

Engine

Engine Controls and Fuel - 3.0L (LFW) or 3.6L (LFX) - Repair Instructions - CTS Coupe & Wagon

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR LEARN

Brake Pedal Position Sensor Learn is a procedure for the ECM to determine the position of the brake pedal position sensor when the brake pedal is in the released position.

NOTE: The Brake Pedal Position Sensor Learn procedure is required when the following service procedures have been performed:

- An Engine Control Module Replacement
 - A BPP Sensor Replacement
 - Any repair procedure that effects the brake pedal position sensor alignment
1. Install a scan tool.
 2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
 3. Navigate to the scan tool Brake Pedal Position Sensor Learn command by selecting the following:
 1. Module Diagnosis
 2. Engine Control Module
 3. Configuration/Reset Functions
 4. Learn Functions
 5. Brake Pedal Position Sensor Learn
 4. Ignition ON, Engine OFF, transmission in Park, brake pedal in the fully released position, select Learn.
 5. Verify Brake Pedal Position Sensor and Brake Pedal Position Sensor Learned Home Position are within 0.1 Volts.
 6. Select Exit.
 7. Perform the body control module (BCM) brake pedal position sensor calibration. Refer to **Brake Pedal Position Sensor Calibration**.

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

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

- An engine replacement
- A engine control module (ECM) replacement

- A crankshaft balancer replacement
- A crankshaft replacement
- A crankshaft position sensor 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. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the following components:

- Crankshaft position sensors activity-If there is a crankshaft position sensor condition, refer to the applicable DTC that set.
- Camshaft position sensor signal activity-If there is a camshaft position sensor signal condition, refer to the applicable DTC that set.
- Engine coolant temperature (ECT)-If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

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

1. Ignition ON, observe the DTC information with a scan tool. Verify no other DTCs are set, except DTCs P0300-P0306, or P0315.
 - If DTCs are set, except DTCs P0300-P0306, or P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Select the Crankshaft Position Variation Learn Procedure with a scan tool and follow the on screen instructions:
3. Verify DTC P0315 does not set.
 - **If DTC P0315 set, or another DTC is present** refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
 - **If the DTC does not set**
4. All OK.

ENGINE CONTROL MODULE REPLACEMENT

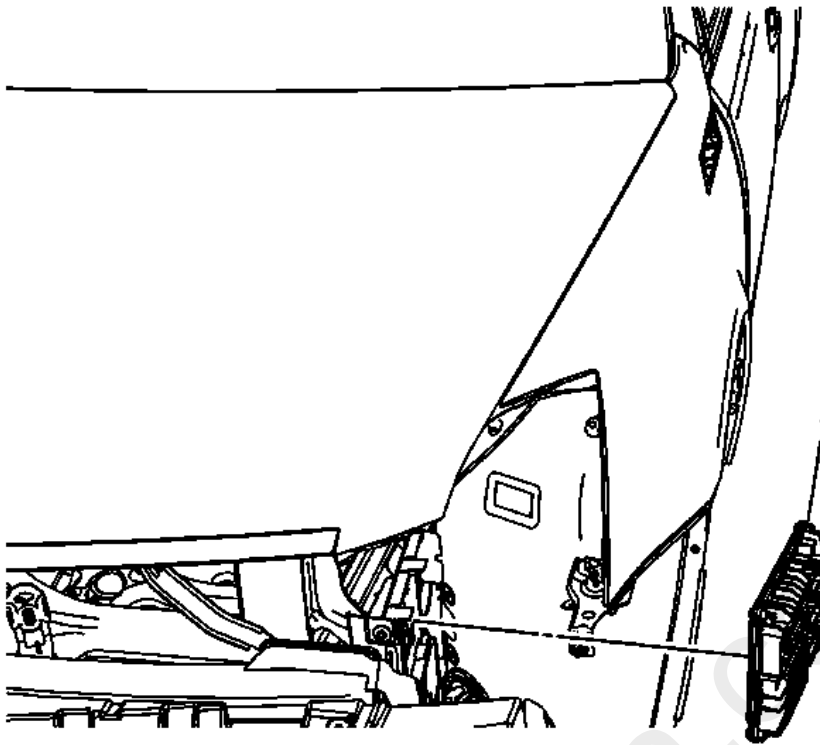


Fig. 1: Engine Control Module
 Courtesy of GENERAL MOTORS COMPANY

Engine Control Module Replacement

Callout	Component Name
Preliminary Procedure Remove the left side head lamp. Refer to <u>Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (TT6)</u> , <u>Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (TT7)</u> , <u>Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (TT8)</u> , <u>Headlamp Assembly or Headlamp Bulb and/or Cornering, Sidemarker, Park, Turn Signal Bulb Replacement (Without TT6/TT7/TT8/T84/T85)</u> .	
	Engine Control Module CAUTION: • Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage. • Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery. • In order to prevent any possible electrostatic discharge damage to the control module, do not touch the connector pins or the soldered components on the

circuit board.

- Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.
- The replacement control module must be programmed.

Procedure

1

1. Release the retaining tabs.
2. Disconnect the electrical connectors.
3. If replacing ECM, reprogram the ECM. Refer to **Control Module References**
4. If equipped with a manual transmission, perform the clutch pedal position sensor learn procedure. Refer to **Clutch Pedal Position Sensor Learn**.

NOTE:

Before removing the engine control module (ECM), use the scan tool to capture the ECM vehicle specific data. This captured data will then need to be restored into the NEW ECM. Refer to **Control Module References**.

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

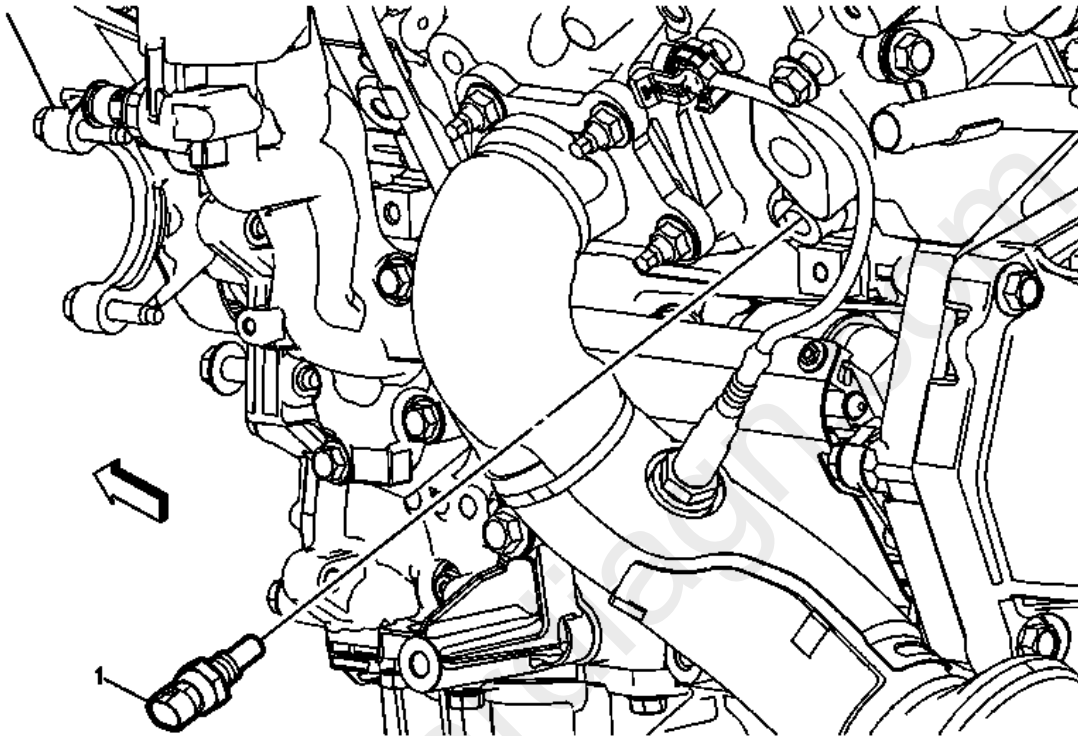


Fig. 2: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedure Partially drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill LFW or LFX)</u> , <u>Cooling System Draining and Filling (GE 47716 LFW or LFX)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the ECT sensor harness connector.

Tighten
22 (16 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

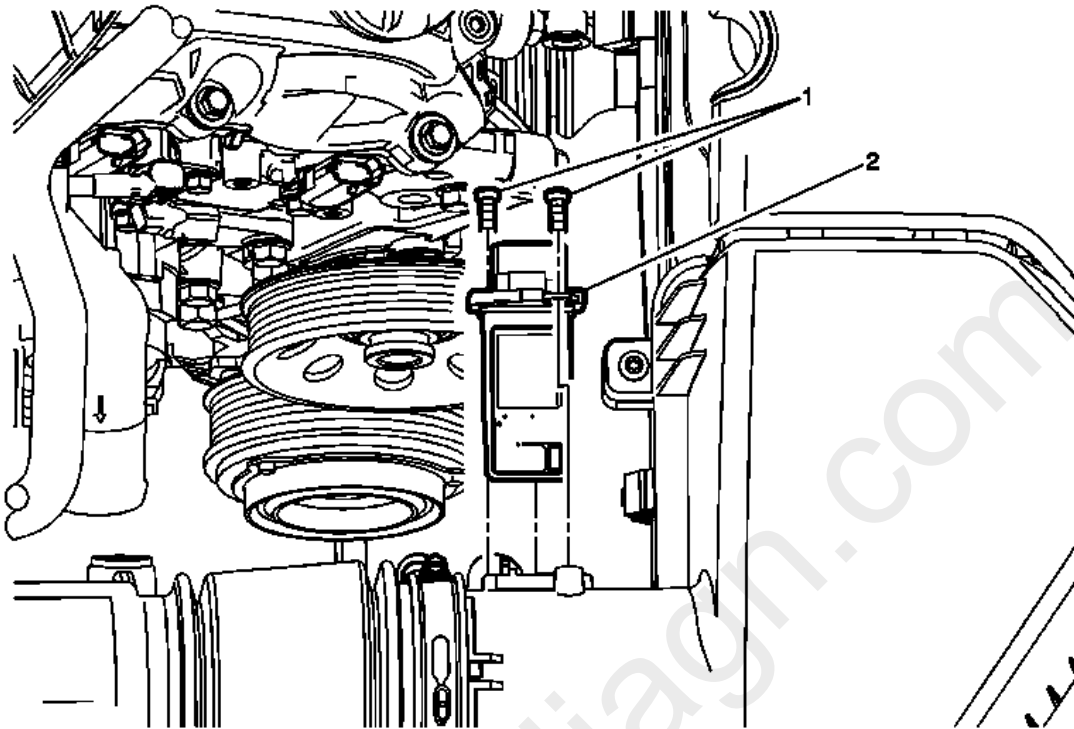


Fig. 3: Mass Airflow Sensor & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3 N.m (27 lb in)
2	Mass Airflow Sensor Procedure Disconnect the MAF electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

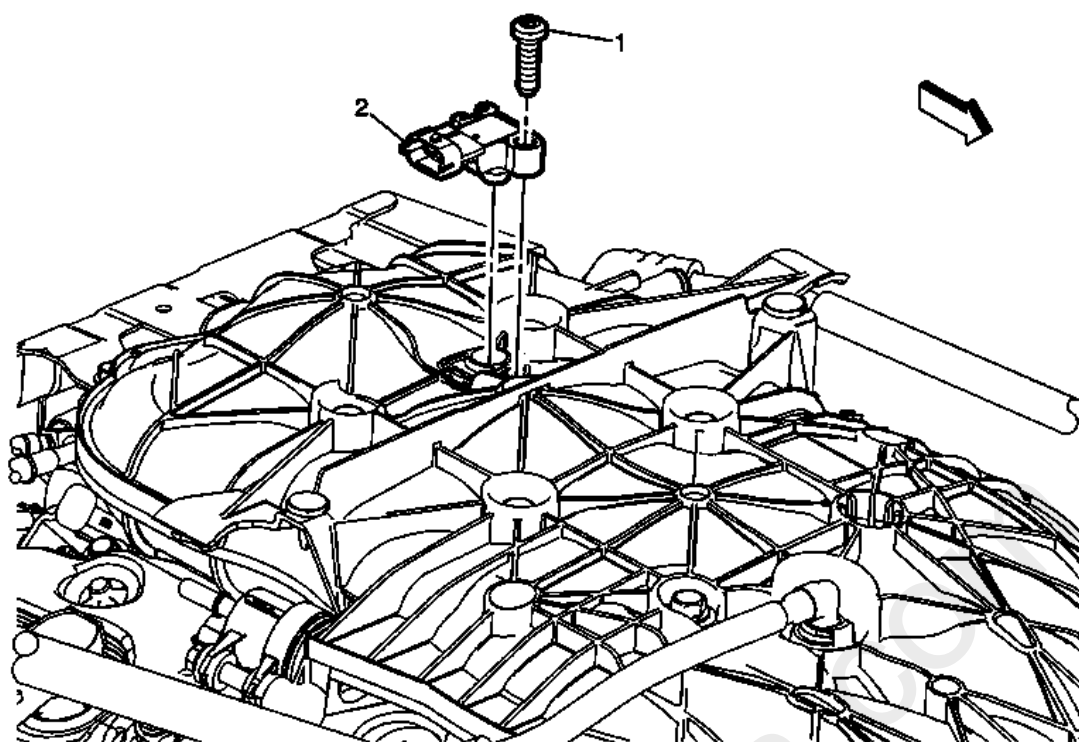


Fig. 4: Manifold Absolute Pressure Sensor & Bolt
 Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Manifold Absolute Pressure Sensor Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 N.m (35 lb in)
2	Manifold Absolute Pressure Sensor Procedure 1. Disconnect the MAP sensor harness connector. 2. Install a NEW O-ring.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

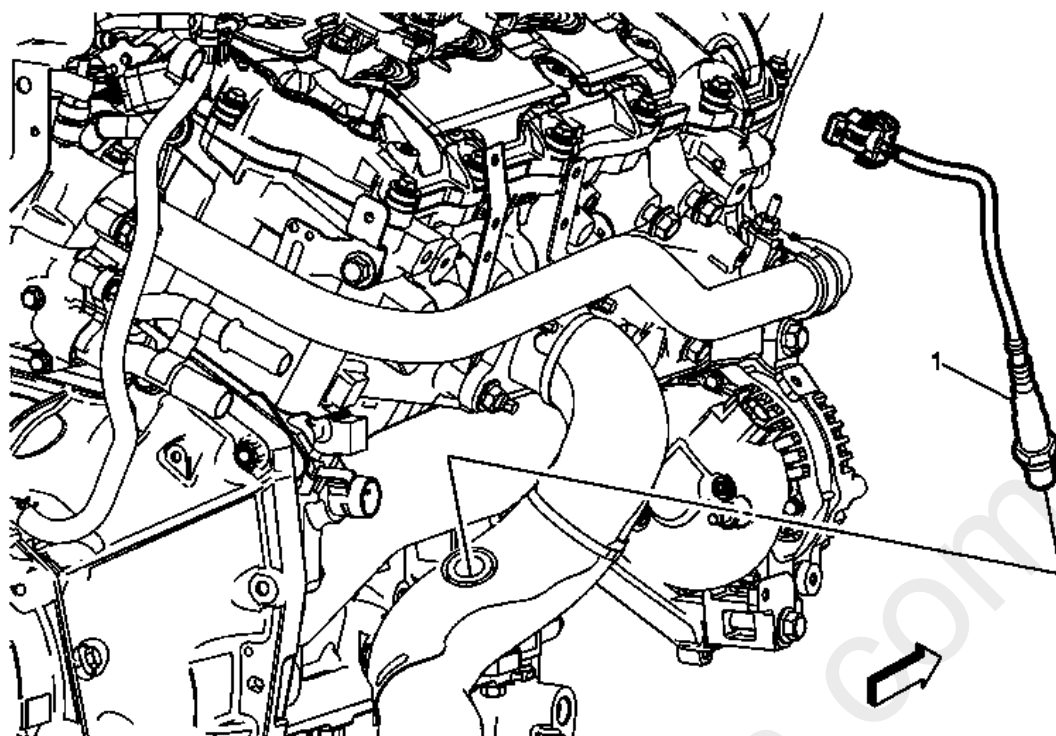


Fig. 5: Heated Oxygen Sensor - Bank 1 Sensor 1
 Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

Callout	Component Name
Preliminary Procedure	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Heated Oxygen Sensor
	CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> .
	CAUTION: Refer to <u>Fastener Caution</u> .
	Procedure 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. 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

41 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

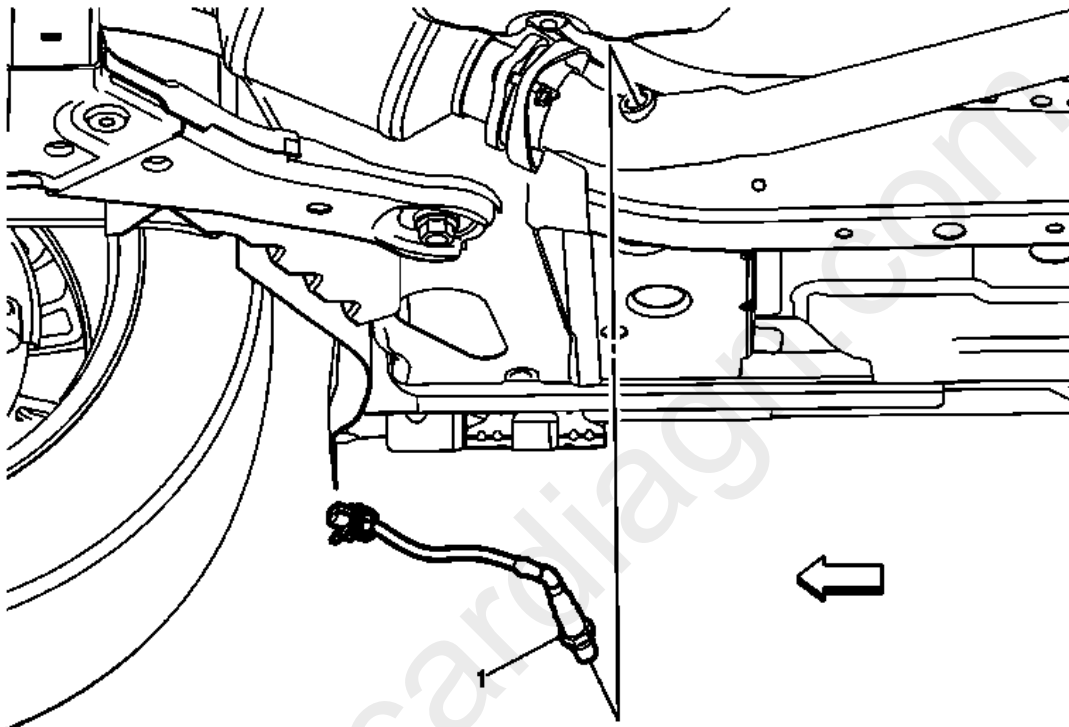


Fig. 6: Heated Oxygen Sensor - Bank 1 Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
	Heated Oxygen Sensor
	CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> .
	CAUTION: Refer to <u>Fastener Caution</u> .

Procedure

1. Disconnect the heated oxygen sensor harness connector.
2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to Adhesives, Fluids, Lubricants, and Sealers .

NOTE:

1

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

41 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

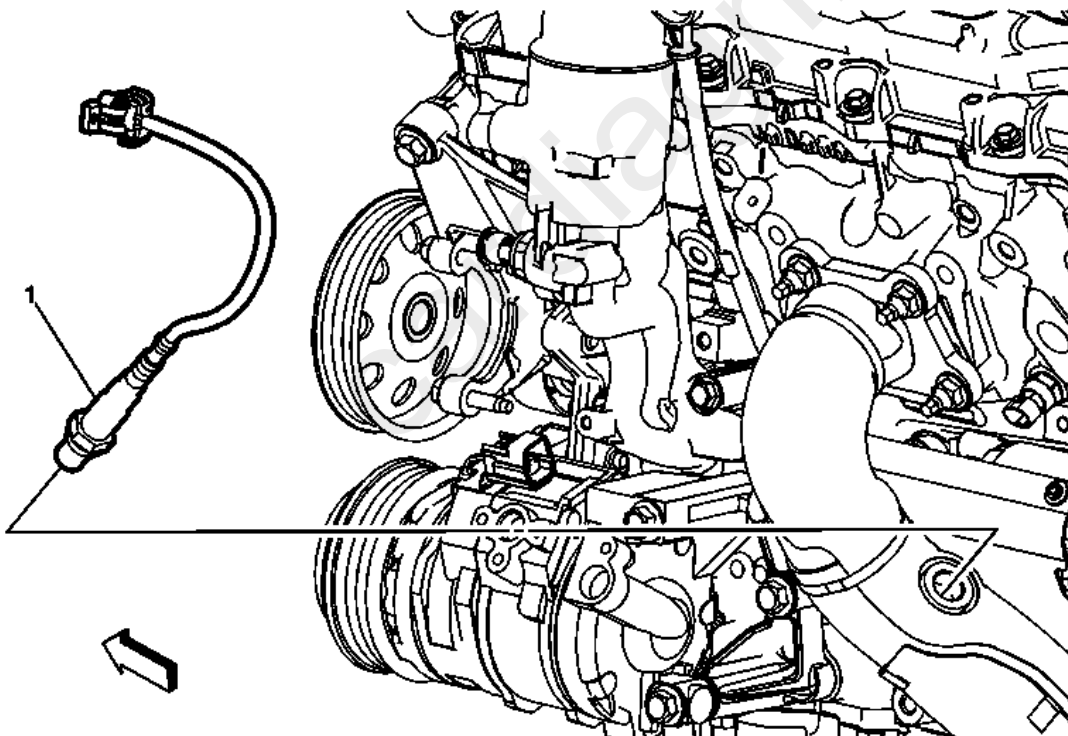


Fig. 7: Heated Oxygen Sensor - Bank 2 Sensor 1

Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 1

Callout	Component Name
---------	----------------

Preliminary Procedure

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

Heated Oxygen Sensor

CAUTION:

Refer to **Heated Oxygen and Oxygen Sensor Caution** .

CAUTION:

Refer to **Fastener Caution** .

Procedure

1

1. Disconnect the heated oxygen sensor harness connector.
2. If reinstalling the old sensor, coat the threads with anti-seize compound. 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

41 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

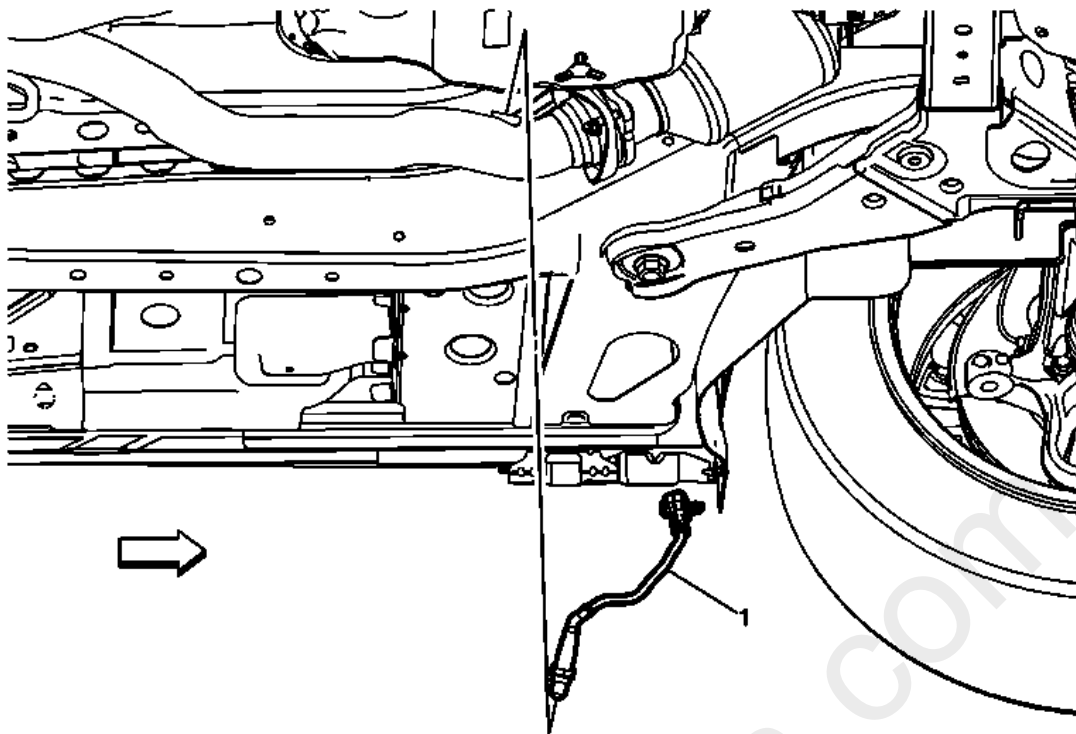


Fig. 8: Heated Oxygen Sensor - Bank 2 Sensor 2
 Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Heated Oxygen Sensor CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. 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

41 N.m (31 lb ft)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

Removal Procedure

1. Remove the closeout/insulator panel from under the dashboard on the drivers side. Refer to **Instrument Panel Insulator Replacement - Left Side (Right Hand Drive)** , **Instrument Panel Insulator Replacement - Left Side (Left Hand Drive)** , or **Instrument Panel Insulator Replacement - Right Side (Right Hand Drive)** , **Instrument Panel Insulator Replacement - Right Side (Left Hand Drive)** .

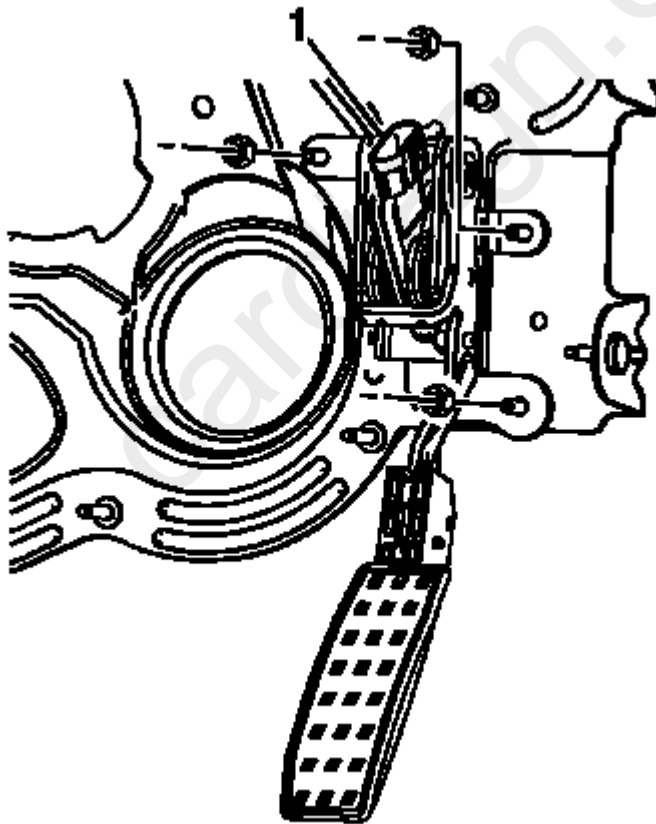


Fig. 9: Locating APP Sensor

Courtesy of GENERAL MOTORS COMPANY

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 electronic throttle control components in cleaning solvents of any type.

2. Disconnect the accelerator pedal position (APP) sensor electrical connector from the accelerator pedal module.
3. Remove the nuts from the APP sensor mounting plate and remove the APP sensor (1) from the front of dash.

Installation Procedure

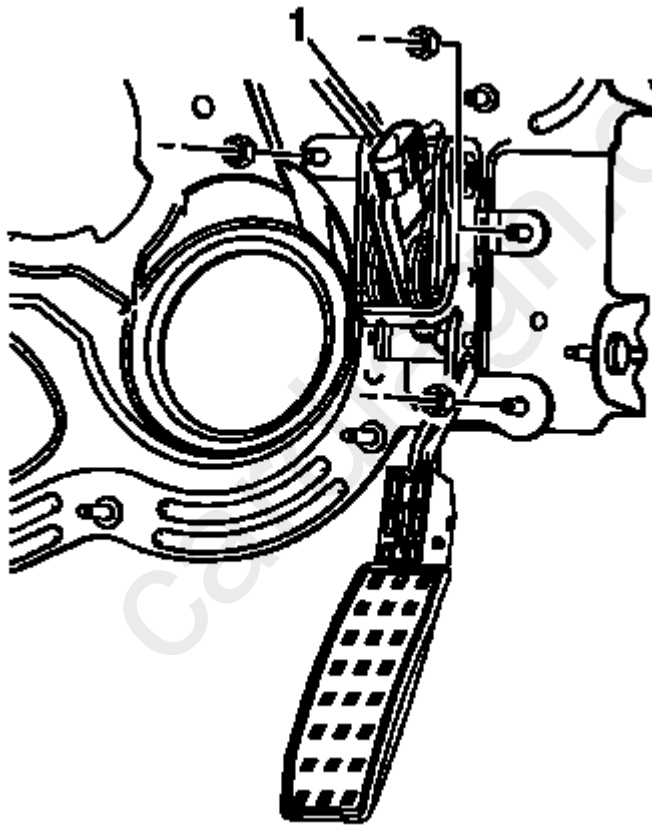


Fig. 10: Locating APP Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the APP sensor (1) to the front of dash.

CAUTION: Refer to Fastener Caution .

2. Install the APP sensor mounting nuts and tighten to 9 N.m (80 lb in).
3. Connect the APP sensor electrical connector.
4. Operate the accelerator pedal and observe the APP angles using a scan tool. The accelerator pedal should operate freely, without binding between closed throttle and wide open throttle.
5. Install the closeout/insulator panel. Refer to Instrument Panel Insulator Replacement - Left Side (Right Hand Drive) , Instrument Panel Insulator Replacement - Left Side (Left Hand Drive) , or Instrument Panel Insulator Replacement - Right Side (Right Hand Drive) , Instrument Panel Insulator Replacement - Right Side (Left Hand Drive) .

THROTTLE BODY ASSEMBLY REPLACEMENT

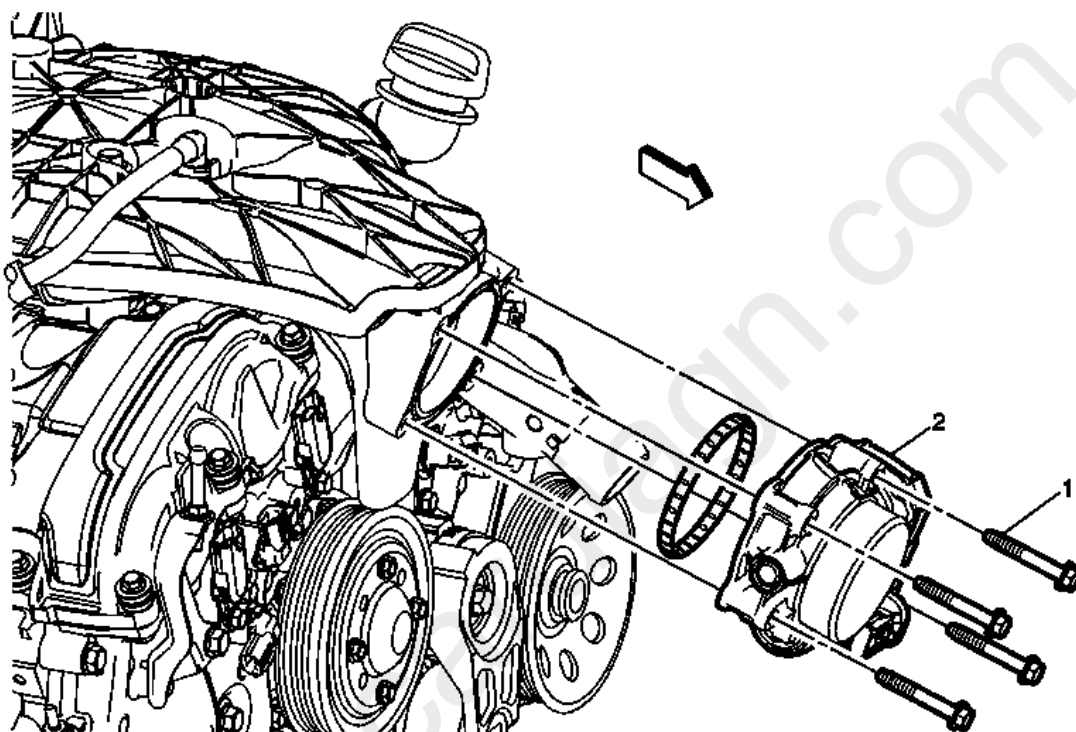


Fig. 11: Throttle Body Assembly & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Replacement

Callout	Component Name
Preliminary Procedure	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Throttle Body Assembly Bolts (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 N.m (89 lb in)
2	Throttle Body Assembly Procedure 1. Disconnect the throttle body assembly harness connector. 2. Install a NEW throttle body assembly seal. 3. Perform the throttle learn procedure. Refer to <u>Q38 Throttle Body: Throttle/Idle Learn.</u>

THROTTLE BODY INSPECTION AND CLEANING

1. Remove the air cleaner intake 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 Top Engine Cleaner GM P/N 1052626 or equivalent product in order to 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 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 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.

1. Remove the fuel pump control module 20A fuse from the rear electrical center. Refer to **Electrical Center Identification Views** .
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.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH 48027 Digital Pressure Gauge

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

Installation Procedure

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

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

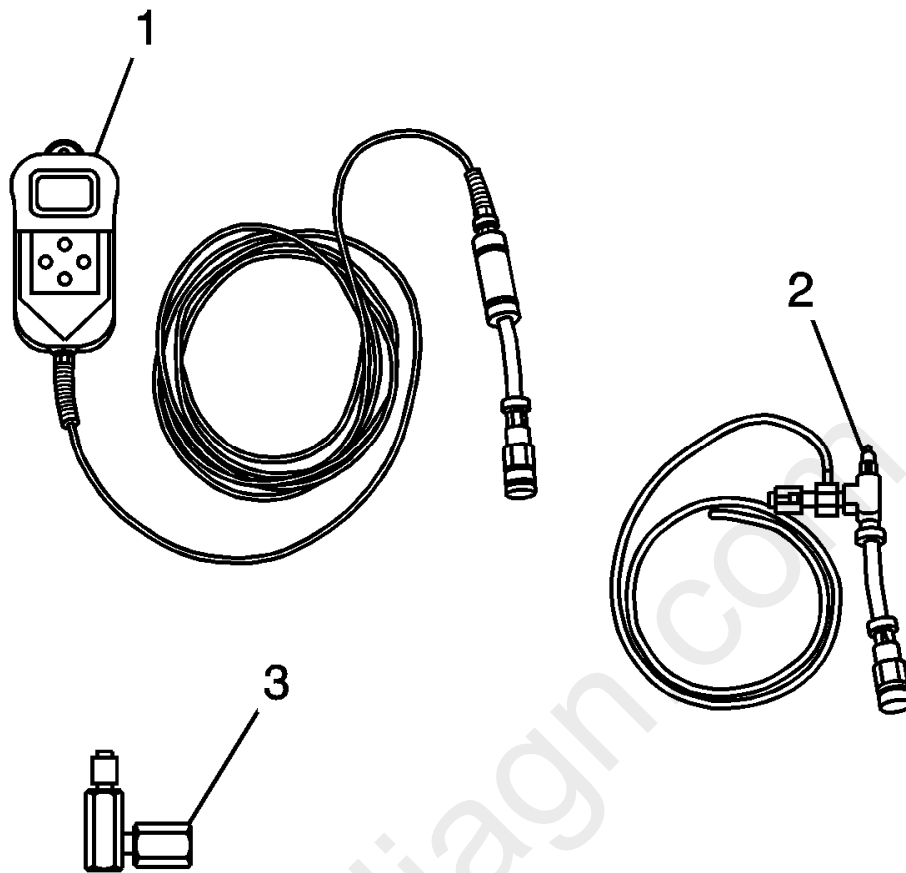


Fig. 12: Digital Fuel Pressure Gauge And Components
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
3. Connect the **CH 48027** gauge (1) to the **CH 48027** adapter (2).
4. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
5. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH 48027** gauge (1), refer to the manufacture's directions.

Removal Procedure

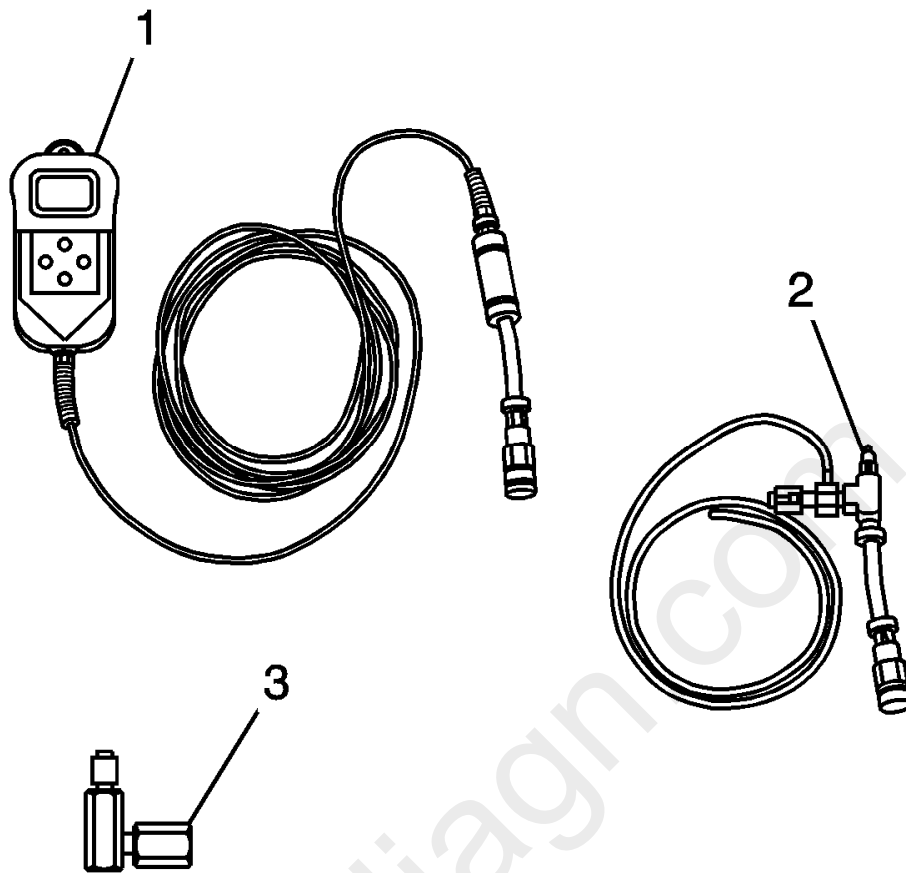


Fig. 13: Digital Fuel Pressure Gauge And Components
Courtesy of GENERAL MOTORS COMPANY

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.

1. Relieve the fuel system pressure, if required. Perform the following steps:
 1. Wrap a shop towel around the fuel rail service port.
 2. Place the hose on the **CH 48027** adapter (2) into an approved gasoline container.
 3. Open the valve on the **CH 48027** adapter (2) in order to bleed any fuel from the fuel rail.
 4. Close the valve on the **CH 48027** adapter (2).
 5. Remove the hose on the **CH 48027** adapter (2) from the approved gasoline container.
 6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

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

2. Disconnect the **CH 48027** gauge (1) from the **CH 48027** gauge (2).
3. Disconnect the **CH 48027** adapter (2) from the **CH 48027** adapter (3).
4. Disconnect the **CH 48027** adapter (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
7. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **J 37088-A** Fuel Line Disconnect Tool Set
- **J 44581** Fuel Line Disconnect Tool

Removal Procedure

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

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

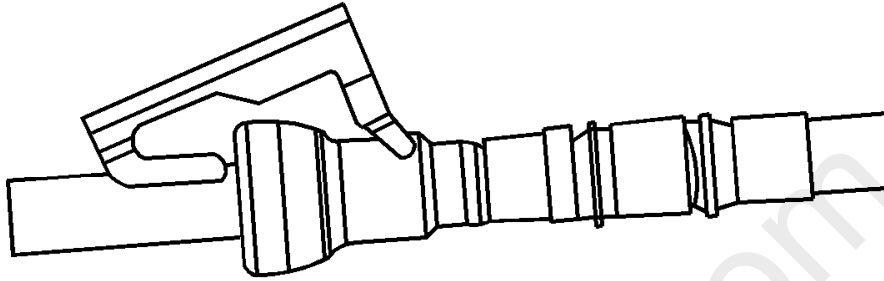


Fig. 14: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

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

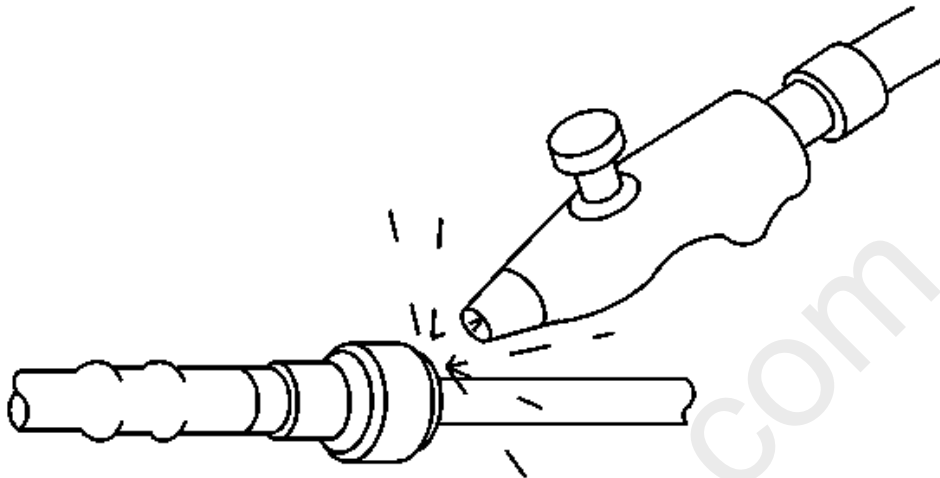


Fig. 15: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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

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

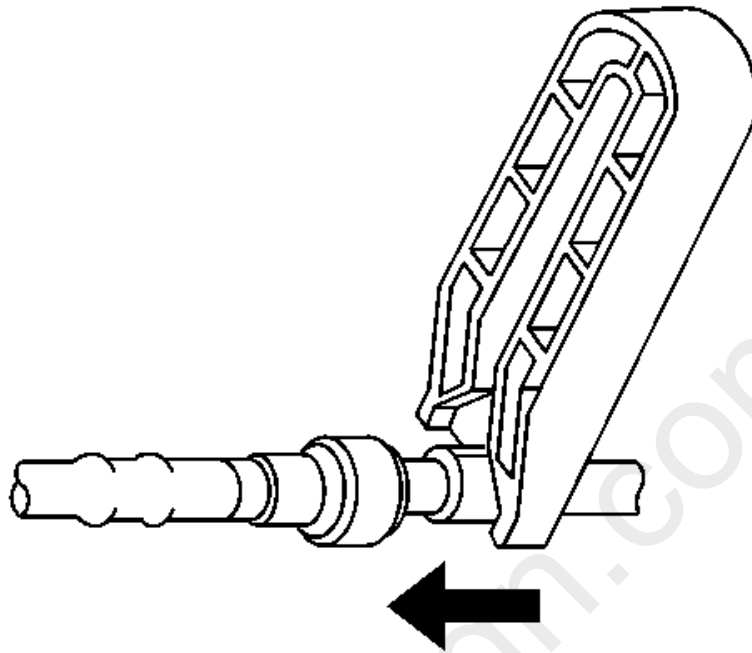


Fig. 16: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **J 37088-A** fuel line disconnect tool set or **J 44581** fuel line disconnect tool. Insert the **J 37088-A** fuel line disconnect tool set or **J 44581** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

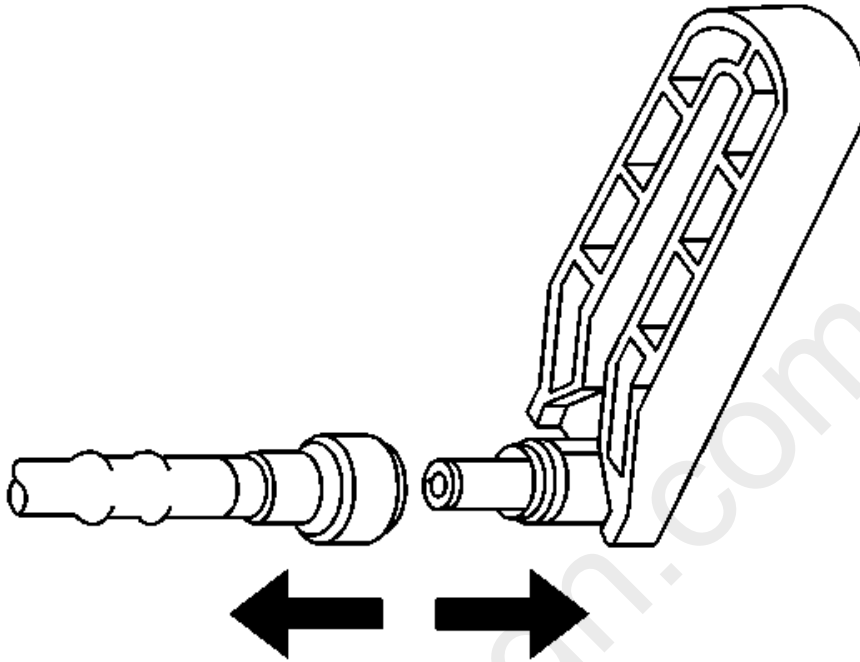


Fig. 17: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

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

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

Installation Procedure

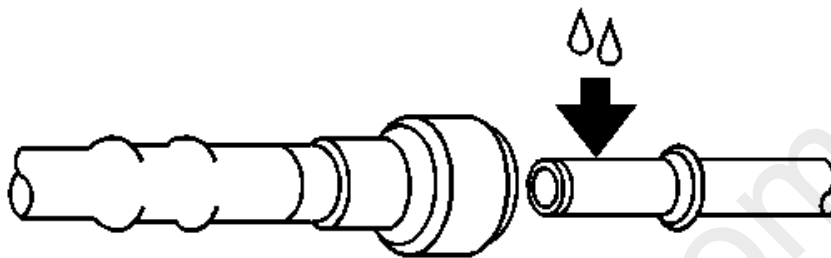


Fig. 18: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

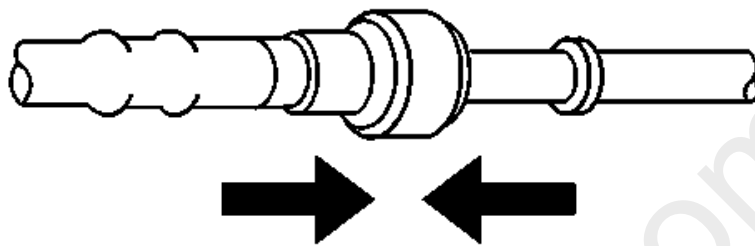


Fig. 19: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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

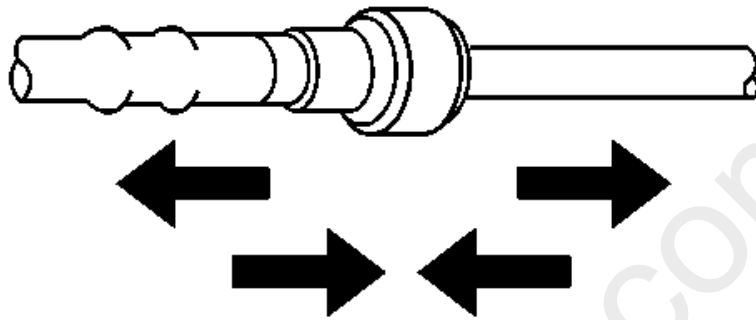


Fig. 20: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

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

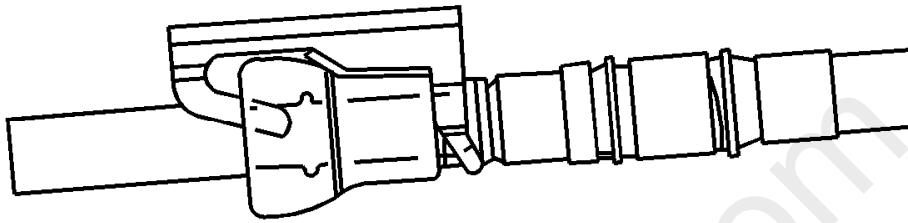


Fig. 21: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS COMPANY

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

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Disconnect Procedure

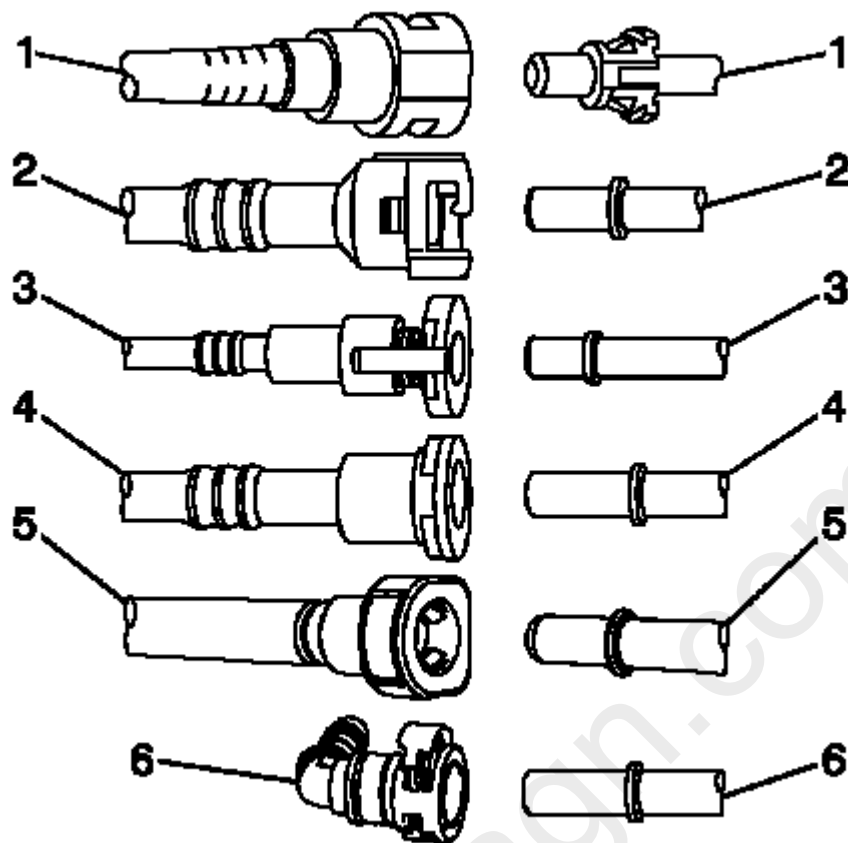


Fig. 22: Identifying Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings
 Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

NOTE: There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)
- Push Down TI (5)

The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

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

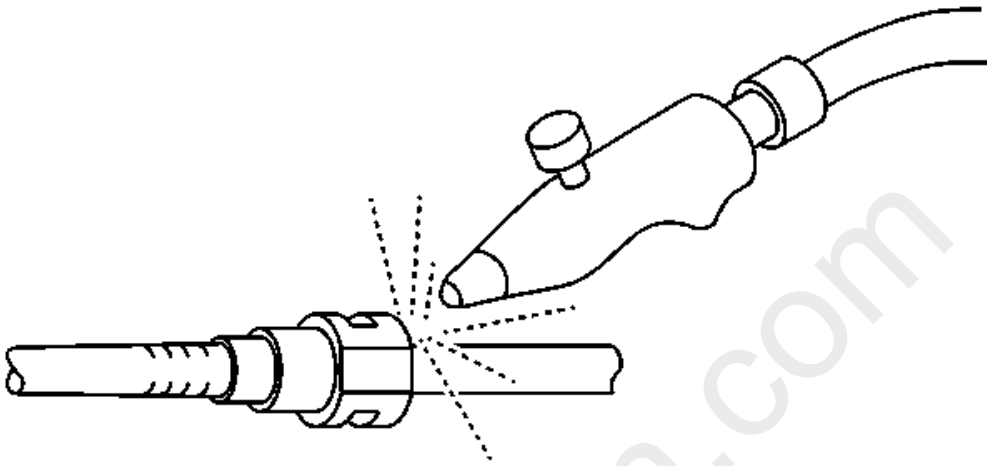


Fig. 23: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

2. Using compressed air, blow any dirt or debris from around the connection.

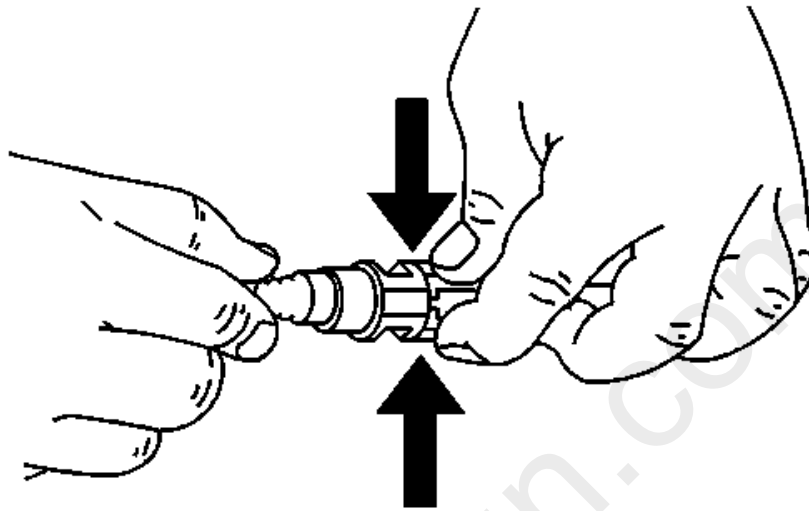


Fig. 24: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. This step applies to Bartholomew style connector ONLY. Squeeze the plastic quick connect fitting release tabs.

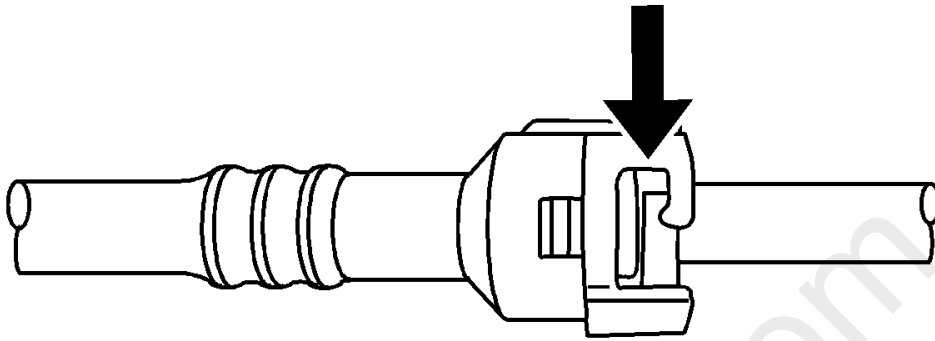


Fig. 25: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Release Tab style connector ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

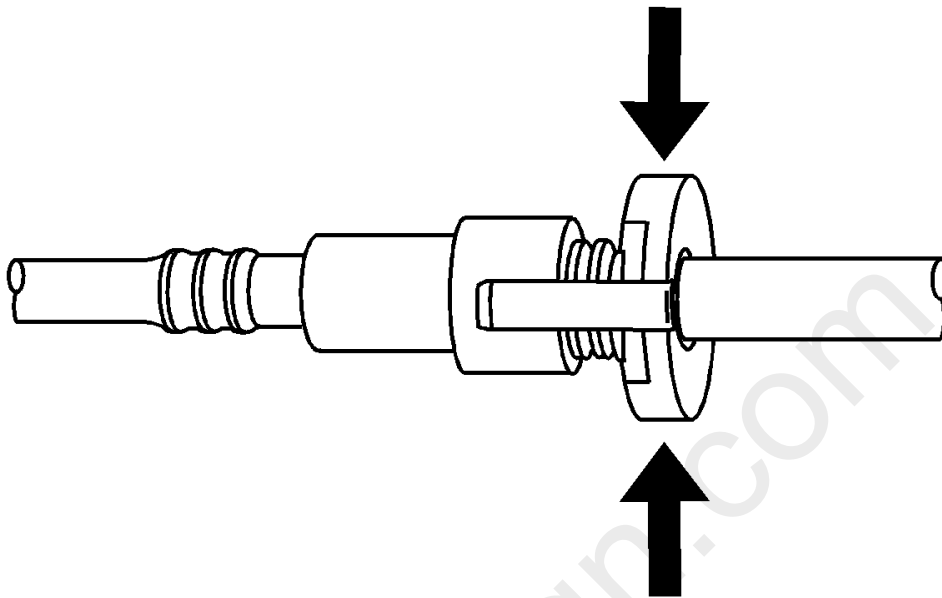


Fig. 26: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to the Squeeze to Release style connector ONLY. Squeeze where indicated by the arrows shown above on both sides of the plastic ring surrounding the quick connect fitting.

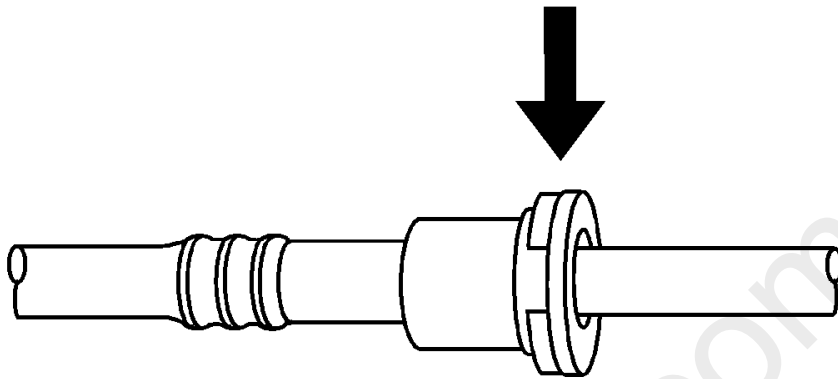


Fig. 27: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

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

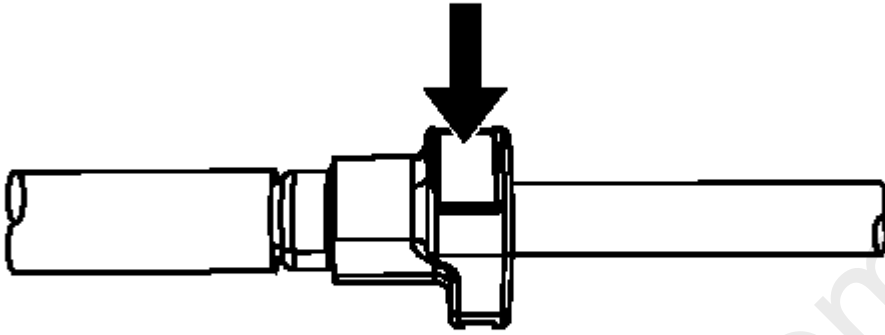


Fig. 28: View Of Push Down TI Style Connector
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Push Down TI style connector ONLY. Release the fitting by pressing on the tab indicated by the arrow.

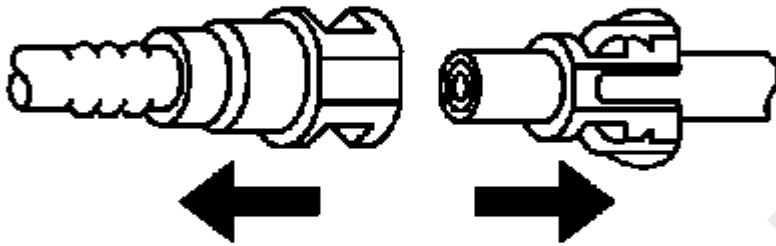


Fig. 29: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

8. Pull the connection apart.

Connect Procedure

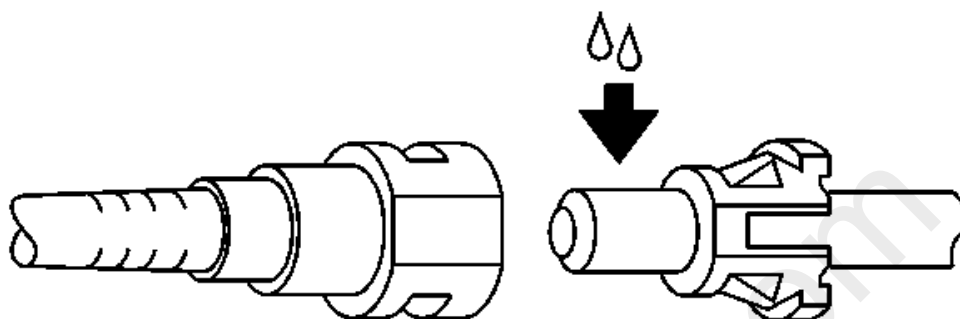


Fig. 30: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Fuel Pipe Fitting Warning .

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

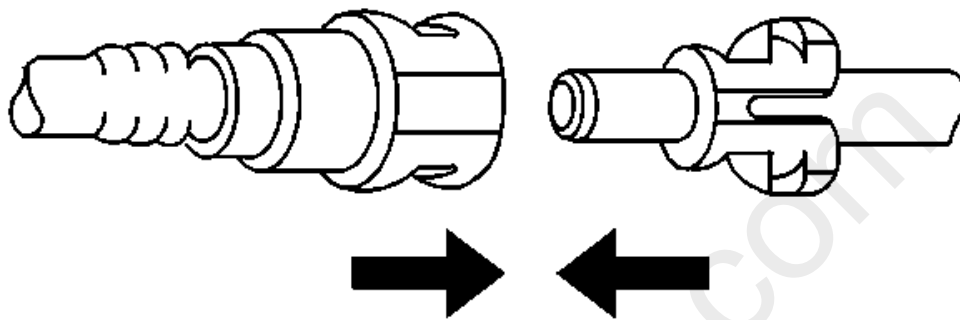


Fig. 31: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

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

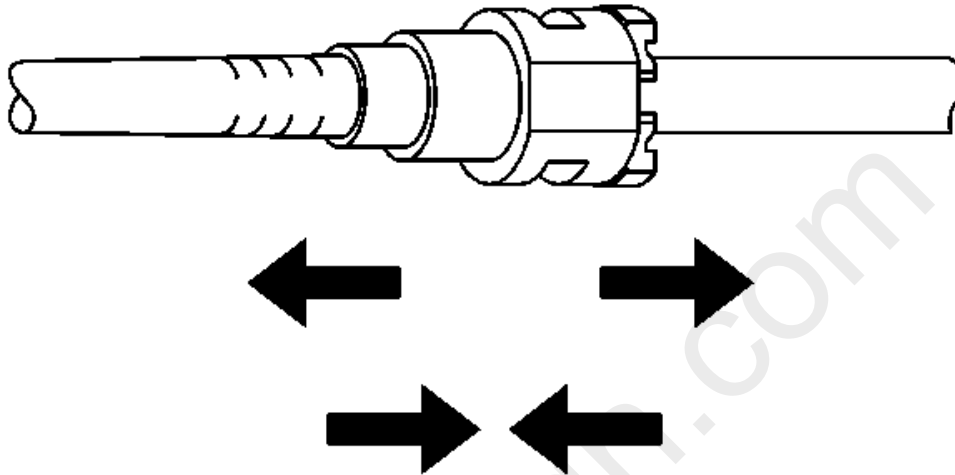


Fig. 32: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the connection 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)** .

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

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing

any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Remove the fuel fill cap.
2. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Loosen the fuel fill pipe hose clamps and slide the fill pipe hose up the filler pipe.
4. Insert the **CH-45004** fuel tank drain hose into the fuel tank until the hose reaches the bottom of the fuel tank.
5. Use an hand or air operated pump device in order to drain as much fuel as possible.

FUEL TANK REPLACEMENT

Removal Procedure

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

1. Drain the fuel tank. Refer to **Fuel Tank Draining**.
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
3. Remove the exhaust system. Refer to **Exhaust System Replacement (Single Exhaust)** , **Exhaust System Replacement (LFX/LFW-Coupe)** , **Exhaust System Replacement (LFX/LFW-Wagon)** .
4. Remove the rear propeller shaft. Refer to **Rear Propeller Shaft Replacement (RPO LFX or LFW with MXO)** , **Rear Propeller Shaft Replacement (RPO LFX or LFW with MX7 or MN6)** .

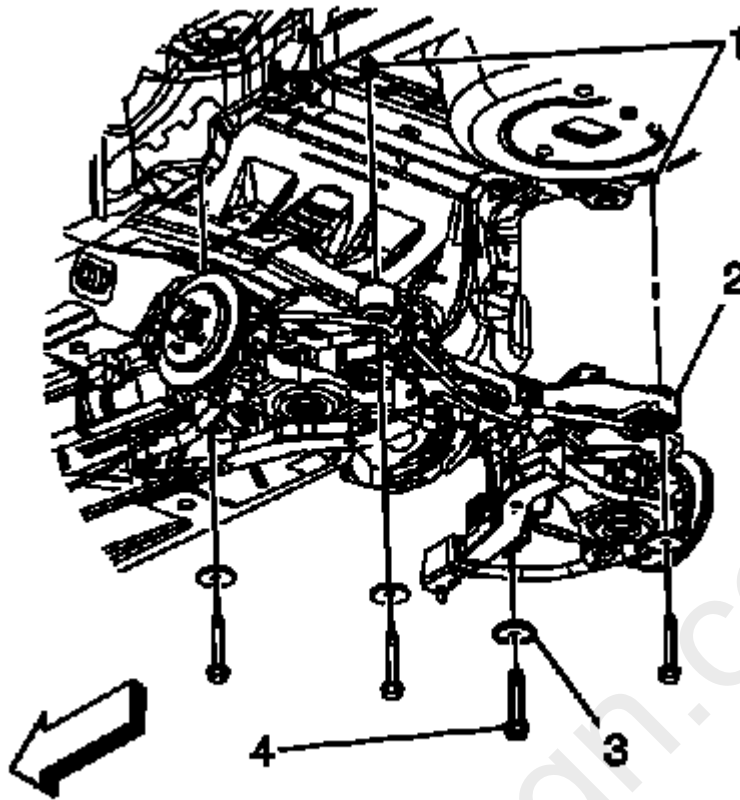


Fig. 33: Frame-To-Bolt Mounting Bolts & Washers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not remove any components from the rear frame assembly once the rear frame assembly is removed from the vehicle.

5. Remove the rear frame assembly (2). Refer to **Rear Frame Replacement** .

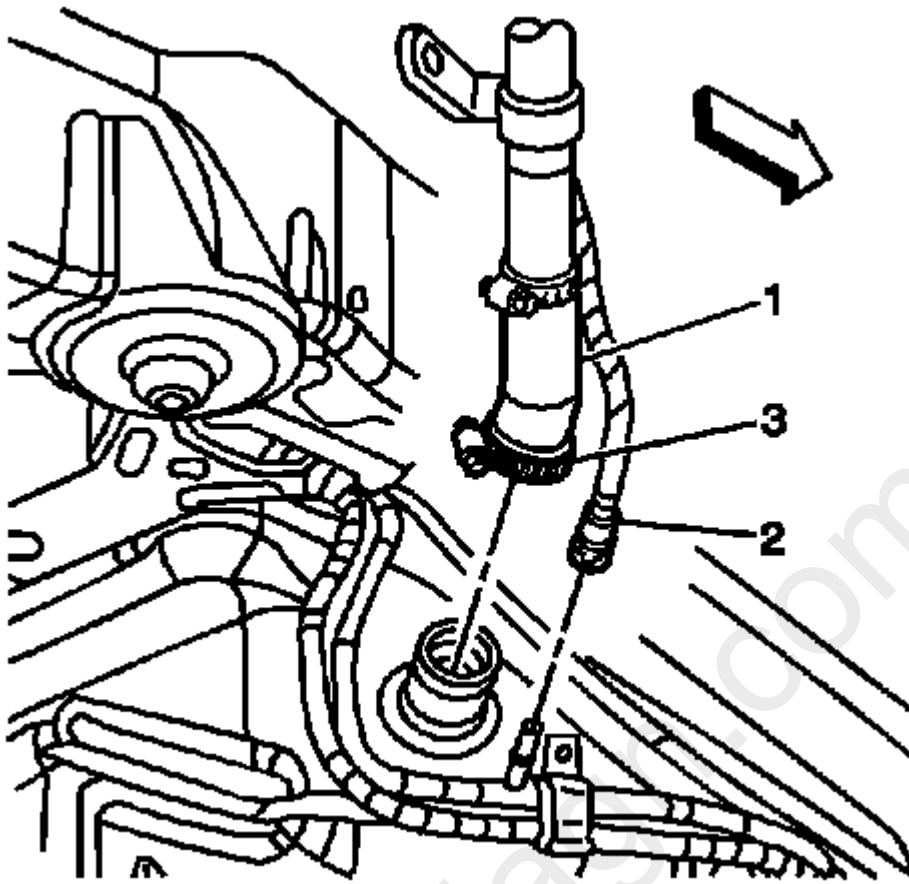


Fig. 34: Identifying Fuel Filler Hose To Fuel tank
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the filler hose (1) from the fuel tank.
7. Disconnect the filler vent tube (2) from the evaporative emission (EVAP) hose. Refer to **Plastic Collar Quick Connect Fitting Service**.

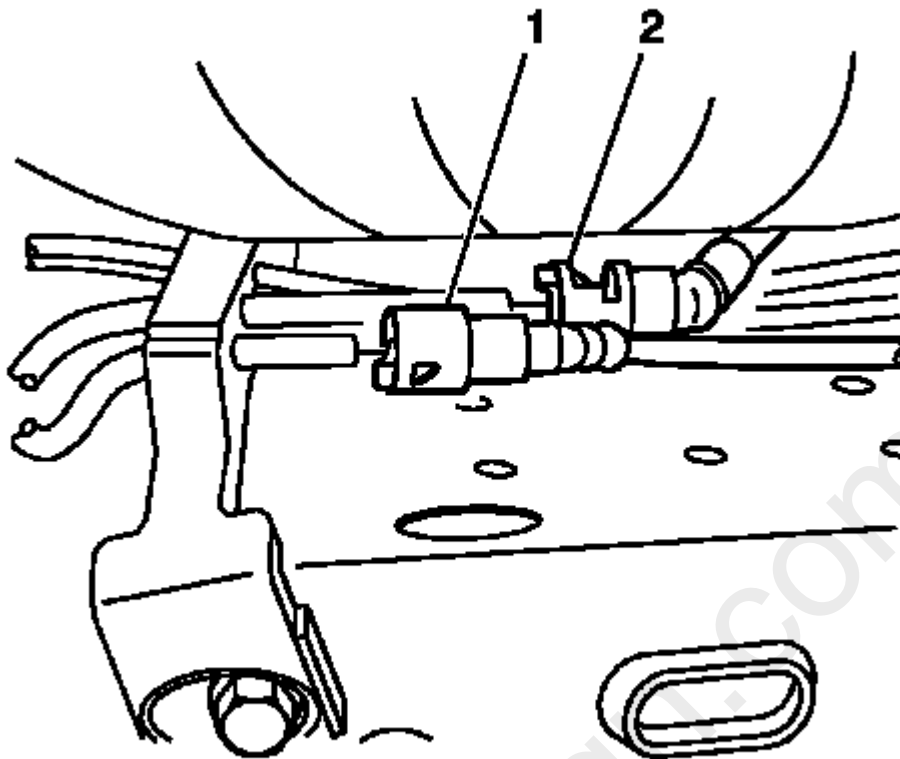


Fig. 35: Identifying Fuel Feed Pipe And Evap Hose
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel feed pipe (1) from the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Disconnect the fuel EVAP hose (2) from the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.

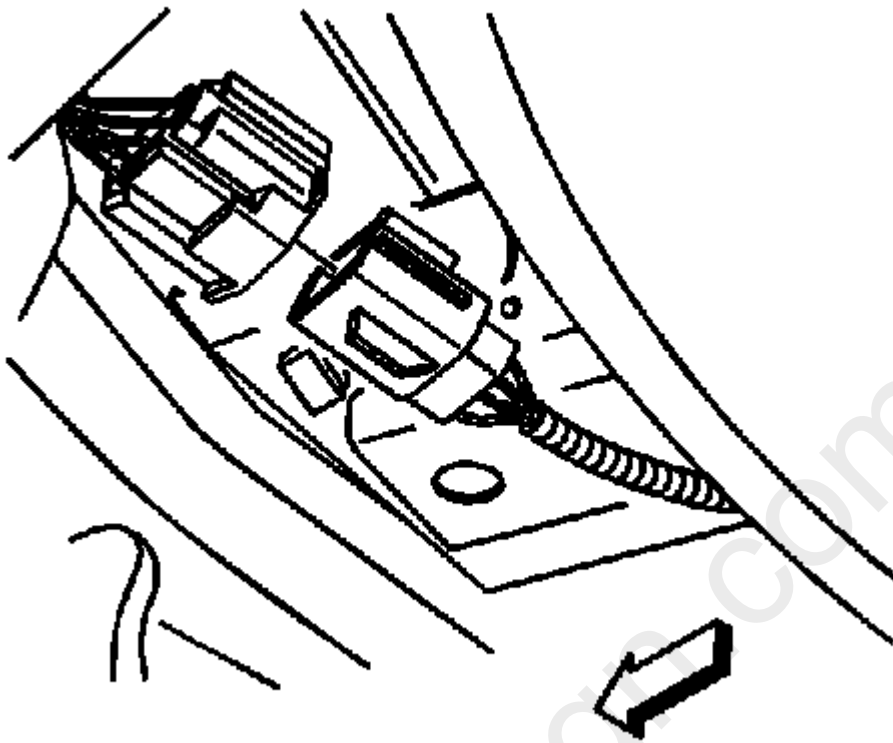


Fig. 36: View Of Fuel Tank Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

10. Release the electrical connector interlock and disconnect the fuel tank electrical connector.
11. Remove the fuel tank electrical connector retainer from the chassis.
12. Remove the fuel tank electrical harness from the chassis mounted retainer.

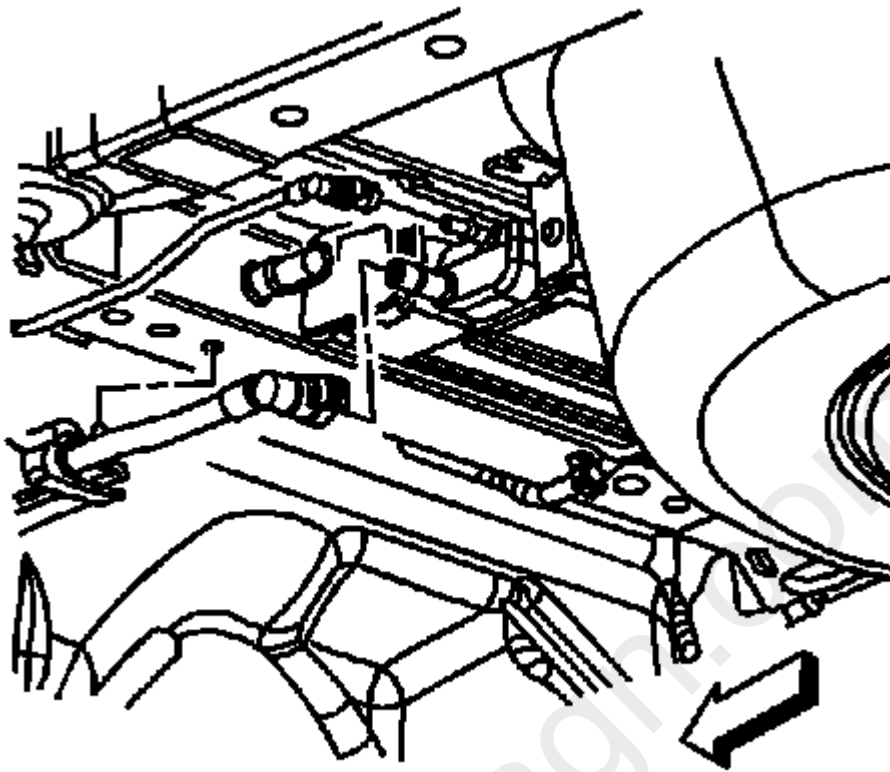


Fig. 37: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the EVAP hoses from the EVAP canister.
14. Pull outward on the retainer tab in order to disengage the retainer from the chassis.

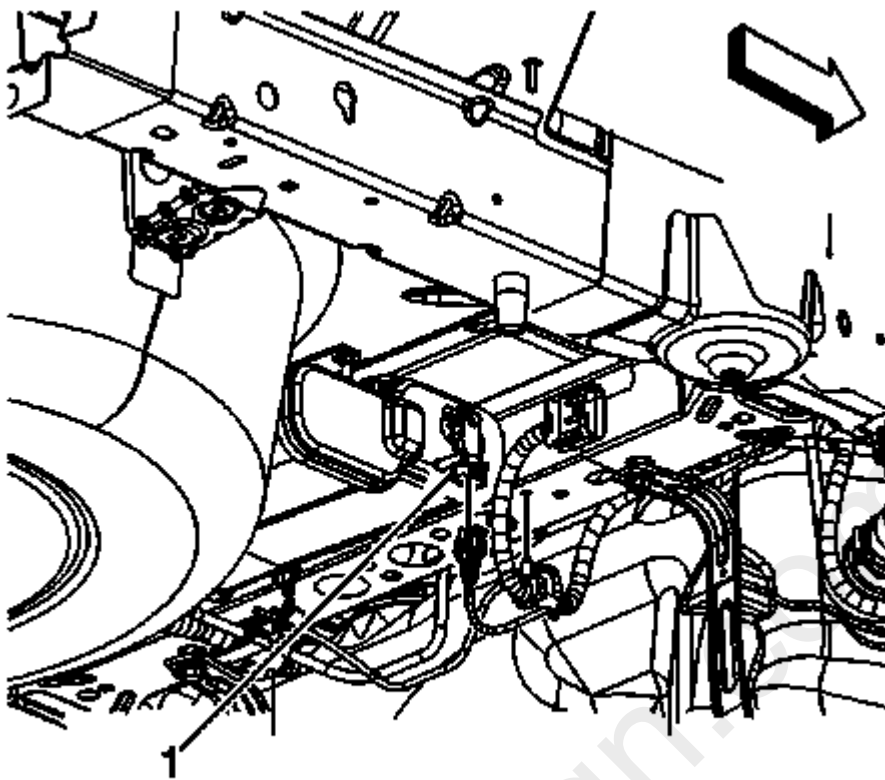


Fig. 38: View Of Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

15. Disconnect the electrical connector from the fuel tank pressure sensor (1).
16. Disconnect the electrical connector from the EVAP canister vent valve.

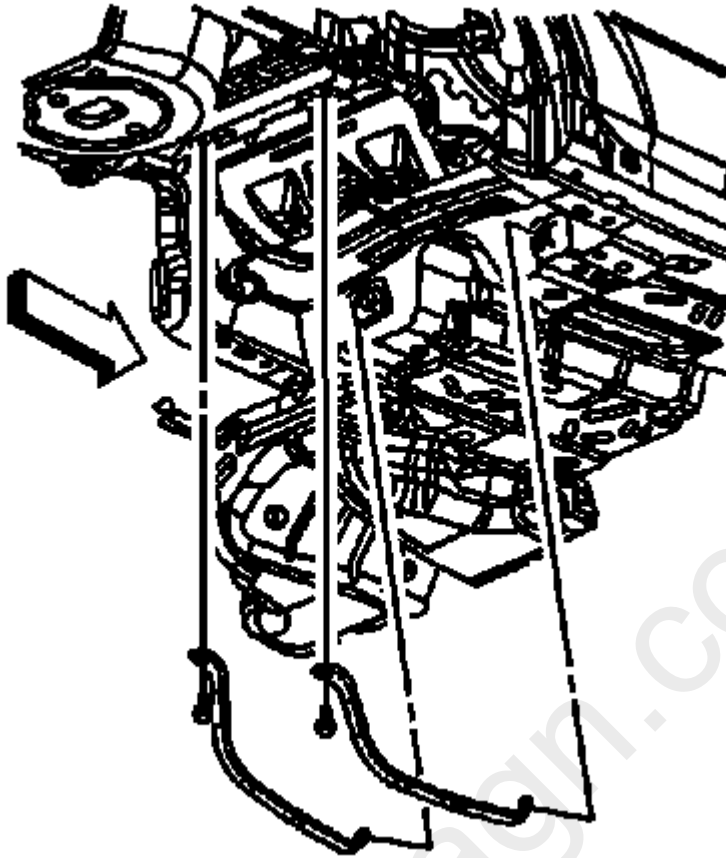


Fig. 39: View Of Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

17. Support the fuel tank with a suitable jack.
18. Remove the fuel tank strap bolts.
19. Remove the fuel tank straps.

NOTE: Ensure the following are free from the surrounding components while lowering the fuel tank:

- The fuel tank wiring harness
- The EVAP wiring harness
- The EVAP hoses at the EVAP
- The fuel/EVAP hoses at the chassis pipes

20. With the aid of an assistant, carefully lower the fuel tank from the vehicle.
21. Remove the following components if replacing just the fuel tank:
 - The right fuel tank pump module-Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side.**

- The left fuel level sensor assembly-Refer to Fuel Level Sensor Replacement - Left Side.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 - The right fuel tank pump module-Refer to Fuel Tank Fuel Pump Module Replacement - Right Side.
 - The left fuel level sensor assembly-Refer to Fuel Level Sensor Replacement - Left Side.

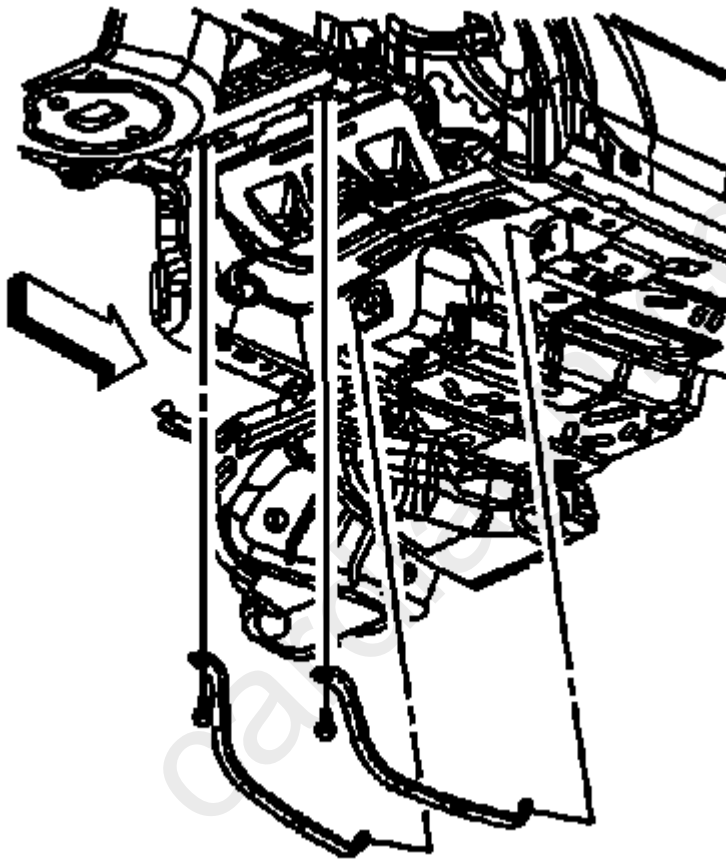


Fig. 40: View Of Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the following are properly routed while raising the fuel tank:

- The fuel tank wiring harness
- The EVAP wiring harness
- The EVAP hoses at the EVAP
- The fuel/EVAP hoses at the chassis pipes

2. With the aid of an assistant, carefully raise the fuel tank to the vehicle.

3. Install the fuel tank straps to the vehicle.

CAUTION: Refer to Fastener Caution .

4. Install the fuel tank strap bolts and tighten to 50 N.m (37 lb ft).

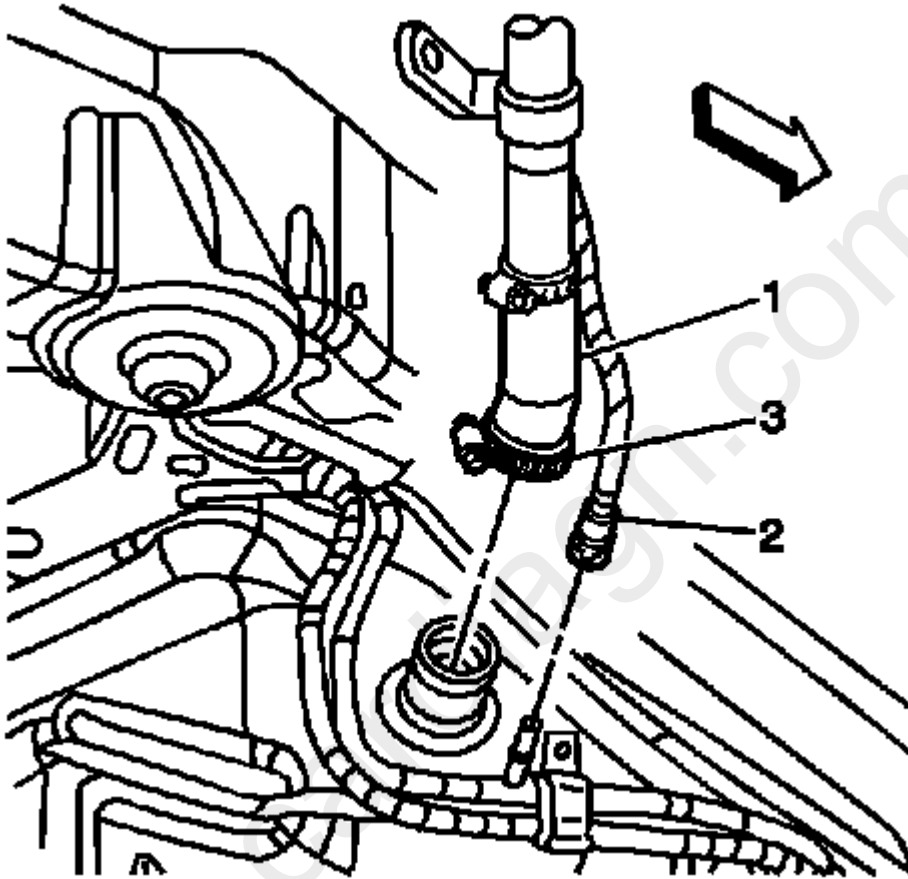


Fig. 41: Identifying Fuel Filler Hose To Fuel tank
Courtesy of GENERAL MOTORS COMPANY

5. Connect the filler hose (1) to the fuel tank and tighten to 3.5 N.m (31 lb in).
6. Connect the filler vent tube (2) to the EVAP hose. Refer to **Plastic Collar Quick Connect Fitting Service**.

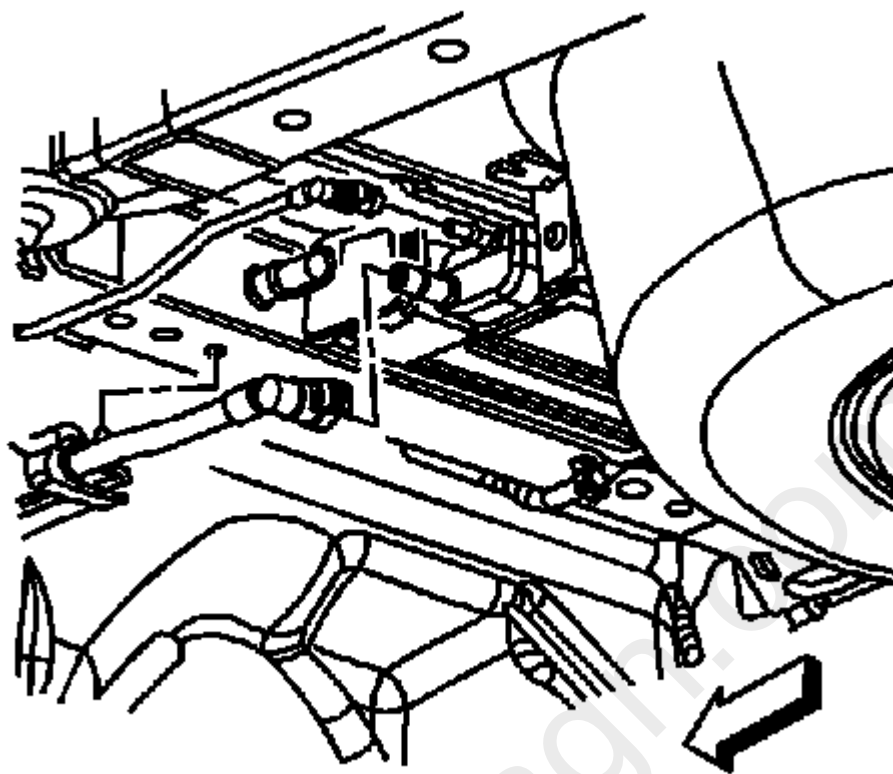


Fig. 42: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS COMPANY

7. Connect the EVAP hoses to the EVAP canister.
8. Connect the EVAP purge valve and fuel tank pressure sensor electrical connectors.

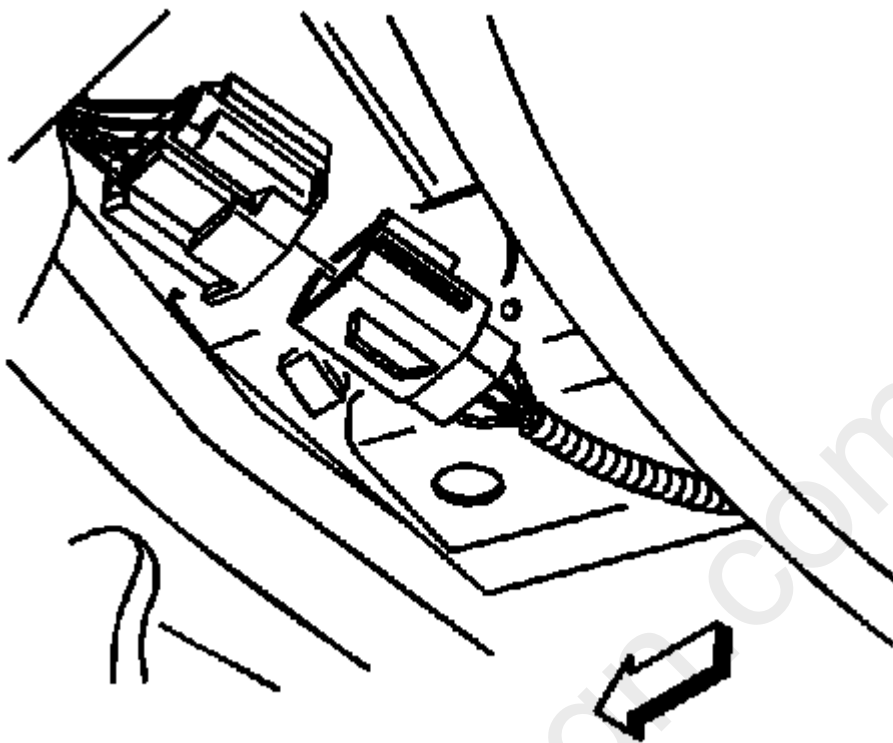


Fig. 43: View Of Fuel Tank Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

9. Install the fuel tank wire harness and wire harness connector to the retainers on the chassis.
10. Connect the fuel tank electrical connector, and engage the connector interlock.

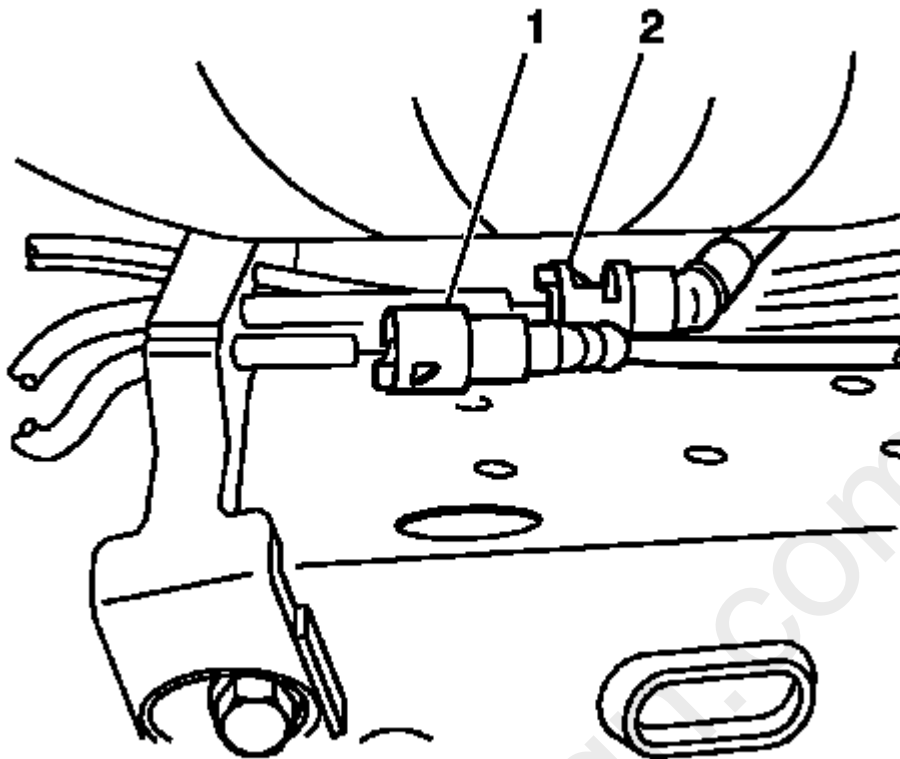


Fig. 44: Identifying Fuel Feed Pipe And Evap Hose
Courtesy of GENERAL MOTORS COMPANY

11. Connect the fuel EVAP hose (2) to the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.
12. Connect the fuel feed pipe (1) to the chassis bundle. Refer to **Plastic Collar Quick Connect Fitting Service**.

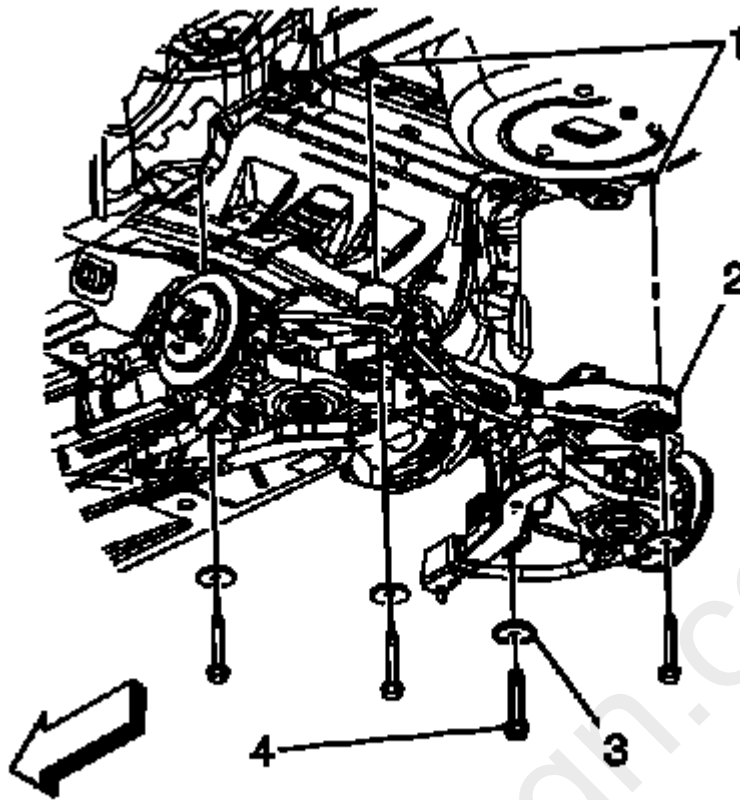


Fig. 45: Removing & Installing Frame-To-Bolt Mounting Bolts & Washers
 Courtesy of GENERAL MOTORS COMPANY

13. Install the rear frame assembly (2). Refer to **Rear Frame Replacement** .
14. Install the propeller shaft. Refer to **Rear Propeller Shaft Replacement (RPO LFX or LFW with MXO)** , **Rear Propeller Shaft Replacement (RPO LFX or LFW with MX7 or MN6)** .
15. Install the exhaust system. Refer to **Exhaust System Replacement (Single Exhaust)** , **Exhaust System Replacement (LFX/LFW-Coupe)** , **Exhaust System Replacement (LFX/LFW-Wagon)** .
16. Refill the fuel tank.
17. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - RIGHT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

Removal Procedure

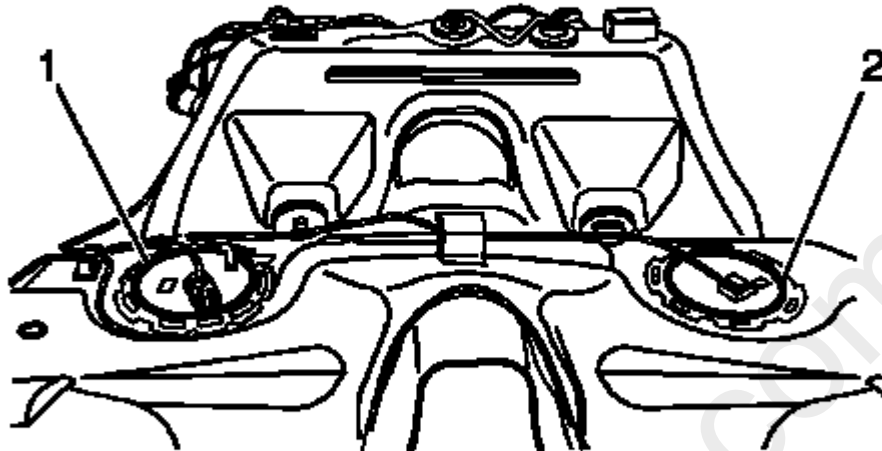


Fig. 46: Fuel Tank Module And Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank in order to gain access to the primary fuel tank module (1). Refer to **Fuel Tank Replacement**.

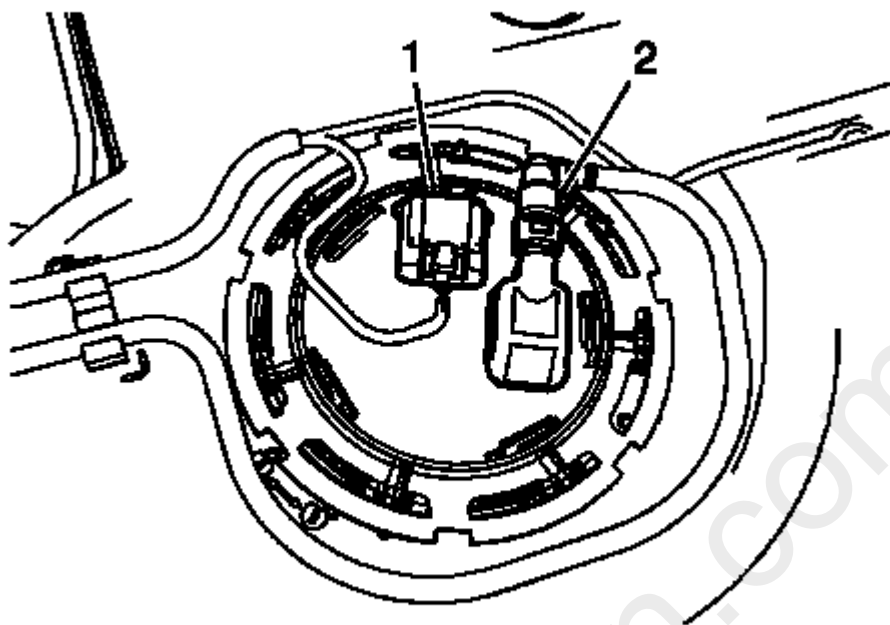


Fig. 47: Identifying Electrical Connector And Fuel Feed Line
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connector (1) and the fuel feed line (2) from the primary fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Remove the fuel feed line (2) from the retainer on the fuel tank and position the hose aside.
4. Release the interlock and disconnect the electrical connector from the primary fuel tank module.
5. Remove the wire harness from the retainer on the fuel tank and position the harness aside.

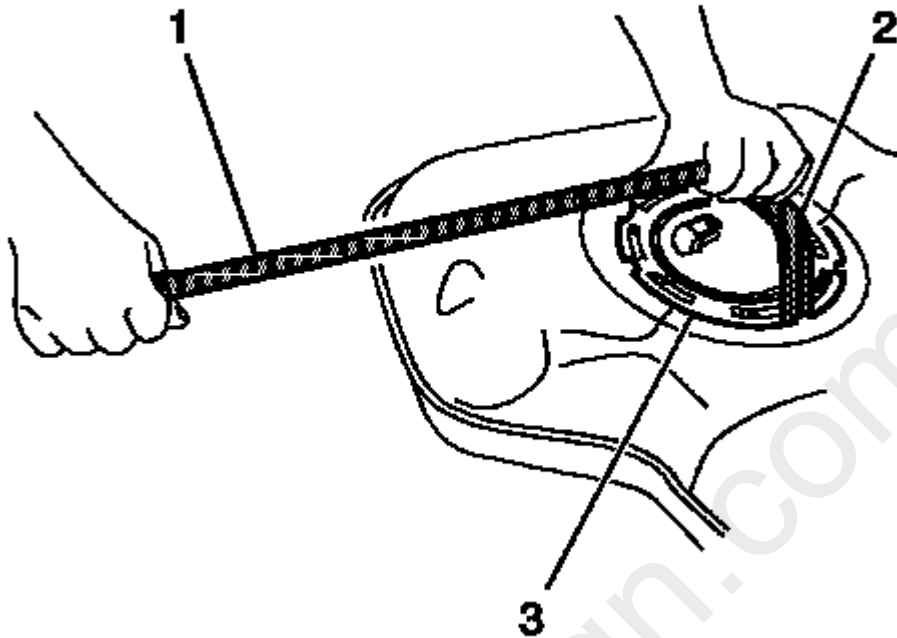


Fig. 48: Breaker-Bar And Fuel Tank Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

CAUTION: Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.

NOTE:

- **DO NOT** use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.
- Do not allow the tool to come in contact with the fuel pipe while unlocking the cam lock ring.

6. Use the **J 45722** fuel sender lock ring wrench (2) and a long breaker-bar (1) in order to unlock the fuel tank module lock ring (3), by turning counterclockwise.
7. Remove the cam lock ring.

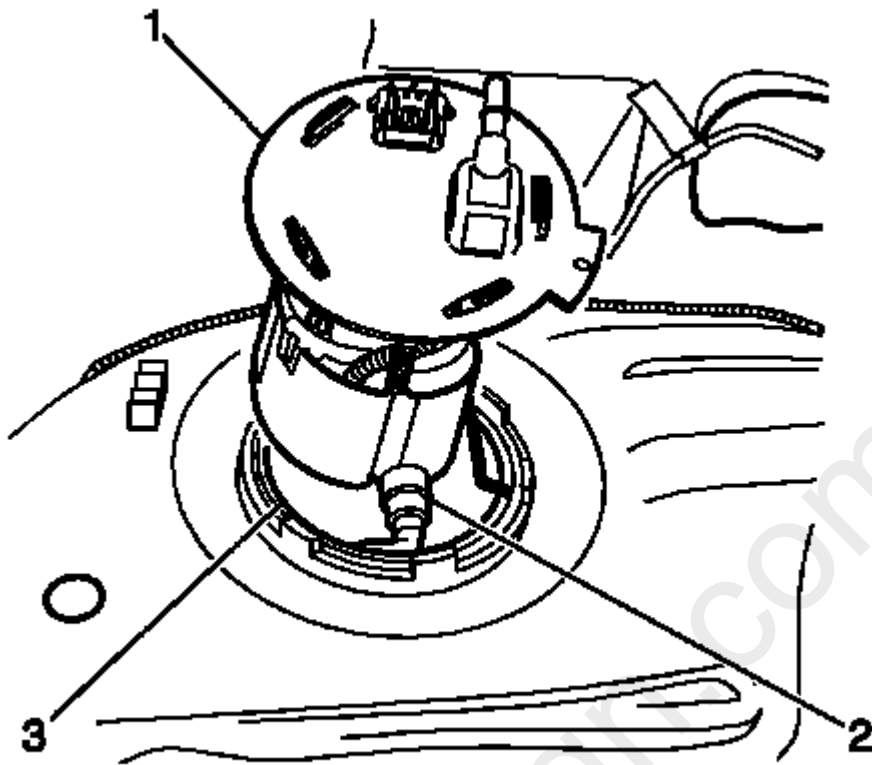


Fig. 49: Identifying Primary Fuel Tank Module, Fuel Transfer Hose Quick Connect Fitting And Fuel Tank Module Seal

Courtesy of GENERAL MOTORS COMPANY

8. Partially remove the primary fuel tank module and disconnect the fuel transfer hose quick connect fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Remove the primary fuel tank module from the fuel tank.
10. Discard the fuel tank module seal (3).

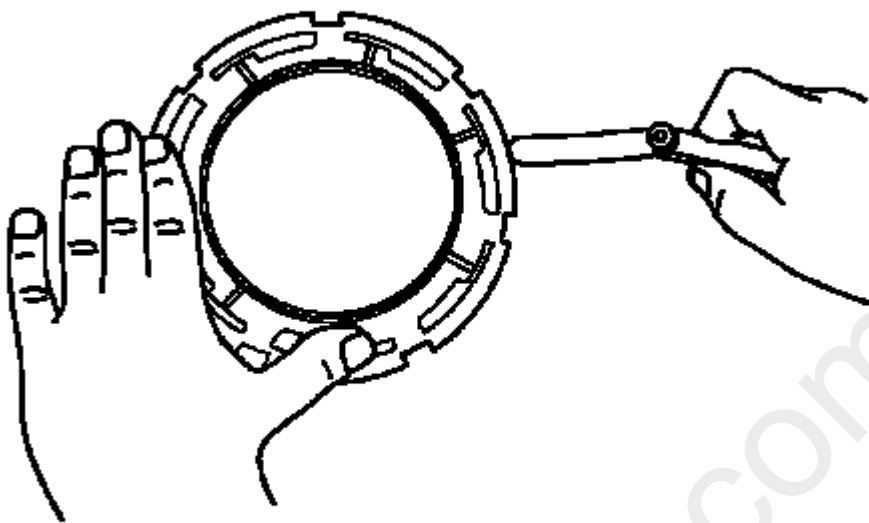


Fig. 50: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if the lock rings are not damaged or warped.
- Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.
- Check the lock ring for flatness.

11. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
12. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
13. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

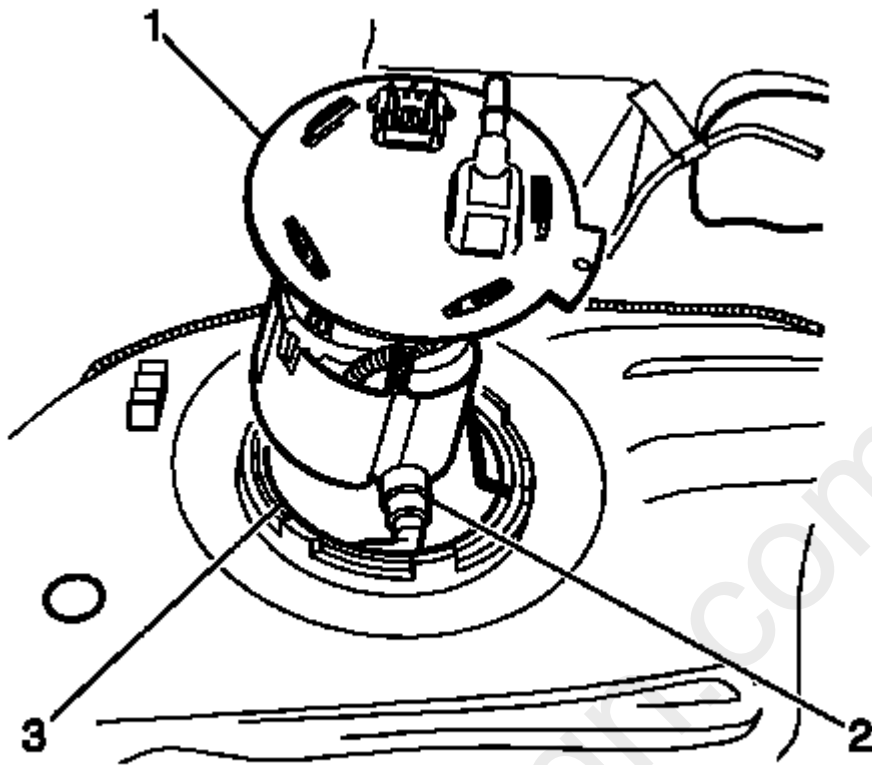


Fig. 51: Identifying Primary Fuel Tank Module, Fuel Transfer Hose Quick Connect Fitting And Fuel Tank Module Seal

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always replace the fuel tank module seal when installing the fuel tank module assembly. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.

1. Install a NEW fuel tank module seal (3).
2. Grasp the fuel transfer hose from inside the fuel tank.
3. Partially install the primary fuel tank module and connect the fuel transfer hose (2).

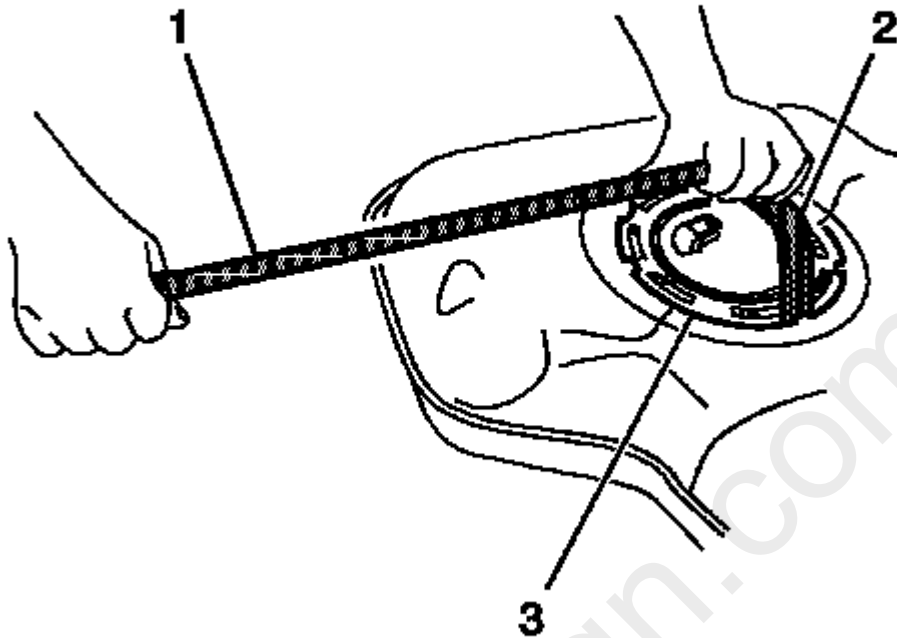


Fig. 52: Breaker-Bar And Fuel Tank Module Lock Ring
Courtesy of GENERAL MOTORS COMPANY

4. Press the primary fuel tank module downward, aligning the module to the encapsulated ring.

NOTE: Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

5. Position the cam lock ring (3) to the fuel tank.

NOTE: DO NOT use impact tools. Significant force will be required to install the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.

6. Use the J 45722 fuel sender lock ring wrench (2) and a long breaker-bar (1) to install the fuel tank module lock ring (3), by turning clockwise, until fully seated.

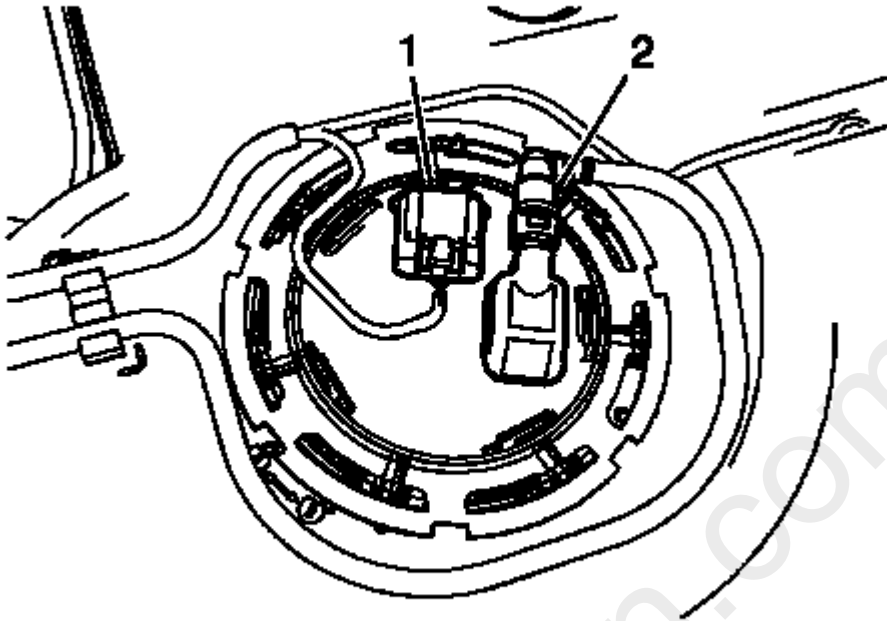


Fig. 53: Identifying Electrical Connector And Fuel Feed Line
Courtesy of GENERAL MOTORS COMPANY

7. Connect the electrical connector (1) and the fuel feed line (2).
8. Install the wire harness to the retainer on the fuel tank.
9. Connect the fuel feed line quick connect fitting to the primary fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
10. Install the fuel feed line to the retainer on the fuel tank.
11. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT (COUPE)

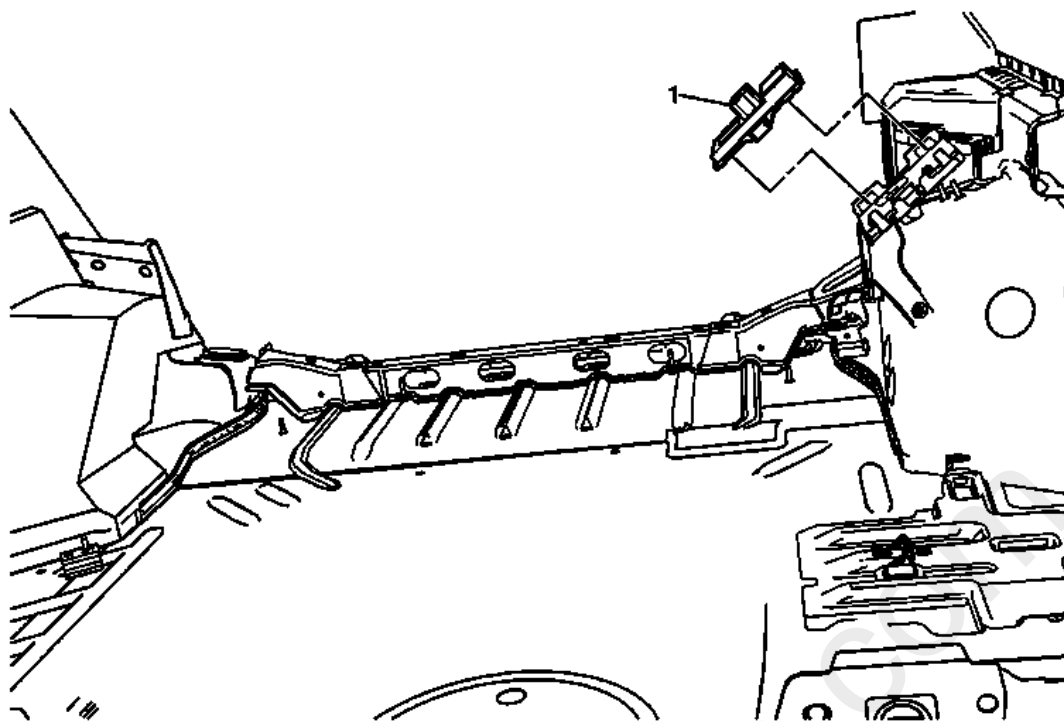


Fig. 54: Identifying Fuel Pump Flow Control Module
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Flow Control Module Replacement (Coupe)

Callout	Component Name
Preliminary Procedure Partially remove the right side rear compartment trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (Coupe)</u> .	
1	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. Release the two integral retainer tabs and remove the module. 3. If replacing the fuel pump flow control module, program the control module. Refer to <u>Control Module References</u> .

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT (WAGON)

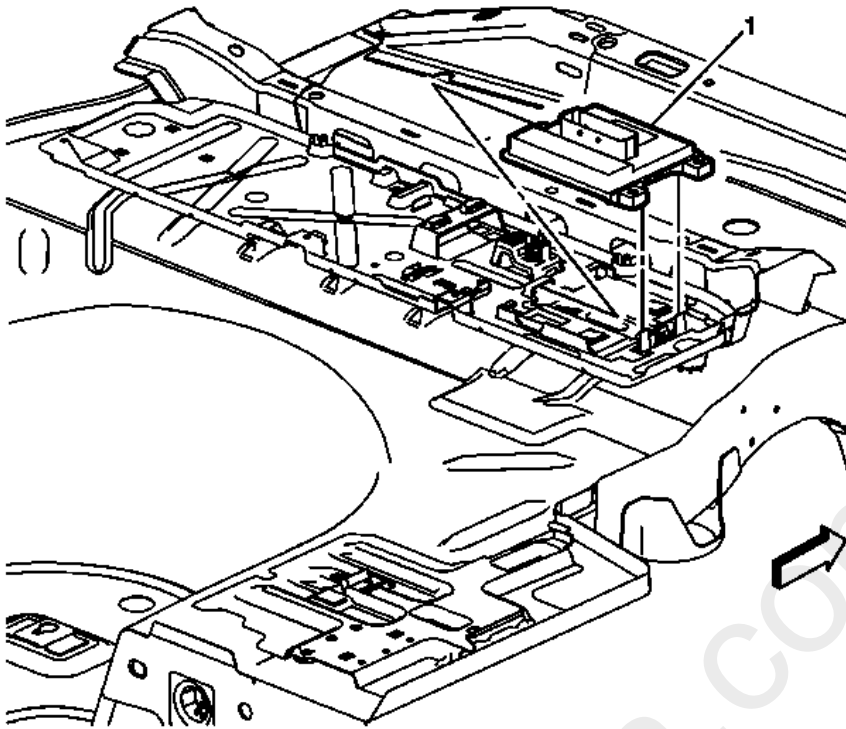


Fig. 55: Fuel Pump Flow Control Module (Wagon)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Flow Control Module Replacement (Wagon)

Callout	Component Name
Preliminary Procedure Remove the rear compartment stowage cover. Refer to <u>Rear Compartment Floor Stowage Compartment Cover Replacement (Wagon)</u> .	
	Fuel Pump Flow Control Module CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Release the retaining tabs. 2. Disconnect the electrical connector. 3. If replacing, reprogram the control module. Refer to <u>Service Programming System (SPS)</u> . Tighten 9 N.m(80 lb in)

FUEL TANK PRESSURE SENSOR REPLACEMENT

Removal Procedure

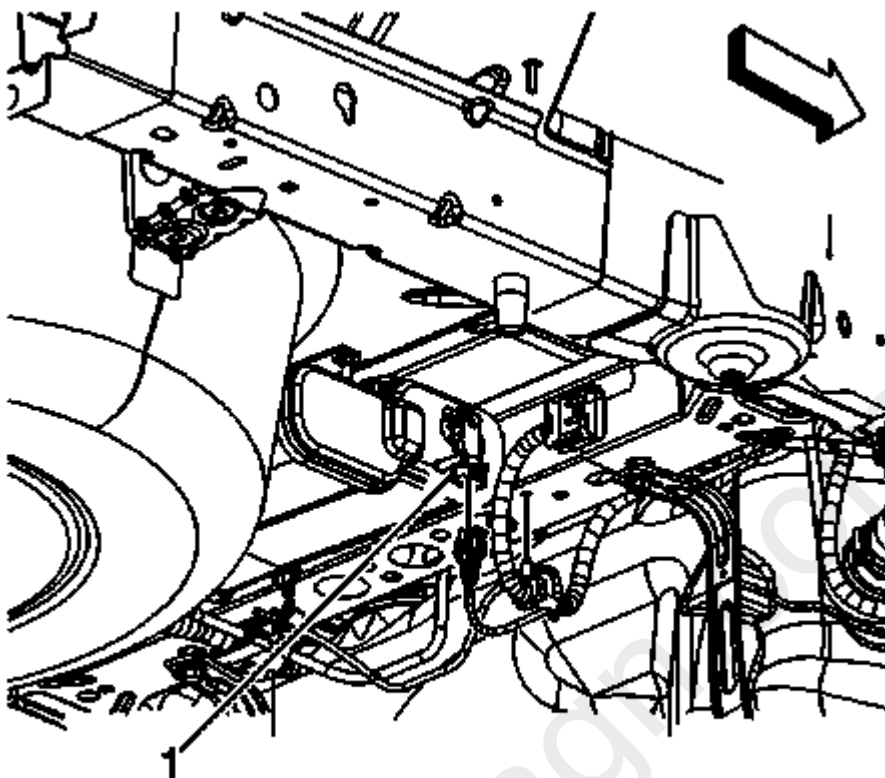


Fig. 56: View Of Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the fuel tank pressure sensor electrical connector (1).

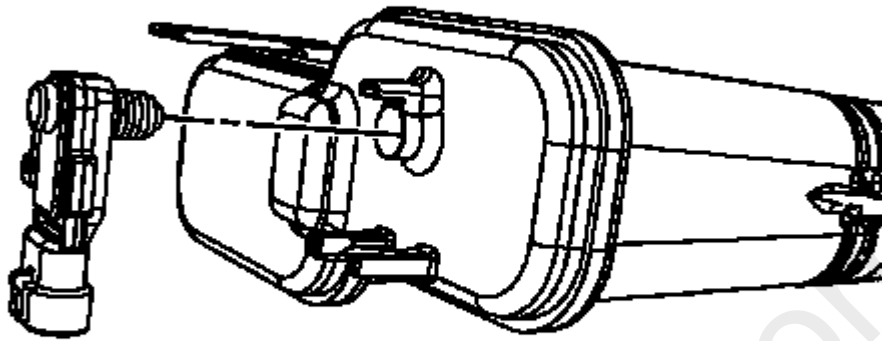


Fig. 57: Removing/Installing Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: There are alignment features on the canister, however, there are no locking tabs on the sensor/canister. The sensor is held into the canister by the tight fit of the multi-lip seal.

3. Remove the fuel tank pressure sensor from the evaporative emission (EVAP) canister.

Installation Procedure

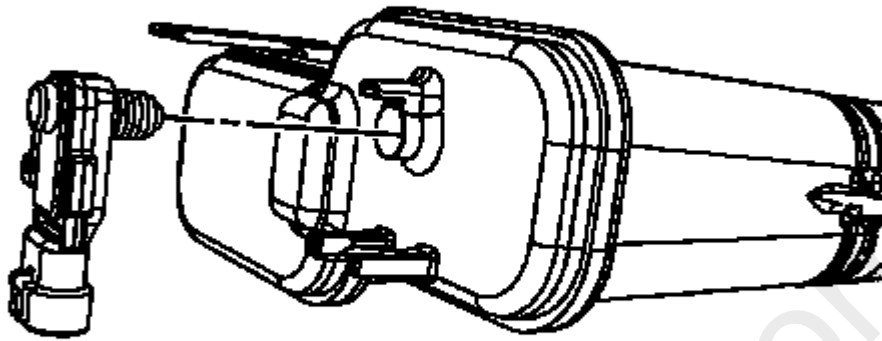


Fig. 58: Removing/Installing Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: There are alignment features on the canister, however, there are no locking tabs on the sensor/canister. The sensor is held into the canister by the tight fit of the multi-lip seal.

1. Install the fuel tank pressure sensor to the EVAP canister until fully seated.

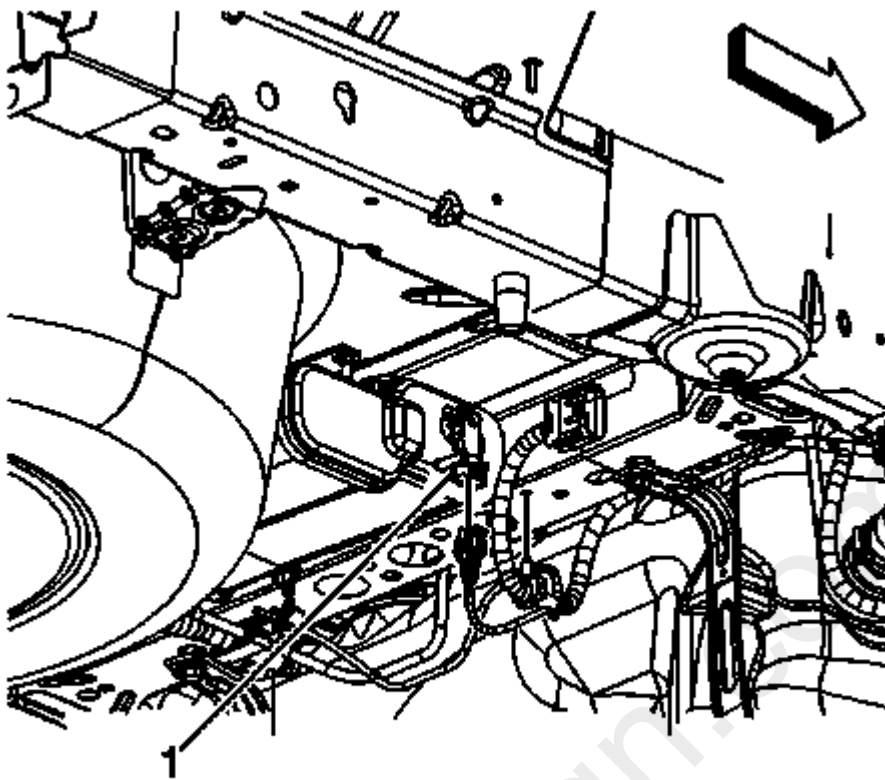


Fig. 59: View Of Fuel Tank Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel tank pressure sensor electrical connector (1).
3. Lower the vehicle.

FILLER TUBE REPLACEMENT

Removal Procedure

1. Remove the fuel filler cap.
2. Drain the fuel tank below the level of the fuel filler hose. Refer to **Fuel Tank Draining**

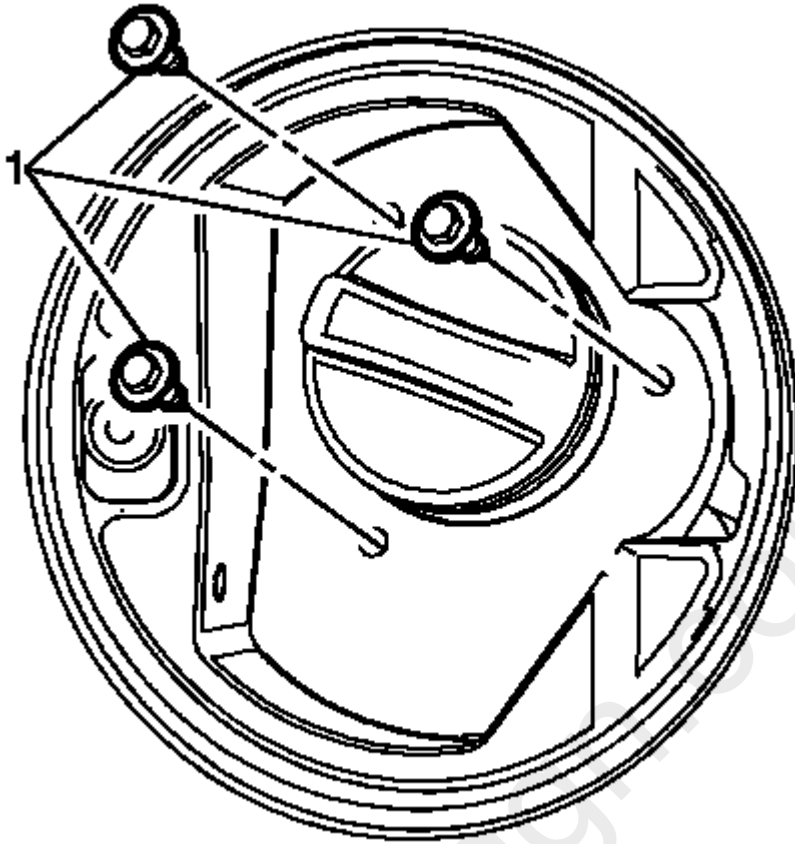


Fig. 60: Fuel Filler Tube Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Remove the bolts (1) securing the fuel filler tube to the body.
4. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation**
5. Remove the right rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement (Coupe)** , **Rear Wheelhouse Liner Replacement (Wagon)**

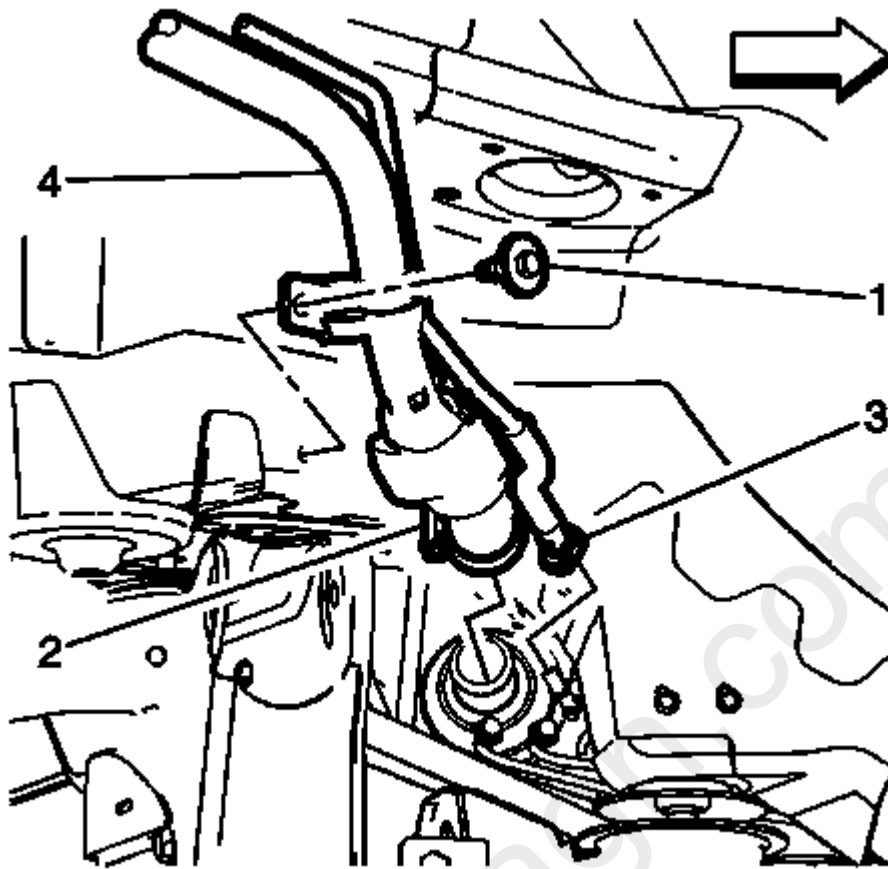


Fig. 61: Fuel Filler Hose, Vent Tube & Brace Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel filler tube brace bolt (1).
7. Disconnect the fuel filler hose (2) from the fuel tank.
8. Disconnect the filler vent tube (3) from the evaporative emission (EVAP) hose. Refer to **Plastic Collar Quick Connect Fitting Service**
9. Remove the fuel filler tube from the vehicle (4).

Installation Procedure

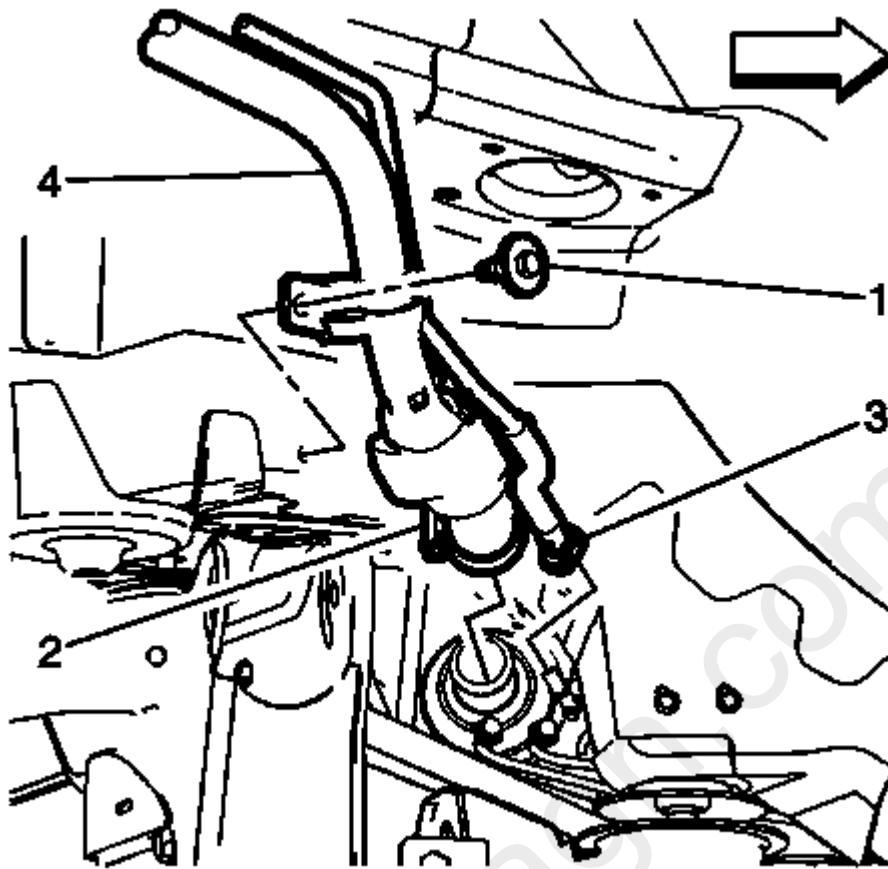


Fig. 62: Fuel Filler Hose, Vent Tube & Brace Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Position the fuel filler tube to the vehicle (4).
2. Connect the filler vent tube (3) to the evaporative emission (EVAP) hose. Refer to **Plastic Collar Quick Connect Fitting Service**
3. Connect the fuel filler hose (2) to the fuel tank.
4. Install the fuel filler tube brace bolt (1) and tighten to 3.5 N.m (31 lb in).

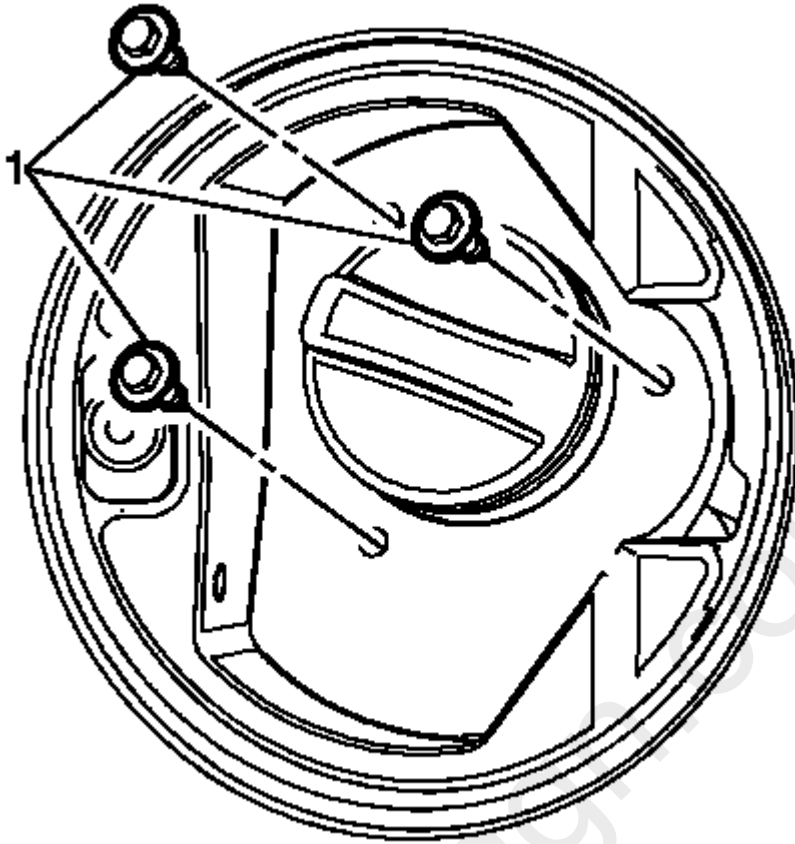


Fig. 63: Fuel Filler Tube Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Install the bolts (1) securing the fuel filler tube to the body and tighten to 9 N.m (80 lb in)
6. Install the right rear wheelhouse liner. Refer to **Rear Wheelhouse Liner Replacement (Coupe)** , **Rear Wheelhouse Liner Replacement (Wagon)**
7. Install the right rear wheel. Refer to **Tire and Wheel Removal and Installation**
8. Add fuel to the fuel tank.
9. Inspect for fuel leaks.
10. Install the fuel filler cap.

FUEL LEVEL SENSOR REPLACEMENT - LEFT SIDE

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

Removal Procedure

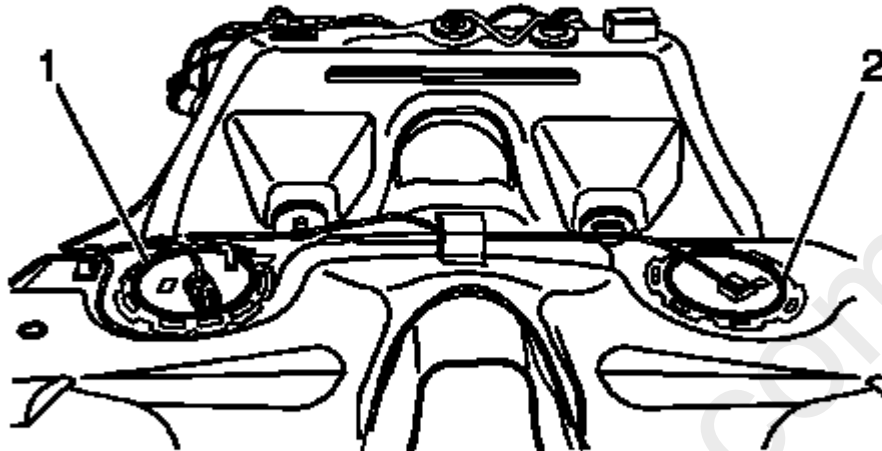


Fig. 64: Fuel Tank Module And Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank in order to gain access to the secondary fuel tank module (2). Refer to **Fuel Tank Replacement**.

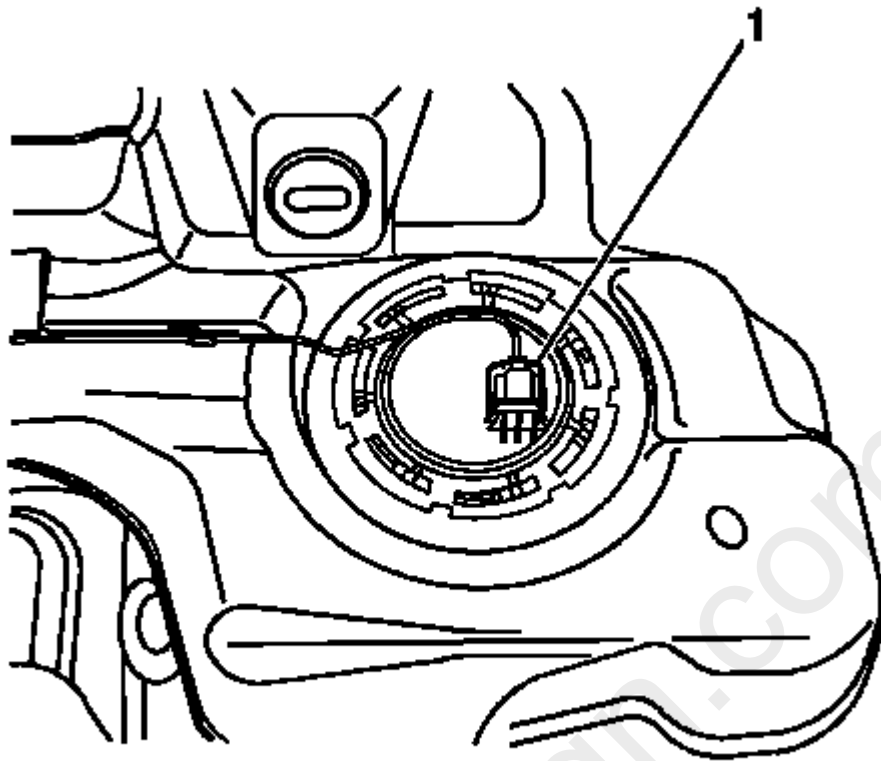


Fig. 65: View Of Electrical Connector Fuel Tank Module
Courtesy of GENERAL MOTORS COMPANY

2. Release the interlock and disconnect the electrical connector (1) from the secondary fuel tank module. Position the connector and wire harness aside.

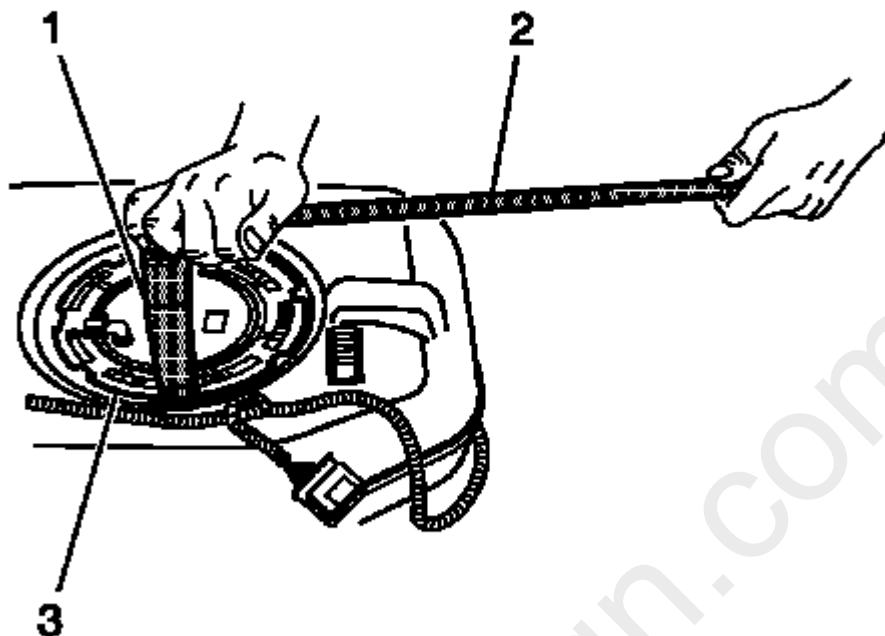


Fig. 66: Long Breaker-Bar And Lock Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

NOTE:

- **DO NOT** use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.
- Do not allow the tool to come in contact with the fuel pipe while unlocking the cam lock ring.

3. Use the **J 45722** fuel sender lock ring wrench (1) and a long breaker-bar (2) in order to unlock the fuel tank module lock ring (3), by turning counterclockwise.
4. Remove the cam lock ring.

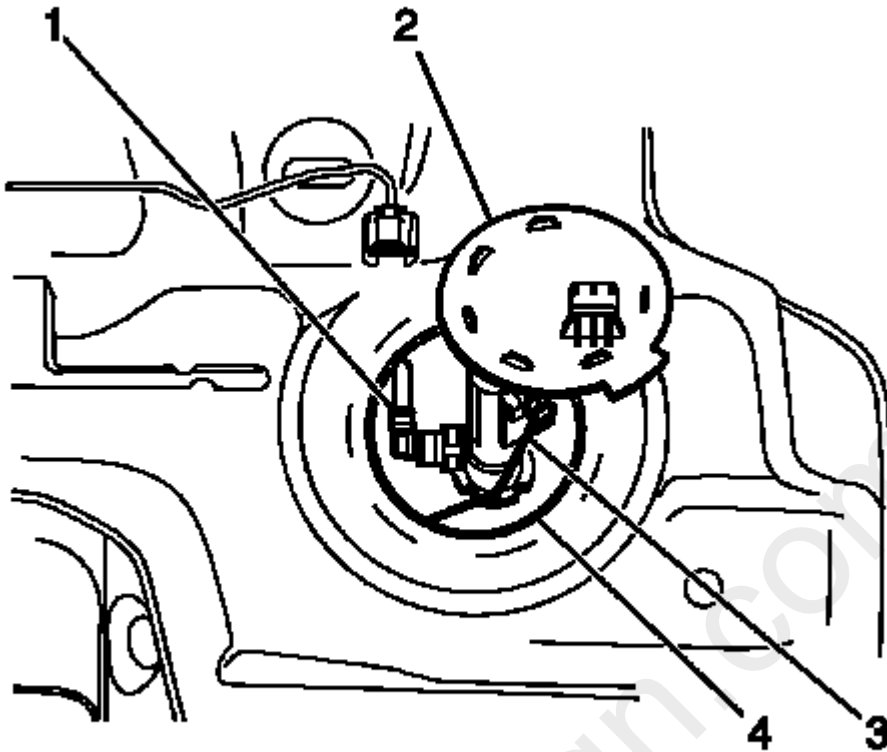


Fig. 67: Secondary Fuel Tank Module, Hose Quick Connect Fitting And Fuel Tank Module Seal
Courtesy of GENERAL MOTORS COMPANY

5. Partially remove the secondary fuel tank module (2) in order to gain access to the fuel transfer hose quick connect fitting (1). Use care not to damage the float arm (3).
6. Disconnect the fuel transfer hose quick connect fitting (1).
7. Remove the secondary fuel tank module from the fuel tank.
8. Discard the fuel tank module seal (4).

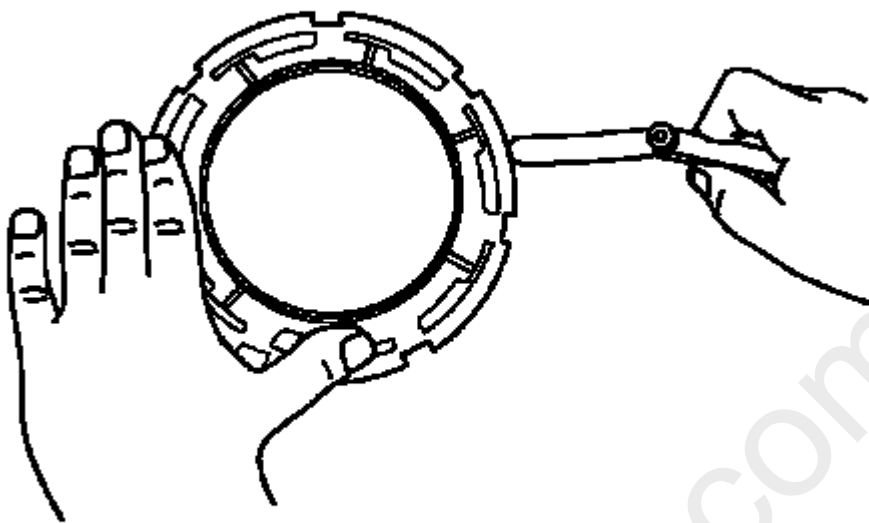


Fig. 68: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if the lock rings are not damaged or warped.
- Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.
- Check the lock ring for flatness.

9. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
10. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
11. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

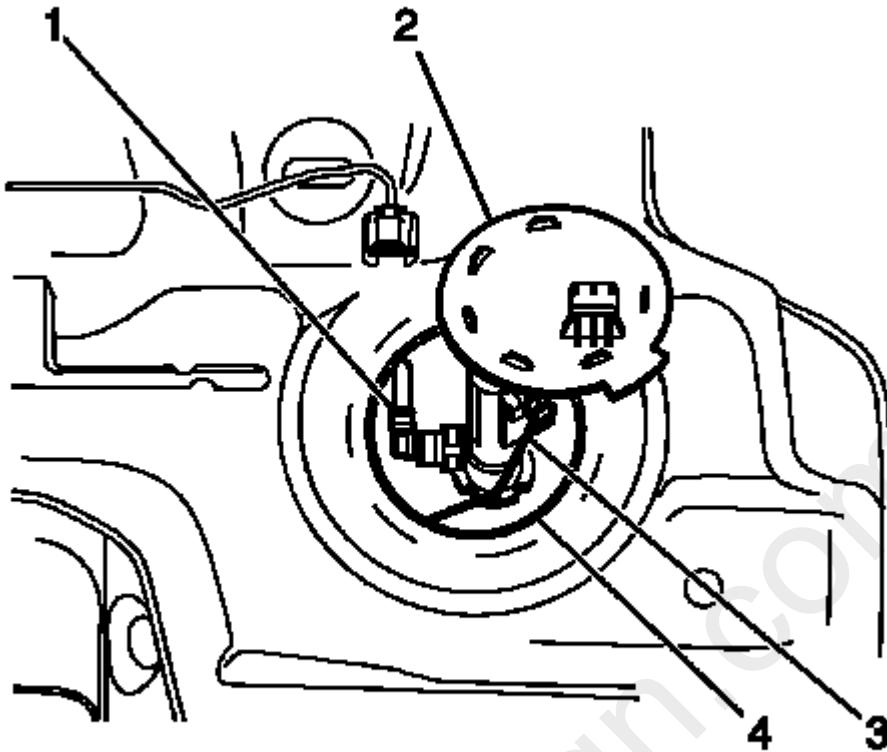


Fig. 69: Secondary Fuel Tank Module, Hose Quick Connect Fitting And Fuel Tank Module Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always replace the fuel tank module seal when installing the fuel tank module assembly. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.

1. Install a NEW fuel tank module seal (4).
2. Grasp the fuel transfer hose from inside the fuel tank.
3. Partially install the secondary fuel tank module (2) to the fuel tank.
4. Connect the fuel transfer hose quick connect fitting (1) to the port on the fuel tank module.

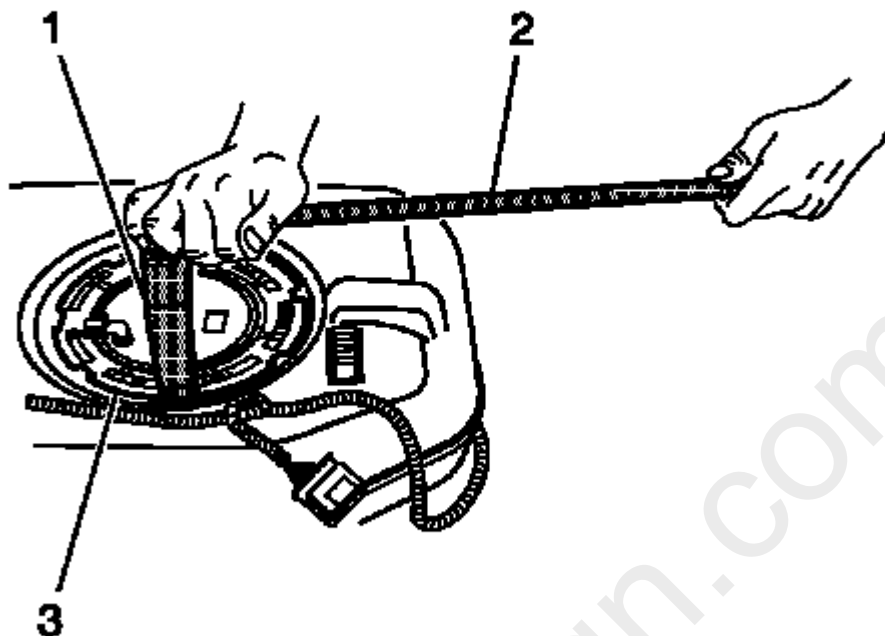


Fig. 70: Long Breaker-Bar And Lock Ring
Courtesy of GENERAL MOTORS COMPANY

5. Press the secondary fuel tank module downward, aligning the module to the encapsulated ring.

NOTE: Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

6. Position the cam lock ring (3) to the fuel tank.

NOTE: DO NOT use impact tools. Significant force will be required to install the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.

7. Use the J 45722 fuel sender lock ring wrench (1) and a long breaker-bar (2) to install the fuel tank module lock ring (3), by turning clockwise, until fully seated.

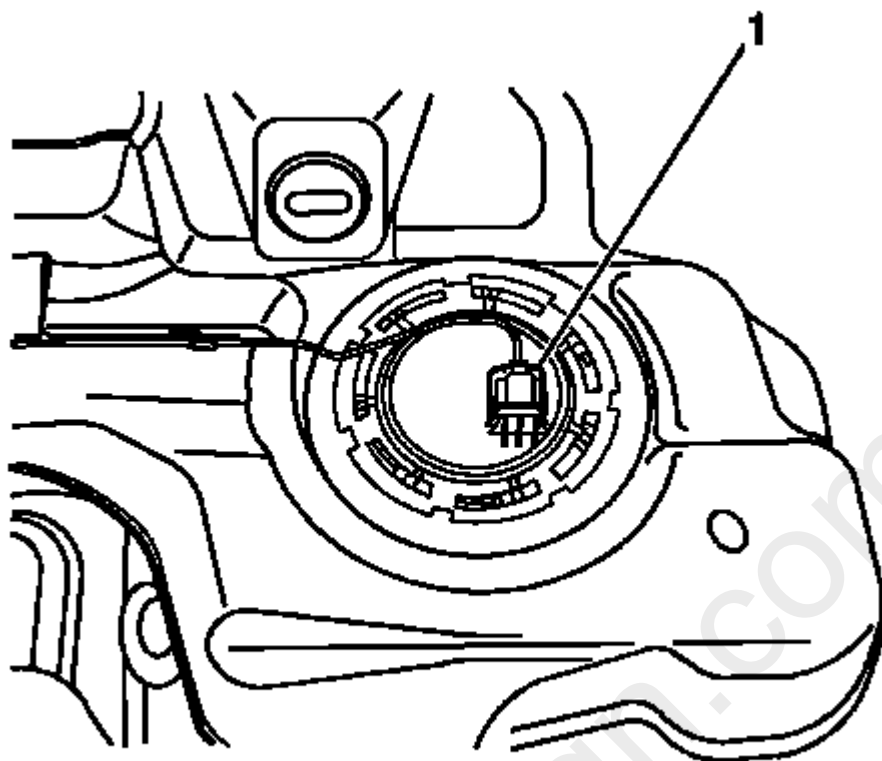


Fig. 71: View Of Electrical Connector Fuel Tank Module
Courtesy of GENERAL MOTORS COMPANY

8. Connect the electrical connector (1) to the secondary fuel tank module and engage the connector interlock.
9. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL LEVEL SENSOR REPLACEMENT - RIGHT SIDE

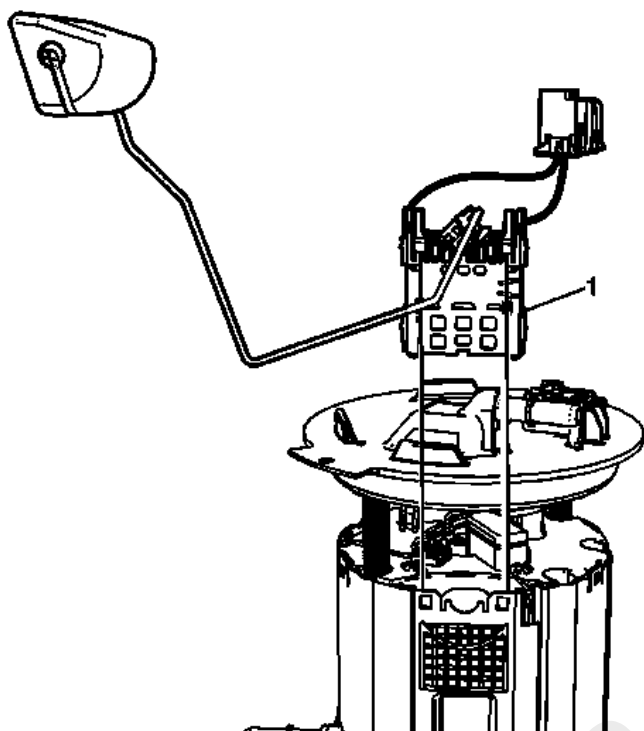


Fig. 72: Fuel Level Sensor - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Fuel Level Sensor Replacement - Right Side

Callout	Component Name
Preliminary Procedure Remove the right fuel tank fuel pump module. Refer to <u>Fuel Tank Fuel Pump Module Replacement - Right Side.</u>	
1	Fuel Level Sensor Procedure 1. Release the retaining tabs. 2. Ensure proper routing of wires. 3. Disconnect the electrical connector.

FUEL FEED REAR PIPE REPLACEMENT

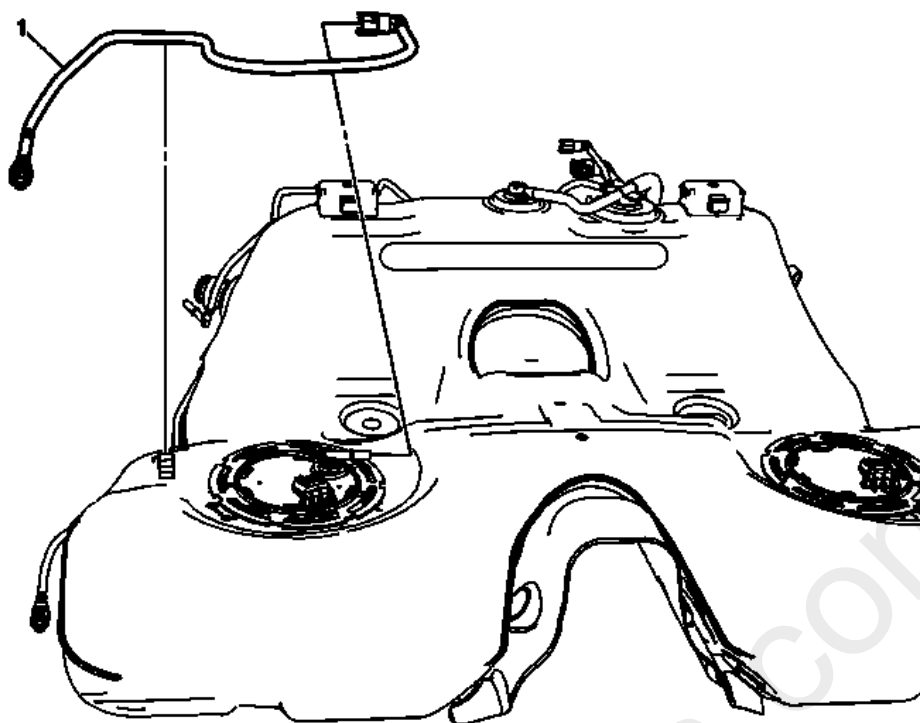


Fig. 73: Fuel Feed Rear Pipe
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Rear Pipe Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the fuel tank. Refer to Fuel Tank Replacement .	
2. Disconnect the quick connect connector. Refer to Plastic Collar Quick Connect Fitting Service .	
1	Fuel Feed Rear Pipe

FUEL LINE REPLACEMENT - CHASSIS (LF1/LLT)

Removal Procedure

The fuel system hose/pipes are serviceable individually or as a complete fuel/brake bundle assembly, the following procedure is servicing the fuel hose/pipes individually.

WARNING: Refer to **Relieving Fuel Pressure Warning** .

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

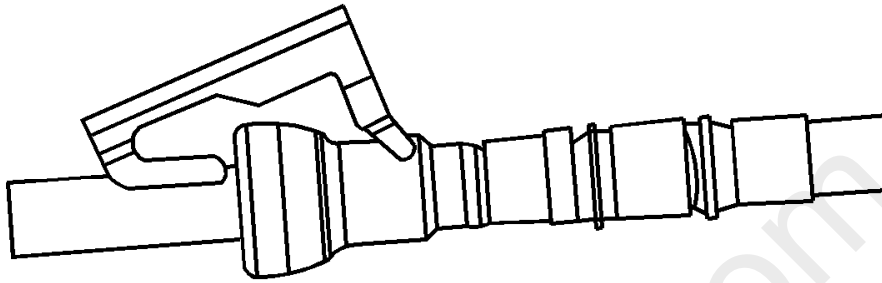


Fig. 74: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel pipe retaining clip from the fuel pipe. Refer to **Metal Collar Quick Connect Fitting Service**.

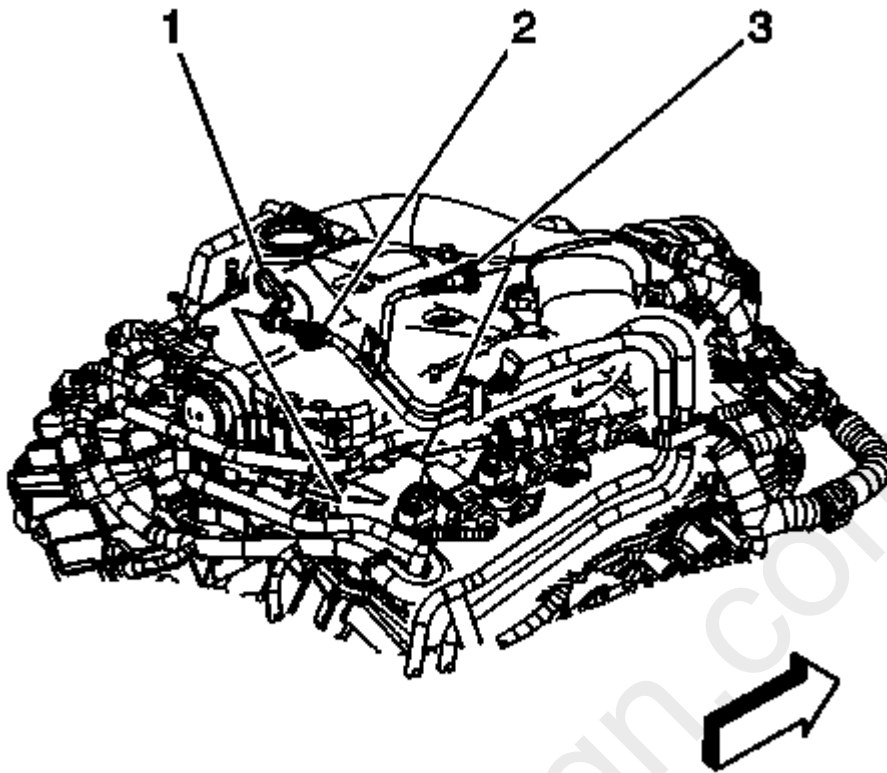


Fig. 75: Top Of Engine View

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the fuel pipe (2) from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
4. Disconnect the evaporative emission (EVAP) purge line (3) from the purge solenoid.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

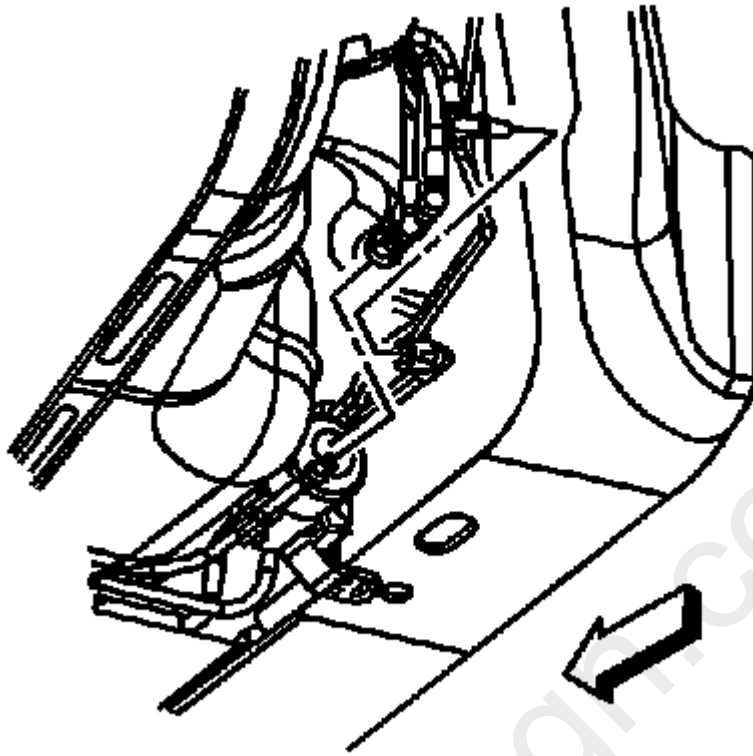


Fig. 76: Identifying Quick-Connect Fitting At The Fuel Filter Inlet
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel pipes from the fuel filter and the fuel tank bundle.

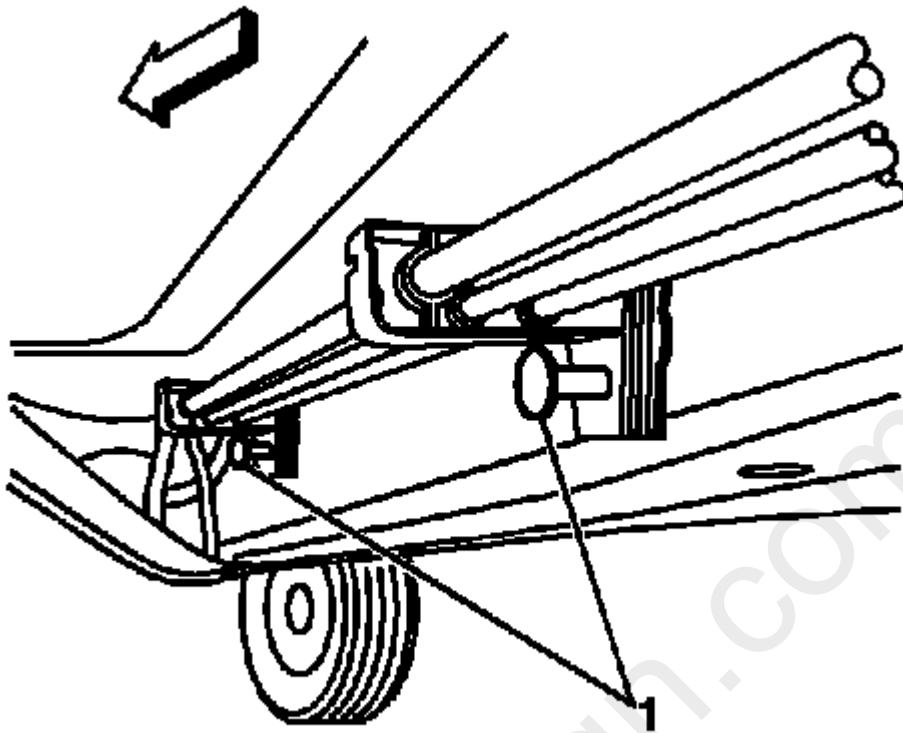


Fig. 77: Locating Fuel/Brake Bundle Chassis Pipe Retainers Locking Mechanisms
Courtesy of GENERAL MOTORS COMPANY

7. Pull the locking mechanism (1) outward in order to disengage the fuel/brake bundle chassis pipe retainers from the rail.

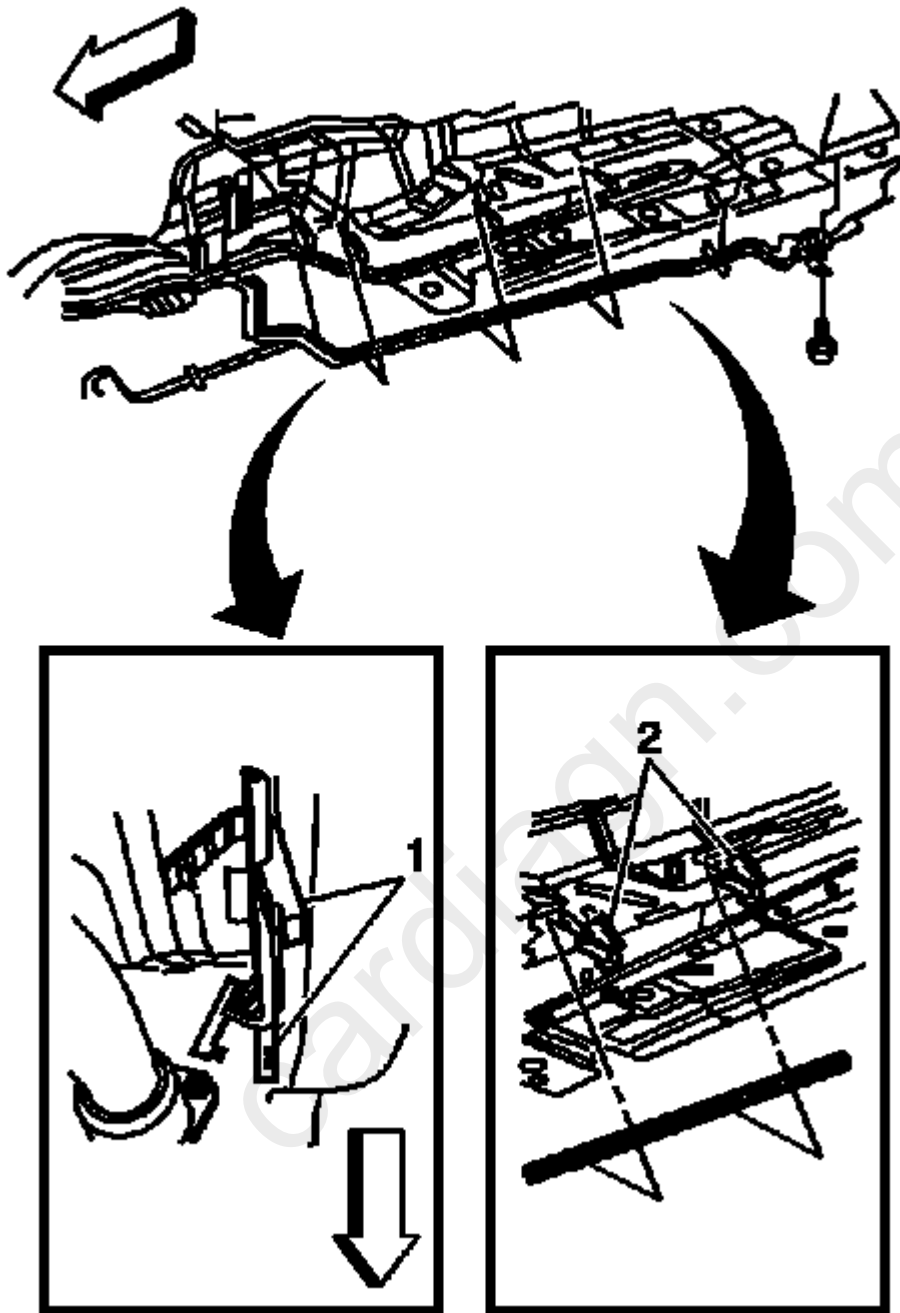


Fig. 78: Locating Fuel/Brake Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Open the retainers (1) located at the forward portion of the rail in order to remove the chassis hose/pipes.
9. Complete the following in order to remove the chassis hose/pipes from the retainers (2) located at the rearward portion of the rail.
 1. Pull the retainers (2) free from the rail.
 2. Open the retainers (2) at the top.

3. Remove the chassis hose/pipes from the retainers (2).

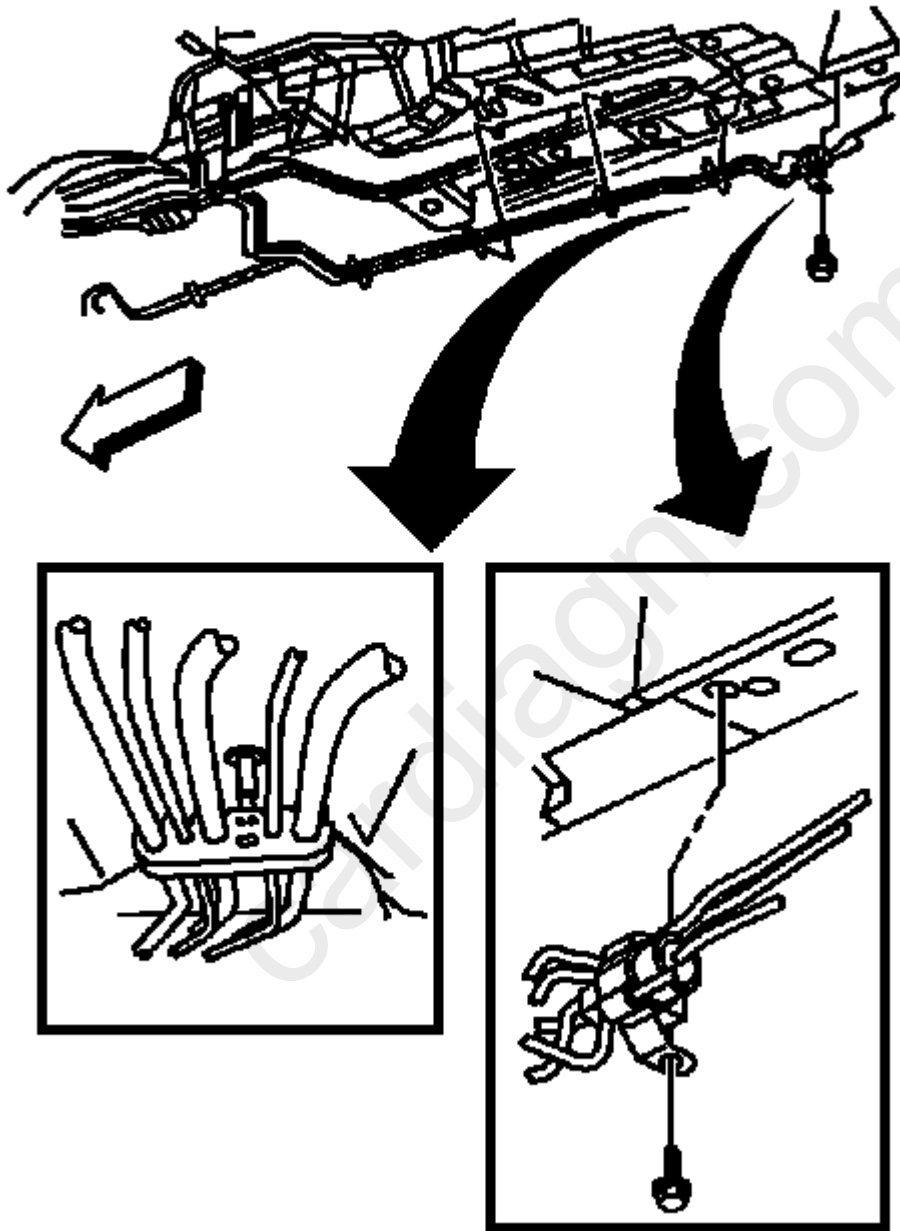


Fig. 79: View Of Fuel Filter Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Pull downward in order to disconnect the fuel/brake bundle chassis pipe retainer from the underbody.
11. Remove the bolt securing the fuel filter bracket to the body.
12. Remove the EVAP hose from the fuel filter bracket.

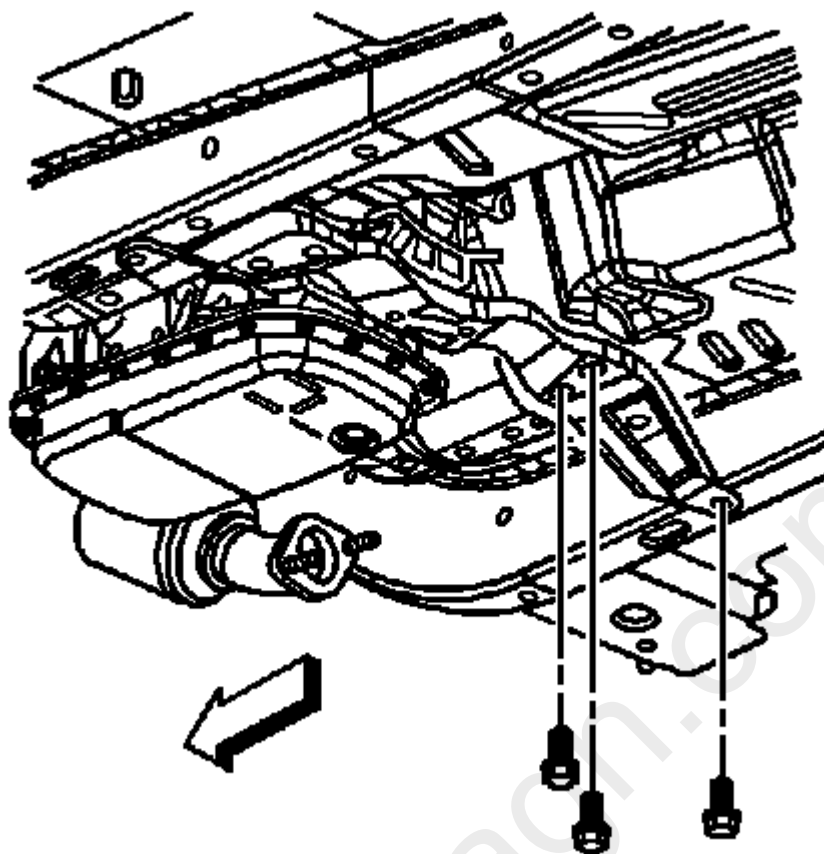


Fig. 80: View Of Transmission Support Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the bolts securing the transmission support to the underbody, from the right side only.

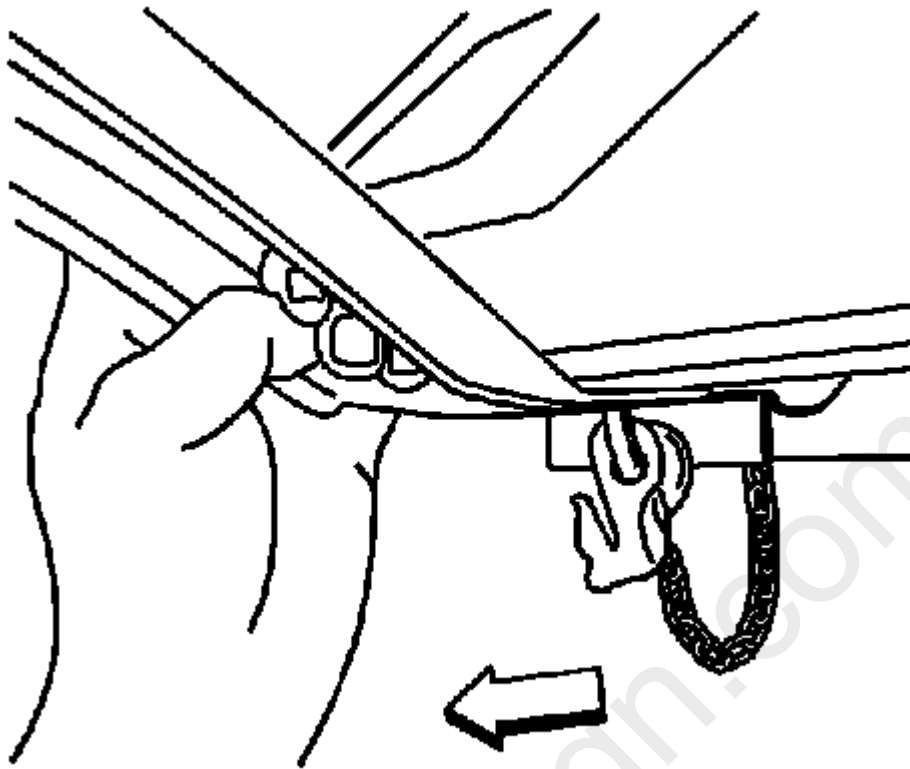


Fig. 81: Pulling Right Side Transmission Support Down
Courtesy of GENERAL MOTORS COMPANY

14. Pull the right side transmission support down only enough to allow removal of the chassis fuel hose/pipes.
15. Partially lower the hoist only enough to simultaneously gain access to both the front and rear portions of the chassis fuel hose/pipes.
16. With the aid of an assistant, carefully guide the chassis fuel hose/pipes down through the engine compartment, removing from the bottom.

Installation Procedure

1. Clean any of the contamination from the male line ends and apply a few drops of clean engine oil.
2. With the aid of an assistant, carefully guide the chassis fuel hose/pipes up through the engine compartment into position.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

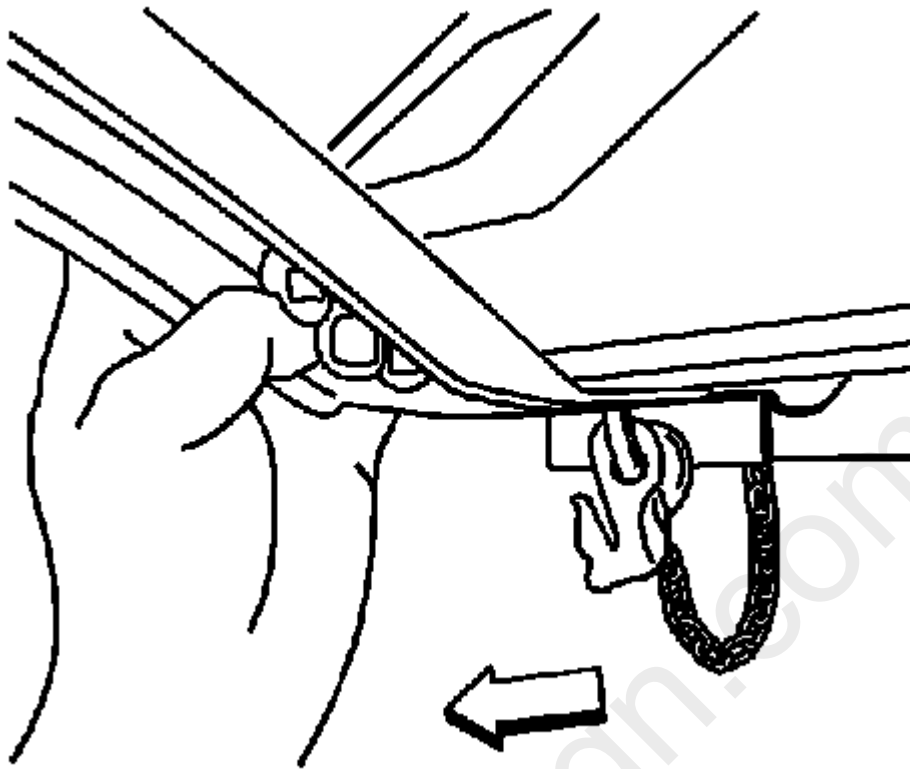


Fig. 82: Pulling Right Side Transmission Support Down
Courtesy of GENERAL MOTORS COMPANY

4. Pull the right side transmission support down only enough to allow installation of the chassis fuel hose/pipes.

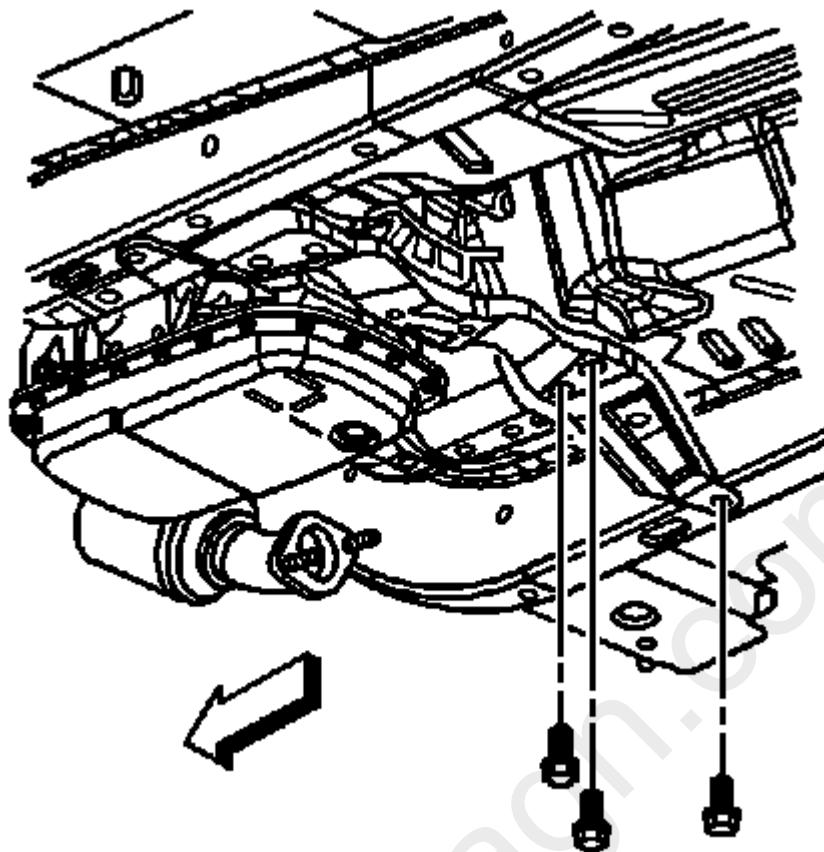


Fig. 83: View Of Transmission Support Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission support right side bolts. Refer to Transmission Support Replacement (Manual CTS-V) , Transmission Support Replacement (Automatic CTS-V) , Transmission Support Replacement (Automatic RWD except CTS-V) , Transmission Support Replacement (Manual except CTS-V) , Transmission Support Replacement (Automatic AWD) .

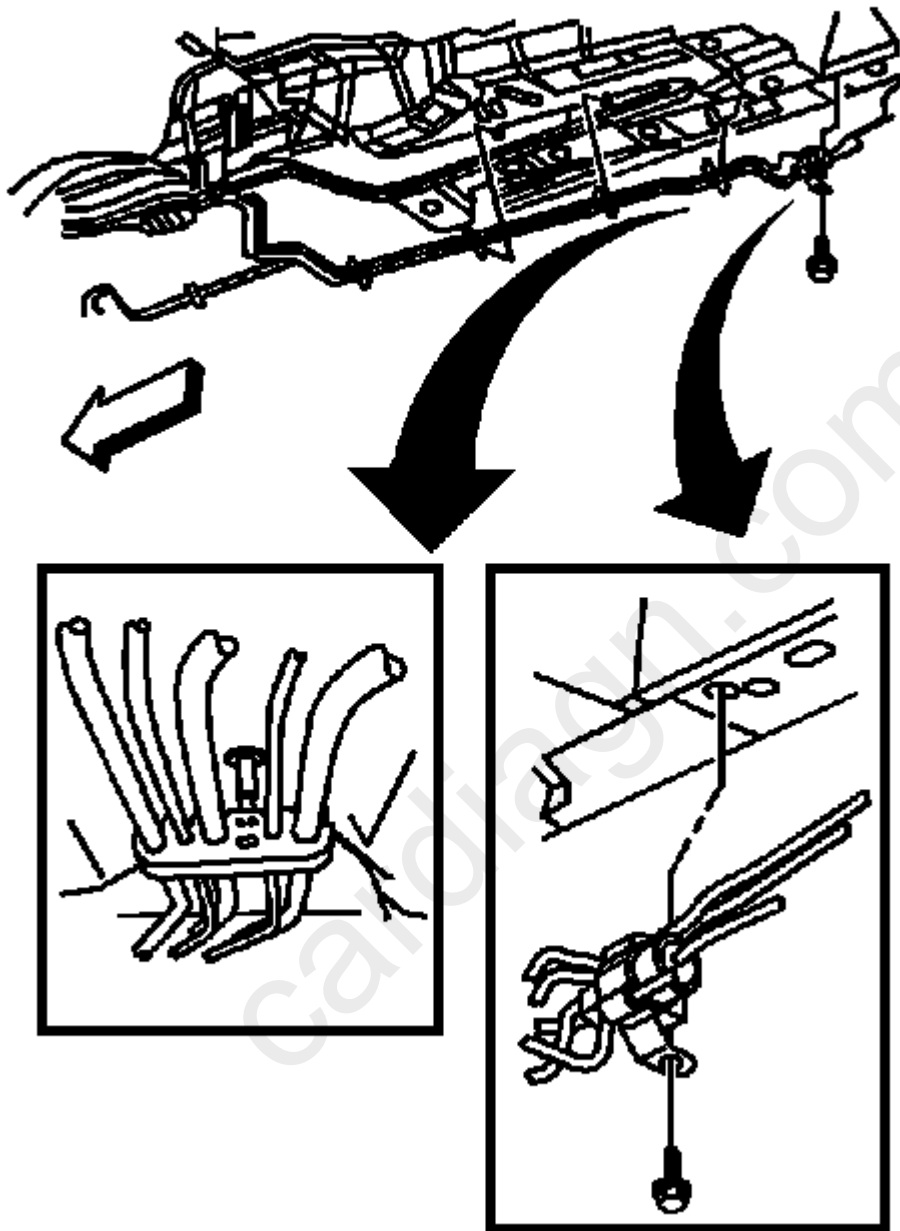


Fig. 84: View Of Fuel Filter Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install the EVAP hose to the fuel filter bracket:

CAUTION: Refer to Fastener Caution .

7. Install the fuel filter bracket bolt and tighten to 9 N.m (80 lb in).
8. Install the fuel/brake bundle to the underbody.

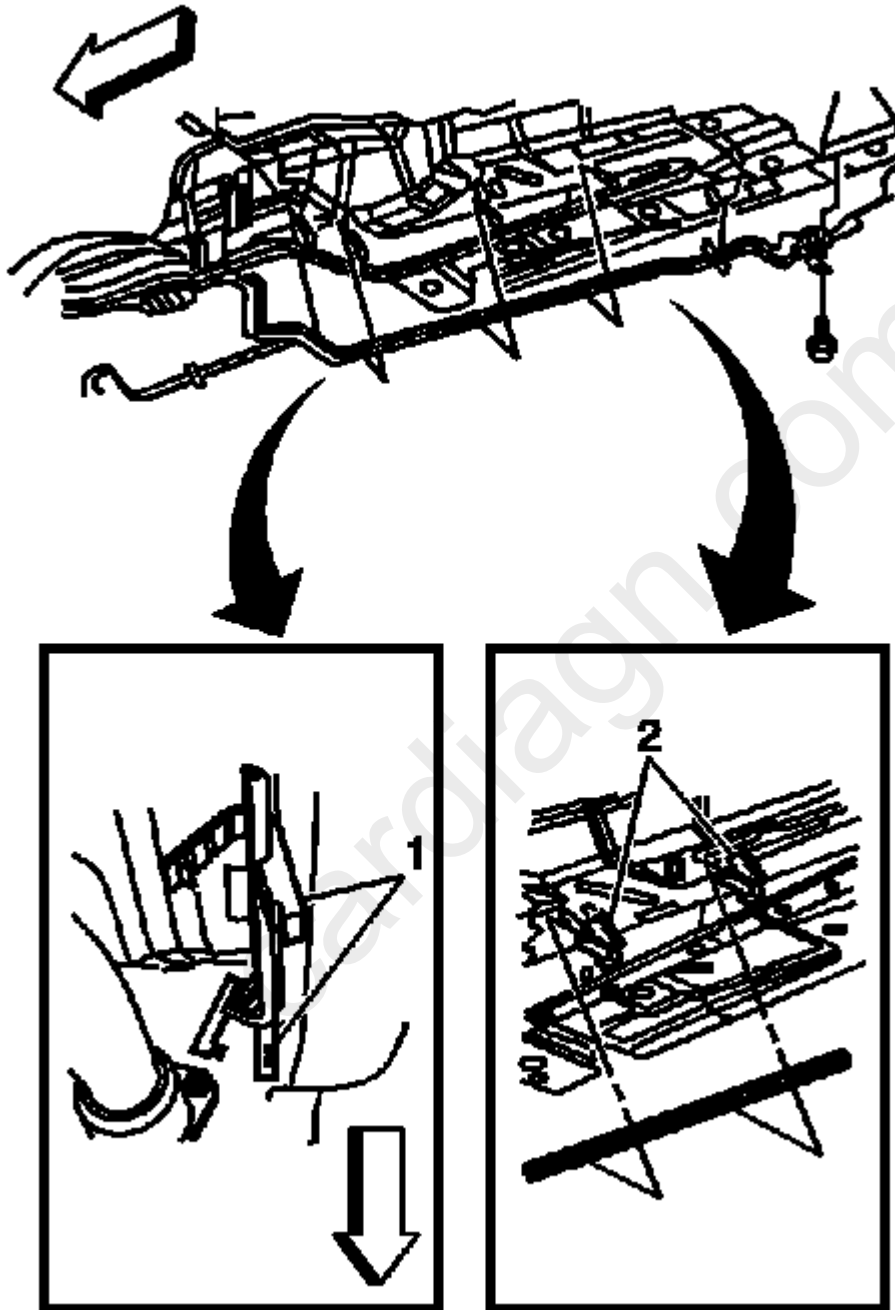


Fig. 85: Locating Fuel/Brake Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

9. Complete the following in order to install the chassis hose/pipes to the retainers (2) located at the rearward portion of the rail:

1. Install the chassis hose/pipes into the retainers (2).
 2. Close the retainers (2) at the top.
 3. Insert the retainers (2) into the rail.
10. Install the chassis hose/pipes into the retainers (1) located at the forward portion of the rail.
 11. Close the retainers.

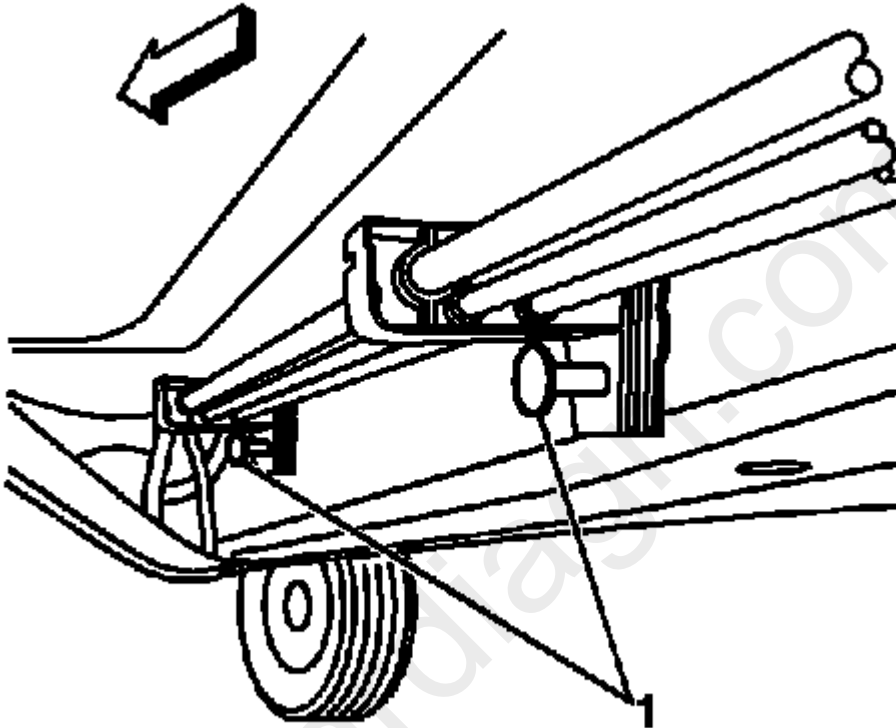


Fig. 86: Locating Fuel/Brake Bundle Chassis Pipe Retainers Locking Mechanisms
Courtesy of GENERAL MOTORS COMPANY

12. Push the locking mechanism (1) inward in order to engage the fuel/brake bundle chassis pipe retainers to the rail.

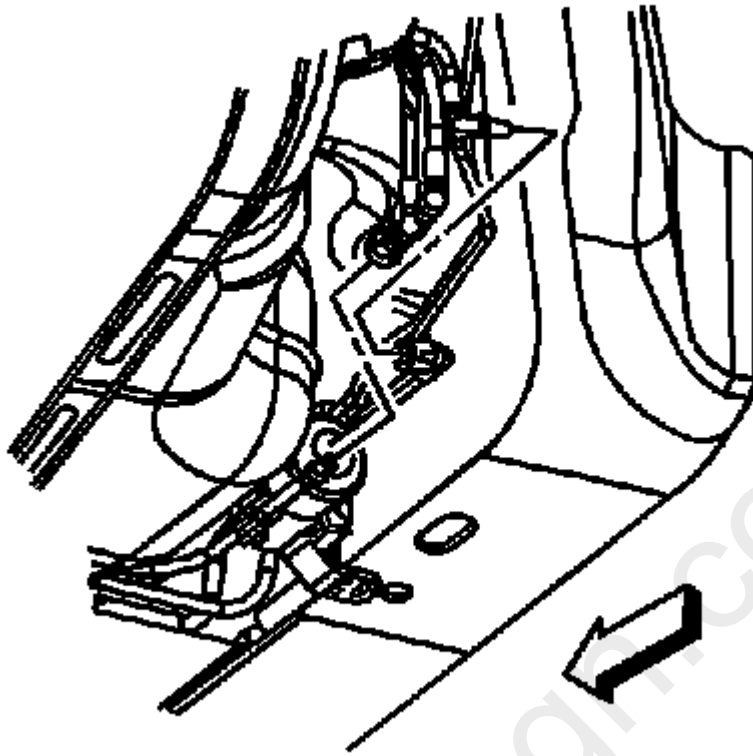


Fig. 87: Identifying Quick-Connect Fitting At The Fuel Filter Inlet
Courtesy of GENERAL MOTORS COMPANY

13. Connect the fuel feed pipe and the EVAP hose to the fuel bundle.
14. Lower the vehicle.

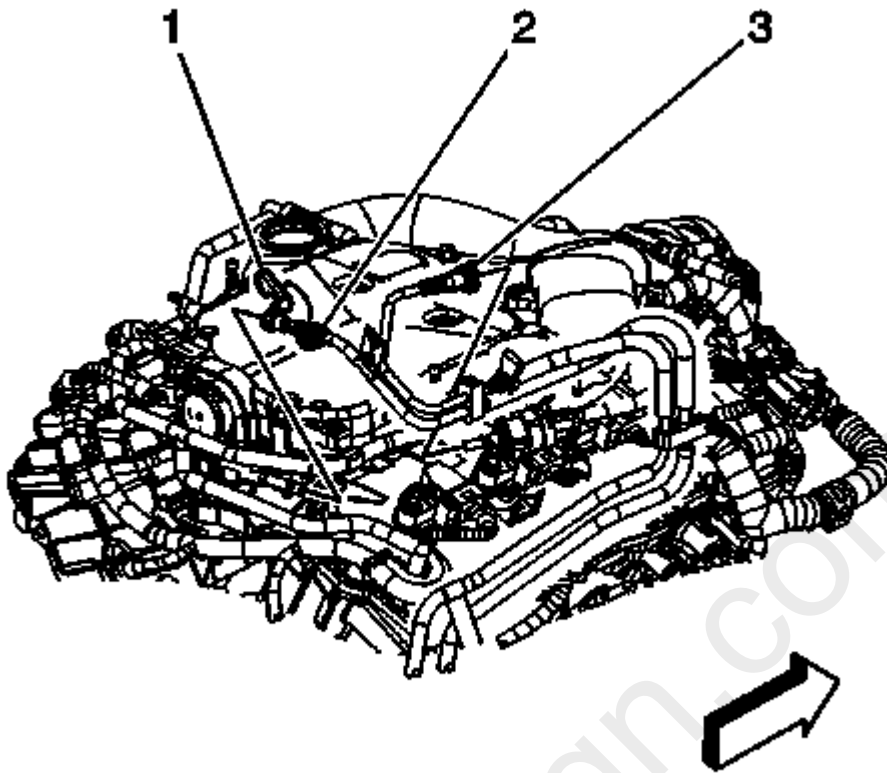


Fig. 88: Top Of Engine View

Courtesy of GENERAL MOTORS COMPANY

15. Connect the evaporative emission (EVAP) purge line (3) to the purge solenoid.
16. Connect the fuel feed pipe (1) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service.**

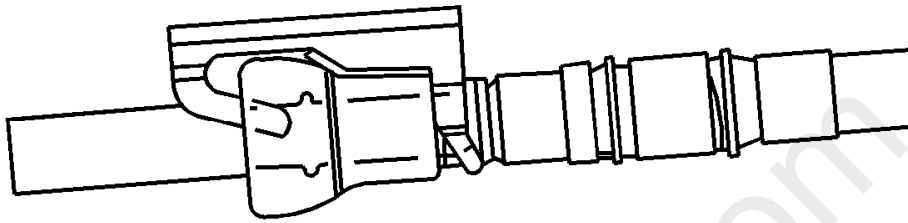


Fig. 89: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS COMPANY

17. Install the fuel pipe retaining clip.

FUEL FEED PIPE REPLACEMENT

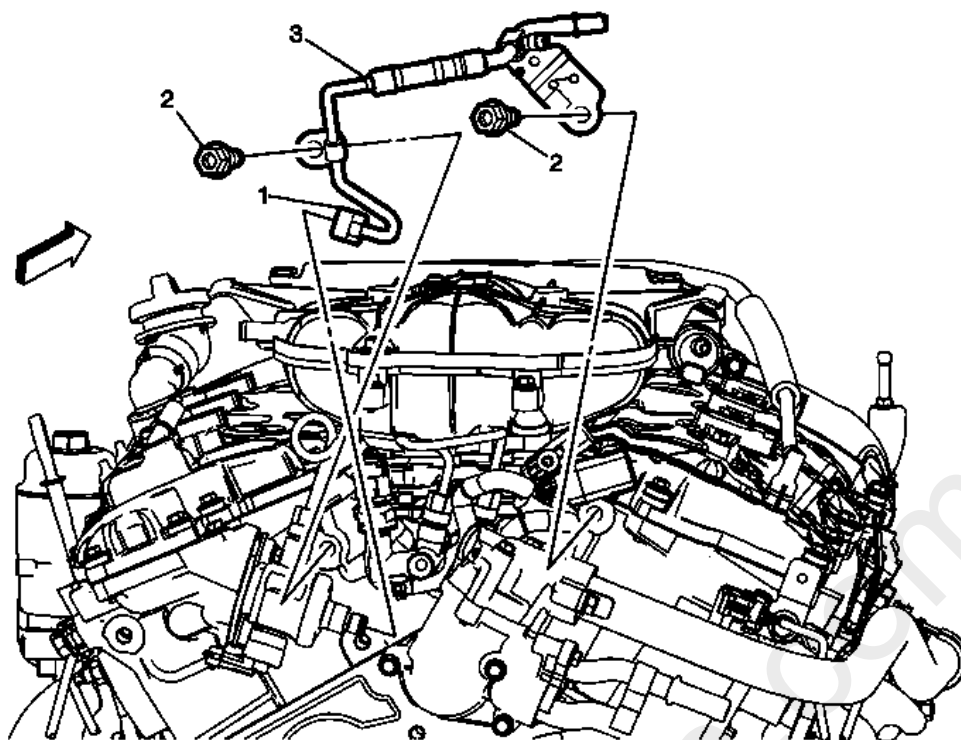


Fig. 90: Fuel Feed Pipe, Fitting & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Pipe Replacement

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement</u>. 4. Disconnect the fuel line. Refer to <u>Metal Collar Quick Connect Fitting Service</u>.	
1	Fuel Feed Pipe Fitting (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 28 N.m (20 lb ft)
2	Fuel Feed Pipe Bolt (Qty: 2) Tighten 50 N.m (36 lb ft)
	Fuel Feed Pipe

3	Procedure 1. DISCARD the old fuel feed pipe, 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 SYSTEM CLEANING

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. You can usually determine the extent of the fuel system contamination during the disassembly.

1. Remove the right fuel tank pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Right Side.
2. Remove the left fuel level sensor assembly. Refer to Fuel Level Sensor Replacement - Left Side
3. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
4. Perform the following procedures:
 - Inspect the fuel tank pump module strainer. Replace the primary fuel tank module if the strainer is contaminated.
 - Inspect the left fuel level sensor assembly for debris. Clean the left fuel level sensor assembly if debris is found.

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

- Use compressed air in order to apply air pressure to the transfer tube.

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

5. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to ensure that the removal of the water from the tank is complete.
6. Refer to Metal Collar Quick Connect Fitting Service in order to disconnect the following quick connect fittings from the fuel rail:
 - The feed hose/pipe
 - The return hose/pipe

7. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.
8. Remove the fuel injectors and fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
9. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

Assemble the fuel system as follows:

1. Install the fuel injectors and fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
2. Install the right fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Right Side**.
3. Install the left fuel level sensor assembly. Refer to **Fuel Level Sensor Replacement - Left Side**.
4. Refer to **Metal Collar Quick Connect Fitting Service** in order to connect the following quick connect fittings to the fuel rail:
 - The feed hose/pipe
 - The return hose/pipe

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL

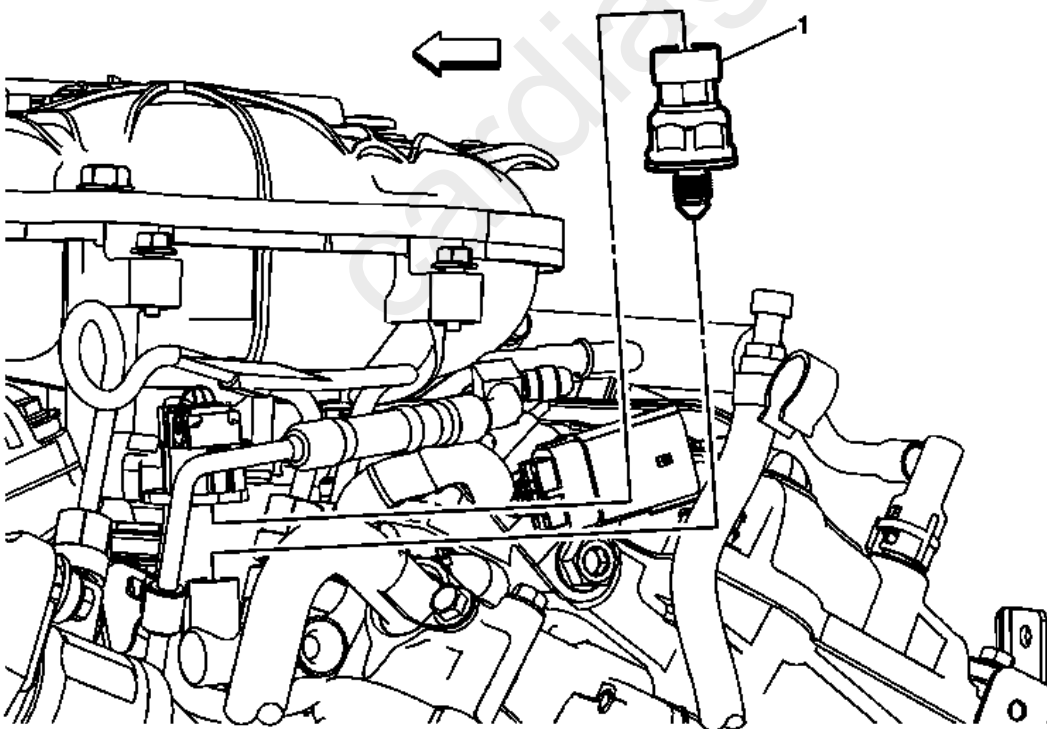


Fig. 91: Fuel Injection Fuel Rail Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail

Callout	Component Name
Preliminary Procedures Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement</u>.	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the fuel injection fuel rail fuel pressure sensor electrical connector. Tighten 33 N.m (25 lb ft)

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1

Special Tools

EN-49248 Injector Rail Assembly Remover

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

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
5. Remove the foam insulator from the fuel rails.

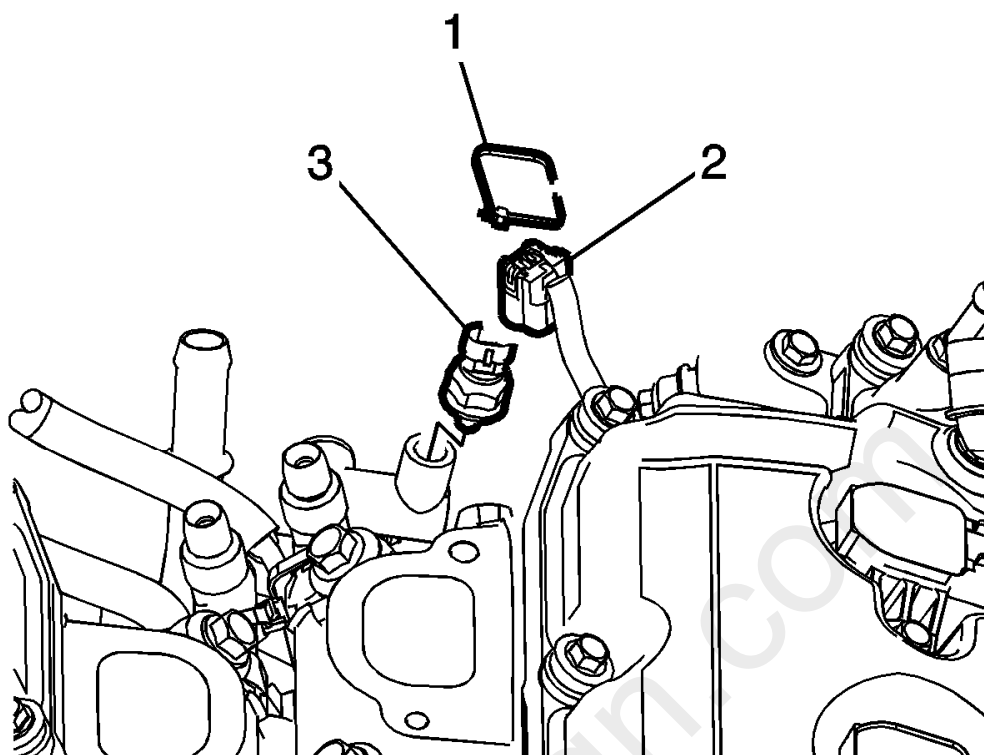


Fig. 92: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Cut the plastic tie strap (1)
7. Disconnect the fuel pressure sensor electrical connector (2).
8. Remove the fuel pressure sensor (3).

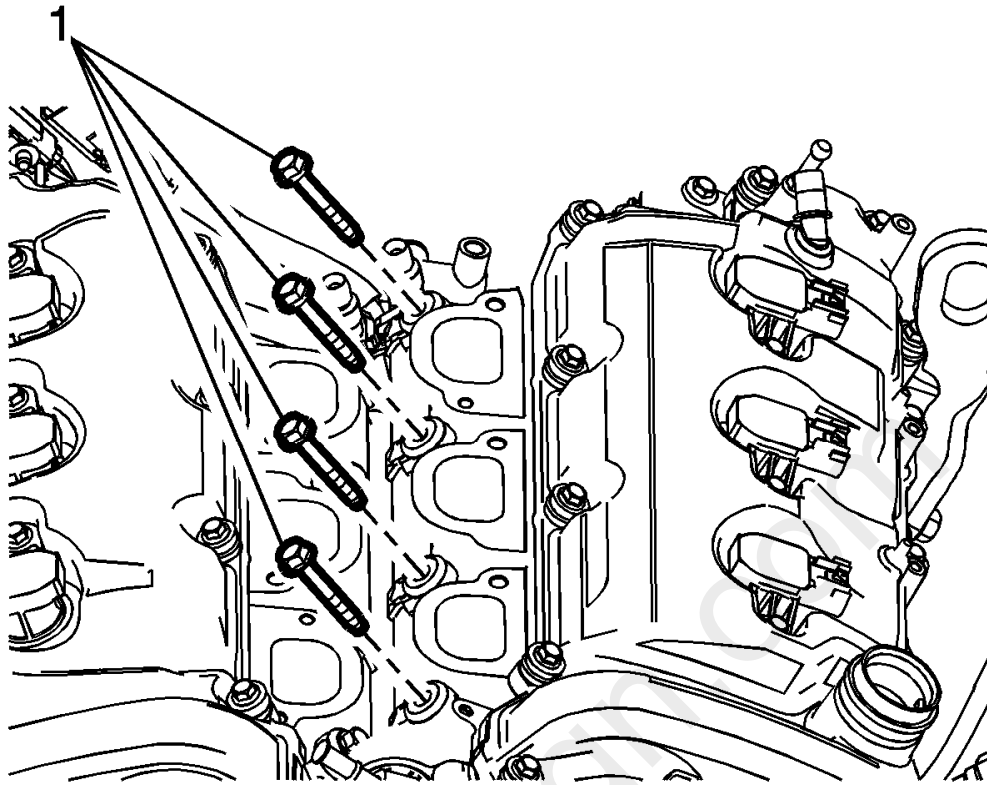


Fig. 93: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Remove the bank 2 fuel rail fasteners (1).

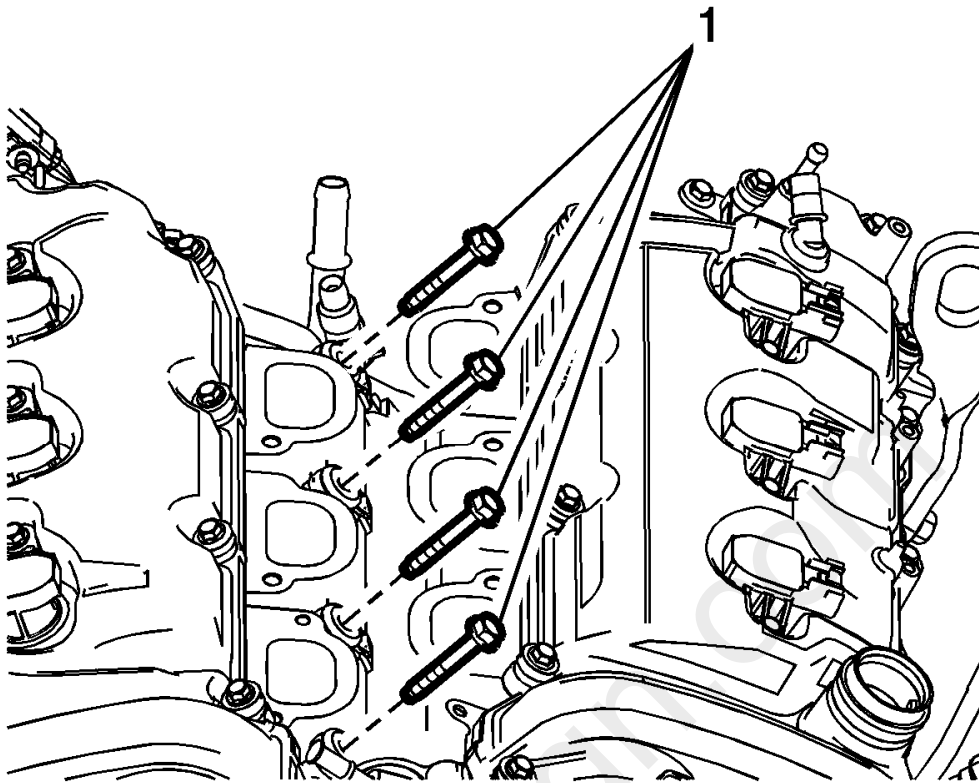


Fig. 94: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bank 1 fuel rail fasteners (1) for clearance purposes.

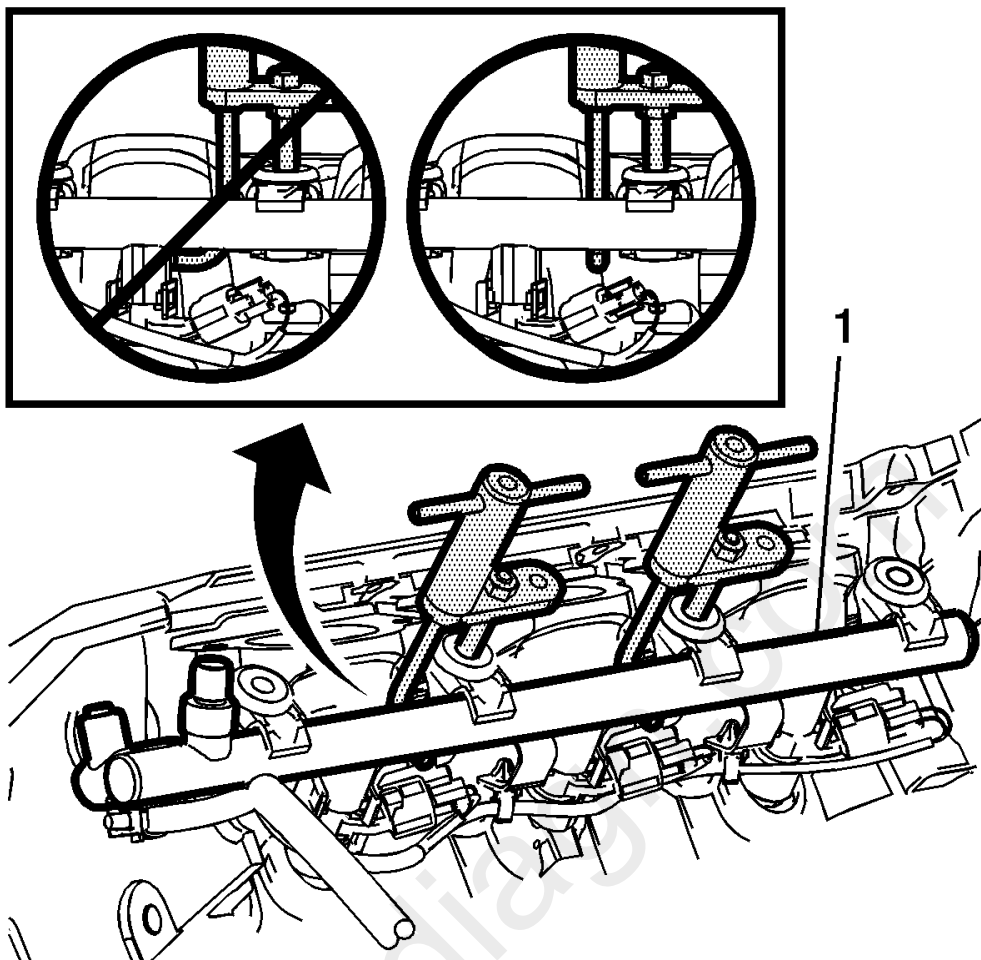


Fig. 95: Raising The Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS COMPANY

11. Using the **EN-49248-4** hook , raise the fuel rail (1) as an assembly.
12. Once the fuel rail is free, remove the **EN-49248** special tool.

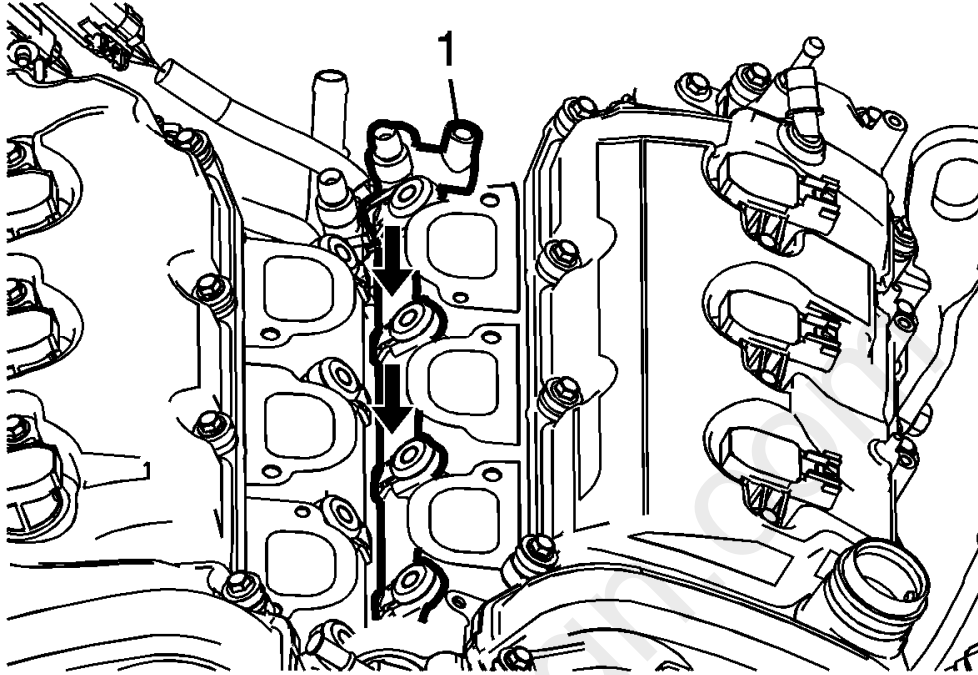


Fig. 96: Sliding The Fuel Rail Toward The Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

13. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4 mm), in order to clear the center injector bore.
14. Disconnect the bank 2 fuel injector and fuel pressure sensor electrical connections.

NOTE: **The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.**

15. Once the fuel rail is removed, clean and inspect the fuel injectors. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LFW or LFX)** .

Installation Procedure

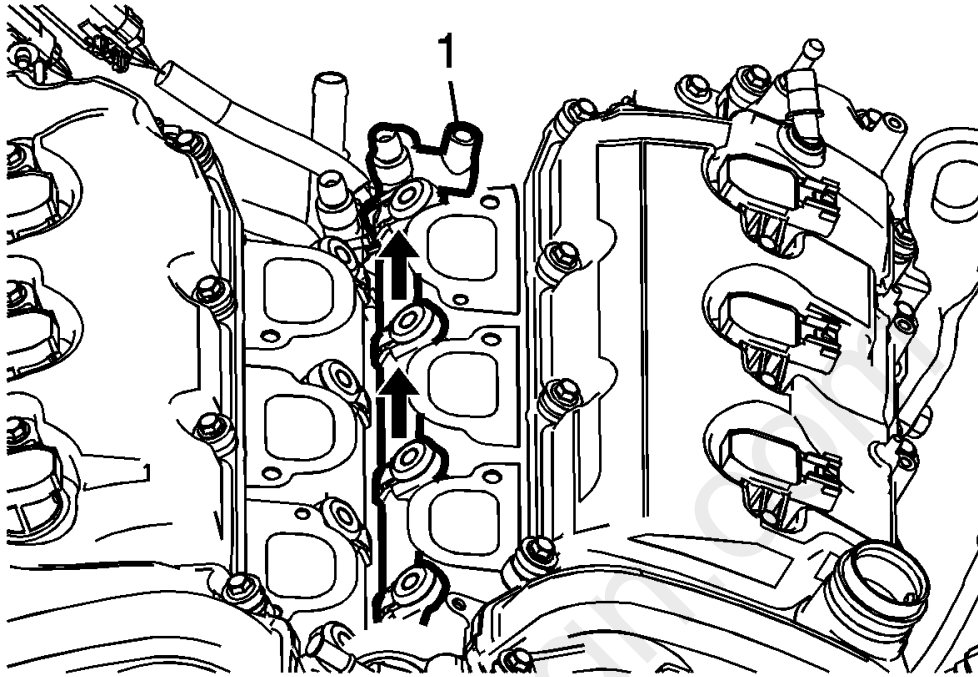


Fig. 97: Sliding The Fuel Rail Toward The Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4 mm), in order to align the center injector bore.

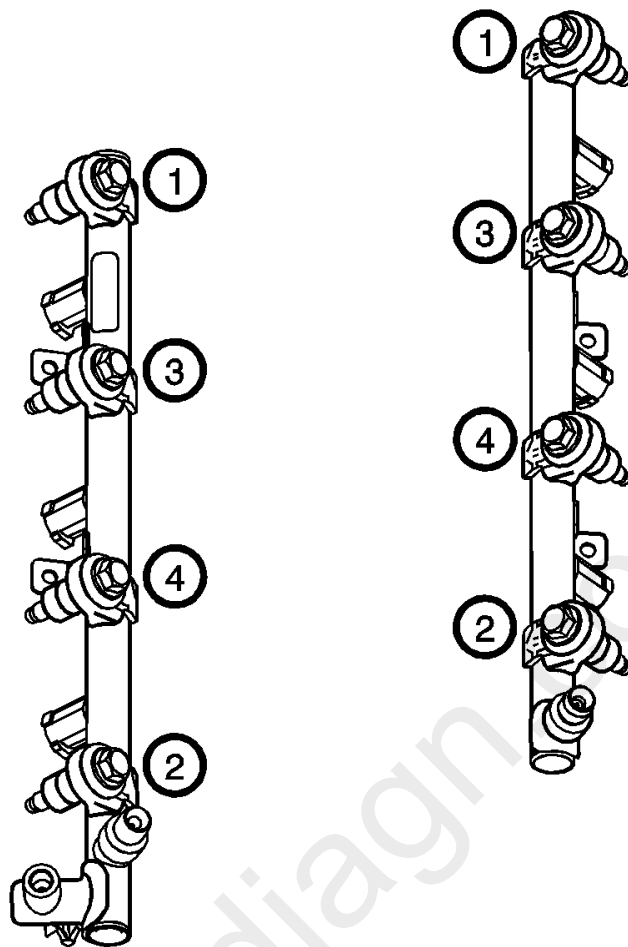


Fig. 98: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. First pass 12 N.m (106 lb in).
 2. Final pass 23 N.m (17 lb ft).

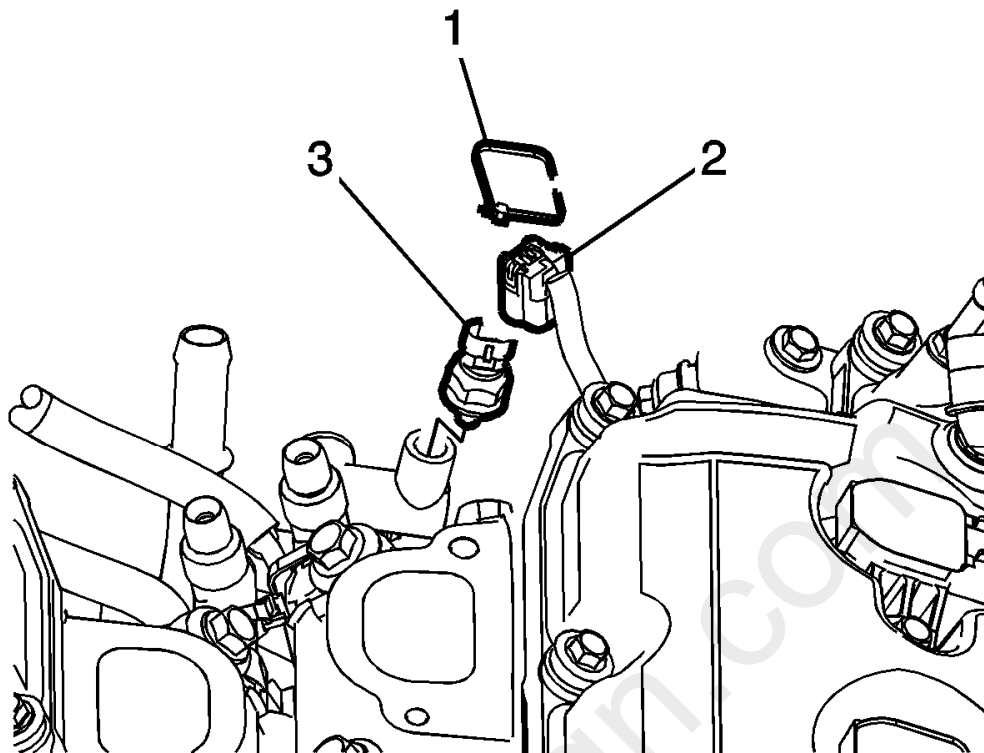


Fig. 99: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the fuel pressure sensor (3) to 33 (25 lb ft)
6. Connect the fuel pressure sensor electrical connector (2) and secure it with a new plastic zip tie.
7. Connect the bank 1 fuel injector electrical connections.
8. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
9. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.
10. Install the foam insulator to the fuel rails.
11. Install the intake manifold. Refer to **Intake Manifold Replacement**.
12. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
13. Install the low side fuel pressure service port cap.

14. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2

Special Tools

EN-49248 Injector Rail Assembly Remover

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

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
5. Remove the foam insulator from the fuel rails.

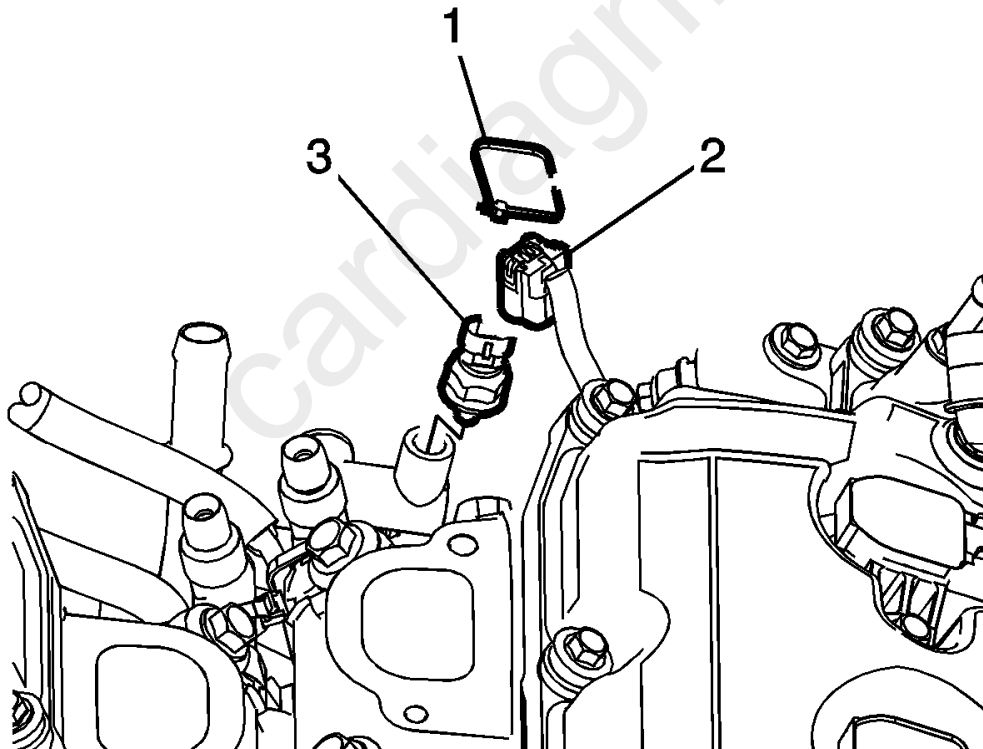


Fig. 100: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Cut the plastic tie strap (1).
7. Disconnect the fuel pressure sensor electrical connector (2).
8. Remove the fuel pressure sensor (3).

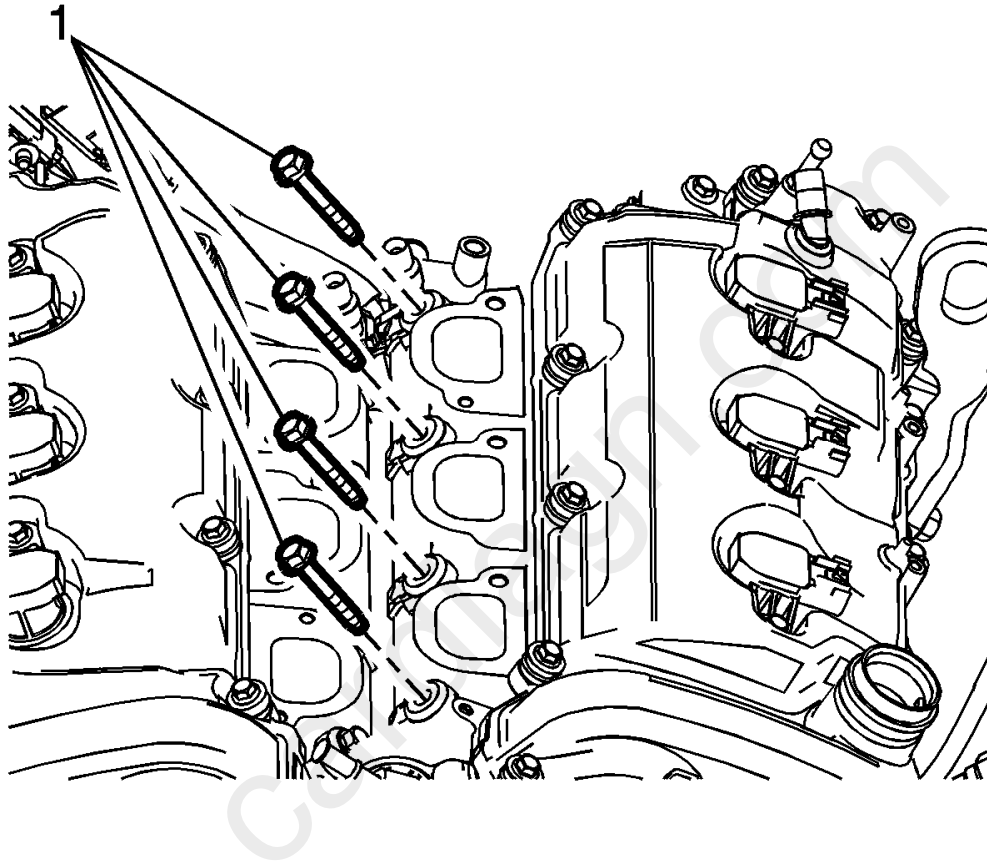


Fig. 101: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Remove the bank 2 fuel rail fasteners (1).

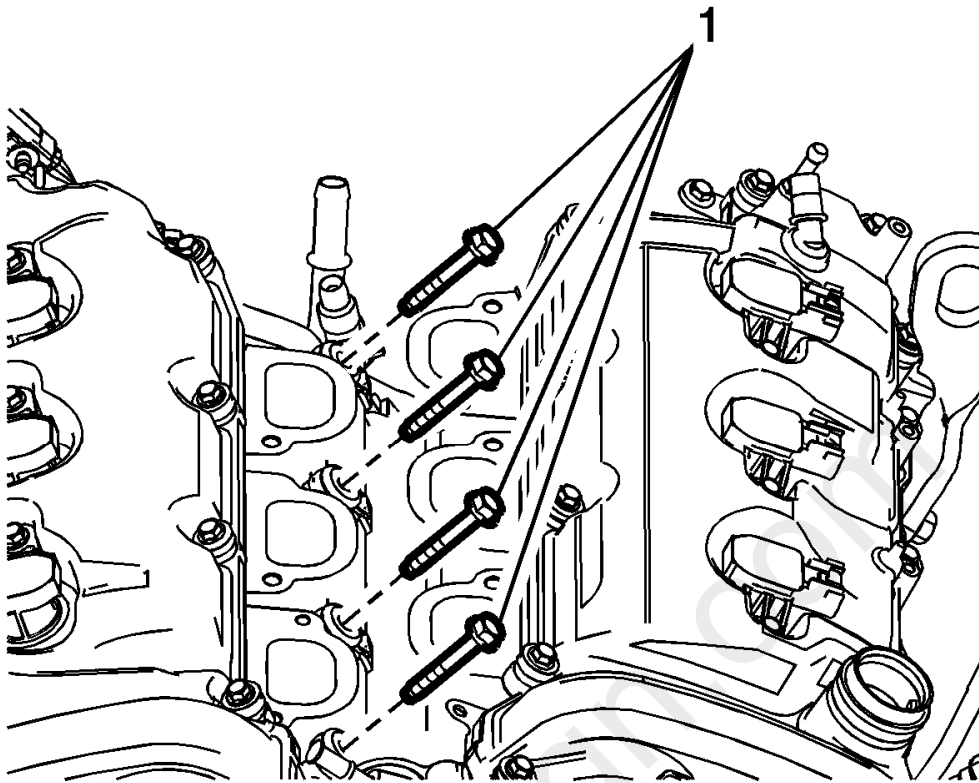


Fig. 102: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bank 1 fuel rail fasteners (1) for clearance purposes.

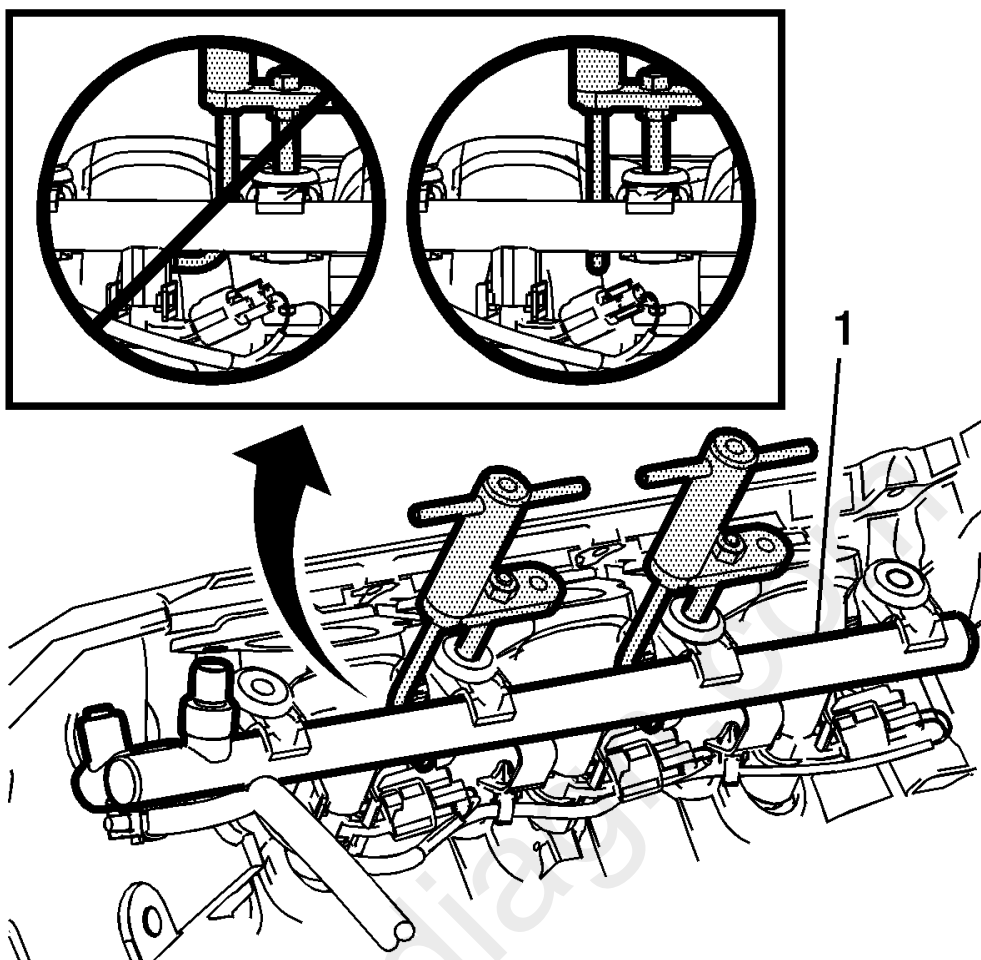


Fig. 103: Raising The Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS COMPANY

11. Using the **EN-49248-4** hook , raise the fuel rail (1) as an assembly.
12. Once the fuel rail is free, remove the **EN-49248** special tool.

NOTE: Do not remove the pipe from the engine, just move it enough to gain necessary clearance for the fuel rail.

13. Remove the fasteners from both ends of the engine coolant inlet pipe. Refer to **Engine Coolant Inlet Pipe Replacement** .

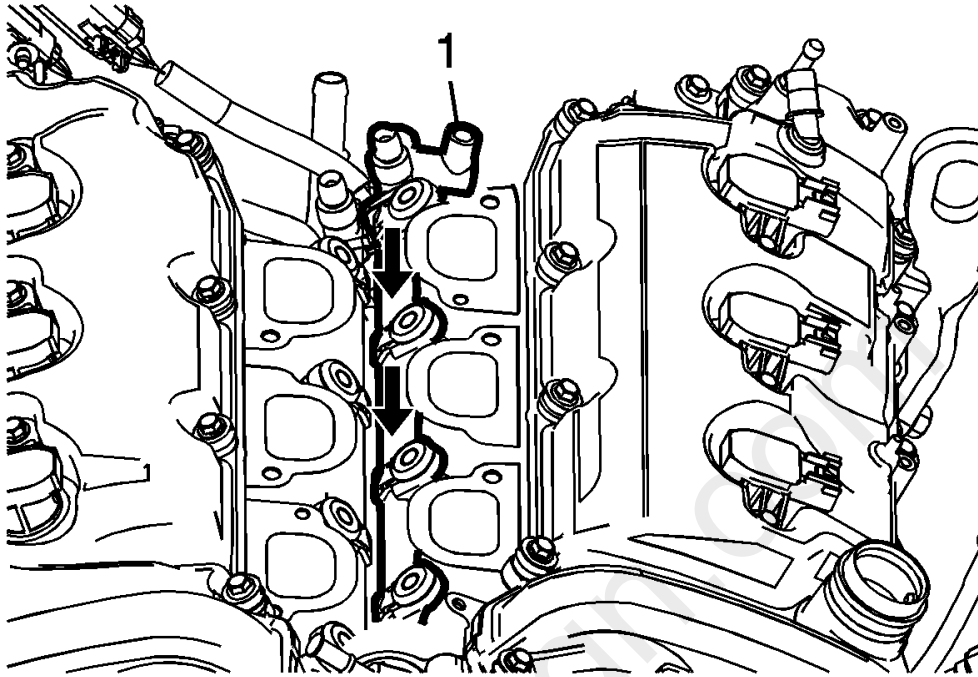


Fig. 104: Sliding The Fuel Rail Toward The Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

14. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4 mm), in order to clear the center injector bore.
15. Disconnect the bank 2 fuel injector and fuel pressure sensor electrical connections.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

16. Once the fuel rail is removed, remove the injectors to clean and inspect. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LFW or LFX)**.

Installation Procedure

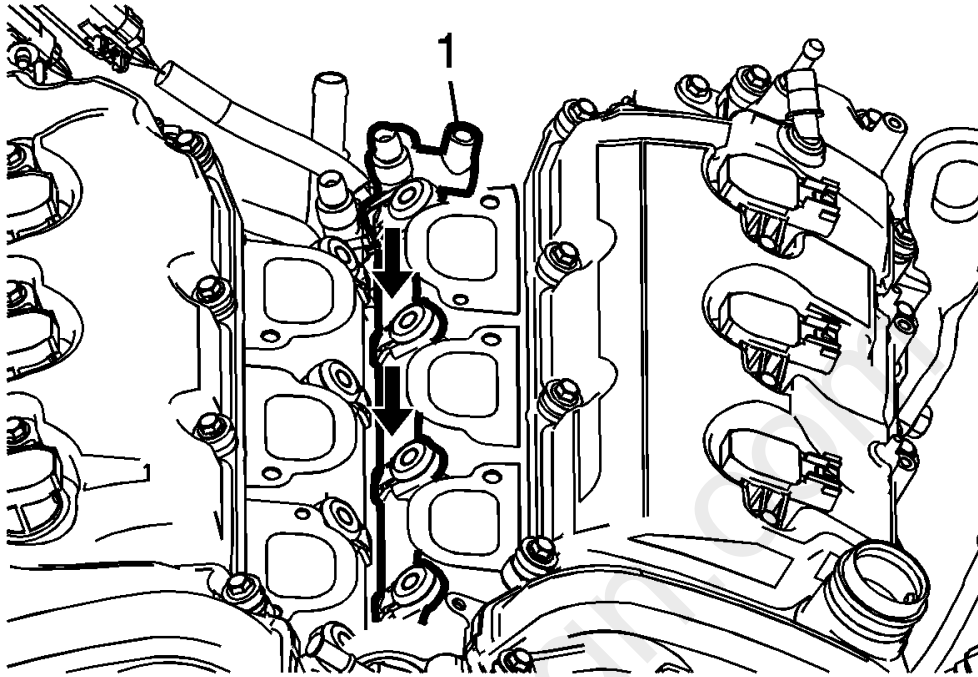


Fig. 105: Sliding The Fuel Rail Toward The Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4 mm), in order to align the center injector bore.
2. Install the fasteners to both ends of the engine coolant inlet pipe. Refer to **Engine Coolant Inlet Pipe Replacement** .

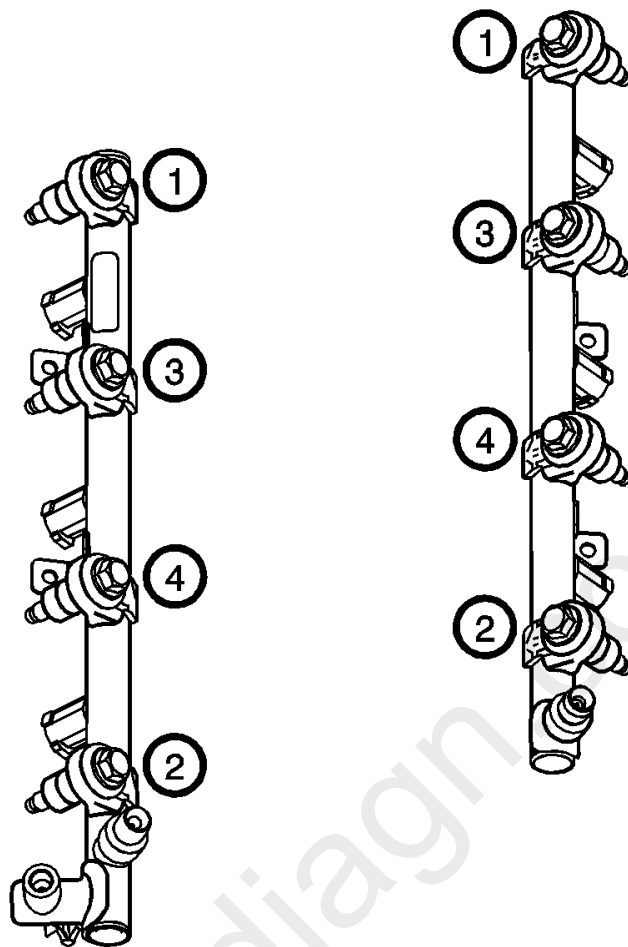


Fig. 106: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Hand tighten the two outer fuel rail fasteners to seat the injectors.
4. Start and hand tighten the remaining fuel rail fasteners.
5. Tighten the fuel rail fasteners in the sequence shown above:
 1. First pass 12 N.m (106 lb in).
 2. Final pass 23 N.m (17 lb ft).

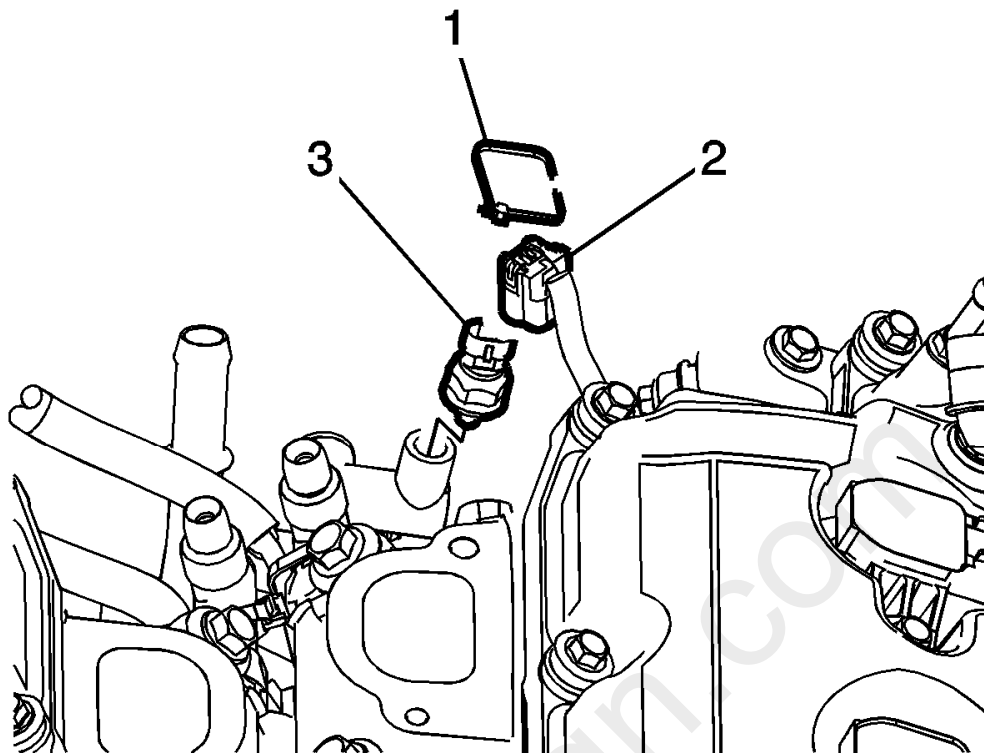


Fig. 107: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the fuel pressure sensor (3) to 33 (25 lb ft).
7. Connect the fuel pressure sensor electrical connector (2) and secure it with a new plastic zip tie.
8. Connect the bank 1 fuel injector electrical connections
9. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
10. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.
11. Install the foam insulator to the fuel rails.
12. Install the intake manifold. Refer to **Intake Manifold Replacement** .
13. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
14. Install the low side fuel pressure service port cap.

15. Install the fuel tank cap.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

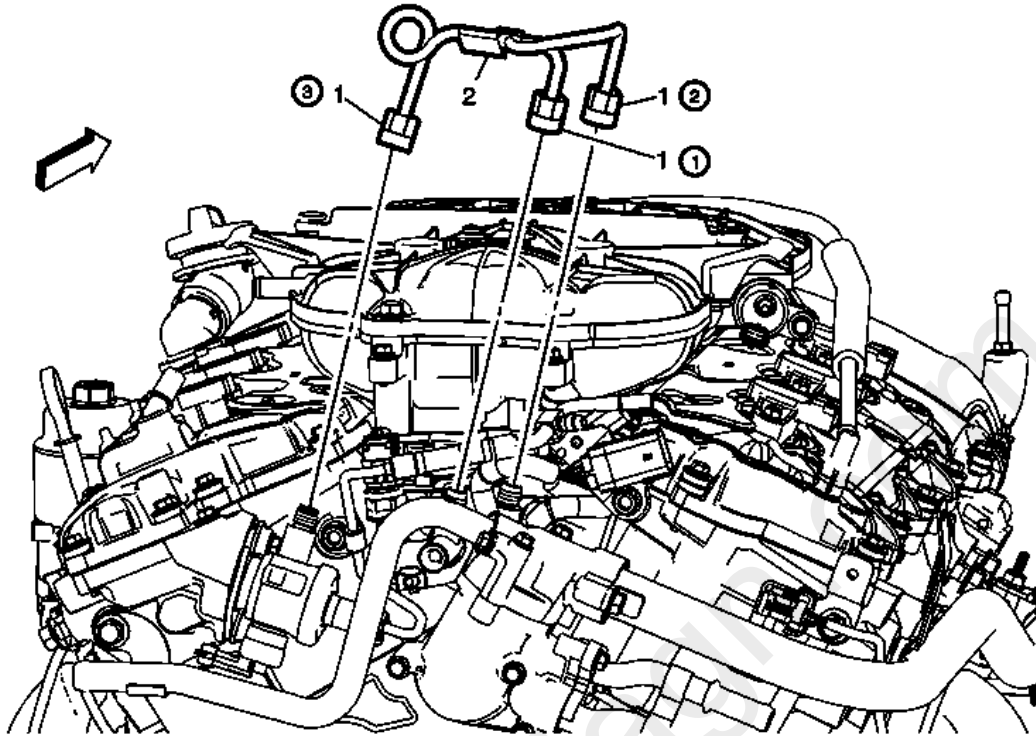


Fig. 108: Fuel Feed Intermediate Pipe & Fittings
Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Intermediate Pipe Replacement

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement</u>.	
1	Fuel Feed Intermediate Pipe Fitting (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u>. Tighten • Tighten the fittings in sequence as numbered: 1, 2, 3 • First Pass 16 N.m (12 lb ft) • Second Pass 32 N.m (24 lb ft)

Fuel Feed Intermediate Pipe

Procedure

2

1. Discard the pipe when removed and install a NEW pipe.
2. Lubricate the pipes with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Pressure up the fuel system and check for leaks.

FUEL PIPE SHIELD REPLACEMENT

Removal Procedure

1. Remove the cross vehicle brace. Refer to **Cross Vehicle Brace Replacement** .
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**
3. Remove the intake manifold insulator.
4. Remove the wiper motor and wiper transmission module. Refer to **Windshield Wiper Motor Replacement** .

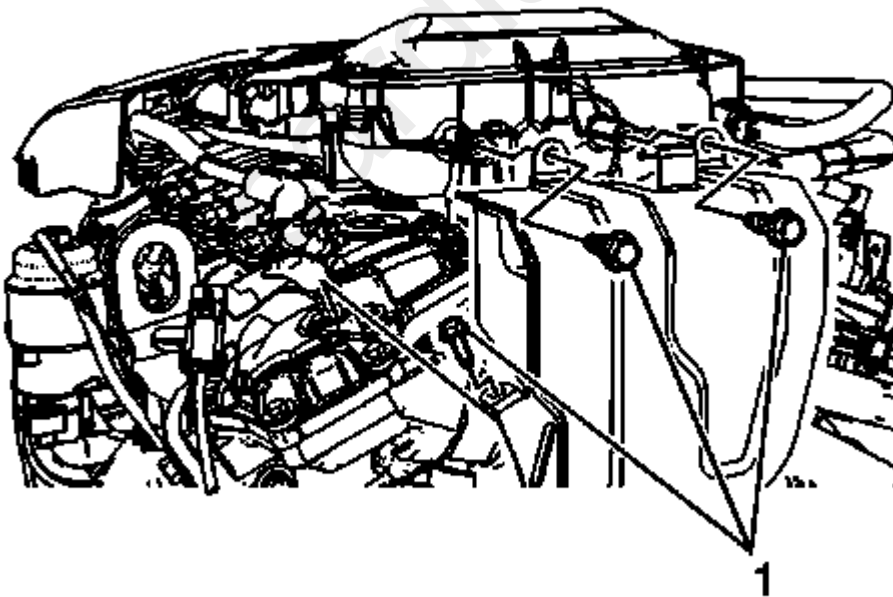


Fig. 109: Removing/Installing Intake Manifold & Cylinder Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel pipe shield to intake manifold bolts (1).
6. Remove the fuel pipe shield to cylinder bolt (1).
7. Carefully remove the fuel pipe shield from the vehicle. Take care not to damage the insulation behind the shield.

Installation Procedure

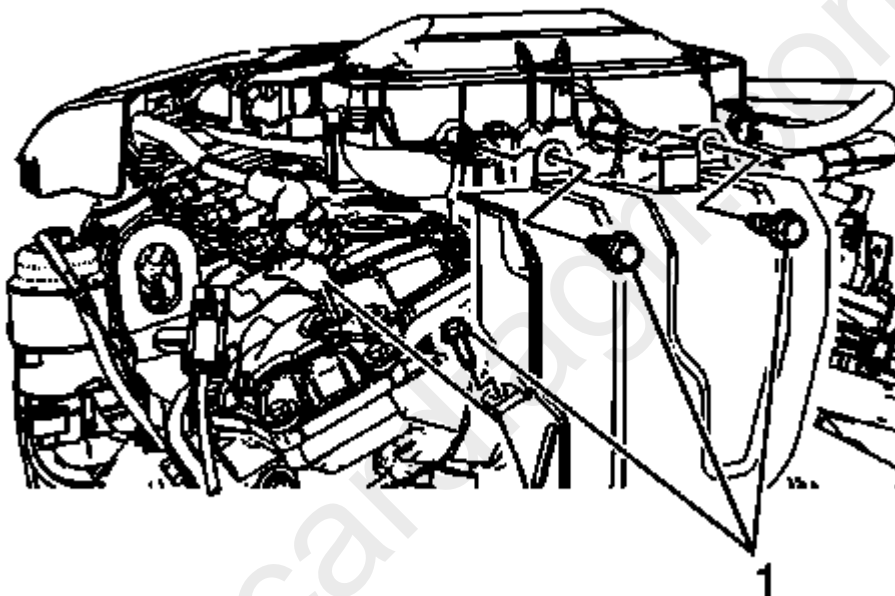


Fig. 110: Removing/Installing Intake Manifold & Cylinder Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the fuel pipe shield behind the high pressure fuel pump. Take care not to damage the insulation behind the shield.
2. Install the fuel pipe shield to cylinder bolt (1). Hand tighten at this time.

CAUTION: Refer to Fastener Caution .

3. Install the fuel pipe shield to intake manifold bolts (1).

1. Tighten the fuel pipe shield to manifold bolts to 23 N.m (17 lb ft).
2. Tighten the fuel pipe shield to head bolt to 10 N.m (89 lb in).
4. Install the wiper motor and wiper transmission module. Refer to **Windshield Wiper Motor Replacement** .
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**
6. Install the cross vehicle brace. Refer to **Cross Vehicle Brace Replacement** .

FUEL PUMP REPLACEMENT

Special Tools

EN-48896 High Pressure Fuel Pump Installation Alignment Gauge

Removal Procedure

1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LFW or LFX)** , **Cooling System Draining and Filling (GE 47716 LFW or LFX)** .
2. Remove both fuel rails. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
4. Remove the radiator surge tank outlet pipe fastener from the cylinder head.
5. Remove the radiator surge tank outlet pipe fastener from the thermostat housing.
6. Swing the radiator surge tank outlet pipe to one side.

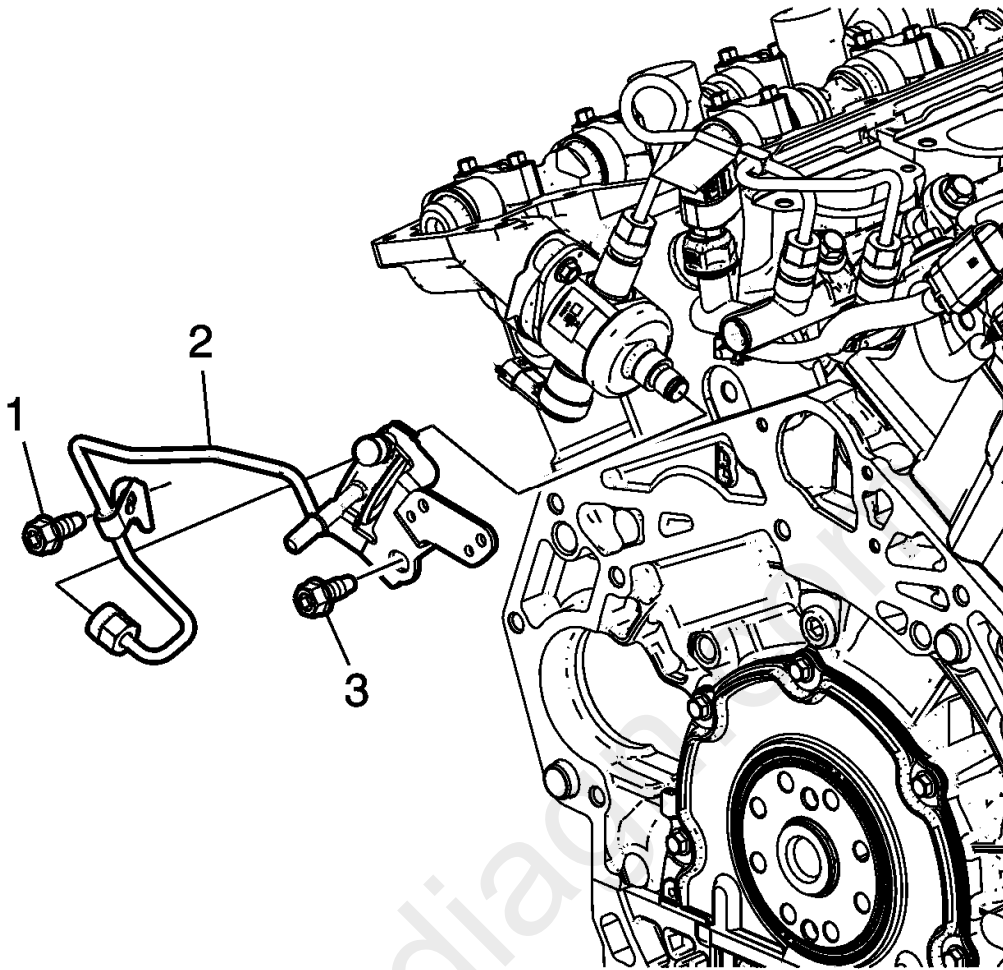


Fig. 111: View Of Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel feed pipe is a one time use pipe and must be replaced every time it is removed.

7. Remove the fuel feed pipe (2). Discard the pipe. Refer to **Fuel Feed Pipe Replacement**.

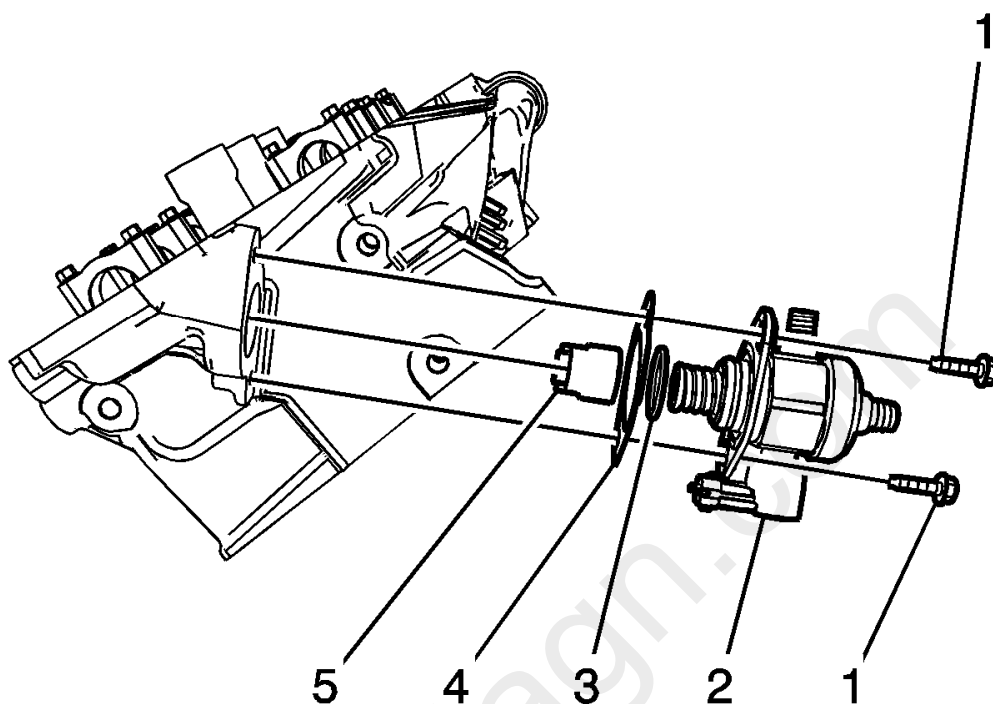


Fig. 112: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

8. Remove and discard the high pressure fuel pump bolts (1).
9. Remove the high pressure fuel pump (2).
10. Remove and discard the high pressure fuel pump O-ring (3).
11. Remove and discard the high pressure fuel pump gasket (4).
12. Remove the high pressure fuel pump roller lifter (5).

Installation Procedure

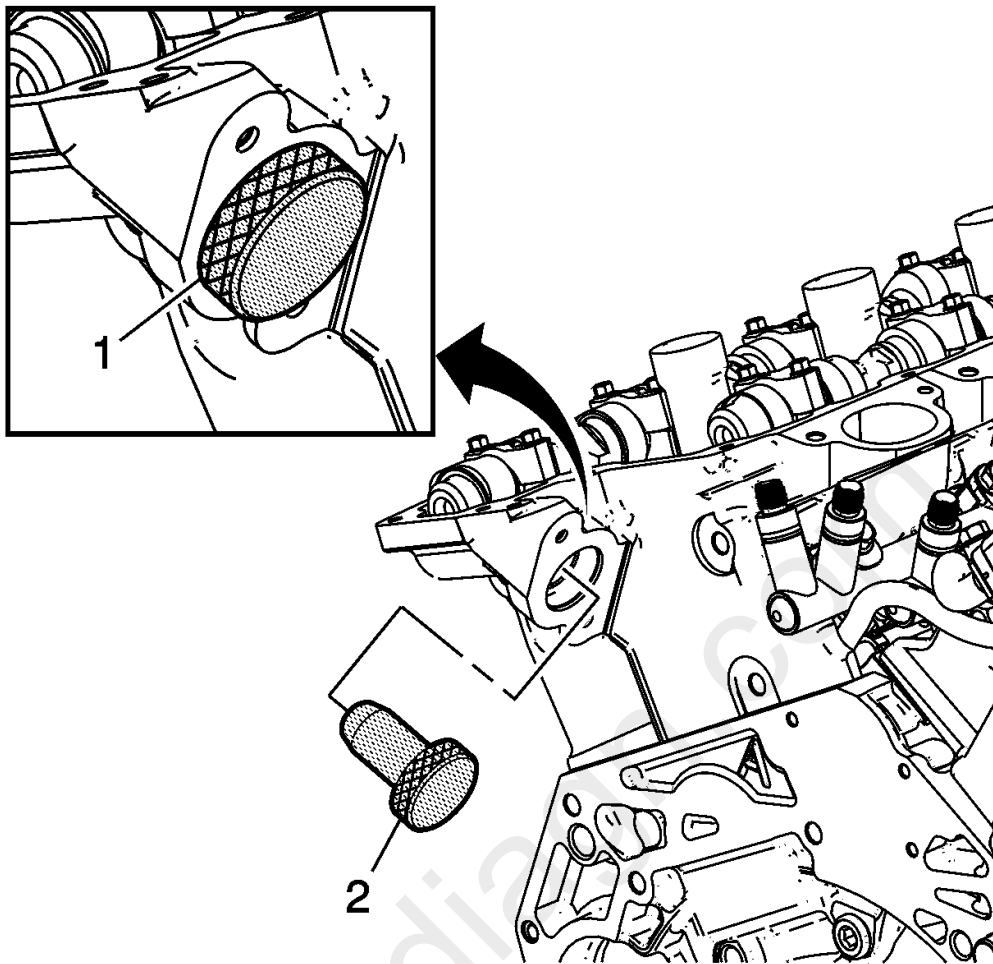


Fig. 113: View Of Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

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

1. Use the **EN-48896** high pressure fuel pump installation alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head (1).

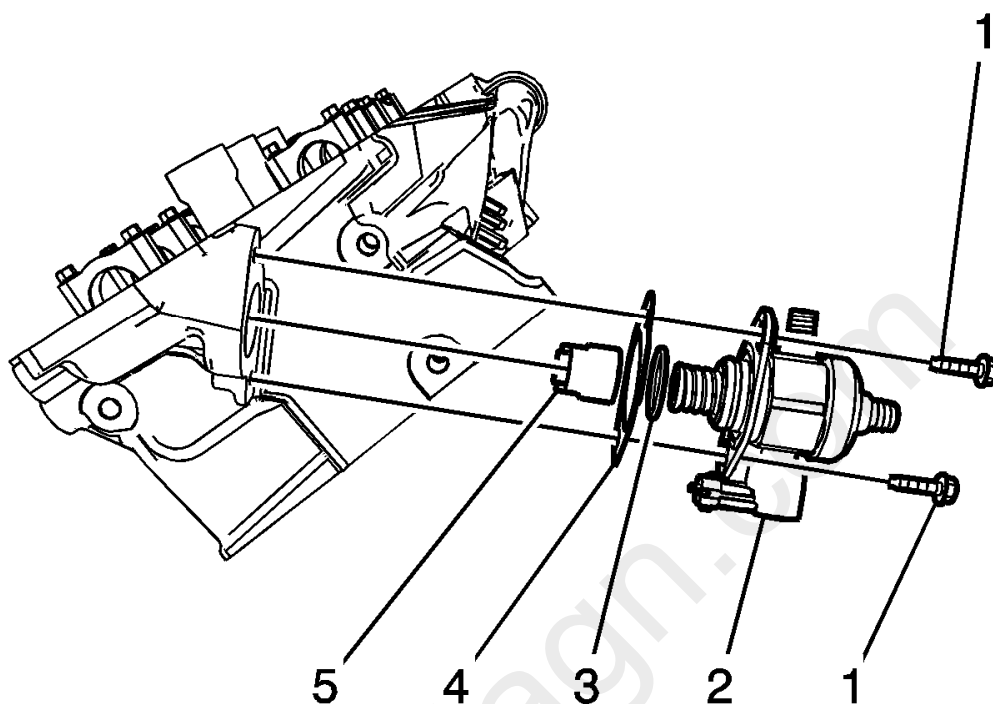


Fig. 114: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

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**

3. Install the high pressure fuel pump roller lifter (5).
4. Install a NEW high pressure fuel pump O-ring (3).

NOTE: **The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.**

5. Position the NEW high pressure fuel pump gasket (4) and bolts (1) to the fuel pump.

NOTE: Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.

6. Install the high pressure fuel pump (2). Force will be required while hand tightening the bolts.

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.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

7. Tighten the high pressure fuel pump retaining bolts to 15 (11 lb ft).
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.

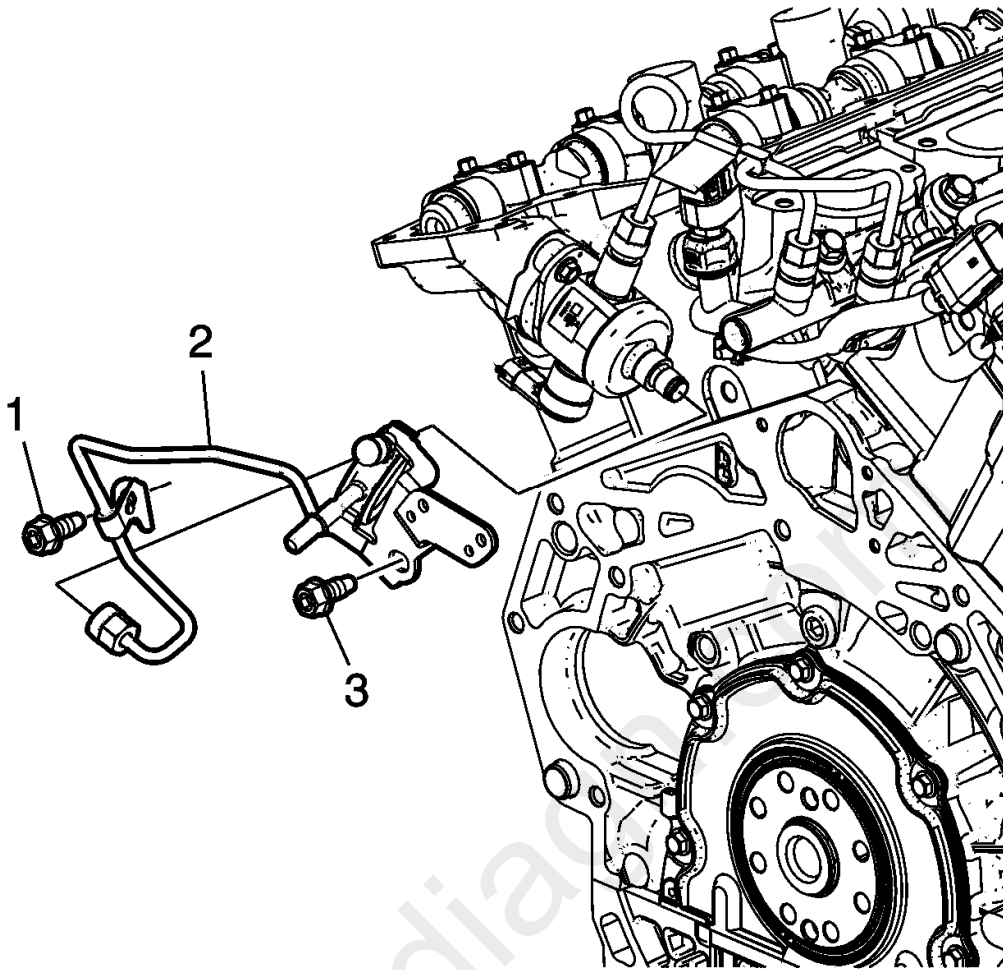


Fig. 115: View Of Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS COMPANY

9. Install a NEW fuel feed pipe (2). Refer to **Fuel Feed Pipe Replacement**.
10. Install a new O-ring seal on the radiator surge tank outlet pipe.
11. Position the radiator surge tank outlet pipe to the thermostat housing and loosely tighten the fastener.
12. Install the radiator surge tank outlet pipe fastener to the cylinder head and tighten to 58 (43 lb ft).
13. Tighten the radiator surge tank outlet pipe fastener to thermostat housing fastener to 9 (80 lb in).
14. Connect the high pressure fuel pump wiring harness.
15. Install both fuel rails. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
16. Refill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LFW or LFX)**, **Cooling System Draining and Filling (GE 47716 LFW or LFX)**.

FUEL INJECTOR REPLACEMENT

Removal Procedure

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

NOTE: The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.

2. Remove the fuel injection fuel rail assembly. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1, or Fuel Injection Fuel Rail Assembly Replacement - Bank 2.
3. For removal of the fuel injectors, refer to Fuel Rail and Injectors Cleaning and Inspection (LFW or LFX).

Installation Procedure

1. Prepare the fuel injectors for assembly, refer to Fuel Rail and Injectors Cleaning and Inspection (LFW or LFX).

NOTE: The fuel injectors have an alignment feature and must be reinstalled as noted during removal.

2. Install the fuel injection fuel rail assembly. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1, or Fuel Injection Fuel Rail Assembly Replacement - Bank 2.
3. Pressure up the fuel system and check for leaks.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

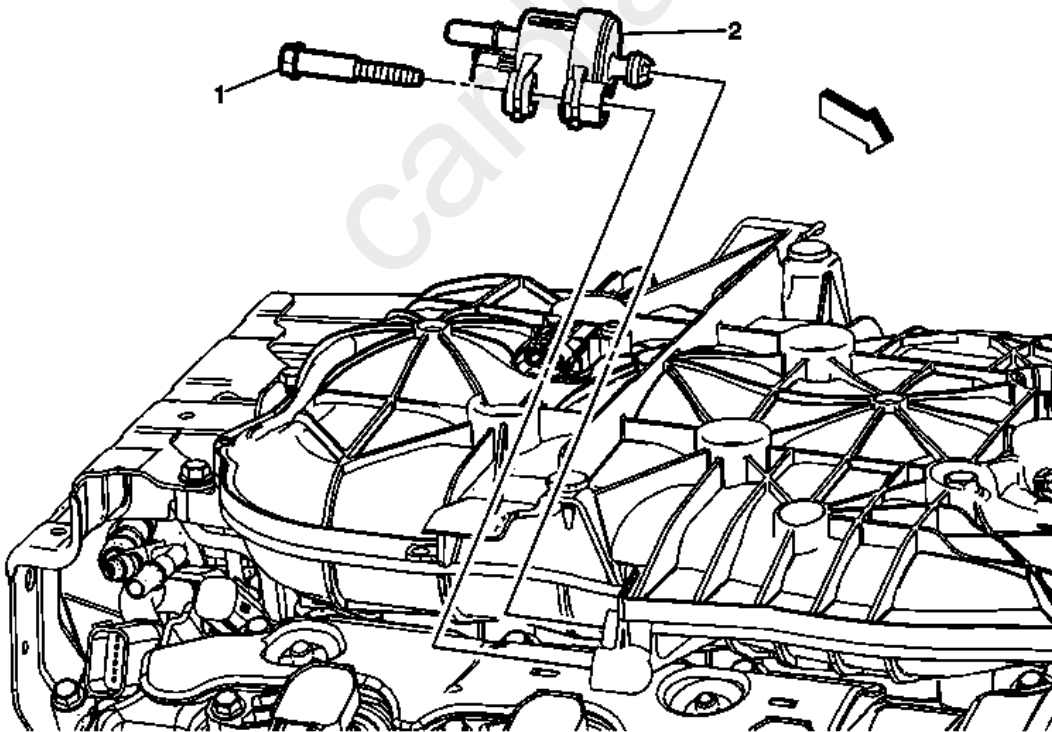


Fig. 116: Evaporative Emission Canister Purge Solenoid Valve & Bolt

Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Evaporative Emission Canister Purge Solenoid Valve Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Evaporative Emission Canister Purge Solenoid Valve Procedure 1. Disconnect the EVAP canister purge solenoid valve harness connector. 2. Disconnect the EVAP line to the EVAP canister purge solenoid valve. 3. Install a NEW O-ring.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Remove the exhaust system. Refer to **Exhaust System Replacement (Single Exhaust)** , **Exhaust System Replacement (LFX/LFW-Coupe)** , **Exhaust System Replacement (LFX/LFW-Wagon)** .
2. Steps 3-5 apply to Wagon only. Proceed to step 6 for Coupe.
3. Place a jack stand under the rear differential assembly.

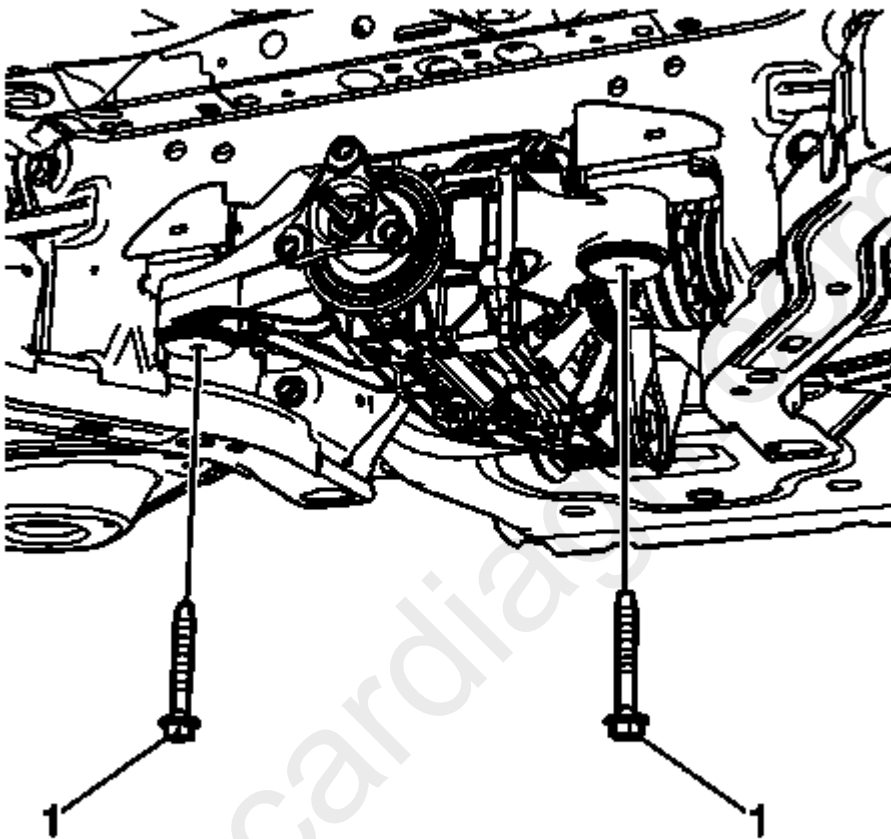


Fig. 117: View of Front Differential Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the two front differential mounting bolts (1).
5. Lower the differential slightly to provide additional clearance to the Evap canister.
6. Remove the two EVAP canister retaining nuts and lower the rear of the canister enough to clear the weld studs.
7. Slide the canister rearward from the body brace to gain access to the canister vent valve.

8. Clean away any debris that may be present around the EVAP canister vent valve.
9. Disconnect the electrical connector from the EVAP canister vent valve.

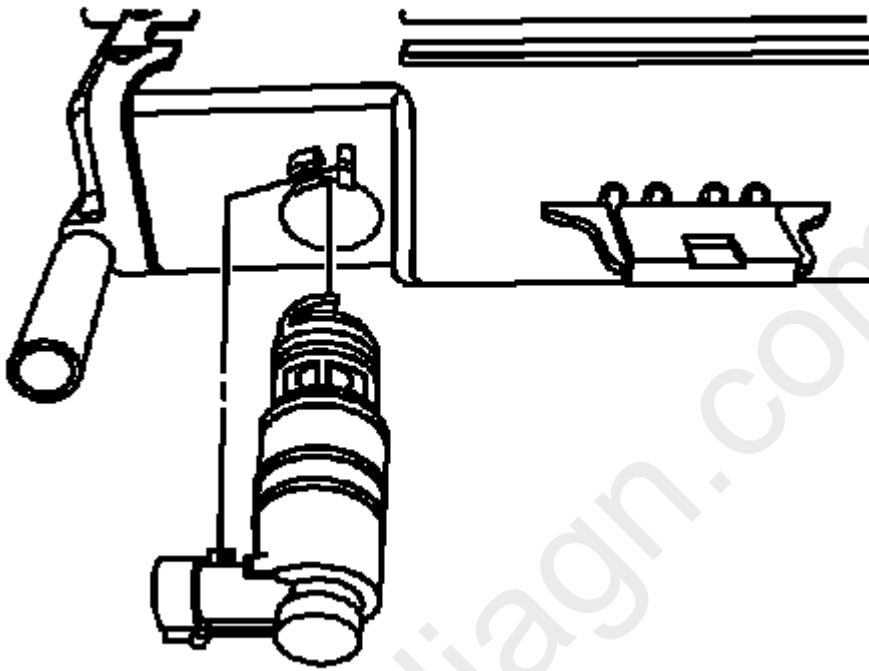


Fig. 118: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

10. Twist the EVAP canister vent valve counterclockwise.
11. Pull the EVAP canister vent valve from the EVAP canister.

Installation Procedure

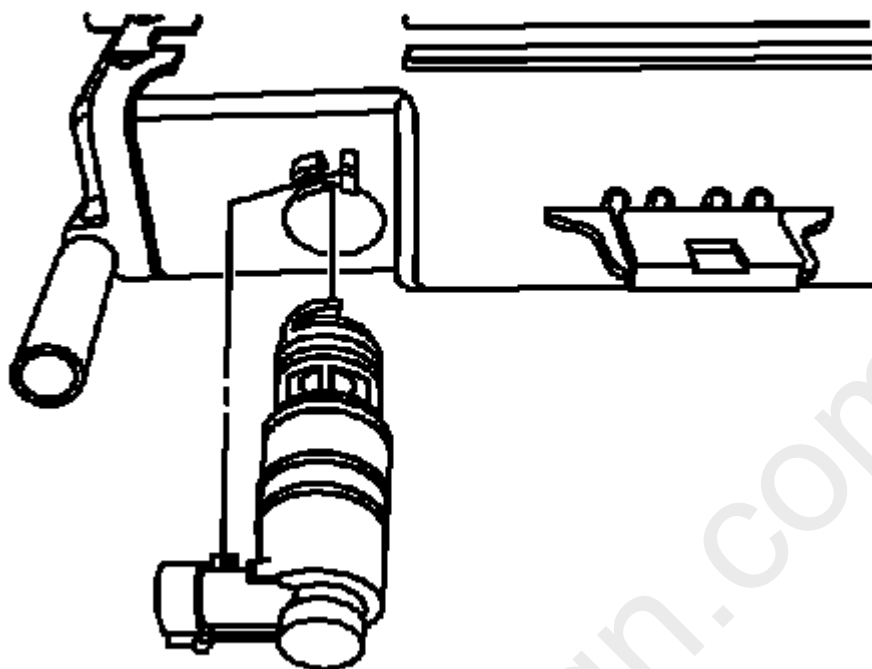


Fig. 119: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

1. Insert the EVAP canister vent valve into the EVAP canister.
2. Twist the EVAP canister vent valve clockwise into the locked position.
3. Connect the electrical connector to the EVAP canister vent valve.
4. Attach the EVAP canister to the body by inserting the fresh air tube and tab on the canister forward into the body brace.
5. Rotate the rear of the canister up over the 2 weld studs on the floor pan.
6. Install the EVAP canister to the body and install the bolts and tighten to 6 (53 lb in).

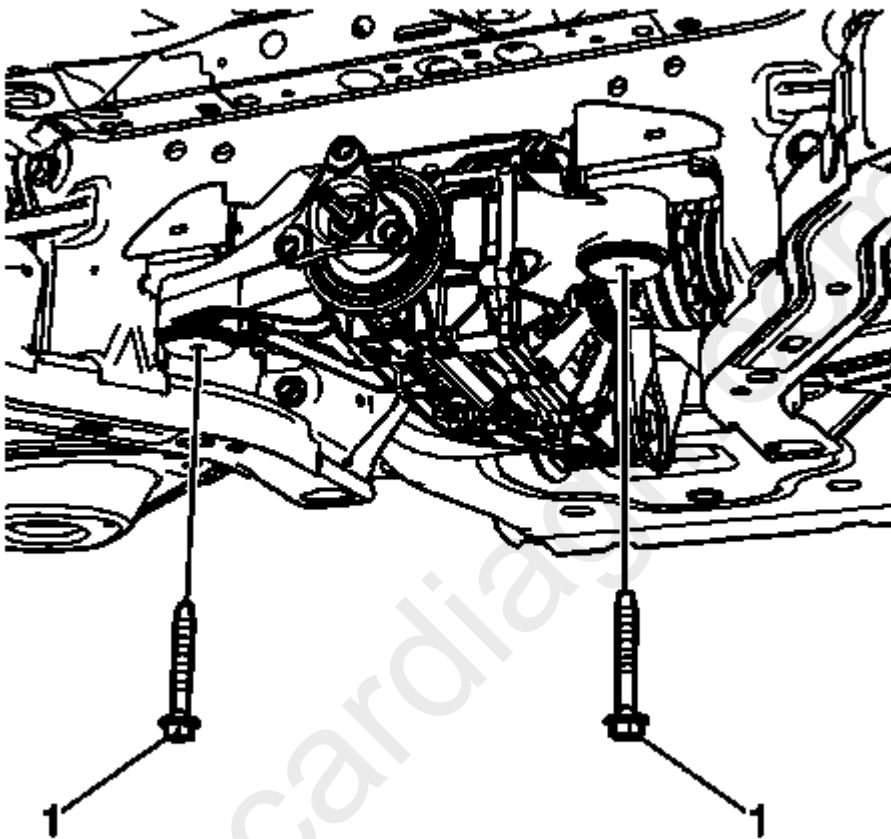


Fig. 120: View of Front Differential Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Wagon only: Raise the rear differential into position and install the front mounting bolts (1) and tighten to 175 (129 lb ft).
8. Install the exhaust system. Refer to **Exhaust System Replacement (Single Exhaust)** , **Exhaust System Replacement (LFX/LFW-Coupe)** , **Exhaust System Replacement (LFX/LFW-Wagon)** .

EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER

Removal Procedure

CAUTION:

- Do not attempt to straighten kinked nylon pipes. Replace any kinked nylon pipes in order to prevent damage to the vehicle.
- Do not attempt to repair sections of nylon pipes. Replace damaged nylon pipes.
- Replace the vapor hoses/pipes with original equipment or parts that meet GM specifications.

1. Remove the fuel tank. Refer to Fuel Tank Replacement.

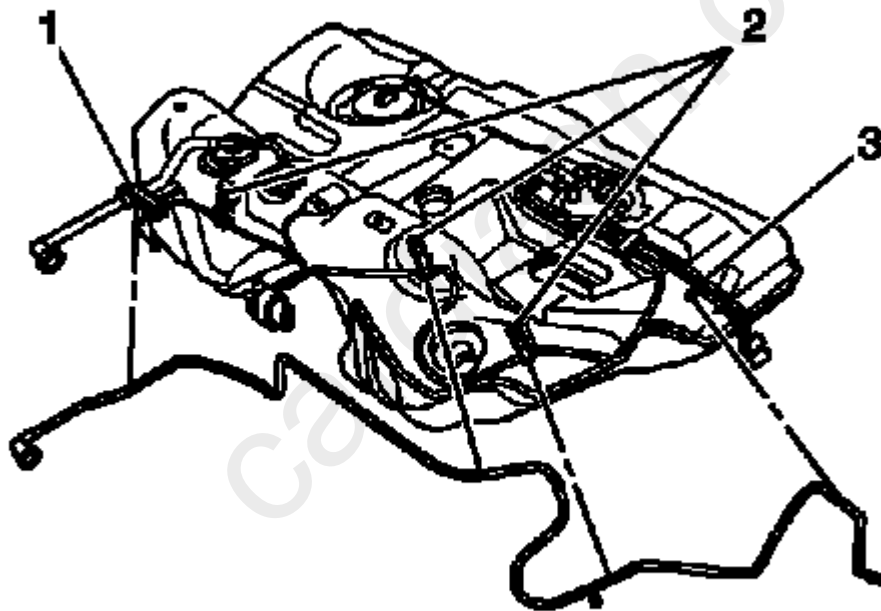


Fig. 121: View Of EVAP Hose Retainers

Courtesy of GENERAL MOTORS COMPANY

2. Remove the chassis to canister evaporative emission (EVAP) hose from the following:
 - The body retainer (1)
 - The 3 retaining features (2) on the fuel tank
 - The retainer clip (3)

3. Remove the EVAP hose from the fuel tank.

Installation Procedure

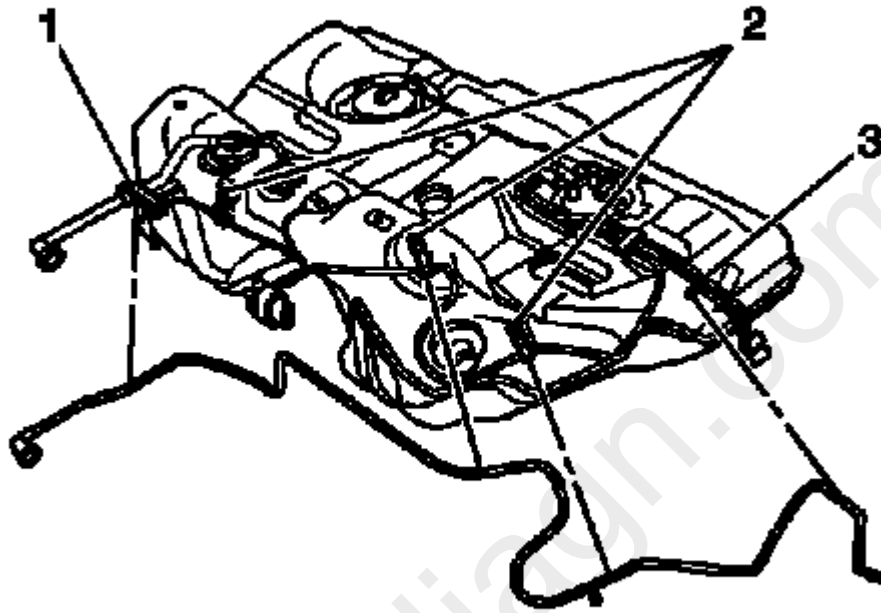


Fig. 122: View Of EVAP Hose Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Position the EVAP hose to the fuel tank.
2. Install the chassis to canister EVAP hose to the following:
 - The body retainer (1)
 - The 3 retaining features (2) on the fuel tank
 - The retainer clip (3)
3. Install the fuel tank. Refer to **Fuel Tank Replacement**.

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

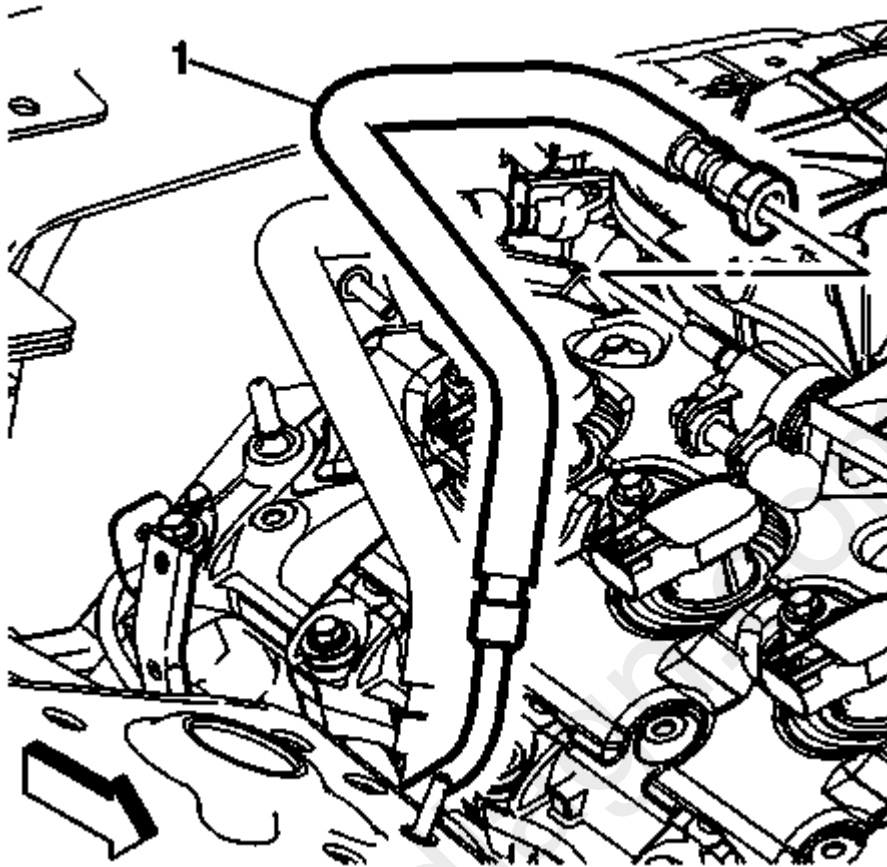


Fig. 123: EVAP Hose
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the EVAP hose (1) from the EVAP canister purge solenoid.

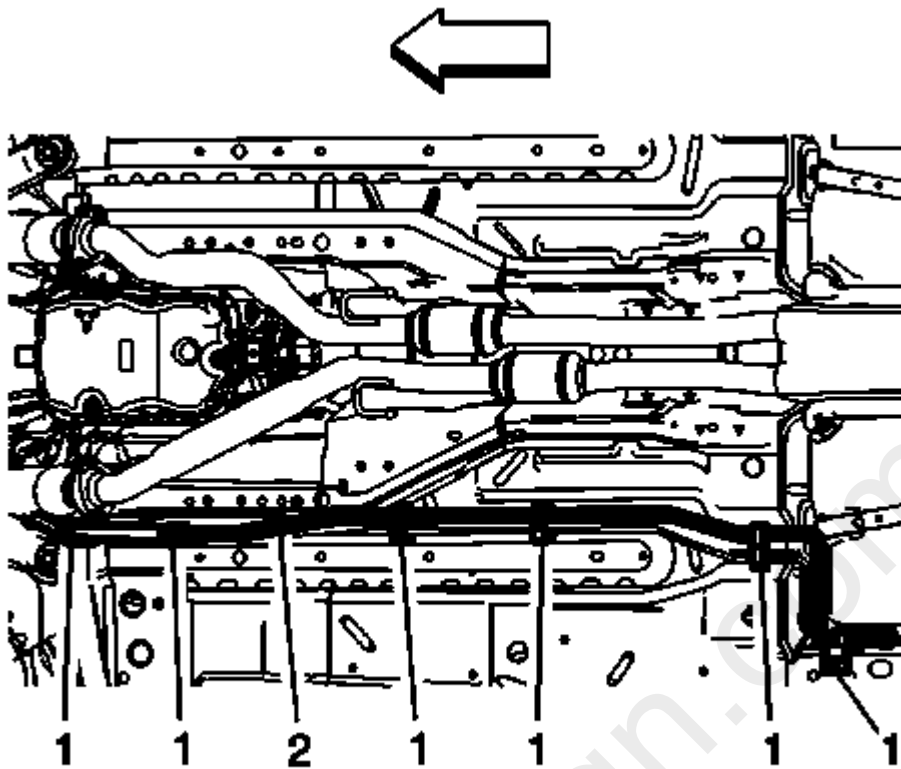


Fig. 124: EVAP Hose & Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the EVAP hose (2) from the retainers (1).
5. Remove the EVAP hose from the vehicle (2).

Installation Procedure

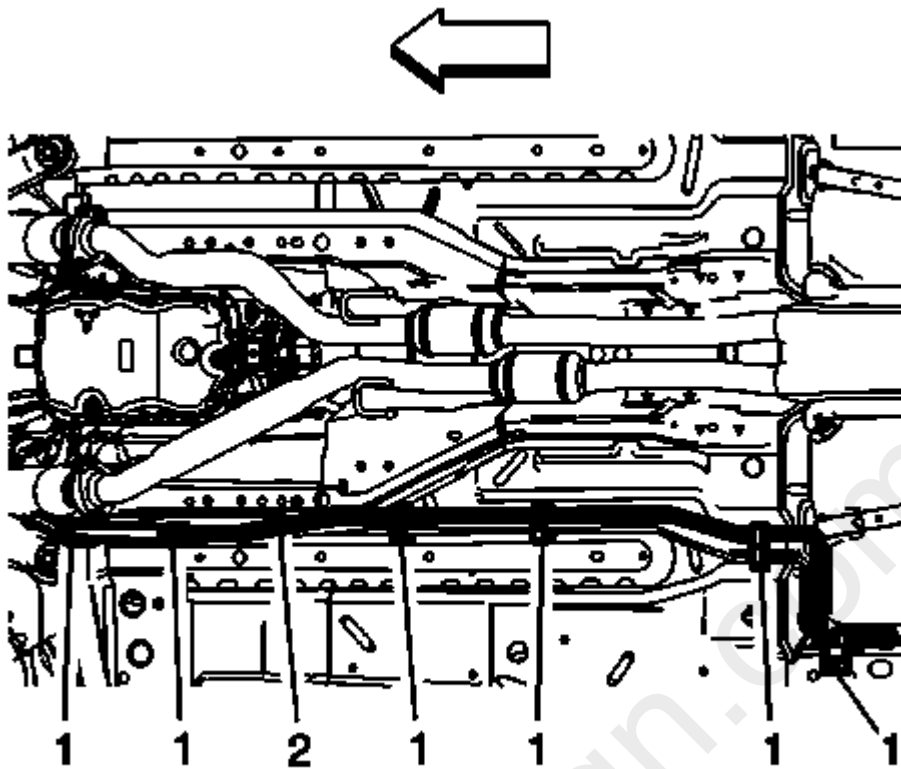


Fig. 125: EVAP Hose & Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the EVAP hose from the vehicle (2).
2. Connect the EVAP hose (2) to the retainers (1).

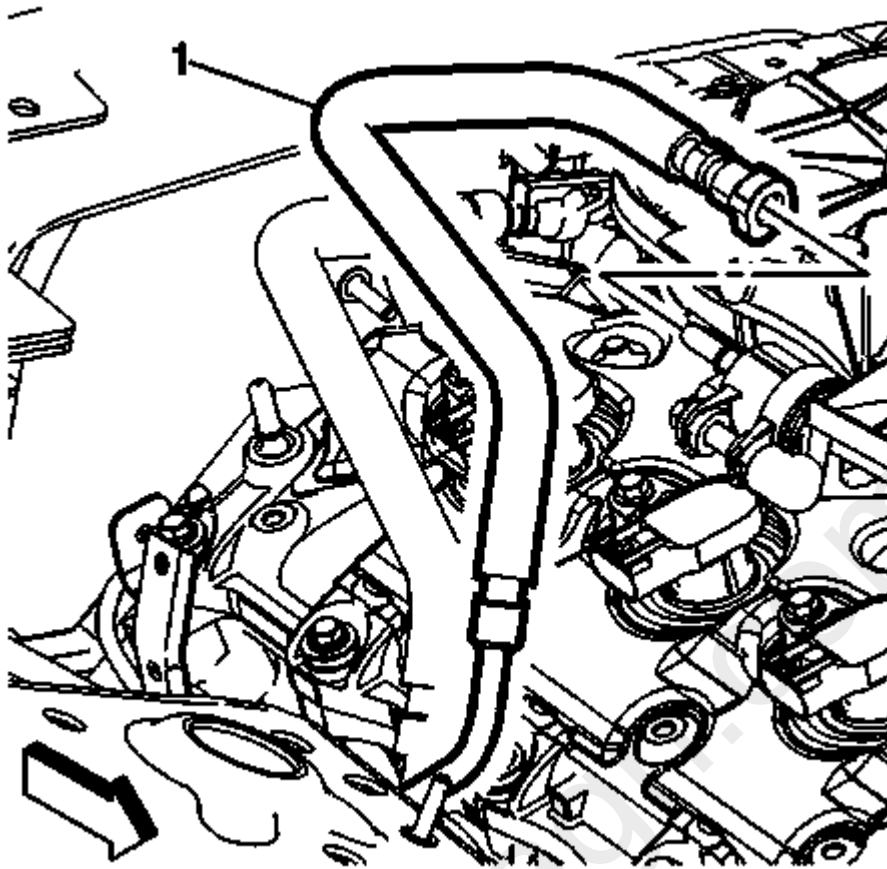


Fig. 126: EVAP Hose
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the EVAP hose (1) from the EVAP canister purge solenoid.
4. Lower the vehicle.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

1. Remove the rear frame. Refer to **Rear Frame Replacement** .

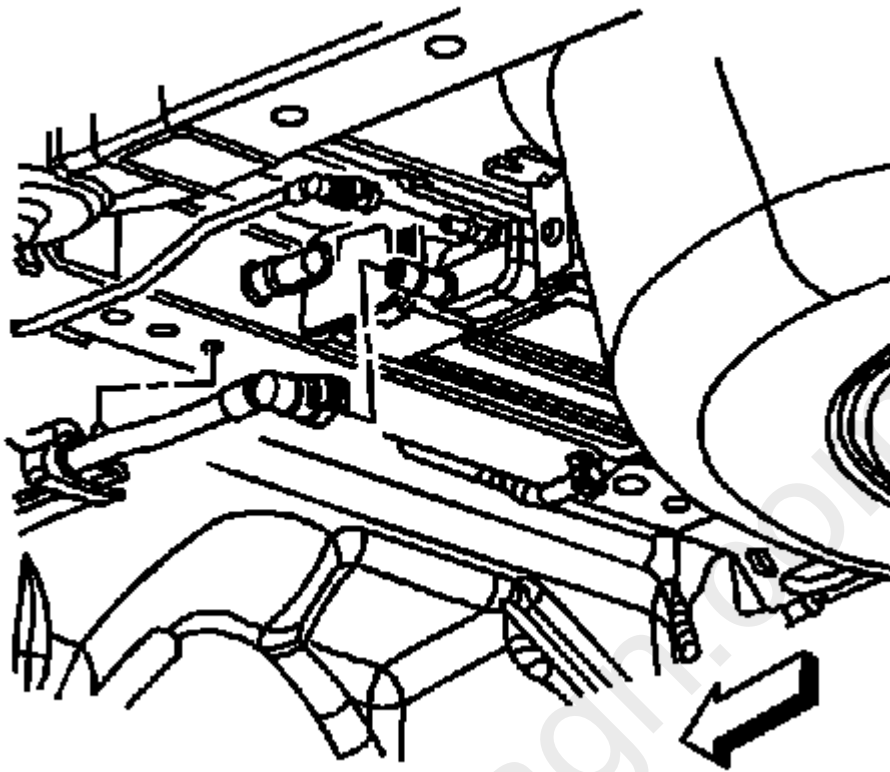


Fig. 127: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the evaporative emission (EVAP) hoses from the EVAP canister.
3. Disconnect the electrical connector from the EVAP canister.

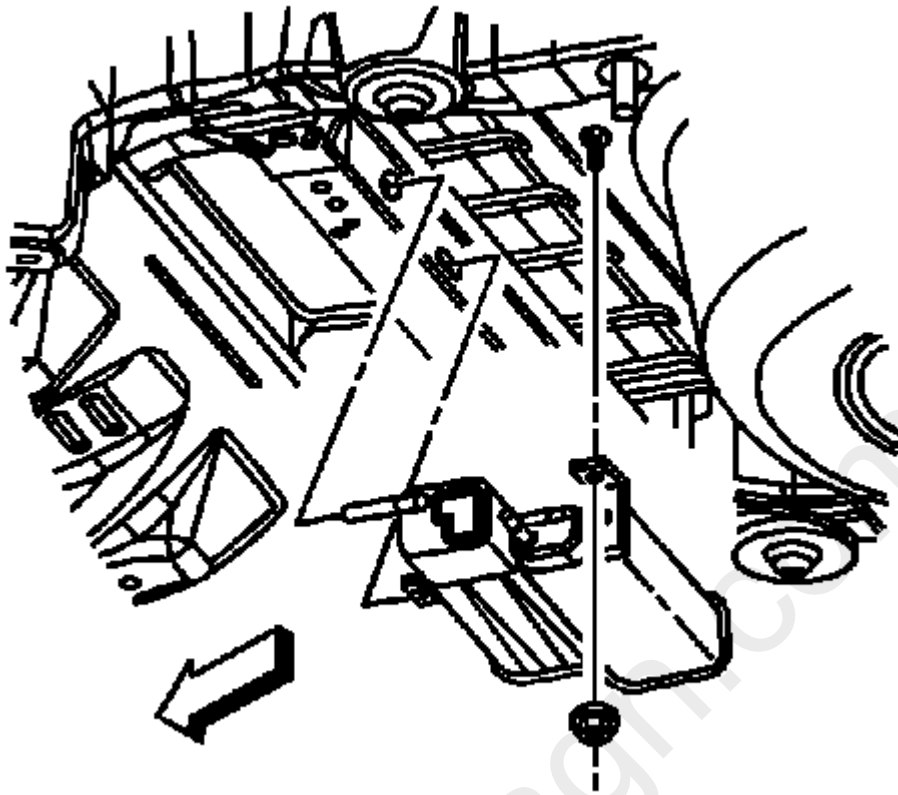


Fig. 128: View Of EVAP Canister Retaining Nuts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the EVAP canister retaining nuts.
5. Complete the following in order to remove the EVAP canister:
 1. Lower the rear of the canister enough to clear the 2 weld studs.
 2. Slide the canister rearward from the body brace.

Installation Procedure

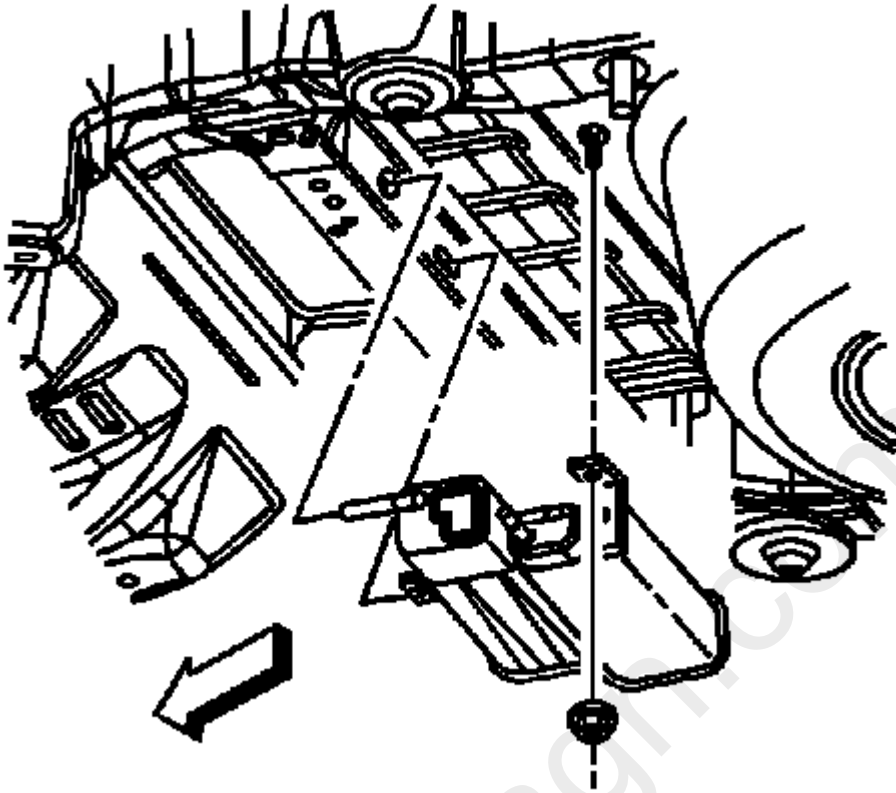


Fig. 129: View Of EVAP Canister Retaining Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Complete the following in order to install the EVAP canister:
 1. Insert the fresh air tube and tab on the canister forward into the body brace.
 2. Rotate the rear of the canister up over the 2 weld studs on the floor pan.

CAUTION: Refer to Fastener Caution .

2. Install the EVAP canister retaining nuts and tighten to 6 N.m (53 lb in).

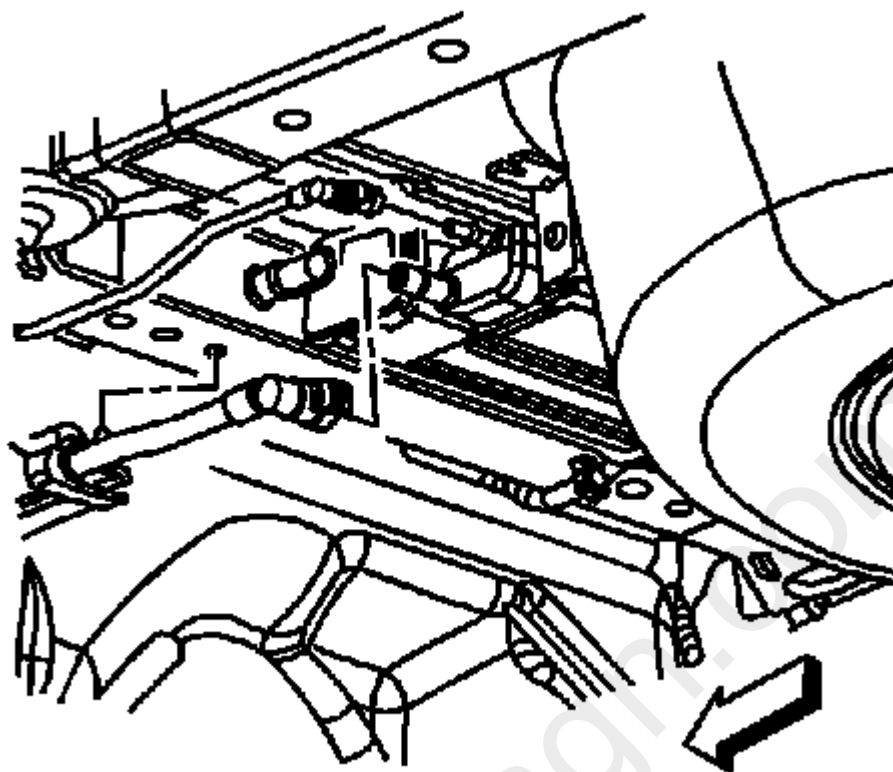


Fig. 130: Identifying EVAP Hoses At EVAP Canister
Courtesy of GENERAL MOTORS COMPANY

3. Connect the EVAP hoses to the EVAP canister.
4. Connect the electrical connector to the EVAP canister.
5. Install the rear frame. Refer to **Rear Frame Replacement** .

EVAPORATIVE EMISSION CANISTER FILTER REPLACEMENT

Removal Procedure

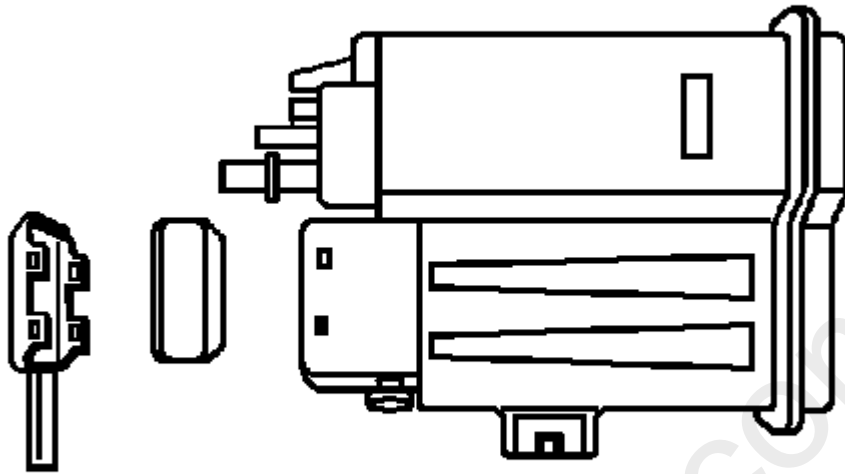


Fig. 131: View Of EVAP Canister Filter
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Using a 90 degree pick, disengage the lower filter cover clips.
3. Insert a flat-bladed tool between the filter cover and canister, and push up to disengage the upper clips.
4. Remove and discard the evaporative emission (EVAP) canister filter cover.
5. Remove and discard the EVAP canister filter.
6. Clean the inside of the EVAP canister filter housing with a clean shop towel.

Installation Procedure

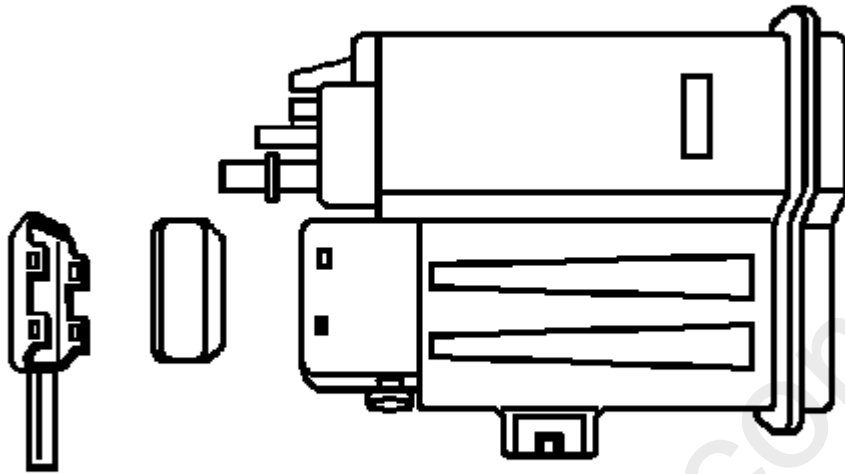


Fig. 132: View Of EVAP Canister Filter
Courtesy of GENERAL MOTORS COMPANY

1. Insert a NEW EVAP canister filter into the EVAP canister.

IMPORTANT: Ensure the NEW seal is properly seated into the NEW cover.

2. Install a NEW EVAP canister filter cover seal to a EVAP NEW canister cover.
3. Snap the EVAP canister filter cover onto the EVAP canister.
4. Lower the vehicle.

IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement** .

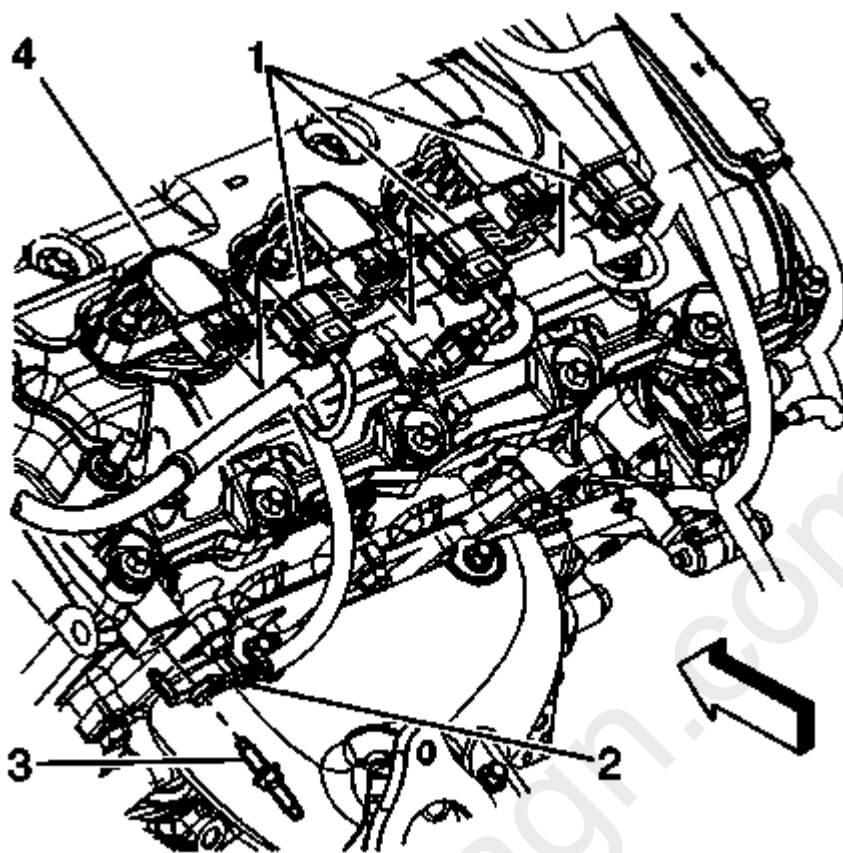


Fig. 133: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s) (4).

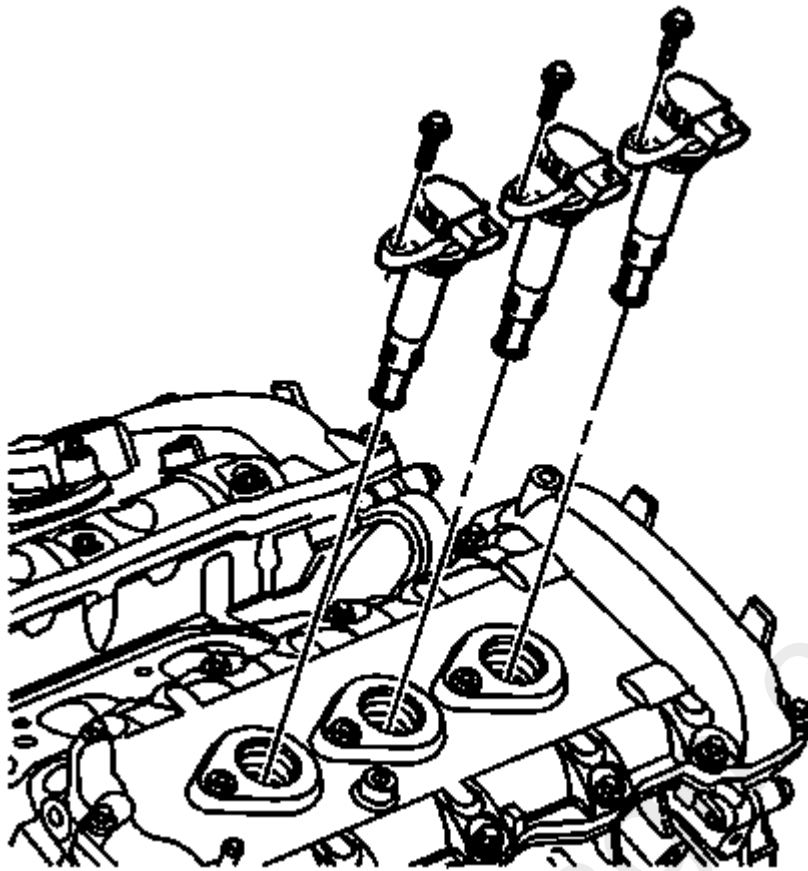


Fig. 134: Ignition Coil View

Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s).
4. Remove the ignition coil(s).

Installation Procedure

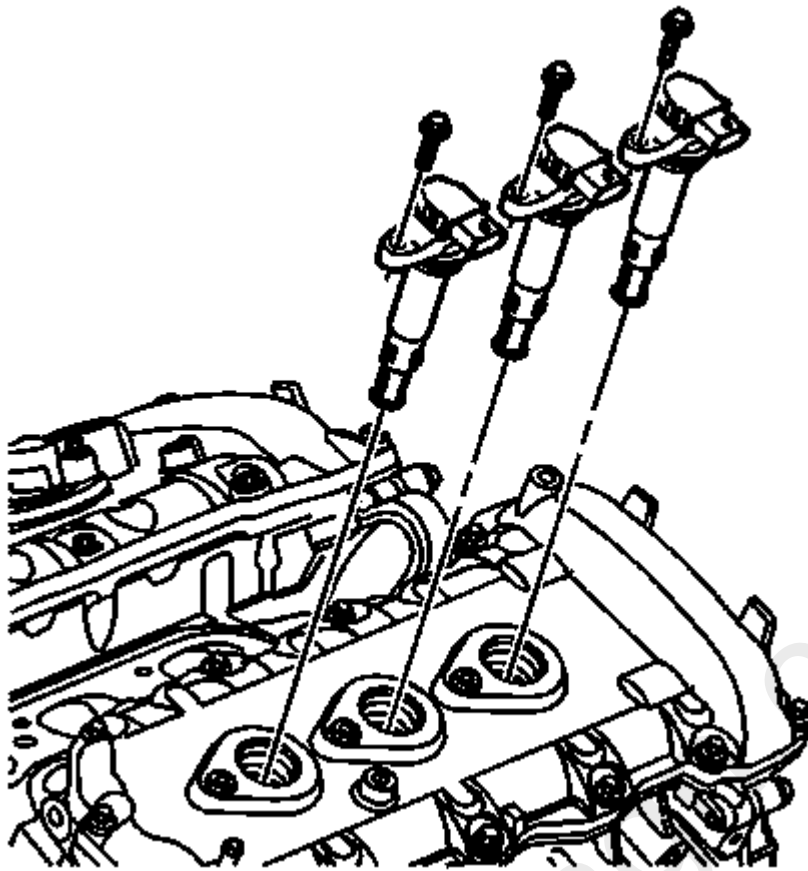


Fig. 135: Ignition Coil View

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s).

Tighten

Tighten the bolt(s) to 10 N.m (89 lb in).

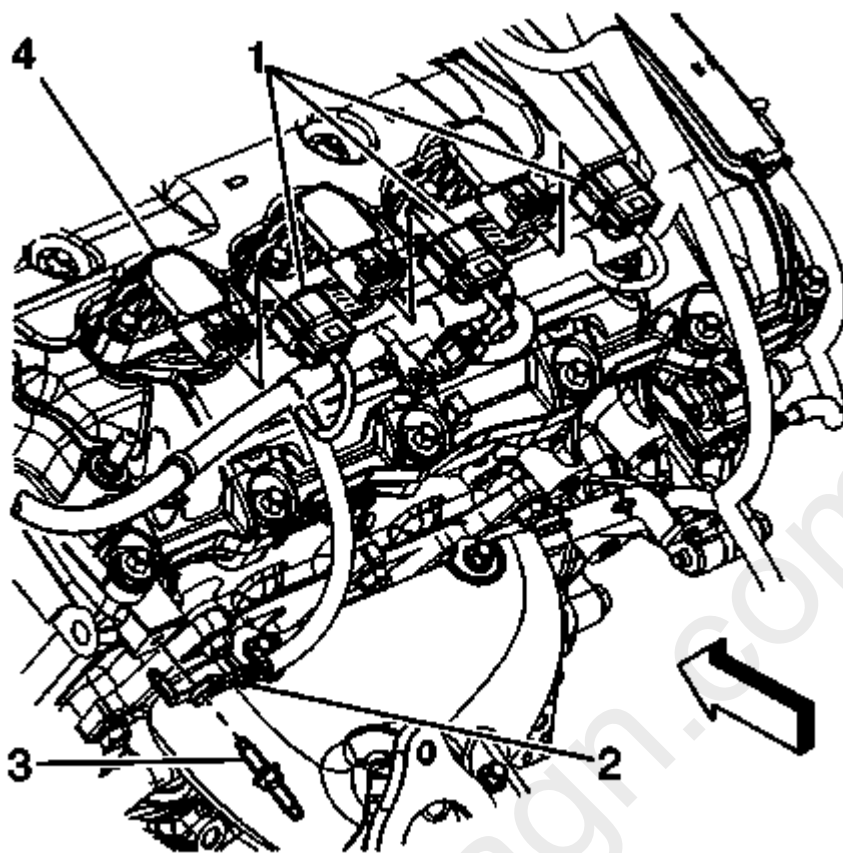


Fig. 136: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (4).
4. Install the intake manifold. Refer to **Intake Manifold Replacement** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

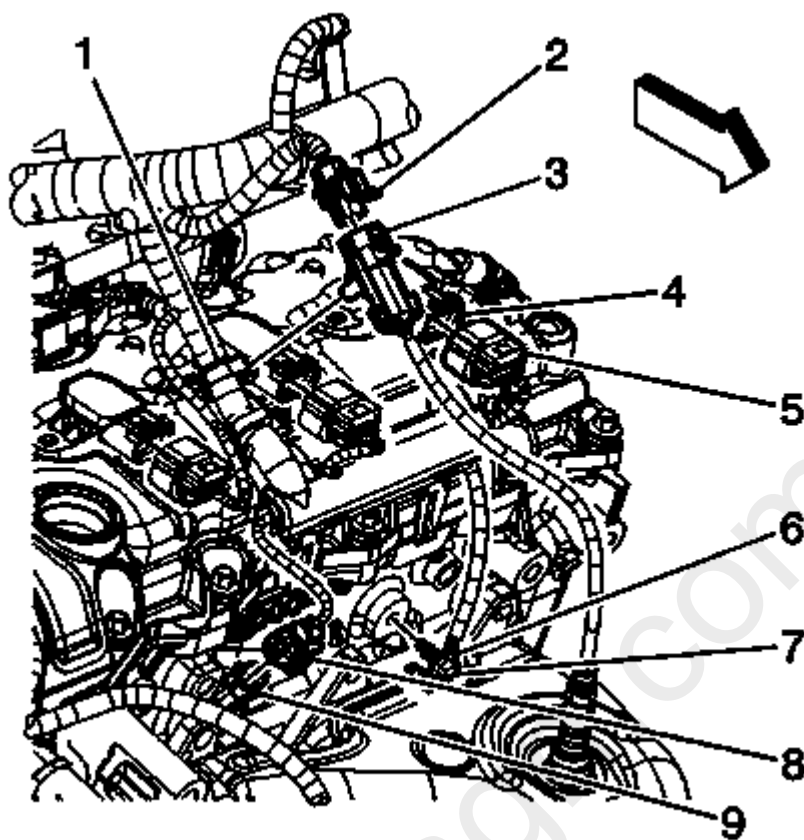


Fig. 137: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Disconnect the engine wiring harness electrical connector(s) (5) from the ignition coil(s) (4).

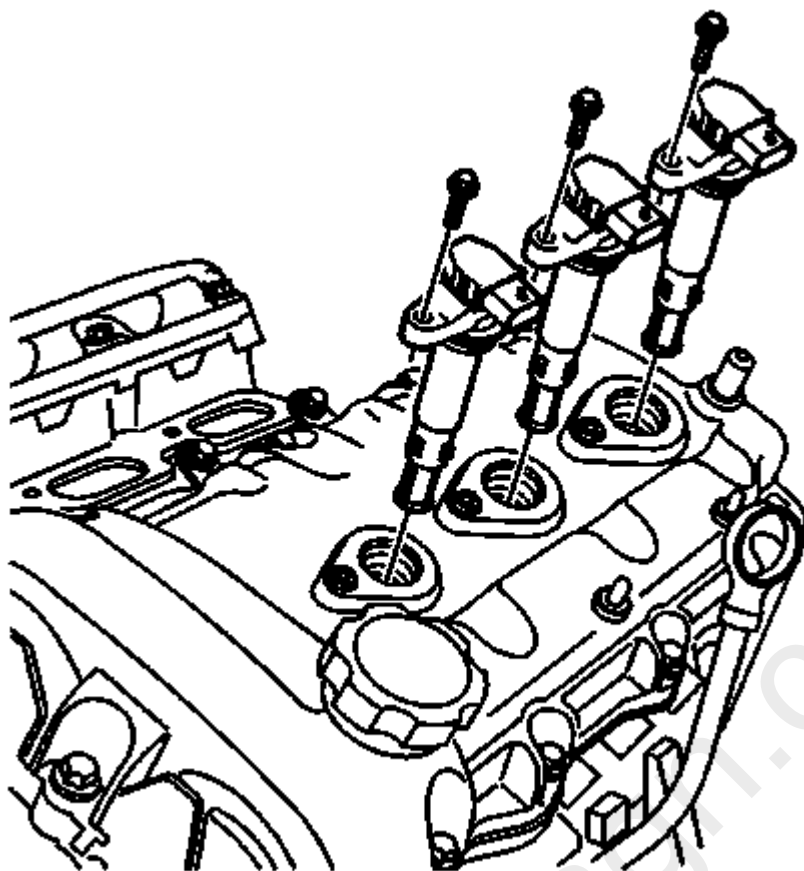


Fig. 138: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s).
4. Remove the ignition coil(s).

Installation Procedure

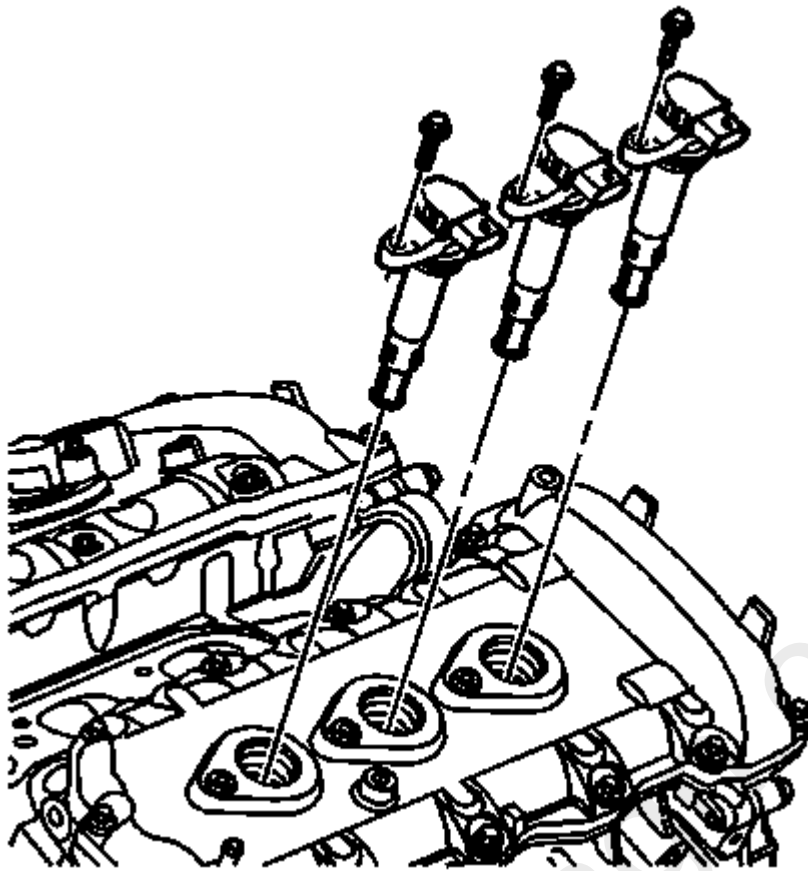


Fig. 139: Ignition Coil View

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) and tighten to 10 N.m (89 lb in).

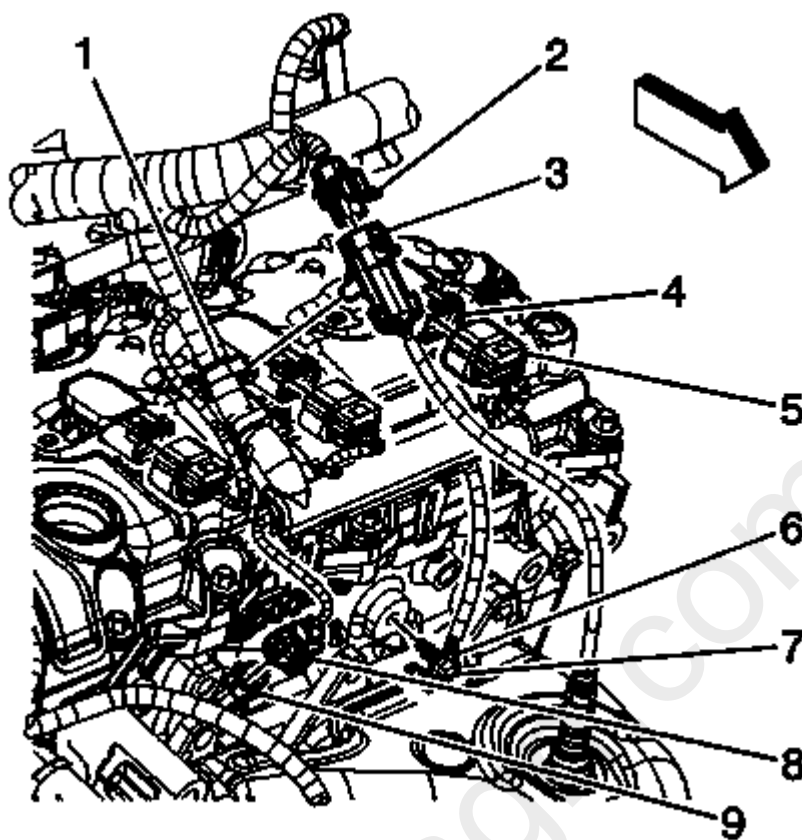


Fig. 140: Identifying Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (5) to the ignition coil(s) (4).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** ..

SPARK PLUG INSPECTION

Spark Plug Usage

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

Spark Plug Inspection

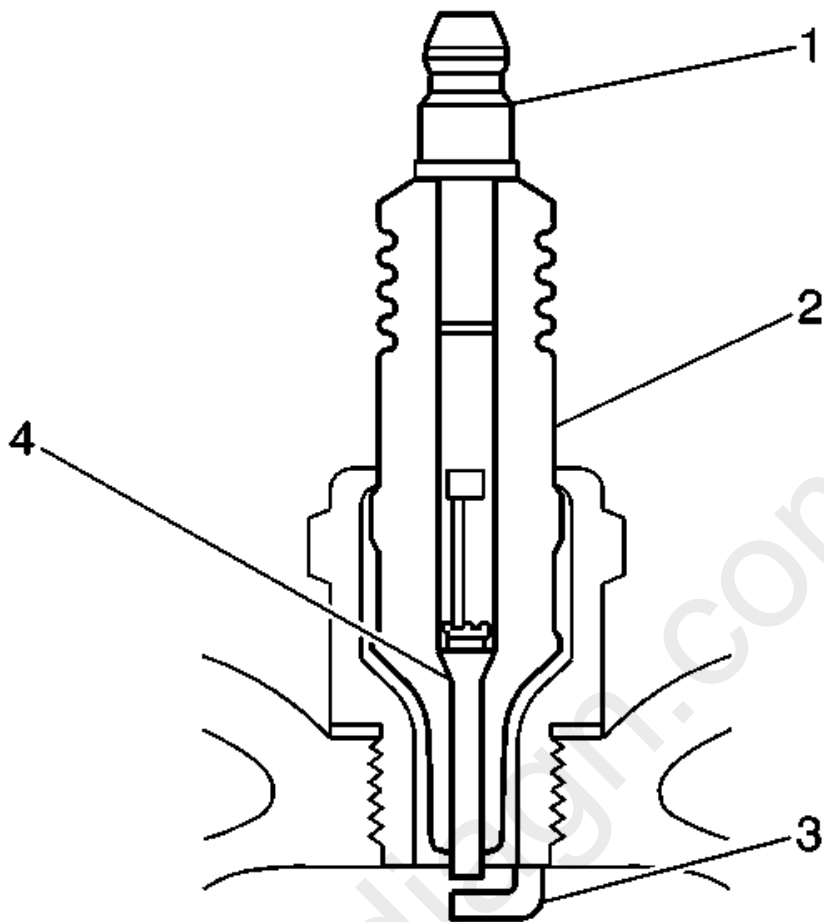


Fig. 141: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

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

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

Spark Plug Visual Inspection

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

SPARK PLUG REPLACEMENT

Removal Procedure

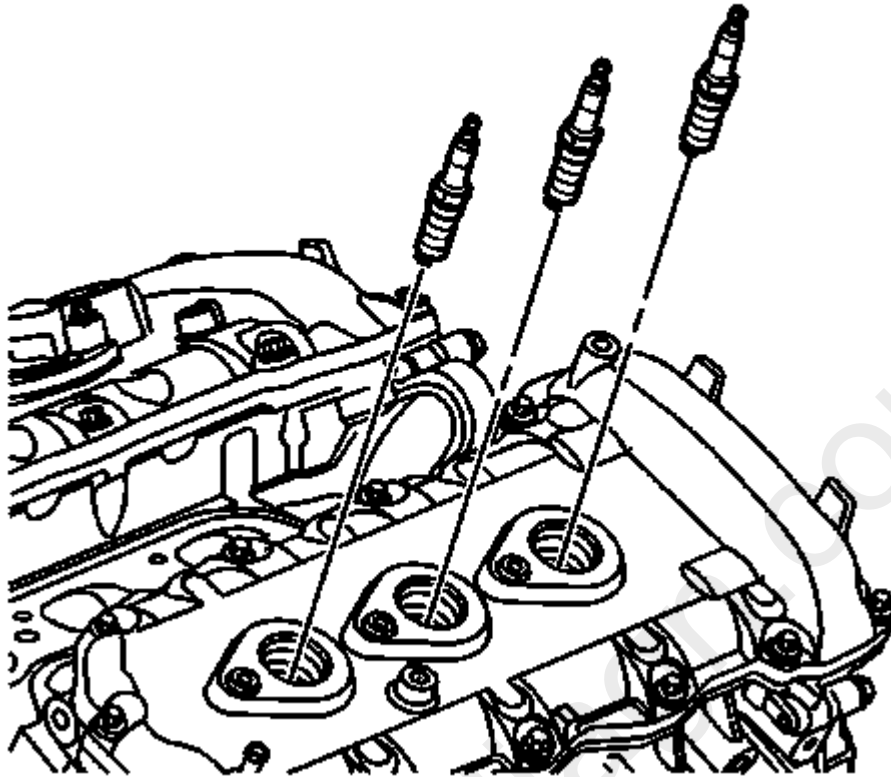


Fig. 142: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Turn the ignition OFF.
2. Remove the ignition coil. Refer to **Ignition Coil Replacement - Bank 1**, and/or **Ignition Coil Replacement - Bank 2**.

WARNING: Refer to **Safety Glasses and Compressed Air Warning** .

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

3. Use compressed air in order to remove debris from the spark plug cavity.

CAUTION: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

4. Remove the spark plug.

Installation Procedure

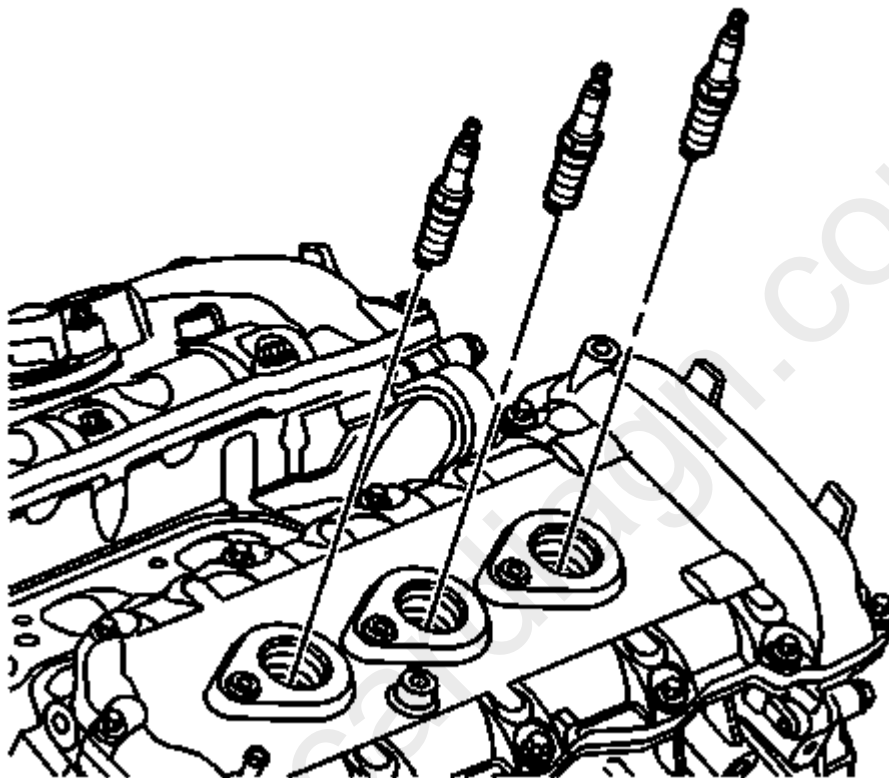


Fig. 143: View Of Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to **Ignition System Specifications** .

CAUTION: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

2. Install the spark plug and tighten to 20 N.m (15 lb ft).
3. Install the ignition coil. Refer to **Ignition Coil Replacement - Bank 1**, and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

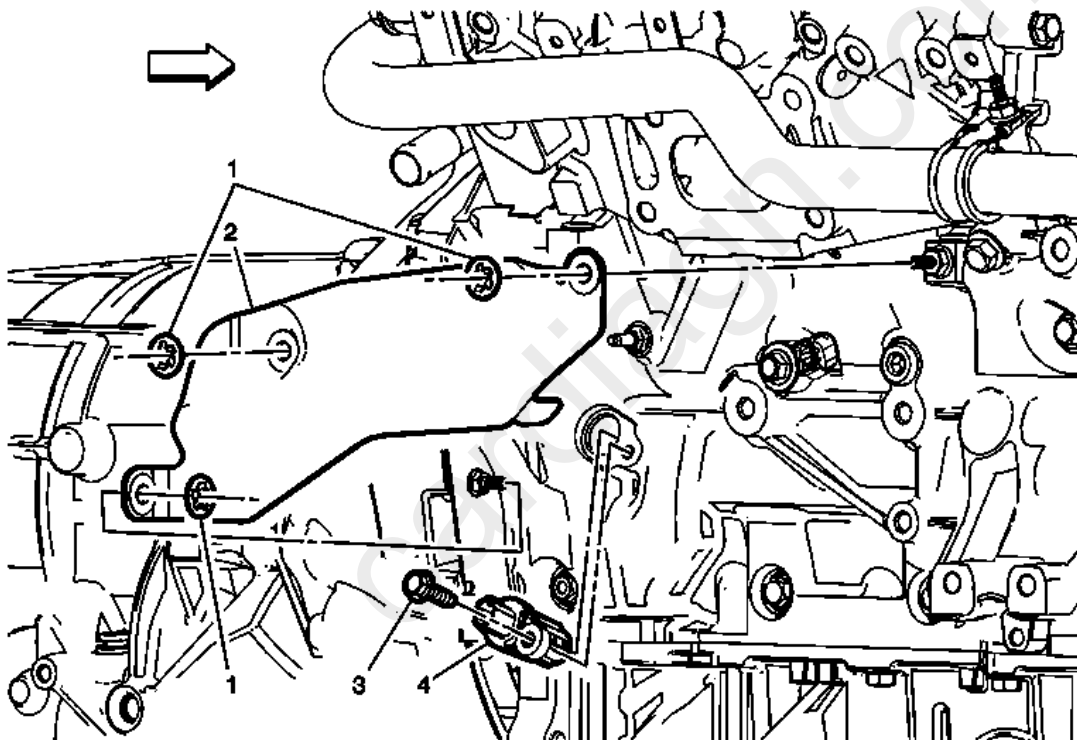


Fig. 144: Crankshaft Position Sensor, Heat Shield & Retainers
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor Replacement

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Heat Shield Retainer (Qty: 3)

	CAUTION: Refer to <u>Fastener Caution</u> .
2	Heat Shield
3	Crankshaft Position Sensor Bolt Tighten 10 N.m (89 lb in)
4	Crankshaft Position Sensor Procedure Disconnect the crankshaft position sensor electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

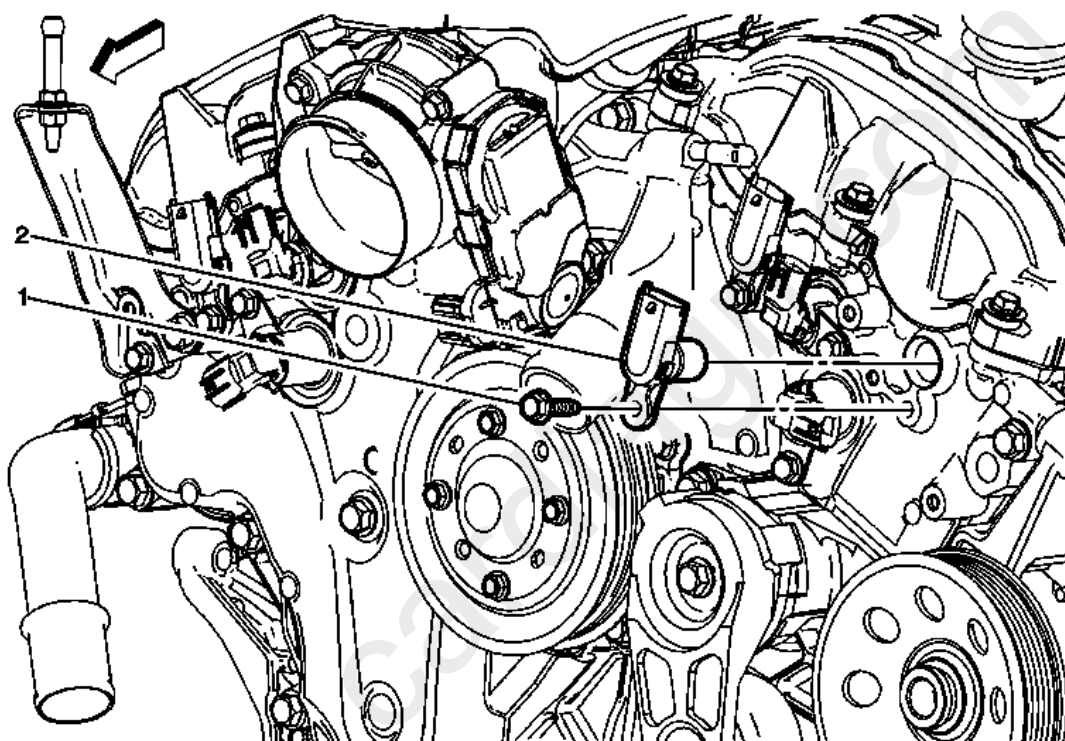


Fig. 145: Camshaft Position Sensor & Fastener - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 N.m (89 lb in) Procedure Disconnect the electrical connector.
2	Camshaft Position Sensor

CAMSHAFT POSITION SENSOR - BANK 2 (LEFT SIDE) INTAKE

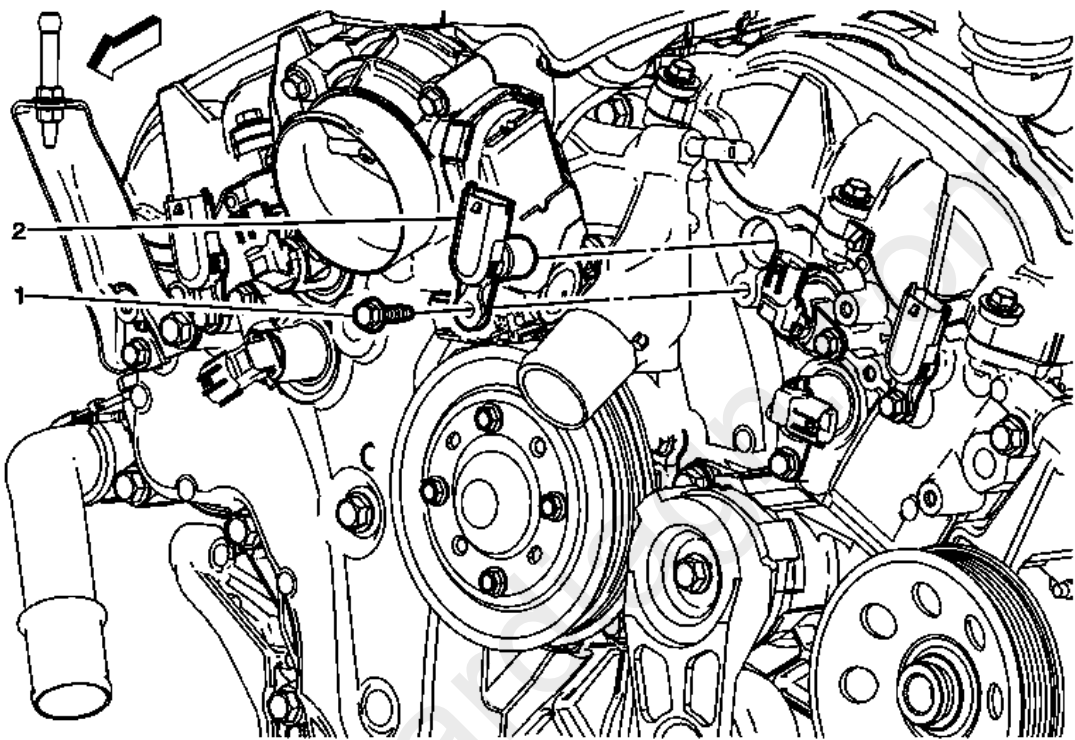


Fig. 146: Camshaft Position Sensor & Fastener - Bank 2 (Left Side) Intake
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in) Procedure

	Disconnect the electrical connector.
2	Camshaft Position Sensor

CAMSHAFT POSITION SENSOR - BANK 1 (RIGHT SIDE) EXHAUST

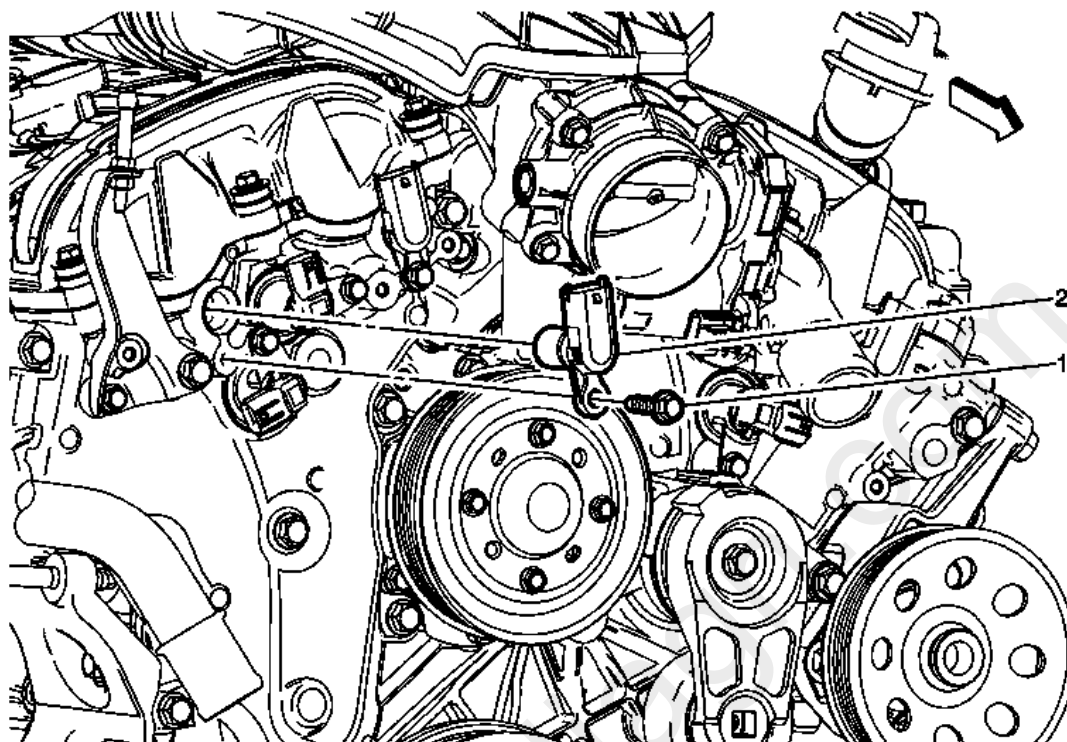


Fig. 147: Camshaft Position Sensor & Fastener - Bank 1 (Right Side) Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in) Procedure Disconnect the electrical connector
2	Camshaft Position Sensor.

CAMSHAFT POSITION SENSOR - BANK 1 (RIGHT SIDE) INTAKE

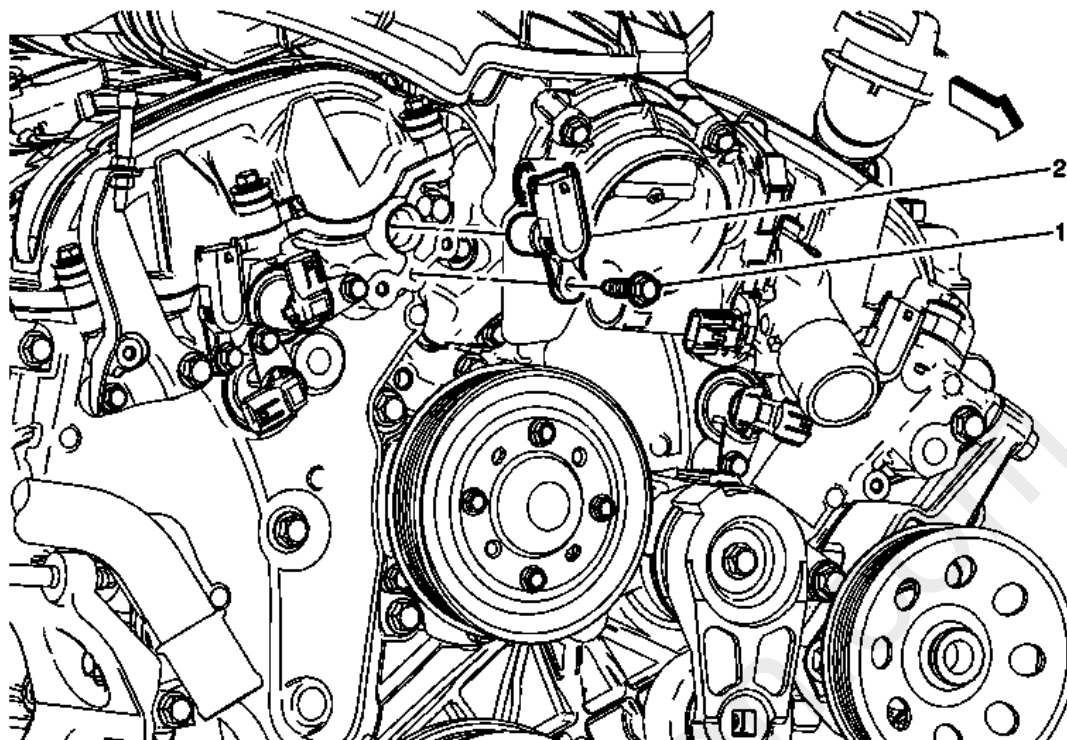


Fig. 148: Camshaft Position Sensor & Fastener - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in) Procedure Disconnect the electrical connector.
2	Camshaft Position Sensor

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID - BANK 1 (RIGHT SIDE) INTAKE

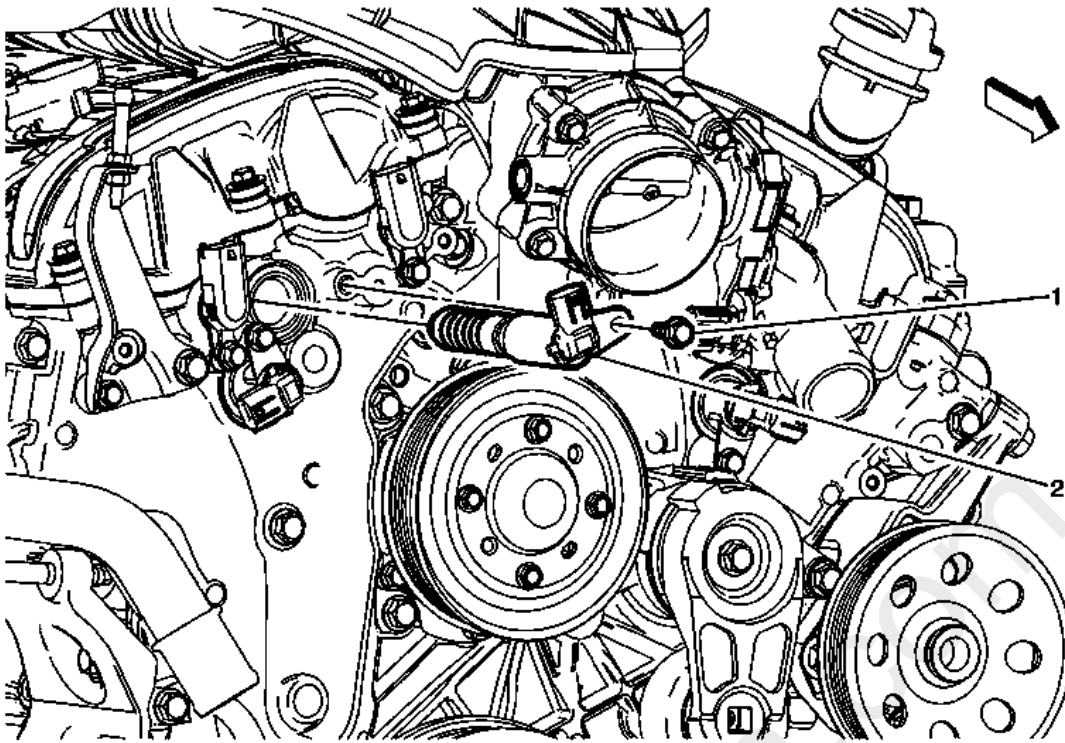


Fig. 149: Camshaft Position Actuator Solenoid Valve & Fastener - Bank 1 (Right Side) Intake
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in) Procedure Disconnect the electrical connector.
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID - BANK 1 (RIGHT SIDE) EXHAUST

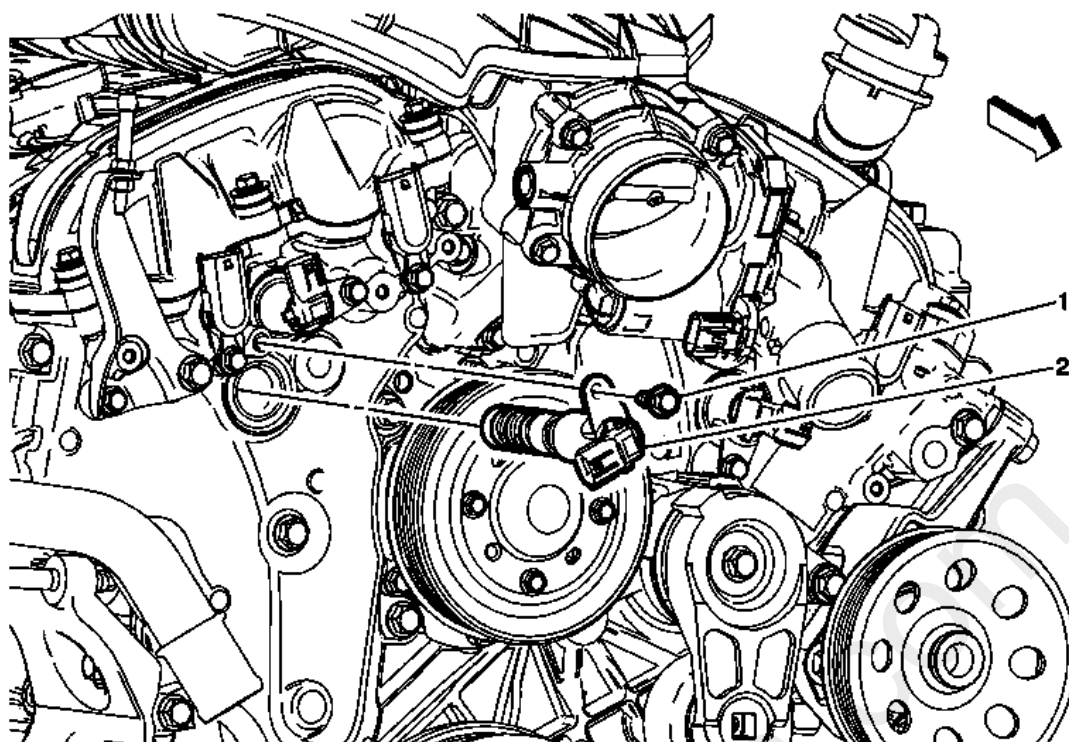


Fig. 150: Camshaft Position Actuator Solenoid Valve & Fastener - Bank 1 (Right Side) Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in) Procedure Disconnect the electrical connector.
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID - BANK 2 (LEFT SIDE) INTAKE

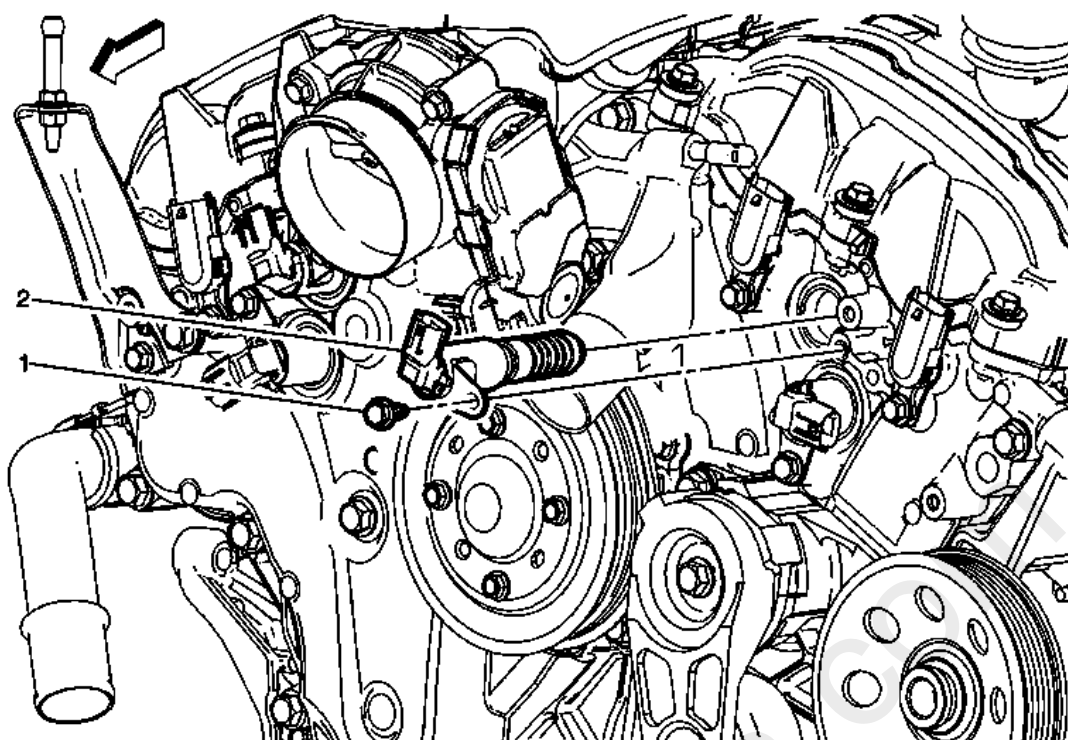


Fig. 151: Camshaft Position Actuator Solenoid Valve & Fastener - Bank 2 (Left Side) Intake
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in) Procedure Disconnect the electrical connector.
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID - BANK 2 (LEFT SIDE) EXHAUST

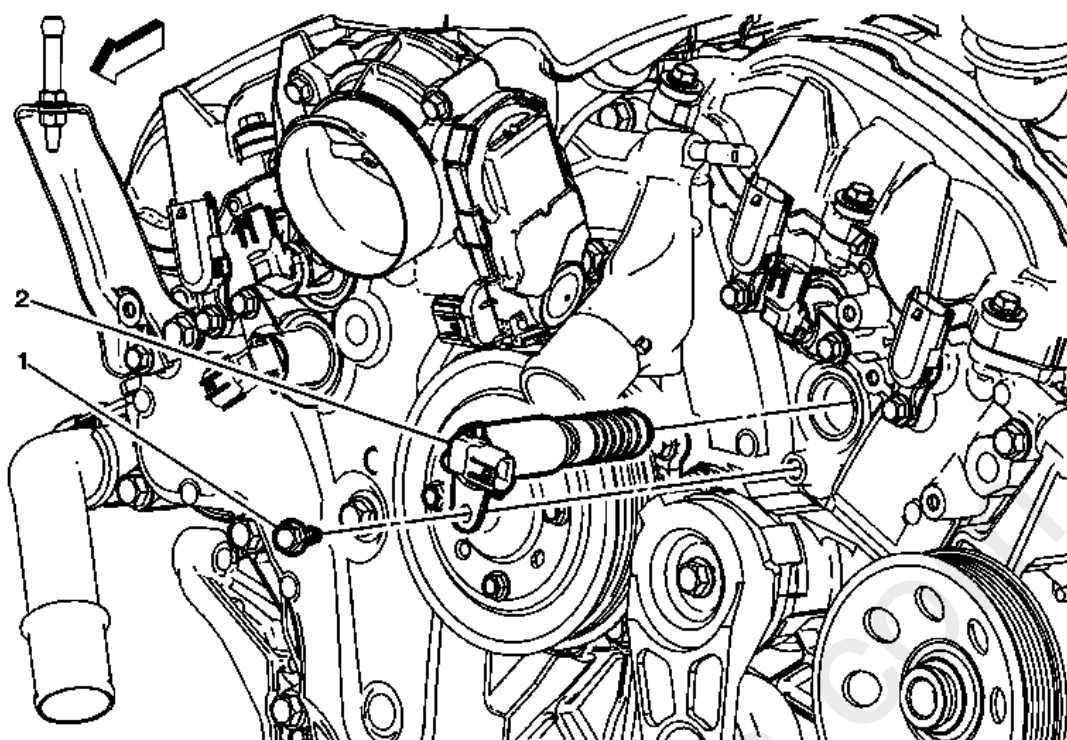


Fig. 152: Camshaft Position Actuator Solenoid Valve & Fastener - Bank 2 (Left Side) Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in) Procedure Disconnect the electrical connector.
2	Camshaft Position Actuator Solenoid Valve

KNOCK SENSOR REPLACEMENT - BANK 1

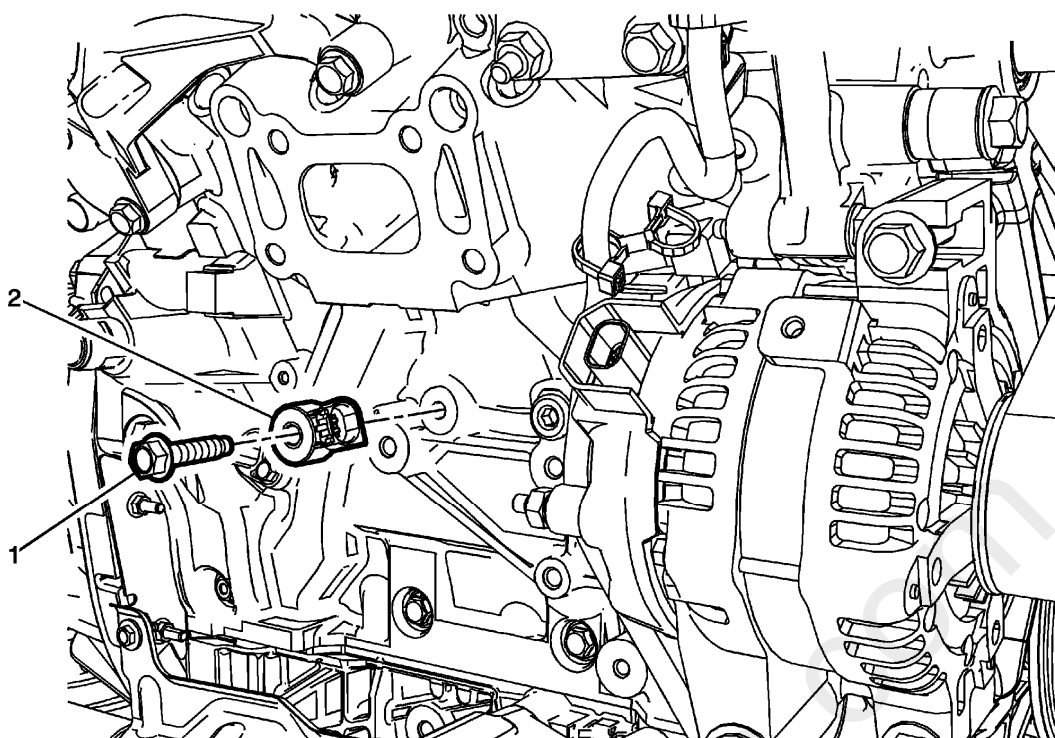


Fig. 153: Knock Sensor & Fastener - Bank 1
 Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement - Bank 1

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LFW,LFX)</u> .	
1	Knock Sensor Fastener Tighten 23 (17 lb ft)
2	Knock Sensor Procedure Disconnect the knock sensor electrical connector.

KNOCK SENSOR - BANK 2

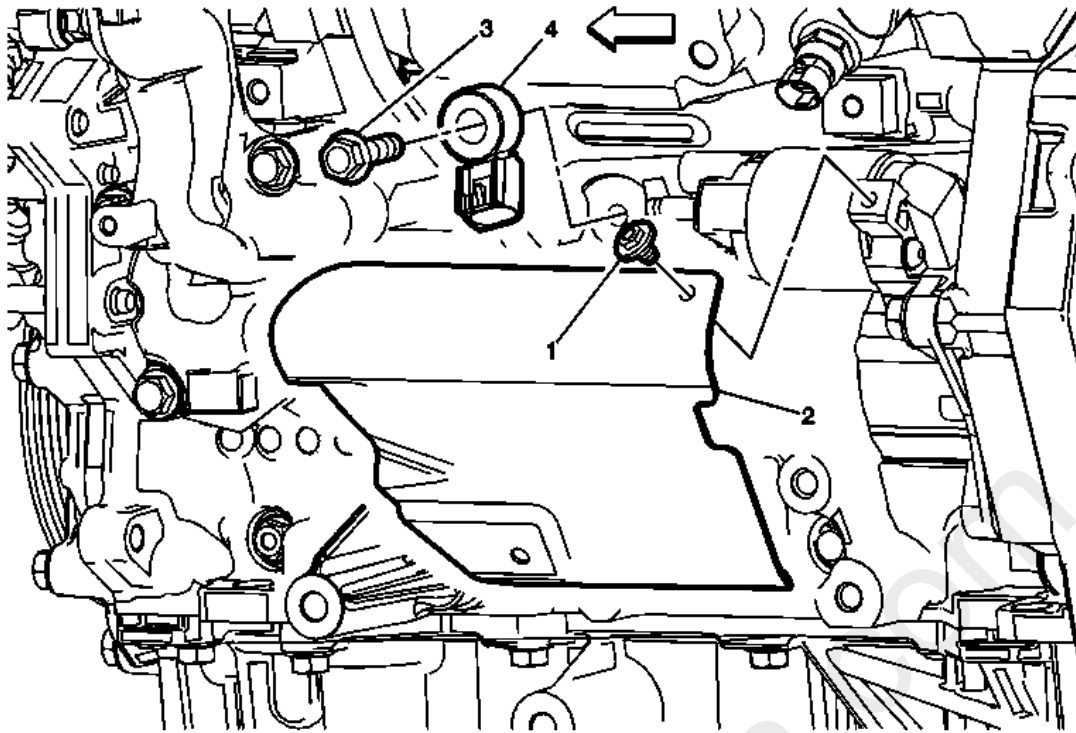


Fig. 154: Knock Sensor, Heat Shield & Fasteners - Bank 2
 Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement - Bank 2

Callout	Component Name
Preliminary Procedures Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Heat Shield Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m(80 lb in)
2	Heat Shield
3	Knock Sensor Fastener Tighten 23 N.m (17 lb ft)
4	Knock Sensor Procedure Disconnect the knock sensor electrical connector.

AIR CLEANER ELEMENT REPLACEMENT

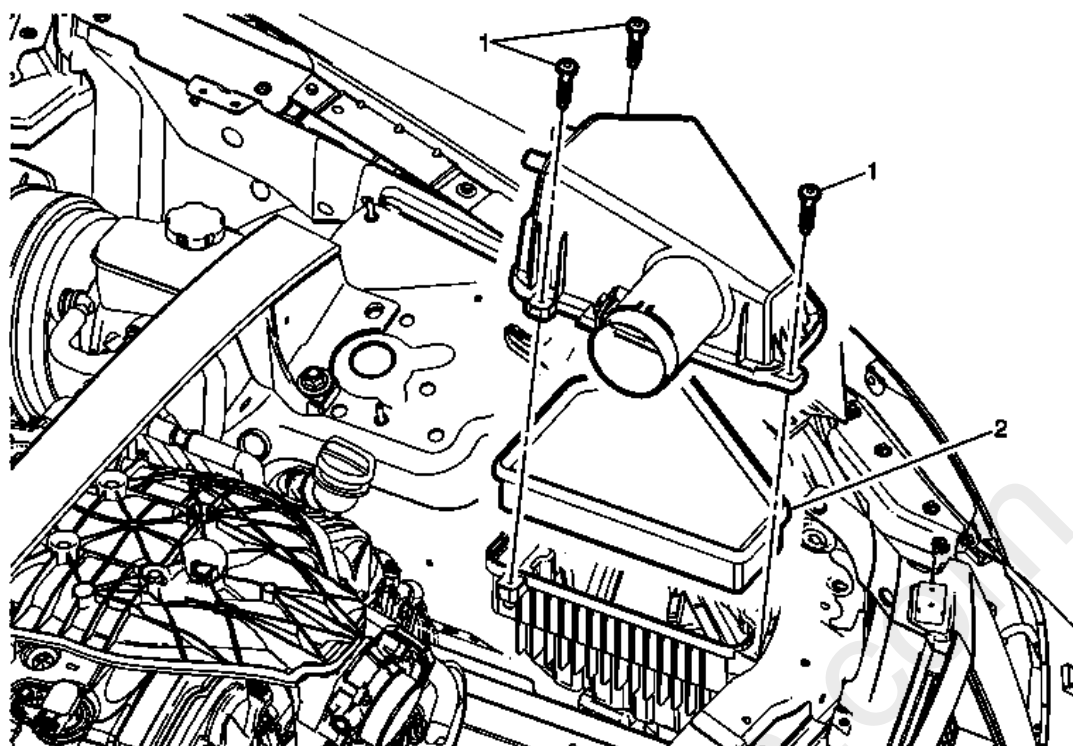


Fig. 155: Air Cleaner Element & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Element Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the sight shield. Refer to <u>Front Compartment Side Sight Shield Replacement</u> . 2. Disconnect the air cleaner duct from the air cleaner assembly. Refer to <u>Air Cleaner Outlet Duct Replacement</u>.	
1	Air Cleaner Assembly Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 N.m (35 lb in)
2	Air Cleaner Element Procedure 1. Reposition the surge tank bypass hose as necessary. 2. Disconnect the electrical connectors.

AIR CLEANER ASSEMBLY REPLACEMENT

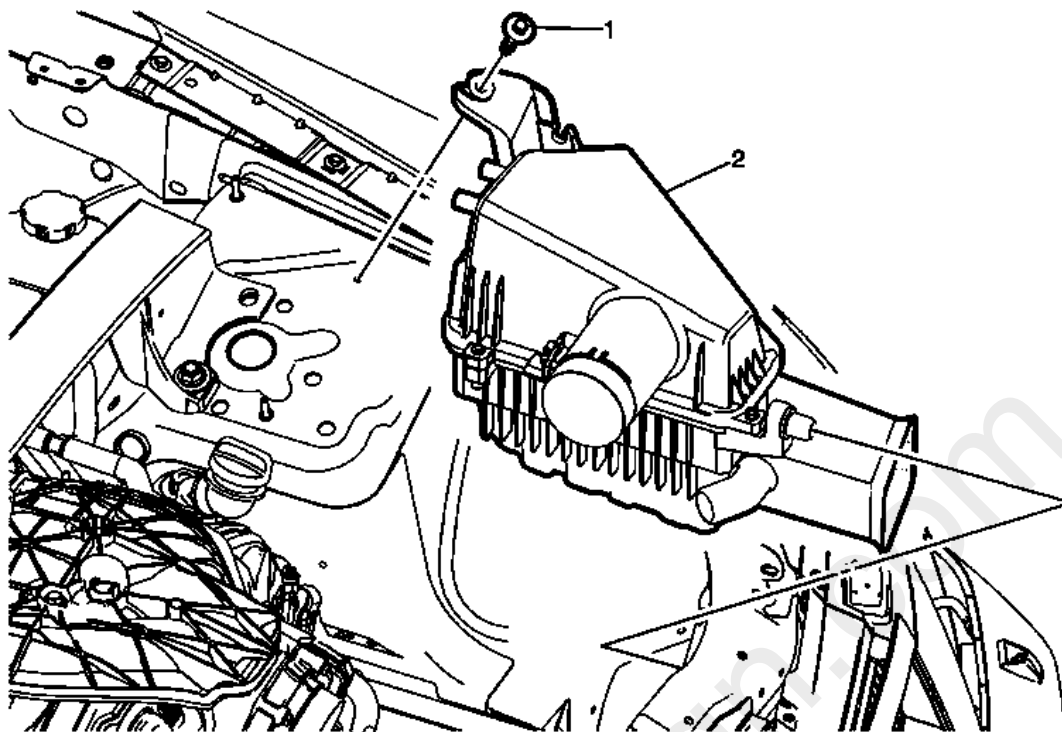


Fig. 156: Air Cleaner Assembly & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Assembly Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the sight shield. Refer to <u>Front Compartment Side Sight Shield Replacement</u> . 2. Remove the air cleaner duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u>. 3. Disconnect the MAF/IAT sensor electrical connector.	
1	Air Cleaner Assembly Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Air Cleaner Assembly Procedure

1. Reposition the surge tank bypass hose as necessary.
2. Disconnect the electrical connectors.
3. Tilt the assembly rear upward while disengaging the air cleaner isolator.

AIR CLEANER OUTLET DUCT REPLACEMENT

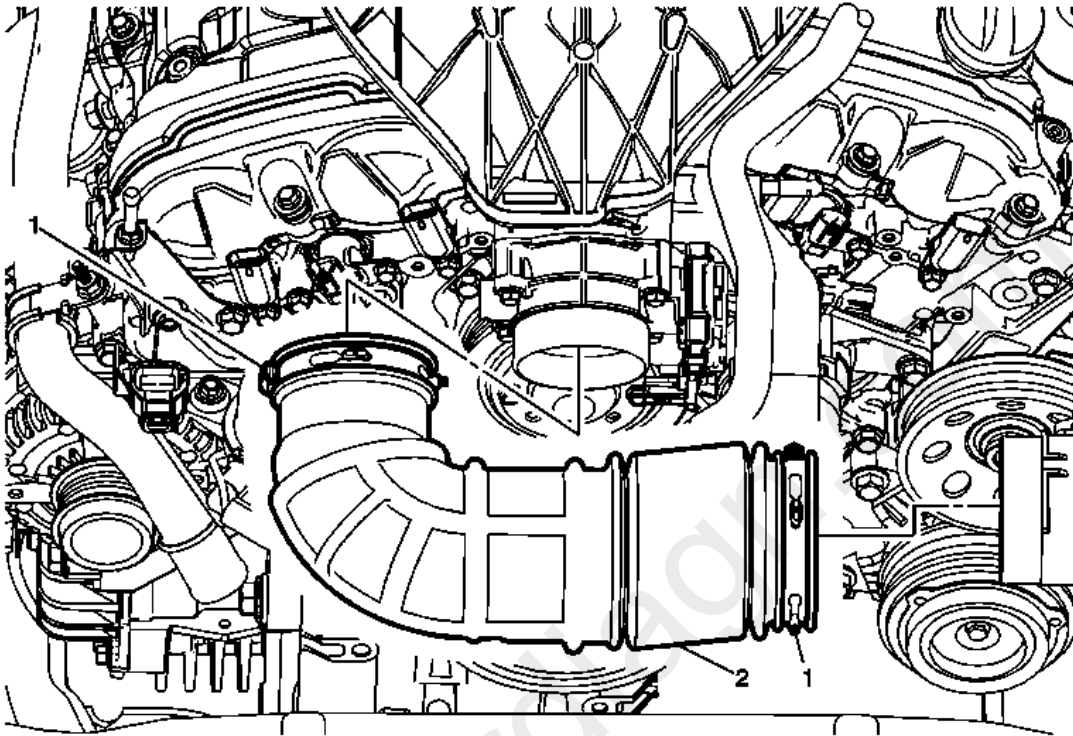


Fig. 157: Air Cleaner Outlet Duct Hose & Clamps
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the PVC pipe from the air cleaner outlet duct. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement</u> .	
1	Air Cleaner Outlet Duct Hose Clamps (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 N.m (35 lb in)

cardiagn.com