

ENGINE PERFORMANCE

Engine Controls and Fuel - 6.2L (LT1) - Repair Instructions - Corvette

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR LEARN

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.

ENGINE CONTROL MODULE REPLACEMENT

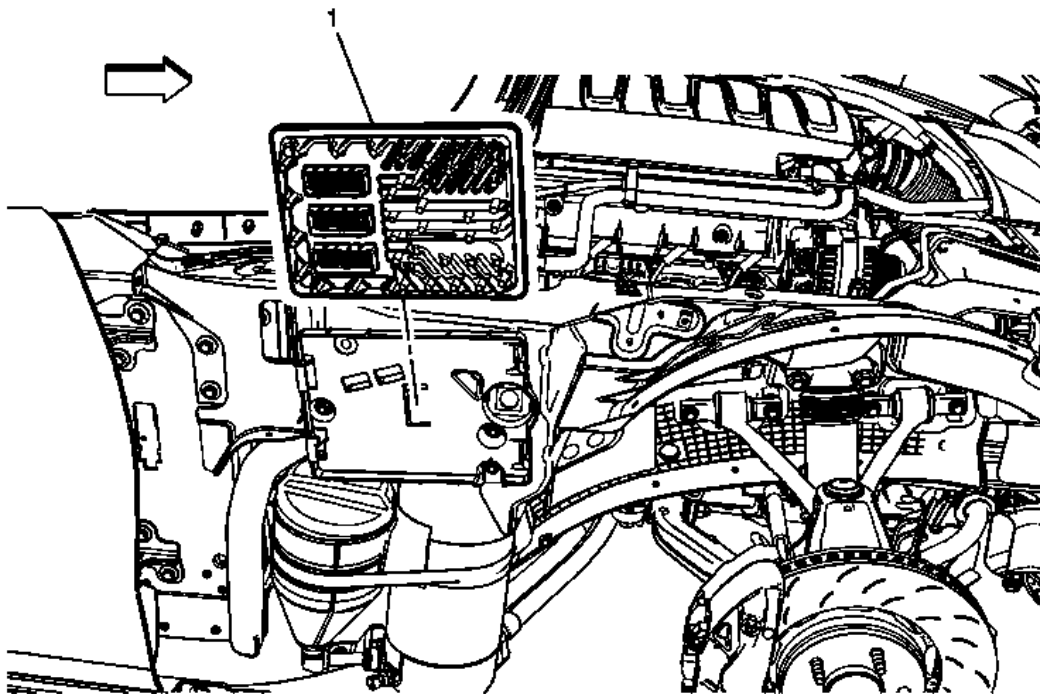


Fig. 1: Engine Control Module
 Courtesy of GENERAL MOTORS COMPANY

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 wheelhouse liner. Refer to <u>Front Wheelhouse Liner Replacement</u> .	
	Electronic Control Module WARNING: Refer to <u>Safety Glasses Warning</u> . 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

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- 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. Release the retaining tab to release ECM from bracket.
3. 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.

CHASSIS CONTROL MODULE REPLACEMENT

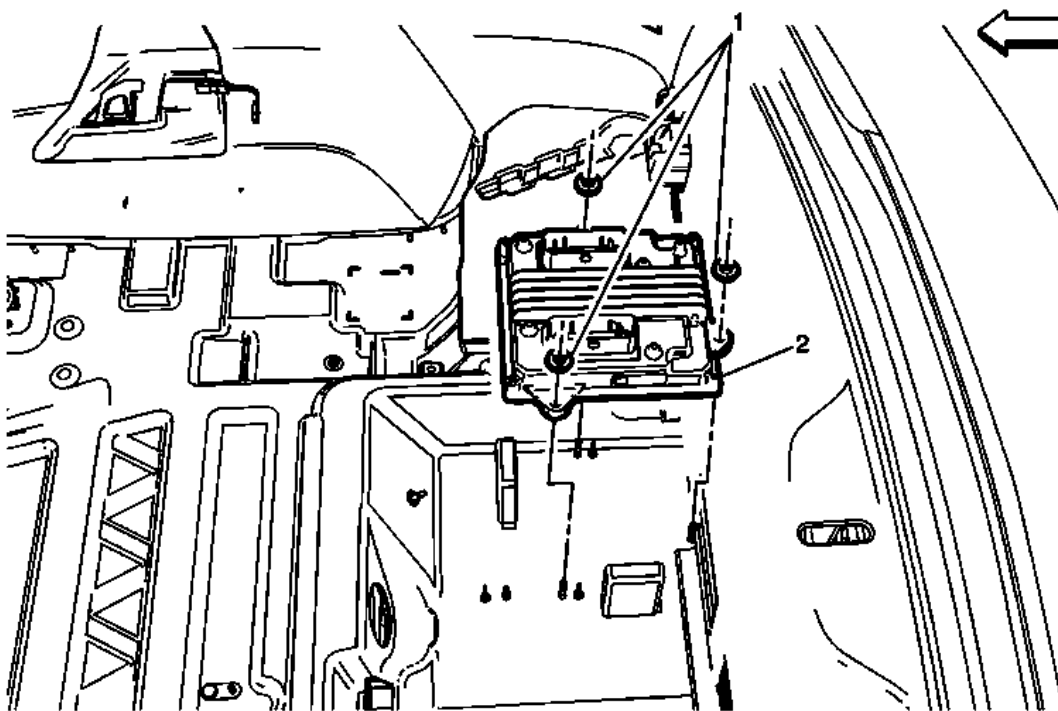


Fig. 2: Chassis Control Module
 Courtesy of GENERAL MOTORS COMPANY

Chassis Control Module Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the rear compartment floor panel trim. Refer to <u>Rear Compartment Floor Panel Trim Replacement (North America)</u> , <u>Rear Compartment Floor Panel Trim Replacement (Export - CU9, CV5, CZ3, C4E)</u> . 2. Disconnect the chassis control module electrical connector.	
1	Chassis Control Module Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 6 (53 lb in)
2	Chassis Control Module Procedure If replacing chassis control module, program the control module. Refer to <u>Control Module References</u>

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

- A crankshaft position sensor replacement
- An engine control module (ECM) replacement
- An engine replacement
- A crankshaft balancer replacement
- A crankshaft 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 System Variation Learn Procedure.

1. Ignition ON, observe the DTC information with a scan tool. Verify no other DTCs are set, except DTCs P0300-P0308 or P0315.
 - If DTCs are set, except DTCs P0300-P0308 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.

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 learn out 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 minutes.

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 seconds.
5. Start and idle the engine for 3 minutes.
6. After the 3 minute 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 seconds and repeat step 6.
 8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

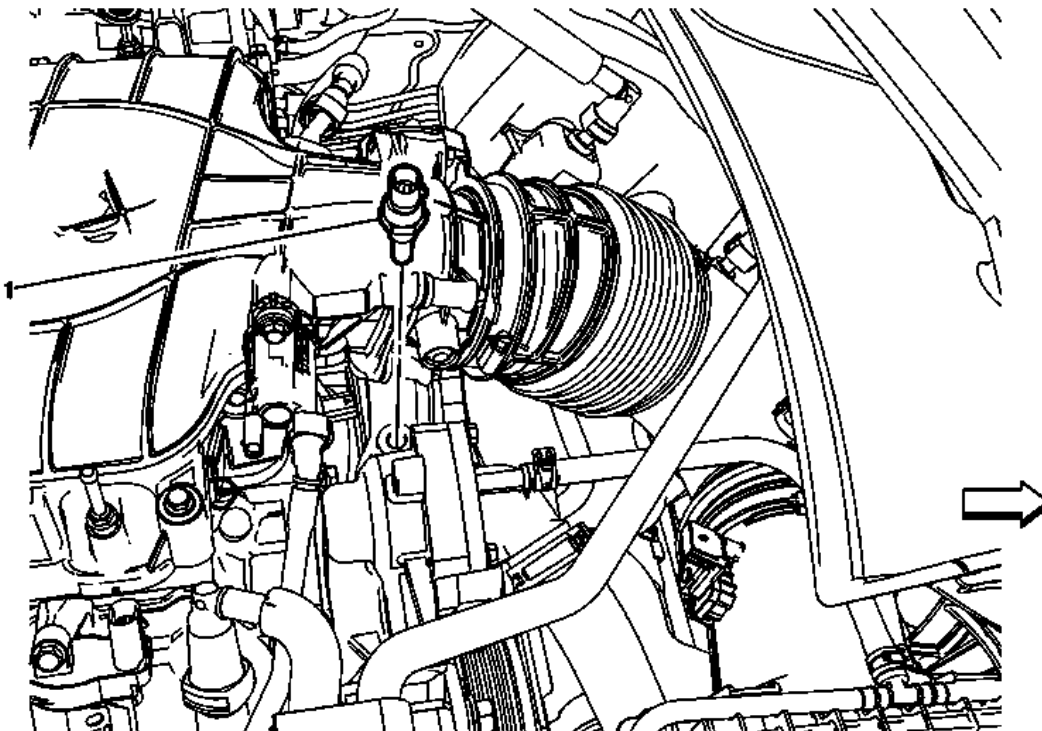


Fig. 3: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (Right)</u> , <u>Intake Manifold Cover Replacement (Left)</u> . 2. Drain the engine coolant. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector from the engine coolant temperature sensor. Tighten 20 (15 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

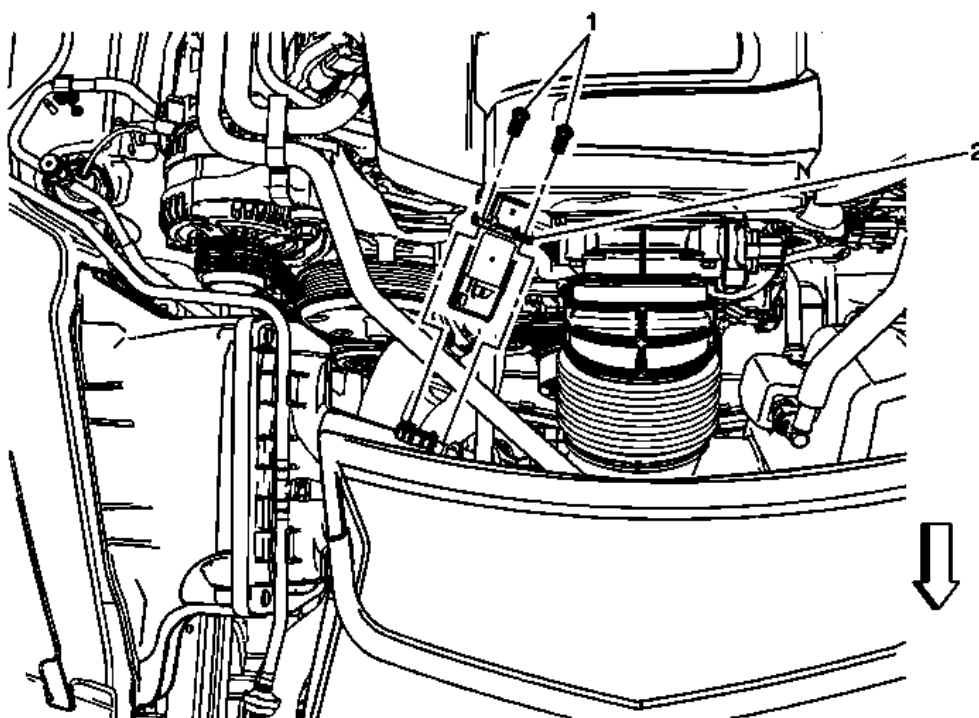


Fig. 4: Mass Airflow Sensor With Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 N.m (35 lb in)
2	Mass Airflow Sensor Procedure Disconnect the mass airflow harness connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

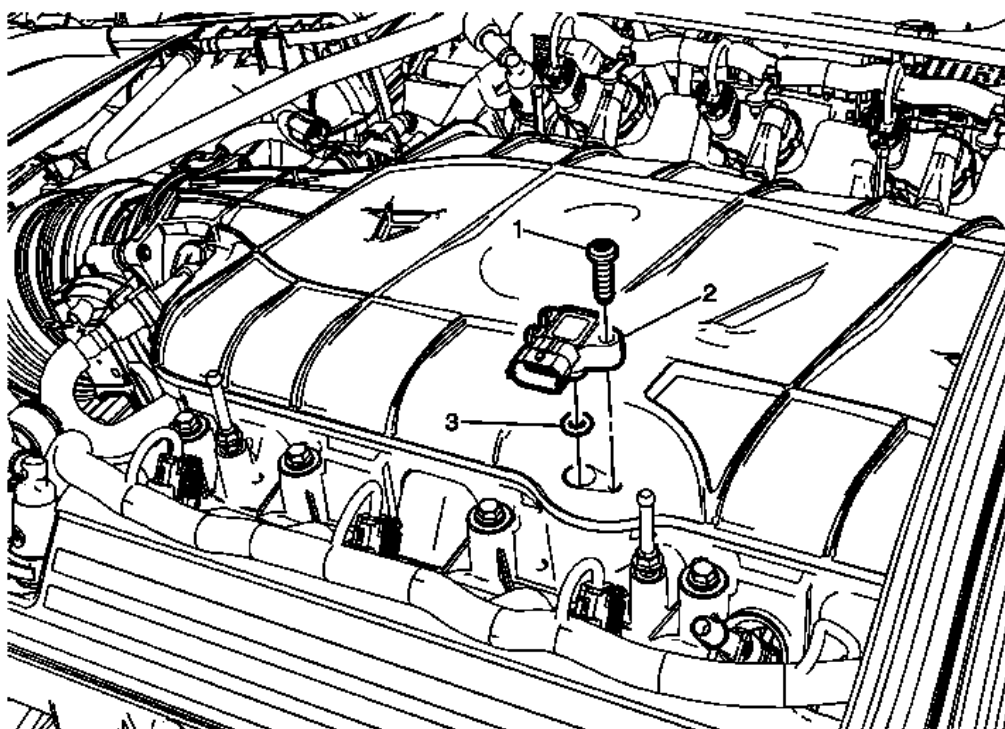


Fig. 5: Manifold Absolute Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (Right)</u> , <u>Intake Manifold Cover Replacement (Left)</u> .	

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4.5 (40 lb in)
2	Manifold Absolute Pressure Sensor Procedure Disconnect the electrical connector from the manifold absolute pressure sensor.
3	Manifold Absolute Pressure Sensor Seal NOTE: Always install the NEW seal supplied with the sensor.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

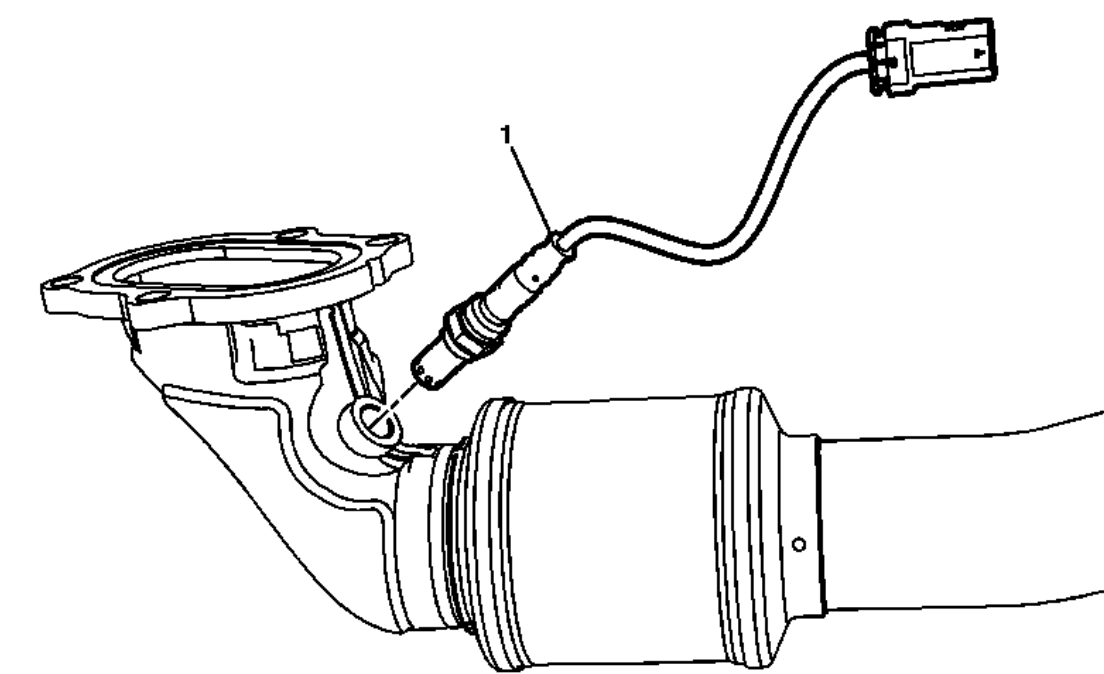


Fig. 6: Heated Oxygen Sensor - Bank 1 Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

Callout	Component Name
Preliminary Procedure Remove the left side catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side</u> .	

Oxygen Sensor

CAUTION:

Refer to Component Fastener Tightening Caution .

CAUTION:

Refer to Heated Oxygen and Oxygen Sensor Caution .

Procedure

1

1. Disconnect the heated oxygen sensor electrical connector.
2. If re-installing the original sensor, coat the sensor threads with anti-seize.
Refer to Adhesives, Fluids, Lubricants and Sealers .

NOTE:

A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

Tighten

42 (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

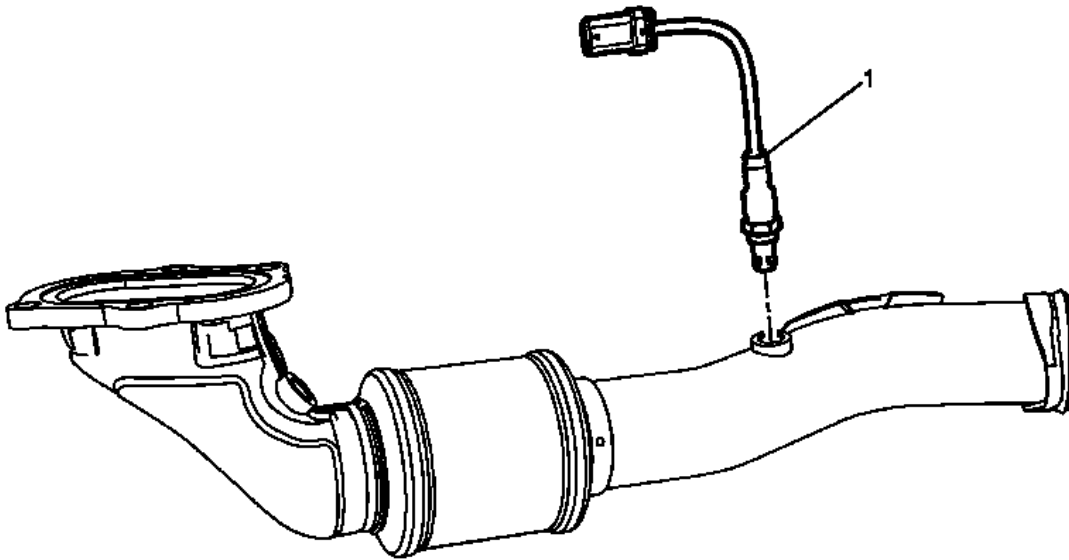


Fig. 7: Heated Oxygen Sensor - Bank 1 Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

Callout	Component Name
Preliminary Procedure Remove the left side catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side</u> .	
1	Oxygen Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . Procedure 1. Disconnect the heated oxygen sensor electrical connector. 2. If re-installing the original sensor, coat the sensor threads with anti-seize. Refer to <u>Adhesives, Fluids, Lubricants and Sealers</u> . NOTE:

A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

Tighten
42 (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

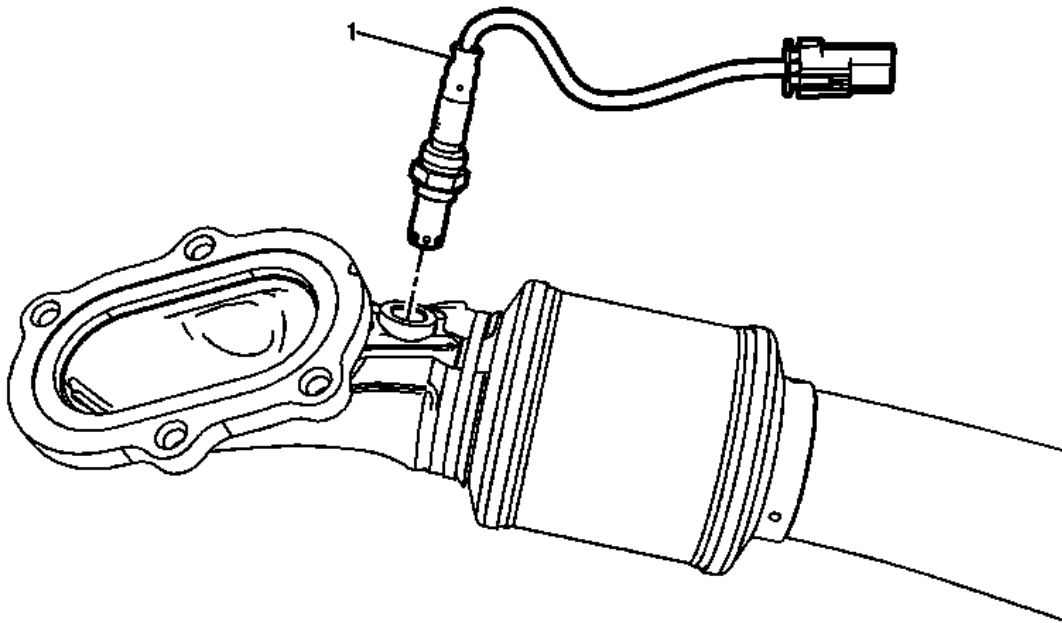


Fig. 8: Heated Oxygen Sensor - Bank 2 Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 1

Callout	Component Name
Preliminary Procedure	
Remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side</u> .	
	Oxygen Sensor
	CAUTION:

CAUTION:

Refer to Heated Oxygen and Oxygen Sensor Caution .

Procedure

1. Disconnect the heated oxygen sensor electrical connector.
2. If re-installing the original sensor, coat the sensor threads with anti-seize.
Refer to Adhesives, Fluids, Lubricants and Sealers .

1

NOTE:

A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

Tighten

42 (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

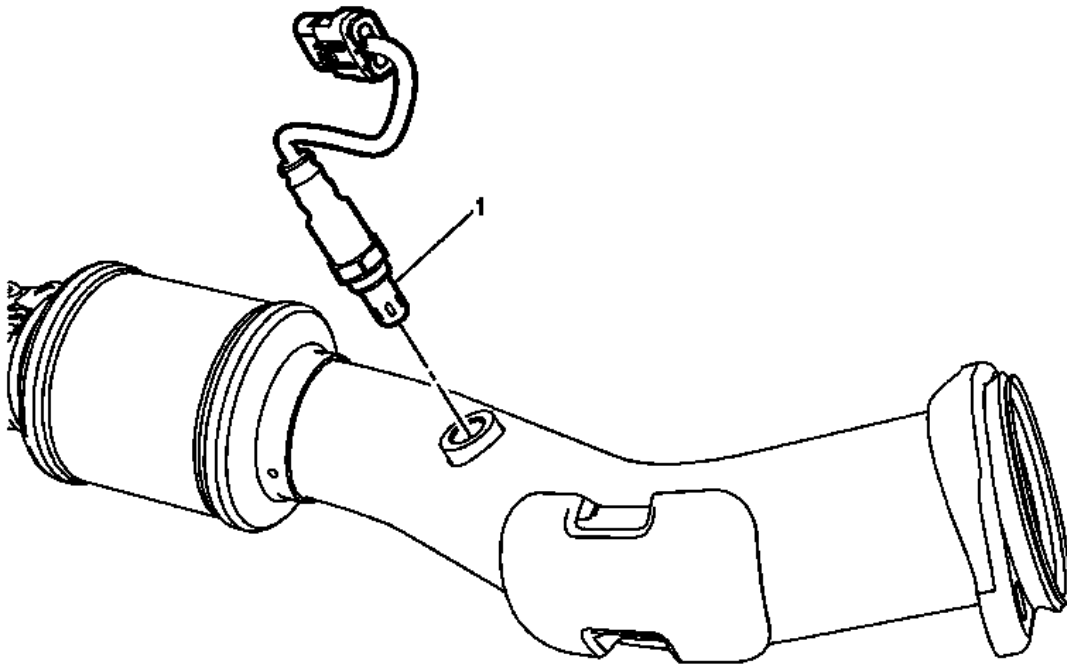


Fig. 9: Heated Oxygen Sensor - Bank 2 Sensor 2

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

Callout	Component Name
Preliminary Procedure Remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side</u> .	
1	Oxygen Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . Procedure 1. Disconnect the heated oxygen sensor electrical connector. 2. If re-installing the original sensor, coat the sensor threads with anti-seize. Refer to <u>Adhesives, Fluids, Lubricants and Sealers</u> . NOTE: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. Tighten 42 (31 lb ft)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

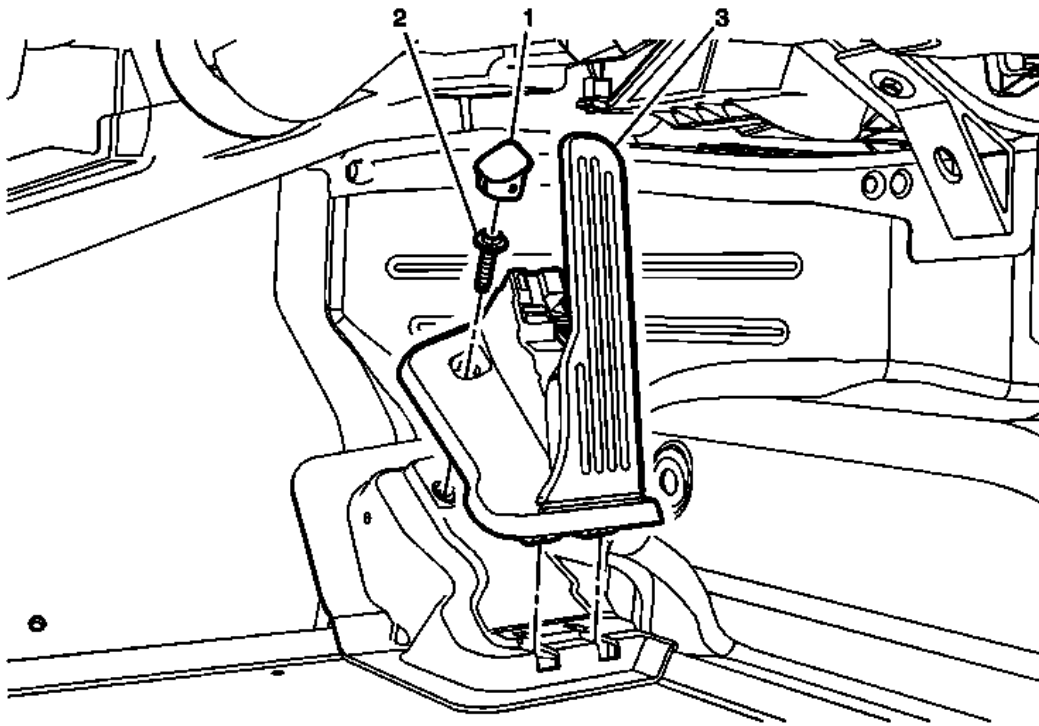


Fig. 10: Accelerator Pedal Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Accelerator Pedal Position Sensor 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

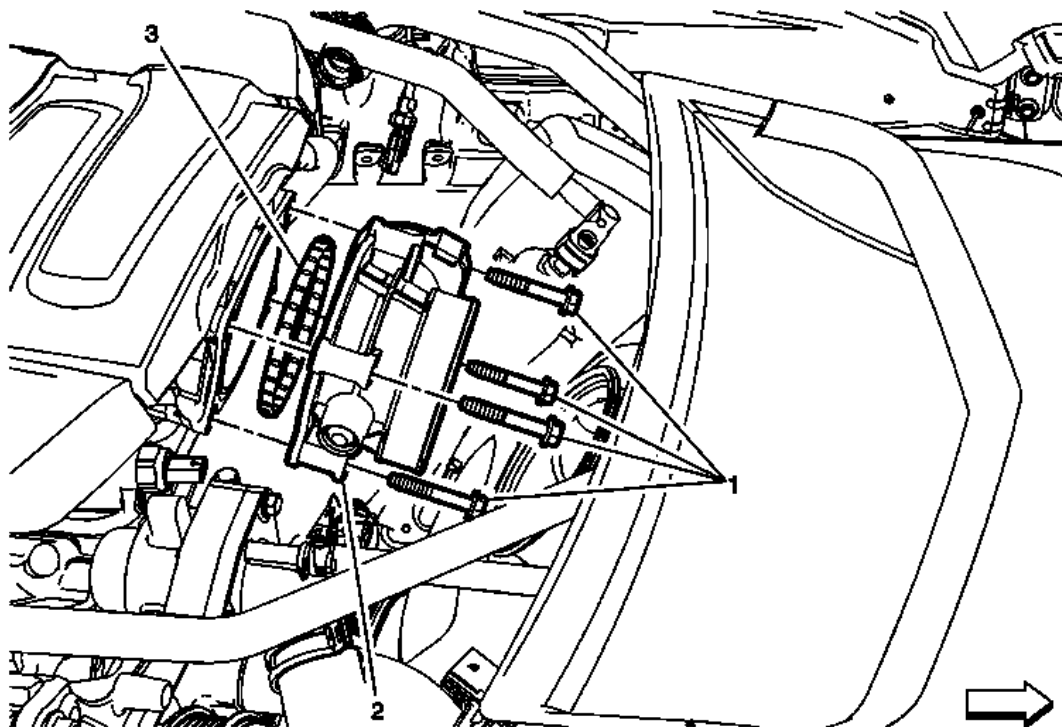


Fig. 11: Throttle Body Assembly
 Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. An 8-digit part identification number is stamped on the throttle body casting. Refer to this number if servicing or if a part replacement is required.	
1	Throttle Body Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 (106 lb in)
	Throttle Body CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the

2	Procedure 1. Disconnect the throttle body harness connector. 2. Perform the throttle learn procedure. Refer to <u>Q38 Throttle Body: Throttle/Idle Learn</u>. NOTE: In order to prevent possible contamination, cover or plug any opening when servicing the throttle body. NOTE: If re-installing the throttle body and cleaning is required, refer to <u>Throttle Body Cleaning</u>.
3	Throttle Body Seal Procedure Install a NEW throttle body seal.

THROTTLE BODY CLEANING

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

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
2. Fully open the throttle valve in order to inspect the throttle body bore and the throttle valve plate for any deposits.

CAUTION: Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

- Throttle position (TP) sensor
- Idle air control (IAC) valve
- Sealed throttle shaft bearings

The cleaners will damage the electric components or sensors.

The cleaners will damage some of these components that contain seals or O-rings.

Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.

Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.

Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

3. Use a clean shop towel and an approved GM engine cleaner. Clean the throttle body bore and the throttle valve plate.

If necessary, use a parts cleaning brush in order to remove heavy deposits.

4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the throttle idle learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn**.

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

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

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 (Right)** , **Intake Manifold Cover Replacement (Left)** .
4. Install the **J 42982** adapter between the fuel feed pipe of the fuel rail and of the fuel feed hose.

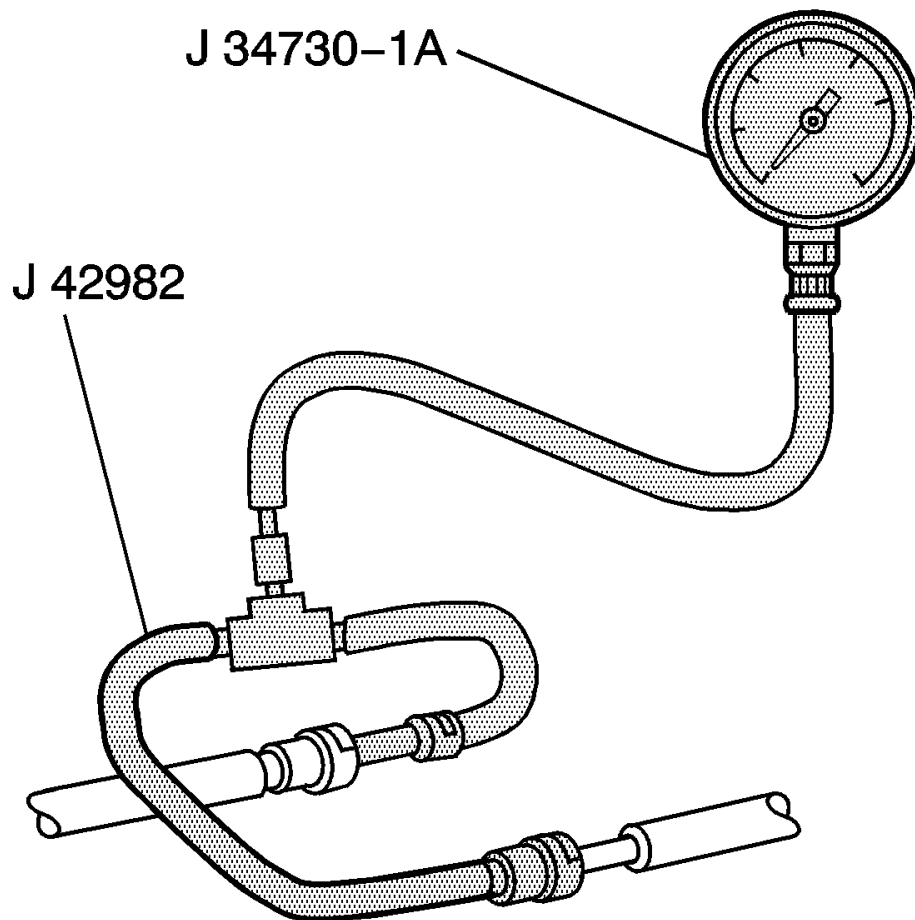


Fig. 12: Fuel Pressure Gage
Courtesy of GENERAL MOTORS COMPANY

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

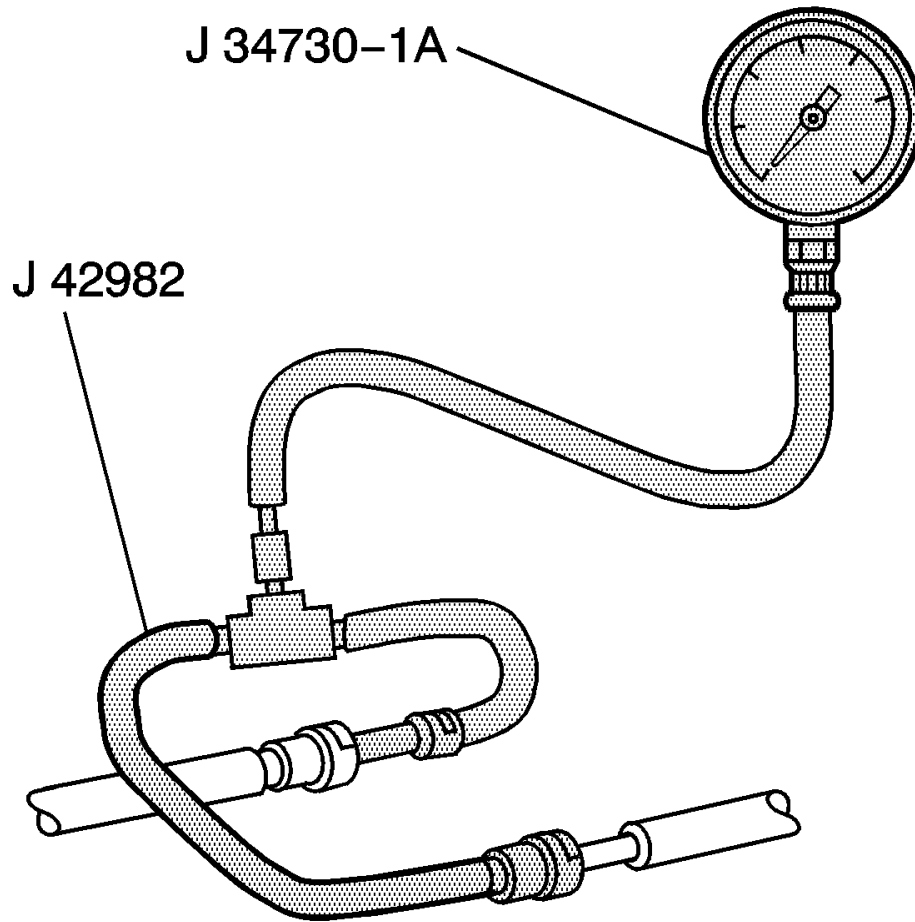


Fig. 13: Fuel Pressure Gage
Courtesy of GENERAL MOTORS COMPANY

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 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 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 (Right)** , **Intake Manifold Cover Replacement (Left)** .

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.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

EN-37088-A Fuel Line Disconnect Tool Set

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

Removal Procedure

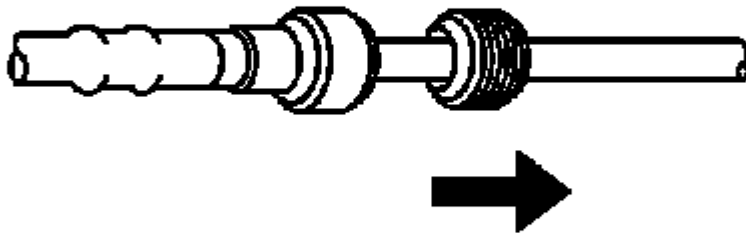


Fig. 14: Sliding Dust Cover From Quick-Connect Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the **Fuel Pressure Relief**.
2. Slide the dust cover from the quick connect fitting.

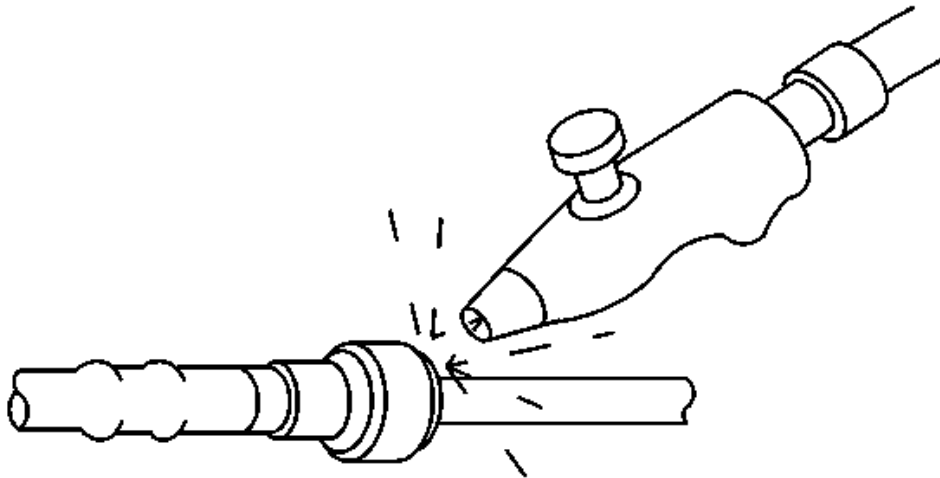


Fig. 15: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Wear safety glasses when using compressed air in order to prevent eye injury.

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

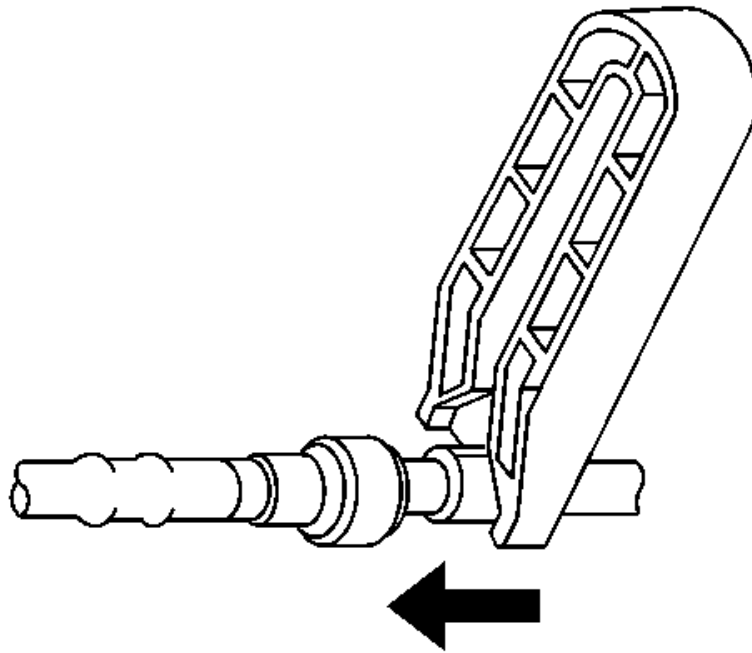


Fig. 16: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Choose the correct tool from the **EN-37088-A** Fuel Line Disconnect Tool Set Tool Set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

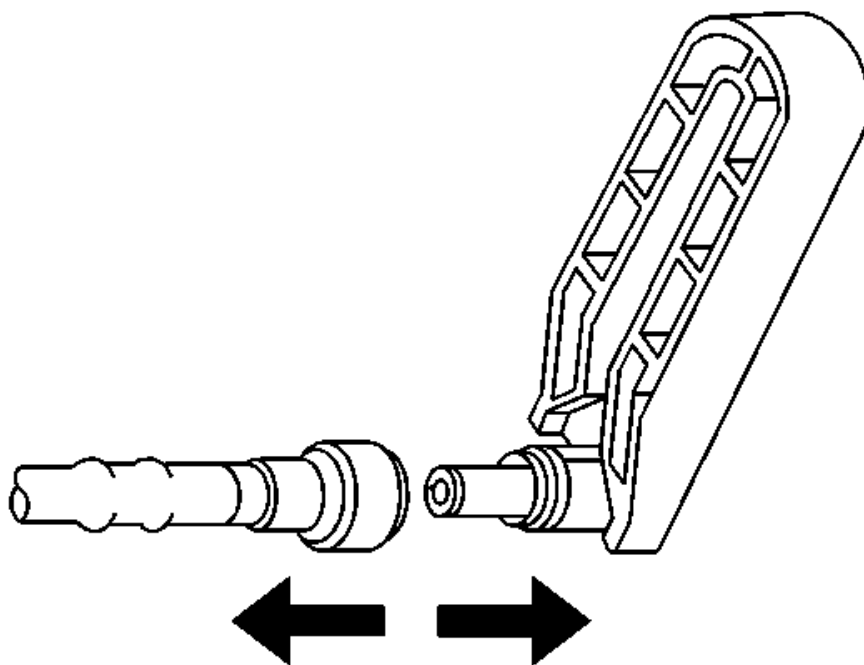


Fig. 17: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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. Clean or replace the components as required.

Installation Procedure

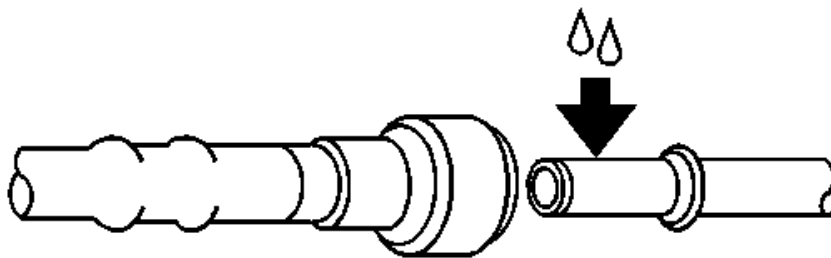


Fig. 18: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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

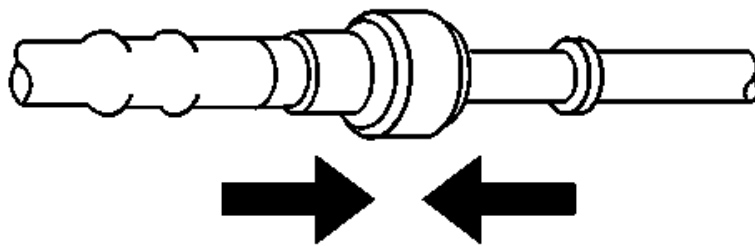


Fig. 19: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the fitting together in order to cause the retaining tabs to snap into place.

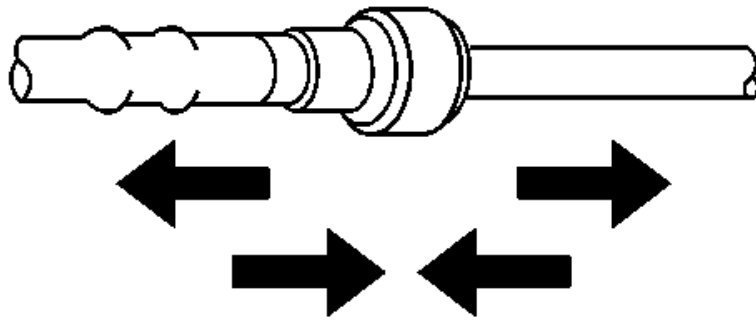


Fig. 20: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

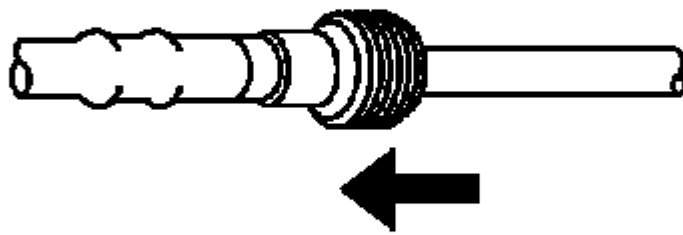


Fig. 21: Installing Dust Cover Over Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Reposition the dust cover over the quick connect fitting.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

EN-37088-A Fuel Line Disconnect Tool Set

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

Removal Procedure

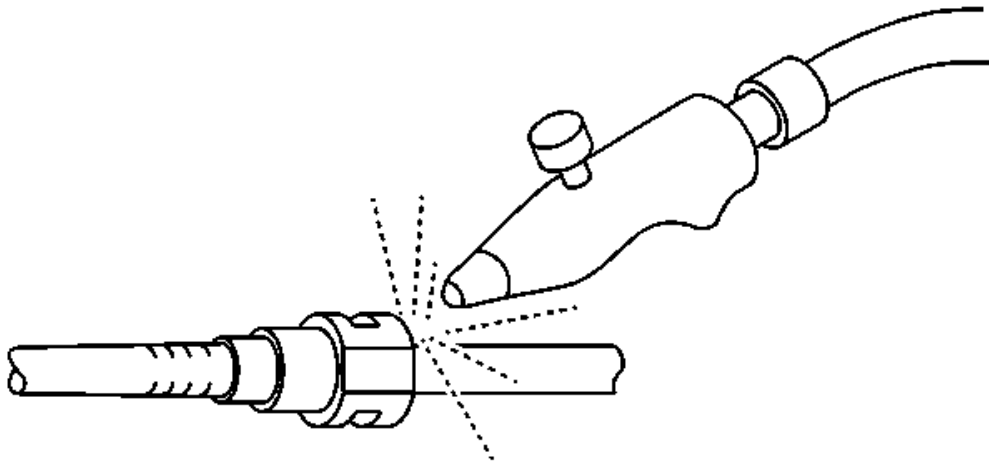


Fig. 22: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the **Fuel Pressure Relief**.

WARNING: Wear safety glasses when using compressed air in order to prevent eye injury.

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

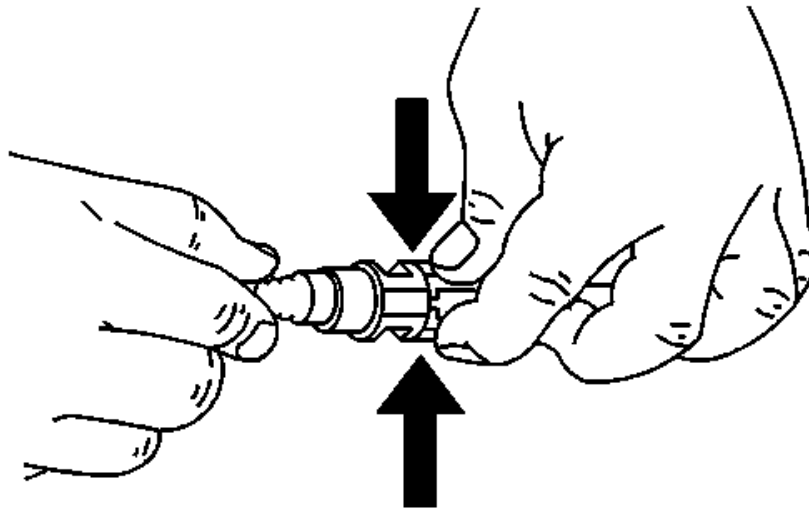


Fig. 23: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Plastic quick connect fittings can be released either by squeezing the plastic retainer release tabs (step 3) or by using the appropriate EN-37088-A Fuel Line Disconnect Tool Set (step 4).

3. Squeeze the plastic retainer release tabs.

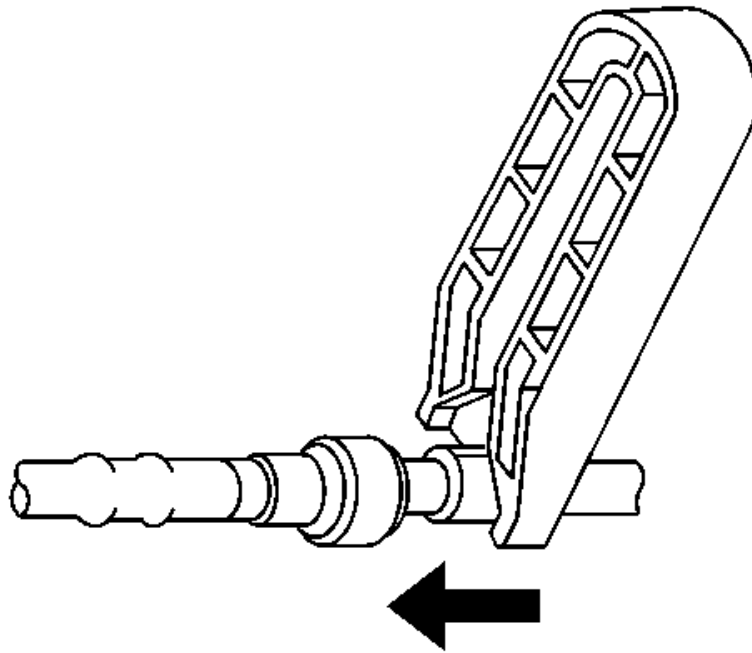


Fig. 24: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Choose the correct tool from the **EN-37088-A** Fuel Line Disconnect Tool Set Tool Set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs. The plastic retainer will remain on the female connector.

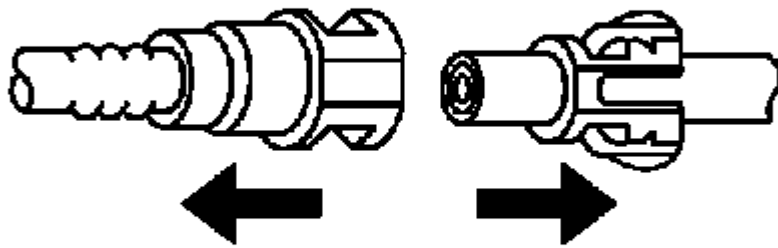


Fig. 25: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

Installation Procedure

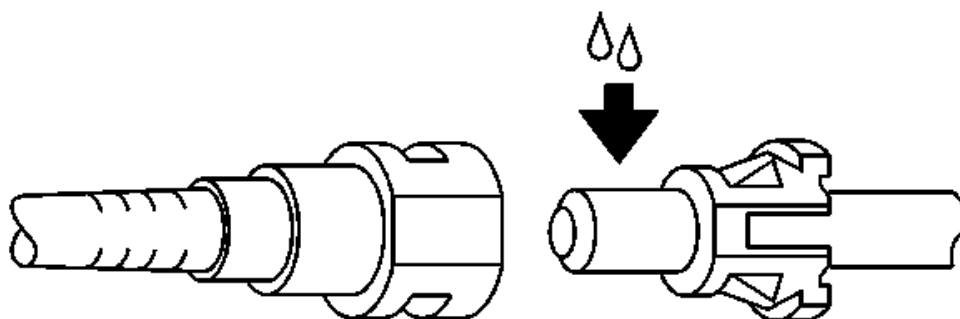


Fig. 26: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

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 fuel pipe end.

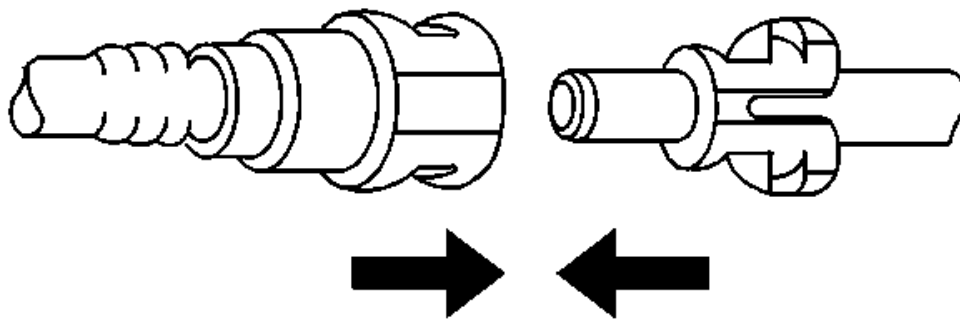


Fig. 27: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

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

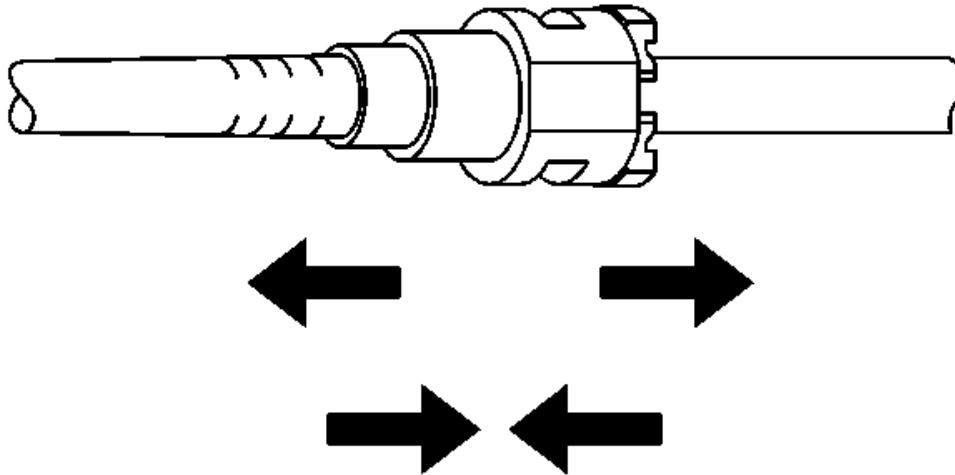


Fig. 28: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the quick-connect fitting in order to make sure the connection is secure.

FUEL TANK DRAINING

Special Tools

CH-45004 Fuel Tank Drain Hose

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

Draining Procedure

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: Drain the fuel tank to at least 3/4 of a tank before removing the fuel sender retaining ring or fuel sender access panel in order to avoid possible fuel spillage. Failing to follow this procedure could result in personal injury.

CAUTION: Drain the fuel tank with a hose which has a 13 mm (0.5 in) or smaller diameter in order to prevent the drain hose from getting stuck inside the fuel tank filler neck pipe check valve. Damage to the check valve may result.

CAUTION: Drain the fuel from the complete system, including injector nozzle(s), the fuel pump, all fuel pipes and the fuel tank if a vehicle is to be stored for any appreciable length of time. Draining the fuel will prevent the formations of fuel system deposits.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel tank filler hose. Refer to **Fuel Tank Filler Hose Replacement**.
3. Drain the LH fuel tank through the fuel tank filler pipe using a hand or air operated fuel pump device and the **CH-45004** Fuel Tank Drain Hose.
4. Remove the transmission. Refer to **Transmission Replacement**.
5. Remove the crossover tube/hose from the RH fuel tank. Refer to **Fuel Tank Crossover Tube Replacement**.
6. Drain the RH fuel tank through the fuel tank crossover connection using a hand or air operated fuel pump device and the **CH-45004** Fuel Tank Drain Hose.

FUEL TANK FILLER EVAPORATIVE EMISSION PIPE REPLACEMENT

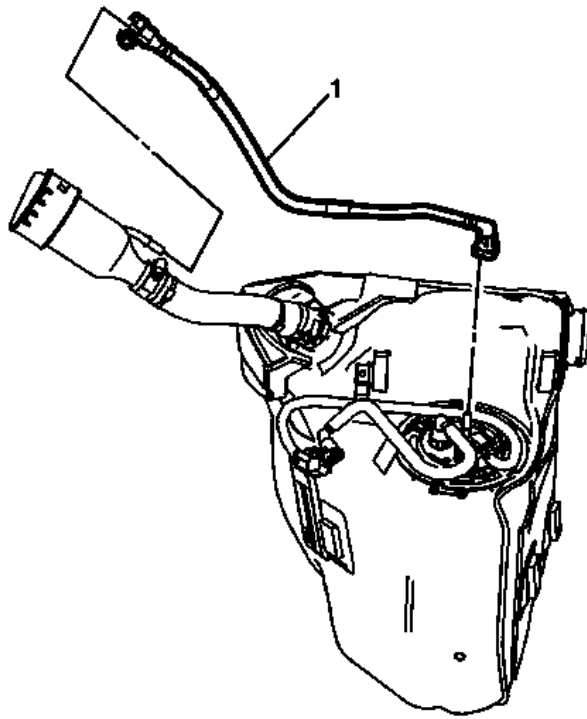


Fig. 29: Fuel Tank Filler Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Filler Evaporative Emission Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank left side. Refer to Fuel Tank Replacement - Left Side .	
1	Fuel Tank Filler Evaporative Emission Pipe Procedure Disconnect the fuel tank filler evaporative emission pipe from the fuel tank filler pipe and the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service

FUEL TANK FILLER HOSE REPLACEMENT

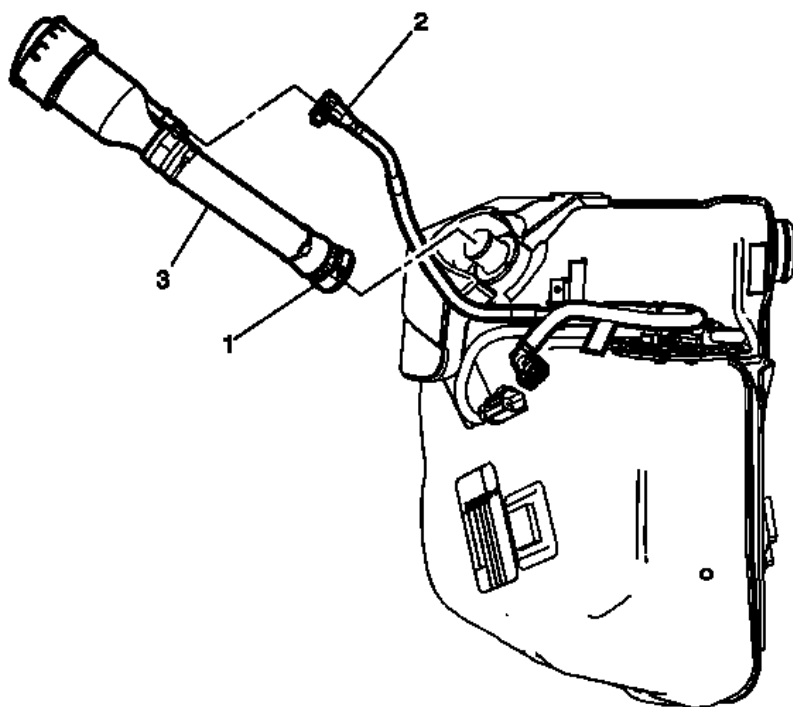


Fig. 30: Fuel Tank Filler Hose
 Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Filler Hose Replacement

Callout	Component Name
Preliminary Procedure	
Remove the fuel tank left side. Refer to Fuel Tank Replacement - Left Side .	
1	Fuel Tank Filler Hose Clamp CAUTION: Refer to Fastener Caution .
2	Fuel Tank Filler Evaporative Emission Pipe Procedure Disconnect the fuel tank filler evaporative emission pipe from the fuel tank filler hose. Refer to Plastic Collar Quick Connect Fitting Service
3	Fuel Tank Filler Hose

FUEL TANK REPLACEMENT - LEFT SIDE

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the fuel tank. Refer to **Fuel Tank Draining**.

3. Remove the left rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement** .
4. Remove both mufflers. Refer to **Exhaust Muffler Replacement - Left Side** and **Exhaust Muffler Replacement - Right Side** .
5. If equipped with manual transmission continue to step 7.
6. If equipped with automatic transmission, remove the transmission. Refer to **Transmission Replacement** .

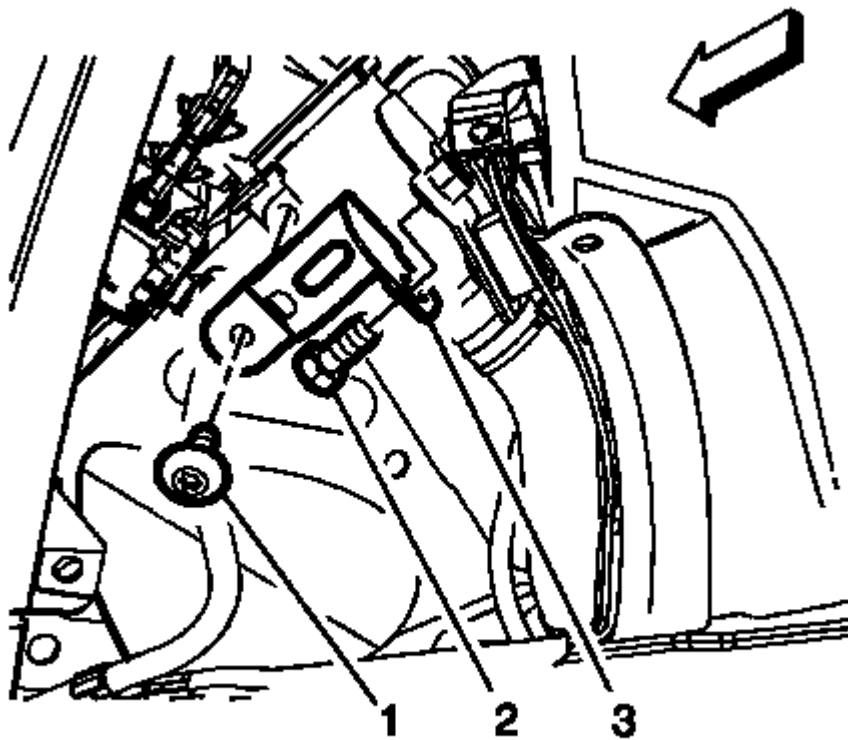


Fig. 31: Fuel Tank Filler Hose Screw And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fuel tank filler hose screw (1) and bolt (2).
8. Remove the fuel tank filler hose bracket (3).
9. Disconnect the fuel pump jumper harness connector.
10. Disconnect the fuel feed hose. Refer to **Plastic Collar Quick Connect Fitting Service**.

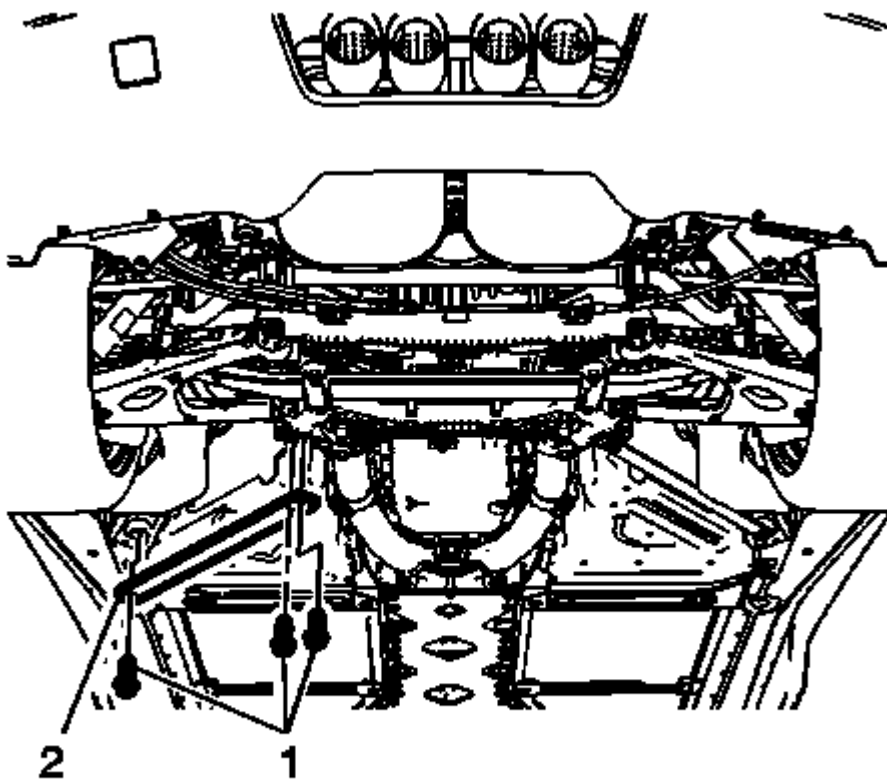


Fig. 32: Left Side Underbody Side Rail Cross Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the left side underbody side rail cross brace bolts (1).
12. Remove the left side underbody side rail cross brace (2).

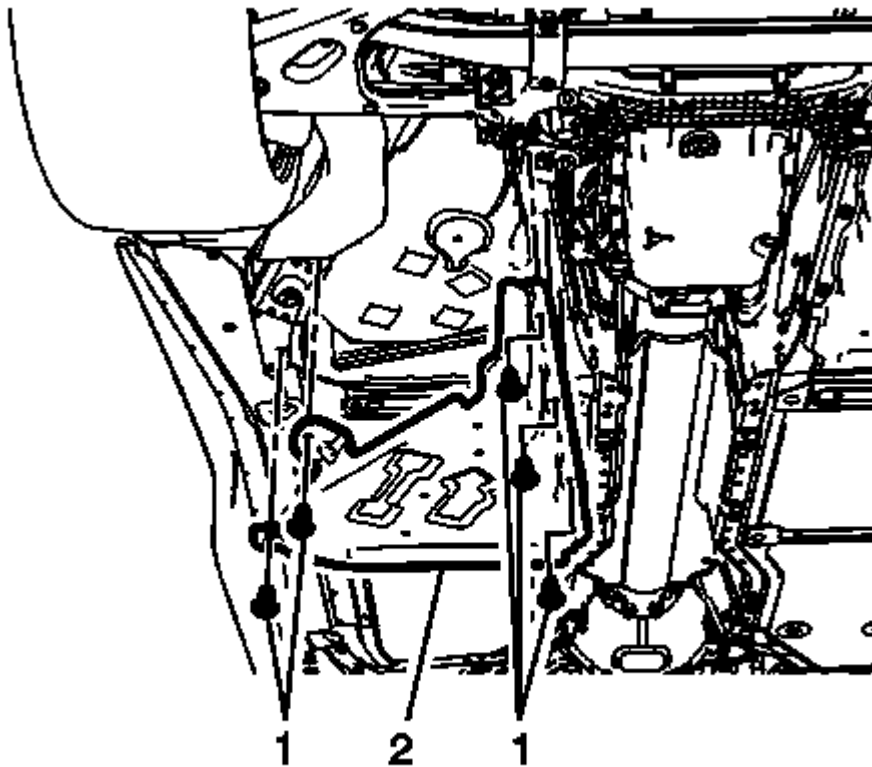


Fig. 33: Left Side Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the left side fuel tank strap bolts (1).
14. Remove the left side fuel tank strap (2).
15. Disconnect the crossover tube from the left side fuel tank. Refer to **Fuel Tank Crossover Tube Replacement**.

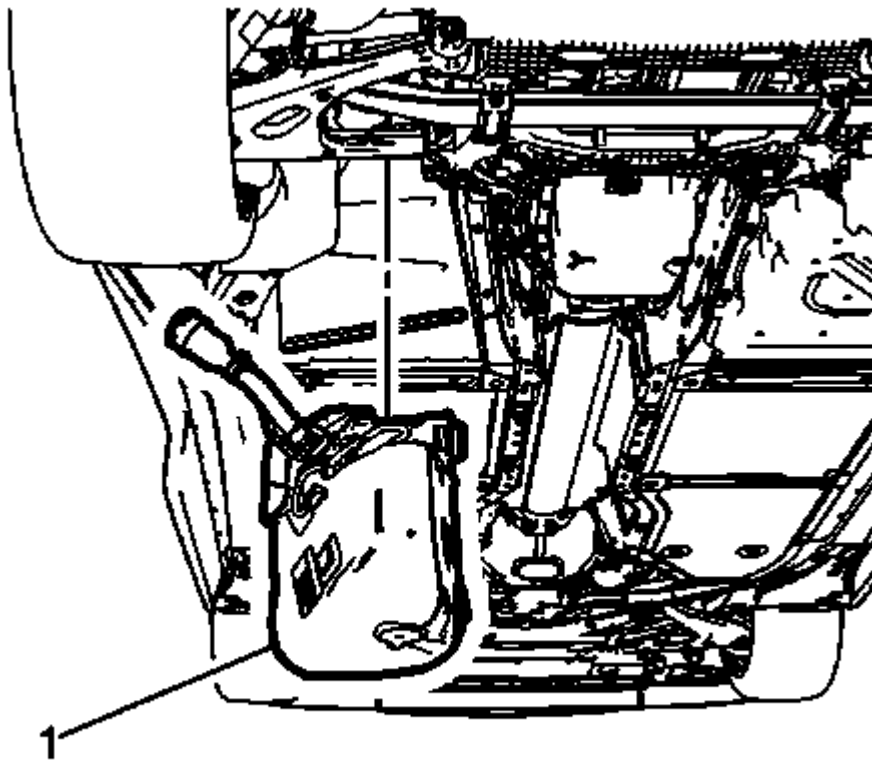


Fig. 34: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

16. Remove the fuel tank (1).

Installation Procedure

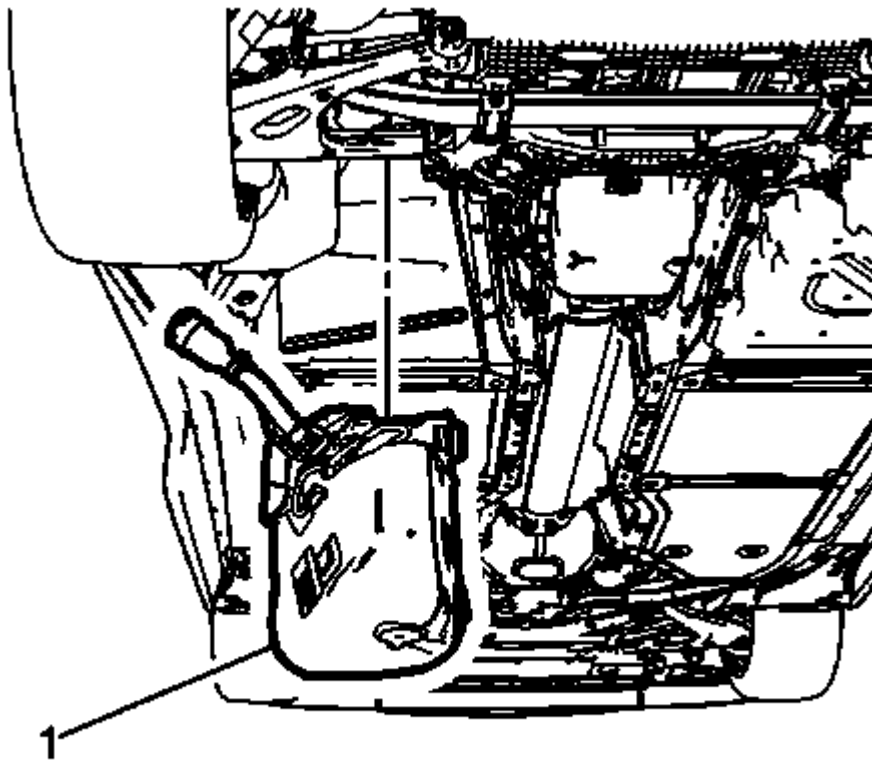


Fig. 35: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank (1).
2. Connect the crossover tube to the left side fuel tank. Refer to **Fuel Tank Crossover Tube Replacement**.

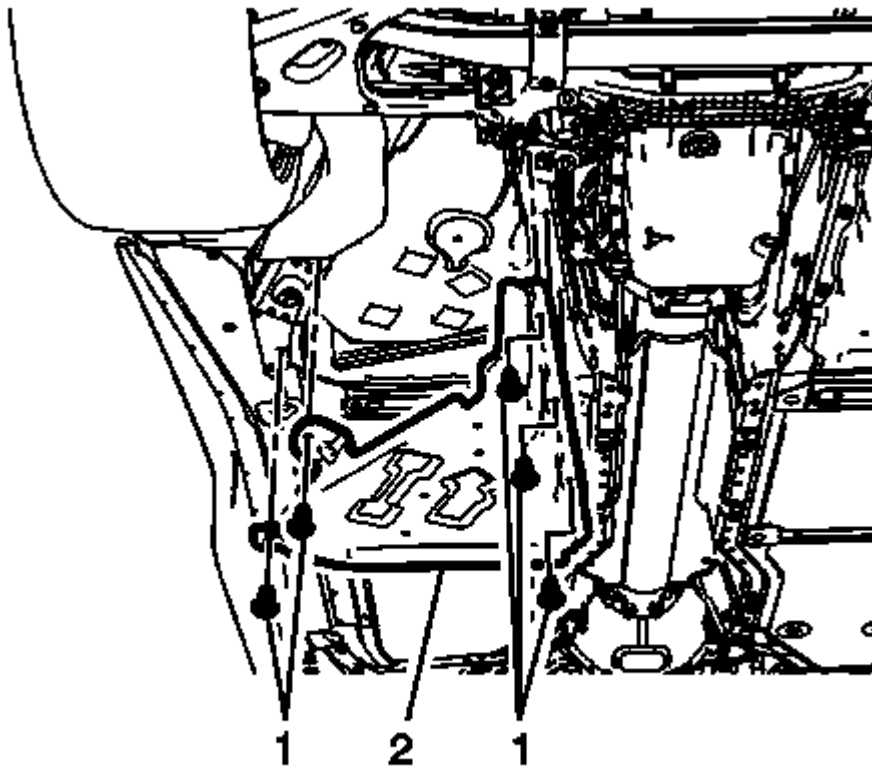


Fig. 36: Left Side Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the left side fuel tank strap (2).

CAUTION: Refer to Fastener Caution .

4. Install the left side fuel tank strap bolts (1) and tighten to 25 (18 lb ft).

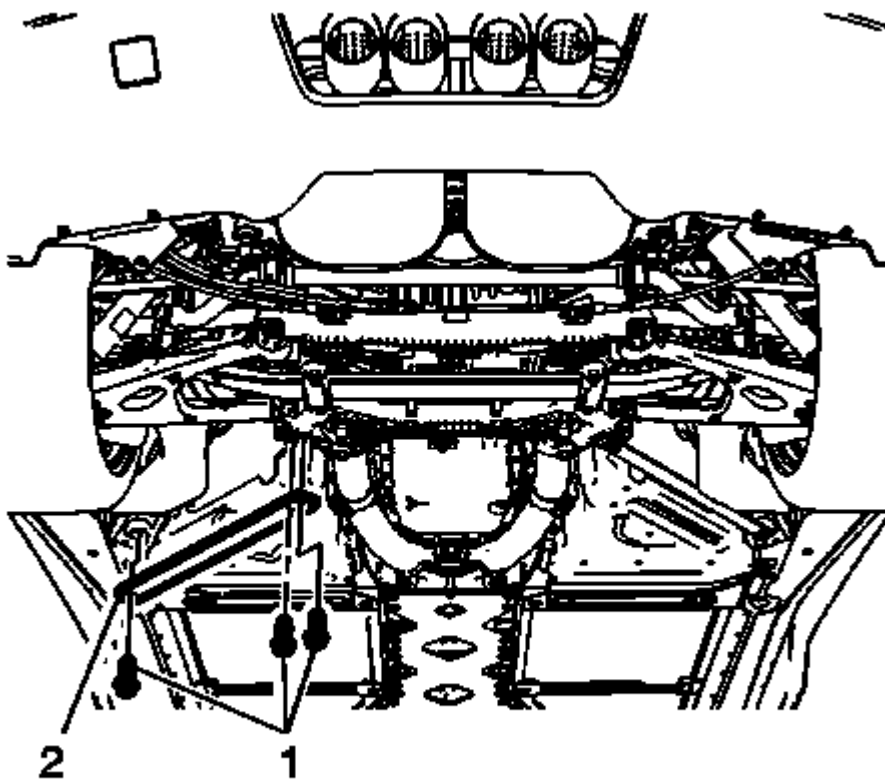


Fig. 37: Left Side Underbody Side Rail Cross Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the left side underbody side rail cross brace (2).
6. Install the left side underbody side rail cross brace bolts (1) and tighten to 100 (74 lb ft).
7. Connect the fuel feed hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Connect the fuel pump jumper harness connector.

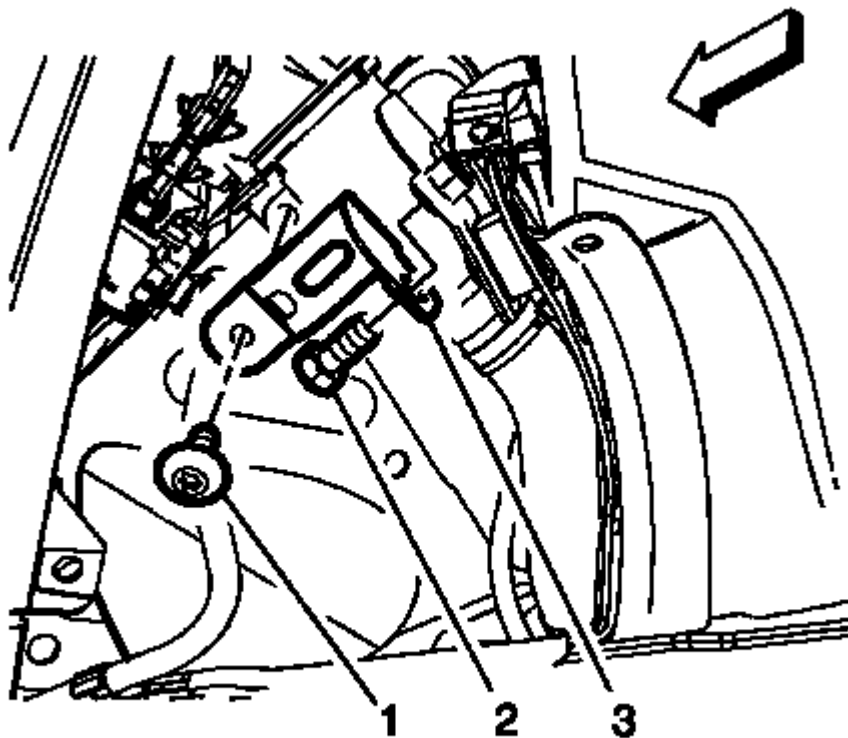


Fig. 38: Fuel Tank Filler Hose Screw And Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install the fuel tank filler hose bracket (3).
10. Install the fuel tank filler hose screw (1) and bolt (2) and tighten to 10 (89 lb in).
11. If equipped with manual transmission continue to step 14.
12. If equipped with automatic transmission, install the transmission. Refer to **Transmission Replacement** .
13. Install both mufflers. Refer to **Exhaust Muffler Replacement - Left Side** and **Exhaust Muffler Replacement - Right Side** .
14. Install the left rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement** .
15. Lower the vehicle.
16. Refuel the fuel tank.
17. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

FUEL TANK REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the fuel tank. Refer to **Fuel Tank Draining**.
3. Remove the right rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement** .
4. Remove both mufflers. Refer to **Exhaust Muffler Replacement - Left Side** and **Exhaust Muffler Replacement - Right Side** .
5. Remove the transmission. Refer to **Transmission Replacement** .

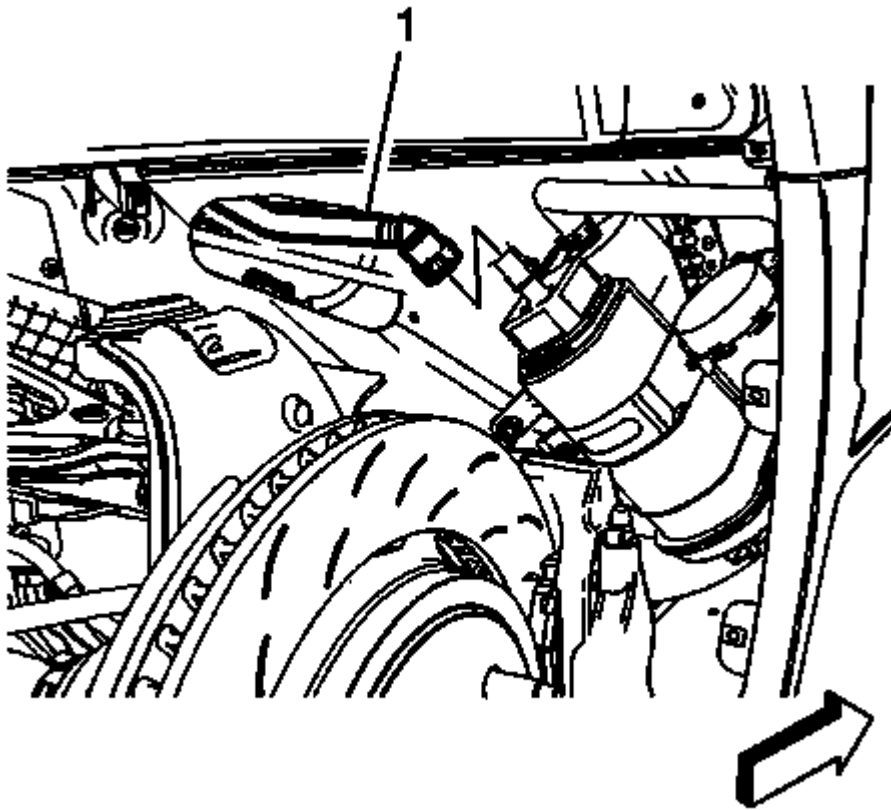


Fig. 39: Evaporative Emission Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the evaporative emission hose (1) from the evaporative emission canister.
7. Disconnect the fuel pump harness connector.

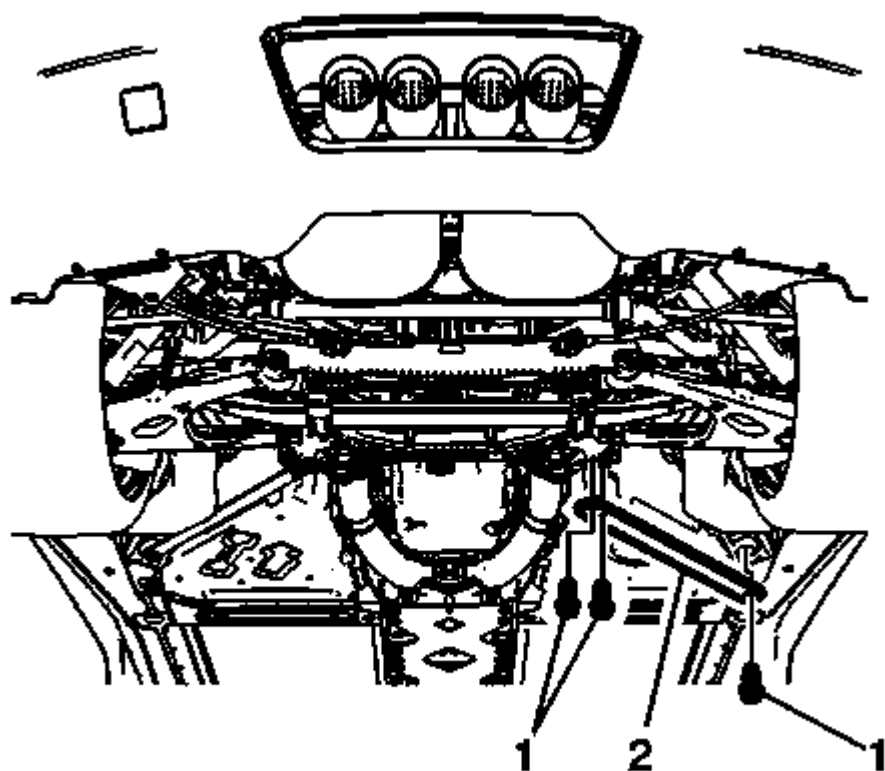


Fig. 40: Right Side Underbody Side Rail Cross Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the right side underbody side rail cross brace bolts (1).
9. Remove the right side underbody side rail cross brace (2).

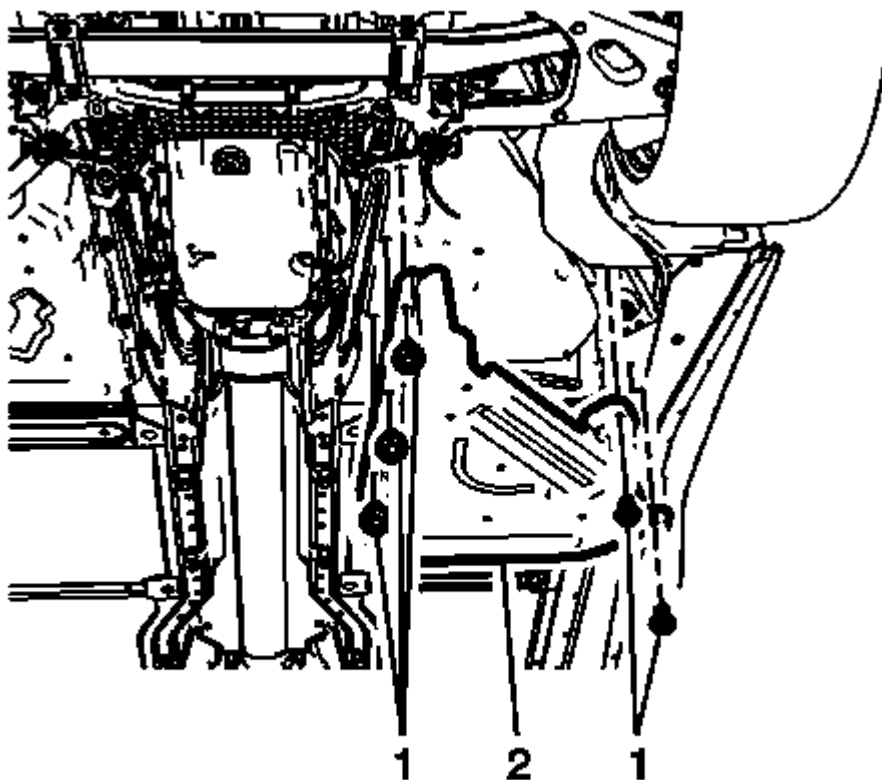


Fig. 41: Right Side Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the right side fuel tank strap bolts (1).
11. Remove the right side fuel tank strap (2).
12. Disconnect the crossover tube from the right side fuel tank. Refer to **Fuel Tank Crossover Tube Replacement**.

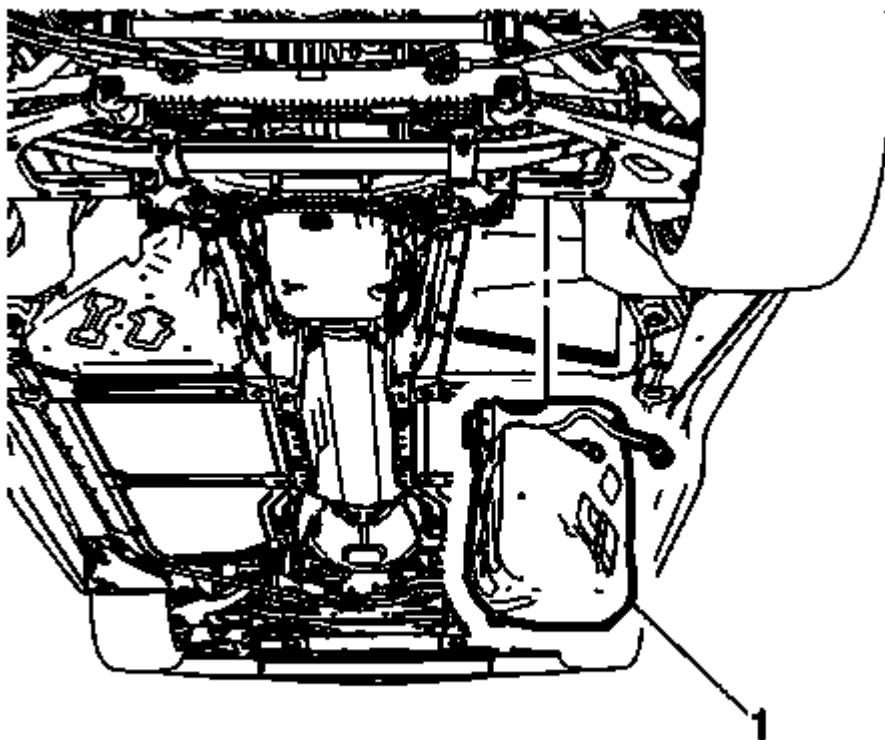


Fig. 42: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

13. Remove the fuel tank (1).

Installation Procedure

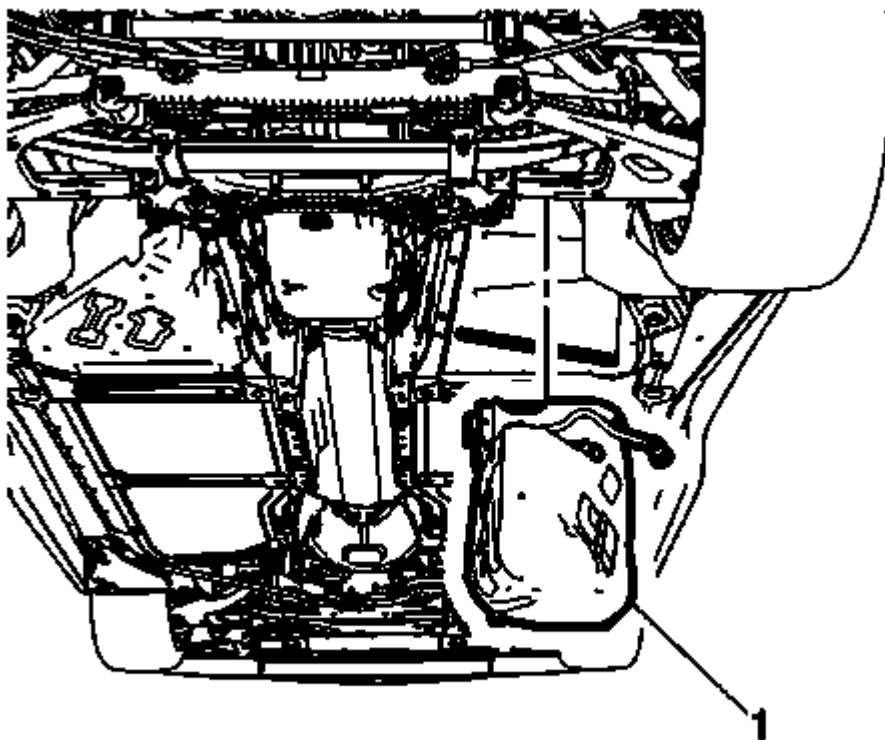


Fig. 43: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank (1).
2. Connect the crossover tube to the right side fuel tank. Refer to **Fuel Tank Crossover Tube Replacement**.

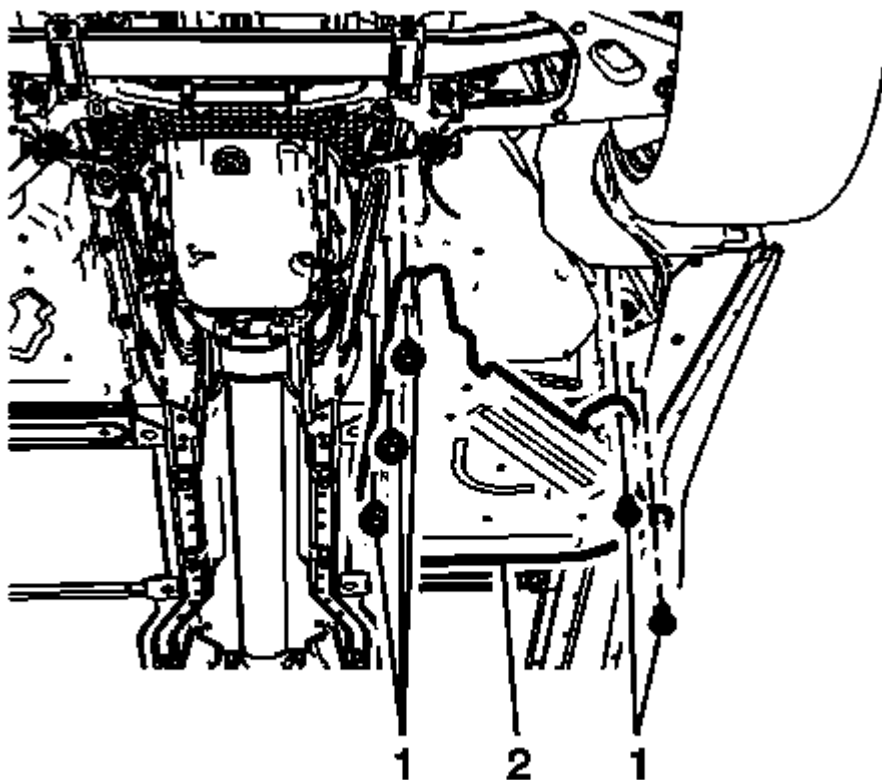


Fig. 44: Right Side Fuel Tank Strap Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the right side fuel tank strap (2).

CAUTION: Refer to Fastener Caution .

4. Install the right side fuel tank strap bolts (1) and tighten to 25 (18 lb ft).

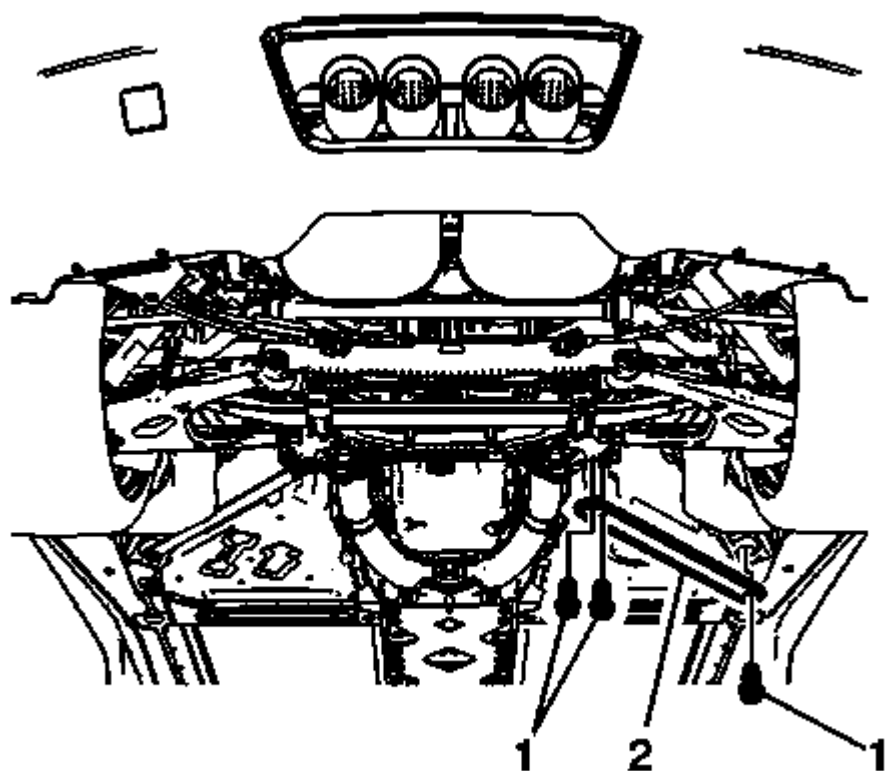


Fig. 45: Right Side Underbody Side Rail Cross Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the right side underbody side rail cross brace (2).
6. Install the right side underbody side rail cross brace bolts (1) and tighten to 100 (74 lb ft).
7. Connect the fuel pump harness connector.

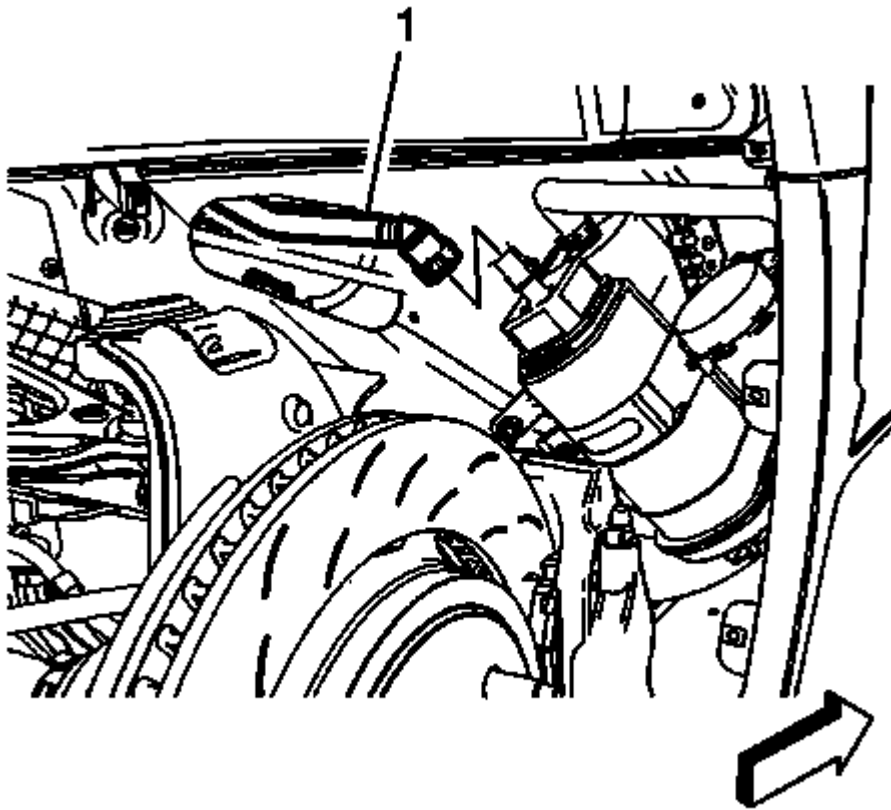


Fig. 46: Evaporative Emission Hose
Courtesy of GENERAL MOTORS COMPANY

8. Install the evaporative emission hose (1) to the evaporative emission canister.
9. Install the transmission. Refer to **Transmission Replacement** .
10. Install both mufflers. Refer to **Exhaust Muffler Replacement - Left Side** and **Exhaust Muffler Replacement - Right Side** .
11. Install the right rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement** .
12. Lower the vehicle.
13. Refuel the fuel tank.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

FUEL TANK CROSSOVER TUBE REPLACEMENT

Removal Procedure

1. Remove both rear wheelhouse liners. Refer to **Rear Wheelhouse Liner Replacement** .
2. Drain the fuel tank. Refer to **Fuel Tank Draining**.

4. Remove both mufflers. Refer to **Exhaust Muffler Replacement - Left Side** and **Exhaust Muffler Replacement - Right Side**.
5. Remove the intermediate exhaust pipes. Refer to **Intermediate Pipe Replacement**.
6. Remove the transmission. Refer to **Transmission Replacement**.
7. Remove the crossover tube center clamp fastener from the body.

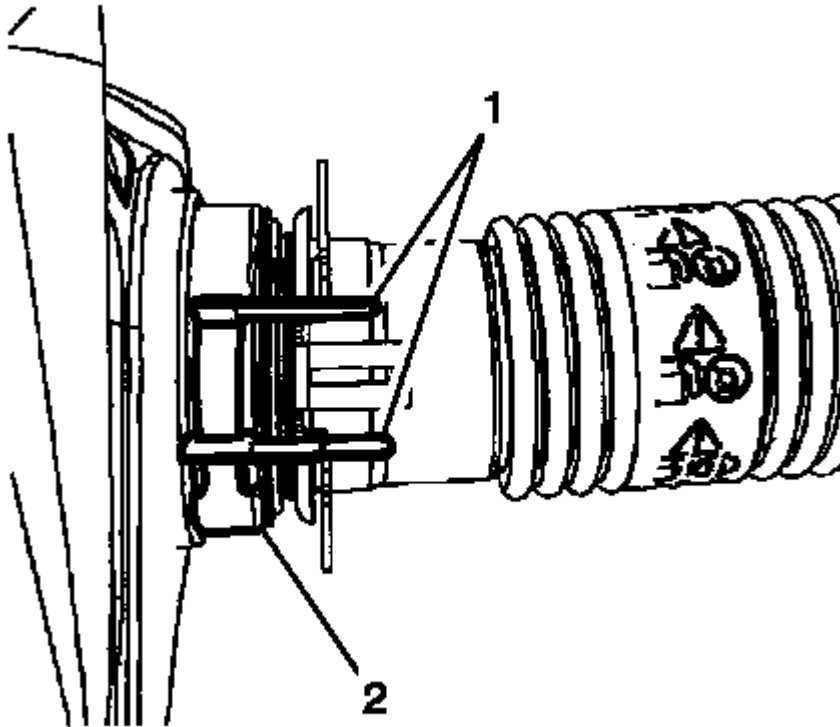


Fig. 47: Crossover Tube Retainer Tabs
Courtesy of GENERAL MOTORS COMPANY

8. Squeeze the crossover tube retainer tabs (1) on the LH connection and push towards the tank into the unlocked position (2).
9. Disconnect the crossover tube from the left fuel tank by pulling down slightly on the center of the crossover tube while pulling the tube straight out of the fuel tank connection.
10. Repeat the above steps for the RH connection.
11. Remove the crossover tube from the vehicle.
12. Squeeze and remove the retainer clamps from the fuel tanks. These will be re-installed on the crossover tube for assembly.

Installation Procedure

1. Inspect the crossover hose O-rings for damage and replace if necessary.
2. Lubricate the crossover tube O-ring mating surfaces with rubber lubricant.

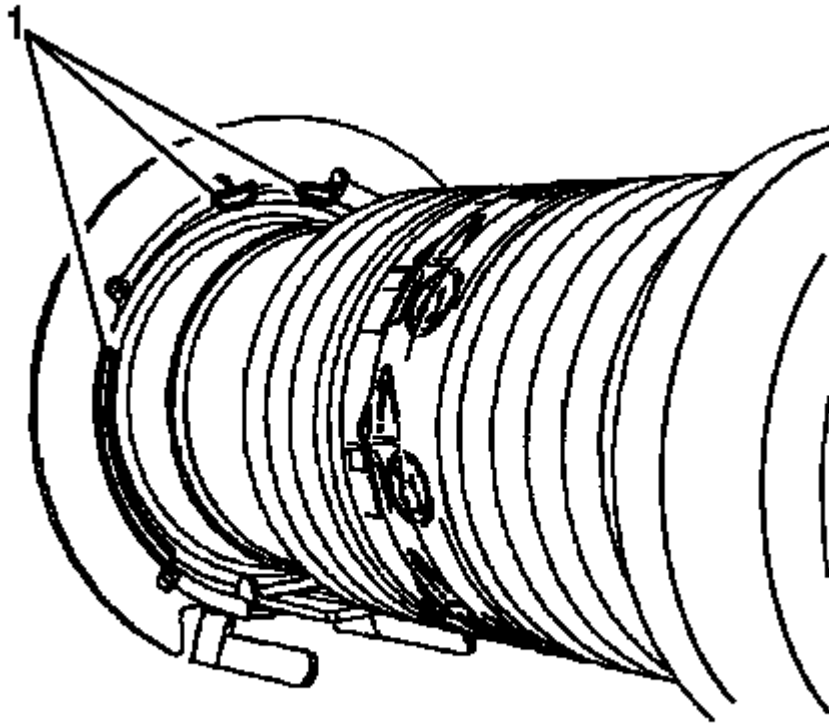


Fig. 48: Retainer Clamps And Ensure Retainer Clamp Tangs
Courtesy of GENERAL MOTORS COMPANY

3. Install the retainer clamps and ensure the retainer clamp tangs (1) are fully engaged in the crossover tube flange.

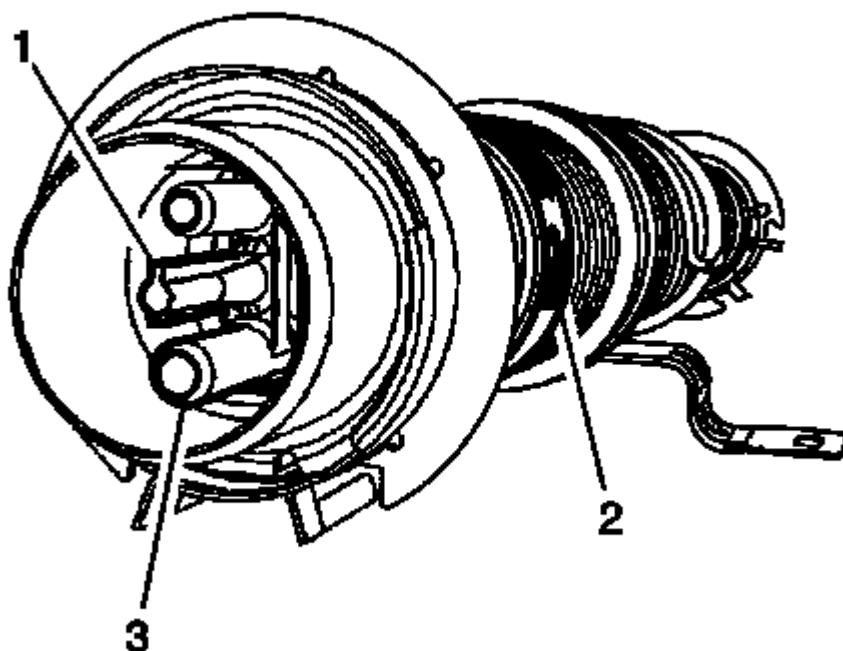


Fig. 49: Location Of Alignment Feature Between Transfer Line
Courtesy of GENERAL MOTORS COMPANY

NOTE: The location of the alignment feature (1) between the transfer lines.

4. Orient the cross over tube so that the large 3/8" transfer line (3) is on the bottom. The end of the tube with the yellow fuel warning label (2) goes into the LH tank
5. Insert the tube into each fuel tank and push firmly. An audible click should be heard from the retainer clamp when engaged.
6. Test the crossover tube to fuel tank connection. Pull on each end to ensure retainers have been fully engaged.

CAUTION: Refer to Fastener Caution .

7. Install the crossover tube center clamp fastener to the body and tighten to 10 (89 lb in).
8. Install the transmission. Refer to Transmission Replacement .
9. Install the intermediate exhaust pipes. Refer to Intermediate Pipe Replacement .
10. Install both mufflers. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler

Replacement - Right Side .

11. Install the rear lower fascia. Refer to **Rear Bumper Lower Fascia Replacement .**
12. Install both rear wheelhouse liners. Refer to **Rear Wheelhouse Liner Replacement .**
13. Fill the fuel tank.

FUEL TANK PRESSURE SENSOR REPLACEMENT

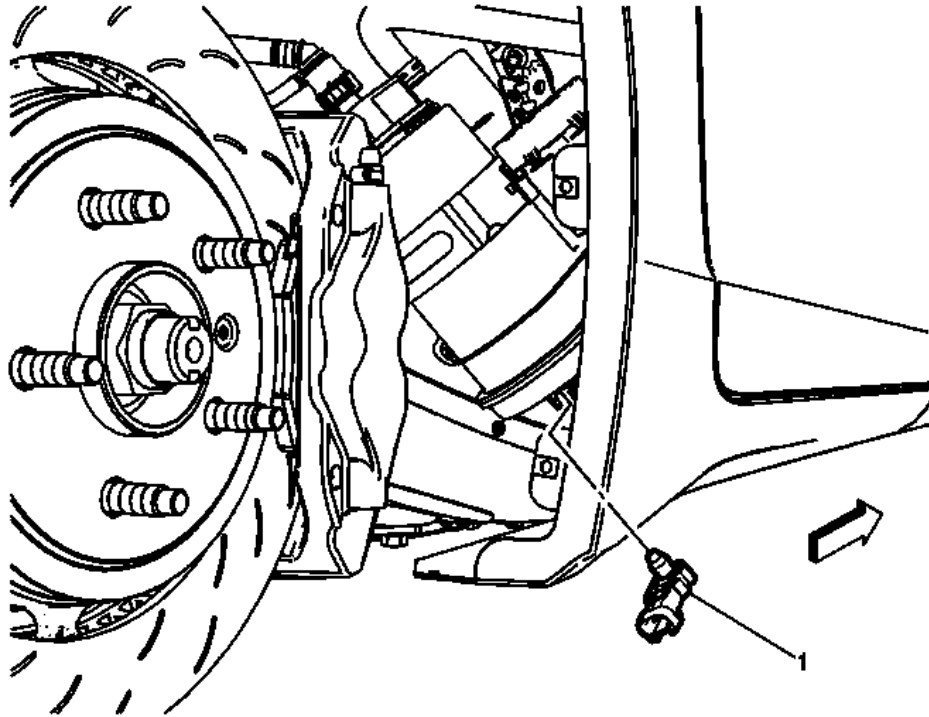


Fig. 50: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Pressure Sensor Replacement

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

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

CH-39765-A Fuel Sender Lock Ring Tool

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

Removal Procedure

1. Remove the left fuel tank. Refer to **Fuel Tank Replacement - Left Side**.

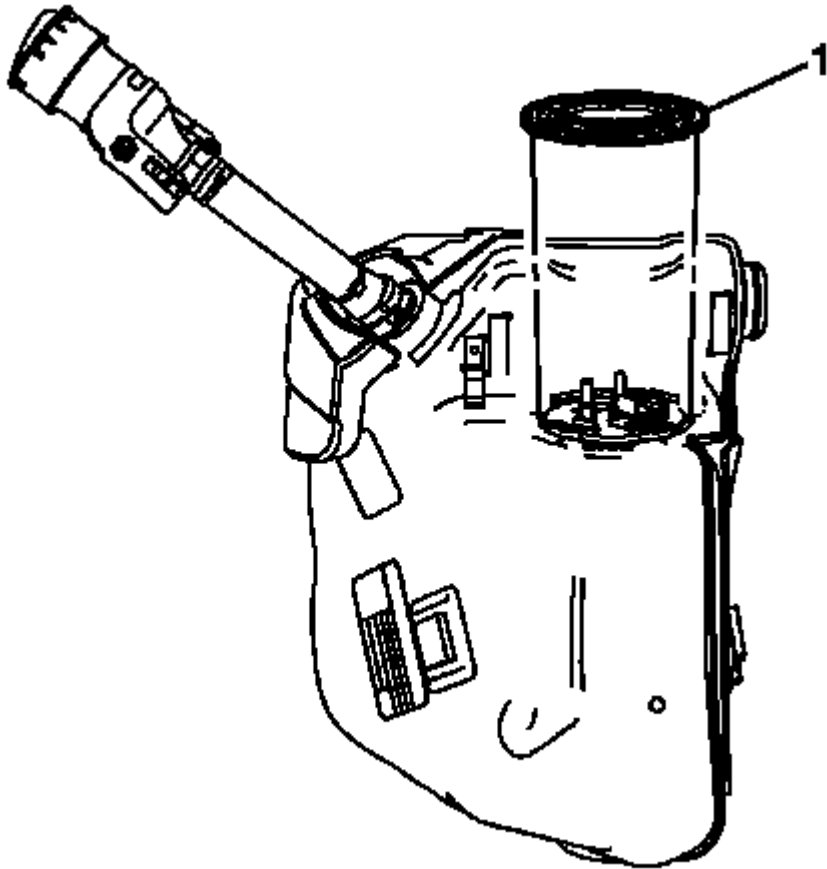


Fig. 51: Fuel Pump Module Locking Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel pump module is spring loaded and will spring upward when the locking ring is removed.

2. Using the **CH-39765-A** ring, turn the fuel pump module locking ring (1) counterclockwise and remove lock ring.

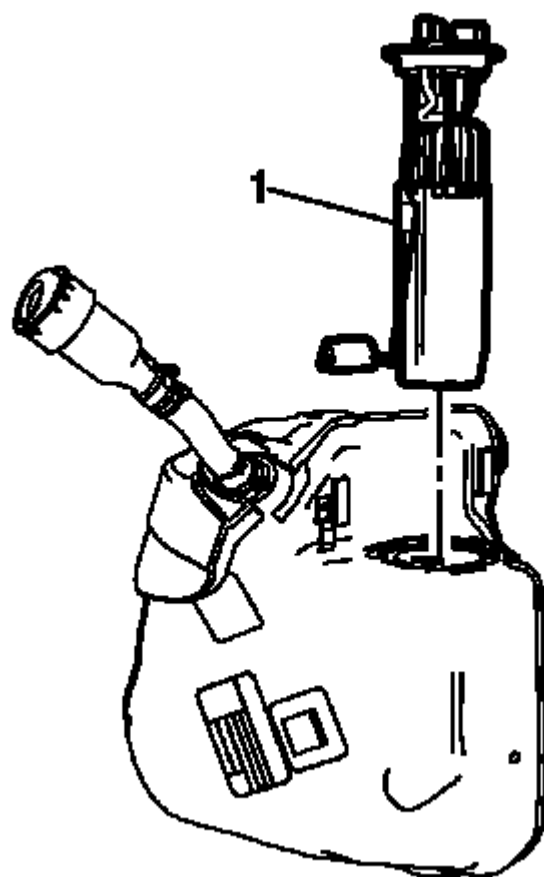


Fig. 52: Fuel Tank Fuel Pump Module
Courtesy of GENERAL MOTORS COMPANY

3. Lift the fuel tank fuel pump module (1) carefully to disconnect the lines from the fuel tank fuel pump module (1) inside the tank.
4. Remove the fuel tank fuel pump module (1) from the tank.

Installation Procedure

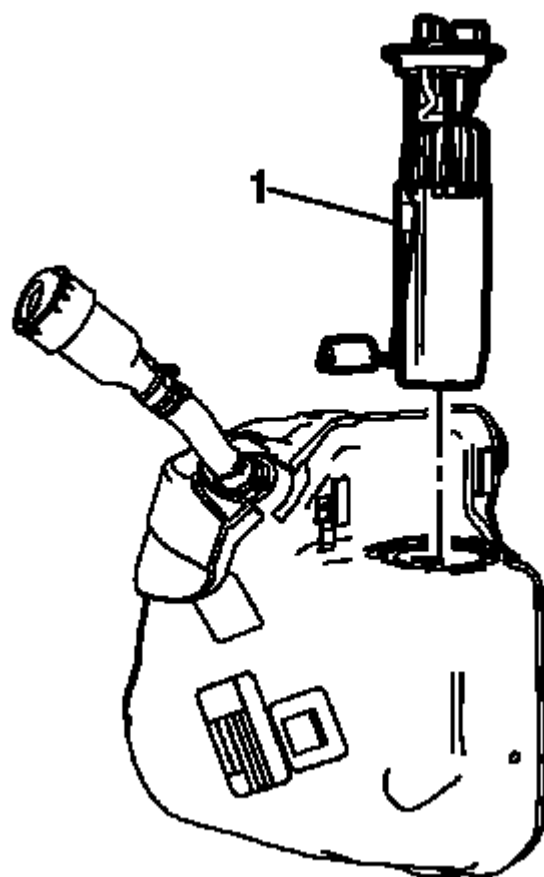


Fig. 53: Fuel Tank Fuel Pump Module
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank fuel pump module (1) into the tank.
2. Carefully lower the fuel tank fuel pump module (1) into the tank and connect the lines to the fuel tank fuel pump module (1) inside the tank.

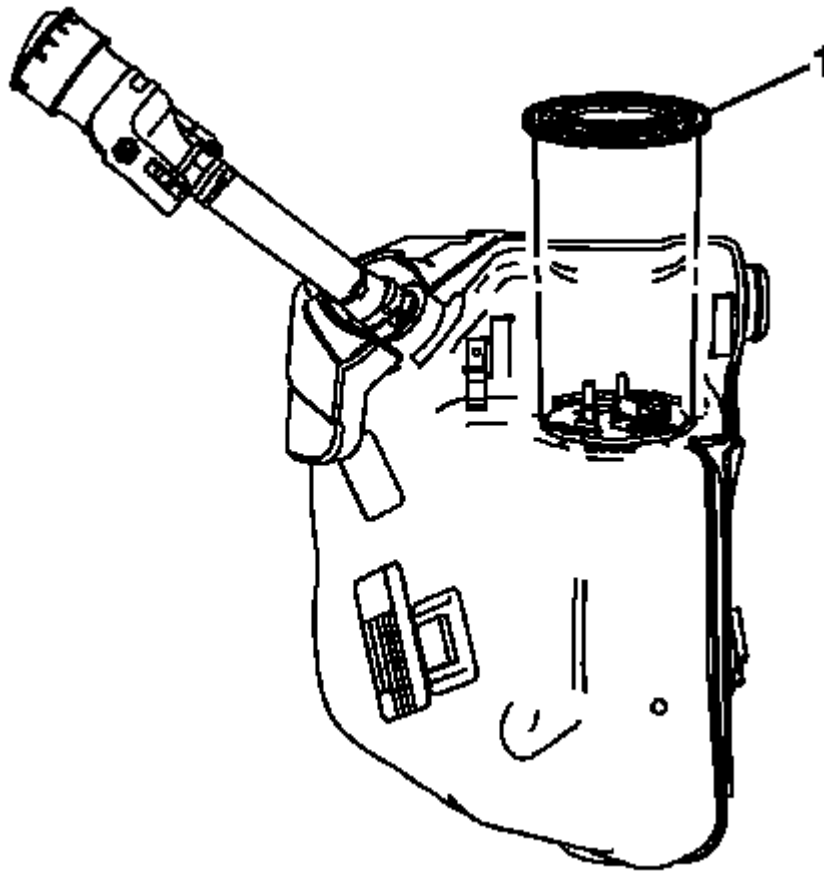


Fig. 54: Fuel Pump Module Locking Ring
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel tank fuel pump module lock ring (1).
4. Using the **CH-39765-A** ring, fully lock the fuel pump module lock ring in place by rotating clockwise.
5. Install the left fuel tank. Refer to **Fuel Tank Replacement - Left Side**.

FUEL FEED PIPE REPLACEMENT

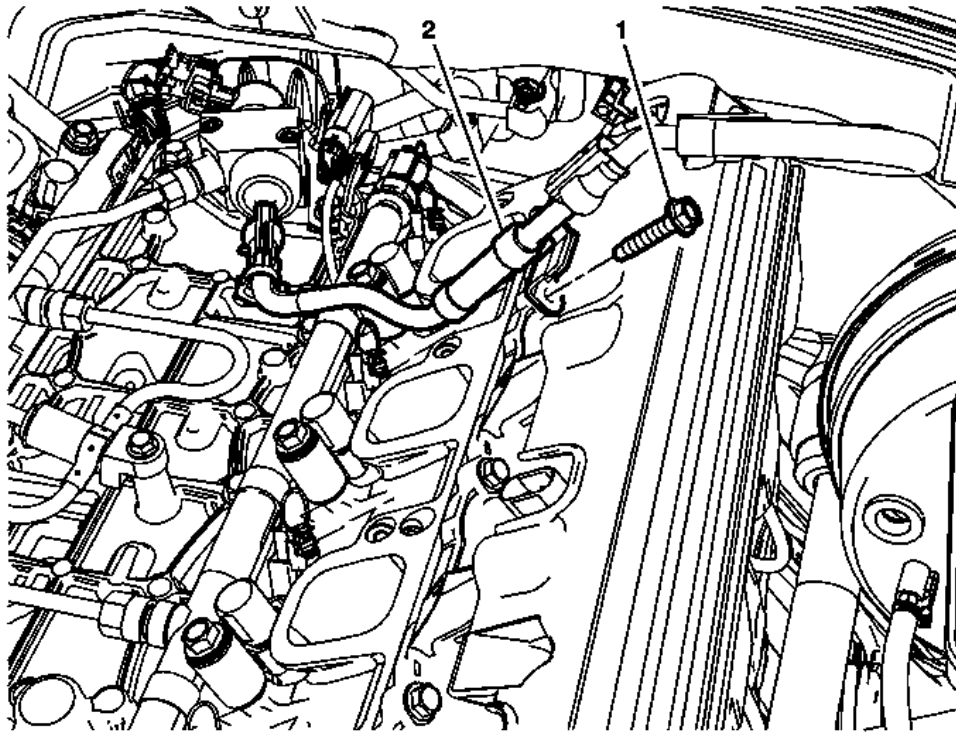


Fig. 55: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Pipe Replacement

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief . 2. Remove the fuel pump insulator. Refer to Fuel Pump Insulator Replacement .	
1	Fuel Feed Pipe Bracket Fastener CAUTION: Refer to Fastener Caution . Tighten 10 (89 lb in)
2	Fuel Feed Pipe Procedure Disconnect the fuel feed pipe quick connects. Refer to Metal Collar Quick Connect Fitting Service .

FUEL PUMP REPLACEMENT

- **EN-51092** Fuel Pump Installation Gauge

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

Removal Procedure

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

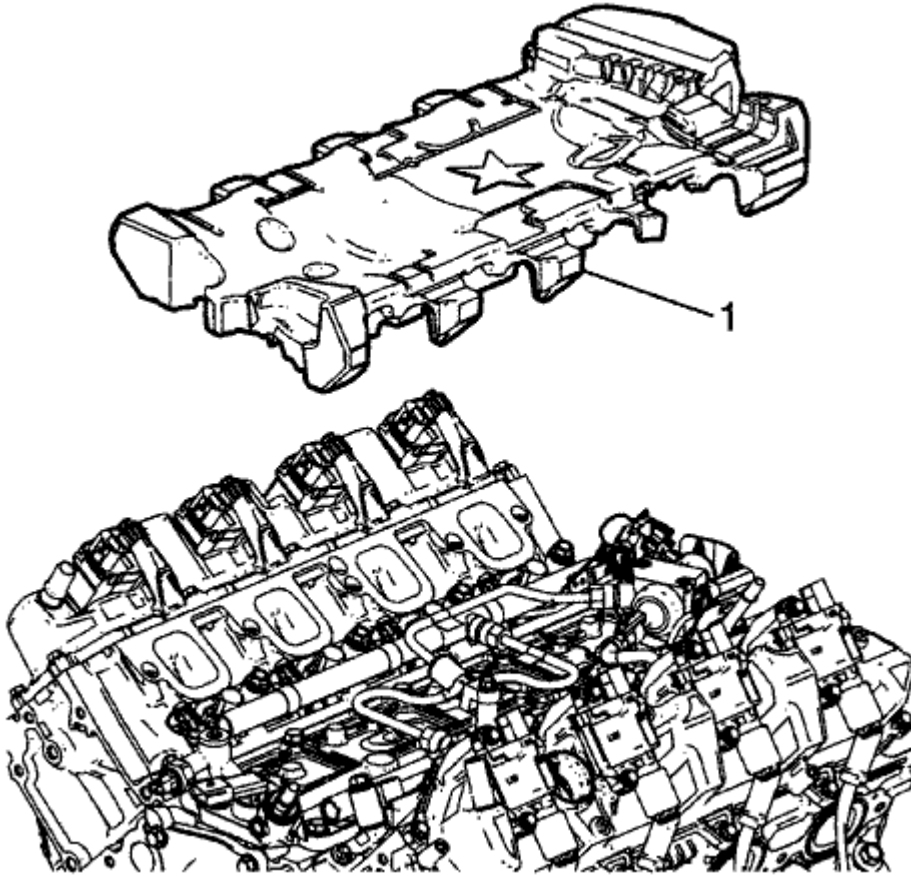


Fig. 56: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel pump insulator (1). Refer to **Fuel Pump Insulator Replacement**.

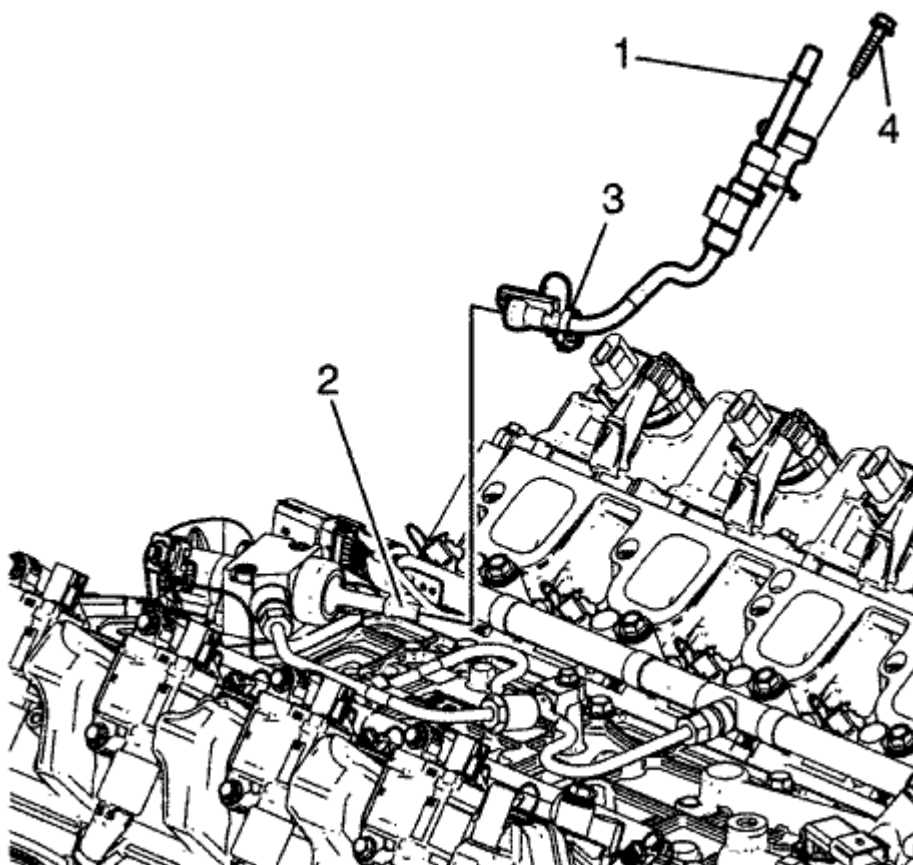


Fig. 57: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel feed pipe fastener (4) then remove the low pressure fuel feed pipe (1) from the fuel pump (2). Refer to **Metal Collar Quick Connect Fitting Service**.

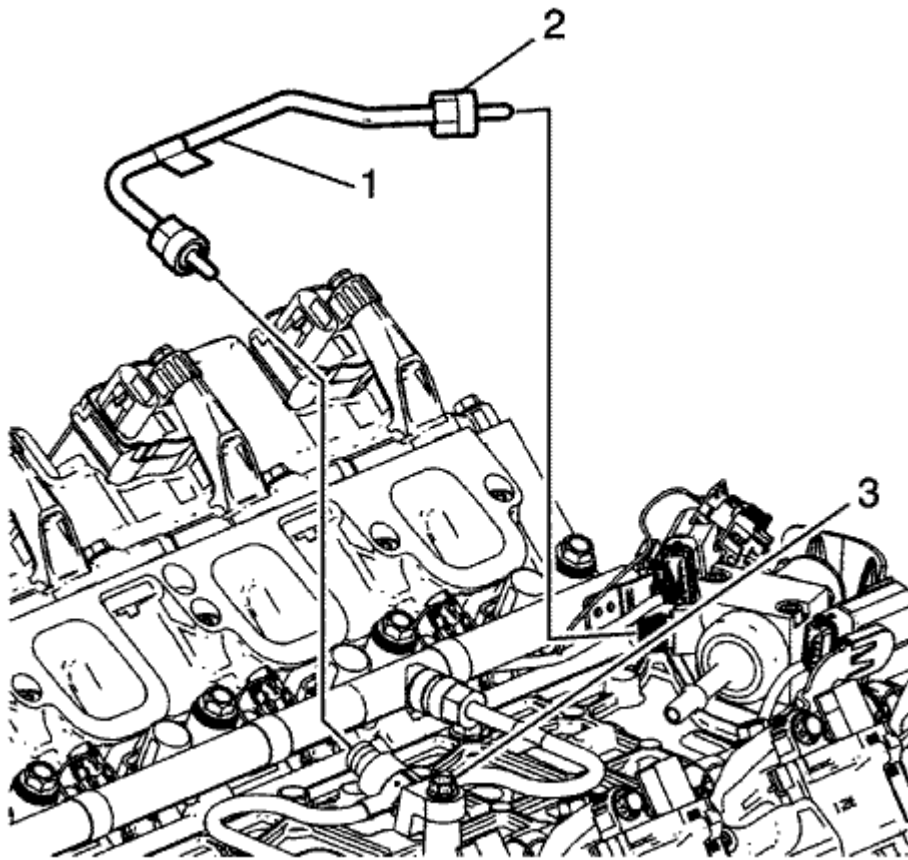


Fig. 58: Crossover Pipe And Fuel Feed Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the high pressure fuel feed pipe (1) that connects the fuel pump to the crossover pipe (3).
5. Disconnect and reposition the fuel pump and injector harness as needed.

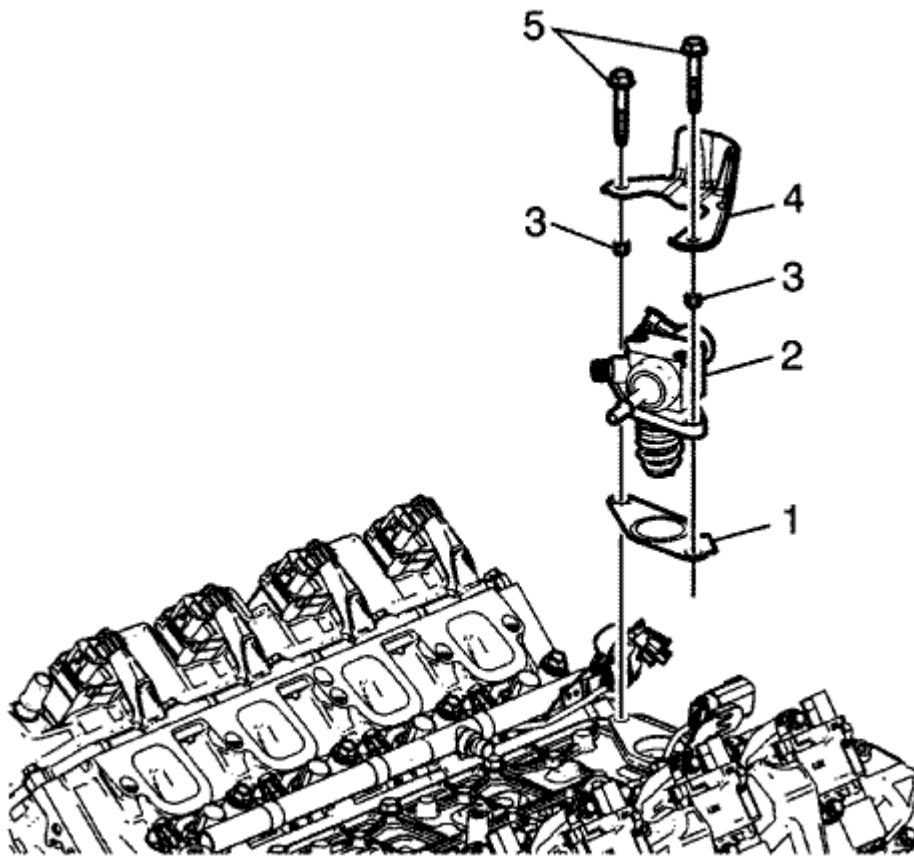


Fig. 59: NEW High Pressure Fuel Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel pump fasteners (5) then remove the fuel pump cover (4) and the plastic fastener retainers (3).
7. Remove the fuel pump (2) and fuel pump gasket (1) from the engine.
8. DISCARD the fuel pump gasket.

Installation Procedure

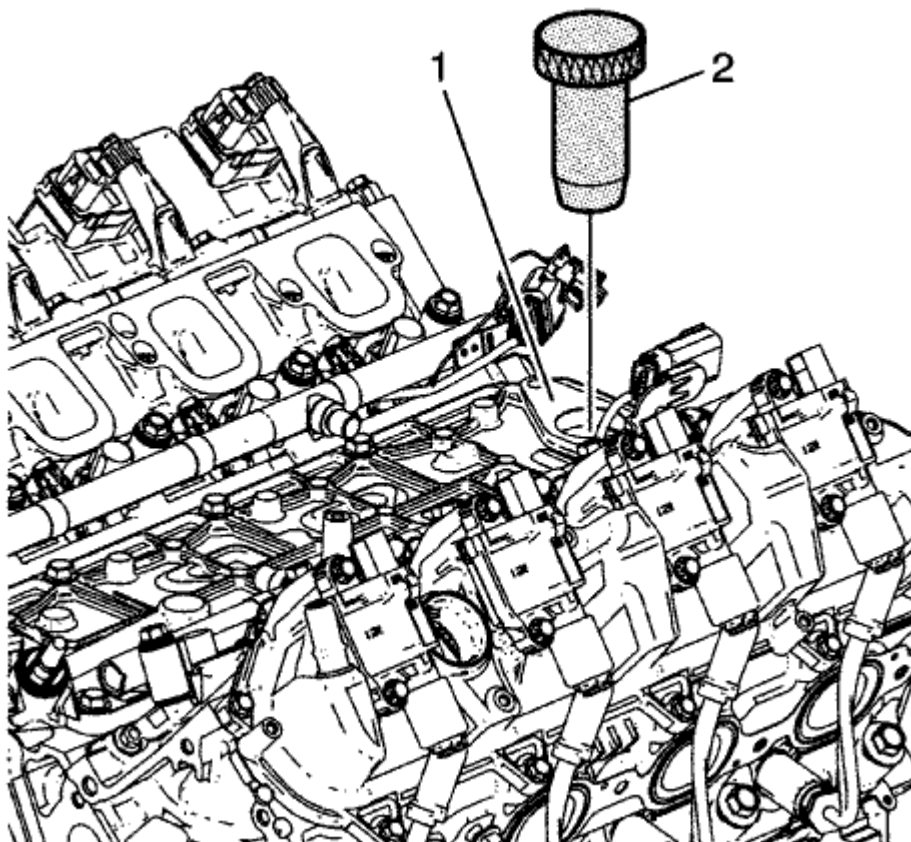


Fig. 60: Lifter Oil Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the **EN-51092** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the top surface of the Lifter Oil Manifold Assembly (1).

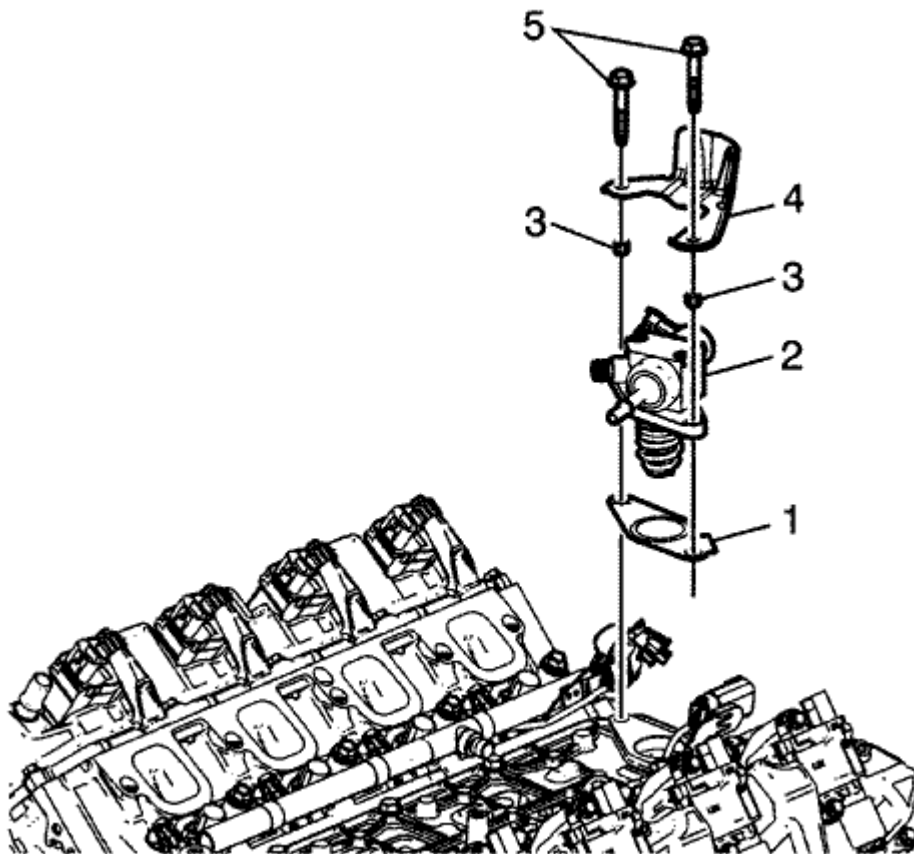


Fig. 61: NEW High Pressure Fuel Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke.

NOTE: Ensure the plastic fastener retainers (3) are installed in the high pressure fuel pump mounting holes before installing.

2. Install a NEW high pressure fuel pump gasket (1).
3. Install the high pressure fuel pump (2) and high pressure fuel pump cover (4).

CAUTION: Refer to Fastener Caution .

CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.

4. Start and hand-tighten the NEW high pressure fuel pump fasteners (5) evenly and tighten the high pressure fuel pump fasteners to 25 N.m (18 lb ft).

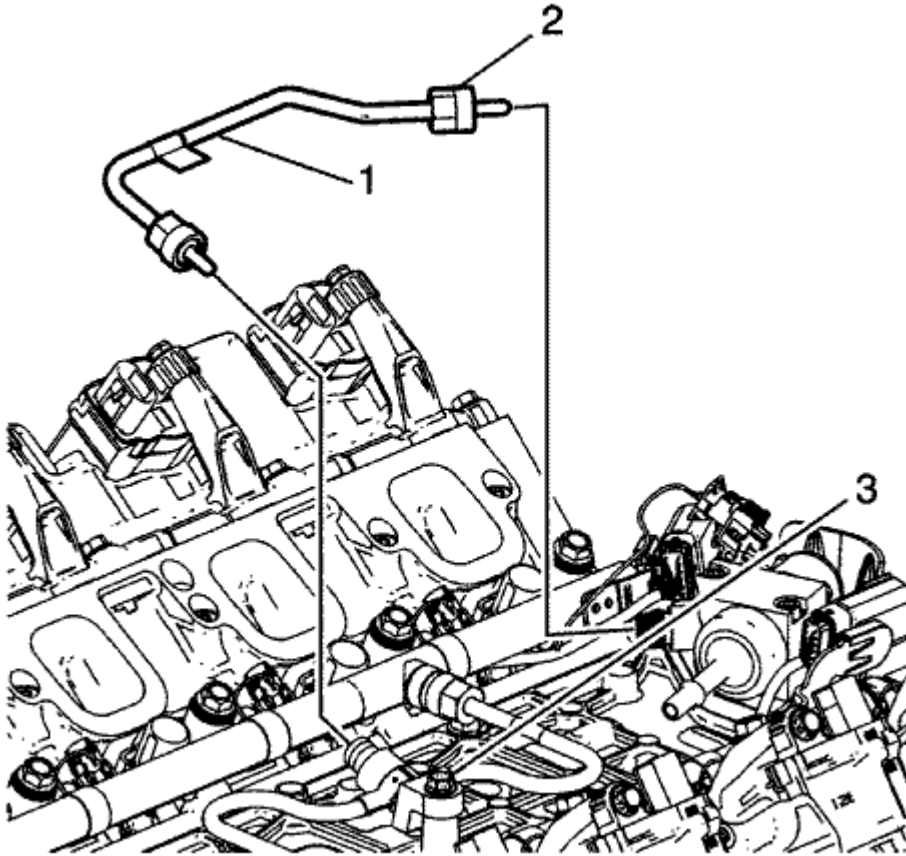


Fig. 62: Crossover Pipe And Fuel Feed Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

- 5.
6. Install the NEW high pressure fuel feed pipe (1) that connects the fuel pump to the crossover pipe (3). Finger-tighten both fuel pipe fitting nuts (2).
7. Tighten the high pressure fuel feed pipe fittings to 30 N.m (22 lb ft) in the following order: at the fuel pump (1) then at the crossover (2).

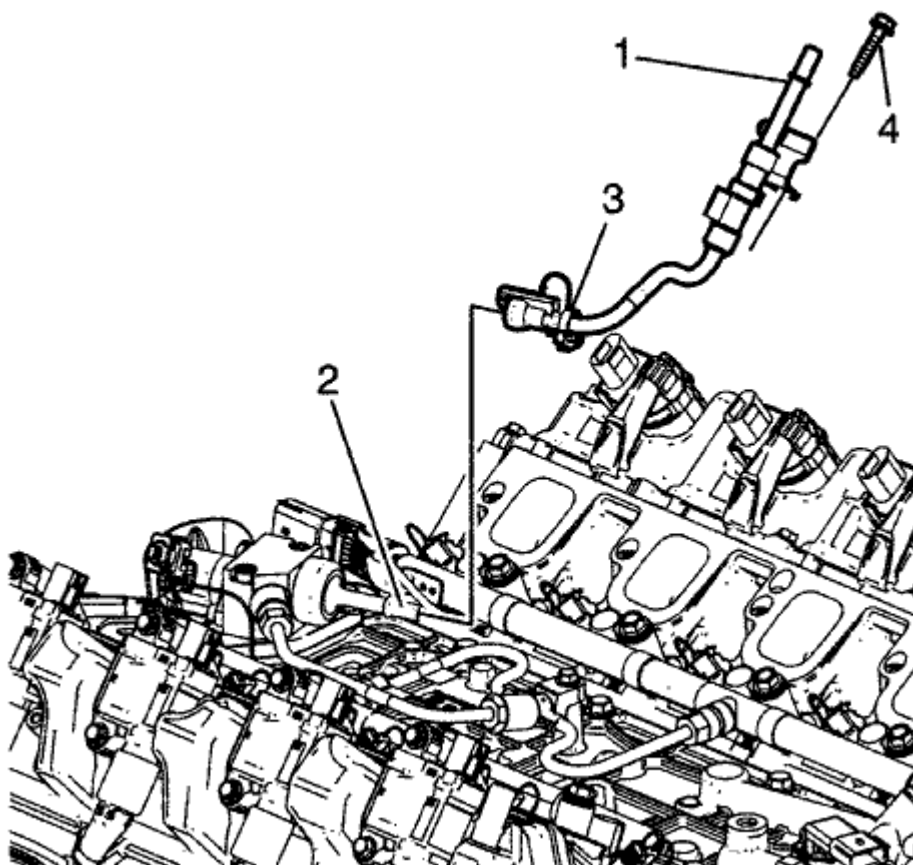


Fig. 63: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install low pressure fuel feed pipe (1) to the fuel pump (2). Press fuel pipe until an audible click is heard. Install redundant clip (3). Refer to **Metal Collar Quick Connect Fitting Service**.
9. Install the low pressure fuel feed pipe to LH rocker cover. Tighten fuel feed fasteners (4) to 10 N.m (89 lb in).

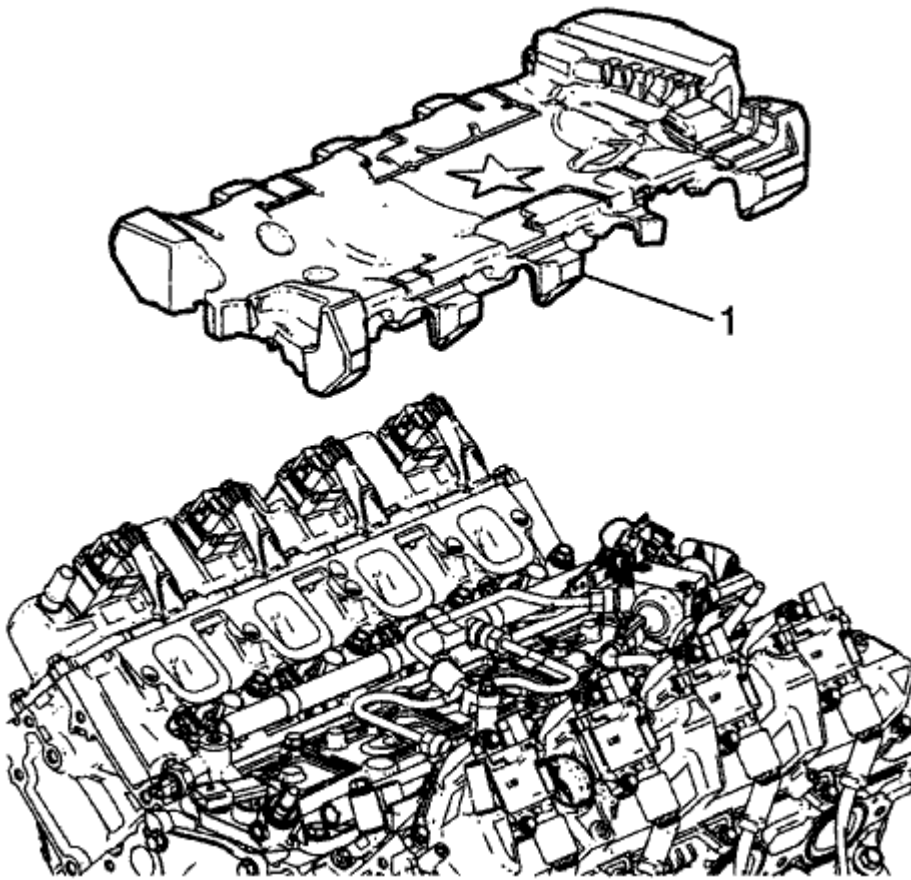


Fig. 64: Fuel Pump Insulator

Courtesy of GENERAL MOTORS COMPANY

10. Install the fuel pump insulator (1). Refer to **Fuel Pump Insulator Replacement**.

FUEL PUMP COVER REPLACEMENT

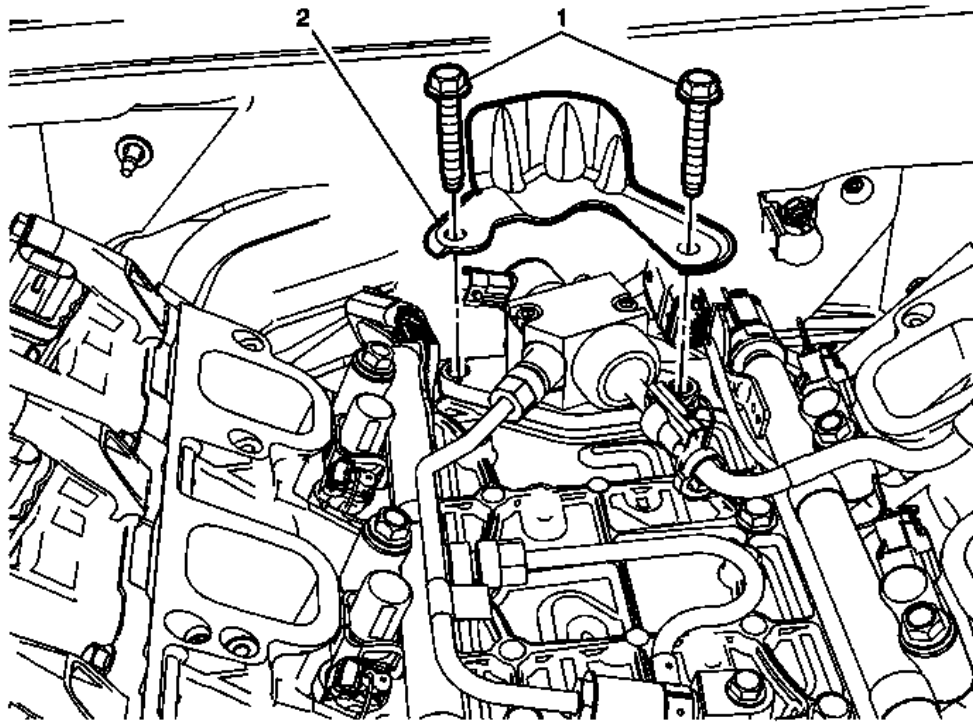


Fig. 65: Fuel Pump Cover
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Cover Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel pump insulator. Refer to Fuel Pump Insulator Replacement .	
1	Fuel Pump Fasteners (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 25 (18 lb ft)
2	Fuel Pump Cover Procedure Slide the fuel pump cover rearward to remove it from the fuel pump. NOTE: A new fuel pump gasket and fuel feed intermediate pipe position 2 should be installed if the fuel pump is removed from the engine.

FUEL PUMP INSULATOR REPLACEMENT

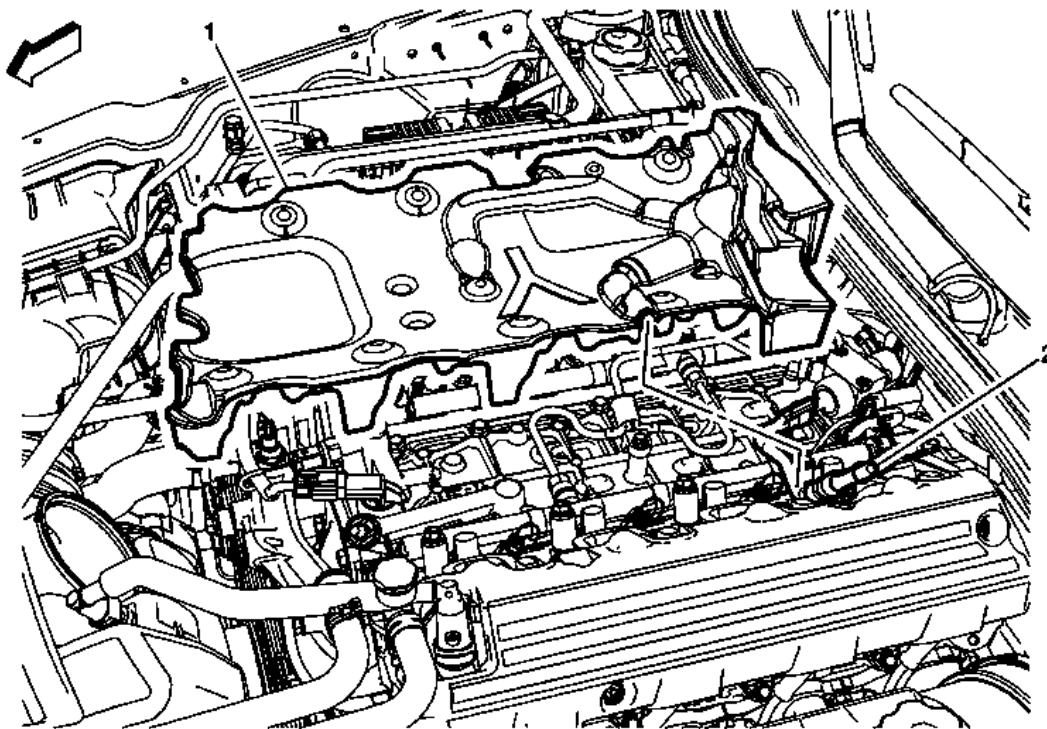


Fig. 66: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Insulator Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold. Refer to Intake Manifold Replacement .	
1	Fuel Pump Insulator Procedure Lift the fuel pump insulator away from the fuel feed pipe.
2	Fuel Feed Pipe NOTE: Align the fuel pump insulator with the fuel feed pipe when installing the fuel pump insulator

FUEL LEVEL SENSOR REPLACEMENT (FUEL SENDER)

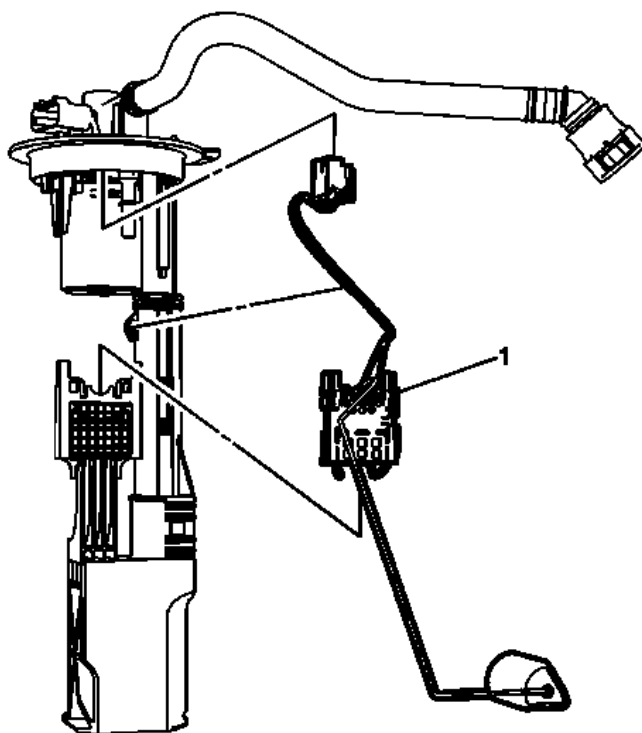


Fig. 67: Fuel Level Sensor (Fuel Sender)
Courtesy of GENERAL MOTORS COMPANY

Fuel Level Sensor Replacement (Fuel Sender)

Callout	Component Name
Preliminary Procedure	
Remove the fuel sender assembly. Refer to Fuel Sender Assembly Replacement .	
1	Fuel Level Sensor
	Procedure 1. Disconnect the electrical connector from the module. 2. Push in the lock tabs above the level sensor body and slide the level sensor out of the slot.

FUEL LEVEL SENSOR REPLACEMENT (FUEL TANK FUEL PUMP MODULE)

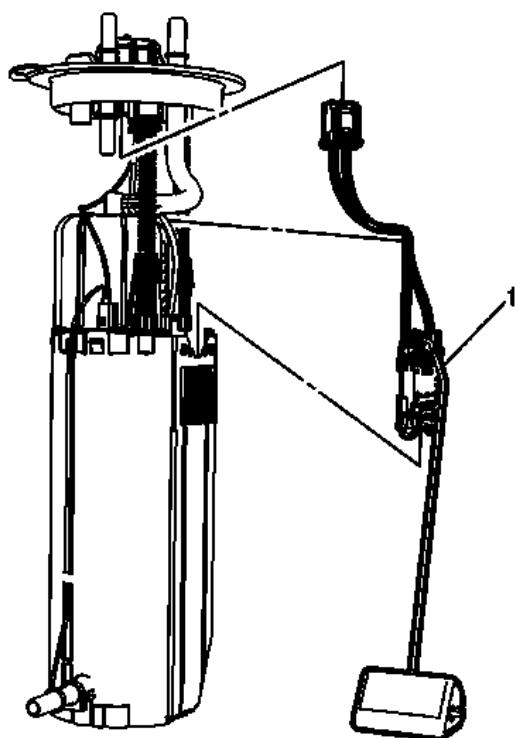


Fig. 68: Fuel Level Sensor (Fuel Tank Fuel Pump Module)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Level Sensor Replacement (Fuel Tank Fuel Pump Module)

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 1. Disconnect the electrical connector from the module. 2. Push in the lock tabs above the level sensor body and slide the level sensor out of the slot.

FUEL SENDER ASSEMBLY REPLACEMENT

Special Tools

CH-39765-A Fuel Sender Lock Ring Tool

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

Removal Procedure

1. Remove the right fuel tank. Refer to **Fuel Tank Replacement - Right Side.**

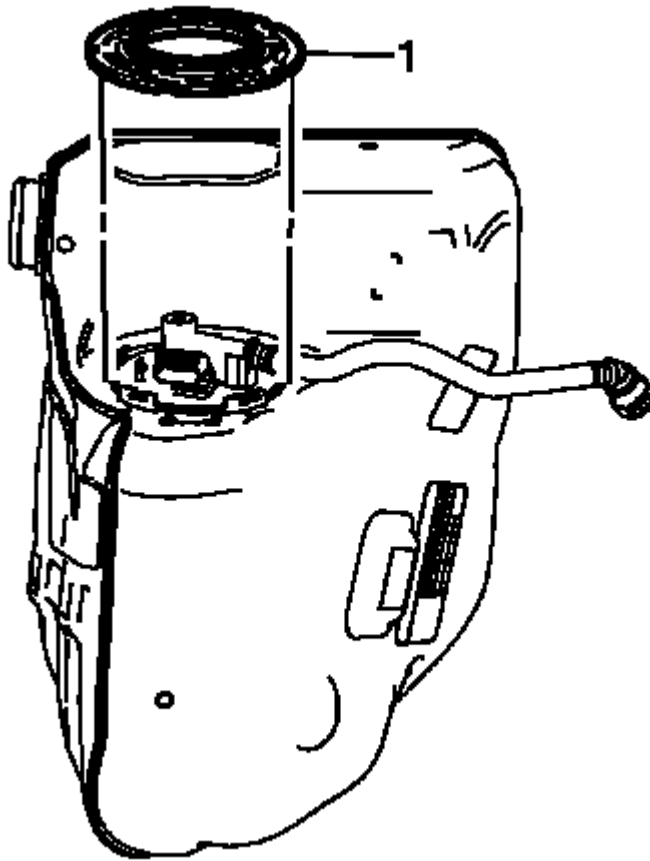


Fig. 69: Turn Fuel Sender Locking Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel sender is spring loaded and will spring upward when the locking ring is removed.

2. Using the **CH-39765-A** ring, turn the fuel sender locking ring (1) counterclockwise and remove lock ring.

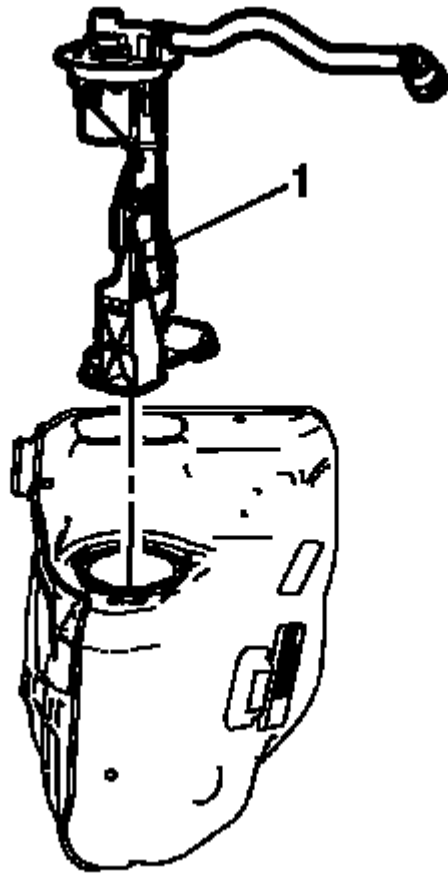


Fig. 70: Fuel Sender
Courtesy of GENERAL MOTORS COMPANY

3. Lift the fuel sender (1) carefully to disconnect the lines from the fuel sender (1) inside the tank.
4. Remove the fuel sender (1) from the tank.

Installation Procedure

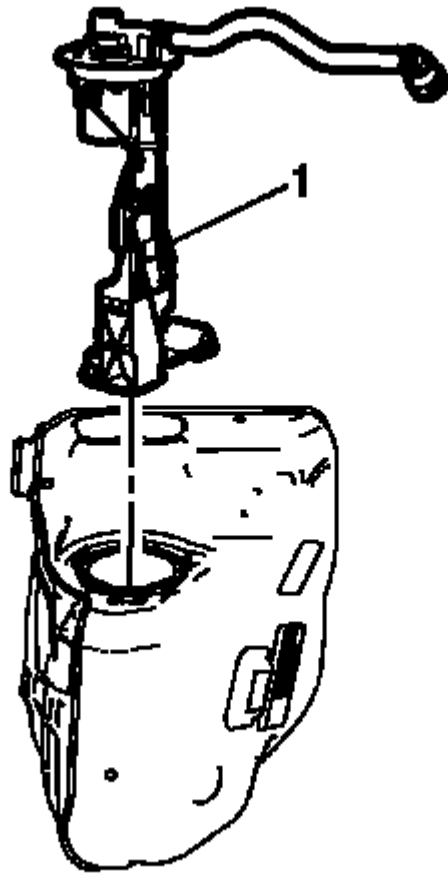


Fig. 71: Fuel Sender
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel sender (1) into the tank.
2. Carefully lower the fuel sender (1) into the tank and connect the lines to the fuel sender (1) inside the tank.

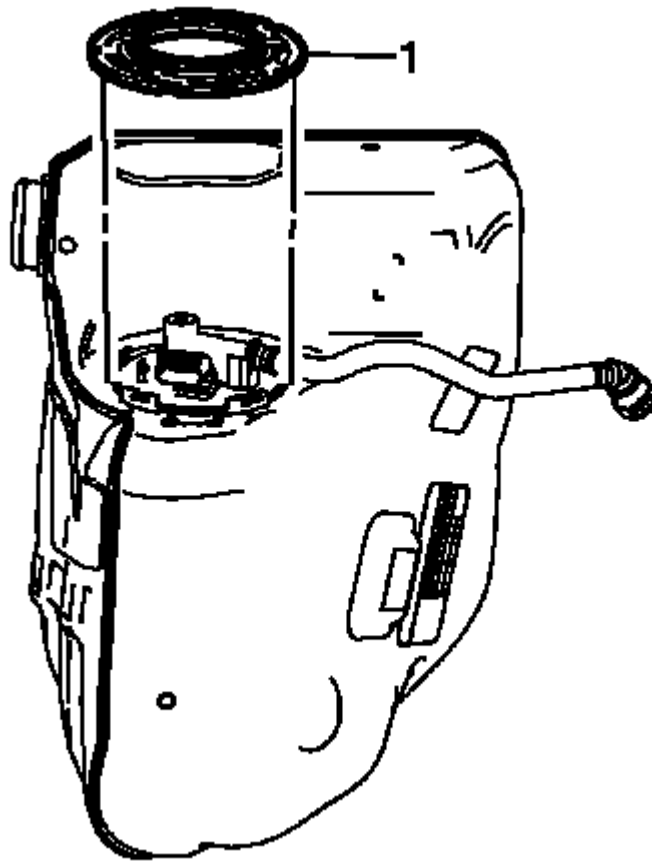


Fig. 72: Turn Fuel Sender Locking Ring
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel sender module lock ring (1).
4. Using the **CH-39765-A** ring, fully lock the fuel sender lock ring in place by rotating clockwise.
5. Install the right fuel tank. Refer to **Fuel Tank Replacement - Right Side.**

FUEL PRESSURE SENSOR REPLACEMENT

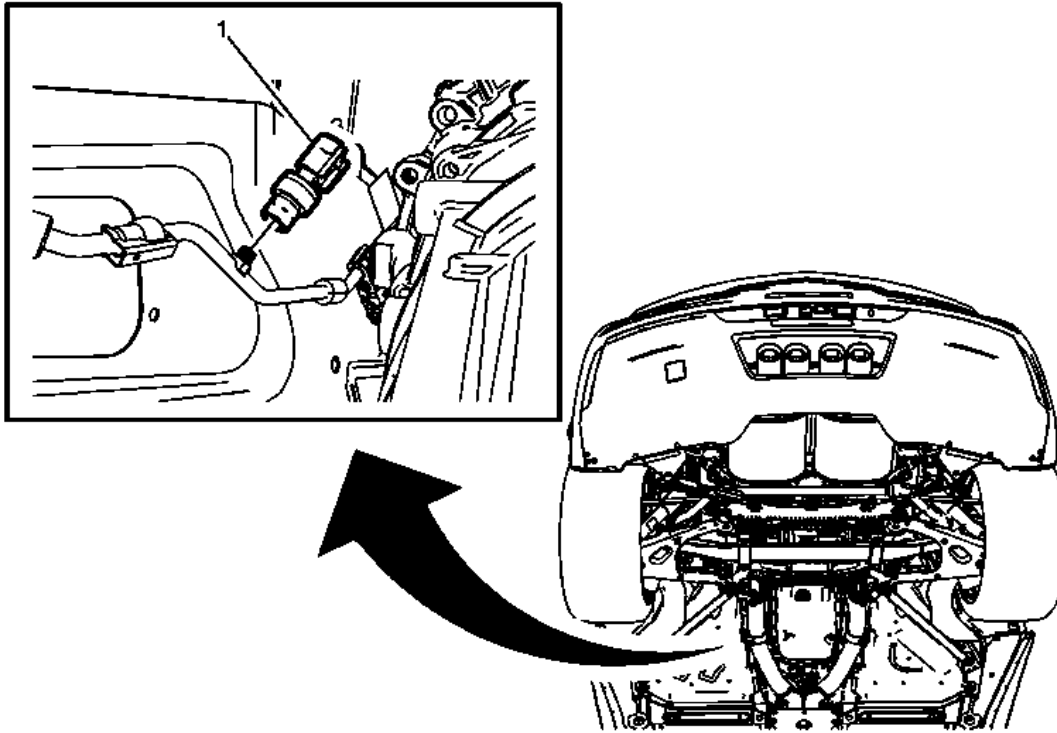


Fig. 73: Fuel Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief . 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .	
1	Fuel Pressure Sensor CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1. Disconnect the electrical connector. 2. Use a NEW O-ring whenever the sensor is removed. Tighten 10 (89 lb in)

FUEL SYSTEM CLEANING

Special Tools

- J 34730-1A Fuel Pressure Gauge
- J 37088-A Fuel Line Disconnect Tool Set

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Relieve the fuel system pressure. Refer to the Fuel Pressure Relief.
3. Drain the fuel tanks. Refer to Fuel Tank Draining.
4. Remove the fuel tanks.
 - For the left fuel tank, refer to Fuel Tank Replacement - Left Side.
 - For the right fuel tank, refer to Fuel Tank Replacement - Right Side.
5. Remove the fuel sender assemblies.
6. Inspect the left fuel sender strainer. Replace a contaminated strainer for the left fuel sender only and inspect the fuel pump.
7. Inspect the left fuel sender fuel pump inlet for debris. Replace the left fuel sender assembly if you find debris in the fuel pump inlet.
8. Inspect the right fuel sender strainers. Replace the right fuel sender assembly if you find a contaminated strainer. The right fuel sender strainers are not serviced separately.

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

9. Flush the fuel tanks with hot water.
10. Pour the water out of the fuel sender assembly openings. Rock the tanks to be sure that removal of the water from the tanks is complete.
11. Install the fuel sender assemblies.
12. Install the fuel tanks.
 - For the left fuel tank, refer to Fuel Tank Replacement - Left Side.
 - For the right fuel tank, refer to Fuel Tank Replacement - Right Side.
13. Refill the fuel system.
14. Install the fuel filler cap.
15. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
16. Perform the following procedure in order to inspect for leaks:
 1. Turn the ignition switch ON for 2 seconds.

3. Turn the ignition switch ON.
4. Inspect for fuel leaks.
17. Program the transmitters. Refer to **Remote Control Door Lock and Theft Deterrent Transmitter Programming** .

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1

Special Tools

- EN-49248 Injector Rail Assembly Remover
- EN-51101-1 Injector Seal Installer and Sizer
- EN-49245-3 Fuel injection seal Installer Sizer
- EN-49245-4 Fuel injection seal Installer Sizer

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

Removal Procedure

1. Remove and DISCARD the fuel feed intermediate pipe position 1 and fuel feed intermediate pipe position 2. Refer to **Fuel Feed Intermediate Pipe Replacement - Position 1**.
2. Remove the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement**.
3. Disconnect the electrical wiring harness connectors from the fuel rail.
4. Clean the cylinder head pocket around the injectors of any dirt or build up to prevent material from entering the combustion chambers.
5. If replacing the fuel injection fuel rail assembly, remove the fuel injection fuel rail pressure sensor. Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**.

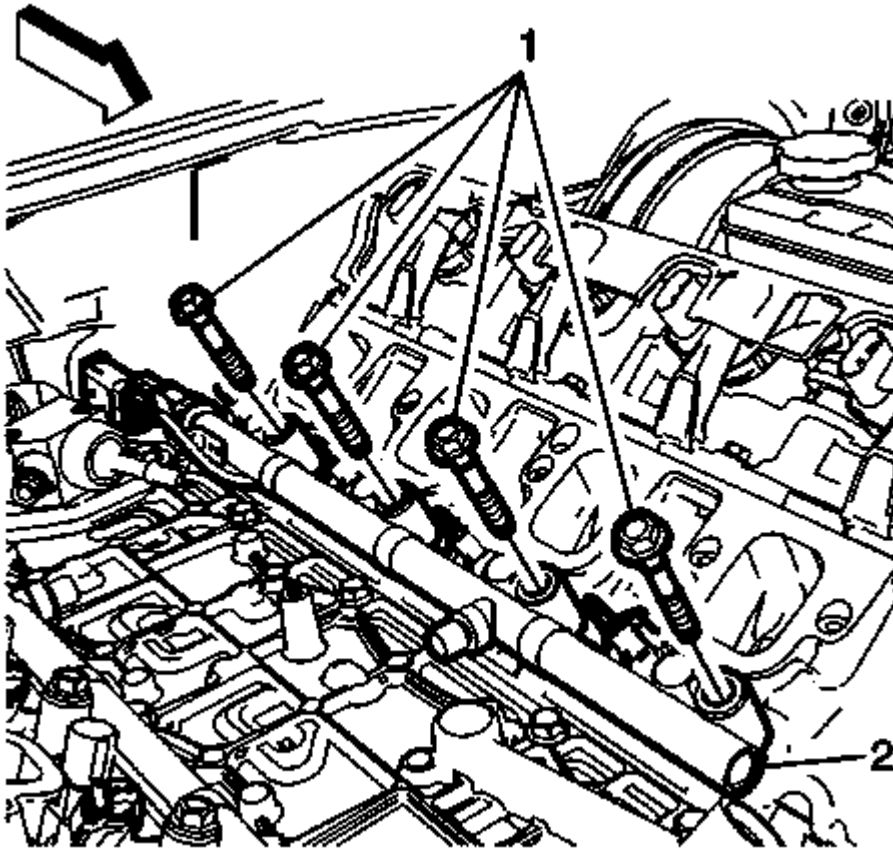


Fig. 74: Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel rail fasteners (1) securing the injector rail (2).

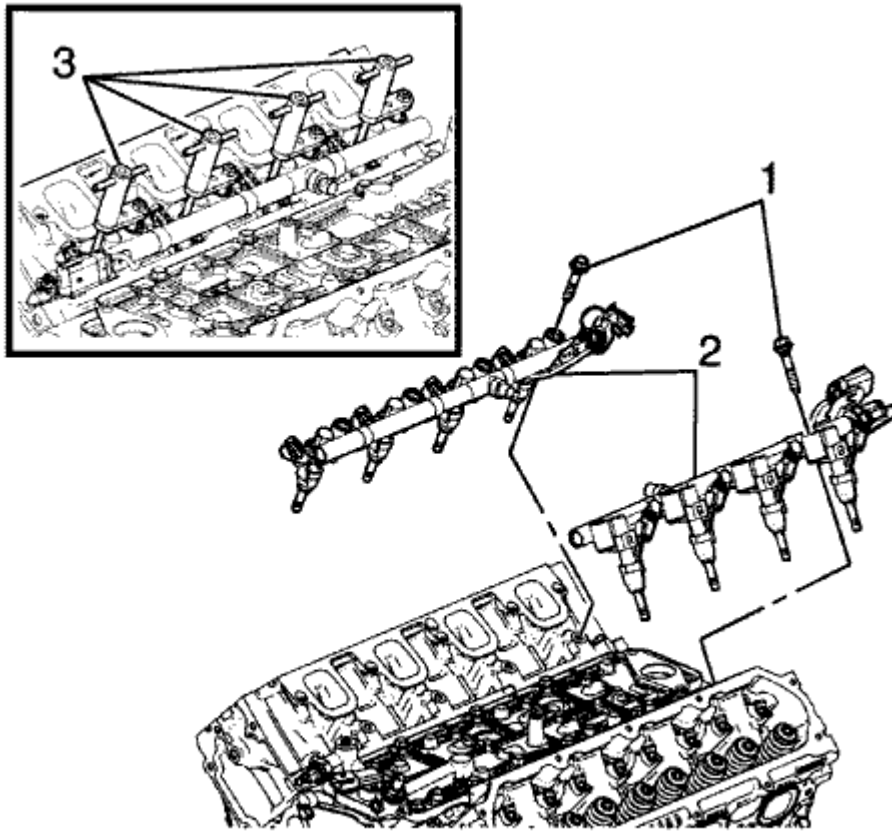


Fig. 75: Installing Two Sets Of EN-49248 Remover
Courtesy of GENERAL MOTORS COMPANY

7. Install two sets of EN-49248 remover (3).
8. Install one remover in each of the fuel rail fastener bores.

NOTE: In some cases, the fuel injectors may be difficult to remove because of heavy carbon build-up or other factors. Excessive force with the removal tool can damage the fuel rail, injectors or both. If injectors are difficult to remove, apply solvent to the base of the injector bores and allow adequate soaking time, to loosen the fuel injectors.

9. Remove by turning each section of the EN-49248 remover an even amount to pull the fuel rail and injectors out evenly.

CAUTION:

- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
- Cap the fittings and plug the holes when servicing the fuel

system in order to prevent dirt and other contaminants from entering open pipes and passages.

10. Simultaneously lift both ends of the fuel rail (2) and remove the fuel rail assembly from the cylinder head.
11. Remove and DISCARD the fuel injector seals.

NOTE: **Whenever the fuel injectors are removed from the cylinder head or fuel rail, they will need to be rebuilt. Refer to Fuel Rail and Injectors Cleaning and Inspection .**

12. If replacing the fuel injection fuel rail, remove the fuel injectors. Refer to Fuel Injector Replacement.

Installation Procedure

NOTE: **The injector seals should be clean and free of debris prior to installation.**

1. If replacing the fuel injection fuel rail, install the fuel injectors. Refer to Fuel Injector Replacement.

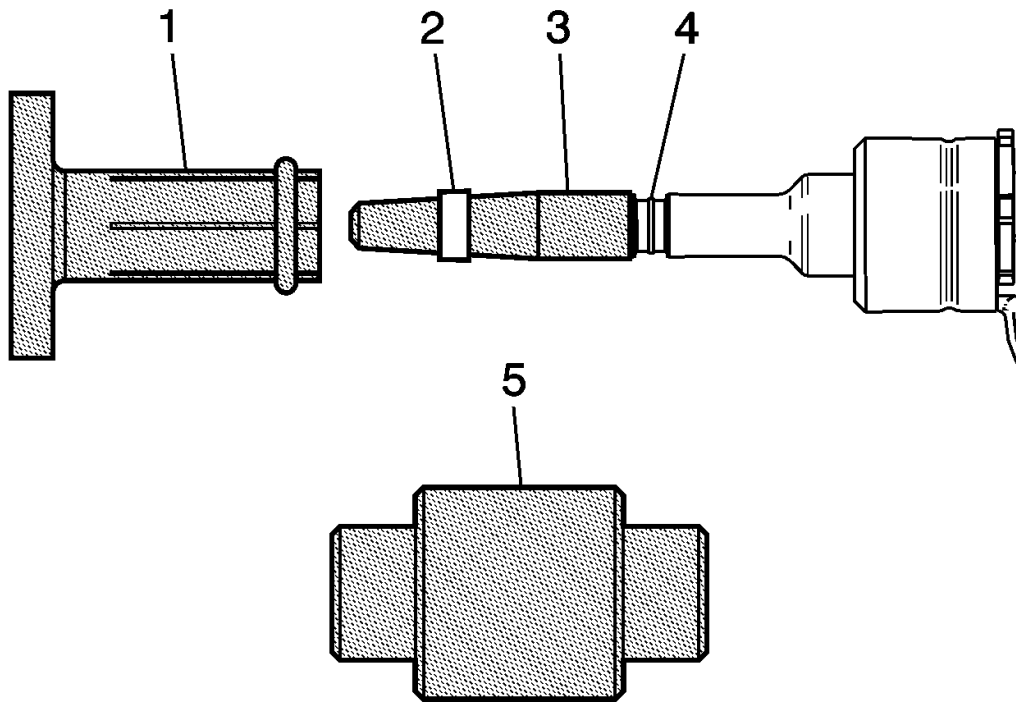


Fig. 76: Installing Seals With Long Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing the NEW seals (2) on the fuel injector.

2. Install EN-51105-1 long protector (3) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a new seal (2) on the EN-51101-1 long protector.
3. Using EN-49245-3 pusher (1), install the seal onto the second recessed area (4) of the fuel injector.

NOTE: The EN-49245-4 is two sided and either direction will size the seal correctly.

4. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

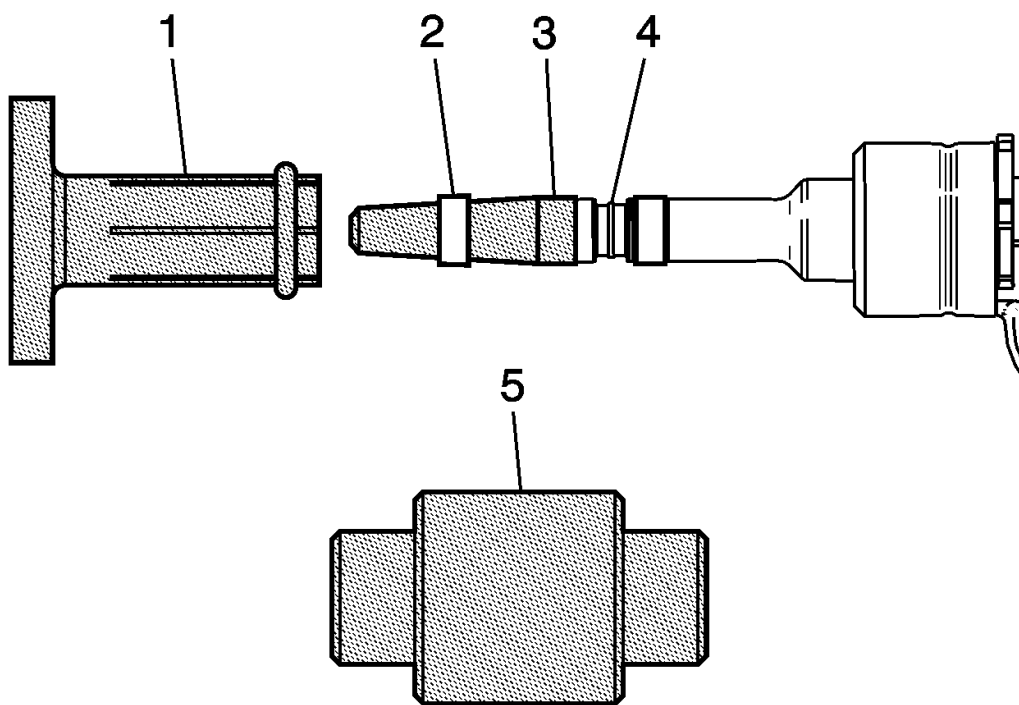


Fig. 77: Installing Seals With Short Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing NEW seals (2) on the injector.

5. Install EN-51105-2 short protector (3) onto the fuel injector tip. Place a NEW seal (2) on EN-51102-2 short protector.
6. Using EN-49245-3 pusher (1), install the seal onto the first recessed area (4) of the fuel injector.

NOTE: The EN-49245-4 is two sided and either direction will size the seal correctly.

7. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

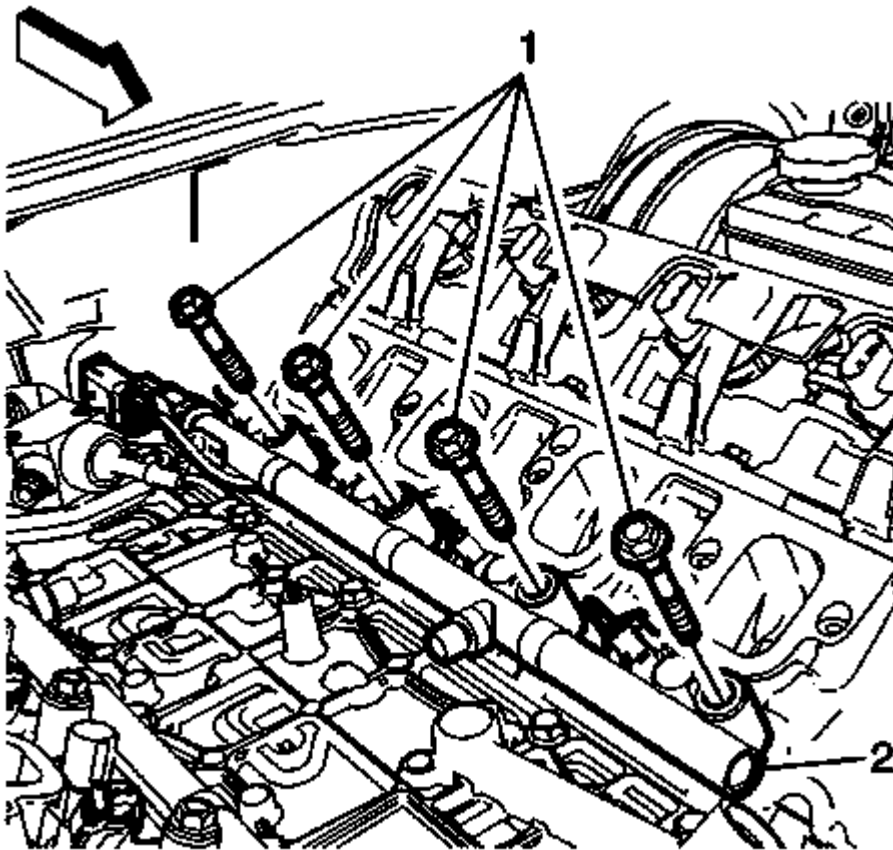


Fig. 78: Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel rail fasteners are retained into the rails using keepers. Care should be taken to ensure that the threadlock is installed after the fasteners are installed in their bore.

8. Install the fuel rail fasteners (1) into the fuel rail (2).
9. Apply a 0.5 mm (0.02 in) band of GM approved threadlock to the threads of the fuel rail fasteners (1). Refer to **Adhesives, Fluids, Lubricants and Sealers** for approved threadlock part number(s).
10. Install the fuel injection fuel rail assembly (2) on to the cylinder head.
11. Start the fuel rail fasteners by hand then draw the injector rail down evenly prior to tightening.

CAUTION: Refer to **Fastener Caution** .

12. Tighten the fuel rail fasteners (1) to 25 (18 lb ft).
13. If removed, install the fuel injection fuel rail pressure sensor. Refer to **Fuel Injection Fuel Rail**

14. Connect the electrical wiring harness connectors to the fuel rail.
15. Install the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement**.
16. Install the NEW fuel feed intermediate pipe position 1 and fuel feed intermediate pipe position 2. Refer to **Fuel Feed Intermediate Pipe Replacement - Position 1**.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2

Special Tools

- EN-49248 Injector Rail Assembly Remover
- EN-51101-1 Injector Seal Installer and Sizer
- EN-49245-3 Fuel Injection Seal Installer Sizer
- EN-49245-4 Fuel Injection Seal Installer Sizer

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

Removal Procedure

1. Remove the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**.
2. Remove and DISCARD the fuel feed intermediate pipe position 1 and fuel feed intermediate pipe position 2. Refer to **Fuel Feed Intermediate Pipe Replacement - Position 1**.
3. Disconnect the electrical wiring harness connectors from the fuel rail and fuel pump.
4. Clean the cylinder head pocket around the injectors of any dirt or buildup to prevent material from entering the combustion chambers.

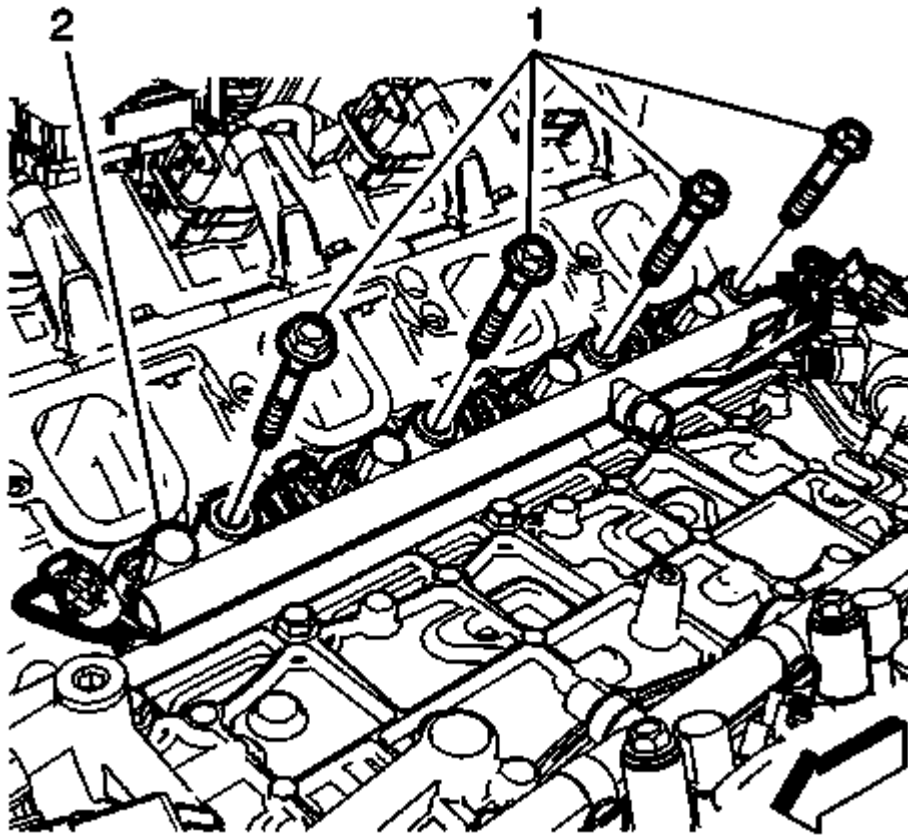


Fig. 79: Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel rail fasteners (1) securing the injector rail (2).

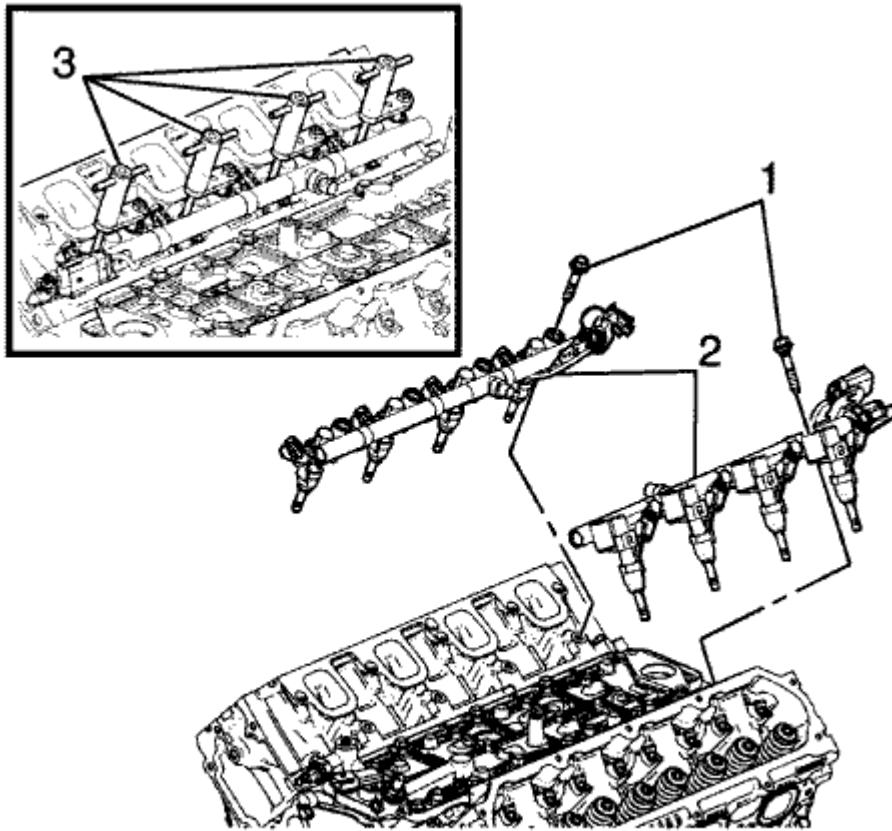


Fig. 80: Installing Two Sets Of EN-49248 Remover
Courtesy of GENERAL MOTORS COMPANY

6. Install two sets of EN-49248 remover (3).
7. Install one remover in each of the fuel rail fastener bores.

NOTE: In some cases, the fuel injectors may be difficult to remove because of heavy carbon build-up or other factors. Excessive force with the removal tool can damage the fuel rail, injectors or both. If injectors are difficult to remove, apply solvent to the base of the injector bores and allow adequate soaking time, to loosen the fuel injectors.

8. Remove by turning each section of the EN-49248 remover an even amount to pull the fuel rail and injectors out evenly.

CAUTION:

- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
- Cap the fittings and plug the holes when servicing the fuel

system in order to prevent dirt and other contaminants from entering open pipes and passages.

9. Simultaneously lift both ends of the fuel rail (2) and remove the fuel rail assembly from the cylinder head.
10. Remove and DISCARD the fuel injector seals.

NOTE: **Whenever the fuel injectors are removed from the cylinder head or fuel rail, they will need to be rebuilt. Refer to Fuel Rail and Injectors Cleaning and Inspection .**

11. If replacing the fuel injection fuel rail, remove the fuel injectors. Refer to Fuel Injector Replacement.

Installation Procedure

NOTE: **The injector seals should be clean and free of debris prior to installation.**

1. If replacing the fuel injection fuel rail, install the fuel injectors. Refer to Fuel Injector Replacement.

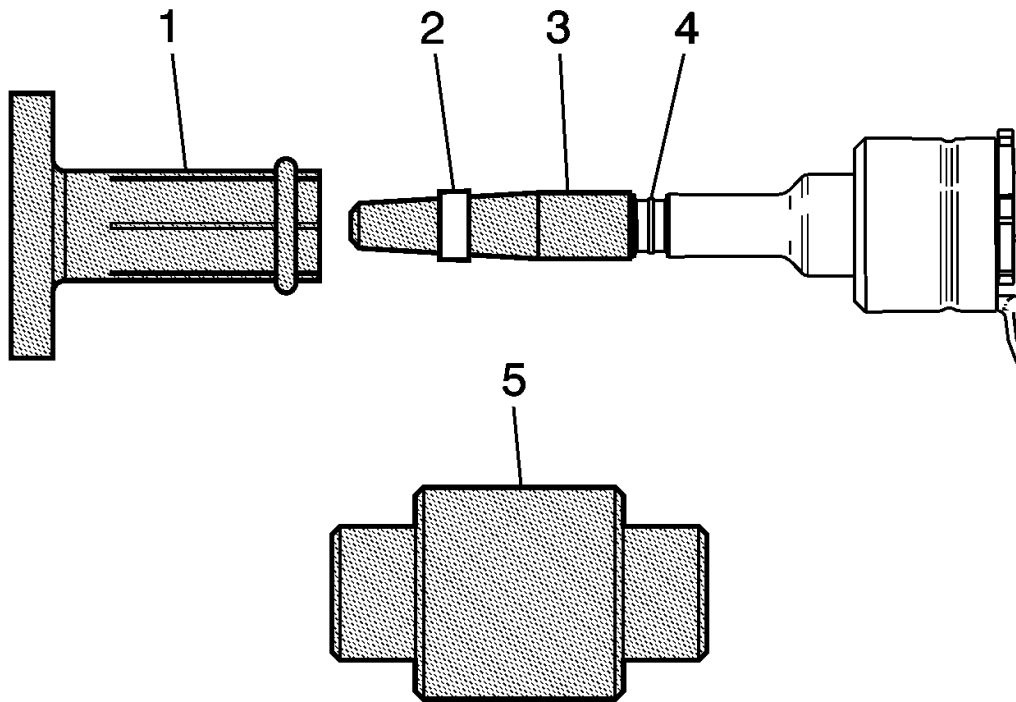


Fig. 81: Installing Seals With Long Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing the NEW seals (2) on the fuel injector.

2. Install EN-51105-1 long protector (3) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a new seal (2) on the EN-51101-1 long protector.
3. Using EN-49245-3 pusher (1), install the seal onto the second recessed area (4) of the fuel injector.

NOTE: The EN-49245-4 is two sided and either direction will size the seal correctly.

4. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

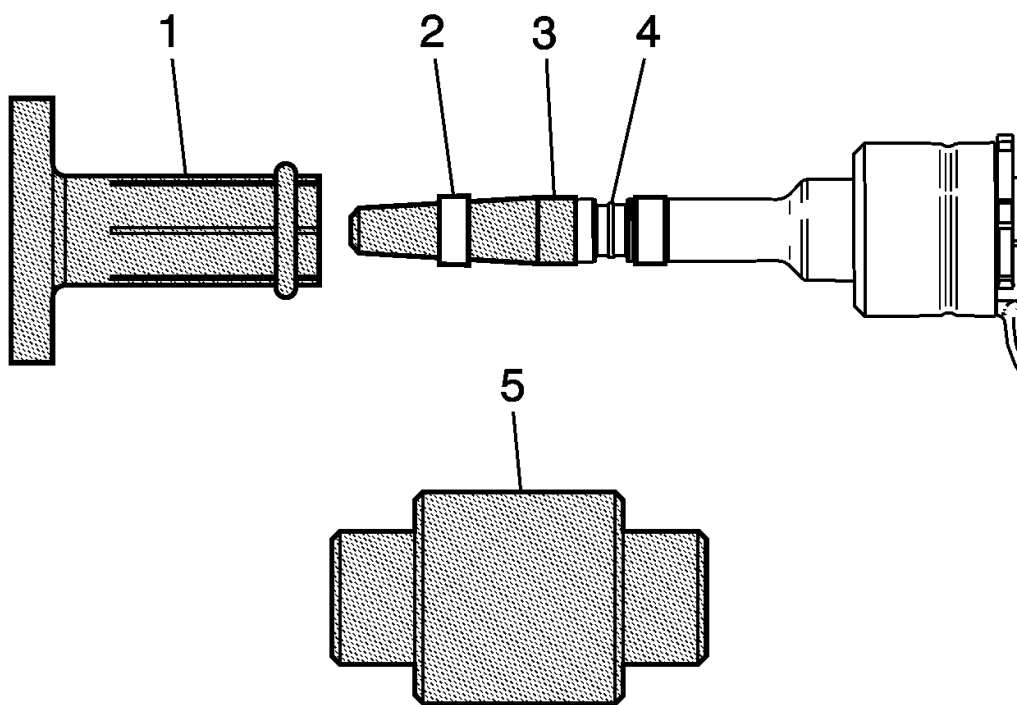


Fig. 82: Installing Seals With Short Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing NEW seals (2) on the injector.

5. Install EN-51105-2 short protector (3) onto the fuel injector tip. Place a NEW seal (2) on EN-51102-2 short protector.
6. Using EN-49245-3 pusher (1), install the seal onto the first recessed area (4) of the fuel injector.

NOTE: The EN-49245-4 is two sided and either direction will size the seal correctly.

7. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

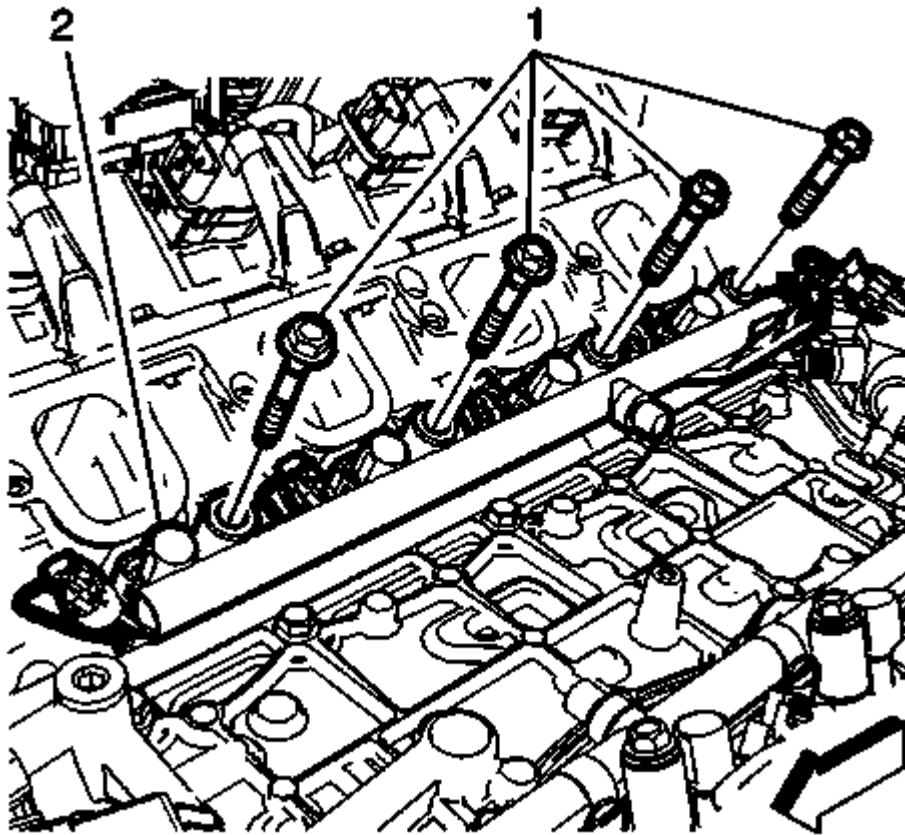


Fig. 83: Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel rail fasteners are retained into the rails using keepers. Care should be taken to ensure that the threadlock is installed after the fasteners are installed in their bore.

8. Install the fuel rail fasteners (1) into the fuel rail (2).
9. Apply a 0.5 mm (0.02 in) band of GM approved threadlock to the threads of the fuel rail fasteners (1). Refer to **Adhesives, Fluids, Lubricants and Sealers** for approved threadlock part number(s).
10. Install the fuel injection fuel rail assembly (2) to the cylinder head.
11. Start the fuel rail fasteners by hand then draw the injector rail down evenly prior to tightening.

CAUTION: Refer to **Fastener Caution** .

12. Tighten the fuel rail fasteners to 25 (18 lb ft).
13. Connect the electrical wiring harness connectors to the fuel rail and fuel pump.

14. Install the NEW fuel feed intermediate pipe position 1 and fuel feed intermediate pipe position 2.
Refer to **Fuel Feed Intermediate Pipe Replacement - Position 1.**
15. Install the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement.**

FUEL INJECTION FUEL RAIL INSULATOR REPLACEMENT

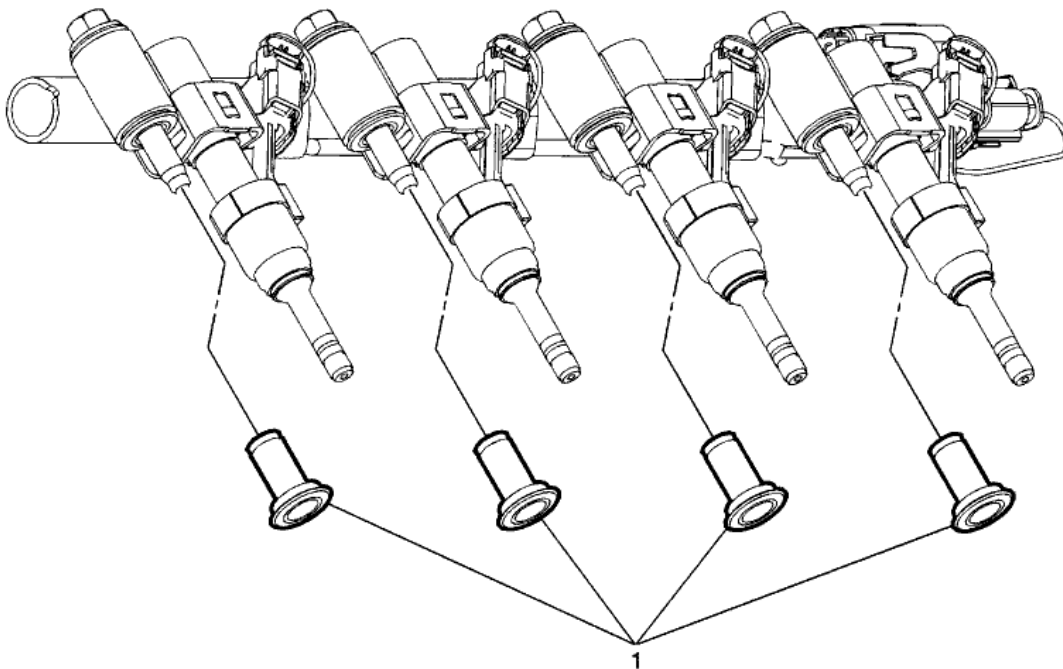


Fig. 84: Fuel Injection Fuel Rail Insulator
Courtesy of GENERAL MOTORS COMPANY

Fuel Injection Fuel Rail Insulator Replacement

Callout	Component Name
Preliminary Procedure	
Remove the fuel injection fuel rail assemblies. Refer to <u>Fuel Injection Fuel Rail Assembly Replacement - Bank 1</u> and <u>Fuel Injection Fuel Rail Assembly Replacement - Bank 2.</u>	
1	Fuel Injection Fuel Rail Insulators

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

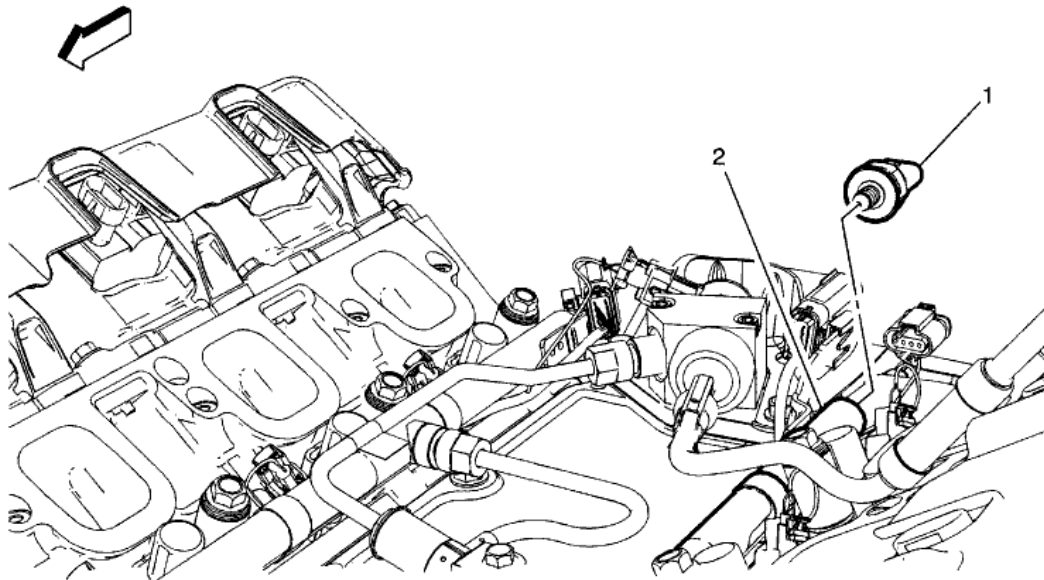


Fig. 85: Fuel Injection Fuel Rail Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement</u>.	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure 1. Disconnect the fuel injection fuel rail fuel pressure sensor electrical wiring harness connector. 2. Lubricate the threads and sealing area in the fuel rail with silicone free engine oil. Refer to <u>Adhesives, Fluids, Lubricants and Sealers</u> for recommended lubricant.

	33 (24 lb ft)
2	Fuel Injection Fuel Rail Assembly NOTE: Prior to removing the sensor, clean any debris from the area to prevent it from entering the fuel system.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT - POSITION 1

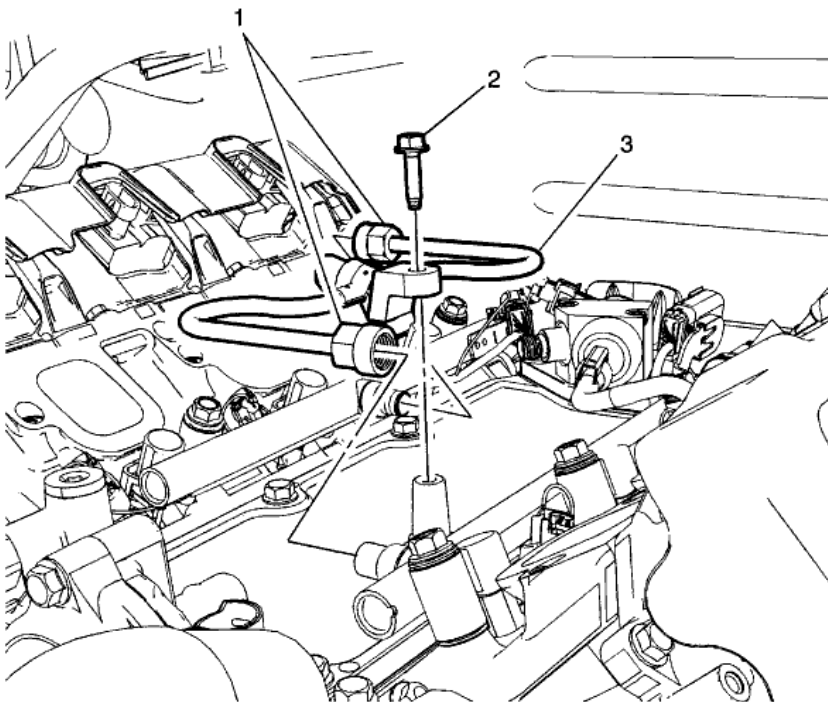


Fig. 86: Fuel Feed Intermediate Pipe - Position 1
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Intermediate Pipe Replacement - Position 1

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief. 2. Remove the fuel pump insulator. Refer to Fuel Pump Insulator Replacement. 3. Remove the fuel feed intermediate pipe position 2. Refer to Fuel Feed Intermediate Pipe Replacement - Position 2.	
	Fuel Feed Intermediate Pipe Fitting (Qty:2) CAUTION:

1	Tighten 28 (21 lb ft)
2	Fuel Feed Intermediate Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
3	Fuel Feed Intermediate Pipe Position 1 Procedure 1. DISCARD the old fuel feed pipe and install a NEW fuel feed pipe. 2. Ensure that the high pressure fuel pipe and fuel rail fittings are clean and dry prior to assembly. 3. Pressure up the fuel system and check for leaks.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT - POSITION 2

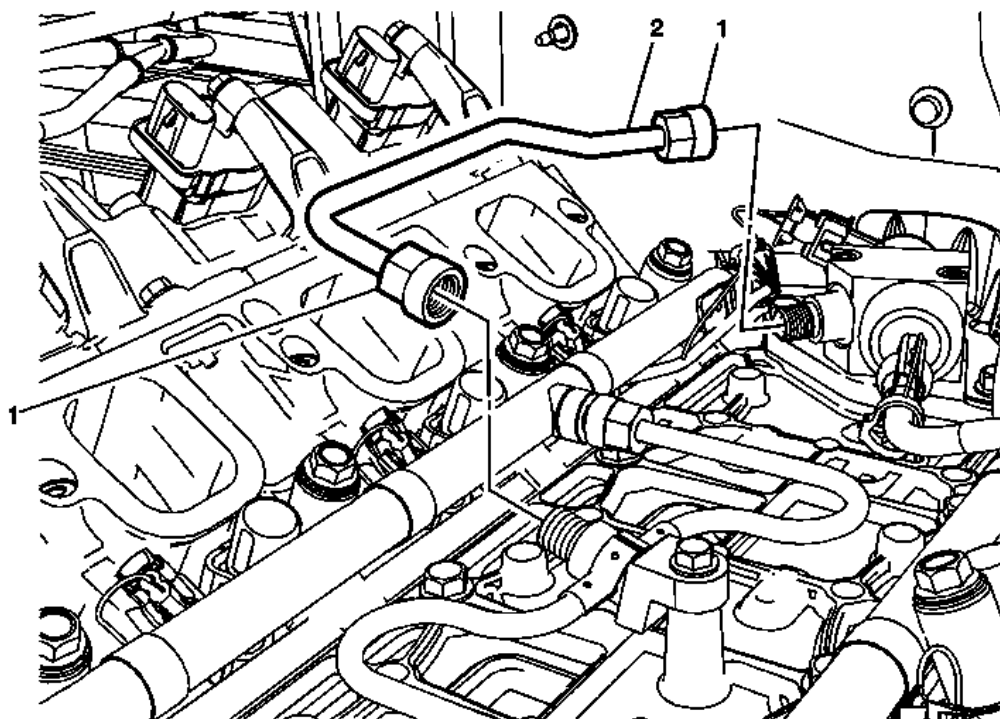


Fig. 87: Fuel Feed Intermediate Pipe - Position 2

Fuel Feed Intermediate Pipe Replacement - Position 2

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u> . 2. Remove the fuel pump insulator. Refer to <u>Fuel Pump Insulator Replacement</u> .	
1	Fuel Feed Intermediate Pipe Fittings (Qty:2) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 28 (21 lb ft)
2	Fuel Feed Intermediate Pipe Position 2 Procedure 1. DISCARD the old fuel feed pipe and install a NEW fuel feed pipe. 2. Ensure that the high pressure fuel pipe and fuel pump fittings are clean and dry prior to assembly. 3. Pressure up the fuel system and check for leaks.

FUEL FEED INTERMEDIATE HOSE REPLACEMENT

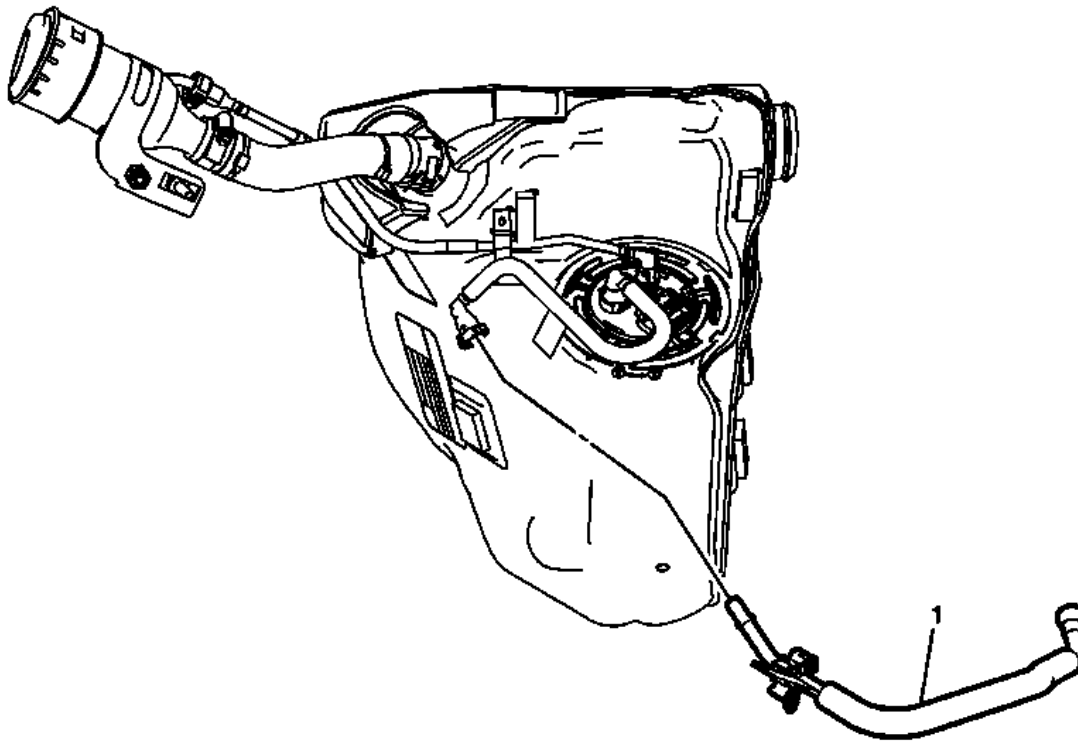


Fig. 88: Fuel Feed Intermediate Hose
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Intermediate Hose Replacement

Callout	Component Name
Preliminary Procedure	
Remove the left side fuel tank. Refer to Fuel Tank Replacement - Left Side .	
1	Fuel Feed Intermediate Hose Procedure Disconnect the fuel feed intermediate hose from the fuel feed hose. Refer to Plastic Collar Quick Connect Fitting Service .

FUEL INJECTOR REPLACEMENT

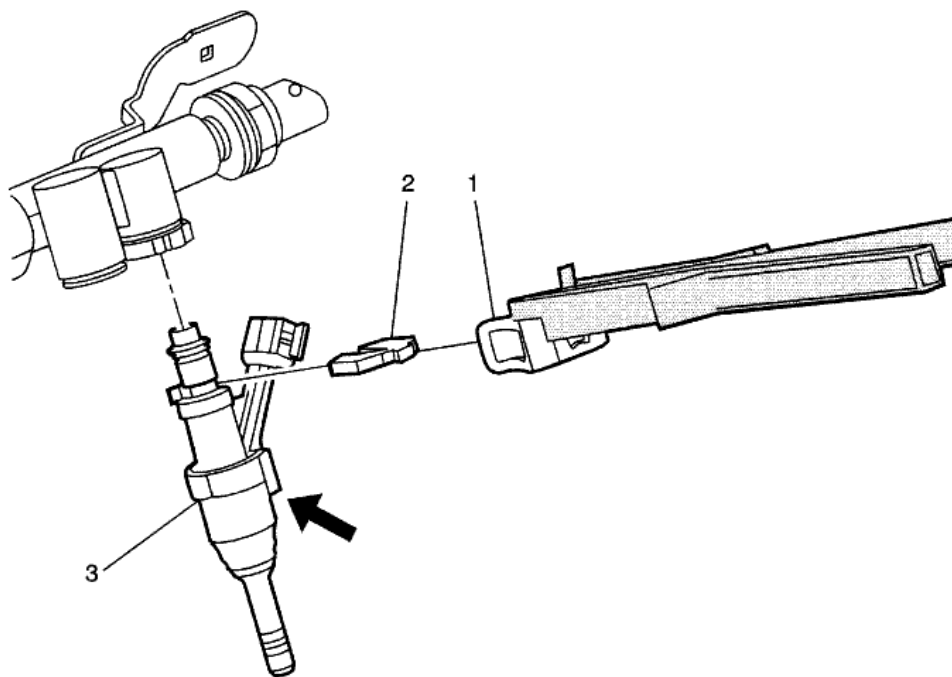


Fig. 89: Fuel Injector
 Courtesy of GENERAL MOTORS COMPANY

Fuel Injector Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel rail. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1 , and/or Fuel Injection Fuel Rail Assembly Replacement - Bank 2 .	
Special Tools EN-51097 For equivalent regional tools. Refer to Special Tools .	
1	Fuel Injector Retainer Procedure Remove and discard the fuel injector retainer clips by installing EN-51097 injector retaining clip installer and spreading both sides of the clip evenly.
2	Fuel Injector Collars NOTE: Always use NEW fuel injector collars supplied with injector when installing the new injector. If reinstalling the injector, it is not necessary to remove the collars unless the collars are being replaced.
	Fuel Injector Procedure Replace the injector seals as needed. Refer to Fuel Rail and Injectors Cleaning

3

NOTE:

Inspect the injectors to be sure that they are clean and free of debris prior to installation. Do NOT lubricate the injector seals. Rebuild the fuel injectors whenever the injector has been removed from the fuel injector rail.

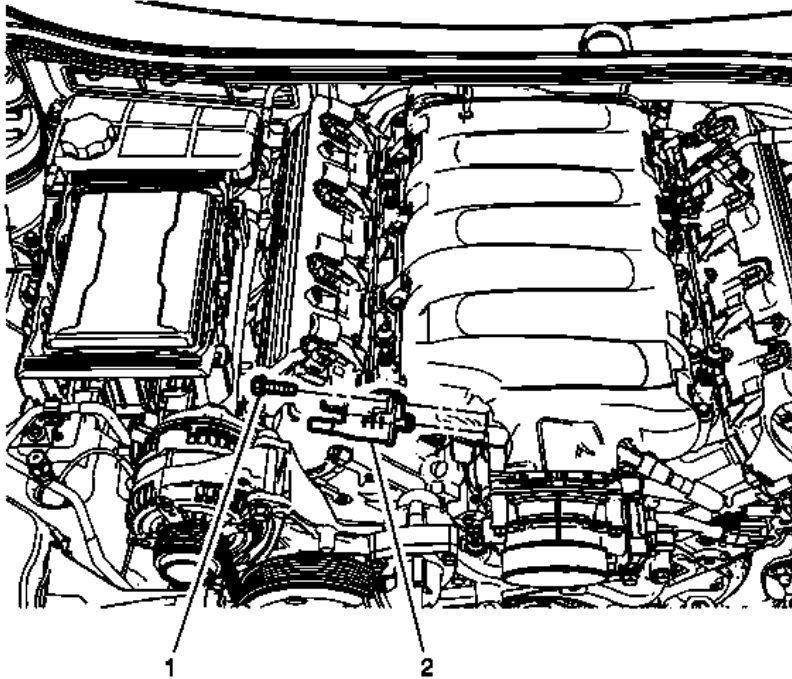
EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

Fig. 90: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the upper intake manifold cover. Refer to <u>Upper Intake Manifold Cover Replacement</u> .	
2. Remove the evaporative emission canister purge pipe. Refer to <u>Evaporative Emission Canister Purge Pipe Replacement</u>	
1	Evaporative Emission Canister Purge Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (89 lb in)
2	Evaporative Emission Canister Purge Solenoid Valve

EVAPORATIVE EMISSION CANISTER PURGE HOSE REPLACEMENT

Removal Procedure

1. Remove the right side exhaust muffler. Refer to **Exhaust Muffler Replacement - Right Side** .
2. Remove the rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement** .

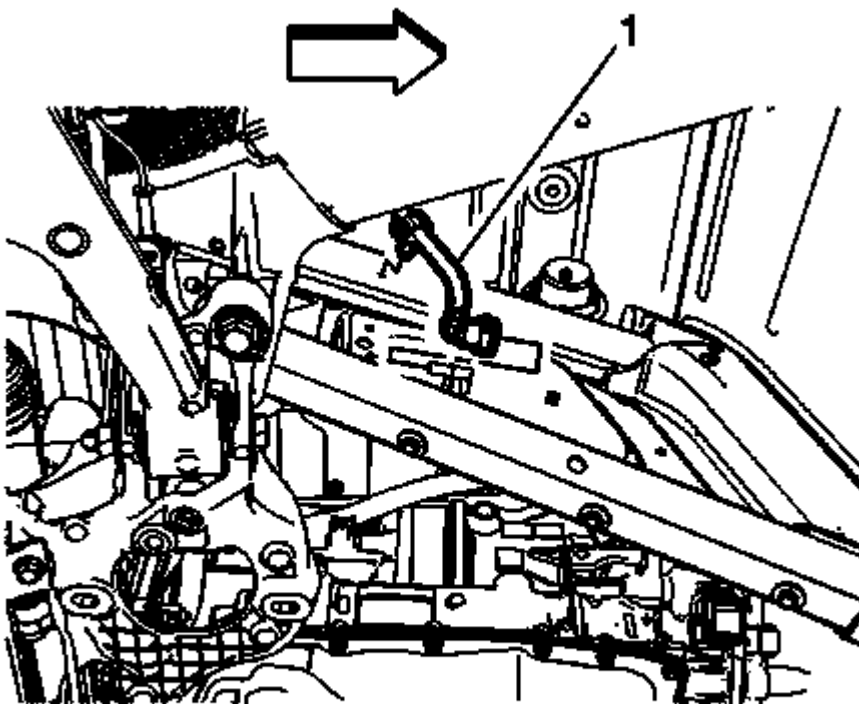


Fig. 91: Evaporative Emission Canister Purge Hose
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the evaporative emission canister purge hose (1) from evaporative emission hose and retainers. Refer to **Plastic Collar Quick Connect Fitting Service**.

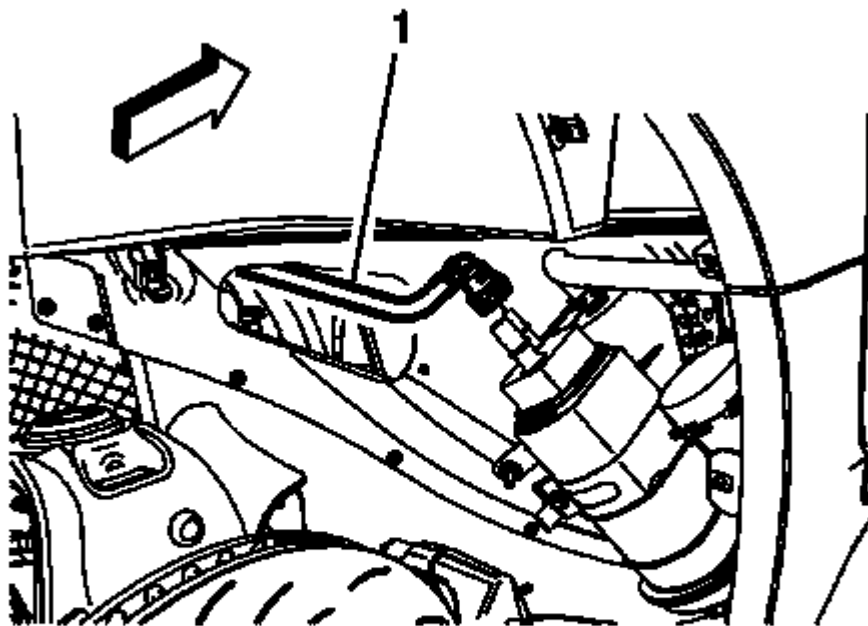


Fig. 92: Evaporative Emission Canister Purge Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the evaporative emission canister purge hose (1) from evaporative emission canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Remove the evaporative emission canister purge hose (1) from the vehicle.

Installation Procedure

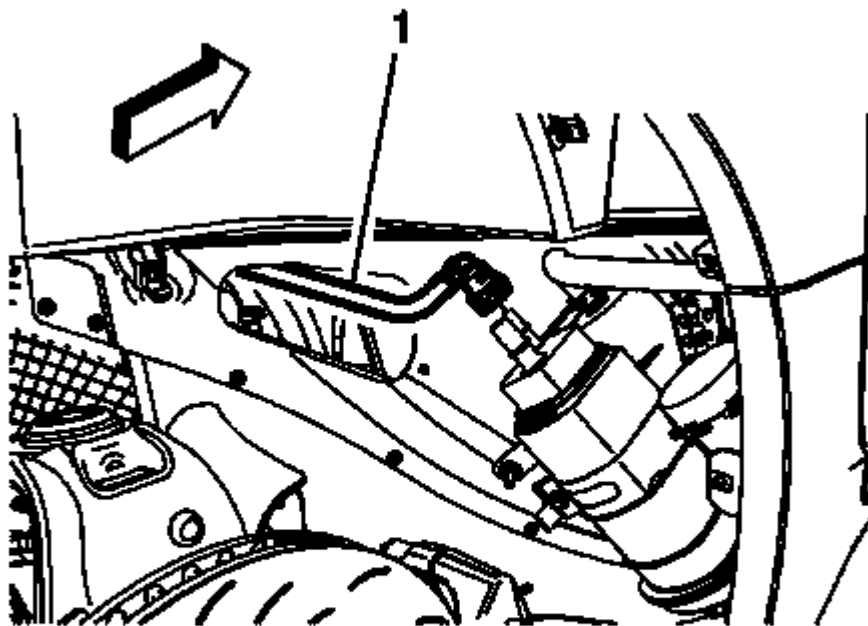


Fig. 93: Evaporative Emission Canister Purge Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission canister purge hose (1) to the vehicle.
2. Connect the evaporative emission canister purge hose (1) to the evaporative emission canister.
Refer to **Plastic Collar Quick Connect Fitting Service**.

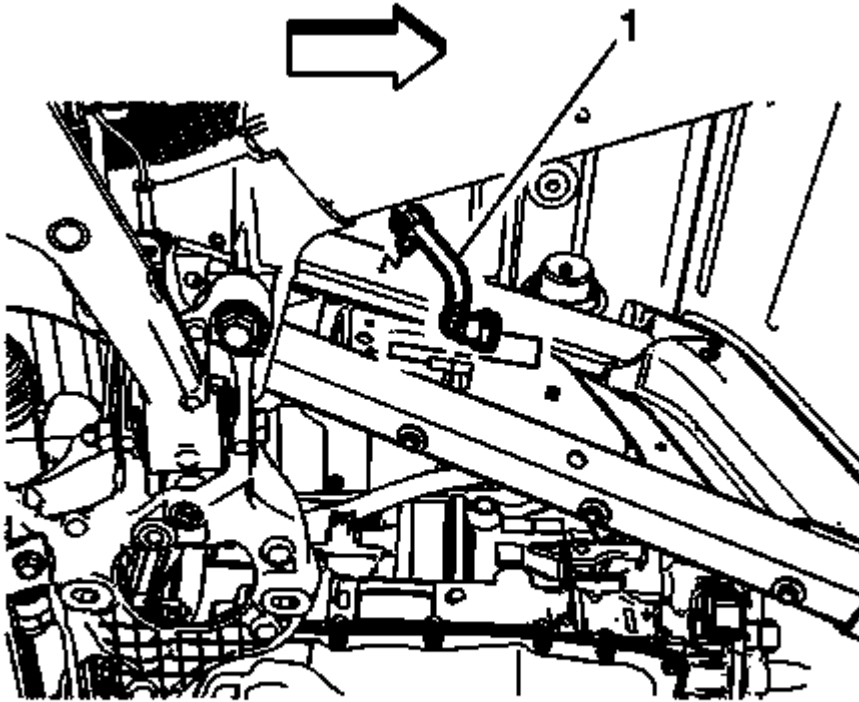


Fig. 94: Evaporative Emission Canister Purge Hose
Courtesy of GENERAL MOTORS COMPANY

3. Connect the evaporative emission canister purge hose (1) to the evaporative emission hose and retainers. Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Install the rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement**.
5. Install the right side exhaust muffler. Refer to **Exhaust Muffler Replacement - Right Side**.

EVAPORATIVE EMISSION CANISTER SOLENOID VALVE HOSE REPLACEMENT

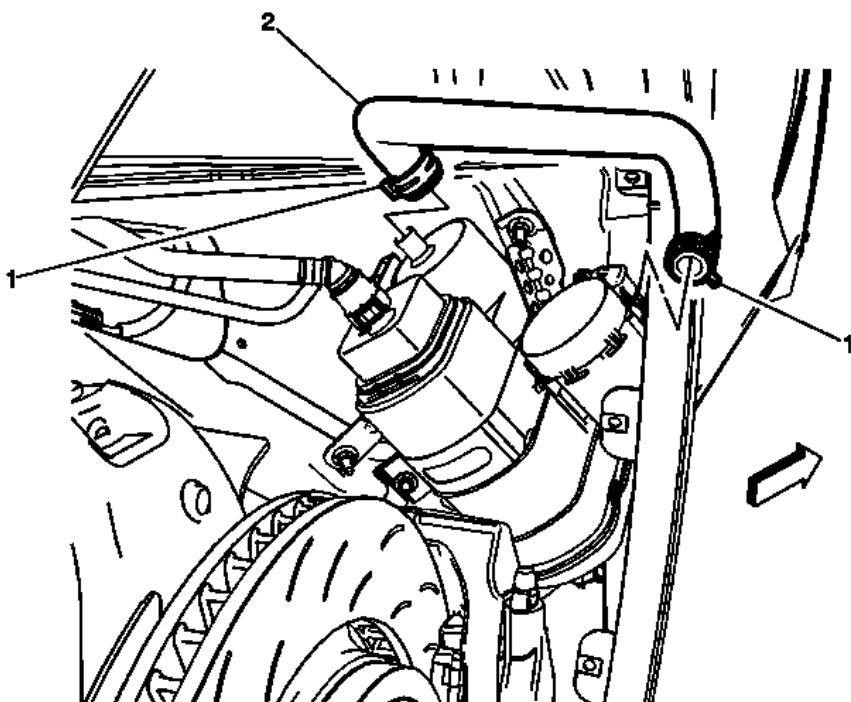


Fig. 95: Evaporative Emission Canister Solenoid Valve Hose
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Solenoid Valve Hose Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear wheelhouse liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Evaporative Emission Canister Solenoid Valve Hose Clamp (Qty: 2)
2	Evaporative Emission Canister Solenoid Valve Hose

EVAPORATIVE EMISSION HOSE REPLACEMENT

Removal Procedure

1. Remove the evaporative emission canister purge pipe. Refer to **Evaporative Emission Canister Purge Pipe Replacement**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the rear body exhaust heat shield. Refer to **Rear Body Exhaust Heat Shield Replacement**

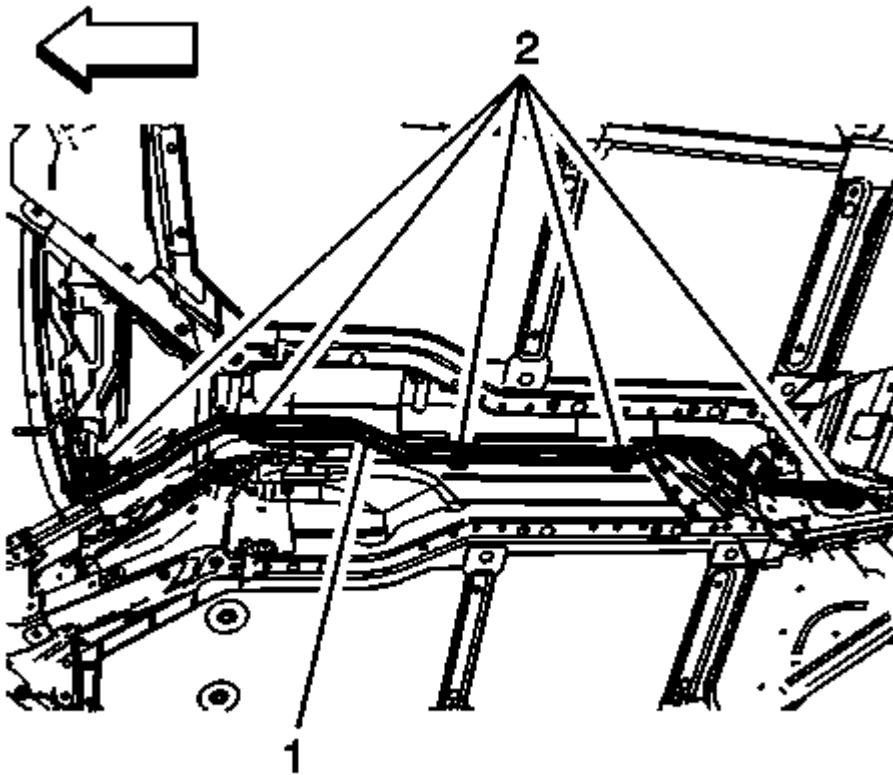


Fig. 96: Evaporative Emission Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Remove the evaporative emission hose (1) from retainers (2) and disconnect from evaporative emission canister purge hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Remove the evaporative emission hose (1) from the vehicle.

Installation Procedure

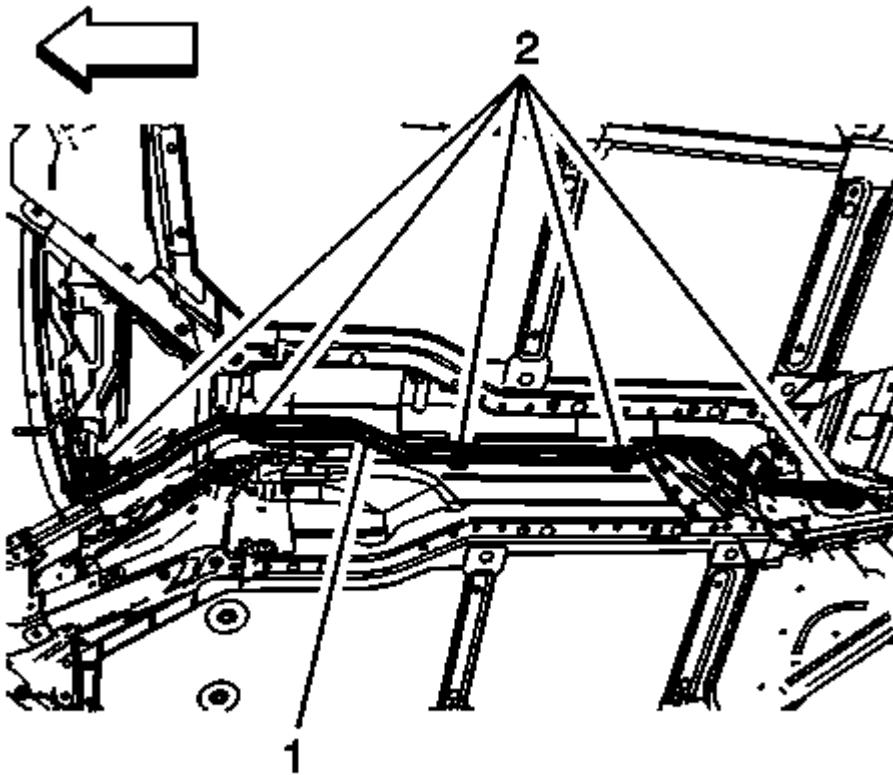


Fig. 97: Evaporative Emission Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission hose (1) to the vehicle.
2. Install the evaporative emission hose (1) to retainers (2) and connect to evaporative emission canister purge hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the rear body exhaust heat shield. Refer to **Rear Body Exhaust Heat Shield Replacement**
4. Lower the vehicle.
5. Install the evaporative emission canister purge pipe. Refer to **Evaporative Emission Canister Purge Pipe Replacement**.

EVAPORATIVE EMISSION CANISTER SOLENOID REPLACEMENT

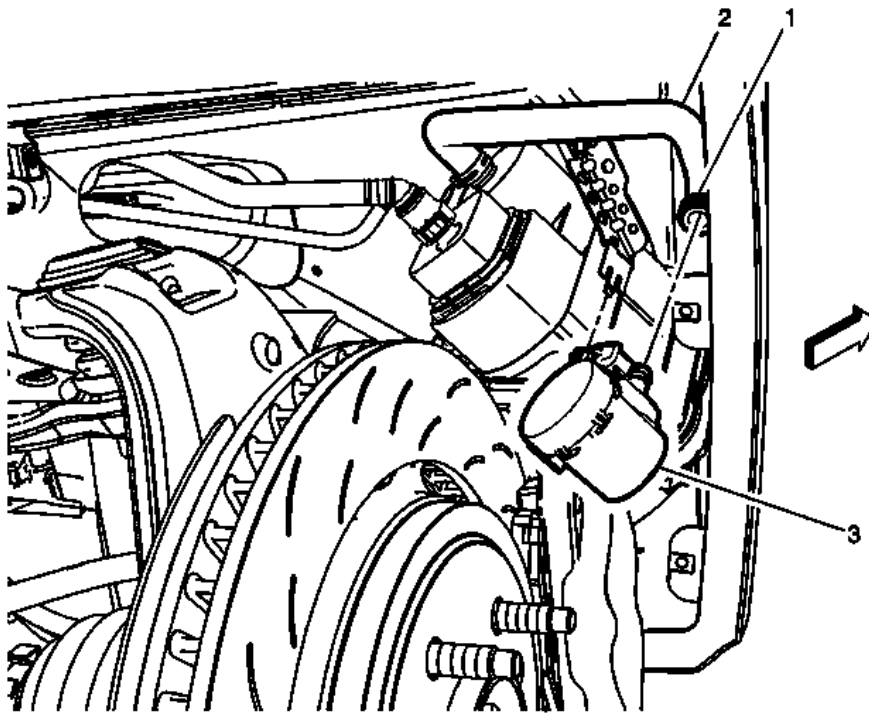


Fig. 98: Evaporative Emission Canister Solenoid
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Solenoid Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear wheelhouse liner. Refer to Rear Wheelhouse Liner Replacement .	
1	Evaporative Emission Canister Purge Hose Clamp
2	Evaporative Emission Canister Purge Hose
3	Evaporative Emission Canister Solenoid
	Procedure
	1. Disconnect the electrical connector.
	2. Depress tab to release solenoid from bracket.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

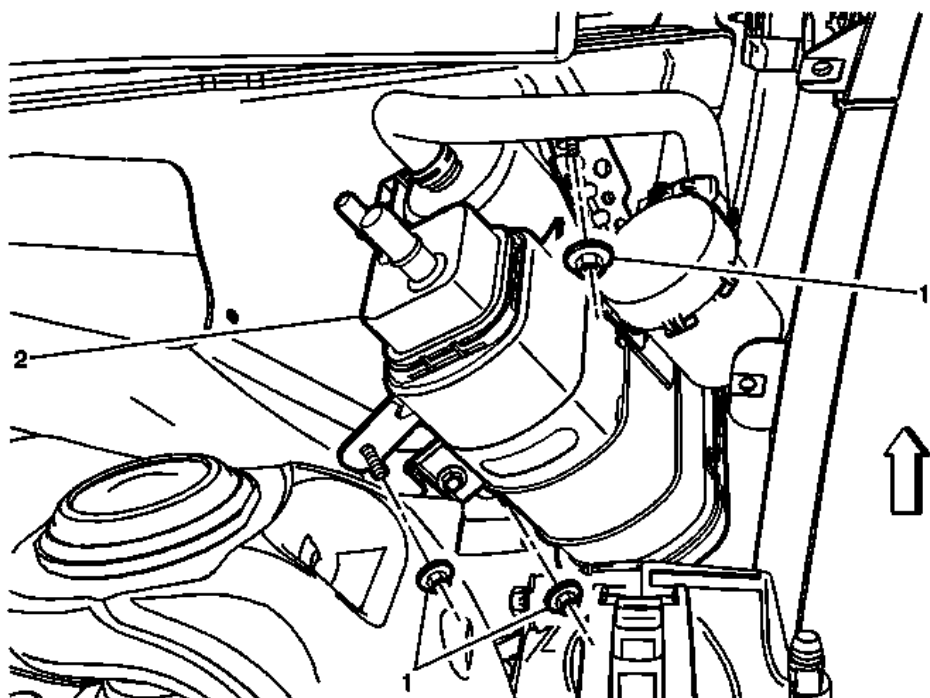


Fig. 99: Evaporative Emission Canister
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the rear wheelhouse liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> . 2. Disconnect the electrical connector.	
1	Evaporative Emission Canister Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 6 (53 lb in)
2	Evaporative Emission Canister Procedure Transfer parts as necessary.

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

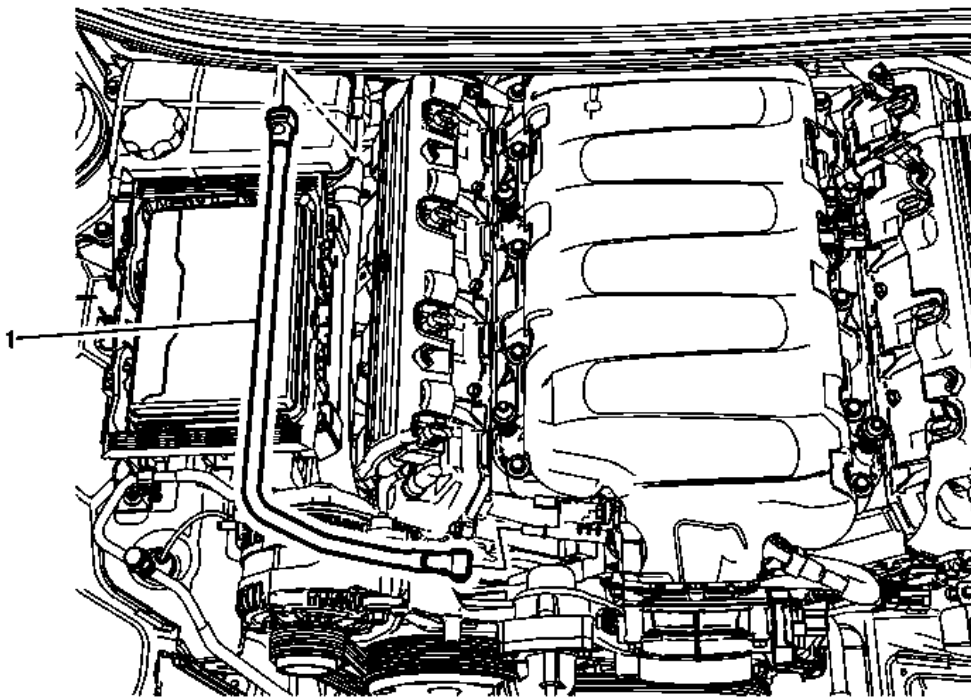


Fig. 100: Evaporative Emission Canister Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (Right)</u> , <u>Intake Manifold Cover Replacement (Left)</u> .	
1	Evaporative Emission Canister Purge Pipe Procedure Disconnect the evaporative emission canister purge pipe from the evaporative emission canister purge valve and the evaporative emission pipe. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>

IGNITION COIL REPLACEMENT

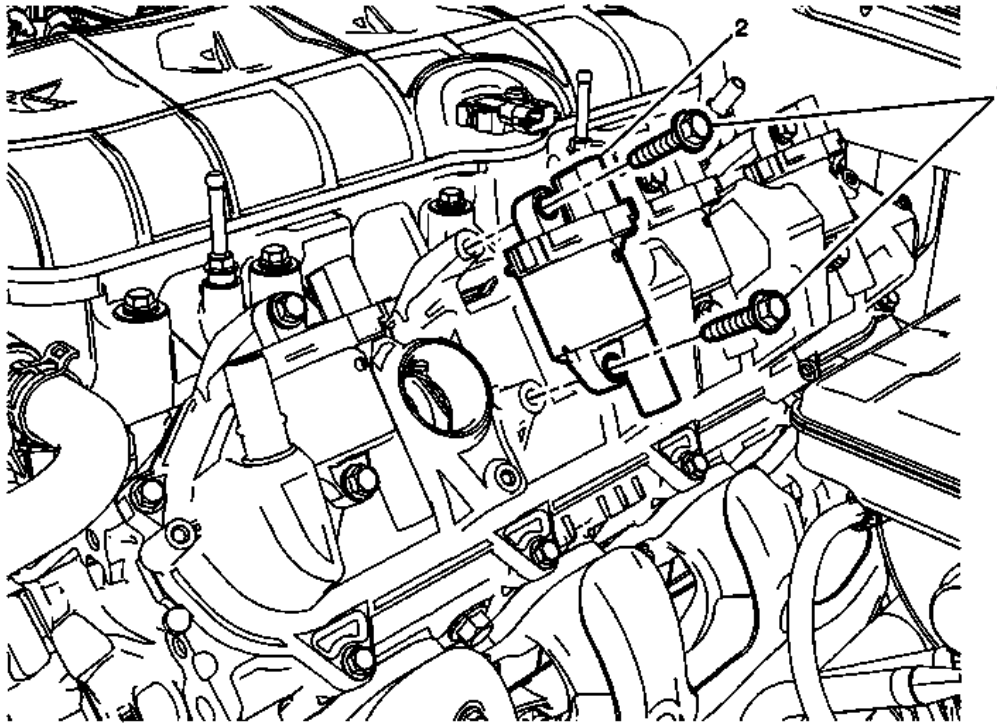


Fig. 101: Ignition Coil
 Courtesy of GENERAL MOTORS COMPANY

Ignition Coil Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the valve rocker arm cover insulator. Refer to <u>Valve Rocker Arm Cover Insulator Replacement - Left Side</u> , and/or <u>Valve Rocker Arm Cover Insulator Replacement - Right Side</u> . 2. Remove the spark plug wires. Refer to <u>Spark Plug Wire Replacement</u>.	
1	Ignition Coil Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Ignition Coil Procedure

2. Disconnect the electrical wiring harness connector from the ignition coil.

SPARK PLUG WIRE INSPECTION

IMPORTANT: Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Correct routing of the spark plug wires. Incorrect routing may cause cross-firing.
2. Inspect for any signs of cracks or splits in the wires.
3. Inspect each boot for the following conditions:
 - Tearing
 - Piercing
 - Arcing
 - Carbon tracking
 - Corroded terminals
4. If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

SPARK PLUG WIRE REPLACEMENT

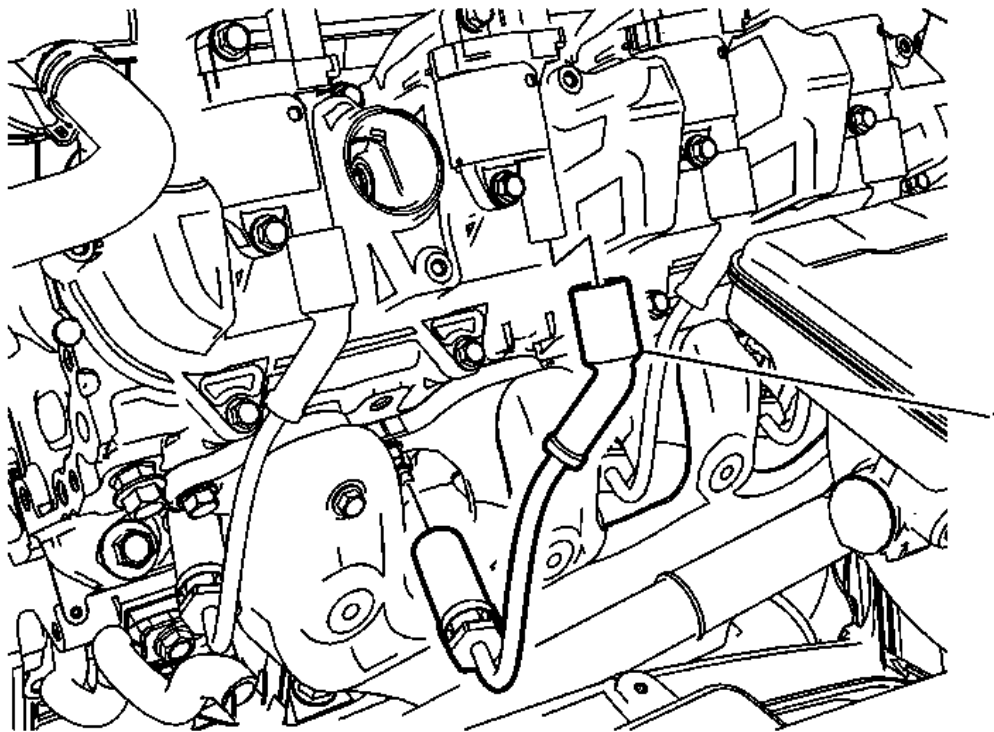


Fig. 102: Spark Plug Wire

Spark Plug Wire Replacement

Callout	Component Name
Preliminary Procedure Remove the valve rocker arm cover insulator. Refer to <u>Valve Rocker Arm Cover Insulator Replacement - Left Side</u> , and/or <u>Valve Rocker Arm Cover Insulator Replacement - Right Side</u> .	
1	Spark Plug Wire Procedure 1. Twist the spark plug wire boot 1/2 turn and remove the spark plug wire. 2. Inspect the spark plug wire for damage and replace if necessary. 3. 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, apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot up to a depth of 15 mm from the end of the boot. Refer to <u>Adhesives, Fluids, Lubricants and Sealers</u> . NOTE: Pull only on the spark plug wire boot to remove the wire.

SPARK PLUG INSPECTION

Spark Plug Usage

- Make sure that the correct spark plug is installed. An incorrect spark plug causes poor driveability conditions. Refer to the Electronic Parts Catalog.
- Make sure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling due to a colder plug
 - A pre-ignition condition, causing spark plug and/or engine damage due to a hotter plug

Spark Plug Inspection

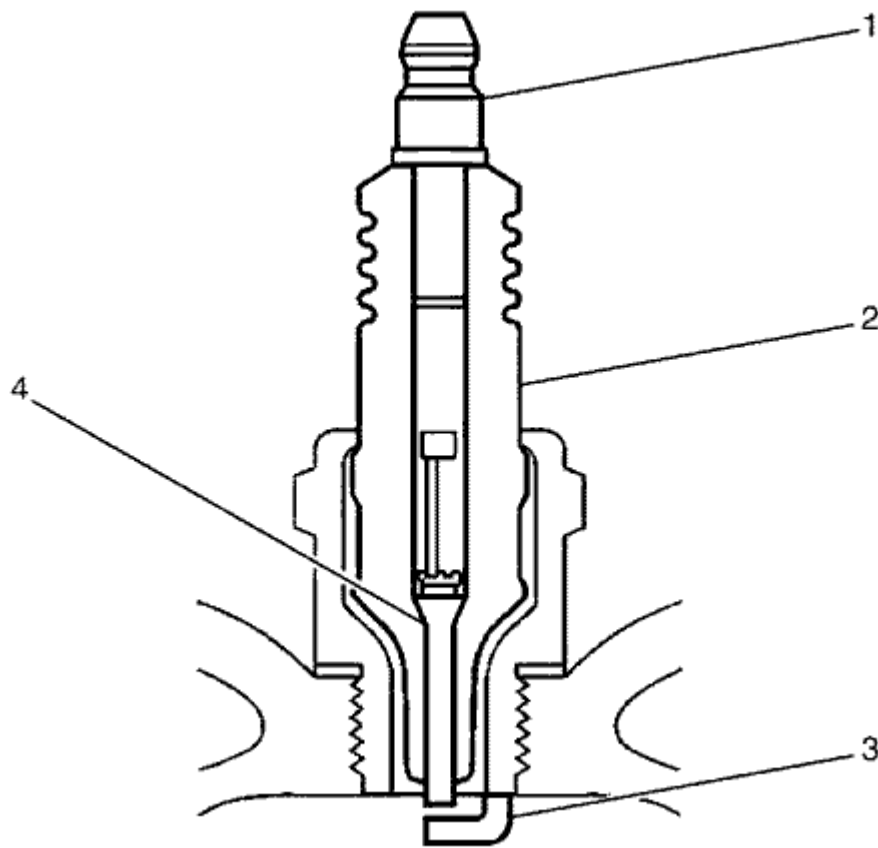


Fig. 103: Identifying Terminal Post & Insulator
Courtesy of GENERAL MOTORS COMPANY

- 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 for carbon tracking soot. This condition is caused by the electrical charge travelling 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 from such as oil, coolant or from water. A saturated spark plug boot causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of through the electrodes (3, 4).
- Inspect for evidence of incorrect arcing.
 - Measure the gap between the centre electrode (4) and the side electrode (3) terminals. Refer to **Ignition System Specifications** .
 - 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 at the centre electrode (4).
- Inspect for a side electrode (3) that is broken or worn.
- Inspect for a broken, worn or loose centre electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose centre electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3 and 4). Deposits on the electrodes reduce or eliminate the gap.
- Inspect for worn or missing platinum pads on the electrodes (3 and 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 spark plugs, with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon-fouled plugs. 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 during light loads can keep the spark plug temperatures so low that the normal combustion deposits may not burn off.
- Deposit fouling. Oil, coolant or additives that include substances such as silicone, evidenced by a very white coating, reduces the spark intensity. Most powdery deposits will not affect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

Removal Procedure

1. Remove the spark plug wires from the spark plugs. Refer to **Spark Plug Wire Replacement**.
2. Loosen each spark plug 1 or 2 turns.
3. Use a brush or use compressed air in order to remove any dirt from the spark plugs.

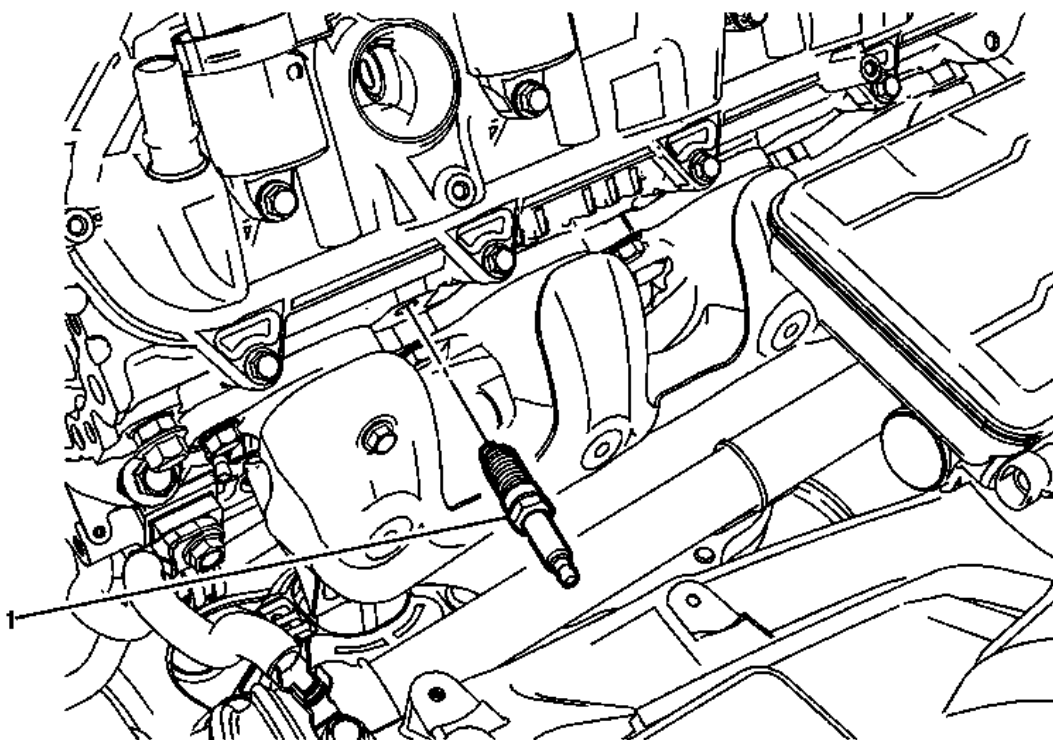


Fig. 104: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

4. Remove the spark plugs (1) one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

Installation Procedure

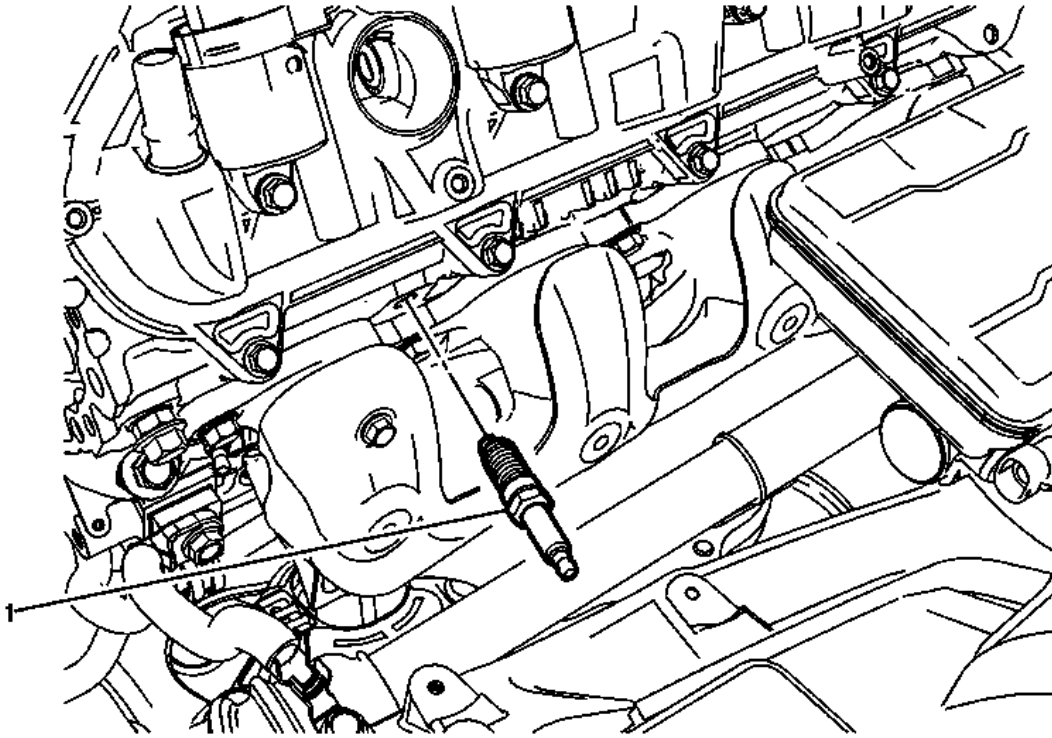


Fig. 105: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Hand start the spark plugs (1) in the corresponding cylinders.

CAUTION: Refer to Component Fastener Tightening Caution .

2. Tighten the spark plugs to 20 (15 lb ft).
3. Install the spark plug wires onto the spark plugs. Refer to Spark Plug Wire Replacement.

CRANKSHAFT POSITION SENSOR REPLACEMENT

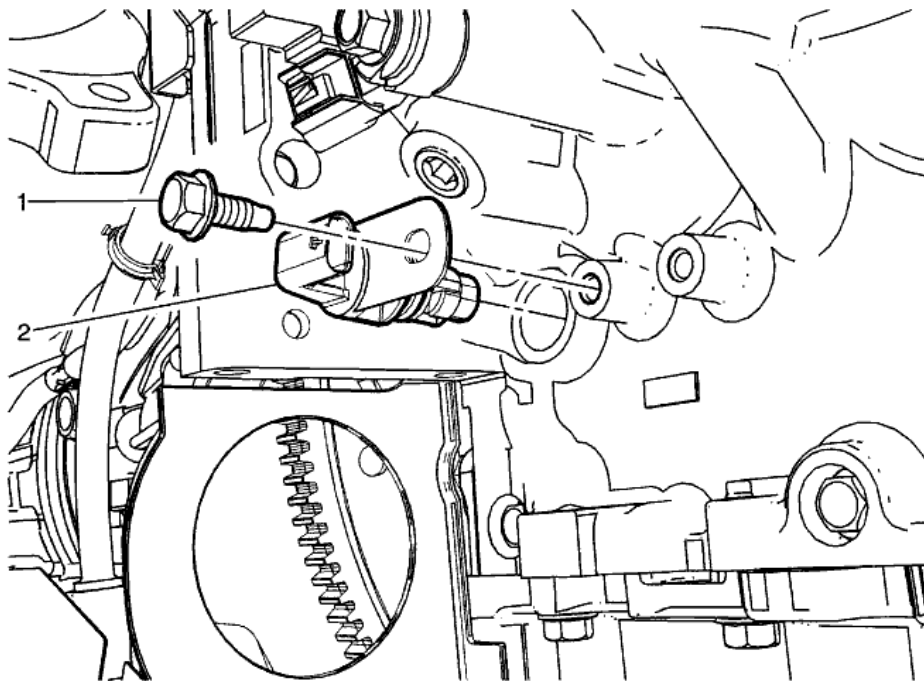


Fig. 106: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the starter. Refer to <u>Starter Replacement (LT1)</u> .	
1	Crankshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Crankshaft Position Sensor Procedure 1. Disconnect the crankshaft position sensor electrical connector. 2. Perform the crankshaft position sensor variation learn after installation of the sensor. Refer to <u>Crankshaft Position System Variation Learn</u>.

CAMSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

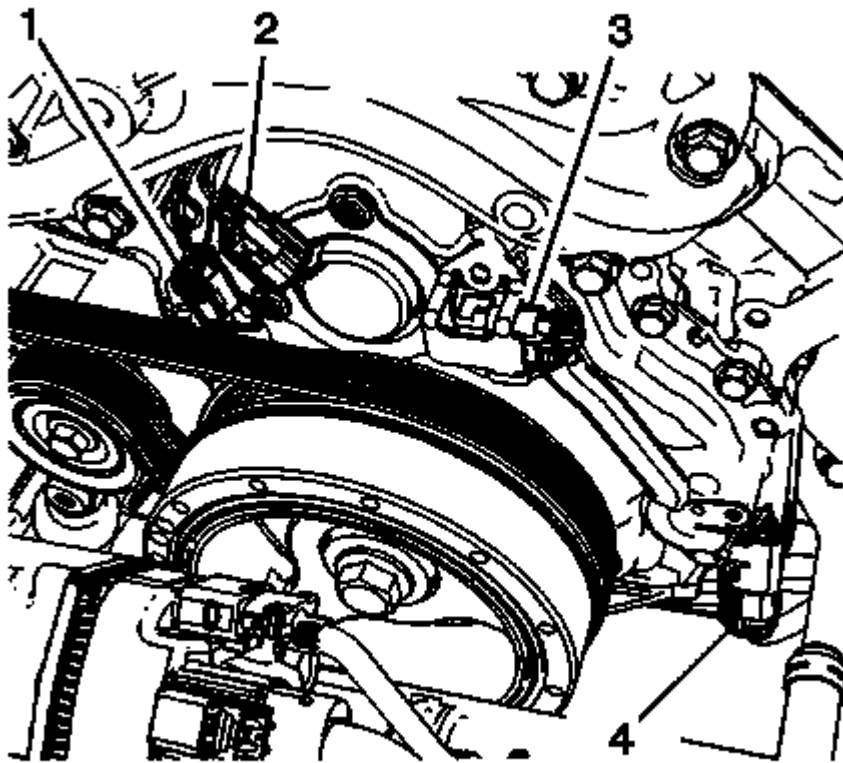


Fig. 107: Oil Pump Flow Control Valve Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the oil pump flow control valve connector (1), camshaft position actuator solenoid connector (2), camshaft position sensor connector (3) and the engine wiring harness connector (4).

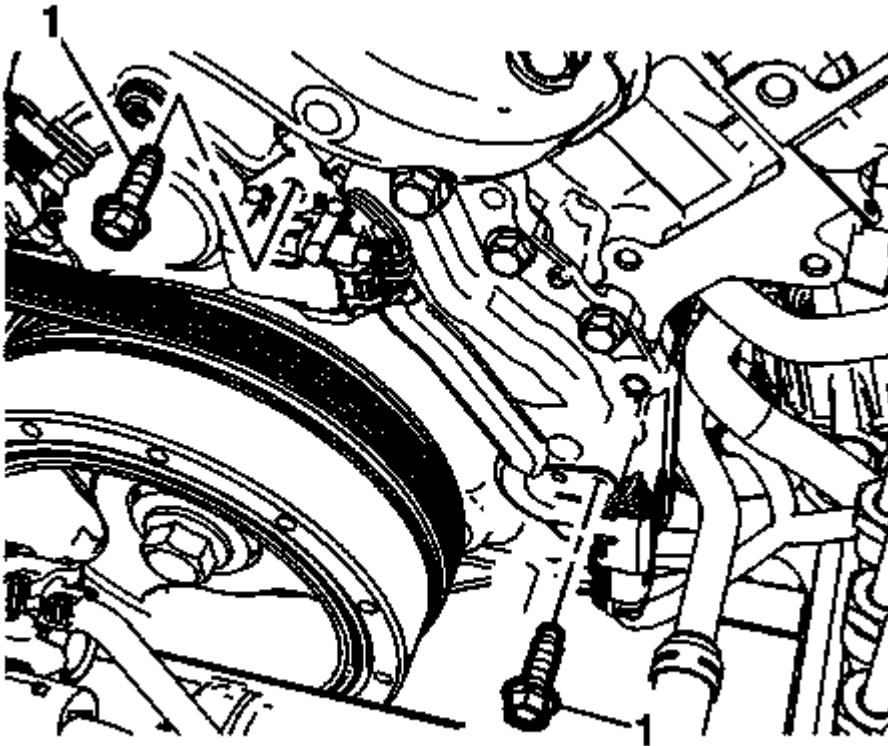


Fig. 108: Camshaft Position Sensor Bracket Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft position sensor bracket fasteners (1) from the engine block.

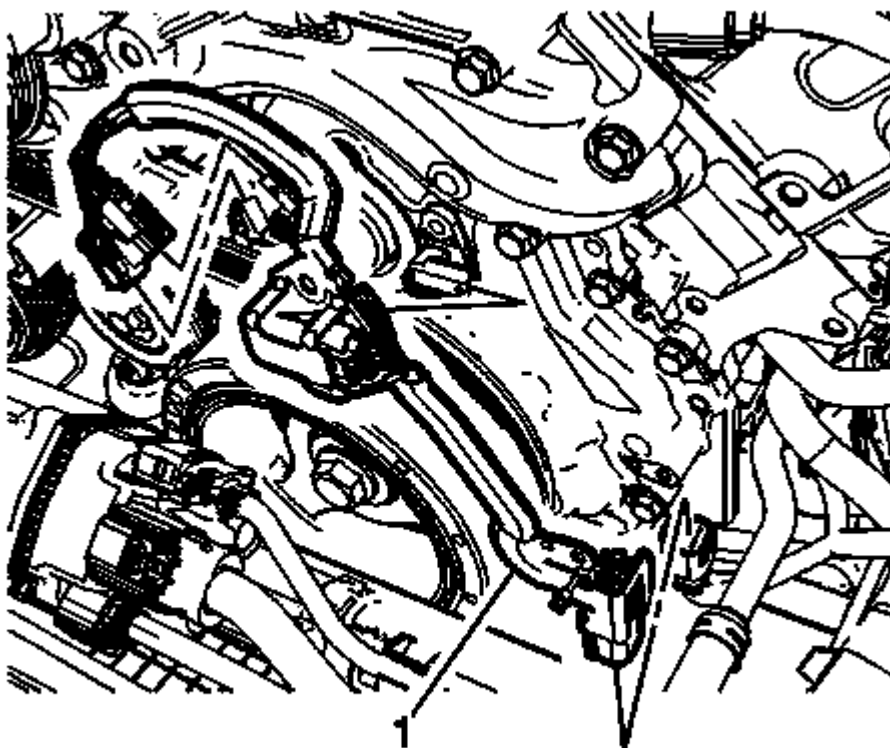


Fig. 109: Camshaft Position Sensor Bracket And Sensor Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft position sensor bracket and sensor wiring harness (1).

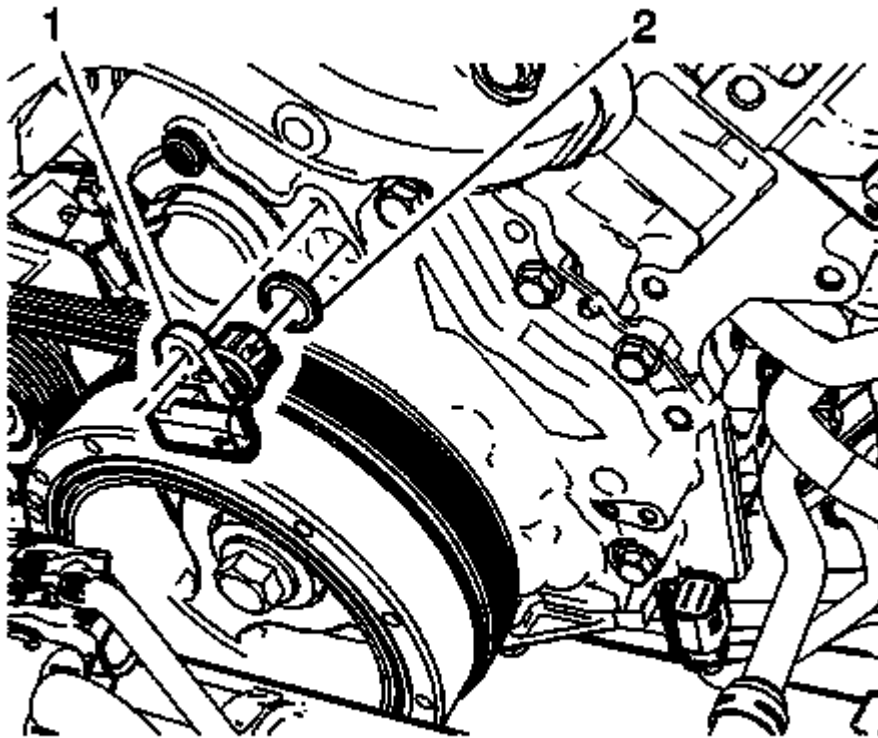


Fig. 110: Camshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: If reinstalling the original camshaft position sensor, inspect the seal (2) for wear and replace as needed. Always install the NEW seal supplied with the new camshaft position sensor.

5. Remove the camshaft position sensor (1) from the engine front cover.

Installation Procedure

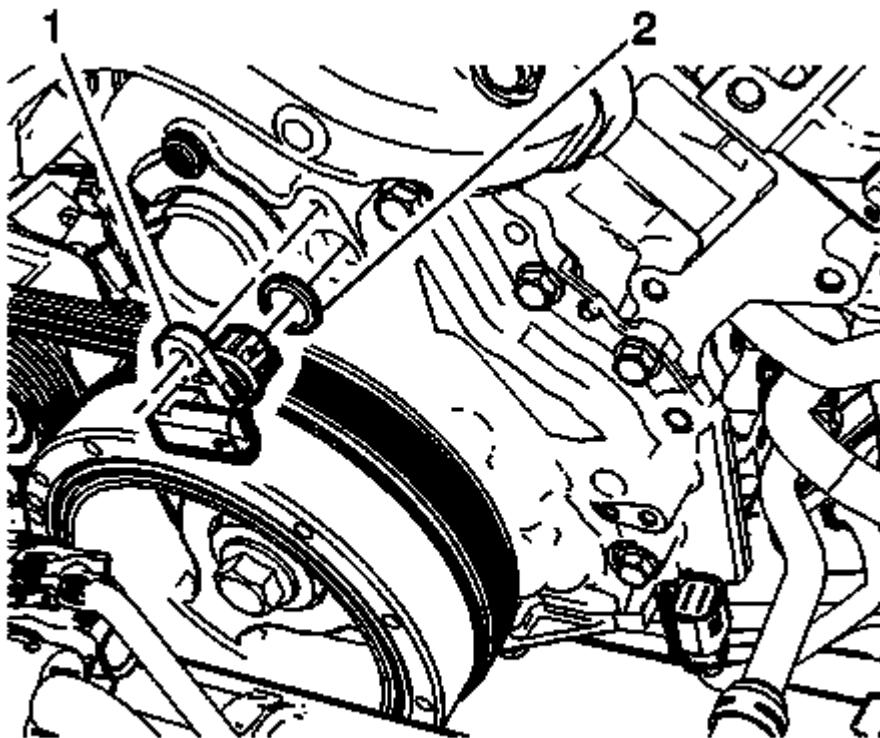


Fig. 111: Camshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: If a new sensor is not being installed, inspect the camshaft sensor seal (2) and replace as needed.

1. Install the camshaft position sensor (1) into the engine front cover.

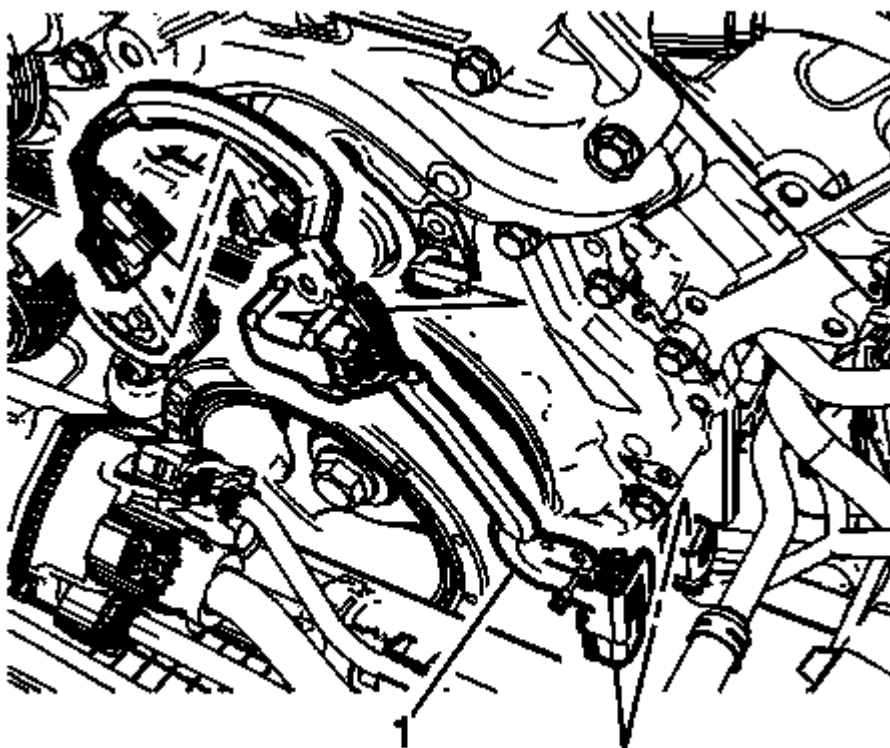


Fig. 112: Camshaft Position Sensor Bracket And Sensor Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft position sensor bracket (1) in place.

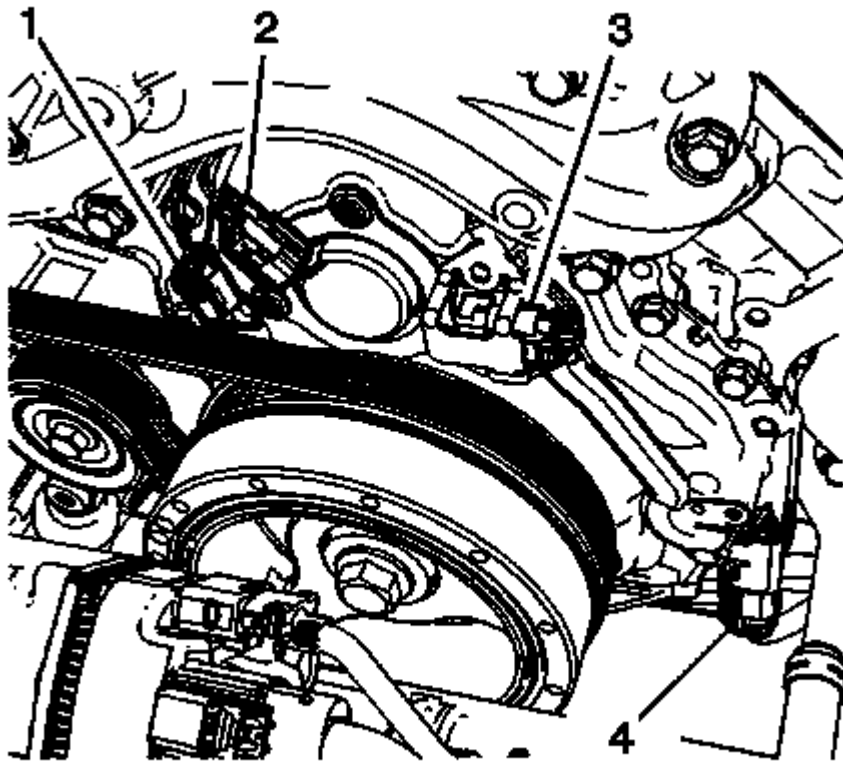


Fig. 113: Oil Pump Flow Control Valve Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the oil pump flow control valve connector (1), camshaft position actuator solenoid connector (2), camshaft position sensor connector (3) and the engine wiring harness connector (4).

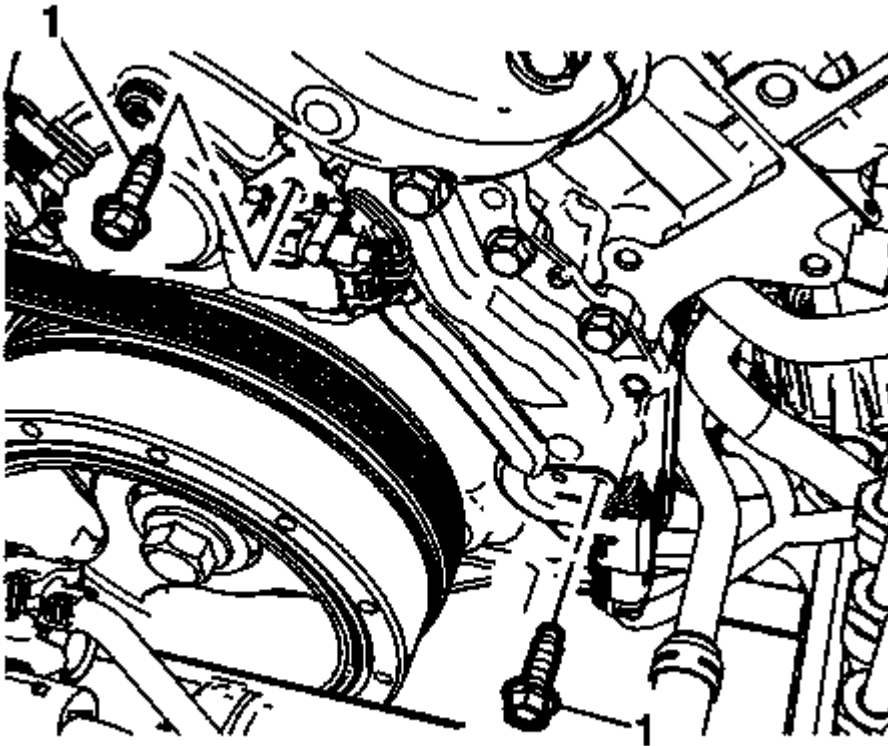


Fig. 114: Camshaft Position Sensor Bracket Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the camshaft position sensor bracket fasteners (1) and tighten to 25 (18 lb ft).
5. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
6. If re-programming is required, refer to **Control Module References** .

KNOCK SENSOR 1 REPLACEMENT

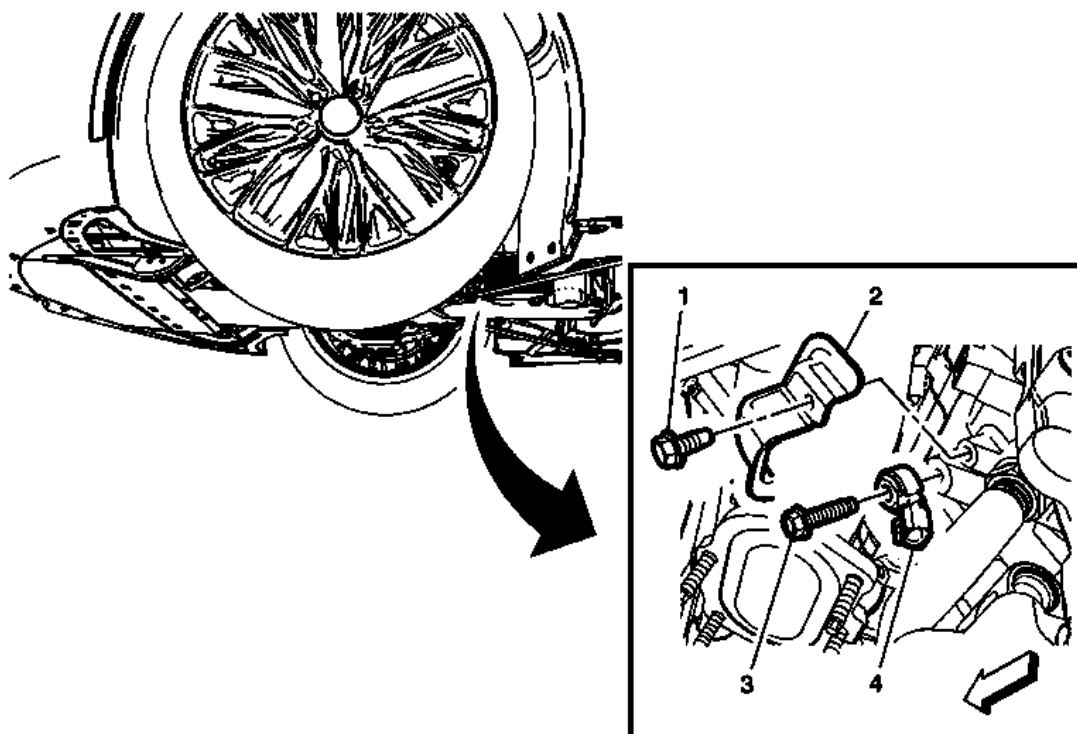


Fig. 115: Knock Sensor 1
Courtesy of GENERAL MOTORS COMPANY

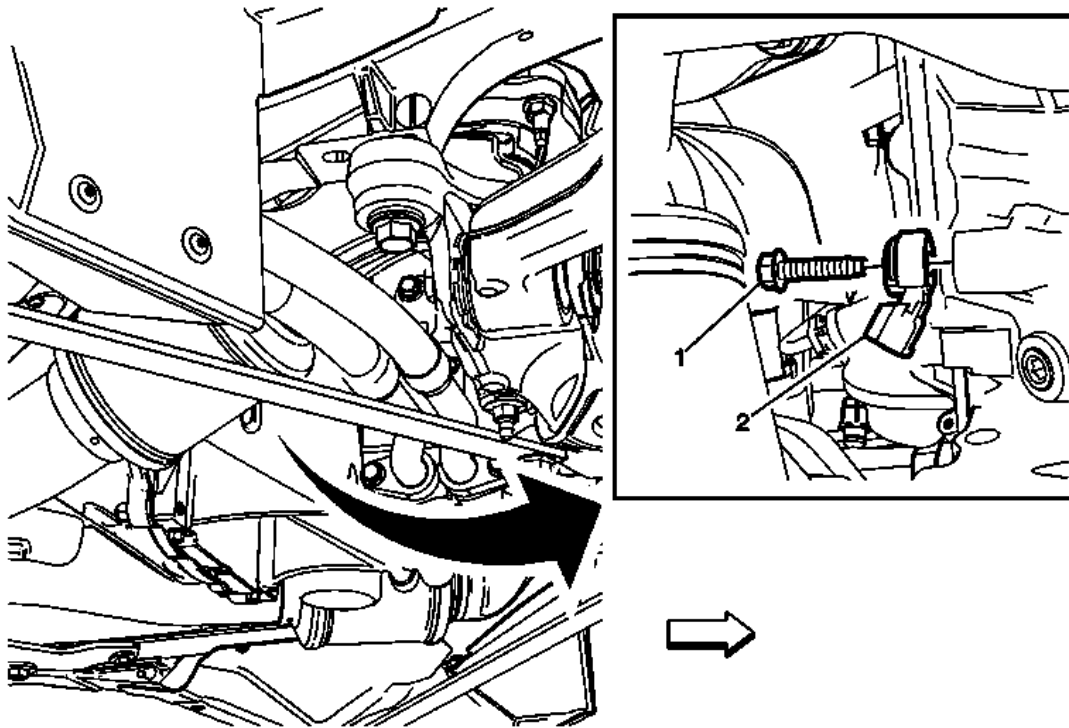
Knock Sensor 1 Replacement

Callout	Component Name
Preliminary Procedure	
Remove the left catalytic converter. Refer to Catalytic Converter Replacement - Left Side .	
1	Knock Sensor Shield Fastener CAUTION: Refer to Fastener Caution . Tighten 25 (18 lb ft)
2	Knock Sensor Shield
3	Knock Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 25 (18 lb ft)

4

Knock Sensor**Procedure**

Disconnect the electrical wiring harness connector from the knock sensor.

KNOCK SENSOR 2 REPLACEMENT**Fig. 116: Knock Sensor 2**

Courtesy of GENERAL MOTORS COMPANY

Knock Sensor 2 Replacement

Callout	Component Name
Preliminary Procedure	
Remove the starter. Refer to Starter Replacement (LT1) .	
1	Knock Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 25 (18 lb ft)
2	Knock Sensor Procedure Disconnect the electrical wiring harness connector from the knock sensor.

AIR CLEANER ELEMENT REPLACEMENT

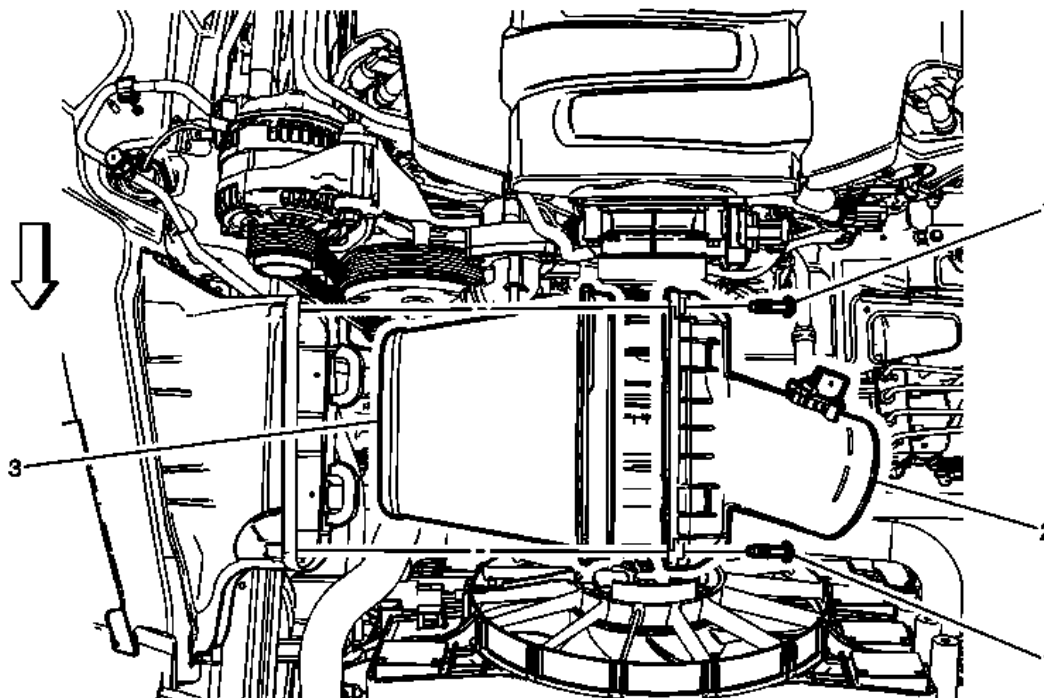


Fig. 117: Air Cleaner Element
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Element Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u>. 2. Disconnect the electrical connector. 3. Carefully lift the surge tank coolant hose from both hose retainers and position to the side.	
1	Air Cleaner Housing Cover Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 (35 lb in)
2	Air Cleaner Housing Cover
3	Air Cleaner Element

AIR CLEANER ASSEMBLY REPLACEMENT

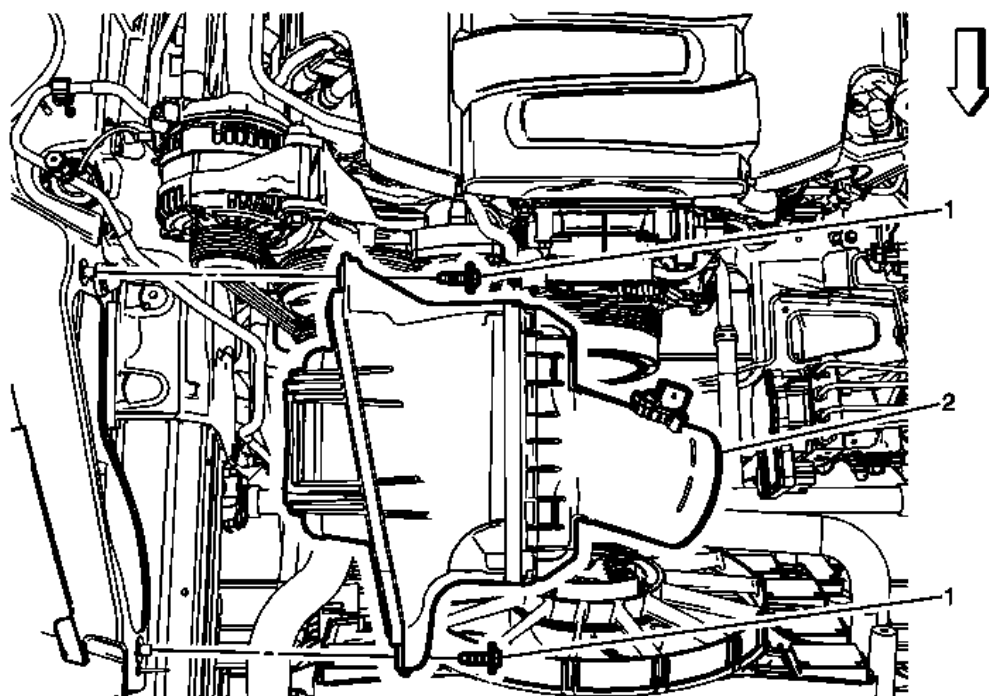


Fig. 118: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Assembly Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. Disconnect the electrical connector. 3. Carefully lift the surge tank coolant hose from both hose retainers and position to the side.	
1	Air Cleaner Assembly Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Air Cleaner Assembly

AIR CLEANER OUTLET DUCT REPLACEMENT

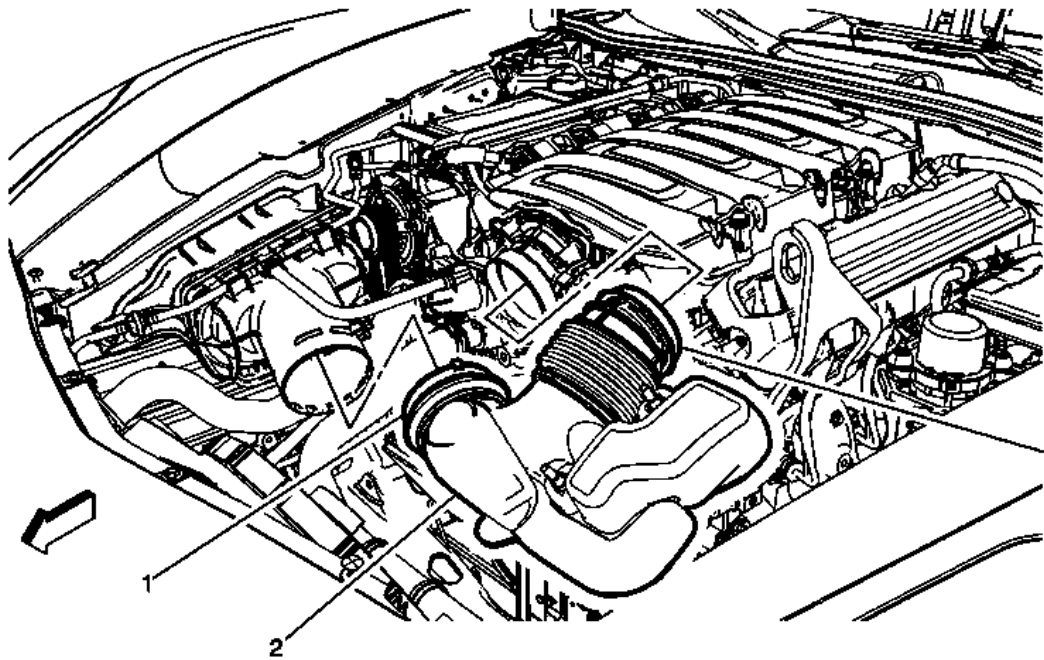


Fig. 119: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the radiator air upper baffle extension. Refer to <u>Radiator Air Upper Baffle Extension Replacement</u> . 2. Disconnect the two PCV tubes from the air cleaner outlet duct. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Air Cleaner Outlet Duct Clamps (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Cleaner Outlet Duct

FUEL PUMP POWER CONTROL MODULE REPLACEMENT

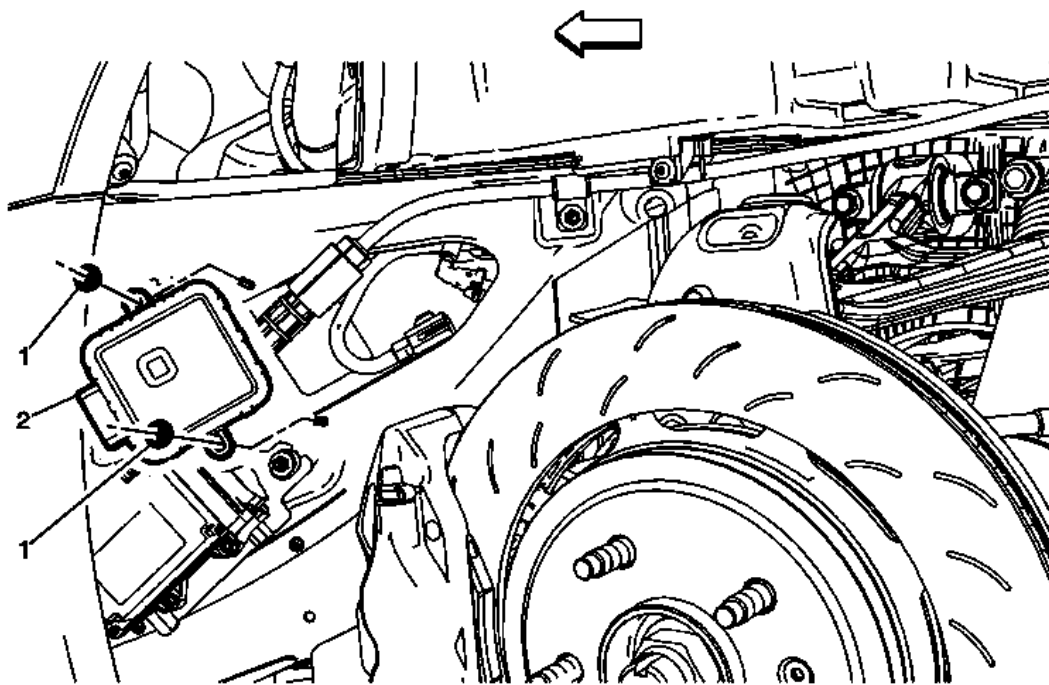


Fig. 120: Fuel Pump Power Control Module
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Power Control Module Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the rear wheelhouse liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> . 2. Disconnect the fuel pump power control module electrical connector.	
1	Fuel Pump Power Control Module Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Fuel Pump Power Control Module Procedure If replacing fuel pump power control module, program the control module. Refer to <u>Control Module References</u>

FUEL FEED HOSE REPLACEMENT (ENGINE TO TANK)

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (Right)** , **Intake Manifold Cover Replacement (Left)** .
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

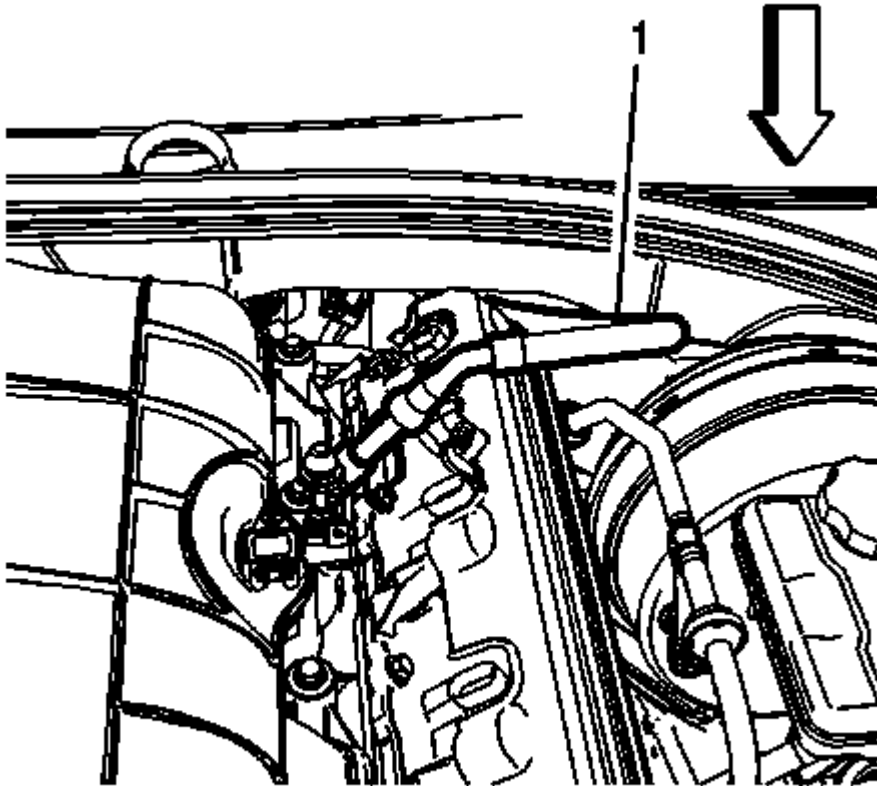


Fig. 121: Removing Fuel Feed Hose And Engine And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel feed hose (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 rear body exhaust heat shield. Refer to **Rear Body Exhaust Heat Shield Replacement**

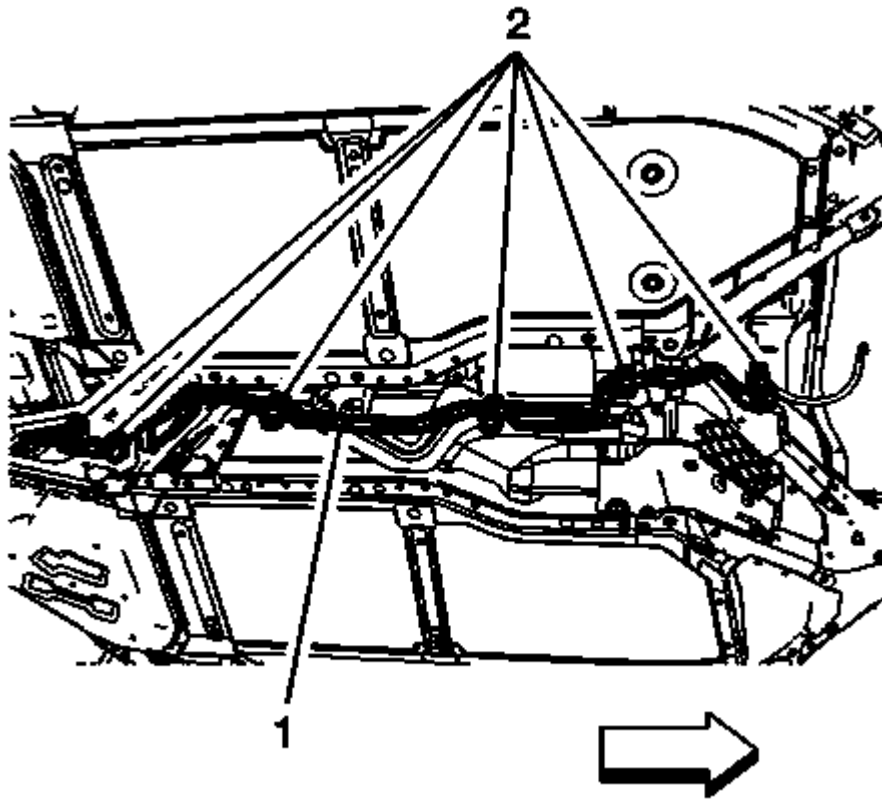


Fig. 122: Fuel Feed Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel feed hose (1) from retainers (2) and disconnect from fuel feed intermediate hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Remove the fuel feed hose (1) from the vehicle.

Installation Procedure

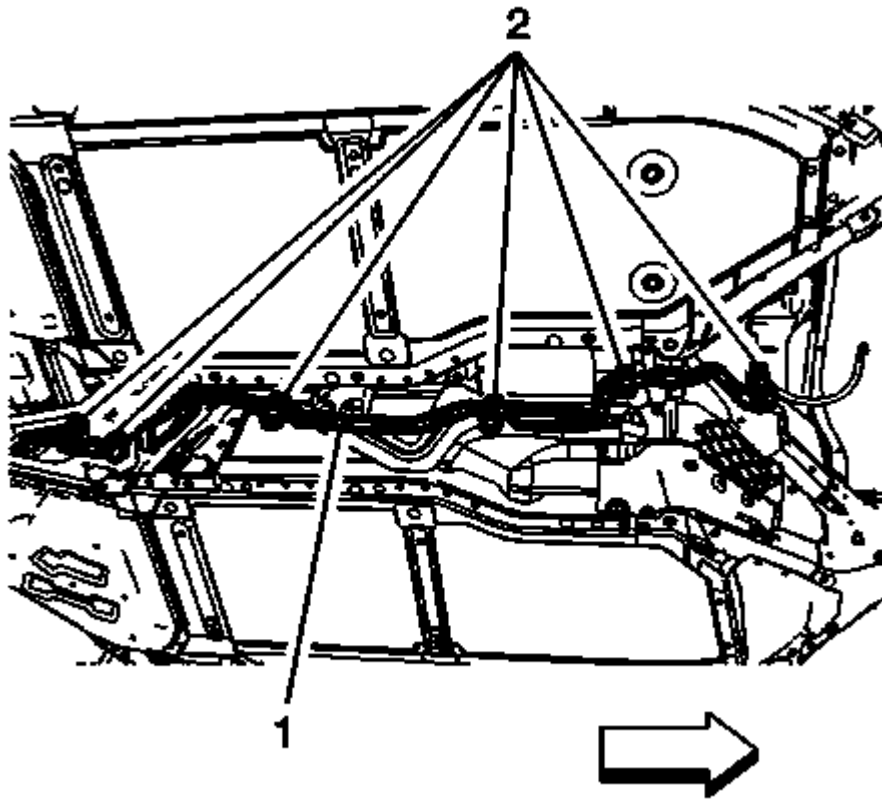


Fig. 123: Fuel Feed Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed hose (1) to the vehicle.
2. Install the fuel feed hose (1) to retainers (2) and connect to fuel feed intermediate hose. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the rear body exhaust heat shield. Refer to **Rear Body Exhaust Heat Shield Replacement**
4. Lower the vehicle.

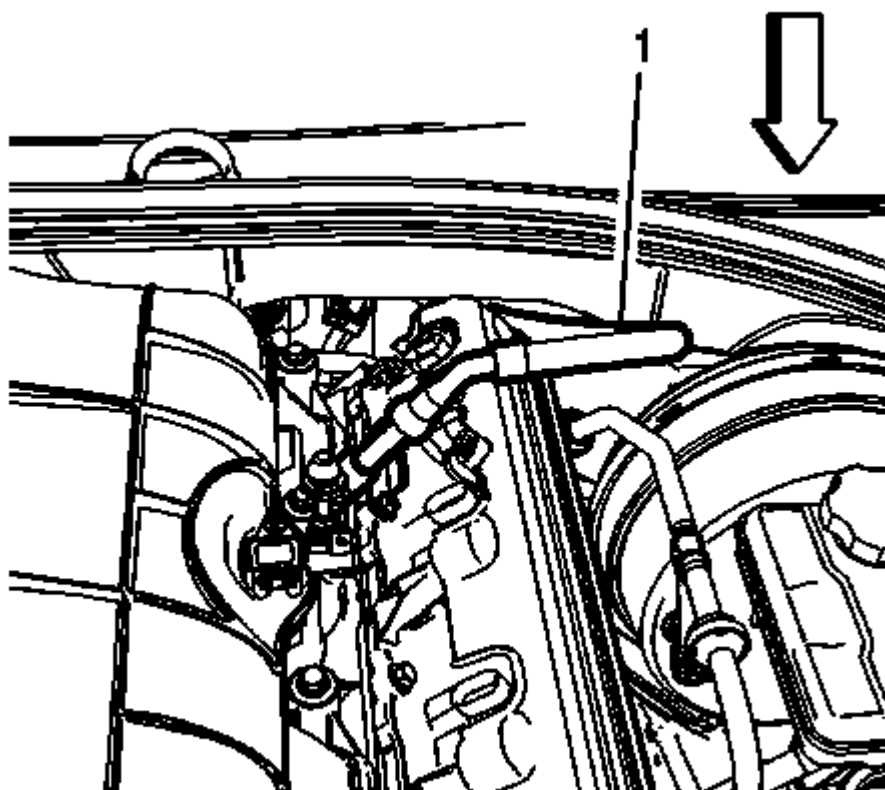


Fig. 124: Removing Fuel Feed Hose And Engine And Retainers
Courtesy of GENERAL MOTORS COMPANY

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

FUEL FEED HOSE REPLACEMENT (AT TANK)

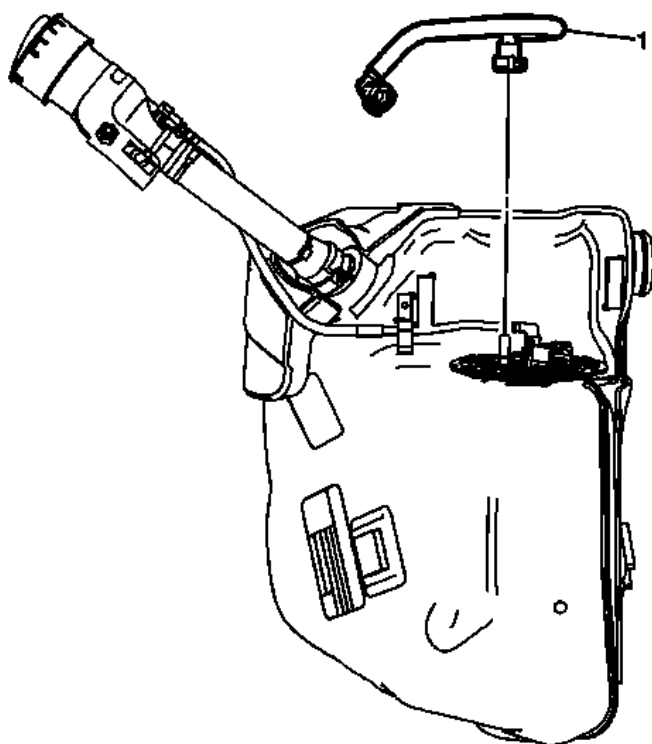


Fig. 125: Fuel Feed Hose (At Tank)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Hose Replacement (At Tank)

Callout	Component Name
Preliminary Procedure 1. Remove the left side fuel tank. Refer to <u>Fuel Tank Replacement - Left Side</u>. 2. Remove the fuel feed intermediate hose. Refer to <u>Fuel Feed Intermediate Hose Replacement</u>.	
1	Fuel Feed Hose Procedure Disconnect the fuel feed hose from the fuel tank fuel pump module. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .