

Engine

Engine Controls and Fuel - 2.0L (LTG) - Repair Instructions - CTS Sedan

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR LEARN

NOTE: Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.

Calibration Criteria

NOTE: Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.
6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

Q38 THROTTLE BODY: THROTTLE/IDLE LEARN

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to unlearn the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- The engine speed is between 450-4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

Throttle Learn

Scan Tool Idle Learn or Idle Learn Reset Procedure - Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, observe the scan tool Throttle Body Idle Airflow Compensation parameter. The Throttle Body Idle Airflow Compensation value should equal 0 % and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Service Bay/On Road Idle Learn Procedure - Performed after the ECM is programmed or replaced

NOTE: Do NOT perform this procedure if DTCs are set. Refer to Diagnostic

Trouble Code (DTC) List - Vehicle .

1. Engine idling for 3 min.
2. Observe the scan tool Desired Idle Speed and the actual Engine Speed parameters.
3. The ECM will start to learn the new idle cells and the Desired Idle Speed should start to decrease.
4. Ignition OFF for 60 s.
5. Start and idle the engine for 3 min.
6. After the 3 min run time the engine should be idling normal.

NOTE: During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

- If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
7. After the drive cycle, the engine should be idling normally.
 - If the engine idle speed has not been learned, turn OFF the ignition for 60 s and repeat step 6.
 8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

NOTE: The Crankshaft Position Variation Learn procedure is also required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement
- An engine control module (ECM) or body control module (BCM) replacement
- A crankshaft balancer replacement
- A crankshaft removal and/or replacement
- A crankshaft position sensor disturbance/removal and/or replacement
- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

NOTE: The ECM monitors certain component signals to determine if all the conditions are met to continue with the Crankshaft Position Variation Learn procedure.

1. Ignition ON, observe the DTC information with a scan tool. Verify no other DTCs are set, except DTCs P0300-P0304, or P0315.
 - If DTCs are set, except DTCs P0300-P0304, or P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

2. Select the Crankshaft Position Variation Learn Procedure with a scan tool and follow the on screen instructions:
3. Verify DTC P0315 does not set.
 - **If DTC P0315 set, or another DTC is present** refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
 - **If the DTC does not set**
4. All OK.

ENGINE CONTROL MODULE REPLACEMENT

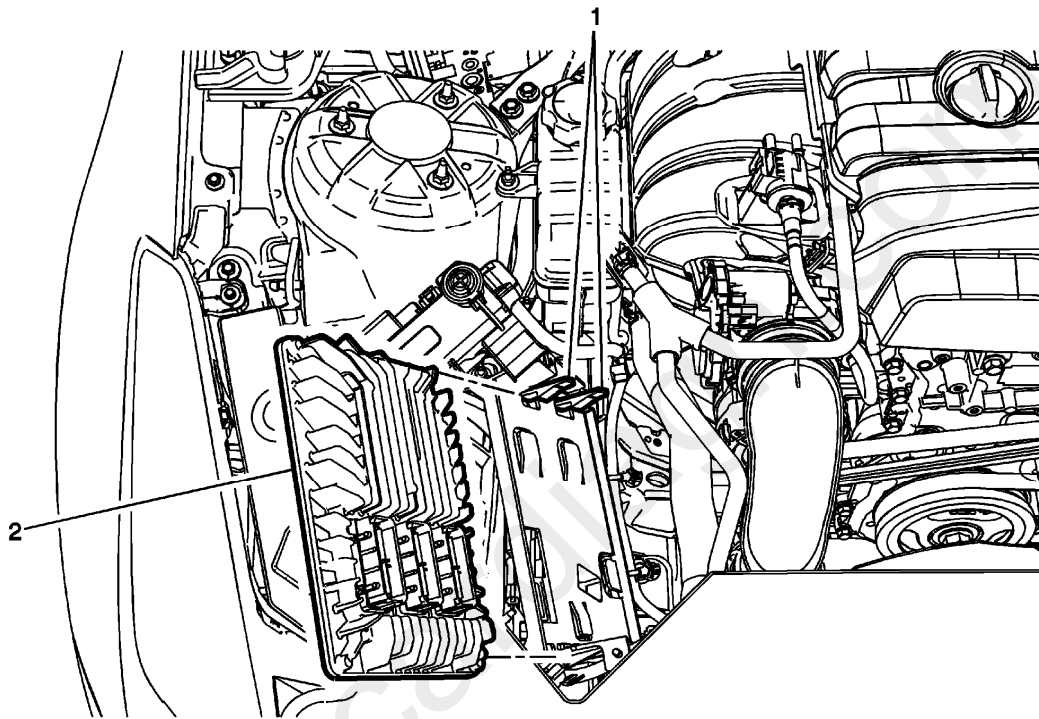


Fig. 1: Engine Control Module
 Courtesy of GENERAL MOTORS COMPANY

Engine Control Module Replacement

Callout	Component Name
Preliminary Procedure	
1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the front compartment fuse block housing. Refer to <u>Front Compartment Fuse Block Housing Replacement</u> .	
1	Electronic Control Module Bracket Retaining Tabs
	Electronic Control Module

WARNING:

Refer to Safety Glasses Warning .

CAUTION:

Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.

CAUTION:

- Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.
- Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery.
- In order to prevent any possible electrostatic discharge damage to the control module, do not touch the connector pins or the soldered components on the circuit board.
- Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.
- The replacement control module must be programmed.

Procedure

1. Disconnect the electrical connectors.
2. If replacing, program the ECM. Refer to Control Module References .

NOTE:

Before removing the engine control module (ECM), record the oil life percentage remaining. Use the scan tool to reset the Engine Oil Life remaining back to the original percentage recorded.

ENGINE CONTROL MODULE BRACKET REPLACEMENT

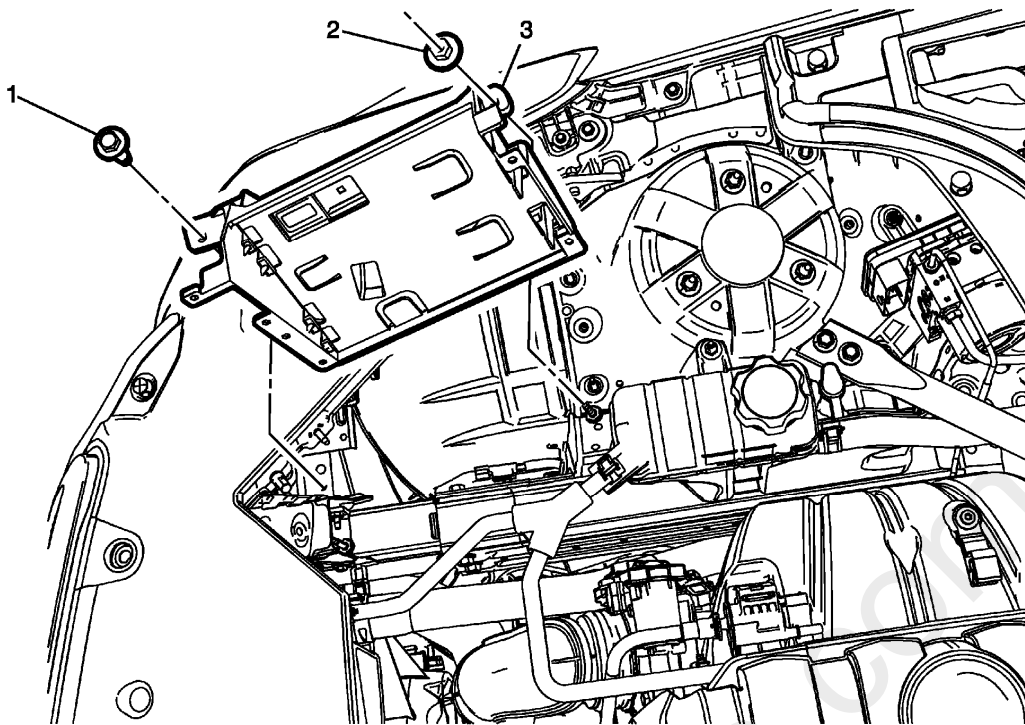


Fig. 2: Engine Control Module Bracket
 Courtesy of GENERAL MOTORS COMPANY

Engine Control Module Bracket Replacement

Callout	Component Name
Preliminary Procedure	
Remove the engine control module. Refer to <u>Engine Control Module Replacement</u>.	
1	Engine Control Module Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 (62 lb in)
2	Engine Control Module Bracket Nut Tighten 7 (62 lb in)
3	Engine Control Module Bracket

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

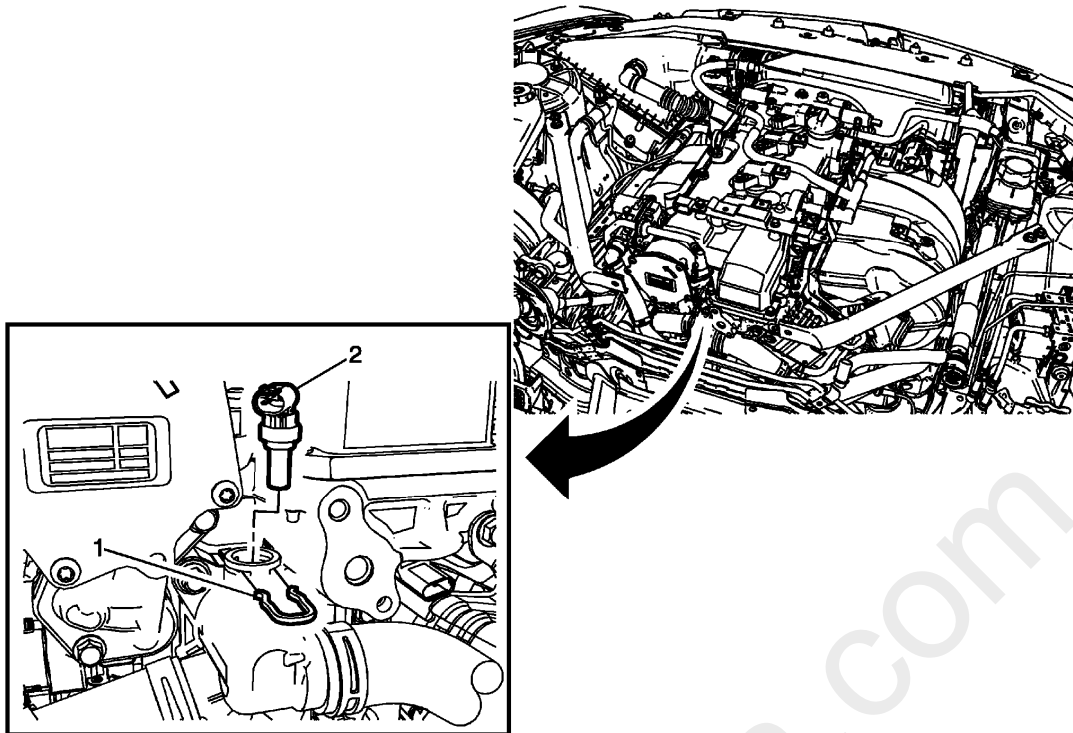


Fig. 3: Engine Coolant Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedure	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) . 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 3. Remove the plenum front panel. Refer to Plenum Front Panel Replacement . 4. Remove the outer fuel pump insulator. Refer to Fuel Pump Insulator Replacement (Inner) , Fuel Pump Insulator Replacement (Outer) . 5. Remove the power brake booster pump. Refer to Power Brake Booster Pump Replacement (LTG) , Power Brake Booster Pump Replacement (LFX, LF3) .	
1	Engine Coolant Temperature Sensor Retaining Clip
2	Engine Coolant Temperature Sensor
	Procedure 1. Disconnect the engine wiring harness electrical connector from the engine coolant temperature sensor. 2. Remove the engine coolant temperature sensor from the thermostat housing. 3. Inspect the seal and replace if necessary.

ENGINE OIL PRESSURE SENSOR REPLACEMENT

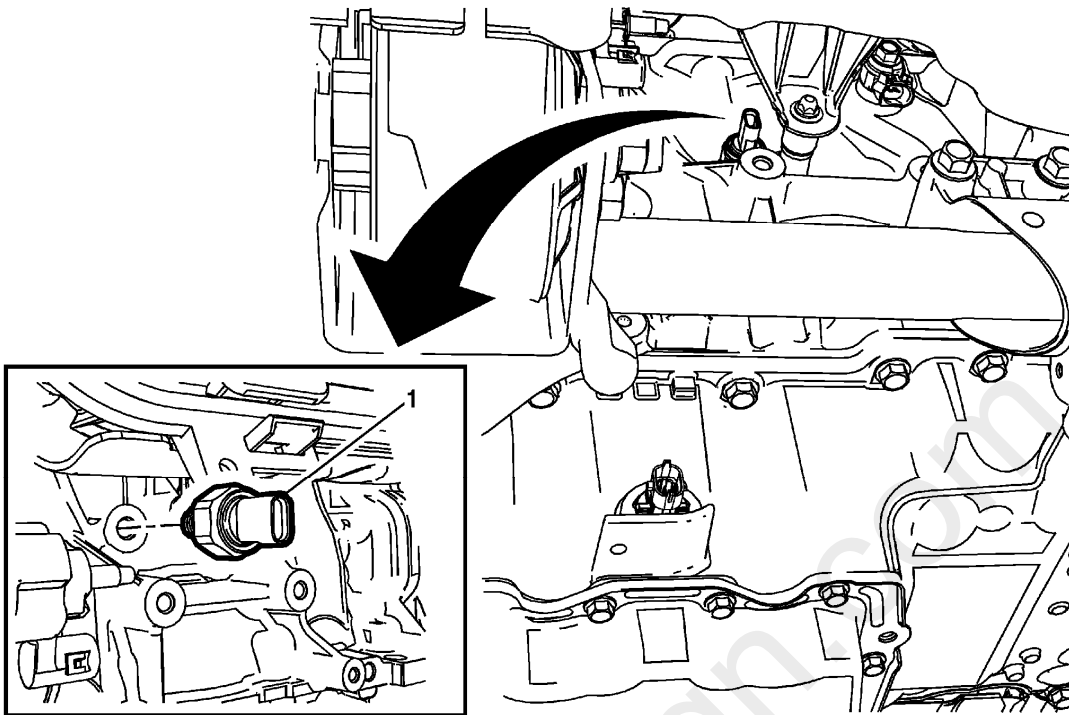


Fig. 4: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure Raise and properly support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Engine Oil Pressure Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the engine oil pressure sensor electrical connector. Tighten 35 (26 lb ft)

INTAKE AIR PRESSURE AND TEMPERATURE SENSOR REPLACEMENT

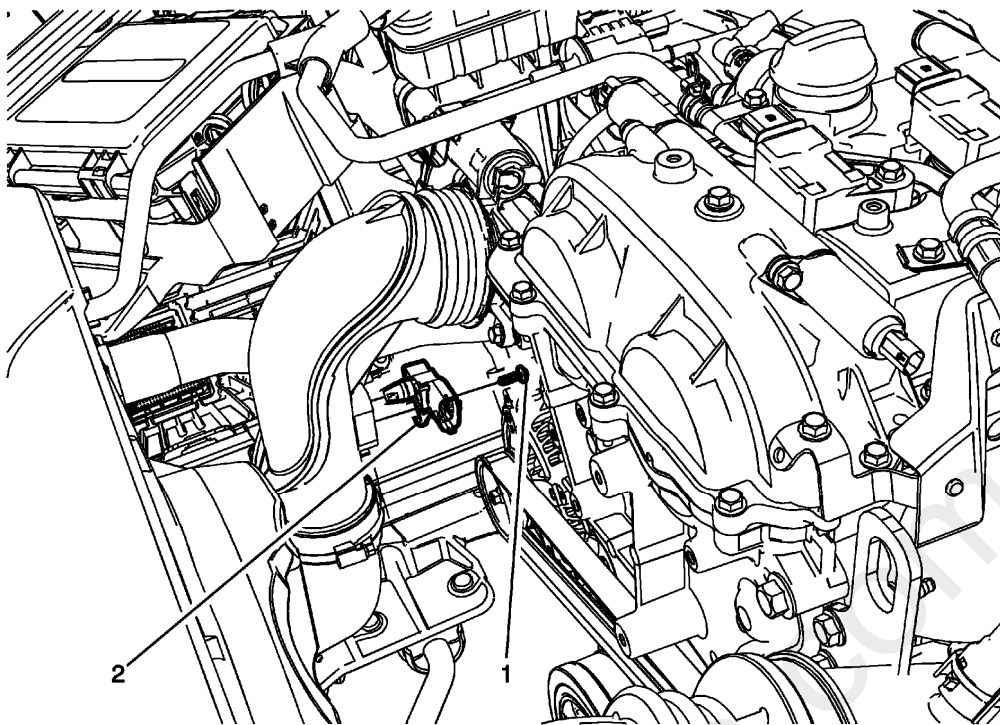


Fig. 5: Intake Air Pressure and Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Intake Air Pressure and Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedure Disconnect the electrical connector.	
1	Intake Air Pressure and Temperature Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .
2	Intake Air Pressure and Temperature Sensor

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

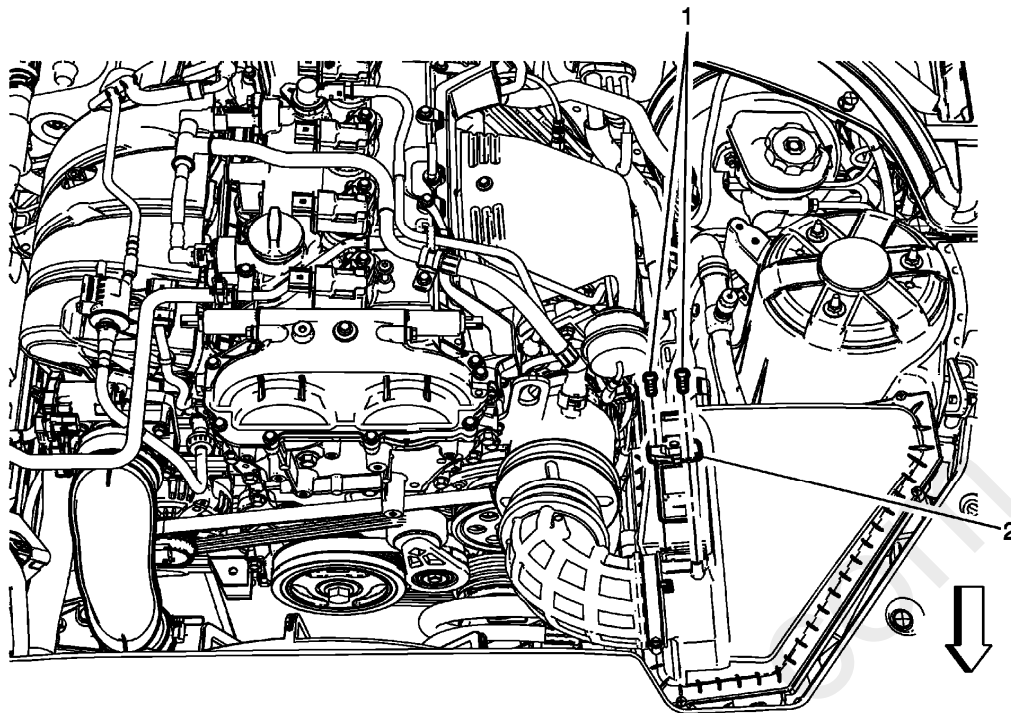


Fig. 6: Mass Airflow Sensor with Intake Air Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

Callout	Component Name
1	Mass Air Flow Sensor Fasteners (Qty :2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Mass Air Flow Sensor Procedure Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

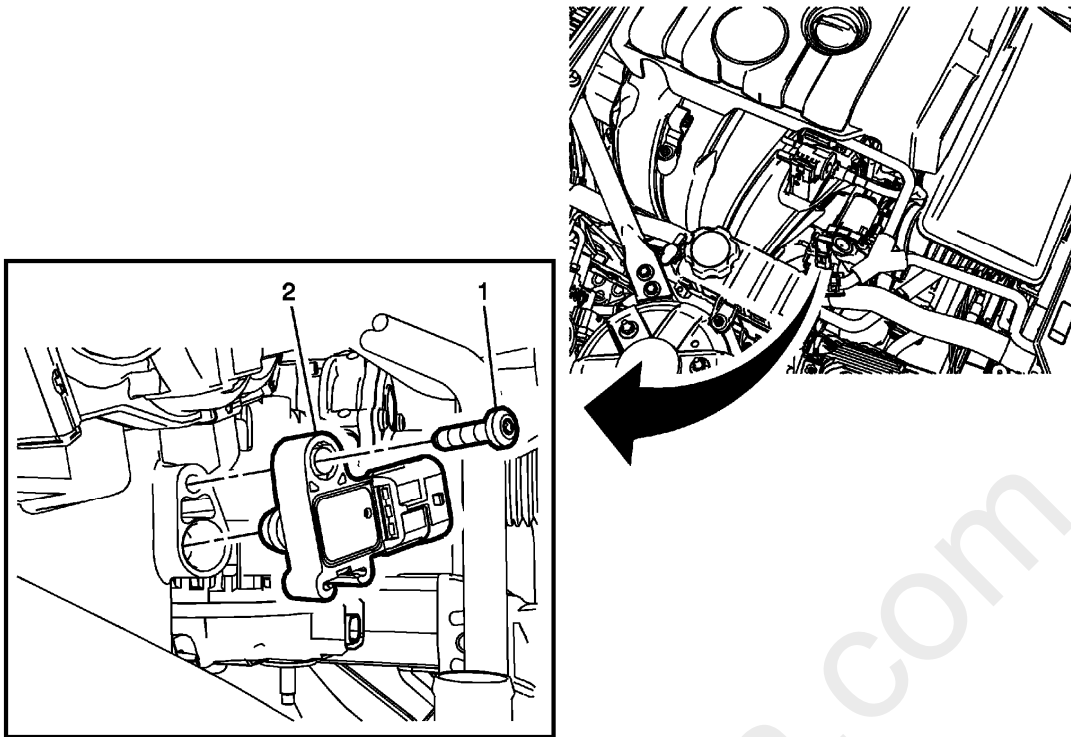


Fig. 7: Manifold Absolute Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement

Callout	Component Name
1	Manifold Absolute Pressure Sensor Retaining Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Manifold Absolute Pressure Sensor Procedure 1. Disconnect the engine wiring harness electrical connector from the manifold absolute pressure sensor. 2. Remove the manifold absolute pressure sensor from the intake manifold. 3. Install a NEW seal if reusing the manifold absolute pressure sensor.

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

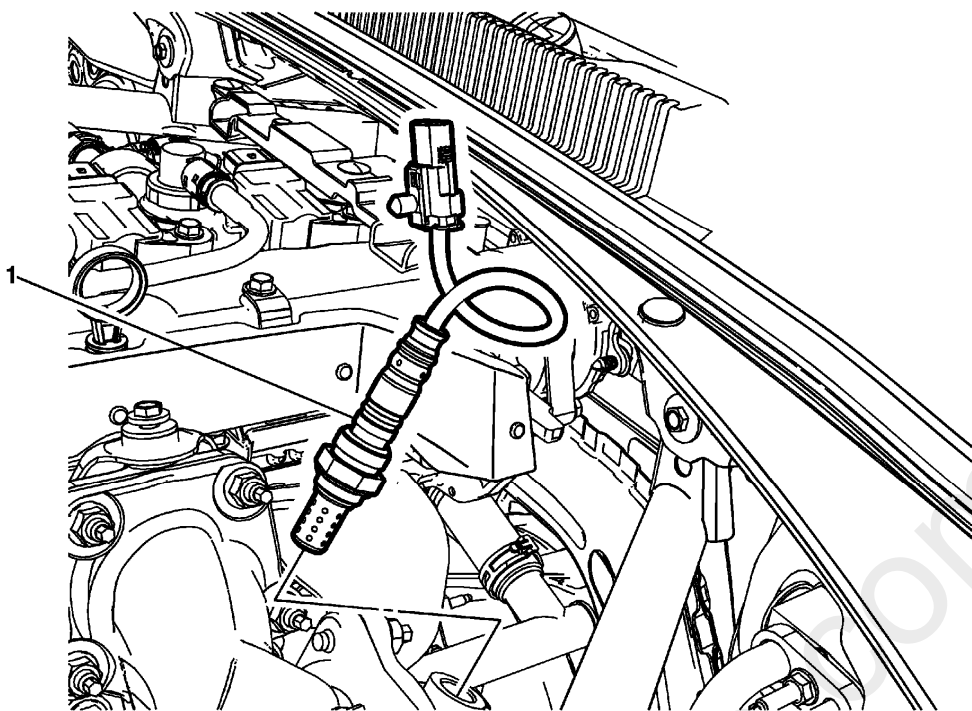


Fig. 8: Heated Oxygen Sensor - Sensor 1
 Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Sensor 1

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector.

NOTE:

- The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S).
- The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F).
- A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation.

Tighten

42 (31 lb ft)

Special Tools

J 39194 Oxygen Sensor Wrench

For regional tools refer to **Special Tools (Diagnostic Tools)** .

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

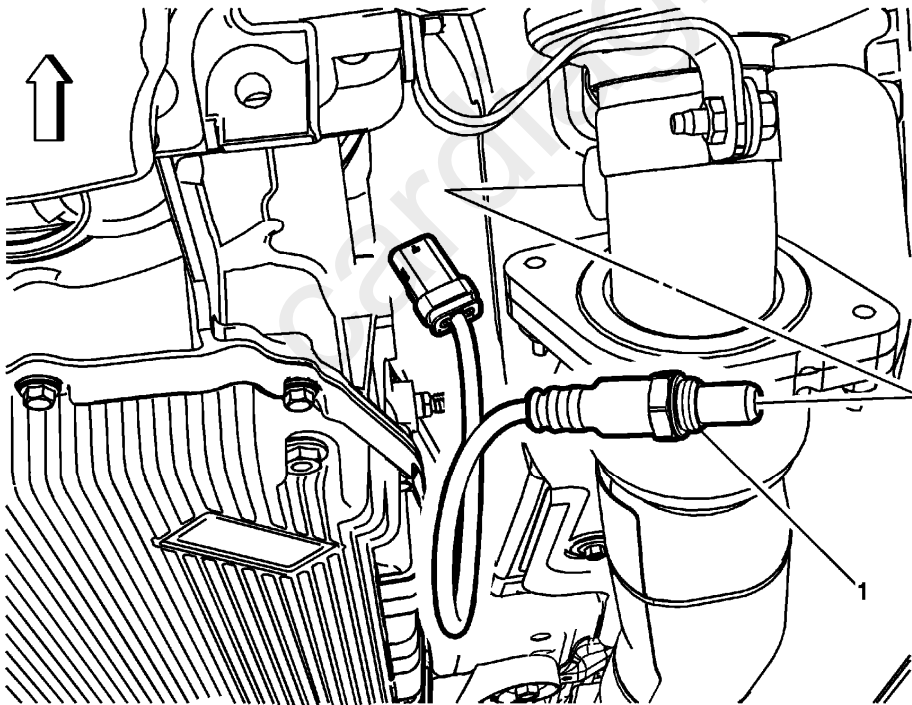


Fig. 9: Heated Oxygen Sensor - Sensor 2

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Sensor 2

Callout	Component Name
Preliminary Procedure	
1. Raise and properly support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to <u>Heated Oxygen Sensor Resistance Learn Reset Caution</u> . CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector. NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Tighten 42 (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For regional tools refer to <u>Special Tools (Diagnostic Tools)</u> .

ACCELERATOR PEDAL WITH POSITION SENSOR ASSEMBLY REPLACEMENT

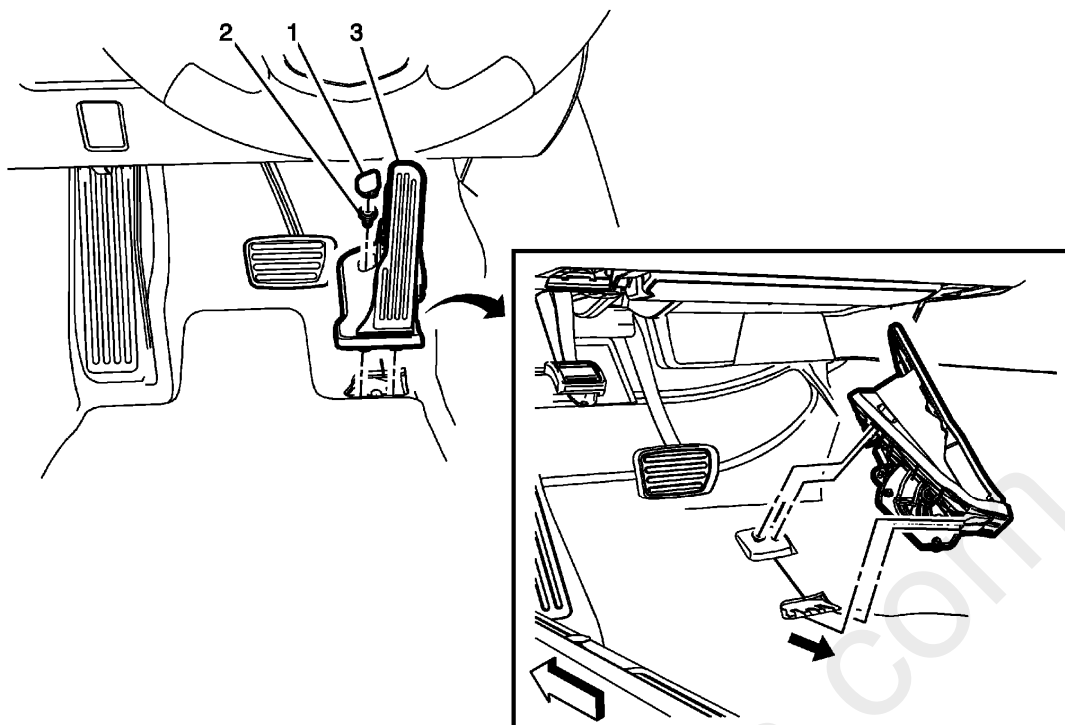


Fig. 10: Accelerator Pedal with Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

Accelerator Pedal with Position Sensor Assembly Replacement

Callout	Component Name
1	Accelerator Pedal Position Sensor Cover
2	Accelerator Pedal Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
3	Accelerator Pedal Position Sensor Procedure 1. Disconnect the connector from the Accelerator Pedal Position Sensor. 2. Tilt the top of the Accelerator Pedal Position Sensor rearward. 3. Slide the Accelerator Pedal Position Sensor back to disengage its lower retaining tabs.

THROTTLE BODY ASSEMBLY REPLACEMENT

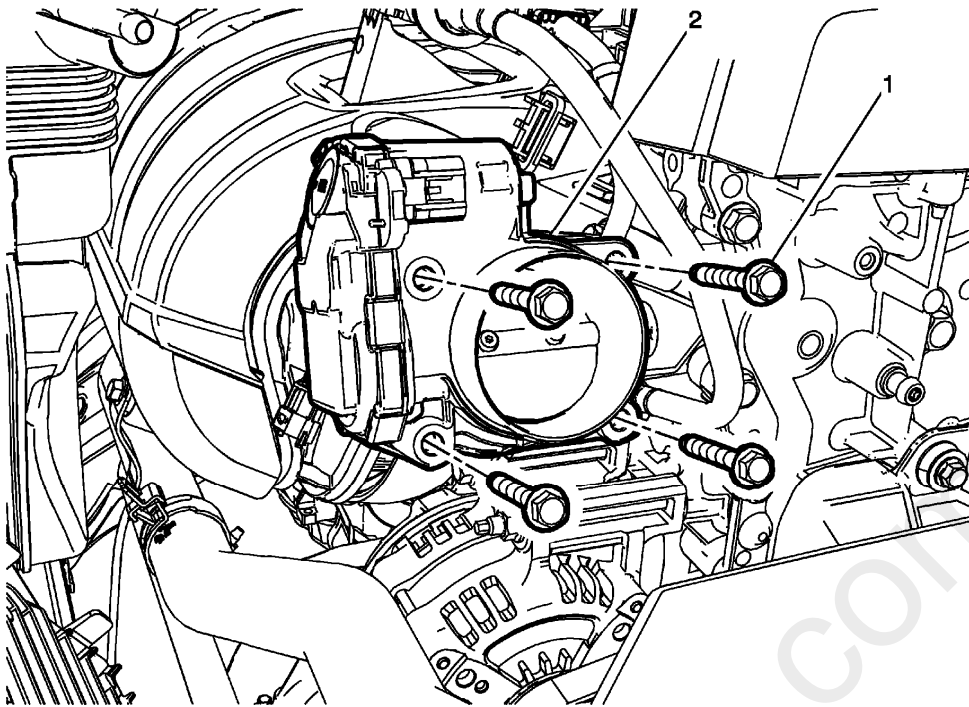


Fig. 11: Throttle Body Assembly
 Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Replacement

Callout	Component Name
CAUTION: Do not use solvent of any type when cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as damage to the gasket surfaces and throttle body assembly may result. Use care in cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as sharp tools may damage the gasket surfaces. CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components. NOTE: DO NOT prop open the throttle blade with the ignition key in the ON position as it may set a diagnostic trouble code (DTC). Preliminary Procedure Remove the air cleaner outlet duct. Refer to <u>Charge Air Cooler Outlet Air Tube Replacement.</u>	
	Throttle Body Assembly Fasteners (Qty: 4)
	CAUTION:

1	Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Throttle Body Assembly Procedure 1. Disconnect the engine wiring harness electrical connector from the throttle body assembly. 2. Inspect the throttle body gasket, and replace if necessary. 3. Perform the throttle learn procedure. Refer to <u>Q38 Throttle Body: Throttle/Idle Learn</u>.

THROTTLE BODY CLEANING

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

NOTE: DO NOT prop open the throttle blade with the ignition key in the ON position as it may set a diagnostic trouble code (DTC).

2. Inspect the throttle body bore and the throttle valve plate for deposits. You must open the throttle valve in order to inspect all of the surfaces.
3. Clean the throttle body bore and the throttle valve plate using a clean shop towel and approved cleaner.
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the throttle/idle learn procedure. Refer to **Control Module References** .

FUEL PRESSURE RELIEF

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

NOTE: If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel pump to shut off.
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

- **CH-47831** Fuel Line Disconnect Tool
- **J 34730-1A** Fuel Pressure Gauge
- **J 42982** Fuel Pressure Gauge Adapter

Installation Procedure

WARNING: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief**.
2. Disconnect the quick connect coupling of the fuel feed hose from the fuel feed pipe of the fuel rail. Use a shop towel in order to catch any remaining fuel that may leak.
3. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
4. Install the **J 42982** adapter between the fuel feed pipe of the fuel rail and of the fuel feed hose.

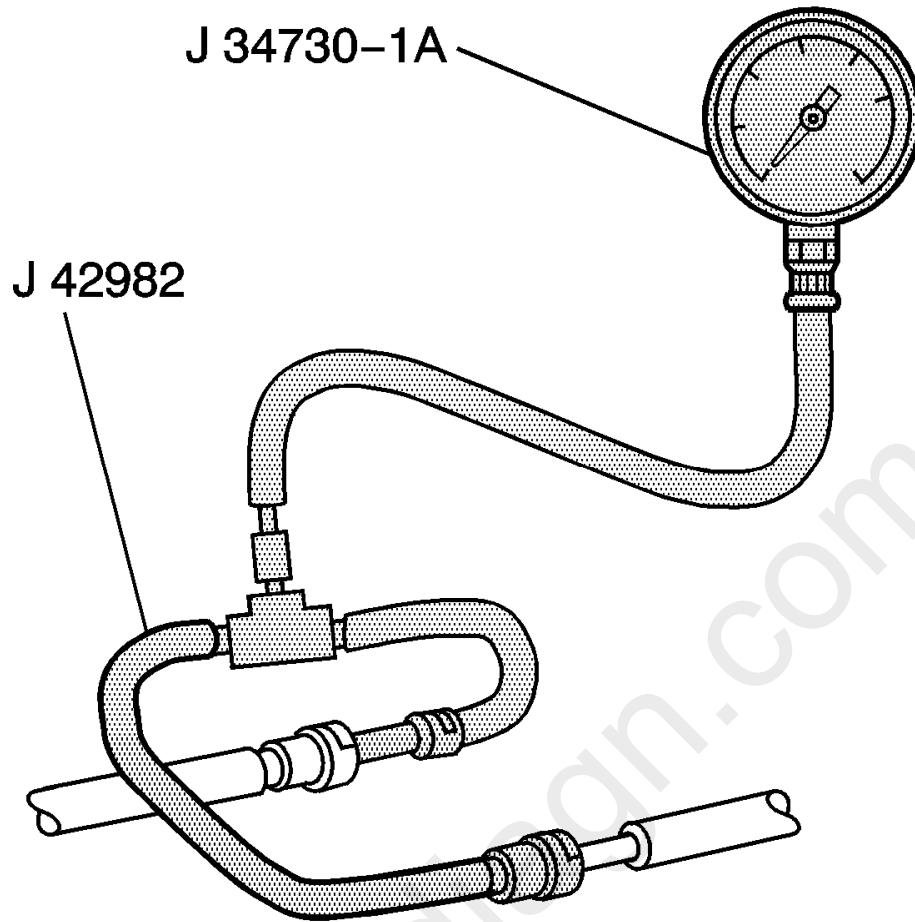


Fig. 12: Fuel Pressure Gage
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the **J 34730-1A** gauge to the **J 42982** adapter , and tighten securely.
6. Turn ON the ignition in order to pressurize the fuel system.
7. Turn OFF the ignition.
8. Check for any fuel leaks.

Removal Procedure

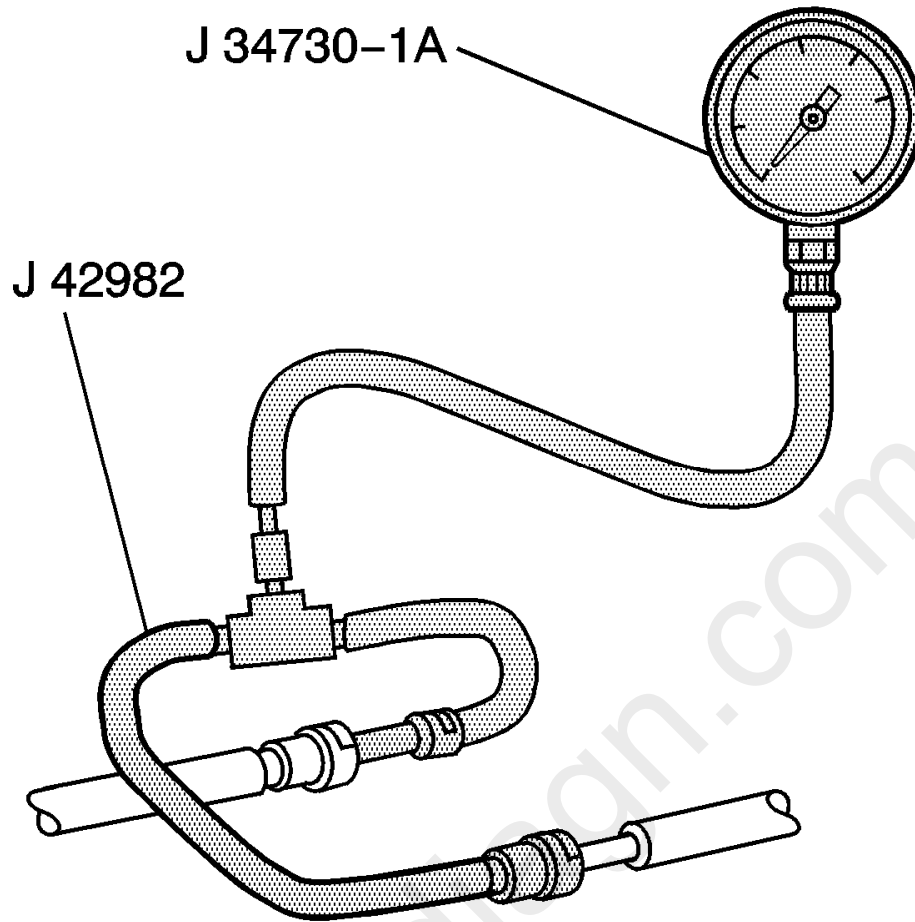


Fig. 13: Fuel Pressure Gage
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel pressure. Refer to the **Fuel Pressure Relief**.
2. Remove the **J 34730-1A** gauge from the **J 42982** adapter.
3. Using the **CH-47831** tool , disconnect the quick connect coupling of the **J 42982** adapter from the fuel feed pipe of the fuel rail. Use a shop towel in order to catch any remaining fuel that may leak.
4. Disconnect the quick connect coupling of the fuel feed hose (3) from the **J 42982** adapter , and remove the adapter. Use a shop towel in order to catch any remaining fuel that may leak.
5. Connect the quick-connect fitting of the fuel feed hose (3) to the fuel feed pipe of the fuel rail.
6. Turn ON the ignition in order to pressurize the fuel system.
7. Turn OFF the ignition.
8. Check for any fuel leaks.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **CH-41769** Fuel Line Disconnect Tool Set
- **CH-44581** Fuel Line Disconnect Tool

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .

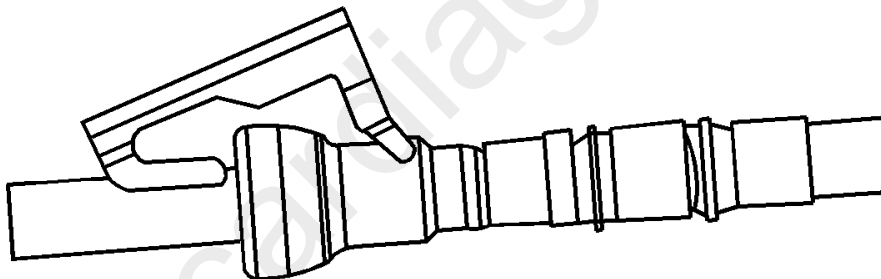


Fig. 14: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

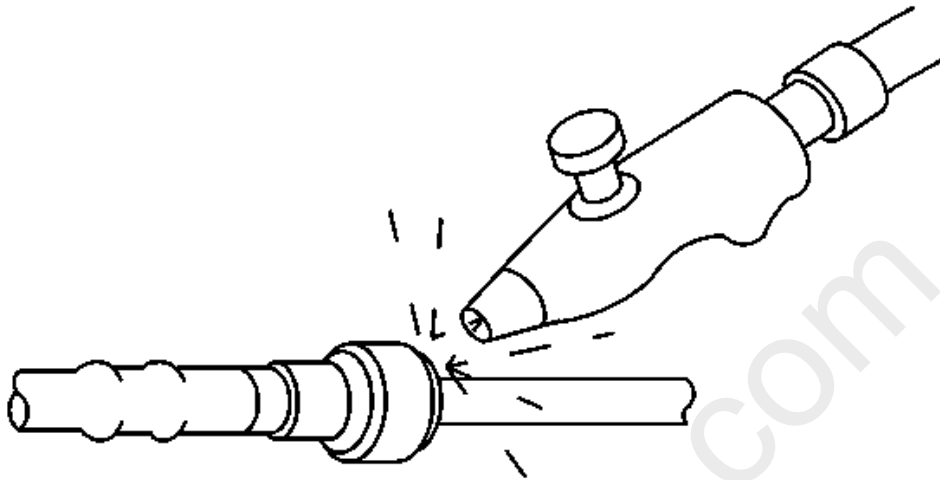


Fig. 15: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

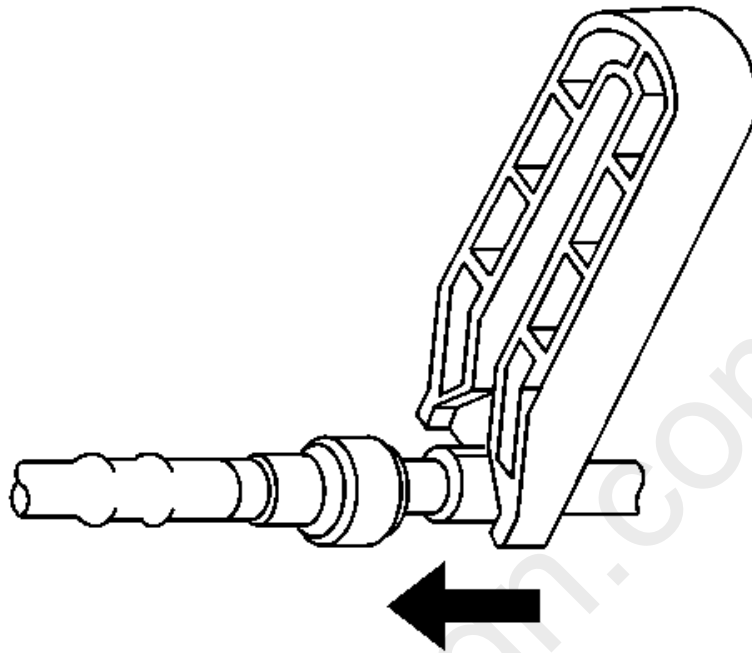


Fig. 16: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool. Insert the **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

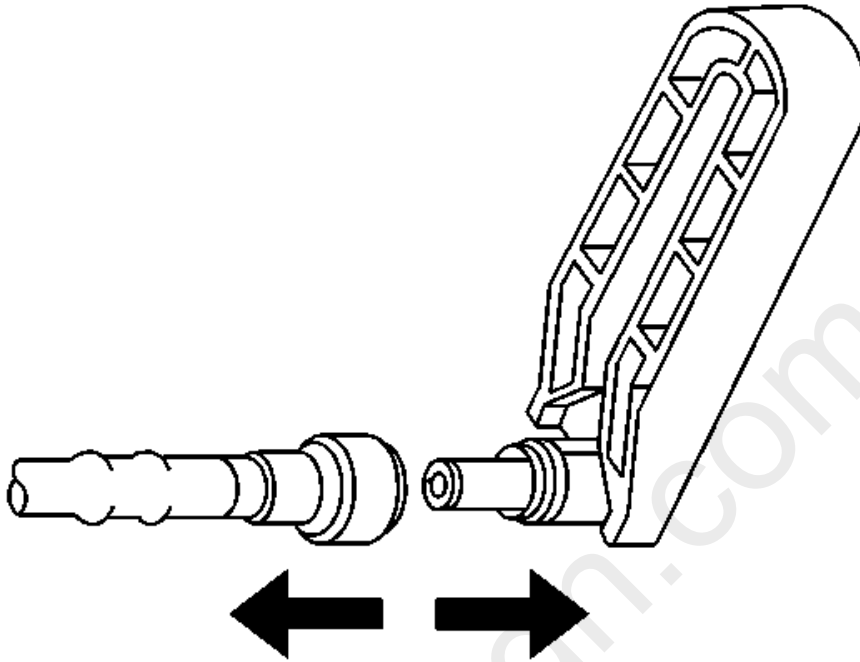


Fig. 17: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

6. Using a clean shop towel, wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs.
8. Clean or replace the components as required.

Installation Procedure

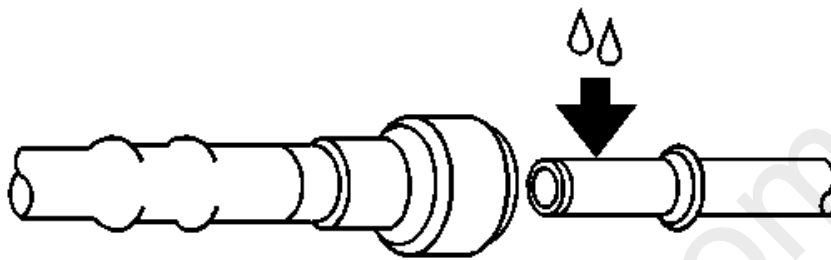


Fig. 18: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.

This will ensure proper reconnection and prevent a possible fuel leak.

During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

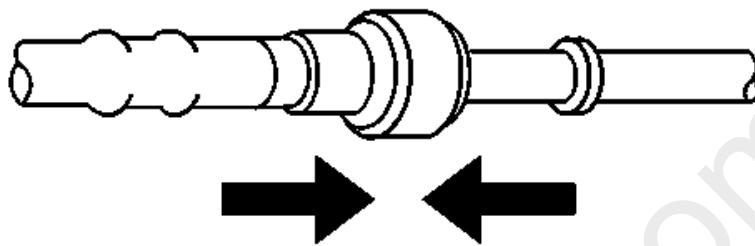


Fig. 19: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

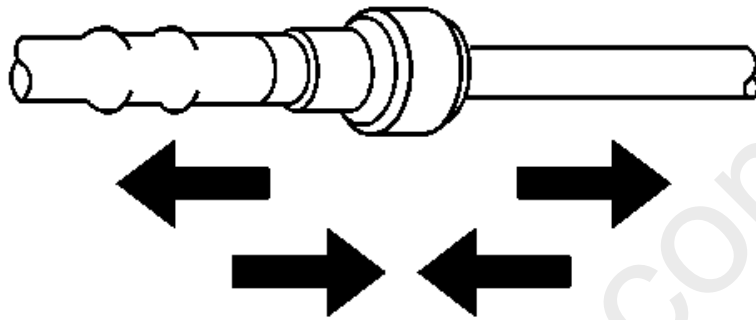


Fig. 20: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

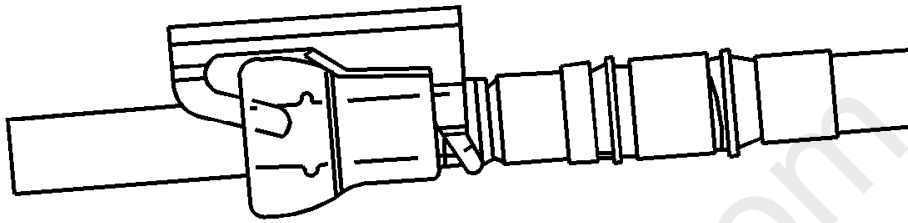


Fig. 21: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the quick-connect fitting.
5. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

NOTE: If servicing a fuel system, insure the fuel pressure has been relieved.

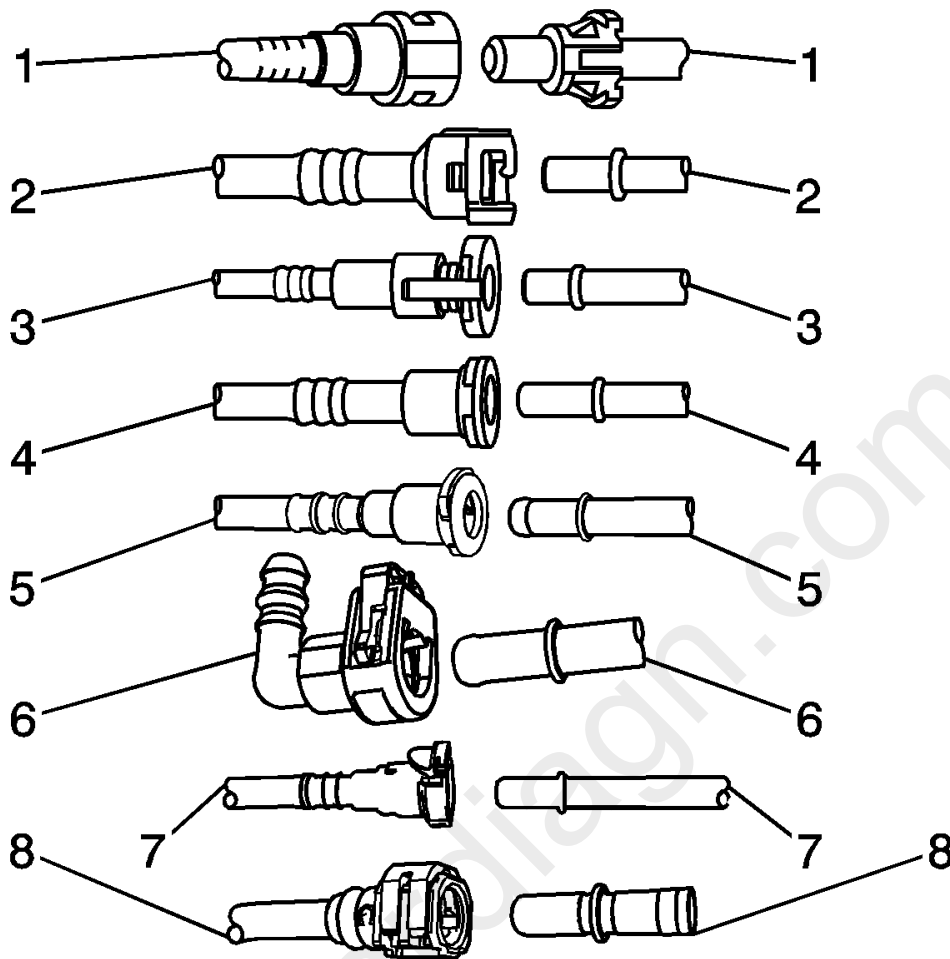


Fig. 22: Plastic Collar Quick Connect Fitting Service
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are several types of plastic collar fuel and evaporative emission quick connect fittings used on this vehicle.

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)
- Global Connect (5)
- TI Loc (6)
- Safe Lock (7)
- Plastic Connector (8)

The following instructions apply to all of these types of plastic collar quick connect fittings except where indicated.

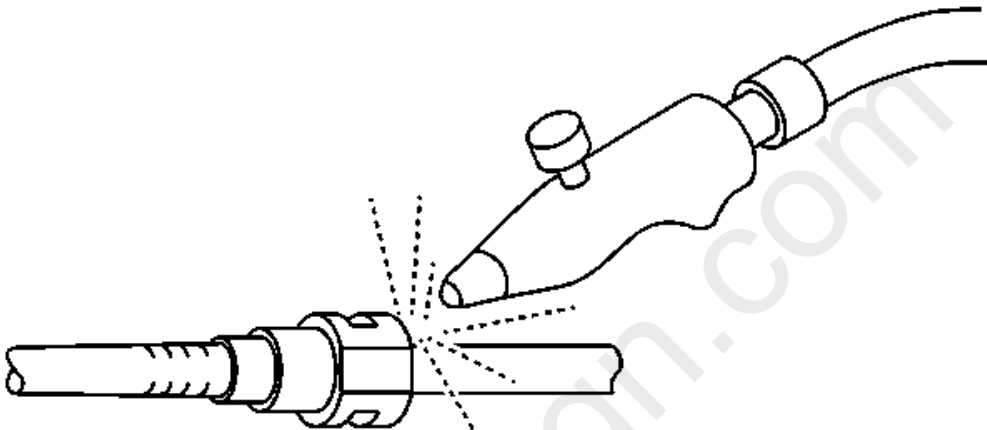


Fig. 23: Blowing Dirt Out Of Fitting (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Using compressed air, blow any dirt out of the quick-connect fitting.

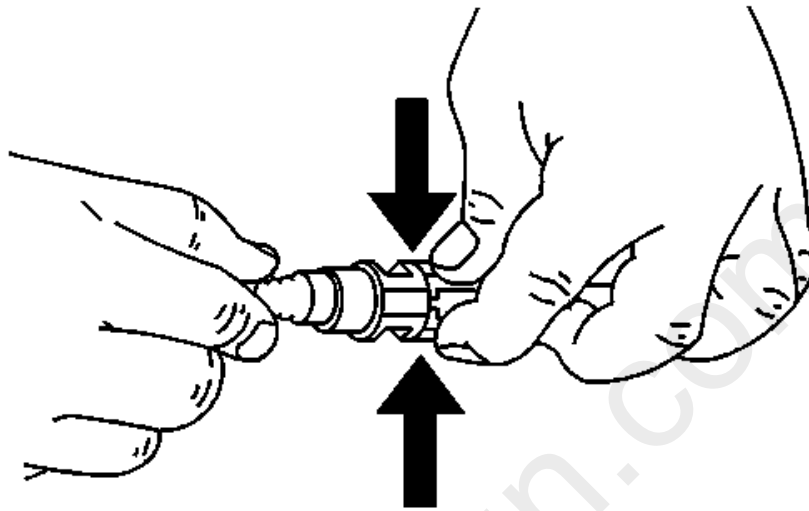


Fig. 24: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

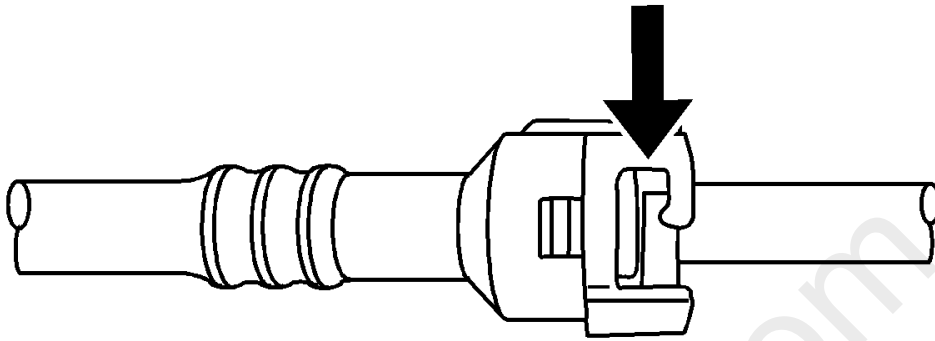


Fig. 25: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. This step applies to Q Release style connectors ONLY. Release the fitting by Pushing the tab toward the other side of the slot in the fitting.

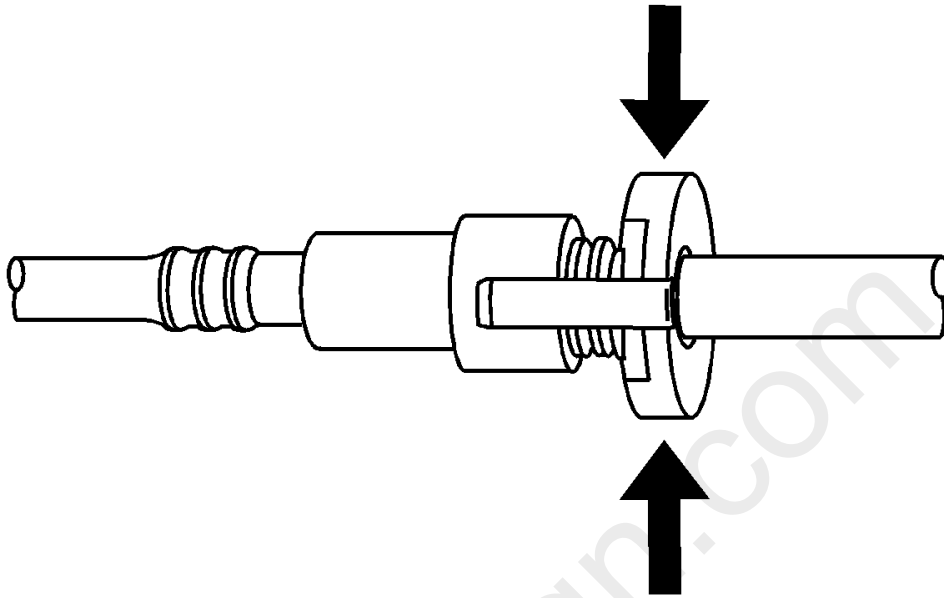


Fig. 26: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

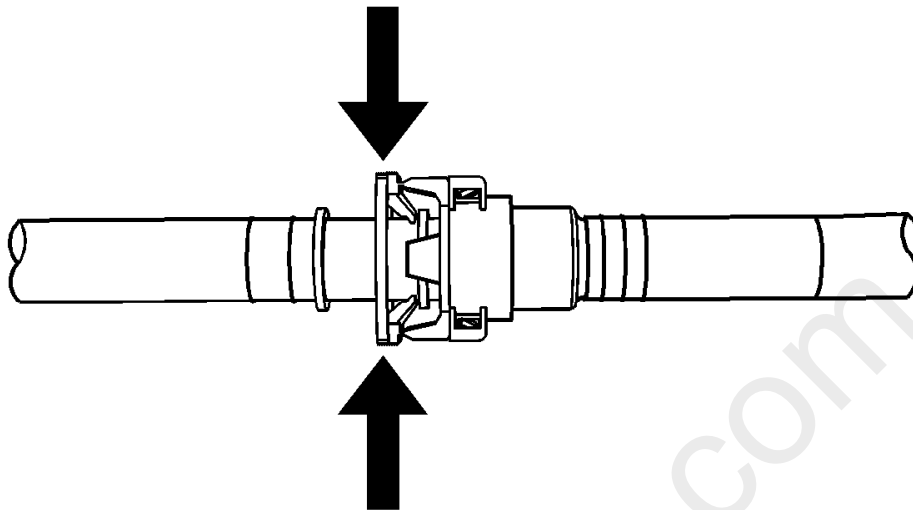


Fig. 27: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to Squeeze to Release style connectors ONLY. Push in the male side slightly in order to slide the retainer away from the retainers, squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

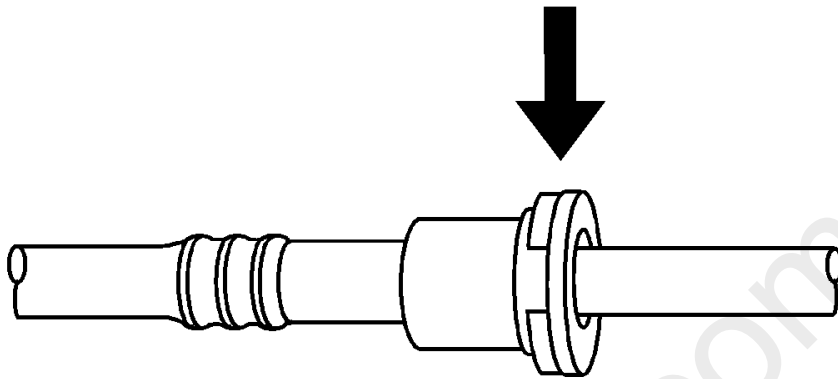


Fig. 28: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

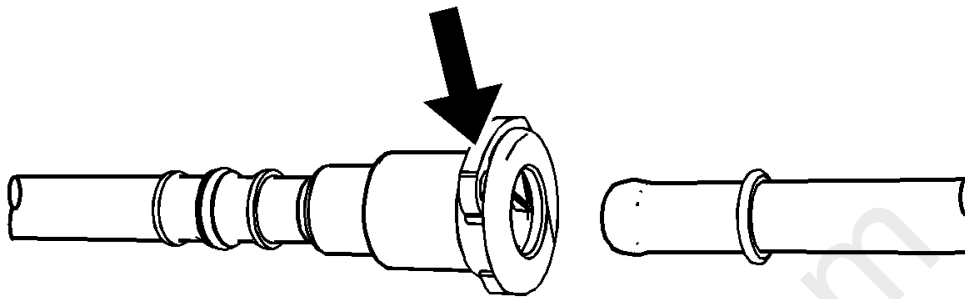


Fig. 29: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Global Connector style only. Push the connector toward the tube in order to release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

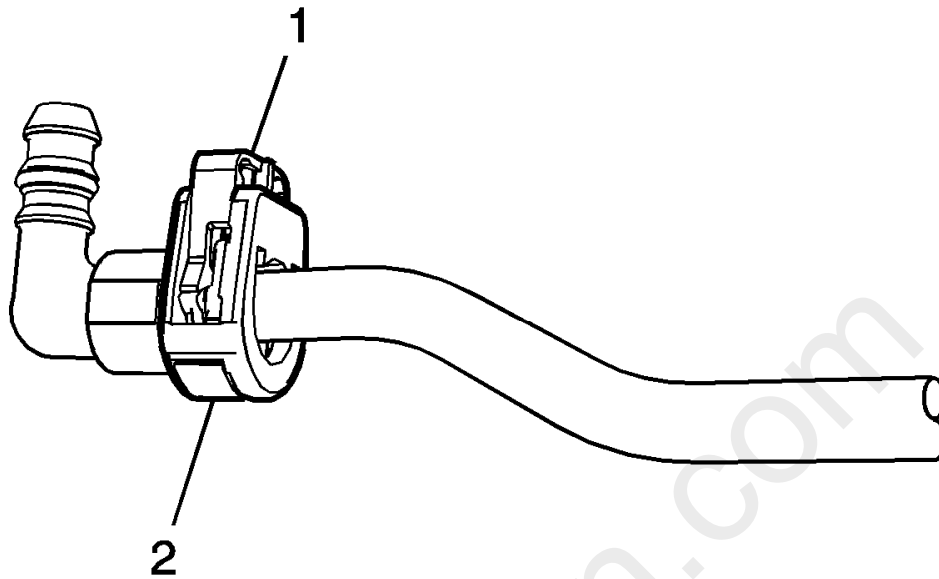


Fig. 30: TI Loc style

Courtesy of GENERAL MOTORS COMPANY

8. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

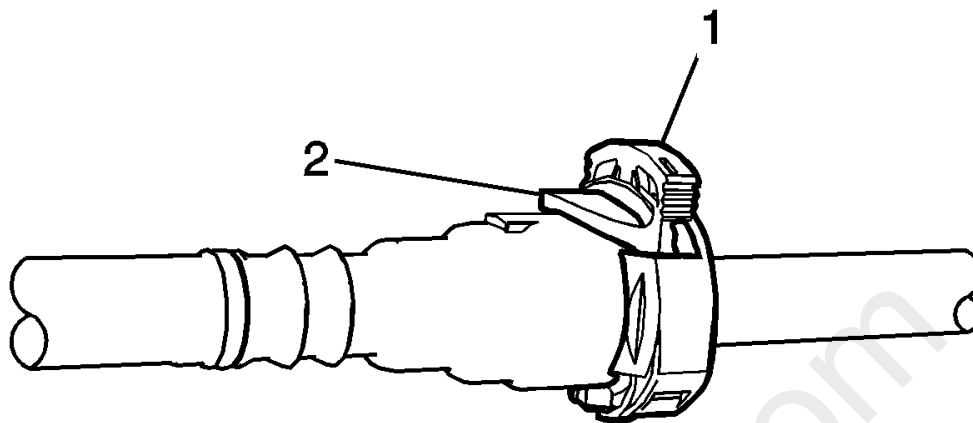


Fig. 31: Safe Lock Style

Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

9. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

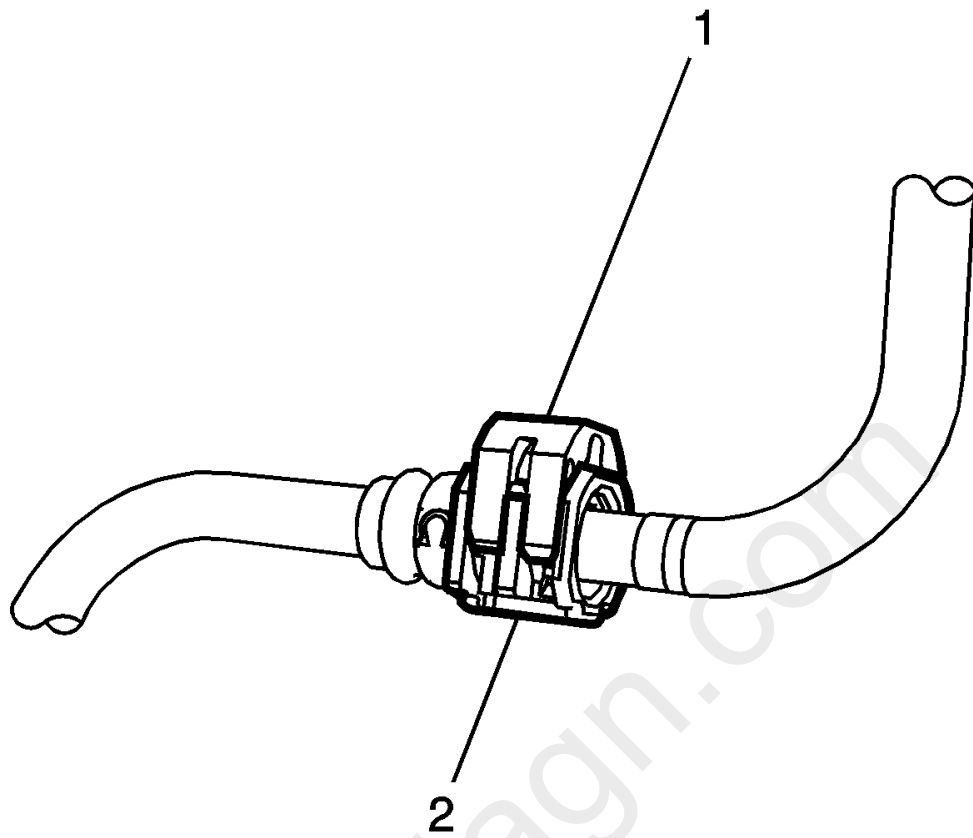


Fig. 32: Releasing Latch And Pulling Connector Straight Out
Courtesy of GENERAL MOTORS COMPANY

10. This step applies to the Plastic Connector style 8, push the connector toward the tube in order to release the pressure. Press the latch (1) inward in order to release the pipe, while pulling the connector (2) straight out.
11. Using a clean shop towel, wipe off the male pipe end.
12. Inspect both ends of the fitting for dirt and burrs.
13. Clean or replace components as necessary.

Installation Procedure

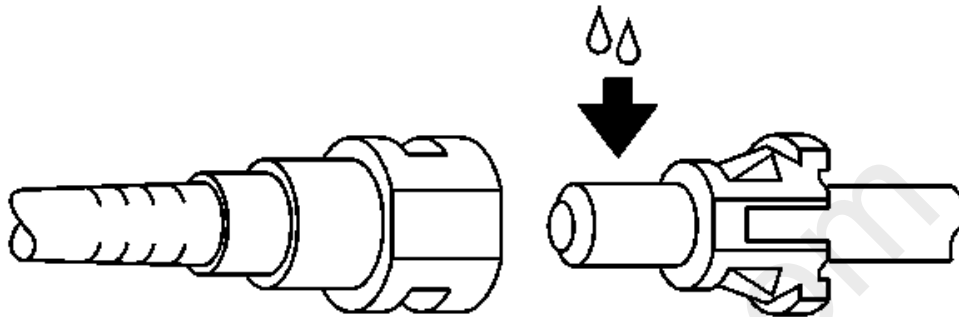


Fig. 33: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Apply a few drops of clean engine oil to the male pipe end.

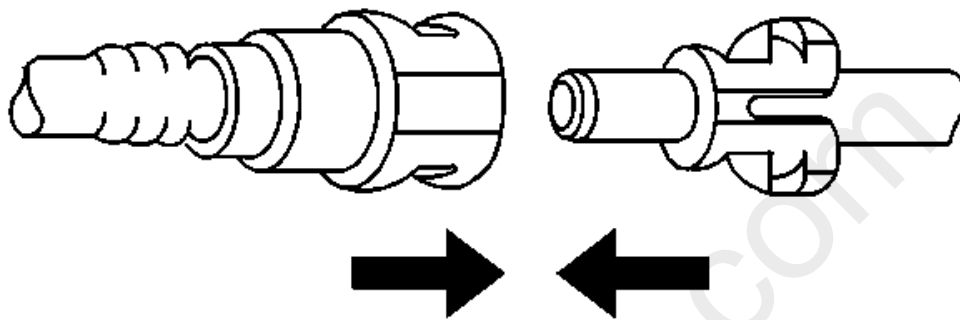


Fig. 34: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

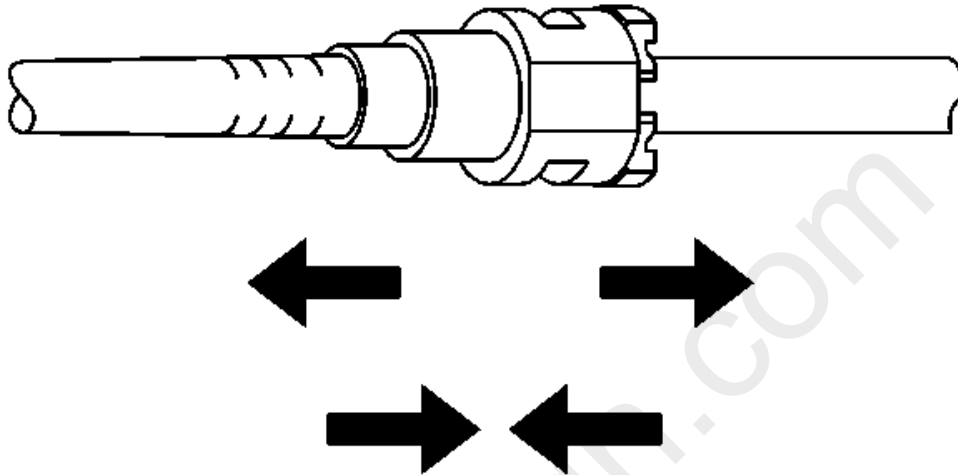


Fig. 35: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

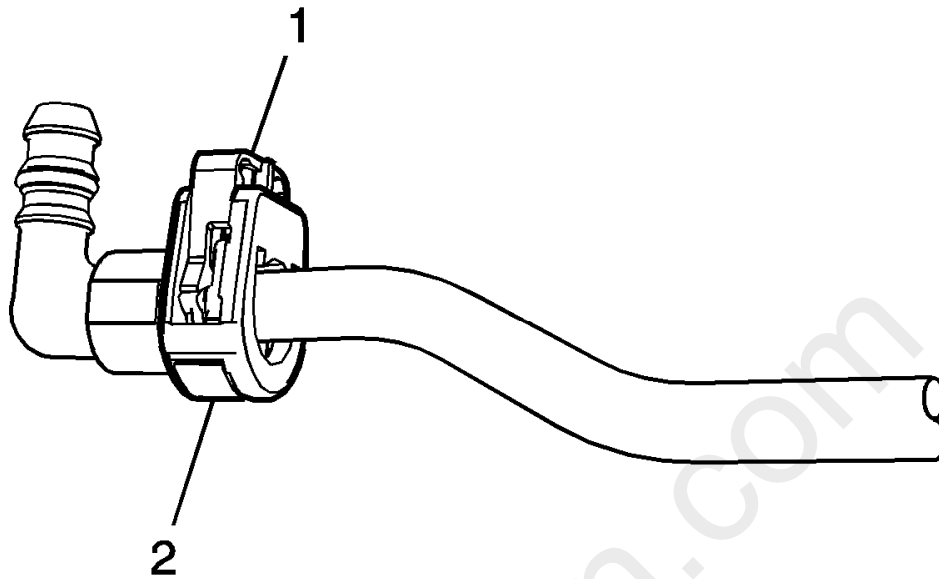


Fig. 36: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

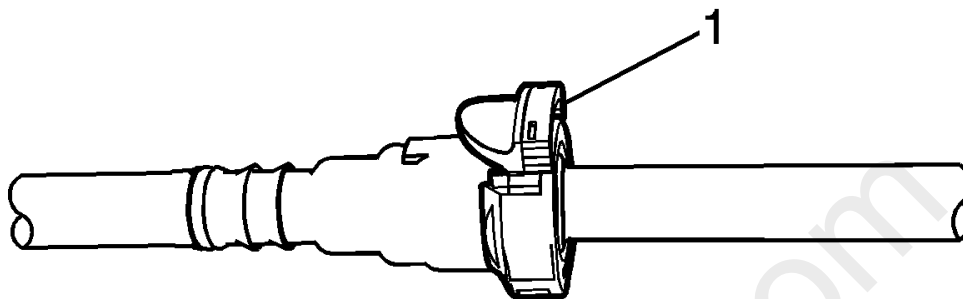


Fig. 37: Push Down On Redundant Latch (1) Until It Is Fully Engaged And Snapped Into Position.
Courtesy of GENERAL MOTORS COMPANY

6. Insert the tube in the connector until the retainer snaps in place.
7. Push down on the second latch (1) in order to secure the connection.

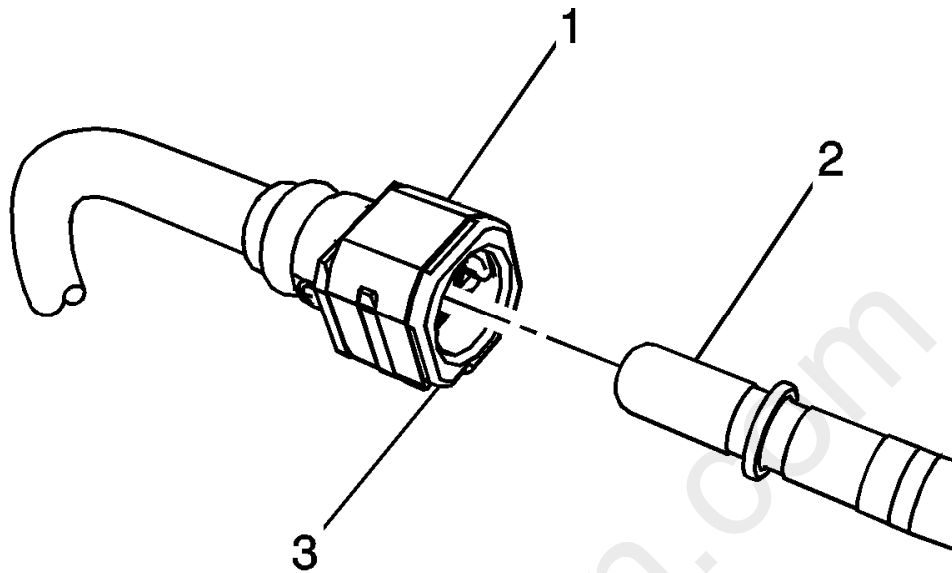


Fig. 38: Latch And Connector

Courtesy of GENERAL MOTORS COMPANY

8. For the plastic connector type 8, depress the latch (1) while inserting the connector (3) on to the pipe (2) .
9. Move the latch (1) upward in order to secure the connection.
10. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

FUEL FILTER REPLACEMENT

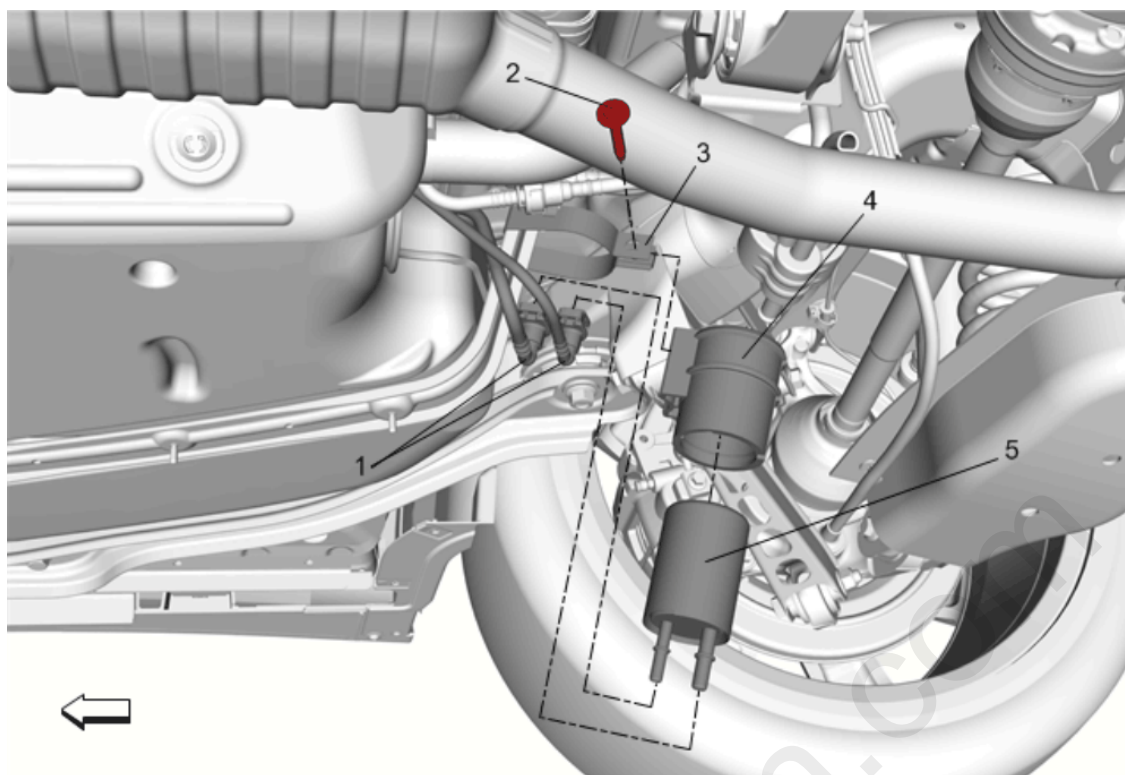


Fig. 39: Fuel Filter

Courtesy of GENERAL MOTORS COMPANY

Fuel Filter Replacement

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel pressure. Refer to <u>Fuel Pressure Relief</u> 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Fuel Pipes Procedure Disconnect the fuel pipes from the fuel filter. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	Fuel Filter Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
3	Fuel Filter Bracket
4	Fuel Filter Housing
5	Fuel Filter

FUEL TANK DRAINING

Special Tools

- **DT 36850** Transjel Lubricant
- **CH 45004** Fuel Tank Drain Hose

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Raise and Support the Vehicle. Refer to Lifting and Jacking the Vehicle

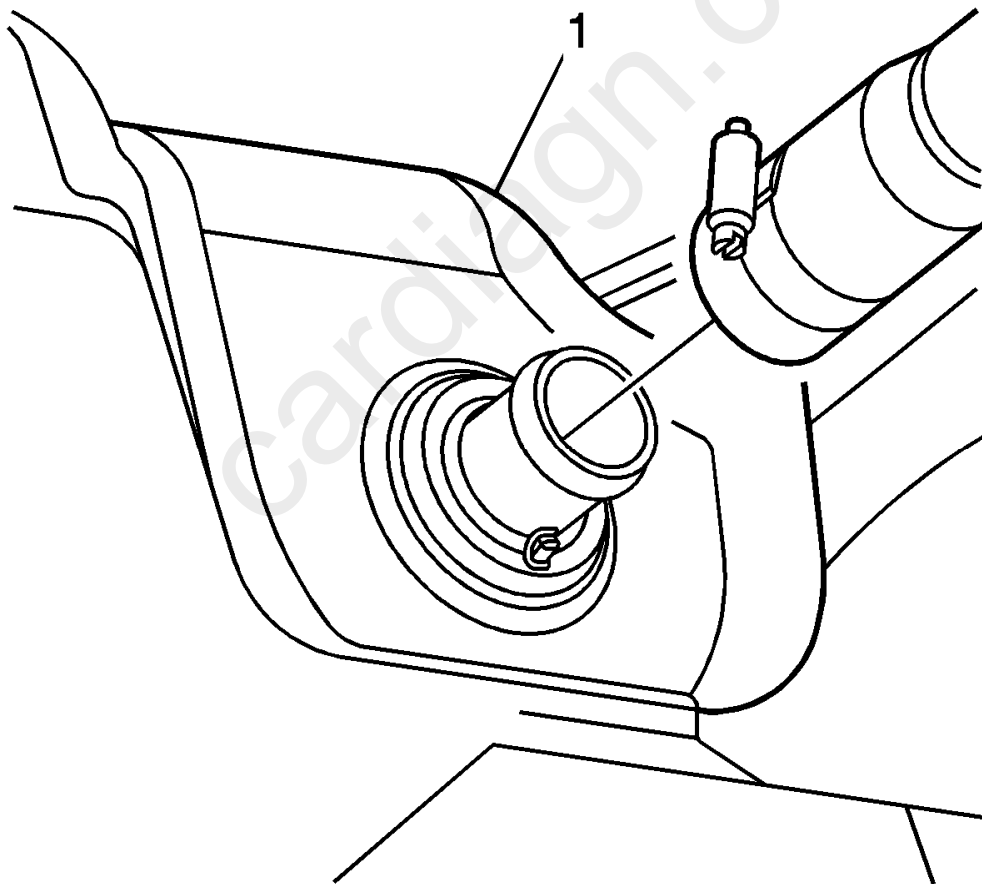


Fig. 40: Insert Fuel Tank Drain Hose Into The Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

NOTE: Place a clean drain pan large enough to capture the fuel that may be expelled once the hose is removed and the CH 45004 Fuel Tank Drain Hose is inserted opening the fill check valve. If the fuel tank is over half full, a large quantity of fuel may be expelled.

NOTE: Lubricate the fuel drain hose with DT 36850 Transjel Lubricant or equivalent to aid in hose insertion. Do not use an unapproved lubricant.

2. Loosen the lower fill hose clamp in order to separate the fill hose from the fuel tank (1).
3. Insert the **CH 45004** Fuel Tank Drain Hose into the fuel tank (1) until the hose reaches the bottom of the fuel tank.
4. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.

FUEL TANK PROTECTOR REPLACEMENT

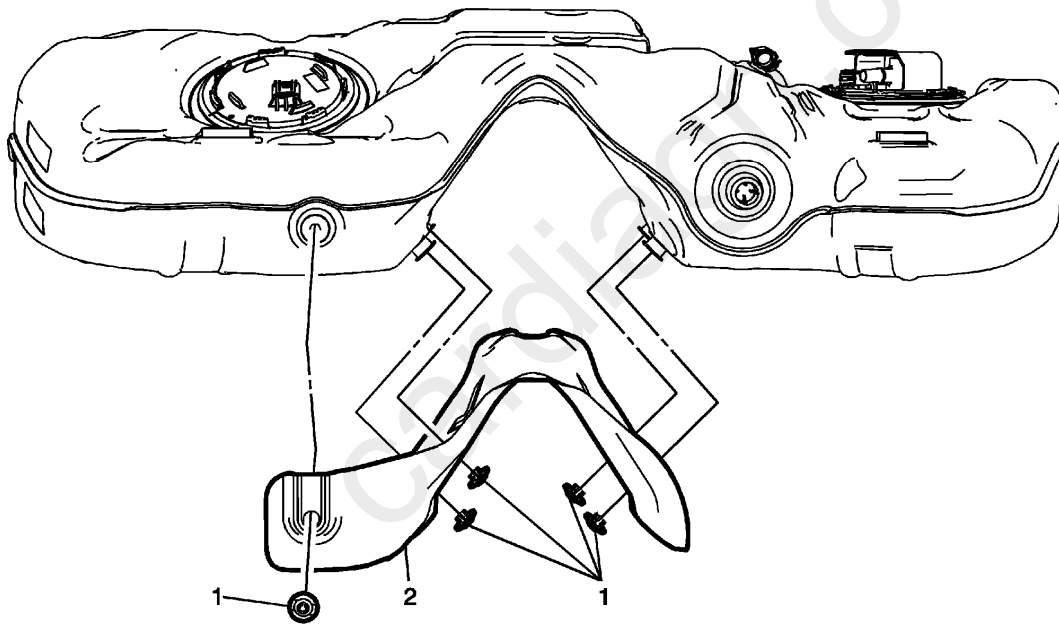


Fig. 41: Fuel Tank Protector
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Protector Replacement

Callout	Component Name
Preliminary Procedure Remove the propeller shaft. Refer to <u>Two-Piece Propeller Shaft Replacement (LFX, LF3)</u> , <u>Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW)</u> .	
1	Fuel Tank Protector Retainers (Qty: 5)

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to Fuel Pressure Relief
2. Drain the fuel tank. Refer to Fuel Tank Draining .
3. Remove the left and right side rear air deflectors. Refer to Underbody Rear Air Deflector Replacement - Left Side , and Underbody Rear Air Deflector Replacement - Right Side .
4. Remove the two piece propeller shaft. Refer to Two-Piece Propeller Shaft Replacement (LFX, LF3) , Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW) .

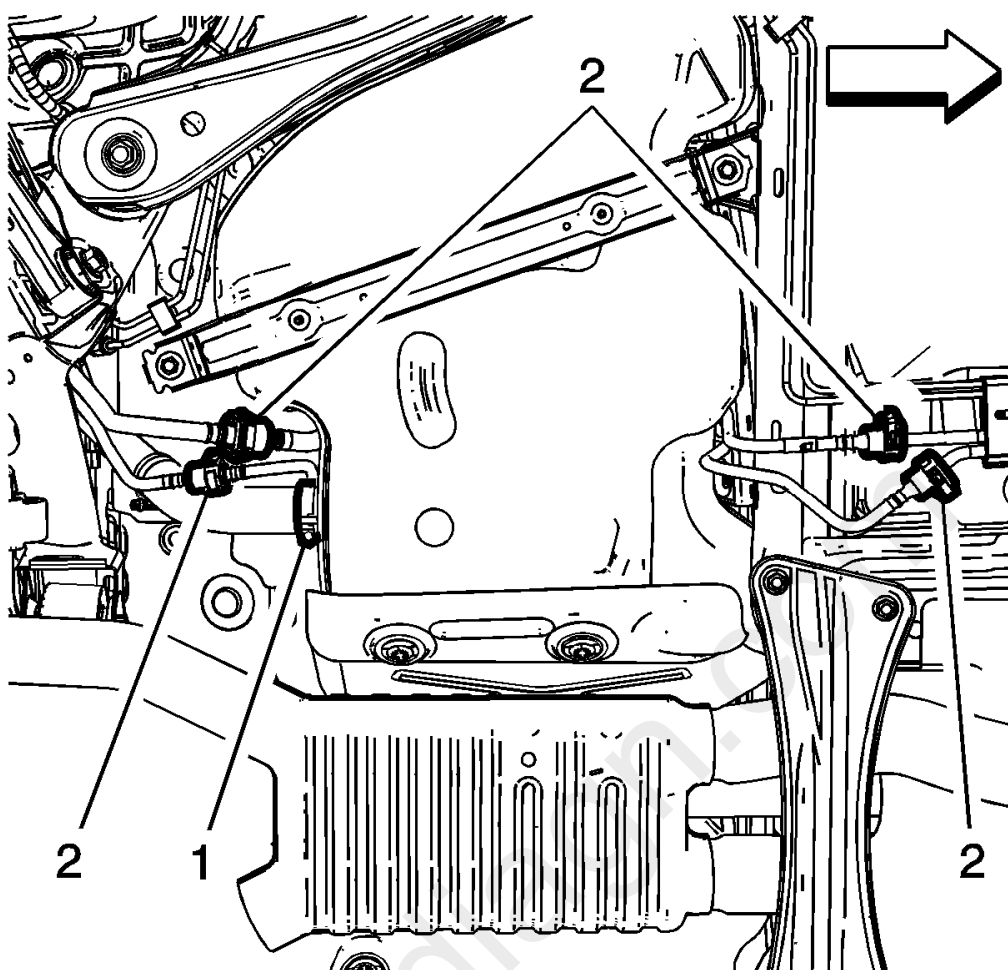


Fig. 42: Evaporative Emission And Fuel Pipes
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the evaporative emission and fuel pipes (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Disconnect the fuel tank electrical connector.

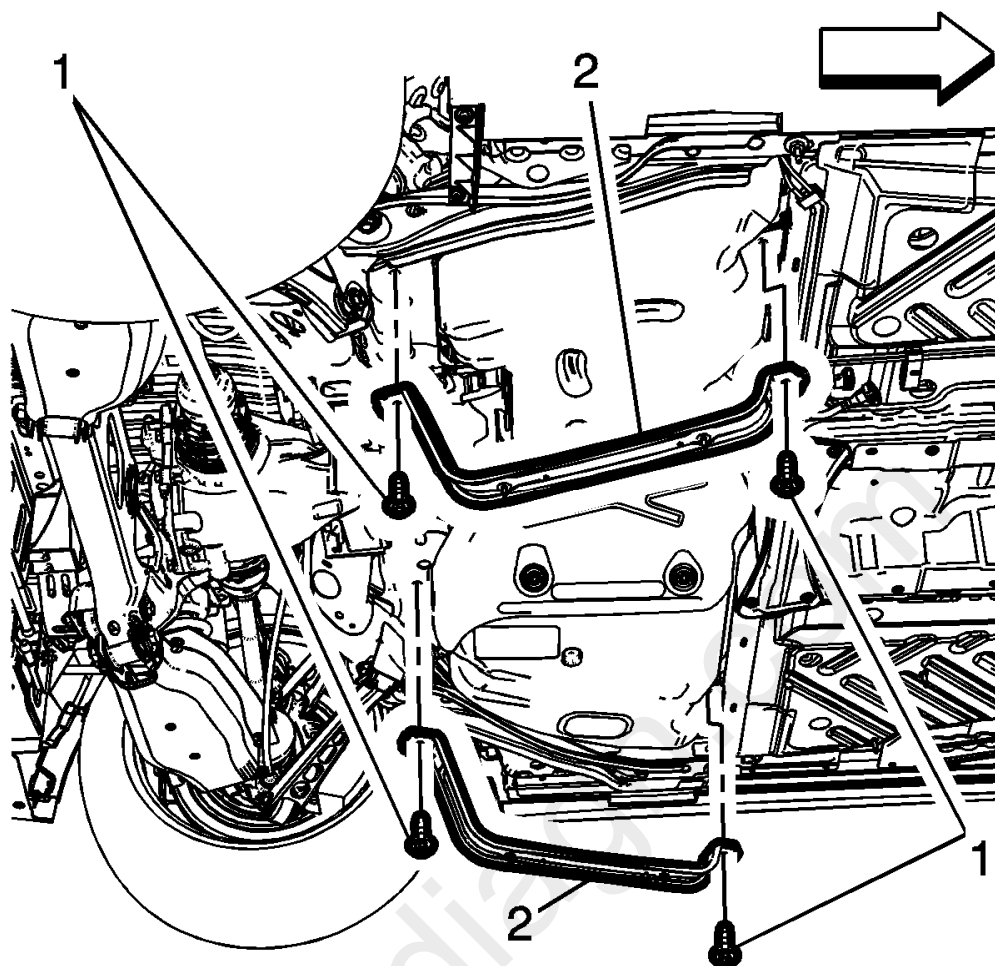


Fig. 43: Fuel Tank Straps And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Support the fuel tank with a suitable jack.
8. Remove the fuel tank strap bolts (1).
9. Remove the fuel tank straps (2).

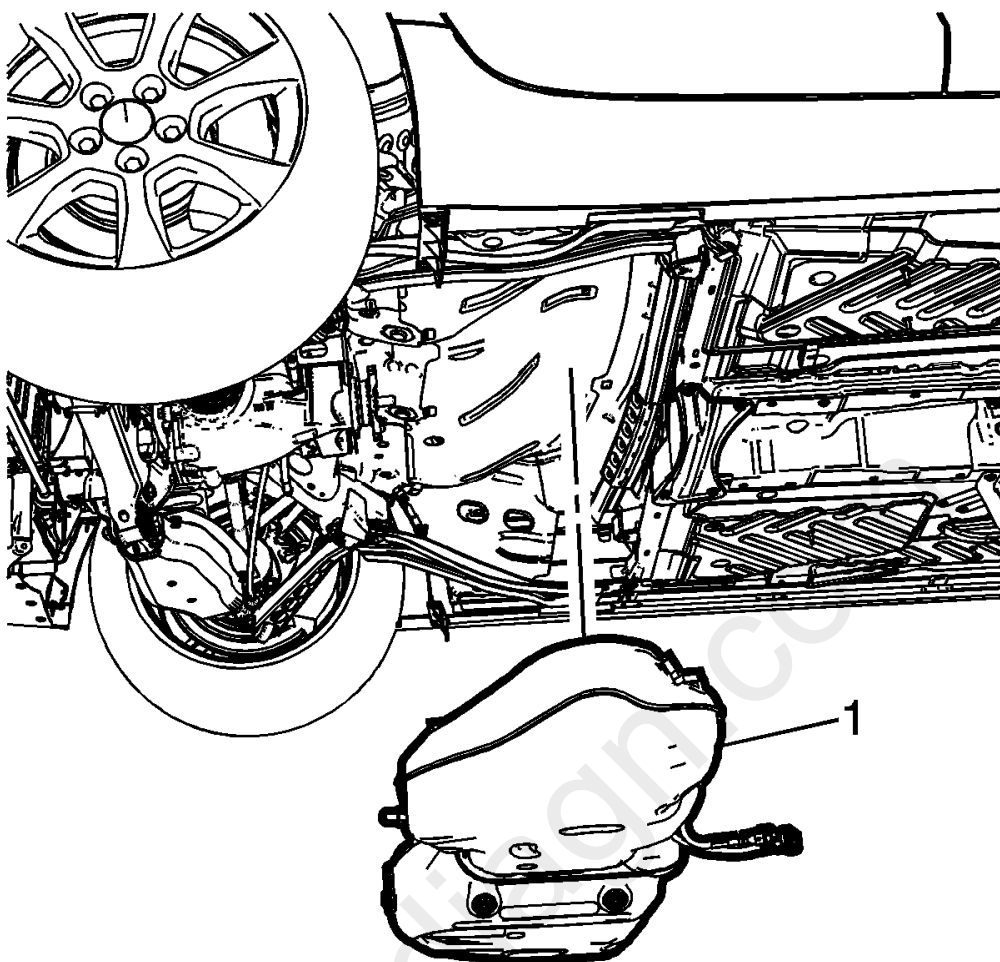


Fig. 44: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

10. Remove the fuel tank (1).
11. Remove the following components if replacing just the fuel tank.
 1. Fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement** .
 2. Transfer components as necessary.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 1. Fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement** .

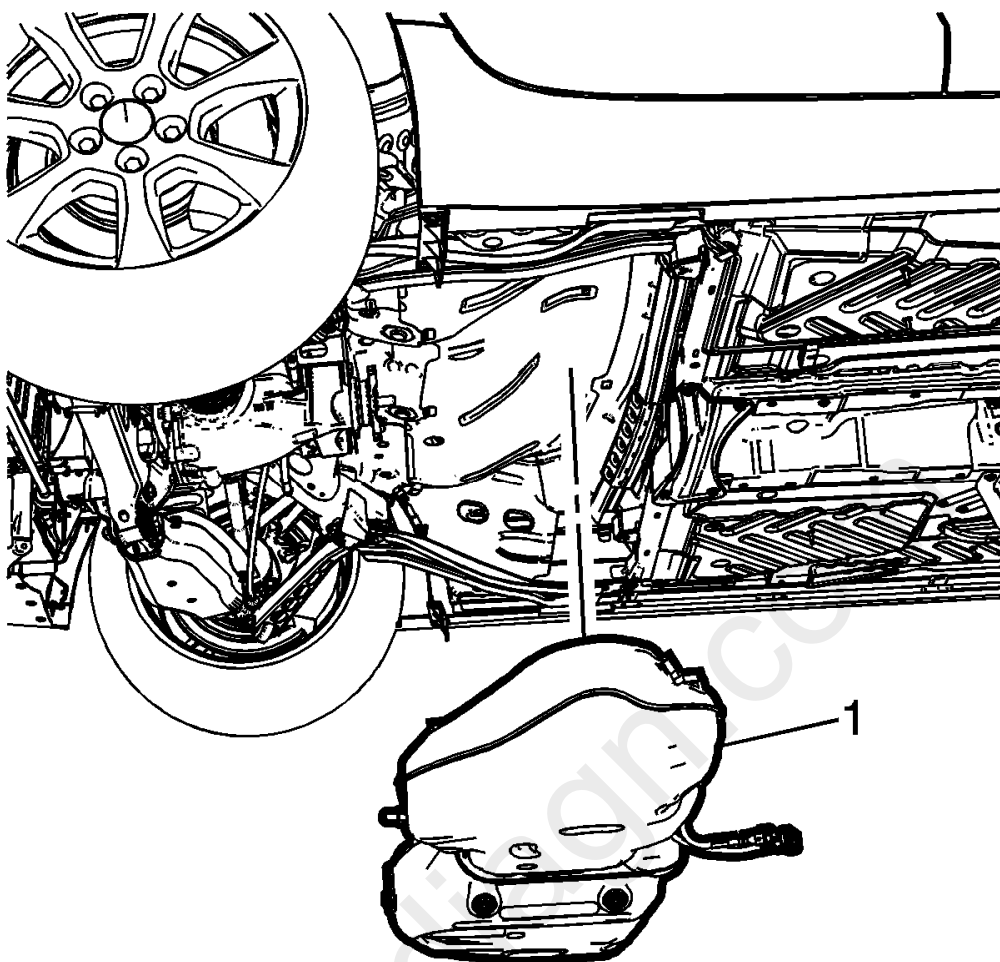


Fig. 45: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

2. Use a suitable jack and install the fuel tank (1).

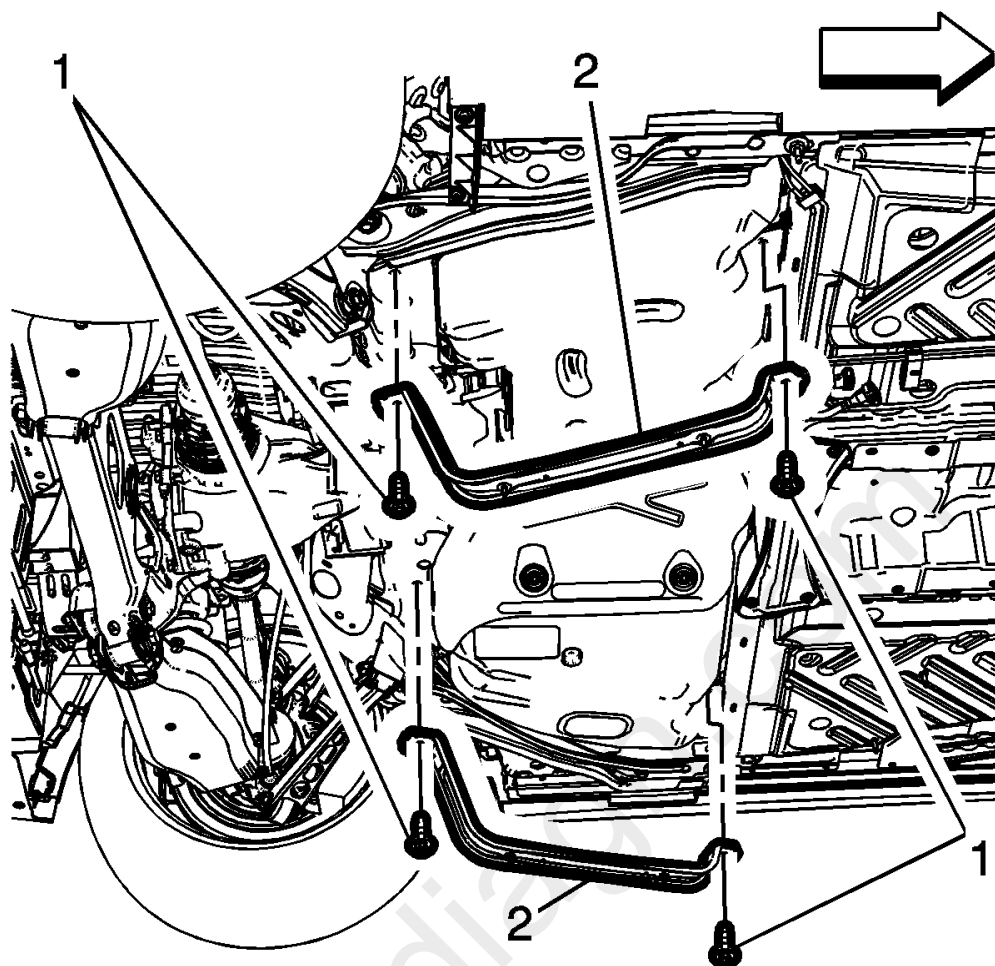


Fig. 46: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel tank straps (2).

CAUTION: Refer to Fastener Caution .

4. Install the fuel tank strap bolts (1) and tighten to 20 N.m (15 lb ft).

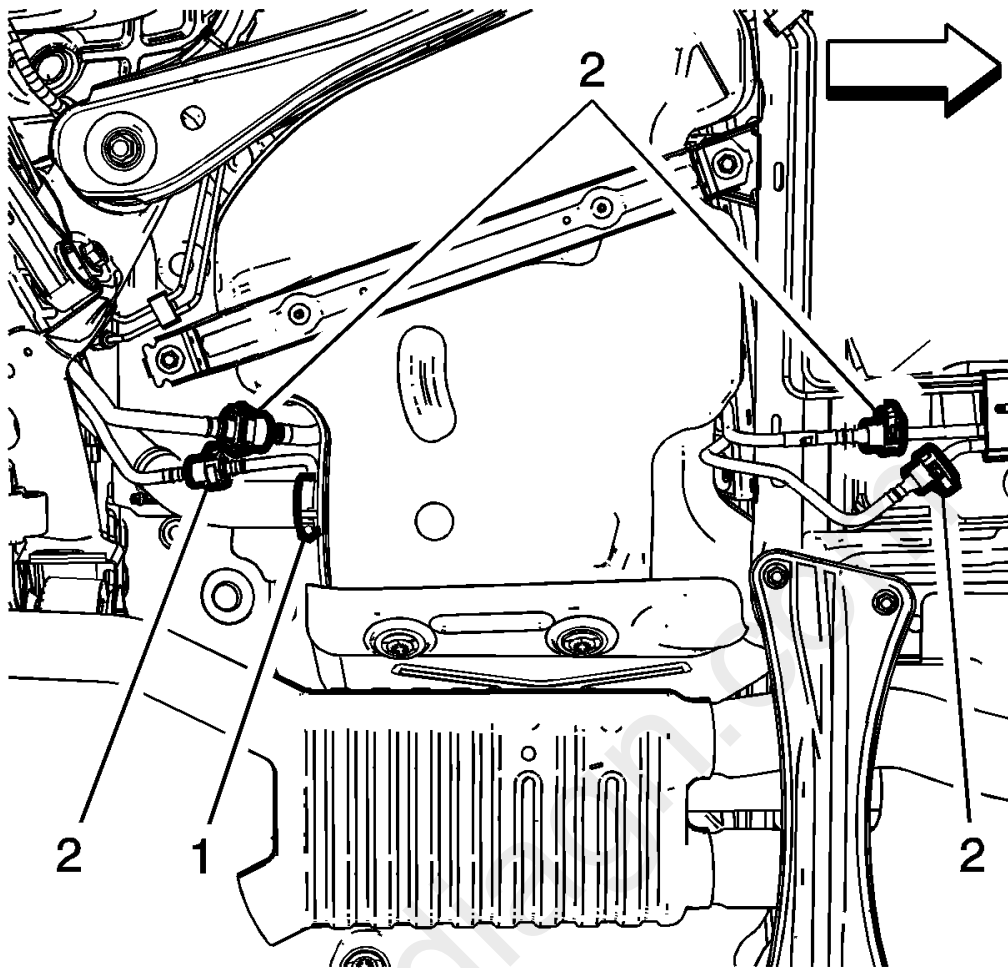


Fig. 47: Evaporative Emission And Fuel Pipes
Courtesy of GENERAL MOTORS COMPANY

5. Connect the evaporative emission and fuel pipes (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Connect the fuel tank electrical connector.
7. Install the two piece propeller shaft. Refer to **Two-Piece Propeller Shaft Replacement (LFX, LF3)** , **Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW)** .
8. Install the left and right side rear air deflectors. Refer to **Underbody Rear Air Deflector Replacement - Left Side** , and **Underbody Rear Air Deflector Replacement - Right Side** .
9. Refill the fuel tank.
10. Inspect for fuel leaks.

FUEL SYSTEM CLEANING

NOTE: When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws

and regulations.

NOTE: Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.

NOTE: Always maintain cleanliness when servicing fuel system components.

1. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)**

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the fuel pump electrical connector and the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.

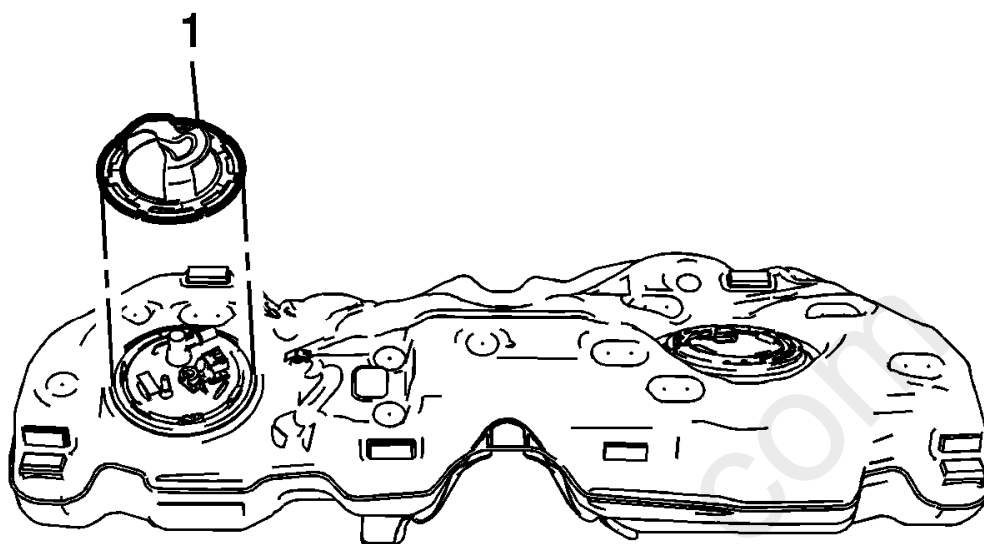


Fig. 48: Fuel Tank Fuel Pump Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

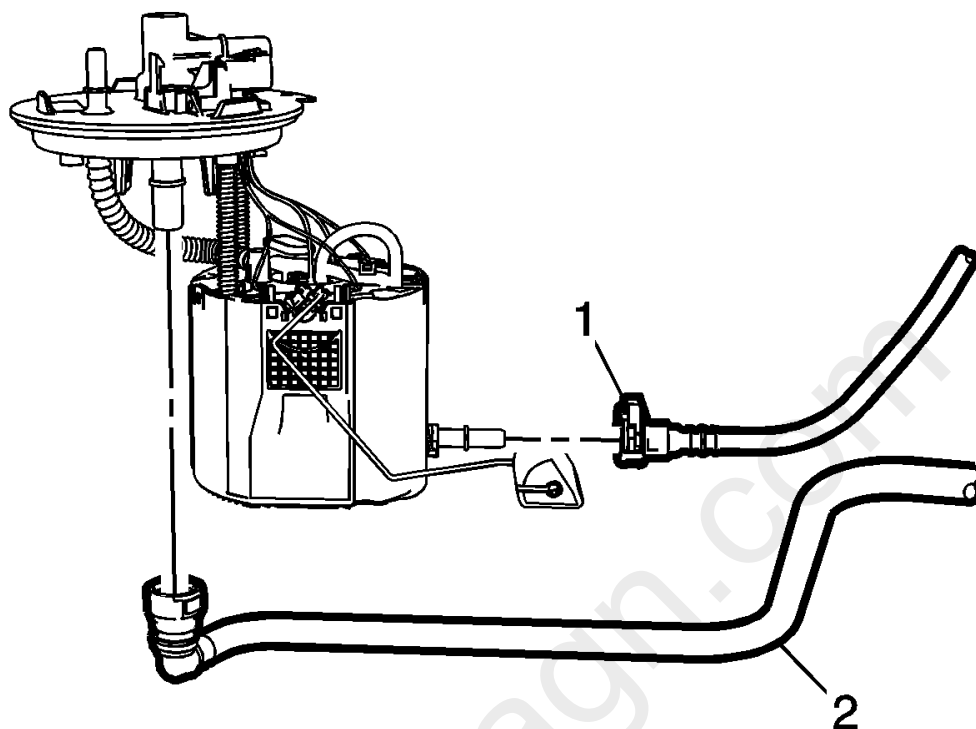


Fig. 49: Pump Vent Hose And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel pump vent hose (1) and transfer hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

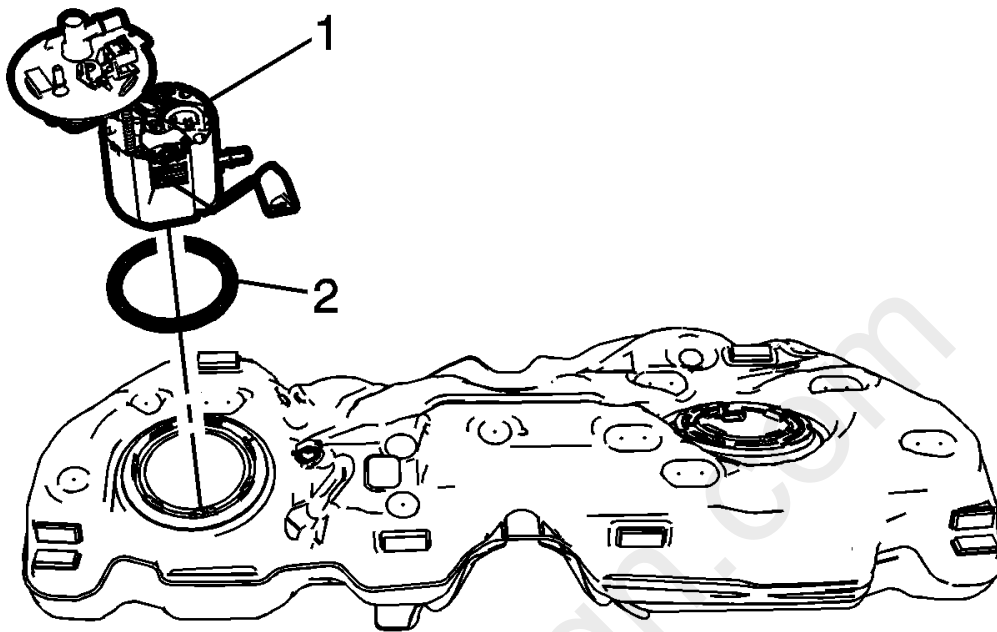


Fig. 50: Fuel Tank Module
Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

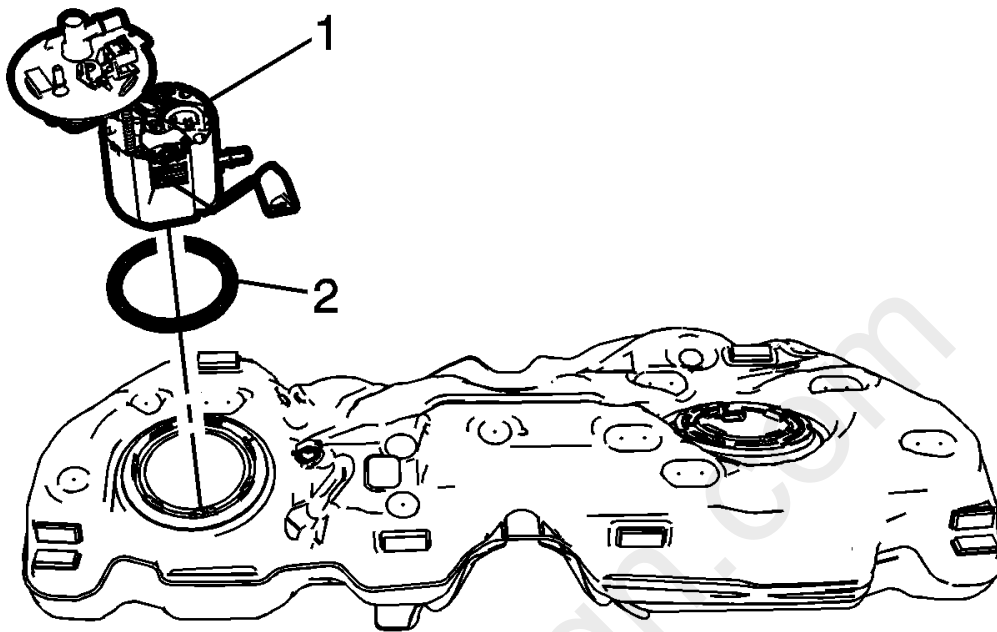


Fig. 51: Fuel Tank Module
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

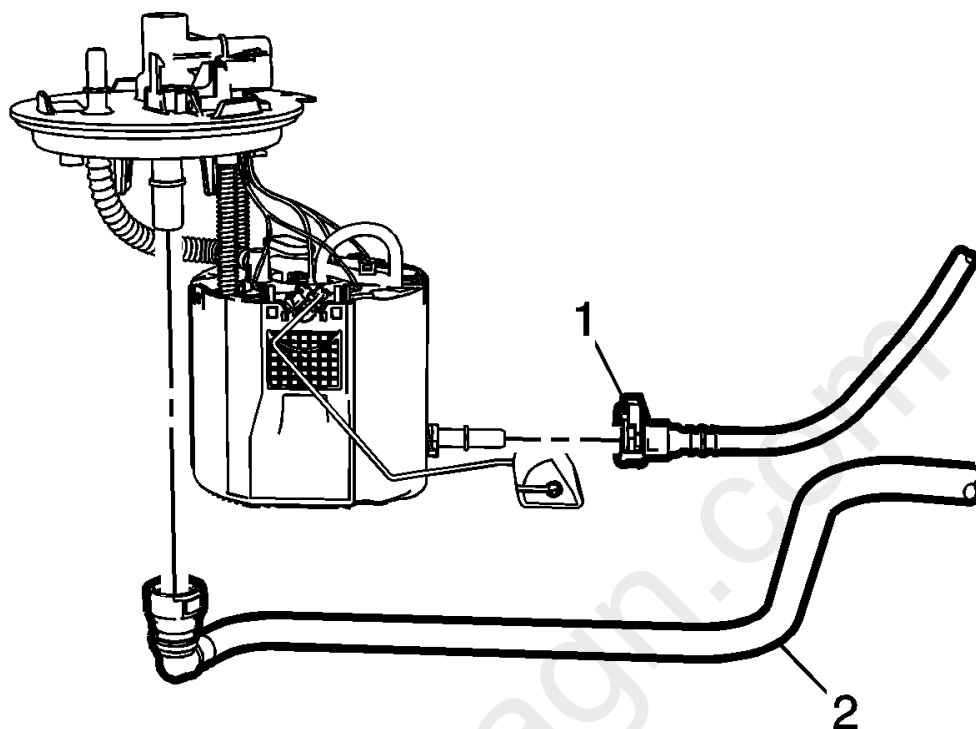


Fig. 52: Pump Vent Hose And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel pump vent hose (1) and transfer hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

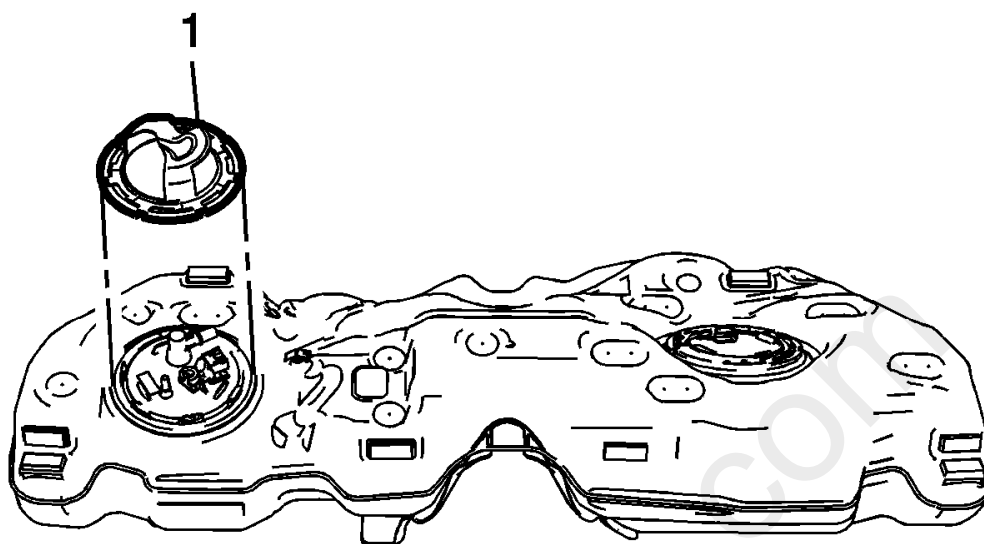


Fig. 53: Fuel Tank Fuel Pump Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).
4. Connect the fuel pump electrical connector and the quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

CHASSIS CONTROL MODULE REPLACEMENT

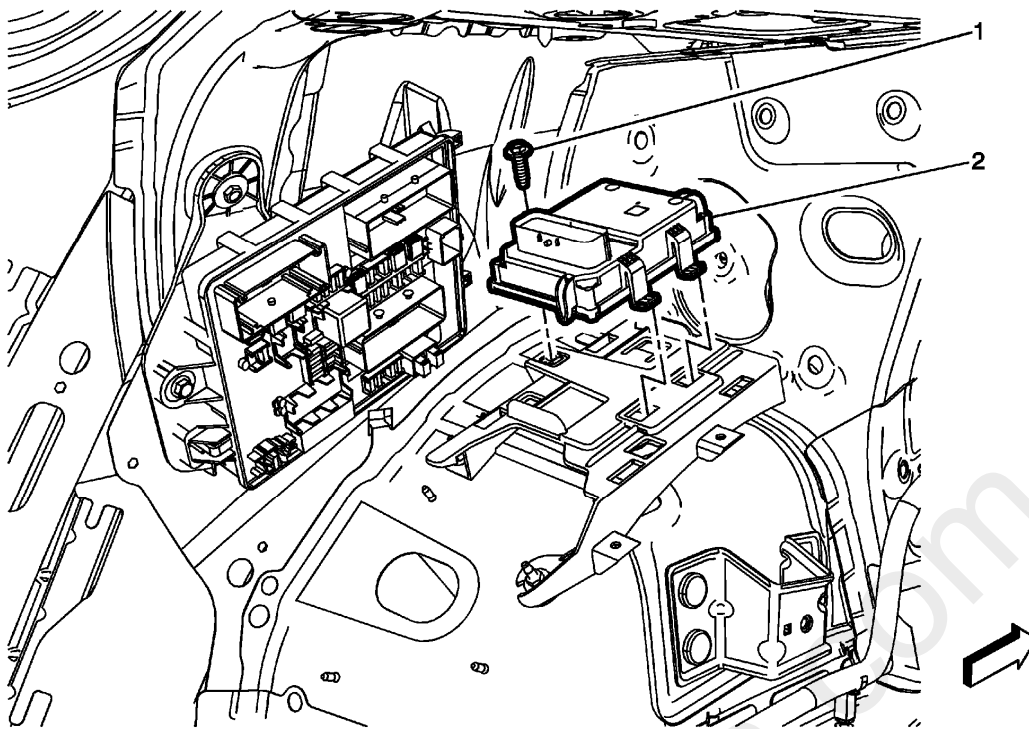


Fig. 54: Chassis Control Module
 Courtesy of GENERAL MOTORS COMPANY

Chassis Control Module Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment left side fuse access panel.	
1	Fuel Pump Flow Control Module Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 (62 lb in)
2	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to <u>Control Module References</u> .

FUEL TANK PRESSURE SENSOR REPLACEMENT

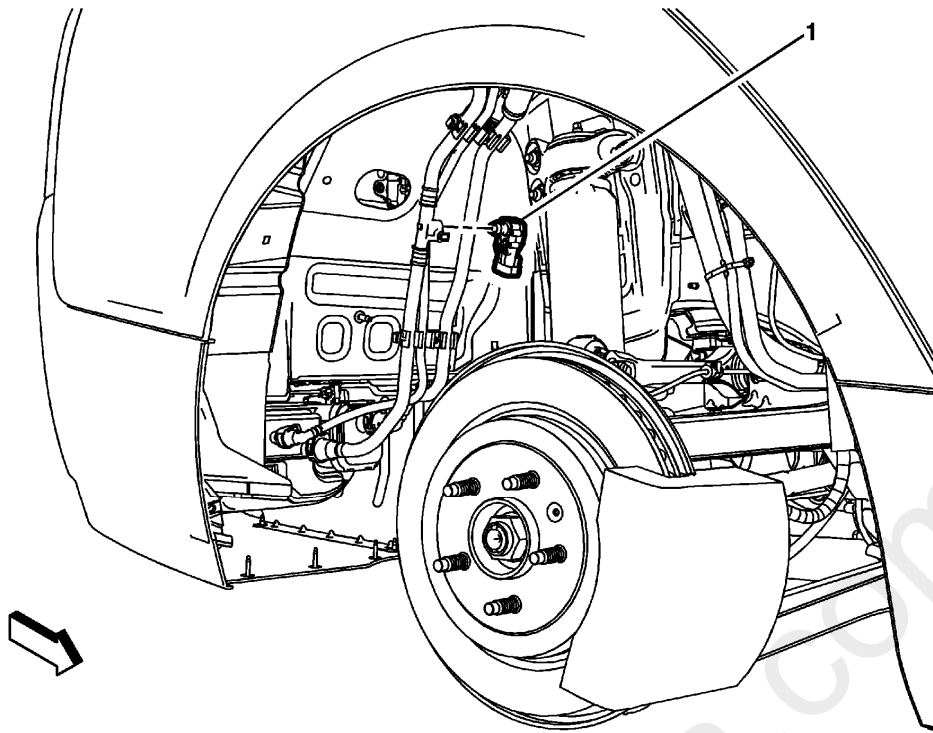


Fig. 55: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Fuel Tank Pressure Sensor Procedure Disconnect the FTP sensor electrical connector.

FUEL SENDER ASSEMBLY REPLACEMENT

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to Special Tools (Diagnostic Tools)

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the fuel sender assembly electrical connector.

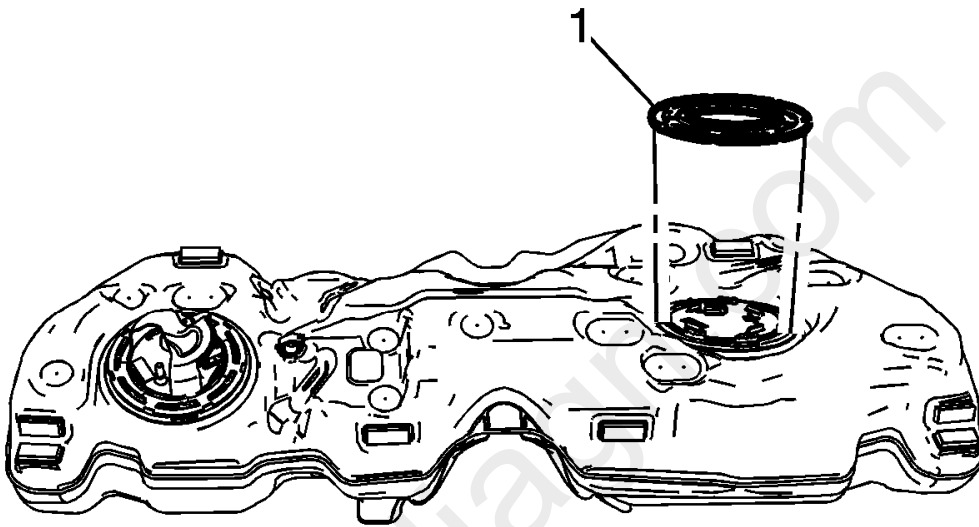


Fig. 56: Fuel Sender Assembly Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

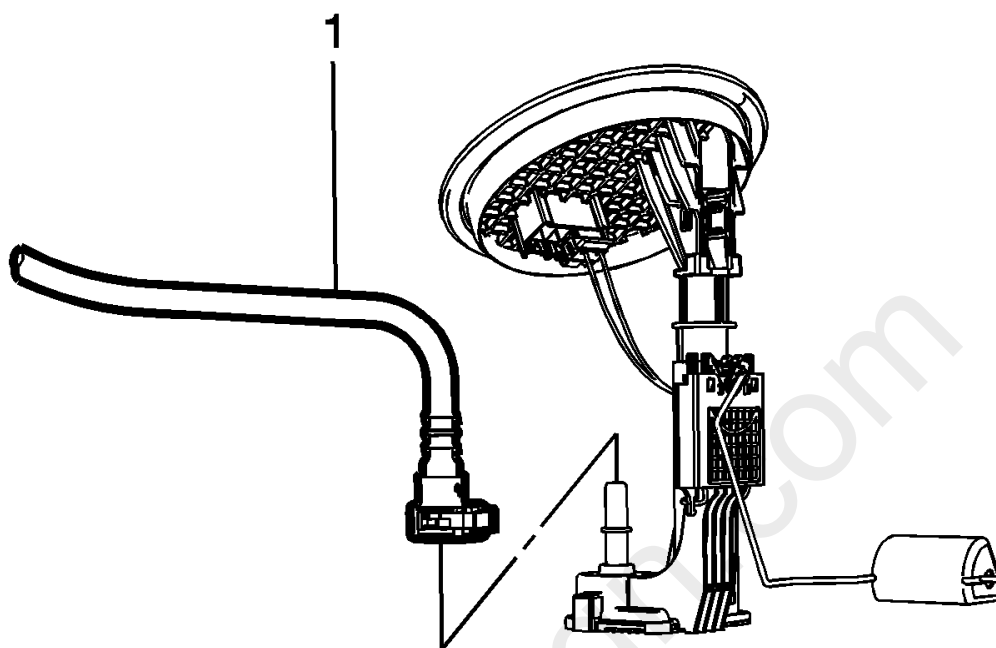


Fig. 57: Fuel Sender Assembly Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel sender assembly transfer hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

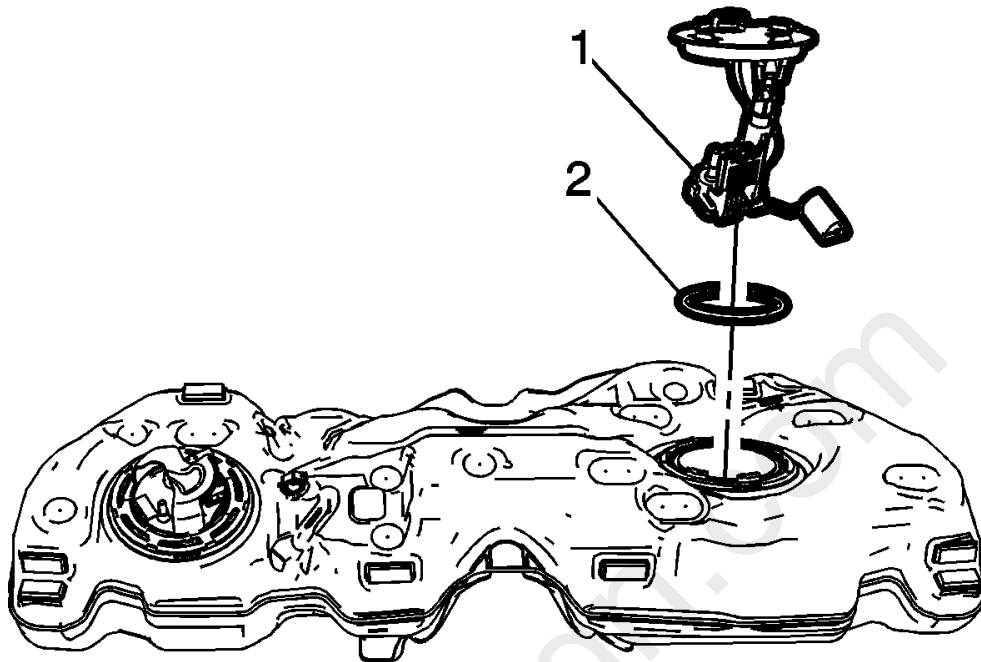


Fig. 58: Fuel Sender Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel sender assembly (1) and the O-ring (2).

Installation Procedure

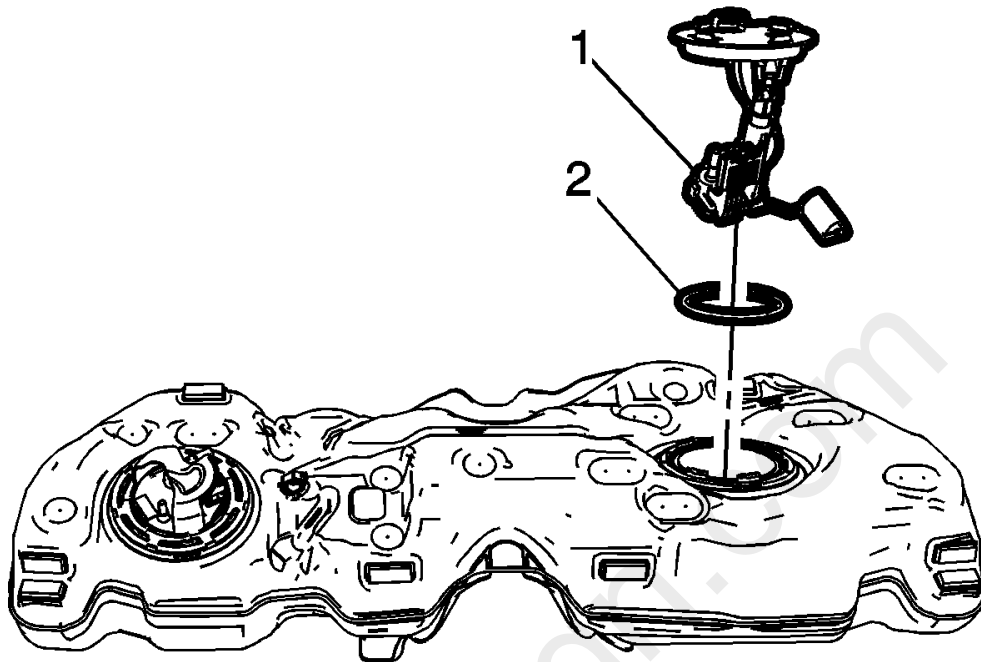


Fig. 59: Fuel Sender Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel sender assembly (1).

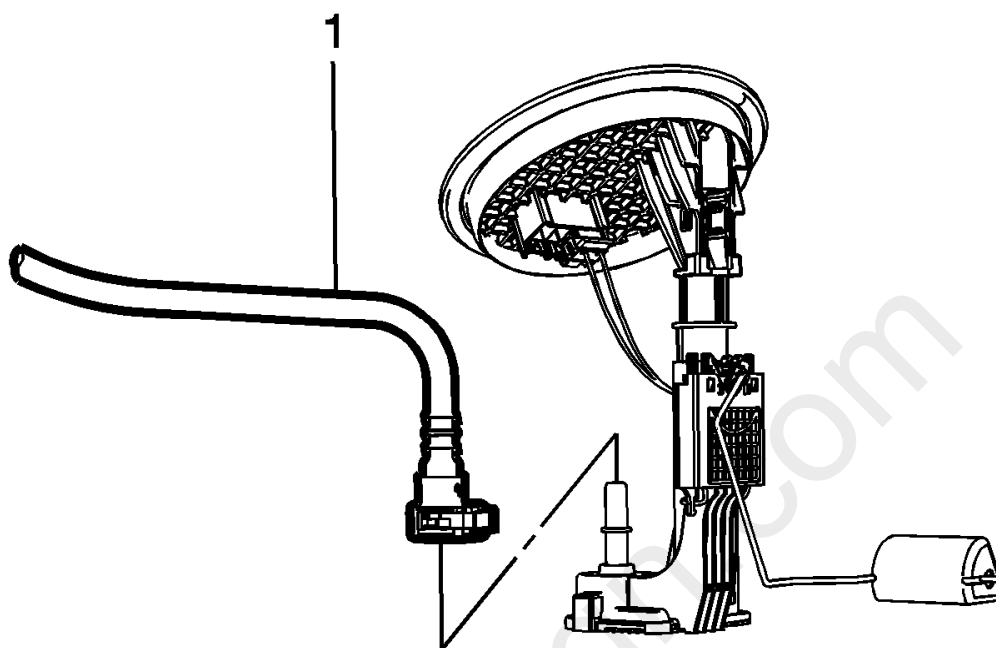


Fig. 60: Fuel Sender Assembly Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel sender assembly transfer hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**.

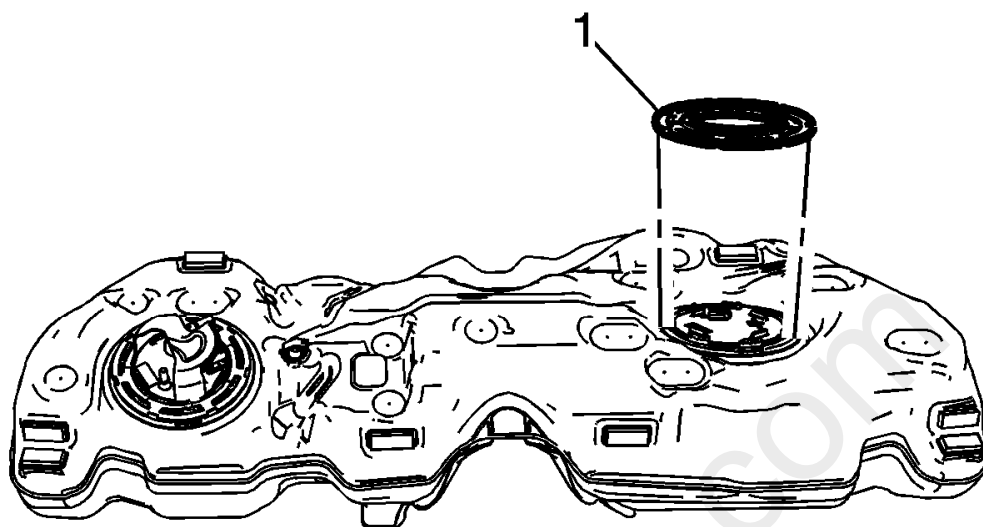


Fig. 61: Fuel Sender Assembly Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).
4. Connect the fuel sender assembly electrical connector.
5. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT

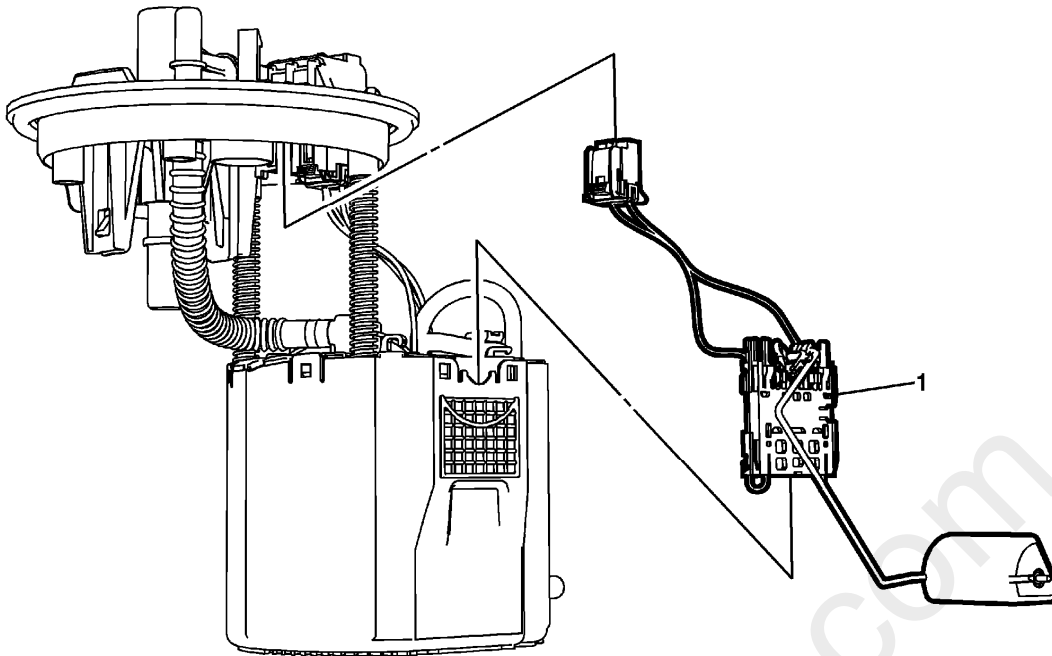


Fig. 62: Fuel Level Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Level Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove the fuel tank fuel pump module. Refer to <u>Fuel Tank Fuel Pump Module Replacement</u>.	
1	Fuel Level Sensor Procedure Release the fuel level sensor tabs and disconnect the electrical connector.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

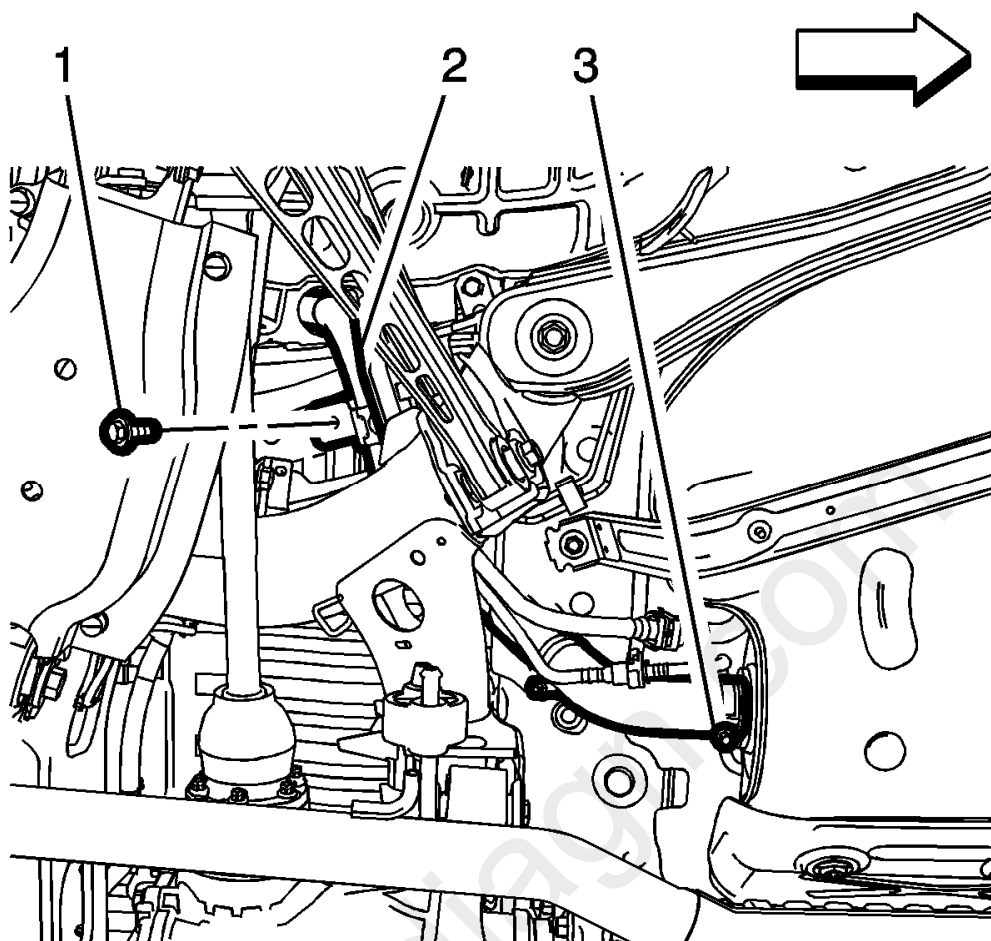


Fig. 63: Fuel Tank Filler Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel tank filler pipe fastener (1).
3. Remove the fuel tank filler pipe clamp (2).
4. Place a clean drain pan large enough to capture the fuel that may be expelled once the hose is removed.
5. Remove the fuel tank filler pipe (3) from the fuel tank.
6. Remove the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
7. Remove the fuel tank filler pipe housing. Refer to **Fuel Tank Filler Pipe Housing Replacement** .

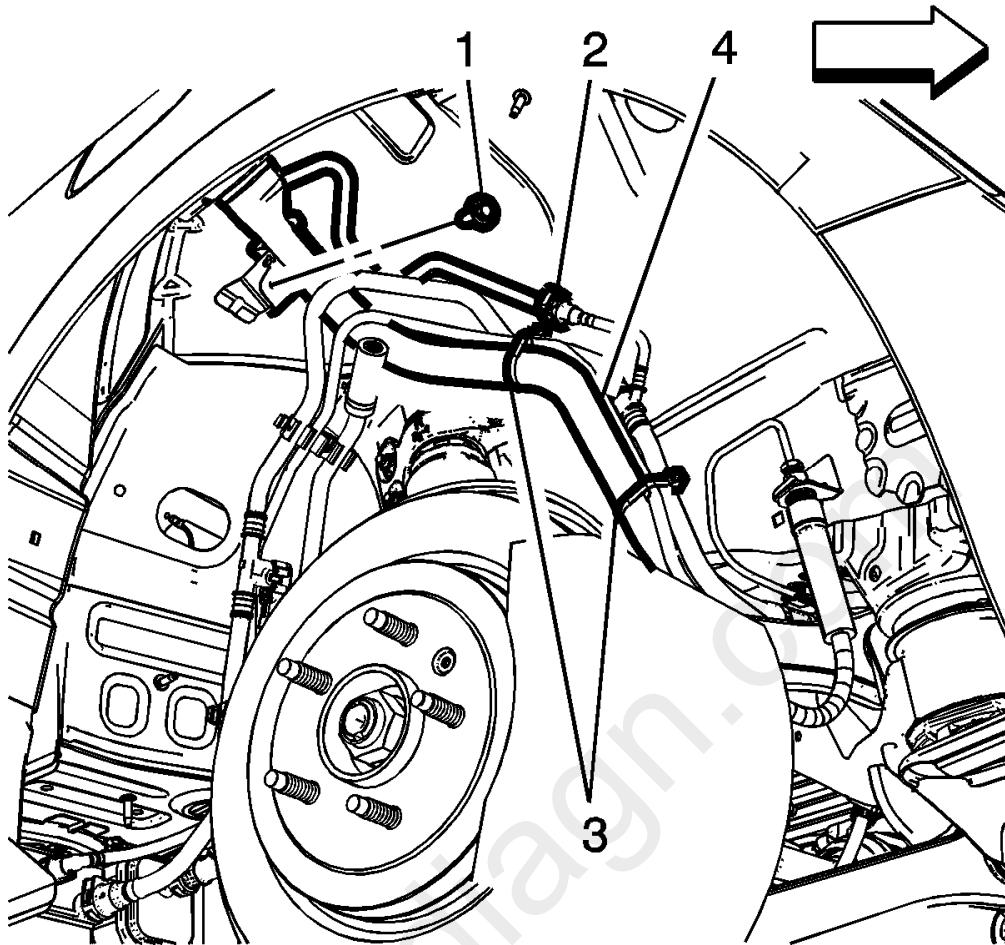


Fig. 64: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Remove the tie straps (3) attaching the evaporative emission canister purge pipe and fuel tank vent hose to the fuel tank filler pipe.
9. Remove the fuel tank filler pipe fastener (1).
10. Remove the fuel tank vent hose (2) from the fuel tank filler pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
11. Support the rear suspension with a jack stand.
12. Loosen the two right side suspension cradle bolts and lower the cradle slightly to remove the fill pipe.
13. Remove the fuel tank filler pipe (4) from the vehicle.

Installation Procedure

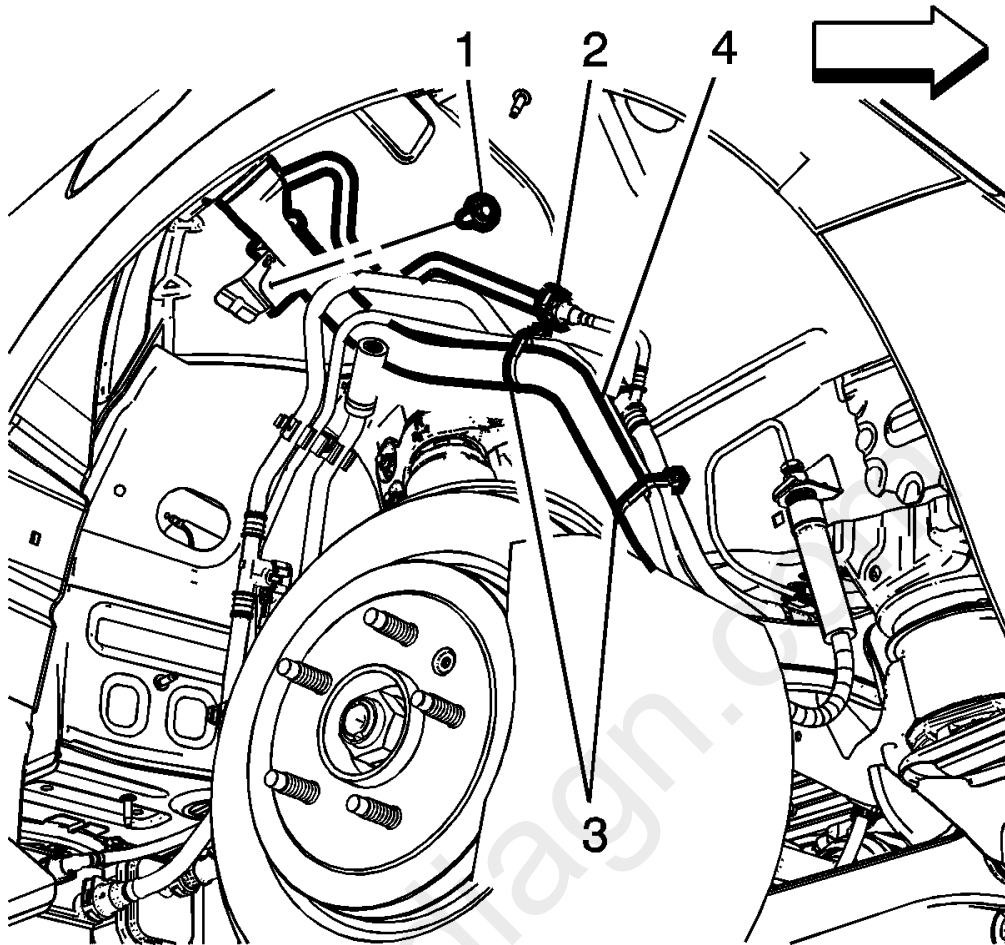


Fig. 65: Fuel Tank Filler Pipe
 Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank filler pipe (4) to the vehicle.
2. Install two new RH side cradle bolts and tighten to specification. Refer to **Rear Suspension Cradle Replacement** .
3. Install the fuel tank vent hose (2) to the fuel tank filler pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

CAUTION: Refer to **Fastener Caution** .

4. Install the fuel tank filler pipe fastener (1) and tighten to 9 (80 lb in).
5. Install NEW tie straps (3) that attach the evaporative emission canister purge pipe and fuel tank vent hose to the fuel tank filler pipe.
6. Install the fuel tank filler pipe housing. Refer to **Fuel Tank Filler Pipe Housing Replacement** .
7. Install the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

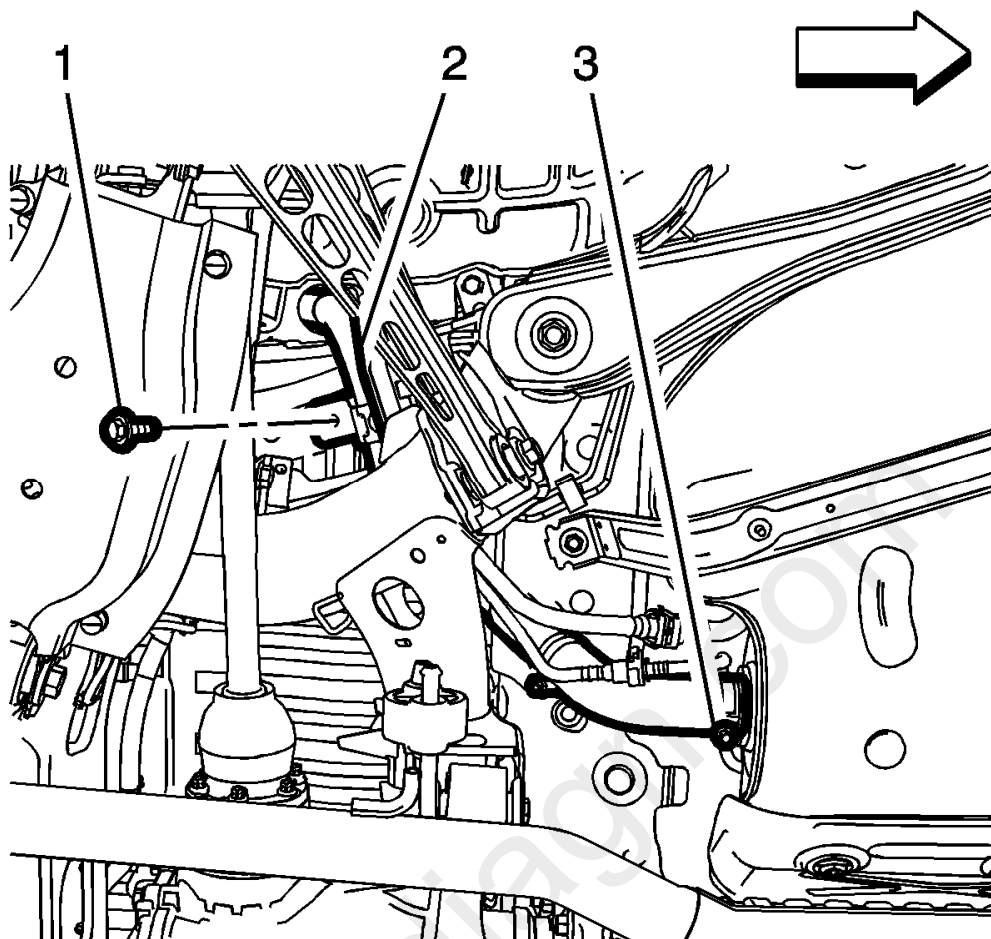


Fig. 66: Fuel Tank Filler Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel tank filler pipe (3) to the fuel tank.
9. Install the fuel tank filler pipe clamp (2).
10. Install the fuel tank filler pipe fastener (1) and tighten to 9 (80 lb in).
11. Remove the drain pan.
12. Lower the vehicle.

FUEL PUMP COVER REPLACEMENT

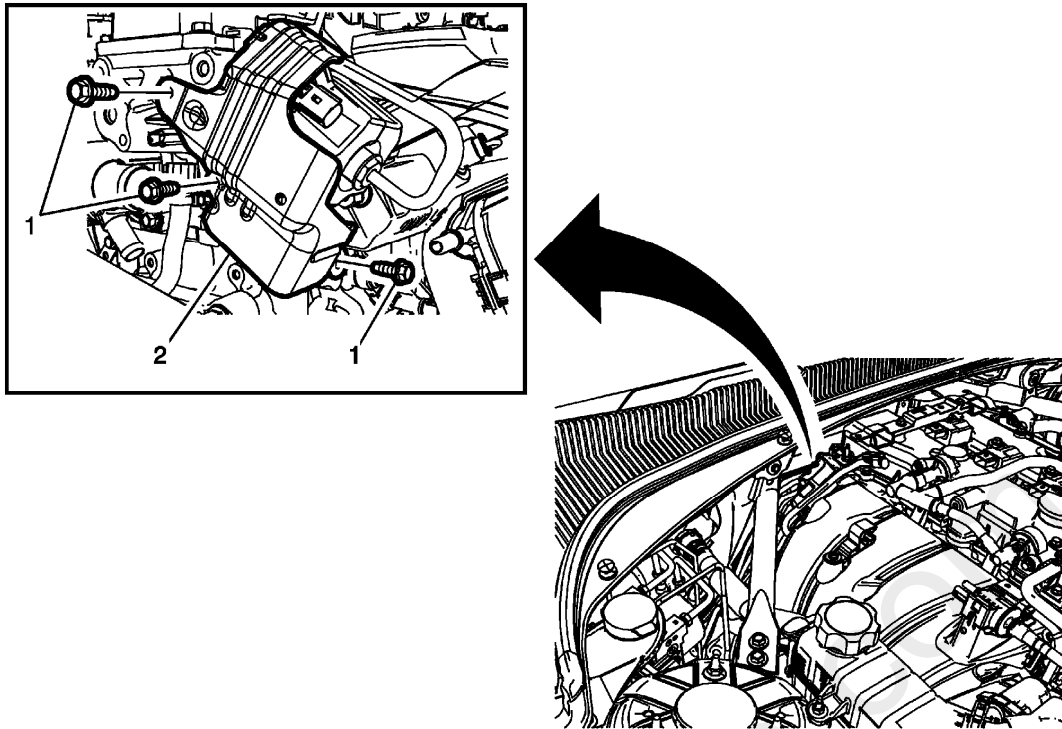


Fig. 67: Fuel Pump Cover

Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Cover Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> . 3. Remove the front end sheet metal diagonal brace. Refer to <u>Front End Sheet Metal Diagonal Brace Replacement - Right Side</u> . 4. Remove the outer fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement (Inner)</u>, <u>Fuel Pump Insulator Replacement (Outer)</u>. 5. Disconnect the radiator inlet pipe from the water outlet. Refer to <u>Radiator Inlet Pipe Replacement (LTG)</u> .	
1	Fuel Pump Cover Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
	Fuel Pump Cover

Procedure

Disconnect the electrical wiring harness connector from the fuel pump.

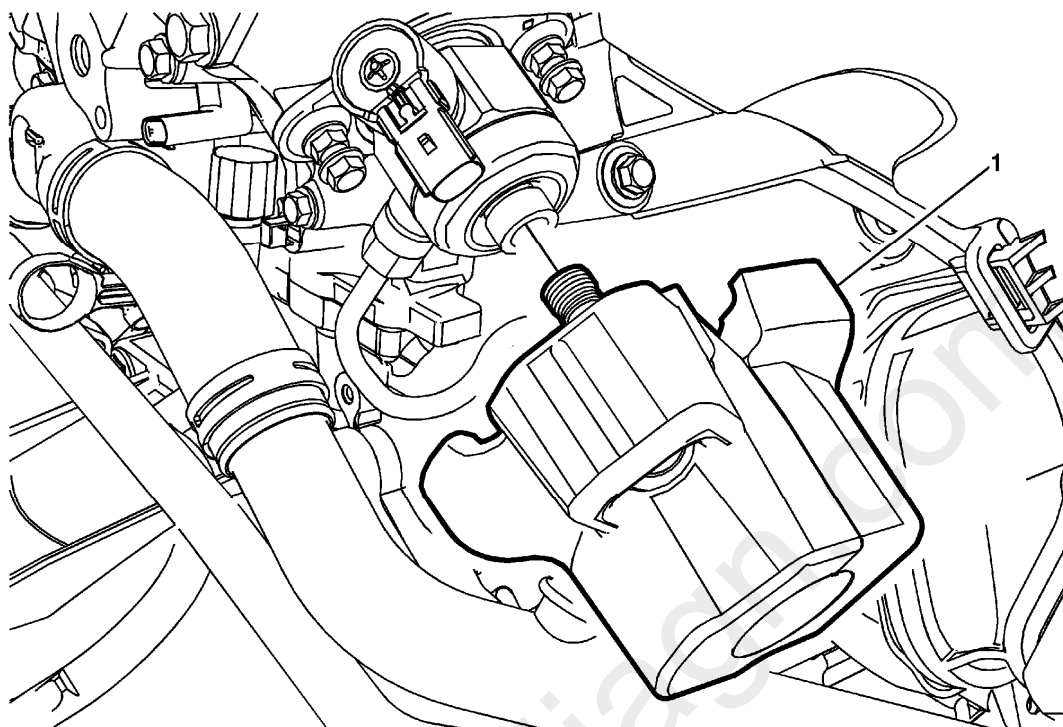
FUEL PUMP INSULATOR REPLACEMENT (INNER)

Fig. 68: Fuel Pump Insulator (Inner)

Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Insulator Replacement (Inner)

Callout	Component Name
Preliminary Procedure	
1.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .
2.	Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> .
3.	Remove the outer fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement (Inner)</u> , <u>Fuel Pump Insulator Replacement (Outer)</u> .
4.	Remove the fuel pump cover. Refer to <u>Fuel Pump Cover Replacement</u> .
1	Fuel Pump Insulator

FUEL PUMP INSULATOR REPLACEMENT (OUTER)

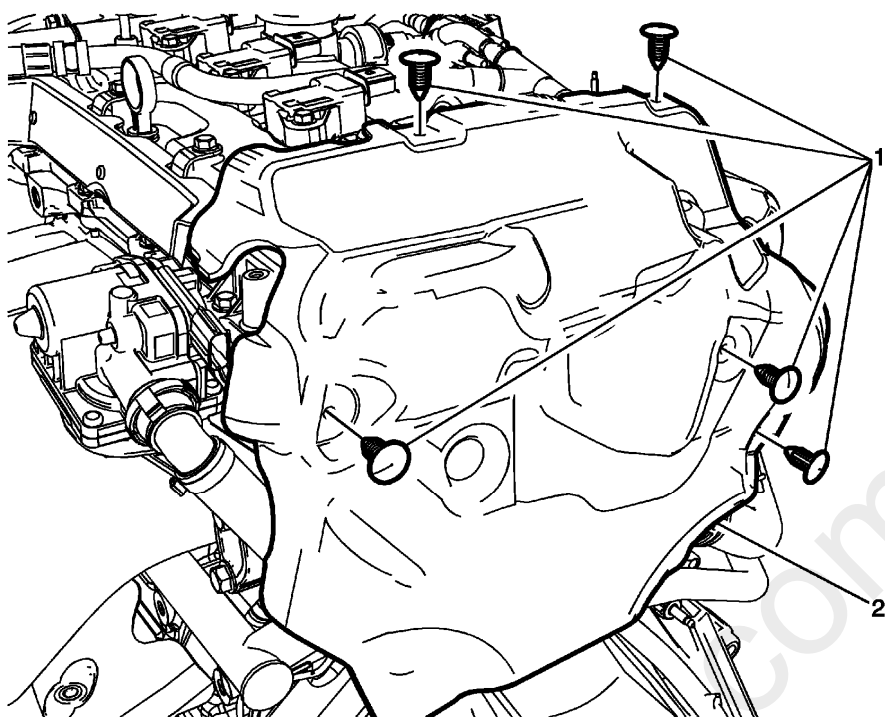


Fig. 69: Fuel Pump Insulator (Outer)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Insulator Replacement (Outer)

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
2. Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> .	
1	Fuel Pump Insulator Retainers
2	Fuel Pump Insulator

FUEL FEED PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

1. Relieve the system fuel pressure. Refer to **Fuel Pressure Relief** .

2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

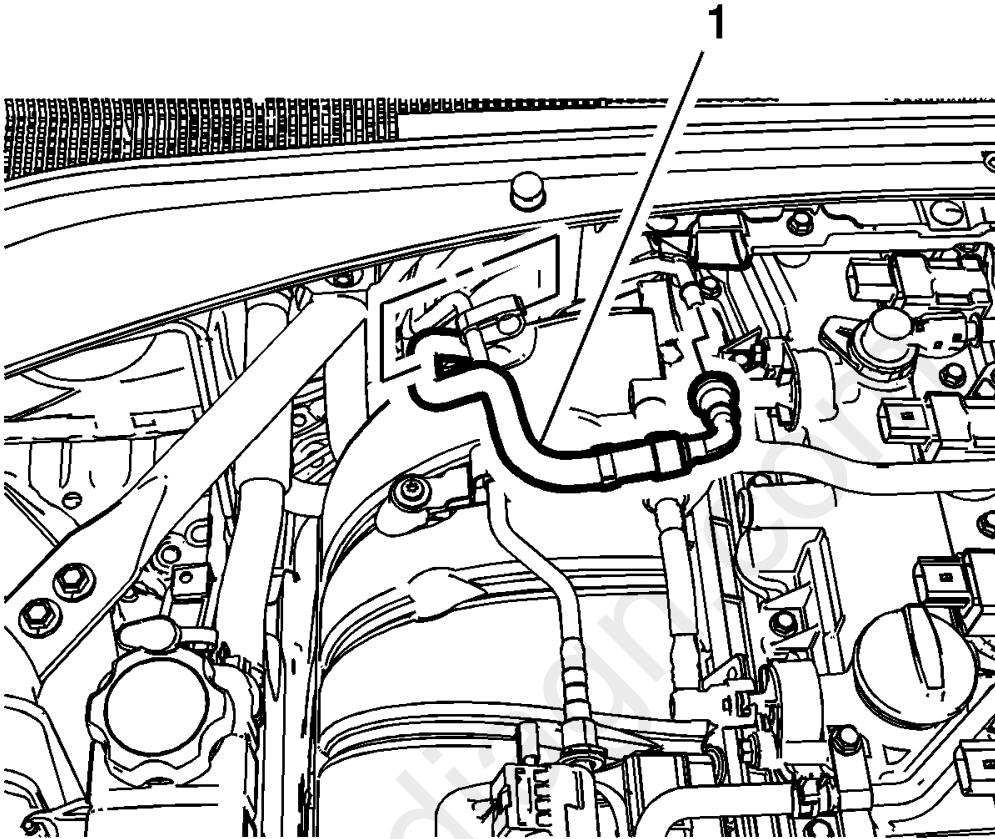


Fig. 70: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel feed pipe (1) from the engine and retainers. Refer to **Metal Collar Quick Connect Fitting Service**.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
6. Remove the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .

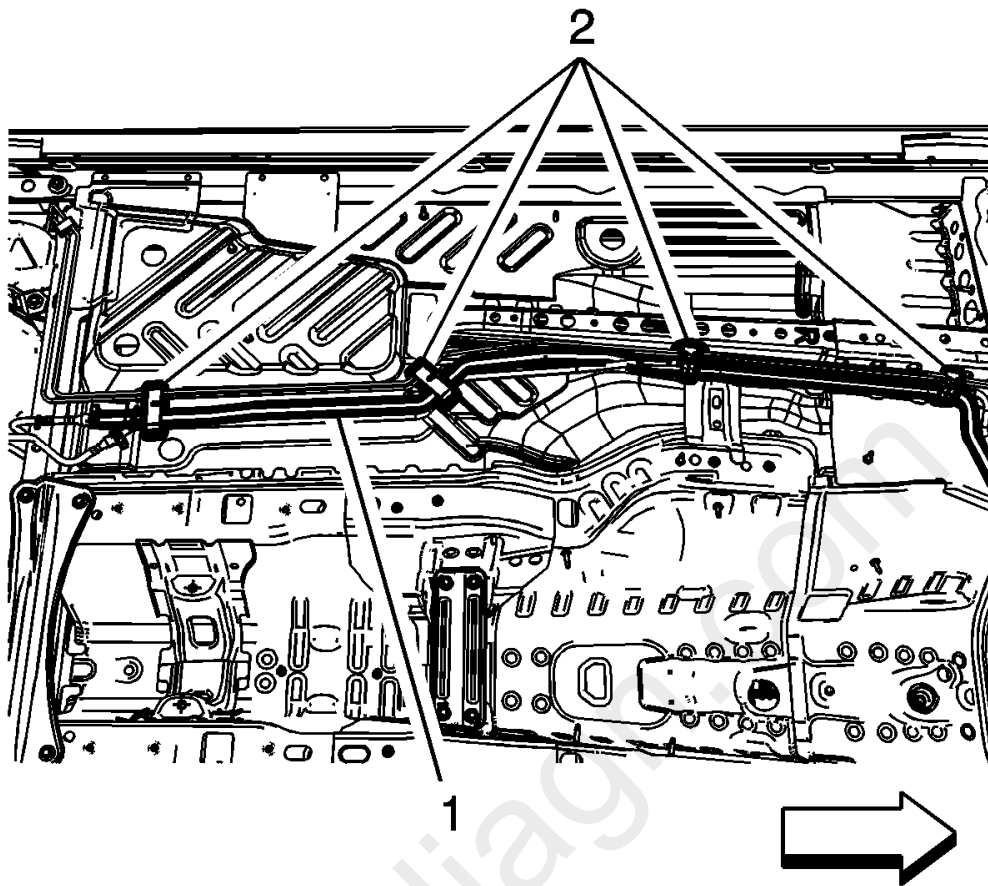


Fig. 71: Fuel Feed Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the fuel feed pipe (1) and remove from retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Remove the fuel feed pipe (1) from the vehicle.

Installation Procedure

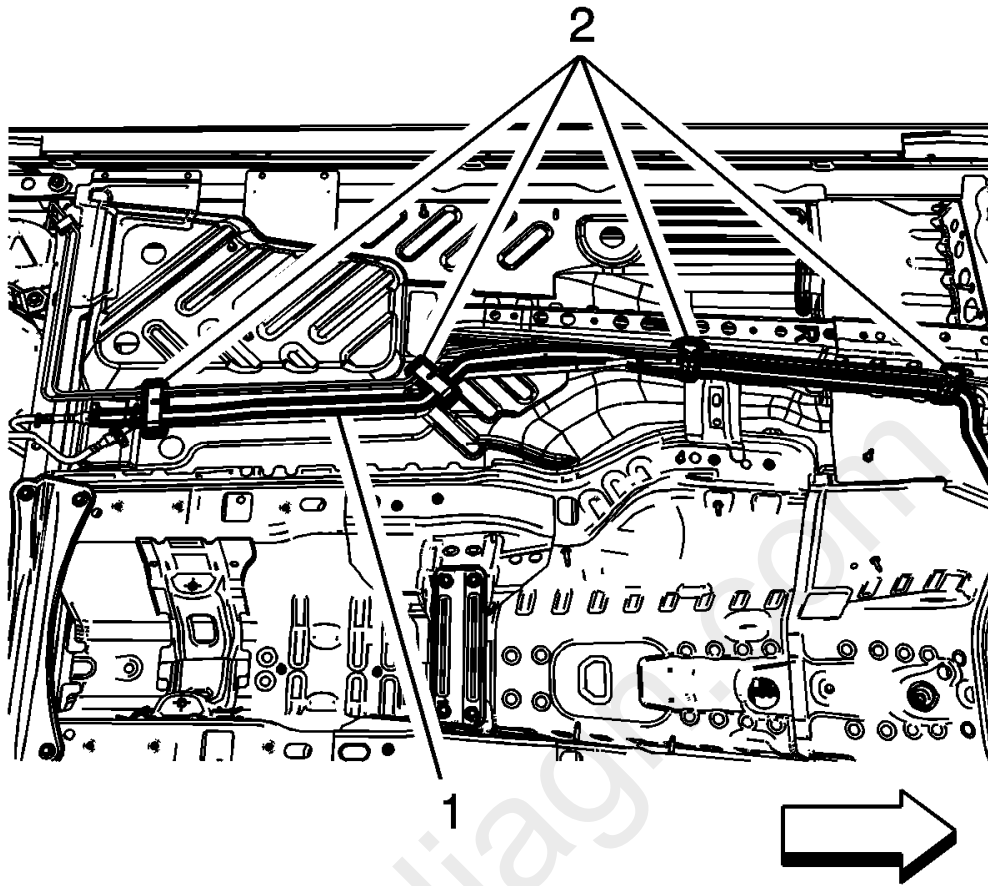


Fig. 72: Fuel Feed Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed pipe (1) to the vehicle.
2. Connect the fuel feed pipe (1) and install to the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .
4. Install the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
5. Lower the vehicle.

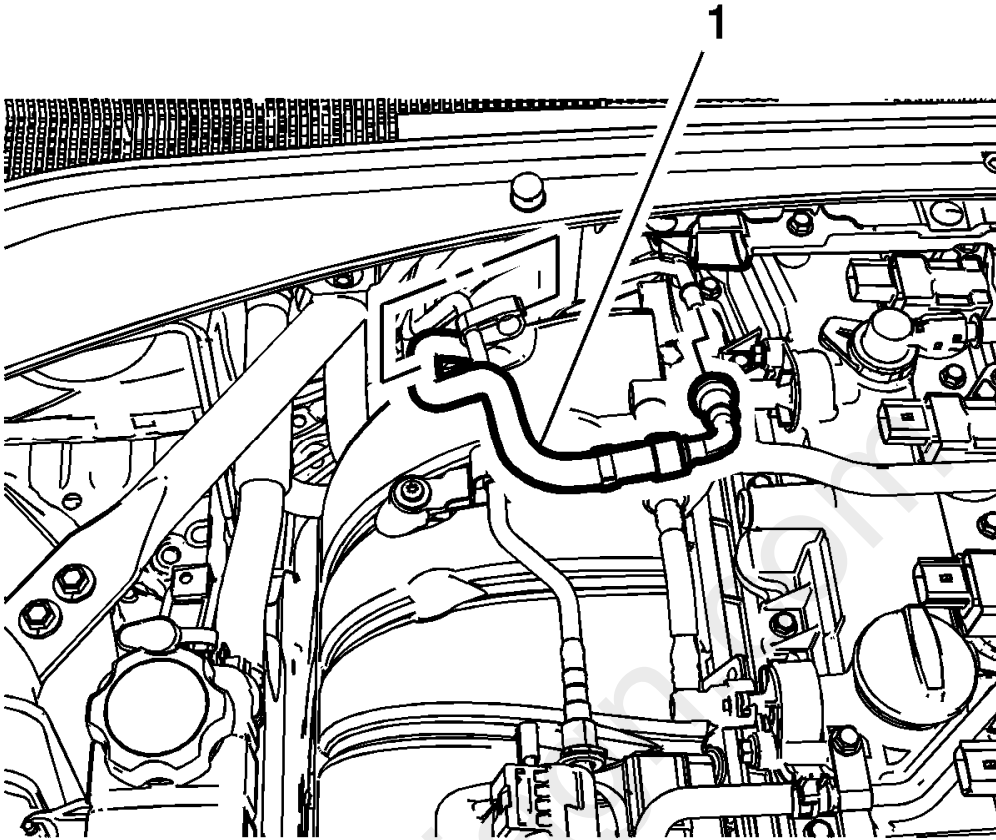


Fig. 73: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Install the fuel feed pipe (1) to the engine and retainers. Refer to **Metal Collar Quick Connect Fitting Service**.
7. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

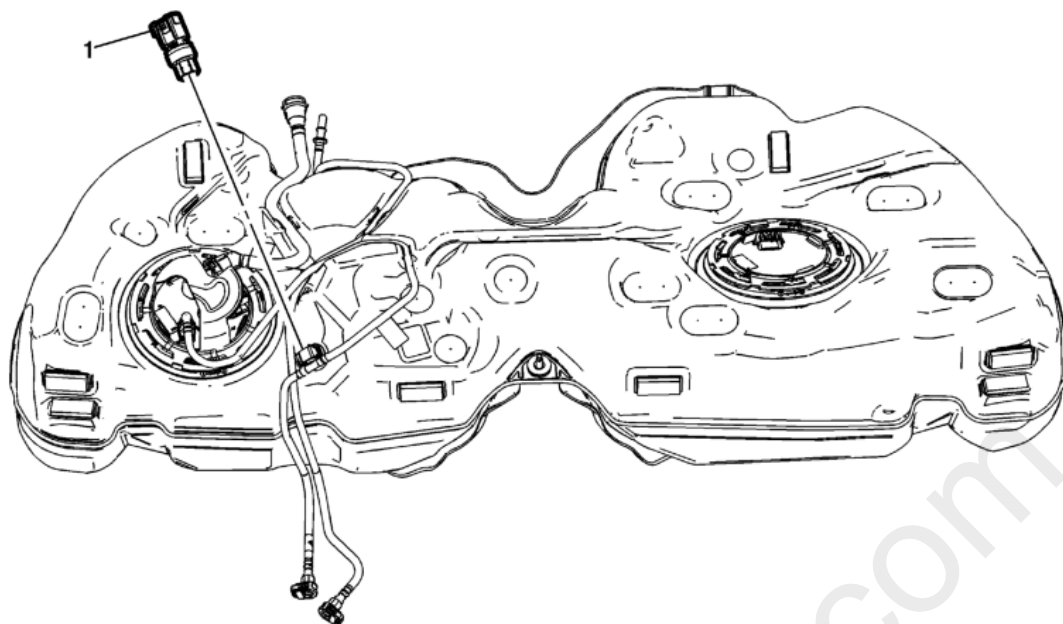


Fig. 74: Fuel Pressure Sensor - Fuel Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Feed Pipe

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> .	
WARNING: Refer to <u>Safety Glasses Warning</u> .	
Preliminary Procedure Remove the fuel tank. Refer to <u>Fuel Tank Replacement</u> .	
1	Fuel Tank Pressure Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect electrical connector and unclip sensor from retainer.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

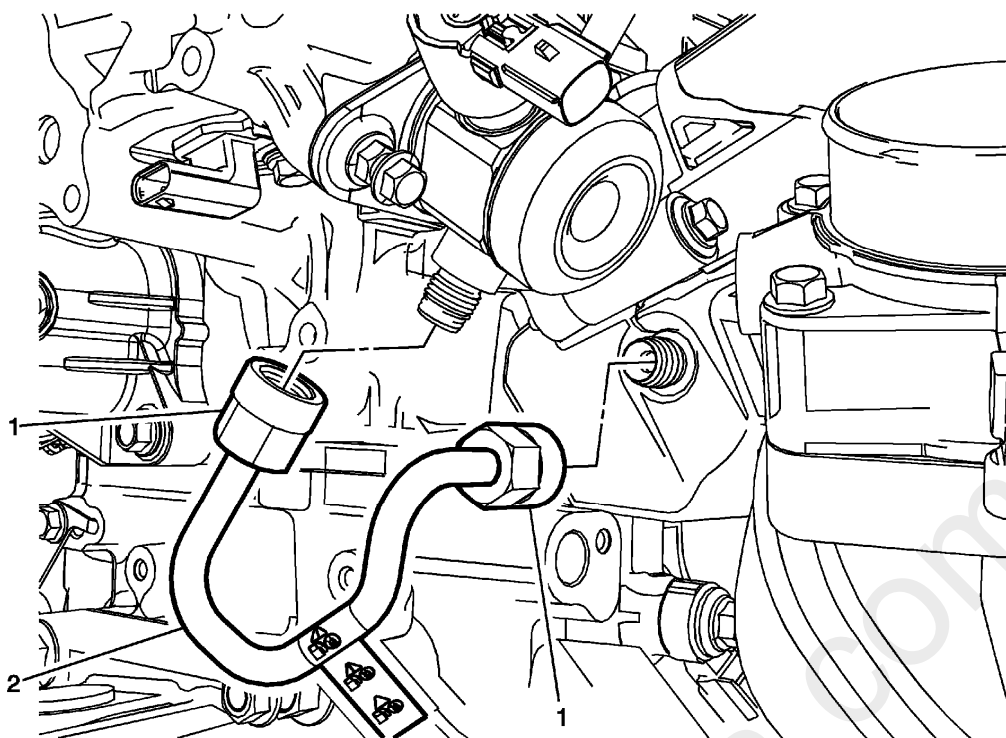


Fig. 75: Fuel Feed Intermediate Pipe
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Intermediate Pipe Replacement

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> .	
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the fuel pump cover. Refer to <u>Fuel Pump Cover Replacement</u> .	
1	Fuel Pump Intermediate Pipe Fittings (Qty: 2) WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete. CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

	Procedure Hand start both ends of the NEW fuel feed intermediate pipe (2). Tighten 1. Tighten the fitting nut to the fuel rail to 15 (11 lb ft). 2. Tighten the fitting nut to the fuel pump to 15 (11 lb ft). 3. Tighten the fitting nut to the fuel rail a final pass to 30 (22 lb ft). 4. Tighten the fitting nut to the fuel pump a final pass to 30 (22 lb ft).
2	Fuel Pump Intermediate Pipe NOTE: The threaded fuel pipes are one time use, always install a NEW fuel pump intermediate pipe.

FUEL TANK VENT VALVE HOSE REPLACEMENT (AT TANK)

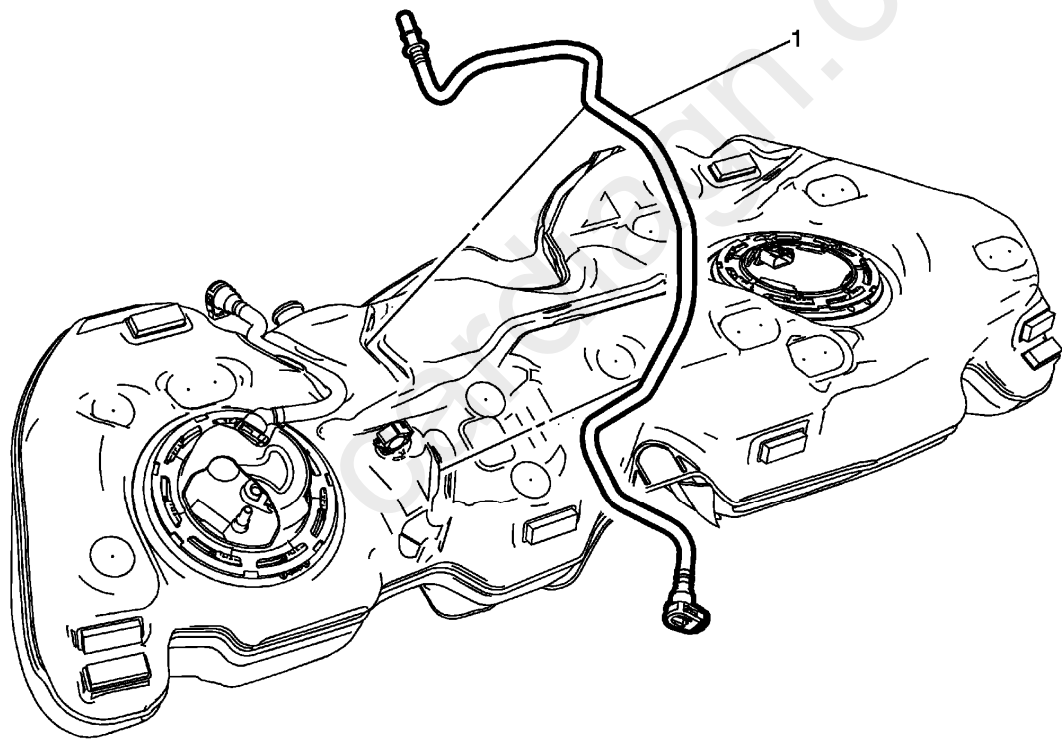


Fig. 76: Fuel Tank Vent Valve Hose (At Tank)
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Vent Valve Hose Replacement (At Tank)

Callout	Component Name
WARNING:	

Refer to Gasoline/Gasoline Vapors Warning .

WARNING:
Refer to Safety Glasses Warning .

Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement.

1	Fuel Tank Vent Valve Hose Procedure Remove the fuel tank vent valve hose from the fuel tank.
---	---

FUEL TANK VENT VALVE HOSE REPLACEMENT (FUEL TANK FUEL PUMP MODULE)

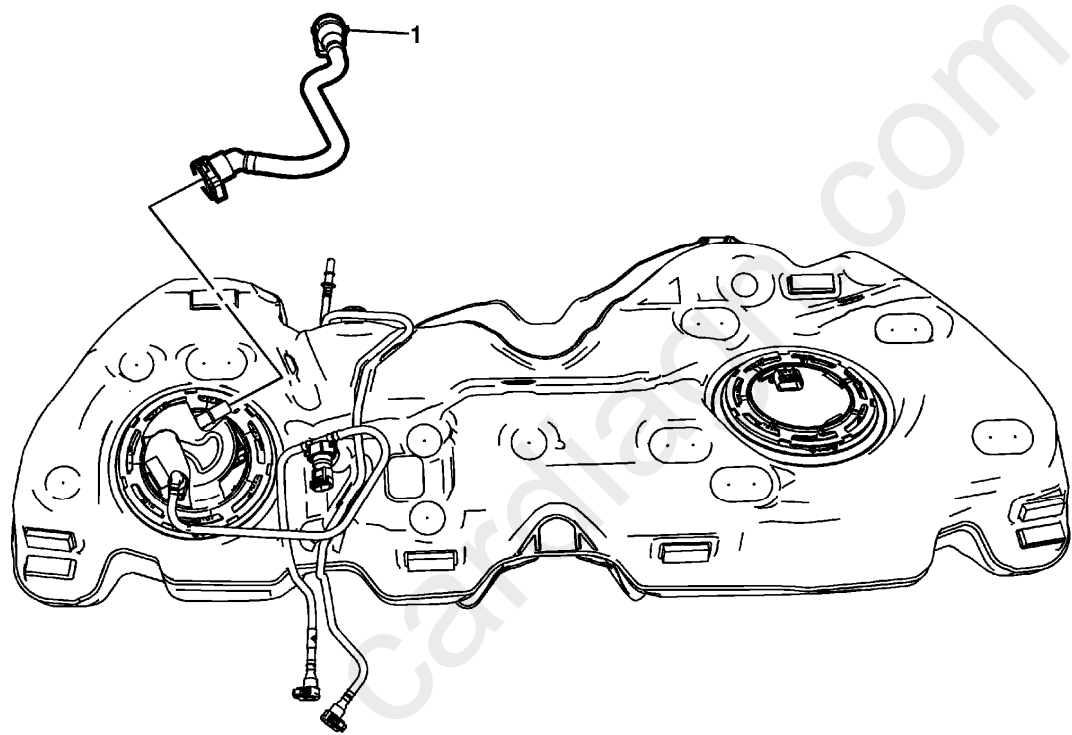


Fig. 77: Fuel Tank Vent Valve Hose (Fuel Tank Fuel Pump Module)
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Vent Valve Hose Replacement (Fuel Tank Fuel Pump Module)

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to <u>Fuel Tank Replacement</u> .	
1	Fuel Tank Vent Valve Hose Procedure Disconnect the fuel tank vent valve hose from the fuel tank fuel pump module. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

FUEL TANK VENT HOSE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

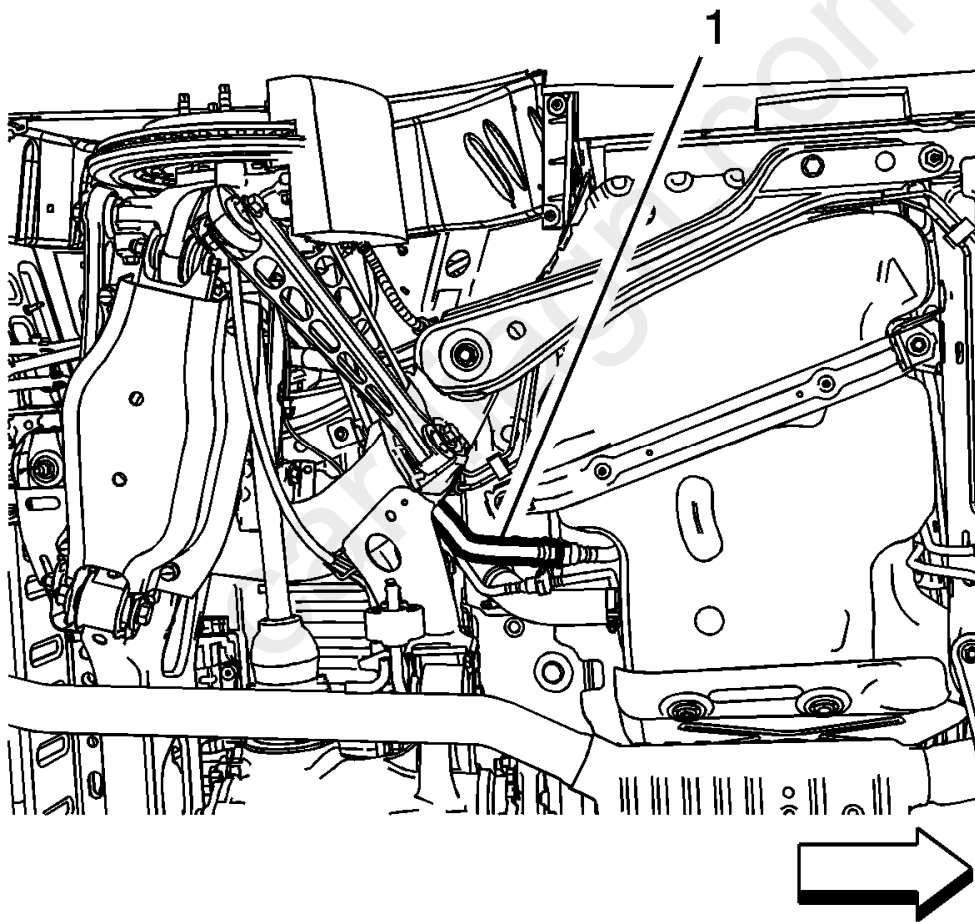


Fig. 78: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel tank vent hose (1) from the fuel tank vent valve hose. Refer to Plastic Collar Quick Connect Fitting Service.

3. Remove the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
4. Disconnect the fuel tank pressure sensor electrical connector.

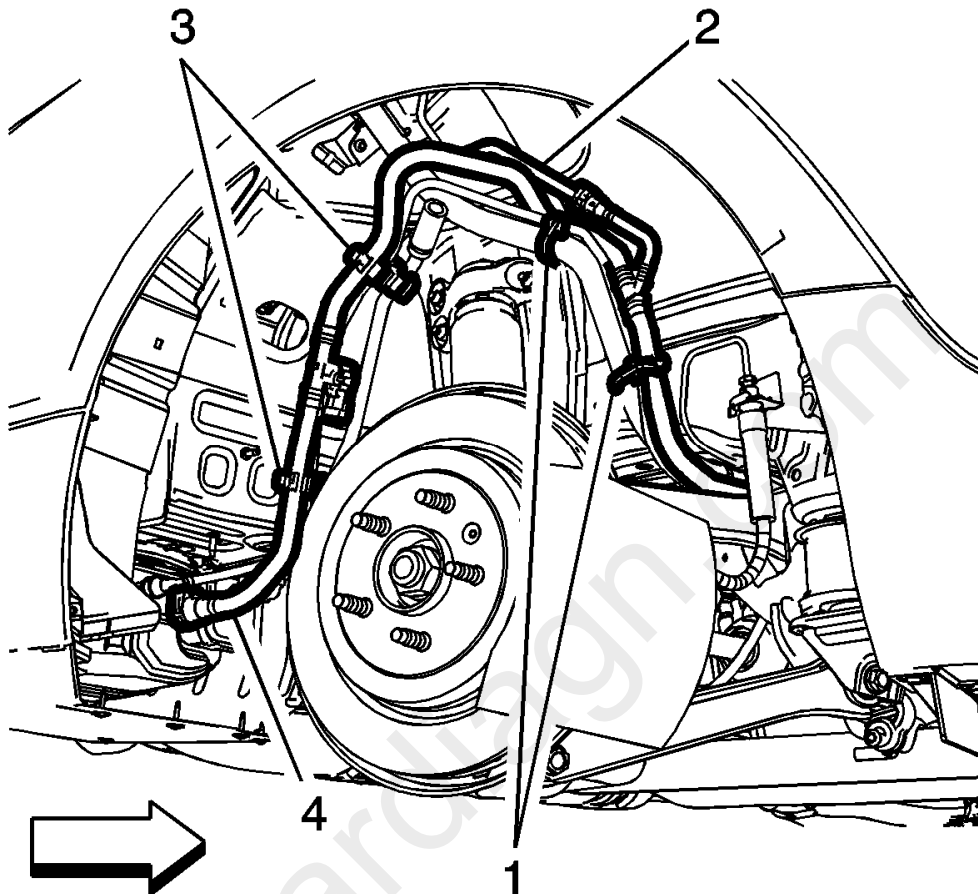


Fig. 79: Fuel Tank Filler Pipe And Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove the tie straps (1) attaching the fuel tank vent hose to the fuel tank filler pipe.
6. Remove the fuel tank vent hose (4) from the fuel tank filler pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Remove the fuel tank vent hose (4) from the retainers (3).
8. Remove the fuel tank vent hose (4) from the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

Installation Procedure

1. If replacing hose then transfer the fuel tank pressure sensor. Refer to **Fuel Tank Pressure Sensor Replacement**.

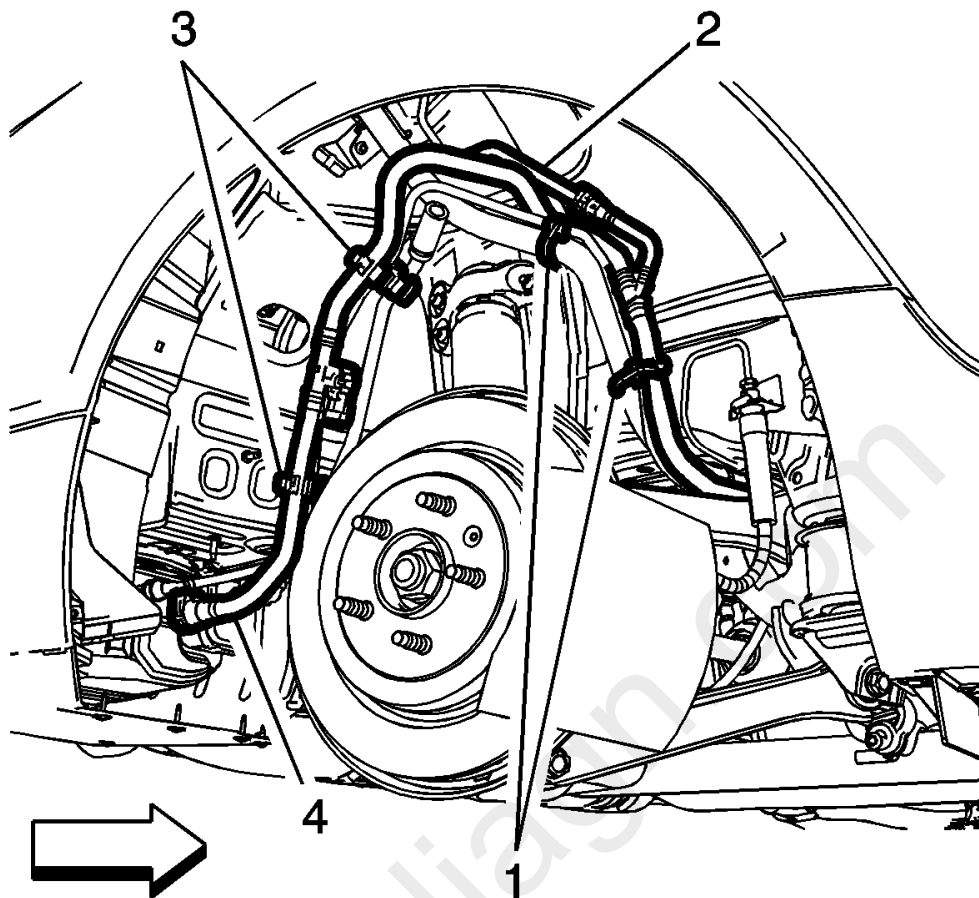


Fig. 80: Fuel Tank Filler Pipe And Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel tank vent hose (4) to the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the fuel tank vent hose (4) to the retainers (3).
4. Install the fuel tank vent hose (4) to the fuel tank filler pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install NEW tie straps (1) to attach the fuel tank vent hose to the fuel tank filler pipe.
6. Connect the fuel tank pressure sensor electrical connector.
7. Install the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

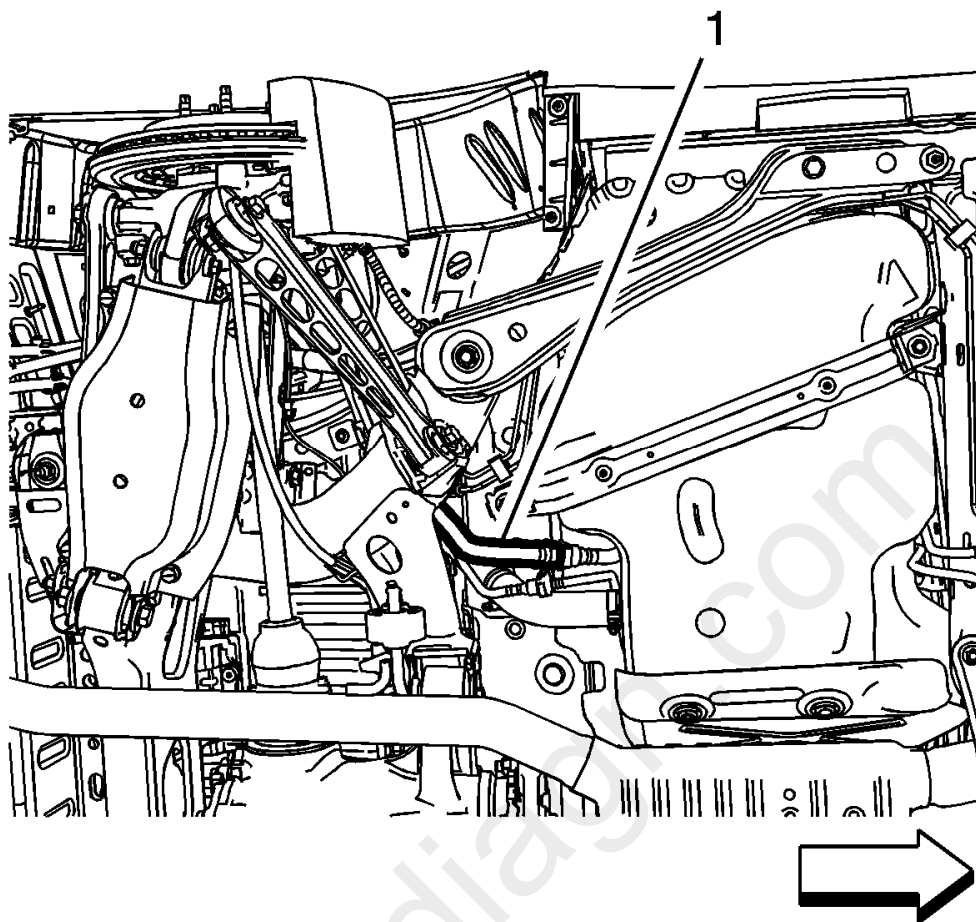


Fig. 81: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect the fuel tank vent hose (1) to the fuel tank vent valve hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Lower the vehicle.

FUEL PUMP REPLACEMENT

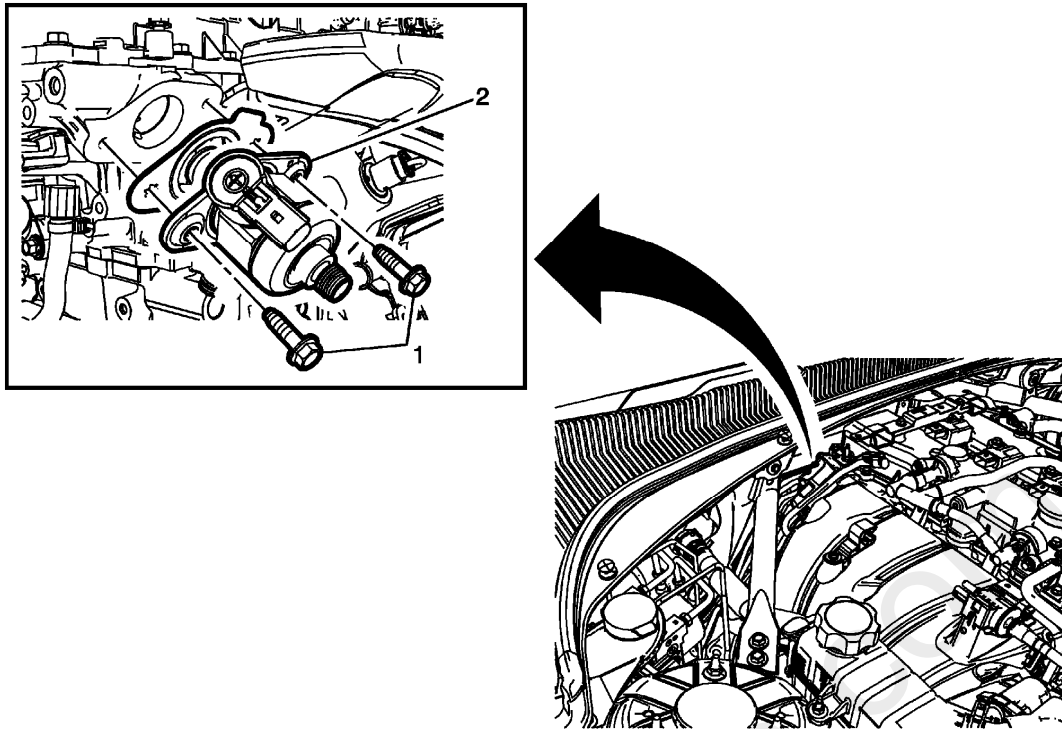


Fig. 82: Fuel Pump

Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Replacement

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> . Preliminary Procedure 1. Relieve fuel pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 3. Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> . 4. Remove the outer fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement (Inner)</u>, <u>Fuel Pump Insulator Replacement (Outer)</u>. 5. Remove the fuel pump cover. Refer to <u>Fuel Pump Cover Replacement</u> . 6. Remove the inner fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement (Inner)</u>, <u>Fuel Pump Insulator Replacement (Outer)</u>. 7. Remove the fuel pump feed pipe. Refer to <u>Fuel Feed Pipe Replacement</u>. 8. Remove the fuel feed intermediate pipe . Refer to <u>Fuel Feed Intermediate Pipe Replacement</u>. Replace with a NEW fuel feed intermediate pipe. Special Tools EN-50790 HP Fuel Pump Installation Alignment Gauge For equivalent regional tools, refer	

to **Special Tools** .

1	Fuel Pump Fasteners (Qty:2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 15 (11 lb ft)
2	Fuel Pump Procedure Install a NEW fuel pump ring and gasket (2). Ensure the fuel pump housing gasket (2) is properly aligned with the tab upward at the 2 O'clock position. NOTE: To aid installation of the fuel pump, rotate the engine so that the fuel pump lobe of the intake cam is at it's lowest point. Use the EN-50790 alignment gauge to ensure that the camshaft lobe is in the base circle position. At the base circle position, the tool will be flush with the head. Lubricate the high pressure fuel pump cylinder head bore with clean silicone free 5W30 engine oil. NOTE: Lubricate the high pressure fuel pump roller with 5W30 engine oil and install into the cylinder head bore. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .

FUEL PUMP FUEL FEED HOSE REPLACEMENT

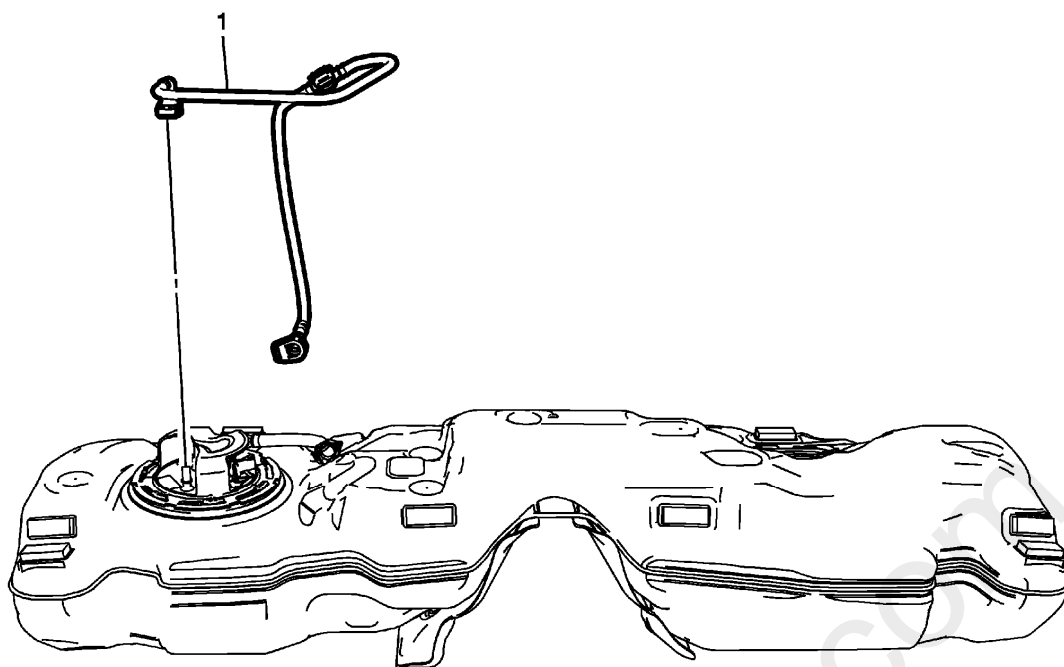


Fig. 83: Fuel Pump Fuel Feed Hose
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Fuel Feed Hose Replacement

Callout	Component Name
Preliminary Procedure	
Remove the fuel tank. Refer to <u>Fuel Tank Replacement</u>.	
1	Fuel Pump Fuel Feed Hose Procedure 1. Disconnect the fuel pressure sensor electrical connector. If replacing hose transfer fuel pressure sensor. Refer to <u>Fuel Pressure Sensor Replacement - Fuel Feed Pipe</u>. 2. Disconnect the fuel pump fuel feed hose from the fuel tank fuel pump module. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Special Tools

- EN-49248 Fuel Rail Assembly Remover
- EN-47909 Injector Bore and Sleeve Cleaning Kit

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

Removal Procedure

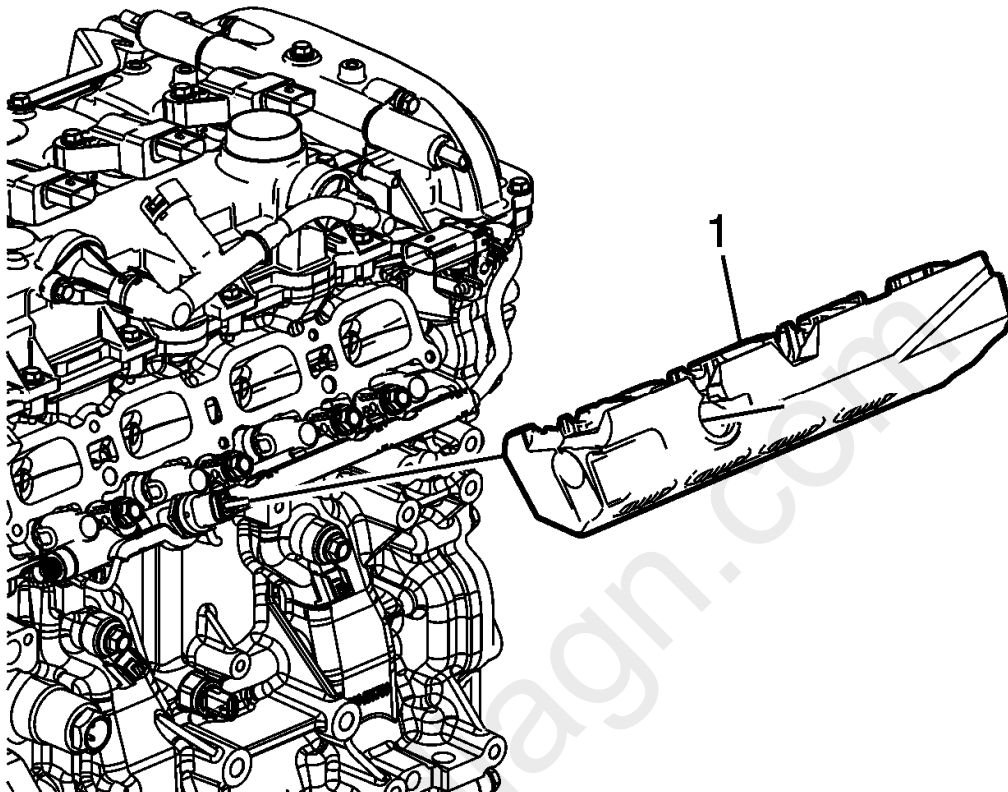


Fig. 84: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injection fuel rail noise shield (1). Refer to **Fuel Injection Fuel Rail Noise Shield Replacement**.
2. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
3. Remove the fuel injection fuel rail pressure sensor. Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**.
4. Disconnect the electrical harness from the fuel rail harness connection.
5. Remove the fuel rail assembly retaining bolts and upper rubber grommets, if necessary.

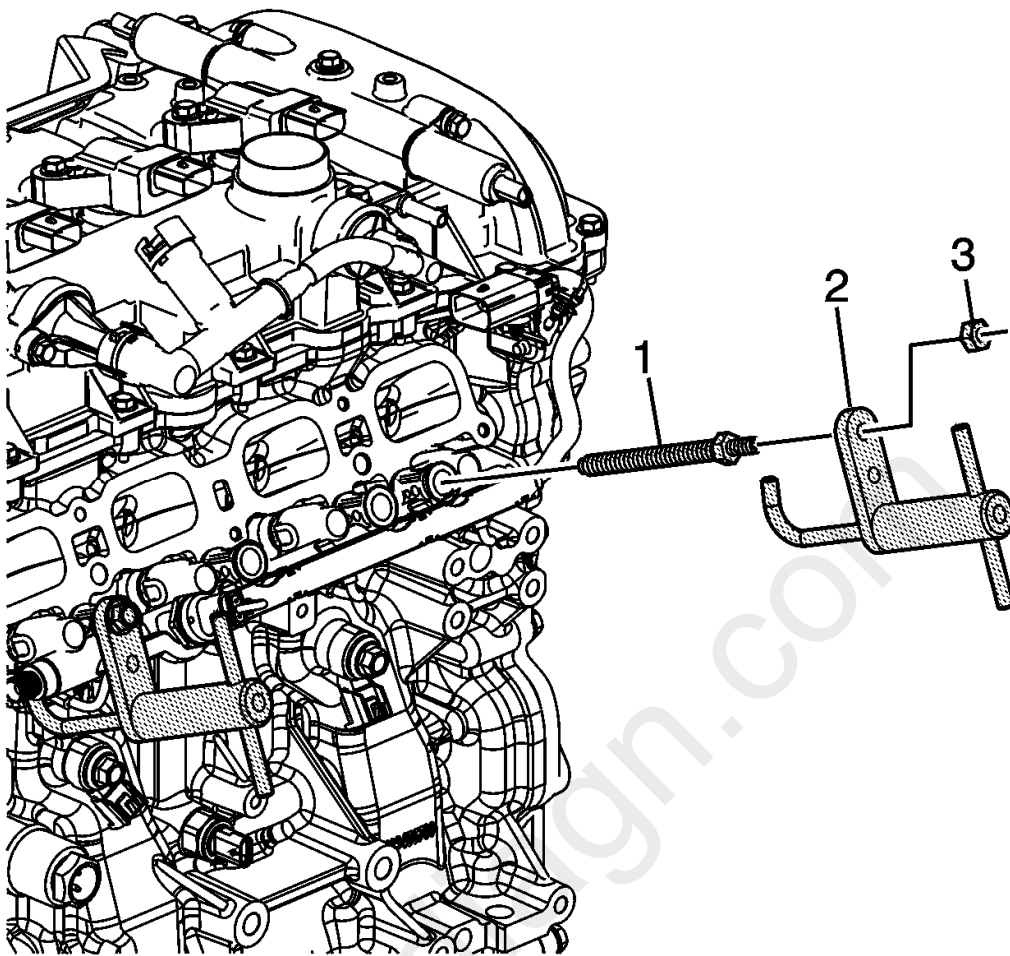


Fig. 85: Identifying EN-49248 Studs
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care to avoid contact with the fuel rail harness during special tool installation and fuel rail removal.

6. Install **EN-49248** studs (1) into the 2 outermost fuel rail assembly retaining bolt locations. Tighten the studs to 22 (16 lb ft).
7. Install **EN-49248** remover (2) onto each stud, and engage the hooks to the fuel rail. Install the nuts (3) retaining the remover onto the studs and tighten until snug.

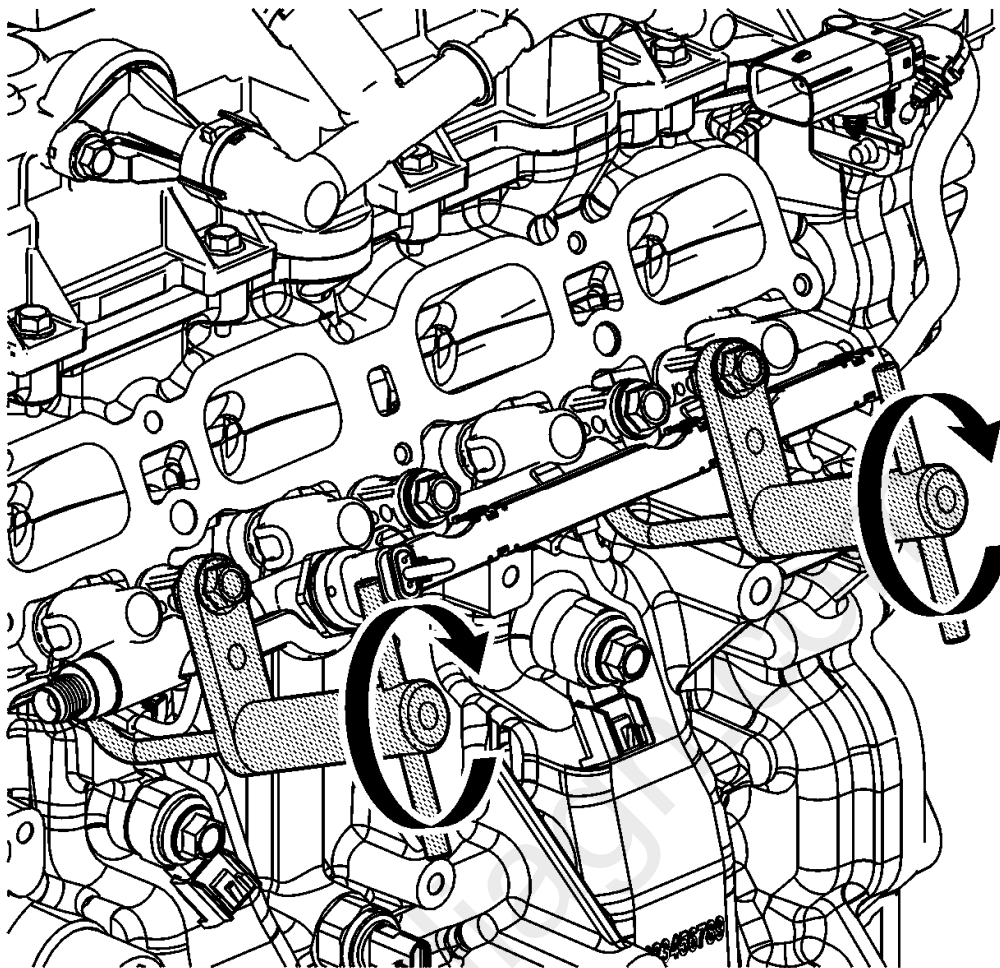


Fig. 86: Fuel Rail Assembly Using Fuel Rail Assembly Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE: EN-49248 will assist in the proper removal of the fuel rail assembly. Ensure that the following conditions are met:

- Turn the handles simultaneously in order to pull the fuel rail straight out along the fuel injector axis.
- DO NOT twist when pulling out on the fuel rail and injector assembly.

8. Using **EN-49248** remover , remove the fuel rail assembly.

Installation Procedure

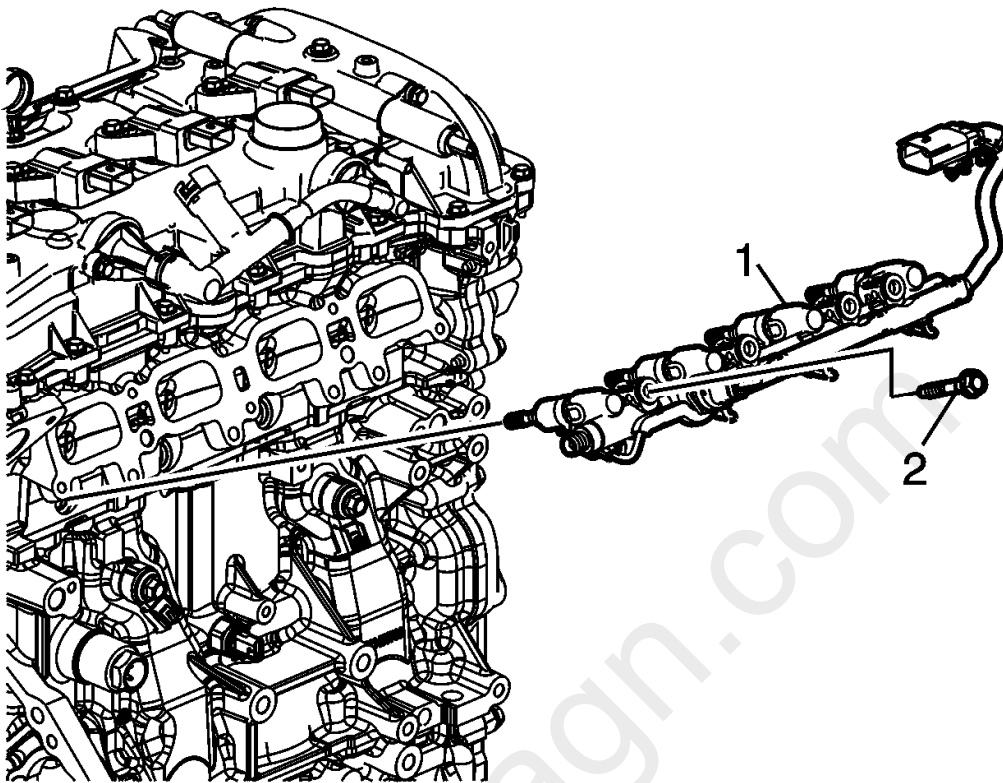


Fig. 87: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Clean the fuel injector bore in the cylinder head using the **EN-47909** kit.
2. Replace the fuel rail insulators, if necessary. Refer to **Fuel Rail and Injectors Cleaning and Inspection** . Replace the fuel rail bolts, if necessary.
3. Install the fuel rail (1) with injectors into the cylinder head evenly.

NOTE: **Mount the bolts evenly to avoid cocking of the fuel injectors during installation.**

4. Hand start the 2 outer fuel rail bolts (2) to seat the injectors into the injector bores.
5. Hand start the remaining fuel rail bolts.

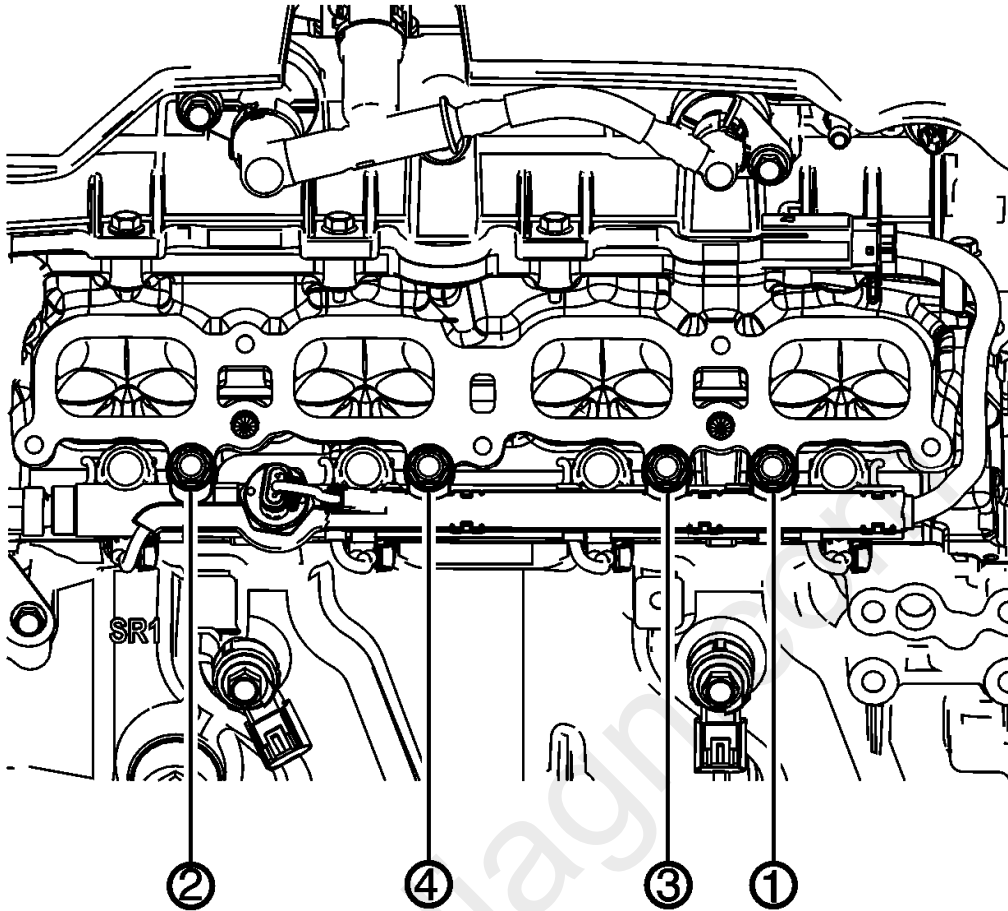


Fig. 88: Fuel Rail Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in sequence to 25 (18 lb ft).
7. Connect the electrical harness to the fuel rail harness connections.
8. Install the fuel injection fuel rail pressure sensor. Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**.
9. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.

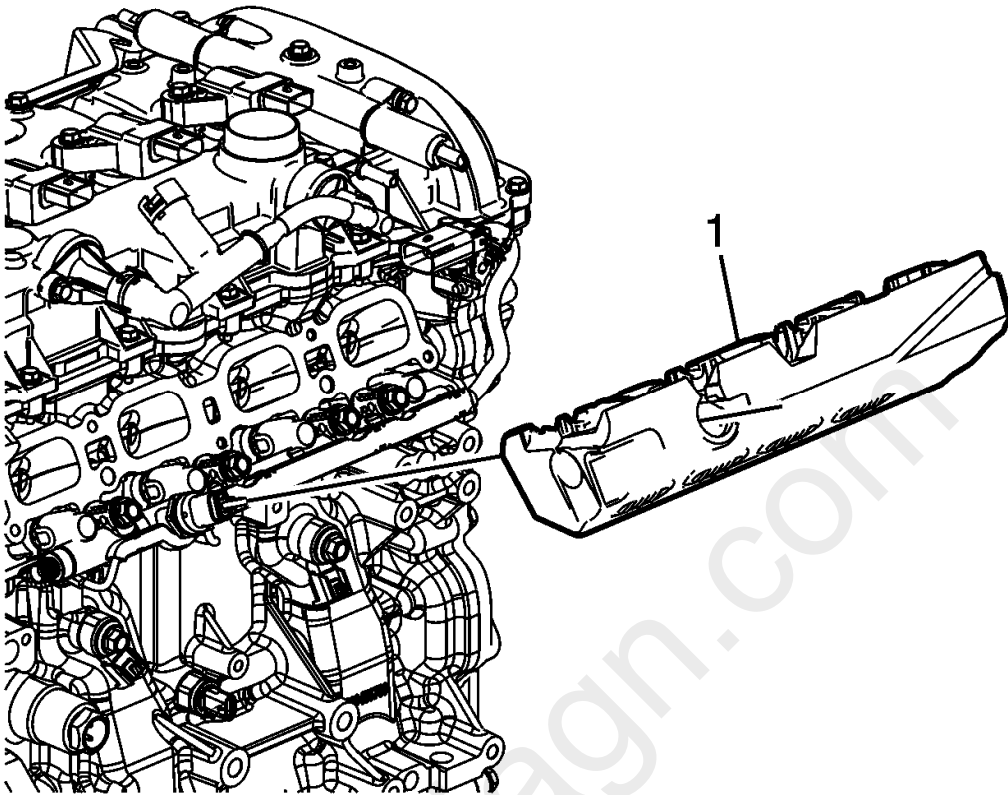


Fig. 89: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

10. Install the fuel injection fuel rail noise shield (1). Refer to **Fuel Injection Fuel Rail Noise Shield Replacement**.

FUEL INJECTION FUEL RAIL NOISE SHIELD REPLACEMENT

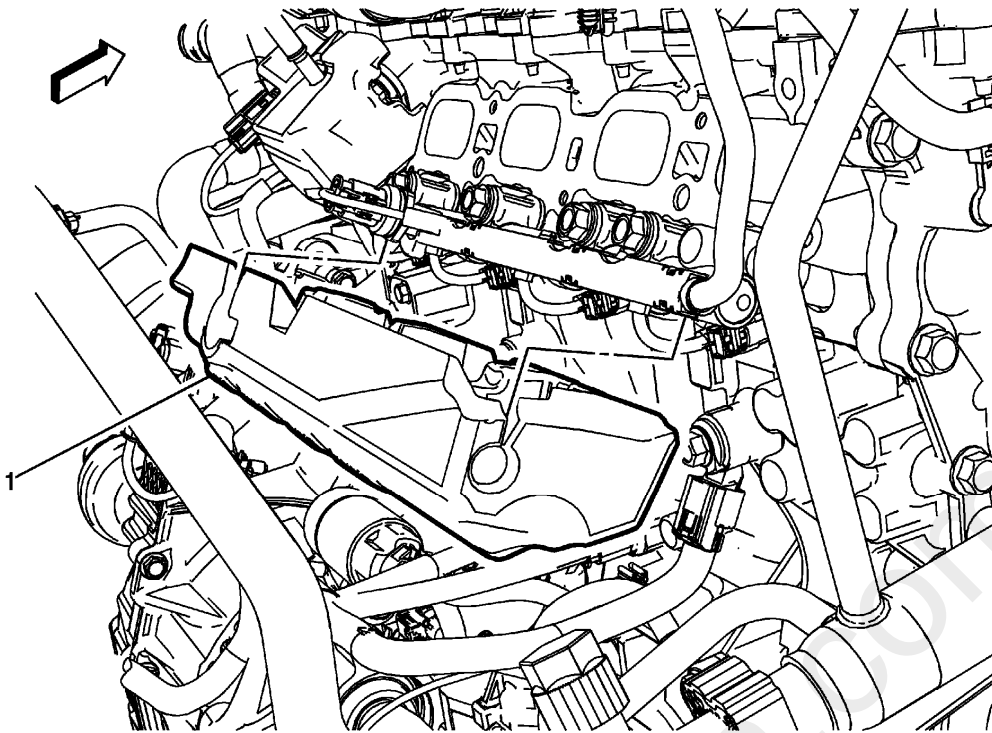


Fig. 90: Fuel Injection Fuel Rail Noise Shield
 Courtesy of GENERAL MOTORS COMPANY

Fuel Injection Fuel Rail Noise Shield Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold. Refer to <u>Intake Manifold Replacement</u> .	
1	Fuel Injection Fuel Rail Noise Shield NOTE: The fuel injection noise shield just snaps into place.

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

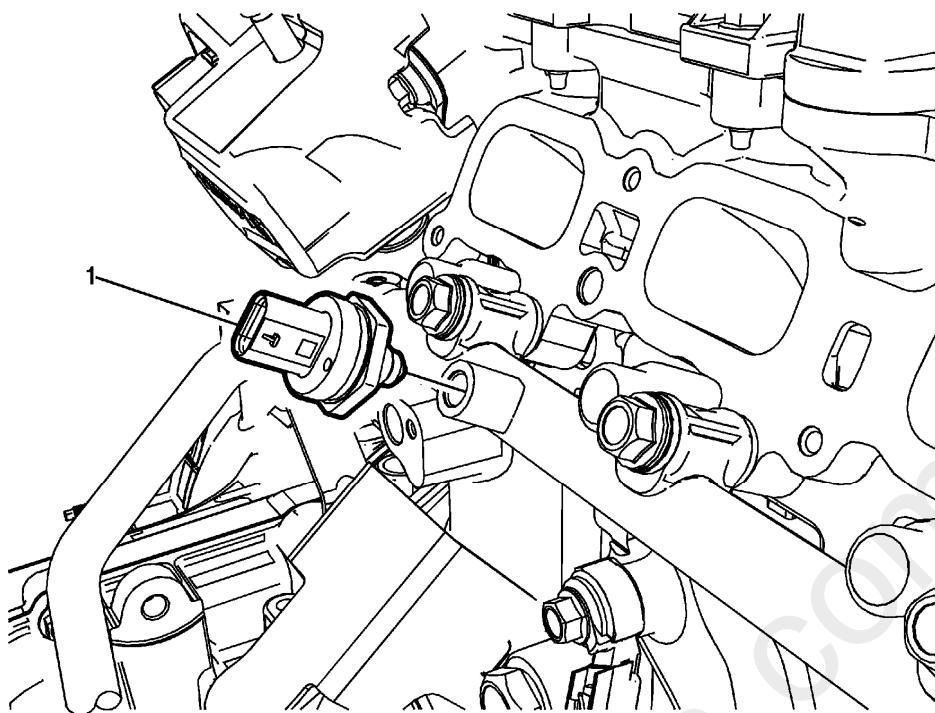


Fig. 91: Fuel Injection Fuel Rail Fuel Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> .	
Preliminary Procedure NOTE: It is not necessary to completely remove the intake manifold to gain access to the Fuel Injection Fuel Rail Fuel Pressure Sensor. Unbolt and reposition the intake manifold. Refer to <u>Intake Manifold Replacement</u> .	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

CAUTION:

Refer to Component Fastener Tightening Caution .

Procedure

Disconnect the electrical wiring harness connector from the fuel injection fuel rail fuel pressure sensor.

Tighten

33 (24 lb ft)

FUEL INJECTOR AND FUEL RAIL REPLACEMENT

Special Tools

- **EN-49248** Fuel Rail Assembly Remover
- **EN-47909** Injector Bore and Sleeve Cleaning Kit

For equivalent regional tools, refer to Special Tools .

Removal Procedure

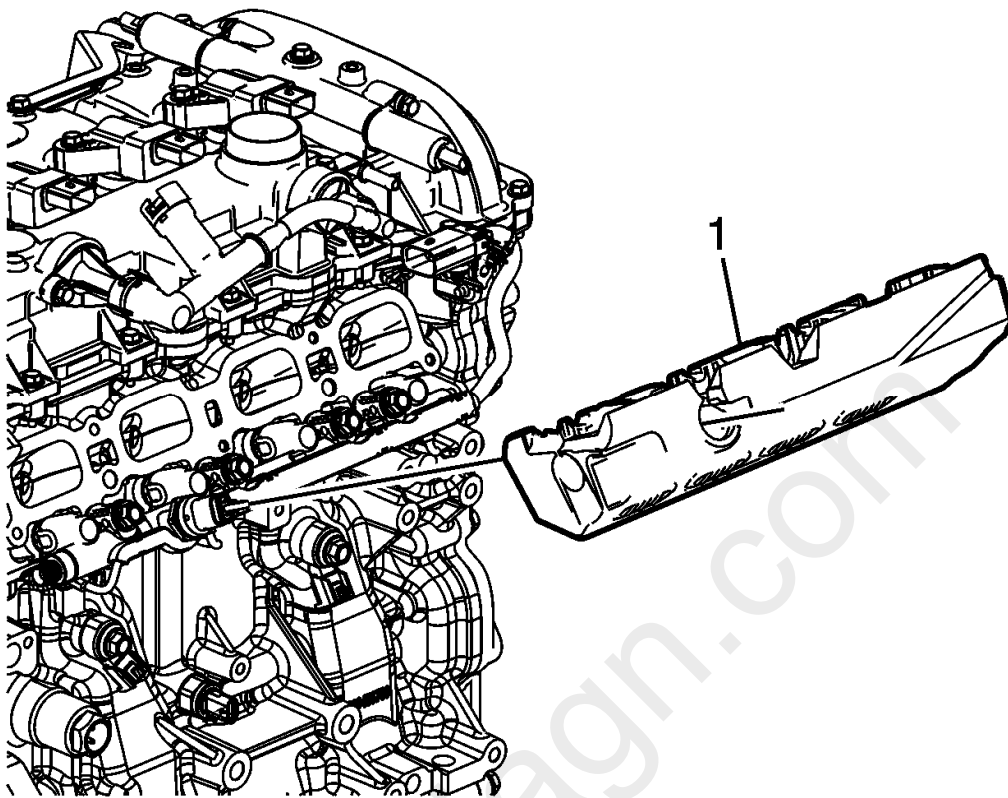


Fig. 92: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injection fuel rail noise shield (1). Refer to **Fuel Injection Fuel Rail Noise Shield Replacement**.
2. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
3. Remove the fuel injection fuel rail pressure sensor. Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**.
4. Disconnect the electrical harness from the fuel rail harness connection.
5. Remove the fuel rail assembly retaining bolts and upper rubber grommets, if necessary.

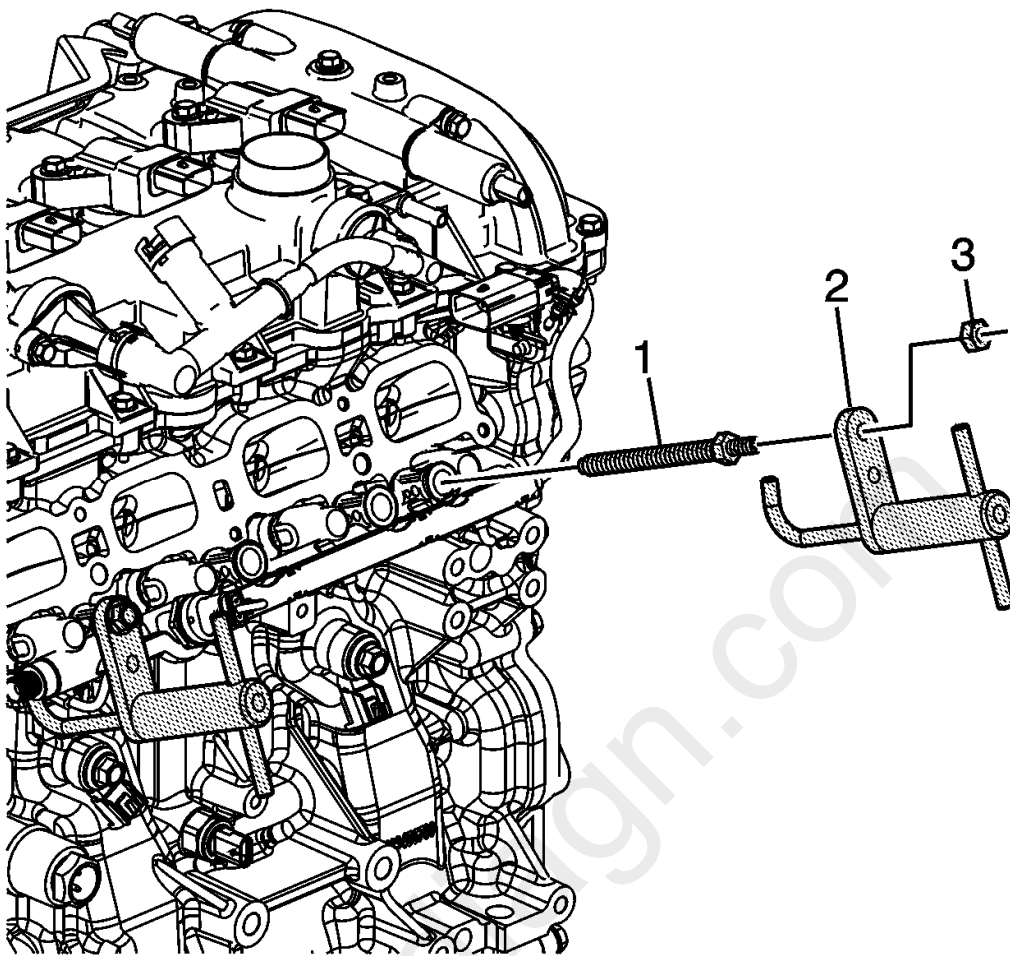


Fig. 93: Identifying Fuel Rail Assembly Remover Studs
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care to avoid contact with the fuel rail harness during special tool installation and fuel rail removal.

6. Install **EN-49248** studs (1) into the 2 outermost fuel rail assembly retaining bolt locations. Tighten the studs to 22 (16 lb ft).
7. Install **EN-49248** remover (2) onto each stud, and engage the hooks to the fuel rail. Install the nuts (3) retaining the remover onto the studs and tighten until snug.

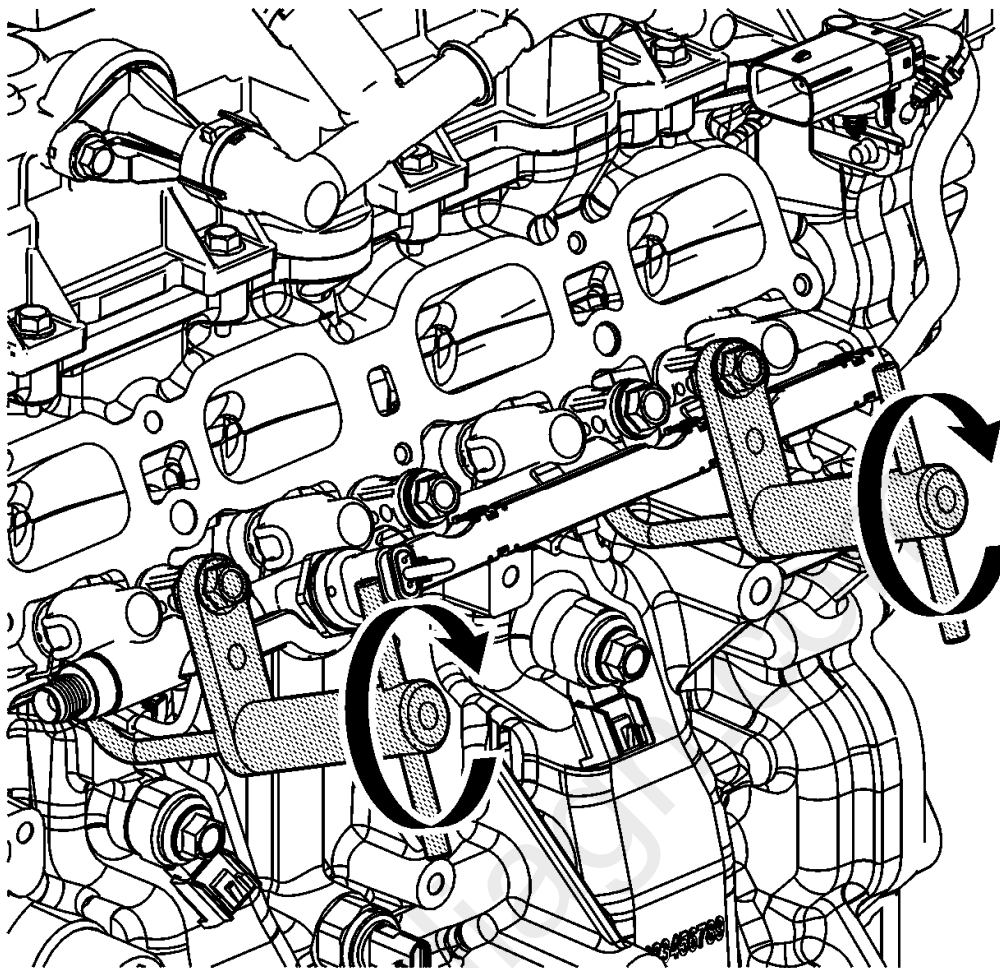


Fig. 94: Fuel Rail Assembly Using Fuel Rail Assembly Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE: EN-49248 will assist in the proper removal of the fuel rail assembly. Ensure that the following conditions are met:

- Turn the handles simultaneously in order to pull the fuel rail straight out along the fuel injector axis.
- DO NOT twist when pulling out on the fuel rail and injector assembly.

8. Using **EN-49248** remover , remove the fuel rail assembly.

Installation Procedure

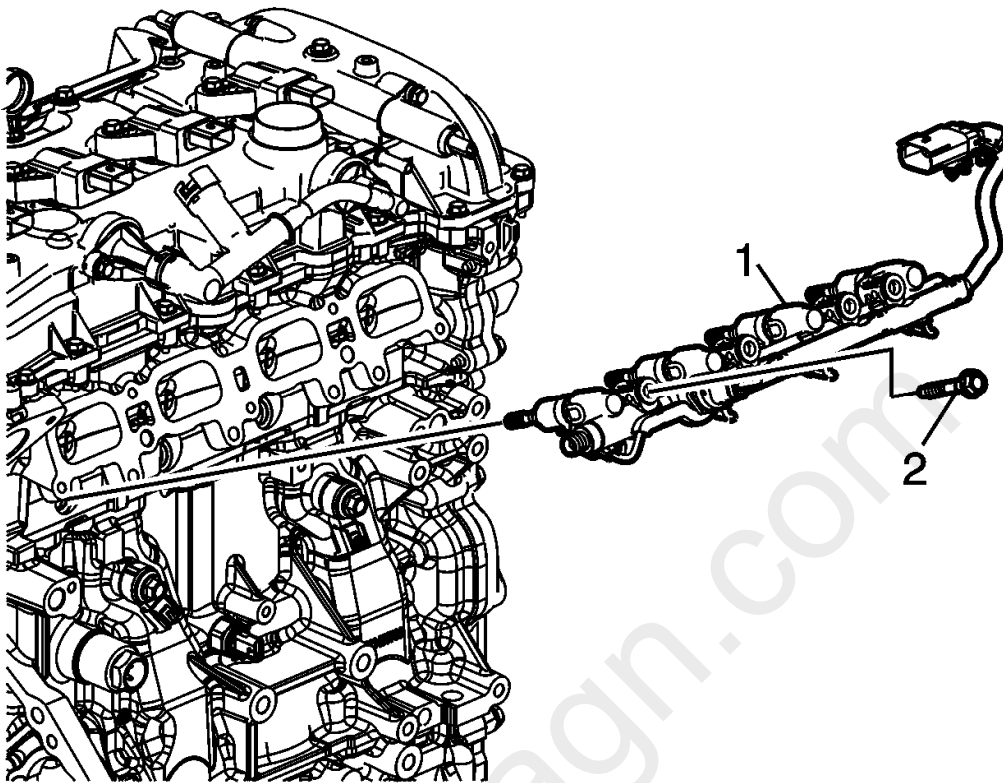


Fig. 95: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Clean the fuel injector bore in the cylinder head using the **EN-47909** kit.
2. Replace the fuel rail insulators, if necessary. Refer to **Fuel Rail and Injectors Cleaning and Inspection** . Replace the fuel rail bolts, if necessary.
3. Install the fuel rail (1) with injectors into the cylinder head evenly.

NOTE: **Mount the bolts evenly to avoid cocking of the fuel injectors during installation.**

4. Hand start the 2 outer fuel rail bolts (2) to seat the injectors into the injector bores.
5. Hand start the remaining fuel rail bolts.

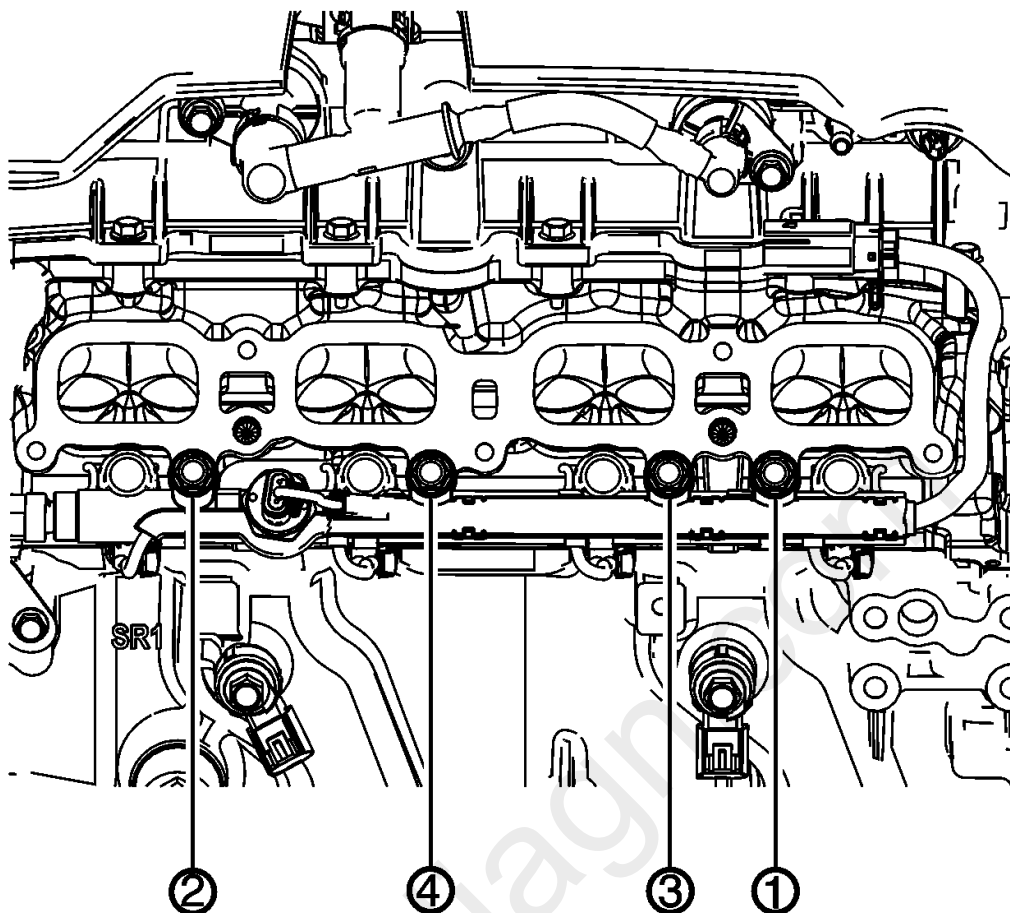


Fig. 96: Fuel Rail Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in sequence to 25 (18 lb ft).
7. Connect the electrical harness to the fuel rail harness connections.
8. Install the fuel injection fuel rail pressure sensor. Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**.
9. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.

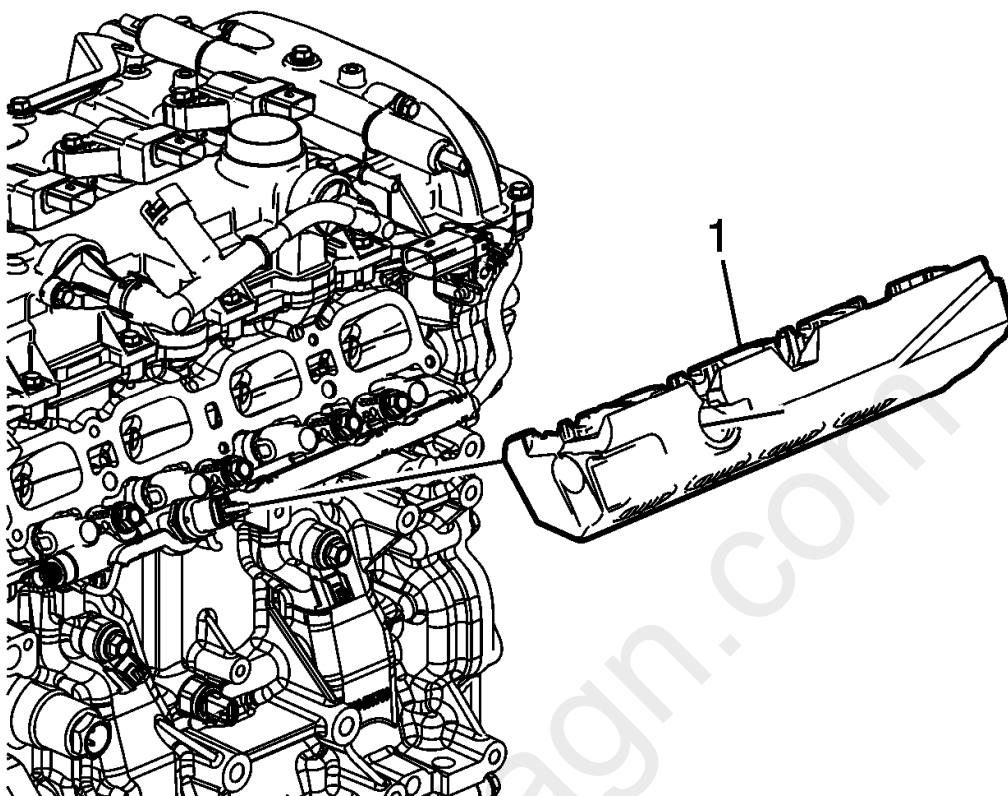


Fig. 97: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

10. Install the fuel injection fuel rail noise shield (1). Refer to **Fuel Injection Fuel Rail Noise Shield Replacement**.

FUEL INJECTOR REPLACEMENT

Special Tools

- EN-47909 Injector Bore and Sleeve Cleaning Kit
- EN-49245 Fuel Injector Seal Installer and Sizer
- EN-50791 Fuel Injector Nozzle Installer

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

CAUTION: Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not

immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

1. Remove the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.

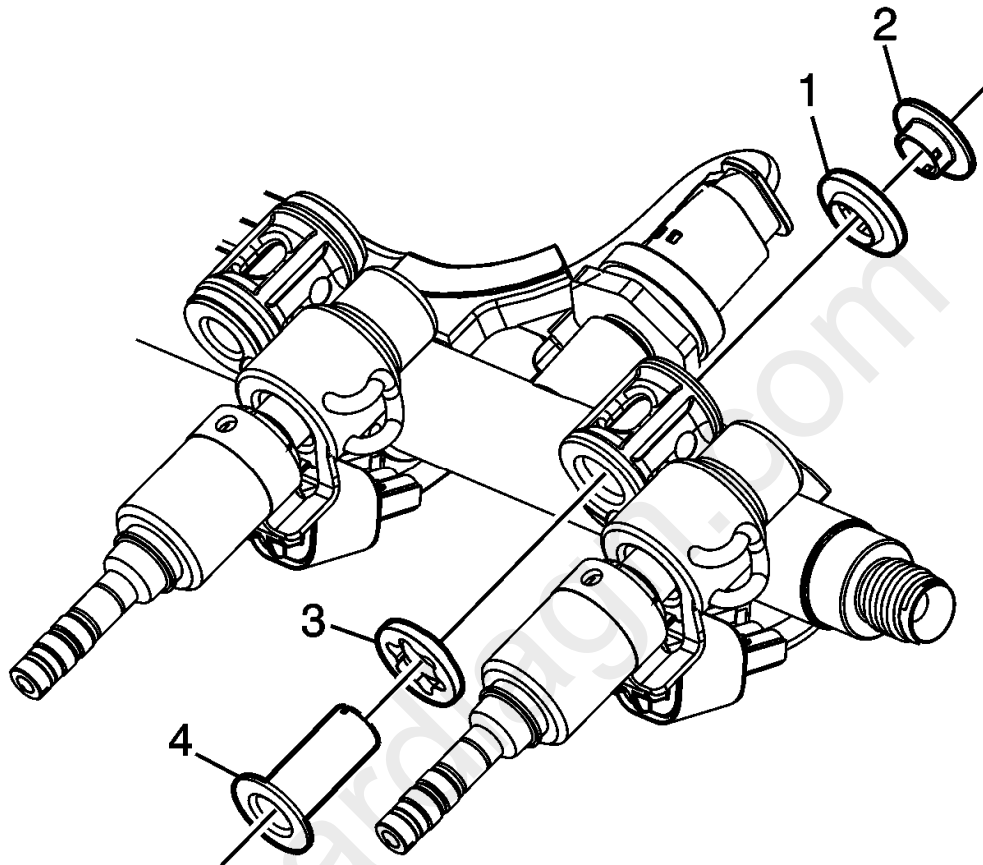


Fig. 98: Fuel Rail Insulator Assemblies
Courtesy of GENERAL MOTORS COMPANY

2. Remove and inspect the fuel rail insulator assemblies (1-4). Replace the entire assembly if any components show signs of wear or the insulators (4) show the following conditions:
 - Dry or cracked appearance
 - Flattened or misshapen appearance

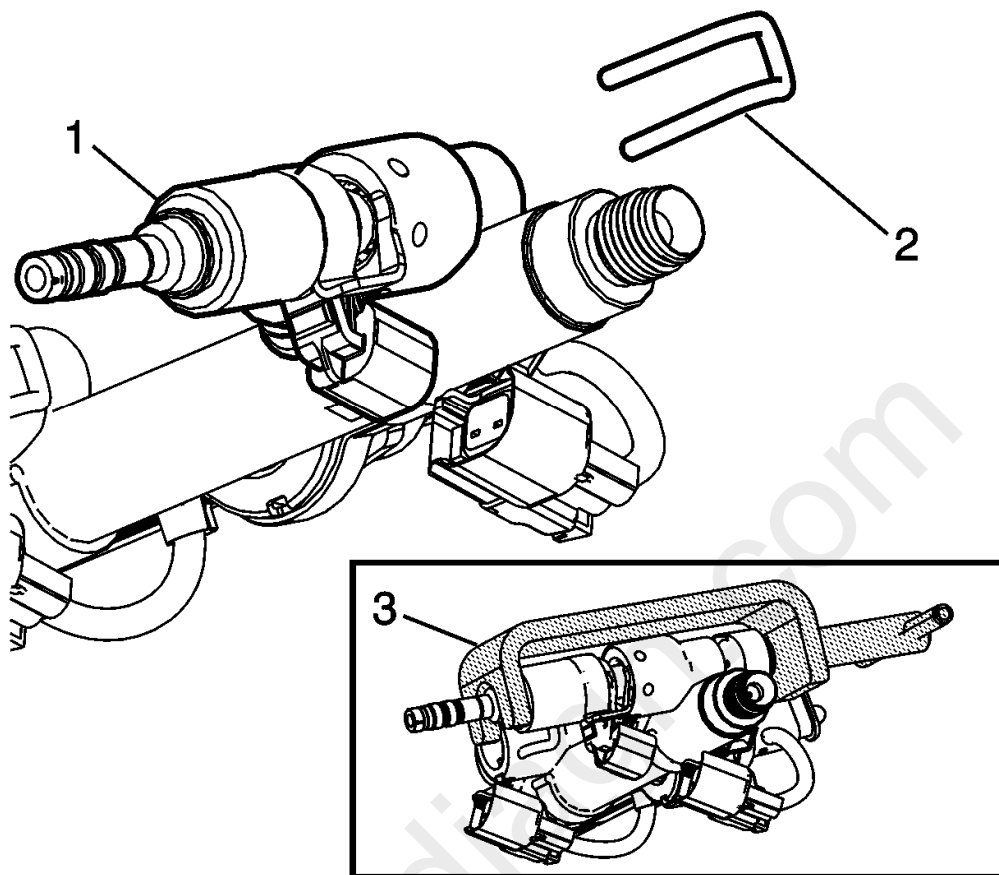


Fig. 99: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connections from the fuel injectors.
4. Use **EN-50791** installer (3) to compress the fuel injector (1), and relieve pressure on the retaining pin (2). Remove the fuel injector retaining pin (2). Remove **EN-50791** installer once the retaining pin is removed.

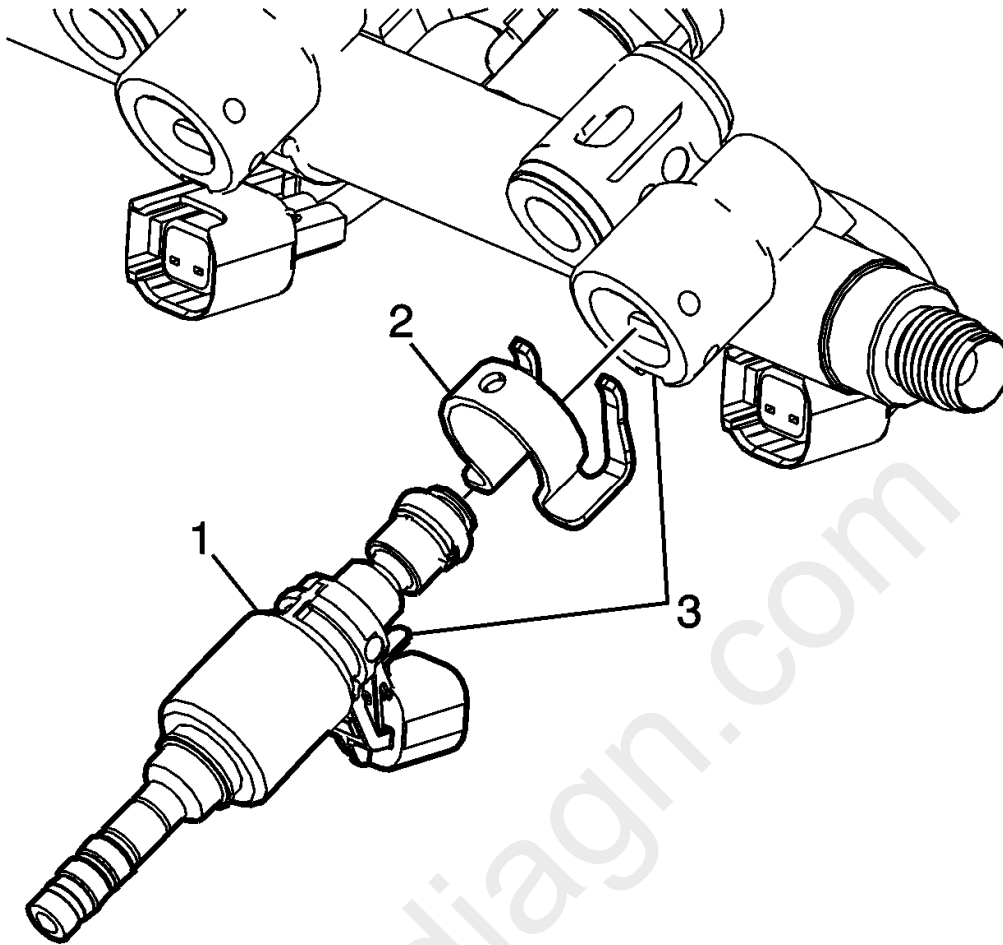


Fig. 100: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

NOTE: Support the fuel injector at the widest point. Support the fuel rail along the bottom.

- DO NOT support or hold the fuel injector by the tip or connector
 - DO NOT tilt or excessively twist the injector during removal
5. Remove the injectors (1) from the fuel rail by pulling straight out along the fuel injector axis. Slight rotation of the fuel injector is acceptable as long as excessive force is not applied to the fuel injector tab while engaged in the fuel rail slot (3).
 6. Remove the fuel injector holding clamp (2) from the rear of the fuel injector.

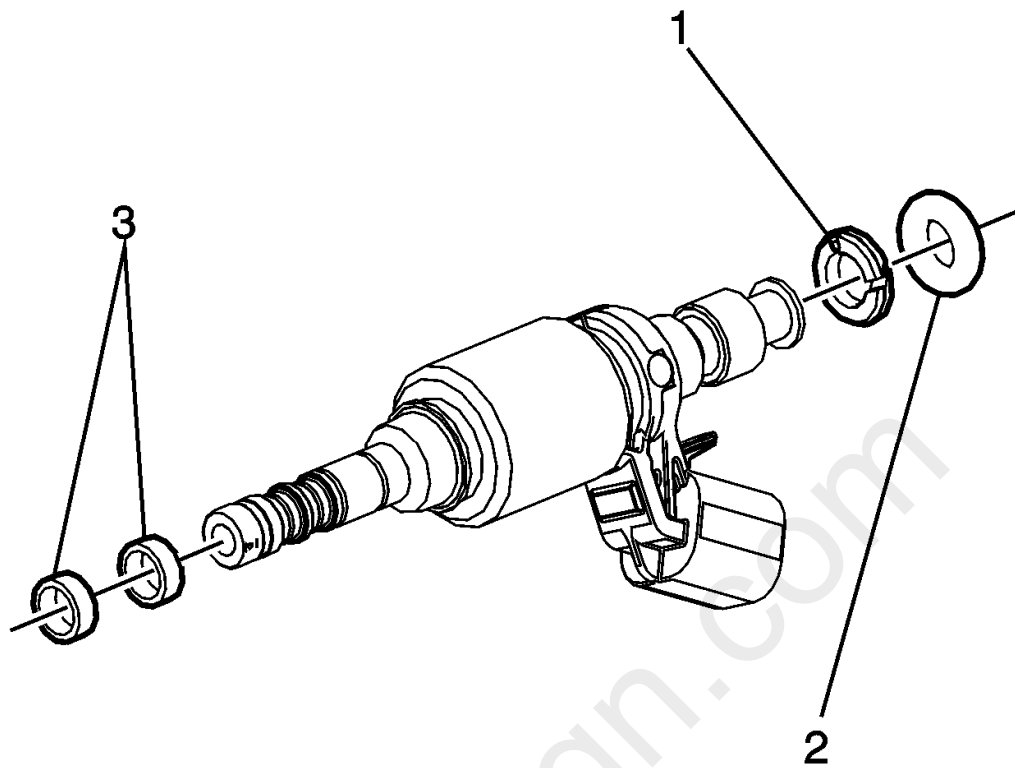


Fig. 101: Fuel Injector O-ring And Plastic Spacer
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the fuel injector O-ring (2) and plastic spacer (1).
8. Remove and discard the fuel injector seals (3).

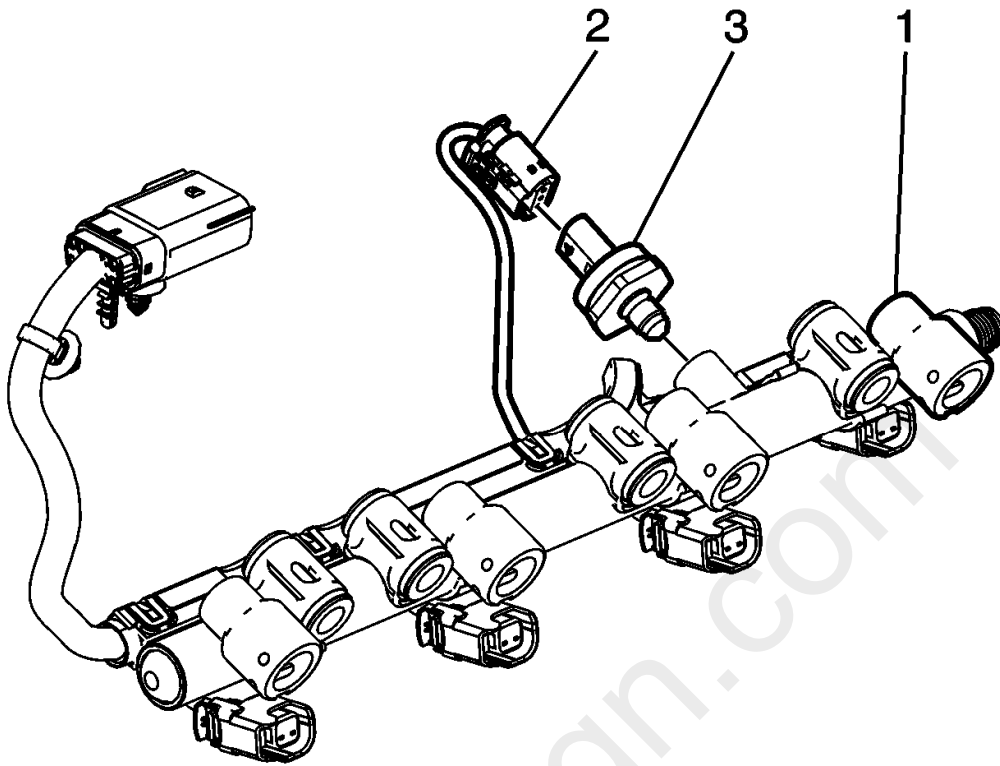


Fig. 102: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not soak or submerge the fuel rail or injectors in solvent. Do not use solvent on the fuel rail label.

9. Clean the exterior of the fuel rail (1) and injectors in solvent.
10. Using **EN-47909** cleaning kit , clean the fuel injector bores and sleeves.
11. Inspect the fuel rail and components for the following conditions:
 - Damage, debris, or restrictions to the fuel rail
 - Damage, debris, or restrictions to the fuel ports in the fuel rail
 - Damage to the mounting area for the fuel rail
 - Damage to the fuel rail mounting bolts
 - Damage to the threads on the fuel rail fuel feed fitting
12. Replace the fuel rail if any damage is found. Do not attempt to repair a fuel rail.

CAUTION: Refer to Fastener Caution .

NOTE: Remove and inspect the fuel pressure sensor only if the sensor is suspect.

13. Inspect the fuel pressure sensor (3) for damage.
 1. Disconnect the harness connector (2) from the fuel pressure sensor.
 2. Remove the fuel pressure sensor. Dry the fuel pressure sensor bore in the fuel rail with a lint free cloth. The bore should be free of fuel, debris, and burrs.
 3. Lubricate the fuel rail fuel pressure sensor bore with clean engine oil.
 4. Lubricate the threads and sealing area on the fuel pressure sensor with clean engine oil.
 5. Install the fuel pressure sensor hand tight.
 6. Remove the fuel pressure sensor and re-lubricate the bore, threads, and sealing area.
 7. Install the fuel pressure sensor and tighten to 33 (24 lb ft).
 8. Connect the harness connector to the fuel pressure sensor.

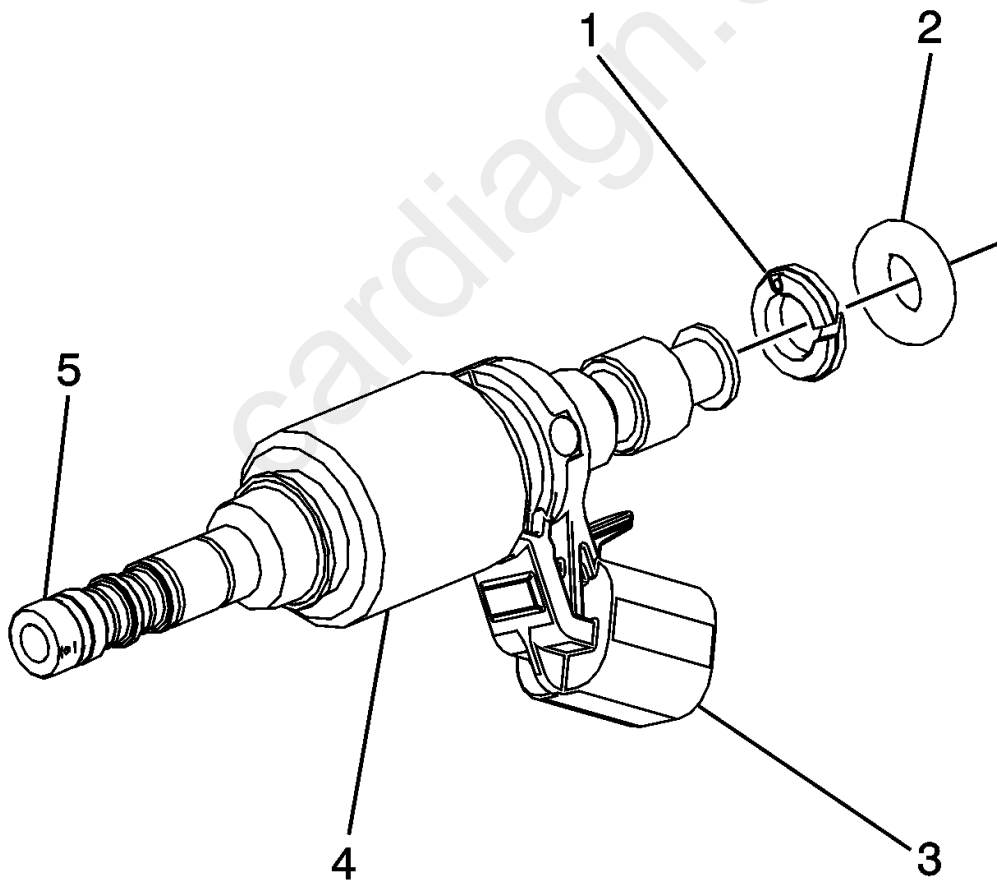


Fig. 103: Fuel Injector Connector

Courtesy of GENERAL MOTORS COMPANY

14. Inspect the fuel injectors for the following conditions:
 - Damage to the fuel injector connector (3)
 - Damage to the fuel injector harness connector
 - Damage to the fuel injector tip (5)
 - Damage to the fuel injector (4)
15. Replace the fuel injector if any damage is found. Do not attempt to repair a fuel injector.
16. Install the a new fuel injector spacer (1).
17. Lubricate the new O-ring (2) with clean, silicone-free 5W30 engine oil.
18. Install the O-ring on the injector.

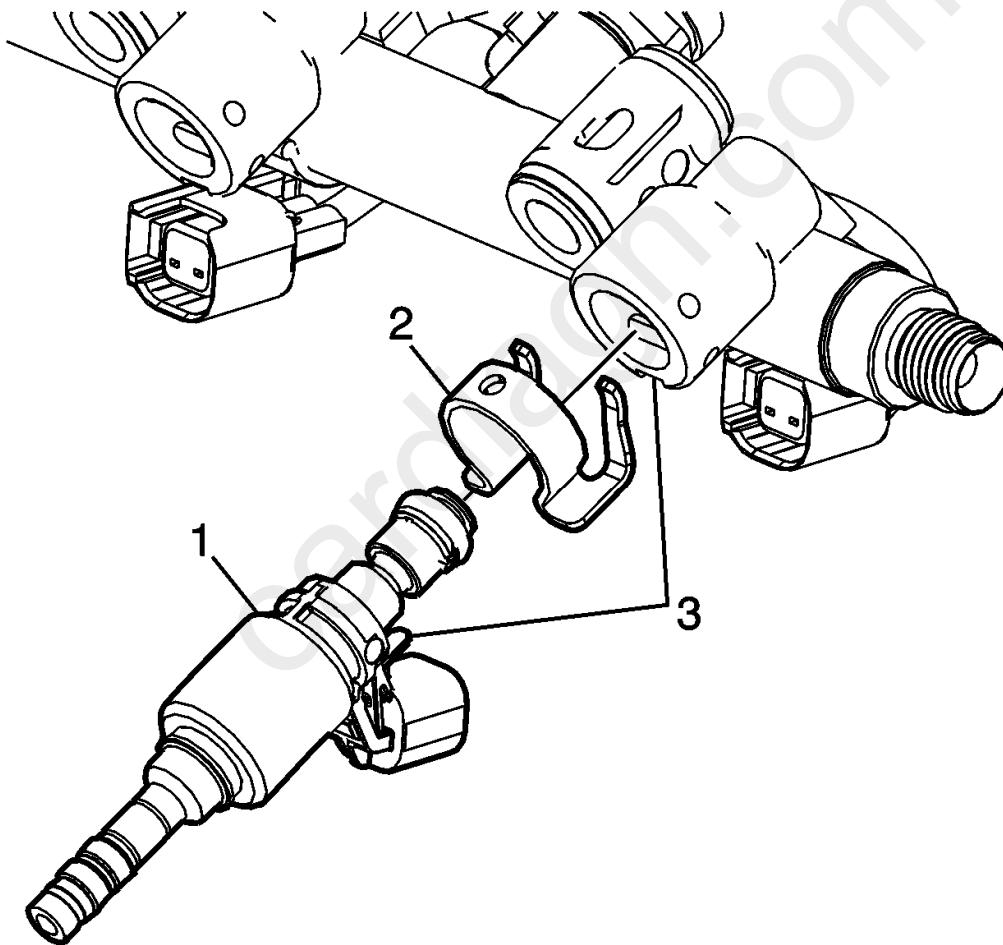


Fig. 104: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

19. Install the fuel injector holding clamp (2) onto the rear of the fuel injector.
20. Hand install fuel injectors (1) to the fuel rail, carefully aligning the fuel injector tab to the slot in the fuel

rail (3).

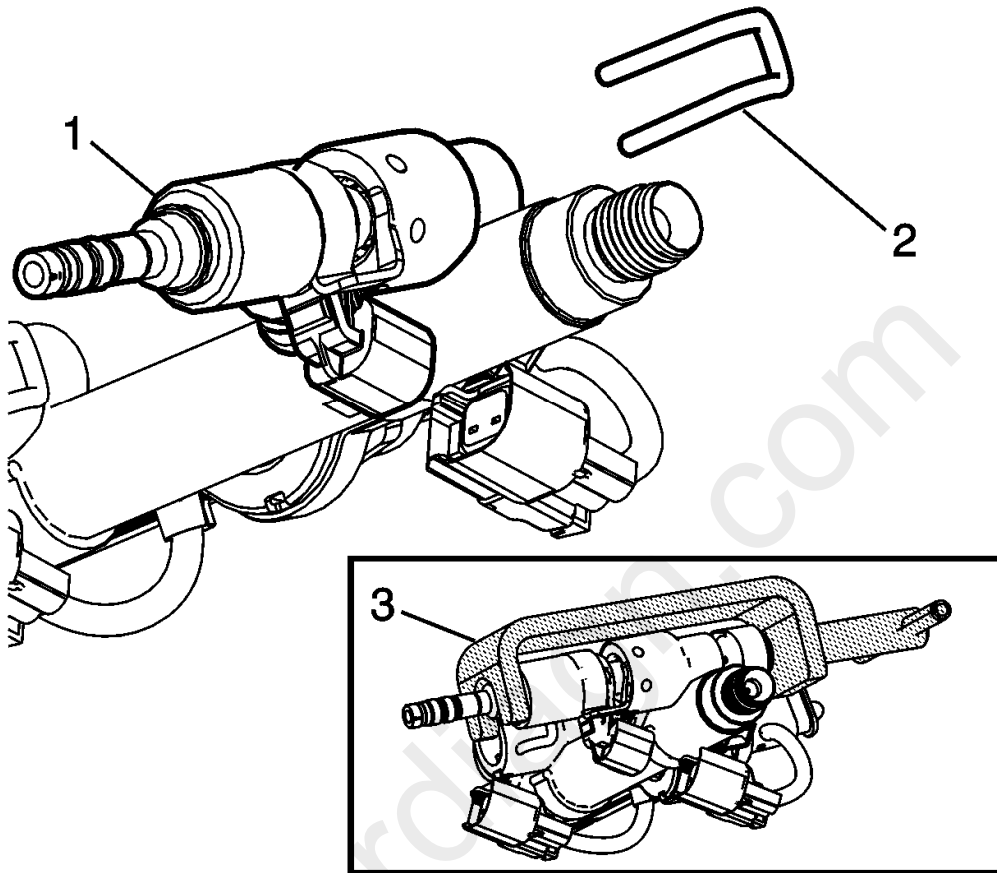


Fig. 105: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: The injector must be fully installed and properly aligned with the fuel rail before installing the retaining pin.

21. Using **EN-50791** installer (3), compress the fuel injector (1) into the fuel rail.
22. Ensure the fuel injector is fully seated in the fuel rail, and install the fuel injector retaining pin (4).
23. Ensure the fuel injector retaining pin is fully seated in the fuel rail. Remove **EN-50791** installer. Repeat process until all fuel injectors are properly installed to the fuel rail.

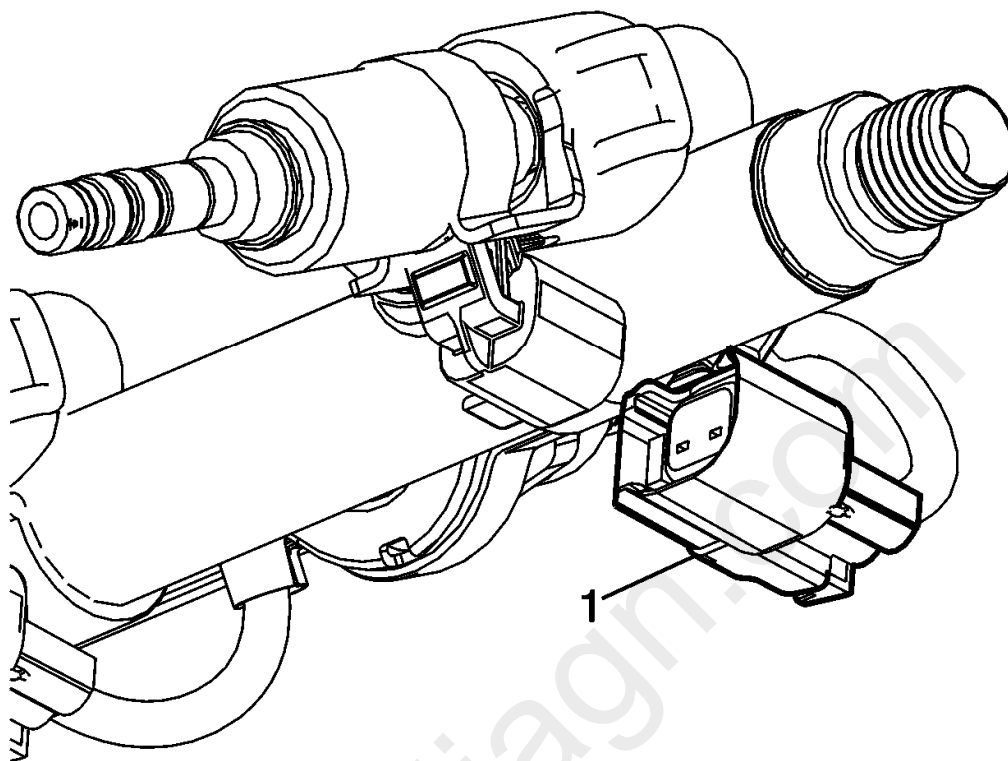


Fig. 106: Fuel Rail Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

24. Connect the electrical connection to the fuel rail.
25. Connect the fuel rail harness connectors (1) to the fuel injectors.

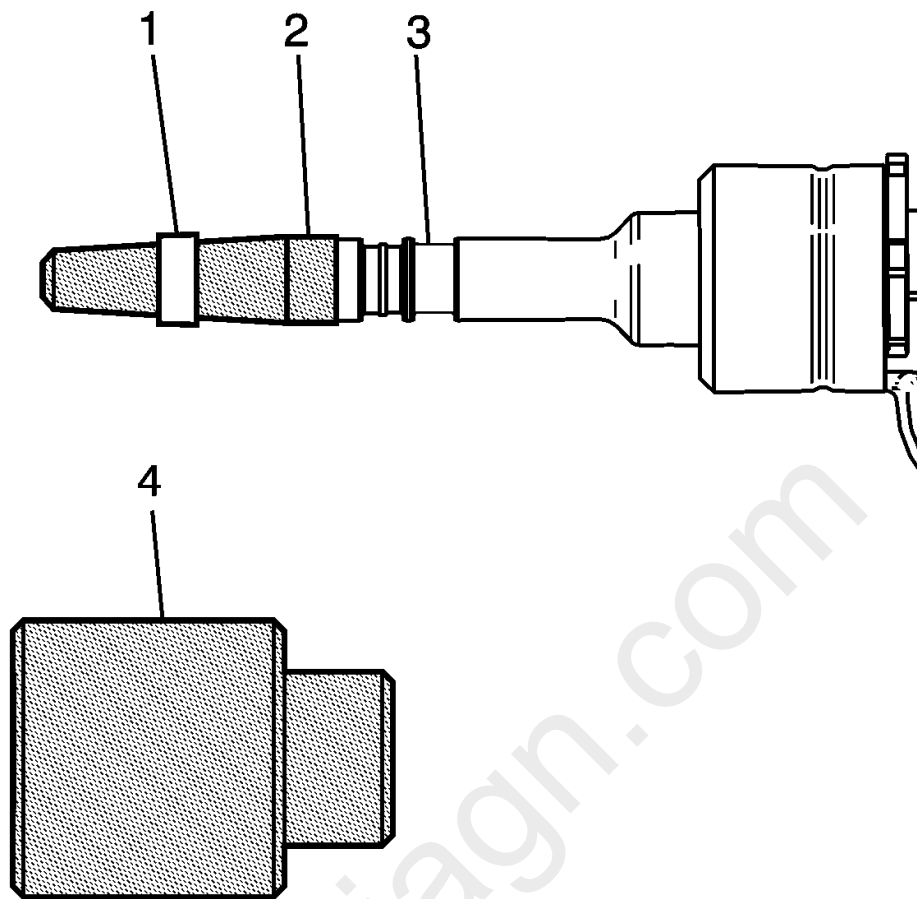


Fig. 107: Second Recessed Area And NEW Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seals on the fuel injector tip.

26. Install **EN-49245** protector (2) onto the fuel injector tip. Place a NEW seal (1) on **EN-49245** protector.
27. Install a seal into the second recessed area (3) of the fuel injector.
28. Compress the seal with your fingers, then resize the seal using the **EN-49245** sizer (4).
29. Place a second NEW seal (1) on **EN-49245** protector.
30. Install the seal into the first recessed area of the fuel injector.
31. Compress the seal with your fingers, then resize the seal using the **EN-49245** sizer (4).
32. Install the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

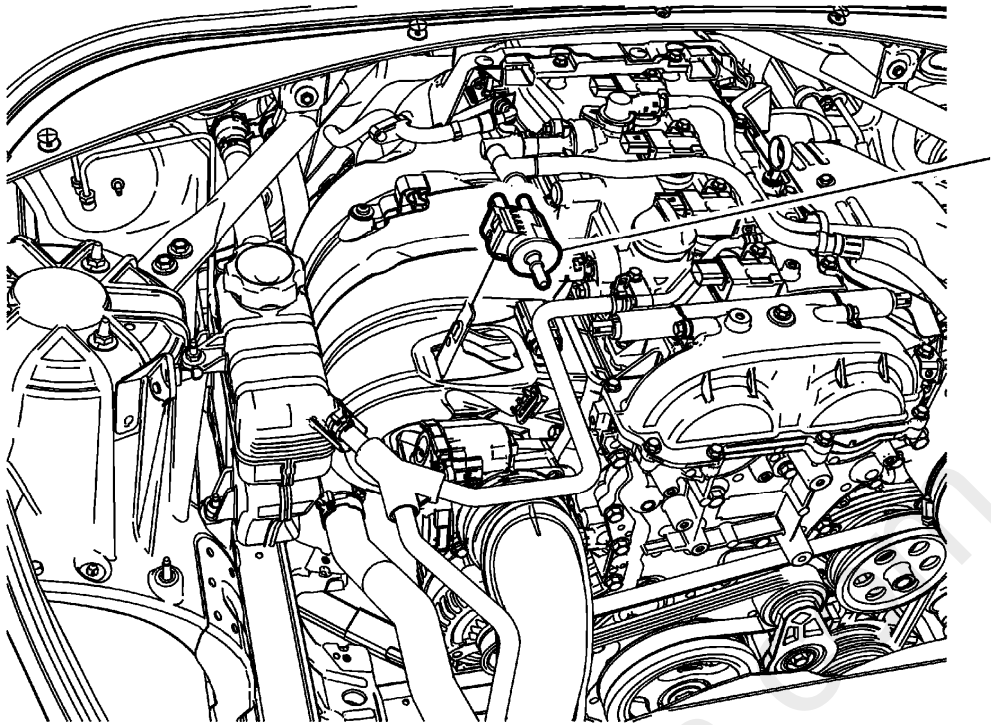


Fig. 108: Evaporative Emission Canister Purge Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement

Callout	Component Name
WARNING: Refer to <u>Gasoline/Gasoline Vapors Warning</u> .	
WARNING: Refer to <u>Safety Glasses Warning</u> .	
Preliminary Procedure Disconnect the evaporative emission lines. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Evaporative Emission Canister Purge Solenoid Valve Procedure 1. Disconnect the evaporative emission canister purge solenoid valve electrical connector. 2. Release the retaining tab.

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

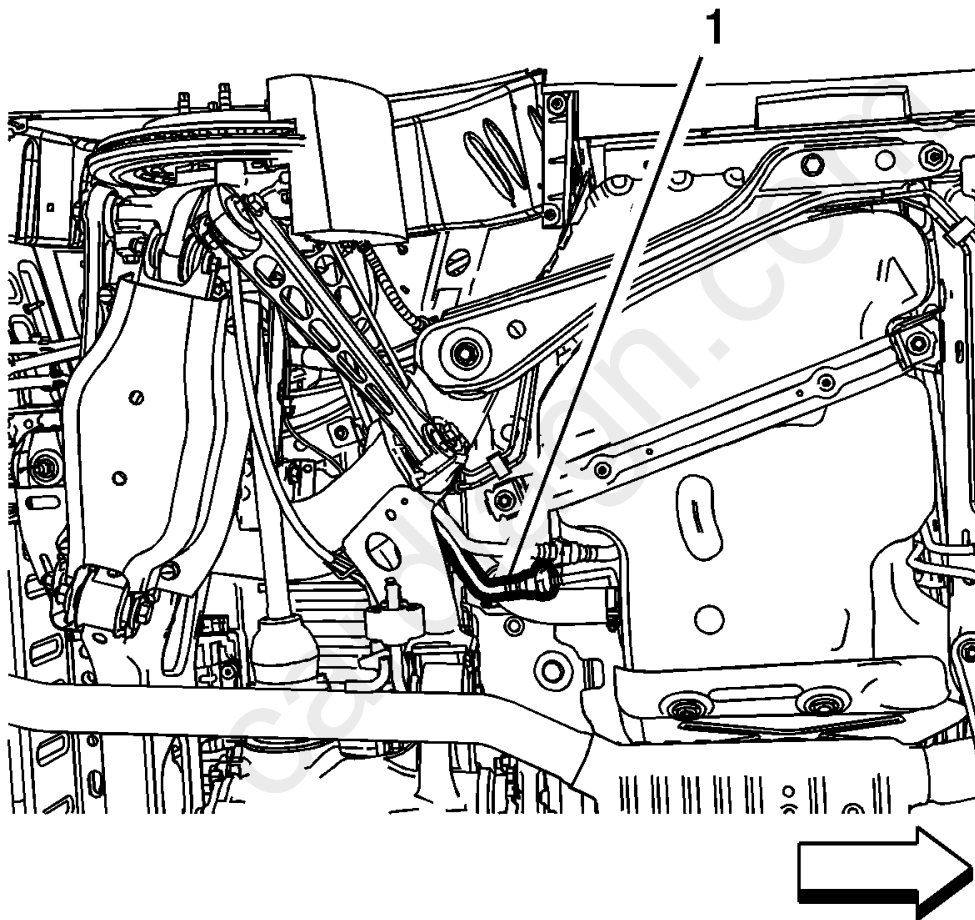


Fig. 109: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the evaporative emission canister purge pipe (1) from the fuel tank vent valve hose. Refer to Plastic Collar Quick Connect Fitting Service.
3. Remove the right rear wheelhouse panel liner. Refer to Rear Wheelhouse Liner Replacement .

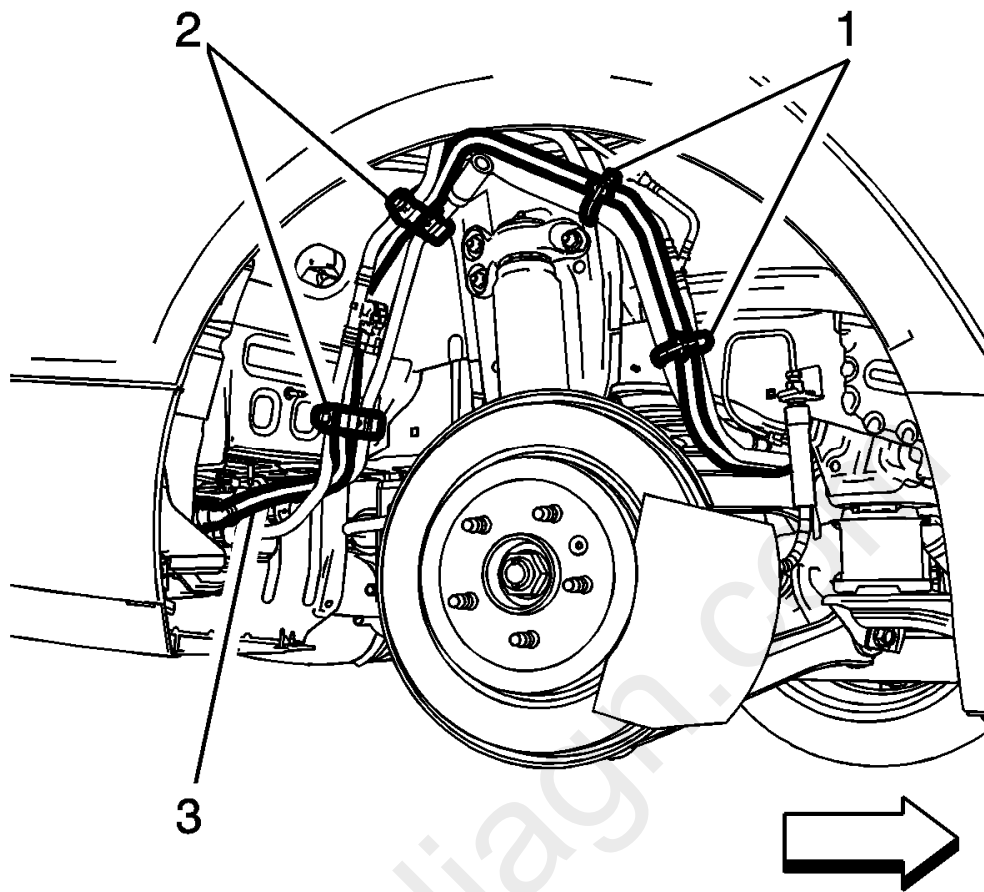


Fig. 110: Fuel Line Tie Straps
Courtesy of GENERAL MOTORS COMPANY

4. Remove the tie straps (1) attaching the evaporative emission canister purge pipe to the fuel tank filler pipe.
5. Remove the evaporative emission canister purge pipe (3) from the retainers (2).
6. Remove the evaporative emission canister purge pipe (3) from the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

Installation Procedure

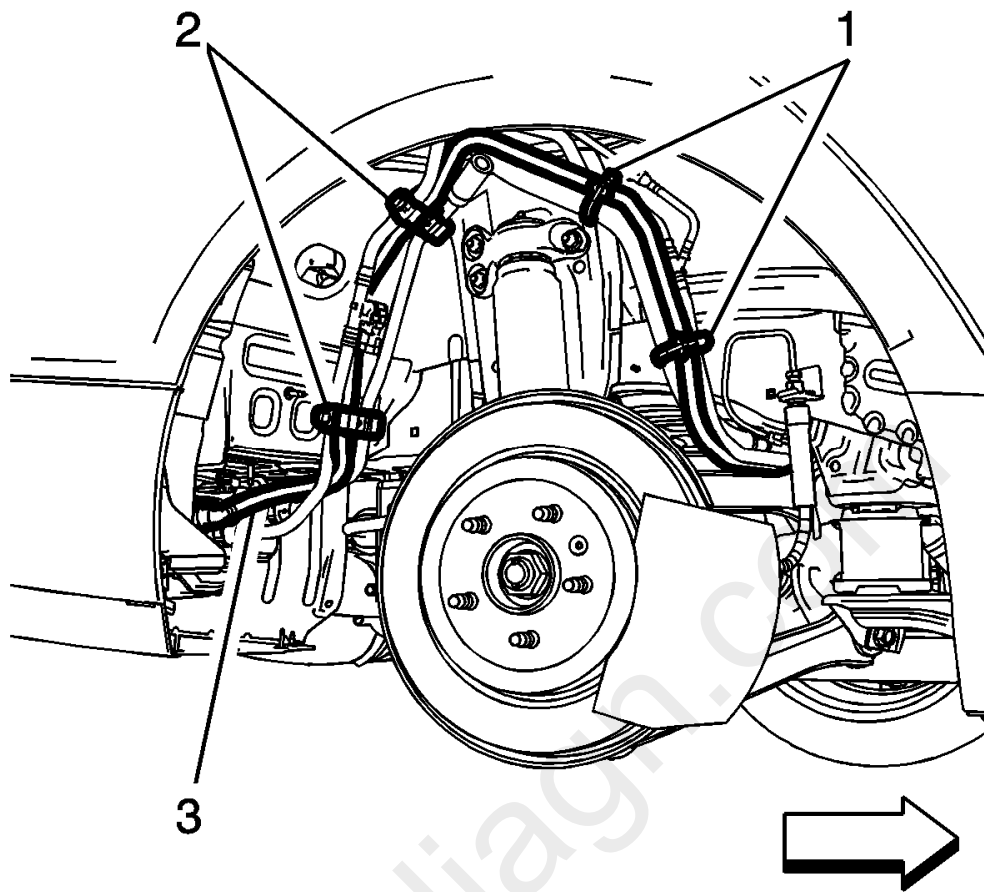


Fig. 111: Fuel Line Tie Straps

Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission canister purge pipe (3) to the EVAP emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
2. Install the evaporative emission canister purge pipe (3) to the retainers (2).
3. Install NEW tie straps (1) to attach the evaporative emission canister purge pipe to the fuel tank filler pipe.
4. Install the right rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

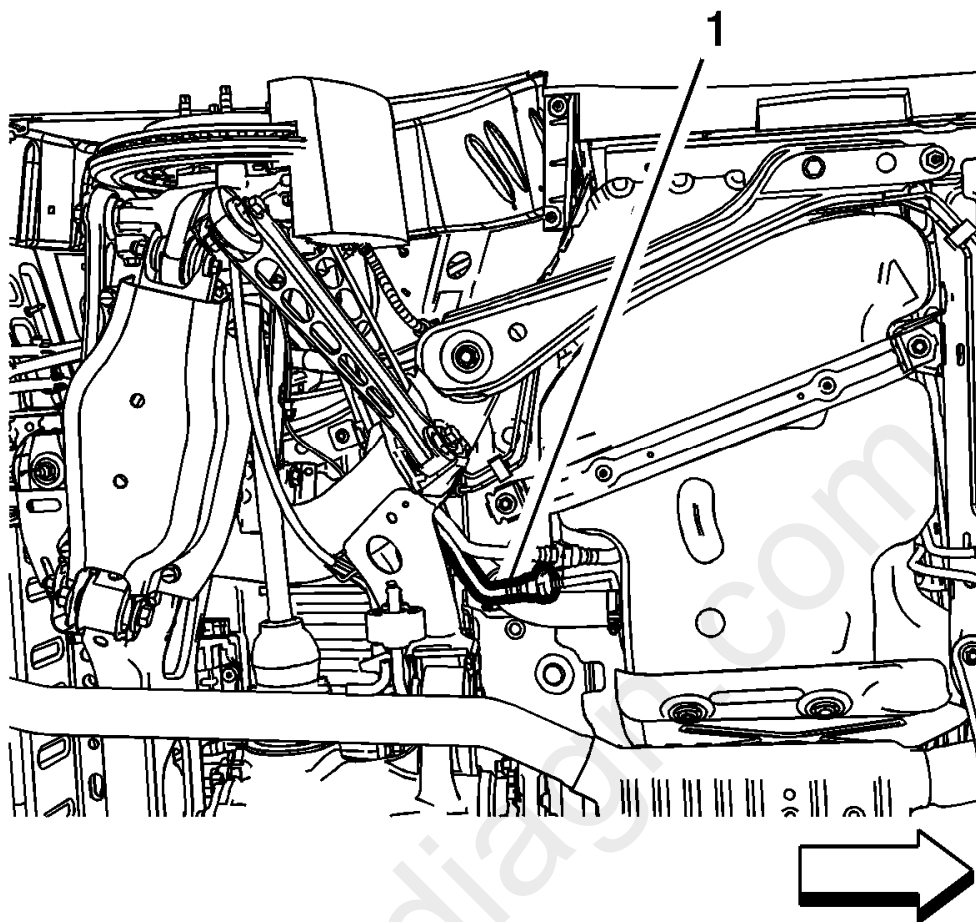


Fig. 112: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Connect the evaporative emission canister purge pipe (1) to the fuel tank vent valve hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Lower the vehicle.

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT

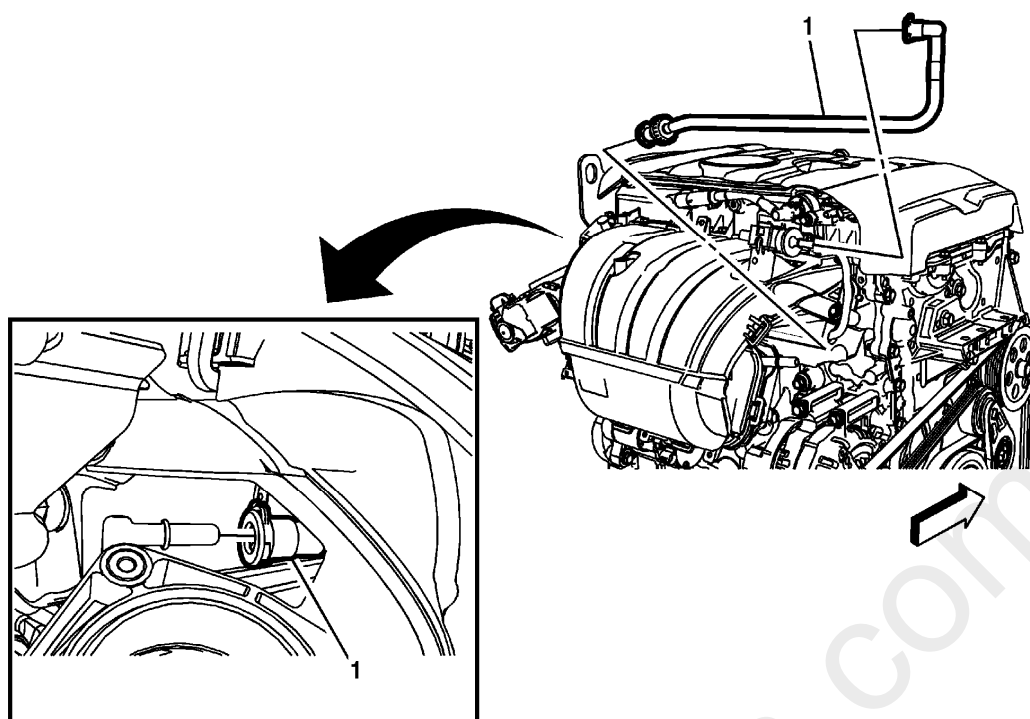


Fig. 113: Evaporative Emission Canister Purge Tube
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Tube Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the throttle body. Refer to <u>Throttle Body Assembly Replacement</u> . 2. Disconnect the evaporative emission canister purge tube from the intake manifold and the evaporative emission canister purge valve. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Evaporative Emission Canister Purge Tube

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

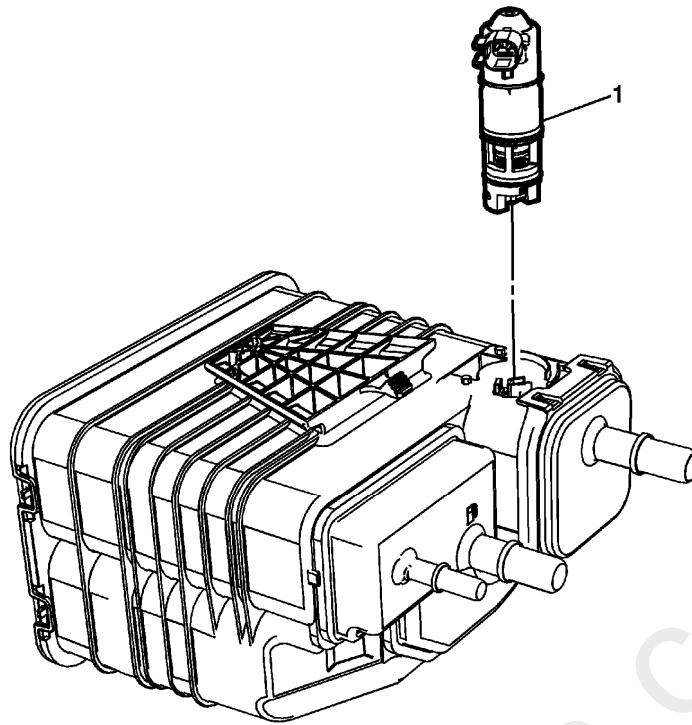


Fig. 114: Evaporative Emission Canister Vent Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Vent Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure	
Remove the evaporative emission canister. Refer to <u>Evaporative Emission Canister Replacement</u>.	
1	Evaporative Emission Canister Vent Solenoid Valve
Procedure	
Disconnect the evaporative emission canister vent solenoid valve electrical connector.	

EVAPORATIVE EMISSION PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .

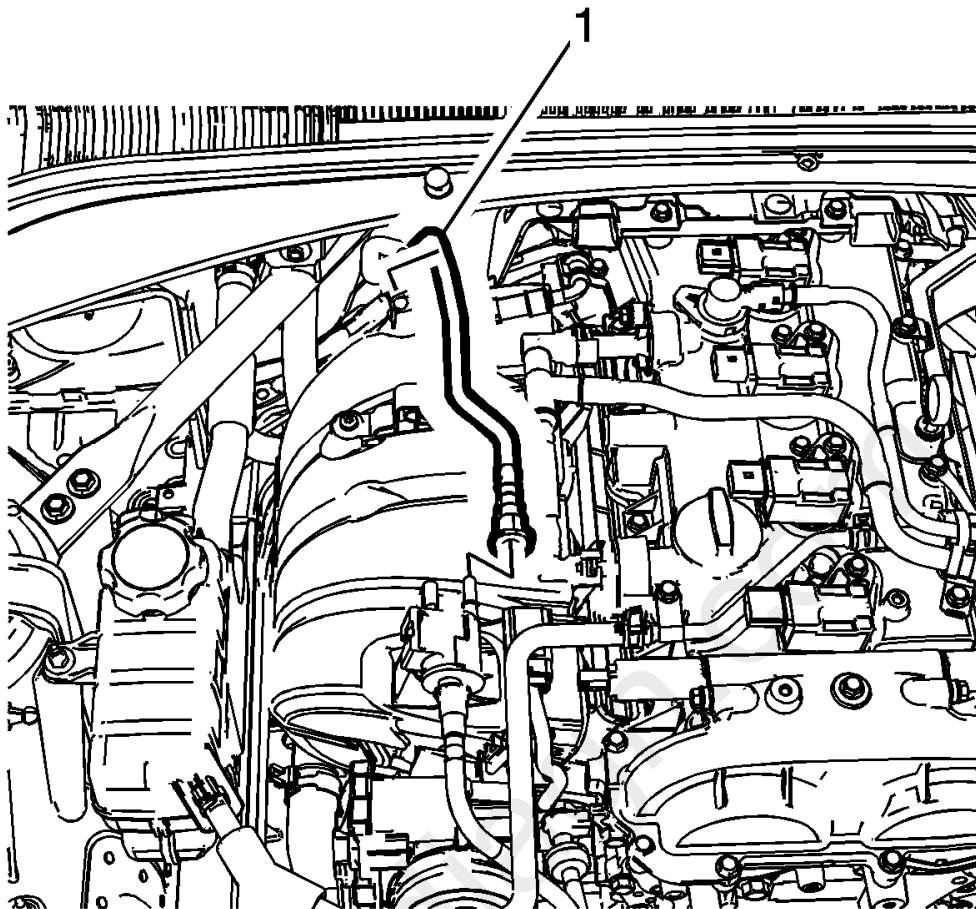


Fig. 115: Evaporative Emission Pipe And Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

2. Remove the evaporative emission pipe (1) from the evaporative emission canister purge solenoid valve and retainers. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
5. Remove the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .

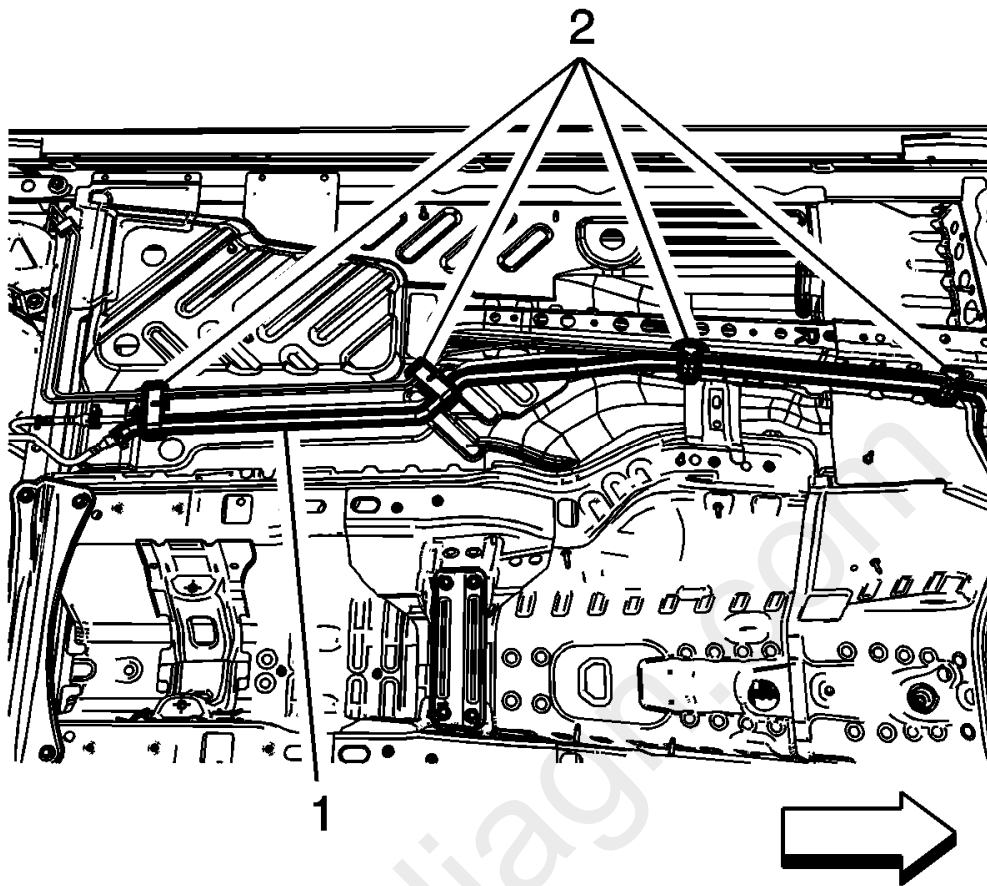


Fig. 116: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the evaporative emission pipe (1) and remove from retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Remove the evaporative emission pipe (1) from the vehicle.

Installation Procedure

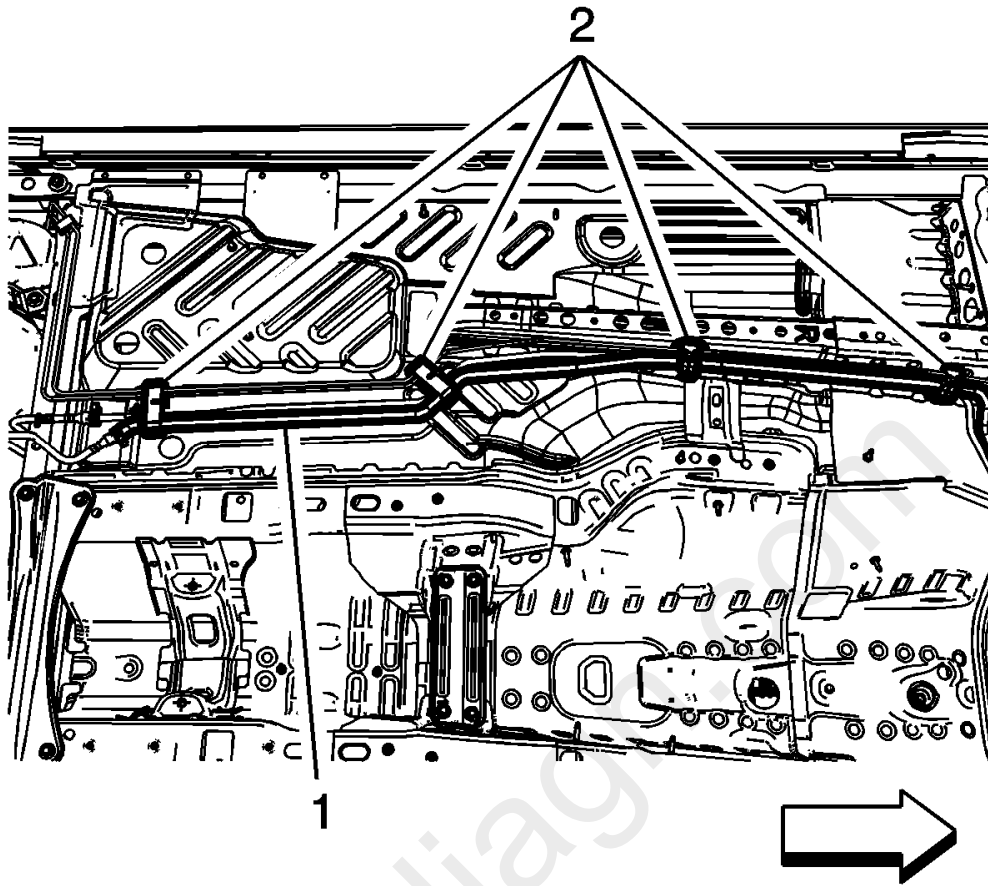


Fig. 117: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission pipe (1) to the vehicle.
2. Connect the evaporative emission pipe (1) and install to the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the front body exhaust heat shield right side. Refer to **Front Body Exhaust Heat Shield Replacement (Right)** , **Front Body Exhaust Heat Shield Replacement (Left)** .
4. Install the underbody front air deflector right side. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
5. Lower the vehicle.

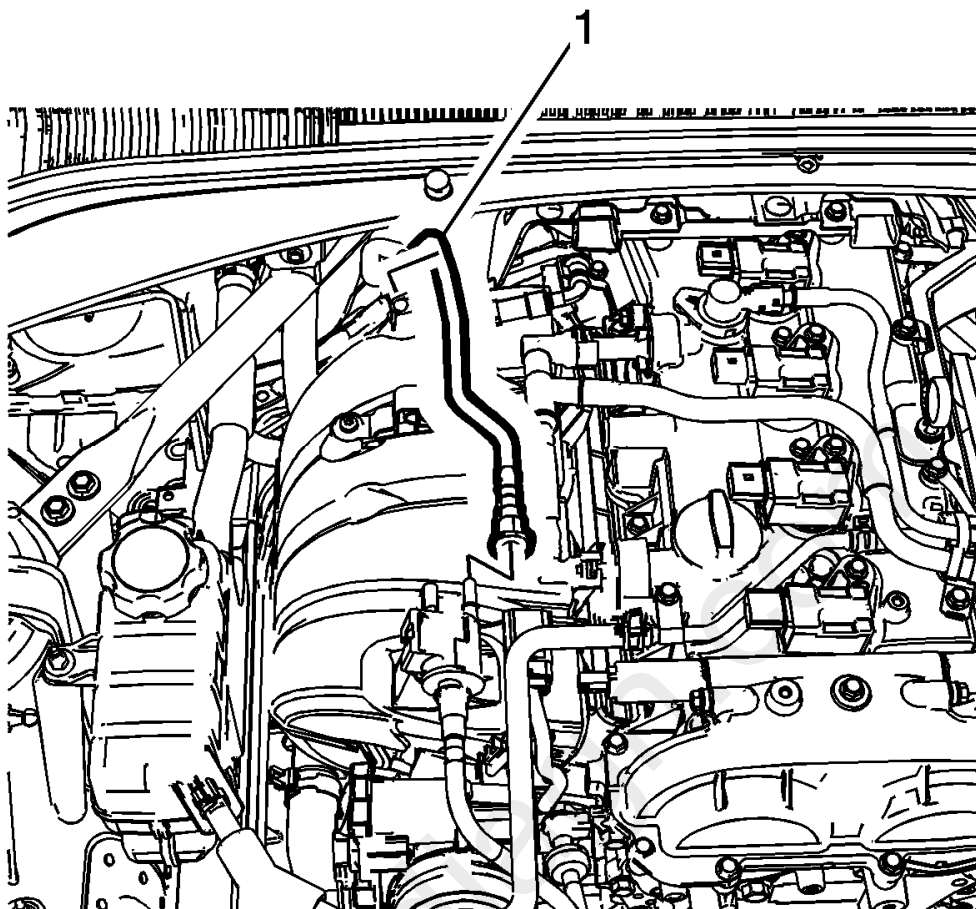


Fig. 118: Evaporative Emission Pipe And Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

6. Install the evaporative emission pipe (1) to the evaporative emission canister purge solenoid valve and retainers. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

EVAPORATIVE EMISSION CANISTER AIR INLET HOSE REPLACEMENT

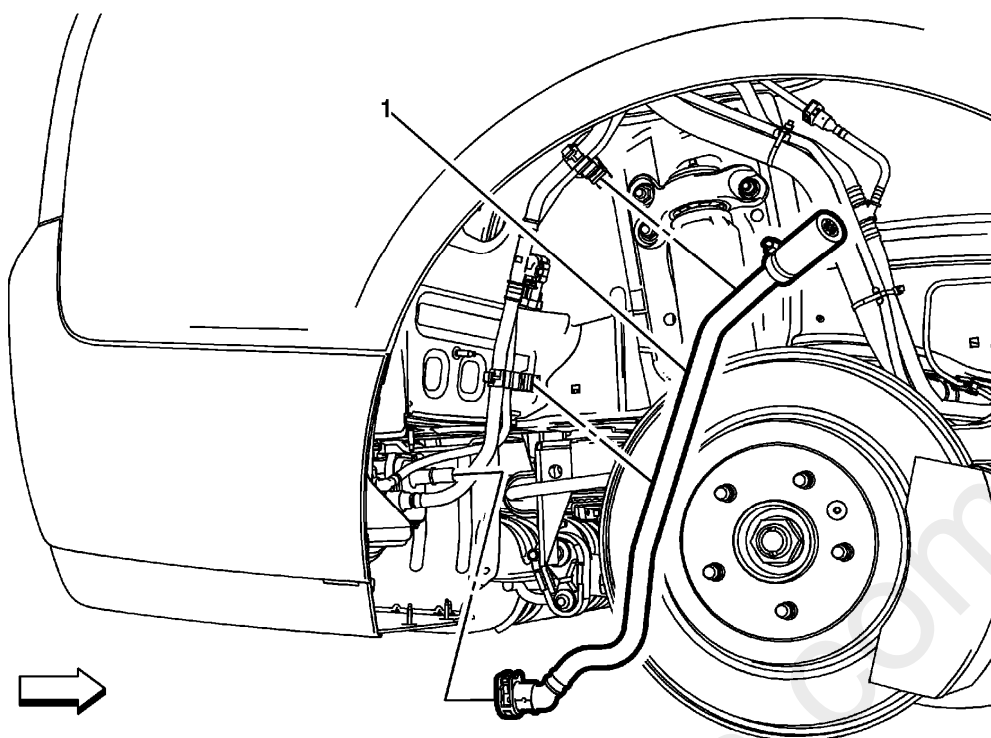


Fig. 119: Evaporative Emission Canister Air Inlet Hose
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Air Inlet Hose Replacement

Callout	Component Name
Preliminary Procedure	
Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Evaporative Emission Canister Air Inlet Hose Procedure Disconnect the EVAP emission canister air inlet hose from the EVAP canister and retainers. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

EVAPORATIVE EMISSION CANISTER REPLACEMENT

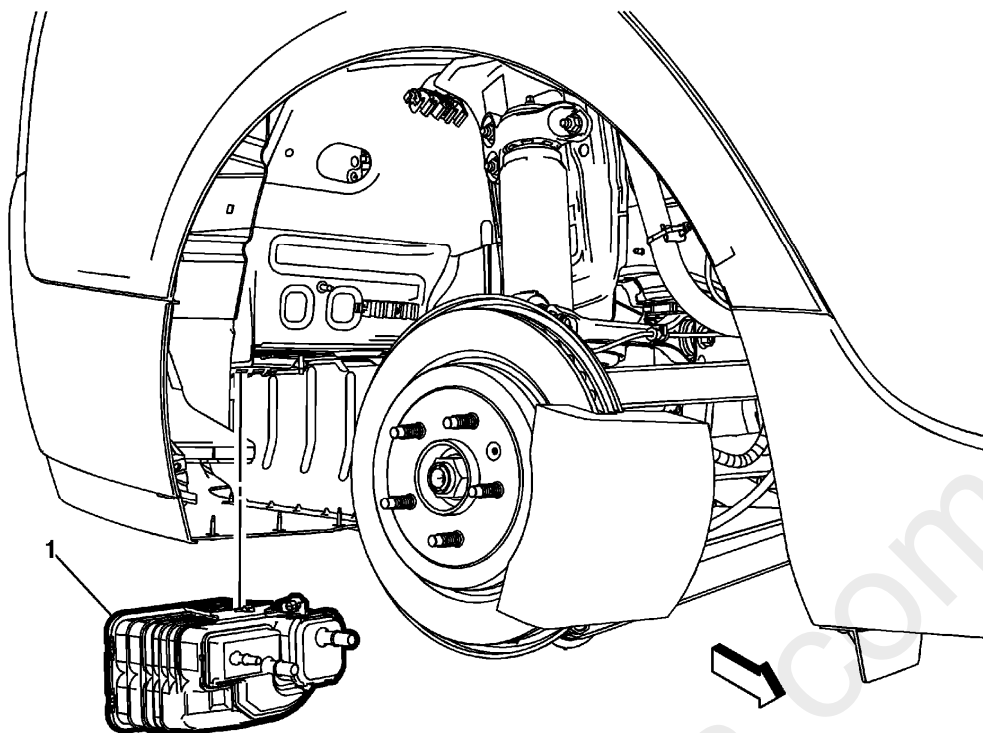


Fig. 120: Evaporative Emission Canister
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> . 2. Disconnect the evaporative emission canister purge pipe. Refer to <u>Evaporative Emission Canister Purge Pipe Replacement</u> . 3. Disconnect the fuel tank vent hose. Refer to <u>Fuel Tank Vent Hose Replacement</u> . 4. Disconnect the evaporative emission canister air inlet hose. Refer to <u>Evaporative Emission Canister Air Inlet Hose Replacement</u> . 5. Disconnect electrical connector.	
1	Evaporative Emission Canister Procedure Depress retaining tab to release EVAP canister.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

GE 41413-200 Evaporative Pressure and Purge Station

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** .

Inspection Procedure

CAUTION: Use the Evaporative Emission (EVAP) System Tester (EEST) GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.

NOTE: Proceed with the following procedure only if referenced by an evaporative emission (EVAP) diagnostic or repair procedure.

1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
 - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
 - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
 - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
3. Turn OFF the main valve on the **GE 41413-200** station.
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.
6. Connect the other end of the vacuum hose to the canister side of the purge pipe.
7. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
8. If the nitrogen does not clear the blockage, replace the purge pipe.
9. Return the EVAP pressure/purge diagnostic station to the stations original condition.
10. Install a new EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
11. Lower the vehicle.
12. Install a new EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
13. Return to the diagnostic table that sent you here.

IGNITION COIL REPLACEMENT

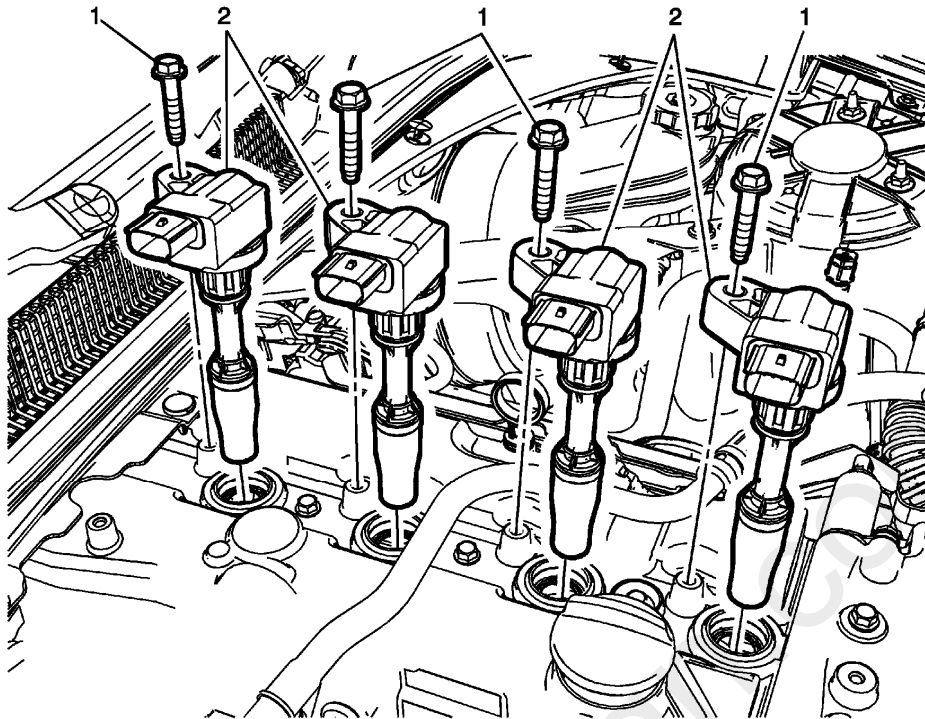


Fig. 121: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

Ignition Coil Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. If replacing the number 4 ignition coil, remove the upper intake manifold bracket. Refer to <u>Upper Intake Manifold Bracket Replacement</u> .	
1	Ignition Coil Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
	Ignition Coils NOTE: Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following

procedure.

Procedure

1. Disconnect the electrical wiring harness connectors from the ignition coils and remove coils as necessary.
2. Apply a thin coating of dielectric grease to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.

SPARK PLUG REPLACEMENT

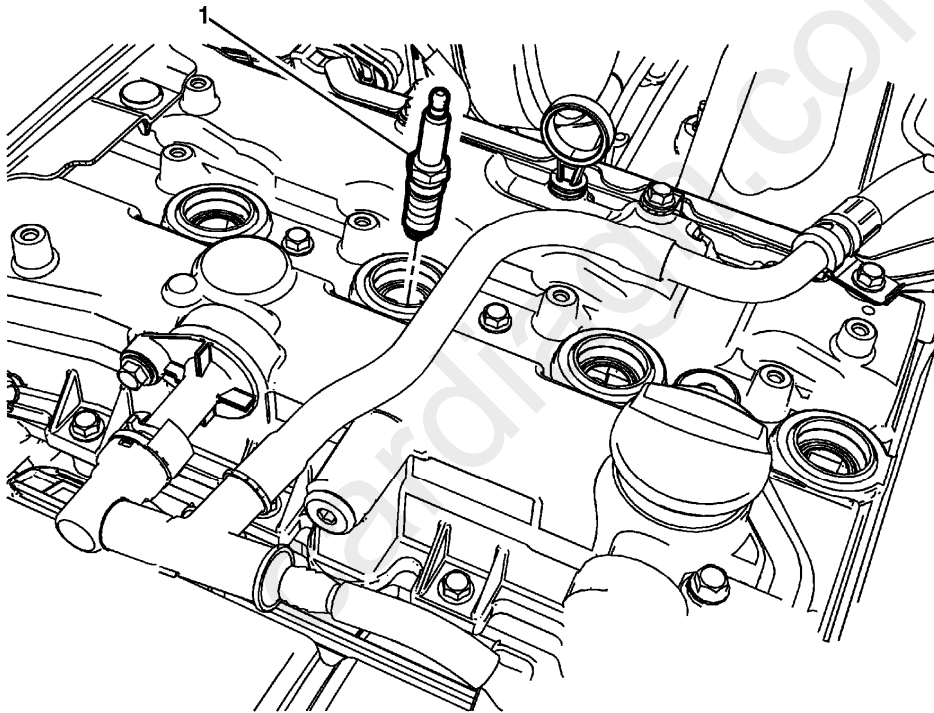


Fig. 122: Spark Plug

Courtesy of GENERAL MOTORS COMPANY

Spark Plug Replacement

Callout	Component Name
CAUTION: This engine has aluminum cylinder heads. Do not remove the spark plugs from a hot engine, allow it to cool first. Removing the spark plugs from a hot engine may cause spark plug thread damage or cylinder head damage.	

Preliminary Procedure Remove the ignition coils. Refer to **Ignition Coil Replacement** .

1	Spark Plugs (Qty: 4) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Inspect the spark plug and verify the gap. Refer to <u>Spark Plug Inspection</u>. Tighten 20 (15 lb ft)
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SPARK PLUG INSPECTION

Spark Plug Usage

Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the Electronic Parts Catalog.

Spark Plug Inspection

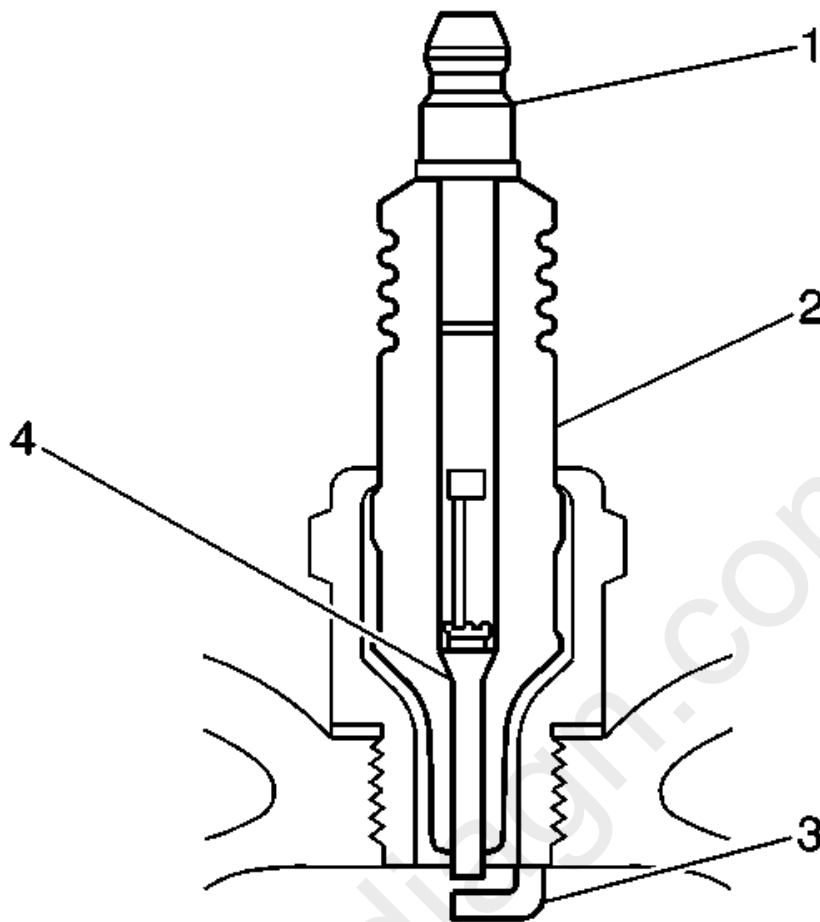


Fig. 123: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- Inspect the terminal post (1) for damage.
 - Inspect for a bent or broken terminal post (1).
 - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
 - Inspect the spark plug boot for damage.
 - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.

- Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be done carefully in order to avoid damaging the small diameter Iridium center electrode. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.
- Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
- Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
- Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation-Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- Carbon Fouled-Dry, fluffy black carbon, or soot caused by the following conditions:
 - Rich fuel mixtures
 - Leaking fuel injectors
 - Excessive fuel pressure
 - Restricted air filter element
 - Incorrect combustion
 - Reduced ignition system voltage output
 - Weak coils
 - Worn ignition wires
 - Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling-Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

CRANKSHAFT POSITION SENSOR REPLACEMENT

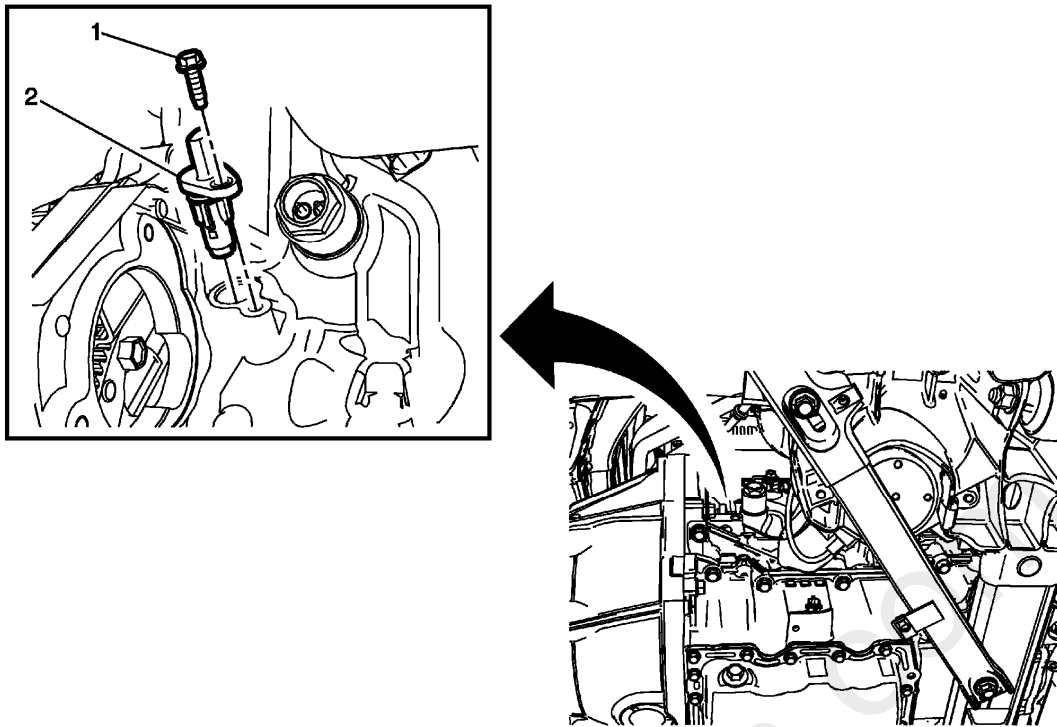


Fig. 124: Crankshaft Position Sensor
 Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor Replacement

Callout	Component Name
Preliminary Procedure 1. Raise and properly support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 3. Remove the starter. Refer to <u>Starter Replacement (LFX)</u> , <u>Starter Replacement (LTG)</u> , <u>Starter Replacement (LF3)</u> .	
1	Crankshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Crankshaft Position Sensor Procedure

1. Disconnect the electrical wiring harness connector from the crankshaft position sensor.
2. If installing a new sensor, perform the crankshaft position system variation learn procedure. Refer to **Crankshaft Position System Variation Learn**.

CAMSHAFT POSITION SENSOR REPLACEMENT - INTAKE

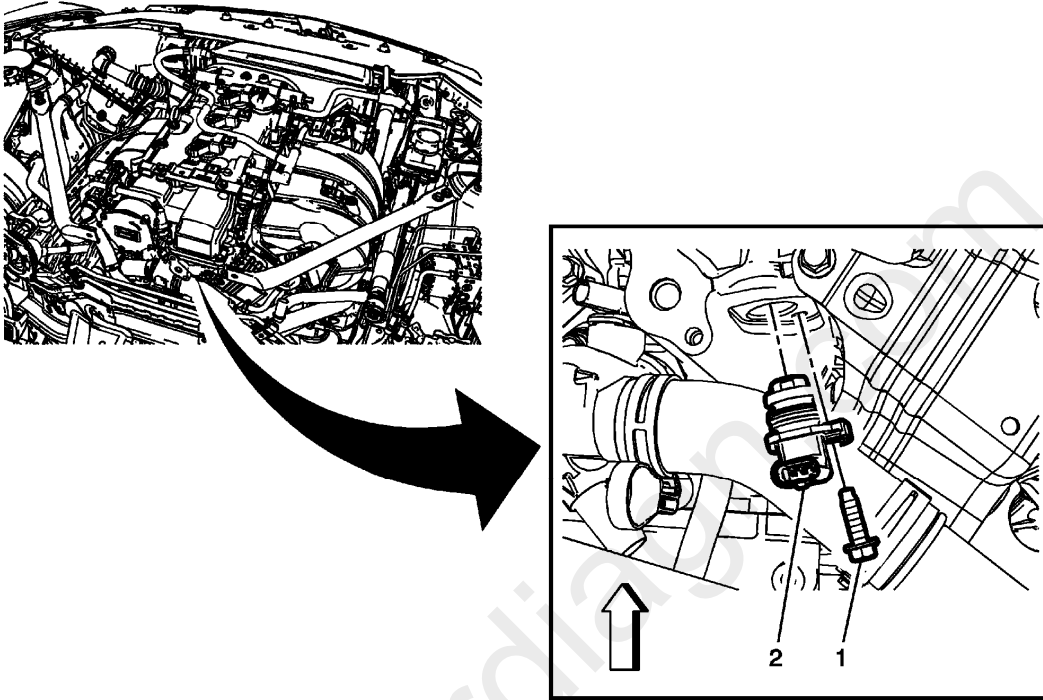


Fig. 125: Camshaft Position Sensor - Intake
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Intake

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> . 3. Remove the fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement (Inner)</u>, <u>Fuel Pump Insulator Replacement (Outer)</u>.	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (89 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical wiring harness connector from the camshaft position sensor.

CAMSHAFT POSITION SENSOR REPLACEMENT - EXHAUST

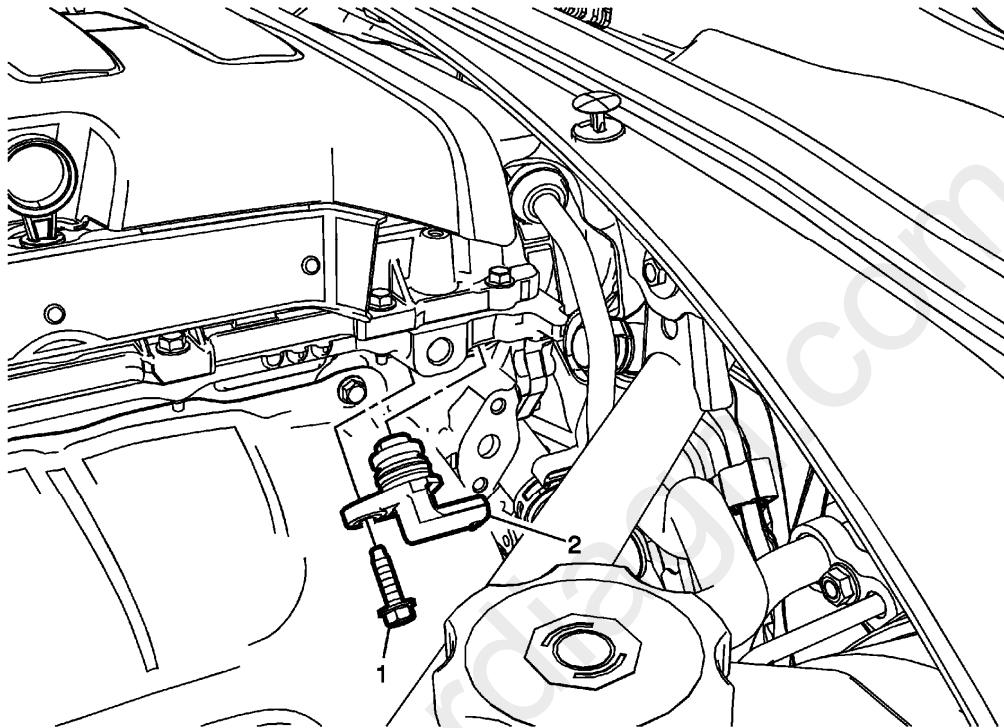


Fig. 126: Camshaft Position Sensor - Exhaust
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Exhaust

Callout	Component Name
Preliminary Procedure Remove the Camshaft Cover Heat Shield. Refer to <u>Camshaft Cover Heat Shield Replacement</u> . Remove the secondary air injection check valve, if equipped. Refer to <u>Secondary Air Injection Check Valve Removal</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)

2

Camshaft Position Sensor

Procedure

Disconnect the electrical wiring harness connector from the camshaft position sensor.

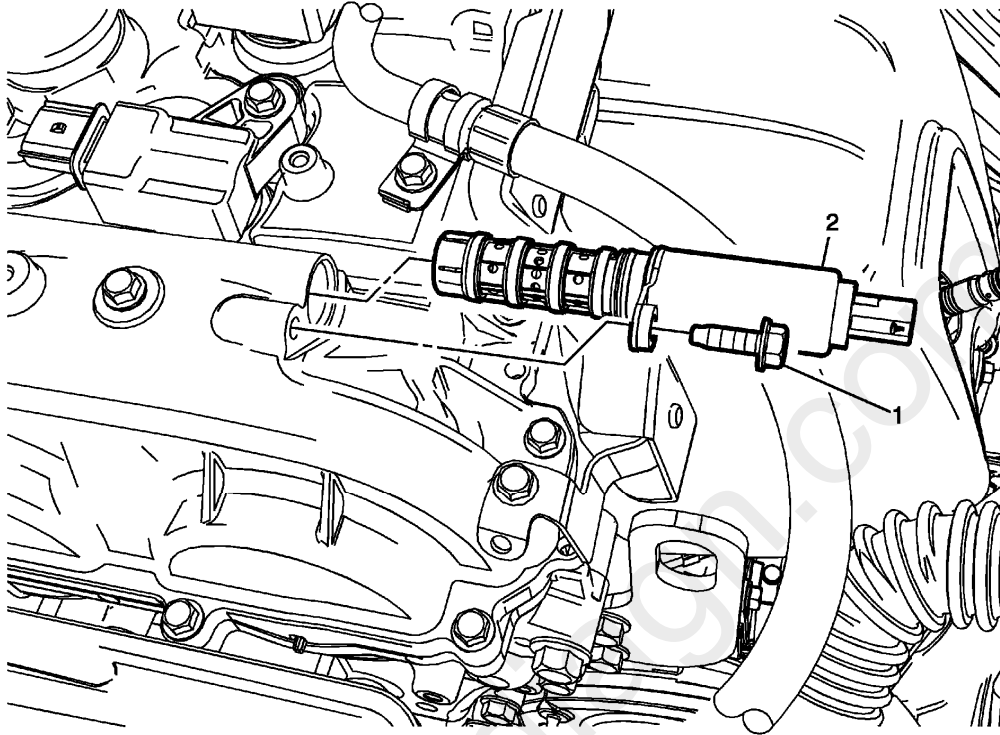
CAMSHAFT POSITION ACTUATOR EXHAUST SOLENOID VALVE REPLACEMENT

Fig. 127: Camshaft Position Actuator Exhaust Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Exhaust Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Actuator Exhaust Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Camshaft Position Actuator Exhaust Solenoid Valve Procedure Disconnect the electrical wiring harness connector from the camshaft position actuator exhaust solenoid valve.

CAMSHAFT POSITION ACTUATOR INTAKE SOLENOID VALVE REPLACEMENT

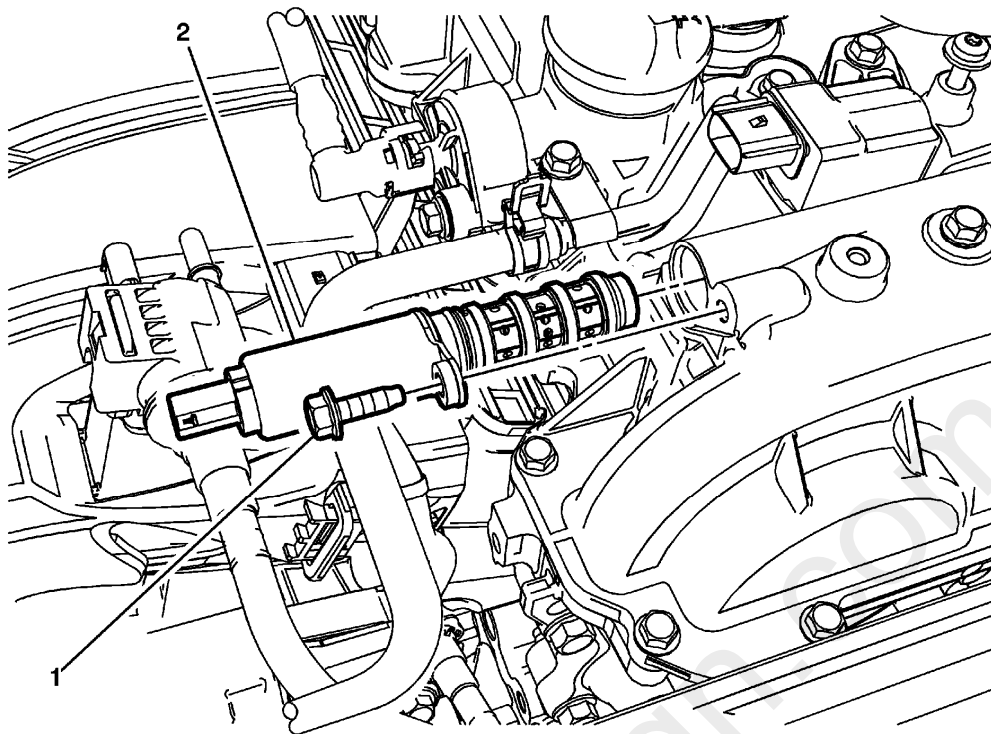


Fig. 128: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Intake Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Actuator Intake Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Camshaft Position Actuator Intake Solenoid Valve Procedure Disconnect the electrical wiring harness connector from the camshaft position actuator intake solenoid valve.

KNOCK SENSOR REPLACEMENT

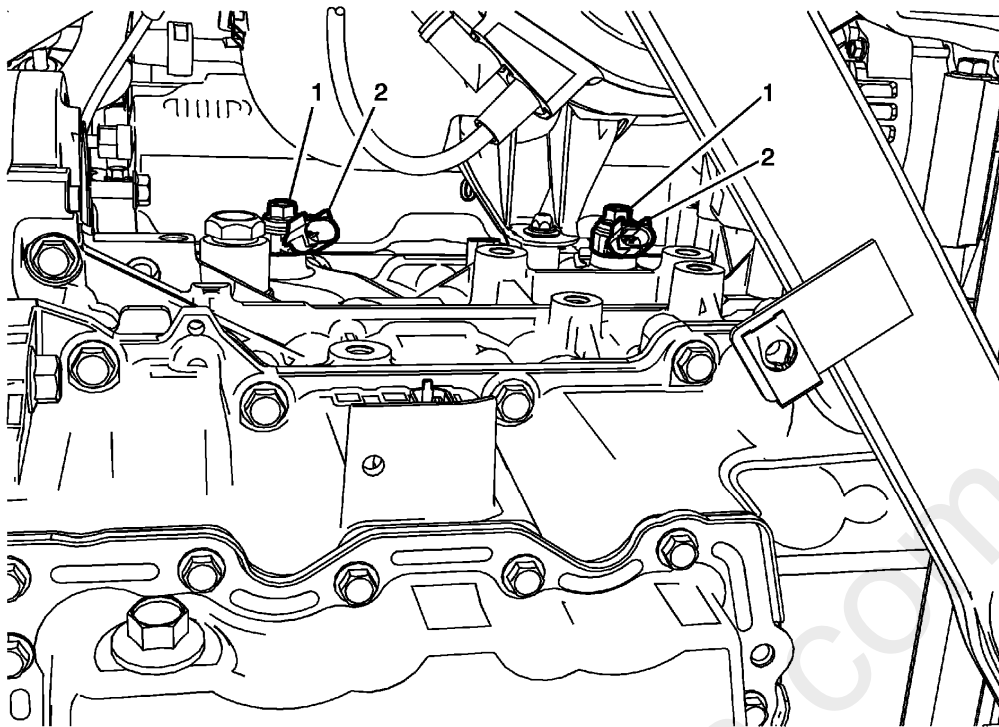


Fig. 129: Knock Sensor

Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold. Refer to <u>Intake Manifold Replacement</u> .	
1	Knock Sensor Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in).
2	Knock Sensors (Qty: 2) Procedure Disconnect the electrical wiring harness connectors from the knock sensors.

OIL PUMP FLOW CONTROL VALVE REPLACEMENT

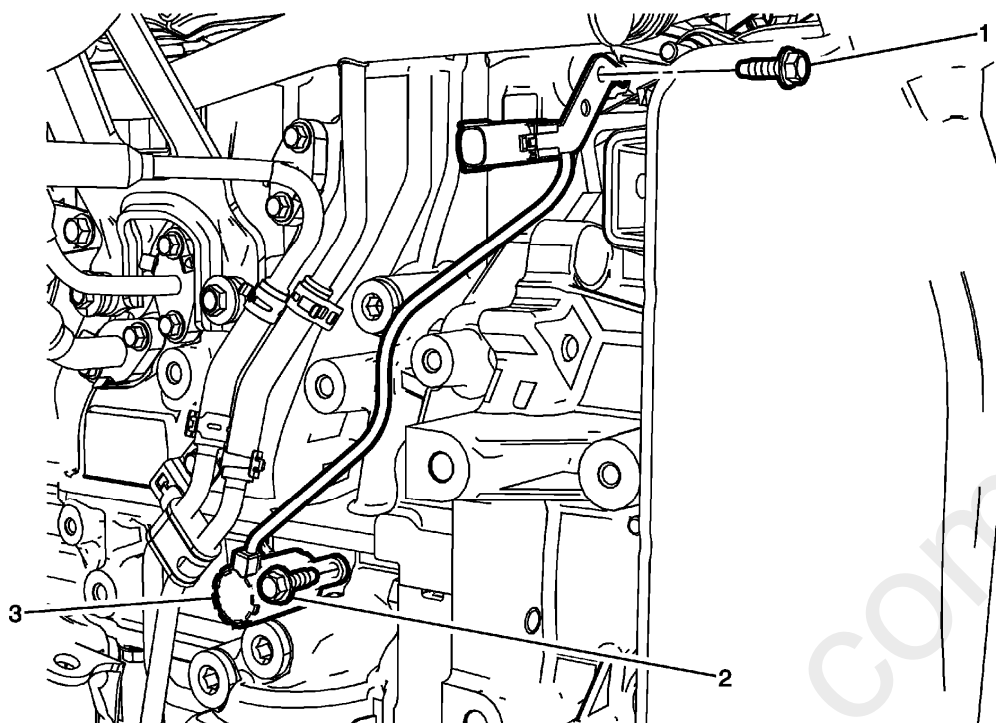


Fig. 130: Oil Pump Flow Control Valve
 Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the catalytic converter. Refer to <u>Catalytic Converter Replacement (LTG)</u> . 2. Remove the oil pump flow control valve heat shield. Refer to <u>Oil Pump Flow Control Valve Heat Shield Replacement</u>.	
1	Oil Pump Flow Control Valve Electrical Wiring Harness Connector Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Oil Pump Flow Control Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (89 lb in)
3	Oil Pump Flow Control Valve Procedure Disconnect the electrical wiring harness connector from the oil pump flow control valve.

OIL PUMP FLOW CONTROL VALVE HEAT SHIELD REPLACEMENT

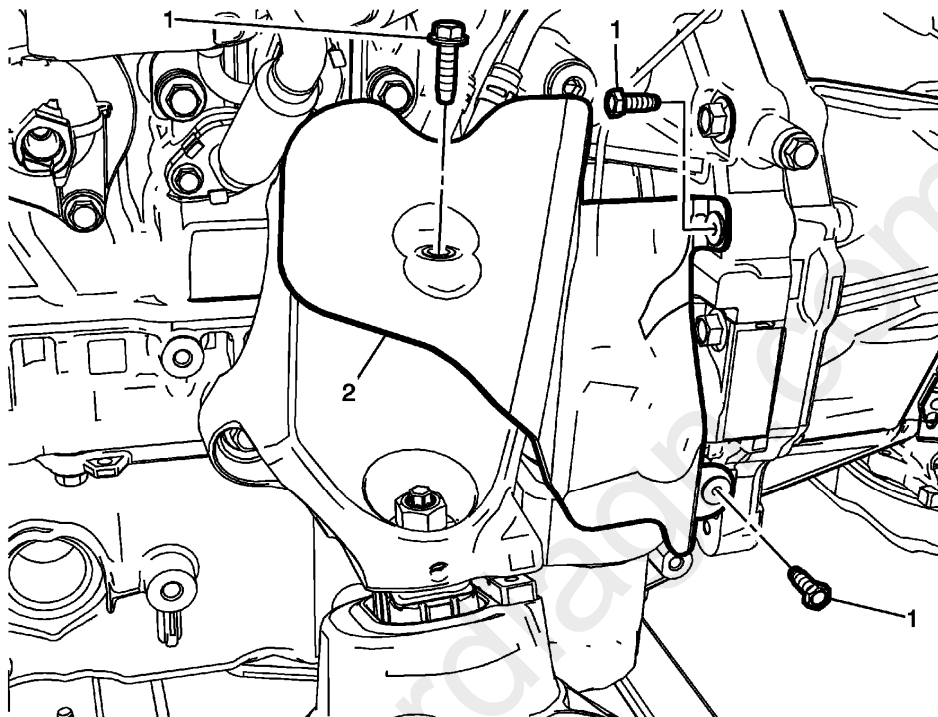


Fig. 131: Oil Pump Flow Control Valve Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Heat Shield Replacement

Callout	Component Name
1	Oil Pump Flow Control Valve Heat Shield Fasteners (Qty 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Oil Pump Flow Control Valve Heat Shield

VACUUM PUMP REPLACEMENT

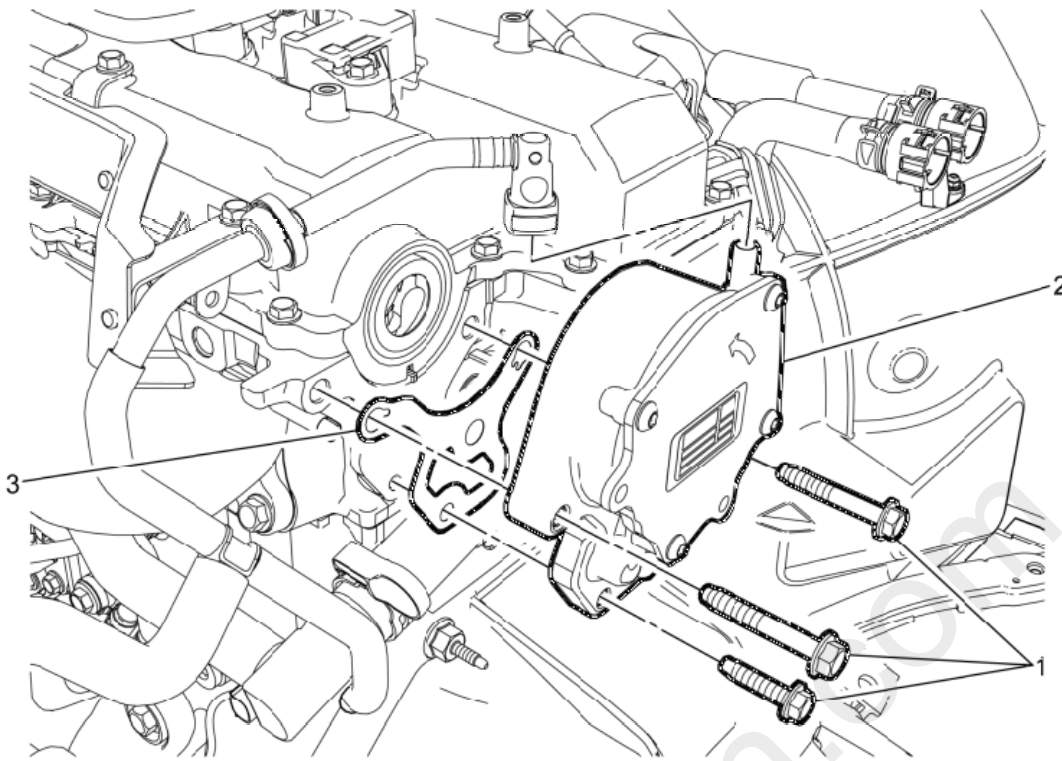


Fig. 132: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

Vacuum Pump Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the plenum front panel. Refer to <u>Plenum Front Panel Replacement</u> . 2. Remove the outer fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement (Inner)</u>, <u>Fuel Pump Insulator Replacement (Outer)</u>. 3. Disconnect the vacuum hose from the vacuum pump. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Vacuum Pump Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Vacuum Pump Procedure

	1. Lubricate the vacuum pump seal with clean engine oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
3	Vacuum Pump Gasket NOTE: Inspect the gasket and replace if necessary.

TURBOCHARGER WASTEGATE ACTUATOR REPLACEMENT

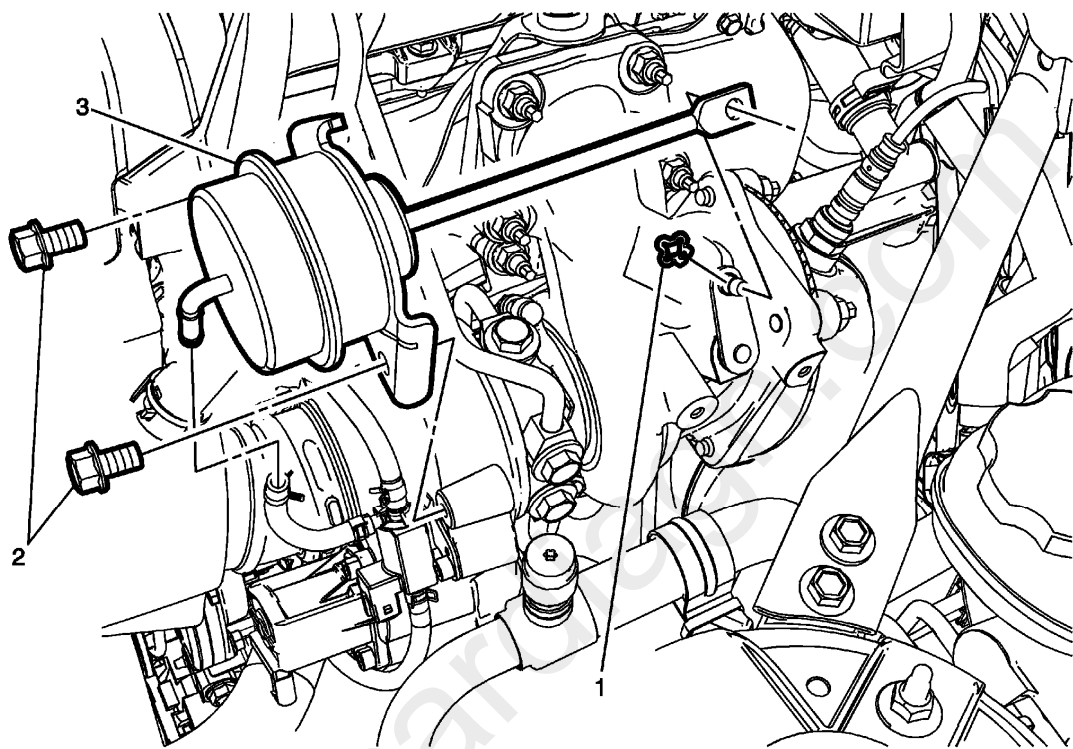


Fig. 133: Turbocharger Wastegate Actuator
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Wastegate Actuator Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> .	
2. Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement</u> .	
1	Turbocharger Wastegate Actuator Arm Retainer
2	Turbocharger Wastegate Actuator Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 20 (15 lb ft)
3	Turbocharger Wastegate Actuator Procedure Disconnect the vacuum line from the turbocharger wastegate actuator.

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE REPLACEMENT

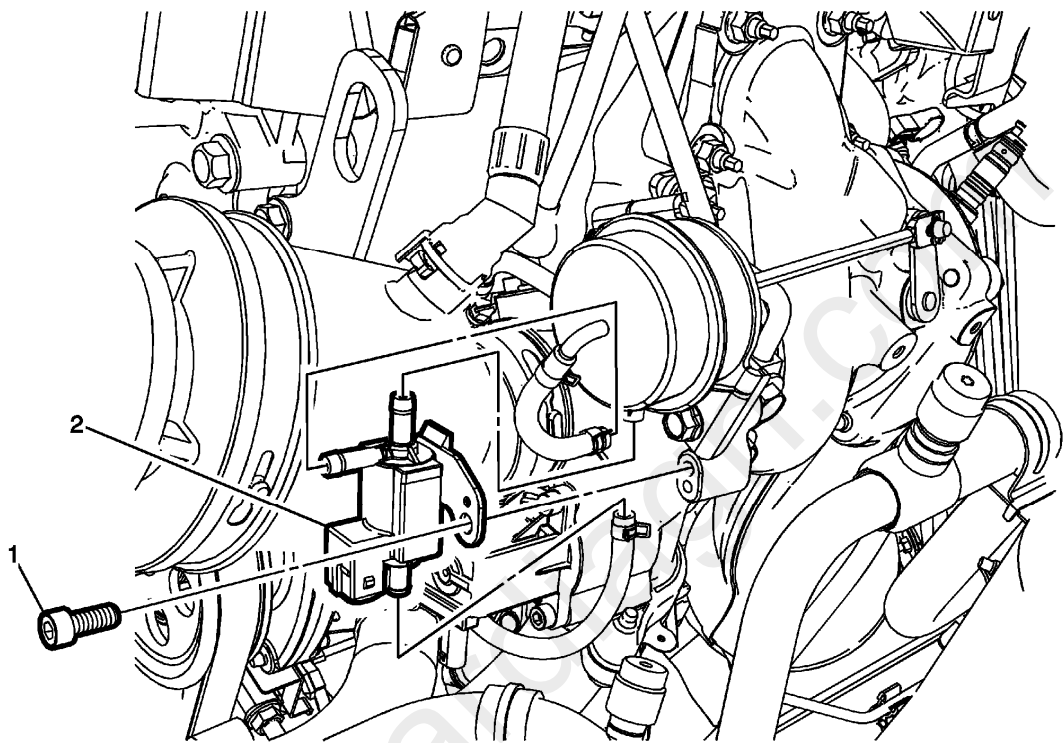


Fig. 134: Turbocharger Wastegate Regulator Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Wastegate Regulator Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> .	
1	Turbocharger Wastegate Regulator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7.8 (69 lb in)
	Turbocharger Wastegate Regulator Solenoid Valve

2	Procedure • Disconnect the turbocharger wastegate regulator harness connector. • Disconnect the vacuum lines from the turbocharger wastegate regulator solenoid valve.
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TURBOCHARGER BYPASS VALVE SOLENOID REPLACEMENT

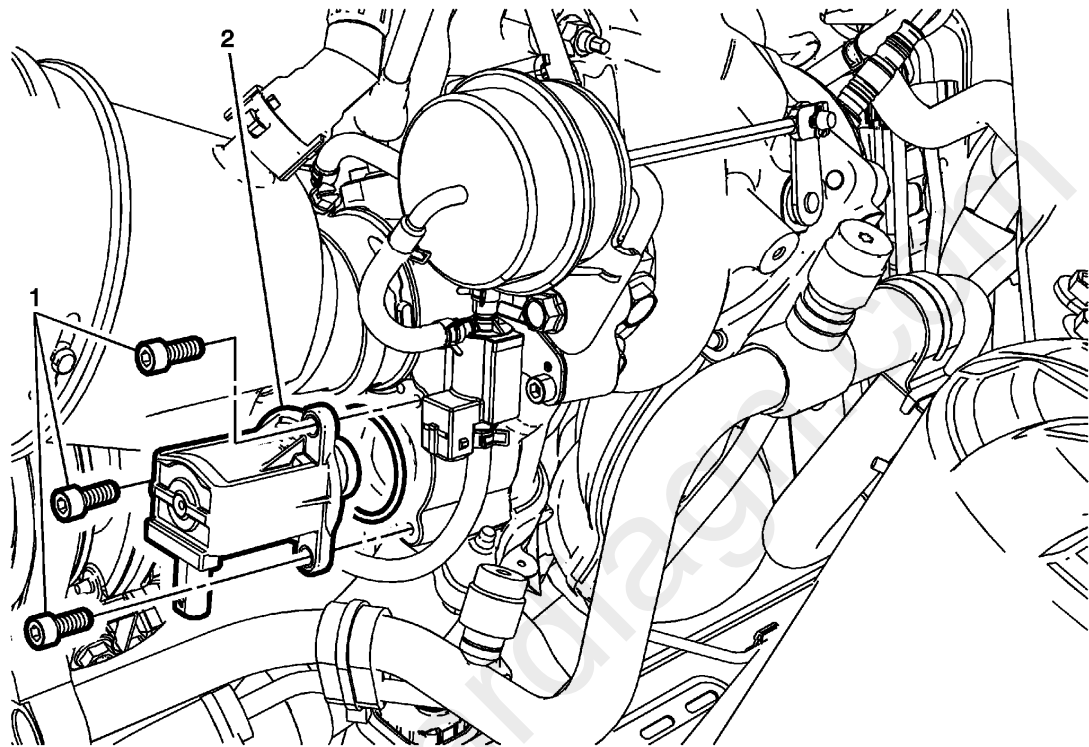


Fig. 135: Turbocharger Bypass Valve Solenoid
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Bypass Valve Solenoid Replacement

Callout	Component Name
Preliminary Procedure Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> .	
1	Turbocharger Bypass Valve Solenoid Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7.8 (69 lb in)
	Turbocharger Bypass Valve Solenoid

Procedure

- 2
 1. Disconnect the turbocharger bypass valve solenoid harness connector.
 2. Inspect the turbocharger bypass valve solenoid seal and replace if necessary.

AIR CLEANER ELEMENT REPLACEMENT (LTG)

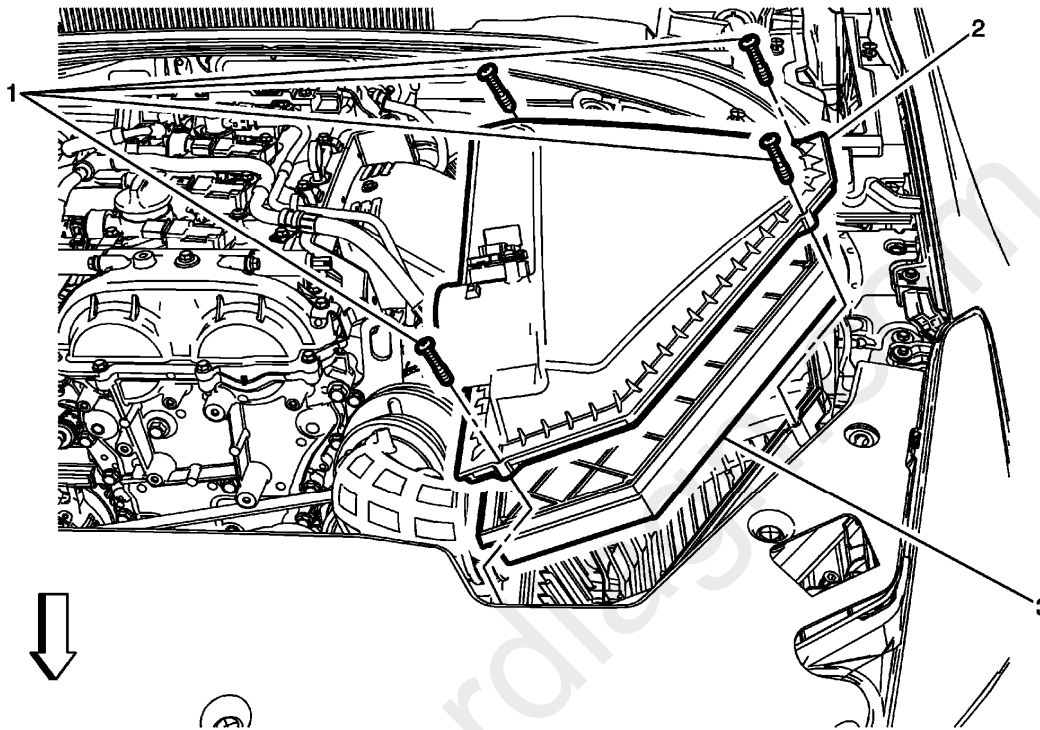


Fig. 136: Air Cleaner Element (LTG)
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Element Replacement (LTG)

Callout	Component Name
1	Air Cleaner Assembly Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Cleaner Upper Cover
3	Air Cleaner Element

AIR CLEANER ASSEMBLY REPLACEMENT

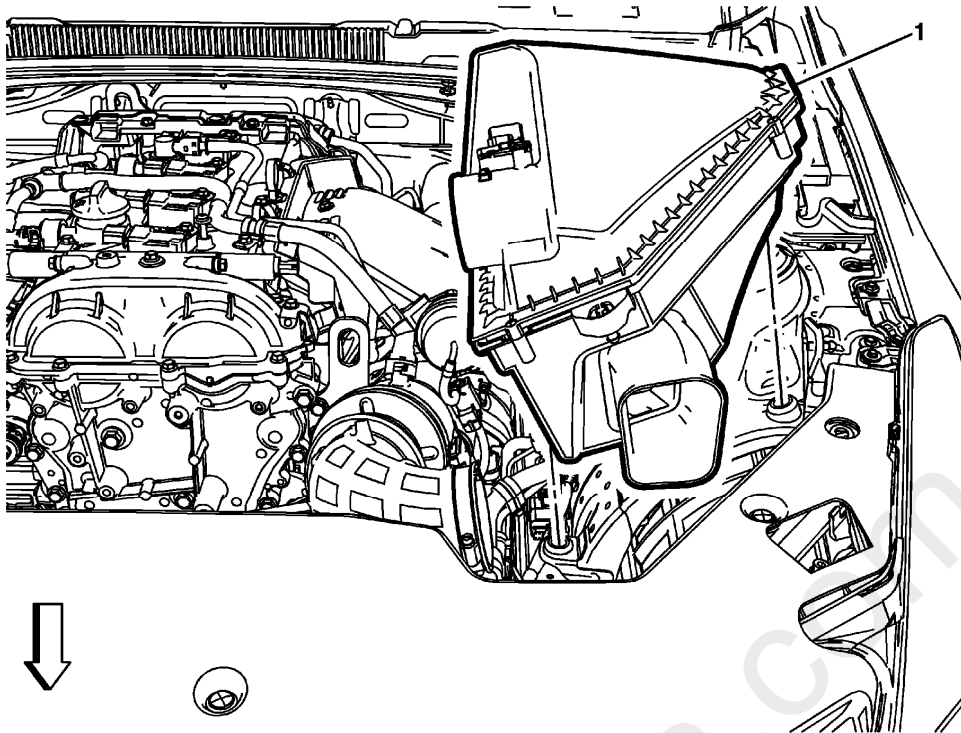


Fig. 137: Air Cleaner Assembly
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Assembly Replacement

Callout	Component Name
Preliminary Procedure 1. Disconnect the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement.</u> 2. Disconnect the mass airflow sensor electrical connector. 3.	
1	Air Cleaner Assembly Procedure 1. Remove the air cleaner housing from the retainers. 2. Transfer parts as necessary.

AIR CLEANER OUTLET DUCT REPLACEMENT

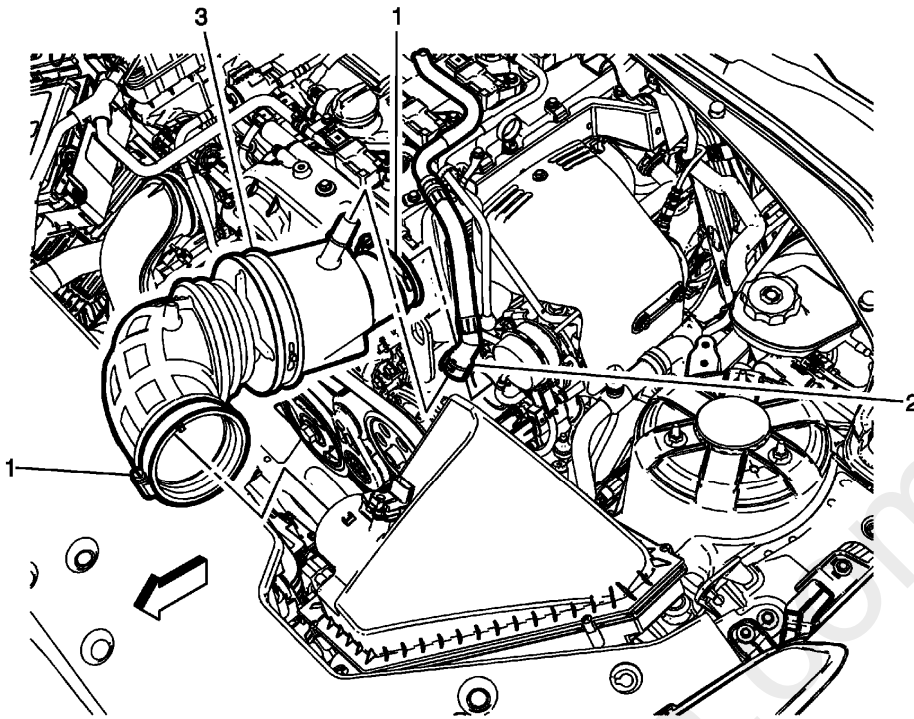


Fig. 138: Air Cleaner Outlet Duct
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement

Callout	Component Name
1	Air Cleaner Outlet Duct Clamps (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	PCV Tube
3	Air Cleaner Outlet Duct Procedure Disconnect the MAF sensor harness from the air cleaner outlet duct.

INTAKE AIR SPLASH SHIELD REPLACEMENT

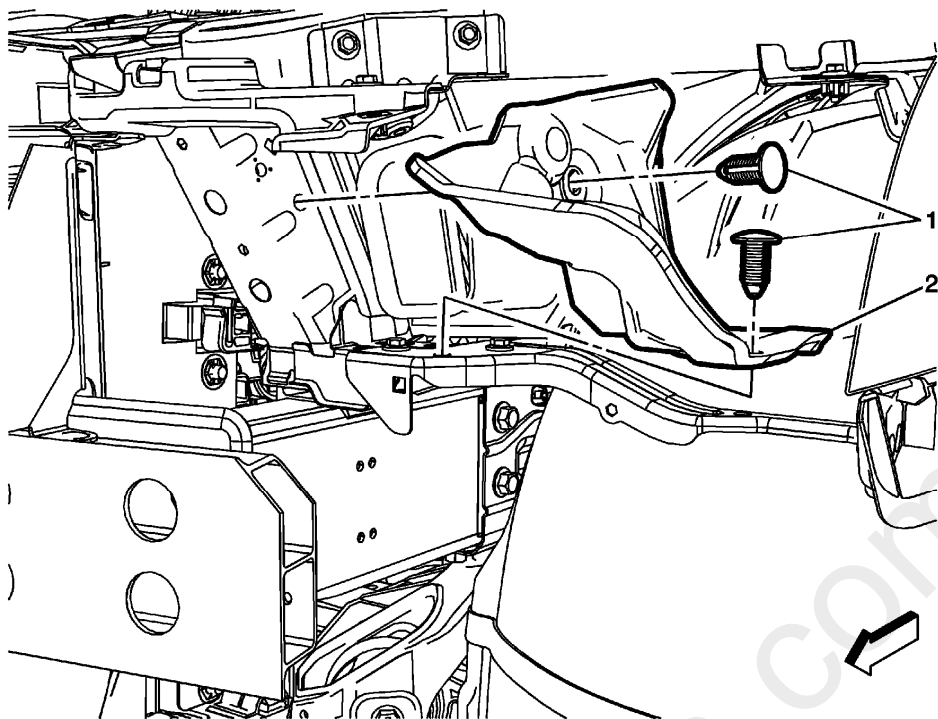


Fig. 139: Intake Air Splash Shield
 Courtesy of GENERAL MOTORS COMPANY

Intake Air Splash Shield Replacement

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> .	
1	Intake Air Splash Shield Retainers (Qty: 2)
2	Intake Air Splash Shield

CHARGE AIR COOLER OUTLET AIR TUBE REPLACEMENT

Removal Procedure

1. Disconnect the intake air pressure and temperature sensor electrical connector.

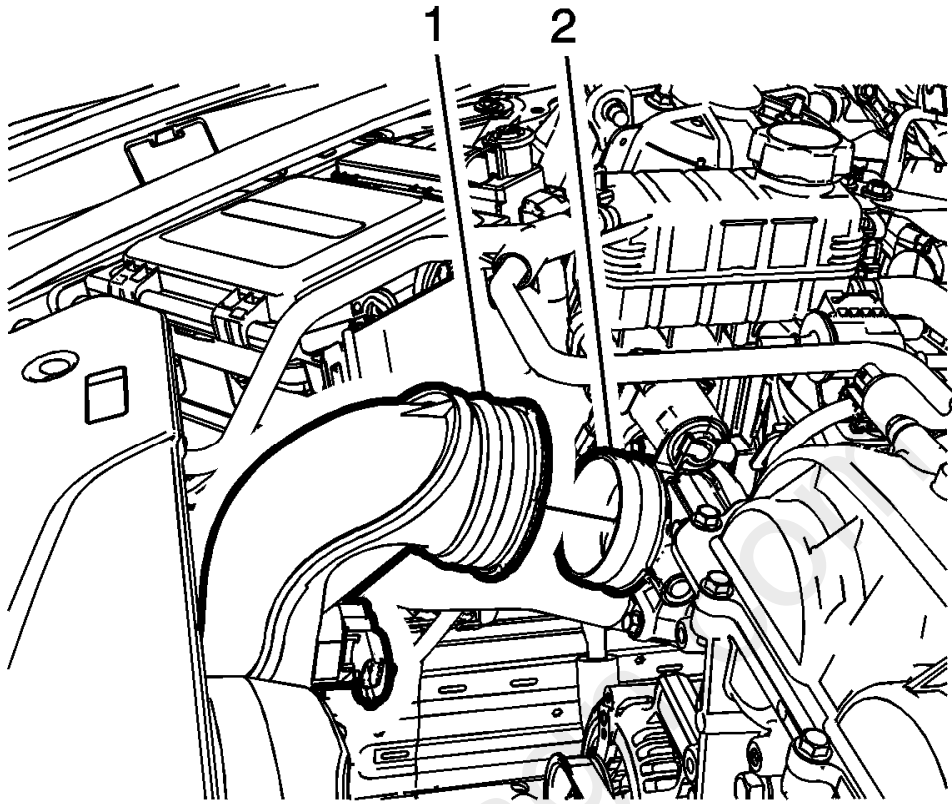


Fig. 140: Charge Air Cooler Outlet Air Tube And Throttle Body
Courtesy of GENERAL MOTORS COMPANY

NOTE: The charge air cooler is equipped with a locking collar. Rotate the collar counterclockwise to release the charge air cooler.

2. Remove the charge air cooler outlet air tube (1) from the throttle body (2) while rotating the collar counterclockwise.
3. Remove the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .

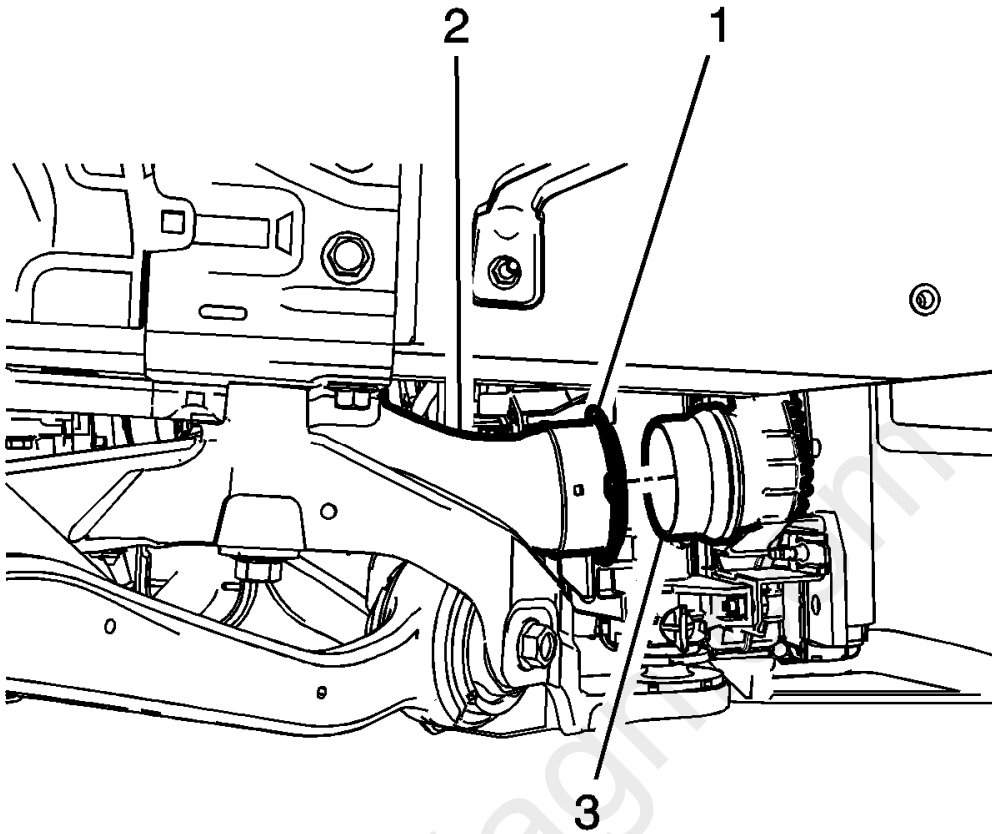


Fig. 141: Charge Air Cooler Outlet Air Tube And Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

4. Pull the release clip (1) outward and disconnect the charge air cooler outlet air tube (2) from the charge air cooler (3).
5. Remove the charge air cooler outlet air tube (2) from the vehicle.

Installation Procedure

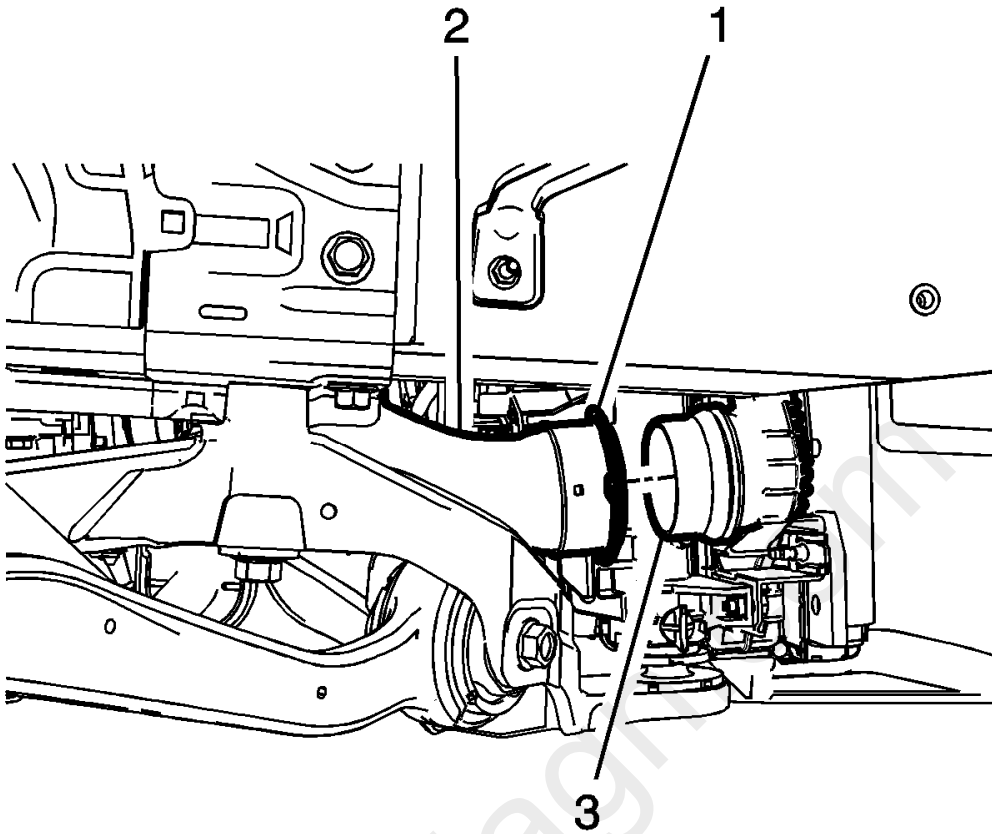


Fig. 142: Charge Air Cooler Outlet Air Tube And Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

1. Install the charge air cooler outlet air tube (2) to the vehicle.
2. Connect the charge air cooler outlet air tube (2) to the charge air cooler (3) and engage the retaining clip (1).
3. Install the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .

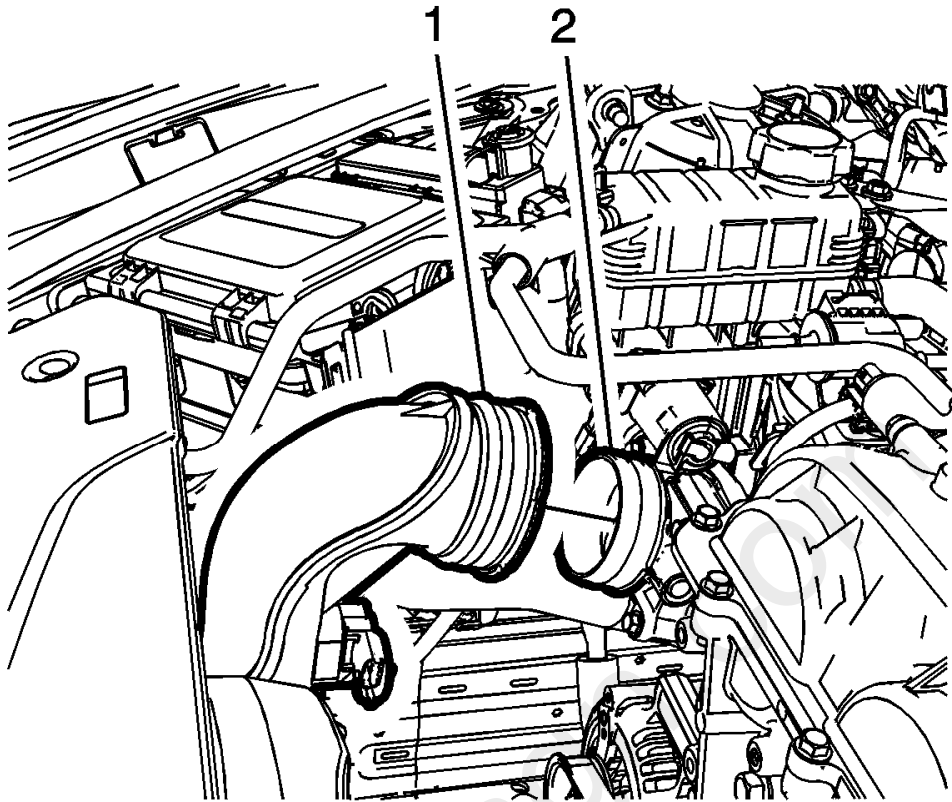


Fig. 143: Charge Air Cooler Outlet Air Tube And Throttle Body
Courtesy of GENERAL MOTORS COMPANY

NOTE: The charge air cooler is equipped with a locking collar. Rotate the charge air cooler collar clockwise to lock the charge air cooler.

4. Install the charge air cooler outlet air tube (1) to the throttle body (2) while rotating the collar clockwise.
5. Connect the intake air pressure and temperature sensor electrical connector.

CHARGE AIR COOLER INLET AIR TUBE REPLACEMENT

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
2. Loosen the clamp and disconnect the charge air cooler inlet air tube from the inlet air hose.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
4. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (AWD)** , **Front Compartment Lower Noise Shield Replacement (RWD)** .

5. Remove the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .

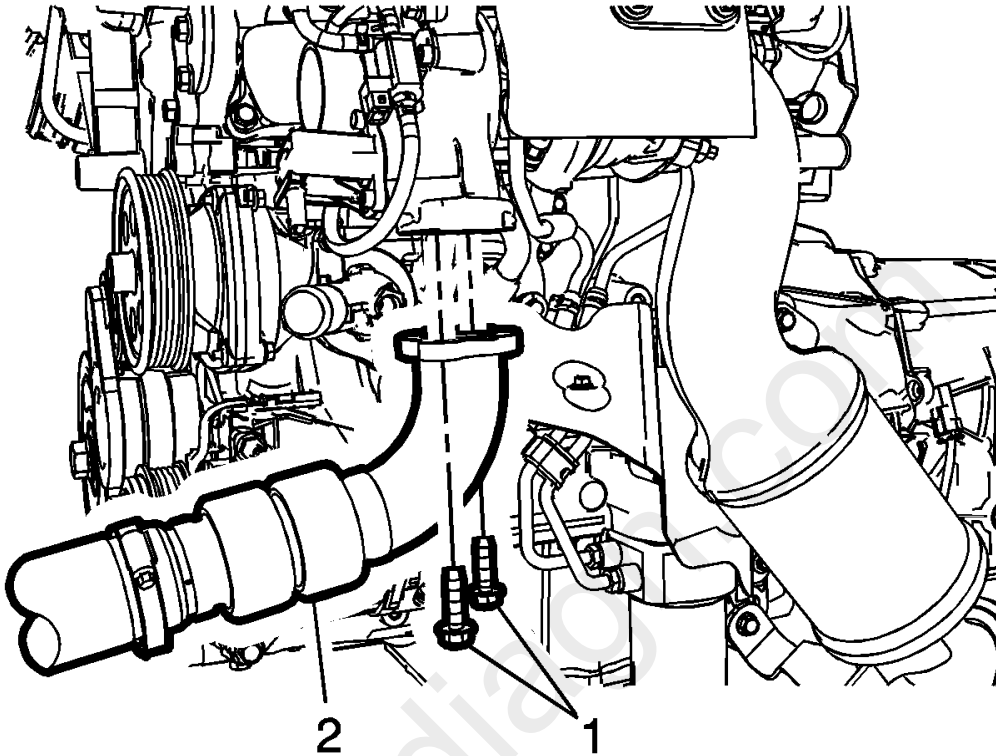


Fig. 144: Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

6. Remove the charge air cooler inlet air tube bolts (1) from the charge air cooler inlet air tube (2).
7. Lower the vehicle.
8. Remove the charge air cooler inlet air tube from the turbocharger.

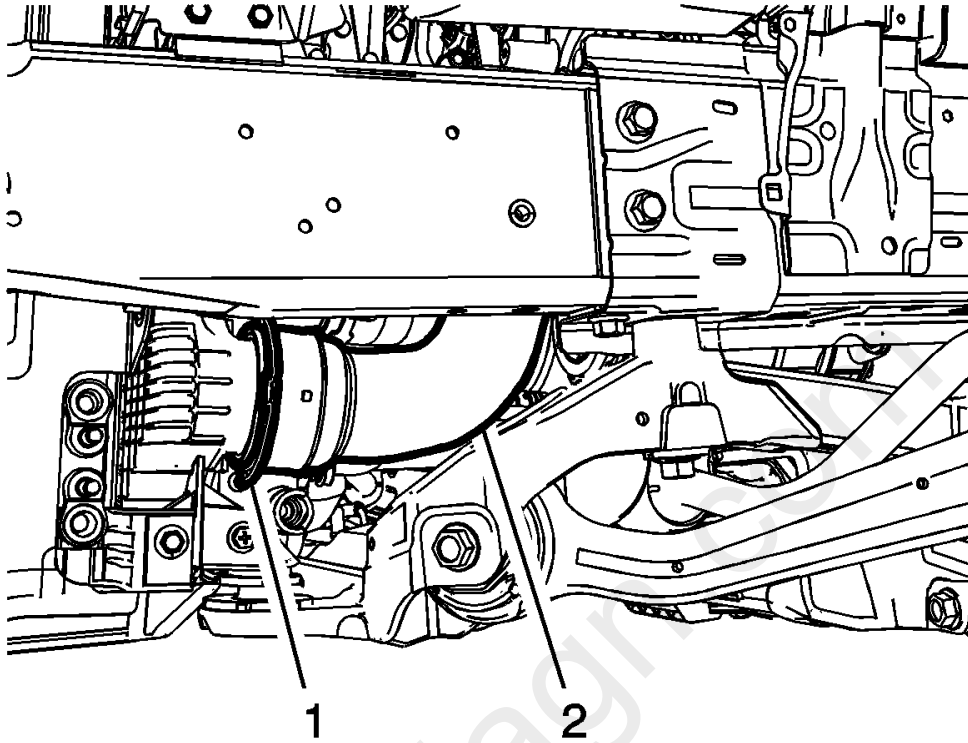


Fig. 145: Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

9. Pull the release clip (1) outward and disconnect the charge air cooler inlet air tube (2) from the charge air cooler.
10. Remove the charge air cooler inlet air tube (2) from the vehicle.

Installation Procedure

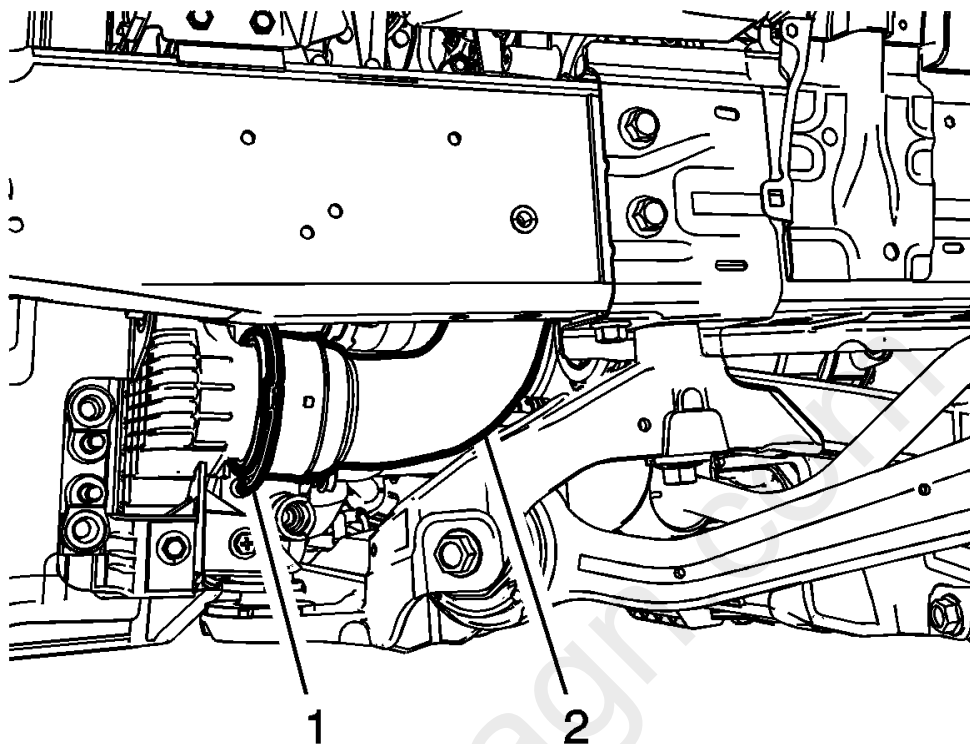


Fig. 146: Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install the charge air cooler inlet air tube (2) to the vehicle.
2. Connect the charge air cooler inlet air tube (2) to the charge air cooler and engage the retaining clip (1).
3. Install the charge air cooler inlet air tube to the turbocharger.
4. Raise the vehicle.

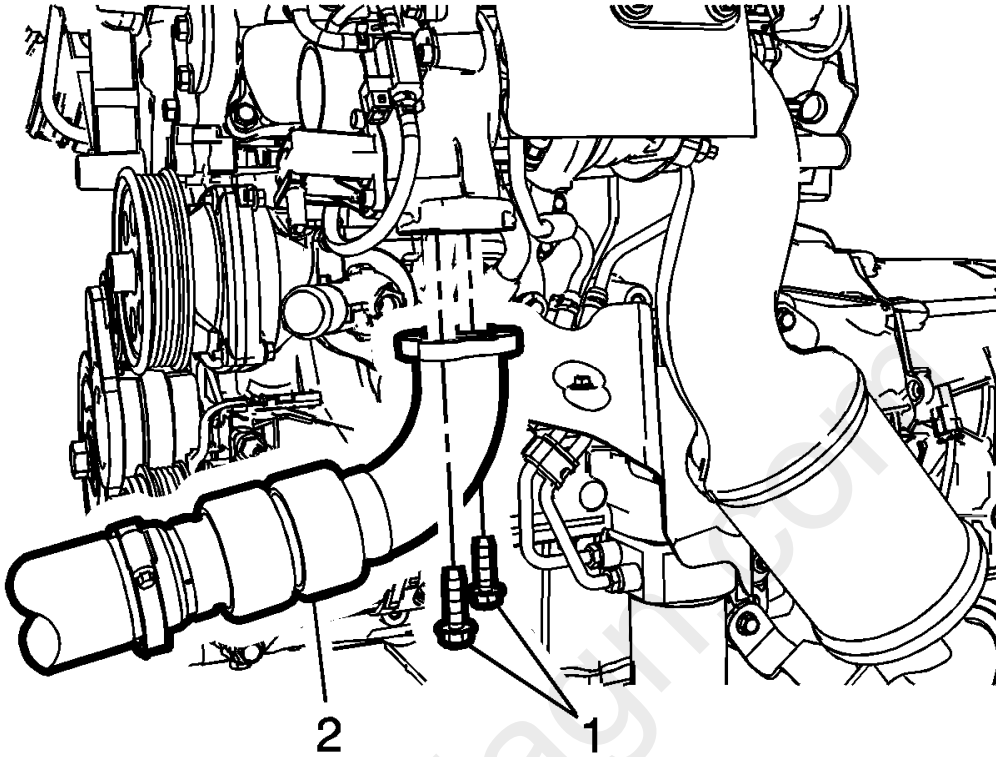


Fig. 147: Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the charge air cooler inlet air tube bolts (1) to the charge air cooler inlet air tube (2) and tighten to 10 (89 lb in).
6. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
7. Install the front compartment lower noise shield. Refer to Front Compartment Lower Noise Shield Replacement (AWD) , Front Compartment Lower Noise Shield Replacement (RWD) .
8. Lower the vehicle.
9. Install the clamp and connect the charge air cooler inlet air tube to the inlet air hose.
10. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.

CHARGE AIR COOLER RADIATOR REPLACEMENT

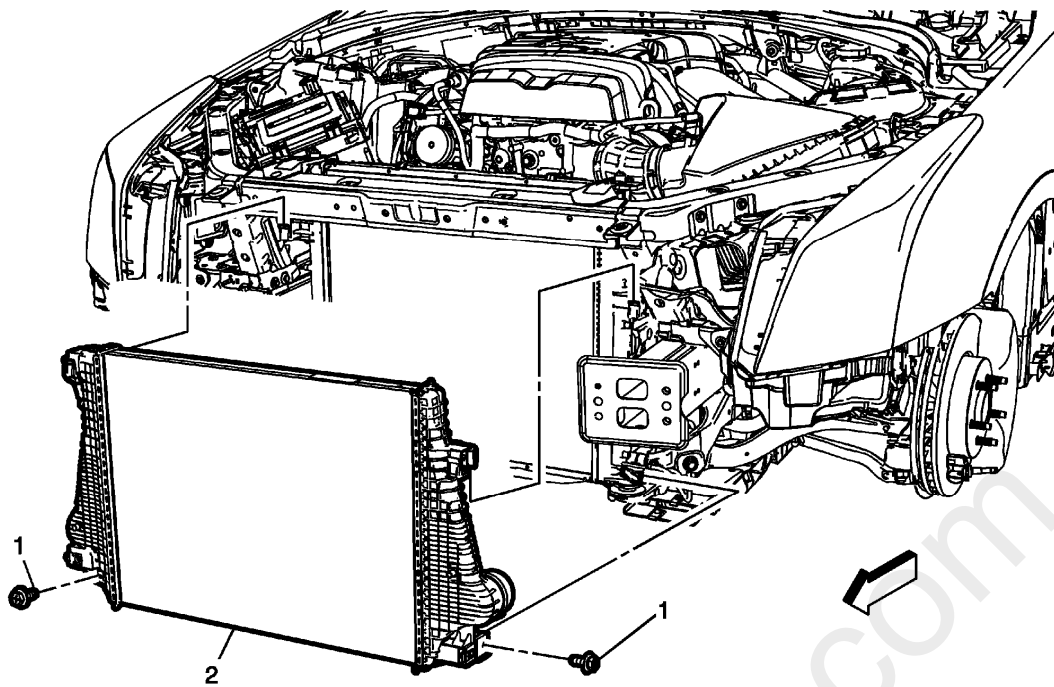


Fig. 148: Charge Air Cooler Radiator
 Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Radiator Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the air conditioning condenser. Refer to <u>Air Conditioning Condenser Replacement (LTG with V03)</u> , <u>Air Conditioning Condenser Replacement (LFX with V03)</u> , <u>Air Conditioning Condenser Replacement (LFX without V03)</u> , <u>Air Conditioning Condenser Replacement (LF3 with V03)</u> , <u>Air Conditioning Condenser Replacement (LTG without V03)</u> . 2. Remove the charge air cooler inlet air tube. Refer to <u>Charge Air Cooler Inlet Air Tube Replacement.</u> 3. Remove the charge air cooler outlet air tube. Refer to <u>Charge Air Cooler Outlet Air Tube Replacement.</u>	
1	Charge Air Cooler Radiator Bolts (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Charge Air Cooler Radiator