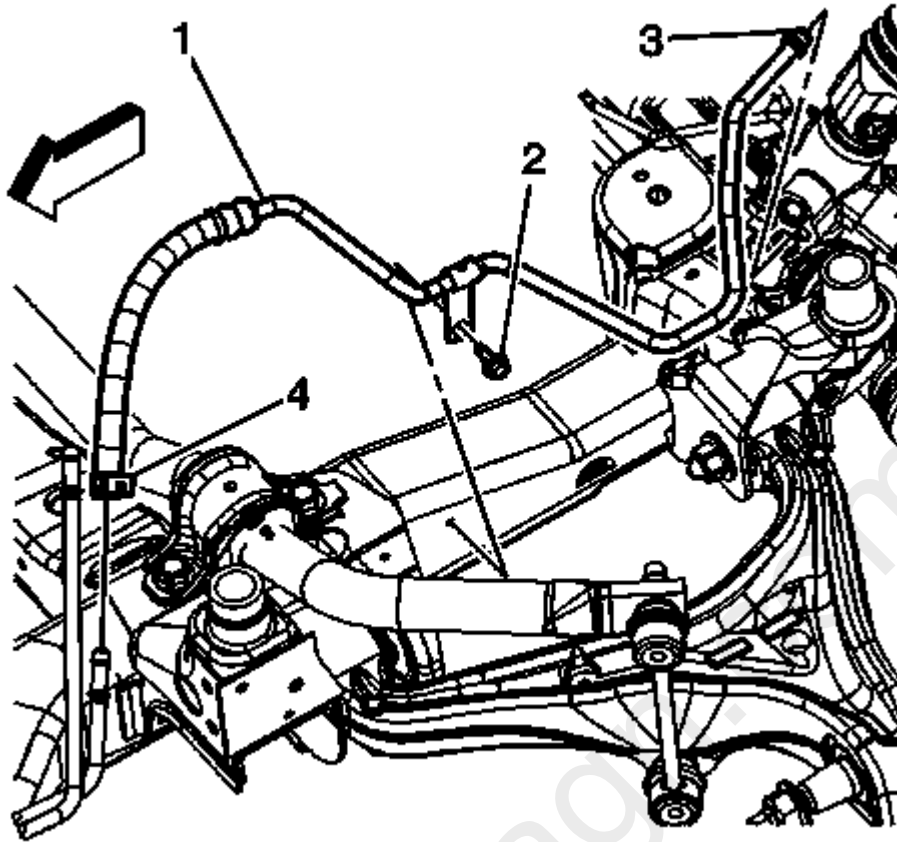


Fig. 83: View of Steering Gear Pipe Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Begin all fasteners by hand before finalizing any torques.**

1. Position the power steering gear outlet hose (1) to the vehicle.
2. Install the power steering gear outlet hose fitting (3) to the steering gear.
3. Connect the power steering gear outlet hose (4) to the power steering cooler hose.

CAUTION: Refer to Fastener Caution .

4. Install the power steering gear inlet and outlet pipe retainer bolt (2) and tighten to 10 N.m (89 lb in).

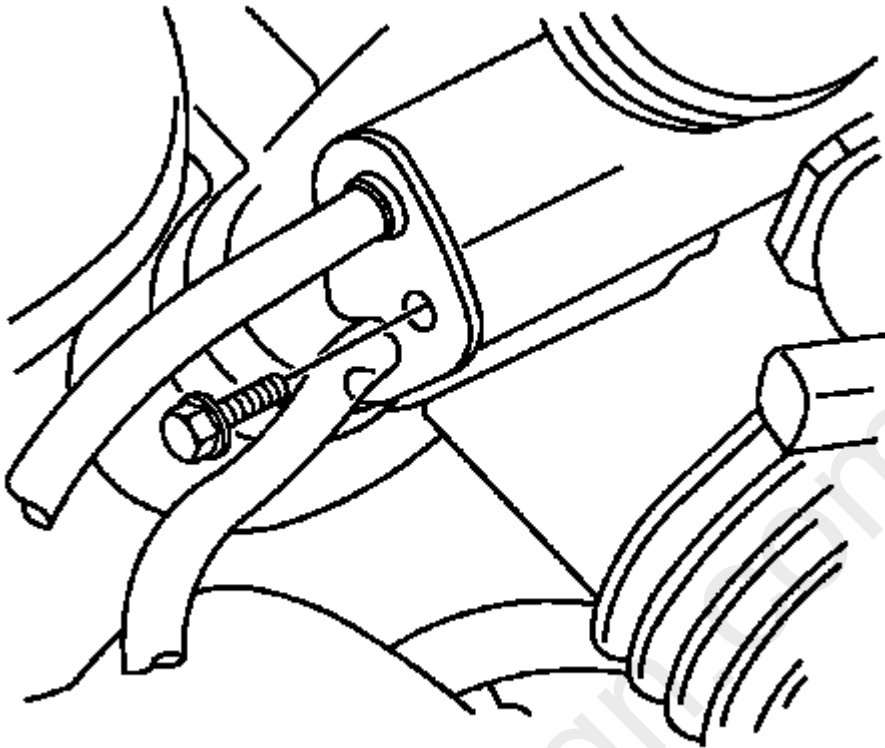


Fig. 84: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the power steering gear inlet hose latch plate bolt and tighten to 22.5 N.m (17 lb ft).
6. Clean any excess fluid from the vehicle and remove the drain pans.
7. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** .
8. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
9. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** .
10. Install the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
11. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.

POWER STEERING GEAR OUTLET PIPE/HOSE REPLACEMENT (LHD WITH LFW, LFX, RWD)

Removal Procedure

1. Remove the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
2. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .

3. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
4. Place drain pans under the vehicle as needed.

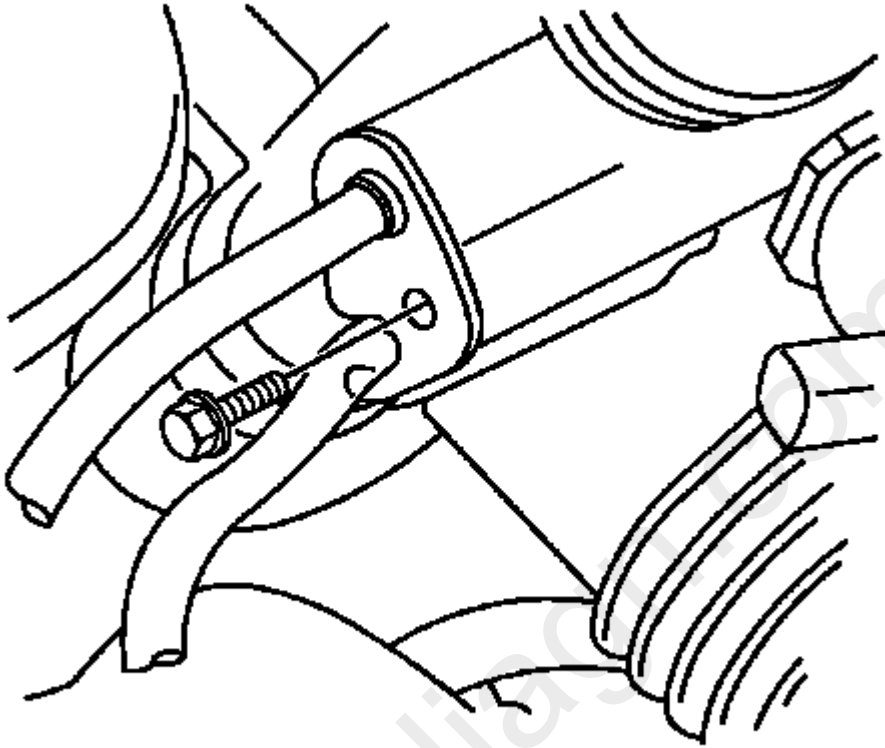


Fig. 85: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power steering gear inlet hose latch plate bolt.

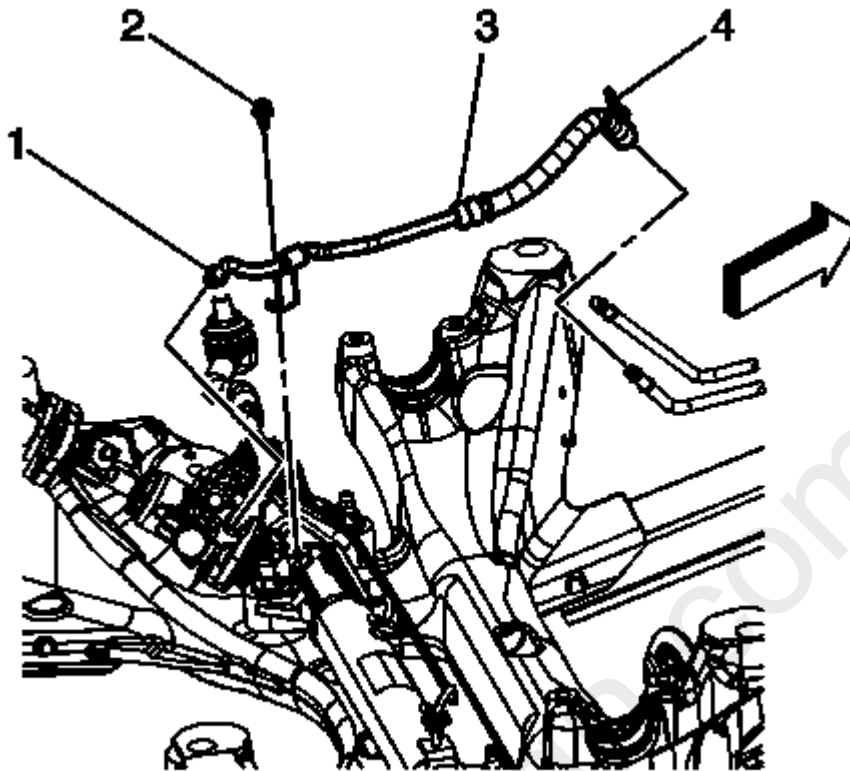


Fig. 86: View of Steering Gear Outlet Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the power steering gear outlet hose bracket bolt (2).
7. Disconnect the power steering gear outlet hose (4) from the power steering cooler hose.
8. Remove the power steering gear outlet hose fitting (1) from the steering gear.
9. Remove the power steering gear outlet hose (3) from the vehicle.

Installation Procedure

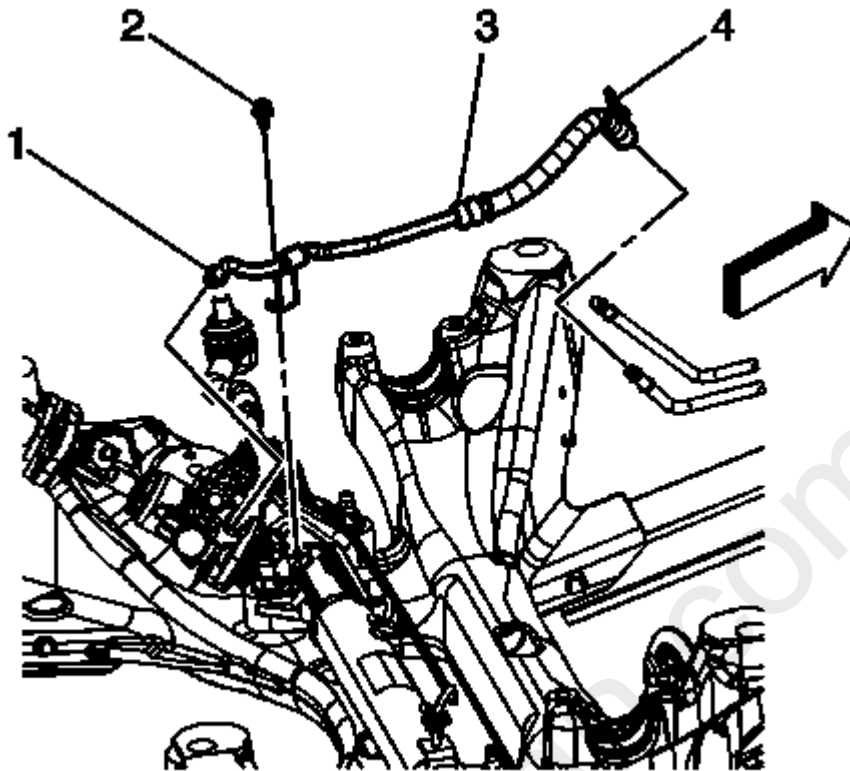


Fig. 87: View of Steering Gear Outlet Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: Begin all fasteners by hand before finalizing any torques.

1. Position the power steering gear outlet hose (3) to the vehicle.
2. Install the power steering gear outlet hose fitting (1) to the steering gear.
3. Connect the power steering gear outlet hose (4) to the power steering cooler hose.

CAUTION: Refer to Fastener Caution .

4. Install the power steering gear outlet hose bracket bolt (2) and tighten to 9 N.m (80 lb in).

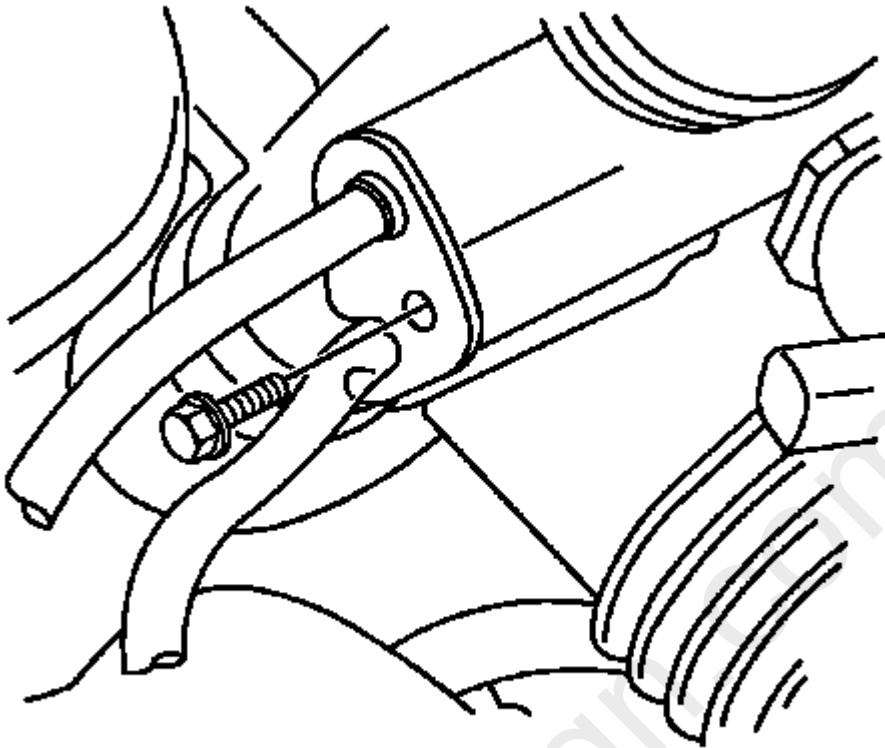


Fig. 88: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the power steering gear inlet hose latch plate bolt and tighten to 22.5 N.m (17 lb ft).
6. Clean any excess fluid from the vehicle and remove the drain pans.
7. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
8. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
9. Install the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
10. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.

POWER STEERING GEAR OUTLET PIPE/HOSE REPLACEMENT (RHD)

Removal Procedure

1. Remove the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
2. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
3. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .

4. Place drain pans under the vehicle as needed.

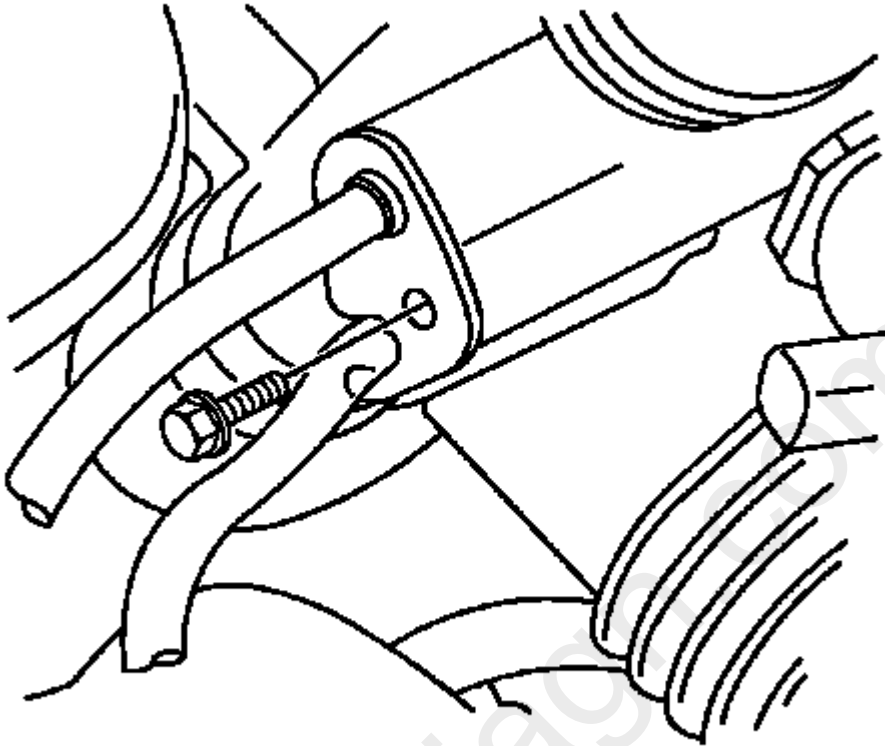


Fig. 89: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power steering gear inlet hose latch plate bolt.

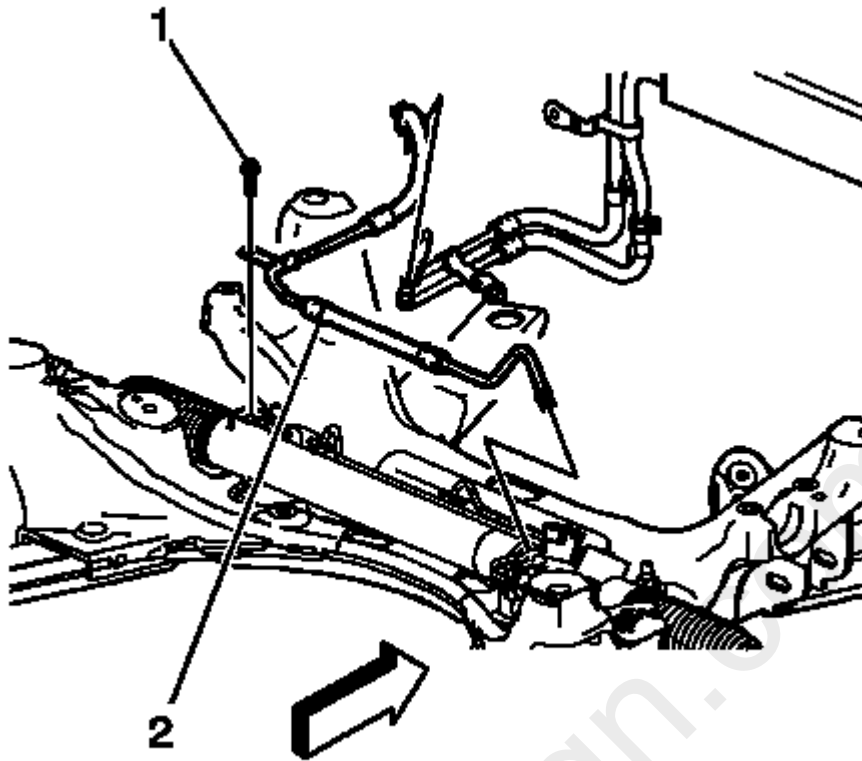


Fig. 90: Identifying Power Steering Gear Inlet Hose Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the power steering gear inlet hose bracket bolt (1).
7. Disconnect the power steering gear outlet hose from the power steering cooler hose.
8. Remove the power steering gear outlet hose fitting from the steering gear.
9. Remove the power steering gear outlet hose (2) from the vehicle.

Installation Procedure

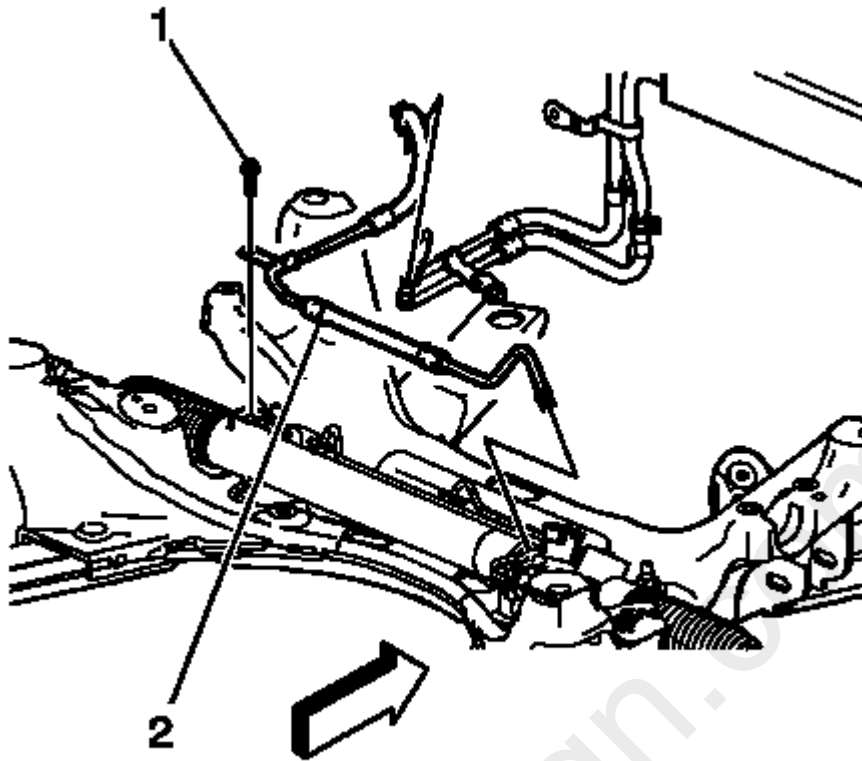


Fig. 91: Identifying Power Steering Gear Inlet Hose Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Begin all fasteners by hand before finalizing any torques.

1. Position the power steering gear outlet hose (2) to the vehicle.
2. Install the power steering gear outlet hose fitting to the steering gear.
3. Connect the power steering gear outlet hose to the power steering cooler hose.

CAUTION: Refer to Fastener Caution .

4. Install the power steering gear inlet hose bracket bolt (1) and tighten to 9 N.m (80 lb in).

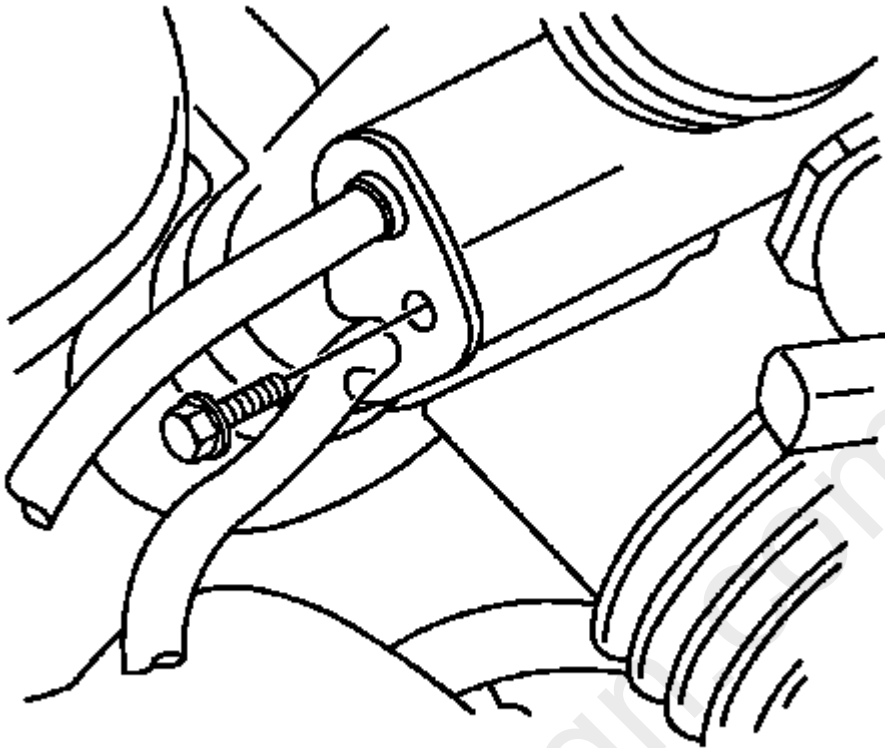


Fig. 92: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the power steering gear inlet hose latch plate bolt and tighten to 22.5 N.m (17 lb ft).
6. Clean any excess fluid from the vehicle and remove the drain pans.
7. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
8. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
9. Install the left front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
10. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.

POWER STEERING GEAR OUTLET PIPE/HOSE REPLACEMENT (LSA)

Removal Procedure

1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Place a drain pan under the vehicle.
3. Siphon the fluid from the power steering fluid reservoir.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

5. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
6. Remove the front compartment lower noise shield if necessary. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
7. Remove the left engine splash shield. Refer to **Engine Splash Shield Replacement** .

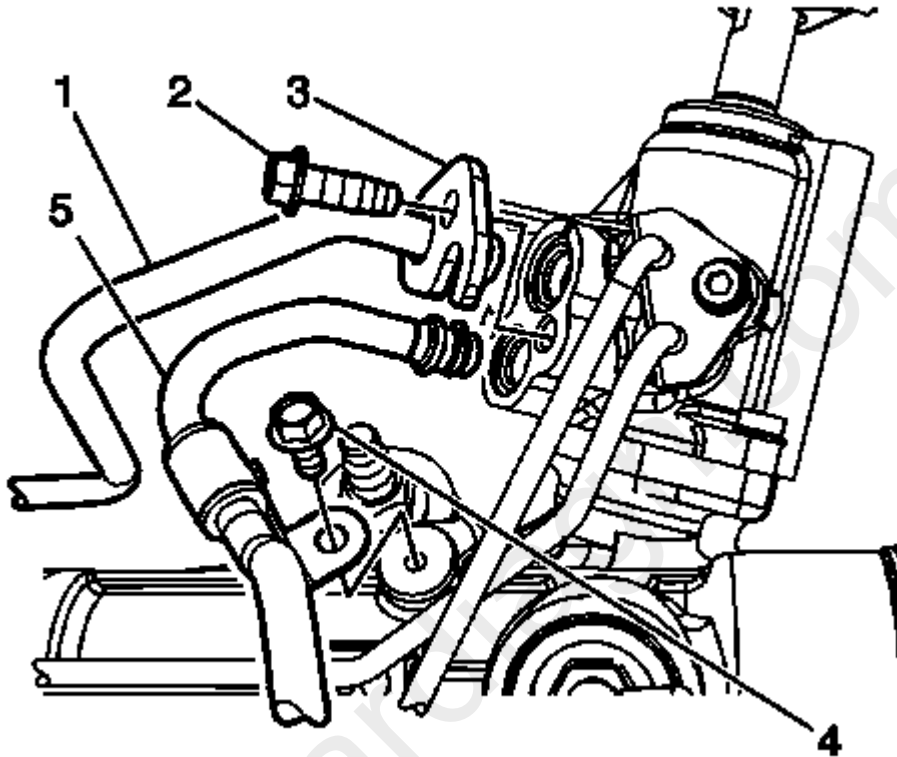


Fig. 93: Identifying Gear Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

8. Remove the gear outlet hose bracket bolt (4).
9. Remove the bolt (2) from the gear inlet hose latch plate (3).
10. Reposition the plate.
11. Remove the power steering gear outlet hose (5) from the steering gear.

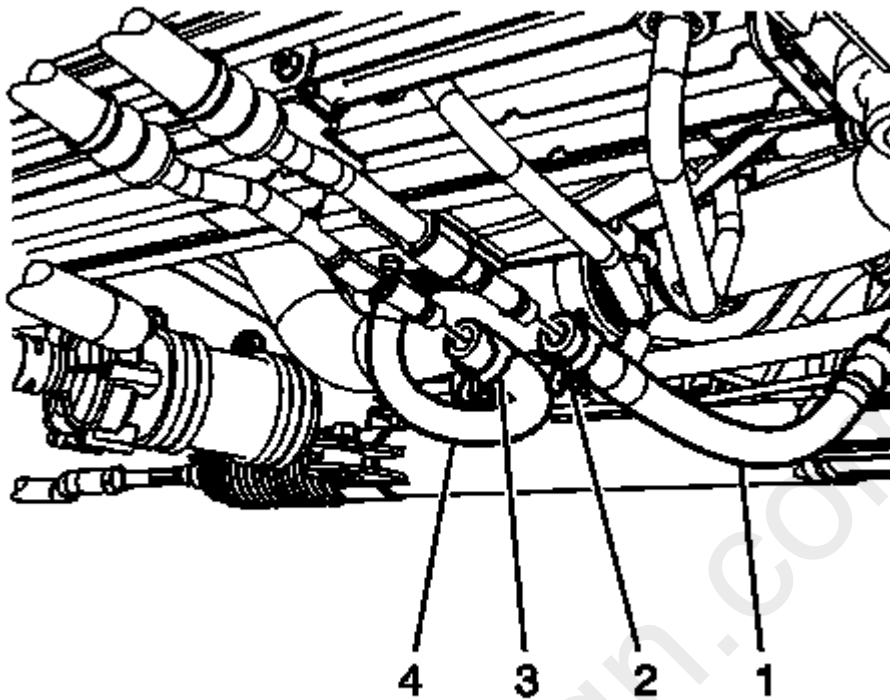


Fig. 94: Identifying Reservoir Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

12. Loosen the clamp (2) and remove the gear outlet hose from the cooler hose.
13. Remove the gear outlet hose from the vehicle.

Installation Procedure

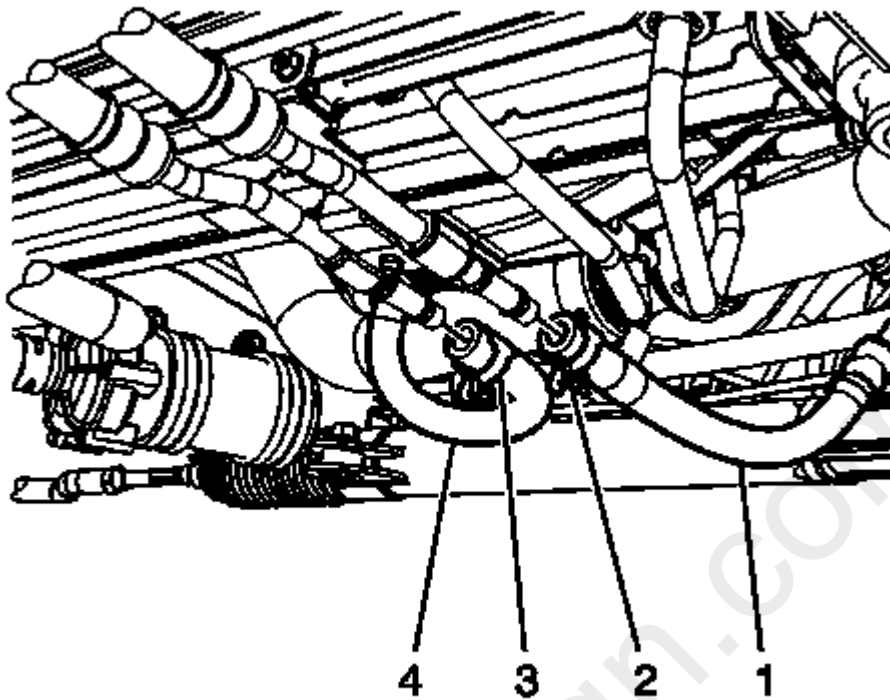


Fig. 95: Identifying Reservoir Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Position the power steering gear outlet hose (1) in the vehicle.
2. Install the gear outlet hose to the cooler hose with the clamp (2).

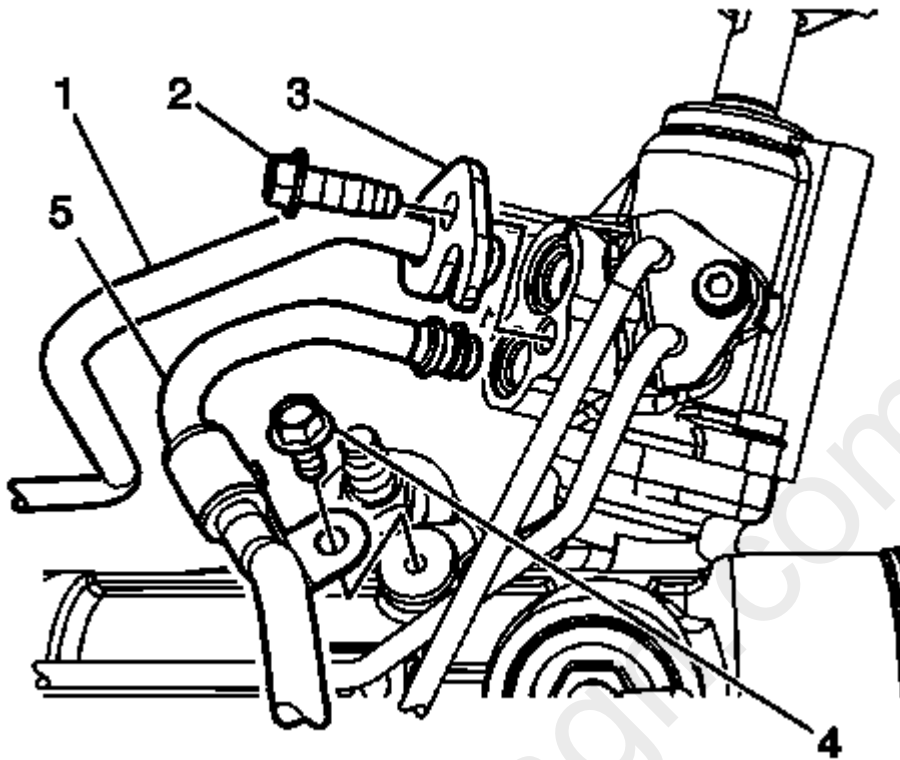


Fig. 96: Identifying Gear Inlet Hose Components
 Courtesy of GENERAL MOTORS COMPANY

3. Install the gear outlet hose (5) to the steering gear.

CAUTION: Refer to Fastener Caution .

4. Install the gear outlet hose bracket bolt (4) and tighten to 9 N.m (80 lb in).
5. Reposition the latch plate (3) onto the gear inlet and outlet hose fittings.
6. Install the latch plate bolt and tighten to 22.5 N.m (17 lb ft).
7. Install the left engine splash shield. Refer to **Engine Splash Shield Replacement** .
8. If you removed the front compartment lower noise shield, install the shield. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
9. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
10. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
11. Remove the drain pan.
12. Lower the vehicle.
13. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

STEERING GEAR PIPE AND SEAL REPLACEMENT

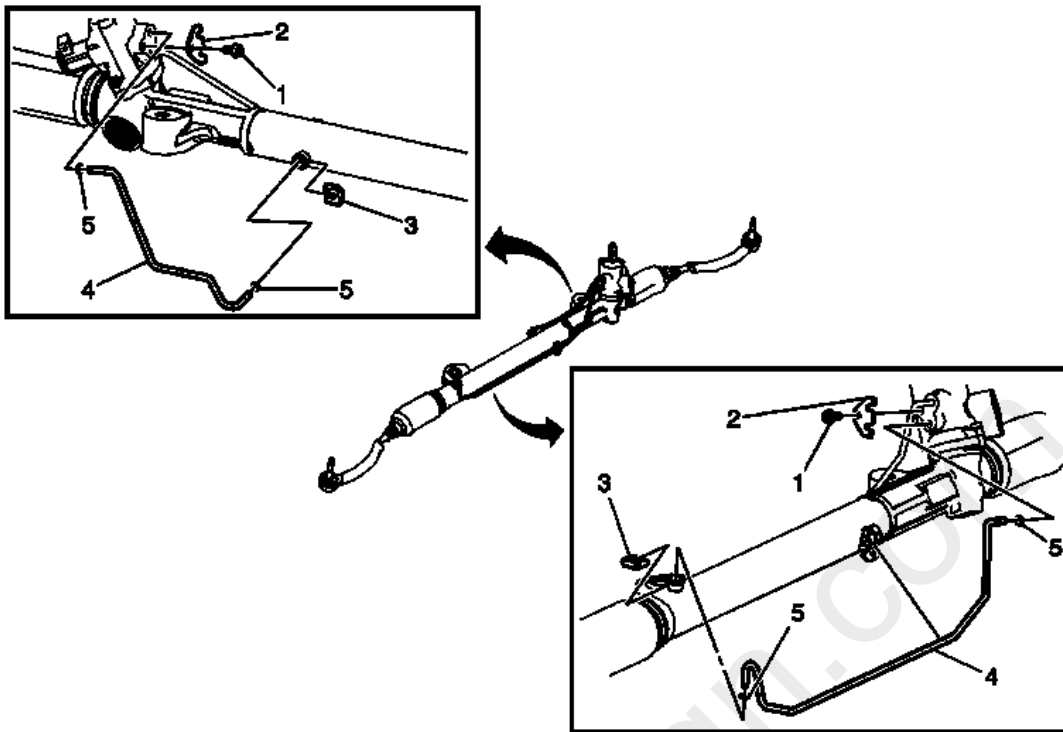


Fig. 97: Steering Gear Pipe And Seal
Courtesy of GENERAL MOTORS COMPANY

Steering Gear Pipe and Seal Replacement

Callout	Component Name
Preliminary Procedure Remove the steering gear. Refer to <u>Steering Gear Replacement (RHD)</u> , <u>Steering Gear Replacement (LHD With AWD)</u> , <u>Steering Gear Replacement (LHD With RWD)</u> .	
1	Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)
2	Steering Gear Pipe retainer
3	Steering Gear Clip
4	Steering Gear Pipe
5	Steering Gear Pipe Seal

STEERING GEAR REPLACEMENT (LHD WITH AWD)

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture** .
2. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
3. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** .
4. Place drain pans under the vehicle as necessary.
5. Separate the lower intermediate steering shaft from the steering gear. Refer to **Lower Intermediate Steering Shaft Replacement** .
6. Separate the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement (AWD)**.
7. Separate the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (AWD)** .

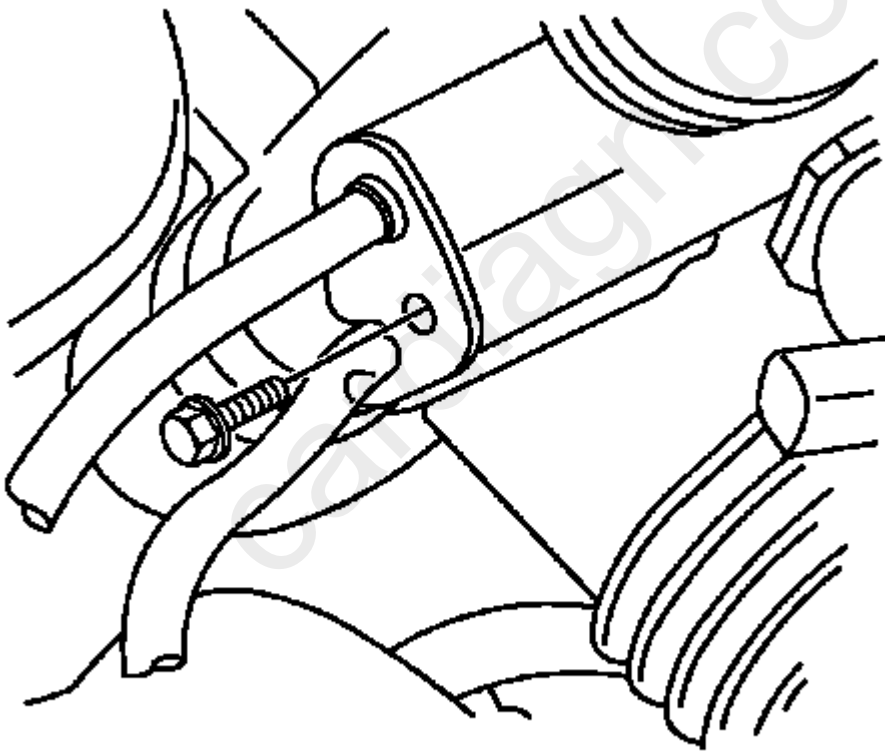


Fig. 98: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power steering gear inlet pipe bracket bolt.
9. Remove any fasteners attaching the power steering gear inlet and outlet hoses to the frame. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX)**, **Power Steering Gear**

Inlet Pipe/Hose Replacement (LFW, LFX) and Power Steering Gear Outlet Pipe/Hose Replacement (AWD).

10. Separate the power steering gear inlet and outlet hoses from the steering gear.
11. Support the front frame with jackstands as necessary.
12. Remove the left and right side engine mount bolts from the front frame. Refer to **Engine Mount Replacement - Left Side (AWD)** , and **Engine Mount Replacement - Right Side (AWD)** .
13. Disconnect any electrical harnesses from the front frame as necessary.
14. Disconnect the power steering gear solenoid electrical connector.
15. Remove the front frame bolts. Refer to **Drivetrain and Front Suspension Frame Replacement (All Wheel Drive)** .
16. Slowly lift the vehicle on the hoist until there is enough room to remove the steering gear from the vehicle.

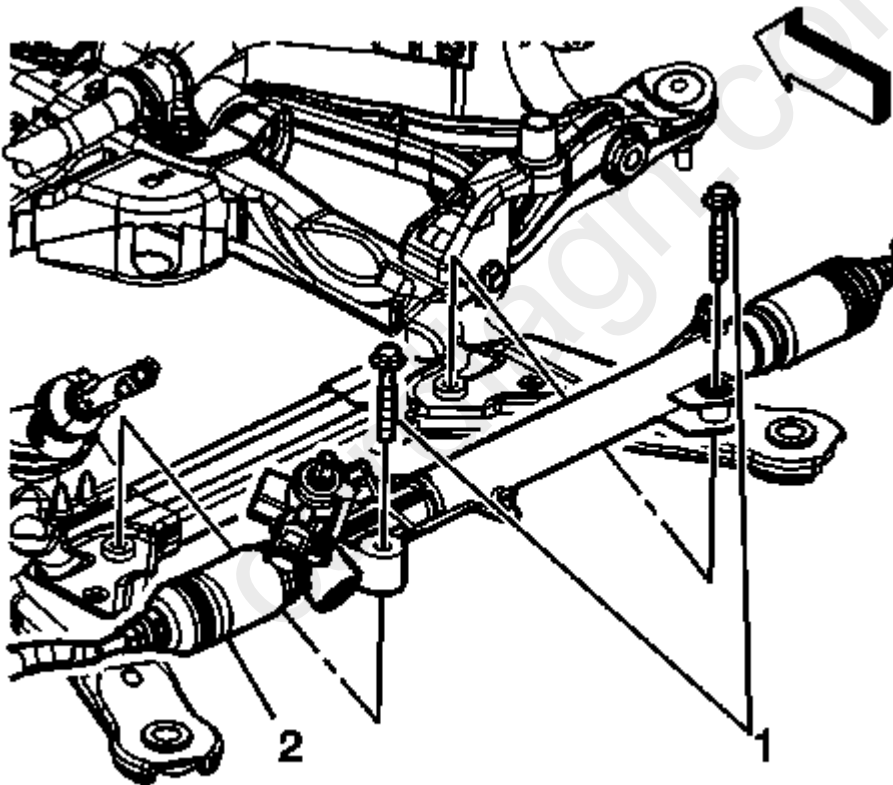


Fig. 99: View of Steering Gear Assembly
Courtesy of GENERAL MOTORS COMPANY

17. Remove the steering gear bolts (1).
18. Remove the steering gear (2) from the front frame.
19. If you are replacing the steering gear, remove the steering linkage outer tie rods.

Installation Procedure

1. If you are replacing the steering gear, install the steering linkage outer tie rods.

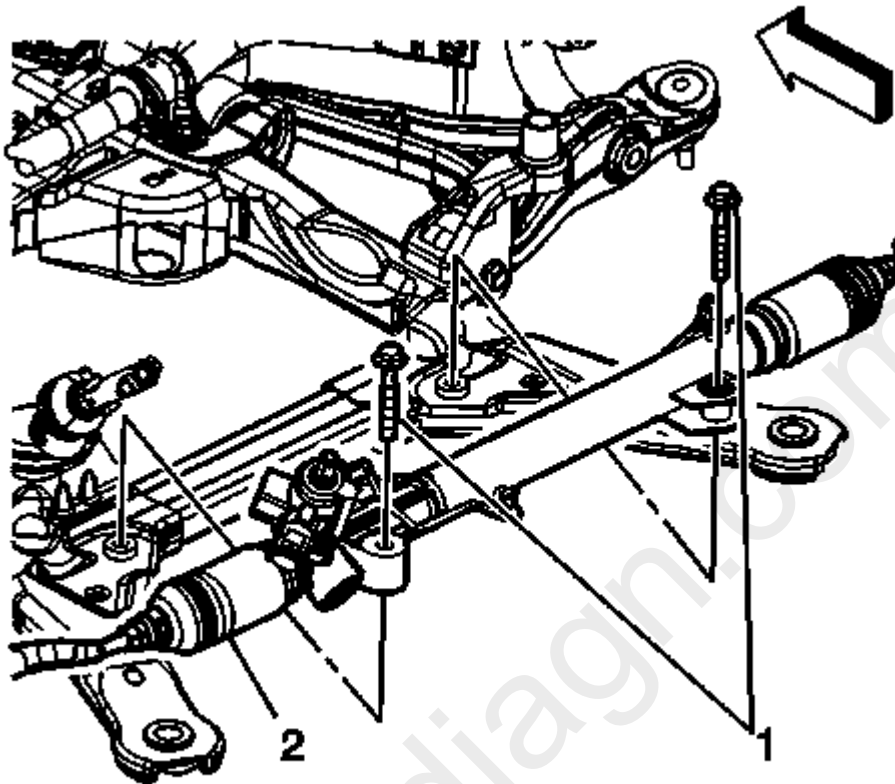


Fig. 100: View of Steering Gear Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Position the steering gear (2) to the front frame.

CAUTION: Refer to Fastener Caution

3. Install the steering gear bolts (1) and tighten to 60 N.m (44 lb ft).
4. Tighten the steering gear bolts an additional 80 degrees.
5. Slowly lower the vehicle on the hoist while keeping the front frame aligned with the left and right side engine mounts.
6. Start the engine mount bolts by hand.
7. Install the front frame bolts. Refer to **Drivetrain and Front Suspension Frame Replacement (All Wheel Drive)** .
8. Torque the engine mount bolts. Refer to **Engine Mount Replacement - Left Side (AWD)** , and **Engine**

Mount Replacement - Right Side (AWD) .

9. Connect the power steering gear solenoid electrical connector.
10. Connect any electrical harnesses to the front frame as necessary.
11. Remove the jackstands from underneath the vehicle.

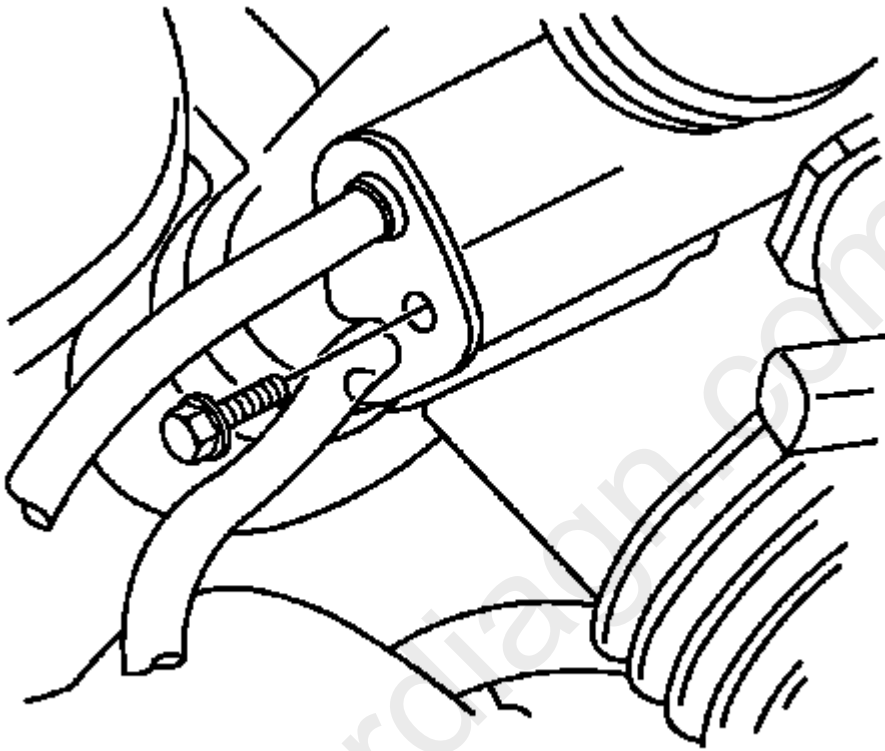


Fig. 101: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Connect the power steering gear inlet and outlet hoses to the steering gear. Install the power steering gear inlet pipe bracket bolt and tighten to 22.5 N.m (17 lb ft).
13. Install any fasteners attaching the power steering gear inlet and outlet hoses to the frame. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX)**, and to **Power Steering Gear Outlet Pipe/Hose Replacement (AWD)**.
14. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (AWD)** .
15. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement (AWD)**.
16. Connect the lower intermediate steering shaft to the steering gear. Refer to **Lower Intermediate Steering Shaft Replacement** .

17. Clean any excess fluid from the vehicle and remove the drain pans.
18. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** .
19. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
20. Remove the engine support fixture. Refer to **Engine Support Fixture** .
21. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
22. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

STEERING GEAR REPLACEMENT (LHD WITH RWD)

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture** .
2. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
3. Remove the front compartment lower noise shield, if equipped. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
4. Place drain pans under the vehicle as necessary.
5. Separate the lower intermediate steering shaft from the steering gear. Refer to **Lower Intermediate Steering Shaft Replacement** .
6. Separate the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement (RWD)**.
7. Separate the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (RWD)** .
8. Separate the power steering gear inlet and outlet hoses from the steering gear and the frame. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LSA)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX)**, and **Power Steering Gear Outlet Pipe/Hose Replacement (LSA)**, **Power Steering Gear Outlet Pipe/Hose Replacement (LHD With LFW, LFX, RWD)**.
9. Support the front frame with jack stands as necessary.
10. Remove the left and right side engine mount bolts from the front frame. Refer to **Engine Mount Replacement - Left Side (RWD)** , and **Engine Mount Replacement - Right Side (RWD)** .
11. Disconnect any electrical harnesses from the front frame as necessary.
12. Disconnect the power steering gear solenoid electrical connector.
13. Remove the front frame bolts. Refer to **Drivetrain and Front Suspension Frame Replacement (Rear Wheel Drive)** .
14. Slowly lift the vehicle on the hoist until there is enough room to remove the steering gear from the vehicle.

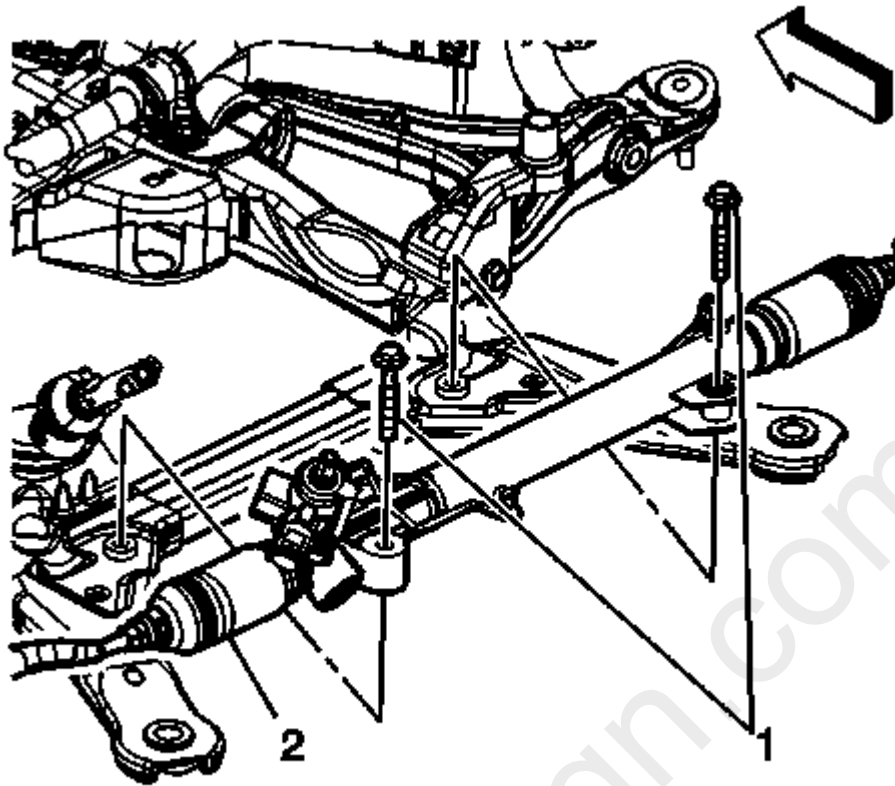


Fig. 102: View of Steering Gear Assembly
Courtesy of GENERAL MOTORS COMPANY

15. Remove the steering gear nuts and bolts (1).
16. Remove the steering gear from the front frame.
17. If you are replacing the steering gear, remove the steering linkage outer tie rods.

Installation Procedure

1. If you are replacing the steering gear, install the steering linkage outer tie rods.

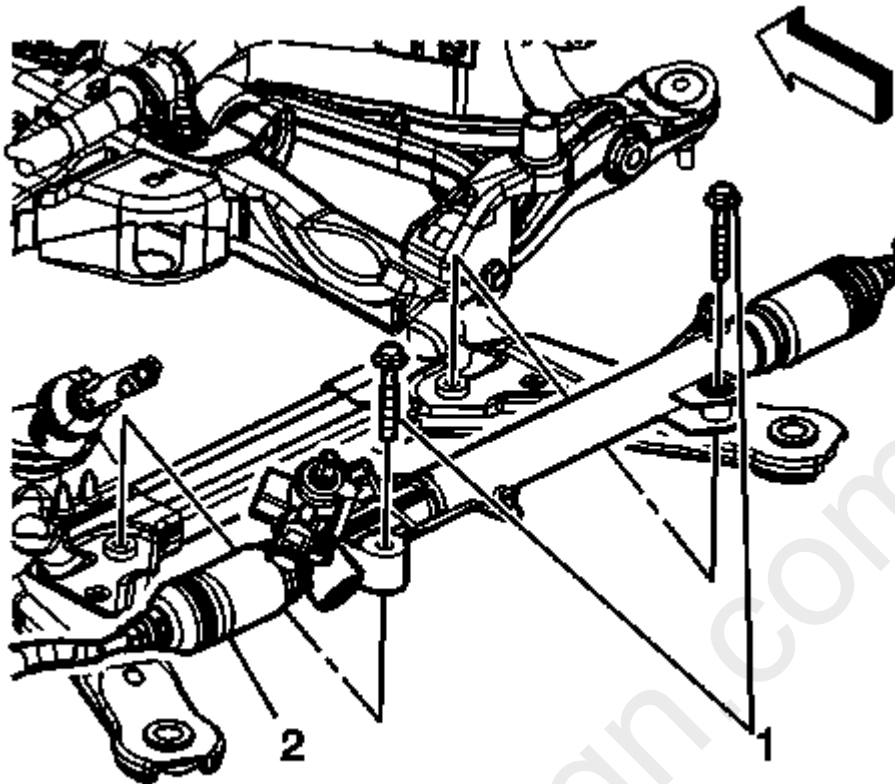


Fig. 103: View of Steering Gear Assembly
 Courtesy of GENERAL MOTORS COMPANY

2. Position the steering gear to the front frame.

CAUTION: Refer to Fastener Caution

3. Install the steering gear nuts and bolts (1) and tighten to 85 N.m (63 lb ft).
4. Slowly lower the vehicle on the hoist while keeping the front frame aligned with the left and right side engine mounts.
5. Start the engine mount bolts by hand.
6. Install the front frame bolts. Refer to **Drivetrain and Front Suspension Frame Replacement (Rear Wheel Drive)** .
7. Torque the engine mount bolts. Refer to **Engine Mount Replacement - Left Side (RWD)** , and **Engine Mount Replacement - Right Side (RWD)** .
8. Connect the power steering gear solenoid electrical connector.
9. Connect any electrical harnesses to the front frame as necessary.
10. Remove the jack stands from underneath the vehicle.

11. Install the power steering gear inlet and outlet hoses to the steering gear and the frame. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LSA)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LHD With LFW, LFX)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX)**, and **Power Steering Gear Outlet Pipe/Hose Replacement (LSA)**, **Power Steering Gear Outlet Pipe/Hose Replacement (LHD With LFW, LFX, RWD)**.
12. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (RWD)** .
13. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement (RWD)**.
14. Connect the lower intermediate steering shaft to the steering gear. Refer to **Lower Intermediate Steering Shaft Replacement** .
15. Clean any excess fluid from the vehicle and remove the drain pans.
16. Install the front compartment lower noise shield, if equipped. Refer to **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
17. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
18. Remove the engine support fixture. Refer to **Engine Support Fixture** .
19. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
20. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

STEERING GEAR REPLACEMENT (RHD)

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture** .
2. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
3. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (All Wheel Drive)** , **Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive)** .
4. Place drain pans under the vehicle as needed.
5. Separate the lower intermediate steering shaft from the steering gear. Refer to **Lower Intermediate Steering Shaft Replacement** .
6. Separate the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement (RWD)**, **Steering Linkage Outer Tie Rod Replacement (AWD)**.
7. Separate the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (RWD)** , **Lower Control Arm Replacement (AWD)** .

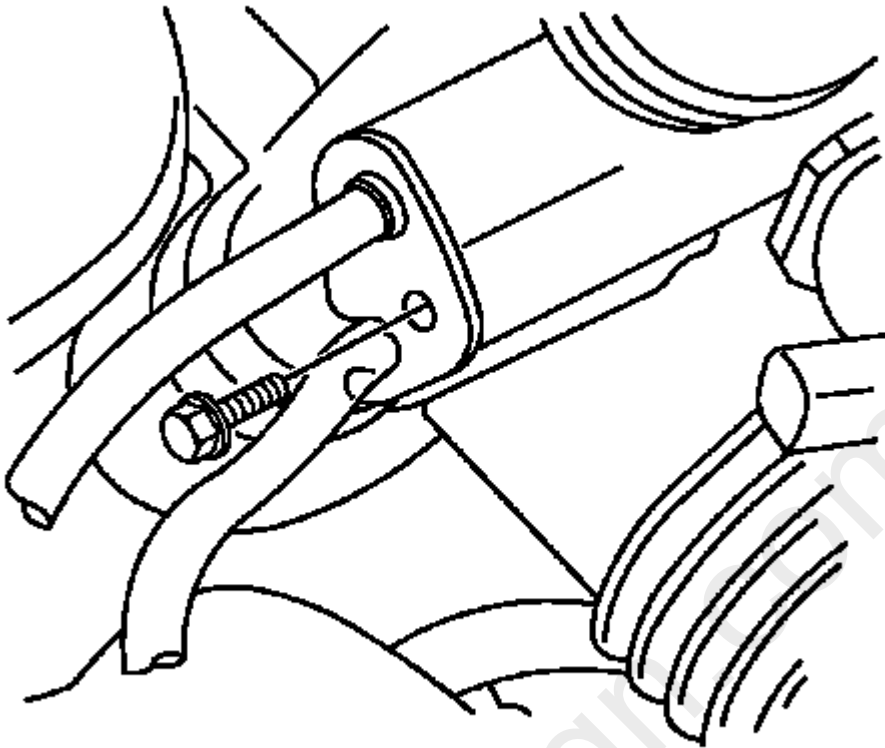


Fig. 104: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power steering gear inlet pipe bracket bolt.
9. Remove any fasteners attaching the power steering gear inlet and outlet hoses to the frame. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LSA)**, **Power Steering Gear Inlet Pipe/Hose Replacement (RHD)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX)**, and **Power Steering Gear Outlet Pipe/Hose Replacement (AWD)**, **Power Steering Gear Outlet Pipe/Hose Replacement (LSA)**.
10. Separate the power steering gear inlet and outlet hoses from the steering gear.
11. Support the front frame with jackstands as needed.
12. Remove the left and right side engine mount bolts from the front frame. Refer to **Engine Mount Replacement - Left Side (RWD)** , **Engine Mount Replacement - Left Side (AWD)** , and **Engine Mount Replacement - Right Side (RWD)** , **Engine Mount Replacement - Right Side (AWD)** .
13. Disconnect any electrical harnesses from the front frame as needed.
14. Disconnect the power steering gear solenoid electrical connector.
15. Remove the front frame bolts. Refer to **Drivetrain and Front Suspension Frame Replacement (All Wheel Drive)** , **Drivetrain and Front Suspension Frame Replacement (Rear Wheel Drive)** .
16. Slowly lift the vehicle on the hoist until there is enough room to remove the steering gear from the vehicle.

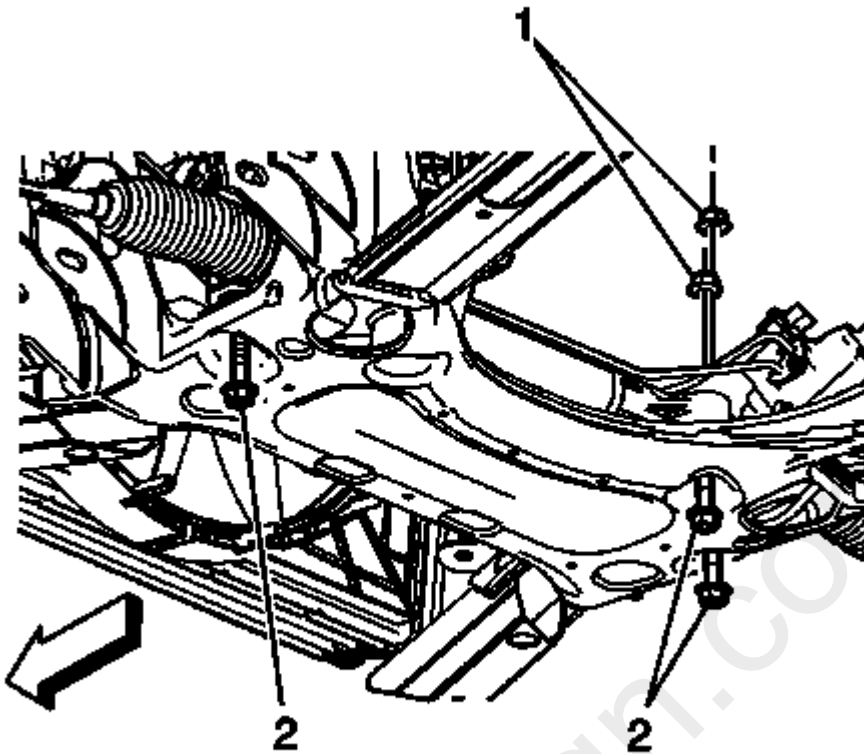


Fig. 105: Identifying Steering Gear Nuts & Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the steering gear nuts (1) and bolts (2).
18. Remove the steering gear from the front frame.
19. If you are replacing the steering gear, remove the steering linkage outer tie rods.

Installation Procedure

1. If you are replacing the steering gear, install the steering linkage outer tie rods.

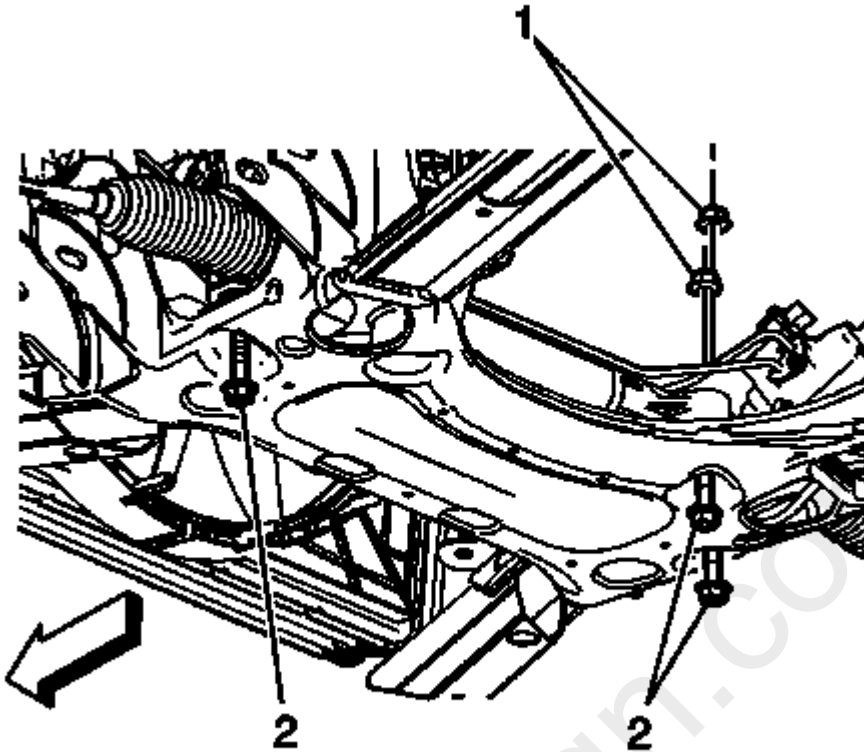


Fig. 106: Identifying Steering Gear Nuts & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Position the steering gear to the front frame.

CAUTION: Refer to Fastener Caution .

3. Install the steering gear nuts (1) and bolts (2) and tighten to 85 N.m (63 lb ft).
4. Slowly lower the vehicle on the hoist while keeping the front frame aligned with the left and right side engine mounts.
5. Start the engine mount bolts by hand.
6. Install the front frame bolts. Refer to **Drivetrain and Front Suspension Frame Replacement (All Wheel Drive)** , **Drivetrain and Front Suspension Frame Replacement (Rear Wheel Drive)** .
7. Torque the engine mount bolts. Refer to **Engine Mount Replacement - Left Side (RWD)** , **Engine Mount Replacement - Left Side (AWD)** , and **Engine Mount Replacement - Right Side (RWD)** , **Engine Mount Replacement - Right Side (AWD)** .
8. Connect the power steering gear solenoid electrical connector.
9. Connect any electrical harnesses to the front frame as needed.

10. Remove the jackstands from underneath the vehicle.

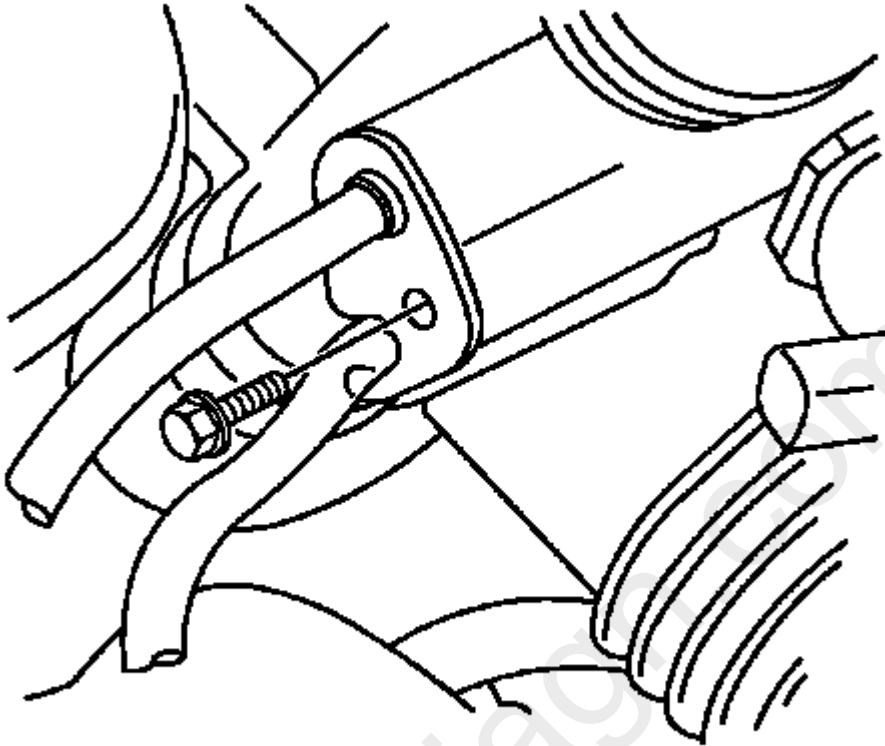


Fig. 107: View Of Power Steering Gear Inlet Hose-To-Power Steering Gear Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Connect the power steering gear inlet and outlet hoses to the steering gear. Install the power steering gear inlet pipe bracket bolt and tighten to 22.5 N.m (17 lb ft).
12. Install any fasteners attaching the power steering gear inlet and outlet hoses to the frame. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement (LSA)**, **Power Steering Gear Inlet Pipe/Hose Replacement (RHD)**, **Power Steering Gear Inlet Pipe/Hose Replacement (LFW, LFX)**, and **Power Steering Gear Outlet Pipe/Hose Replacement (RHD)**, **Power Steering Gear Outlet Pipe/Hose Replacement (AWD)**, **Power Steering Gear Outlet Pipe/Hose Replacement (LSA)**.
13. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (RWD)** , **Lower Control Arm Replacement (AWD)** .
14. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement (RWD)**, **Steering Linkage Outer Tie Rod Replacement (AWD)**.
15. Connect the lower intermediate steering shaft to the steering gear. Refer to **Lower Intermediate Steering Shaft Replacement** .
16. Clean any excess fluid from the vehicle and remove the drain pans.
17. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield**

Replacement (All Wheel Drive) , Front Compartment Lower Noise Shield Replacement (Rear Wheel Drive) .

- 18. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
- 19. Remove the engine support fixture. Refer to **Engine Support Fixture** .
- 20. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
- 21. Measure and adjust the front toe. refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

STEERING LINKAGE INNER TIE ROD REPLACEMENT (ALL WHEEL DRIVE)

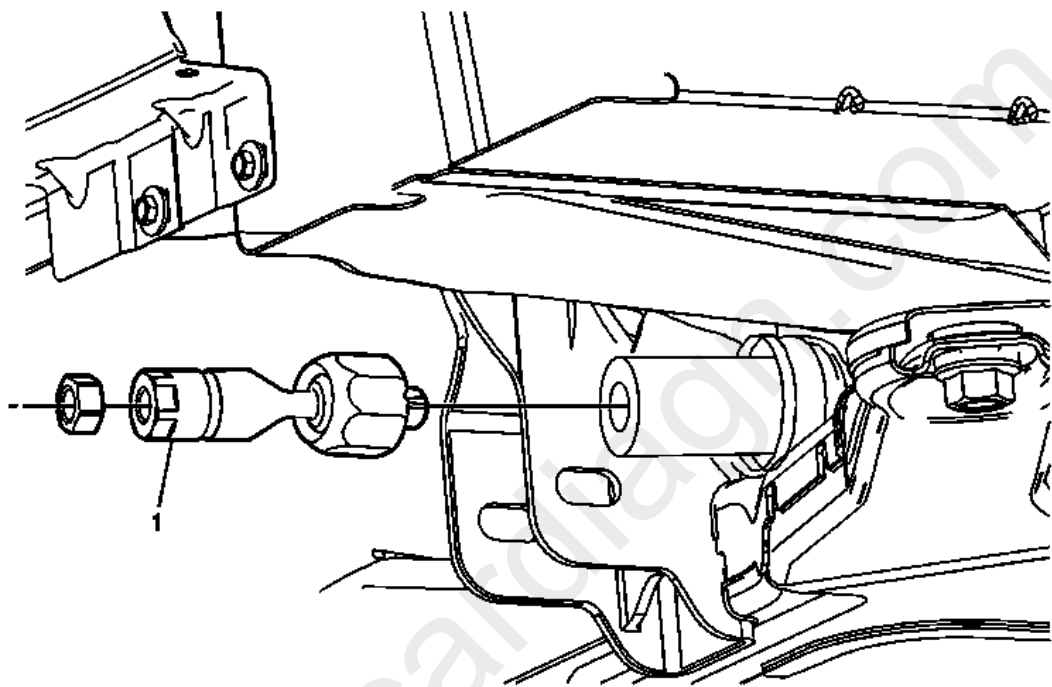


Fig. 108: Steering Linkage Inner Tie Rod (All Wheel Drive)
Courtesy of GENERAL MOTORS COMPANY

Steering Linkage Inner Tie Rod Replacement (All Wheel Drive)

Callout	Component Name
Preliminary Procedure	
Remove the steering gear boot. Refer to <u>Steering Gear Boot Replacement (AWD)</u> .	
1	Steering Linkage Inner Tie Rod CAUTION: Refer to <u>Fastener Caution</u> . Procedure

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

100 N.m (74 lb ft)

STEERING LINKAGE INNER TIE ROD REPLACEMENT (REAR WHEEL DRIVE)

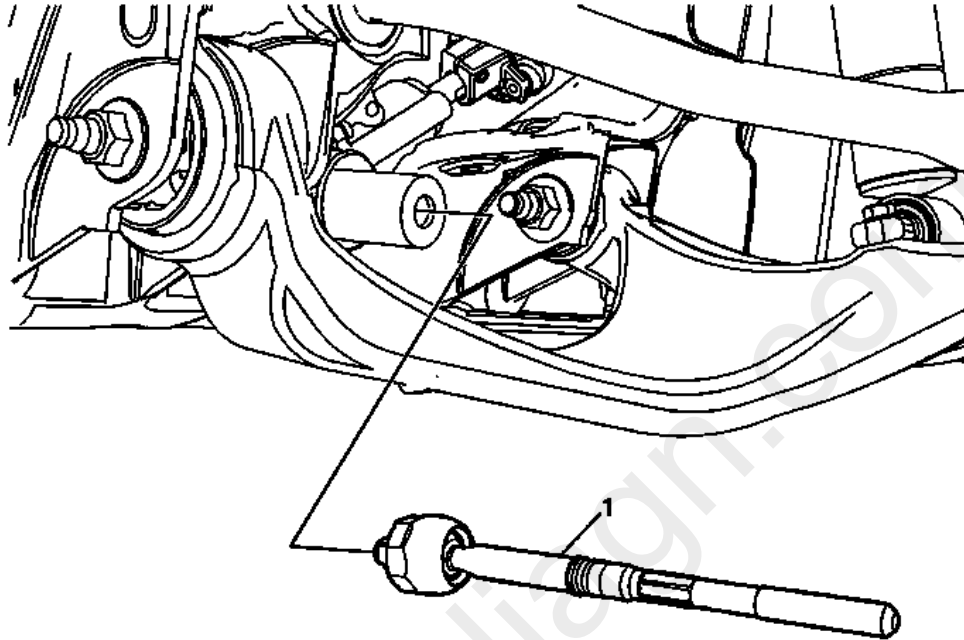


Fig. 109: Steering Linkage Inner Tie Rod (Rear Wheel Drive)

Courtesy of GENERAL MOTORS COMPANY

Steering Linkage Inner Tie Rod Replacement (Rear Wheel Drive)

Callout	Component Name
Preliminary Procedure	
Remove the steering gear boot. Refer to <u>Steering Gear Boot Replacement (RWD)</u> .	
1	Steering Linkage Inner Tie Rod End CAUTION: Refer to <u>Fastener Caution</u> . Procedure After installing the steering linkage inner tie rod, measure and adjust the front toe. refer to <u>Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment</u> . Tighten 100 N.m (74 lb ft)

STEERING GEAR VALVE SOLENOID REPLACEMENT

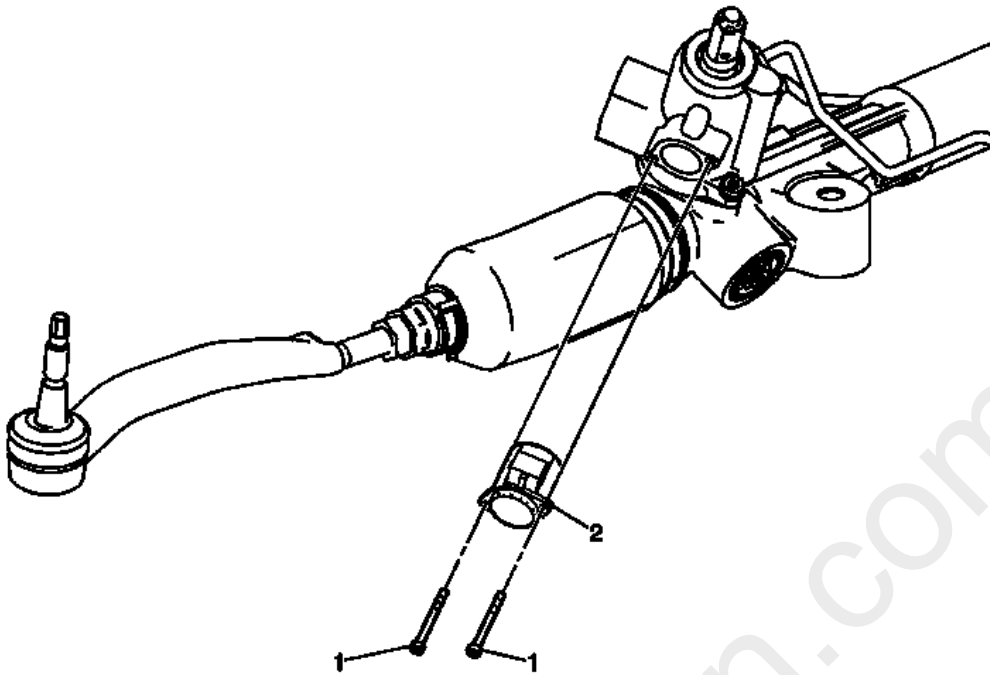


Fig. 110: Power Steering Gear Solenoid/Actuator
Courtesy of GENERAL MOTORS COMPANY

Steering Gear Valve Solenoid Replacement

Callout	Component Name
Preliminary Procedure Hoist the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Power Steering Gear Solenoid Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3 N.m (27 lb in)
2	Power Steering Gear Solenoid Procedure 1. Disconnect any electrical connectors as needed. 2. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u> . • Before repairs, place drain pans under the vehicle as needed.

- After repairs, clean any excess fluid from the vehicle and remove the drain pans.

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 pump is either belt-driven or direct cam-driven.

The power steering fluid reservoir holds the power steering fluid. The power steering fluid reservoir may be integral with the power steering pump or remotely located. The vehicle may have a combination of a power steering fluid reservoir integral with the power steering pump and a remotely located power steering fluid reservoir. 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. An intermediate rod moves 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 hose 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 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.

VARIABLE EFFORT STEERING SYSTEM DESCRIPTION AND OPERATION

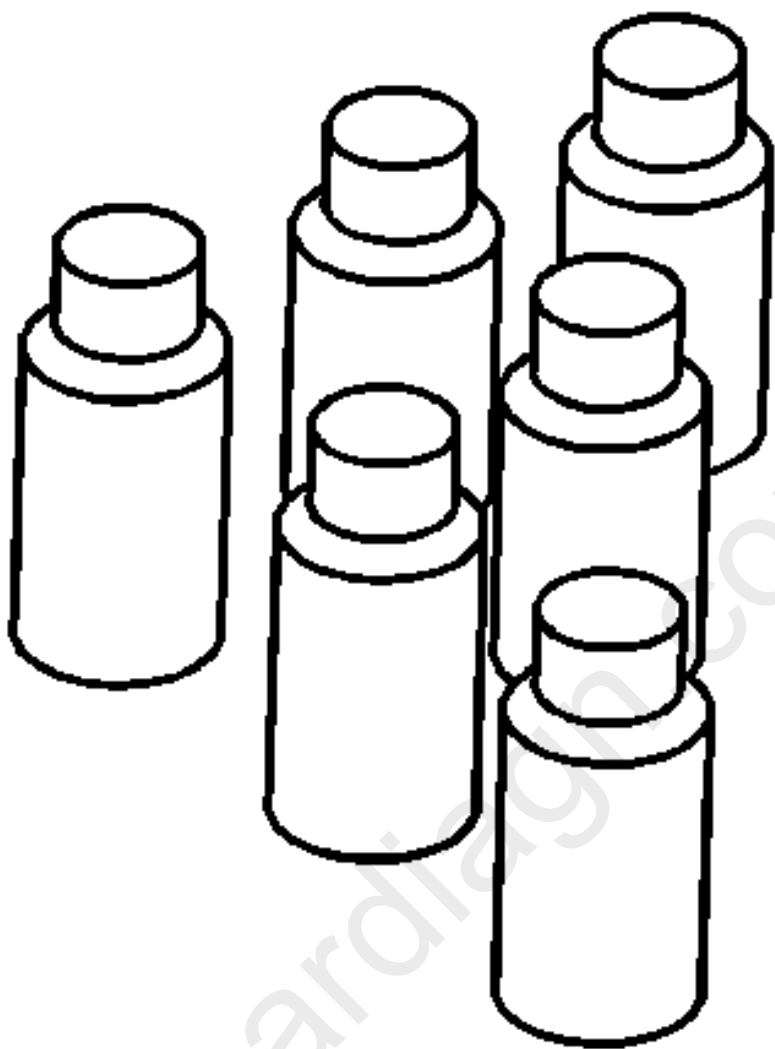
The variable effort steering (VES) system varies the amount of effort to steer the vehicle as wheel speed changes or lateral acceleration occurs. The electronic brake control module (EBCM) controls an actuator located in the steering rack and pinion. The actuator consists of an electromagnetic coil and a normally open pintle valve. The valve regulates an orifice that bleeds inlet pressure through a return passage to regulate the amount of pressure available for steering assist. The EBCM commands current from 0-1 amp to the VES actuator which varies the amount of effort required to steer the vehicle. At low speeds, 1 amp of current is commanded to the VES actuator and the pintle valve is fully closed which provides maximum pressure and maximum steering assist for easy turning and parking maneuvers. As speed increases, current is decreased and the pintle valve opens the orifice, decreasing available pressure providing firmer steering and directional stability. The VES system uses the steering wheel position sensor input to calculate lateral acceleration during abrupt driving maneuvers. The system also uses the antilock brake system (ABS) wheel speed sensor inputs to determine vehicle speed. The EBCM is constantly monitoring these inputs to achieve the desired current to the VES actuator. The EBCM has the ability to detect malfunctions in the VES actuator or the circuits to the actuator. Any malfunctions detected will cause the VES outputs to be disabled, and the actuator will return to an open state. The EBCM will command the driver information center (DIC) to display the SERVICE STEERING SYS warning message via the high speed GMLAN serial data circuit.

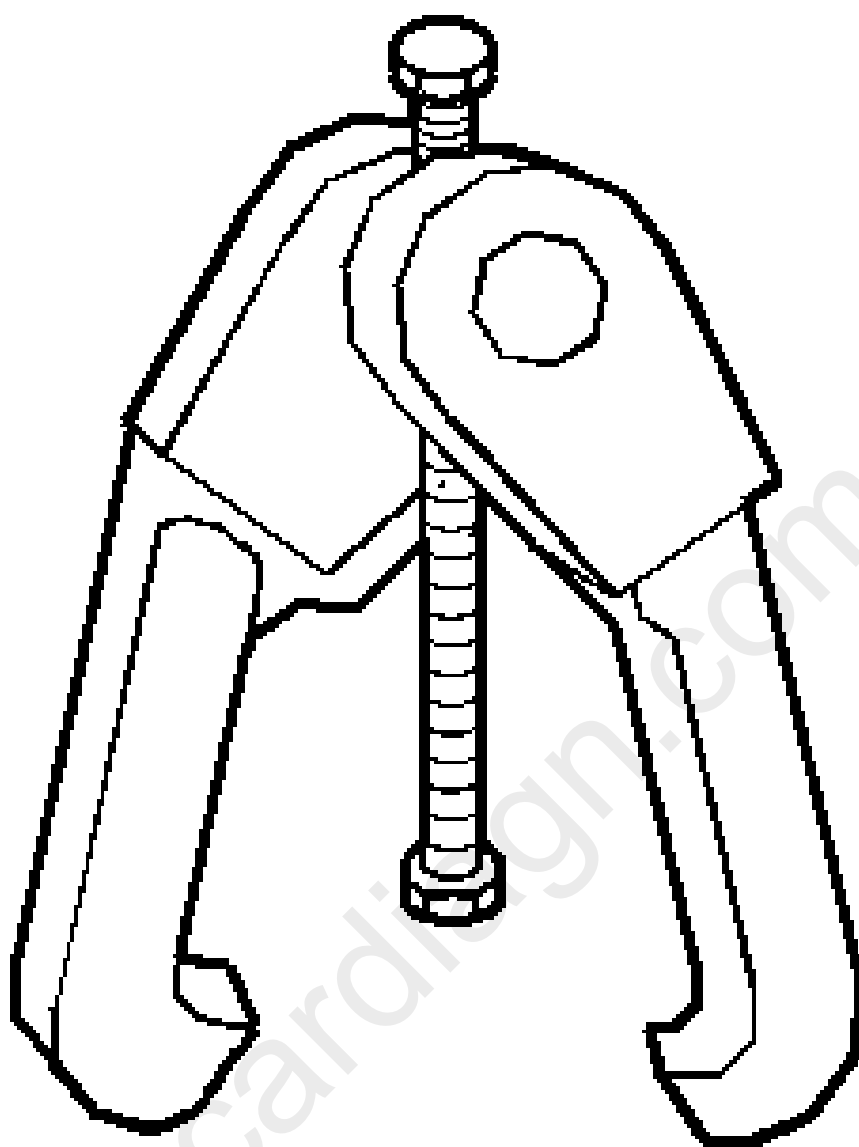
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

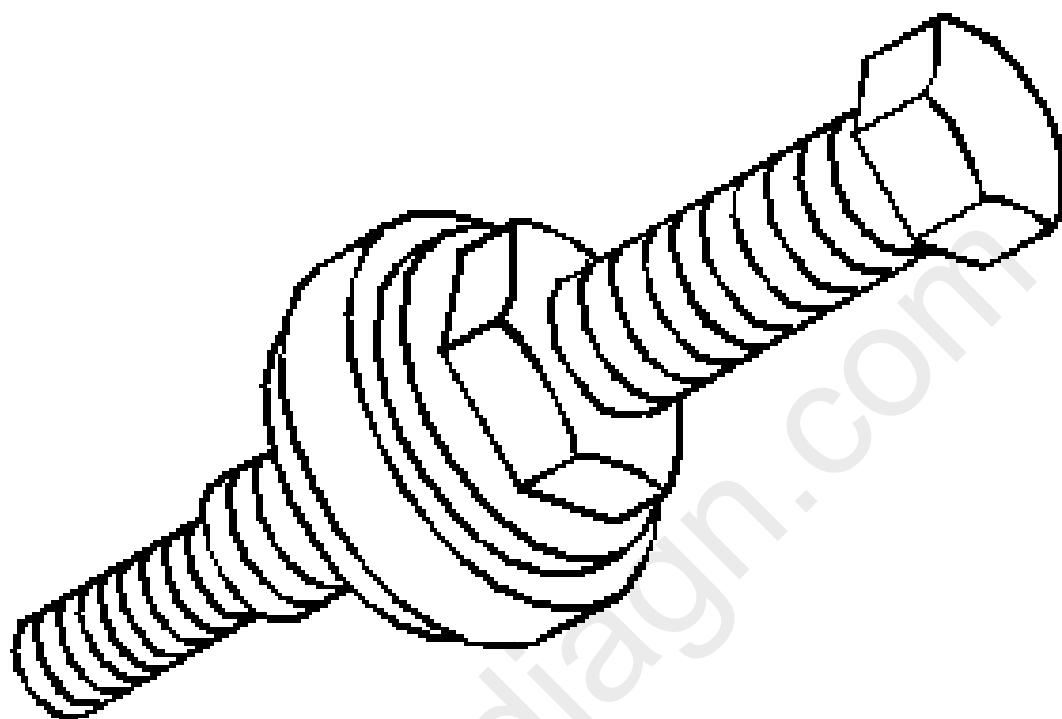
Illustration	Tool Number/ Description
	GE-28431-6

J-28431-6
Fluorescent
Dye

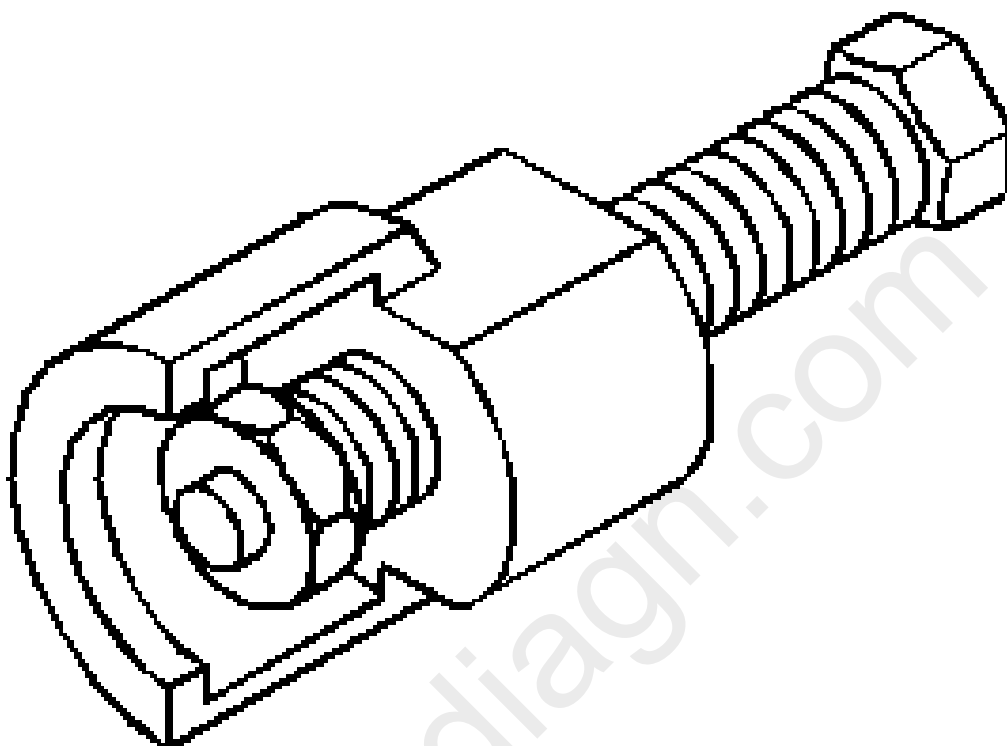




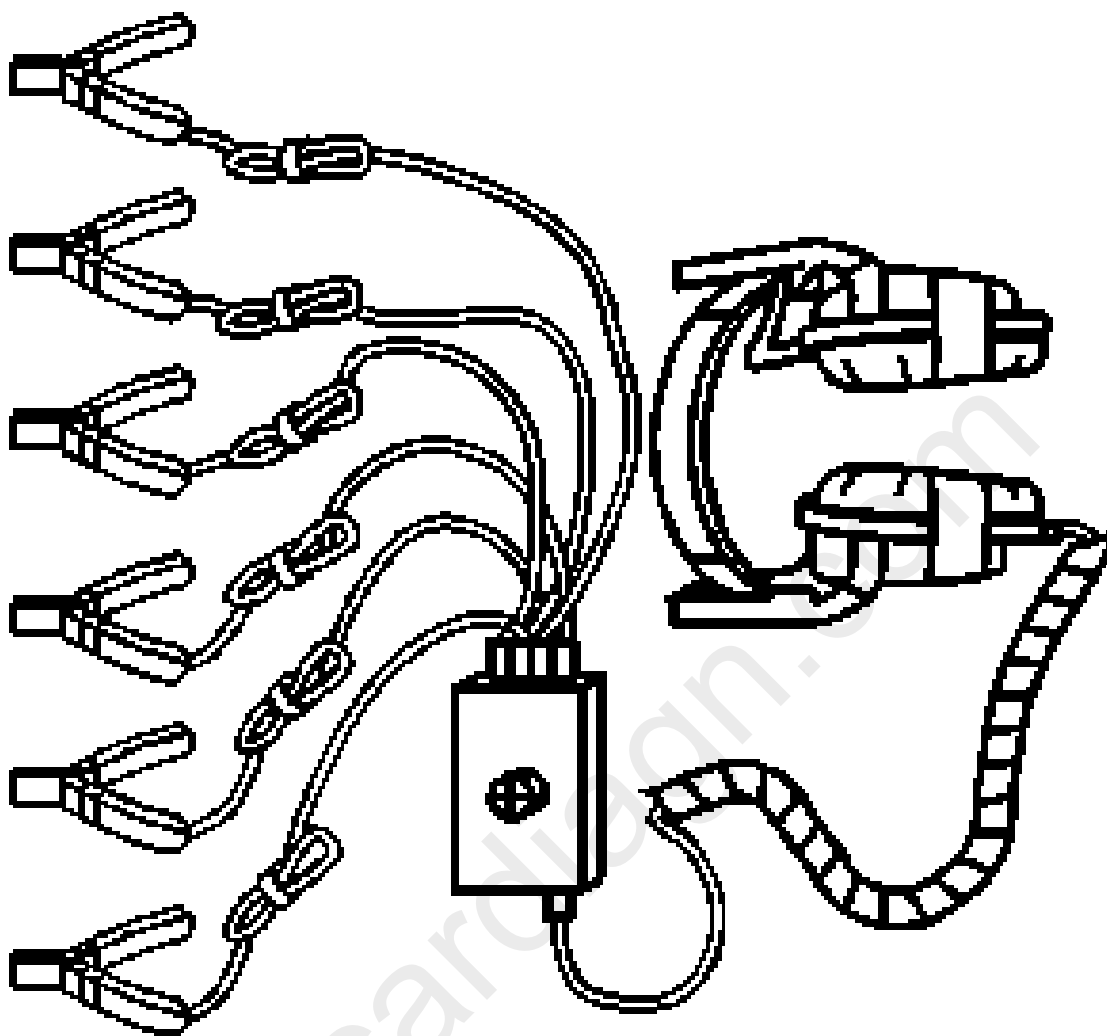
J-24319-B
Steering
Linkage
and Tie Rod
Puller



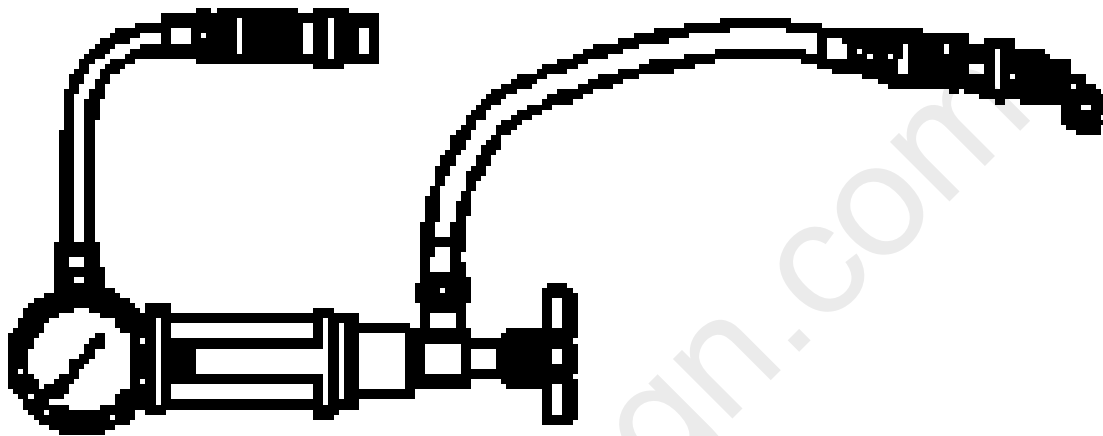
J-25033-C
Pulley
Installer



J-25034-C
Pulley
Remover



J-39570
Chassis Ear



J-44721
Power
Steering
Analyzer