

2010 STEERING

Power Steering - Equinox & Terrain

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Power Steering Assist Motor Bolt	8 N.m	71 lb in
Power Steering Fluid Cooling Pipe Bolt	9 N.m	80 lb in
Power Steering Fluid Cooling Pipe Fitting	34 N.m	25 lb ft
Power Steering Fluid Cooling Pipe Nut	9 N.m	80 lb in
Power Steering Fluid Reservoir Bolt	9 N.m	80 lb in
Power Steering Fluid Reservoir Nut	9 N.m	80 lb in
Power Steering Gear Inlet Hose Fitting	34 N.m	25 lb ft
Power Steering Pump Bolt	23 N.m	17 lb ft
Steering Gear Bolt	110 N.m	81 lb ft
Steering Gear Heat Shield Bolt	9 N.m	80 lb in
Steering Gear Pipe Fitting	15 N.m	11 lb ft
Steering Linkage Inner Tie Rod	105 N.m	77 lb ft
Steering Linkage Outer Tie Rod Nut	60 N.m	44 lb ft

POWER STEERING PUMP SPECIFICATIONS

Vehicle	Engine Code	Engine Size	High Flow		Pressure Relief	
			LPM	GPM	kPa	PSI
Chevrolet Equinox / GMC Terrain	LF1	3.0 L	9.5/11.5	2.51/3.04	12000/12800	1740/1856

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Power Steering Fluid	DEXRON® VI ATF	88861003	88861004

SCHEMATIC AND ROUTING DIAGRAMS

POWER STEERING SCHEMATICS

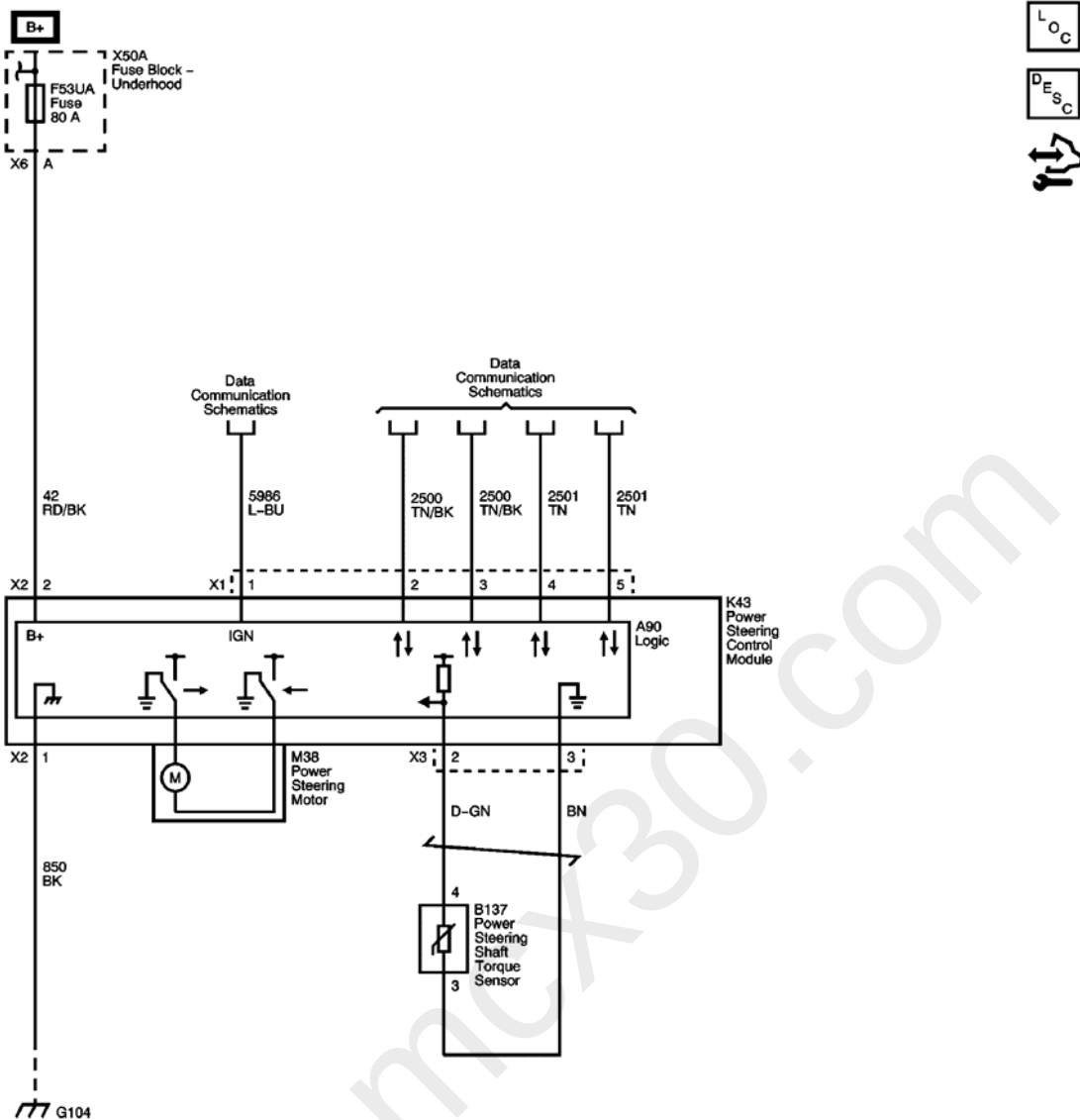


Fig. 1: Power Steering

Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC C0176	C0176 54: Control Module Temperature Sensor High Temperature
DTC C044A	C044A 71: Steering System Engine Speed Signal Circuit Invalid Data
DTC C0456	C0456 4B: Steering Position Sensor Calibration not Learned
DTC C0475	C0475 00: Electric Steering Motor Circuit Malfunction

	C0475 59: Electric Steering Motor Circuit Protection Time-Out
DTC C047A	C047A 00: Electric Steering Motor Position Sensor Circuit Malfunction
DTC C0545	C0545 00: Steering Wheel Torque Sensor Malfunction
DTC C0565	C0565 5A: Vehicle Identification Number Not Plausible
DTC C0569	C0569 3A: System Configuration Incorrect Component Installed

DTC C0176

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0176 54

Control Module Temperature Sensor High Temperature

Circuit/System Description

The power steering control module monitors the temperature of the power steering system. The power steering control module uses voltage, current levels and input from an internal temperature sensor to calculate an estimated system temperature. If the power steering control module detects a high system temperature event is occurring, the amount of assist is reduced to lower system temperature to prevent thermal damage to the power steering components.

Conditions for Running the DTC

- The ignition is ON, with the engine ON.
- Power steering system voltage is 9-16 volts.
- Repetitive steering input is present.

Conditions for Setting the DTC

The power steering control module detects a high system temperature.

Action Taken When the DTC Sets

- DTC C0176 54 is stored in memory.
- Steering assist is reduced.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.

- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Diagnostic Aids

- DTC C0176 54 does not indicate that a malfunction has occurred. Rather that the power steering control module had to limit current to the power steering motor to avoid thermal damage to the power steering system components. Discuss with the customer about driving conditions when the steering assist was reduced.
- Ensure that no steering components down stream of the power steering column assembly, such as ball joints, tie rod ends, universal joints, or the steering gear assembly, are mechanically binding.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or Power Steering System Description and Operation (LAF)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the DTC sets outside of the conditions for running and setting. Since most occurrences of this DTC are caused by excessive driver inputs, review with the customer the conditions under which the DTC set.
 - If the DTC set within the conditions for running and setting, the power steering is operating as designed.
2. Operate the vehicle within the conditions that the customer experienced and verify the DTC does not reset.

- If the DTC resets, replace the K43 Power Steering Control Module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering)**
- **Control Module References** for power steering control module replacement, setup and programming

DTC C044A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C044A 71

Steering System Engine Speed Signal Circuit Invalid Data

Circuit/System Description

The power steering control module receives the engine speed signal from the engine control module.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The power steering control module detects a invalid engine speed signal on the CAN Bus.

Action Taken When the DTC Sets

- DTC C044A is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or Power Steering System Description and Operation (LAF)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC C044A 71 is not set.

- If the DTC is set, replace the K43 Power Steering Control Module.

Repair Procedures

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Steering Gear Replacement (Electronic Power Steering) or Steering Gear Replacement (Hydraulic Power Steering)
- Control Module References for power steering control module replacement, setup, and programming

DTC C0456

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0456 4B

Steering Position Sensor Calibration not Learned

Circuit/System Description

If the power steering control module is replaced, the calibration needs to be learned to the new power steering control module using a scan tool. If there is no communication with the power steering control module, replace the steering gear.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The calibration is not learned to the new power steering control module.

Action Taken When the DTC Sets

- DTC C0456 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No Steering assist.

Conditions for Clearing the DTC

The calibration needs to be learned to the new power steering control module using a scan tool, perform the Electronic Power Steering, Special Functions, Steering Angle Sensor Centering procedure.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or **Power Steering System Description and Operation (LAF)**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0456 4B is not set.
 - If the DTC is set, calibrate the steering position sensor. Refer to **Power Steering Control Module Calibration**. If the DTC resets, replace the steering gear.
2. Replace the K43 Power Steering Control Module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering)**
- **Control Module References** for power steering control module replacement, setup, and programming

DTC C0475

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0475 00

Electric Steering Motor Circuit Malfunction

DTC C0475 59

Electric Steering Motor Circuit Protection Time-Out

Circuit/System Description

C0475 00

The power steering control module continuously monitors the voltage and current levels being commanded to the 3-phase steering motor. The power steering control module compares the desired and actual current levels to detect malfunctions in the power steering motor, or the circuits to the motor.

C0475 59

The power steering control module continuously monitors the thermal cycle counter of the steering gear. If the thermal cycle counter exceeds the maximum allowable limit, the steering gear has reached its end of life and must be replaced.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

C0475 00

The power steering control module detects a short to ground, short to voltage, or an open/high resistance on any of the internal motor circuits.

C0475 59

The power steering control module detects the thermal cycle counter has exceeded the maximum allowable limit and the whole steering gear system must be replaced.

Action Taken When the DTC Sets

- The DTC is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No steering assist.

Conditions for Clearing the DTC

C0475 00

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

C0475 59

This DTC cannot be cleared.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or Power Steering System Description and Operation (LAF)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

C0475 00

1. Ignition OFF, disconnect the X1 harness connector at the K43 Power Steering Control Module.
2. Test for less than 1 ohms between the ground circuit terminal 1 and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the K43 Power Steering Control Module.

C0475 59

Verify that DTC C0475 59 is not set.

- If the DTC is set, replace the K43 Power Steering Control Module.

Repair Procedures

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Steering Gear Replacement (Electronic Power Steering) or Steering Gear Replacement (Hydraulic Power Steering)
- Control Module References for power steering control module replacement, setup and programming

DTC C047A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C047A 00

Electric Steering Motor Position Sensor Circuit Malfunction

Circuit/System Description

The power steering control module continuously monitors the motor position sensor voltage signals. The voltage signals of the motor position sensor and the digital torque sensor index current signal are both processed by the power steering control module to detect and calculate the steering wheel angle.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The power steering control module detects a short to ground, short to voltage, or an open/high resistance on any of the internal motor position sensor circuits.

Action Taken When the DTC Sets

- No steering assist.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or **Power Steering System Description and Operation (LAF)**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C047A 00 is not set.
 - If the DTC is set, perform the power steering control module centering procedure. If the DTC resets, replace the K43 Power Steering Control Module.
2. Replace the K43 Power Steering Control Module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering)**
- **Control Module References** for power steering control module replacement, setup and programming

DTC C0545

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0545 00

Steering Wheel Torque Sensor Malfunction

Circuit/System Description

The power steering control module continuously monitors the digital torque sensor's torque and index current signals. As the steering wheel is turned and torsional twist is applied to the steering shaft, the steering input and output shafts are monitored via the torque signal circuit and then processed by the power steering control module to calculate the steering torque.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The power steering control module detects a short to ground, short to voltage, or an open/high resistance on any of the internal motor position sensor circuits.

Action Taken When the DTC Sets

- DTC C0545 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No steering assist.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or **Power Steering System Description and Operation (LAF)**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC C0545 00 is not set.

- If the DTC is set, replace the steering gear.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering)**
- **Control Module References** for power steering control module replacement, setup and programming

DTC C0565

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0565 5A

Vehicle Identification Number Not Plausible

Circuit/System Description

The vehicle identification number (VIN) is programmed into the power steering control module during initial programming of the module.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The power steering control module is not properly programmed.

Action Taken When the DTC Sets

- DTC C0565 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Diagnostic Aids

A newly replaced power steering control module can set one or more DTC on its initial ignition ON cycle.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or Power Steering System Description and Operation (LAF)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0565 is not present.
 - If the DTC is present, program the K43 Power Steering Control Module and verify the DTC does not reset.
2. If the DTC resets, replace the K43 Power Steering Control Module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering)**
- **Control Module References** for power steering control module replacement, setup, and programming

DTC C0569

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 3A

System Configuration Incorrect Component Installed

Circuit/System Description

The power steering control module continuously monitors the thermal cycle counter of the steering gear. If the power steering control module is replaced, the thermal cycle counter needs to be copied from the existing power steering control module over to the new power steering control module using the SPS Electric Power Steering Setup Procedure. If there is no communication with the power steering control module, replace the steering gear.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The thermal cycle counter needs to be copied from the existing power steering control module over to the new power steering control module using the SPS Electric Power Steering Setup Procedure.

Action Taken When the DTC Sets

- DTC C0569 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No Steering assist.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Steering System Description and Operation (Hydraulic Power Steering) or Power Steering System Description and Operation (LAF)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0569 3A is not set.
 - If the DTC is set, reprogram the power steering control module. If the DTC resets, replace the steering gear.
2. Replace the K43 Power Steering Control Module.

Repair Procedures

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Steering Gear Replacement (Electronic Power Steering) or Steering Gear Replacement (Hydraulic Power Steering)
- Control Module References for power steering control module replacement, setup, and programming

SYMPTOMS - POWER STEERING SYSTEM

NOTE: Review the system description and operation in order to familiarize yourself with the system functions. Refer to Power Steering System Description and Operation (Hydraulic Power Steering) or Power Steering System Description and Operation (LAF).

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.
- If equipped with hydraulic power steering, inspect for leaking power steering components. If necessary, refer to **Power Steering Fluid Leaks**.
- If equipped with hydraulic power steering, verify the power steering fluid level is correct. Refer to **Checking and Adding Power Steering Fluid**.
- If equipped with hydraulic power steering, inspect the power steering fluid for the following indications of contamination:
 - Milky fluid - water
 - Brown fluid - burnt
 - Debris in fluid - plastic or dirt
- If the hydraulic power steering system is contaminated, 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 (Electronic Power Steering)** or **Rattle, Clunk, or Shudder Noise from the Power Steering System (Hydraulic Power Steering)**
- **Whine or Growl Noise from the Power Steering System (Electronic Power Steering)** or **Whine or Growl Noise from the Power Steering System (Hydraulic Power Steering)**
- **Increase in Effort While Turning Steering Wheel**
- **Poor Return of Steering Wheel**
- **Steering Wheel Surges/Jerks While Turning (Electronic Power Steering)**
- **Steering Wheel Kickback (Electronic Power Steering)**
- **Steering Effort Too Easy in One or Both Directions**
- **Steering Effort Hard or Too Easy in One or Both Directions (Electronic Power Steering)**
- **Steering Effort Hard in One or Both Directions**

POWER STEERING SYSTEM TEST

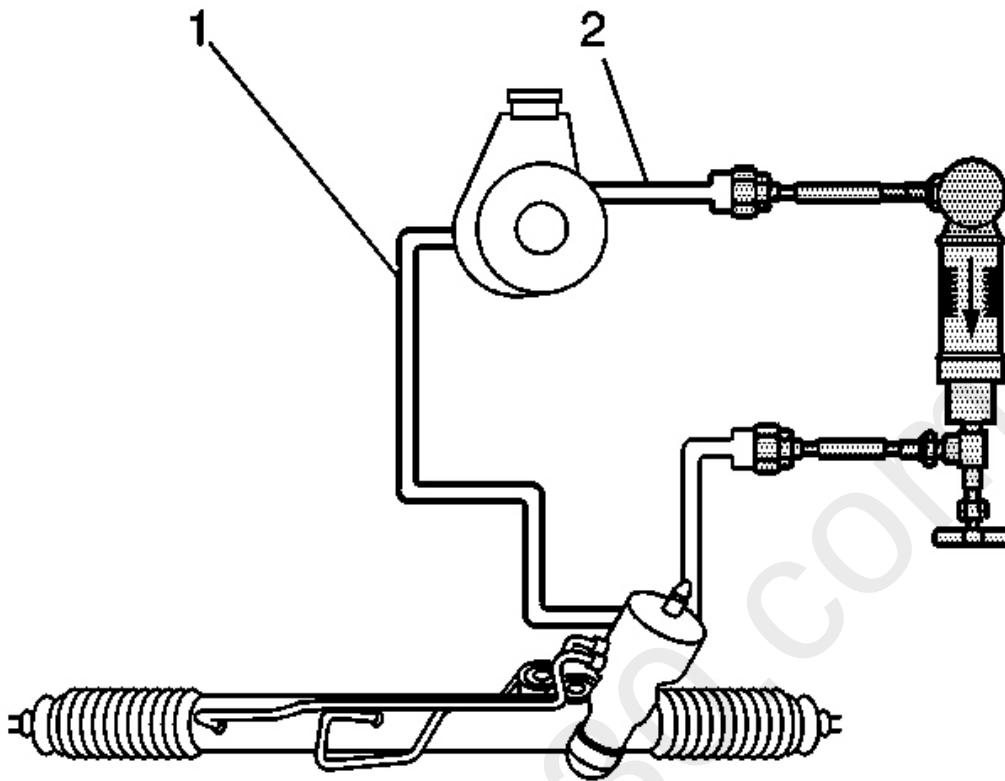


Fig. 2: Identifying Power Steering Hoses
 Courtesy of GENERAL MOTORS CORP.

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

Test Description

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

- 5:** This step tests the system for restrictions.
- 7:** This step tests the following components for the following conditions:
 - The pump for internal leaks
 - The power steering pipes for kinks
- 8:** This step tests the ability of the pump to regulate flow at maximum pressure.
- 10:** This step tests the ability of the pump to regulate flow under normal operating conditions.

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

Step	Action	Value(s)	Yes	No
DEFINITION: The Power Steering System Test Procedure will perform the following functions: • Test the operation of the hydraulic power steering system. • Test the operation of the power steering pump and power steering gear. • Identify restrictions in the system.				
1	Inspect the power steering fluid for the following indications of contamination: • Milky fluid - water • Brown fluid - burnt • Debris in fluid - plastic or dirt Is the fluid free of contamination?	-	Go to Step 3	Go to Step 2
2	Flush the power steering system. Refer to <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	-
	1. Fully open the J-44721: Power Steering System Analyzer valve.			

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

8	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</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 (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</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>.	-		

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 (ELECTRONIC POWER STEERING)

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 - Steering Wheel and Column</u>
2	Verify a rattle noise is present by driving the vehicle on a rough road. Verify a clunk noise is present by turning the steering wheel to the left and to the right several times with the key in the ON position. Is a rattle or a clunk noise present?	Go to Step 3	System OK
3	Inspect the steering gear for the proper installation. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Is the steering gear installation incorrect?	Go to Step 6	Go to Step 4
4	Inspect the intermediate steering shaft. Is the intermediate steering shaft worn?	Go to Step 8	Go to Step 5
5	Inspect the suspension. Is the suspension worn?	Go to Step 7	Go to <u>Noise Diagnosis - Front Suspension</u>
6	Install the steering gear correctly. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Did you complete the repair?	Go to Step 9	-
7	Replace the worn suspension components. Did you complete the repair?	Go to Step 9	-
8	Replace the intermediate steering shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> . Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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

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 the power steering hoses incorrect?	Go to Step 11	Go to Step 4

4	Inspect the engine drive belt for cracking or excessive wear. Refer to . 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 and the power steering mounting bracket for the proper installation. Refer to <u>Power Steering Pump Replacement</u> . Is the power steering pump installation incorrect?	Go to Step 14	Go to Step 7
7	Inspect the power steering gear for the proper installation. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Is the power steering gear installation incorrect?	Go to Step 15	Go to Step 8
8	Inspect for looseness in the inner tie rods or in the outer tie rods. 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 worn?	Go to Step 16	Go to Step 9
9	Inspect the suspension. Is the suspension worn?	Go to Step 17	Go to Step 10
10	Inspect the intermediate shaft. Is the intermediate shaft worn?	Go to Step 18	Go to Step 3
11	Adjust or replace the hoses. Refer to the appropriate procedures: • <u>Power Steering Fluid Cooling Pipe Replacement</u> • <u>Power Steering Fluid Reservoir Outlet Hose Replacement</u> • <u>Power Steering Gear Inlet Pipe/Hose Replacement</u> Did you complete the repair?	Go to Step 19	-
12	Replace the engine drive belt. Refer to or <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</u> . Did you complete the repair?	Go to Step 19	-
14	Install the power steering pump correctly. Refer to <u>Power Steering Pump Replacement</u> . Did you complete the repair?	Go to Step 19	-
	Install the power steering gear correctly. Refer to		

15	<u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</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</u> or to <u>Steering Linkage Outer Tie Rod Replacement</u> . Did you complete the repair?	Go to Step 19	-
17	Replace the worn suspension components. Did you complete the repair?	Go to Step 19	-
18	Replace the intermediate shaft. Refer to <u>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 (ELECTRONIC POWER STEERING)

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 gear for looseness and/or worn bushings. Is the steering gear loose or are the bushings worn?	Go to Step 6	Go to Step 4
4	Inspect the power steering motor for a whine or growl noise using the J-39570: Chassis Ear . Is the noise present at the power steering motor?	Go to Step 7	Go to Step 5
5	Inspect the power steering gear for a whine or growl noise using the J-39570: Chassis Ear . Is the noise present at the power steering gear?	Go to Step 8	Go to Step 3
6	Tighten the power steering gear fasteners or replace the power steering gear due to worn bushings. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Did you complete the repair?	Go to Step 9	-
7	Replace the electronic power steering assist motor control. Refer to <u>Power Steering Assist Motor Replacement</u> . Did you complete the repair?	Go to Step 9	-

8	Replace the power steering gear. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

WHINE OR GROWL NOISE FROM THE POWER STEERING SYSTEM (HYDRAULIC POWER STEERING)

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 (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Did you complete the repair?	Go to Step 11	-
9	Replace the power steering pump. Refer to <u>Power Steering Pump Replacement</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

INCREASE IN EFFORT WHILE TURNING STEERING WHEEL

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 there is an increase in effort while turning is present. Does the system operate normally?	System OK	Go to Step 3
3	Check for the following tire related conditions: • Incorrect tire inflation-Refer to <u>Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label</u> . • Improper tire size Did you find and correct the condition?	Go to Step 10	Go to Step 4
4	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Check for a binding or worn tie rod end. Is the tie rod binding or worn?	Go to Step 7	Go to Step 5
5	Check for a worn or binding intermediate shaft. Is the intermediate shaft worn or binding?	Go to Step 8	Go to Step 6
6	Check for a worn or binding steering gear. Is the steering gear worn or binding?	Go to Step 9	System OK
7	Replace the outer tie rod. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> . Did you complete the repair?	Go to Step 10	-
8	Replace the intermediate shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> . Did you complete the repair?	Go to Step 10	-
9	Replace the steering gear. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Did you complete the repair?	Go to Step 10	-

10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-
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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>
2	Verify that poor return of the steering wheel is present. Does the system operate normally?	System OK	Go to Step 3
3	1. Raise and support the vehicle. Refer to <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 WHEEL SURGES/JERKS WHILE TURNING (ELECTRONIC POWER STEERING)

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 the steering wheel surges or jerks while turning.		

	Does the steering wheel surge or jerk while turning?	Go to Step 3	System OK
3	Inspect the front suspension for worn or binding components. Did you find and correct the condition?	Go to Step 15	Go to Step 4
4	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Inspect the steering linkage outer tie rod for wear or a binding condition. Is the steering linkage outer tie rod worn or binding?	Go to Step 10	Go to Step 5
5	Inspect the intermediate shaft for wear or a binding condition. Is the intermediate shaft worn or binding?	Go to Step 11	Go to Step 6
6	Inspect the steering gear for wear or a binding condition. Is the steering gear worn or binding?	Go to Step 12	Go to Step 7
7	Inspect the steering column for wear or a binding condition. Is the steering column worn or binding?	Go to Step 13	Go to Step 8
8	Inspect the power steering assist motor for an indication of excessive heat. Does the power steering assist motor appear to be overheated?	Go to Step 9	Go to Step 14
9	NOTE: Do not perform excessive parking lot maneuvers during testing. Excessive parking lot maneuvers can cause the power steering motor to heat up. Allow the power steering motor to cool and retest the system. Did you correct the condition?	Go to Step 15	Go to Step 14
10	Replace the steering linkage outer tie rod. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> . Did you complete the repair?	Go to Step 15	System OK
11	Replace the intermediate shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> . Did you complete the repair?	Go to Step 15	-
12	Replace the steering gear. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> . Did you complete the repair?	Go to Step 15	-
13	Replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 15	-
	Replace the power steering assist motor. Refer to		

14	<u>Power Steering Assist Motor Replacement.</u> Did you complete the repair?	Go to Step 15	-
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

STEERING WHEEL KICKBACK (ELECTRONIC POWER STEERING)

Condition	Action
The steering column mounting bolts are loose.	Tighten the pivot bolt and the mounting bolts to specification.
The steering gear is loosely mounted.	Tighten the steering gear mounting bolts to specification.
The tie rod ends are loose or damaged.	If necessary, inspect for damage and replace the tie rod ends. Refer to <u>Steering Linkage Outer Tie Rod Replacement.</u>

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 OR TOO EASY IN ONE OR BOTH DIRECTIONS (ELECTRONIC POWER STEERING)

Condition	Action
The battery power is low.	Ensure proper battery voltage.
The intermediate shaft dash seal is binding.	Adjust the dash seal or replace the intermediate shaft if necessary. Refer to <u>Intermediate Steering Shaft Replacement .</u>
The intermediate shaft joints are loose or worn.	Inspect the joints and the pinch bolts for damage, and replace the intermediate shaft if necessary. Refer to <u>Intermediate Steering Shaft Replacement .</u>
The steering gear is binding.	If necessary, inspect and replace the steering gear. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement</u>

	<u>(Hydraulic Power Steering).</u>
The upper steering shaft is bent.	If necessary, replace the steering column. Refer to <u>Steering Column Replacement</u> .
The connectors to the assist motor are damaged or disconnected.	Verify the connectors are properly connected. Verify the connectors are not damaged. If the connectors are damaged, replace the connectors.
The sensor wire is damaged.	Replace the steering gear. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u> .
The controller is malfunctioning.	Confirm the DTC. If necessary, replace the motor/module assembly. Refer to <u>Power Steering Assist Motor Replacement</u> .
The motor shaft is binding.	Confirm the DTC. If necessary, replace the motor/module assembly. Refer to <u>Power Steering Assist Motor Replacement</u> .

STEERING EFFORT HARD IN ONE OR BOTH DIRECTIONS

Step	Action	Yes	No
1	Did you review the Power Steering System General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Power Steering System</u>
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 <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

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**.

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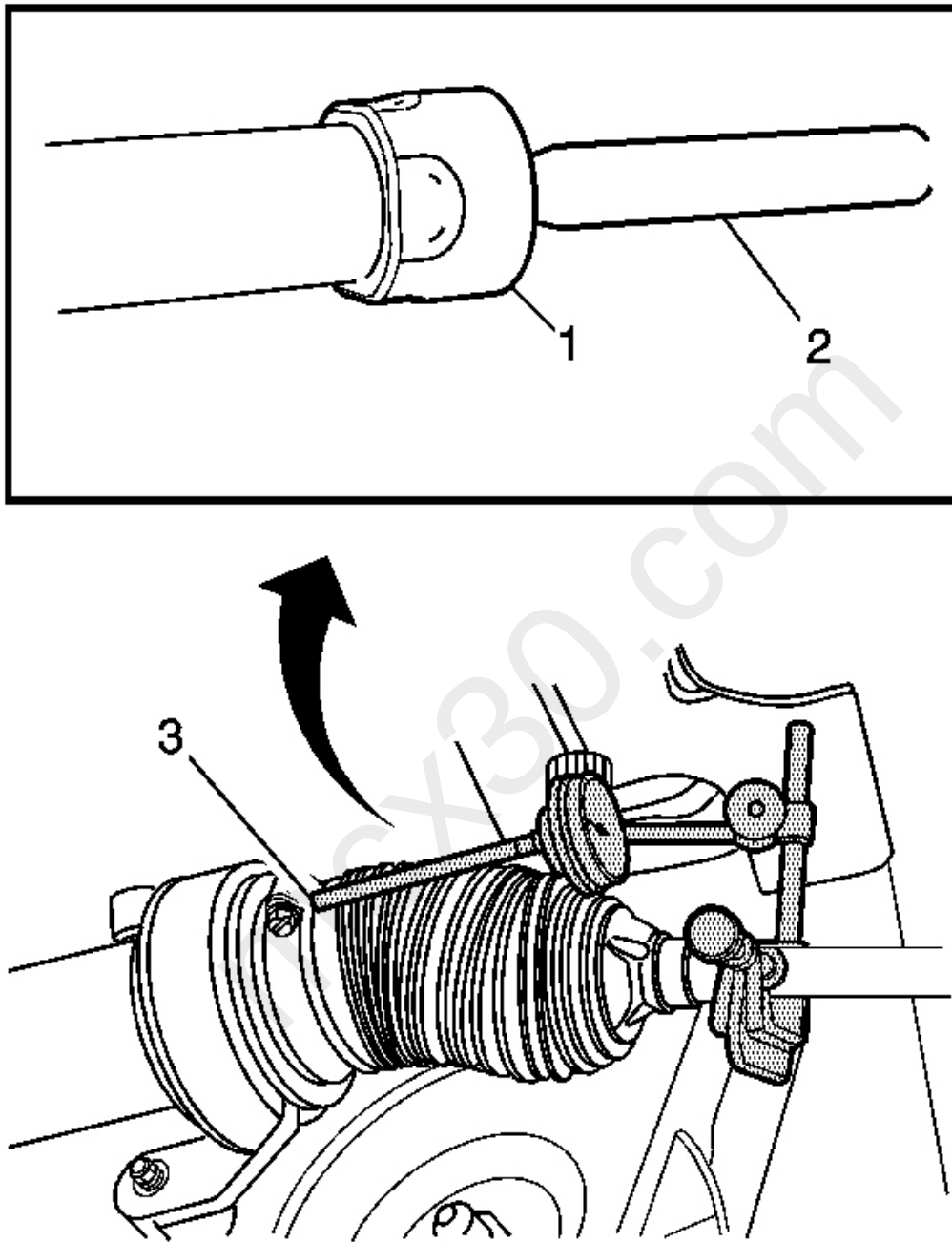


Fig. 3: Measuring Lash Between Inner Tie Rod & Steering Gear Housing
Courtesy of GENERAL MOTORS CORP.

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

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

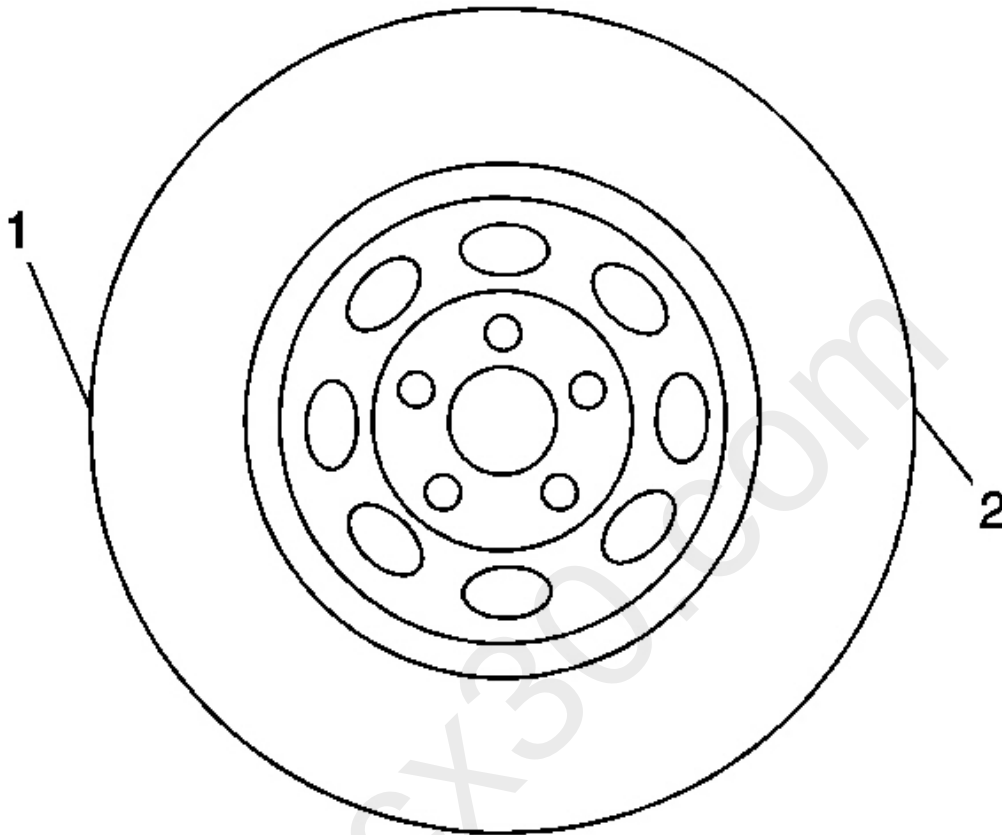


Fig. 4: Identifying Grasping Positions
Courtesy of GENERAL MOTORS CORP.

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

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

11. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD INSPECTION

Special Tools

J-8001: Dial Indicator Set

For equivalent regional tools, refer to Special Tools.

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

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

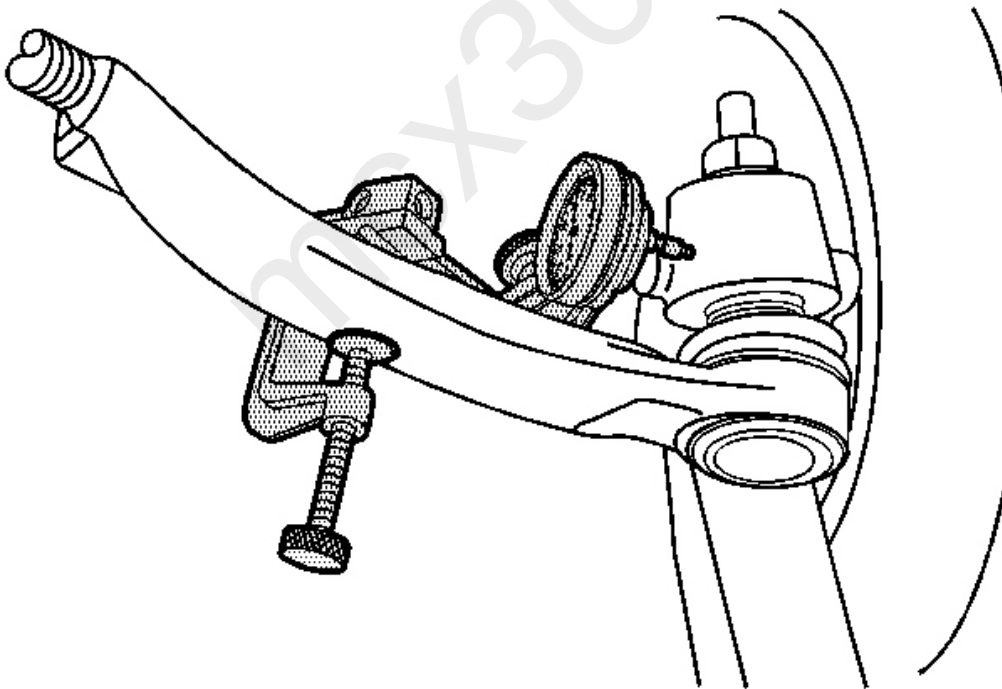


Fig. 5: Measuring Outer Tie Rod Lash

Courtesy of GENERAL MOTORS CORP.

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

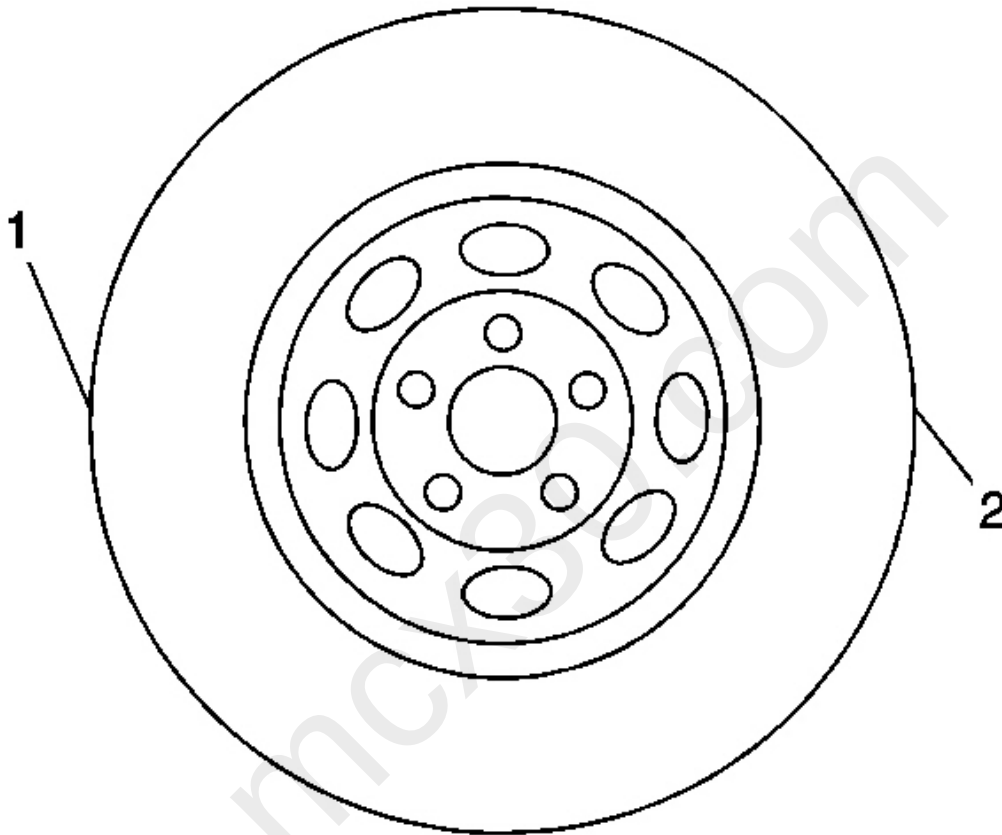


Fig. 6: Identifying Grasping Positions
Courtesy of GENERAL MOTORS CORP.

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

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 - LOWER

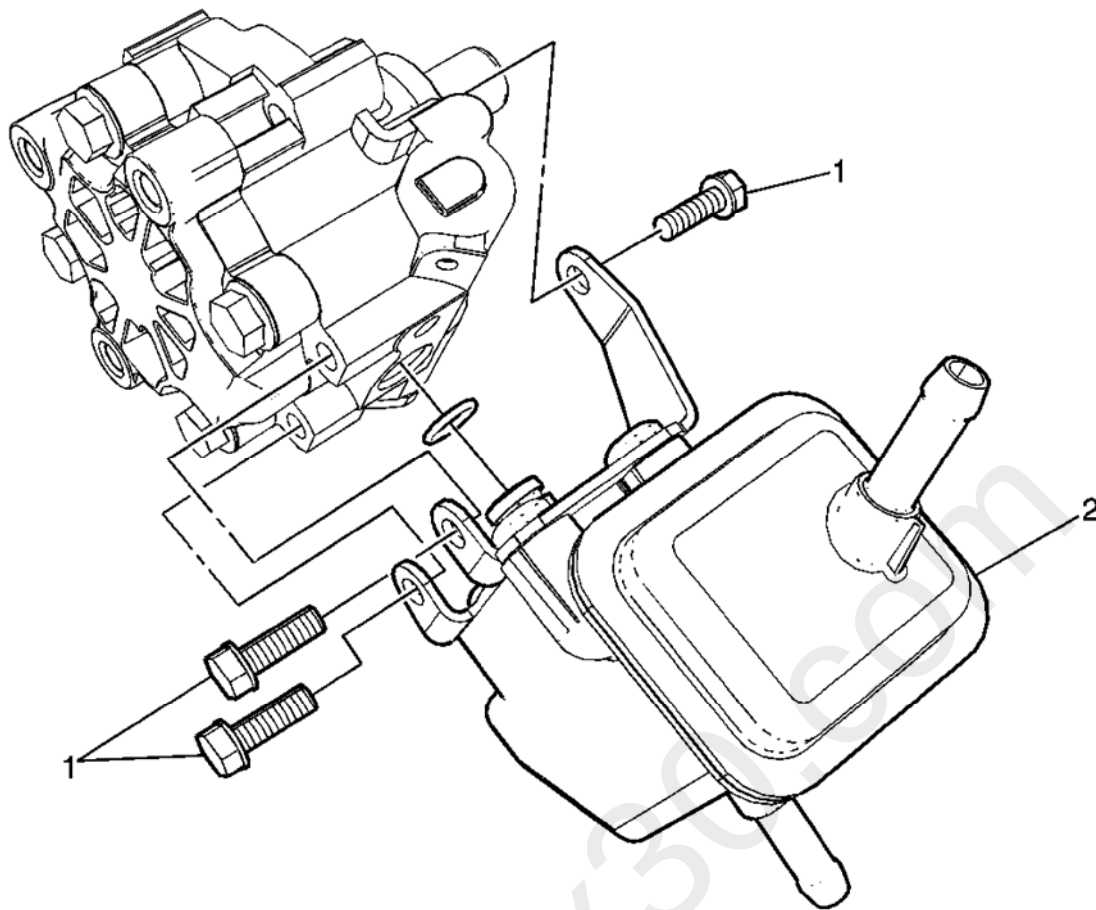


Fig. 7: Power Steering Fluid Reservoir - Lower
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the power steering pump pulley. Refer to <u>Power Steering Pump Pulley Replacement</u> .	
1	Power Steering Fluid Reservoir Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Power Steering Fluid Reservoir Procedure: Install a NEW power steering pump seal.

POWER STEERING FLUID RESERVOIR REPLACEMENT - UPPER

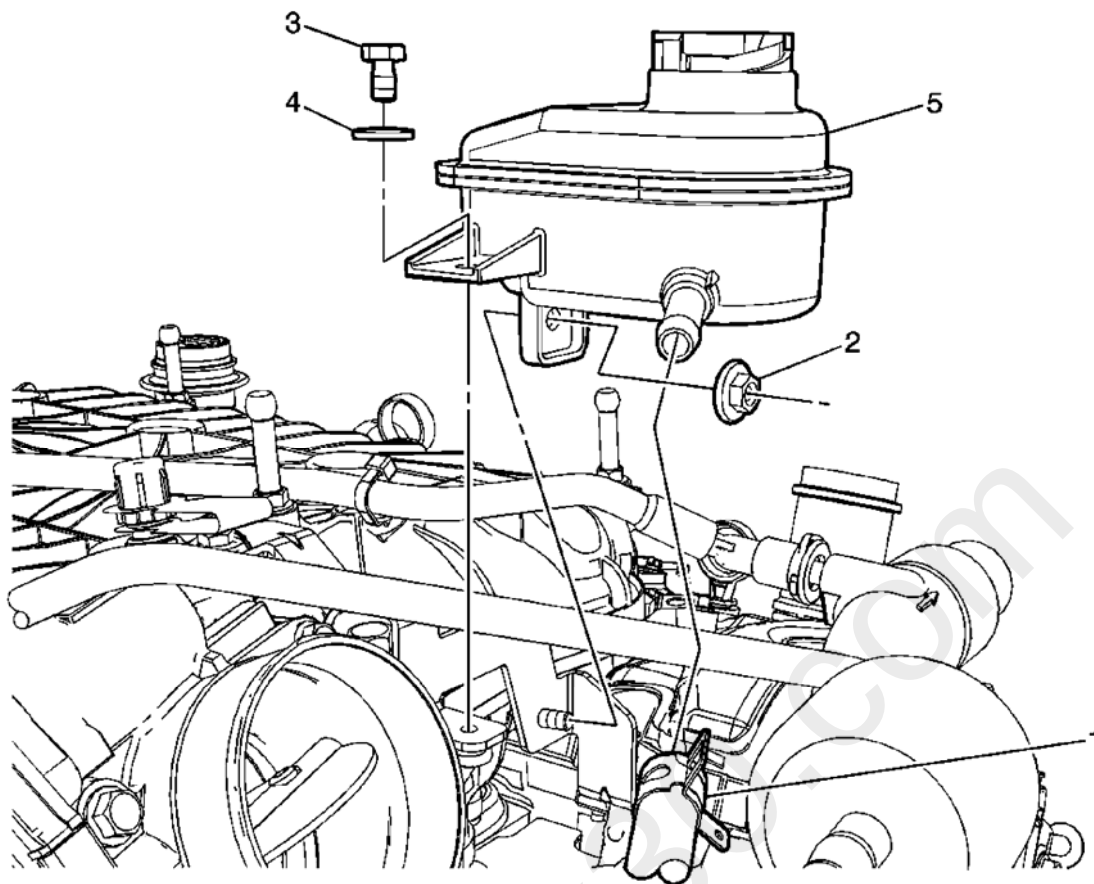


Fig. 8: Power Steering Fluid Reservoir - Upper
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Place drain pans under the vehicle. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 3. Remove as much power steering fluid from the upper power steering fluid reservoir as possible. 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> .	
1	Power Steering Fluid Reservoir Outlet Hose Procedure: Disconnect the power steering fluid reservoir outlet hose from the upper power steering fluid reservoir.
2	Power Steering Fluid Reservoir Nut CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 9 N.m (80 lb in)
3	Power Steering Fluid Reservoir Bolt Tighten: 9 N.m (80 lb in)
4	Power Steering Fluid Reservoir Washer
5	Power Steering Fluid Reservoir - Upper 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 PUMP PULLEY REPLACEMENT

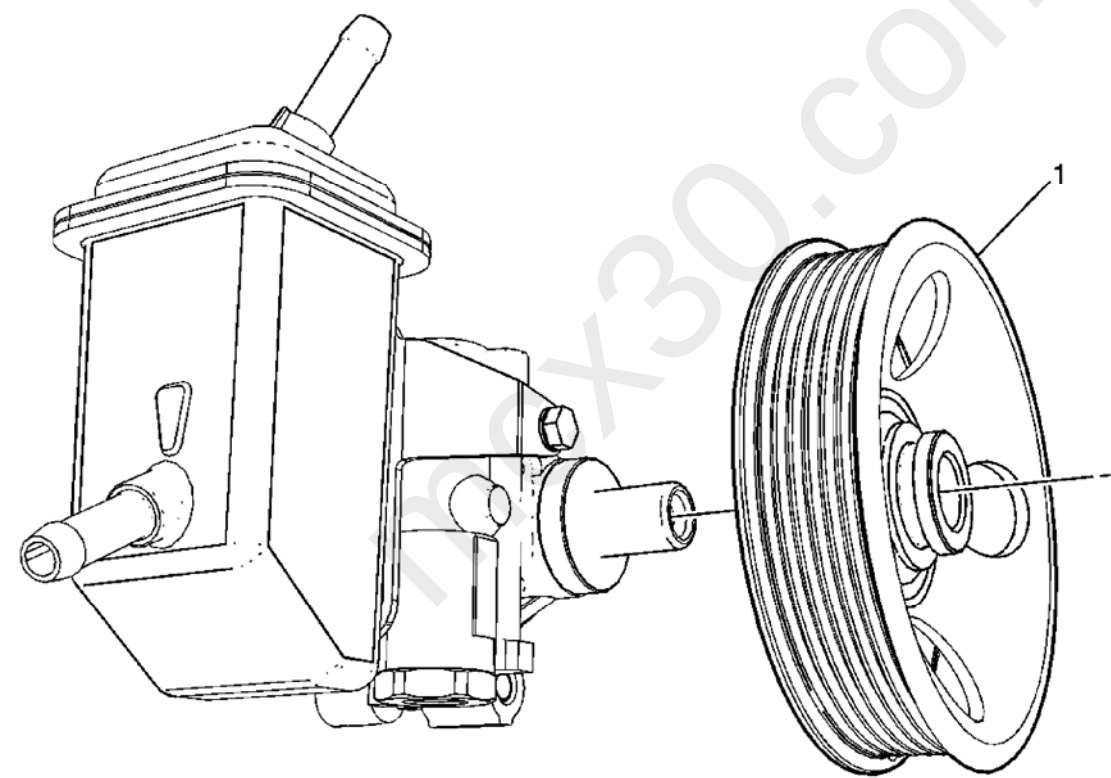


Fig. 9: Power Steering Pump Pulley
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the power steering pump. Refer to <u>Power Steering Pump Replacement.</u>	
	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 pump pulley on the shaft is within 0.25 mm (0.010 in).

1

Special Tools

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

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

POWER STEERING PUMP REPLACEMENT

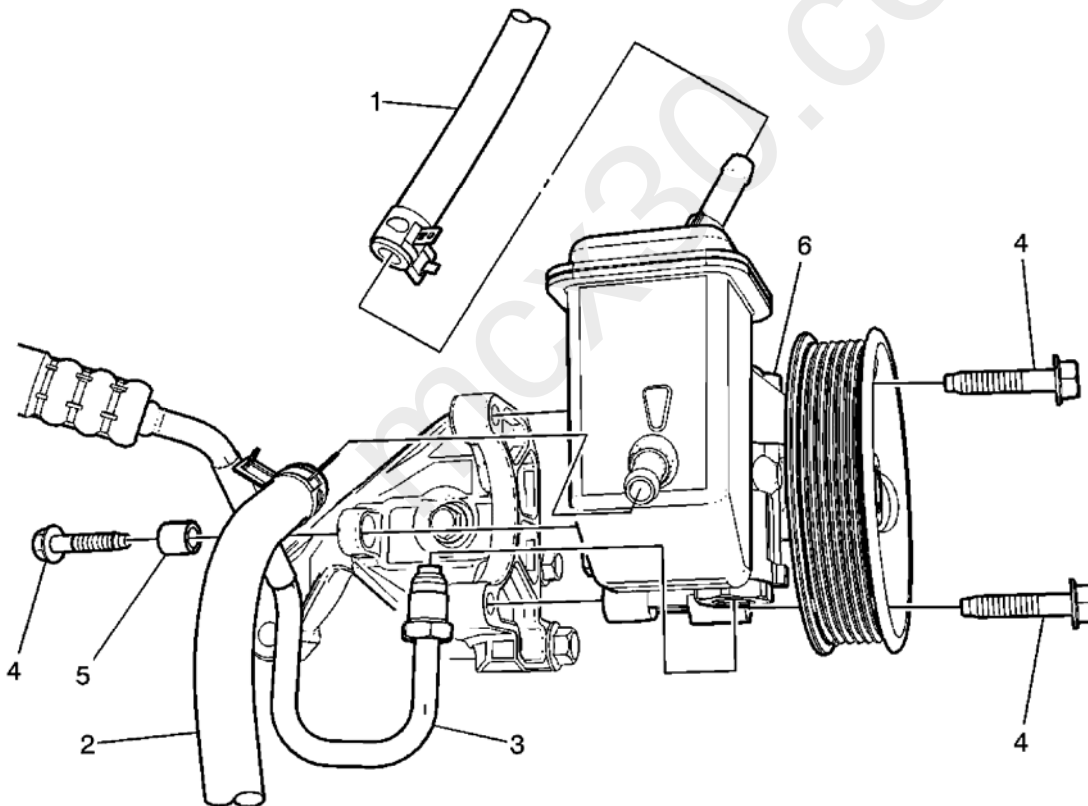


Fig. 10: Power Steering Pump

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedures

1. Place drain pans under the vehicle.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove as much power steering fluid from the upper power steering fluid reservoir as possible.
4. Remove the right front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the drive belt from the power steering pump pulley only. Refer to **Drive Belt Replacement** .

1	Power Steering Fluid Reservoir Outlet Hose Procedure: Disconnect the power steering fluid reservoir outlet hose from the lower power steering fluid reservoir.
2	Power Steering Fluid Cooling Pipe Procedure: Disconnect the power steering fluid cooling pipe from the lower power steering fluid reservoir.
3	Power Steering Gear Inlet Hose Procedure: Disconnect the power steering gear inlet hose from the power steering pump. Refer to <u>Power Steering Gear Inlet Pipe/Hose Replacement</u> .
4	Power Steering Pump Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tip: Note the routing for installation. The left side bolt has a spacer. Tighten: 23 N.m (17 lb ft)
5	Power Steering Pump Bolt Spacer
6	Power Steering Pump Procedure 1. Remove the power steering pump through the right front wheel well opening. 2. Transfer the power steering pump pulley. Refer to <u>Power Steering Pump Pulley Replacement</u>. 3. Transfer the lower power steering fluid reservoir. Refer to <u>Power Steering Fluid Reservoir Replacement - Lower</u>. 4. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>. 5. Clean any excess power steering fluid from the vehicle.

STEERING LINKAGE OUTER TIE ROD REPLACEMENT

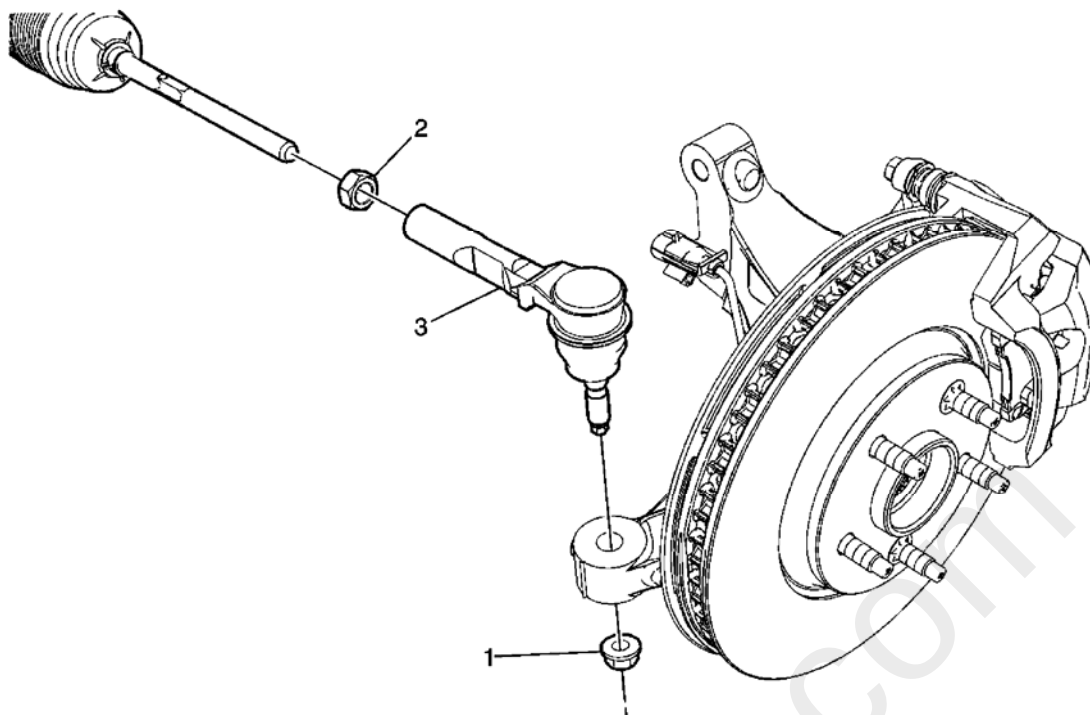


Fig. 11: Steering Linkage Outer Tie Rod
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the front tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Steering Linkage Outer Tie Rod Nut CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Use a wrench in order to hold the stud and prevent the stud from turning during removal of the steering linkage outer tie rod nut. 2. Replace the nut with a NEW nut. Tighten: 60 N.m (44 lb ft)
2	Steering Linkage Inner Tie Rod Nut Procedure 1. Use paint in order to place match marks on the steering linkage inner tie rod nut and on the steering linkage inner tie rod.

	2. During installation, align the match marks. 3. Do not tighten the nut during installation. Tighten the nut after adjusting the front toe. Refer to <u>Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment</u>.
3	Steering Linkage Outer Tie Rod CAUTION: Do not free the ball stud by using a pickle fork or a wedge-type tool. Damage to the seal or bushing may result. Procedure 1. Use the J-24319-B: Puller in order to separate the steering linkage outer tie rod from the steering knuckle. 2. Inspect the steering linkage inner tie rod for bent or damaged threads. 3. Clean the tapered surface of the steering knuckle. 4. Measure and adjust the front toe. Refer to <u>Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment</u>. Special Tools: J-24319-B: Steering Linkage and Tie Rod Puller For equivalent regional tools, refer to <u>Special Tools</u>.

STEERING GEAR BOOT REPLACEMENT

Special Tools

J-22610: Keystone Clamp Pliers

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

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
2. Remove the steering linkage outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.
3. Remove the steering linkage inner tie rod nut.

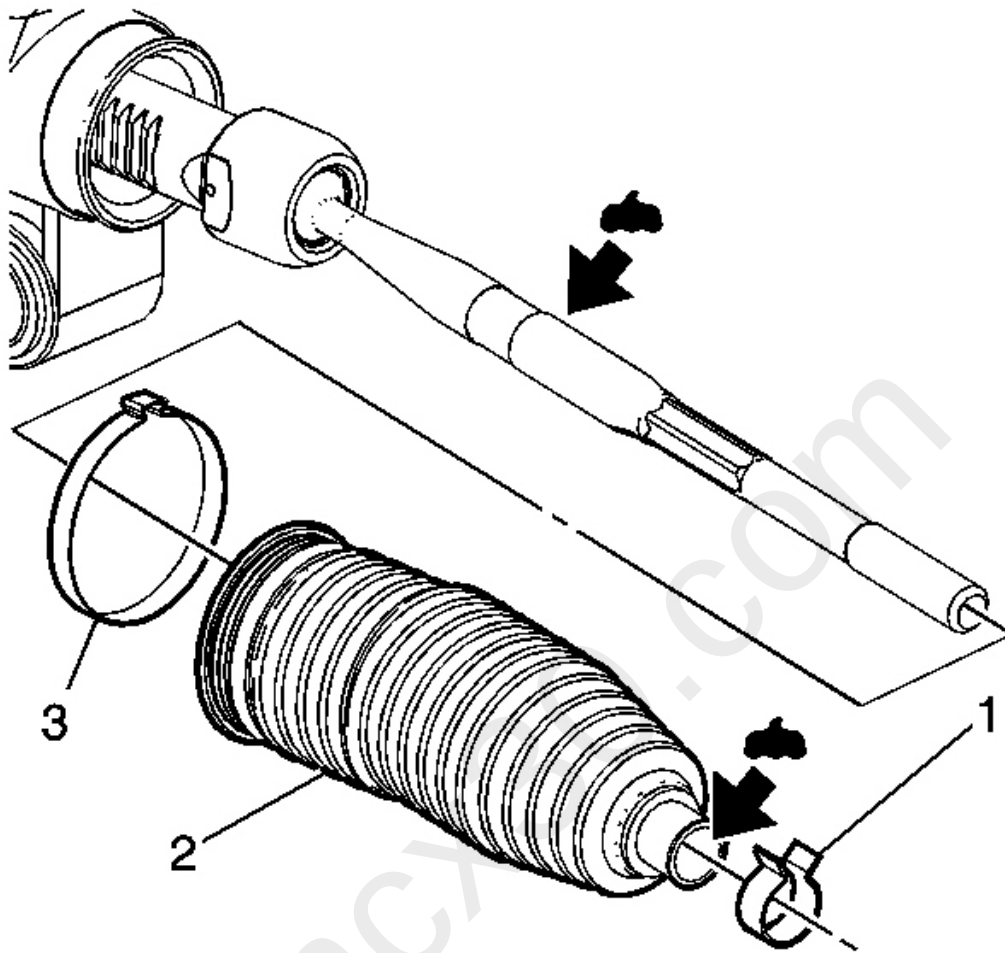


Fig. 12: Steering Gear Boot Components
Courtesy of GENERAL MOTORS CORP.

4. Remove the outer boot clamp (1).

Discard the clamp.

5. Cut the inner boot clamp (3).

Discard the clamp.

6. Remove the steering gear boot (2).

7. Clean the steering linkage inner tie rod and steering gear boot contact area of any grease and debris.

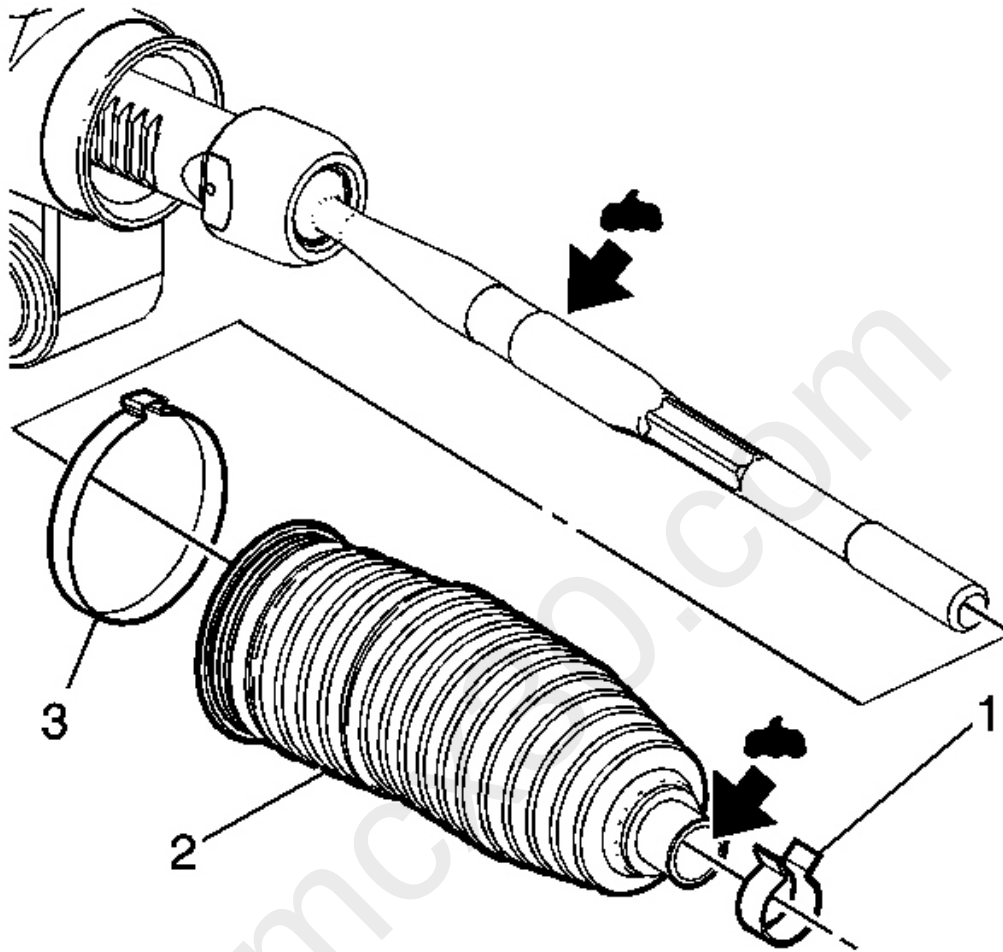


Fig. 13: Steering Gear Boot Components
Courtesy of GENERAL MOTORS CORP.

NOTE: The steering linkage inner tie rod and the steering gear boot must be free of moisture and debris.

1. Apply approximately 3/4 of the supplied grease packet to the inside of the small end of the steering gear boot (2). Apply the remainder of the grease to the steering linkage inner tie rod where the small end of the steering gear boot touches the inner tie rod.

NOTE: Ensure the larger end of the steering gear boot is firmly seated in the

correct location on the steering gear.

2. Install the steering gear boot with the NEW inner boot clamp (3) loosely attached.

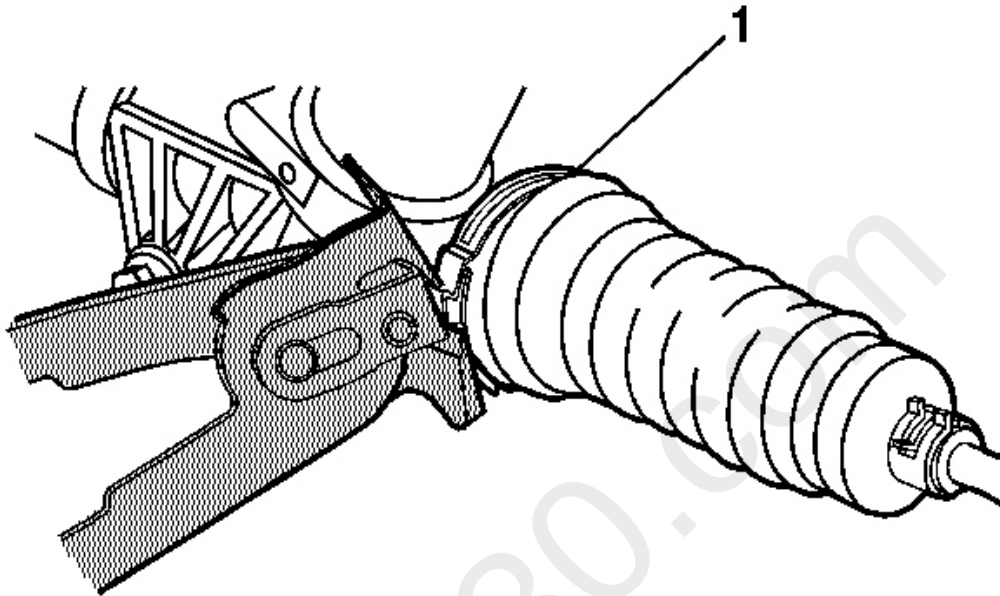


Fig. 14: Inner Boot Clamp
Courtesy of GENERAL MOTORS CORP.

3. Use the **J-22610** pliers in order to install the NEW inner boot clamp (1).

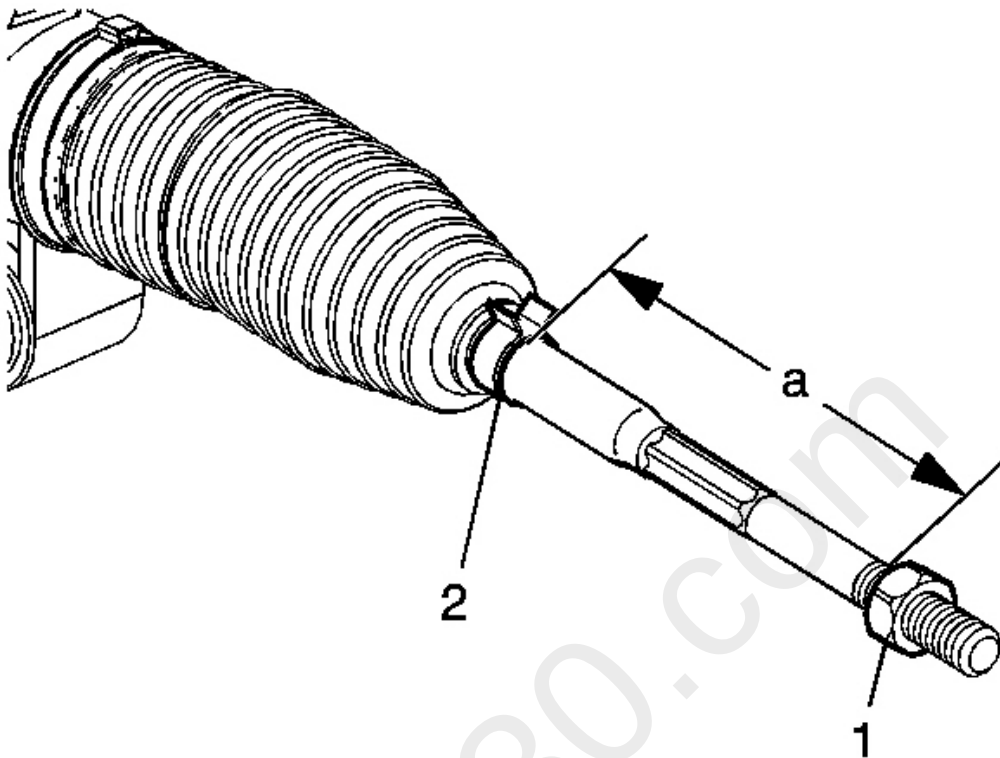


Fig. 15: Locating Steering Gear Boot
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the small end of the steering gear boot is firmly seated in the correct location on the steering linkage inner tie rod.

4. Install the NEW outer boot clamp (2).
5. Install the steering linkage inner tie rod nut (1) approximately 174 mm (6.85 in) (a) from the outer boot clamp.
6. Install the steering linkage outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.
7. Measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment**.
8. Lower the vehicle.

POWER STEERING FLUID COOLING PIPE REPLACEMENT

Removal Procedure

1. Place drain pans under the vehicle.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove as much power steering fluid from the upper power steering fluid reservoir as possible.
4. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement (Equinox)** or **Front Bumper Fascia Replacement (Terrain)** .

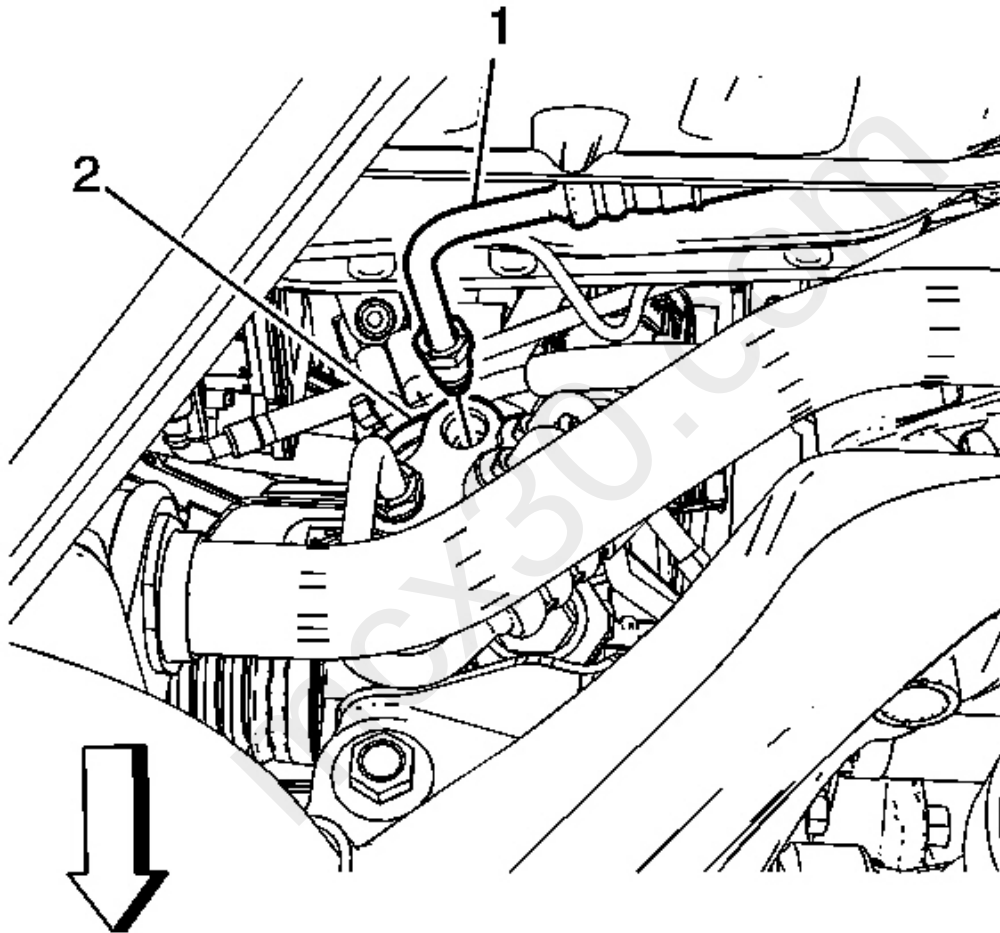


Fig. 16: Power Steering Fluid Cooling Pipe & Power Steering Gear
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the power steering fluid cooling pipe (1) from the power steering gear (2).

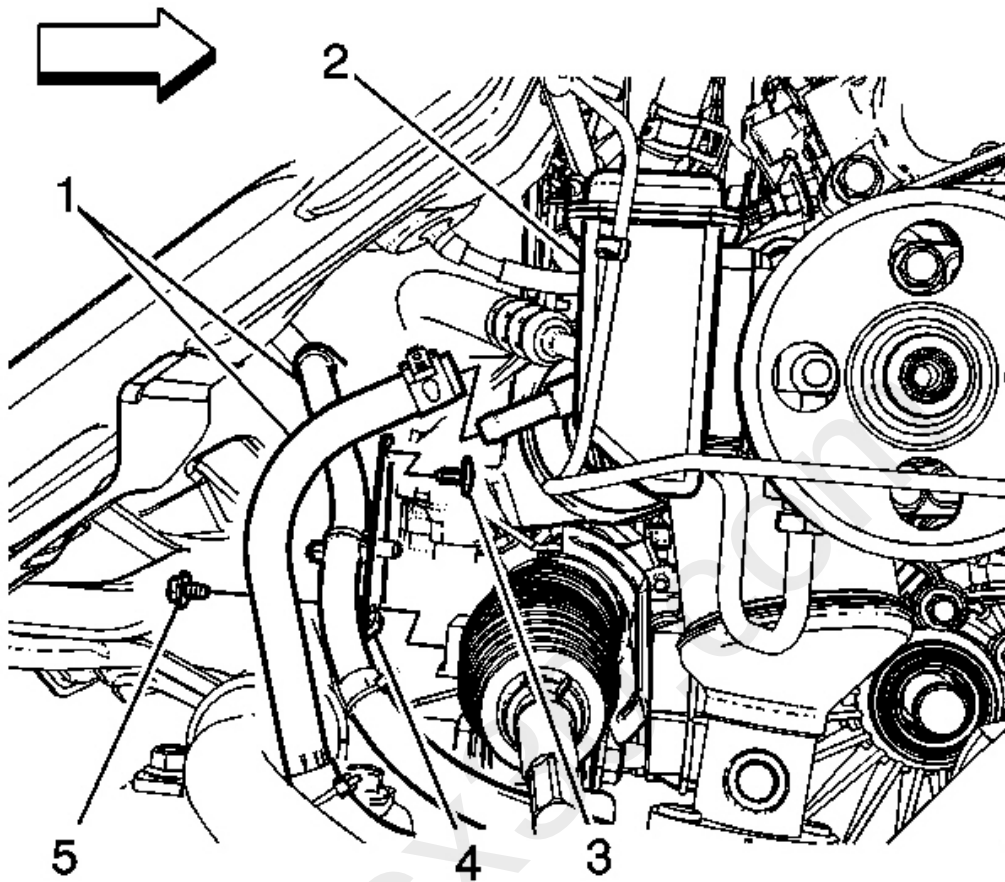


Fig. 17: Power Steering Fluid Cooling Pipe & Lower Power Steering Fluid Reservoir
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the power steering fluid cooling pipe (1) from the lower power steering fluid reservoir (2).
7. Remove the power steering fluid cooling pipe bolt (5) from the bracket (4).
8. Disconnect the power steering fluid cooling pipe clip (3) from the bracket.

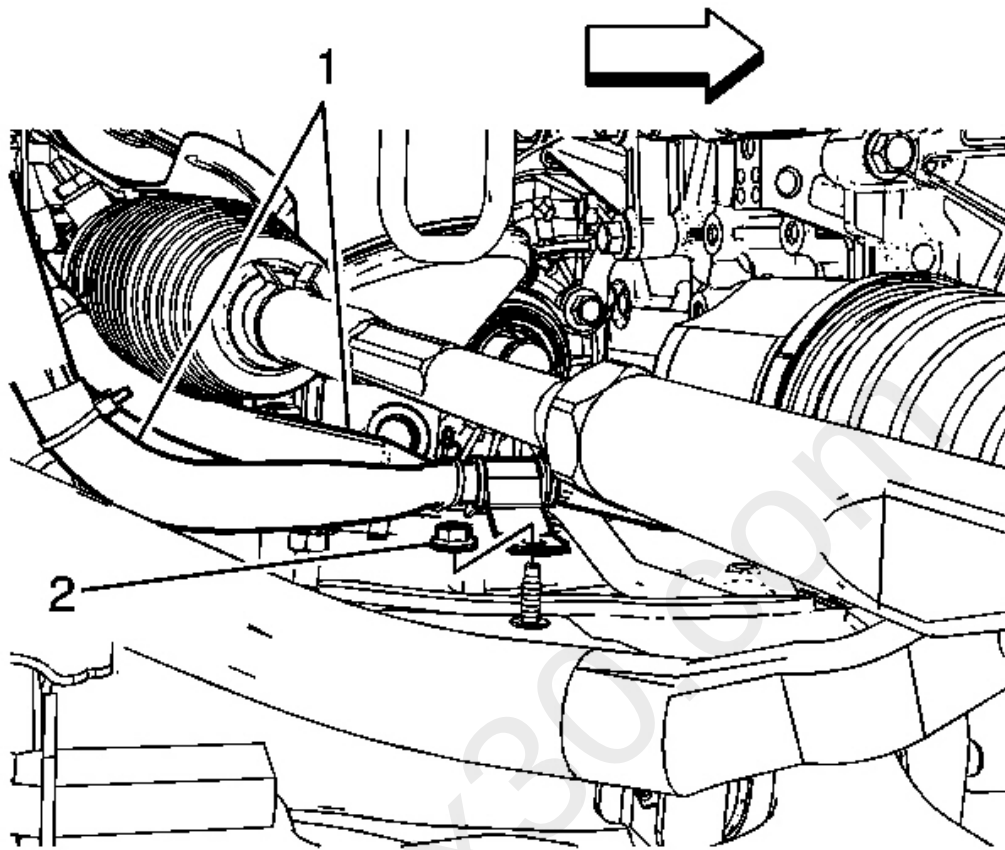


Fig. 18: Power Steering Fluid Cooling Pipe Nut
Courtesy of GENERAL MOTORS CORP.

9. Remove the power steering fluid cooling pipe nut (2) and disconnect the bracket from the stud.

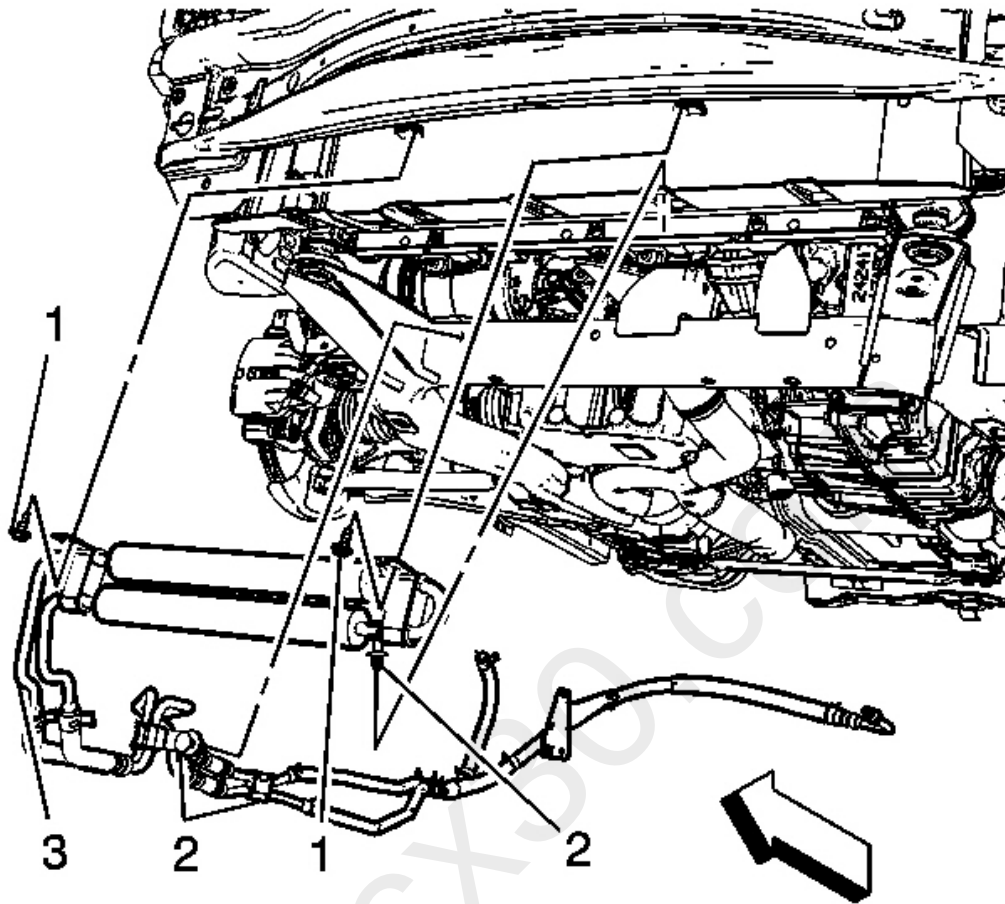


Fig. 19: Power Steering Fluid Cooling Pipe Components
Courtesy of GENERAL MOTORS CORP.

10. Remove the 2 power steering fluid cooling pipe bolts (1) from the front bumper impact bar.
11. Disconnect the 3 power steering fluid cooling pipe clips (2).
12. Remove the power steering fluid cooling pipe (3) from the vehicle.

Installation Procedure

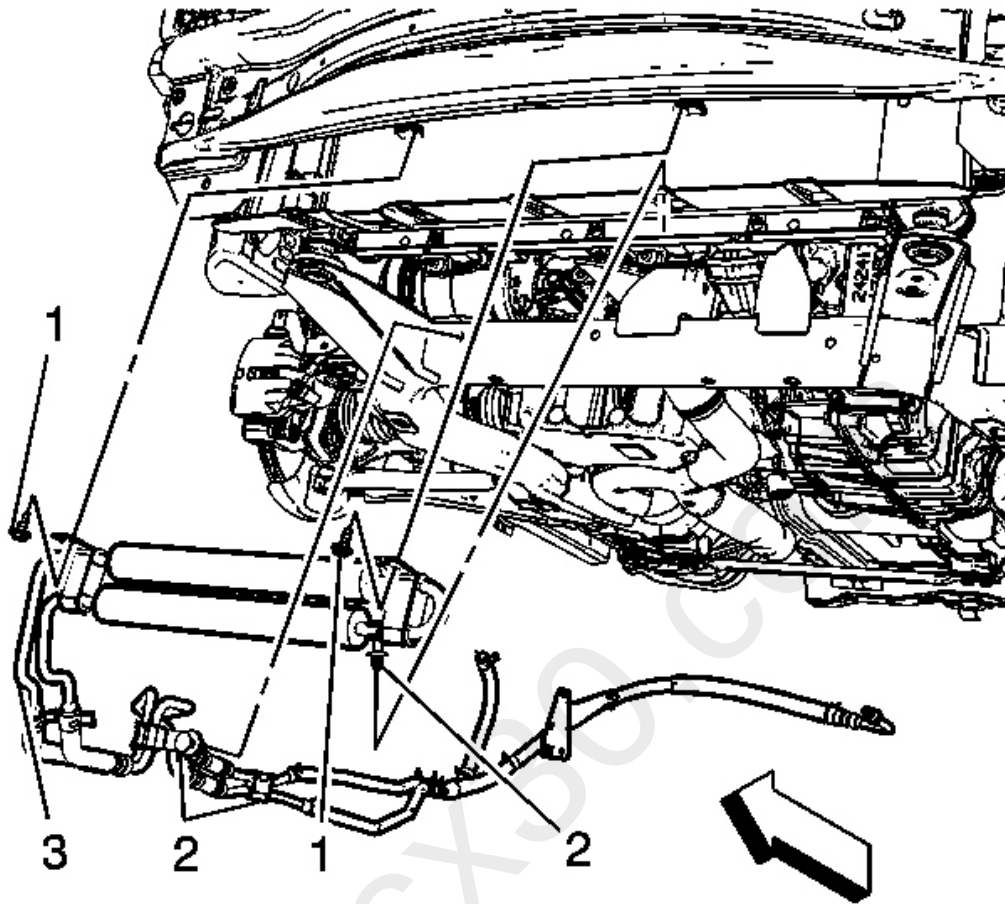


Fig. 20: Power Steering Fluid Cooling Pipe Components
Courtesy of GENERAL MOTORS CORP.

1. Position the power steering fluid cooling pipe (3) in the vehicle.
2. Connect the 3 power steering fluid cooling pipe clips (2).

CAUTION: Refer to Fastener Caution .

3. Install the 2 power steering fluid cooling pipe bolts (1) to the front bumper impact bar and tighten to 9 N.m (80 lb in).

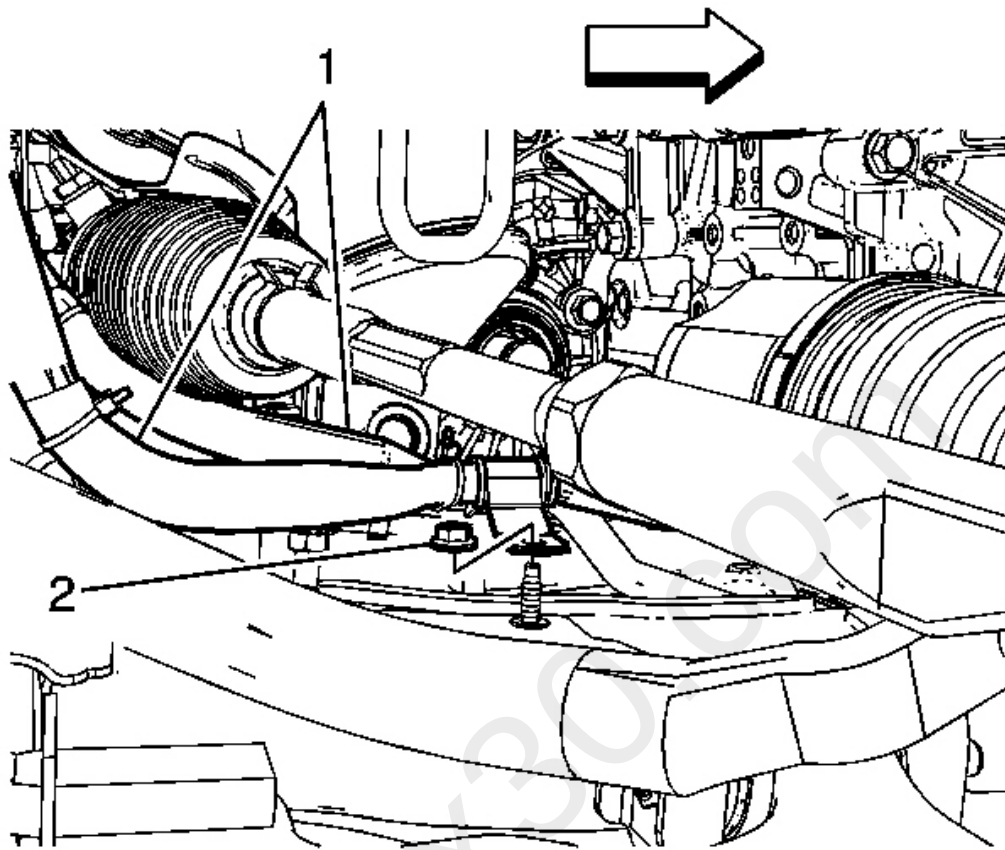


Fig. 21: Power Steering Fluid Cooling Pipe Nut
Courtesy of GENERAL MOTORS CORP.

4. Connect the power steering fluid cooling pipe bracket to the stud. Install the power steering fluid cooling pipe nut (2) and tighten to 9 N.m (80 lb in).

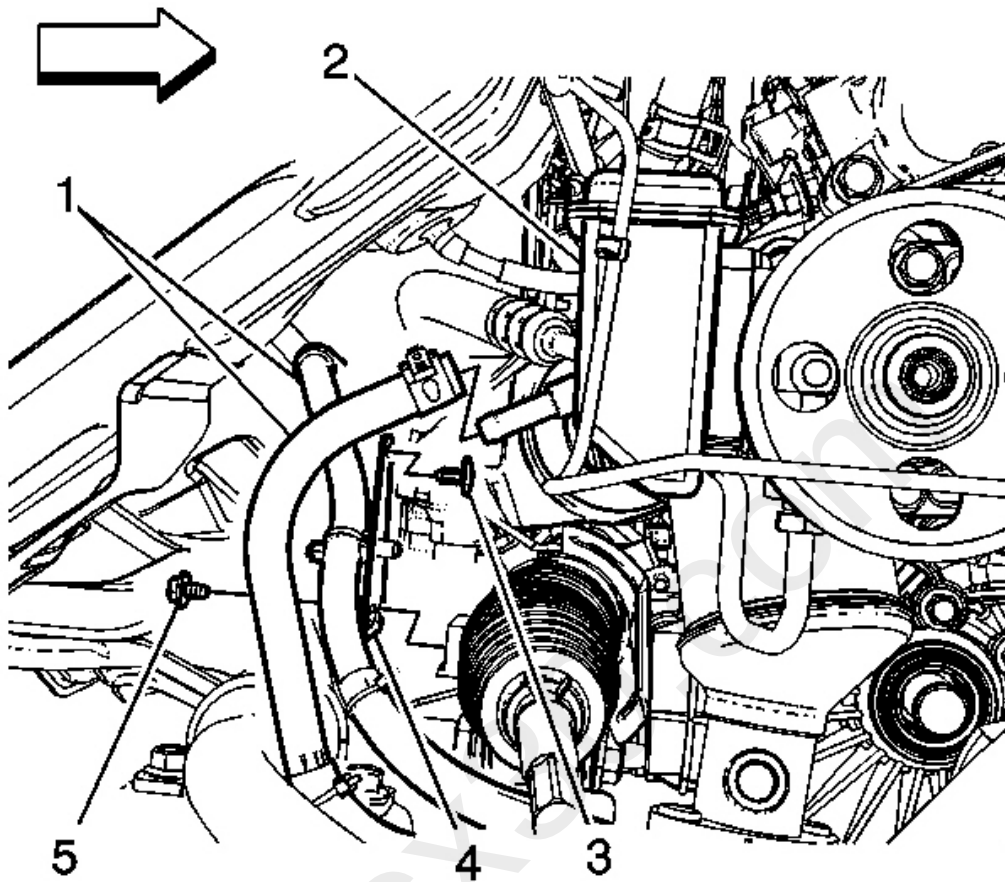


Fig. 22: Power Steering Fluid Cooling Pipe & Lower Power Steering Fluid Reservoir
Courtesy of GENERAL MOTORS CORP.

5. Connect the power steering fluid cooling pipe clip (3) to the bracket (4).
6. Install the power steering fluid cooling pipe bolt (5) to the bracket and tighten to 9 N.m (80 lb in).
7. Connect the power steering fluid cooling pipe (1) to the reservoir (2).

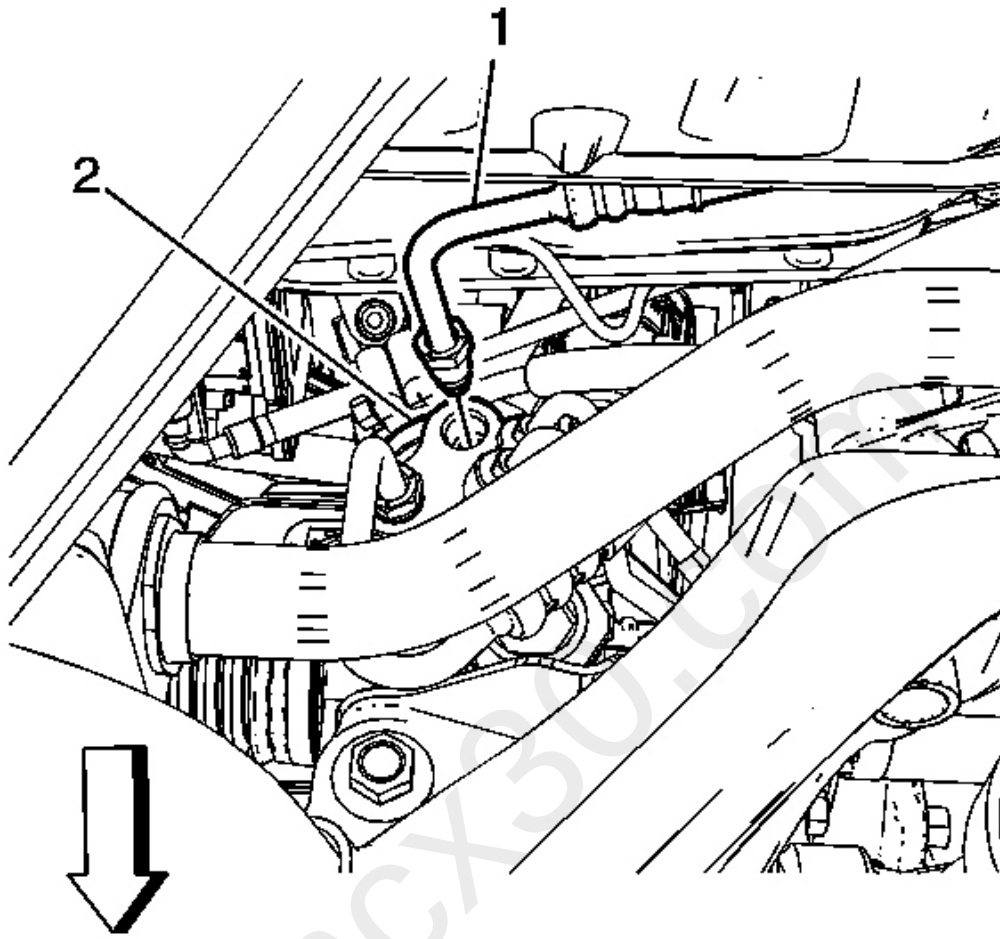


Fig. 23: Power Steering Fluid Cooling Pipe & Power Steering Gear
Courtesy of GENERAL MOTORS CORP.

8. Connect the power steering fluid cooling pipe (1) to the power steering gear (2). Tighten the fitting to 34 N.m (25 lb ft).
9. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
10. Clean any excess power steering fluid from the vehicle.
11. Remove the drain pans.
12. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement (Equinox)** or **Front Bumper Fascia Replacement (Terrain)**.
13. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

POWER STEERING FLUID RESERVOIR OUTLET HOSE REPLACEMENT

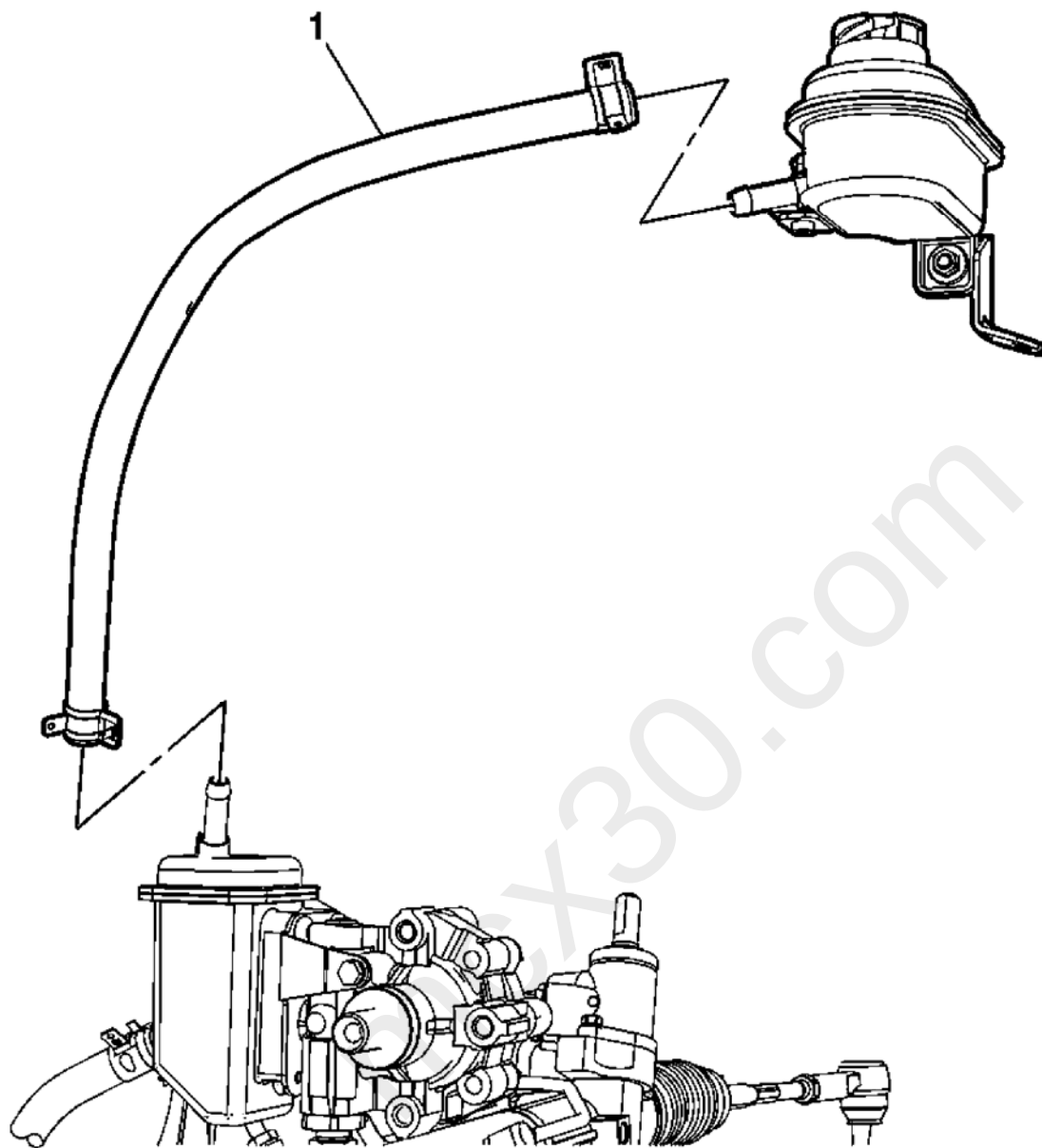


Fig. 24: Power Steering Fluid Reservoir Outlet Hose
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Place drain pans under the vehicle.
2.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .
3.	Remove as much power steering fluid from the upper power steering fluid reservoir as possible.
4.	Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .

- 5. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
- 6. Remove the right front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

1	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 GEAR INLET PIPE/HOSE REPLACEMENT

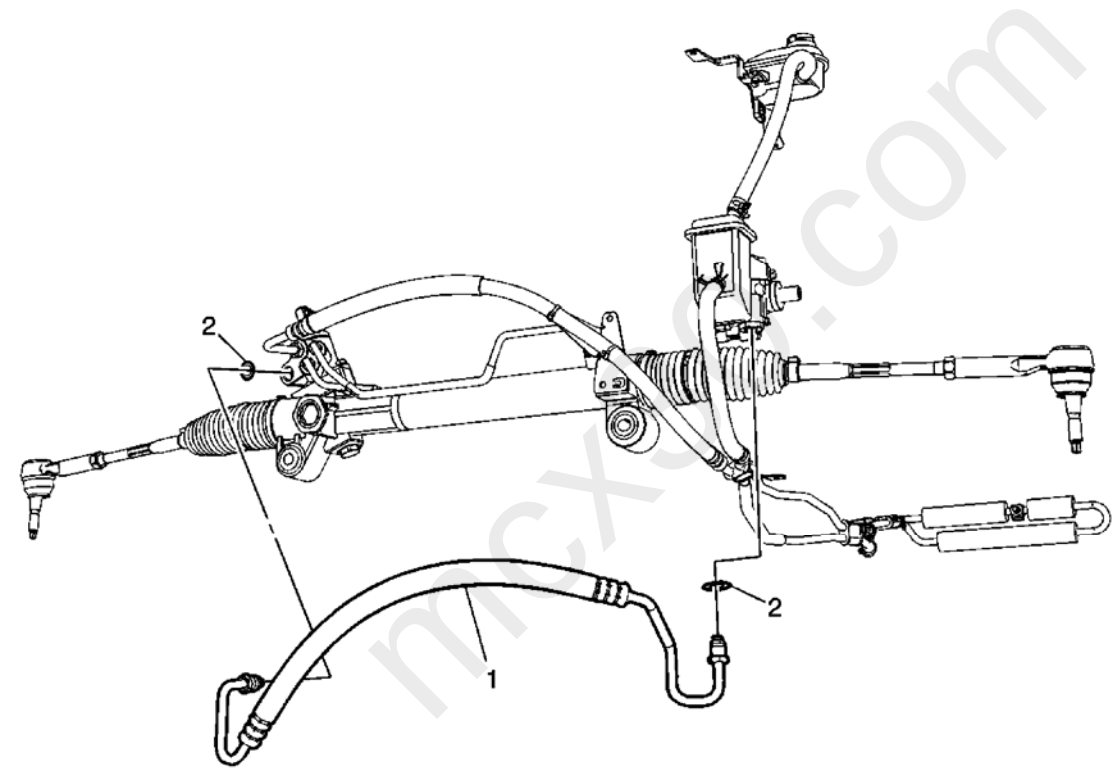


Fig. 25: Power Steering Gear Inlet Pipe/Hose
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Place drain pans under the vehicle. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 3. Remove as much power steering fluid from the upper power steering fluid reservoir as possible. 4. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	

1	Power Steering Gear Inlet Hose CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 34 N.m (25 lb ft)
2	Power Steering Gear Inlet Hose O-ring Seal (Qty: 2) Procedure 1. Install NEW power steering gear inlet hose O-ring seals. 2. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>. 3. Clean any excess power steering fluid from the vehicle.

STEERING GEAR PIPE AND SEAL REPLACEMENT

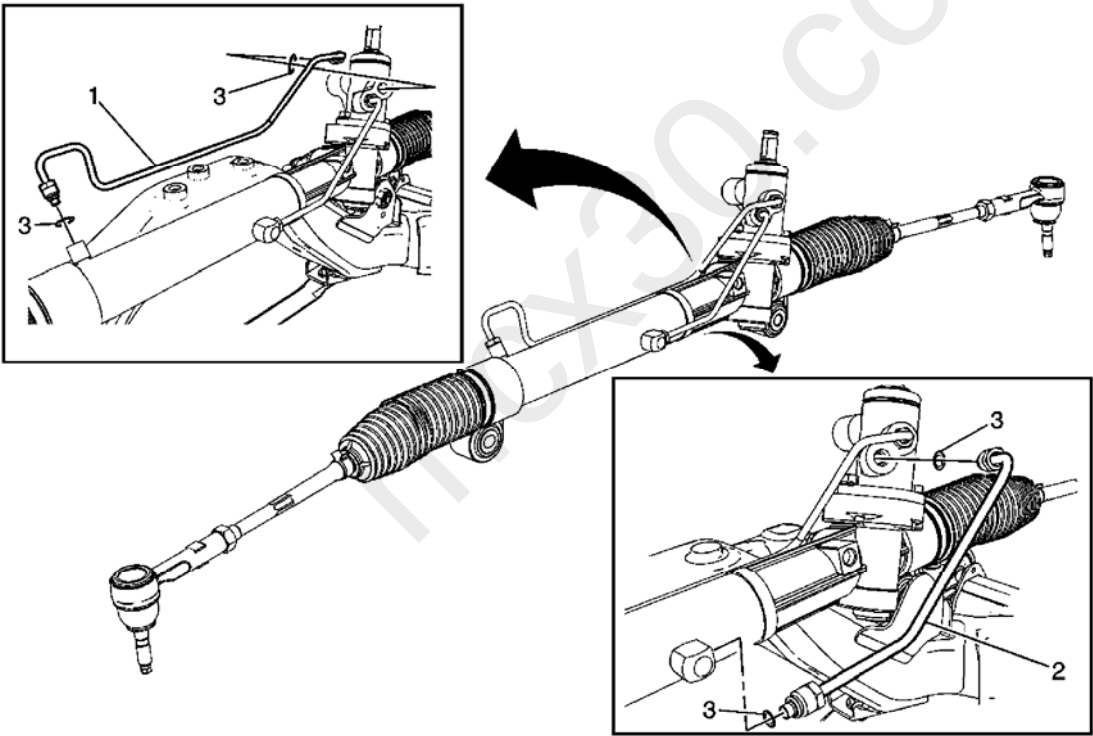


Fig. 26: Steering Gear Pipe & Seal
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the hydraulic power steering gear. Refer to <u>Steering Gear Replacement (Electronic Power Steering)</u> or <u>Steering Gear Replacement (Hydraulic Power Steering)</u>	

1	Steering Gear Pipe CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 15 N.m (11 lb ft)
2	Steering Gear Pipe Tighten: 15 N.m (11 lb ft)
3	Steering Gear Pipe Seal (Qty: 4) Procedure 1. Remove the steering gear pipe seals. Discard the seals. 2. Install NEW steering gear pipe seals.

STEERING GEAR HEAT SHIELD REPLACEMENT (ELECTRONIC POWER STEERING)

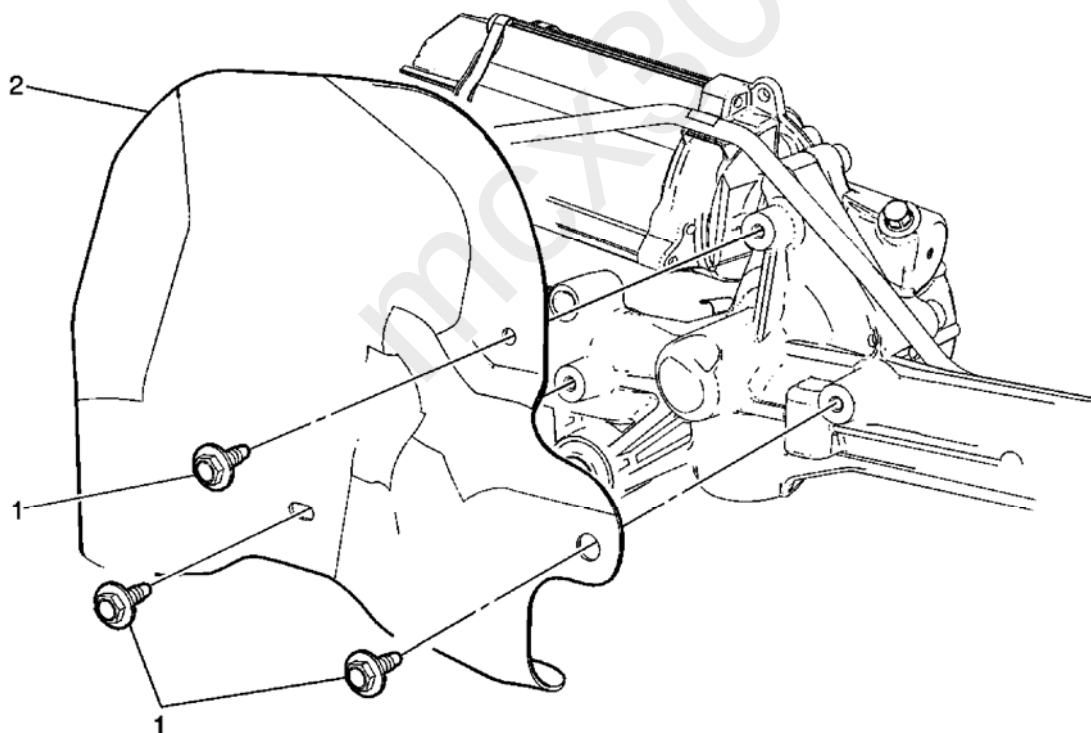


Fig. 27: Steering Gear Heat Shield (Electronic Power Steering)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Steering Gear Heat Shield Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Steering Gear Heat Shield

STEERING GEAR REPLACEMENT (ELECTRONIC POWER STEERING)

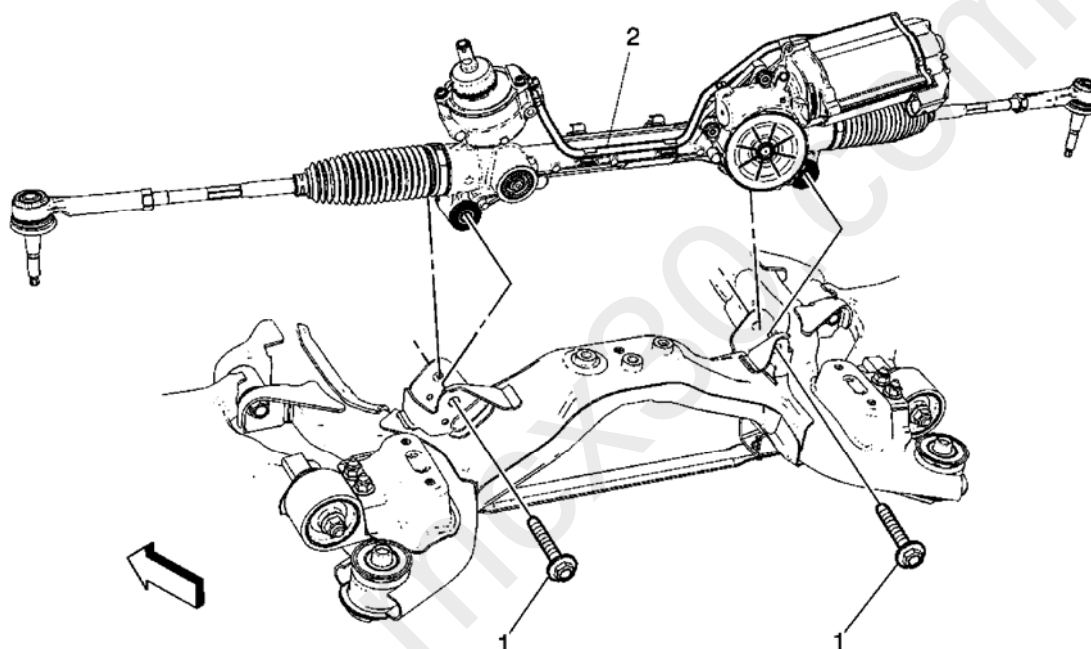


Fig. 28: Steering Gear (Electronic Power Steering)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage: • Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat. • Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.	

- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumping or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

CAUTION:

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

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

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

Preliminary Procedure

1. With the front wheels in the straight ahead position, turn the ignition switch to the OFF position and remove the key from the ignition lock cylinder. Rotate the steering wheel in order to lock the steering column.
2. Capture the key cycle count from the old steering gear control module. Refer to **Power Steering Control Module Programming and Setup**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
4. Disconnect the outer tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
5. Remove the right side catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LF1)**.
6. Remove the propeller shaft, if equipped. Refer to **Propeller Shaft Replacement**.
7. Remove the transmission rear mount from the transmission rear mount bracket. Refer to **Transmission Rear Mount Replacement (FWD)** or **Transmission Rear Mount Replacement (AWD)** if equipped with MH7 or MHC. Refer to **Transmission Rear Mount Replacement** if equipped with MH2 or MH4.
8. Disconnect the intermediate steering shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement**.
9. Partially lower the rear of the drivetrain and front suspension frame in order to gain clearance for

the steering gear. Refer to **Drivetrain and Front Suspension Frame Replacement** .

Steering Gear Bolt (Qty: 2)

CAUTION:

Refer to **Fastener Caution** .

Procedure

1

1. Remove the 2 steering gear bolts.

Discard the bolts.

2. Install 2 NEW steering gear bolts.

Tighten: 110 N.m (81 lb ft)

Steering Gear

Procedure

2

1. Remove the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (Electronic Power Steering)**.
2. Disconnect the electrical connectors. Refer to **FEP Connectors (Steering Gear)** .
3. Carefully remove the steering gear through the right front wheel opening.
4. Transfer parts if necessary. Refer to **Power Steering Assist Motor Replacement** if necessary.
5. After the installation is complete, measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .
6. Transfer the key cycle count from the old steering gear control module to the new steering gear control module. Refer to **Power Steering Control Module Programming and Setup** .

STEERING GEAR REPLACEMENT (HYDRAULIC POWER STEERING)

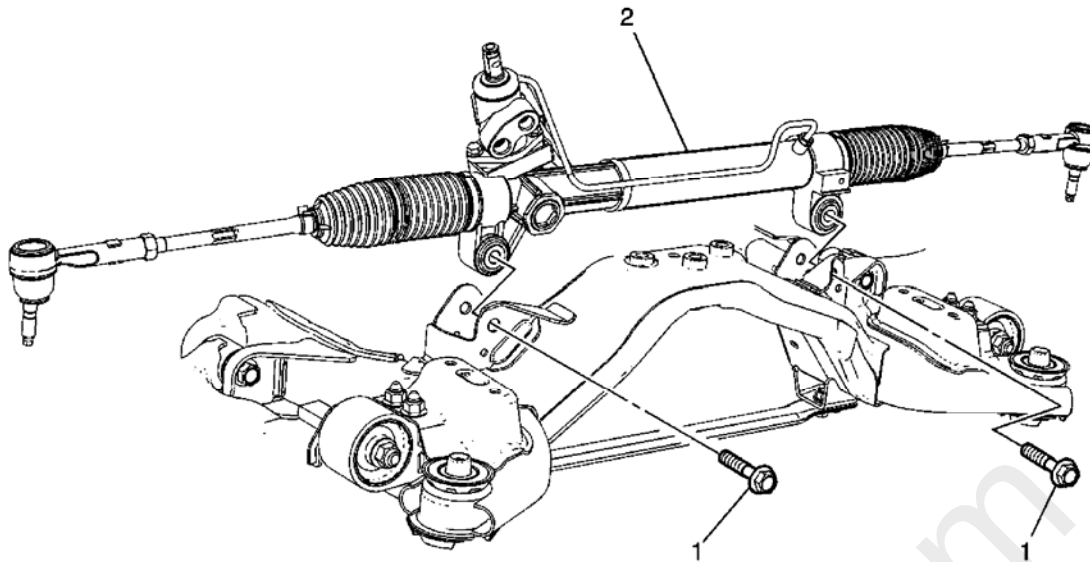


Fig. 29: Steering Gear (Hydraulic Power Steering)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components: • The steering column • The intermediate shaft(s) • The steering gear After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil. Preliminary Procedure 1. With the front wheels in the straight ahead position, turn the ignition switch to the OFF position and remove the key from the ignition lock cylinder. 2. Rotate the steering wheel in order to lock the steering column. 3. Place drain pans under the vehicle. 4. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 5. Remove as much power steering fluid from the power steering fluid reservoir as possible.	

6. Disconnect the 2 outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
7. Disconnect the power steering gear inlet pipe from the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
8. Disconnect the power steering fluid cooling pipe from the steering gear. Refer to **Power Steering Fluid Cooling Pipe Replacement**.
9. Disconnect the intermediate steering shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement**.
10. Position a jack stand under the rear of the drivetrain and front suspension frame. Partially lower the rear of the drivetrain and front suspension frame in order to gain clearance for the steering gear. Refer to **Drivetrain and Front Suspension Frame Replacement**.

1	Steering Gear Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u>. Procedure: Install NEW steering gear bolts. Tighten: 110 N.m (81 lb ft)
2	Steering Gear Procedure 1. Carefully remove the steering gear through the left front wheel opening. 2. After the installation is complete, fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>. 3. Clean any excess power steering fluid from the vehicle. 4. Measure and adjust the front toe. Refer to <u>Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment</u>.

STEERING LINKAGE INNER TIE ROD REPLACEMENT

Removal Procedure

1. Remove 1 steering gear boot. Refer to **Steering Gear Boot Replacement**.
2. Turn the steering wheel in order to position the steering gear rack so that only 2 rack teeth and the flat surface of the rack are visible outside the steering gear housing.
3. If equipped with a hydraulic power steering gear, bend the tabs on the steering gear rack thrust washer in order to release the steering linkage inner tie rod.

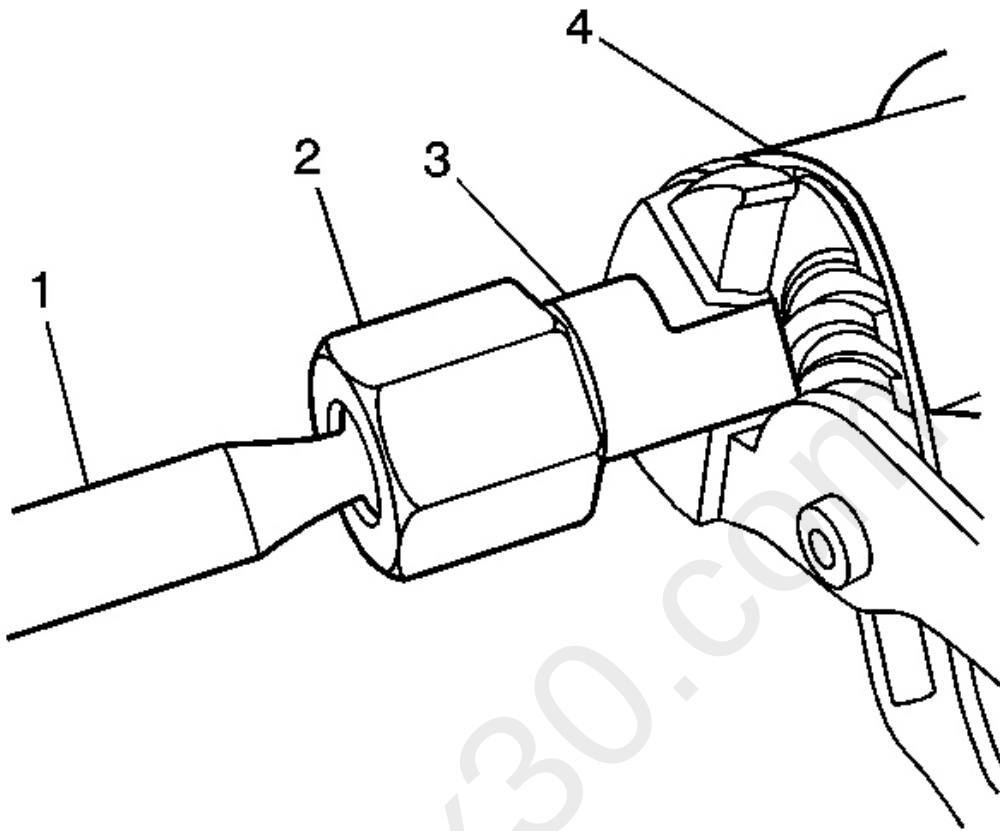


Fig. 30: Steering Linkage Inner Tie Rod
Courtesy of GENERAL MOTORS CORP.

4. Place a soft jaw pipe wrench or soft jaw pliers on the flat surface of the steering gear rack (3) between the steering gear housing (4) and the inner tie rod housing (2).
5. Place a crows foot wrench on the flats of the inner tie rod housing (2).

CAUTION: Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear.

6. Rotate the steering linkage inner tie rod housing counterclockwise while holding the steering gear rack stationary until the steering linkage inner tie rod separates from the steering gear rack.
7. If equipped with a hydraulic power steering gear, remove the steering gear rack thrust washer.

Discard the washer.

Installation Procedure

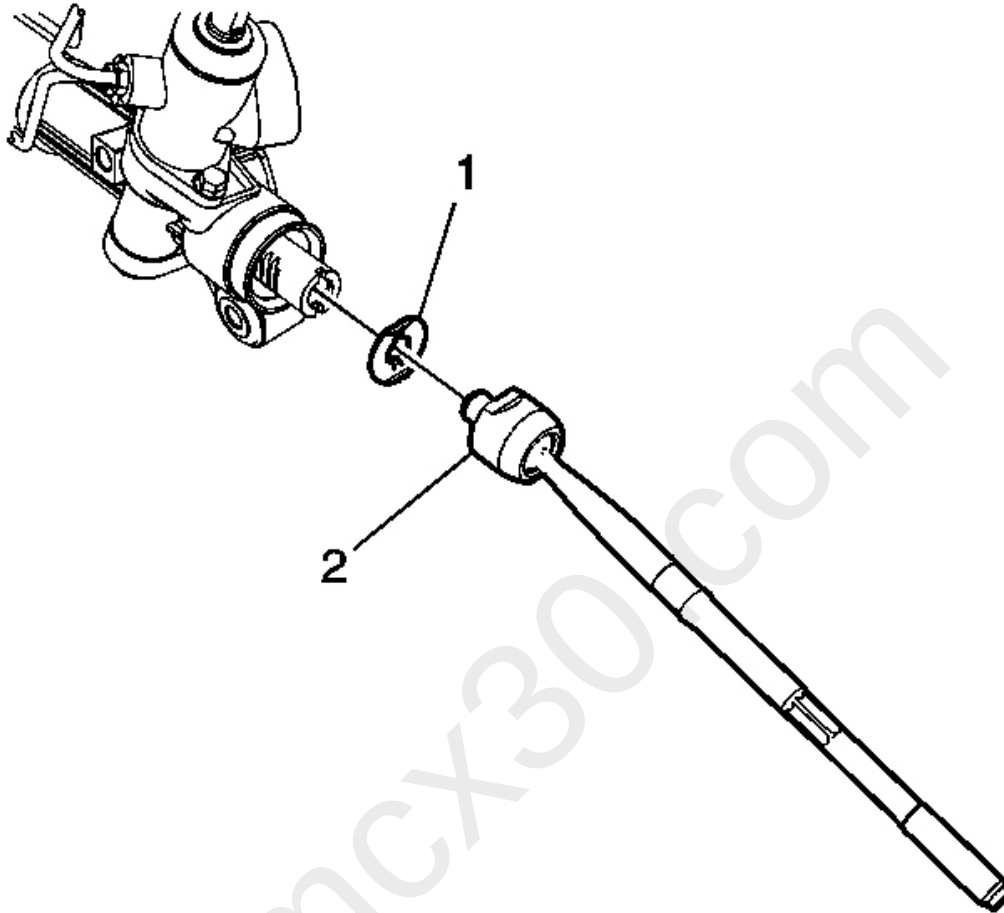


Fig. 31: Retaining Washer & Steering Gear Inner Tie Rod Housing
Courtesy of GENERAL MOTORS CORP.

1. If equipped with a hydraulic power steering gear, position the NEW steering gear rack thrust washer (1).
2. Install the steering linkage inner tie rod (2) to the steering gear rack.

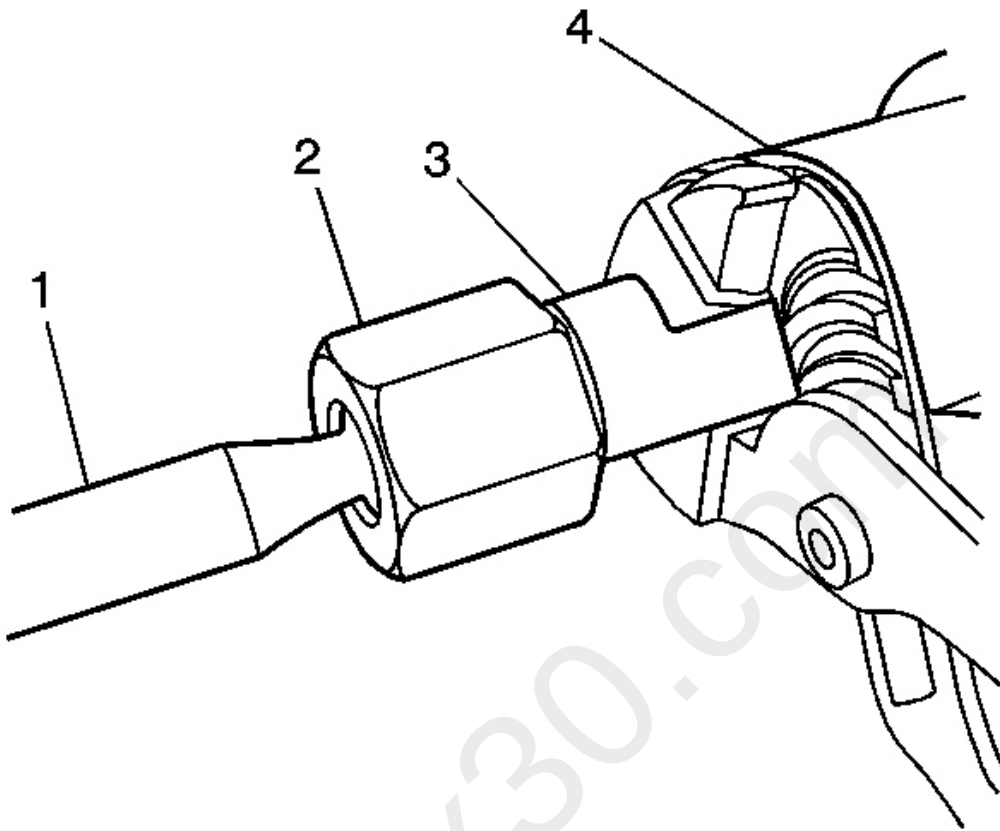


Fig. 32: Steering Linkage Inner Tie Rod
Courtesy of GENERAL MOTORS CORP.

3. Place a soft jaw pipe wrench or soft jaw pliers on the flat surface of the steering gear rack (3) between the steering gear housing (4) and the inner tie rod housing (2).

CAUTION: Refer to Fastener Caution .

4. Place a torque wrench with a crows foot wrench attachment on the flats of the inner tie rod housing and tighten to 105 N.m (77 lb ft).
5. If equipped with a hydraulic power steering gear, bend the tabs over on the steering gear rack thrust washer in order to secure the inner tie rod.
6. Install the steering gear boot. Refer to **Steering Gear Boot Replacement**.

STEERING GEAR COUPLING REPLACEMENT

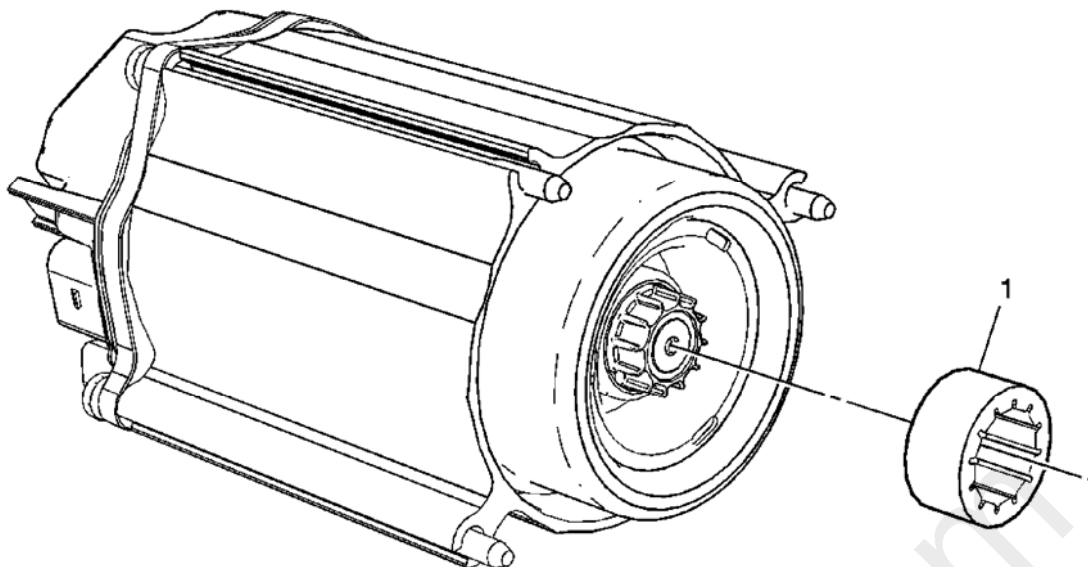


Fig. 33: Steering Gear Coupling
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the power steering assist motor. Refer to <u>Power Steering Assist Motor Replacement</u>	
1	Steering Gear Coupling Tip: The steering gear coupling connects the power steering assist motor to the steering gear.

POWER STEERING ASSIST MOTOR REPLACEMENT

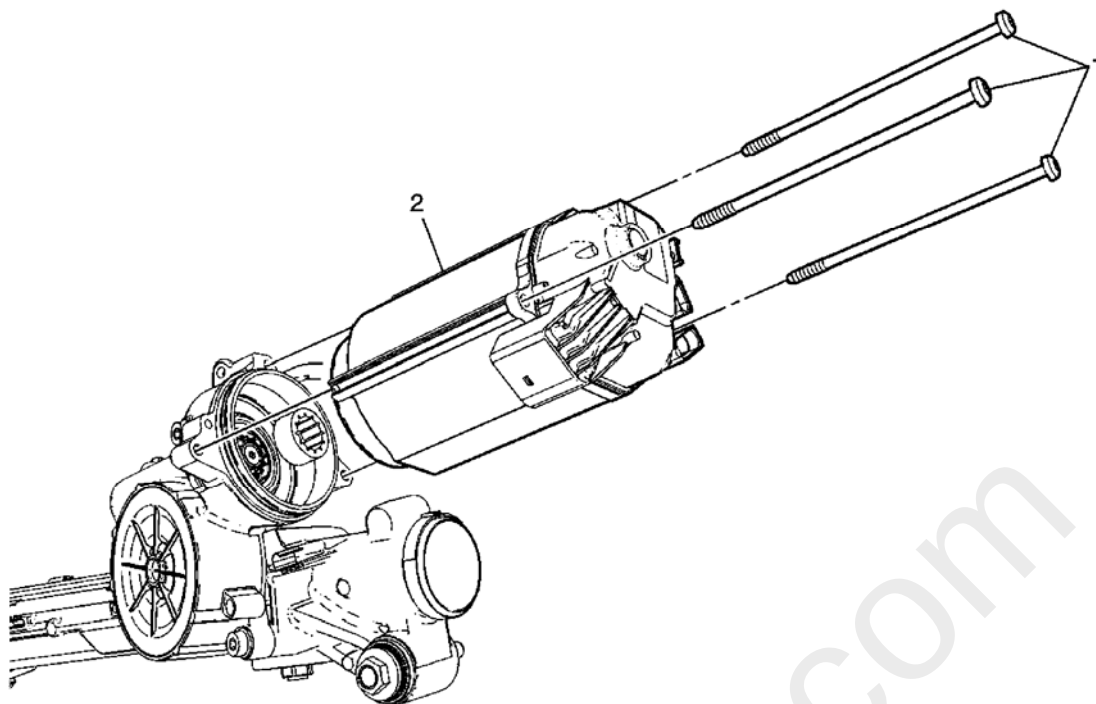


Fig. 34: Power Steering Assist Motor
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage: • Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat. • Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage. • Do not allow tools to contact exposed terminals when servicing connectors. • Do not remove components from their protective packaging until required to do so. • Avoid the following actions unless required by the diagnostic procedure: ○ Jumpering or grounding of the components or connectors. ○ Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes. • Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.	
Preliminary Procedures 1. Capture the key cycle count from the old steering gear control module. Refer to Power Steering	

Control Module Programming and Setup .

2. Remove the electronic power steering gear. Refer to **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering)**.

1	Power Steering Assist Motor Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Remove the 3 power steering assist motor bolts. Discard the bolts. 2. Install 3 NEW power steering assist motor bolts. Tighten: 8 N.m (71 lb in)
2	Power Steering Assist Motor Procedure 1. Remove the O-ring from the steering gear housing. Discard the O-ring. 2. Install a NEW O-ring around the steering gear housing. 3. Install the steering gear coupling to the assist motor armature. 4. Align the steering gear coupling on the assist motor armature to the steering gear. 5. Align the power steering assist motor bolts to the steering gear while pressing the motor over the gear housing O-ring. 6. Transfer the key cycle count from the old steering gear control module to the new steering gear control module. Refer to <u>Power Steering Control Module Programming and Setup</u> .

POWER STEERING CONTROL MODULE CALIBRATION

Steering Angle Sensor Centering and Software Endstop Learning

WARNING: An inaccurate or not centered steering angle sensor could limit the operation of the electric power steering (EPS) and result in personal injury.

Centering of the steering angle sensor and software endstop learning might be required after certain service procedures are performed. Some of these procedures are as follows:

- Steering angle sensor replacement
- Steering gear replacement
- Power steering assist motor replacement
- Steering column replacement
- Steering linkage inner tie rod replacement
- Steering linkage outer tie rod replacement

NOTE: **It is necessary to perform the steering angle sensor centering before the software endstop learning.**

Steering Angle Sensor Centering

For the centering procedure of the external steering angle sensor (electronic stability program) refer to **Steering Angle Sensor Centering** . The centering procedure of the internal steering angle sensor (w/o electronic stability program) can be completed with the following steps:

Conditions: Front axle measured and set, engine running, vehicle speed 0 km/h (0 MPH), internal steering angle sensor is activated.

1. Using the steering wheel, align the front wheels in the center forward position.
2. Using a scan tool, perform the Configuration/Reset Functions, Steering Wheel Angle Sensor Centering procedure.
3. Steer from the center position slowly 90° to the left.
4. Steer slowly back to the center position and then slowly 90° to the right.
5. Steer slowly back to the center position.
6. Perform the steering movements again.
7. Centering procedure is completed.

Software Endstop Learning

The software endstop learning procedure can be completed with the following steps:

Conditions: Front axle measured and set, vehicle speed 0 km/h (0 MPH), internal steering angle sensor is calibrated or external steering angle sensor sends a valid CAN signal.

1. Using a scan tool, perform the Configuration/Reset Functions, Power Steering Softstops Reset procedure and follow the on-screen instructions.
2. Using a scan tool, perform the Configuration/Reset Functions, Power Steering Softstops Learn procedure and follow the on-screen instructions.
3. Software endstop learning procedure is completed.

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION (HYDRAULIC POWER STEERING)

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

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

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

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

- A recirculating ball system
- A rack and pinion system

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

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

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

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

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

POWER STEERING SYSTEM DESCRIPTION AND OPERATION (LAF)

The power steering system consists of the following components:

- The power steering control module
- The power steering motor
- The power steering motor rotational sensor
- The torque sensor
- The steering gear (rack and dual pinion)

The rack & dual pinion electric power steering system reduces the amount of effort needed to steer the vehicle utilizing the power steering control module to control the power steering motor to maneuver the steering gear. The power steering control module also uses a combination of the torque sensor, motor rotational sensor, battery voltage circuit and GMLAN serial data circuit to perform the system functions. The power steering control module monitors vehicle speed and engine speed from the engine control module via the GMLAN serial data circuit to determine the amount of steering assist needed to steer the vehicle. At low speeds more assist is provided for easy turning during parking maneuvers. At higher speeds less assist is provided for improved road feel and directional stability.

The power steering control module uses a combination of the torque sensor, motor rotational sensor, vehicle speed, and calculated system temperature inputs to determine the amount of assist needed. The power steering control module continuously monitors the digital torque sensor torque and index current signals. As the steering wheel is turned and torsional twist is applied to the steering shaft, the steering input and output shafts are monitored via the torque signal circuit and then processed by the power steering control module to calculate the steering torque. The voltage signals of the motor position sensor and the digital torque sensor index current signal are both processed by the power steering control module to detect and calculate the steering wheel angle.

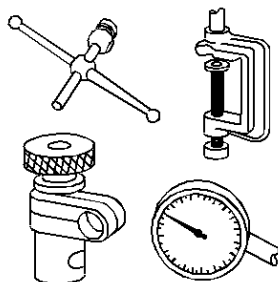
The power steering control module responds to the change in the digital torque sensor signals as well as the motor rotational sensor voltage signals by commanding current to the power steering motor. The power steering control module controls the pulse width modulated motor drive circuit to drive the 3-phase motor. The power steering control module & motor assembly is attached to the base of the steering gear housing and assists the steering gear pinion to maneuver the rack from left to right according to turning the steering wheel.

The power steering control module has the ability to calculate an internal system temperature to protect the power steering system from damage caused by high temperature. To reduce a high system temperature, the power steering control module will reduce the amount of current commanded to the power steering motor, which reduces the amount of steering assist. The power steering control module has the ability to detect malfunctions within the electric power steering system. Any malfunction detected that disables steering assist will cause the SERVICE POWER STEERING message to be displayed on the driver information center.

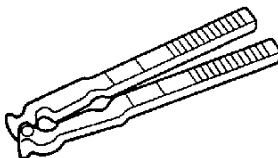
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

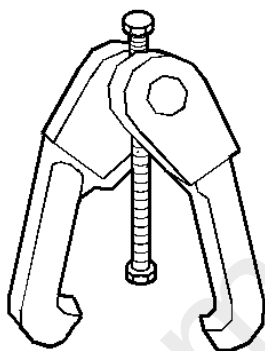
Illustration	Tool Number/ Description



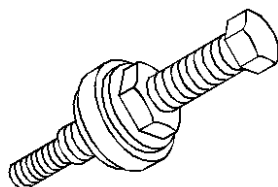
J-8001
Dial Indicator Set



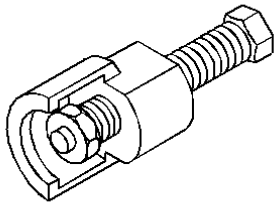
J-22610
Keystone Clamp Pliers



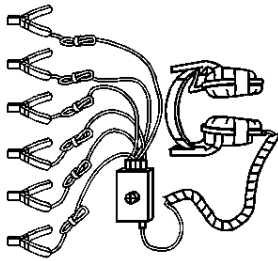
J-24319-B
Steering Linkage and Tie Rod Puller



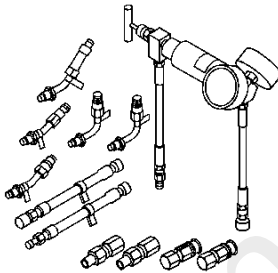
J-25033-C
Pulley Installer



J-25034-C
Pulley Remover



J-39570
Chassis Ear



J-44721
Power Steering Analyzer