

[2009 Chevrolet Traverse](#) | [Acadia, Enclave, OUTLOOK, Traverse \(VIN R/V\) Service Manual](#) | [Engine](#) | [Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L](#) | [Specifications](#) | Document ID: 552804

## Temperature Versus Resistance - Engine Coolant Temperature Sensor

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
<b>Engine Coolant Temperature (ECT)</b>		
-40/-40	40,490	50,136
-20/-4	14,096	16,827
-10/14	8,642	10,152
0/32	5,466	6,326
20/68	2,351	2,649
25/77	1,941	2,173
40/104	1,118	1,231
60/140	573	618
80/176	313	332
100/212	182	191
120/248	109	116
140/284	068	074

## Temperature Versus Resistance - Intake Air Temperature Sensor

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
<b>Intake Air Temperature (IAT) Sensor</b>		
-40/-40	35,140	43,760
-20/-4	12,660	15,120
-10/14	7,943	9,307
0/32	5,119	5,892
20/68	2,290	2,551
25/77	1,900	2,100
40/104	1,096	1,238
60/140	565	654
80/176	312	370
100/212	184	222
120/248	114	141
140/284	74	93

## Altitude Versus Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

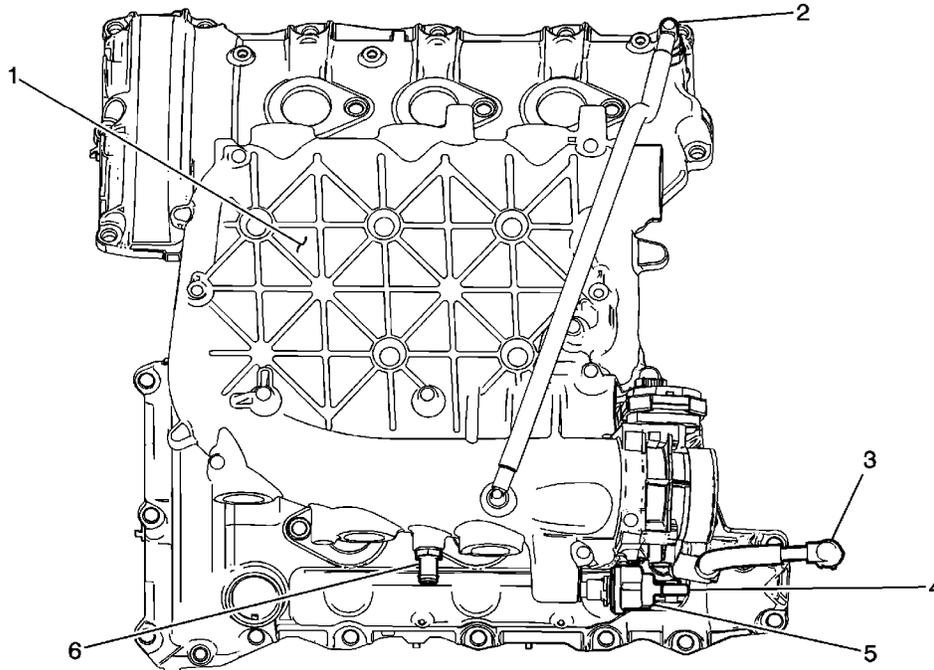
## Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-2-3-4-5-6	
Spark Plug Gap (non-adjustable)	1.10 mm	0.044 in
Spark Plug Torque	20 N·m	15 lb ft
Spark Plug Type	AC 41-990	

## Fastener Tightening Specifications

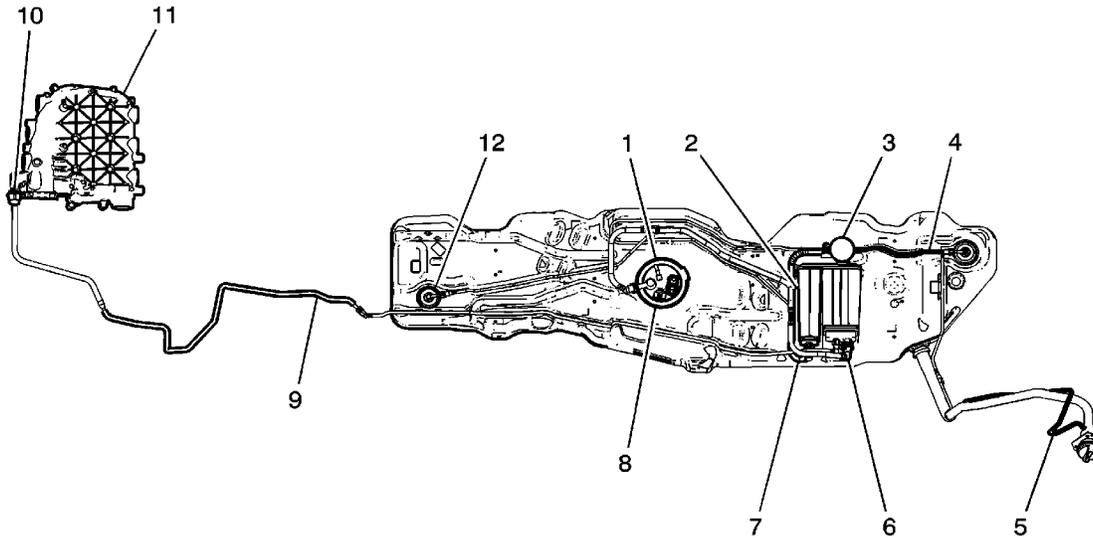
Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor Bolt	8 N·m	71 lb in
Air Cleaner Lower Housing Screw	9 N·m	80 lb in
Air Cleaner Outlet Duct Clamp	4 N·m	35 lb in
Camshaft Position (CMP) Actuator Solenoid Valve Bolt	10 N·m	89 lb in
Camshaft Position (CMP) Sensor Bolt	10 N·m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N·m	89 lb in
Engine Control Module (ECM) Bracket Bolt	6 N·m	53 lb in
Engine Coolant Temperature (ECT) Sensor	22 N·m	16 lb ft
Evaporative Emission (EVAP) Purge Solenoid Valve Bracket Bolt	10 N·m	89 lb in
Fuel Feed/Evaporative Emission (EVAP) Pipe Clip Bolt	8 N·m	71 lb in
Fuel Feed/Evaporative Emission (EVAP) Pipe Clip Nut	9 N·m	80 lb in
Fuel Rail Bolt	10 N·m	89 lb in
Fuel Tank Fill Hose Clamp	3.3 N·m	29 lb in
Fuel Tank Fill Pipe Bracket Bolt	12 N·m	106 lb in
Fuel Tank Fill Pipe Housing to Fuel Tank Fill Pipe Bolt	2 N·m	18 lb in
Fuel Tank Strap Bolt	47 N·m	35 lb ft
Heated Oxygen Sensor (HO2S)	42 N·m	31 lb ft
Intake Manifold Tuning Valve Bolt	10 N·m	89 lb in
Ignition Coil Bolt	10 N·m	89 lb in
Knock Sensor Bolt	23 N·m	17 lb ft
Mass Air Flow (MAF)/Intake Air Temperature Sensor Screw	4 N·m	35 lb in
Manifold Absolute Pressure (MAP) Sensor Bolt	10 N·m	89 lb in
Power Steering Fluid Reservoir Bracket Bolt	9 N·m	80 lb in
Spark Plug	20 N·m	15 lb ft
Throttle Body Bolt	10 N·m	89 lb in
Underhood Bussed Electrical Center (UBEC) Bracket Bolt/Nut	10 N·m	89 lb in

## Emission Hose Routing Diagram



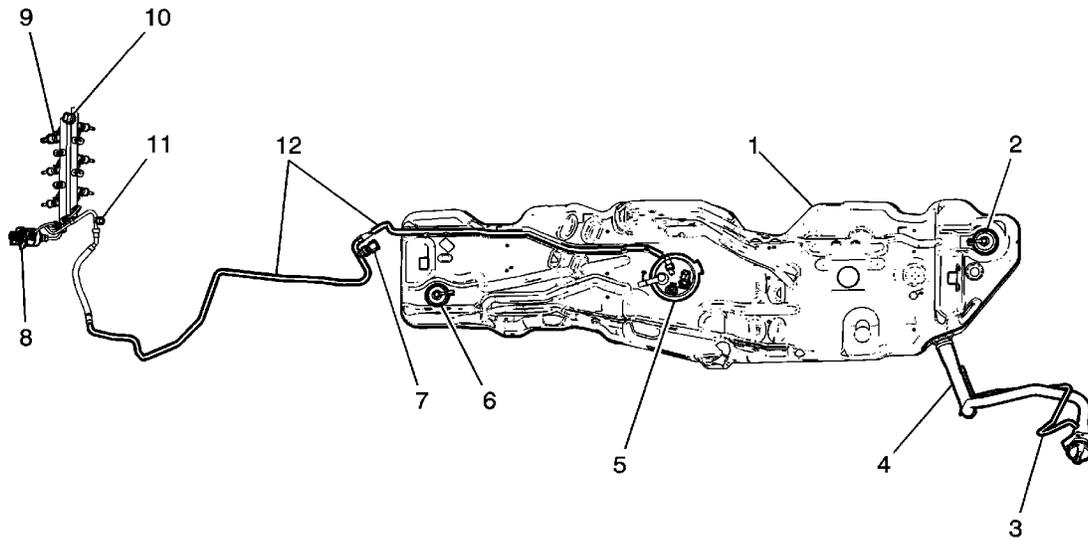
- (1) Intake Manifold
- (2) Positive Crankcase Ventilation (PCV) Orifice
- (3) PCV Fresh Air Inlet Hose
- (4) Hose/Pipe to Evaporative Emission (EVAP) Canister
- (5) EVAP Purge Valve
- (6) To Brake Booster

## Evaporative Emissions Hose Routing Diagram



- (1) Fuel Tank Module
- (2) Evaporative Emission (EVAP) Canister
- (3) EVAP Canister Vent Solenoid Valve
- (4) Rollover Valve/Fuel Tank Vent to EVAP Canister
- (5) Fuel Fill Tube Vapor Recirculation Hose/Pipe
- (6) Vapor Pipe to Fuel Tank Module
- (7) Fresh Air Vent Pipe to EVAP Vent Solenoid Valve
- (8) Fuel Tank Pressure (FTP) sensor
- (9) EVAP Canister Purge Pipe
- (10) EVAP Canister Purge Solenoid Valve
- (11) Intake Manifold
- (12) Rollover Valve/Fuel Tank Vent to EVAP Canister

## Fuel Hose/Pipes Routing Diagram



- (1) Fuel Tank
- (2) Fuel Tank Rollover Vent Valve
- (3) Fuel Fill Tube Vapor Recirculation Hose/Pipe
- (4) Fuel Fill Tube
- (5) Fuel Tank Module
- (6) Fuel Tank Rollover Vent Valve
- (7) Fuel Feed Pressure Sensor
- (8) Fuel Rail Pressure (FRP) Regulator/High Pressure Fuel Pump
- (9) Fuel Rail and Fuel Injectors
- (10) FRP Sensor
- (11) Fuel Pressure Test Connection
- (12) Fuel Feed Hose/Pipe

## Engine Control Module Replacement

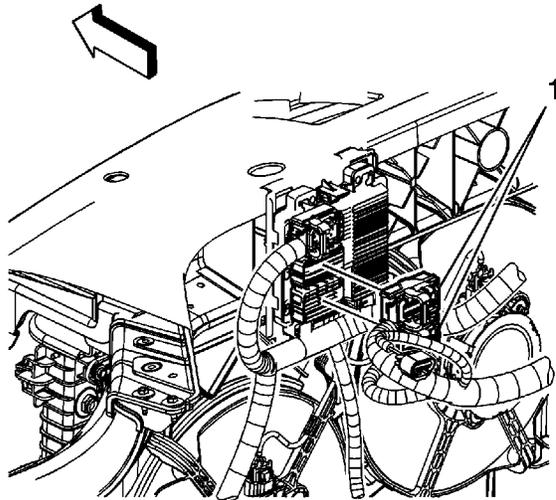
### Caution:

- 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.

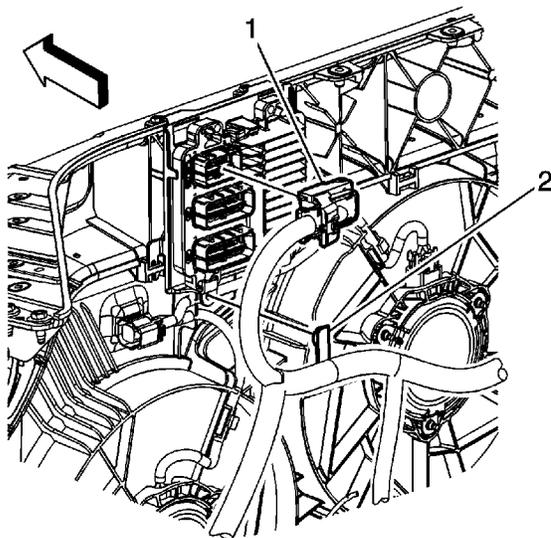
**Note:** It is necessary to record the remaining engine oil life. If the replacement module is not programmed with the remaining engine oil life, the engine oil life will default to 100 percent. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5 000 km (3,000 mi) from the last engine oil change.

**Note:** It is necessary to record the remaining automatic transmission fluid life. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid life will default to 100 percent. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid will need to be changed at 83 000 km (50,000 mi) from the last automatic transmission fluid change.

## Removal Procedure

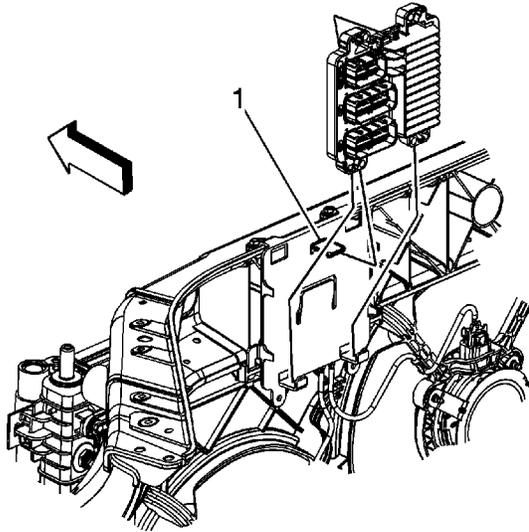


1. Turn the ignition OFF.
2. Using a scan tool, retrieve the percentage of remaining engine oil and the remaining automatic transmission fluid life. Record the remaining engine oil and the remaining automatic transmission fluid life.
3. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
4. Disconnect the engine wiring harness middle and lower electrical connectors (1) from the ECM.

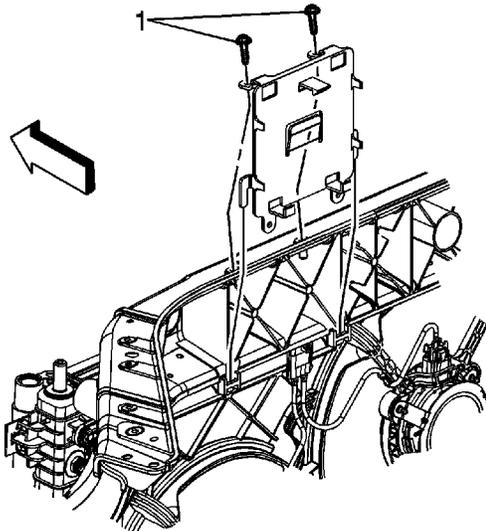


5. If also replacing the ECM bracket, remove the engine wiring harness clip (2) from the ECM bracket tab.
6. Disconnect the engine wiring harness upper electrical connector (1) from the ECM.

**Caution:** In order to prevent any possible electrostatic discharge damage to the ECM, do not touch the connector pins.



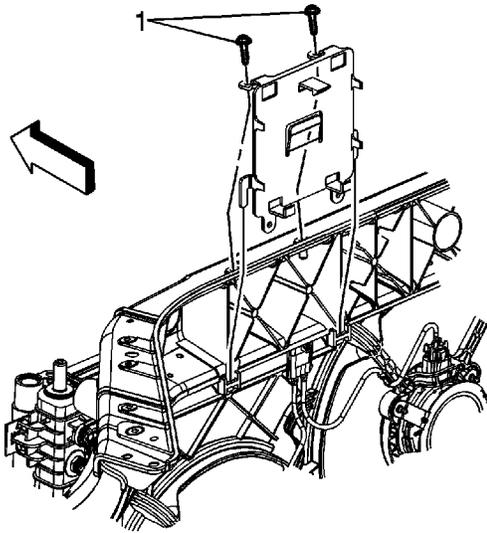
7. Gently lift up the retaining tab (1) and lift the ECM up and out of the support brackets on the ECM bracket.



8. If necessary, remove the ECM bracket bolts (1) and bracket.

## Installation Procedure

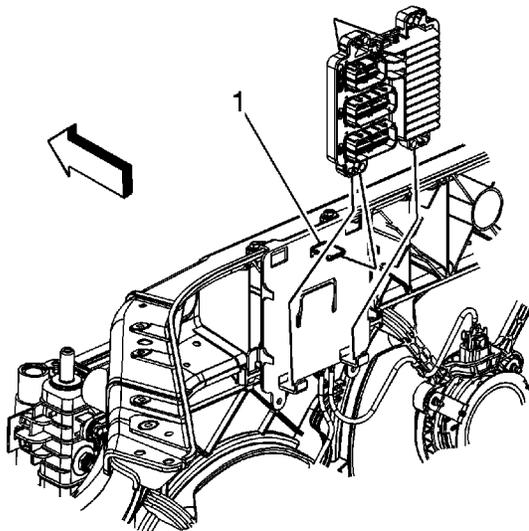
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



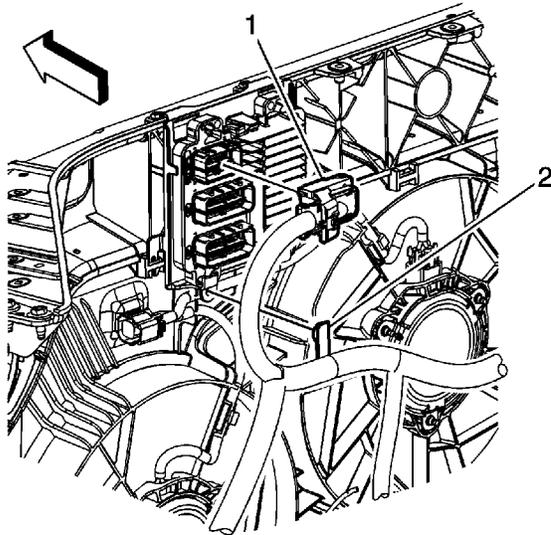
1. If necessary, position the ECM bracket and install the bolts (1).

**Tighten**

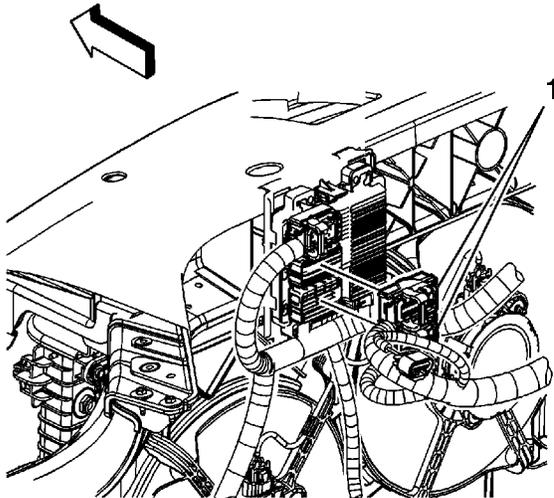
Tighten the bolts to 6 N·m (53 lb in).



2. Install the ECM onto the ECM bracket support tabs and snap the ECM into place under the retaining tab (1).



3. Connect the engine wiring harness upper electrical connector (1) to the ECM.
4. If the ECM bracket was also replaced, install the engine wiring harness clip (2) to the ECM bracket tab.



5. Connect the engine wiring harness middle and lower electrical connectors (1) to the ECM.
6. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
7. If a NEW ECM was installed, reprogram the ECM. Refer to [Engine Control Module Programming and Setup](#).

# Throttle Learn

## Description

The engine control module (ECM) learns the idle position of the throttle body to ensure the correct idle operation. Anytime the ECM or the throttle body is replaced, the ECM must learn the idle position. The engine idle may be unstable or a DTC may set if the idle position is not learned.

## Conditions for Running the Idle Learn Procedure

- DTCs P0121, P0122, P0123, P0221, P0222, P0223, P0638, P2100, P2101, P2105, and P2119 are not set.
- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The accelerator pedal position is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.
- The engine coolant temperature is between 5-85°C (41-185°F).
- The intake air temperature is between 5-60°C (41-140°F).

## Idle Learn Procedure

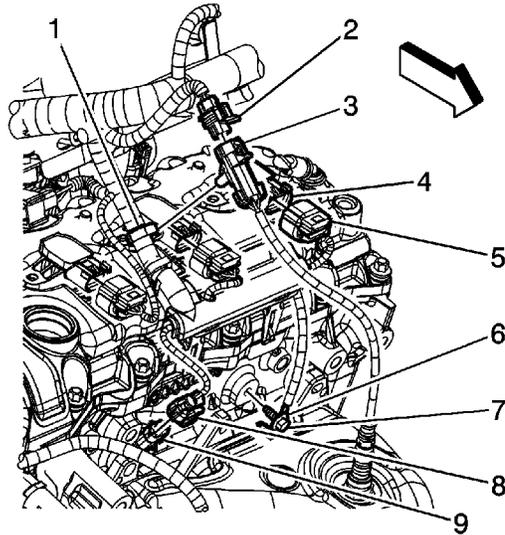
### **Note:**

- Ensure the above conditions are met before performing with this procedure.
- Do not perform this procedure if a throttle position (TP) sensor or other throttle actuator control (TAC) system DTCs are set other than P2176. The ECM will not perform the idle learn procedure with a DTC set.

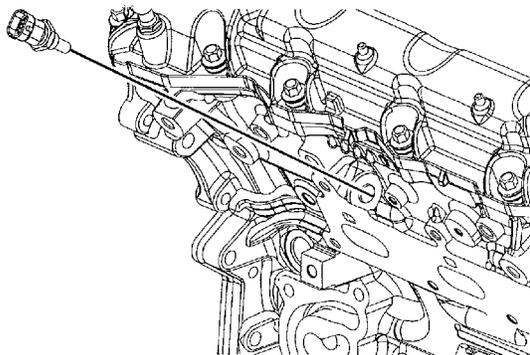
1. Turn OFF the ignition for 30 seconds.
2. Turn ON the ignition, with the engine OFF for 60 seconds.
3. Turn OFF the ignition.
4. Turn ON the ignition, with the engine OFF.
5. Clear the DTCs with a scan tool.

## Engine Coolant Temperature Sensor Replacement

### Removal Procedure



1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
2. Slide the electrical connector heat shield up the wiring harness.
3. Disconnect the engine wiring harness electrical connector (8) from the engine coolant temperature (ECT) sensor (9).

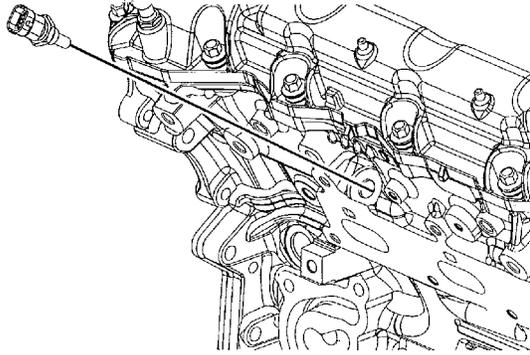


4. Remove the ECT sensor.

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## Installation Procedure

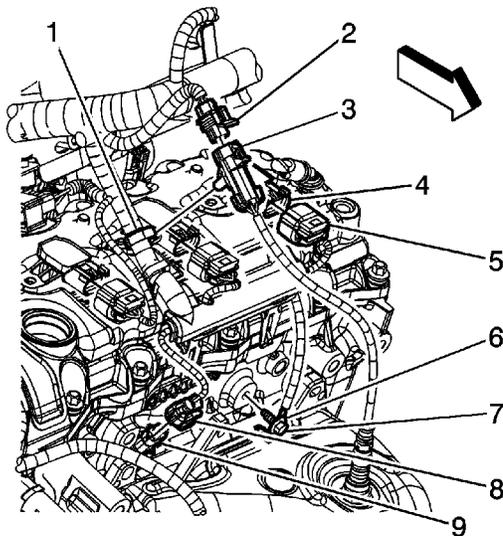
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



1. Install the ECT sensor.

### Tighten

Tighten the sensor to 22 N·m (16 lb ft).

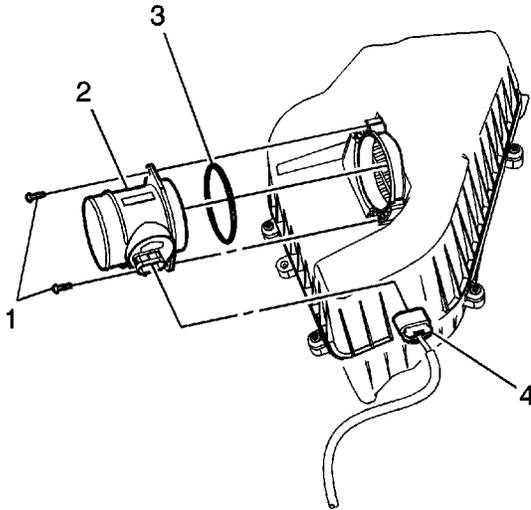


2. Connect the engine wiring harness electrical connector (8) to the ECT sensor (9).
3. Slide the electrical connector heat shield down over the connector.

4. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).

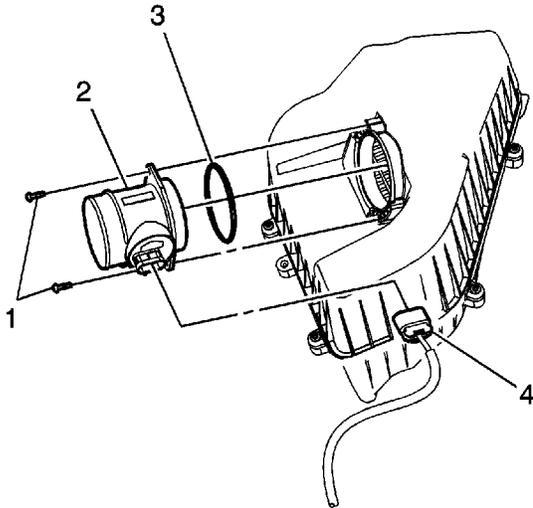
# Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

## Removal Procedure



1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
2. Disconnect the engine wiring harness electrical connector (4) from the mass air flow (MAF)/intake air temperature (IAT) sensor.
3. Remove the MAF/IAT sensor screws (1).
4. Remove the MAF/IAT sensor (2) from the air cleaner assembly.
5. Remove the MAF/IAT sensor seal (3).

## Installation Procedure



1. Install the MAF/IAT sensor seal (3) onto the MAF/IAT sensor.
2. Install the MAF/IAT sensor (2) to the air cleaner assembly.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

3. Install the MAF/IAT sensor screws (1).

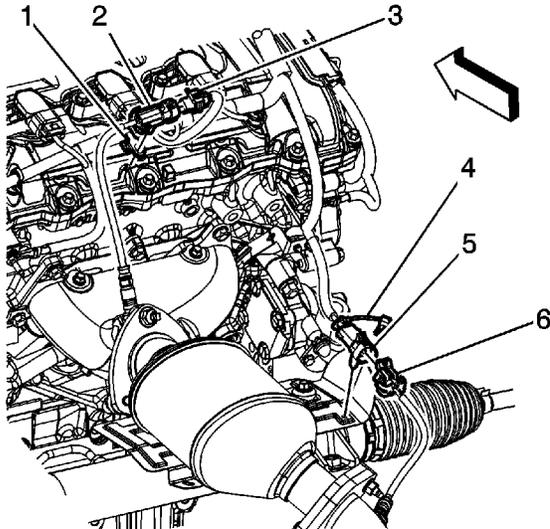
#### **Tighten**

Tighten the screws to 4 N·m (35 lb in).

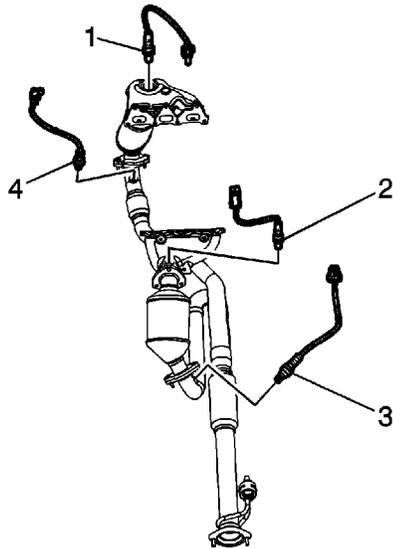
4. Connect the engine wiring harness electrical connector (4) to the MAF/IAT sensor.
5. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

## Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 Removal Procedure

**Caution:** Refer to [Heated Oxygen and Oxygen Sensor Caution](#) in the Preface section.



1. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the engine wiring harness electrical connector (3) from the heated oxygen sensor (HO2S) electrical connector (2).
3. Remove the HO2S electrical connector retainer from the engine wiring harness clip (1).

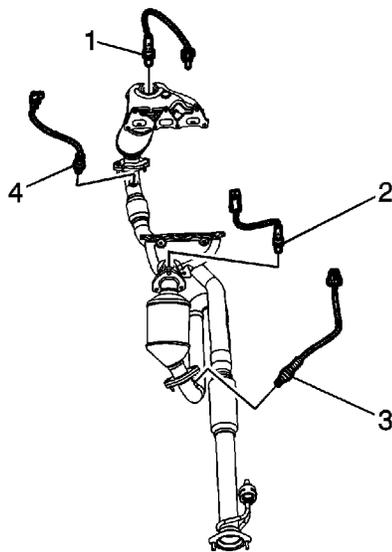




4. Remove the HO2S (2) from the exhaust manifold.

## Installation Procedure

**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 the reinstallation.



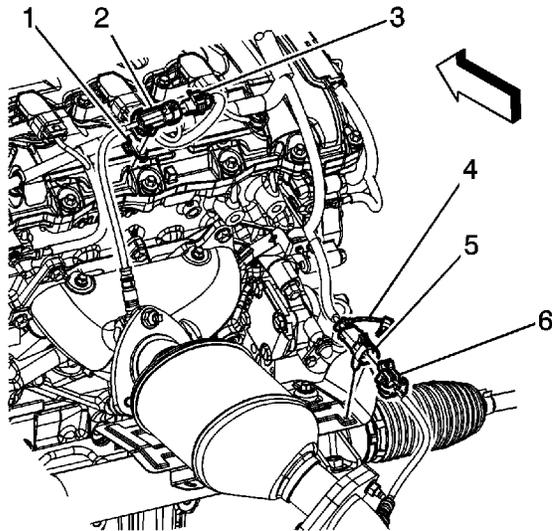
1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the HO2S (2) to the exhaust manifold.

### Tighten

Tighten the sensor to 42 N·m (31 lb ft).

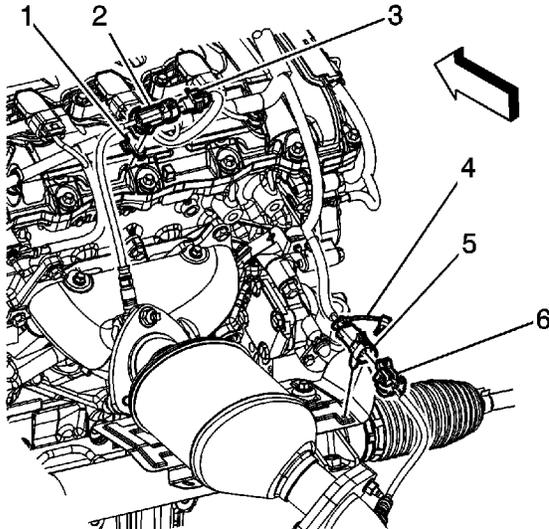


3. Connect the engine wiring harness electrical connector (3) to the HO2S electrical connector (2).
4. Install the HO2S electrical connector retainer to the engine wiring harness clip (1).
5. Lower the vehicle.

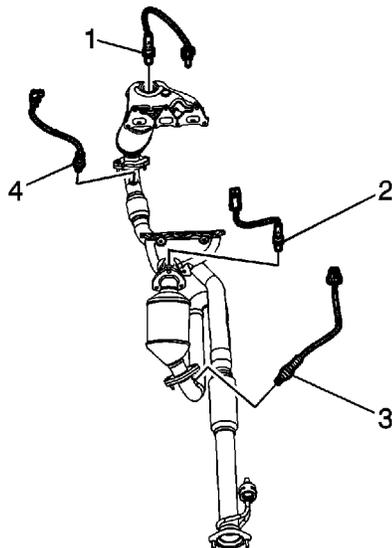
## Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

### Removal Procedure

**Caution:** Refer to [Heated Oxygen and Oxygen Sensor Caution](#) in the Preface section.



1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the connector position assurance (CPA) retainer (4).
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (6) from the engine wiring harness electrical connector (5).

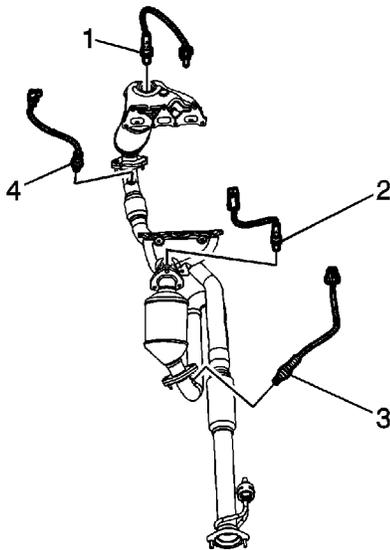




4. Remove the HO<sub>2</sub>S (3) from the exhaust pipe.

## Installation Procedure

**Note:** A special anti-seize compound is used in the HO<sub>2</sub>S 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 the reinstallation.



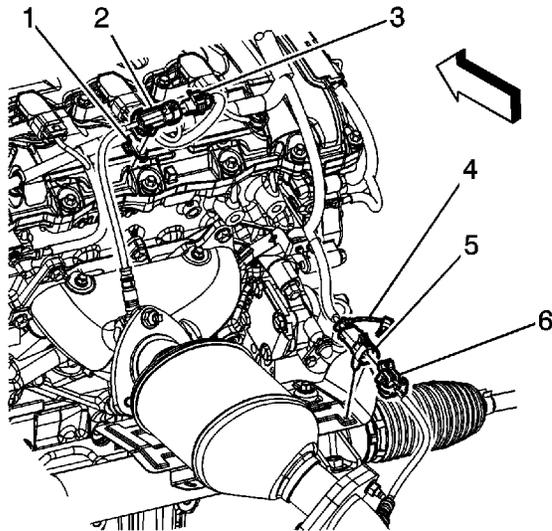
1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the HO<sub>2</sub>S (3) to the exhaust pipe.

### Tighten

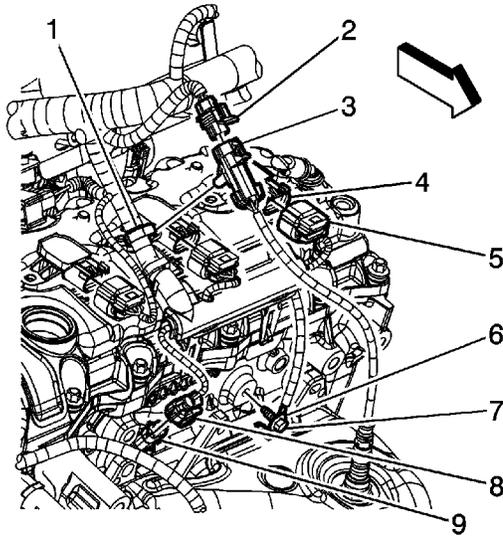
Tighten the sensor to 42 N·m (31 lb ft).



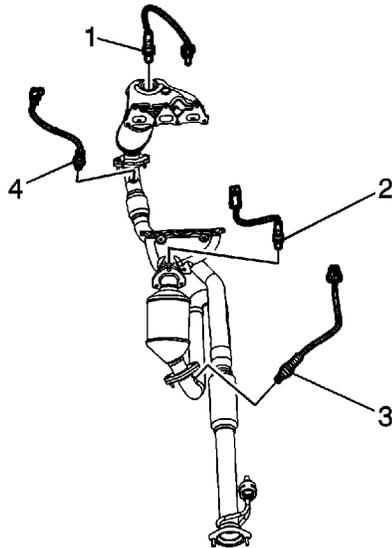
3. Connect the HO2S electrical connector (6) to the engine wiring harness electrical connector (5).
4. Install the CPA retainer (4).
5. Lower the vehicle.

## Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 Removal Procedure

**Caution:** Refer to [Heated Oxygen and Oxygen Sensor Caution](#) in the Preface section.



1. Remove the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Disconnect the engine wiring harness electrical connector (2) from the heated oxygen sensor (HO2S) electrical connector (3).
3. Remove the HO2S electrical connector retainer from the engine wiring harness clip (1).

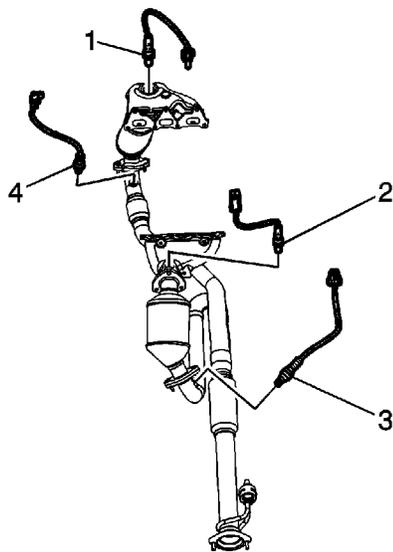




4. Remove the HO2S (1) from the exhaust manifold.

## Installation Procedure

**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 the reinstallation.



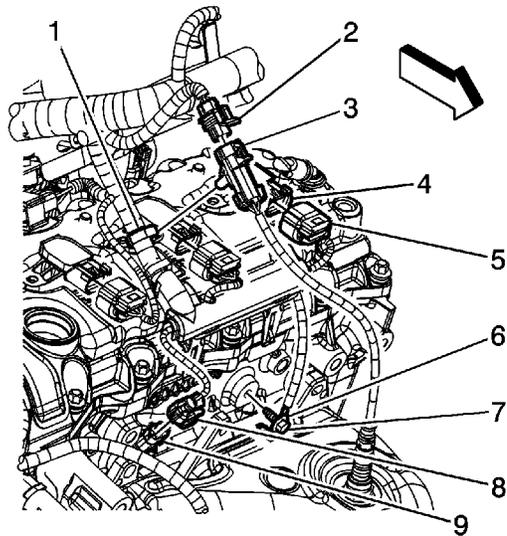
1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the HO2S (1) to the exhaust manifold.

### Tighten

Tighten the sensor to 42 N·m (31 lb ft).

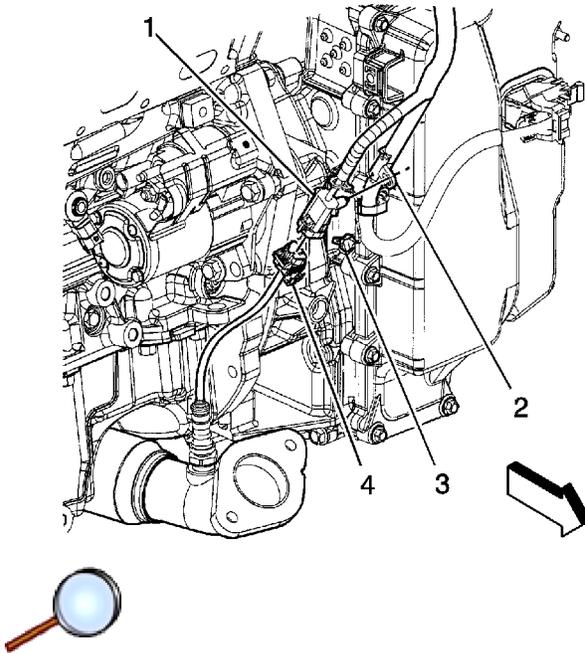


3. Connect the engine wiring harness electrical connector (2) to the HO2S electrical connector (3).
4. Install the HO2S electrical connector retainer to the engine wiring harness clip (1).
5. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

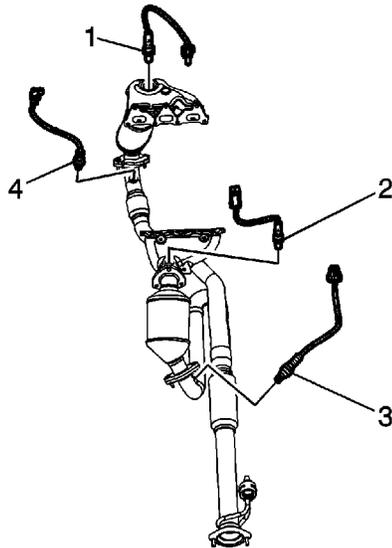
## Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

### Removal Procedure

**Caution:** Refer to [Heated Oxygen and Oxygen Sensor Caution](#) in the Preface section.



1. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the connector position assurance (CPA) retainer (3).
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (4) from the engine wiring harness electrical connector (1).

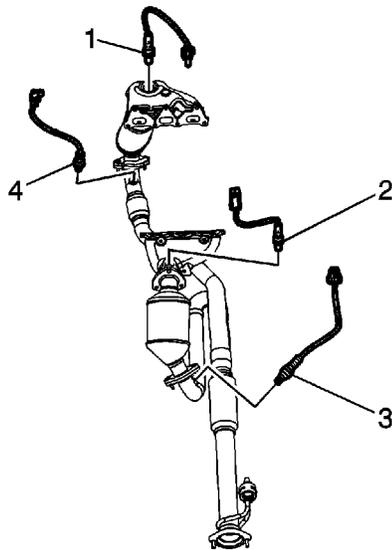




4. Remove the HO2S (4) from the exhaust pipe.

## Installation Procedure

**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 the reinstallation.



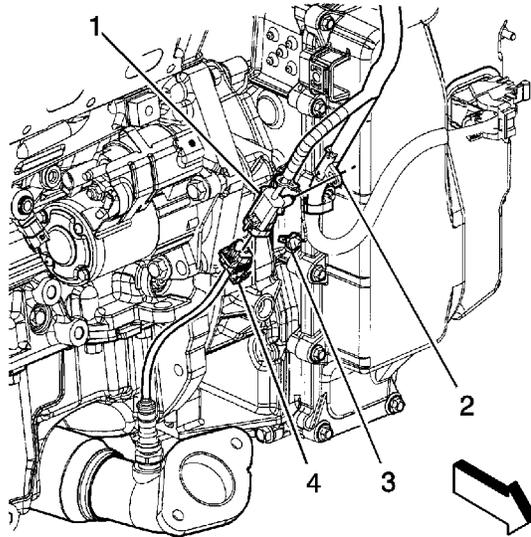
1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the HO2S (4) to the exhaust pipe.

### Tighten

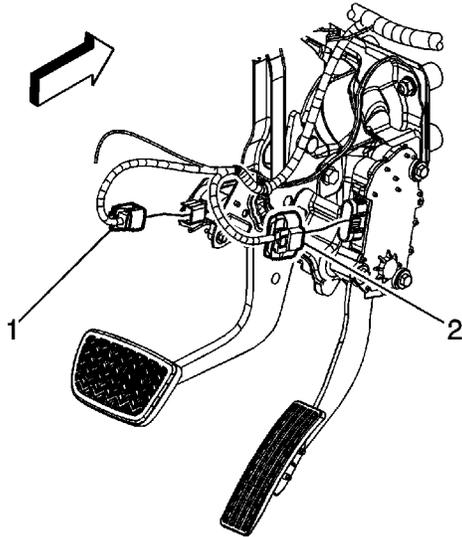
Tighten the sensor to 42 N·m (31 lb ft).



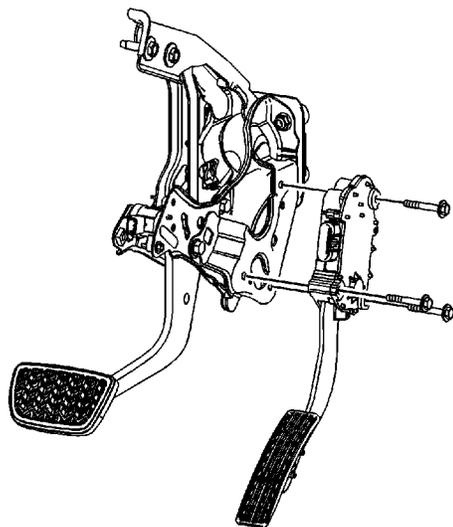
3. Connect the HO2S electrical connector (4) to the engine wiring harness electrical connector (1).
4. Install the CPA retainer (3).
5. Lower the vehicle.

## Accelerator Pedal Position Sensor Replacement

### Removal Procedure



1. Remove the left instrument panel (I/P) insulator. Refer to [Instrument Panel Insulator Panel Replacement - Left Side](#).
2. Remove the driver knee bolster. Refer to [Driver Knee Bolster Replacement](#).
3. Remove the I/P wiring harness electrical connector (2) from the accelerator pedal position (APP) sensor assembly.

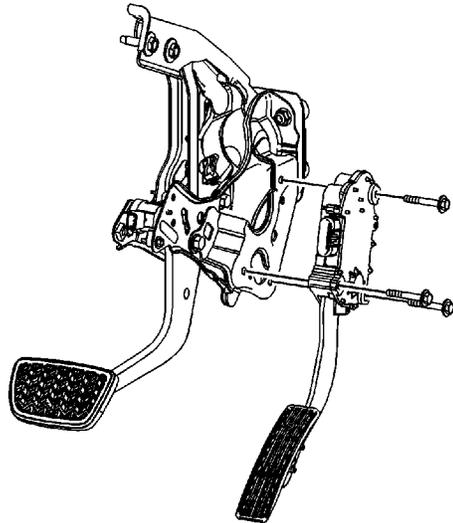


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**Note:** Due to clearance issues, the upper attachment bolt cannot be removed from the APP sensor assembly. Loosen the bolt completely and leave the bolt in the component until the assembly is removed from the vehicle.

4. Remove the APP sensor bolts and sensor assembly from the vehicle.

## Installation Procedure



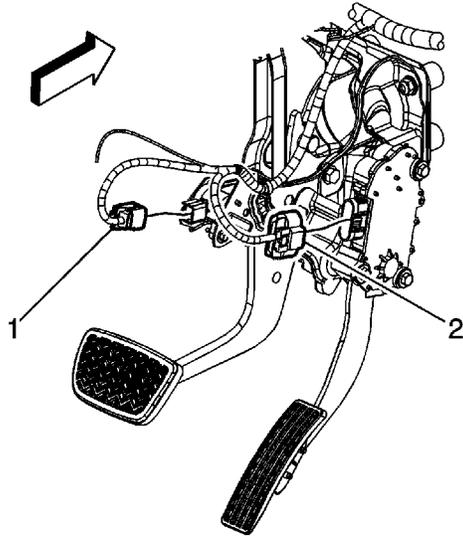
1. Install the upper bolt into the APP sensor assembly.
2. Install the APP sensor assembly into the vehicle.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

3. Install the remaining 2 lower APP sensor assembly bolts.

### **Tighten**

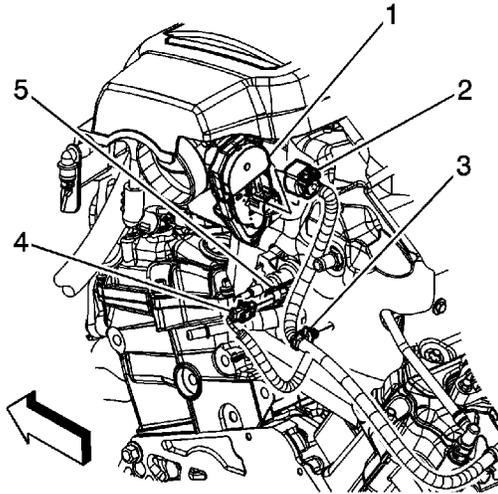
Tighten the bolts to 8 N·m (71 lb in).



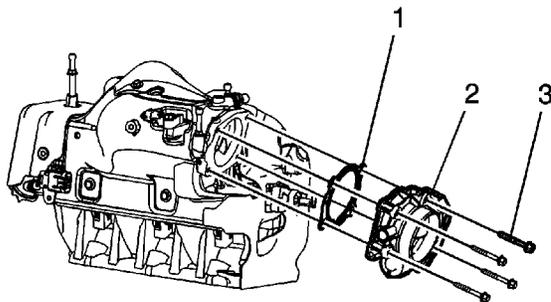
4. Install the I/P wiring harness electrical connector (2) to the APP sensor assembly.
5. Install the driver knee bolster. Refer to [Driver Knee Bolster Replacement](#).
6. Install the left I/P insulator. Refer to [Instrument Panel Insulator Panel Replacement - Left Side](#).

## Throttle Body Assembly Replacement

### Removal Procedure



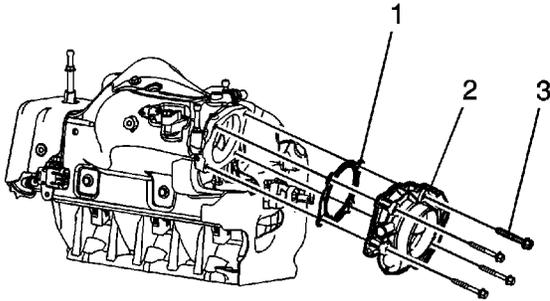
1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
2. Disconnect the engine wiring harness electrical connector (2) from the electronic throttle control (1).



3. Remove the throttle body bolts (3).
4. Remove the throttle body (2) and gasket (2). Discard the gasket.

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## Installation Procedure



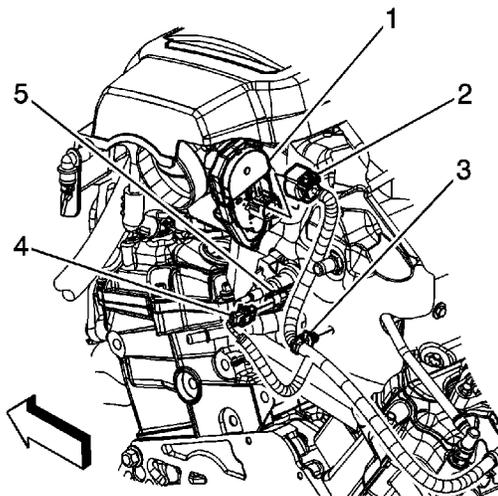
1. Position a NEW throttle body gasket (1) and throttle body (2) to the upper intake manifold.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the throttle body bolts (3).

### Tighten

Tighten the bolts to 10 N·m (89 lb in).





3. Connect the engine wiring harness electrical connector (2) to the electronic throttle control (1).
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Perform the throttle learn procedure. Refer to [Throttle Learn](#).

## Throttle Body Inspection and Cleaning

**Note:** Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. The source of the deposit is exhaust gas recirculation (EGR) gas. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected. This procedure should not be performed on vehicles with mileage under 80 450 km (50,000 mi).

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

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

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

2. Inspect the throttle body bore and the throttle valve plate for deposits. You will need to open the throttle valve in order to inspect all surfaces.

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

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM top engine cleaner, GM P/N 1052626 (Canadian P/N 993026) or AC-Delco Carburetor Tune-Up Conditioner, P/N X66-P, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

## Fuel Pressure Relief (With CH-48027)

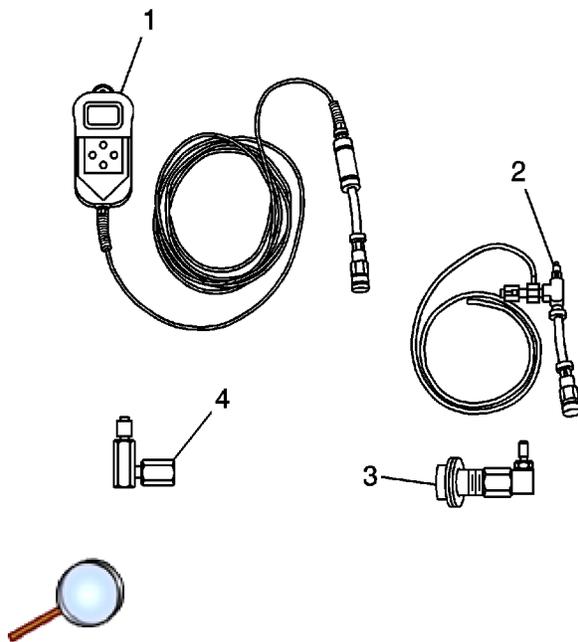
### Special Tools

CH-48027 Digital Pressure Gage

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.

**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.

1. If the fuel system requires repair, prevent fuel spillage by removing the fuel pump fuse. Refer to [Electrical Center Identification Views](#) .



2. Remove the engine cover, if required.
3. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
4. Remove the fuel rail service port cap.

**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 gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

5. Wrap a shop towel around the fuel rail service port.
6. Connect the CH-48027-3 (4) to the fuel rail service port.
7. Connect the CH-48027-2 (2) to the CH-48027-3 (4).

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8. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
9. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
10. Close the valve on the CH-48027-2 (2).
11. Remove the hose on the CH-48027-2 (2) from the 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

**Note:** If relieving the fuel pressure for the fuel pressure gage installation and removal, it is NOT necessary to proceed with the following steps.

12. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
13. Disconnect the CH-48027-3 (4) from the fuel rail service port.
14. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
15. Install the fuel rail service port cap.
16. Install the engine cover, if required.
17. Tighten the fuel fill cap.

## Fuel Pressure Relief (Without CH-48027)

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.

**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.

1. If the fuel system requires repair, prevent fuel spillage by removing the fuel pump fuse. Refer to [Electrical Center Identification Views](#) .
2. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
3. Remove the engine cover, if required.
4. Remove the fuel rail service port cap.
5. Wrap a shop towel around the fuel rail service port and using a small flat-bladed tool, depress (open) the fuel rail test port valve.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
7. Install the fuel rail service port cap.
8. Install the engine cover, if required.
9. Tighten the fuel fill cap.

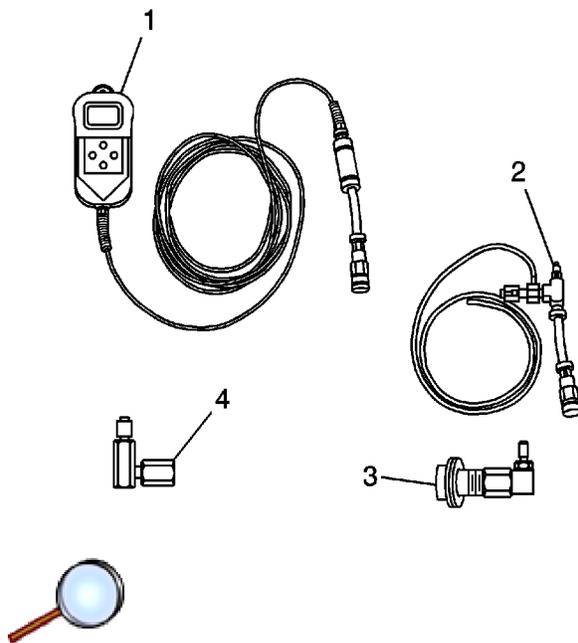
# Fuel Pressure Gage Installation and Removal

## Special Tools

[CH-48027](#) Digital Pressure Gage

## Installation Procedure

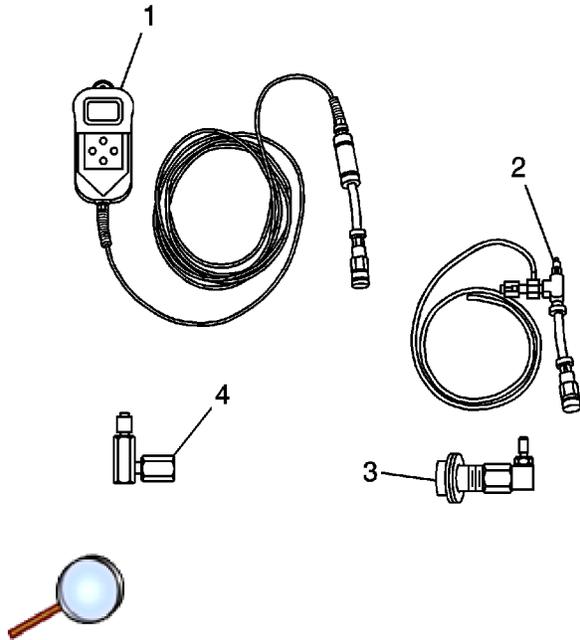
**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.



**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.

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the [CH-48027](#), refer to the manufacture's directions.

## Removal Procedure



1. Relieve the fuel system pressure, if required. Perform the following steps:

**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 gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

- 1.1. Wrap a shop towel around the fuel rail service port.
- 1.2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
- 1.3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
- 1.4. Close the valve on the CH-48027-2 (2).
- 1.5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
- 1.6. 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-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
4. Disconnect the CH-48027-3 (4) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Tighten the fuel fill cap.

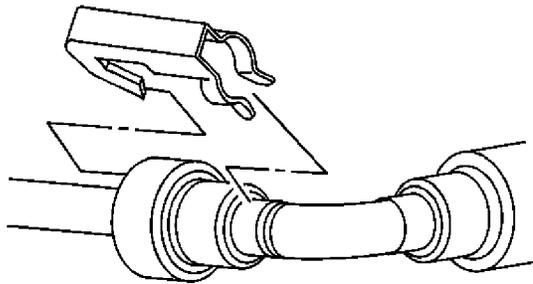
# Metal Collar Quick Connect Fitting Service

## Special Tools

J 37086-A Fuel Line Disconnect Tool Set

## Removal Procedure

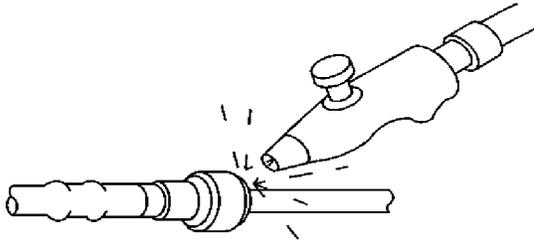
**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.



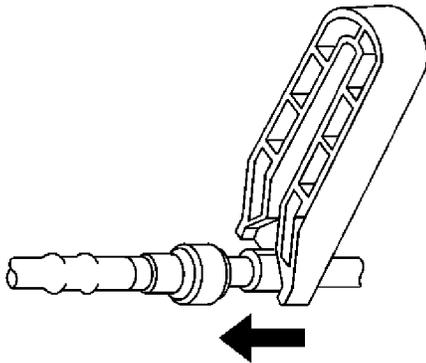
1. Relieve the fuel system pressure. Refer to the [Fuel Pressure Relief](#).
2. Remove the fuel feed line quick connect fitting retainer.

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.

**Caution:** Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) in the Preface section.

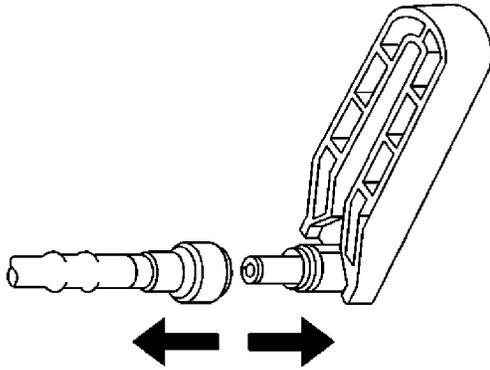


3. Blow dirt out of the fitting using compressed air.



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

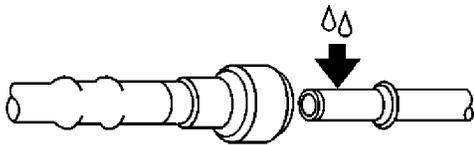
**Warning:** Refer to [Relieving Fuel Pressure Warning](#) in the Preface section.



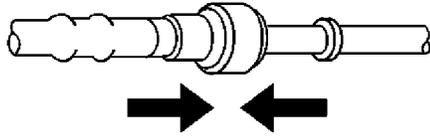
5. Pull the connection apart.
6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

## Installation Procedure

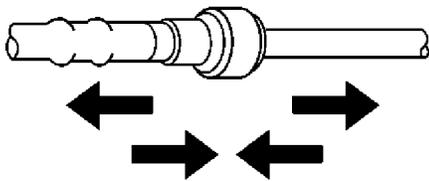
**Warning:** Refer to [Fuel Pipe Fitting Warning](#) in the Preface section.



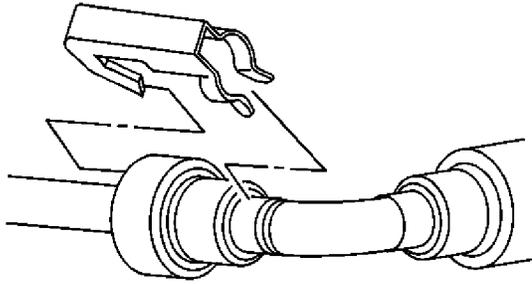
1. Apply a few drops of clean engine oil to the male pipe end.



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



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

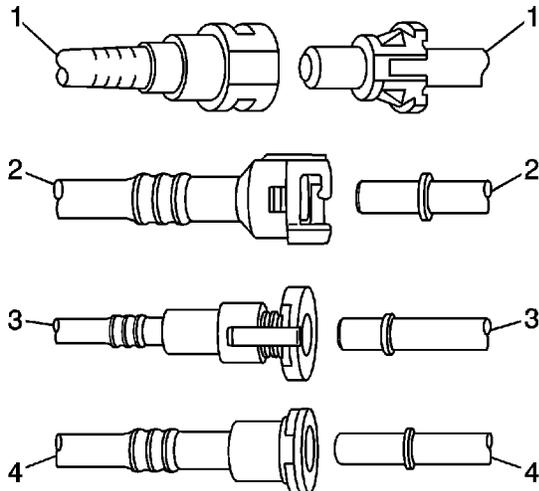


4. Install the retainer to the quick-connect fitting.

## Plastic Collar Quick Connect Fitting Service

### Removal Procedure

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.



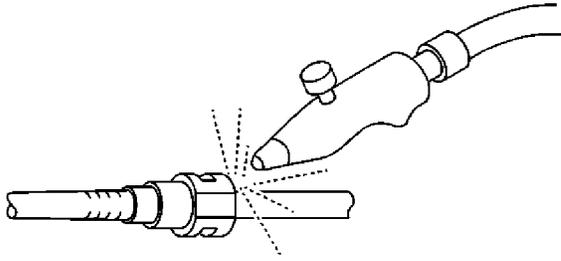
**Note:** There are several types of plastic collar fuel and evaporative emission quick connect fittings used on this vehicle.

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)

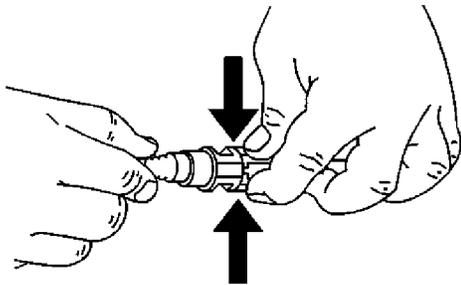
1. Relieve the fuel system pressure. Refer to the [Fuel Pressure Relief](#).

**Warning:** Refer to [Safety Glasses Warning](#) in the Preface section.

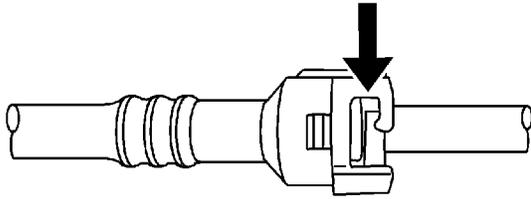
**Caution:** Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) in the Preface section.



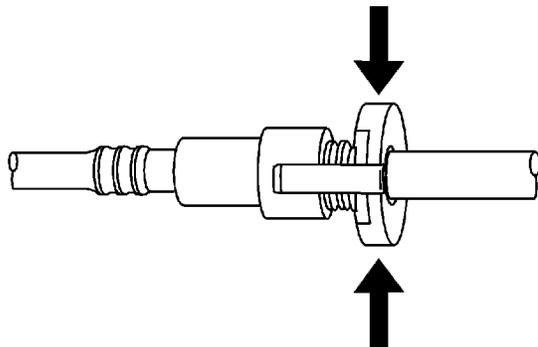
2. Using compressed air, blow any dirt out of the quick-connect fitting.



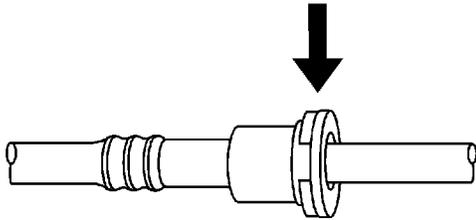
3. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick connect fitting release tabs.



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

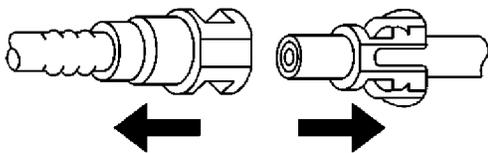


5. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick connect fitting.



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

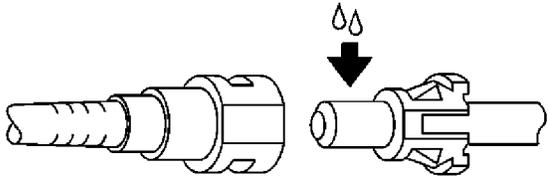
**Warning:** Refer to [Relieving Fuel Pressure Warning](#) in the Preface section.



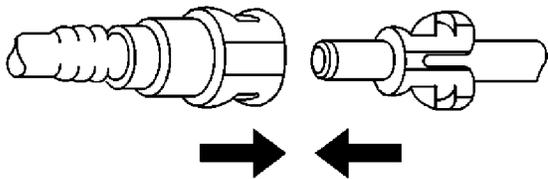
7. Pull the connection apart.

## Installation Procedure

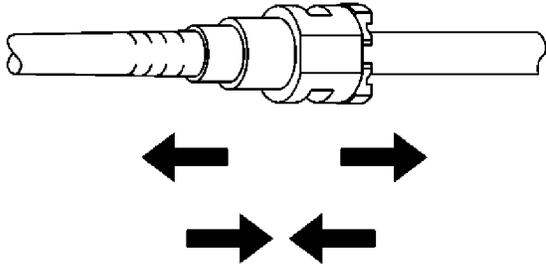
**Warning:** Refer to [Fuel Pipe Fitting Warning](#) in the Preface section.



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



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



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

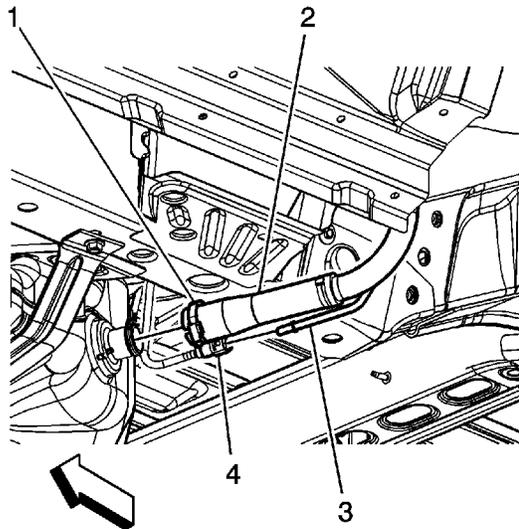
## Fuel Tank Draining

### Special Tools

[J 45004](#) Fuel Tank Drain Hose

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

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



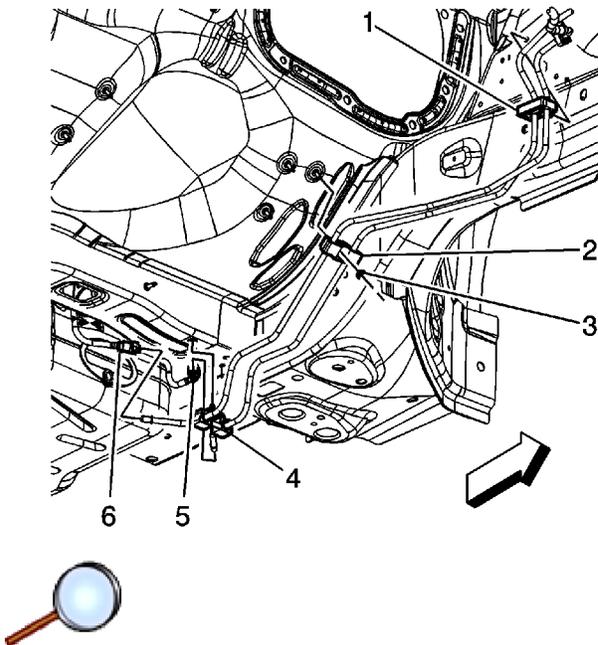
1. Remove the fuel fill cap.
2. Insert the [J 45004](#) into the fuel tank through the fuel tank fill pipe until the hose reaches the bottom of the fuel tank.
3. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.
4. Remove the [J 45004](#) from the fuel tank fill pipe.
5. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
6. Loosen the fuel tank fill hose clamp (1) at the fuel tank.
7. Disconnect the evaporative emission (EVAP) canister vent rear pipe quick connect fitting (4) from the recirculation line on the fuel fill pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).
8. Separate the fuel tank fill hose from the fuel tank.
9. Insert the [J 45004](#) into the fuel tank through the fuel tank opening.
10. Use the hand or air operated pump device again, drain as much fuel from the fuel tank as possible.

## Fuel Tank Replacement

### Removal Procedure

**Warning:** Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

**Warning:** Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.

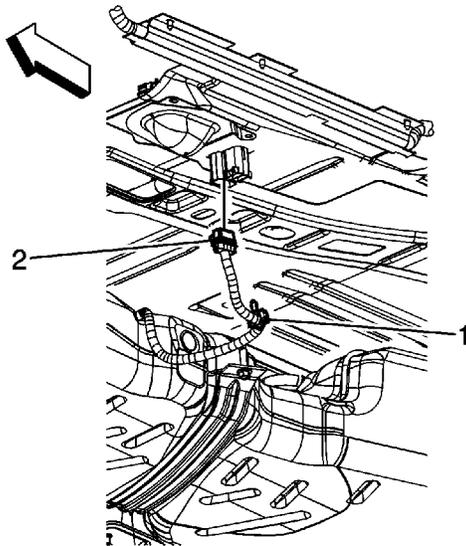


1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Drain the fuel tank. Refer to [Fuel Tank Draining](#).

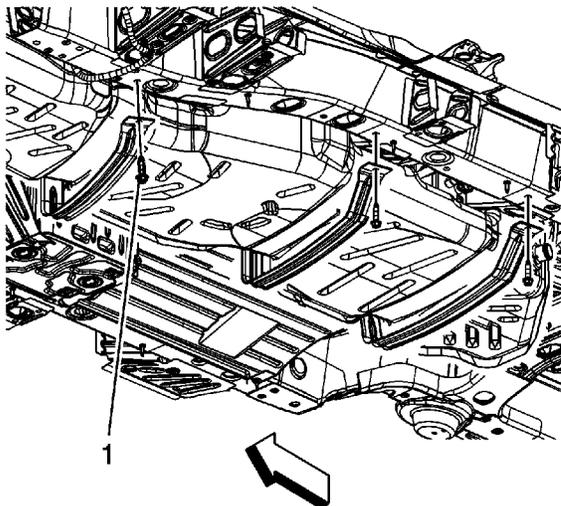
**Warning:** Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

**Caution:** Clean all fuel pipe connections and surrounding areas before disconnecting the fuel pipes to avoid contamination of the fuel system.

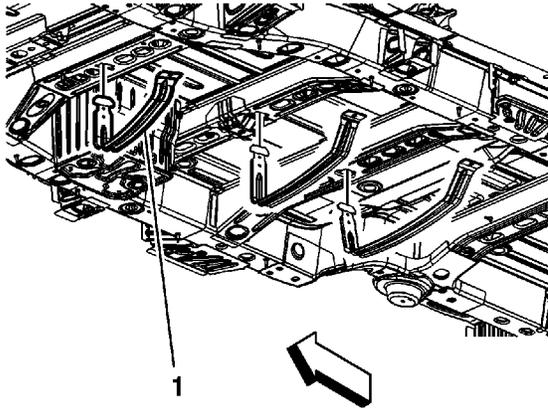
3. Disconnect the fuel pump fuel feed line quick connect fitting (6) from the chassis fuel line. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Disconnect the fuel tank evaporative emission (EVAP) canister vent front pipe quick connect fitting (5) from the chassis EVAP line. Refer to [Plastic Collar Quick Connect Fitting Service](#).



5. Disconnect the vent hose from the left rear of the fuel tank.
6. Disconnect the fuel sender wiring harness electrical connector (2) from the body wiring harness electrical connector.
7. Remove the fuel sender wiring harness clip (1) from the underbody side rail extension.

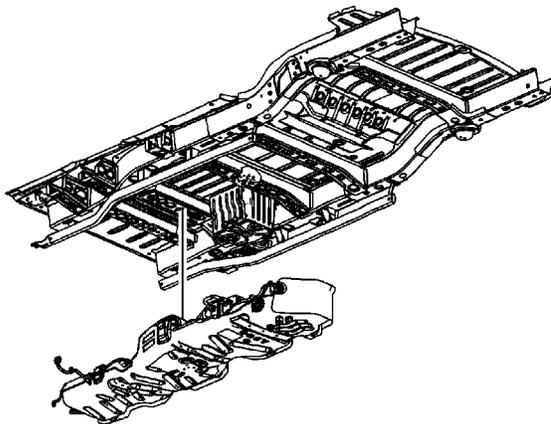


8. Remove the left underbody side rail. Refer to [Underbody Rear Side Rail Replacement](#).
9. Support the fuel tank with a suitable adjustable jack.
10. Remove the fuel tank strap bolts (1). Allow the fuel tank straps to hang.

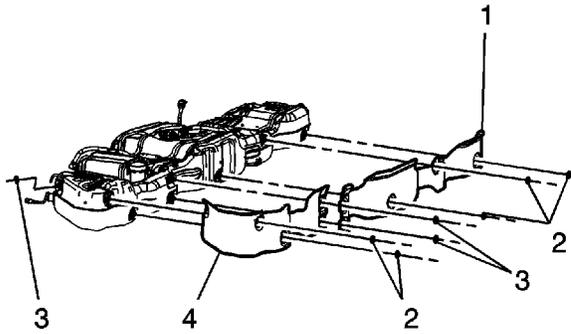


**Caution:** Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.

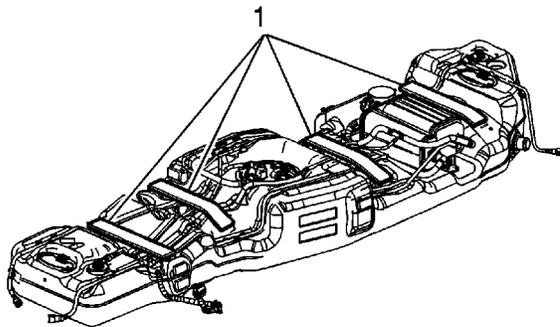
11. Push up on the rear of the strap slightly and rotate the strap towards the rear of the vehicle, in order to remove the fuel tank straps (1).



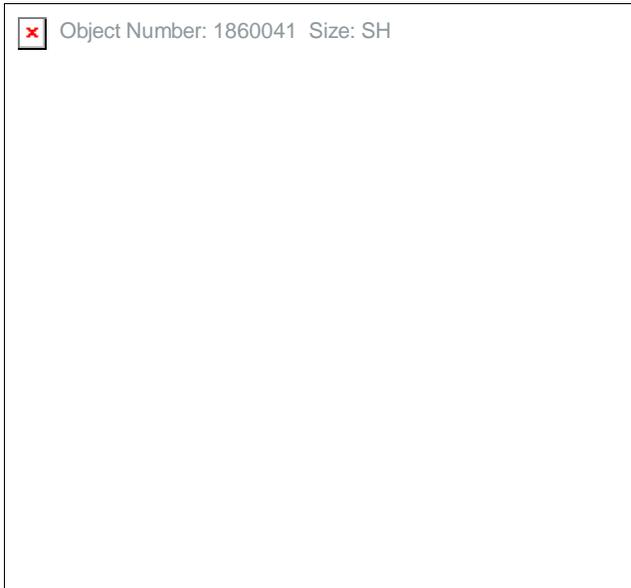
12. Using the adjustable jack and the aid of an assistant, lower the fuel tank from the underbody of the vehicle.
13. With the aid of the assistant, remove the fuel tank from the adjustable jack, and place on a flat work surface.



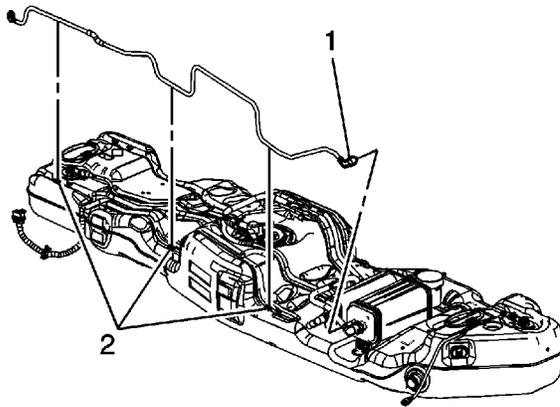
14. If replacing the fuel tank, perform the following steps, otherwise proceed to step 21 in the installation procedure.
15. Remove the fuel tank front and rear shield push on nuts (2).
16. Remove the fuel tank front and rear shield nuts (3).
17. Remove the fuel tank front (1) and rear (4) shields.



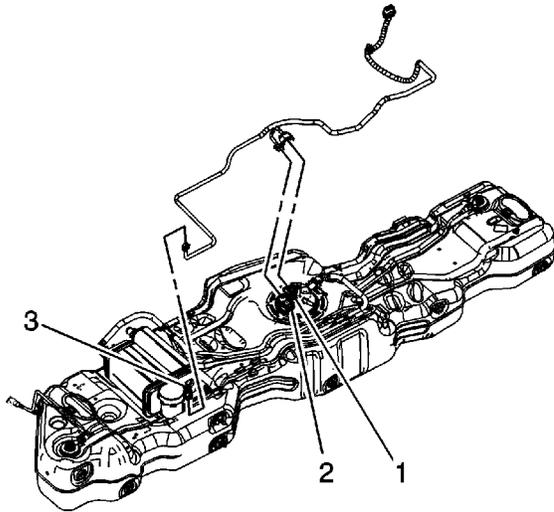
18. Remove the foam pad insulators (1) from the top of the fuel tank.



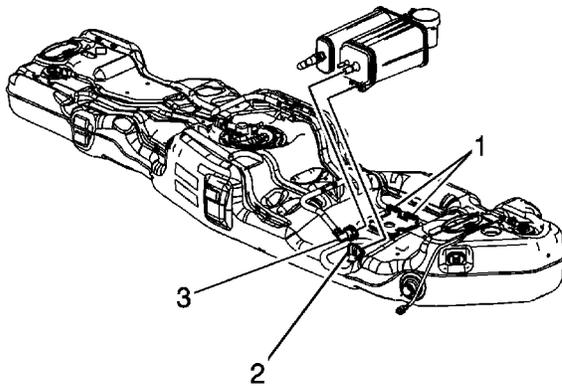
19. Disconnect the fuel pump fuel feed line quick connect fitting (1) from the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
20. Remove the fuel pump fuel feed line from the retaining features (2) built into the fuel tank and out from under the EVAP canister vent rear pipe.



21. Disconnect the EVAP canister vent front pipe quick connect fitting (1) from the EVAP canister. Refer to [Plastic Collar Quick Connect Fitting Service](#).
22. Remove the EVAP canister vent front pipe from the retaining features (2) built into the fuel tank.



23. Disconnect the fuel sender wiring harness electrical connectors from the fuel tank module (1), fuel tank pressure sensor (2), and EVAP canister vent solenoid (3).
24. Remove the fuel sender wiring harness.

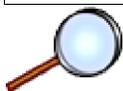


25. Disconnect the EVAP canister vent rear pipe quick connect fitting (1) from the EVAP canister. Refer to [Plastic Collar Quick Connect Fitting Service](#).
26. Squeeze the retainer (2) in order to disengage the retainer from the EVAP canister, and remove the EVAP canister assembly from the EVAP canister bracket retainers (1).



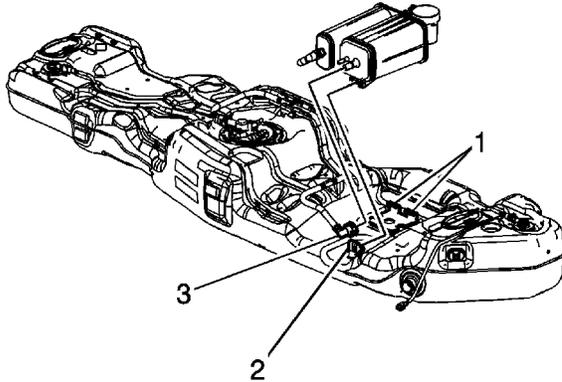
27. Disconnect the EVAP canister vent rear pipe quick connect fittings (1) from the fuel tank rollover valves. Refer to [Plastic Collar Quick Connect Fitting Service](#).
28. Disconnect the EVAP canister vent rear pipe quick connect fitting (2) from the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
29. Remove the EVAP canister vent rear pipe from the retaining features (3) built into the fuel tank.
30. Remove the fuel tank module. Refer to [Fuel Tank Module Replacement](#).

## Installation Procedure

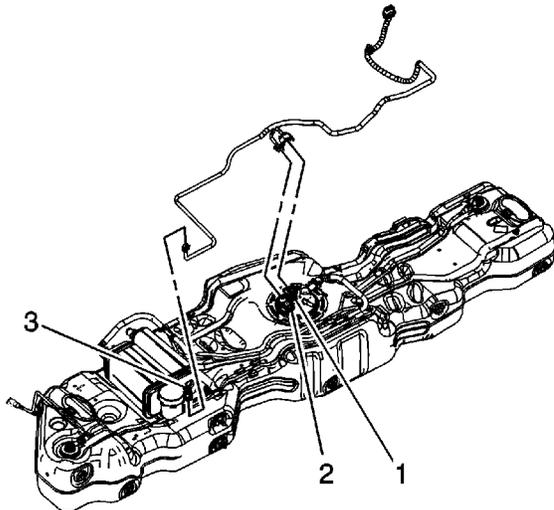


1. If the fuel tank was replaced, perform the following steps, otherwise proceed the step 21.
2. Install the fuel tank module. Refer to [Fuel Tank Module Replacement](#).

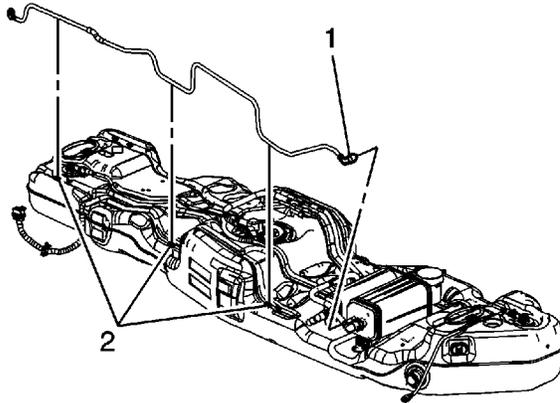
3. Lay the EVAP canister vent rear pipe into position on the fuel tank.
4. Connect the EVAP canister vent rear pipe quick connect fittings (1) to the fuel tank rollover valves. Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Connect the EVAP canister vent rear pipe quick connect fitting (2) to the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
6. Install the EVAP canister vent rear pipe to the retaining features (3) built into the fuel tank.



7. Insert the rear of the EVAP canister into the EVAP canister bracket retainers (1), squeeze the retainer (2), and set the EVAP canister assembly into place.
8. Connect the EVAP canister vent rear pipe quick connect fitting (1) to the EVAP canister. Refer to [Plastic Collar Quick Connect Fitting Service](#).



9. Place the fuel sender wiring harness into the channel in the fuel tank.
10. Connect the fuel sender wiring harness electrical connectors to the fuel tank module (1), fuel tank pressure sensor (2), and EVAP canister vent solenoid (3).

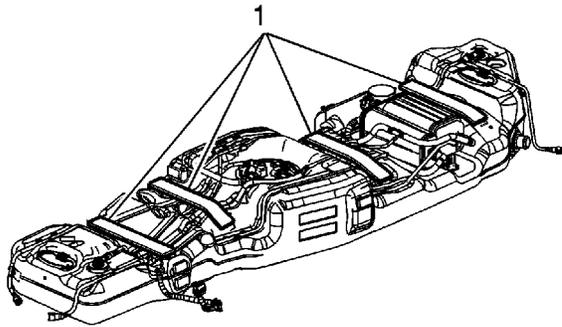


11. Lay the EVAP canister vent front pipe into position on the fuel tank.
12. Connect the EVAP canister vent rear pipe quick connect fitting (1) to the EVAP canister. Refer to [Plastic Collar Quick Connect Fitting Service](#).
13. Install the EVAP canister vent rear pipe to the retaining features (2) built into the fuel tank.

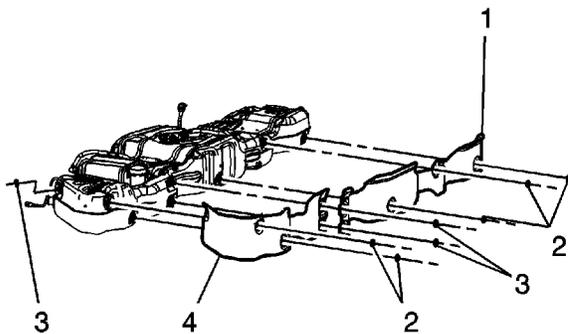
 Object Number: 1860041 Size: SH



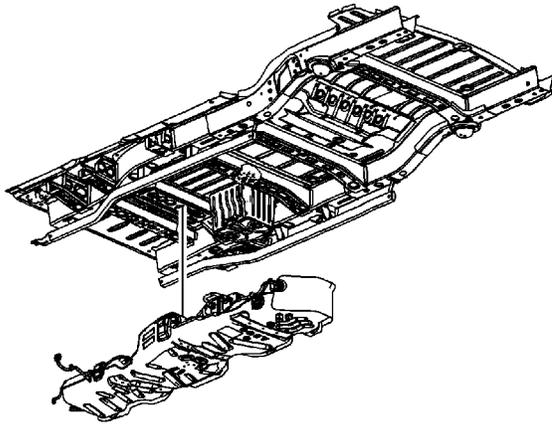
14. Route the fuel pump fuel feed pipe under the EVAP canister vent rear pipe and lay into position on the fuel tank.
15. Connect the fuel pump fuel feed line quick connect fitting (1) to the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
16. Install the fuel pump fuel feed line to the retaining features (2) built into the fuel tank.



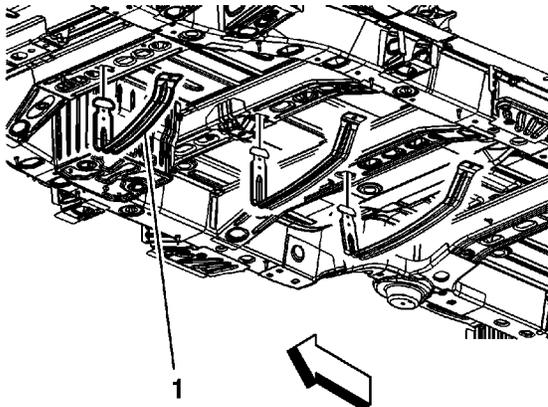
17. Install the foam pad insulators (1) onto the top of the fuel tank.



18. Install the fuel tank rear (4) and front (1) shields onto the fuel tank.  
19. Install the fuel tank front and rear shield push on nuts (2).  
20. Install the fuel tank front and rear shield nuts (3) until snug.

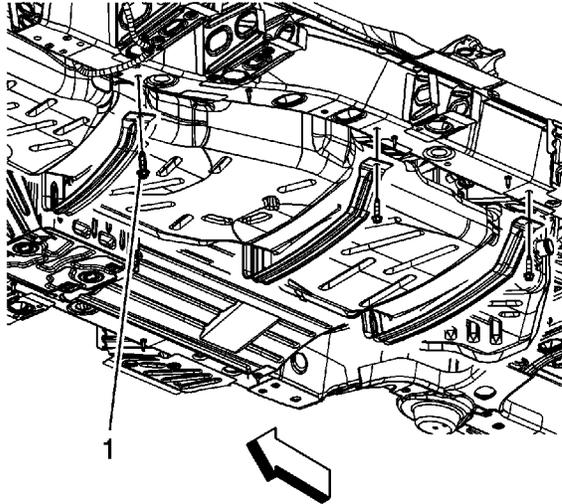


21. With the aid of an assistant, remove the fuel tank from the work surface and place on the adjustable jack.
22. With the aid of the assistant, raise the fuel tank into position under the vehicle.



23. Install the fuel tank straps (1).

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

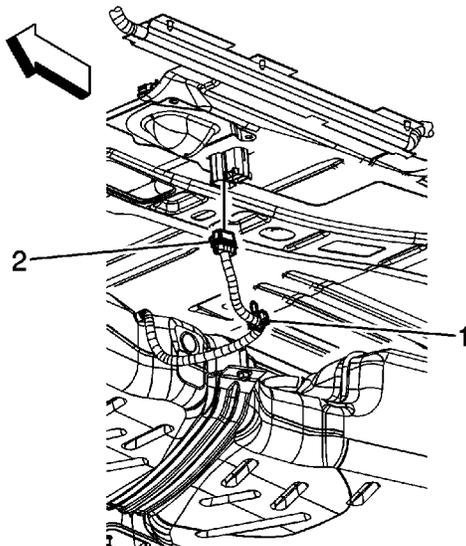


24. Install the fuel tank strap bolts (1).

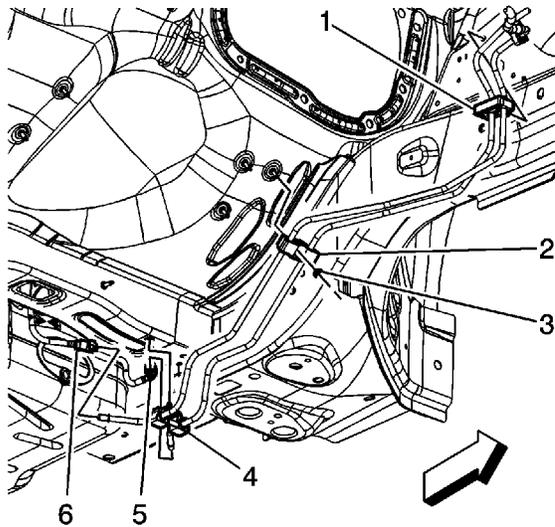
#### **Tighten**

Tighten the bolts to 47 N·m (35 lb ft).

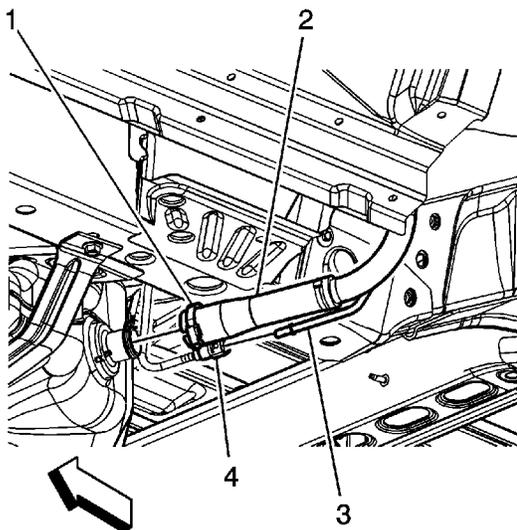
25. Remove the adjustable jack from under the fuel tank.  
 26. Install the left underbody side rail. Refer to [Underbody Rear Side Rail Replacement](#).



27. Connect the fuel sender wiring harness electrical connector (2) to the body wiring harness electrical connector.  
 28. Install the fuel sender wiring harness clip (1) to the underbody side rail extension.  
 29. Connect the vent hose to the left rear of the fuel tank.



30. Connect the fuel tank EVAP canister vent front pipe quick connect fitting (5) to the chassis EVAP line. Refer to [Plastic Collar Quick Connect Fitting Service](#).
31. Connect the fuel pump fuel feed line quick connect fitting (6) to the chassis fuel line. Refer to [Plastic Collar Quick Connect Fitting Service](#).



**Note:** Ensure that the notch in the fill hose aligns with the tab on the fuel tank.

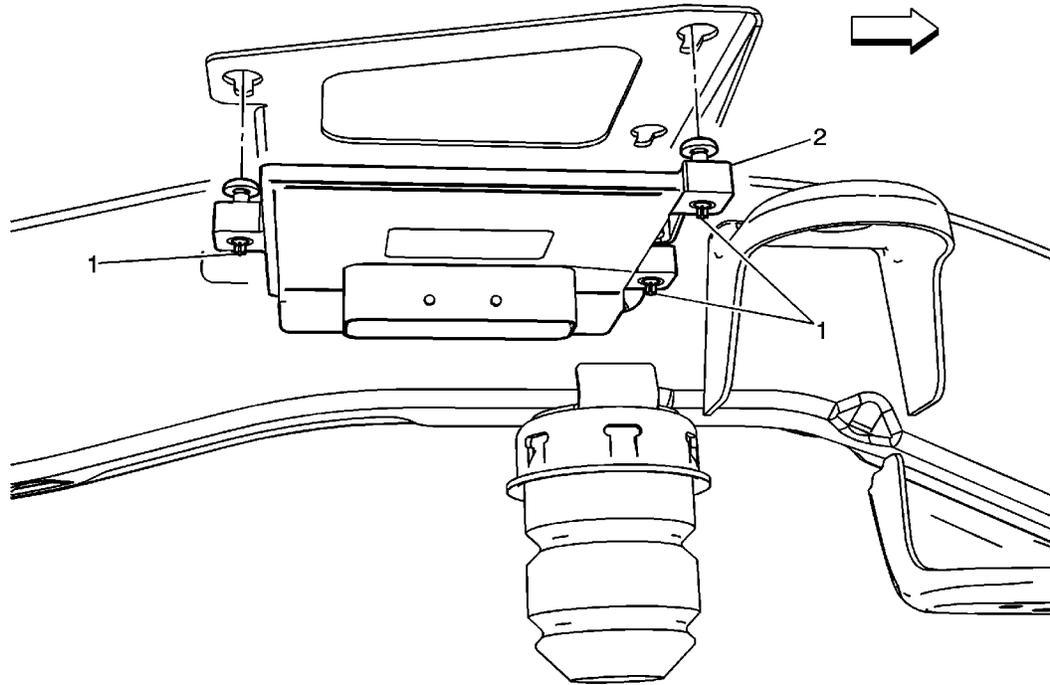
32. Position and install the fuel tank fill pipe (2) to the fuel tank.
33. Connect the EVAP canister vent rear pipe quick connect fitting (4) to the recirculation line on the fuel fill pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).
34. Tighten the fuel tank fill hose clamp (1) at the fuel tank.

**Tighten**

Tighten the clamp to 3.3 N·m (29 lb in).

35. Lower the vehicle.
36. Refill the fuel tank.
37. Tighten the fuel fill cap.
38. Use the following procedure in order to inspect for leaks:
  - 38.1. Turn the ignition ON, with the engine OFF, for 2 seconds.
  - 38.2. Turn the ignition OFF for 10 seconds.
  - 38.3. Turn the ignition ON, with the engine OFF.
  - 38.4. Inspect for fuel leaks.
39. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

## Fuel Pump Flow Control Module Replacement

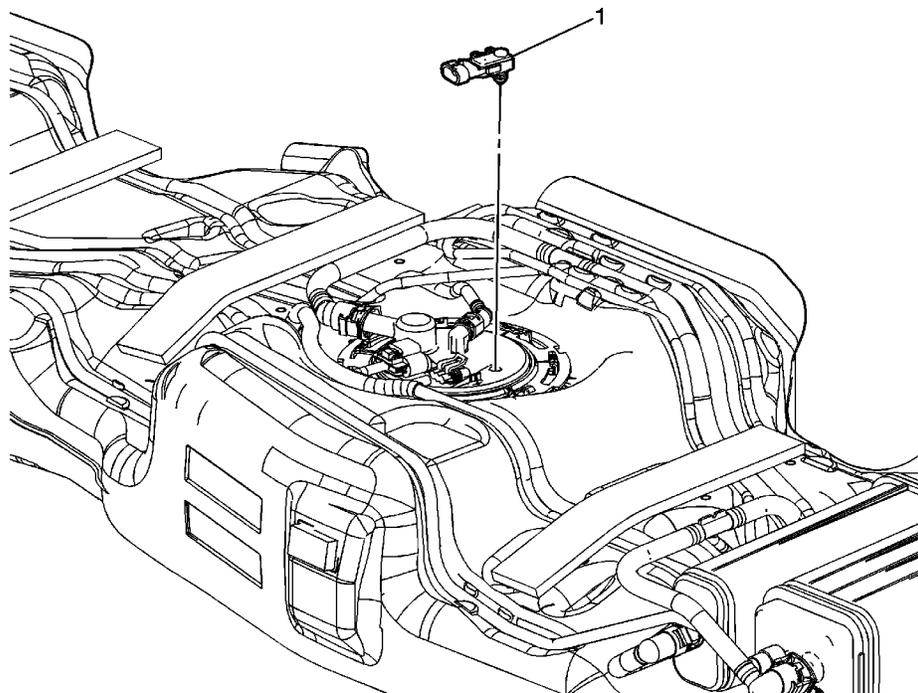


Callout	Component Name
<b>Preliminary Procedure</b>	
<b>Lift and support the vehicle. Refer to <a href="#">Lifting and Jacking the Vehicle</a>.</b>	
1	<p>Fuel Pump Flow Control Module Fastener (Qty: 3)</p> <p><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> in the Preface section.</p> <p><b>Tip</b> The bolts used are two headed and can be loosened from the module side, then maneuvered out of the slots.</p> <p><b>Tighten</b> 9 N·m (80 lb in)</p>
2	<p>Fuel Pump Flow Control Module</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Disconnect the electrical connector.</li> <li>2. If replacing the fuel pump flow control module, program the control module.</li> </ol>

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Refer to [Control Module References](#).

## Fuel Tank Pressure Sensor Replacement

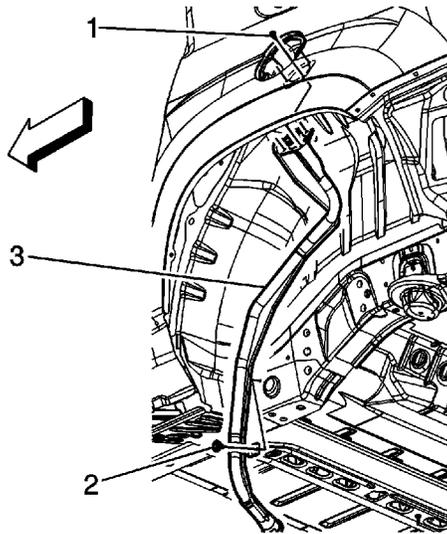


Callout	Component Name
<b>Preliminary Procedure</b>	
Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a> .	
1	<b>Procedure</b> Disconnect the fuel sender wiring harness electrical connector.

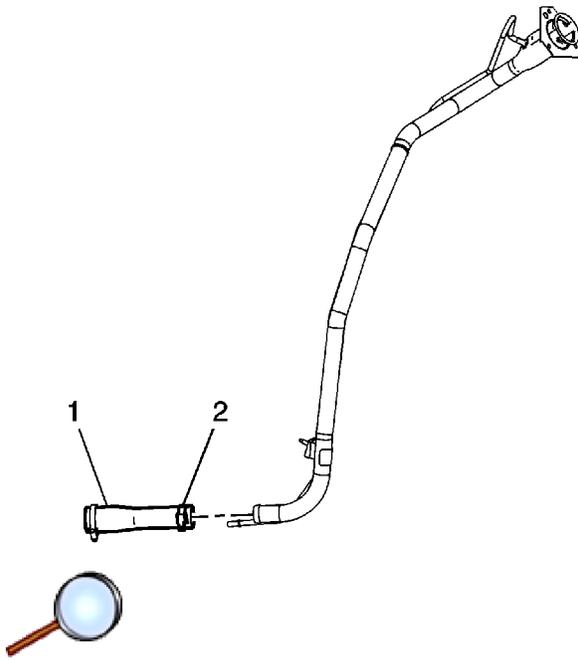
## Filler Tube Replacement

### Removal Procedure

**Warning:** Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

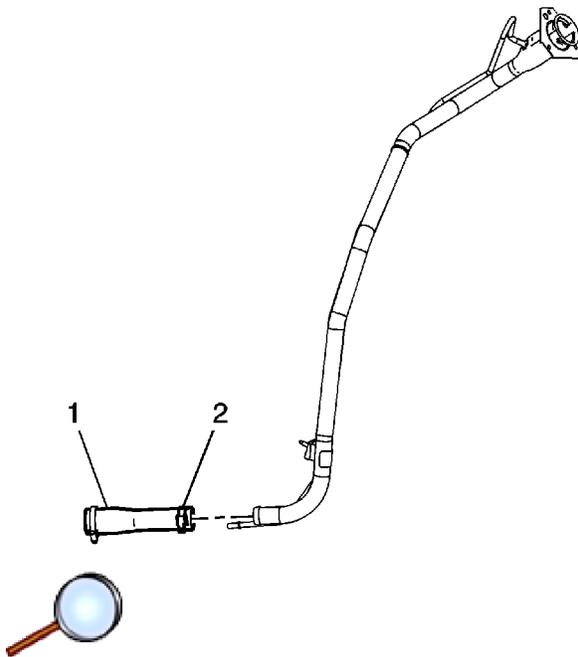


1. Remove the fuel fill cap.
2. Remove the fuel tank fill pipe housing to fuel tank fill pipe bolts (1).
3. Drain the fuel tank. Refer to [Fuel Tank Draining](#).
4. Remove the left rear wheel and tire. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the left rear wheelhouse liner panel. Refer to [Rear Wheelhouse Panel Liner Replacement](#).
6. Remove the fuel tank fill pipe bracket bolt (2).
7. Remove the fuel tank fill pipe assembly (3) from the vehicle.



8. Loosen the fuel tank fill hose clamp (2), if necessary.
9. Remove the fuel tank fill hose (1), if necessary.

## Installation Procedure



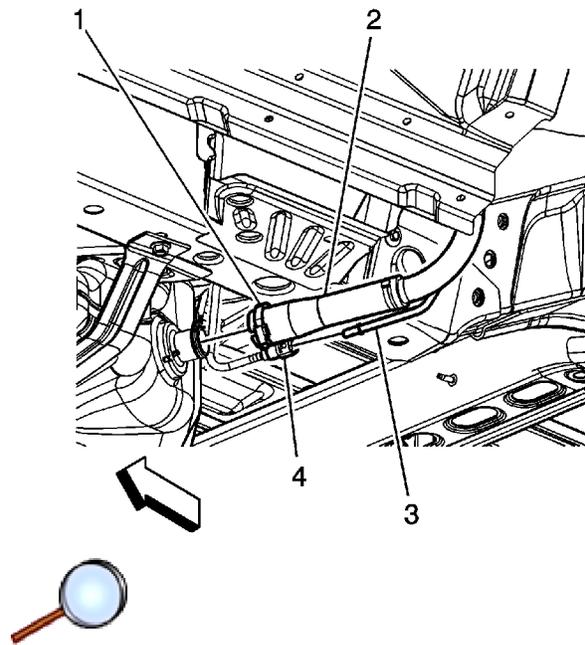
1. Install the fuel tank fill hose (1), if necessary.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Tighten the fuel tank fill hose clamp (2), if necessary.

**Tighten**

Tighten the clamp to 3.3 N·m (29 lb in).

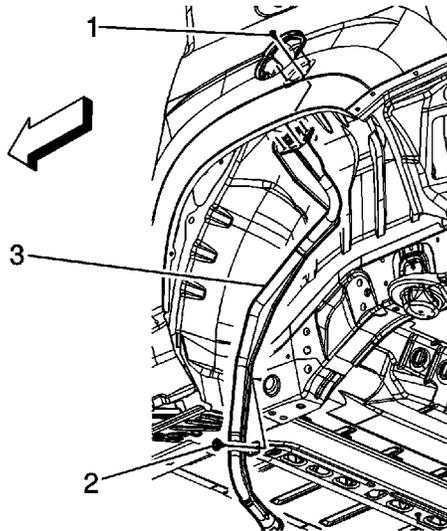


**Note:** Ensure that the notch in the fill hose aligns with the tab on the fuel tank.

3. Position and install the fuel tank fill hose (2) to the fuel tank.
4. Connect the evaporative emission (EVAP) canister vent rear pipe quick connect fitting (4) to the recirculation line on the fuel tank fill pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Tighten the fuel tank fill hose clamp (1) at the fuel tank.

**Tighten**

Tighten the clamp to 3.3 N·m (29 lb in).



6. Install the fuel tank fill pipe bracket bolt (2).

**Tighten**

Tighten the bolt to 12 N·m (106 lb in).

7. Install the left rear wheelhouse liner panel. Refer to [Rear Wheelhouse Panel Liner Replacement](#).
8. Install the left rear wheel and tire. Refer to [Tire and Wheel Removal and Installation](#).
9. Lower the vehicle.
10. Install the fuel tank fill pipe housing to fuel tank fill pipe bolts (1).

**Tighten**

Tighten the bolts to 2 N·m (18 lb in).

11. Install the fuel fill cap.

# Fuel Tank Module Replacement

## Special Tools

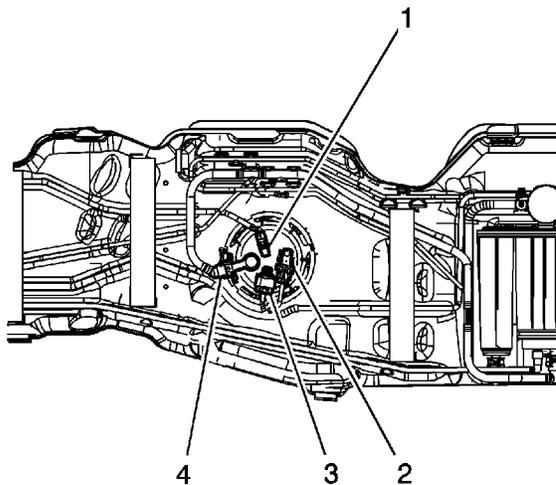
[J 45722](#) Fuel Sender Lock Ring Wrench

## Removal Procedure

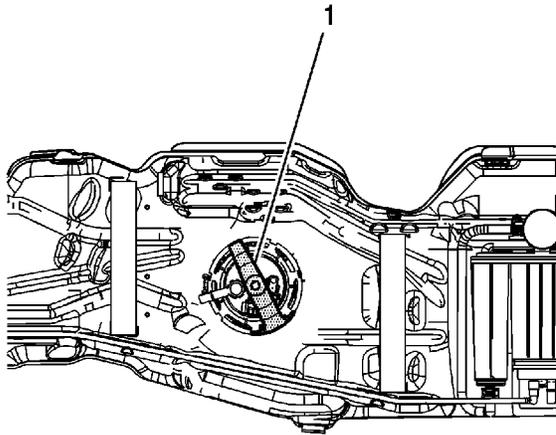
**Warning:** Whenever fuel line fittings are loosened or removed, wrap a shop cloth around the fitting and have an approved container available to collect any fuel.

**Caution:** Clean all fuel pipe and hose connections and surrounding areas before disassembling to avoid possible contamination of the fuel system. Spray the fuel pump module cam-lock ring tang with penetrating oil prior to attempting removal.

**Note:** A NEW fuel tank module seal is necessary each time the fuel tank module is serviced. Obtain a NEW seal prior to beginning this service procedure.

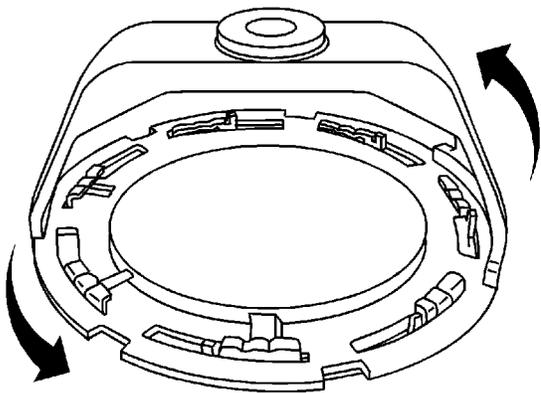


1. Remove the fuel tank. Refer to [Fuel Tank Replacement](#).
2. Disconnect the fuel pump fuel feed line quick connect fitting (1) from the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
3. Disconnect evaporative emission (EVAP) canister vent front pipe quick connect fitting (4) from the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Reposition the fuel pump fuel feed line and the EVAP canister vent front pipe out of the way.
5. Disconnect the fuel sender wiring harness electrical connector (2) from the fuel tank pressure sensor.
6. Disconnect the fuel sender wiring harness electrical connector (3) from the fuel tank module.



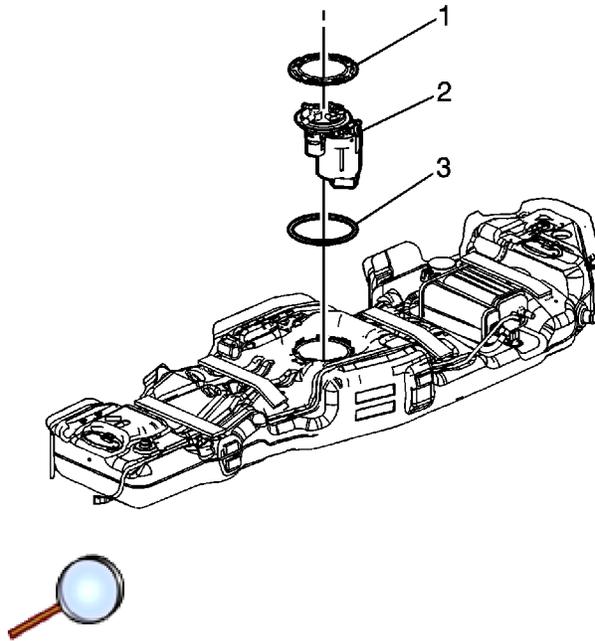
**Caution:** Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

7. Install the [J 45722](#) (1) to the fuel tank module 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.

8. Using the [J 45722](#) and a long breaker-bar, rotate the lock ring counterclockwise unlocking the fuel tank module lock ring.
9. Remove the [J 45722](#) .

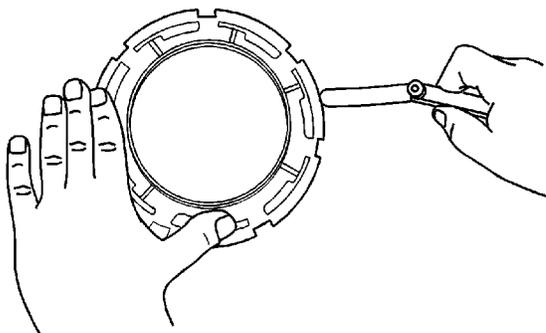


**Caution:** Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.

10. Remove the fuel tank module lock ring (1).
11. Slowly raise the module (2) until the fuel level sensor float arm is just visible.

**Note:** When removing the module from the fuel tank, be aware that the module reservoir bucket is full of fuel. The module must be tipped slightly during removal to avoid bending the fuel level sensor float arm.

12. Tilt the module towards the lower front corner of the fuel tank to allow the level sensor float arm to clear the tank opening. Remove the module from the fuel tank.
13. Carefully discard the fuel in the module reservoir bucket into an approved container.
14. Remove and discard the fuel tank module seal (3).
15. Remove the fuel level sensor, if required. Refer to [Fuel Level Sensor Replacement](#).



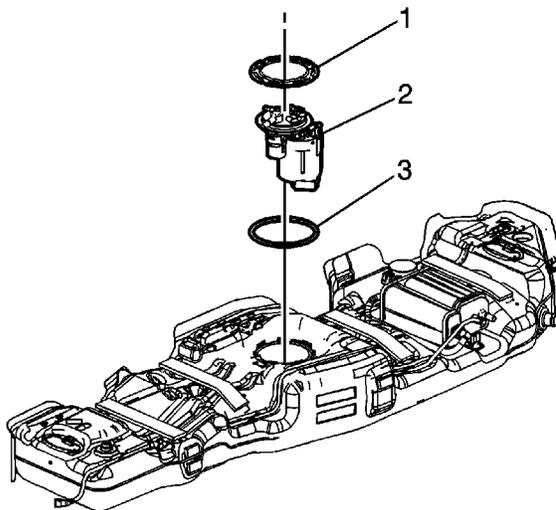


**Note:**

- Some lock ring were manufactured with DO NOT REUSE stamped into them. These lock rings may be reused if they 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.

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

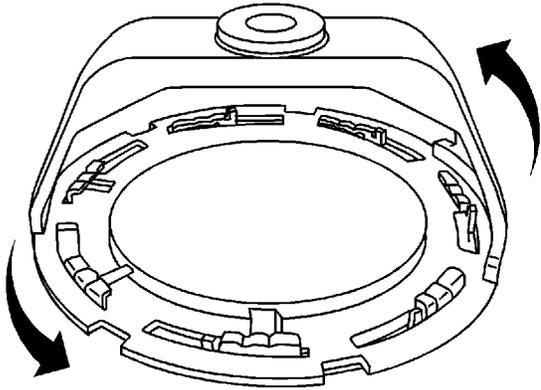
## Installation Procedure



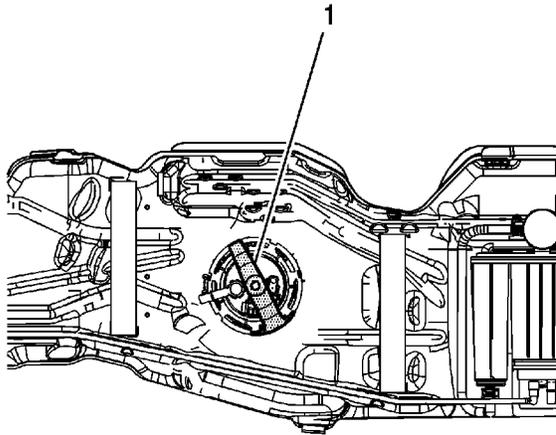
1. Install the fuel level sensor, if required. Refer to [Fuel Level Sensor Replacement](#).
2. Install a NEW fuel tank module seal (3) onto the fuel tank.

**Note:** The bucket must be tipped slightly during installation to avoid bending the fuel level sensor float arm.

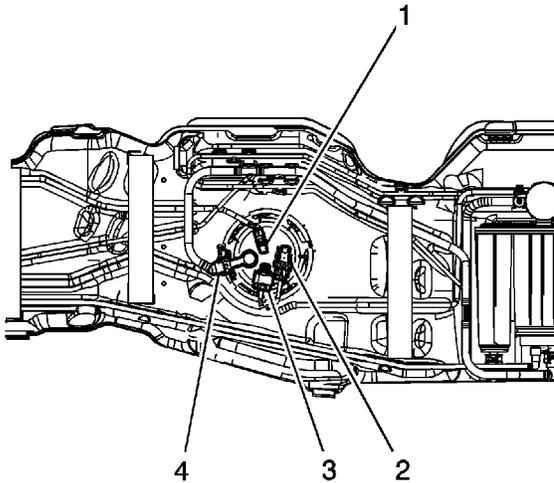
3. Tilt the module towards the lower front corner of the fuel tank to allow the level sensor float arm to clear the tank opening. Install the module into the fuel tank.
4. Position and install the fuel tank module lock ring (1).



5. Install the [J 45722](#) to the fuel tank module lock ring.
6. Using the [J 45722](#) and a long breaker-bar, rotate the lock ring clockwise locking the fuel tank module lock ring.



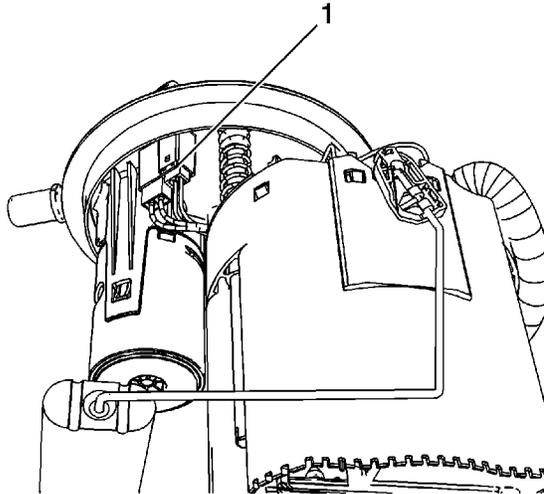
7. Remove the [J 45722](#) (1) from the fuel tank module lock ring.



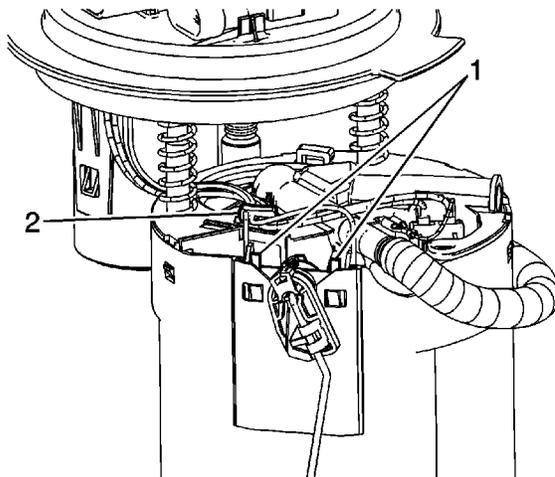
8. Connect the fuel sender wiring harness electrical connector (3) to the fuel tank module.
9. Connect the fuel sender wiring harness electrical connector (2) to the fuel tank pressure sensor.
10. Position the fuel pump fuel feed line and the EVAP canister vent front pipe to the fuel tank.
11. Connect EVAP canister vent front pipe quick connect fitting (4) to the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
12. Connect the fuel pump fuel feed line quick connect fitting (1) to the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
13. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

## Fuel Level Sensor Replacement

### Removal Procedure

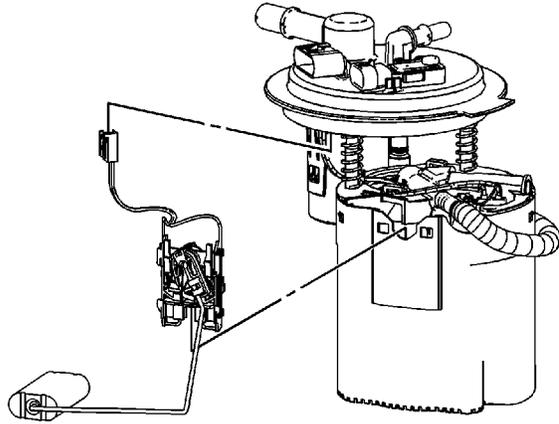


1. Remove the fuel tank module. Refer to [Fuel Tank Module Replacement](#) .
2. Push down on the fuel level sensor electrical connector tab (1), disengaging the retainer, and disconnect the electrical connector.



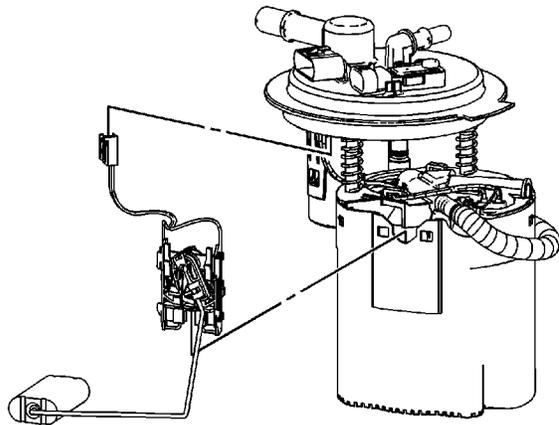
3. Remove the fuel level sensor wiring from under the module clip (2).
4. Push in the fuel level sensor tabs (1) disengaging the sensor clips from the module bucket.

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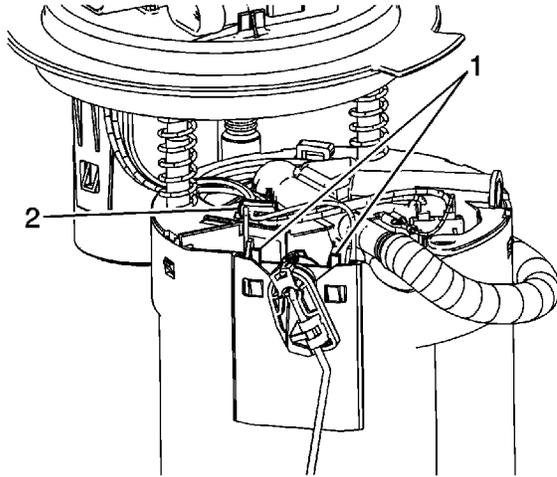


5. Slide the fuel level sensor up out from the module bucket.

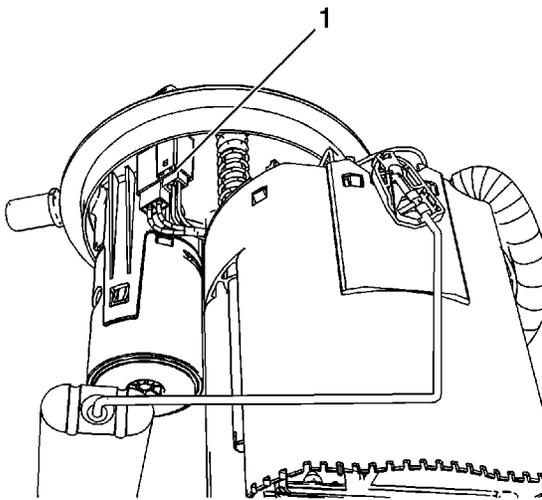
## **Installation Procedure**



1. Position the fuel level sensor to the module bucket and slide the sensor down.

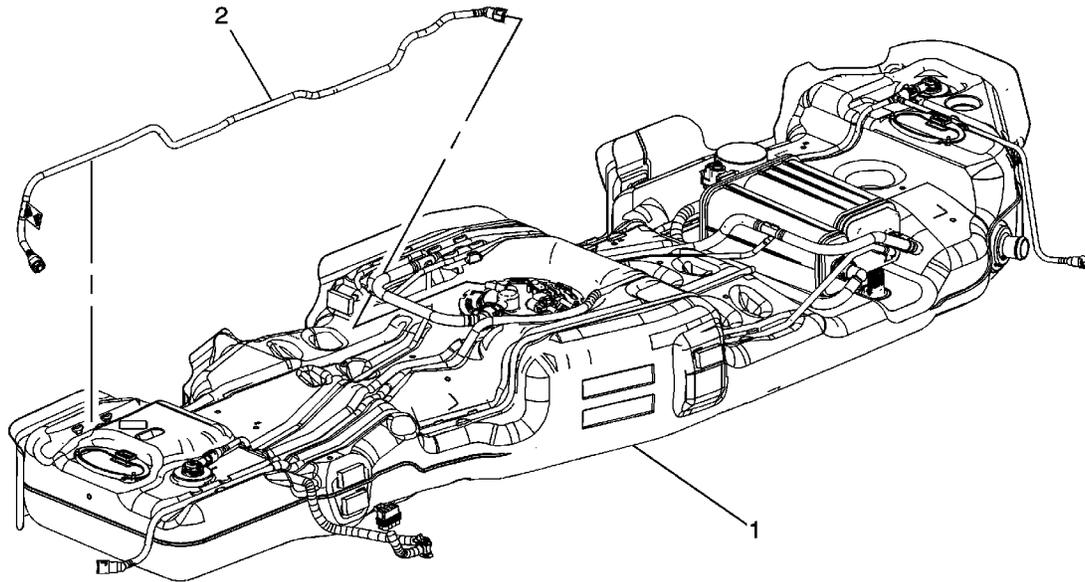


2. Ensure that the fuel level sensor tabs (1) engage the module bucket.
3. Install the fuel level sensor wiring under the module clip (2).



4. Connect the fuel level sensor electrical connector (1) to the module cover.
5. Install the fuel tank module. Refer to [Fuel Tank Module Replacement](#) .

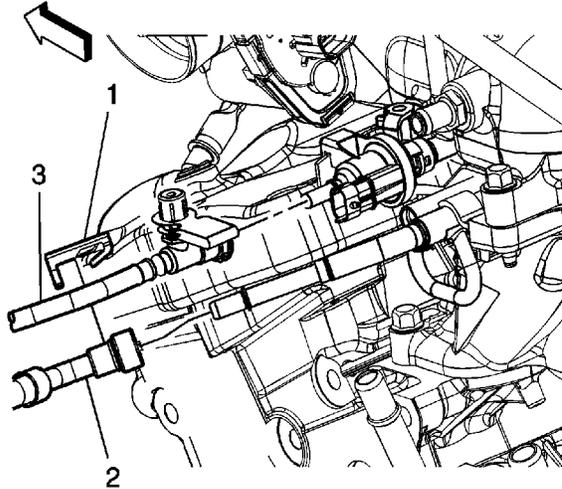
# Fuel Pump Fuel Feed Hose Replacement



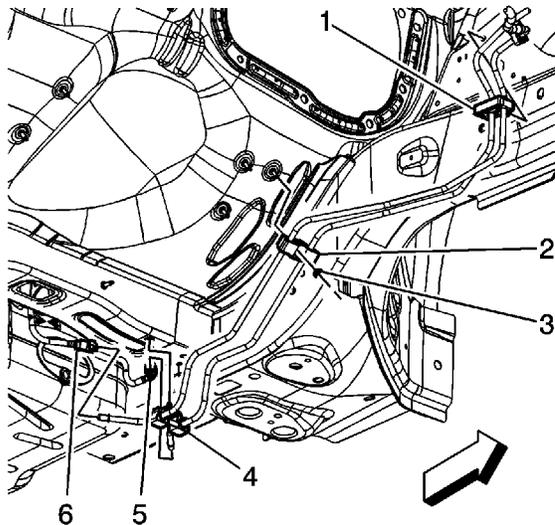
Callout	Component Name
<p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"> <li>1. Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a> .</li> <li>2. Remove the foam pad insulators.</li> </ol>	
1	Fuel Tank
2	<p>Fuel Pump Fuel Feed Hose</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Disconnect the quick connect fitting from the module. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> .</li> <li>2. Disengage from the tank retaining features.</li> <li>3. When installing, route under the evaporative emission (EVAP) canister vent front pipe.</li> </ol>

## Fuel Hose/Pipes Replacement - Chassis

### Removal Procedure



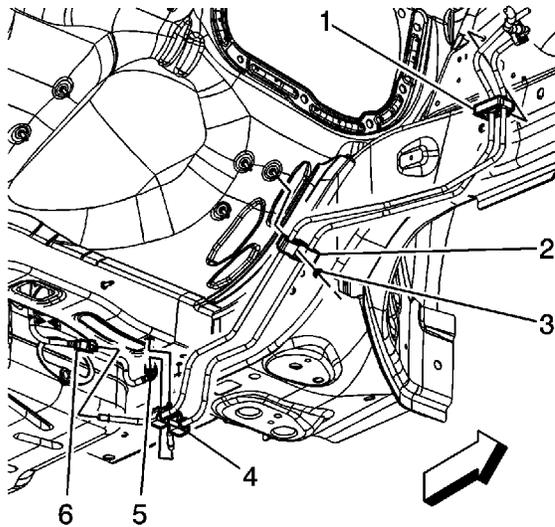
1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Remove the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
3. Remove air cleaner assembly. Refer to [Fuel Injector Sight Shield Replacement](#).
4. Disconnect the brake pressure modulator valve from the body to provide clearance for the fuel pipes. Refer to [Brake Pressure Modulator Valve Replacement](#)
5. Disconnect the fuel feed pipe (2) quick connect fitting from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
6. Disconnect the evaporative emission (EVAP) pipe (3) quick connect fitting from the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).
7. Cap the fuel rail and the EVAP purge solenoid in order to prevent possible fuel and/or EVAP system contamination.



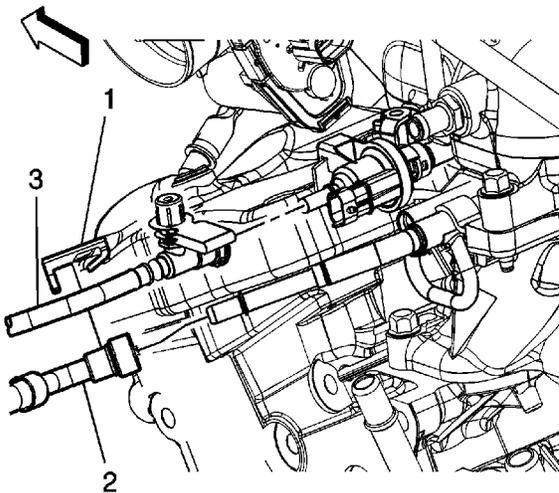
8. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
9. Remove the intermediate steering shaft. Refer to [Intermediate Steering Shaft Replacement](#).
10. Disconnect the fuel pump fuel feed pipe quick connect fitting (6) from the chassis fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
11. Disconnect the EVAP canister vent front pipe quick connect fitting (5) from the chassis EVAP pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
12. Remove the fuel feed/EVAP pipe assembly clip (1) from the body.
13. Remove the fuel feed/EVAP pipe assembly clip nut (3) and clip (2) from the stud.
14. Loosen the fuel feed/EVAP pipe clip (4) bolt, and remove the fuel feed/EVAP pipe assembly from the vehicle.
15. Mark the location of the retainers on the new pipes and remove the plastic retainers from the old pipes using a soapy solution.

## Installation Procedure

**Caution:** Refer to [Fastener Caution](#) in the Preface section.



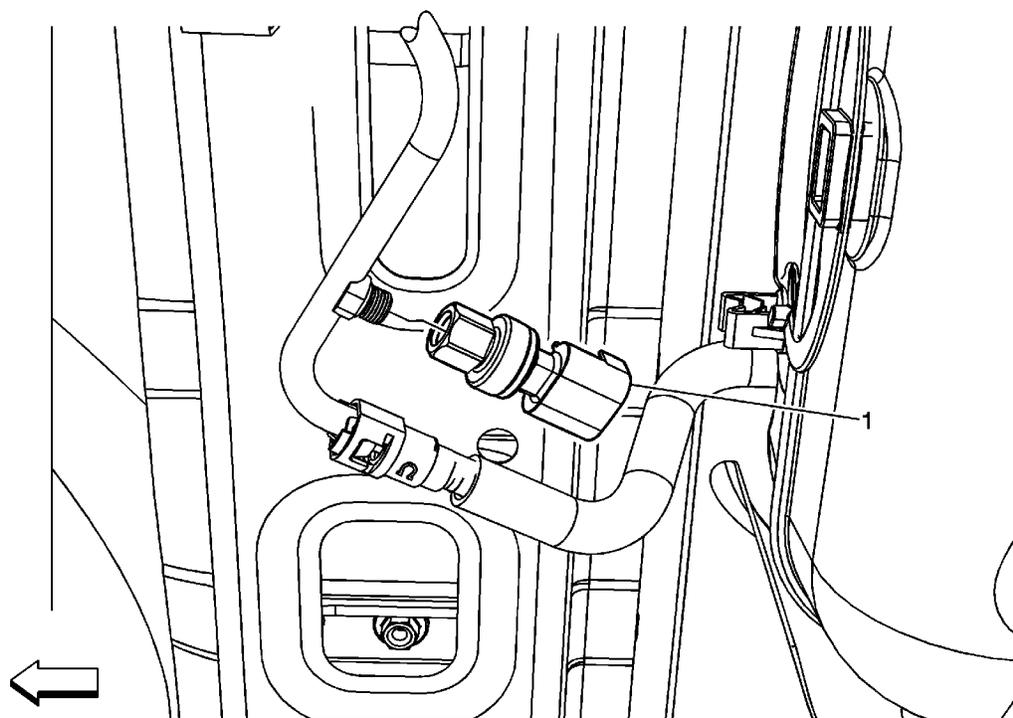
1. Position the fuel feed and EVAP pipes to the vehicle individually, and install the plastic retainers to the marked locations. Tighten the fuel feed/EVAP pipe clip (4) bolt to **8 N·m (71 lb in)**.
2. Install the fuel feed/EVAP pipe clip (2) and nut (3) to the stud and tighten to **9 N·m (80 lb in)**.
3. Install the fuel feed/EVAP pipe clip (1) to the body.
4. Connect the EVAP canister vent front pipe quick connect fitting (5) to the chassis EVAP pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Connect the fuel pump fuel feed pipe quick connect fitting (6) to the chassis fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
6. Install the intermediate steering shaft. Refer to [Intermediate Steering Shaft Replacement](#).



7. Remove the caps from the fuel rail and the EVAP purge solenoid.
8. Connect the EVAP pipe (3) quick connect fitting to the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).

9. Connect the fuel feed pipe (2) quick connect fitting to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
10. Tighten the fuel fill cap.
11. Use the following procedure in order to inspect for leaks:
  - Turn the ignition ON, with the engine OFF, for 2 seconds.
  - Turn the ignition OFF for 10 seconds.
  - Turn the ignition ON, with the engine OFF.
  - Inspect for fuel leaks.
12. Reconnect the brake pressure modulator valve from the body to provide clearance for the fuel pipes. Refer to [Brake Pressure Modulator Valve Replacement](#)
13. Install the air cleaner assembly. Refer to [Fuel Injector Sight Shield Replacement](#).
14. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

## Fuel Pressure Sensor Replacement - Fuel Feed Pipe

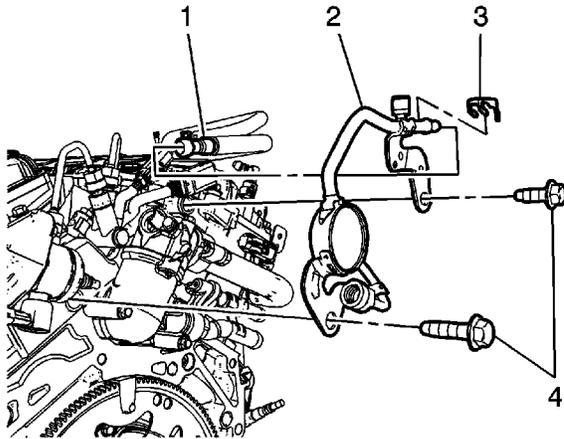


Callout	Component Name
<b>Preliminary Procedure</b>	
Raise and support the vehicle. Refer to <a href="#">Lifting and Jacking the Vehicle</a>	
1	Fuel Pressure Sensor  <b>Caution:</b> To avoid fuel system contamination clean the area where the sensor connects to the fuel line or fuel injection fuel rail before removing the sensor.  <b>Procedure</b>  Disconnect the electrical connector.

## Fuel Feed Pipe Replacement (LLT)

### Removal Procedure

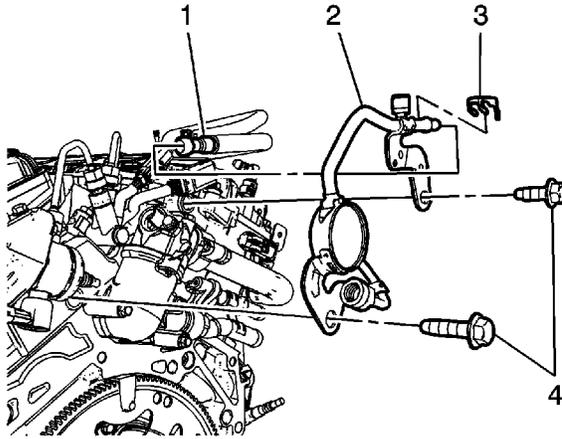
1. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Remove the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Relieve the low side fuel system pressure. Refer to [Fuel Pressure Relief](#).



4. Disconnect the fuel feed line quick connect fitting from the fuel feed pipe (2). Refer to [Metal Collar Quick Connect Fitting Service](#).
5. Loosen the fuel feed pipe fitting to the high pressure fuel pump.
6. Remove the fuel feed pipe bolts (4) from the cylinder heads.
7. Remove the fuel feed pipe from the engine and high pressure fuel pump.

### Installation Procedure

1. Ensure that the fuel feed pipe and fuel pump fittings are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Position the fuel feed pipe (2) to the cylinder head and high pressure fuel pump.
4. Install the fuel feed pipe fitting to the high pressure fuel pump hand tight.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

5. Install the fuel feed pipe bolts (4).
  - 5.1. Tighten the bolts to **50 N·m (37 lb ft)**.
  - 5.2. Tighten the fitting to **28 N·m (20 lb ft)**.
6. Connect the fuel feed line quick connect fitting to the fuel feed pipe (2). Refer to [Fuel Pipe Shield Replacement](#).

**Note:** If a fuel leak accrues at the high pressure fuel pump, the pump will need to be replaced.

7. Inspect for leaks using the following procedure:
  - 7.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 7.2. Turn OFF the ignition, for 10 seconds.
  - 7.3. Turn ON the ignition, with the engine OFF.
  - 7.4. Inspect for fuel leaks.
8. Install the low side fuel pressure service port cap.
9. Install the fuel tank cap.
10. Install the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
11. Install the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

## Fuel System Cleaning

**Important:** If the fuel filter is plugged, the fuel tank should be inspected internally and cleaned if necessary.

1. Remove the fuel tank module. Refer to [Fuel Tank Module Replacement](#) .
2. Inspect the fuel pump module strainer. Replace the pump module assembly if the fuel strainer is contaminated.

**Important:** 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.

3. Flush the fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
5. Allow the tank to dry completely before reassembly.
6. Disconnect the fuel feed pipe at the engine fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#) .

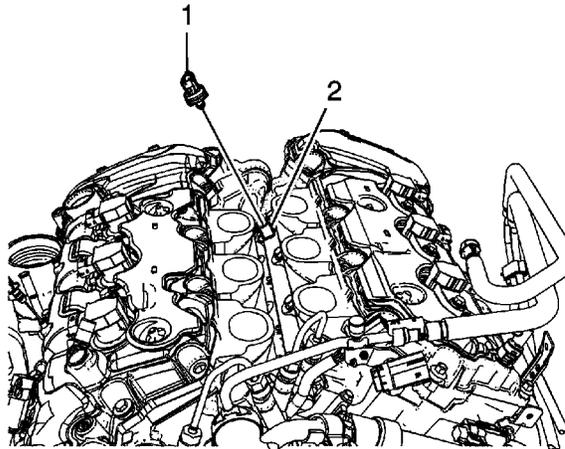
**Important:** Only use oil-free compressed air to blow out the fuel pipes.

7. Clean the fuel pipes by applying air pressure in the opposite direction of the fuel flow.
8. Connect the fuel feed pipe to the engine fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#) .
9. Install the fuel tank module. Refer to [Fuel Tank Module Replacement](#) .

# Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail

## Removal Procedure

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Remove the intake manifold. Refer to [Intake Manifold Replacement](#)
3. Remove the foam insulator from the fuel rails.



**Caution:** To avoid fuel system contamination clean the area where the sensor connects to the fuel line or fuel injection fuel rail before removing the sensor.

**Note:** Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

4. Using a 27 mm socket, remove the fuel pressure sensor (1) from the fuel injection fuel rail (2). Discard the fuel pressure sensor.
5. Allow any fuel to drain from the fuel rail and pressure sensor location.
6. Dry the sealing cone in the fuel rail and the area around the sensor joint with a lint free cloth.
7. Inspect the sealing cone in the fuel rail. The surface should be free of fuel, debris, and burrs.

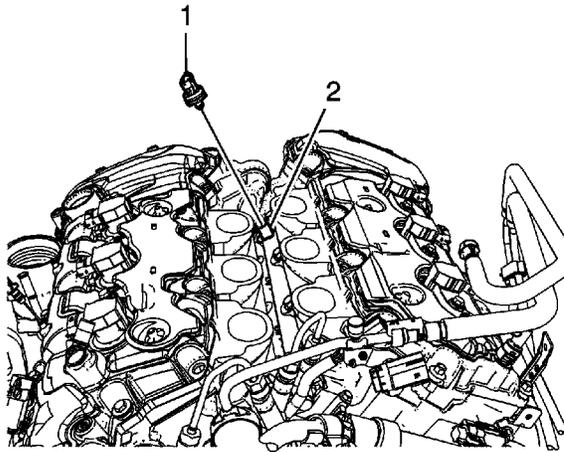
## Installation Procedure

**Note:** Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

**Note:** Ensure that the fuel rail threads have been cleaned of any excess fuel, or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

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1. Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
2. Lubricate the threads and sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) hand tight.
4. Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

5. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) and tighten to **33 N·m (25 lb ft)**.
6. Install the foam insulator from the fuel rails.
7. Install the intake manifold. Refer to [Intake Manifold Replacement](#)

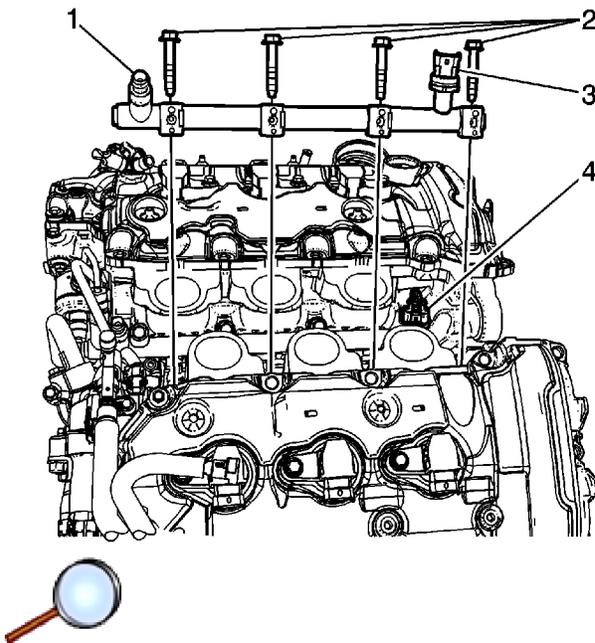
**Note:** If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

8. Inspect for fuel leaks using the following procedure:
  - 8.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 8.2. Turn OFF the ignition, for 10 seconds.
  - 8.3. Turn ON the ignition, with the engine OFF.
  - 8.4. Inspect for fuel leaks.

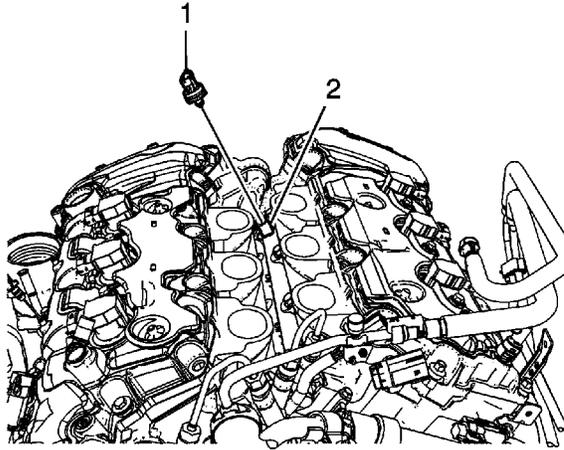
## Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LLT)

### 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 high pressure fuel pipe. Discard the pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
5. Remove the fuel rail crossover pipe. Refer to [Fuel Injection Fuel Rail Crossover Tube Replacement](#). Discard the pipe.
6. Remove the foam insulator from the fuel rails.



7. Disconnect the fuel pressure sensor electrical connector and cut the wire harness tie straps.
8. Remove the fuel rail (1) bolts (2).

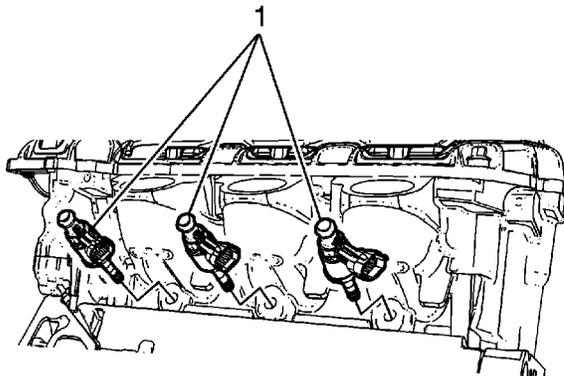


9. Remove the fuel pressure sensor. Refer to [Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail](#)
10. Remove and discard the direct fuel injector hold down clamps.

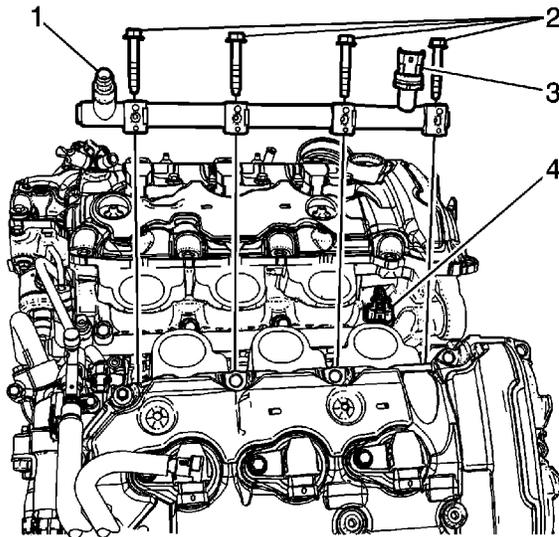
**Note:** The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

11. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to [Fuel Injector Replacement](#).

## Installation Procedure

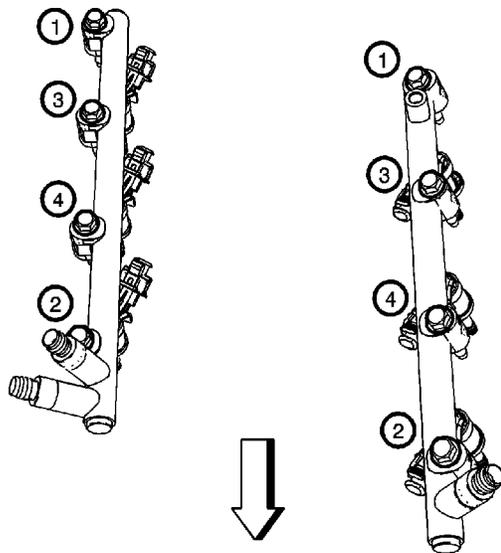


1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to [Fuel Injector Replacement](#).
2. Install NEW direct injector hold down clamps to the injector.



3. On a new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (1) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts, and hand tighten.

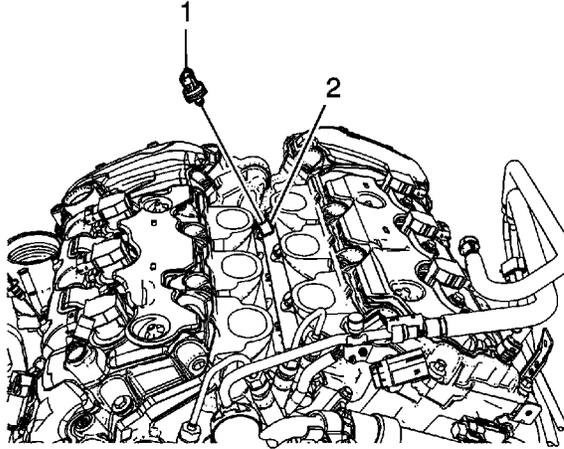
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



6. Tighten the fuel rail bolts in the sequence shown:

### Tighten

1. Tighten the Bank 1 fuel rail bolts first pass to 12 N·m (106 lb in).
2. Tighten the Bank 1 fuel rail bolts final pass to 23 N·m (17 lb ft).
7. Install a NEW fuel rail crossover pipe. Refer to [Fuel Injection Fuel Rail Crossover Tube Replacement](#).
8. Install a NEW high pressure fuel pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
9. Install the high pressure fuel sensor (1). Refer to [Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail](#).

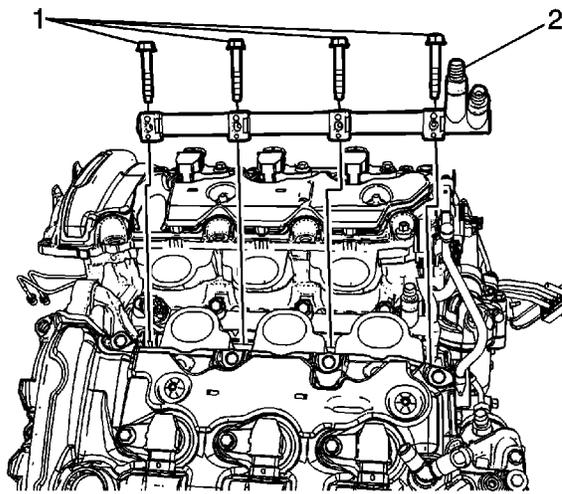


10. Connect the fuel injector wiring harness electrical connector (1) to the fuel injectors, fuel rail and fuel pressure sensor.
11. Inspect for fuel leaks using the following procedure:
  - 11.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 11.2. Turn OFF the ignition, for 10 seconds.
  - 11.3. Turn ON the ignition, with the engine OFF.
  - 11.4. Inspect for fuel leaks.
12. Install the foam insulator from the fuel rails.
13. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
14. Install the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
15. Install the low side fuel pressure service port cap.
16. Install the fuel tank cap.

## Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LLT)

### 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 high pressure fuel sensor. Refer to [Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail](#).
4. Remove the fuel rail crossover pipe. Refer to [Fuel Injection Fuel Rail Crossover Tube Replacement](#). Discard this pipe.

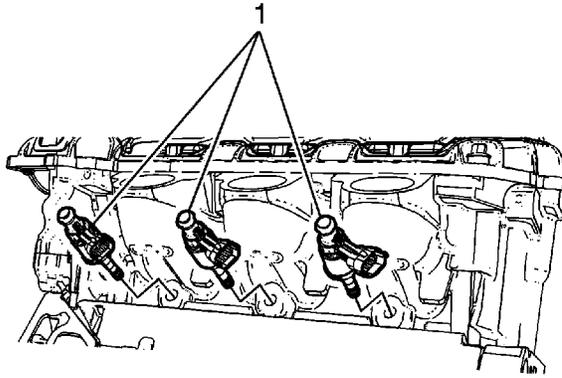


5. Remove the fuel rail bolts (1).
6. Carefully remove the Bank 2 fuel rail (2) from the engine. Lift the rear of the rail to ease removal.
7. Remove and discard the direct fuel injector hold down clamps.

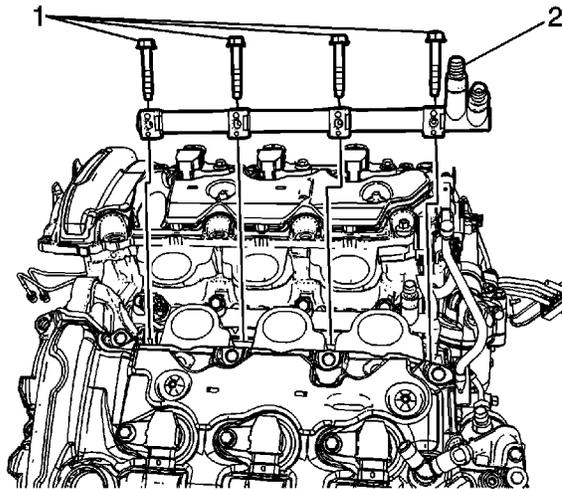
**Important:** The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

8. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to [Fuel Injector Replacement](#).

### Installation Procedure

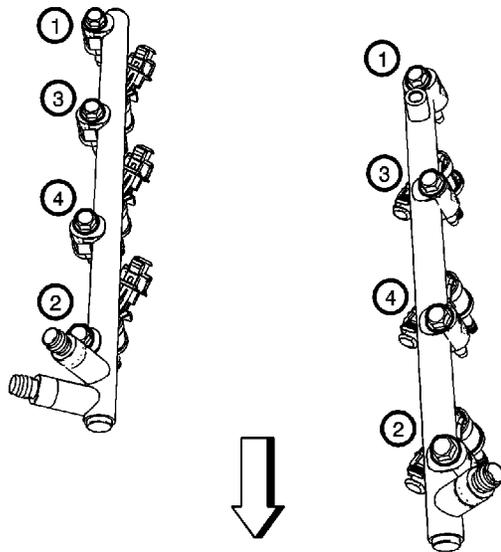


1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to [Fuel Injector Replacement](#).
2. Install new direct injector hold down clamps to the injectors.

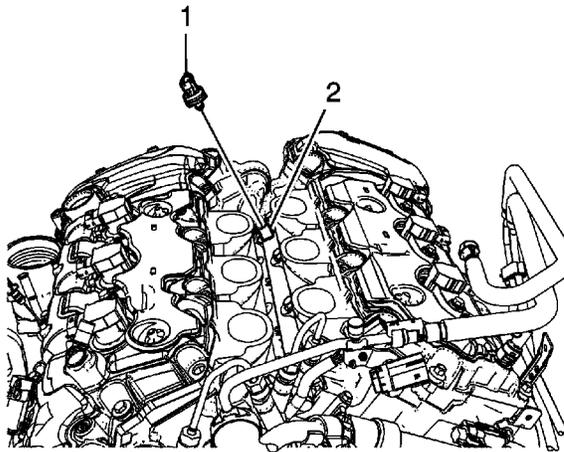


3. On the new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2 outer fuel rail bolts first, then the 2 inner bolts and hand tighten.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.



6. Tighten the fuel rail bolts in the sequence shown:
  - 6.1. Tighten the Bank 1 fuel rail bolts first pass to **12 N·m (106 lb in)**.
  - 6.2. Tighten the Bank 1 fuel rail bolts a final pass to **23 N·m (17 lb ft)**.
7. Install a NEW fuel rail crossover pipe. Refer to [Fuel Injection Fuel Rail Crossover Tube Replacement](#).



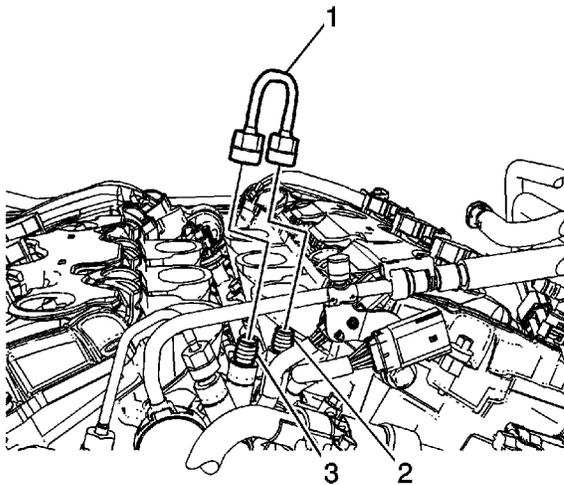
8. Install the high pressure fuel sensor. Refer to [Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail](#).
9. Connect the fuel injector wiring harness electrical connector (1) from the fuel injectors, fuel rail and fuel pressure sensor.
10. Inspect for fuel leaks using the following procedure:
  - 10.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 10.2. Turn OFF the ignition, for 10 seconds.

- 10.3. Turn ON the ignition, with the engine OFF.
- 10.4. Inspect for fuel leaks.
11. Install the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

# Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)

## Removal Procedure

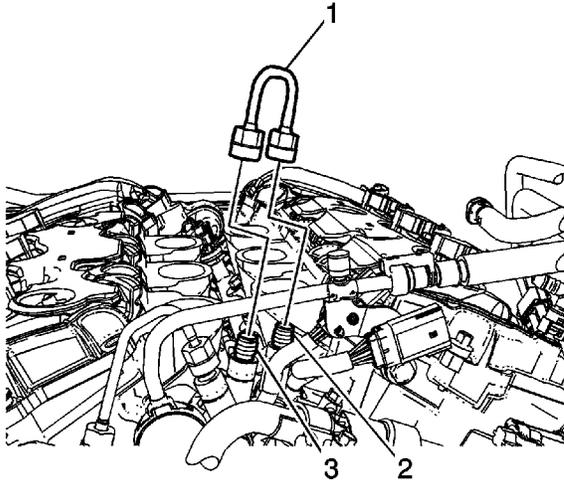
1. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Remove the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
4. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).



5. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (2).
6. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (3).
7. Remove the fuel rail crossover pipe (1) from the vehicle. Discard the pipe.

## Installation Procedure

1. Ensure that the fuel rail crossover pipe, right fuel rails fittings and left fuel rail fittings are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Position the fuel rail crossover pipe (1) to the right fuel rails fitting (2) and left fuel rail fitting (3).

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

4. Tighten the fuel rail crossover pipe fittings.
  - 4.1. Tighten the fittings first pass to **16 N·m (12 lb ft)**.
  - 4.2. Tighten the fittings final pass to **32 N·m (24 lb ft)**.

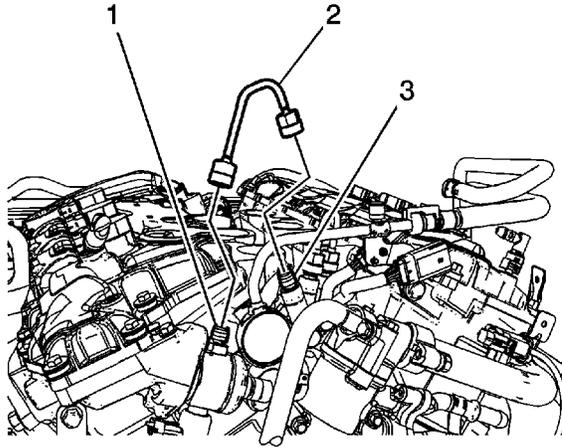
**Note:** If a fuel leak accrues at the right fuel rail fitting (2) or left fuel rail fitting (3), that component will need to be replaced.

5. Inspect for leaks using the following procedure:
  - 5.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 5.2. Turn OFF the ignition, for 10 seconds.
  - 5.3. Turn ON the ignition, with the engine OFF.
  - 5.4. Inspect for fuel leaks.
6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
9. Install the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
10. Install the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

## Fuel Feed Intermediate Pipe Replacement (LLT)

### Removal Procedure

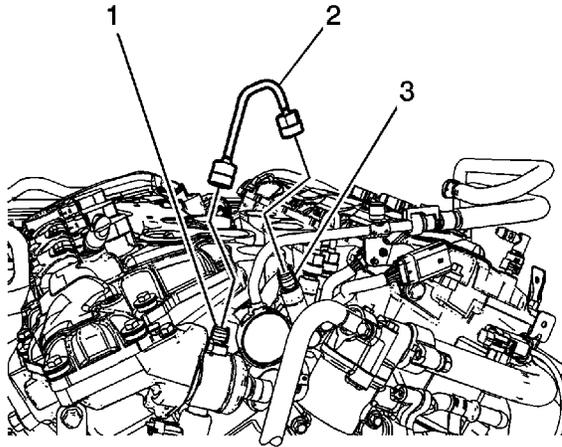
1. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Remove the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Relieve fuel system pressure. Refer to [Fuel Pressure Relief](#).



4. Remove the foam insulator from the pipes.
5. Loosen the high pressure pipe fitting to the high pressure fuel pump (1).
6. Loosen the high pressure pipe fitting to the left fuel rail (3).
7. Remove the high pressure fuel pipe (2) from the vehicle. Discard the pipe.

### Installation Procedure

1. Ensure that the high pressure fuel pipe, fuel rail fitting and fuel pump fitting are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Position the high pressure fuel pipe (2) to the high pressure fuel pump fitting (1) and left fuel rail (3). hand tighten the fitting.

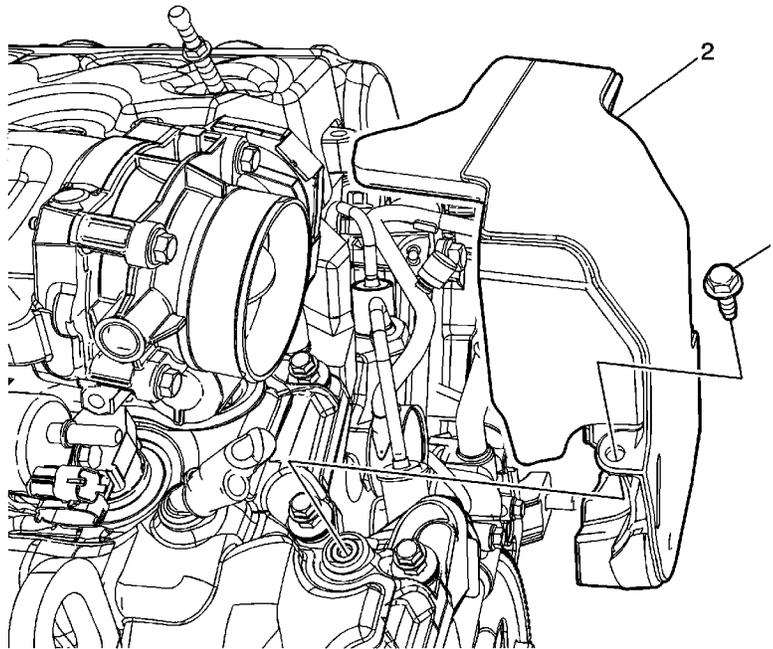
**Caution:** Refer to [Fastener Caution](#) in the Preface section.

4. Tighten the high pressure fuel pipe fitting.
  - 4.1. Tighten the fitting a first pass to **16 N·m (12 lb ft)**.
  - 4.2. Tighten the fitting a final pass to **32 N·m (24 lb ft)**.

**Note:** If a fuel leak accrues at the high pressure fuel pump or the fuel rail, that component will need to be replaced.

5. Inspect for leaks using the following procedure:
  - 5.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 5.2. Turn OFF the ignition, for 10 seconds.
  - 5.3. Turn ON the ignition, with the engine OFF.
  - 5.4. Inspect for fuel leaks.
6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
9. Install the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

## Fuel Pipe Shield Replacement



Callout	Component Name
<b>Preliminary Procedure</b>	
1. Remove the fuel injection sight shield. Refer to <a href="#">Fuel Injector Sight Shield Replacement</a> 2. Remove the air cleaner assembly. Refer to <a href="#">Air Cleaner Assembly Replacement</a>	
1	Fuel Pump Shield Bolt  <b>Caution:</b> Refer to <a href="#">Fastener Caution</a> in the Preface section.  <b>Tighten</b> 10N·m(89 lb in)
2	Fuel Pump Shield

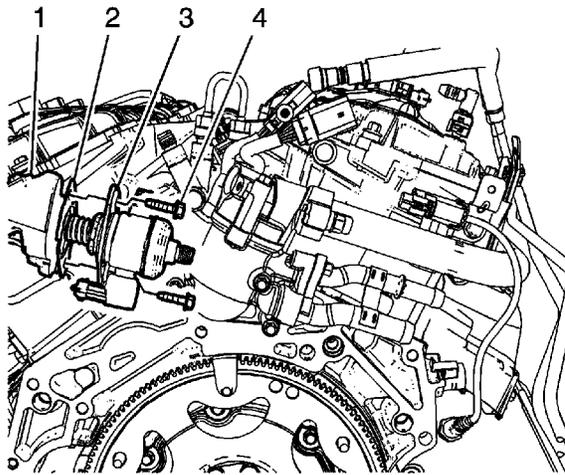
# Fuel Pump Replacement (LLT)

## Special Tools

*EN-48896* High Pressure Fuel Pump Installation Alignment Gage

## Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to [Fuel Pressure Relief](#) .
2. Remove the high pressure fuel pump shield. Refer to [Fuel Pipe Shield Replacement](#) .
3. Remove the intake manifold. Refer to [Intake Manifold Replacement](#) .



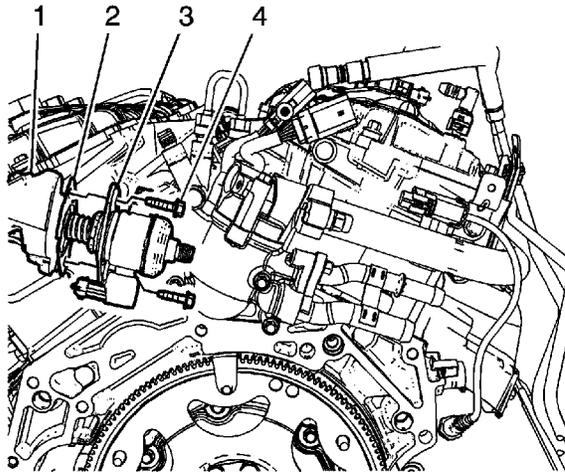
4. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
5. Remove the low pressure feed pipe. Refer to [Fuel Feed Pipe Replacement](#) .
6. Remove the high pressure pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#) . Discard this pipe.
7. Remove and discard the high pressure fuel pump bolts (4).
8. Remove the high pressure fuel pump (3).
9. Remove and discard the high pressure fuel pump gasket (2).
10. Remove and discard the high pressure fuel pump O-ring.
11. Remove the high pressure fuel pump roller lifter.

## Installation Procedure

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

1. Use the *EN-48896* alignment gage to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelude GM P/N 12345501 (Canadian P/N 992704) or equivalent.

3. Install high pressure fuel pump roller lifter.
4. Install a NEW high pressure fuel pump O-ring.



**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 (2) and bolts (4) to the fuel pump.
6. Install the high pressure fuel pump (3) to the cylinder head (1). Force will be required while hand tightening the bolts.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

7. Tighten the high pressure fuel pump retaining bolts to **15 N·m (11 lb ft)** .
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#) .
10. Install the fuel feed pipe to the high pressure fuel pump. Refer to [Fuel Feed Pipe Replacement](#) .
11. Connect the high pressure fuel pump wiring harness.
12. Install the fuel tank cap.

**Note:** If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

13. Inspect for leaks using the following procedure:
  - 13.1. Turn ON the ignition, with the engine OFF for 2 seconds.
  - 13.2. Turn OFF the ignition, for 10 seconds.
  - 13.3. Turn ON the ignition, with the engine OFF.
  - 13.4. Inspect for fuel leaks.
14. Install the pressure relief cap to the fuel feed pipe.
15. Install the intake manifold. Refer to [Intake Manifold Replacement](#) .
16. Install the high pressure fuel pump shield. Refer to [Fuel Pipe Shield Replacement](#) .

## Fuel Injector Replacement (LLT)

### Special Tools

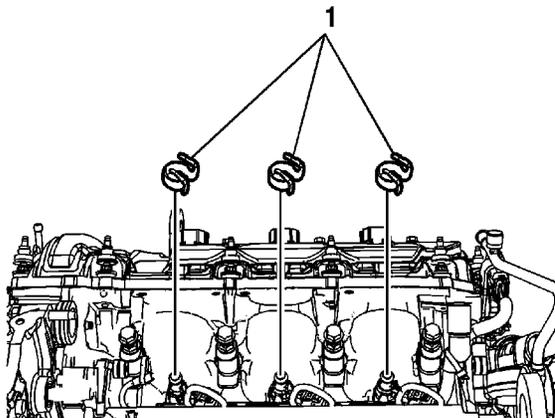
- *EN-47909* Injector Bore and Sleeve Cleaning Kit
- *EN-48266* Injector Seal Installer and Sizer
- *J 2619-01* Slide Hammer
- *J-37281-A* Injector Remover
- *J 39313* Spark Plug Port Adapter

### Removal Procedure

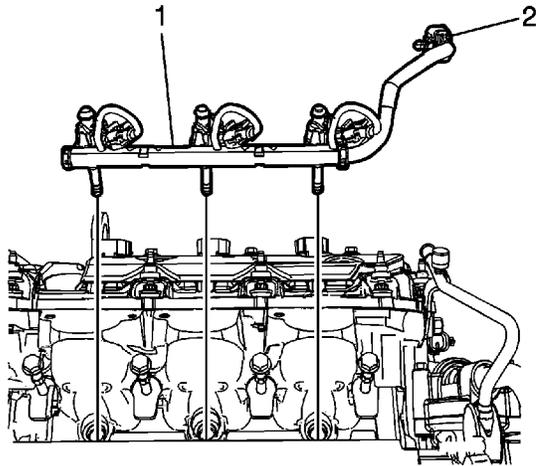
1. Relieve the high side fuel system pressure. Refer to [Fuel Pressure Relief](#).

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

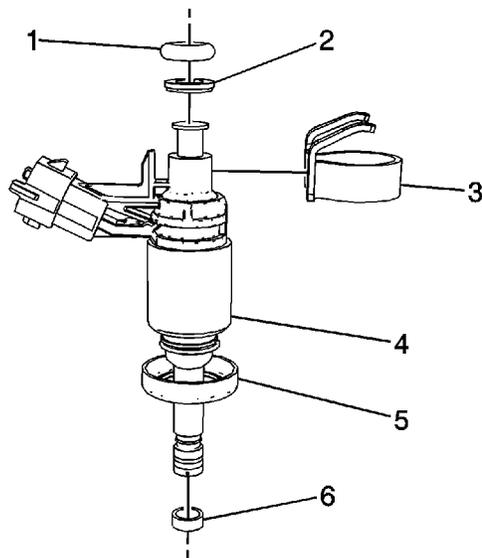
2. Remove the fuel injection fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1](#) or [Fuel Injection Fuel Rail Assembly Replacement - Bank 2](#).



3. Remove and discard the three fuel injector retaining rings (1).

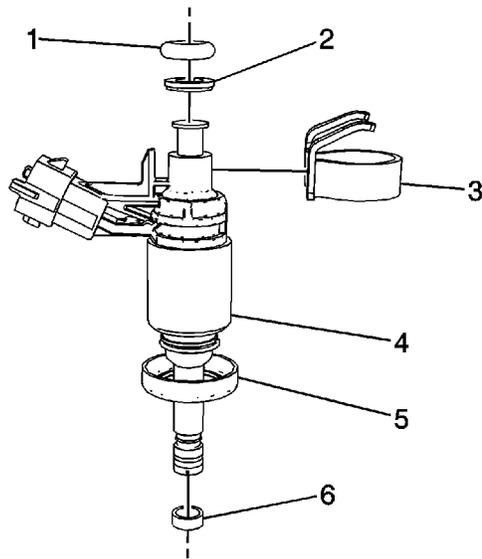


4. Remove the direct fuel injectors and harness (1) as an assembly, and disconnect the electrical connector (2). If necessary, use the *J-2619-01* slide hammer with the *J-37281-A* injector remover in order to remove the direct fuel injectors evenly.



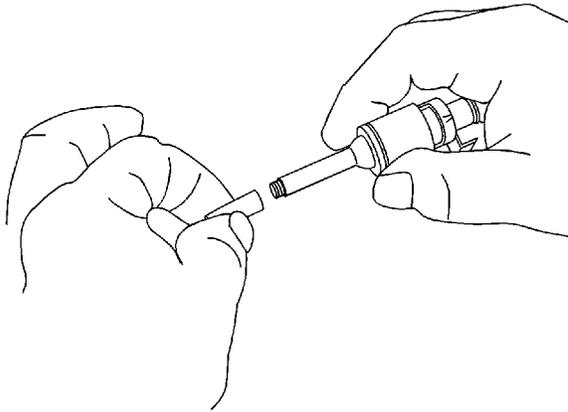
5. Remove and discard the following components from the fuel injectors (4).
  - Upper O-ring Seal (1)
  - Plastic Spacer (2)
  - Retaining Ring (3)
  - Isolator Cup (5)
  - Teflon Seal (6)
6. Inspect the fuel rail injector bores and clean with the *J-39313* adapter , and *EN-47909* cleaning kit , if required.

## Installation Procedure

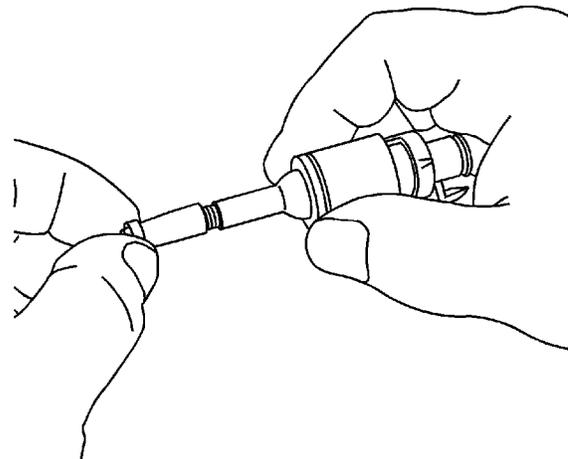


**Note:** Lubricate a NEW O-ring seal (1) with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

1. Install the following NEW components to the fuel injectors. Use steps 2 through 8 to install these components.
  - Upper O-ring Seal (1)
  - Plastic Spacer (2)
  - Retaining Ring (3)
  - Isolator Cup (5)
  - Teflon Seal (6)

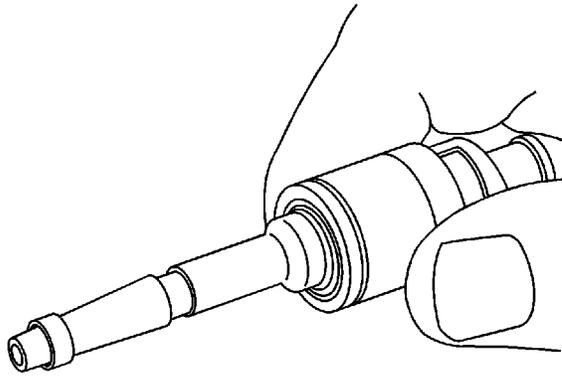


2. From the *EN-48266* Installer , position the EN 48266-1 to the injector tip.

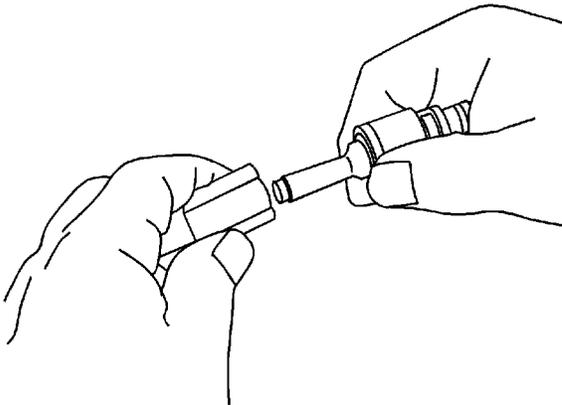


**Note:** DO NOT lubricate the NEW teflon seal.

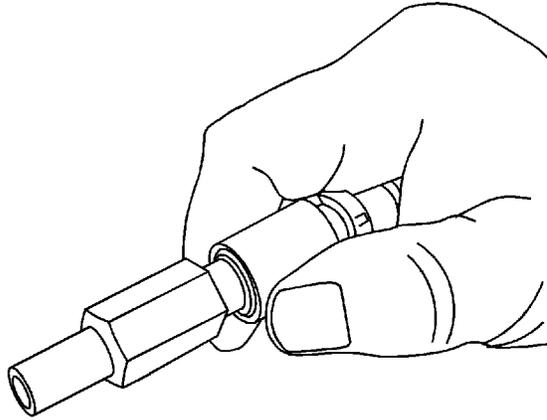
3. Install a NEW teflon seal onto the EN 48266-1.



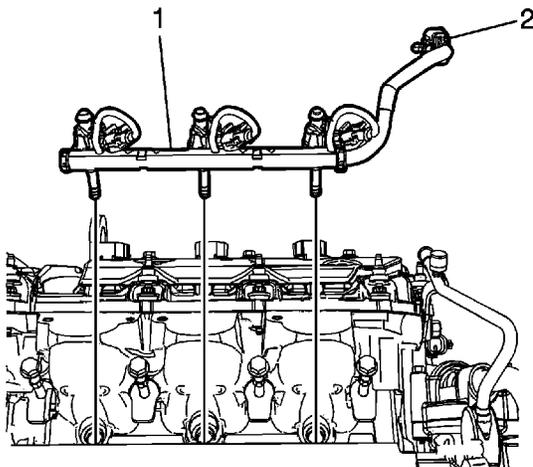
4. Pull the NEW teflon seal by hand over the EN 48266-1 and into the groove in the injector.
5. Remove the EN 48266-1 from the injector tip.



6. From the *EN-48266* Installer , install the EN 48266-2 to the injector tip.



7. Using the EN 48266-2, resize the teflon seal. Install the EN 48266-2, until it bottoms out against the injector body, and rotate the EN 48266-2 while applying only moderate force 180 degrees in one direction and then 180 degrees back in the other direction.
8. Remove the EN 48266-2.

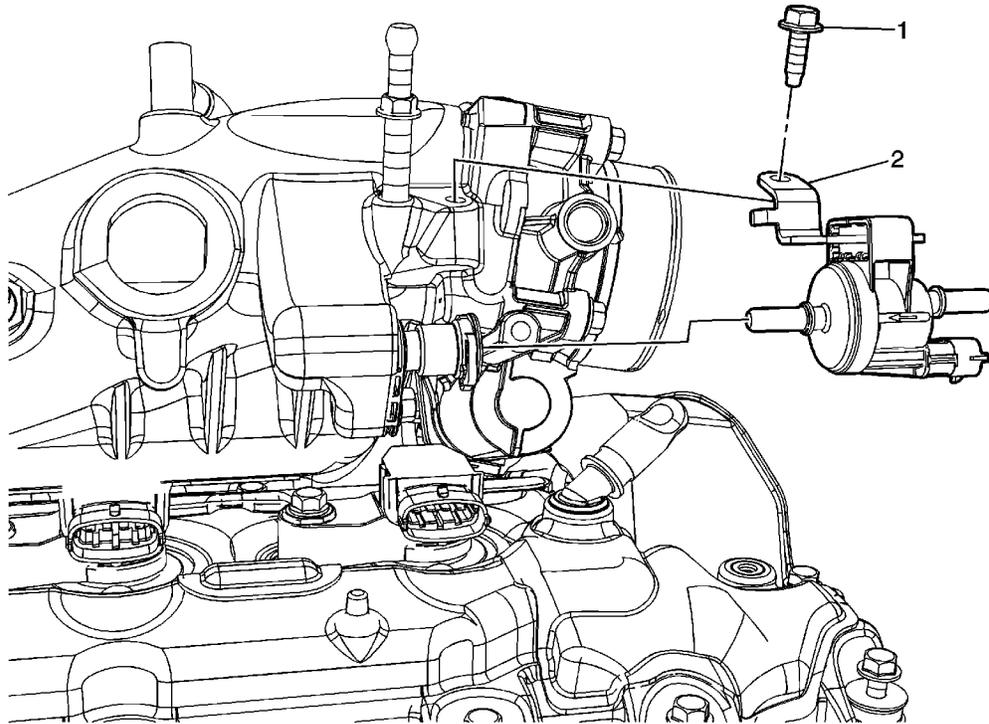


9. Install the direct fuel injectors and harness (1) as an assembly and connect the electrical connector (2).

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

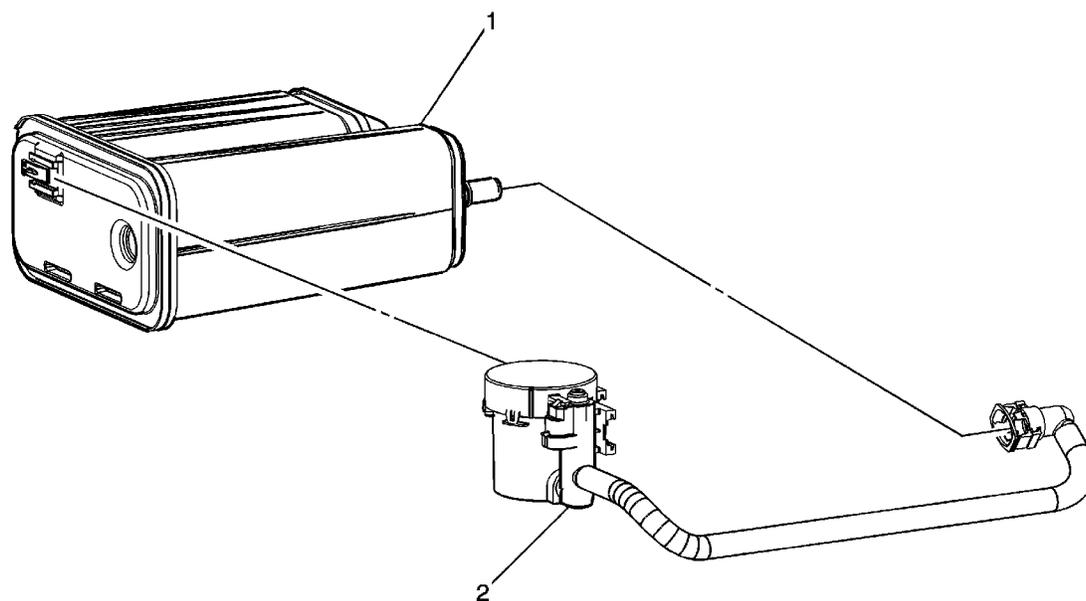
10. Install the fuel injection fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1](#) or [Fuel Injection Fuel Rail Assembly Replacement - Bank 2](#).

# Evaporative Emission Canister Purge Solenoid Valve Replacement



Callout	Component Name
<p><b>Preliminary Procedure</b></p> <p>Disconnect the canister purge tube quick connect fittings from the purge solenoid. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p>	
<p>1</p>	<p>Evaporative Emission Canister Purge Solenoid Valve Bolt</p> <p><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> in the Preface section.</p> <p><b>Tighten</b> 10 N·m (89 lb in)</p>
<p>2</p>	<p>Evaporative Emission Canister Purge Solenoid Valve</p> <p><b>Procedure</b></p> <p>Disconnect the electrical connector.</p>

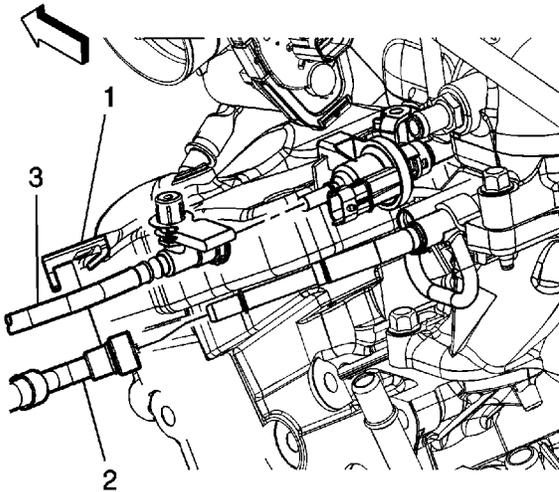
# Evaporative Emission Canister Vent Solenoid Valve Replacement



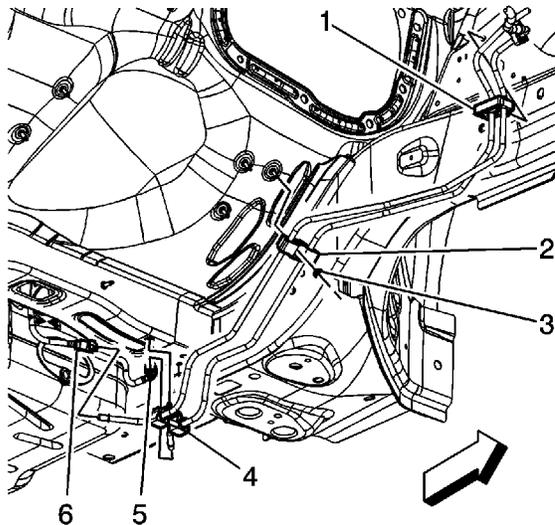
Callout	Component Name
<p><b>Preliminary Procedure</b></p> <p>Remove the evaporative emission (EVAP) canister. Refer to <a href="#">Evaporative Emission Canister Replacement</a>.</p>	
1	Evaporative Emission Canister
2	<p>Evaporative Emission Canister Vent Solenoid Valve Hose</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Disconnect the quick connect fitting at the EVAP canister. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</li> <li>2. Push in the retainer on the rear of the EVAP canister disengaging the vent solenoid valve.</li> </ol>

## Evaporative Emission Hoses/Pipes Replacement - Chassis/Canister

### Removal Procedure



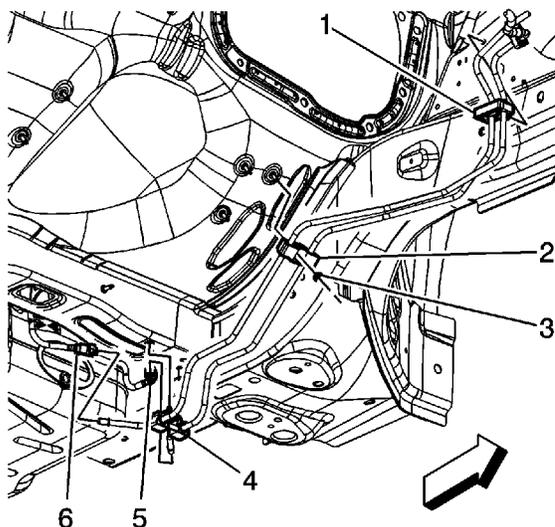
1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Remove the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
3. Remove the intermediate steering shaft. Refer to [Intermediate Steering Shaft Replacement](#).
4. Disconnect the fuel feed pipe (2) quick connect fitting from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
5. Disconnect the evaporative emission (EVAP) pipe (3) quick connect fitting from the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).
6. Cap the fuel rail and the EVAP purge solenoid in order to prevent possible fuel and/or EVAP system contamination.



7. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
8. Disconnect the fuel pump fuel feed pipe quick connect fitting (6) from the chassis fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
9. Disconnect the EVAP canister vent front pipe quick connect fitting (5) from the chassis EVAP pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
10. Remove the fuel feed/EVAP pipe assembly clip (1) from the body.
11. Remove the fuel feed/EVAP pipe assembly clip nut (3) and clip (2) from the stud.
12. Loosen the fuel feed/EVAP pipe clip (4) bolt, and remove the fuel feed/EVAP pipe assembly from the vehicle.

## Installation Procedure

**Caution:** Refer to [Fastener Caution](#) in the Preface section.





1. Position the fuel feed/EVAP pipe assembly to the vehicle, and tighten the fuel feed/EVAP pipe clip (4) bolt.

### Tighten

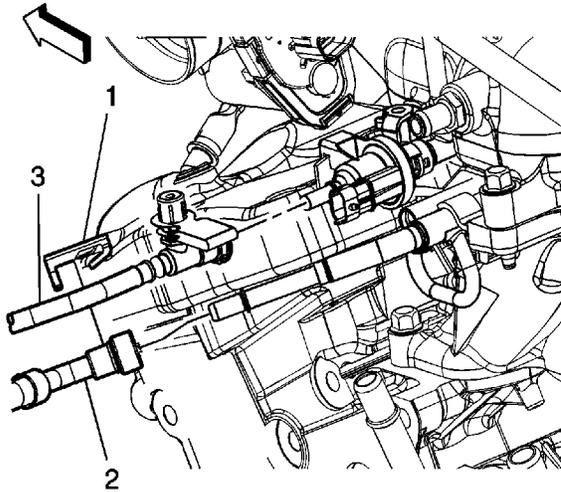
Tighten the bolt to 8 N·m (71 lb in).

2. Install the fuel feed/EVAP pipe clip (2) and nut (3) to the stud.

### Tighten

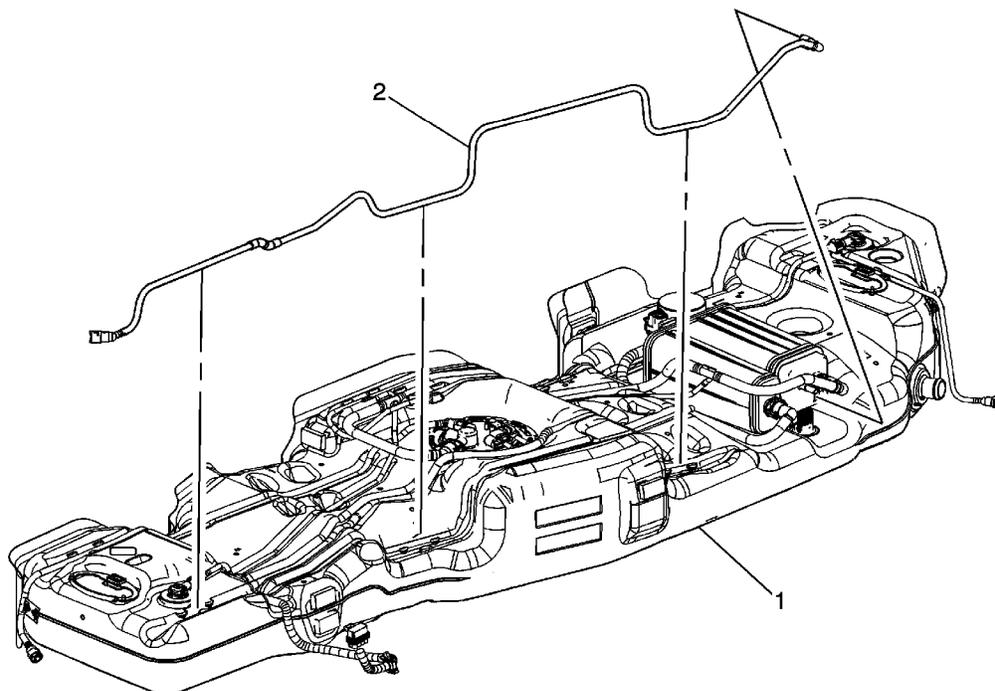
Tighten the nut to 9 N·m (80 lb in).

3. Install the fuel feed/EVAP pipe clip (1) to the body.
4. Connect the EVAP canister vent front pipe quick connect fitting (5) to the chassis EVAP pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Connect the fuel pump fuel feed pipe quick connect fitting (6) to the chassis fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
6. Lower the vehicle.



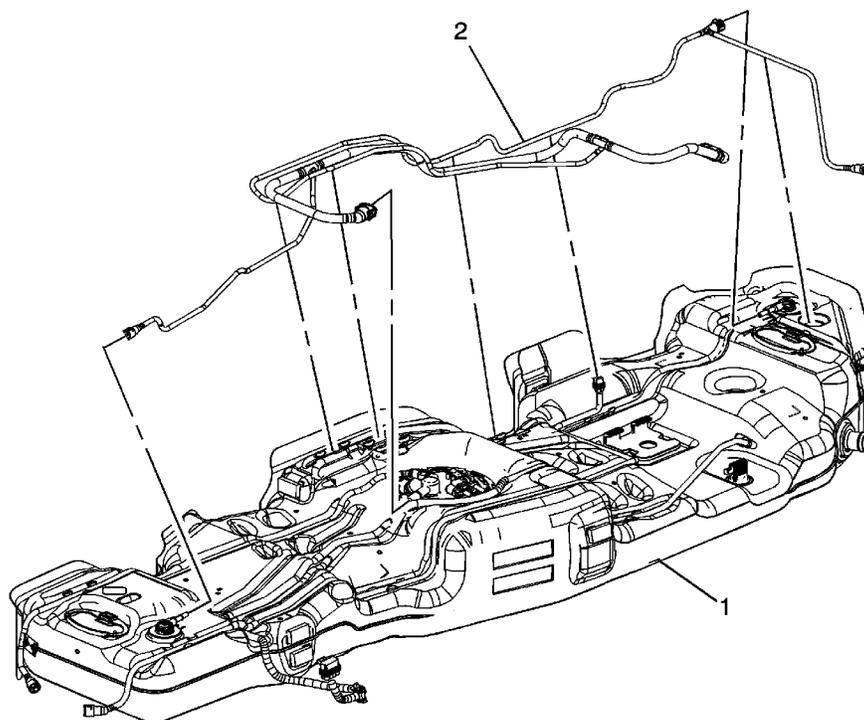
7. Remove the caps from the fuel rail and the EVAP purge solenoid.
8. Connect the EVAP pipe (3) quick connect fitting to the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).
9. Connect the fuel feed pipe (2) quick connect fitting to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
10. Tighten the fuel fill cap.
11. Use the following procedure in order to inspect for leaks:
  - Turn the ignition ON, with the engine OFF, for 2 seconds.
  - Turn the ignition OFF for 10 seconds.
  - Turn the ignition ON, with the engine OFF.
  - Inspect for fuel leaks.
12. Install the intermediate steering shaft. Refer to [Intermediate Steering Shaft Replacement](#).
13. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

# Evaporative Emission Canister Vent Front Pipe Replacement



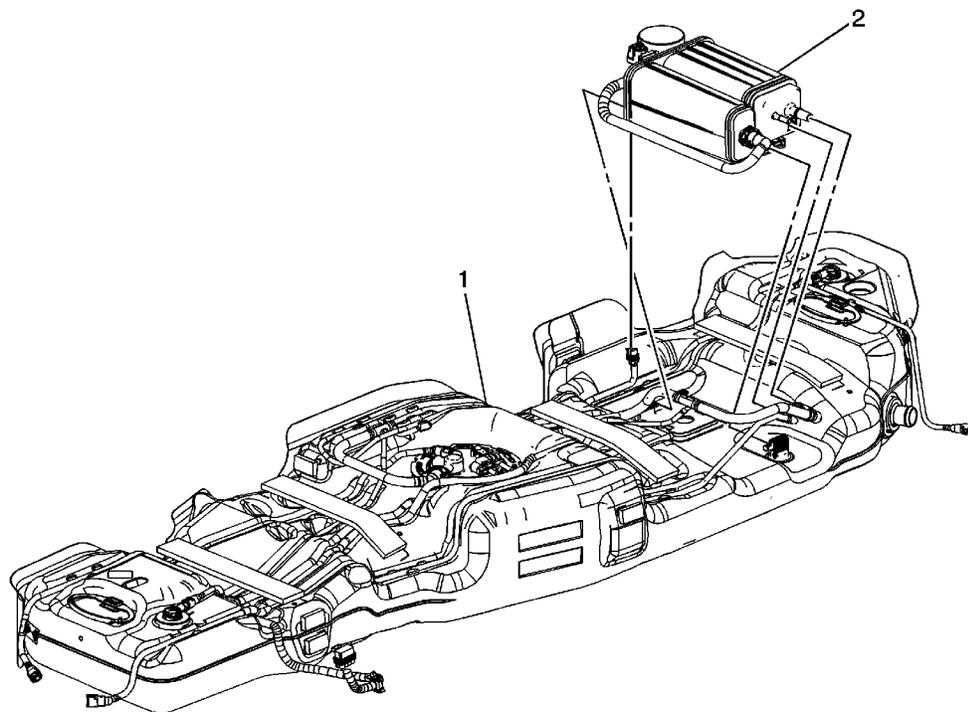
Callout	Component Name
<p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"> <li>1. Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a> .</li> <li>2. Remove the foam pad insulators, as required.</li> </ol>	
1	Fuel Tank
2	<p>Evaporative Emission Canister Vent Front Pipe</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Disconnect the quick connect fitting from the evaporative emission canister. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> .</li> <li>2. Disengage from the tank retaining features.</li> </ol>

# Evaporative Emission Canister Vent Rear Pipe Replacement



Callout	Component Name
<p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"> <li>1. Remove the EVAP canister. Refer to <a href="#">Evaporative Emission Canister Replacement</a> .</li> <li>2. Remove the foam pad insulators.</li> </ol>	
1	Fuel Tank
2	<p>Evaporative Emission Canister Vent Rear Pipe</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Disconnect the quick connect fitting from the fuel tank module. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> .</li> <li>2. Disconnect the quick connect fittings from the rollover valves. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> .</li> <li>3. Disengage from the tank retaining features.</li> </ol>

# Evaporative Emission Canister Replacement



Callout	Component Name
<b>Preliminary Procedure</b>	
Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a> .	
1	Fuel Tank
2	Evaporative Emission Canister  <b>Procedure</b> <ol style="list-style-type: none"> <li>1. Disconnect the fuel sender wiring harness electrical connector from the EVAP canister vent solenoid valve.</li> <li>2. Disconnect the EVAP canister vent front pipe quick connect fitting from the EVAP canister. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> .</li> <li>3. Disconnect the EVAP canister vent rear pipe quick connect fitting from the EVAP canister. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> .</li> <li>4. Disengage the EVAP canister retainer on the fuel tank.</li> </ol>

# Evaporative Emission System Cleaning

## Special Tools

[J 41413](#) EVAP Pressure and Purge Station

## Inspection Procedure

**Caution:** Use the EVAP Pressure/Purge Diagnostic Station J 41413 in order to provide a clean, dry, low pressure gas source. Do not substitute any other pressurized gas source. Damage may result to the EVAP system.

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

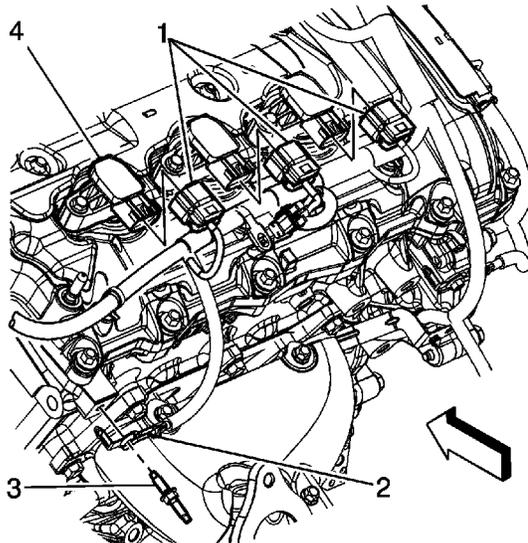
1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
  - If no carbon particles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

## Cleaning Procedure

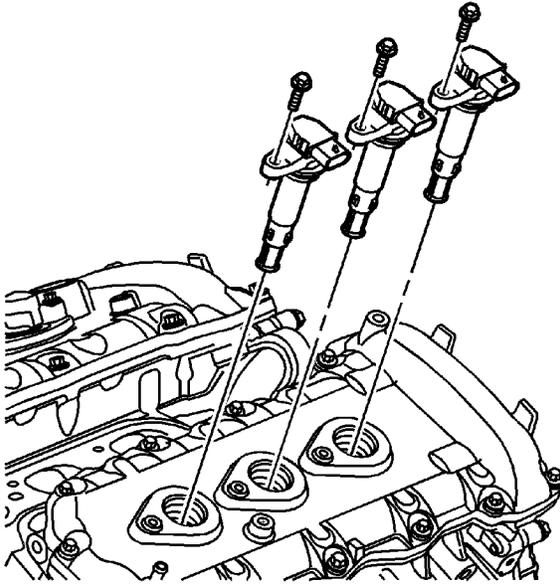
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the EVAP canister. Refer to [Evaporative Emission Canister Replacement](#).
3. Turn OFF the main valve on the [J 41413](#).
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section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

## Ignition Coil Replacement - Bank 1

### Removal Procedure

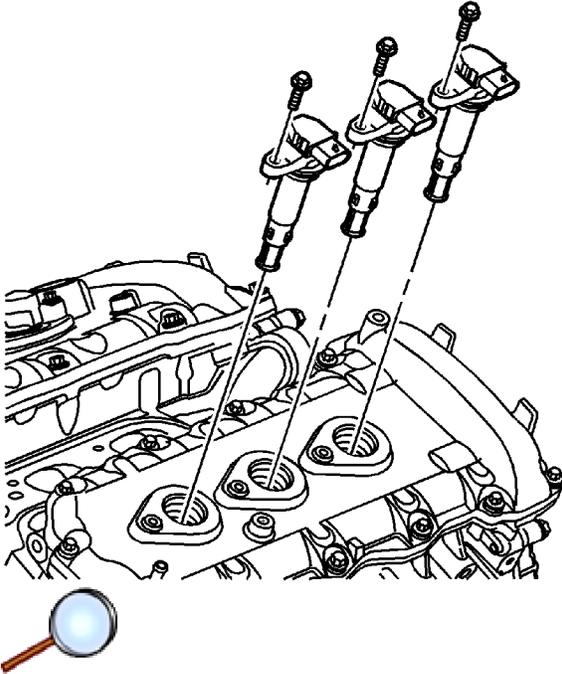


1. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s) (4).
2. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#)



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

## Installation Procedure



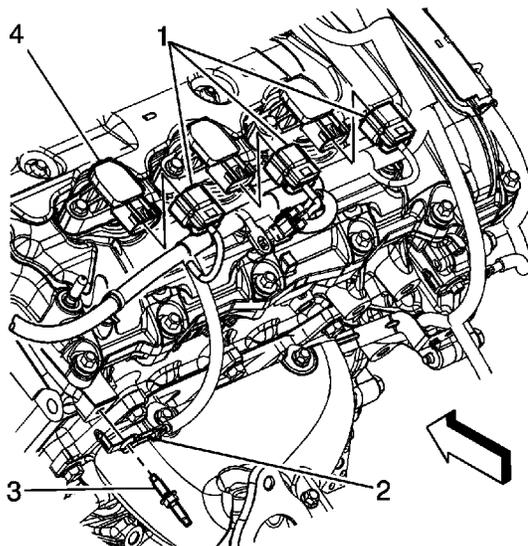
1. Install the ignition coil(s).

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the ignition coil bolt(s).

### Tighten

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

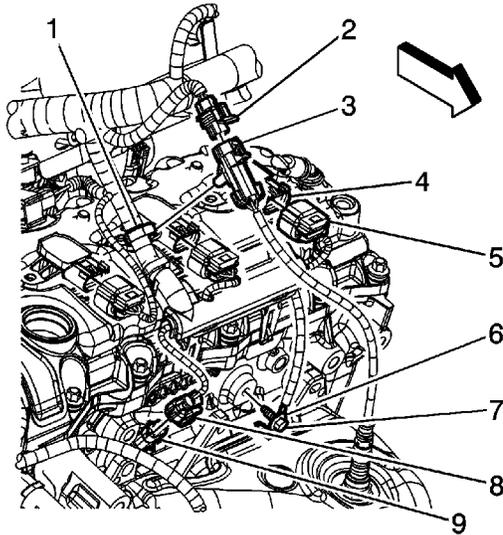




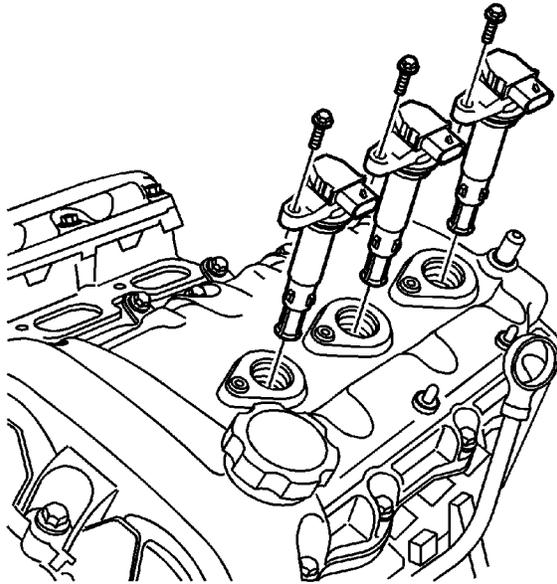
3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (4).
4. Install the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#)

## Ignition Coil Replacement - Bank 2

### Removal Procedure

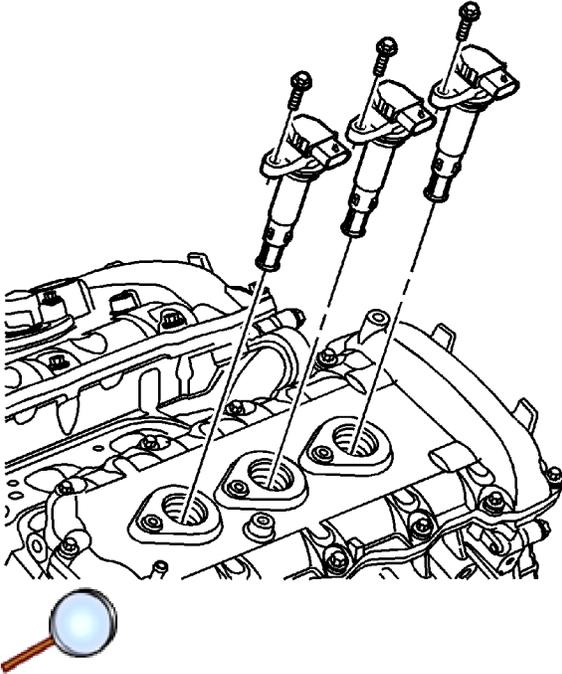


1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#)
2. Disconnect the engine wiring harness electrical connector(s) (5) from the ignition coil(s) (4).



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

## Installation Procedure



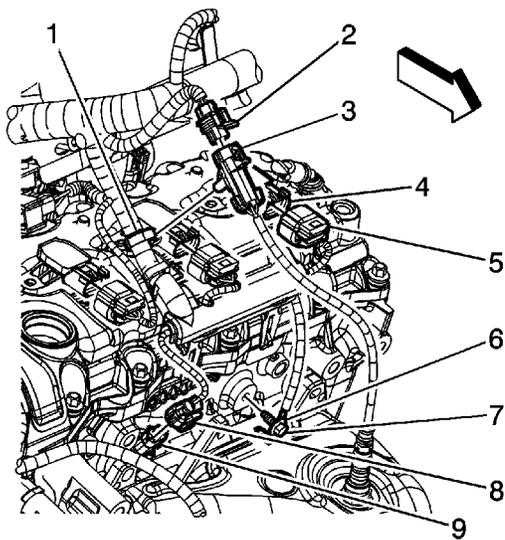
1. Install the ignition coil(s).

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the ignition coil bolt(s).

### Tighten

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





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

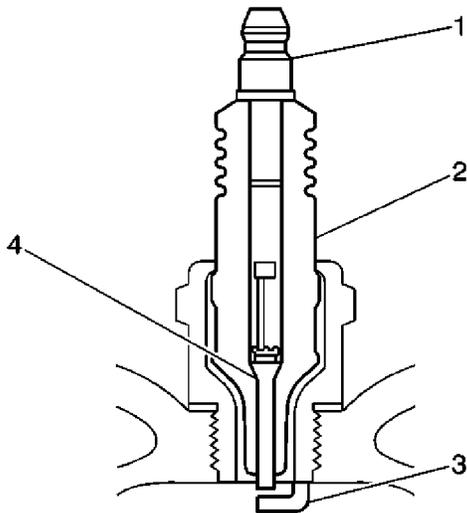
## Spark Plug Inspection

### Spark Plug Usage

- | Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to [Ignition System Specifications](#) for the correct spark plug.
- | Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
  - Spark plug fouling--Colder plug
  - Pre-ignition causing spark plug and/or engine damage--Hotter plug

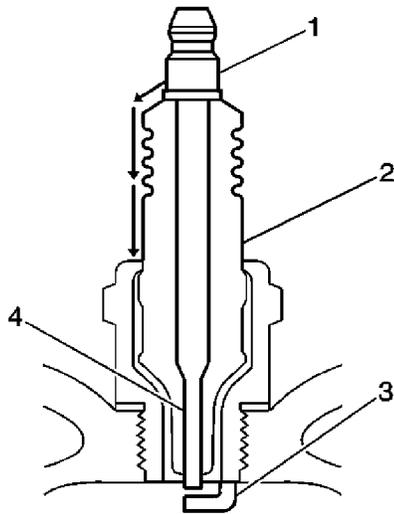
### Spark Plug Inspection

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- | 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.

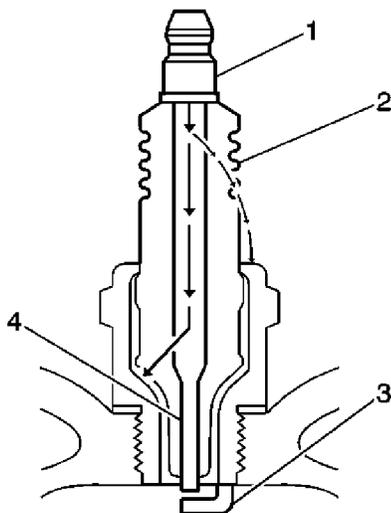
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Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:

- 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).

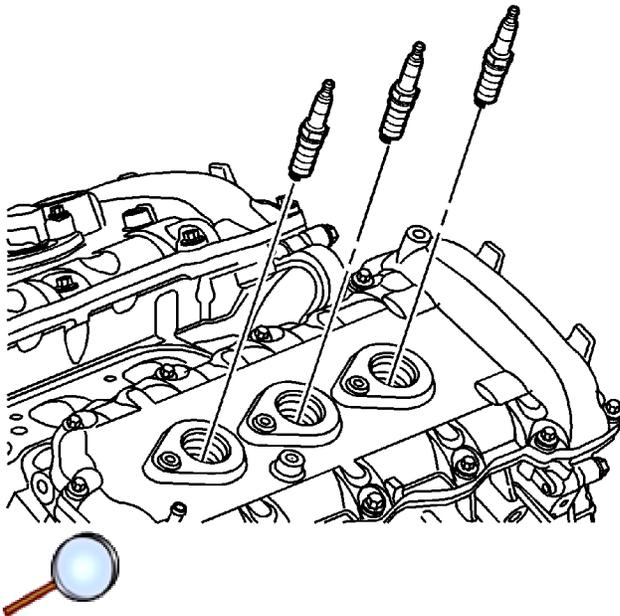
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- Excessive fuel pressure
- Restricted air filter element
- Incorrect combustion
- Reduced ignition system voltage output
- Weak coils
- Worn ignition wires
- Incorrect spark plug gap
- Excessive idling or slow speeds under light loads can keep spark 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



1. Remove the ignition coil(s). Refer to [Ignition Coil Replacement - Bank 1](#) and/or [Ignition Coil Replacement - Bank 2](#).

**Warning:** Refer to [Safety Glasses and Compressed Air Warning](#) in the Preface section.

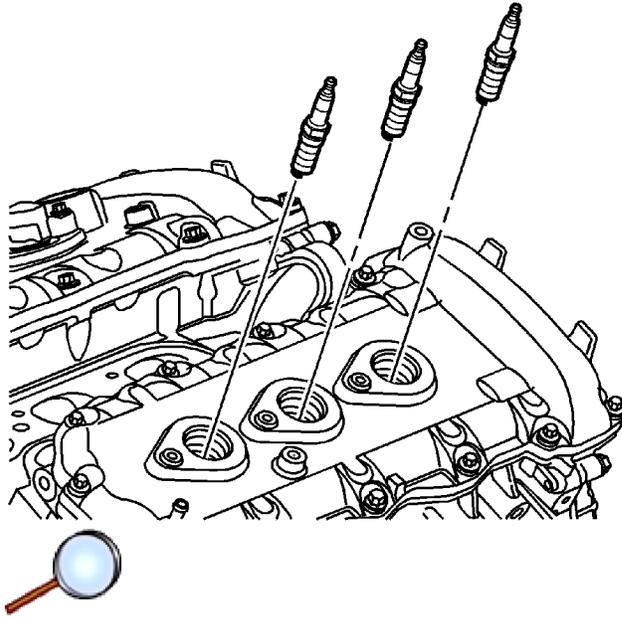
**Caution:** Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of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

2. 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.

3. Remove the spark plug.

### Installation Procedure



**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 gage 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:** Refer to [Fastener Caution](#) in the Preface section.

**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.

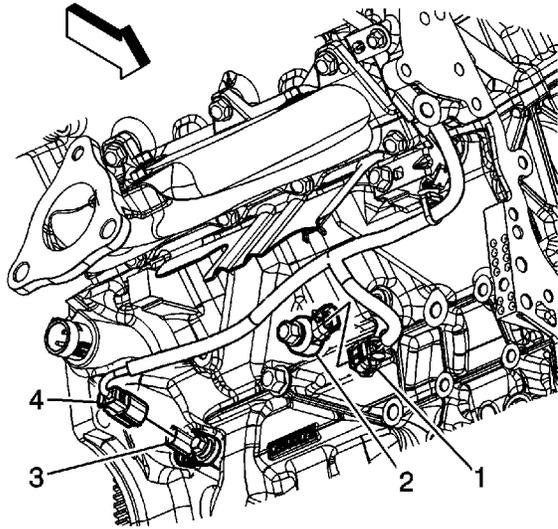
#### **Tighten**

Tighten the spark plug to 20 N·m (15 lb ft).

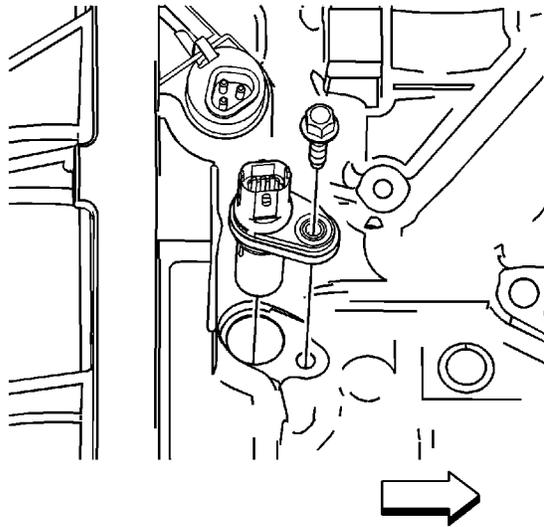
3. Install the ignition coil(s). Refer to [Ignition Coil Replacement - Bank 1](#) and/or [Ignition Coil Replacement - Bank 2](#).

## Crankshaft Position Sensor Replacement

### Removal Procedure



1. Remove the exhaust manifold lower heat shield. Refer to [Exhaust Manifold Lower Heat Shield Replacement](#).
2. Disconnect the engine wiring harness electrical connector (3) from the crankshaft position (CKP) sensor (4).

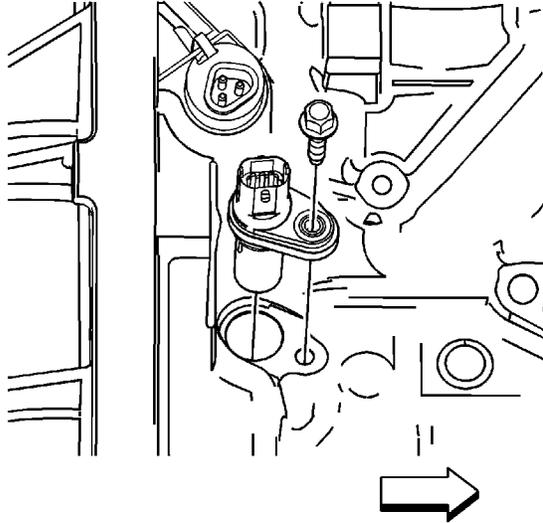


3. Remove the crankshaft sensor bolt.

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4. Remove the crankshaft sensor.

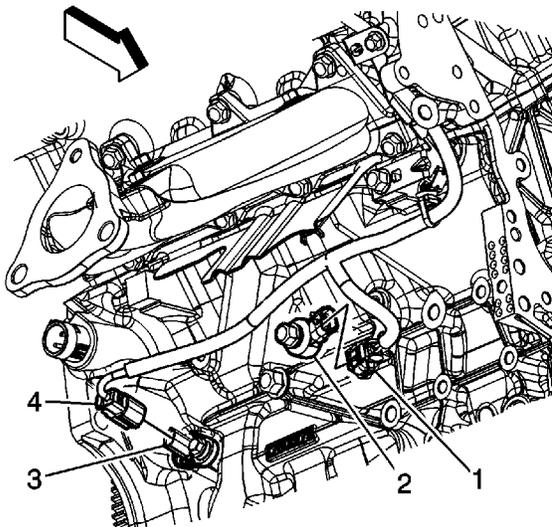
## Installation Procedure



1. Install the crankshaft position sensor.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

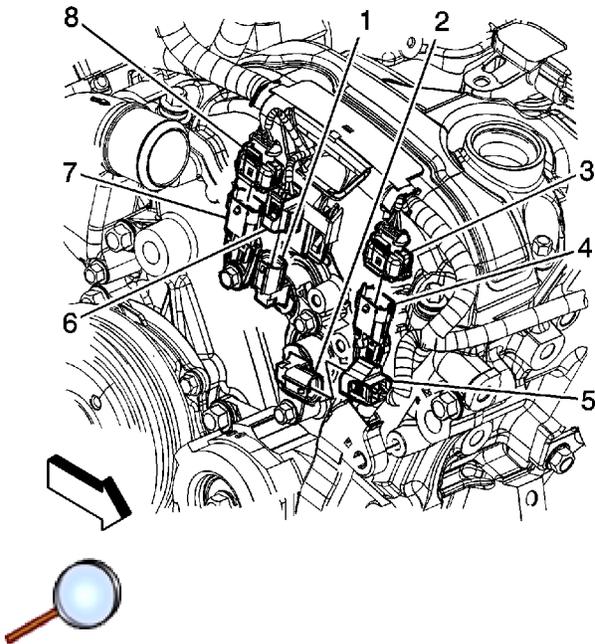
2. Install the crankshaft position sensor bolt and tighten to **10 N·m (89 lb in)**.



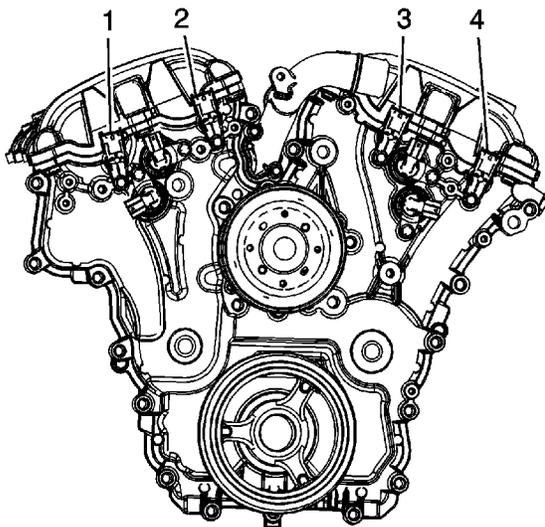
3. Connect the engine wiring harness electrical connector (3) to the CKP sensor (4).
4. Install the exhaust manifold lower heat shield. Refer to [Exhaust Manifold Lower Heat Shield Replacement](#).

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

### Removal Procedure



1. Remove the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Disconnect the engine wiring harness electrical connector (3) from the bank 2 exhaust camshaft position (CMP) sensor (4).

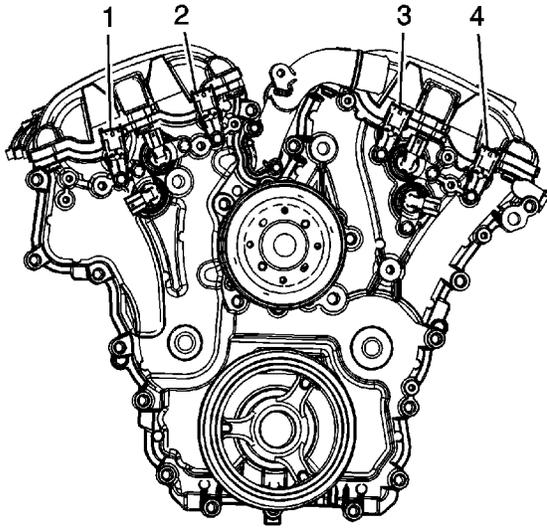




3. Remove the CMP sensor bolt and sensor (4).

## Installation Procedure

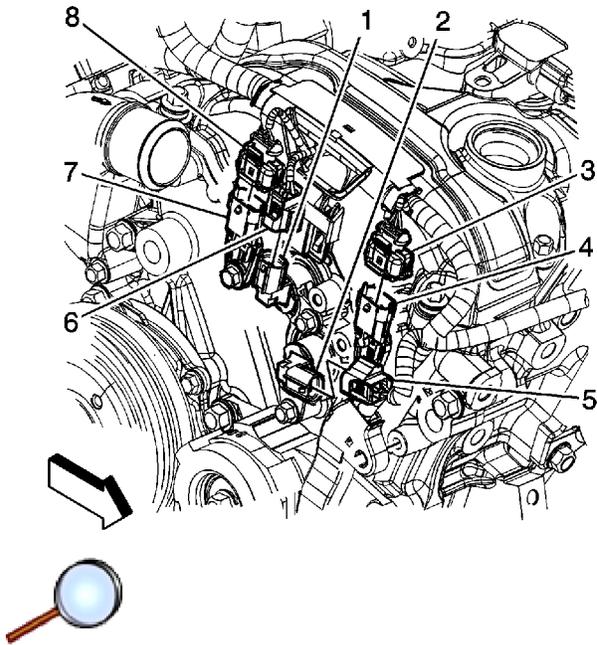
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



1. Install the CMP sensor (4) and bolt.

### Tighten

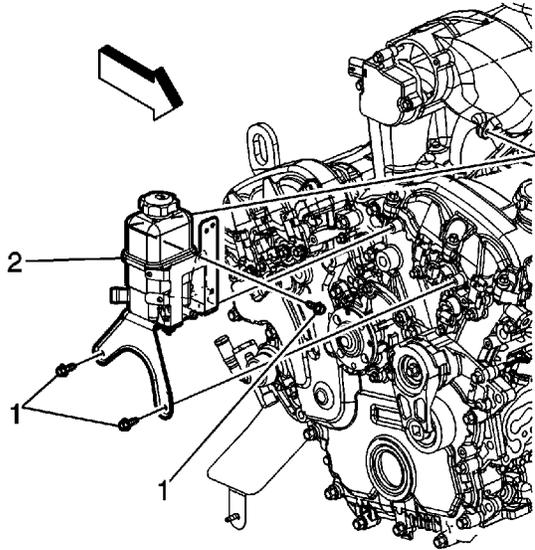
Tighten the bolt to 10 N·m (89 lb in).



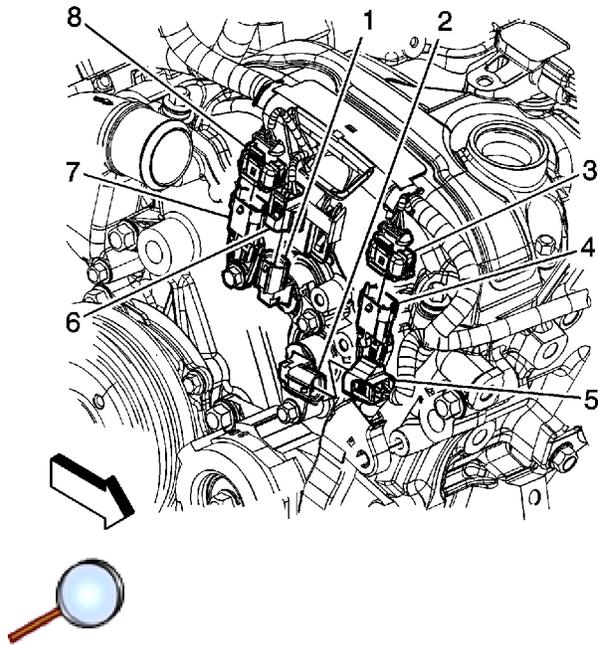
2. Connect the engine wiring harness electrical connector (3) to the bank 2 exhaust CMP sensor (4).
3. Install the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).

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

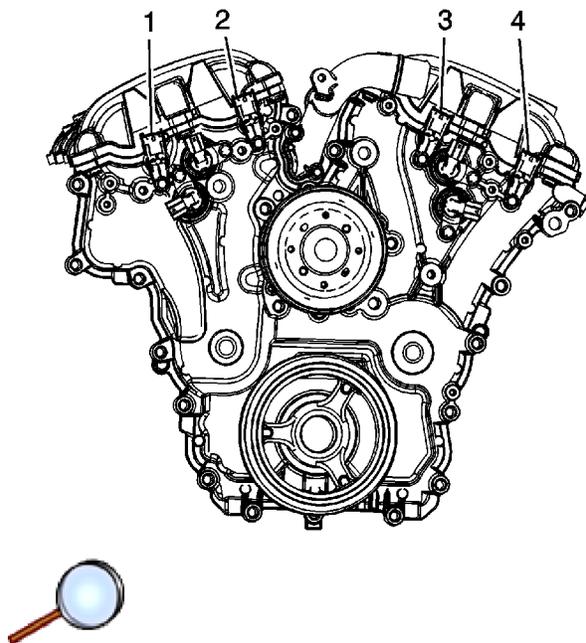
### Removal Procedure



1. Remove the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Remove the radiator inlet hose from the water outlet. Refer to [Radiator Inlet Hose Replacement](#).
3. Remove the power steering fluid reservoir bracket bolts (1).
4. Remove and reposition the power steering fluid reservoir bracket (2) out of the way.



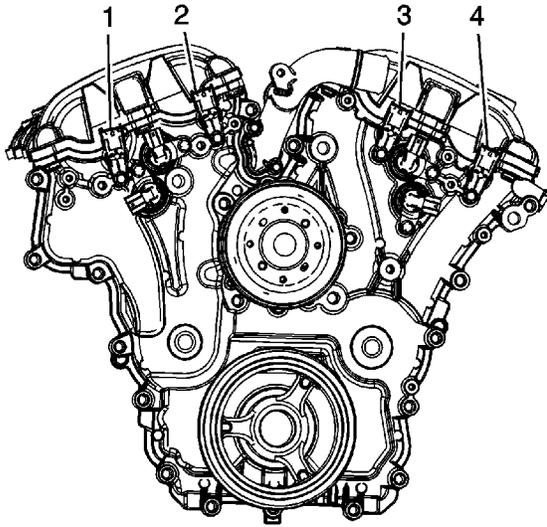
5. Disconnect the engine wiring harness electrical connector (8) from the bank 2 intake camshaft position (CMP) sensor (7).



6. Remove the CMP sensor bolt and sensor (3).

## Installation Procedure

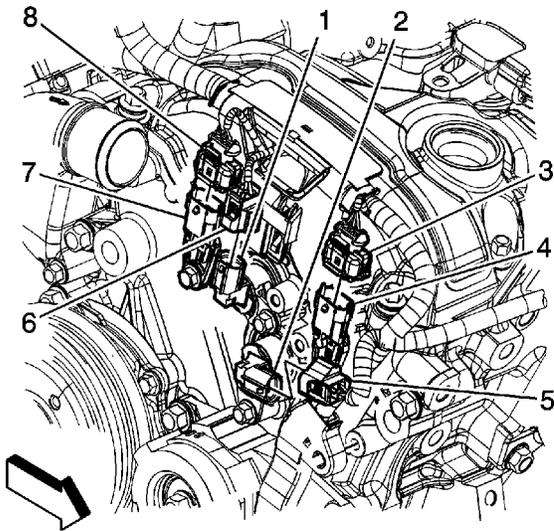
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



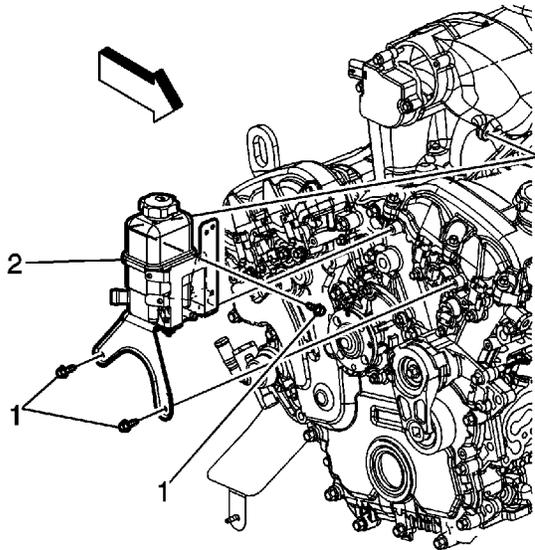
1. Install the CMP sensor (3) and bolt.

**Tighten**

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



2. Connect the engine wiring harness electrical connector (8) to the bank 2 intake CMP sensor (7).



3. Position and install the power steering fluid reservoir bracket (2).
4. Install the power steering fluid reservoir bracket bolts (1).

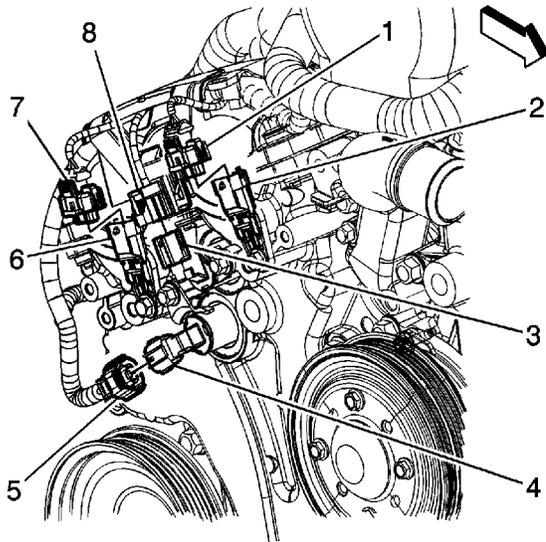
### **Tighten**

Tighten the bolts to 9 N·m (8 lb in).

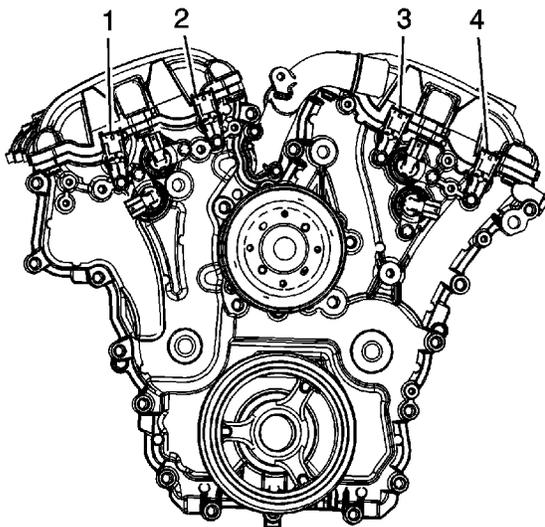
5. Install the radiator inlet hose to the water outlet. Refer to [Radiator Inlet Hose Replacement](#).
6. Install the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).

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

### Removal Procedure



1. Remove the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Disconnect the engine wiring harness electrical connector (7) from the bank 1 exhaust camshaft position (CMP) sensor (6).

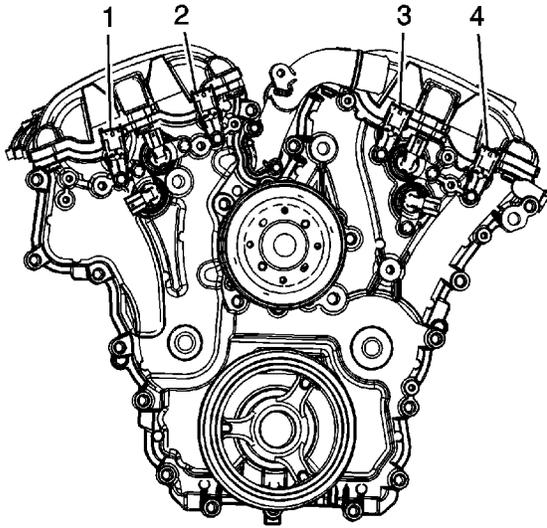




3. Remove the CMP sensor bolt and sensor (1).

## Installation Procedure

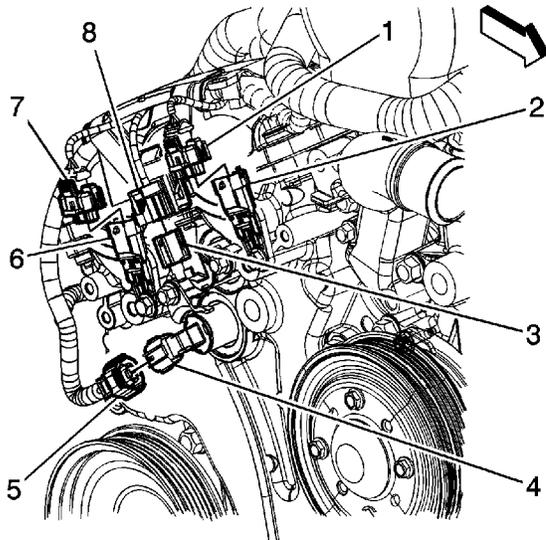
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



1. Install the CMP sensor (1) and bolt.

### Tighten

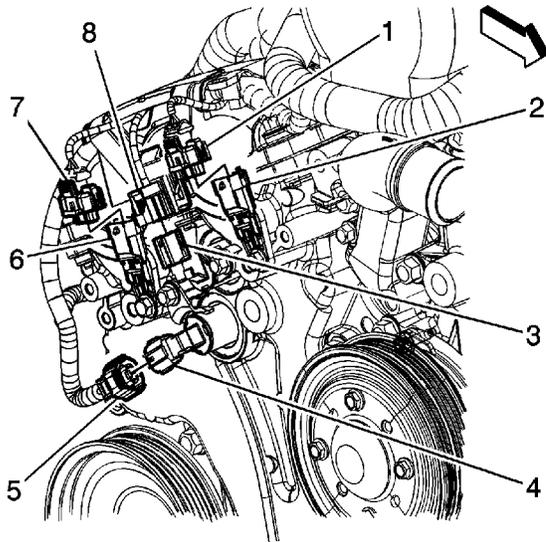
Tighten the bolt to 10 N·m (89 lb in).



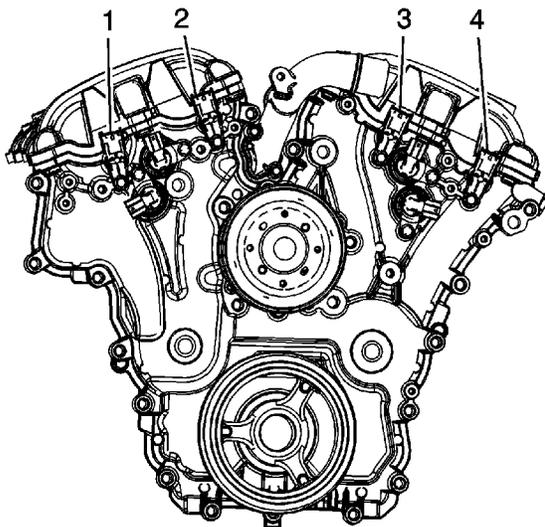
2. Connect the engine wiring harness electrical connector (7) to the bank 1 exhaust CMP sensor (6).
3. Install the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).

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

### Removal Procedure



1. Remove the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Disconnect the engine wiring harness electrical connector (1) from the bank 1 intake camshaft position (CMP) sensor (2).

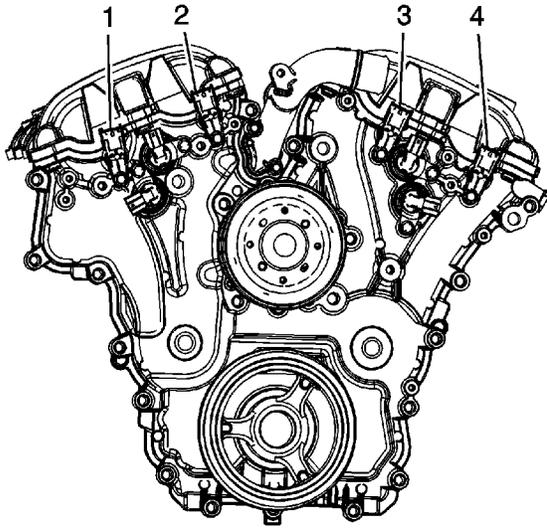




3. Remove the CMP sensor bolt and sensor (2).

## Installation Procedure

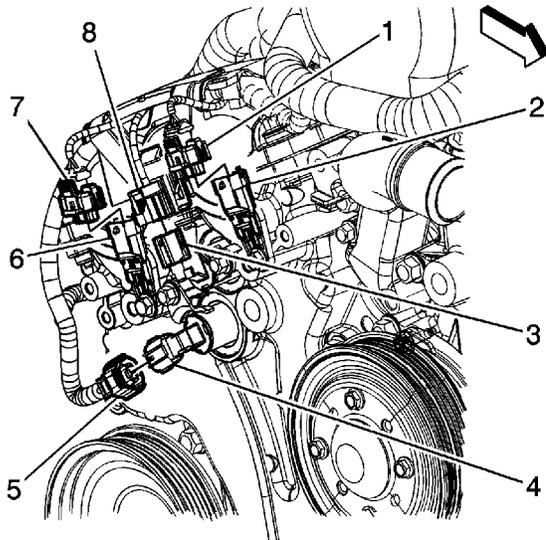
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



1. Install the CMP sensor (2) and bolt.

### Tighten

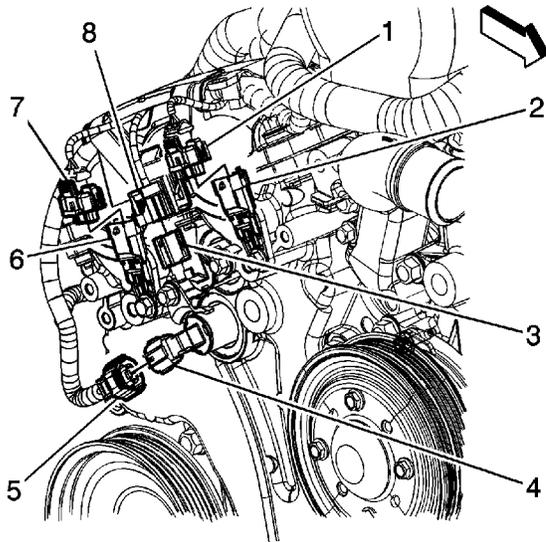
Tighten the bolt to 10 N·m (89 lb in).



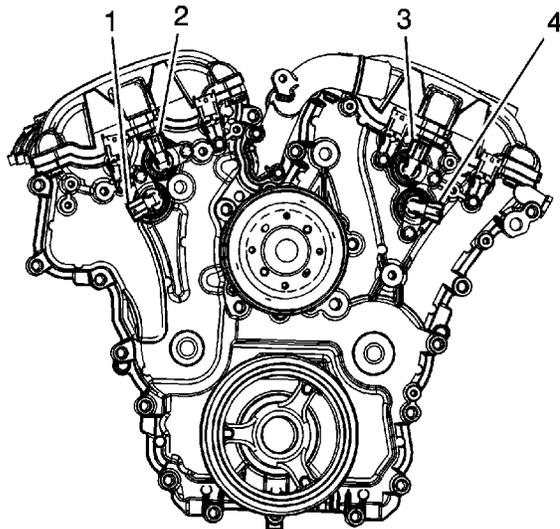
2. Connect the engine wiring harness electrical connector (1) to the bank 1 intake CMP sensor (2).
3. Install the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).

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

### Removal Procedure



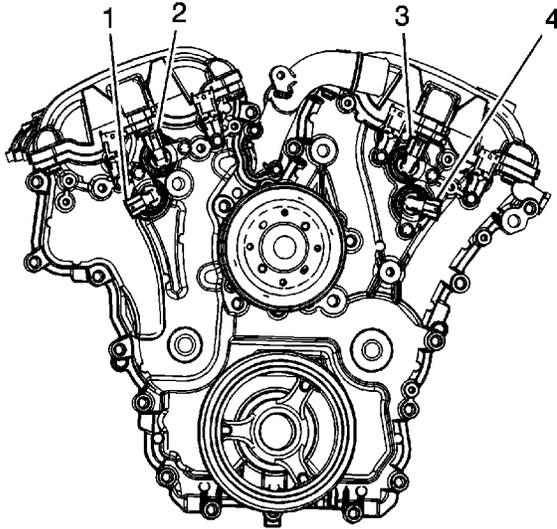
1. Remove the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Disconnect the engine wiring harness electrical connector (8) from the bank 1 intake CMP actuator solenoid valve.





3. Remove the CMP actuator solenoid valve bolt and valve (2).
4. Inspect the CMP actuator solenoid valve seal and replace as necessary.

## Installation Procedure



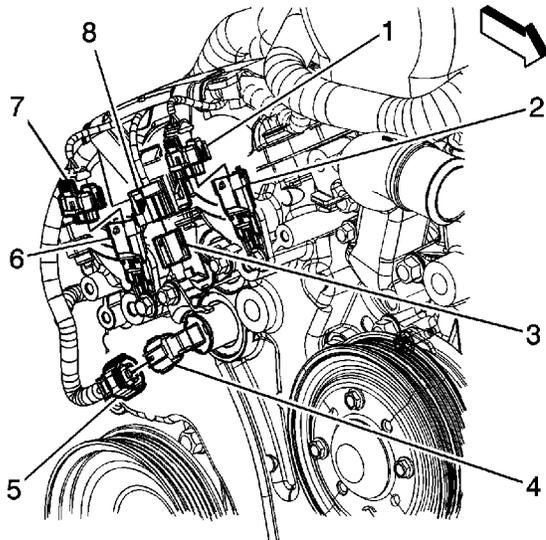
1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the CMP actuator solenoid valve (2) and bolt.

### **Tighten**

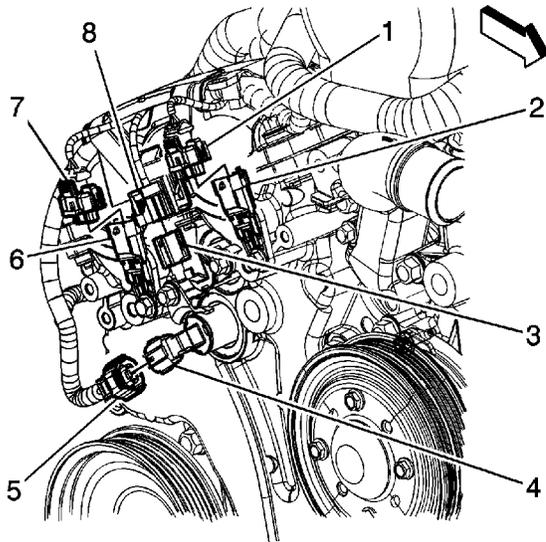
Tighten the bolt to 10 N·m (89 lb in).



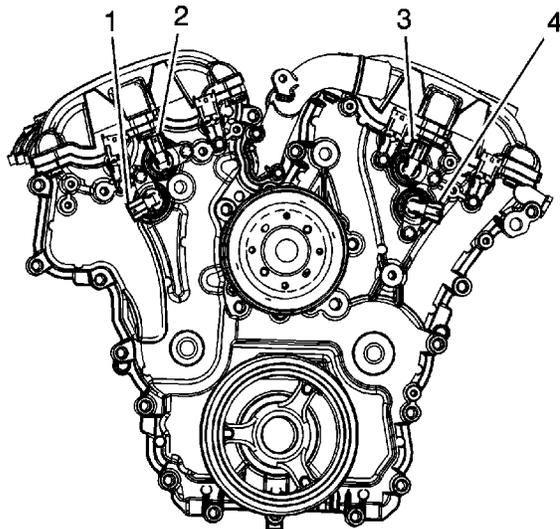
3. Connect the engine wiring harness electrical connector (8) to the bank 1 intake CMP actuator solenoid valve.
4. Install the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).

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

### Removal Procedure



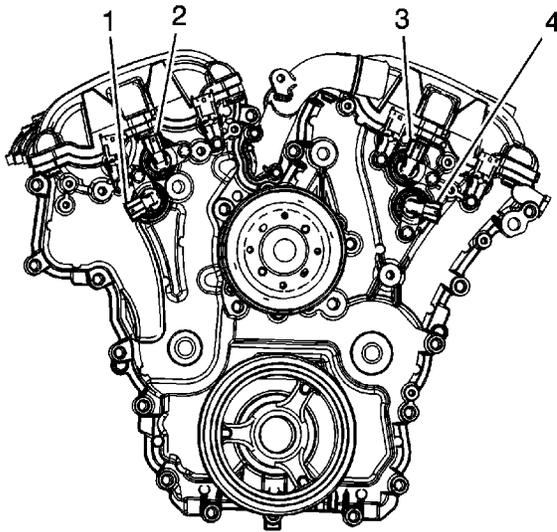
1. Remove the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Disconnect the engine wiring harness electrical connector (5) from the bank 1 exhaust camshaft position (CMP) actuator solenoid valve.





3. Remove the CMP actuator solenoid valve bolt and valve (1).
4. Inspect the CMP actuator solenoid valve seal and replace as necessary.

## Installation Procedure



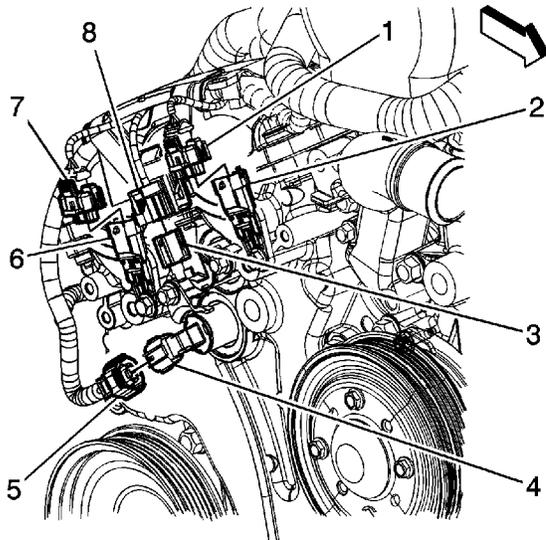
1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the CMP actuator solenoid valve (1) and bolt.

### **Tighten**

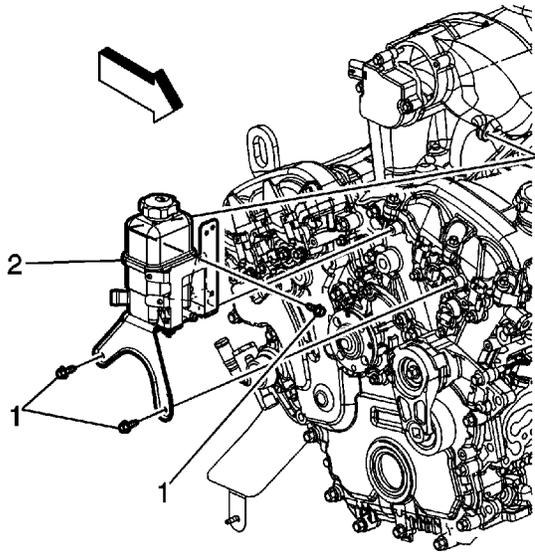
Tighten the bolt to 10 N·m (89 lb in).



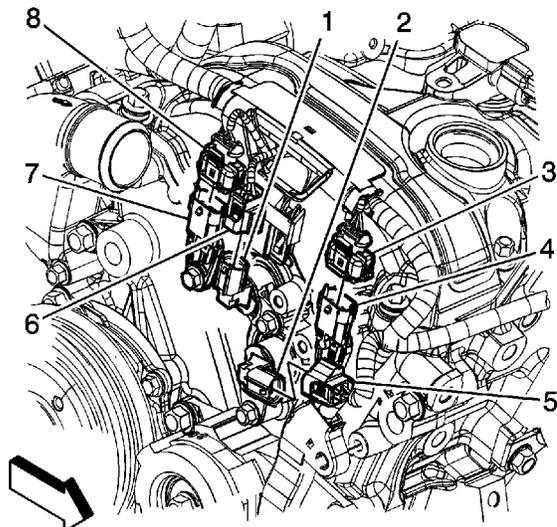
3. Connect the engine wiring harness electrical connector (5) to the bank 1 exhaust CMP actuator solenoid valve.
4. Install the engine mount strut and bracket. Refer to [Engine Mount Strut Replacement - Right Side](#) and [Engine Mount Strut Bracket Replacement - Right Side](#).

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

### Removal Procedure

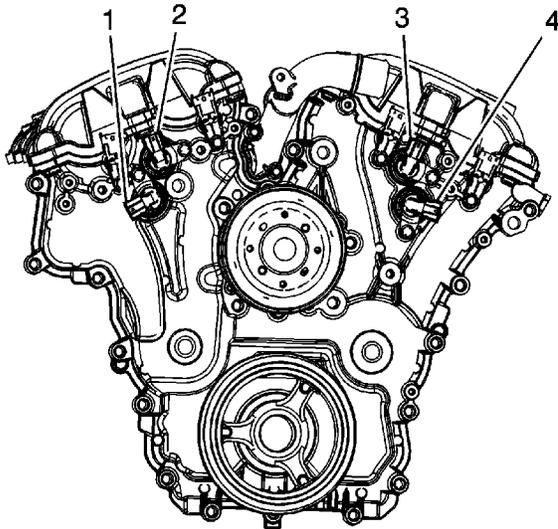


1. Remove the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Remove the radiator inlet hose from the water outlet. Refer to [Radiator Inlet Hose Replacement](#).
3. Remove the power steering fluid reservoir bracket bolts (1).
4. Remove and reposition the power steering fluid reservoir bracket (2) out of the way.



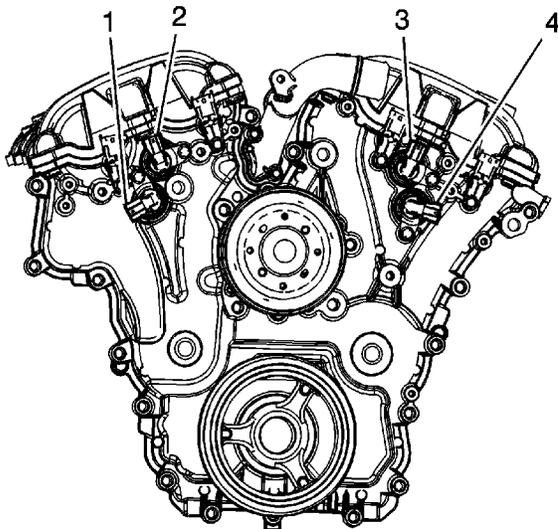


5. Disconnect the engine wiring harness electrical connector (6) from the bank 2 intake camshaft position (CMP) actuator solenoid valve.



6. Remove the CMP actuator solenoid valve bolt and valve (3).
7. Inspect the CMP actuator solenoid valve seal for damage and replace as necessary.

## Installation Procedure



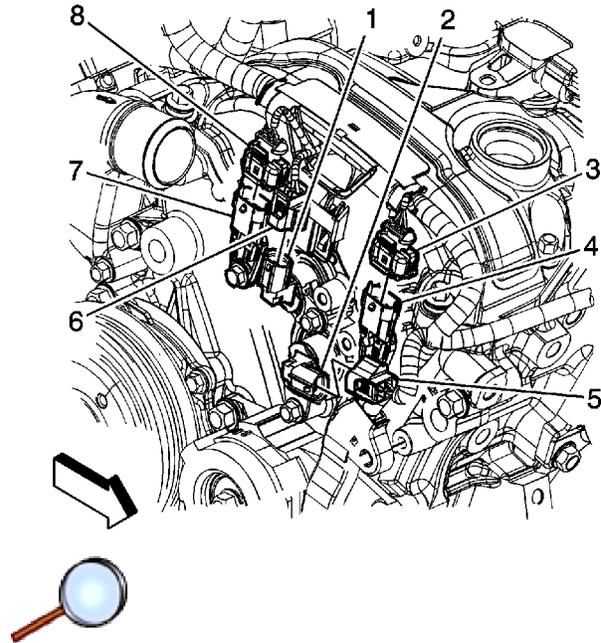
1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

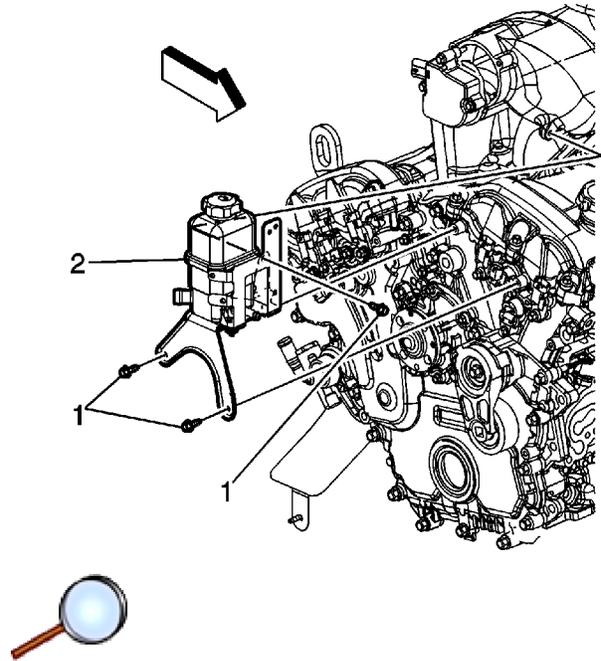
2. Install the CMP actuator solenoid valve (3) and bolt.

### Tighten

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



3. Connect the engine wiring harness electrical connector (6) to the bank 2 intake CMP actuator solenoid valve.



4. Position and install the power steering fluid reservoir bracket (2).
5. Install the power steering fluid reservoir bracket bolts (1).

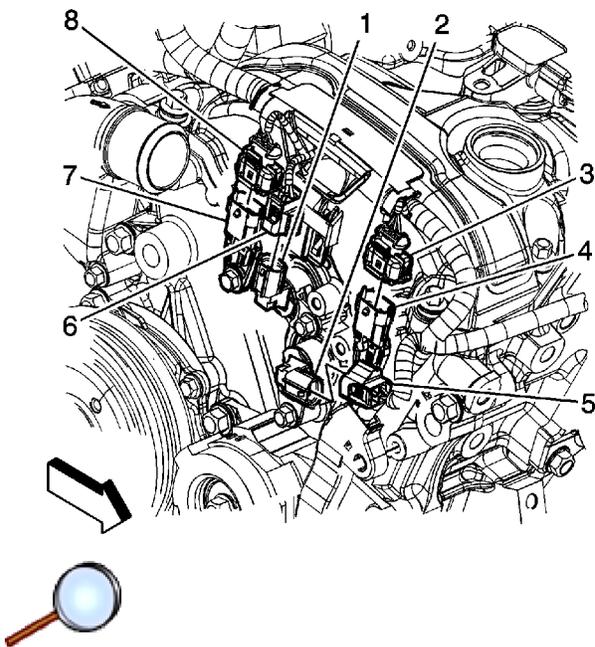
**Tighten**

Tighten the bolts to 9 N·m (80 lb in).

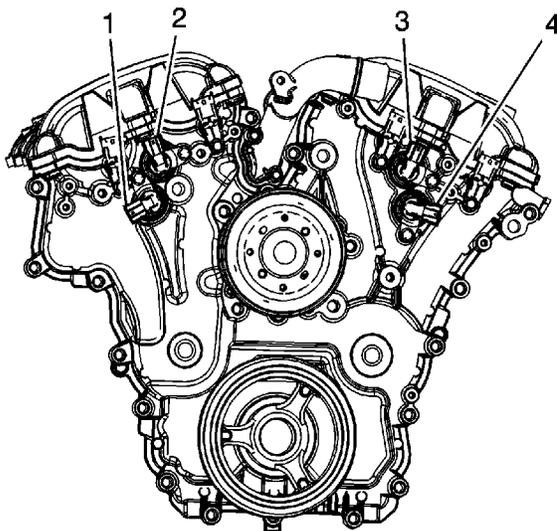
6. Install the radiator inlet hose to the water outlet. Refer to [Radiator Inlet Hose Replacement](#).
7. Install the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).

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

### Removal Procedure



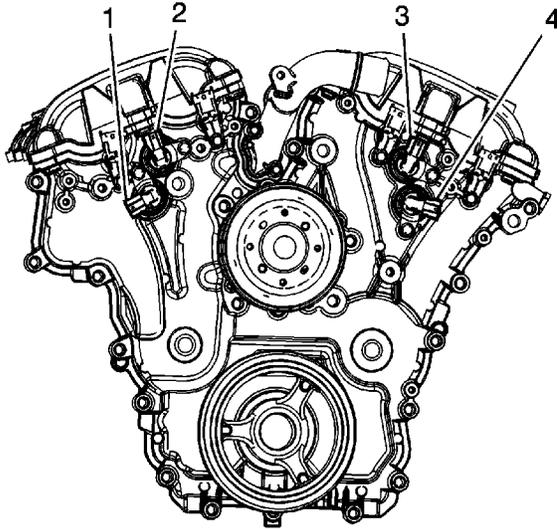
1. Remove the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).
2. Disconnect the engine wiring harness electrical connector (5) from the bank 2 exhaust camshaft position (CMP) actuator solenoid valve.





3. Remove the CMP actuator solenoid valve bolt and valve (4).
4. Inspect the CMP actuator solenoid valve seal for damage and replace as necessary.

## Installation Procedure



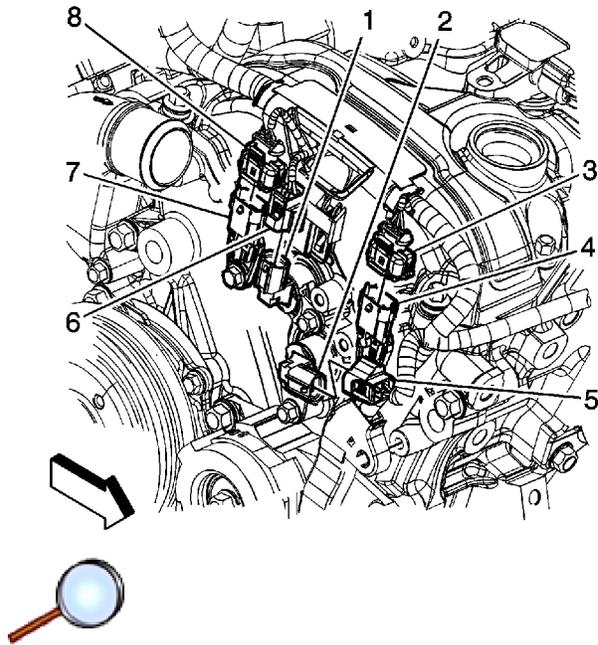
1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

2. Install the CMP actuator solenoid valve (4) and bolt.

### **Tighten**

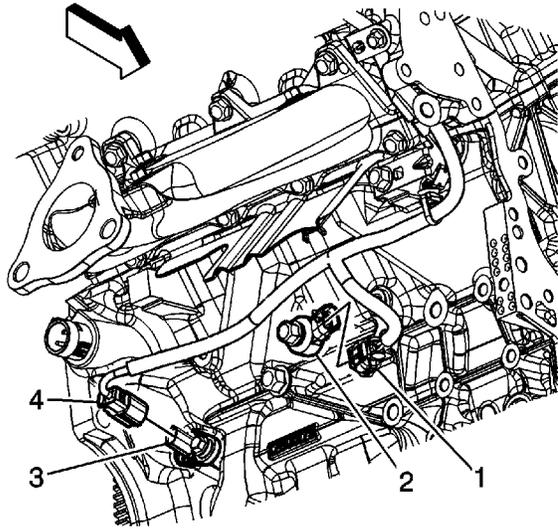
Tighten the bolt to 10 N·m (89 lb in).



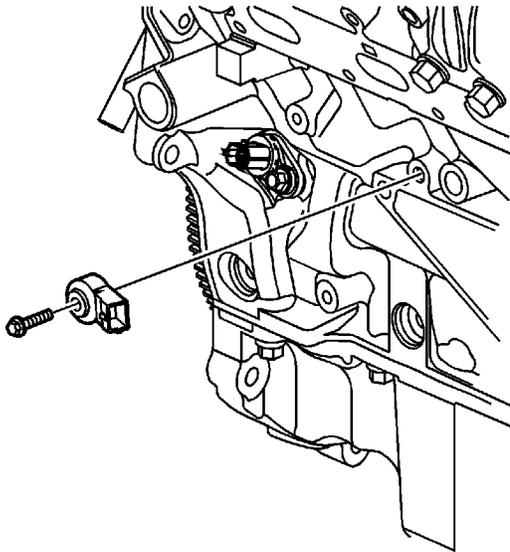
3. Connect the engine wiring harness electrical connector (5) to the bank 2 exhaust CMP actuator solenoid valve.
4. Install the engine mount strut bracket. Refer to [Engine Mount Strut Bracket Replacement - Right Side](#).

## Knock Sensor Replacement - Bank 1

### Removal Procedure



1. Remove the exhaust manifold lower heat shield. Refer to [Exhaust Manifold Lower Heat Shield Replacement](#).
2. Disconnect the engine wiring harness electrical connector (1) from the bank 1 knock sensor (2).

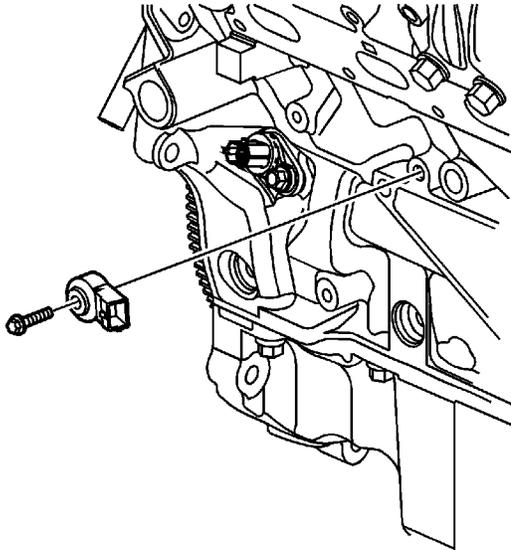


3. Loosen the knock sensor bolt and remove the knock sensor.

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## Installation Procedure

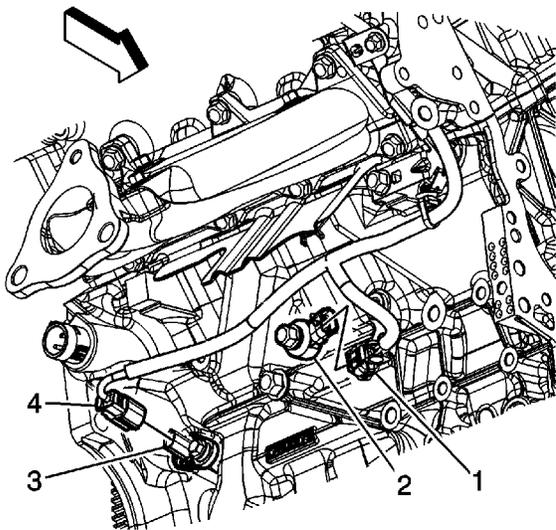
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



1. Position the knock sensor and tighten the knock sensor bolt.

### Tighten

Tighten the bolt to 23 N·m (17 lb ft).

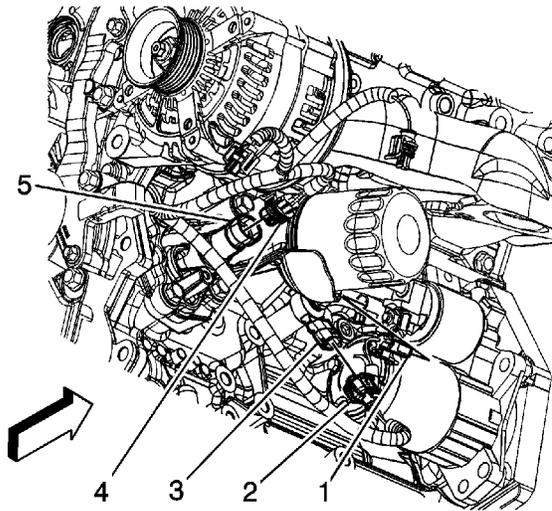


2. Connect the engine wiring harness electrical connector (1) to the bank 1 knock sensor (2).
3. Install the exhaust manifold lower heat shield. Refer to [Exhaust Manifold Lower Heat Shield](#)

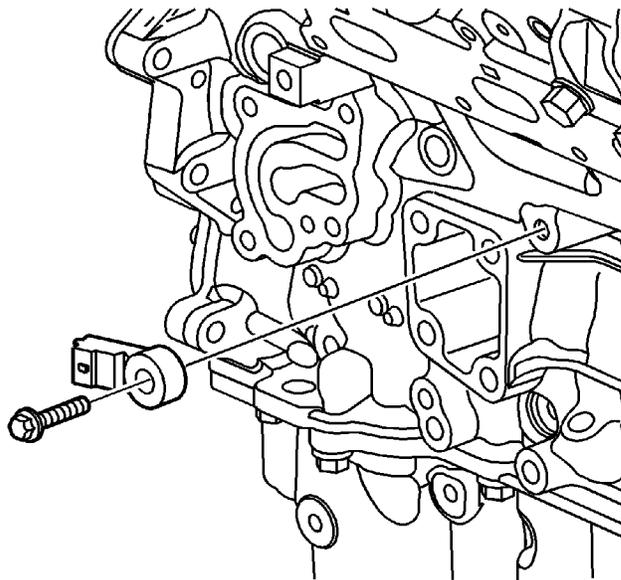
[Replacement.](#)

## Knock Sensor Replacement - Bank 2

### Removal Procedure



1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the engine oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
3. Lower the vehicle.
4. Disconnect the engine wiring harness electrical connector (2) from the bank 2 knock sensor (3).

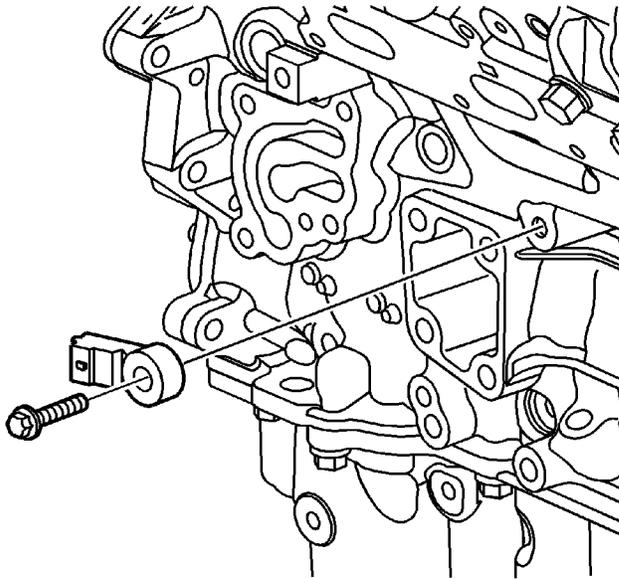




5. Loosen the knock sensor bolt and remove the knock sensor.

## Installation Procedure

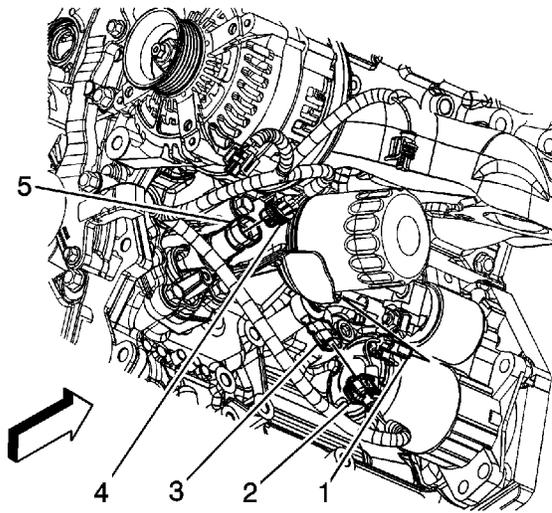
**Caution:** Refer to [Fastener Caution](#) in the Preface section.



1. Position the knock sensor and tighten the knock sensor bolt.

### **Tighten**

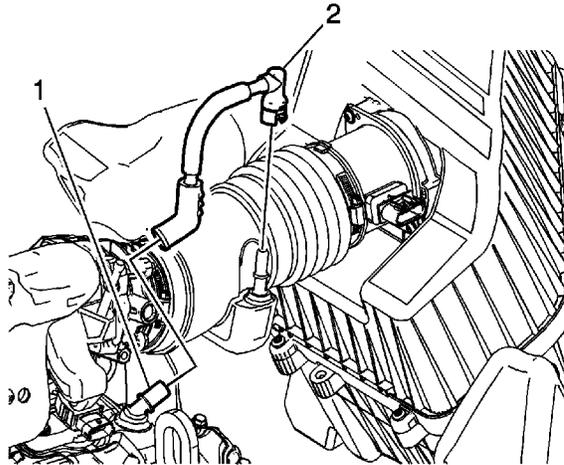
Tighten the bolt to 23 N·m (17 lb ft).



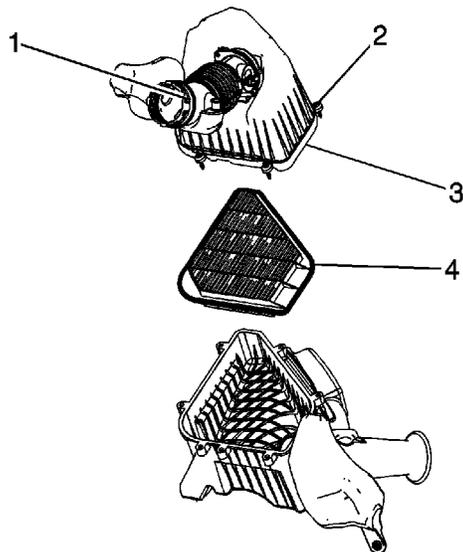
2. Connect the engine wiring harness electrical connector (2) to the bank 2 knock sensor (3).
3. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Install a NEW engine oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
5. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Air Cleaner Element Replacement

### Removal Procedure



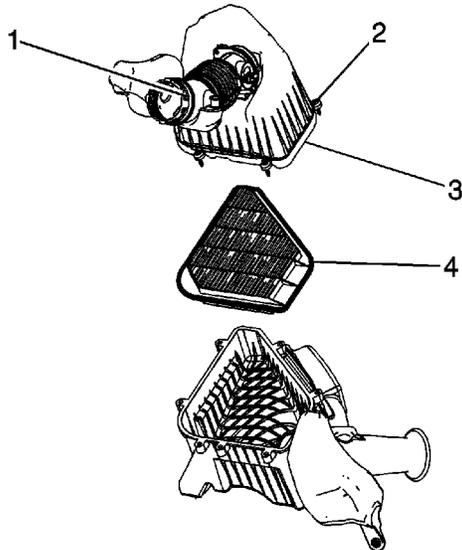
1. Remove the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Disconnect the positive crankcase ventilation (PCV) fresh air tube from the camshaft cover fitting (1).
3. Disconnect the PCV quick disconnect (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Disconnect the engine wiring harness electrical connector from the mass airflow (MAF)/intake air temperature (IAT) sensor.





5. Loosen the air cleaner outlet duct clamp (1) at the throttle body.
6. Loosen the 6 air cleaner housing cover screws (2).
7. Separate the air cleaner outlet duct from the throttle body.
8. Remove the air cleaner housing cover (3) (with outlet duct).
9. Remove and discard the air cleaner element (4).

## Installation Procedure



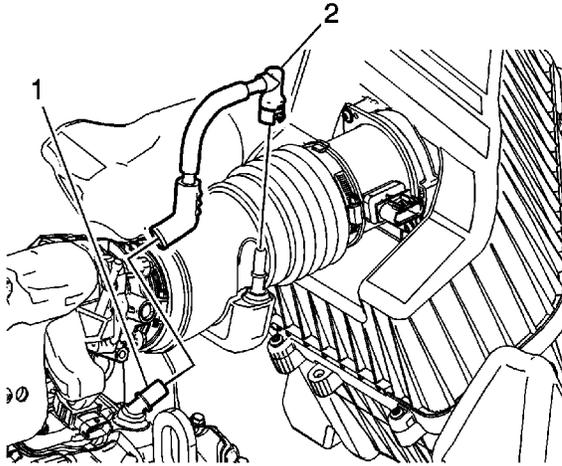
1. Install a NEW air cleaner element (4).
2. Position the air cleaner housing cover (3) (with outlet duct) onto the air cleaner lower housing.
3. Install the air cleaner outlet duct onto the throttle body.
4. Tighten the 6 air cleaner housing cover screws (2) until snug.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

5. Tighten the air cleaner outlet duct clamp (1) at the throttle body.

### **Tighten**

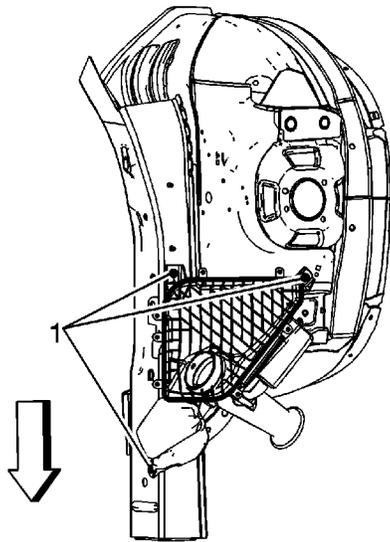
Tighten the clamp to 4 N·m (35 lb in).



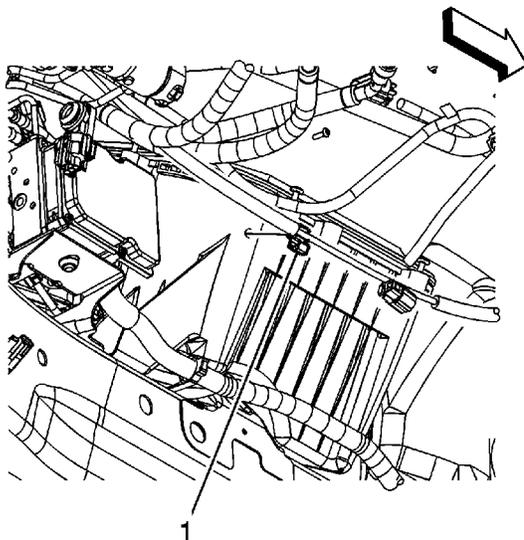
6. Connect the engine wiring harness electrical connector to the MAF/IAT sensor.
7. Connect the PCV quick disconnect (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
8. Connect the PCV fresh air tube to the camshaft cover fitting (1).
9. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

## Air Cleaner Assembly Replacement

### Removal Procedure

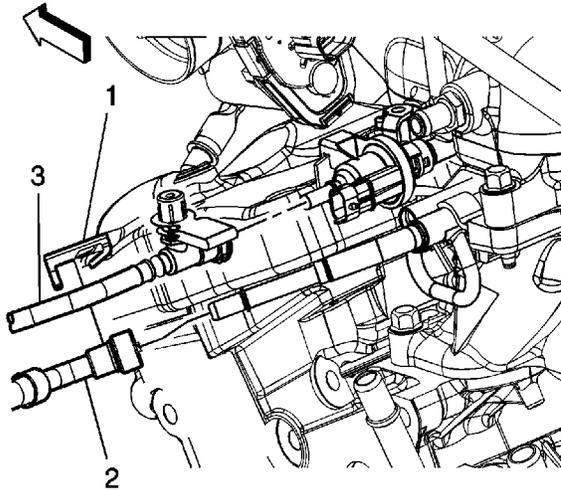


1. Remove the air cleaner element. Refer to [Air Cleaner Element Replacement](#).
2. Remove the air cleaner lower housing screws (1).

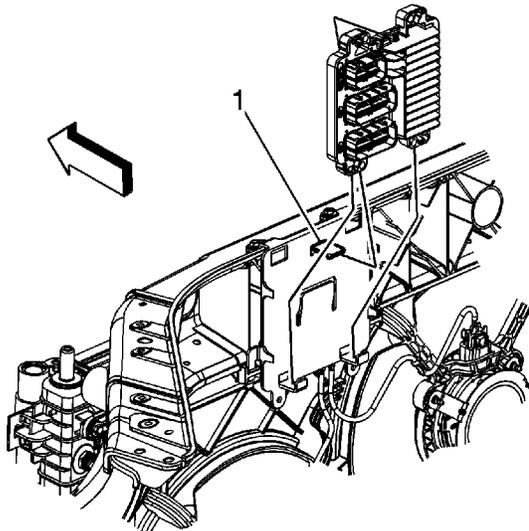


3. Remove the hood release cable clip (1) from the air cleaner lower housing.

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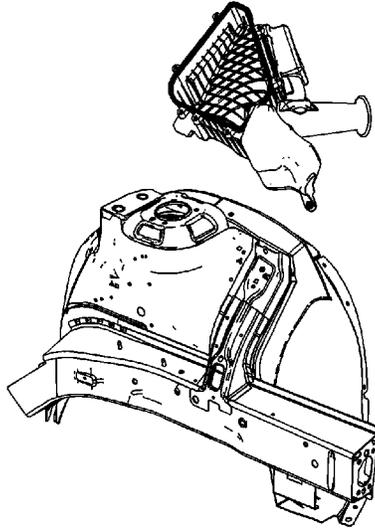


4. Disconnect the fuel feed pipe (2) quick connect fitting from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
5. Disconnect the evaporative emission (EVAP) pipe (3) quick connect fitting from the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).



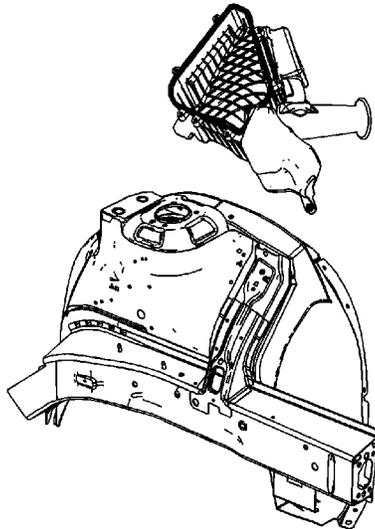
**Note:** The engine control module (ECM) electrical connector do not need to be disconnected in order to reposition the ECM.

6. Gently lift up the retaining tab (1) and remove the ECM from the bracket, reposition out of the way.

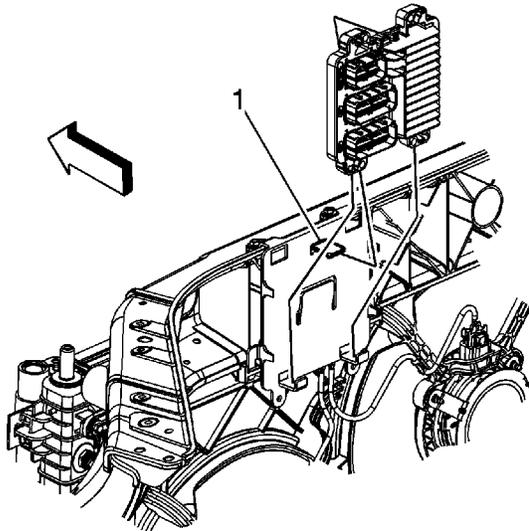


7. Remove the air cleaner lower housing.

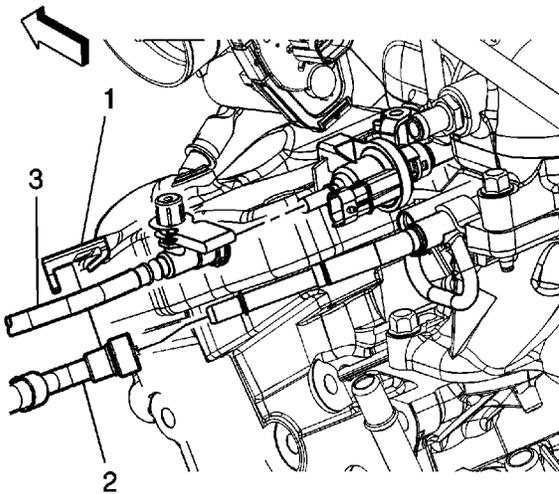
## **Installation Procedure**



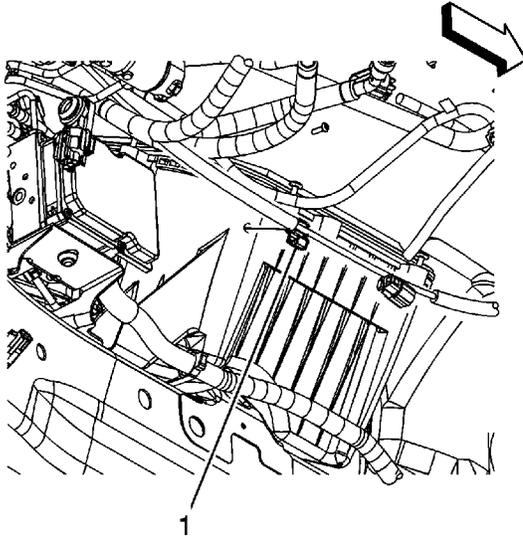
1. Position the air cleaner lower housing to the side rail.



2. Position and install the ECM to the bracket.

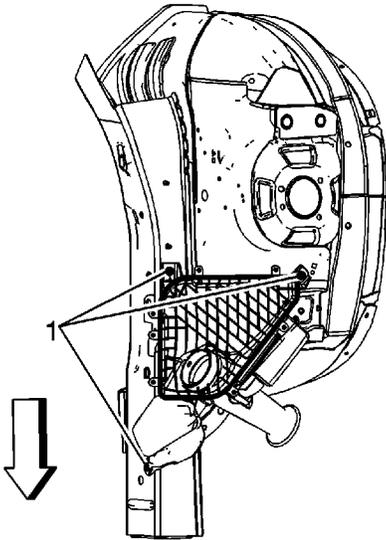


3. Connect the evaporative emission (EVAP) pipe (3) quick connect fitting to the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Connect the fuel feed pipe (2) quick connect fitting to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).



5. Install the hood release cable clip (1) to the air cleaner lower housing.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.



6. Install the air cleaner lower housing screws (1).

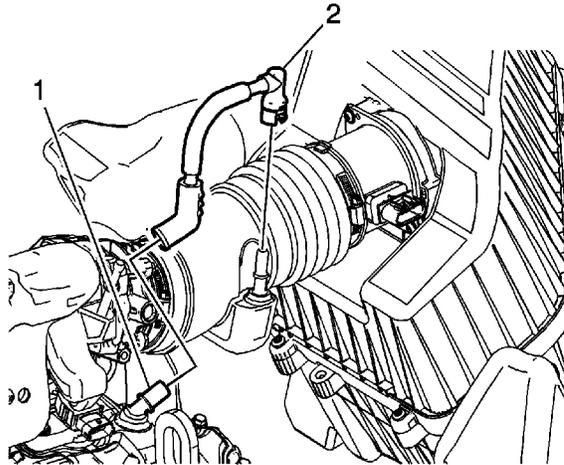
**Tighten**

Tighten the screws to 9 N·m (80 lb in).

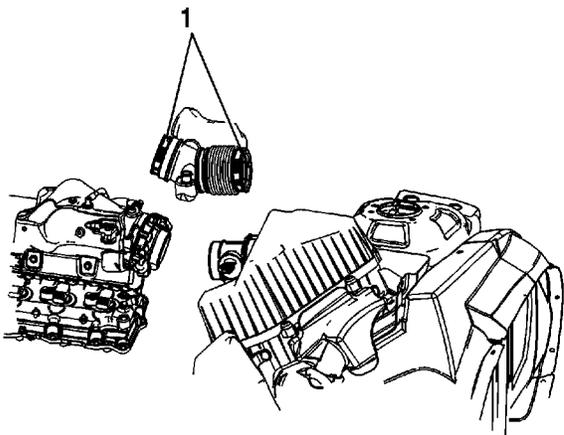
7. Install the air cleaner element. Refer to [Air Cleaner Element Replacement](#).

## Air Cleaner Outlet Duct Replacement

### Removal Procedure



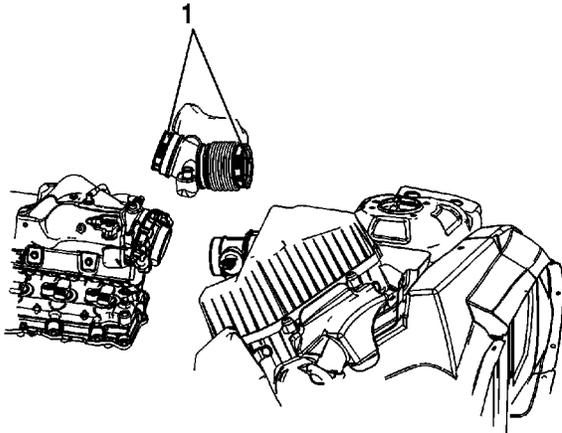
1. Remove the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Disconnect the positive crankcase ventilation (PCV) fresh air tube from the camshaft cover fitting (1).
3. Disconnect the PCV quick disconnect (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).



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4. Loosen the air cleaner outlet duct clamps (1) at the mass air flow (MAF)/intake air temperature (IAT) sensor and throttle body.
5. Remove the air cleaner outlet duct.

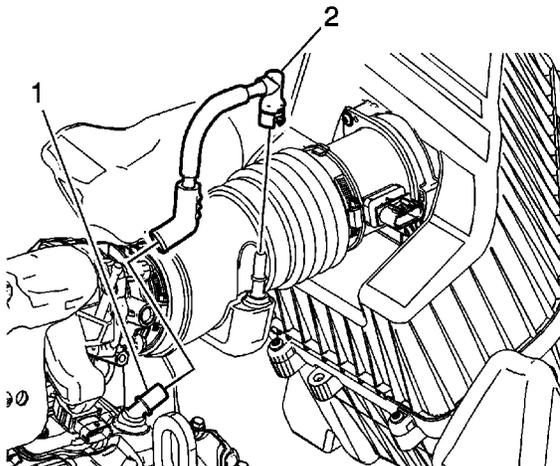
## Installation Procedure



1. Loosely install the air cleaner outlet duct then install the fuel injector sight shield to ensure proper clearance.
2. Remove the fuel injector sight shield.

**Caution:** Refer to [Fastener Caution](#) in the Preface section.

3. Tighten the air cleaner outlet duct clamps (1) to **4 N·m (35 lb in)** at the MAF/IAT sensor and throttle body.





4. Connect the PCV quick disconnect (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Connect the PCV fresh air tube to the camshaft cover fitting (1).
6. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).