

Temperature Versus Resistance - Engine Coolant Temperature Sensor

Temperature C° / F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Engine Coolant Temperature (ECT)		
-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
Intake Air Temperature (IAT) Sensor		
-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

[2009 Cadillac CTS](#) | [CTS \(VIN D\) Service Manual](#) | [Engine](#) | [Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L](#) | [Specifications](#) | **Document ID: 1857322**

Ignition System Specifications

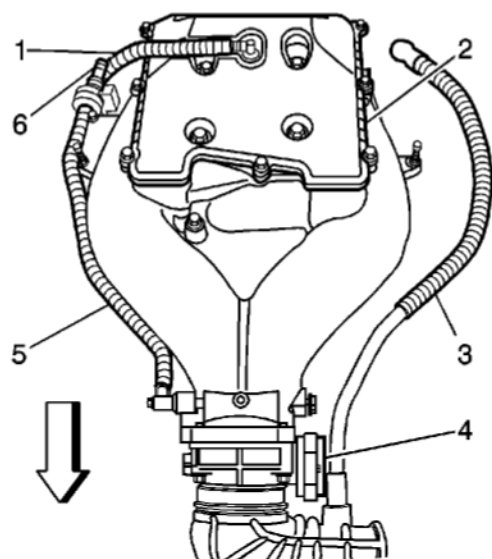
Application	Specification	
	Metric	English
Firing Order	1-2-3-4-5-6	
Spark Plug Gap (non-adjustable)	1.10 mm	0.044 in
Spark Plug Torque	20 N·m	15 lb ft
Spark Plug Type	AC 41-990	

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor Mounting Nut	9 N·m	80 lb in
Air Cleaner Bolt	9 N·m	80 lb in
Air Cleaner Cover Screw	4 N·m	35 lb in
Air Cleaner Duct Clamps	4 N·m	35 lb in
Barometric Pressure Sensor Bolt	10 N·m	89 lb in
Camshaft Position Actuator Solenoid Valve	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) and Bracket Bolt	10 N·m	89 lb in
Engine Control Module (ECM) Electrical Connector Bracket Bolt	10 N·m	89 lb in
Engine Control Module (ECM) Redundant Ground Bolt	10 N·m	89 lb in
Engine Control Module (ECM) Wiring Harness Ground Bolt	5 N·m	44 lb in
Engine Control Module (ECM) Wiring Harness Retaining Bolt	23 N·m	17 lb ft
Engine Coolant Temperature (ECT) Sensor	22 N·m	16 lb ft
Evaporative Emission (EVAP) Canister Nut	6 N·m	53 lb in
Fuel Feed Pipe Bolt	50 N·m	28 lb ft
Fuel Filler Tube Bolt	3.5 N·m	31 lb in
Fuel Filler Tube Brace Bolt	9 N·m	80 lb in
Fuel Filler Tube Hose Clamp	3.5 N·m	31 lb in
Fuel Filter Bracket Bolt	9 N·m	80 lb in
Fuel Filter Outlet Fitting	30 N·m	22 lb ft
Fuel Pipe Shield to Cylinder Head Bolt	10 N·m	89 lb in
Fuel Pipe Shield to Intake Manifold Bolt	23 N·m	17 lb ft
Fuel Pressure Sensor	33 N·m	28 lb in
Fuel Pump Bolt - High Pressure LLT	15 N·m	11 lb ft
Fuel Pump Bolts	15 N·m	11 lb ft
Fuel Rail Bolt - LY7	10 N·m	89 lb in
Fuel Rail Bolts - LLT		
• First Pass	12 N·m	106 lb in
• Final Pass	23 N·m	17 lb ft
Fuel Rail Crossover Tube Fittings		
• First Pass	16 N·m	12 lb ft
• Final Pass	32 N·m	24 lb ft
Fuel Tank Strap Bolt	50 N·m	37 lb ft
Heated Oxygen Sensor (HO2S)	40 N·m	30 lb ft

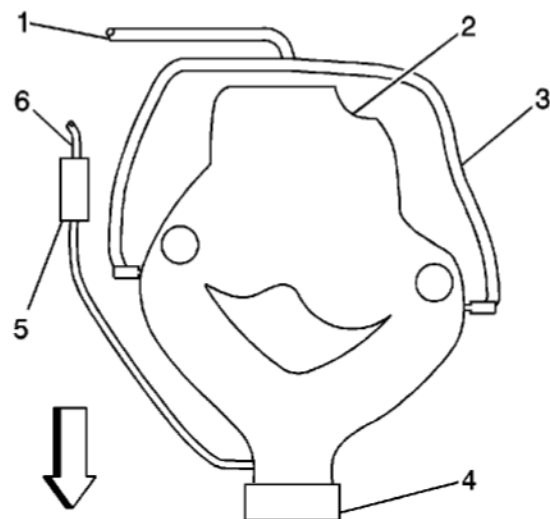
Ignition Coil Bolt	10 N·m	89 lb in
Intake Manifold Runner Control Solenoid Bolt	10 N·m	89 lb in
Intermediate Fuel Pipe Fitting		
• First Pass	16 N·m	12 lb ft
• Final Pass	32 N·m	24 lb ft
Knock Sensor Bolt	23 N·m	17 lb ft
MAF Sensor Screw	3.25 N·m	29 lb in
Manifold Absolute Pressure (MAP) Sensor Bolt	10 N·m	89 lb in
Rear Frame Bolt	200 N·m	148 lb ft
Shock Bolt - Lower	90 N·m	66 lb ft
Spark Plug	20 N·m	15 lb ft
Throttle Body Bolt	10 N·m	89 lb in

Emission Hose Routing Diagram (with LLT)



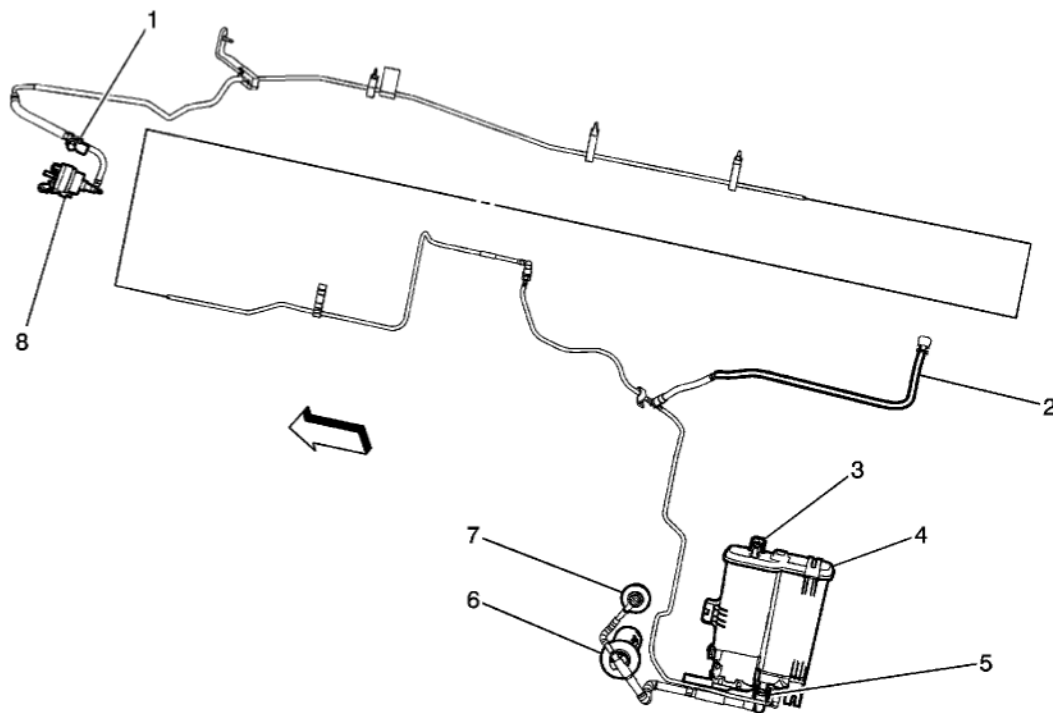
- (1) Positive Crankcase Ventilation (PCV) Hose
- (2) Upper Intake Manifold Plenum
- (3) Fresh Air Breather Hose
- (4) Throttle Body Assembly
- (5) Evaporative Emissions (EVAP) Canister Purge Solenoid Vacuum Supply Hose
- (6) Evaporative Emissions (EVAP) Canister Purge Solenoid

Emission Hose Routing Diagram (w/o LLT)



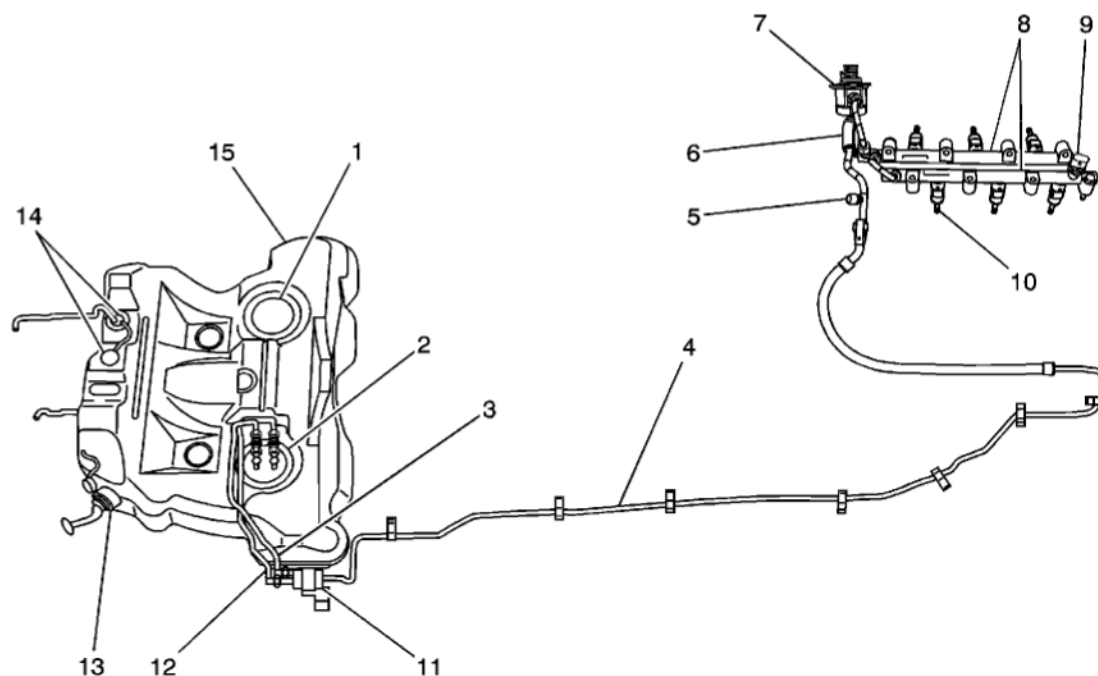
- (1) Positive Crankcase Ventilation (PCV) Hose to Cam Cover
- (2) Upper Intake Manifold
- (3) PCV Hose to Intake Manifold
- (4) Throttle Body Assembly
- (5) Evaporative Emissions (EVAP) Canister Purge Solenoid
- (6) Emissions Hose to EVAP Canister

Evaporative Emissions Hose Routing Diagram



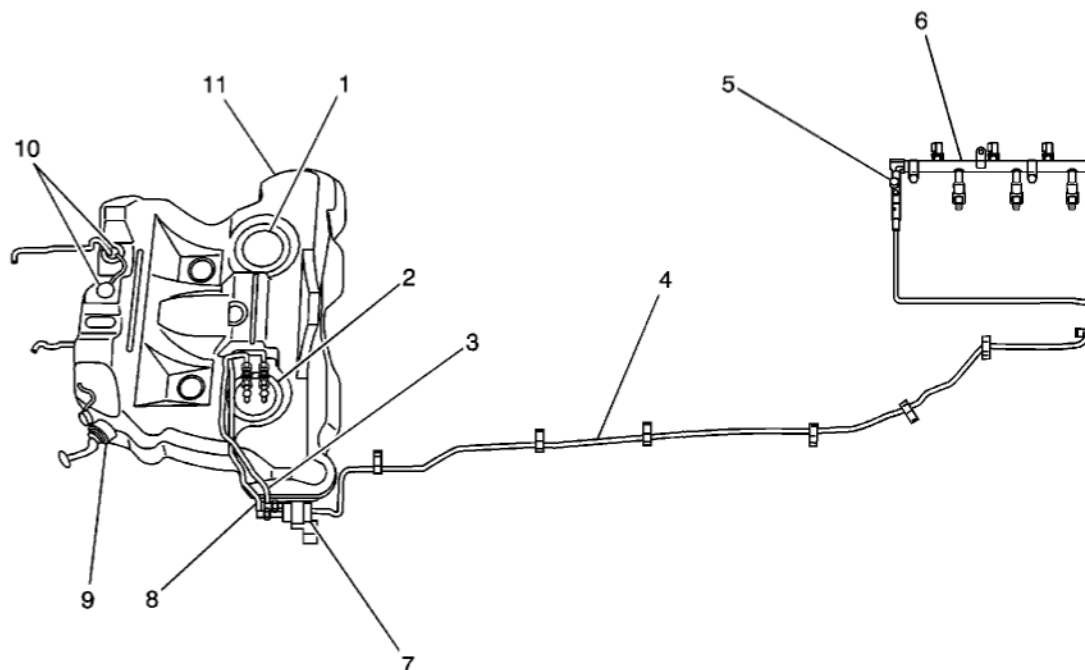
- (1) EVAP Service Port Connection - if equipped
- (2) Fuel Filler Pipe Vapor Recirculation Hose
- (3) Fuel Tank Pressure (FTP) Sensor
- (4) EVAP Purge Canister
- (5) EVAP Vent Valve
- (6) Fill Limit Vent Valve (FLVV)
- (7) Fuel Tank Vent/Rollover Valve
- (8) EVAP Purge Solenoid

Fuel Hose / Pipes Routing Diagram (with LLT)



- (1) Secondary Fuel Sender Assembly - Left
- (2) Primary Fuel Sender Assembly - Right
- (3) Fuel Feed Hose
- (4) Fuel Feed Pipe
- (5) Fuel Pressure Test Connection
- (6) Fuel Pulse Dampener
- (7) High Pressure Fuel Pump
- (8) Fuel Rail
- (9) Fuel Rail Pressure Sensor
- (10) Fuel Injector
- (11) Fuel Filter - if equipped
- (12) Fuel Return Hose - if equipped
- (13) Fuel Filler Tube
- (14) Fill Limit Vent Valve (FLVV)
- (15) Fuel Tank

Fuel Hose / Pipes Routing Diagram (w / o LLT)



- (1) Secondary Fuel Sender Assembly - Left
- (2) Primary Fuel Sender Assembly - Right
- (3) Fuel Feed Hose
- (4) Fuel Feed Pipe
- (5) Fuel Pressure Test Connection
- (6) Fuel Rail and Injectors
- (7) Fuel Filter
- (8) Fuel Return Hose
- (9) Fuel Filler Tube
- (10) Fill Limit Vent Valve (FLVV)
- (11) Fuel Tank

Engine Control Module Replacement

Service of the engine control module (ECM) should consist of either replacement of the ECM or programming of the electrically erasable programmable read only memory (EEPROM). If the diagnostic procedures call for the ECM to be replaced, the replacement ECM should be checked to ensure that the correct part is being used. If the correct part is being used, remove the faulty ECM and install the new service ECM.

Warning: Replacement or reprogramming of the ECM, or replacement of the clutch pedal position sensor (CPPS) or clutch pedal requires that a CPPS learn procedure be performed. Failure to perform the CPPS learn procedure may result in personal injury or damage to the vehicle or its components if the vehicle is in gear and the starter motor is accidentally engaged.

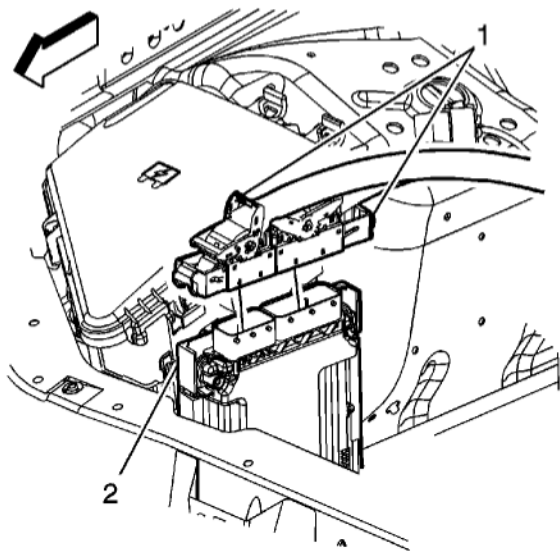
Caution:

- 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 5000 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 83000 km (50,000 mi) from the last automatic transmission fluid change.

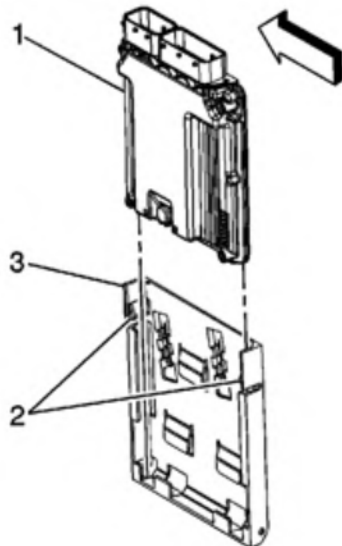
Removal Procedure



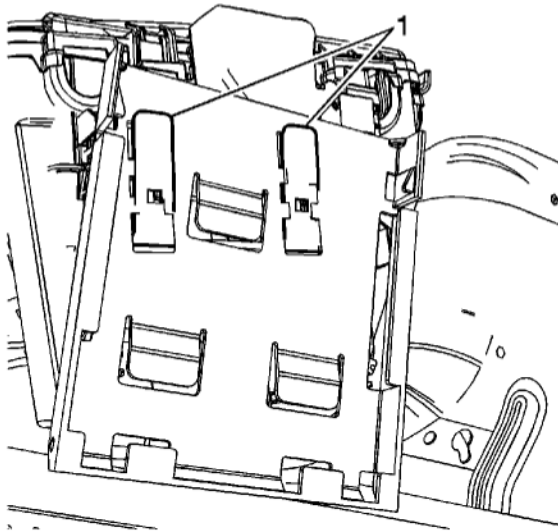
1. Using a scan tool, retrieve the percentage of remaining engine oil and automatic transmission fluid life. Record the remaining engine oil and automatic transmission fluid life.
2. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

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

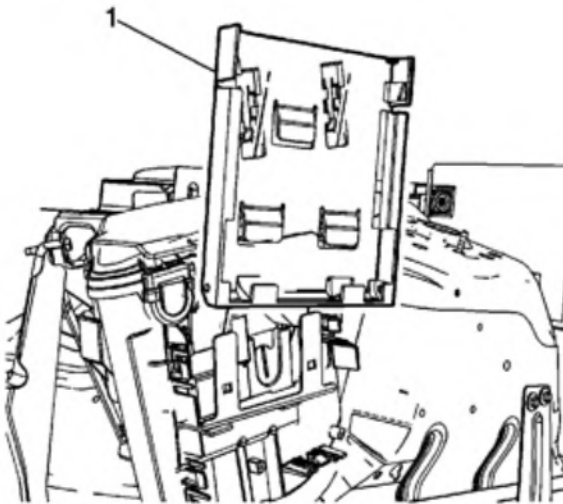
3. Unlock and disconnect the engine wiring harness electrical connectors (1) from the ECM (2).



4. Use the tabs (3) in order to disengage the retainers (2) on the ECM bracket from the ECM (1) and remove the ECM.

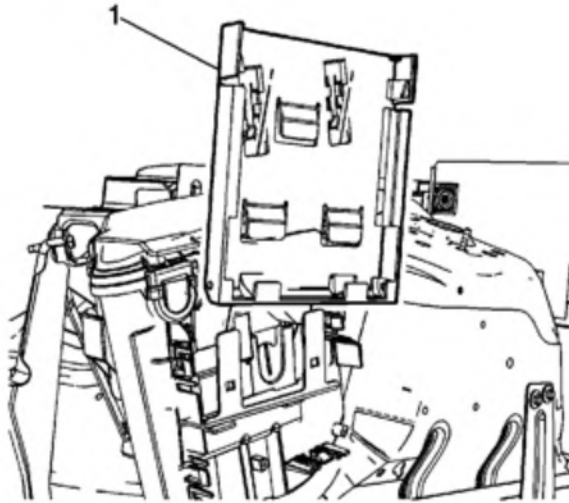


5. If replacing the ECM bracket perform the following steps, otherwise proceed to step 4 in the installation procedure.
6. Using a small flat-bladed tool, depress the locking tabs (1) on the ECM bracket.

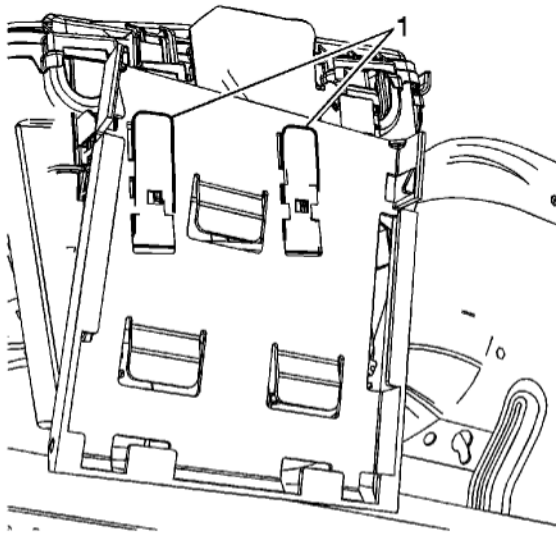


7. Slide up and remove the ECM bracket (1).

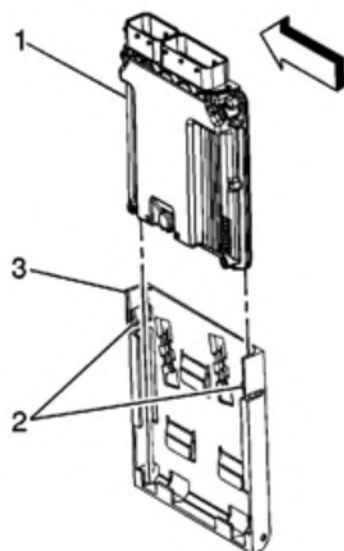
Installation Procedure



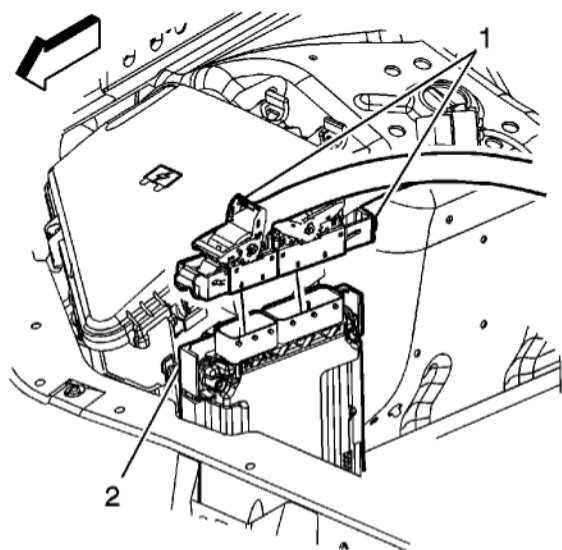
1. If replacing the ECM bracket perform the following steps, other wise proceed to step 4.
2. Slide down and install the ECM bracket (1).



3. Ensure that the ECM bracket engages the locking tabs (1).



4. Slide the ECM (1) into the ECM bracket, ensure that the ECM engages the bracket retainers (2).



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

5. Connect and lock the engine wiring harness electrical connectors (1) to the ECM (2).
6. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
7. Program the ECM, if required. Refer to [Control Module References](#).
8. Turn OFF the ignition for a least 5 seconds after the programming event is complete.
9. If equipped with a manual transmission, perform the clutch pedal position sensor learn procedure. Refer to [Clutch Pedal Position Sensor Learn](#).

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, P2107, 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

Important:

- Ensure the above conditions are met before proceeding 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.

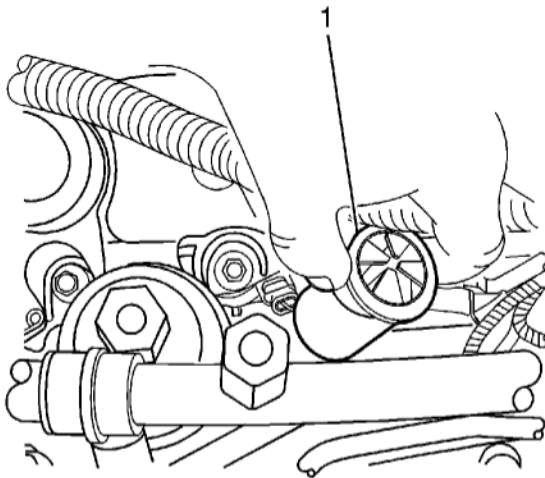
1. Turn OFF the ignition for 30 seconds.
2. Turn ON the ignition, with the engine OFF for 60 seconds.
3. Turn OFF the ignition.
4. Turn ON the ignition, with the engine OFF.
5. Clear the DTCs with a scan tool.

Engine Coolant Temperature Sensor Replacement

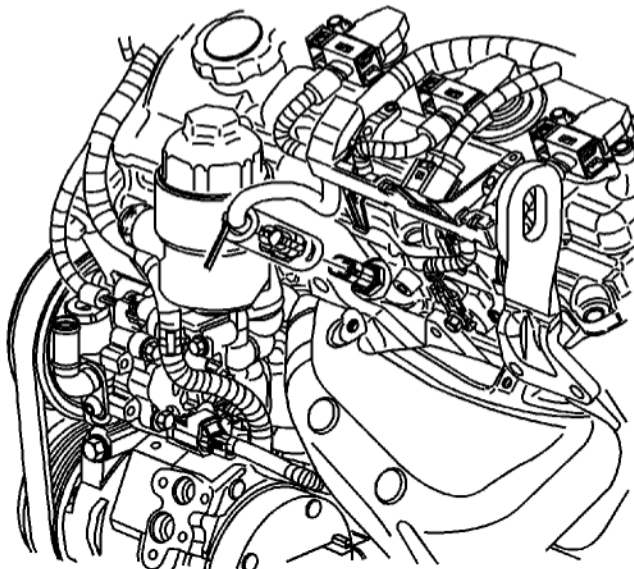
Removal Procedure

Warning: Allow sufficient time for the engine to cool before removing the ECT sensor. A hot engine may cause an excessive coolant loss or a personal injury.

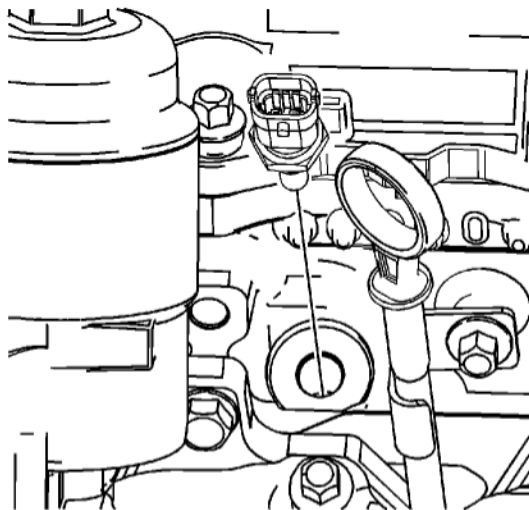
1. Turn the ignition OFF.
2. Remove the engine oil dipstick indicator.



3. Slide the electrical connector heat protector (1) off the electrical connector.



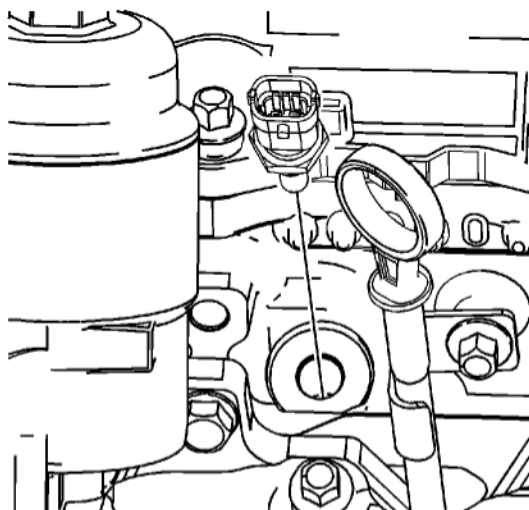
4. Disconnect the coolant temperature sensor electrical connector.



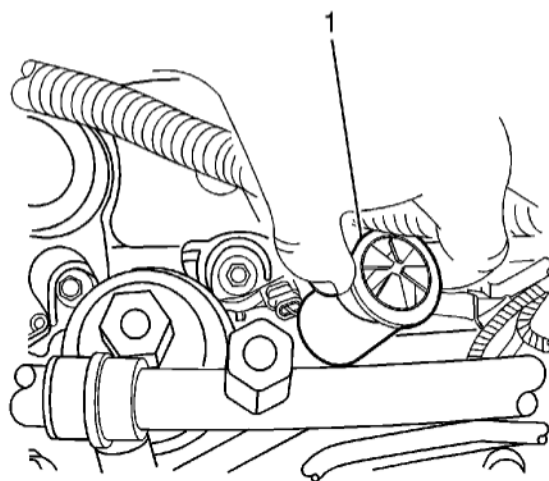
5. Remove the coolant temperature sensor.

Installation Procedure

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

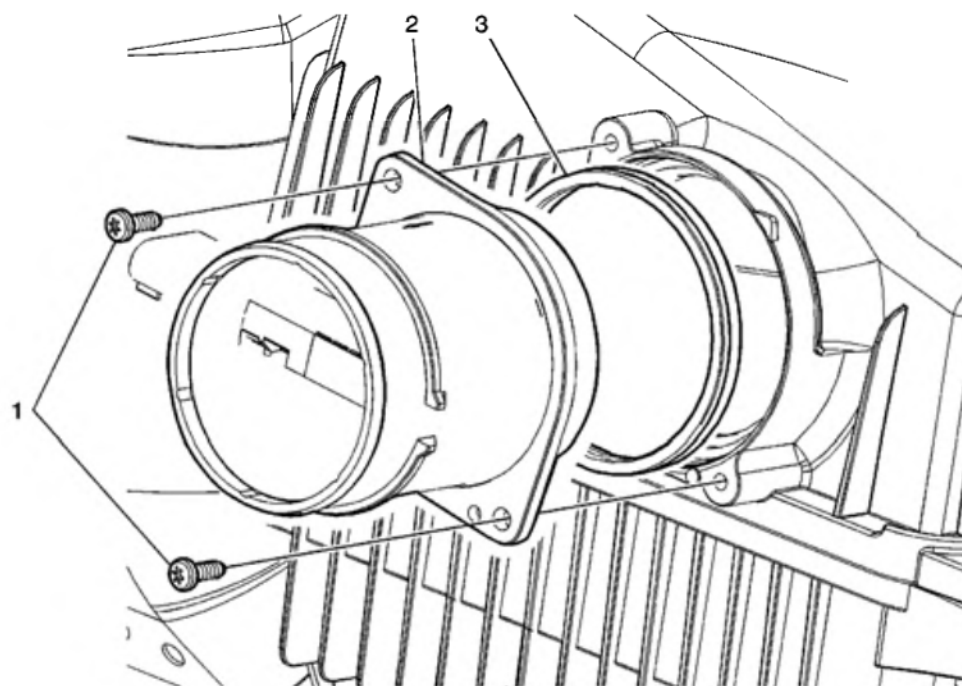


1. Install the coolant temperature sensor and tighten to **22 N·m (16 lb ft)**.
2. Install the coolant temperature sensor electrical connector.



3. Slide the electrical connector heat protector (1) onto the electrical connector.
4. Inspect and fill the cooling system as necessary. Refer to [Cooling System Draining and Filling](#).

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement



Callout	Component Name
Preliminary Procedures - Turn OFF the ignition. - Remove the air cleaner duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Screw (Qty: 2) Caution: Refer to Fastener Caution in the Preface section. Tighten 3.25 N·m (29 lb in)
2	Mass Airflow Sensor/Intake Temperature Sensor Procedure Disconnect the sensor wiring harness.
3	Seal

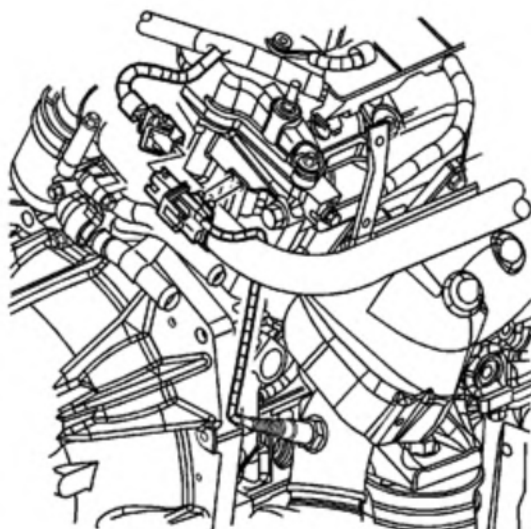
Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

Removal Procedure

Caution: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

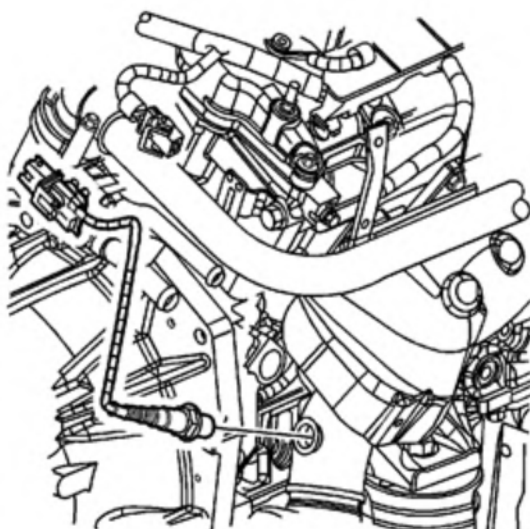
Note: Bank 1 is the right bank.



1. Turn the ignition OFF.
2. Remove the fuel injector sight shield, if necessary. Refer to [Fuel Injector Sight Shield Replacement](#).
3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S electrical connector from the wiring harness bracket.
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

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

Note: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

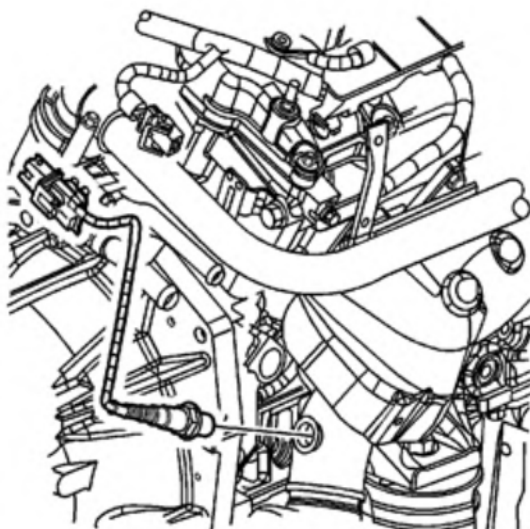


6. Remove the HO2S from the catalytic converter.

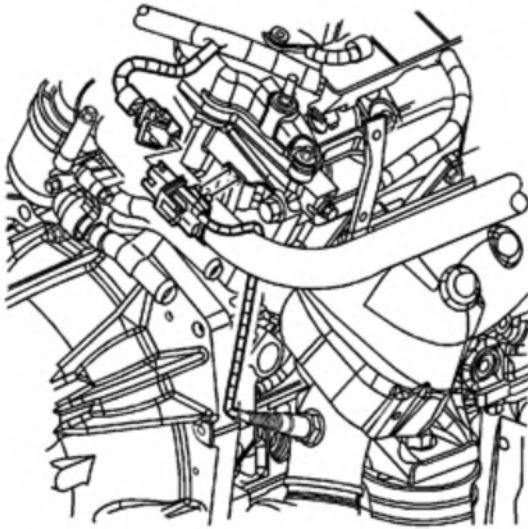
Installation Procedure

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

Caution: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.



1. Install the HO2S to the catalytic converter and tighten to **40 N·m (30 lb ft)**.
2. Lower the vehicle.



3. Install the HO2S electrical connector to the wiring harness bracket.
4. Connect the HO2S electrical connector.
5. Install the fuel injector sight shield, if necessary. Refer to [Fuel Injector Sight Shield Replacement](#).

Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

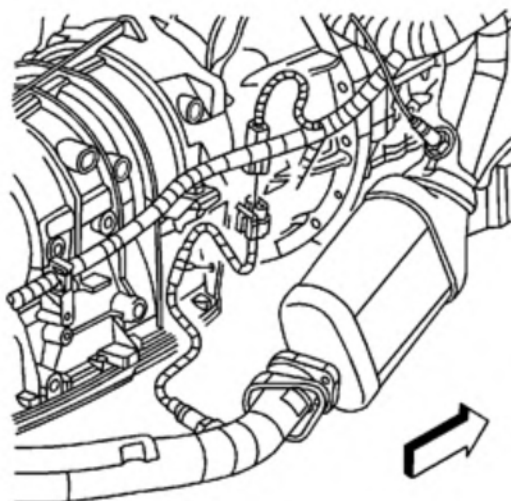
Removal Procedure

Caution: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

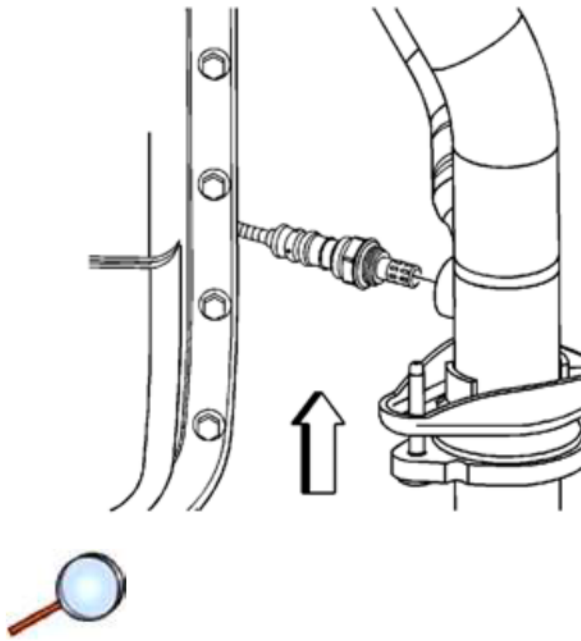
Note: Bank 1 is the right side.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S wiring harness from the transmission case.

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



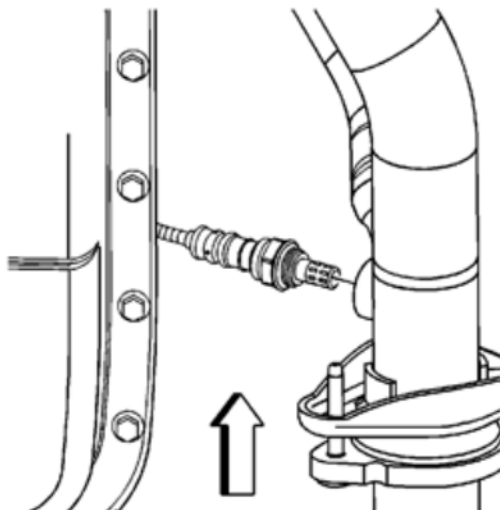
Note: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO₂S.

Installation Procedure

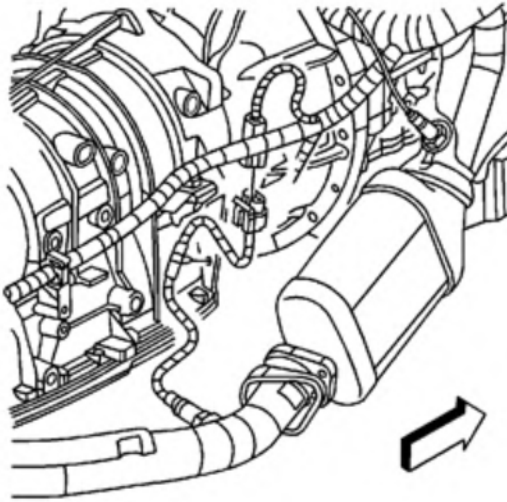
Caution: Refer to [Component Fastener Tightening Caution](#) in the Preface section.

Caution: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.





1. Install the HO2S and tighten to **40 N·m (30 lb ft)**.



2. Connect the HO2S electrical connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

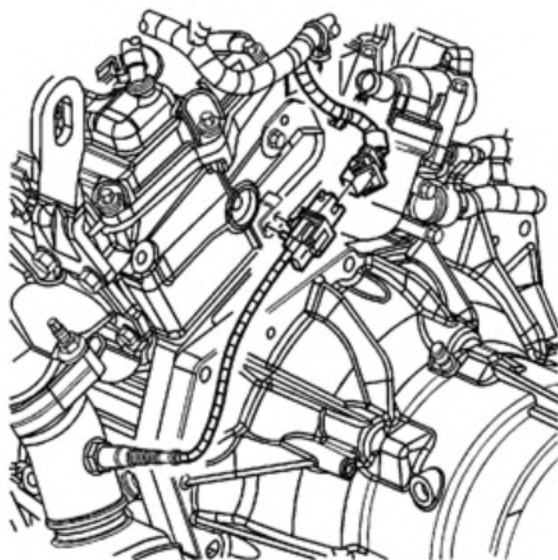
Heated Oxygen Sensor Replacement - Bank 2 Sensor 1

Removal Procedure

Caution: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

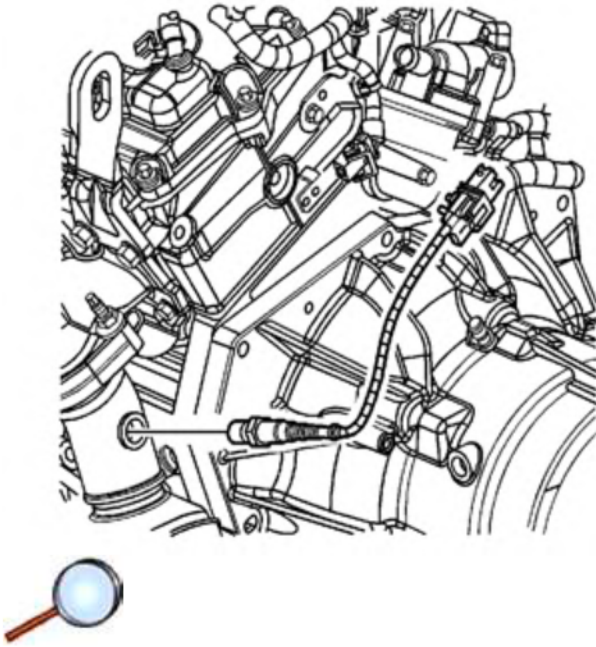
Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

Note: Bank 2 is the left bank.



1. Turn the ignition OFF.
2. Remove the fuel injector sight shield, if necessary. Refer to [Fuel Injector Sight Shield Replacement](#).
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Disconnect the heated oxygen sensor (HO2S) electrical connector.
5. Remove the HO2S electrical connector from the wiring harness bracket.

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



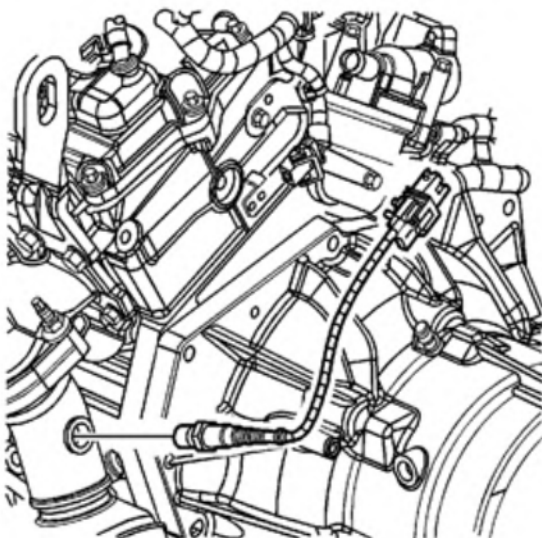
Note: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

6. Remove the HO₂S.

Installation Procedure

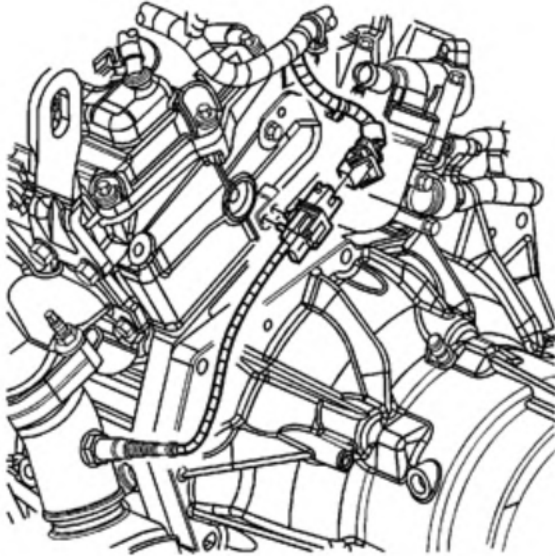
Caution: Refer to [Component Fastener Tightening Caution](#) in the Preface section.

Caution: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.





1. Install the HO₂S and tighten to **40 N·m (30 lb ft)**.



2. Install the HO₂S electrical connector to the wiring harness bracket.
3. Connect the HO₂S electrical connector.
4. Lower the vehicle.
5. Install the fuel injector sight shield, if necessary. Refer to [Fuel Injector Sight Shield Replacement](#).

Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

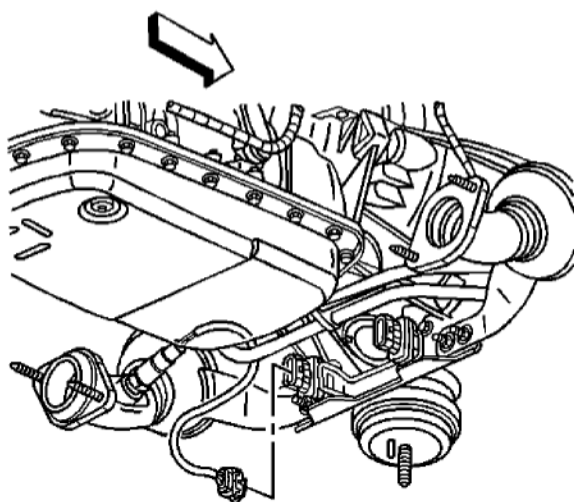
Removal Procedure

Caution: The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

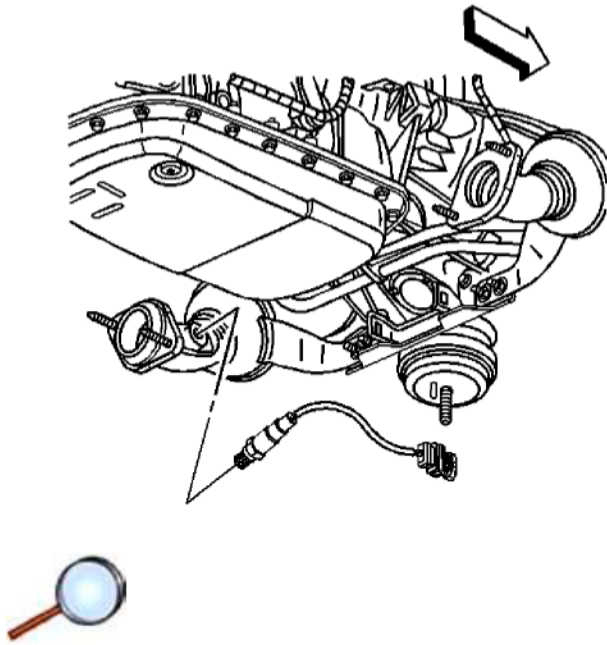
Note: Bank 2 is the left bank.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



3. Disconnect the heated oxygen sensor (HO2S) electrical connector.
4. Remove the HO2S wiring harness from the transmission case.

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



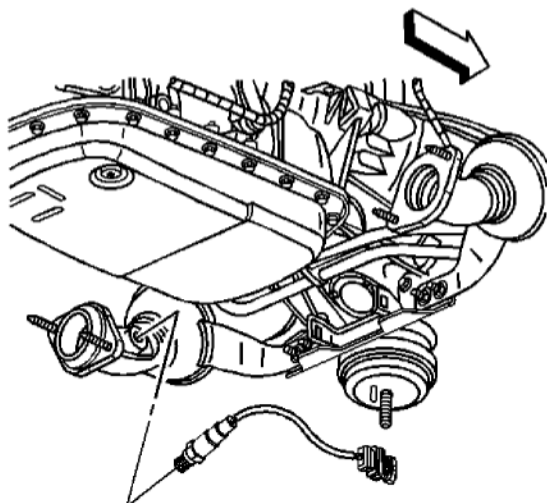
Note: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO2S.

Installation Procedure

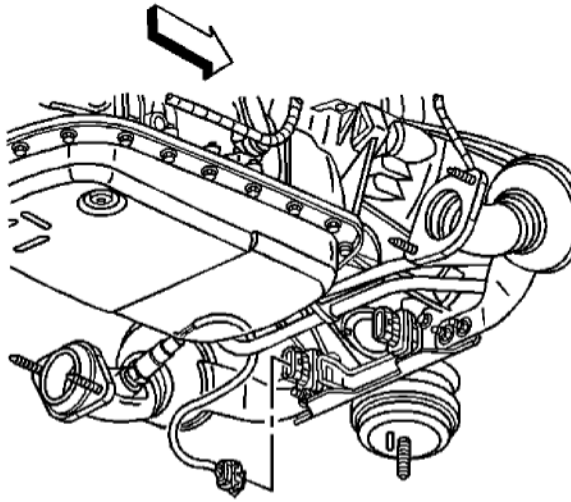
Caution: Refer to [Component Fastener Tightening Caution](#) in the Preface section.

Caution: A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.





1. Install the HO2S and tighten to **40 N·m (30 lb ft)**.

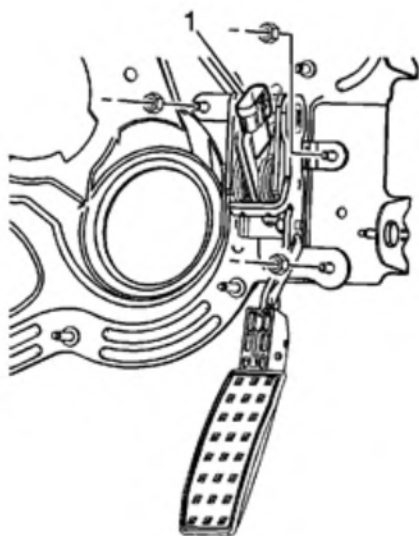


2. Connect the HO2S electrical connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

Accelerator Pedal Position Sensor Replacement

Removal Procedure

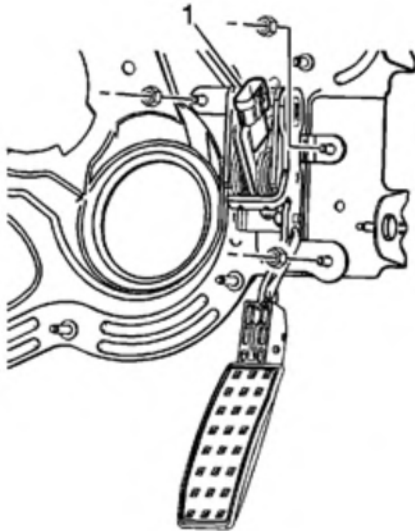
1. Remove the closeout/insulator panel from under the dashboard on the drivers side. Refer to [Instrument Panel Insulator Replacement - Left Side](#) or [Instrument Panel Insulator Replacement - Right Side](#).



Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

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

Installation Procedure

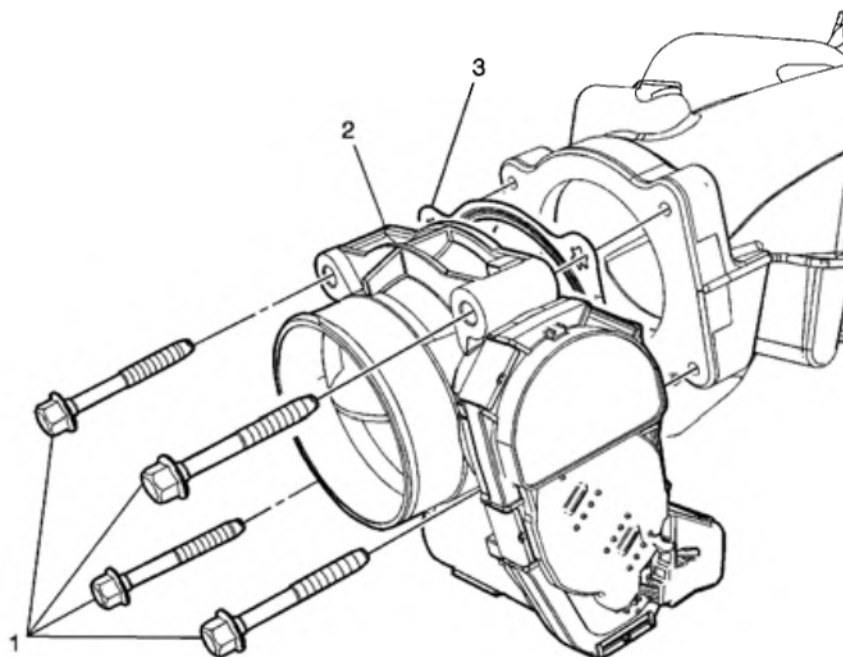


1. Install the APP sensor to the front of dash.

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

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

Throttle Body Assembly Replacement



Callout	Component Name
Preliminary Procedures 1. Turn OFF the ignition. 2. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement. 3. Remove the air cleaner duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Bolt (Qty: 4) Caution: Refer to Fastener Caution in the Preface section. Tighten 10 N·m (89 lb in)
2	Throttle Body Procedure Disconnect the wiring harness connector.
3	Gasket

Throttle Body Inspection and Cleaning

1. Remove the air cleaner intake duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
2. Fully open the throttle valve in order to inspect the throttle body bore and the throttle valve plate for any deposits.

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

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

The cleaners will damage the electric components or sensors.

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

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

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

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

3. Use a clean shop towel and Top Engine Cleaner GM P/N 1052626 or equivalent product in order to clean the throttle body bore and the throttle valve plate.

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

4. Install the air cleaner duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

Fuel Pressure Relief (With High Pressure Pump - LLT)

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

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

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

Fuel Pressure Relief (Without CH 48027 - LY7)

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 (LP1, LY7)

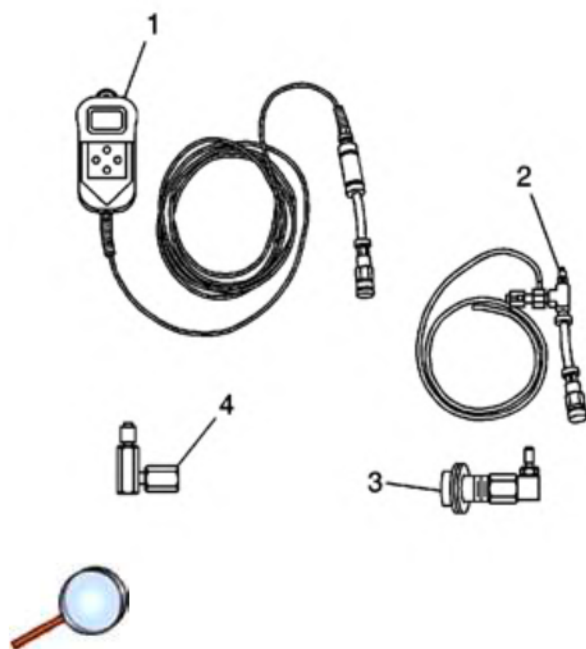
Special Tools

[CH-48027](#) Digital Pressure Gage

Installation Procedure

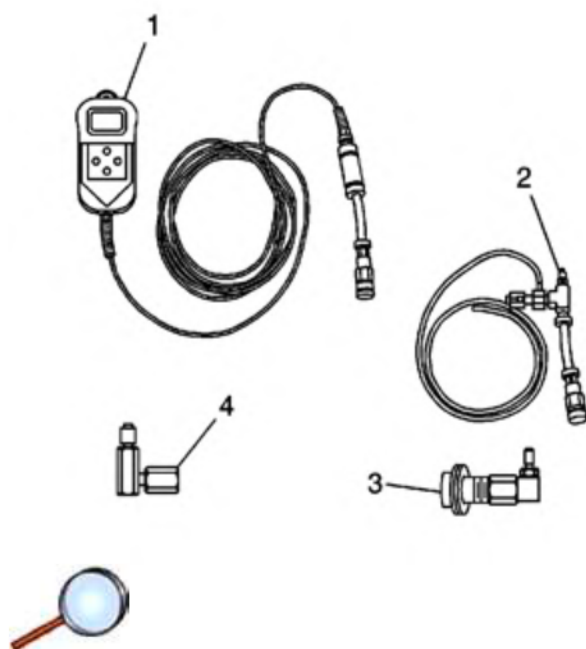
Warning: Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.

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

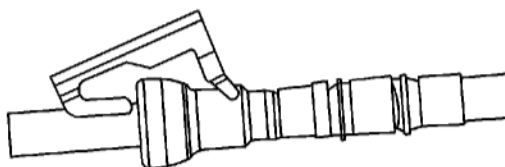
Special Tools

- [J 37088-A](#) Fuel Line Disconnect Tool Set
- [J 44581](#) Fuel Line Disconnect Tool

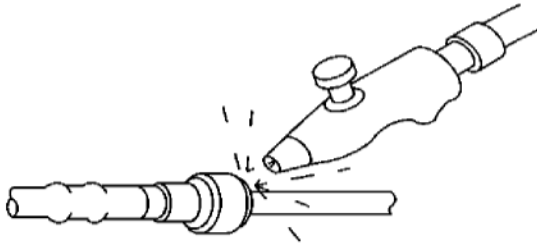
Removal Procedure

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

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

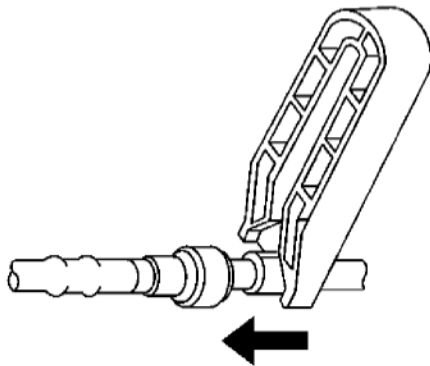


2. Remove the retainer from the quick-connect fitting.

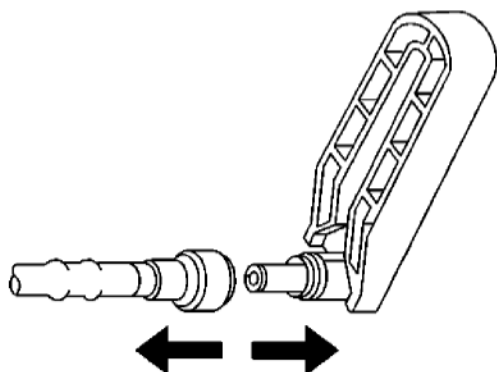


Warning: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

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



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

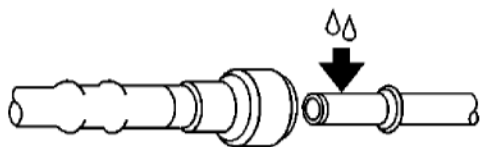


5. Pull the connection apart.

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

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

Installation Procedure



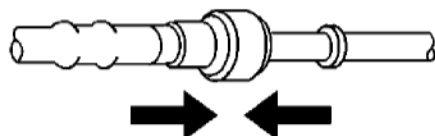


Warning: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.

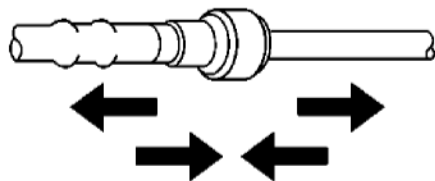
This will ensure proper reconnection and prevent a possible fuel leak.

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

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

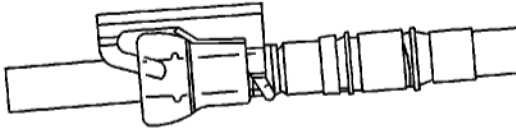


2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.





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

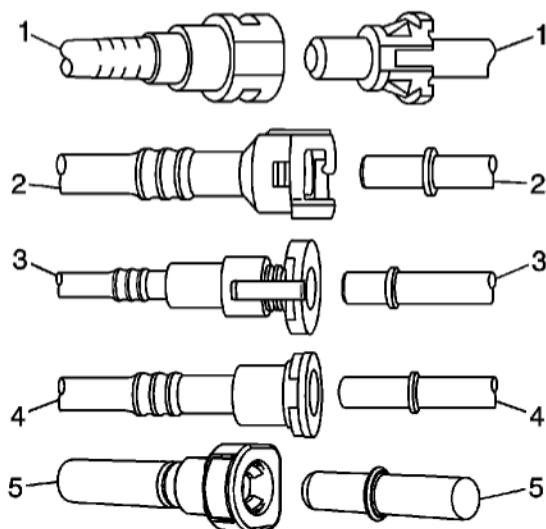


4. Install the retainer to the quick-connect fitting.
5. Inspect for leaks using the following procedure:
 - 5.1. Turn the ignition ON, with the engine OFF for 2 seconds.
 - 5.2. Turn the ignition OFF, for 10 seconds.
 - 5.3. Turn the ignition ON, with the engine OFF for 2 seconds.
 - 5.4. Turn the ignition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

Plastic Collar Quick Connect Fitting Service

Disconnect 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.

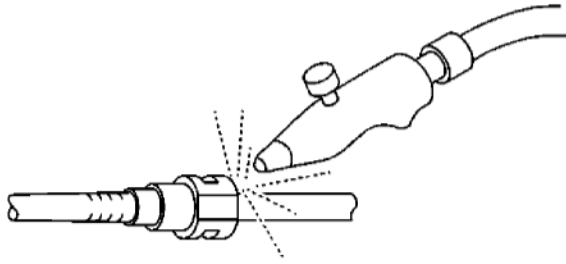
- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)
- Push Down TI (5)

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

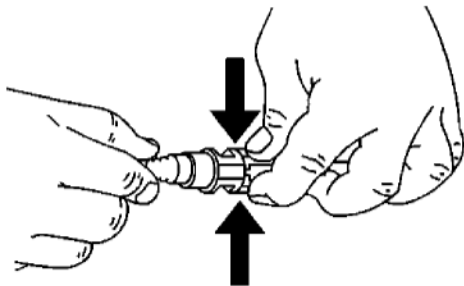
1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).

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

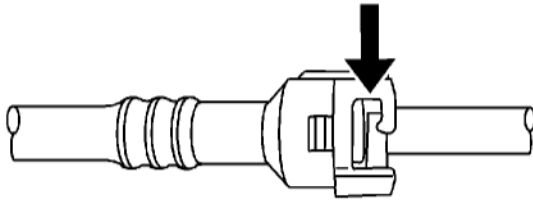
Caution: Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) in the Preface section.



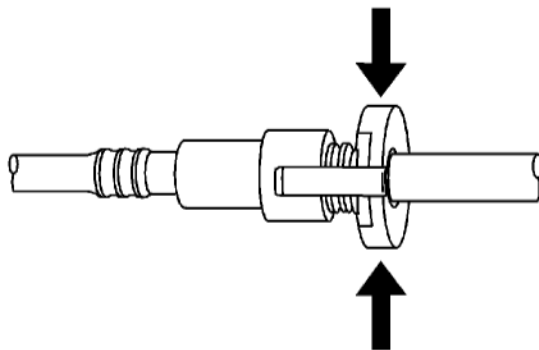
2. Using compressed air, blow any dirt or debris from around the connection.



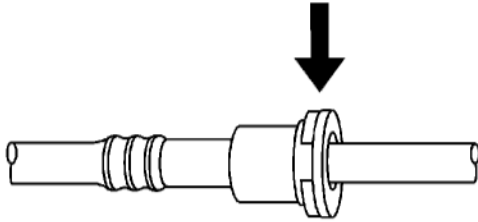
3. This step applies to Bartholomew style connector ONLY. Squeeze the plastic quick connect fitting release tabs.



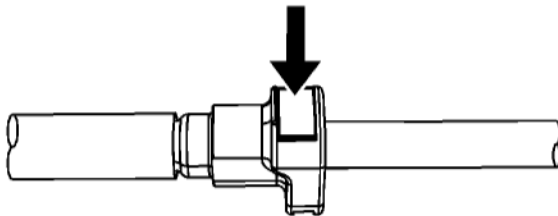
4. This step applies to Release Tab style connector ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.



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

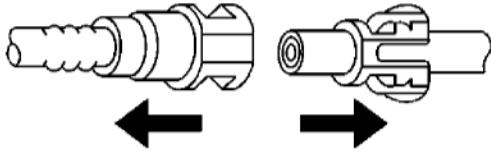


6. This step applies to the Sliding Retainer style connector ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab does not move try pressing the tab in from the opposite side. The tab will only move in one direction.



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

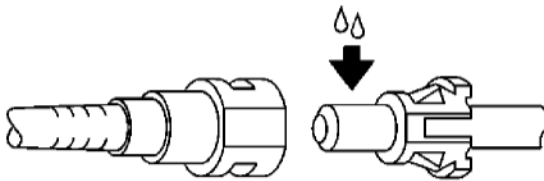
Warning: Refer to [Relieving Fuel Pressure Warning](#) in the Preface section.



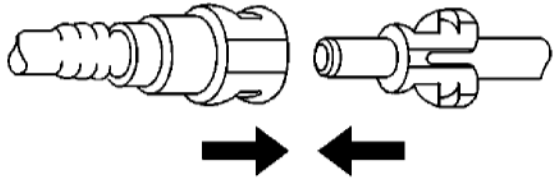
8. Pull the connection apart.

Connect Procedure

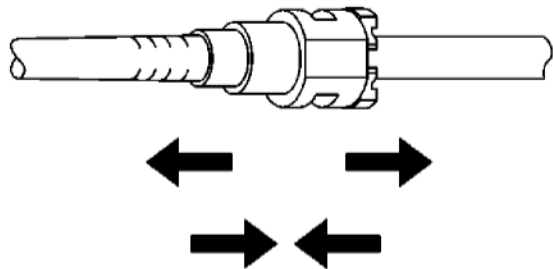
Warning: Refer to [Fuel Pipe Fitting Warning](#) in the Preface section.



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 connection in order to make sure the connection is secure.

Fuel Tank Draining

Special Tools

- [J 36850](#) Transjel Lubricant
- [J 45004](#) Fuel Drain Hose

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

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 filler cap.

Note: Lubricate the fuel drain hose with [J 36850](#) or equivalent to aid in hose insertion and removal. Do not use an unapproved lubricant.

2. Insert the [J 45004](#) into the fuel tank until the hose reaches the bottom of the fuel tank.
3. Use an air operated pump device in order to drain the fuel into an approved gasoline container.

Up to 26 liters (7 gallons) of residual fuel may remain in the secondary side of the fuel tank.

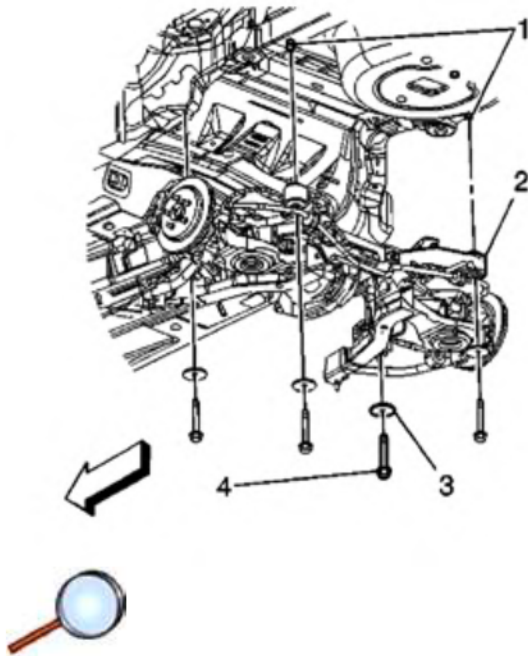
4. Simultaneously twist and pull in order to remove the [J 45004](#) from the fuel tank.

Fuel Tank Replacement

Removal Procedure

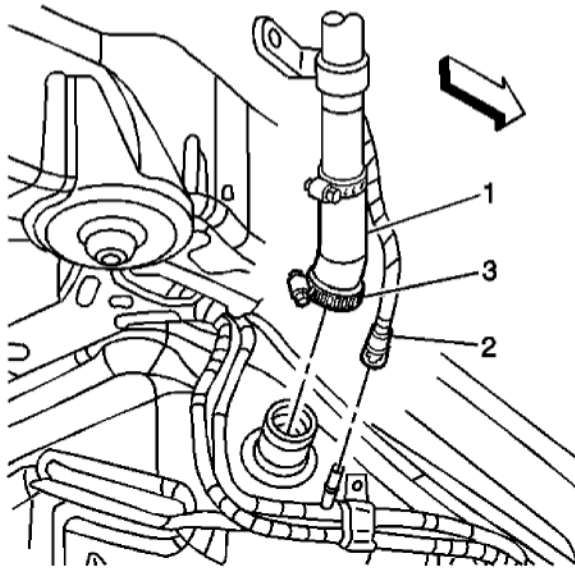
Warning: Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.

1. Drain the fuel tank. Refer to [Fuel Tank Draining](#).
2. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
3. Remove the exhaust system. Refer to [Exhaust System Replacement](#).
4. Remove the rear propeller shaft. Refer to [Rear Propeller Shaft Replacement](#).

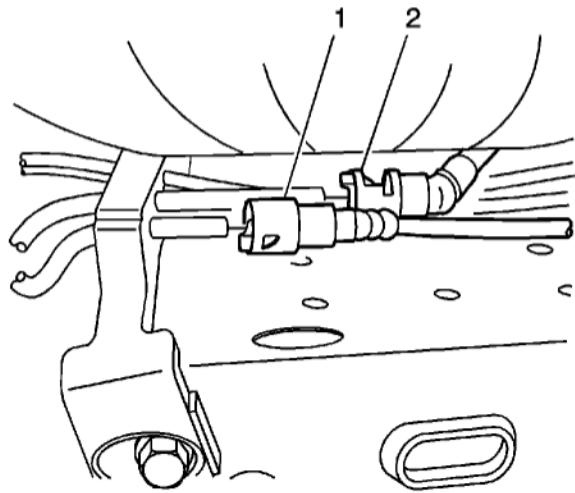


Note: Do not remove any components from the rear frame assembly once the rear frame assembly is removed from the vehicle.

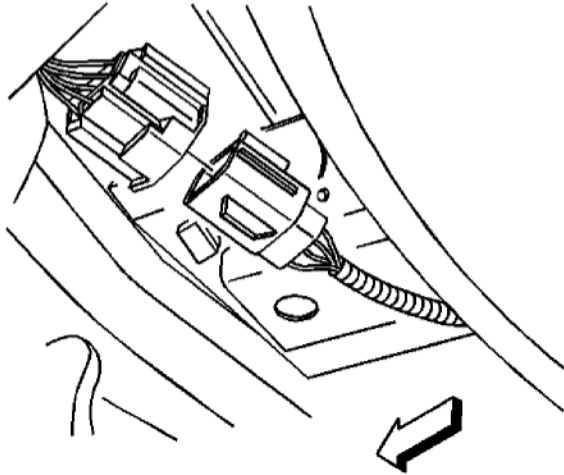
5. Remove the rear frame assembly (2). Refer to [Rear Frame Replacement](#).



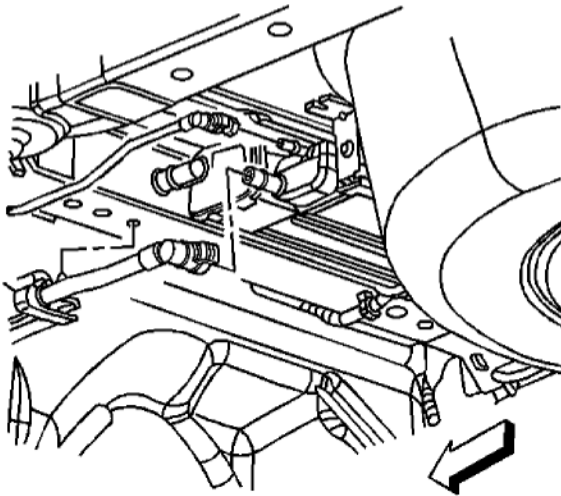
6. Disconnect the filler hose (1) from the fuel tank.
7. Disconnect the filler vent tube (2) from the evaporative emission (EVAP) hose. Refer to [Plastic Collar Quick Connect Fitting Service](#).



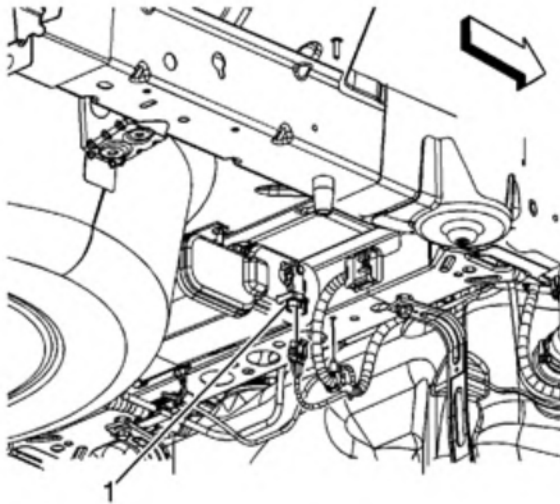
8. Disconnect the fuel feed pipe (1) from the chassis bundle. Refer to [Plastic Collar Quick Connect Fitting Service](#).
9. Disconnect the fuel EVAP hose (2) from the chassis bundle. Refer to [Plastic Collar Quick Connect Fitting Service](#).



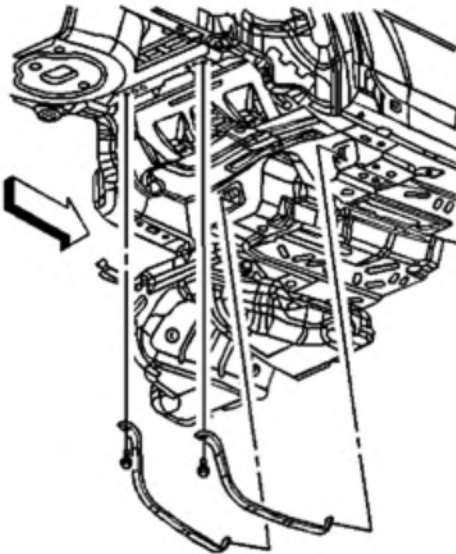
10. Release the electrical connector interlock and disconnect the fuel tank electrical connector.
11. Remove the fuel tank electrical connector retainer from the chassis.
12. Remove the fuel tank electrical harness from the chassis mounted retainer.



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



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



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

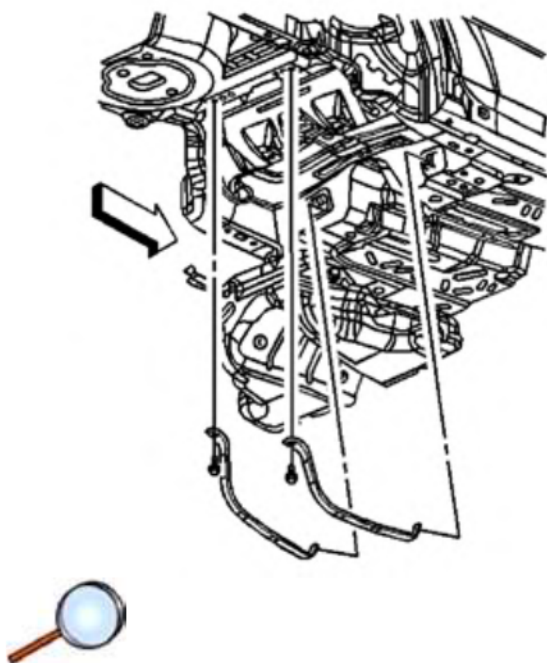
Note: Ensure the following are free from the surrounding components while lowering the fuel tank:

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

20. With the aid of an assistant, carefully lower the fuel tank from the vehicle.
21. Remove the following components if replacing just the fuel tank:
 - The primary fuel tank module--Refer to [Primary Fuel Tank Module Replacement](#).
 - The secondary fuel tank module--Refer to [Secondary Fuel Tank Module Replacement](#).

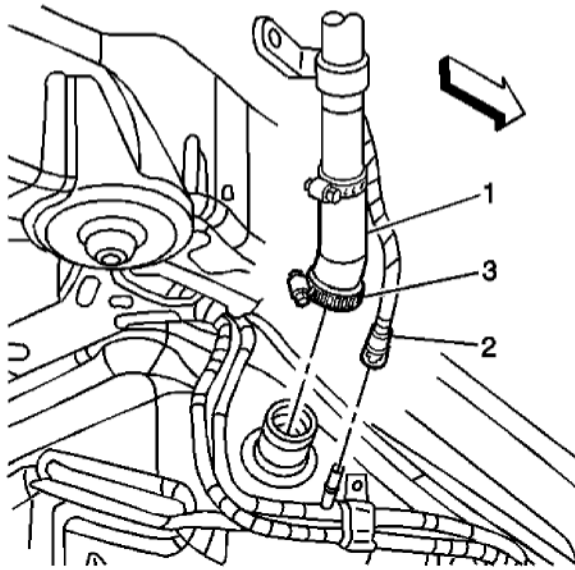
Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 - The primary fuel tank module--Refer to [Primary Fuel Tank Module Replacement](#).
 - The secondary fuel tank module--Refer to [Secondary Fuel Tank Module Replacement](#).

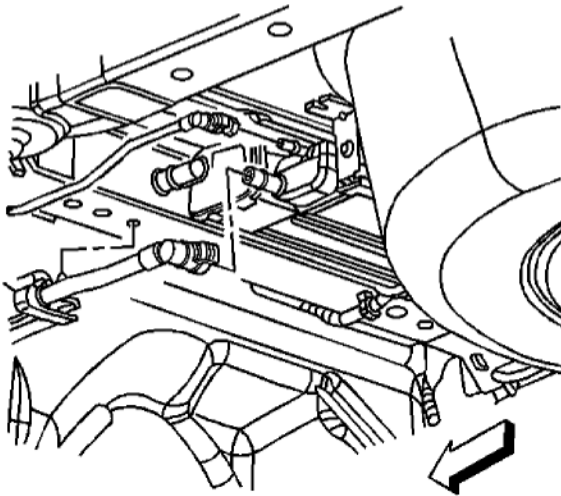


Note: Ensure the following are properly routed while raising the fuel tank:

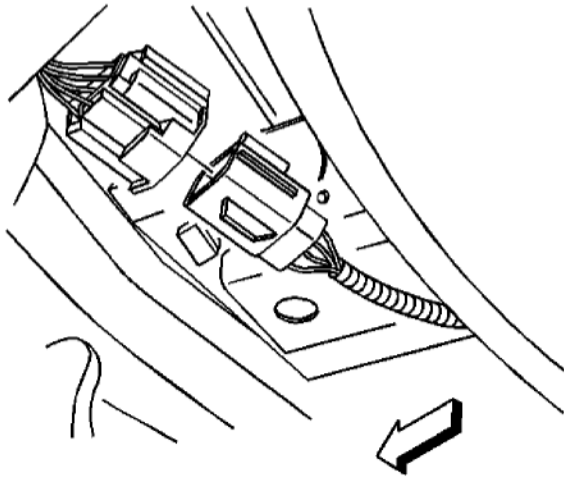
- The fuel tank wiring harness
 - The EVAP wiring harness
 - The EVAP hoses at the EVAP
 - The fuel/EVAP hoses at the chassis pipes
2. With the aid of an assistant, carefully raise the fuel tank to the vehicle.
 3. Install the fuel tank straps to the vehicle.
- Caution:** Refer to [Fastener Caution](#) in the Preface section.
4. Install the fuel tank strap bolts and tighten to **50 N·m (37 lb ft)**.



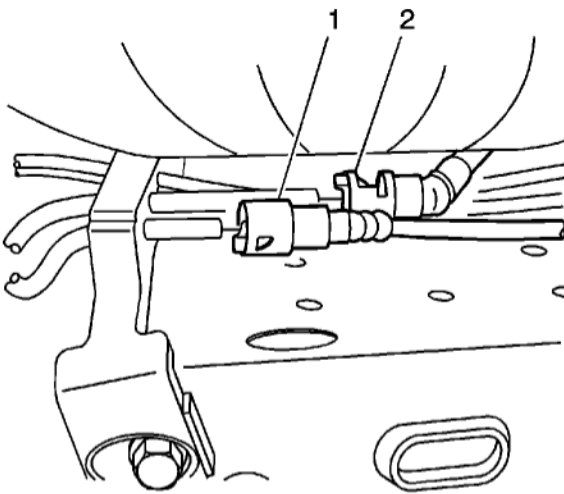
5. Connect the filler hose (1) to the fuel tank and tighten to **3.5 N·m (31 lb in)**.
6. Connect the filler vent tube (2) to the EVAP hose. Refer to [Plastic Collar Quick Connect Fitting Service](#).



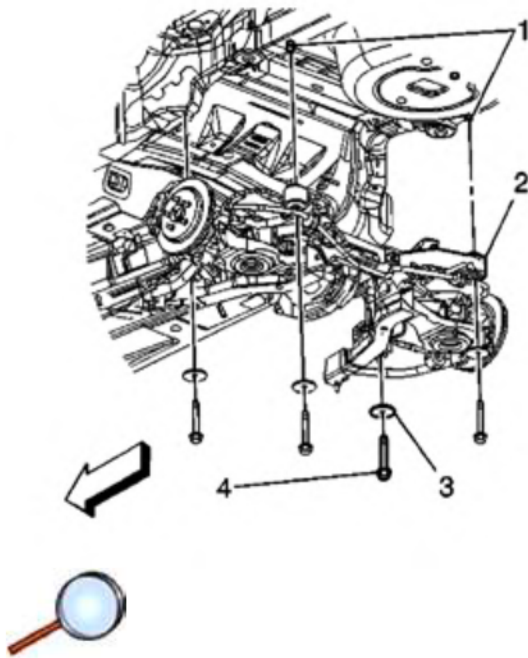
7. Connect the EVAP hoses to the EVAP canister.
8. Connect the EVAP purge valve and fuel tank pressure sensor electrical connectors.



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

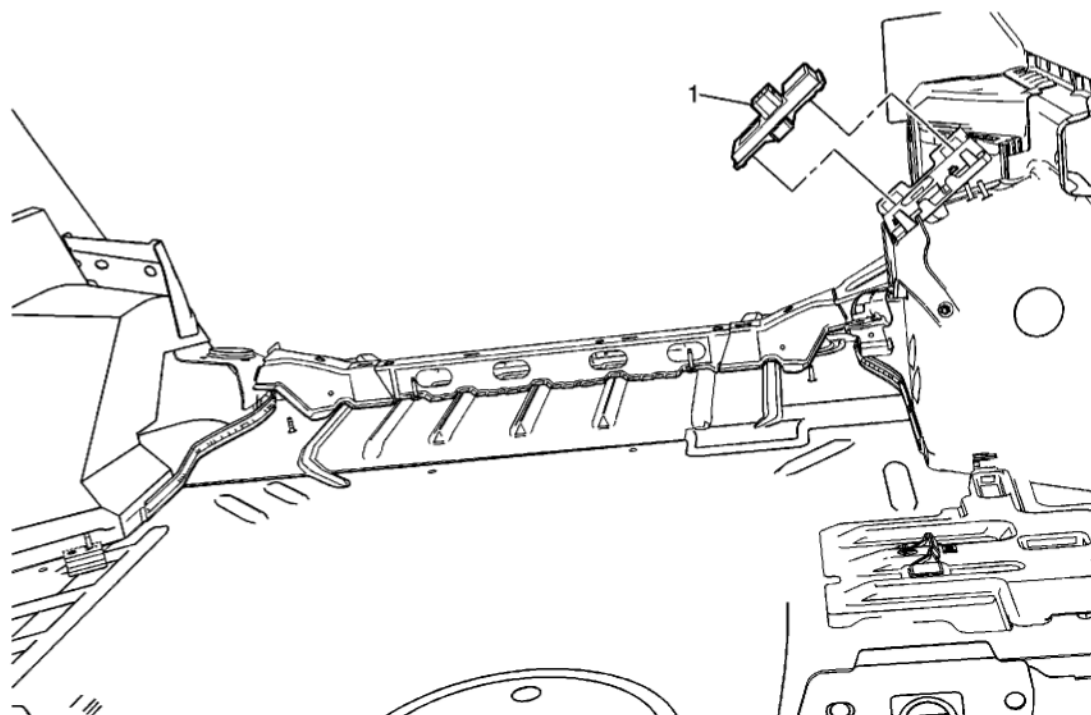


11. Connect the fuel EVAP hose (2) to the chassis bundle. Refer to [Plastic Collar Quick Connect Fitting Service](#).
12. Connect the fuel feed pipe (1) to the chassis bundle. Refer to [Plastic Collar Quick Connect Fitting Service](#).



13. Install the rear frame assembly (2). Refer to [Rear Frame Replacement](#).
14. Install the propeller shaft. Refer to [Rear Propeller Shaft Replacement](#).
15. Install the exhaust system. Refer to [Exhaust System Replacement](#).
16. Refill the fuel tank.
17. Inspect for fuel leaks.

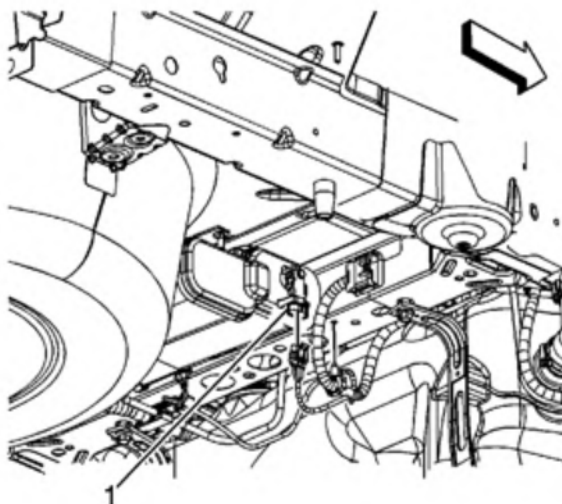
Fuel Pump Flow Control Module Replacement



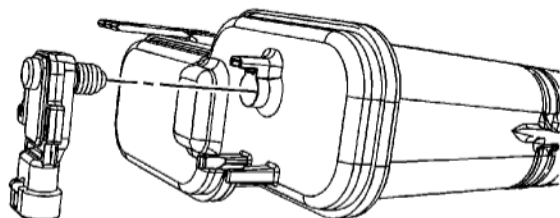
Callout	Component Name
Preliminary Procedure	
Partially remove the passenger side rear compartment trim panel. Refer to Rear Compartment Side Trim Panel Replacement .	
1	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. Release the two integral retainer tabs and remove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

Fuel Tank Pressure Sensor Replacement

Removal Procedure



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

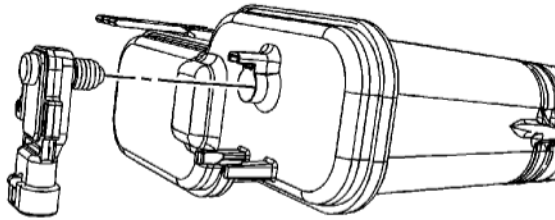


Important: There are alignment features on the canister, however, there are no locking tabs on the sensor/canister. Ensure a tight fit of the multi-lip.

seal.

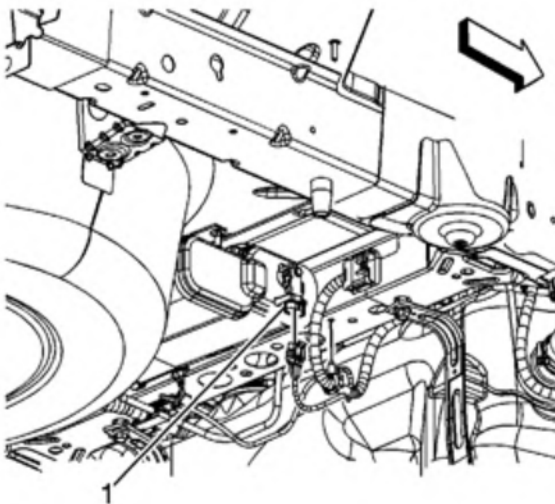
3. Remove the fuel tank pressure sensor from the evaporative emission (EVAP) canister.

Installation Procedure



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

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



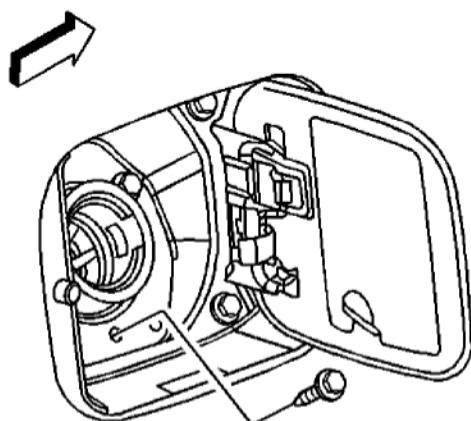


2. Connect the fuel tank pressure sensor electrical connector (1).
3. Lower the vehicle.

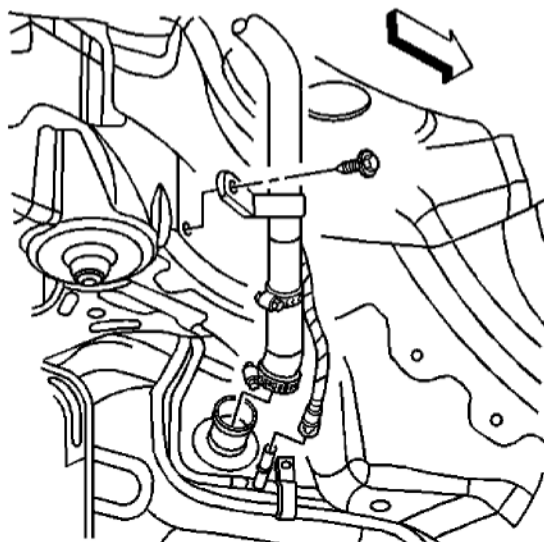
Filler Tube Replacement

Removal Procedure

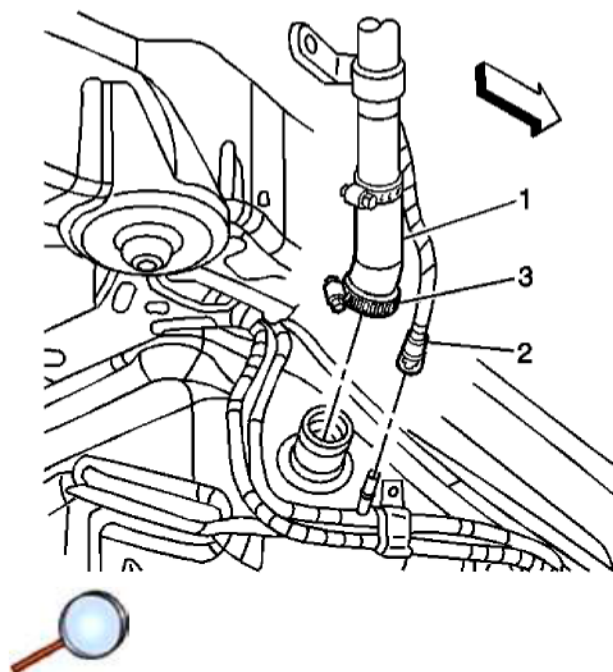
1. Remove the fuel filler cap.
2. Drain the fuel tank below the level of the fuel filler hose. Refer to [Fuel Tank Draining](#).



3. Remove the bolts securing the fuel filler tube to the body.
4. Remove the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the right rear wheelhouse liner. Refer to [Rear Wheelhouse Panel Liner Replacement](#).



6. Remove the fuel filler tube brace bolt.

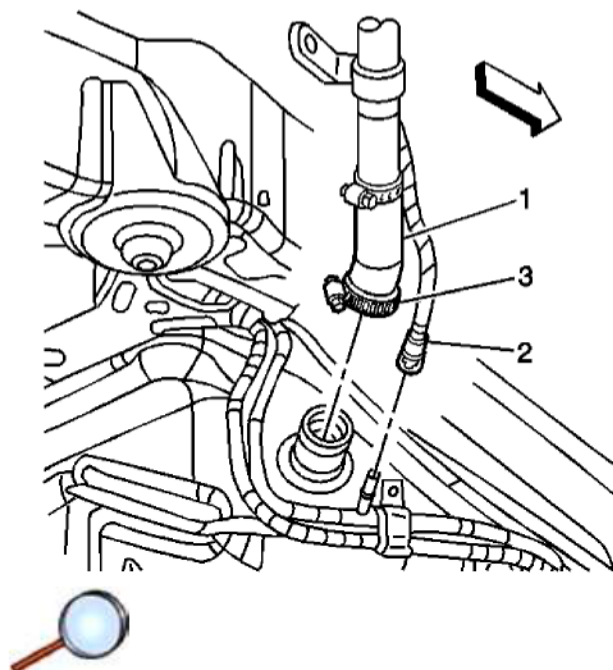


7. Disconnect the fuel filler hose (1) from the fuel tank.
8. Disconnect the filler vent tube (2) from the evaporative emission (EVAP) hose. Refer to [Plastic Collar Quick Connect Fitting Service](#).
9. Remove the fuel filler tube from the vehicle.

Installation Procedure

1. Position the fuel filler tube to the vehicle.

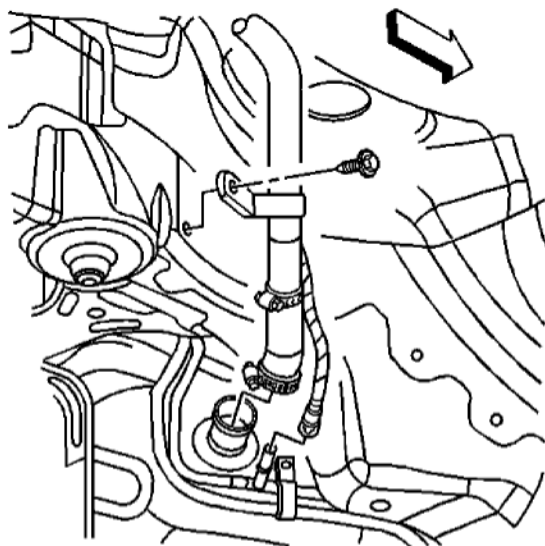
Caution: Refer to [Component Fastener Tightening Caution](#) in the Preface section.



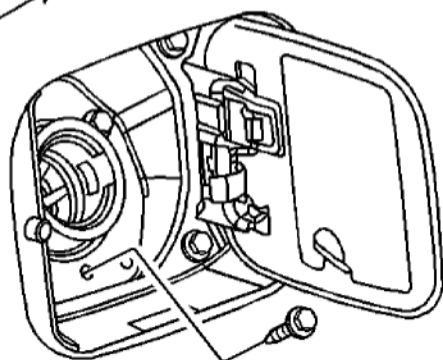
2. Connect the filler hose (1) to the fuel tank and tighten to **3.5 N·m (31 lb in)**.

3. Connect the filler vent tube (2) to the EVAP hose. Refer to [Plastic Collar Quick Connect Fitting Service](#).

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



4. Install the fuel filler tube brace bolt and tighten to **9 N·m (80 lb in)**.



5. Install the bolts securing the fuel filler tube to the body and tighten to **3.5 N·m (31 lb in)**.
6. Install the right rear wheelhouse liner. Refer to [Rear Wheelhouse Panel Liner Replacement](#).
7. Install the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
8. Add fuel to the fuel tank.
9. Inspect for fuel leaks.
10. Install the fuel filler cap.

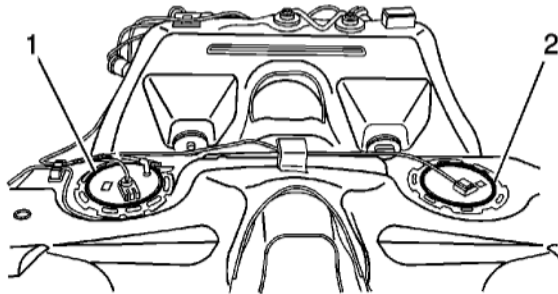
Primary Fuel Tank Module Replacement

Special Tools

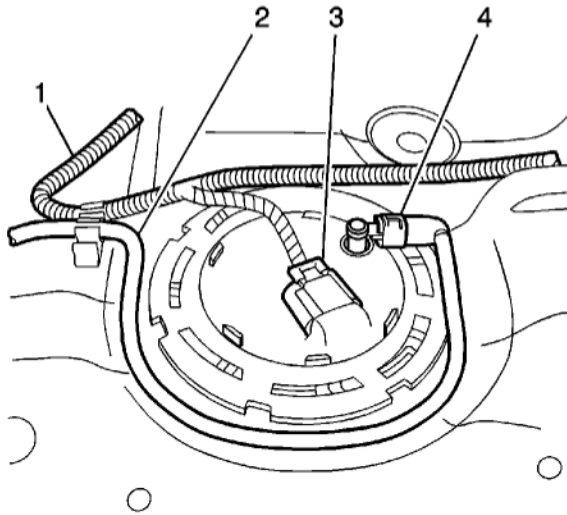
[J 45722](#) Fuel Sender Lock Ring Wrench

Removal Procedure

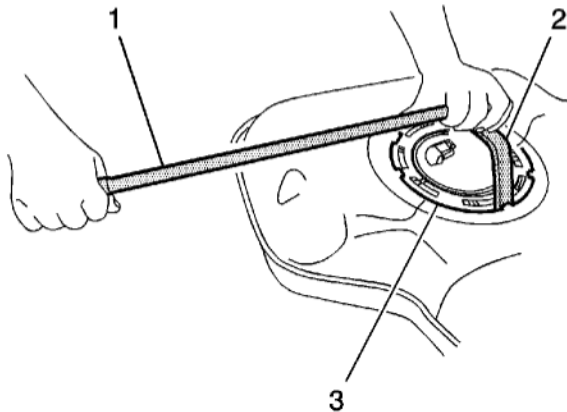
Warning: Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.



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



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



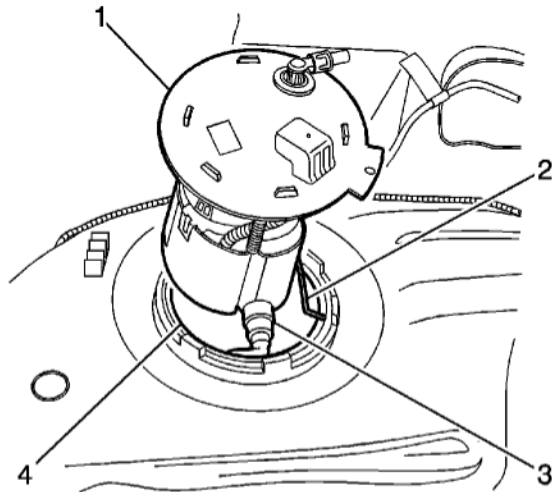
Caution: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

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

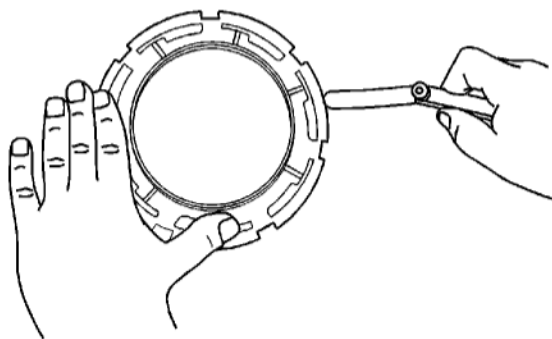
Note:

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

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



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

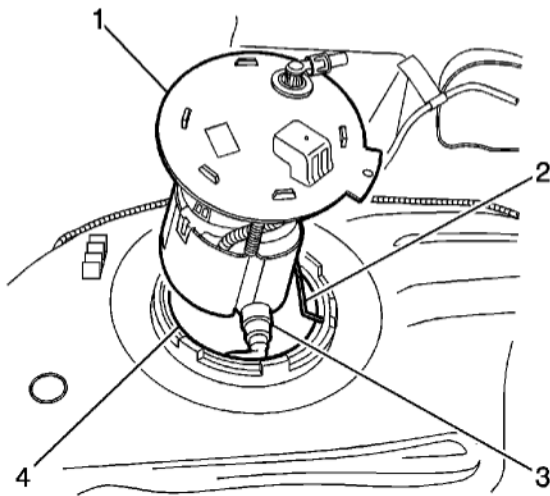


**Note:**

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

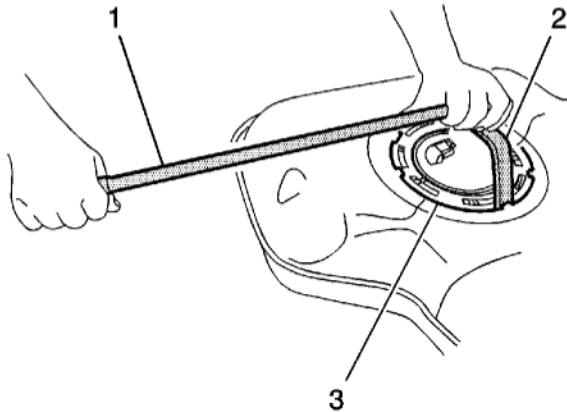
12. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gage at 7 points.
13. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
14. If warpage is greater than 0.41 mm (0.016 in), the lock ring must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

Installation Procedure



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

1. Install a NEW fuel tank module seal (4).
2. Grasp the fuel transfer hose from inside the fuel tank.
3. Partially install the primary fuel tank module (1) to the fuel tank.
4. Connect the fuel transfer hose quick connect fitting (3) to the port on the fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).



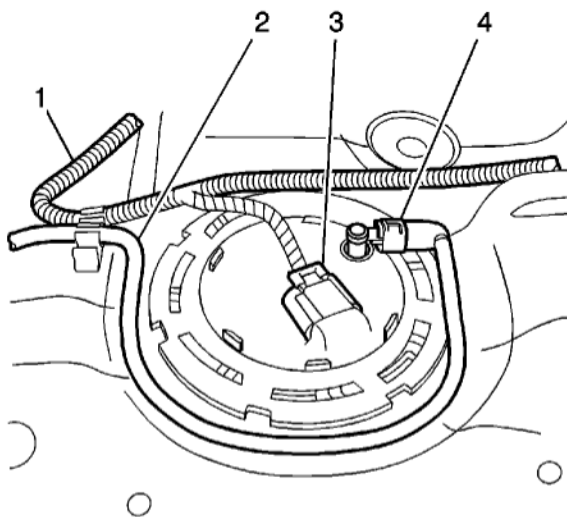
5. Press the primary fuel tank module downward, aligning the module to the encapsulated ring.

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

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

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

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



8. Connect the electrical connector (3) to the primary fuel tank module and engage the connector interlock.
9. Install the wire harness (1) to the retainer on the fuel tank.
10. Connect the fuel feed hose quick connect fitting (4) to the primary fuel tank module. Refer to [Plastic Collar Quick Connect Fitting Service](#).
11. Install the fuel feed hose (2) to the retainer on the fuel tank.
12. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

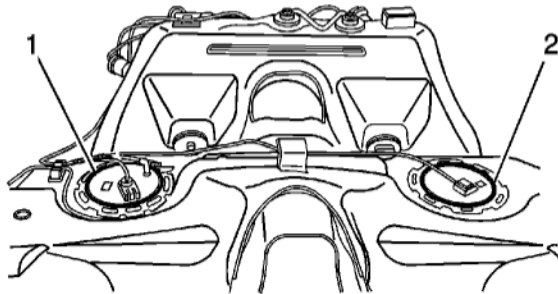
Secondary Fuel Tank Module Replacement

Special Tools

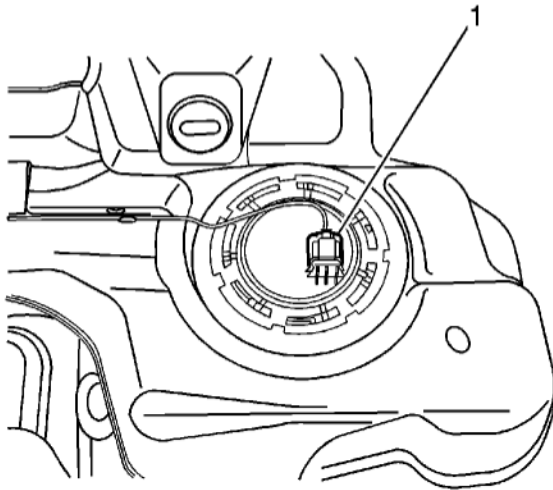
[J 45722](#) Fuel Sender Lock Ring Wrench

Removal Procedure

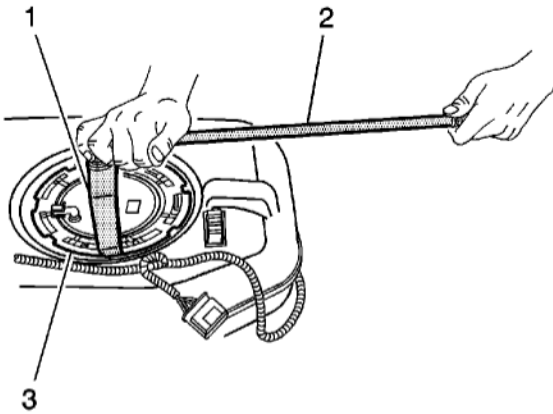
Warning: Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.



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



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

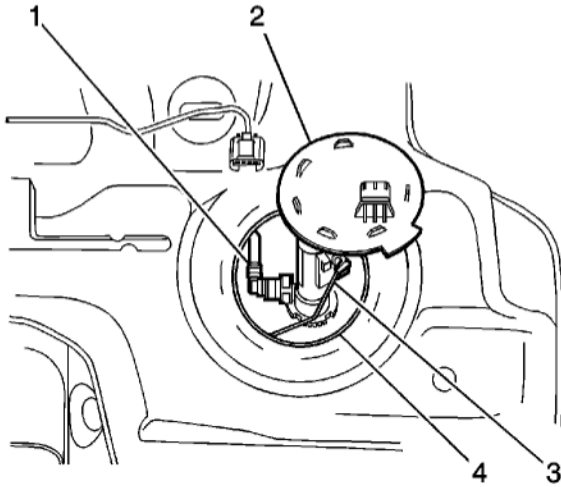


Caution: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

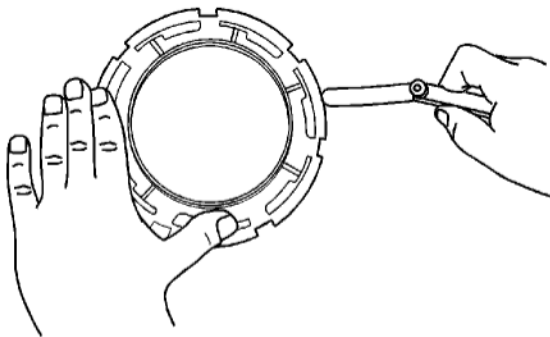
Note:

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

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



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

**Note:**

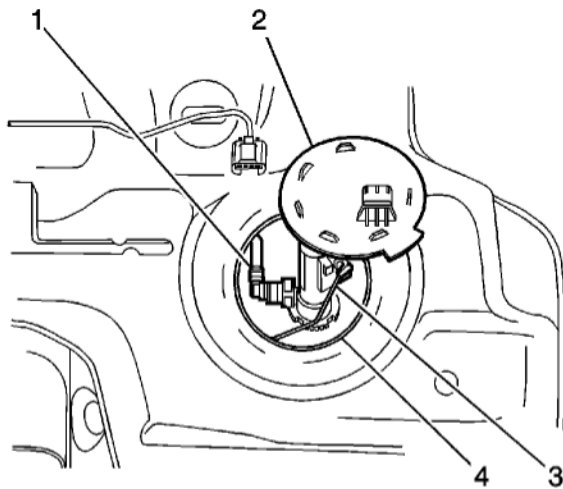
- Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if the lock rings are not damaged or warped.
- Inspect the lock ring for damage due to improper removal or installation procedures. If

damage is found, install a NEW lock ring.

- Check the lock ring for flatness.

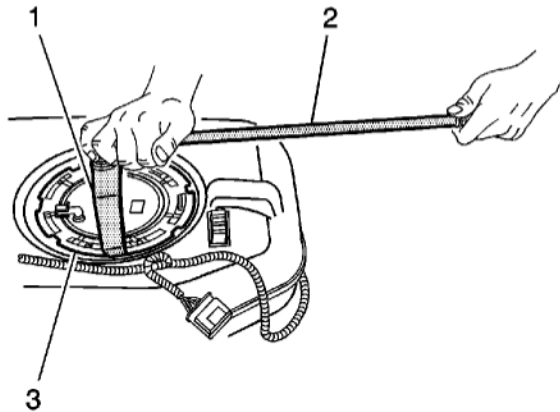
9. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gage at 7 points.
10. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
11. If warpage is greater than 0.41 mm (0.016 in), the lock ring must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

Installation Procedure



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

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



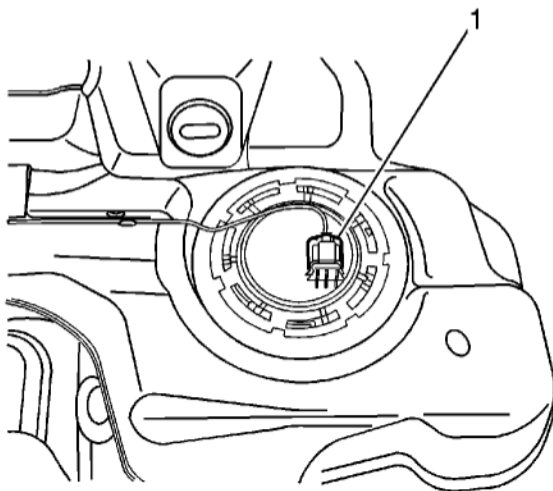
5. Press the secondary fuel tank module downward, aligning the module to the encapsulated ring.

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

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

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

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





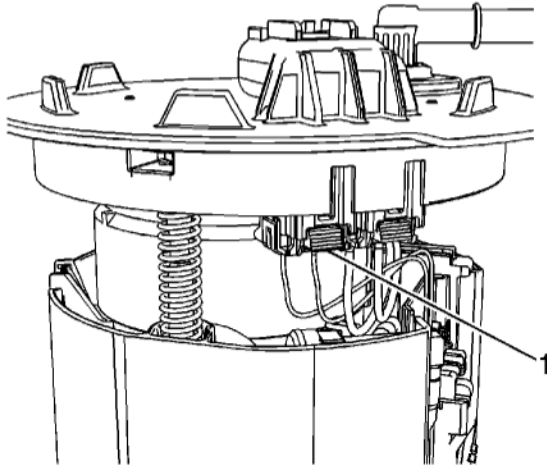
8. Connect the electrical connector (1) to the secondary fuel tank module and engage the connector interlock.
9. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

Primary Fuel Level Sensor Replacement

Removal Procedure

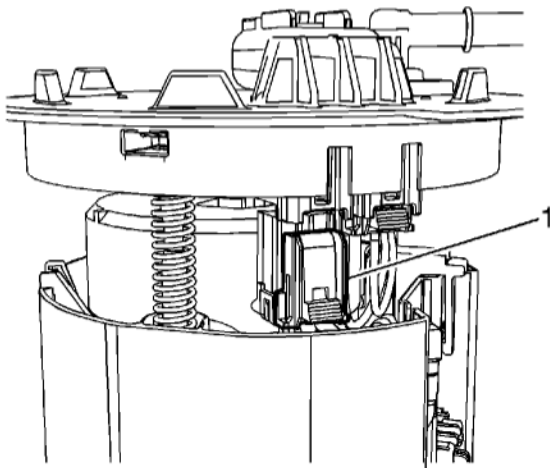
Warning: Refer to [Gasoline/Gasoline Vapors Warning](#) in the Preface section.

1. Remove the primary fuel tank module. Refer to [Primary Fuel Tank Module Replacement](#).



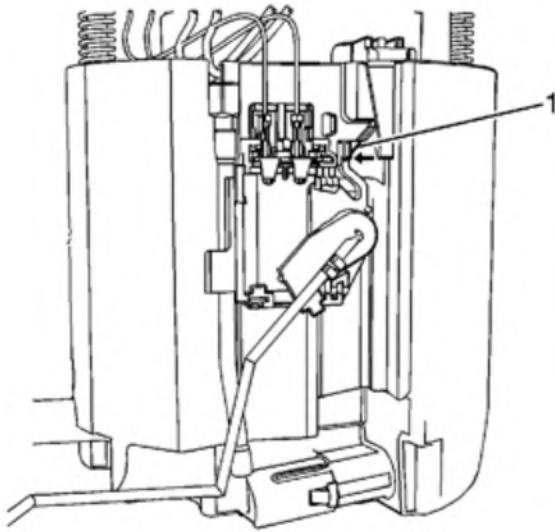
Note: Do not pull on the connector wires.

2. Press in the locking tab (1) and disconnect the fuel level sensor electrical connector.



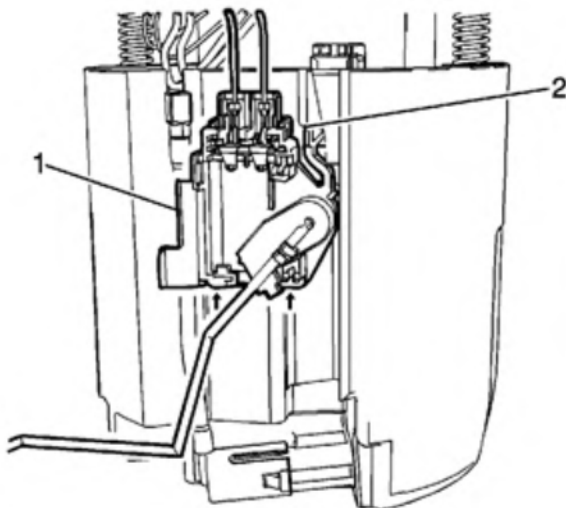


3. Disconnect the fuel level sensor electrical connector (1).

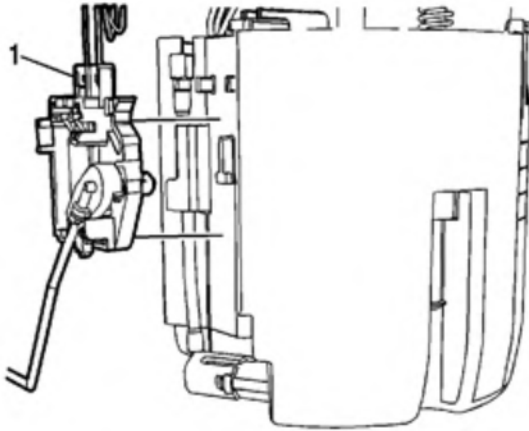


Note: Do not touch the resistor circuit board.

4. Disengage the locking tab (1) on the fuel level sensor by pushing inward.

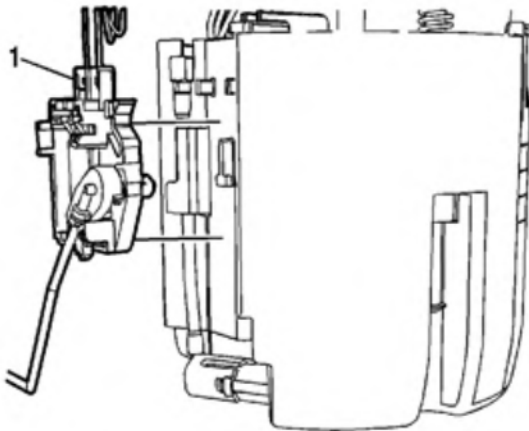


5. Slide the fuel level sensor (1) upward to the stationary lock (2).

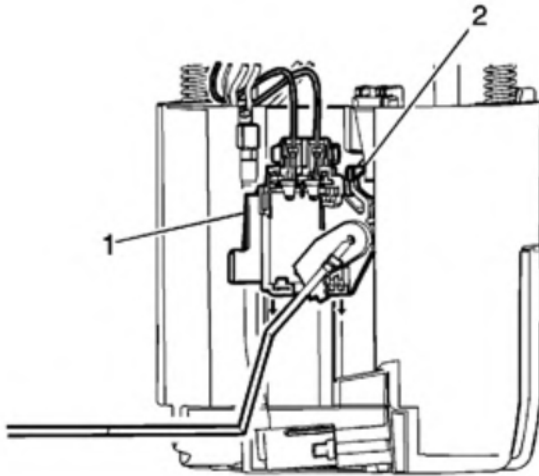


6. Remove the fuel level sensor (1).

Installation Procedure

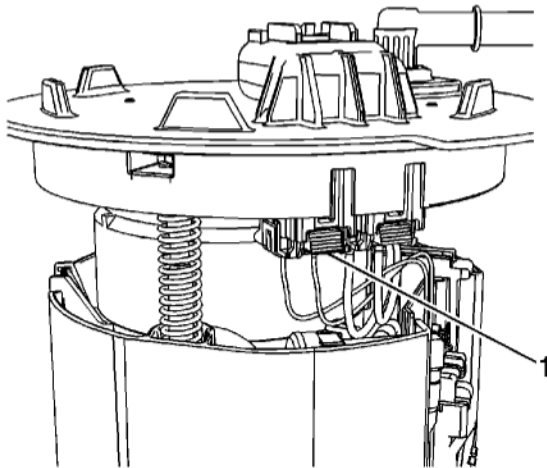


1. Install the fuel level sensor (1).



Note: Do not push on the electrical terminals.

2. Slide the fuel level sensor (1) downward until the locking tab (2) locks into place.



Note: Do not push on the electrical wires.

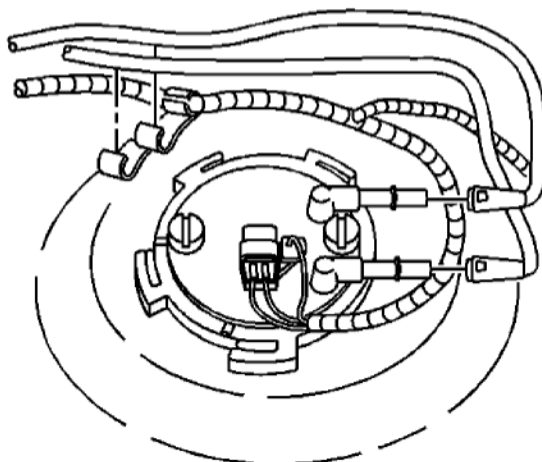
Note: Ensure the connector locking tab is fully seated into the flange.

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

Fuel Hoses/Pipes Replacement - Filter to Tank

Removal Procedure

1. Remove the fuel tank. Refer to [Fuel Tank Replacement](#).

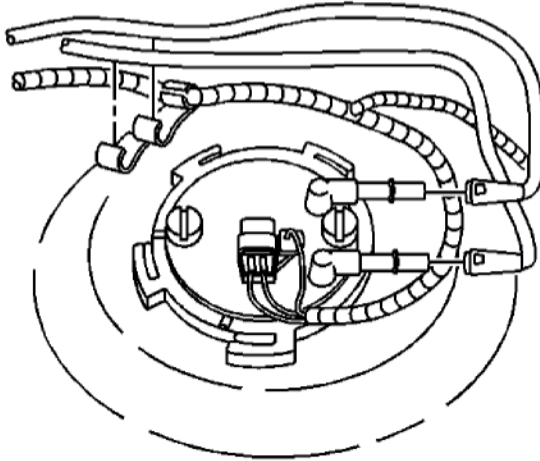


Caution: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
 - The hose connections
 - The areas surrounding the connections
2. Disconnect the fuel lines from the primary fuel tank module. Refer to [Metal Collar Quick Connect Fitting Service](#) and [Plastic Collar Quick Connect Fitting Service](#).
 3. Disconnect the hoses from the retaining feature at the fuel tank.

Installation Procedure

1. Clean any contamination from the male pipe ends of the primary fuel tank module.



2. Connect the hoses to the retaining feature at the fuel tank.
3. Connect the fuel lines from the primary fuel tank module. Refer to [Metal Collar Quick Connect Fitting Service](#) and [Plastic Collar Quick Connect Fitting Service](#).
4. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

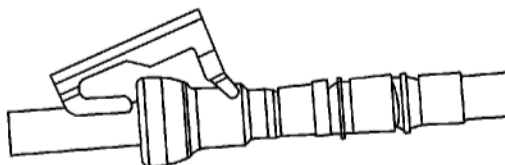
Fuel Hose / Pipes Replacement - Chassis (LP1, LY7)

Removal Procedure

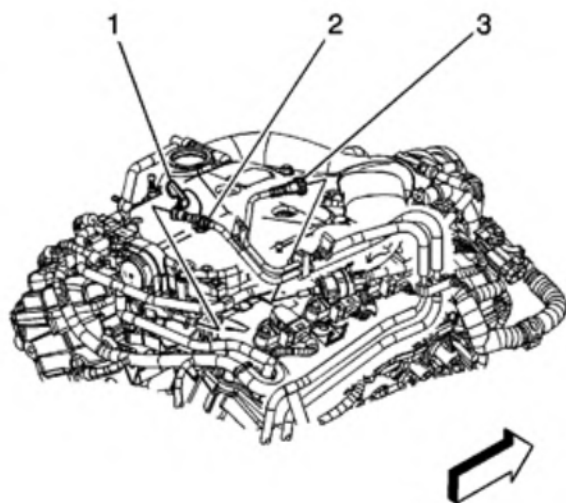
The fuel system hose/pipes are serviceable individually or as a complete fuel/brake bundle assembly, the following procedure is servicing the fuel hose/pipes individually.

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

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

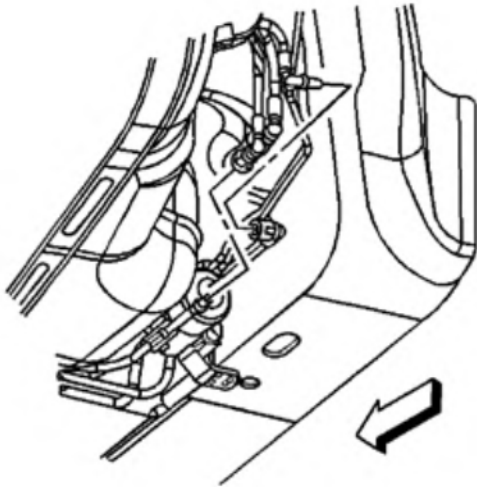


2. Remove the fuel pipe retaining clip from the fuel pipe. Refer to [Metal Collar Quick Connect Fitting Service](#).

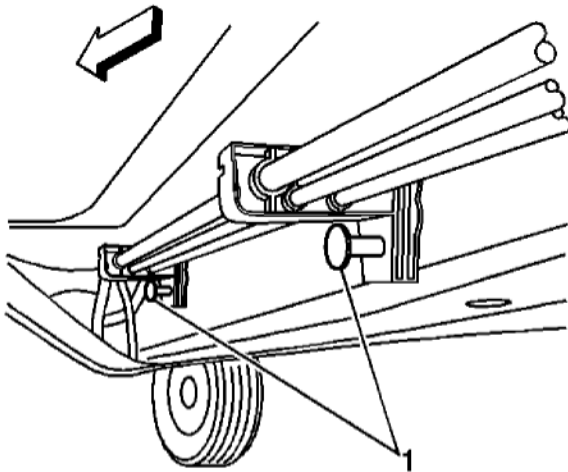




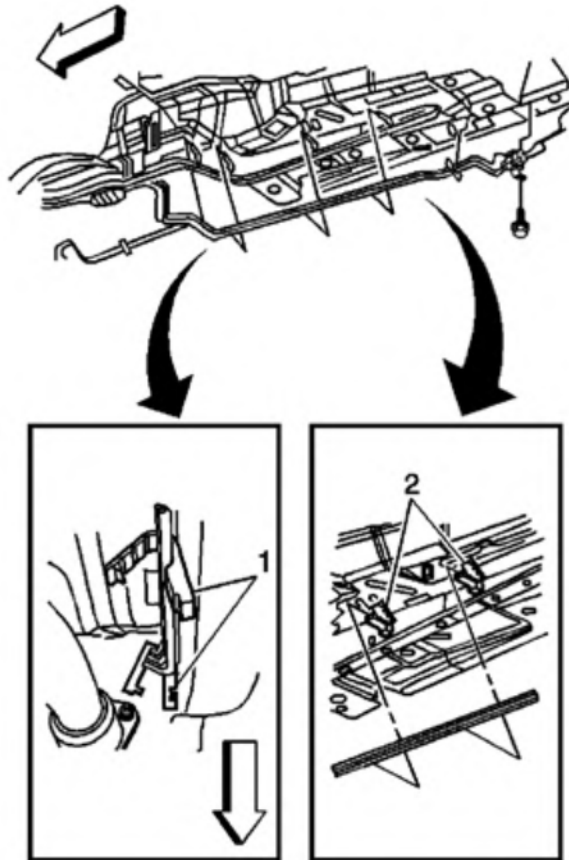
3. Disconnect the fuel pipe (2) from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
4. Disconnect the evaporative emission (EVAP) purge line (3) from the purge solenoid.
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



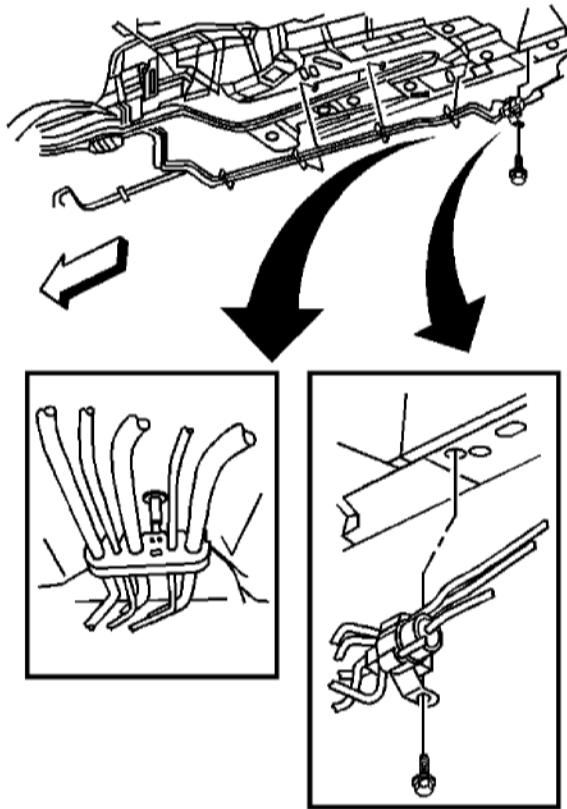
6. Disconnect the fuel pipes from the fuel filter and the fuel tank bundle.



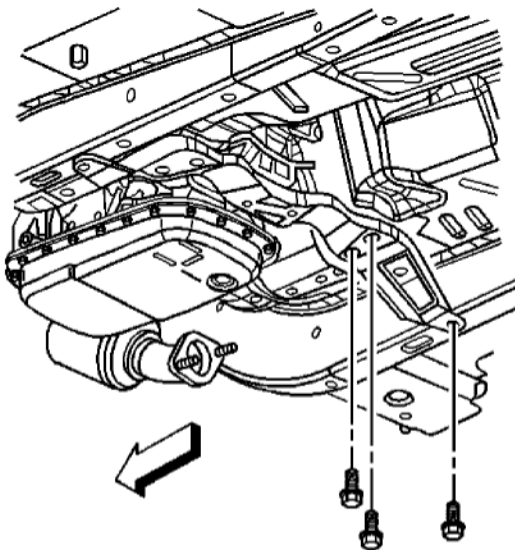
7. Pull the locking mechanism (1) outward in order to disengage the fuel/brake bundle chassis pipe retainers from the rail.



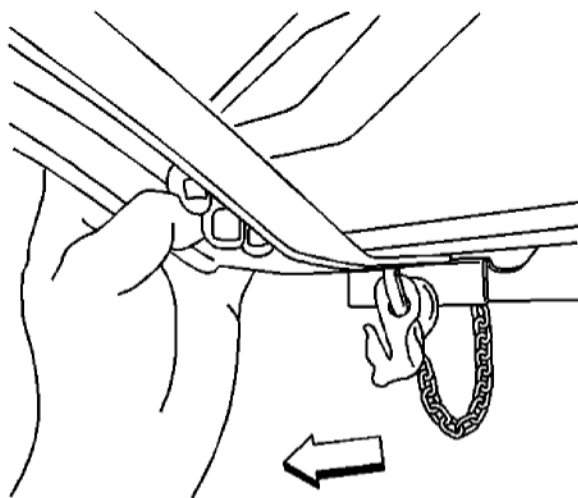
8. Open the retainers (1) located at the forward portion of the rail in order to remove the chassis hose/pipes.
9. Complete the following in order to remove the chassis hose/pipes from the retainers (2) located at the rearward portion of the rail.
 - 9.1. Pull the retainers (2) free from the rail.
 -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



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



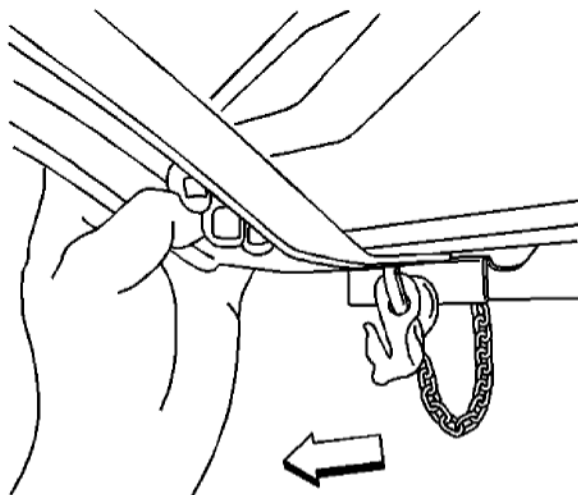
13. Remove the bolts securing the transmission support to the underbody, from the right side only.



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

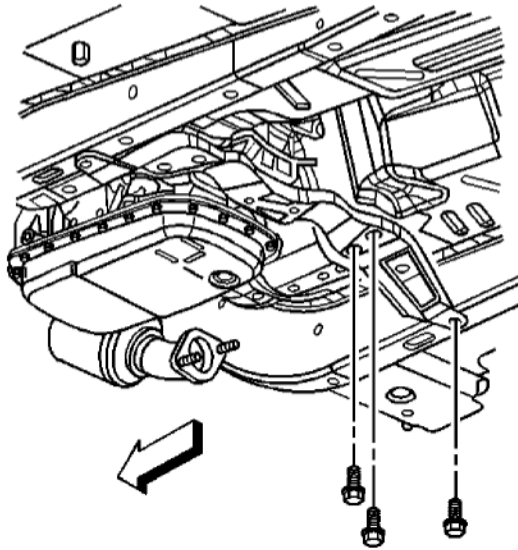
Installation Procedure

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

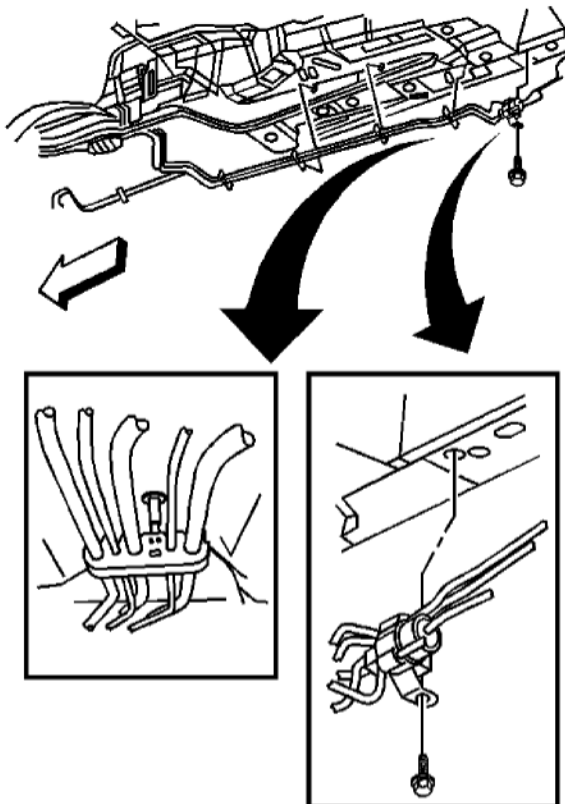




4. Pull the right side transmission support down only enough to allow installation of the chassis fuel hose/pipes.



5. Install the transmission support right side bolts. Refer to [Transmission Support Replacement](#).

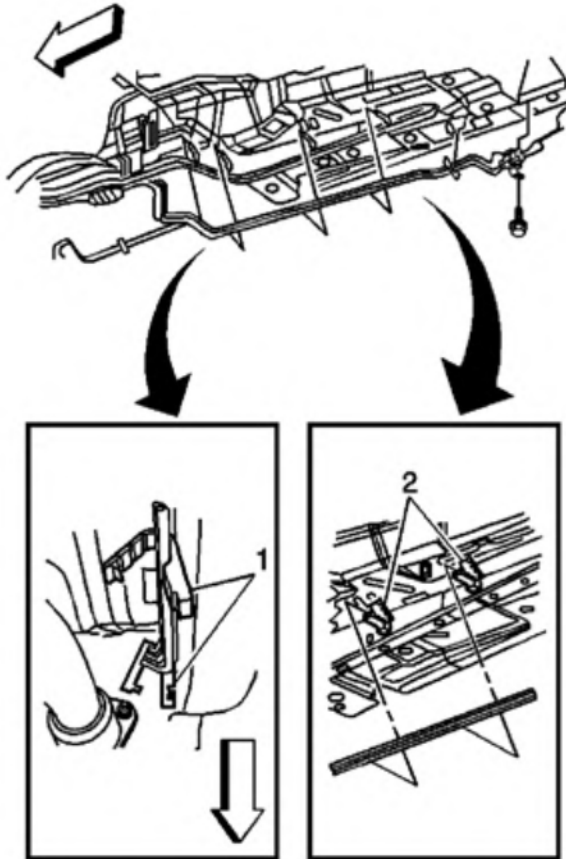




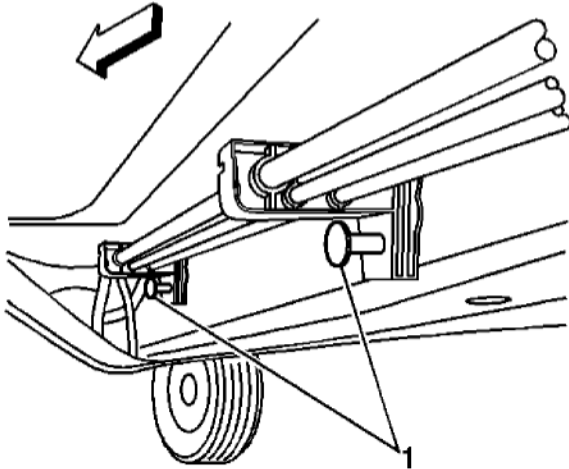
6. Install the EVAP hose to the fuel filter bracket:

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

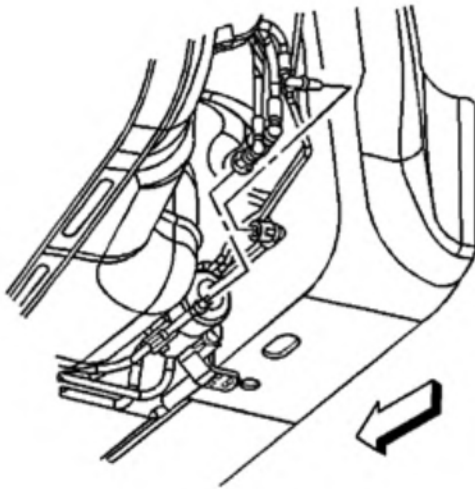
7. Install the fuel filter bracket bolt and tighten to **9 N·m (80 lb in)**.
8. Install the fuel/brake bundle to the underbody.



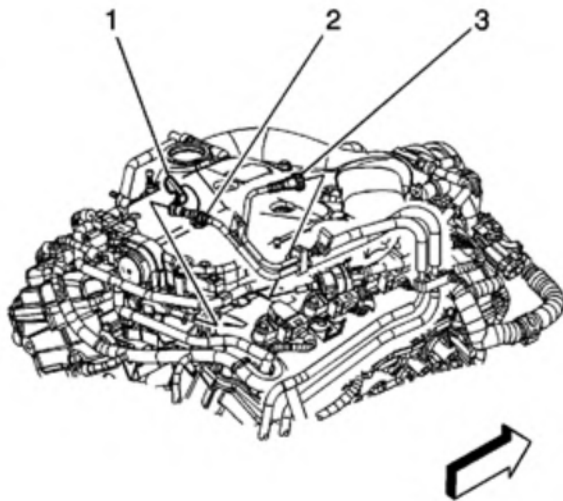
9. Complete the following in order to install the chassis hose/pipes to the retainers (2) located at the rearward portion of the rail:
 - 9.1. Install the chassis hose/pipes into the retainers (2).
 - 9.2. Close the retainers (2) at the top.
 - 9.3. Insert the retainers (2) into the rail.
10. Install the chassis hose/pipes into the retainers (1) located at the forward portion of the rail.
11. Close the retainers.



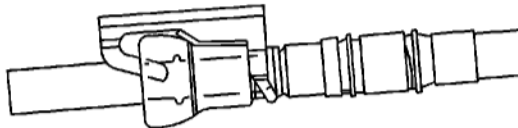
12. Push the locking mechanism (1) inward in order to engage the fuel/brake bundle chassis pipe retainers to the rail.



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



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

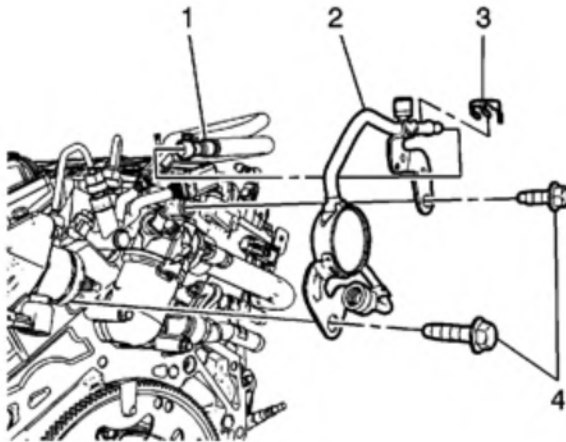


17. Install the fuel pipe retaining clip.

Fuel Feed Pipe Replacement (LLT)

Removal Procedure

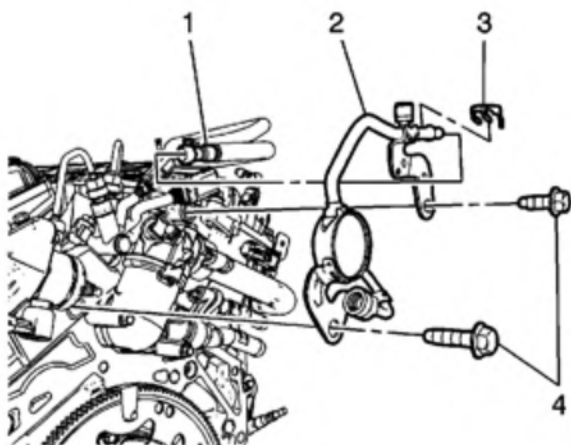
1. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Remove the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Relieve the low side fuel system pressure. Refer to [Fuel Pressure Relief](#).
4. Remove the radiator surge tank outlet pipe. Refer to [Radiator Surge Tank Outlet Hose/Pipe Replacement](#).



5. Disconnect the fuel feed line quick connect fitting from the fuel feed pipe (2). Refer to [Metal Collar Quick Connect Fitting Service](#).
6. Loosen the fuel feed pipe fitting to the high pressure fuel pump.
7. Remove the fuel feed pipe bolts (4) from the cylinder heads.
8. 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).
 - Tighten the bolts to **50 N·m (37 lb ft)**.
 - 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 radiator surge tank outlet pipe. Refer to [Radiator Surge Tank Outlet Hose/Pipe Replacement](#).
11. Install the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
12. Install the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

Fuel System Cleaning

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

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

1. Remove the fuel module assemblies. Refer to [Primary Fuel Tank Module Replacement](#) and [Secondary Fuel Tank Module Replacement](#).
2. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
3. Perform the following procedures:
 - Inspect the fuel sender strainer. Replace the primary fuel tank module if the strainer is contaminated.
 - Inspect the secondary fuel tank module for debris. Clean the secondary fuel tank module if debris is found.

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

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

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

4. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to ensure that the removal of the water from the tank is complete.
5. Refer to [Metal Collar Quick Connect Fitting Service](#) in order to disconnect the following quick connect fittings from the fuel rail:
 - The feed hose/pipe
 - The return hose/pipe
6. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.
7. Remove the fuel injectors and fuel rail. Refer to [Fuel Injector and Fuel Rail Replacement](#).
8. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

Assemble the fuel system as follows:

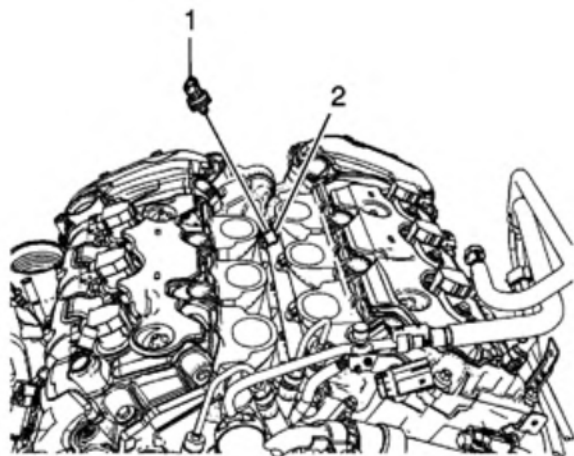
1. Install the fuel injectors and fuel rail. Refer to [Fuel Injector and Fuel Rail Replacement](#).
2. Install the fuel module assemblies. Refer to [Primary Fuel Tank Module Replacement](#) and [Secondary Fuel Tank Module Replacement](#).
3. Refer to [Metal Collar Quick Connect Fitting Service](#) in order to connect the following quick connect fittings to the fuel rail:

- The feed hose/pipe
- The return hose/pipe

Fuel Pressure Sensor Replacement (LLT)

Removal Procedure

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



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.

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

Installation Procedure

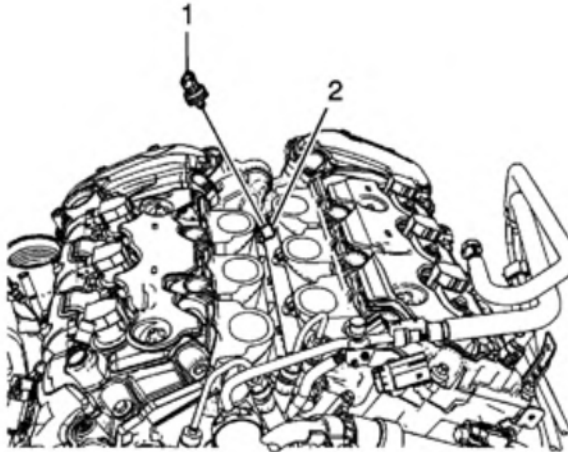
Note: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

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.

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

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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](#)

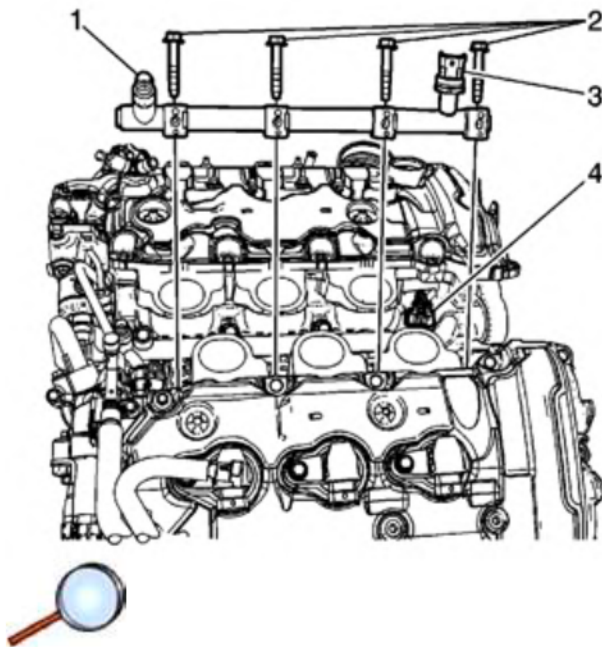
Note: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

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.
9. Install the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).

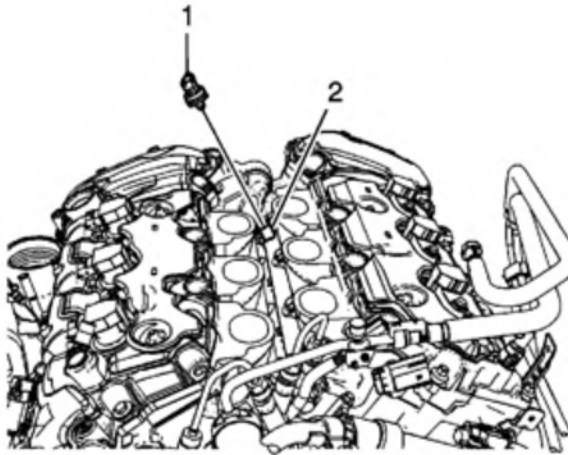
Fuel Injection Fuel Rail Assembly Replacement - Bank 1

Removal Procedure

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Remove the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).
3. Remove the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
4. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).
5. Remove the high pressure fuel pipe. Discard the pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
6. Remove the fuel rail crossover pipe. Refer to [Fuel Injection Fuel Rail Crossover Tube Replacement](#). Discard the pipe.
7. Remove the foam insulator from the fuel rails.



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

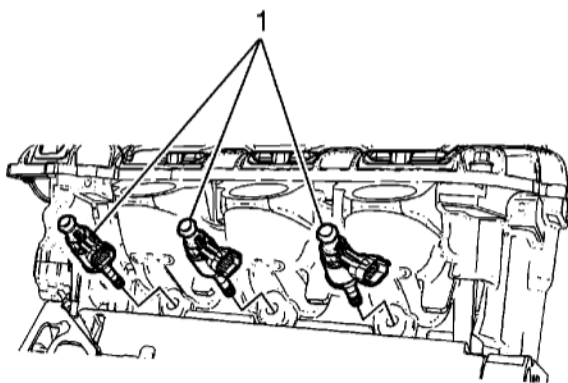


10. Remove the fuel pressure sensor. Refer to [Fuel Pressure Sensor Replacement](#)
11. Remove and discard the direct fuel injector hold down clamps.

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

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

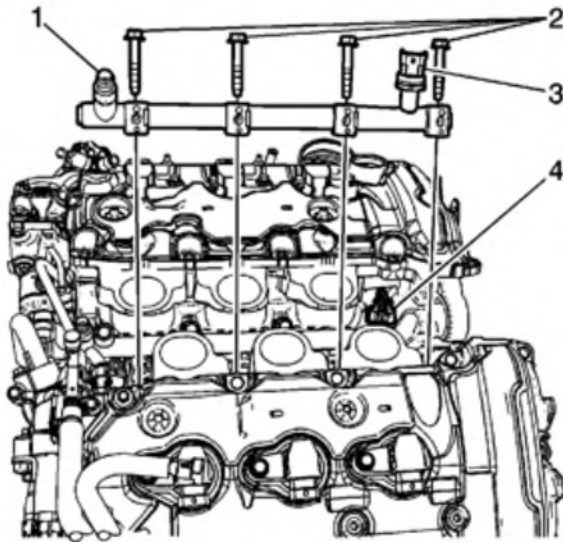
Installation Procedure



1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to [Fuel Injector](#)

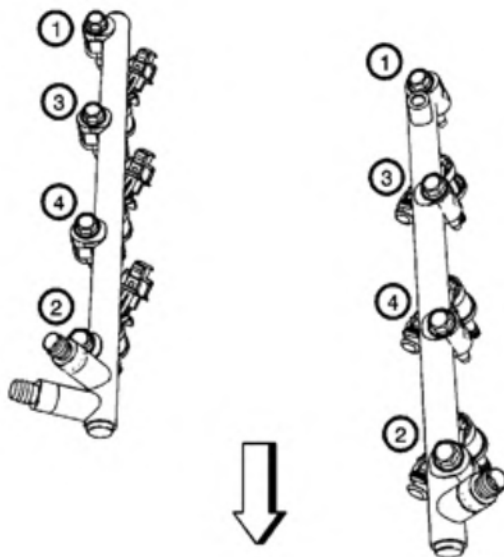
[Replacement.](#)

2. Install NEW direct injector hold down clamps to the injector.



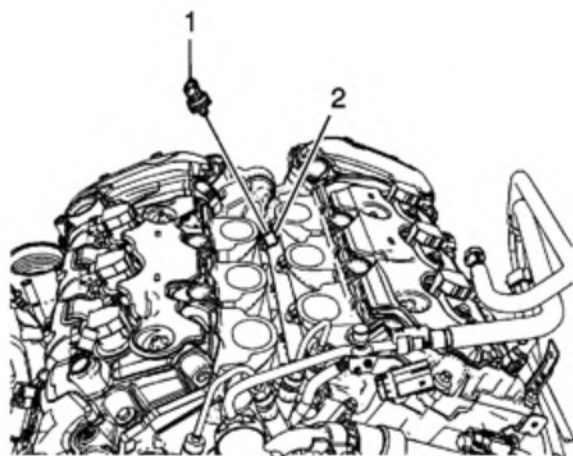
3. On a new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (1) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the 2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



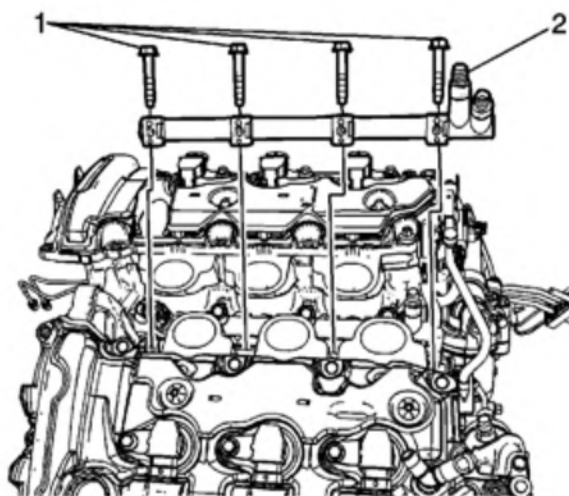
Caution: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

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.
17. Install the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).

Fuel Injection Fuel Rail Assembly Replacement - Bank 2

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](#).
4. Remove the fuel rail crossover pipe. Refer to [Fuel Injection Fuel Rail Crossover Tube Replacement](#). Discard this pipe.

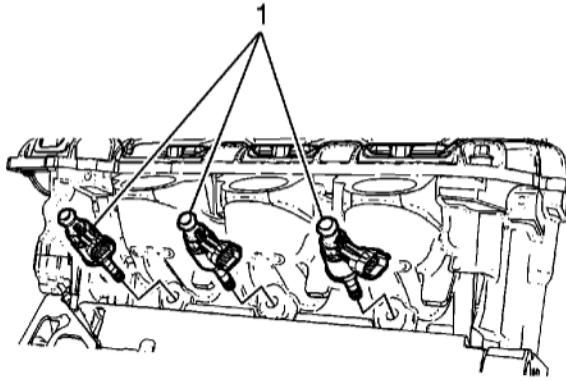


5. Remove the fuel rail bolts (1).
6. Carefully remove the Bank 2 fuel rail (2) from the engine. Lift the rear of the rail to ease removal.
7. Remove and discard the direct fuel injector hold down clamps.

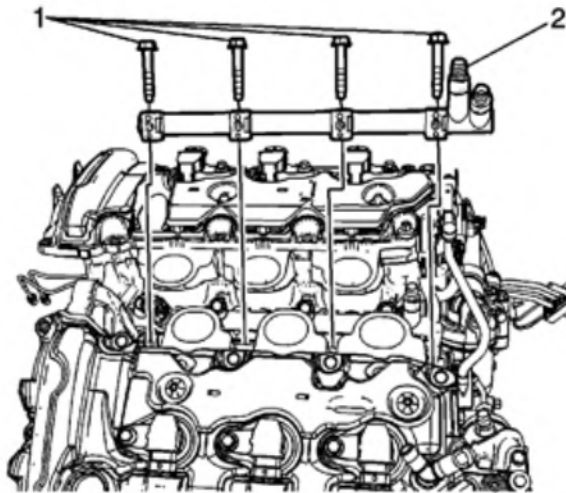
Note: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

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

Installation Procedure

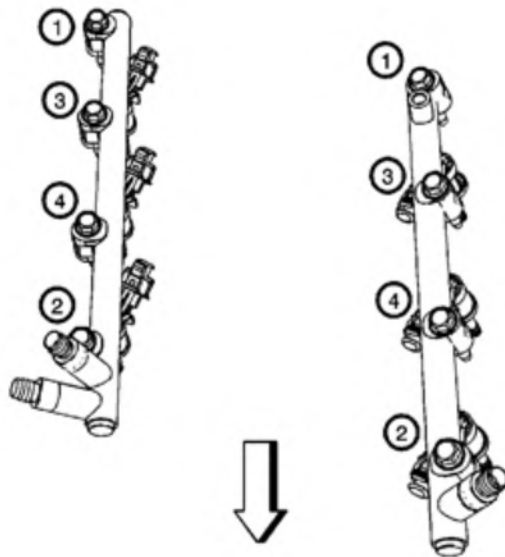


1. Install the rebuilt direct fuel injectors (1) to the cylinder heads. Refer to [Fuel Injector Replacement](#).
2. Install new direct injector hold down clamps to the injectors.

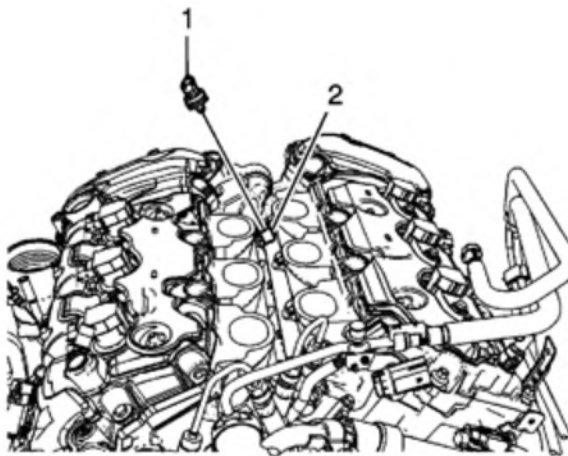


3. On the new fuel rail, lubricate the fuel injector cups with silicon free engine oil GM P/N 12345610 (Canadian P/N 9931930) or equivalent.
4. Carefully place the fuel rail (2) into position, placing the front into the fuel rail over the front injector and rotating the rear downward.
5. Install the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



Caution: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

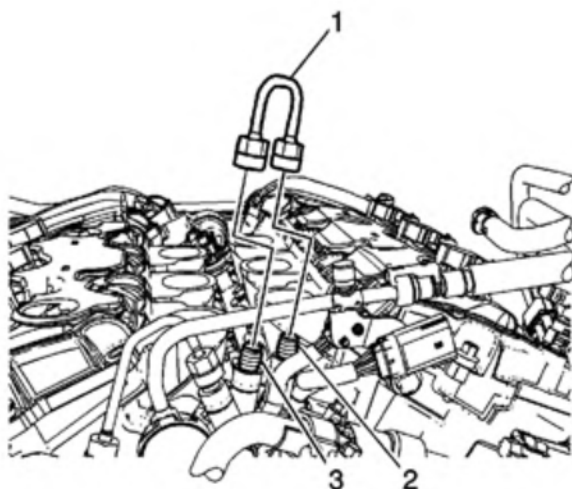
8. Install the high pressure fuel sensor. Refer to [Fuel Pressure Sensor Replacement](#).
9. Connect the fuel injector wiring harness electrical connector (1) from the fuel injectors, fuel rail and fuel pressure sensor.
10. Inspect for fuel leaks using the following procedure:

- 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

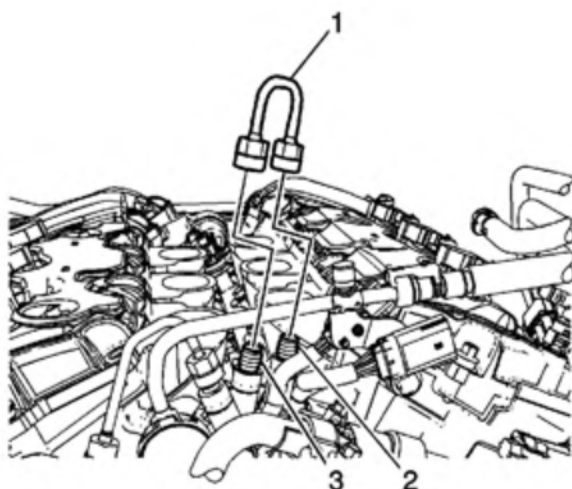
1. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Remove the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
4. Remove the intake manifold. Refer to [Intake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

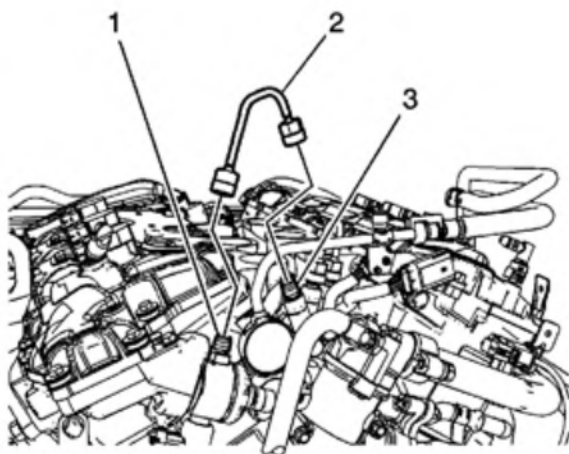
Note: If a fuel leak accrues at the right fuel rail fitting (2) or left fuel rail fitting (3), that component will need to be replaced.

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

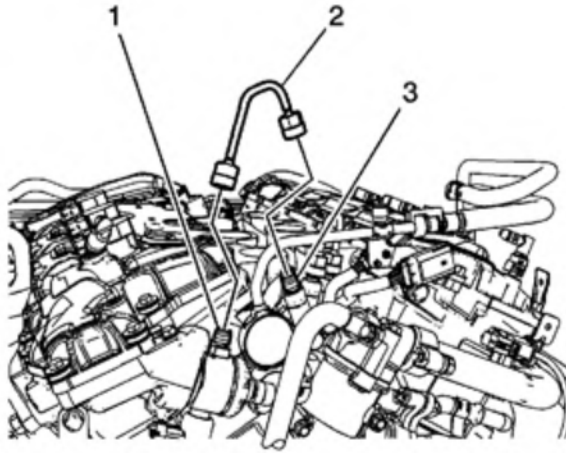
1. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).
2. Remove the high pressure pump shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Relieve fuel system pressure. Refer to [Fuel Pressure Relief](#).



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)**.

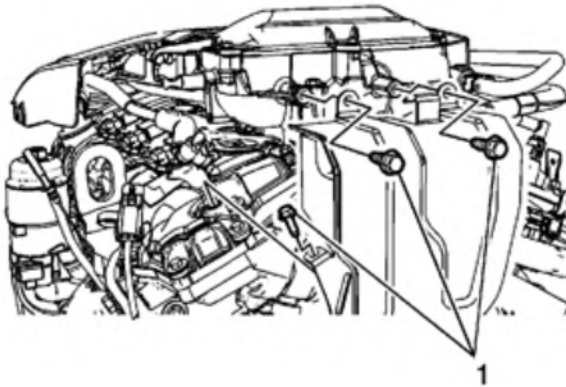
Note: If a fuel leak accrues at the high pressure fuel pump or the fuel rail, that component will need to be replaced.

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 (LLT)

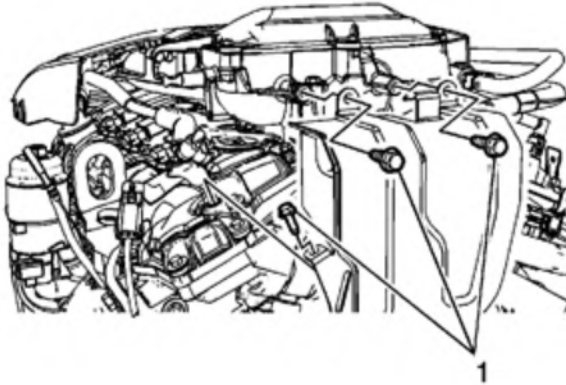
Removal Procedure

1. Remove the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).
2. Remove the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#)
3. Remove the intake manifold insulator.
4. Remove the wiper transmission. Refer to [Windshield Wiper Transmission Replacement](#).



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

Installation Procedure



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

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

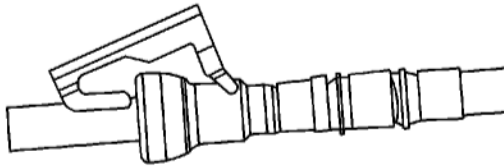
3. Install the fuel pipe shield to intake manifold bolts (1).
 - 3.1. Tighten the fuel pipe shield to manifold bolts to **23 N·m (17 lb ft)**.
 - 3.2. Tighten the fuel pipe shield to head bolt to **10 N·m (89 lb in)**.
4. Install the wiper transmission. Refer to [Windshield Wiper Transmission Replacement](#).
5. Install the fuel injection sight shield. Refer to [Fuel Injector Sight Shield Replacement](#)
6. Install the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).

Fuel Injector and Fuel Rail Replacement (LP1, LY7)

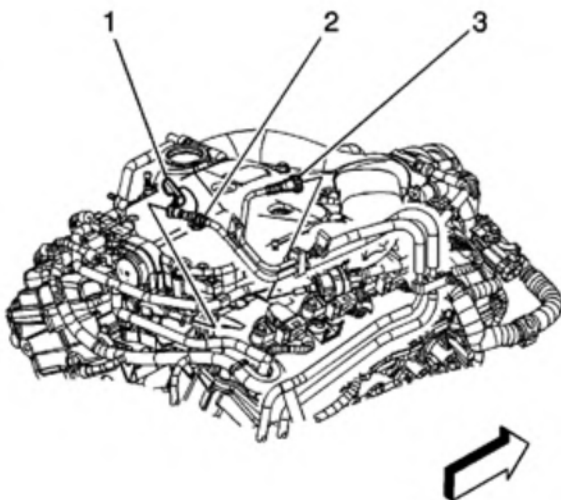
Removal Procedure

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

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Remove the upper intake manifold with the lower intake manifold. Refer to [Upper Intake Manifold Replacement](#).



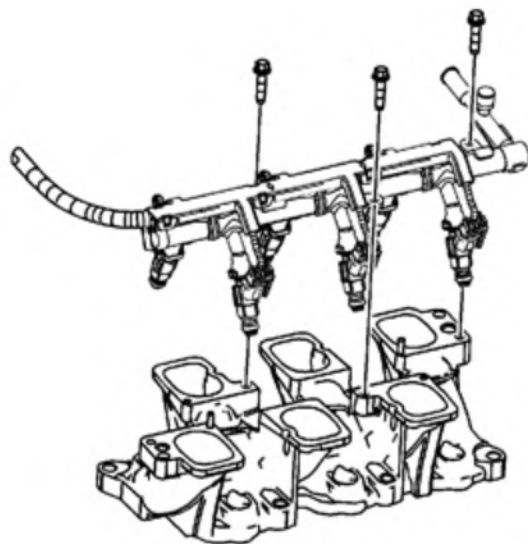
3. Remove the fuel pipe retaining clip.



4. Disconnect the fuel feed pipe (2) from the fuel injector rail. Refer to [Metal Collar Quick Connect Fitting Service](#).

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

5. Use compressed air in order to remove debris from the area where the fuel injectors enter the intake manifold.

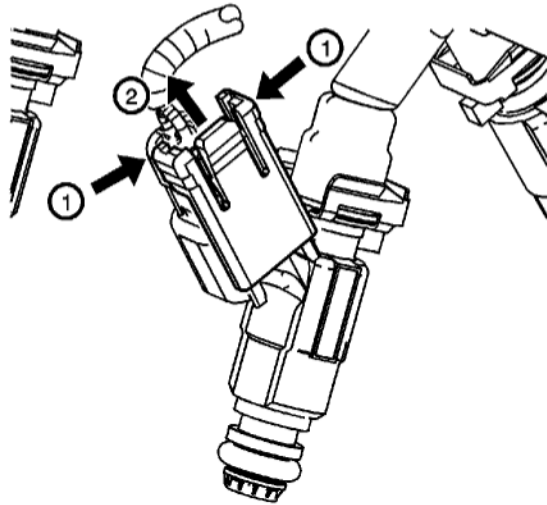


6. Remove the fuel rail bolts.

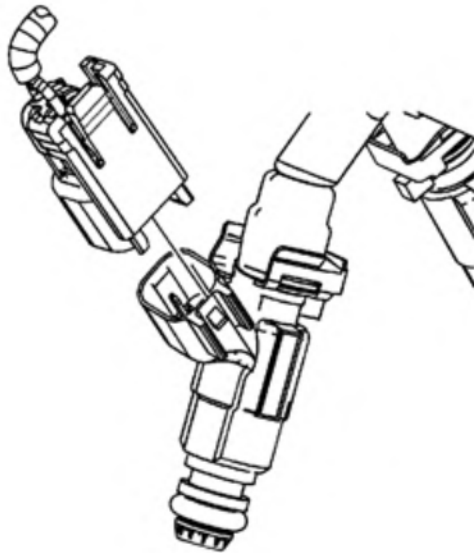
Caution:

- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
- Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.

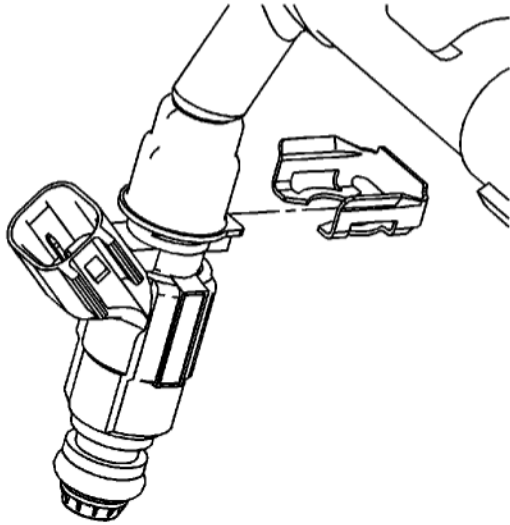
7. Remove the fuel rail with the fuel injectors.



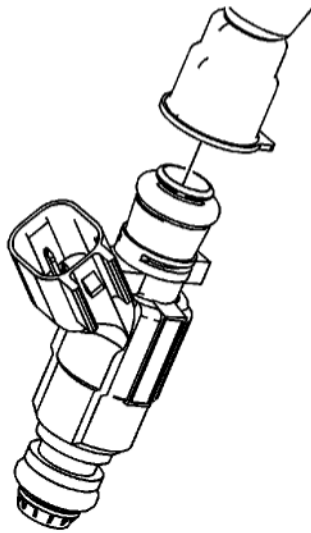
8. Disengage the fuel injector electrical connector lock.



9. Disconnect the fuel injector electrical connector.



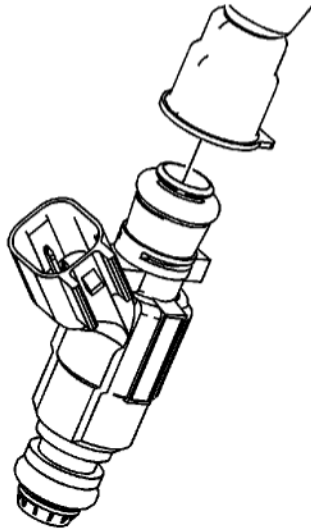
10. Remove the fuel injector retainer clip.



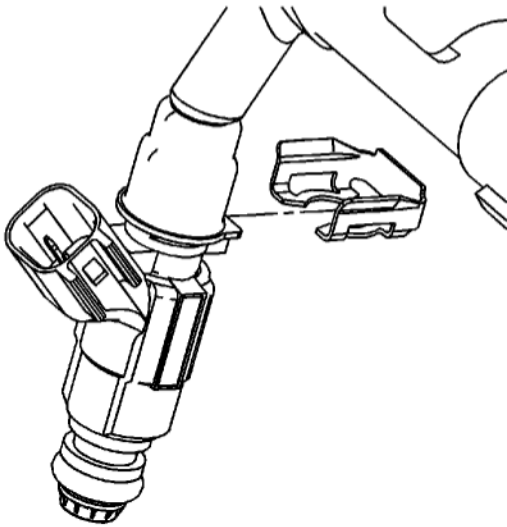
11. Remove the fuel injector.
12. Remove and discard the fuel injector seals.

Installation Procedure

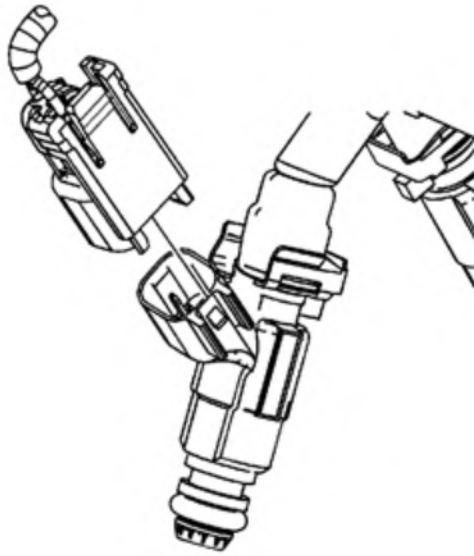
1. Install NEW fuel injector seals.



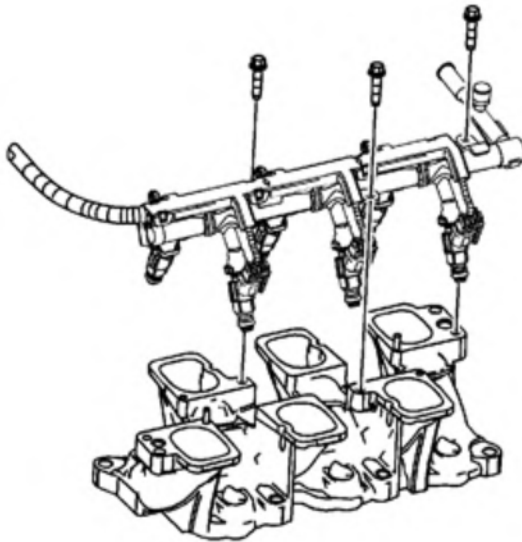
2. Install the fuel injector.



3. Install the fuel injector retainer clip.



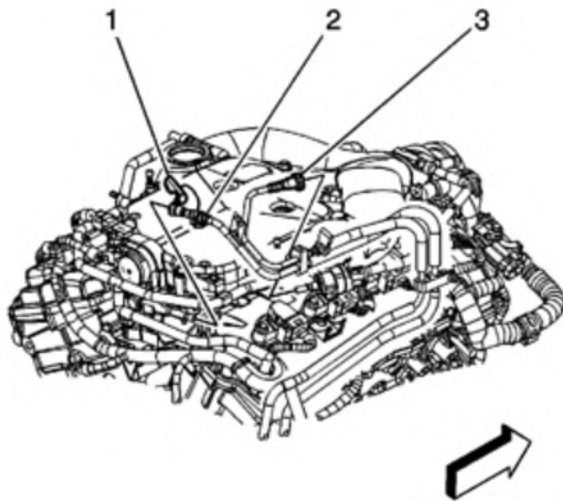
4. Install the fuel injector electrical connector.
5. Engage the fuel injector electrical connector lock.



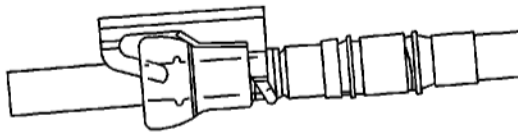
6. Install the fuel rail with the fuel injectors.

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

7. Install the fuel rail bolts and tighten to **10 N·m (89 lb in)**.



8. Connect the fuel feed pipe (2) to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).



9. Install the fuel pipe retaining clip.
10. Install the upper intake manifold. Refer to [Upper Intake Manifold Replacement](#).

Fuel Injector Replacement

Special Tools

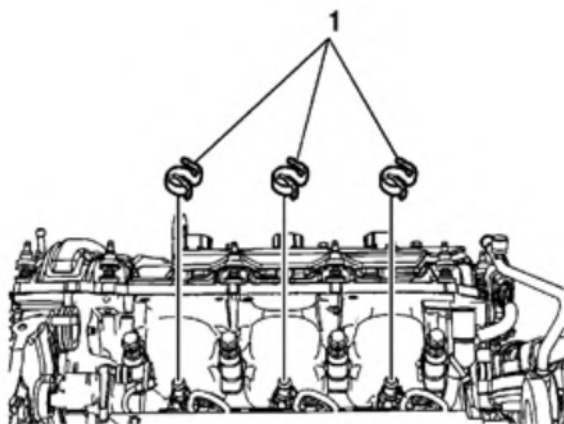
- [EN-47909](#) Injector Bore and Sleeve Cleaning Kit
- [EN-48266](#) Injector Seal Installer and Sizer
- [J 2619-01](#) Slide Hammer
- [J-37281-A](#) Injector Remover
- [J 39313](#) Spark Plug Port Adapter

Removal Procedure

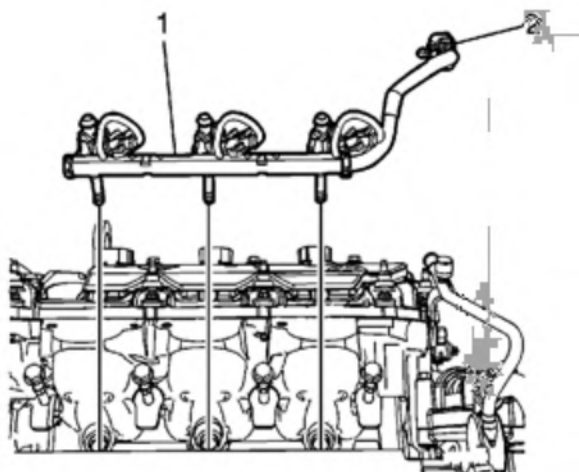
1. Relieve the high side fuel system pressure. Refer to [Fuel Pressure Relief](#).

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

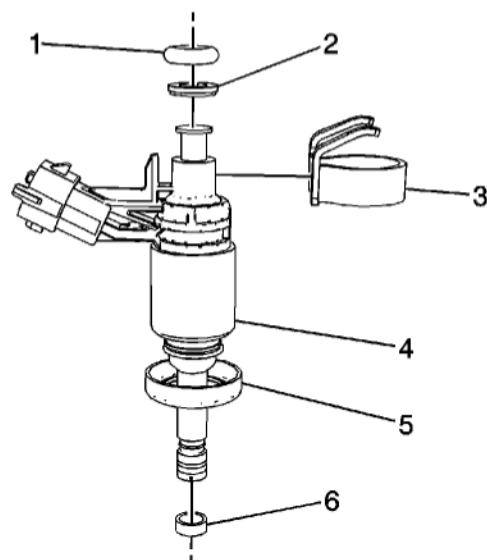
2. Remove the fuel injection fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1](#) or [Fuel Injection Fuel Rail Assembly Replacement - Bank 2](#).



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

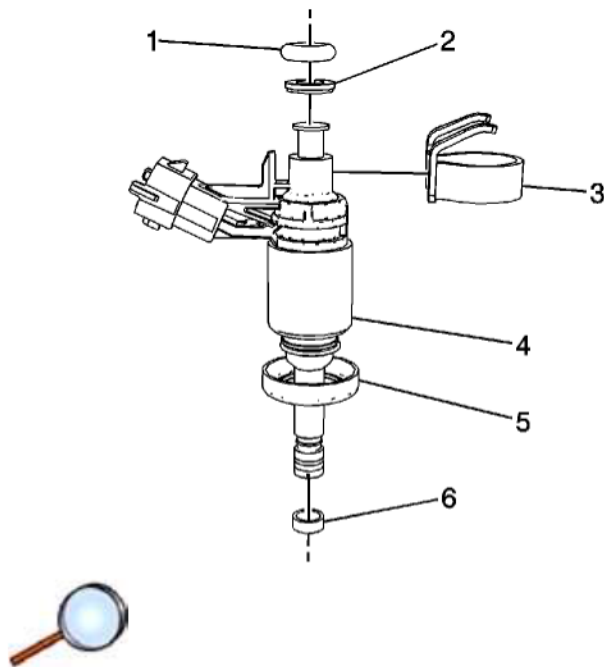


4. Remove the direct fuel injectors and harness (1) as an assembly, and disconnect the electrical connector (2). If necessary, use the [J 2619-01](#) with the [J-37281-A](#) in order to remove the direct fuel injectors evenly.



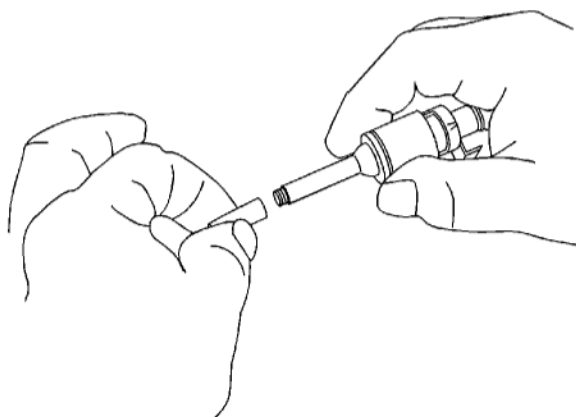
5. Remove and discard the following components from the fuel injectors (4).
- Upper O-ring Seal (1)
 - Plastic Spacer (2)
 - Retaining Ring (3)
 - Isolator Cup (5)
 - Teflon Seal (6)
6. Inspect the fuel rail injector bores and clean with [J 39313](#) , and [EN-47909](#) , if required.

Installation Procedure

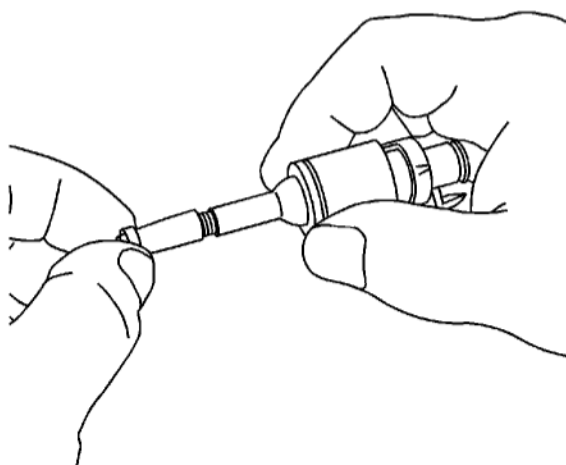


Note: Lubricate a NEW O-ring seal (1) with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.

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)

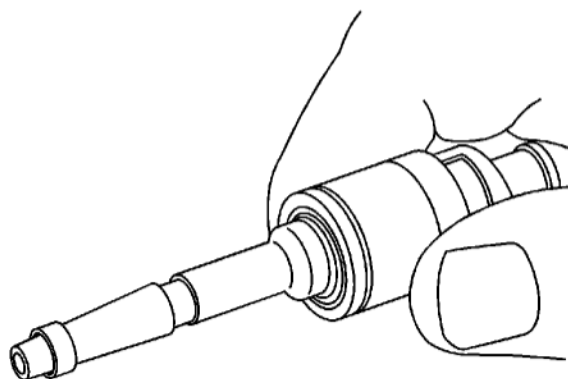


2. From the [EN-48266](#) , position the EN 48266-1 to the injector tip.

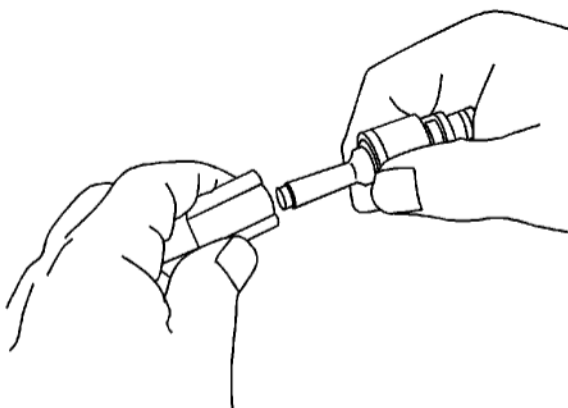


Note: DO NOT lubricate the NEW teflon seal.

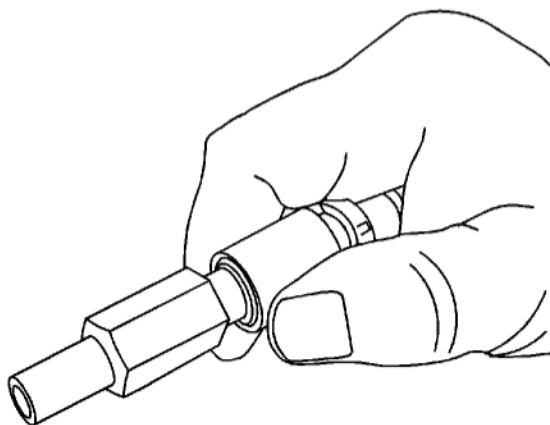
3. Install a NEW teflon seal onto the EN 48266-1.



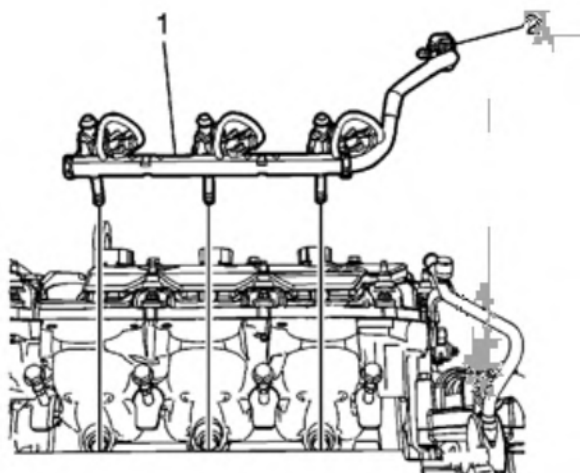
4. Pull the NEW teflon seal by hand over the EN 48266-1 and into the groove in the injector.
5. Remove the EN 48266-1 from the injector tip.



6. From the [EN-48266](#) , 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.



Caution: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

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](#).

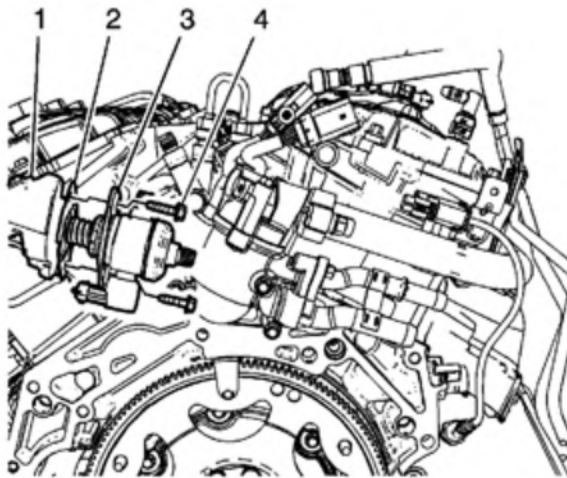
Fuel Pump Replacement (LLT)

Special Tools

[EN-48896](#) HP 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 cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).
3. Remove the high pressure fuel pump shield. Refer to [Fuel Pipe Shield Replacement](#).
4. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).
5. Remove the wiper module. Refer to [Windshield Wiper Motor Replacement](#).

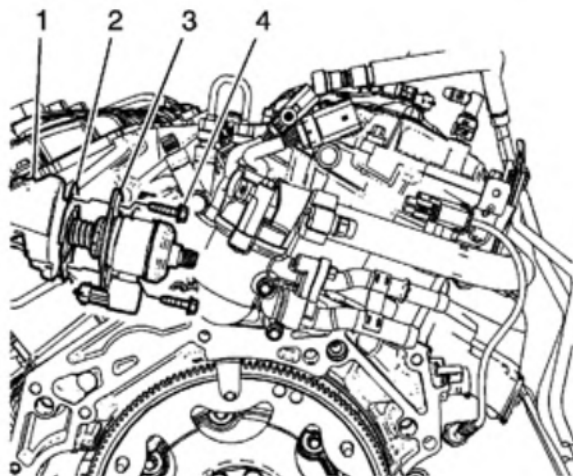


6. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
7. Remove the radiator surge tank outlet pipe. Refer to [Radiator Surge Tank Outlet Hose/Pipe Replacement](#).
8. Remove the low pressure feed pipe. Refer to [Fuel Feed Pipe Replacement](#).
9. Remove the high pressure pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#). Discard this pipe.
10. Remove and discard the high pressure fuel pump bolts (4).
11. Remove the high pressure fuel pump (3).
12. Remove and discard the high pressure fuel pump gasket (2).
13. Remove and discard the high pressure fuel pump O-ring.
14. 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](#) 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 prelube 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 radiator surge tank outlet pipe. Refer to [Radiator Surge Tank Outlet Hose/Pipe Replacement](#).
13. Install the fuel tank cap.

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

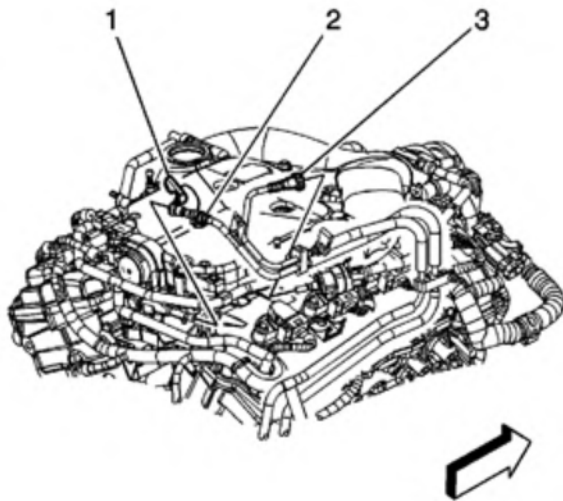
14. Inspect for leaks using the following procedure:
 - 14.1. Turn ON the ignition, with the engine OFF for 2 seconds.
 - 14.2. Turn OFF the ignition, for 10 seconds.
 - 14.3. Turn ON the ignition, with the engine OFF.

14.4. Inspect for fuel leaks.

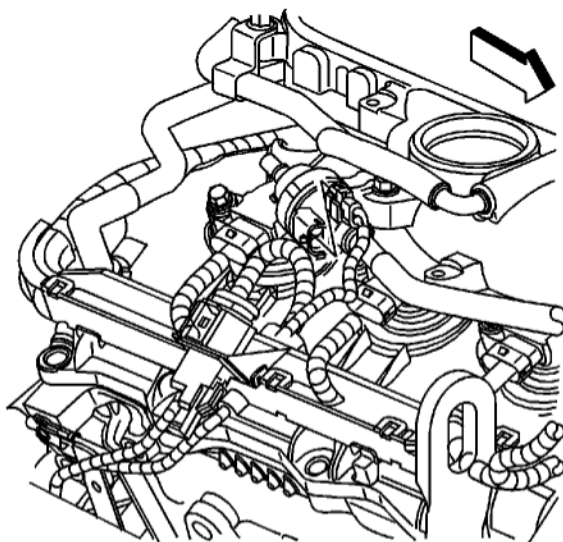
15. Install the pressure relief cap to the fuel feed pipe.
16. Install the wiper module. Refer to [Windshield Wiper Motor Replacement](#).
17. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
18. Install the high pressure fuel pump shield. Refer to [Fuel Pipe Shield Replacement](#).
19. Install the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#).

Evaporative Emission Canister Purge Solenoid Valve Replacement

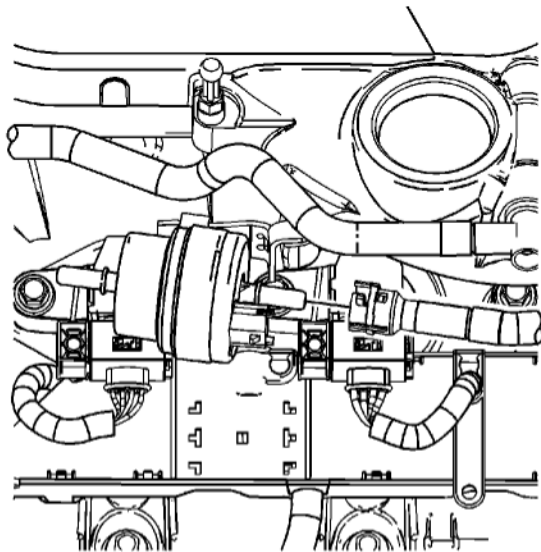
Removal Procedure



1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#) .
3. Disconnect the purge line (3) from the purge valve solenoid.

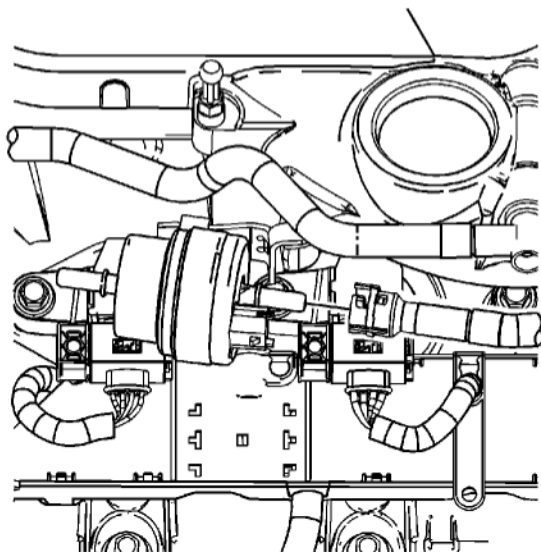


4. Disconnect the purge valve solenoid electrical connector.

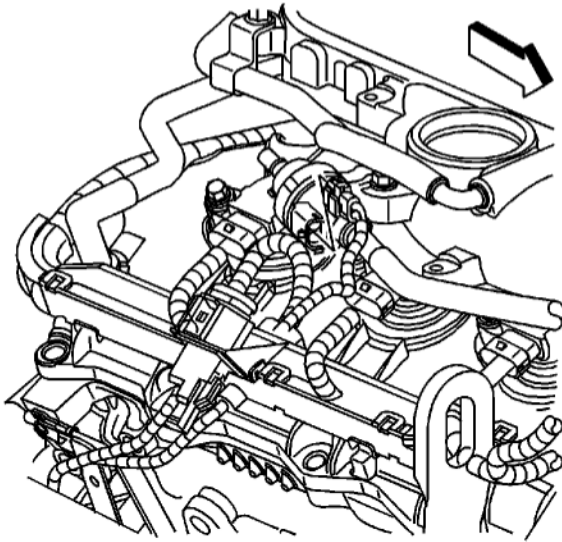


5. Disconnect the purge line from the manifold side of the purge valve solenoid.
6. Remove the purge valve solenoid from the bracket.

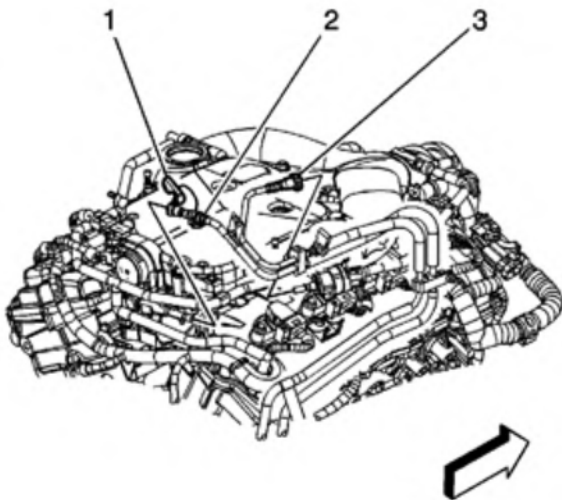
Installation Procedure



1. Install the purge valve solenoid to the bracket.
2. Disconnect the purge line from the manifold side of the purge valve solenoid.



3. Disconnect the purge valve solenoid electrical connector.

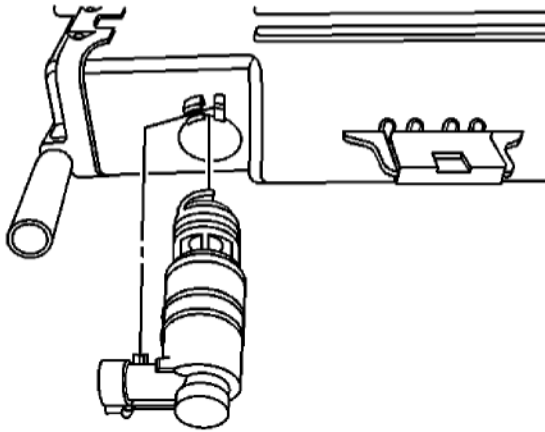


4. Connect the purge line (3) to the purge valve solenoid.
5. Install the fuel injector sight shield. Refer to [Fuel Injector Sight Shield Replacement](#).

Evaporative Emission Canister Vent Solenoid Valve Replacement

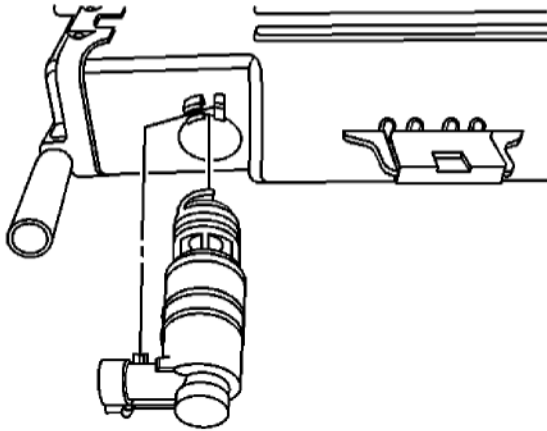
Removal Procedure

1. Remove the evaporative emission (EVAP) canister. Refer to [Evaporative Emission Canister Replacement](#).
2. Clean away any debris that may be present around the EVAP canister vent valve.



3. Twist the EVAP canister vent valve counterclockwise.
4. Pull the EVAP canister vent valve from the EVAP canister.

Installation Procedure



1. Insert the EVAP canister vent valve into the EVAP canister.
2. Twist the EVAP canister vent valve clockwise into the locked position.
3. Install the EVAP canister. Refer to [Evaporative Emission Canister Replacement](#) .

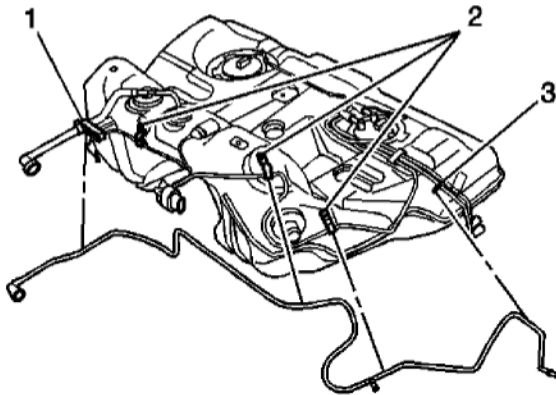
Evaporative Emission Hoses / Pipes Replacement - Chassis / Canister

Removal Procedure

Caution:

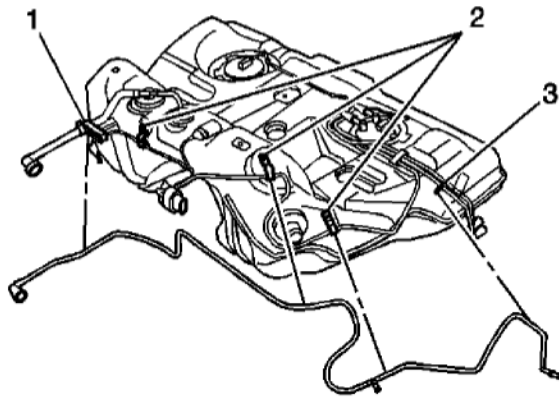
- Do not attempt to straighten kinked nylon pipes. Replace any kinked nylon pipes in order to prevent damage to the vehicle.
- Do not attempt to repair sections of nylon pipes. Replace damaged nylon pipes.
- Replace the vapor hoses/pipes with original equipment or parts that meet GM specifications.

1. Remove the fuel tank. Refer to [Fuel Tank Replacement](#).



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

Installation Procedure

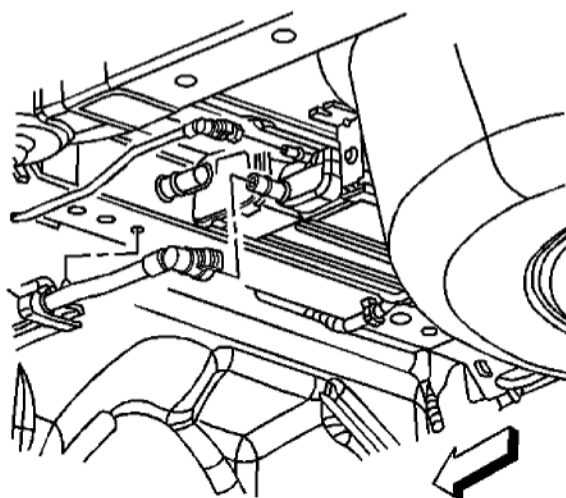


1. Position the EVAP hose to the fuel tank.
2. Install the chassis to canister EVAP hose to the following:
 - The body retainer (1)
 - The 3 retaining features (2) on the fuel tank
 - The retainer clip (3)
3. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

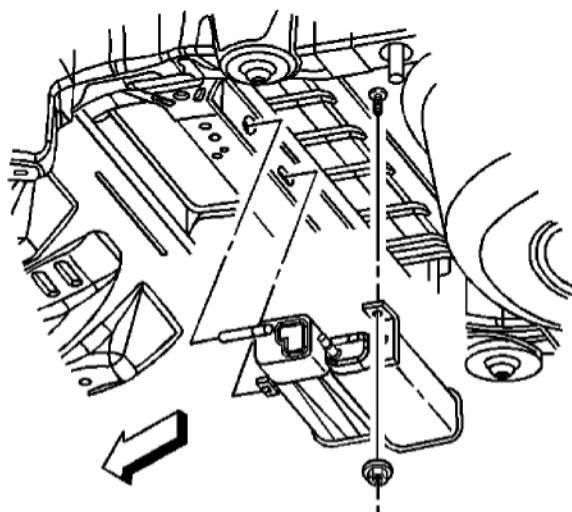
Evaporative Emission Canister Replacement

Removal Procedure

1. Remove the rear frame. Refer to [Rear Frame Replacement](#).



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

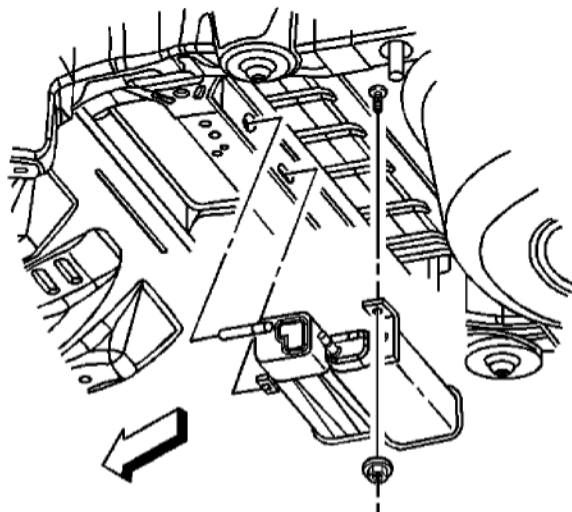


4. Remove the EVAP canister retaining nuts.
5. Complete the following in order to remove the EVAP canister:
 - 5.1. Lower the rear

ds.

5.2. Slide the canister rearward from the body brace.

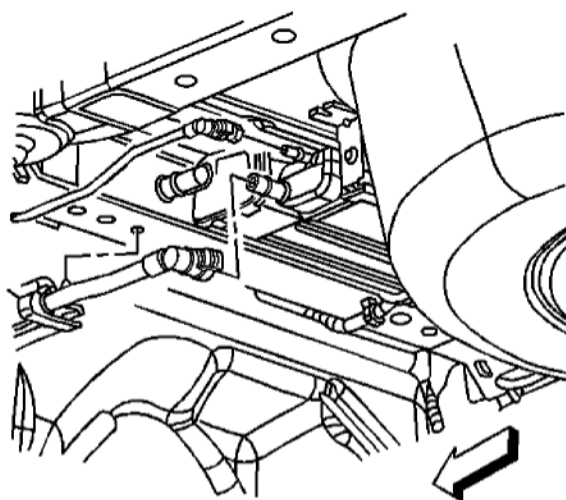
Installation Procedure



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

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

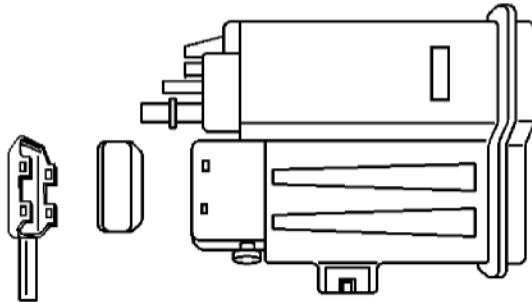
2. Install the EVAP canister retaining nuts and tighten to **6 N·m (53 lb in)**.



3. Connect the EVAP hoses to the EVAP canister.
4. Connect the electrical connector to the EVAP canister.
5. Install the rear frame. Refer to [Rear Frame Replacement](#).

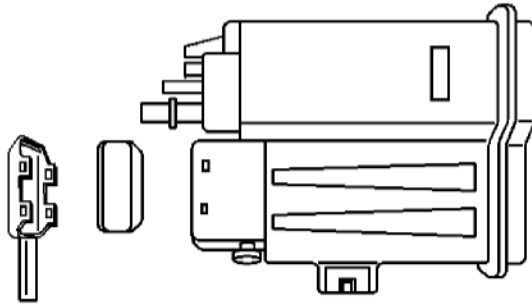
Evaporative Emission Canister Filter Replacement

Removal Procedure



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

Installation Procedure



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

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

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

Ignition Coil Replacement - Bank 1 (LP1, LY7)

Removal Procedure

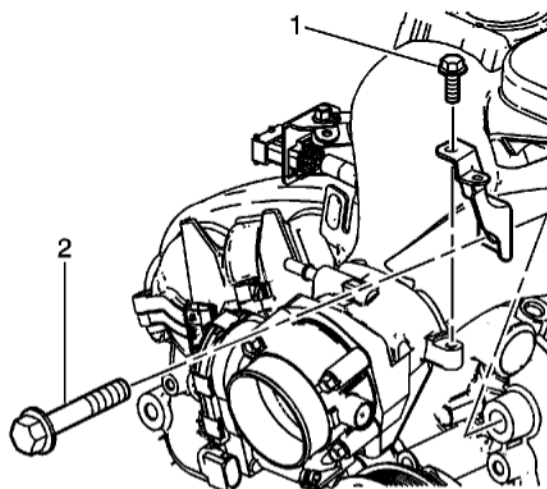
1. Turn the ignition OFF.
2. Remove the engine cover. Refer to [Fuel Injector Sight Shield Replacement](#).

Note: Do NOT disconnect the fuel pipes and/or hoses.

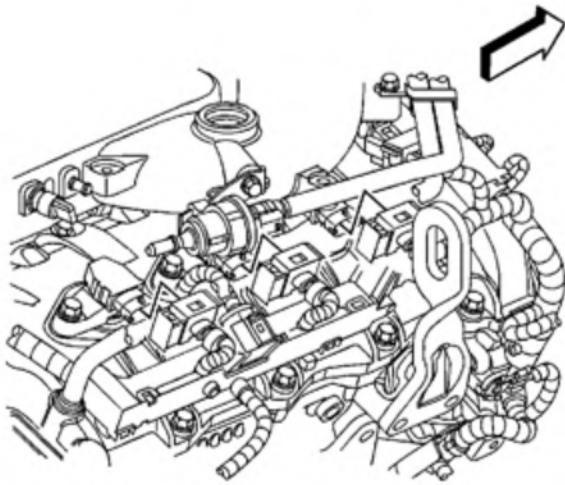
3. If you are replacing the ignition coil for cylinder 1 or 3, remove and reposition the intake manifold. Perform the following steps:
 - 3.1. Disconnect the air cleaner duct from the throttle body.
 - 3.2. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

Note: Do NOT separate the upper intake manifold from the lower intake manifold.

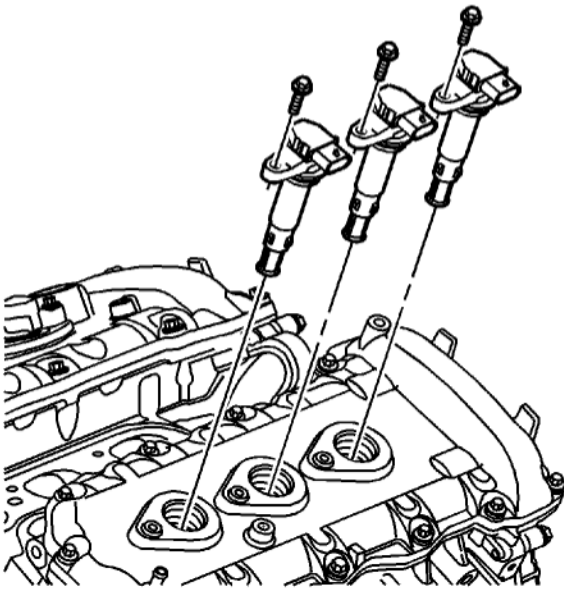
- 3.3. Remove the intake manifold bolts.



- 3.4. Remove the intake manifold brace bolts (1 and 2) and the brace.
 - 3.5. Remove and reposition the upper intake manifold with the lower intake manifold in order to gain sufficient clearance for ignition coil removal.

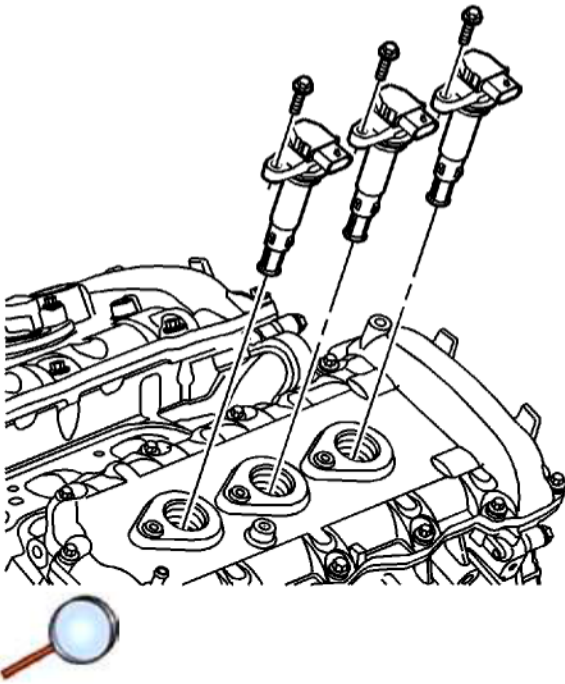


4. Remove the ignition coil electrical connector(s).



5. Remove the ignition coil bolt(s).
6. Remove the ignition coil(s).

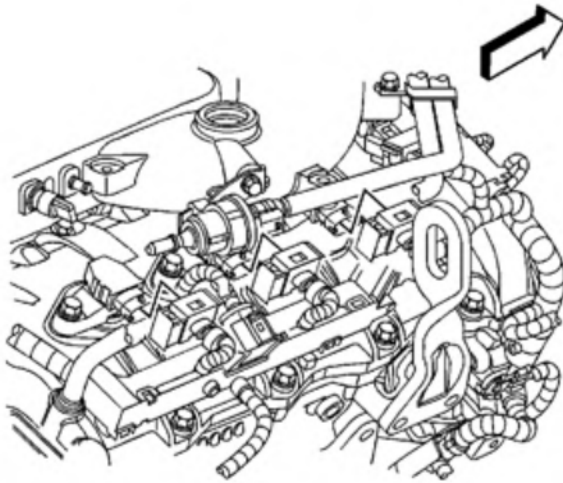
Installation Procedure



1. Install the ignition coil(s).

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

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



3. Install the ignition coil electrical connector(s).
4. If necessary, install the intake manifold. Refer to [Lower Intake Manifold Replacement](#).
5. Install the engine cover. Refer to [Fuel Injector Sight Shield Replacement](#).

Ignition Coil Replacement - Bank 2 (LP1, LY7)

Removal Procedure

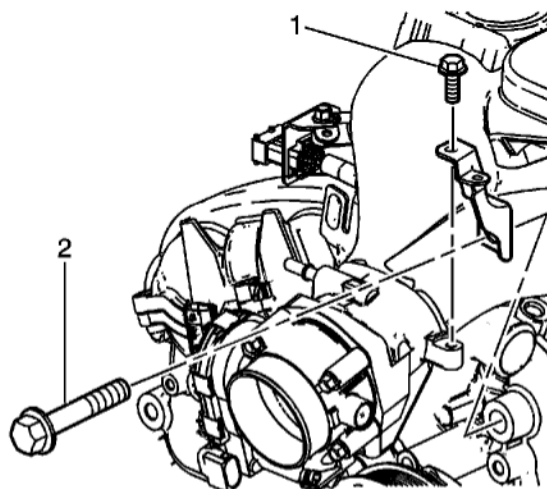
1. Turn the ignition OFF.
2. Remove the engine cover. Refer to [Fuel Injector Sight Shield Replacement](#).

Note: Do NOT disconnect the fuel pipes and/or hoses.

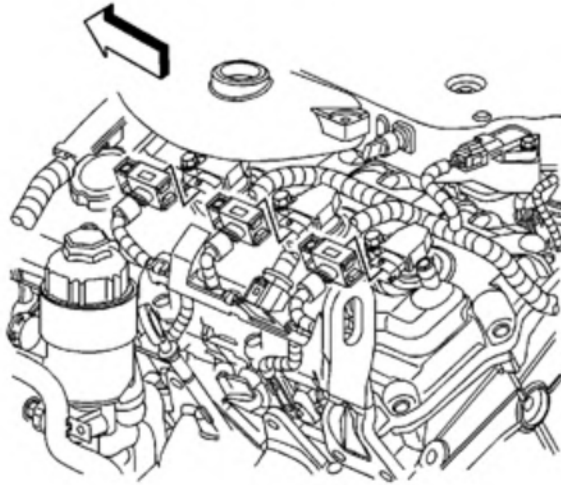
3. If you are replacing the ignition coil for cylinder 2, remove and reposition the intake manifold. Perform the following steps:
 - 3.1. Disconnect the air cleaner duct from the throttle body.
 - 3.2. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

Note: Do NOT separate the upper intake manifold from the lower intake manifold.

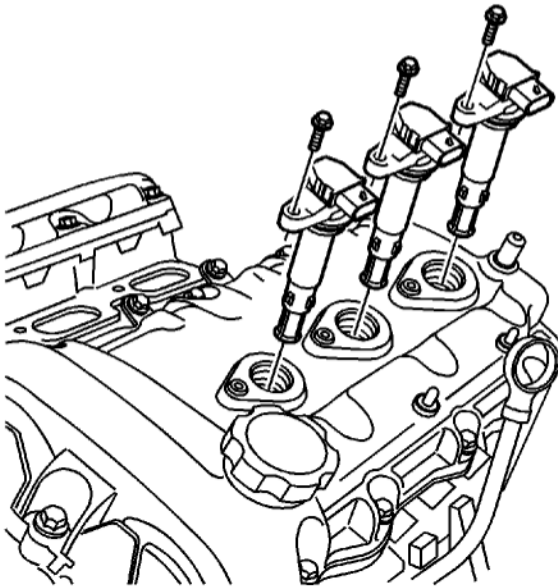
- 3.3. Remove the intake manifold bolts.



- 3.4. Remove the intake manifold brace bolts (1 and 2) and the brace.
 - 3.5. Remove and reposition the upper intake manifold with the lower intake manifold in order to gain sufficient clearance for ignition coil removal.

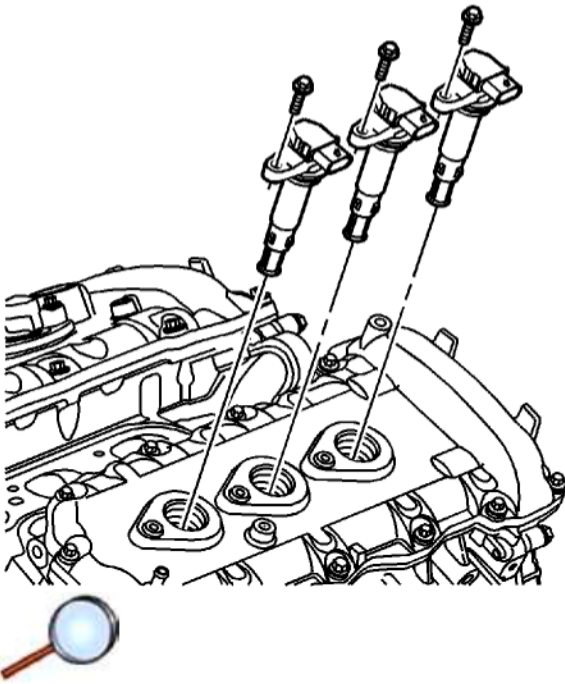


4. Remove the ignition coil electrical connector(s).



5. Remove the ignition coil bolt(s).
6. Remove the ignition coil(s).

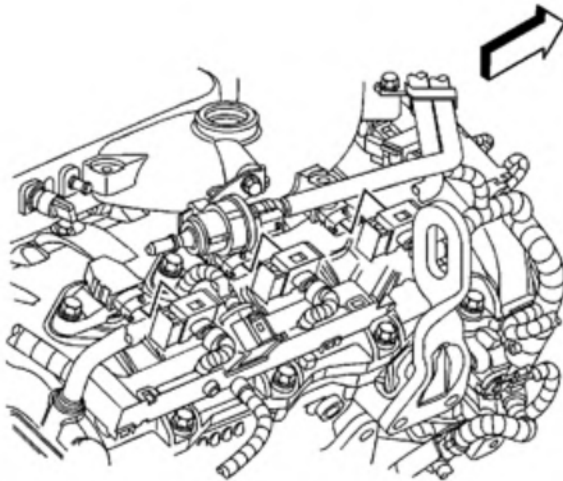
Installation Procedure



1. Install the ignition coil(s).

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

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



3. Install the ignition coil electrical connector(s).
4. If necessary, install the upper intake manifold. Refer to [Upper Intake Manifold Replacement](#).

Spark Plug Inspection

Spark Plug Operation

Worn or dirty spark plugs may operate well at idle speeds, but frequently fail at higher load. Bad spark plugs are often responsible for the following conditions:

- Power loss
- Poor fuel economy
- Loss of speed
- Hard starting
- Poor engine performance

Normal spark plug operation results in brown to grayish tan deposits on the area of the spark plug that enters the cylinder. A small amount of reddish brown, yellow, and white powdery residue may also be present on the insulator tip around the center electrode. These deposits are normal combustion by-products of fuels and lubricating oils which contain additives.

Misfiring is a general term that applies to a poor running engine. With misfiring, the ignition spark is not igniting the air/fuel mixture at the proper time. While other possible causes must be investigated, the spark plugs should be inspected first. Spark voltage should not reach ground before jumping across the gap at the tip of the spark plug. This leaves the air/fuel mixture unburned, causing misfiring. Pre-ignition misfiring occurs when the spark plug tip overheats, igniting the mixture before the spark jumps.

Carbon fouling of the spark plug is indicated by dry carbon deposits on the portion of the spark plug inside of the cylinder. Excess idling and driving at slower speeds under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Rich fuels or poor ignition system output may also cause carbon fouling.

Oil fouling of the spark plug appears as wet oily deposits on the portion of the spark plug inside of the cylinder. This may be caused by the following conditions:

- Oil getting past worn piston rings
- Breaking in a new or recently overhauled engine

Deposit fouling of the spark plug occurs when the normal reddish brown, yellow, or white deposits of combustion by-products become sufficient enough to cause misfiring. In some cases, these deposits melt and form a shiny glaze on the insulator around the center electrode. If the fouling is found only in one or two of the cylinders, valve stem clearances or the intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the intake valve side of the spark plug.

Excess gap means that the air space between the center and side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to improper gap adjustment or to excess wear of the electrodes during use. A gap that is too small may cause idling instability. Excess gap wear might indicate vehicle operation at continual high speeds or with high engine loads. This causes the spark plugs to run too hot. Excessively lean fuel may also cause the wear.

Improper torque or seating can cause a spark plug to run hot, eventually leading to excess gap wear. In extreme cases, an overtightened or under-tightened spark plug can cause exhaust blow-by. The cylinder head seats must make good contact for sufficient heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep the spark plug from seating even though the proper torque is applied. Once the spark plugs are properly seated, tighten the spark plugs properly.

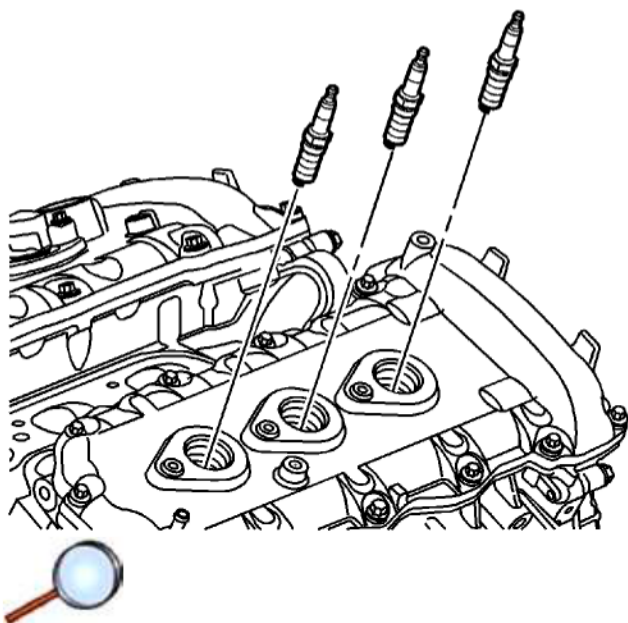
Cracked or broken insulators and insulator tips may be the result of improper installation or heat shock. Heat shock is a rapid increase in the insulator tip temperature which causes the insulator material to crack. The upper insulators can be broken when a poorly-fitting tool is used during servicing, or when the spark plug is hit from the outside. Cracks in the upper insulator may be inside the shell or invisible. The breakage may not cause problems until oil or water penetrates the crack later. Heat shock breakage in the lower insulator tip generally occurs during severe engine operating conditions such as higher RPM or heavy loading. Over advanced timing or low grade fuels may also cause heat shock breakage. Always replace spark plugs with broken or cracked insulators.

Damage during gapping can occur when the tool is pushed against the center electrode or the surrounding insulator, causing the insulator to crack. When gapping a spark plug, bend only the outside electrode. Keep tools free of any other parts.

Spark plugs with less than the recommended amount of service can sometimes be cleaned and re-gapped, then returned to service. If there is any doubt about the serviceability of a spark plug, replace the spark plug.

Spark Plug Replacement

Removal Procedure



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

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

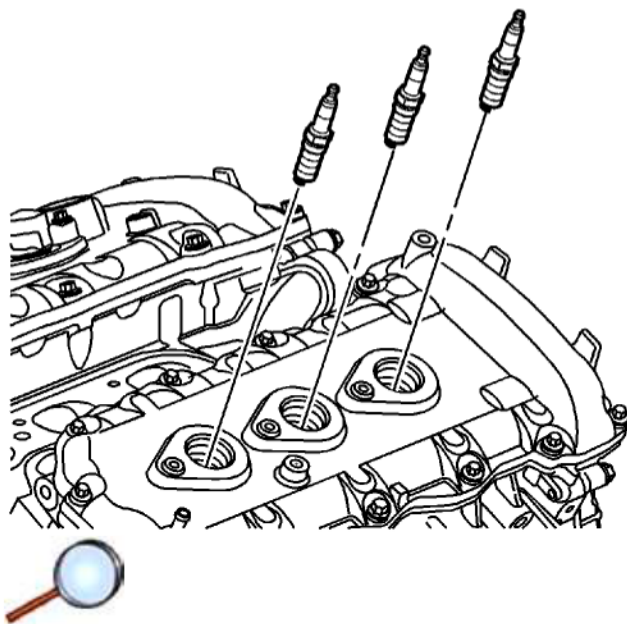
Caution: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the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

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

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

4. Remove the spark plug.

Installation Procedure



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](#).

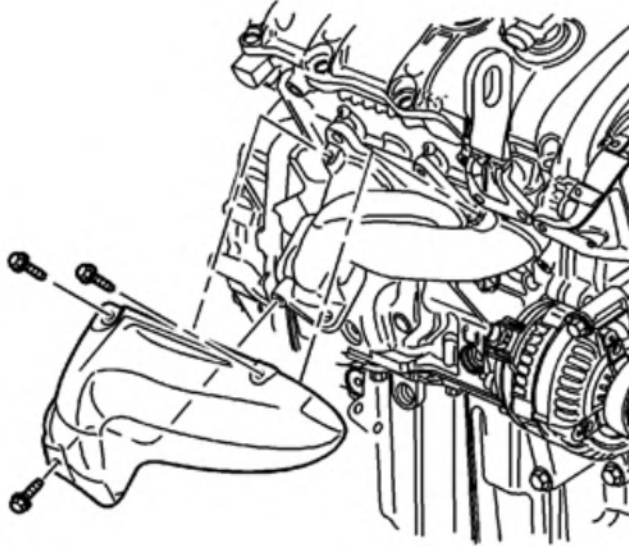
Caution: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread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

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

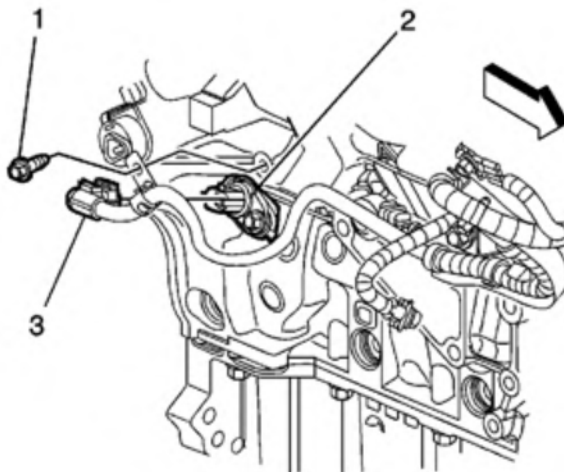
Crankshaft Position Sensor Replacement

Removal Procedure

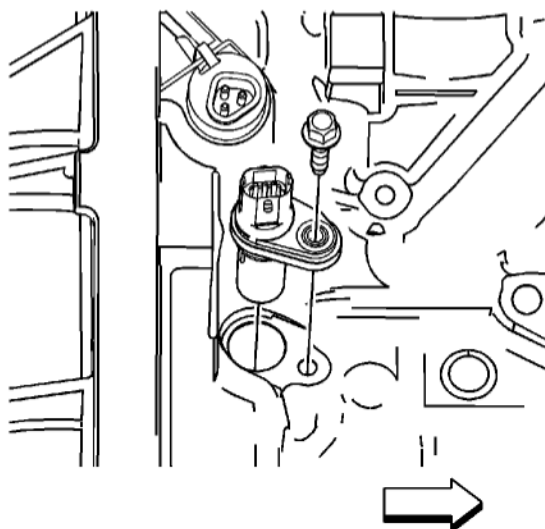
1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



3. Remove the exhaust manifold heat shield to obtain access.

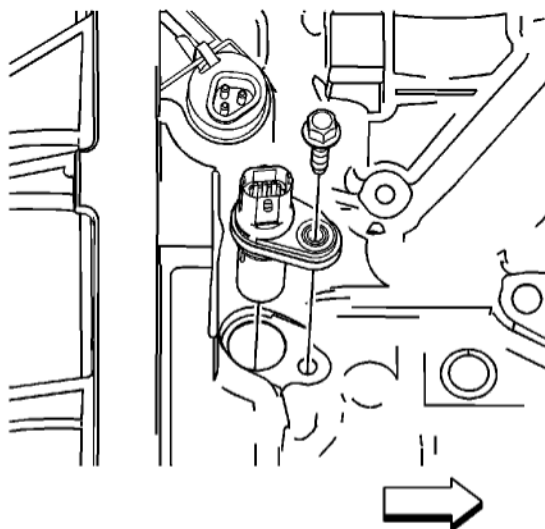


4. Disconnect the crankshaft position (CKP) electrical connector (3).



5. Remove the crankshaft sensor bolt.
6. Remove the crankshaft sensor.

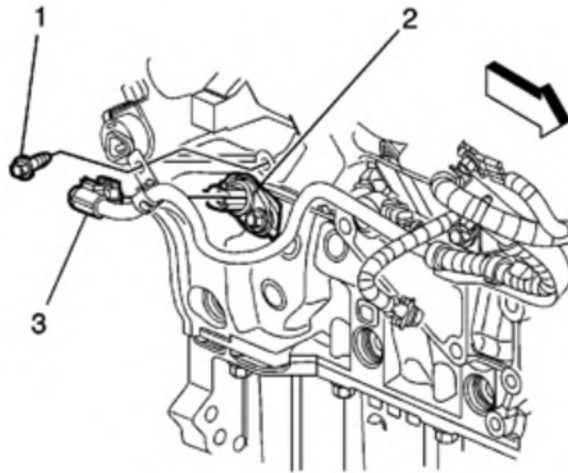
Installation Procedure



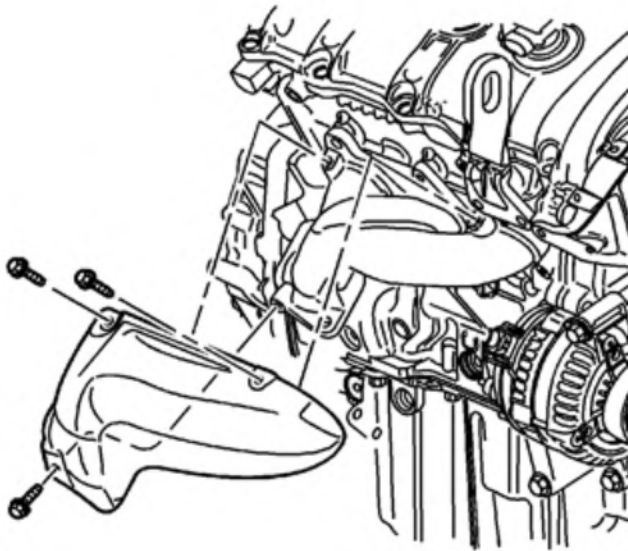
1. Install the crankshaft position sensor.

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 CKP electrical connector (3).



4. Install the exhaust manifold heat shield and tighten to **10 N·m (89 lb in)**.
5. Lower the vehicle.

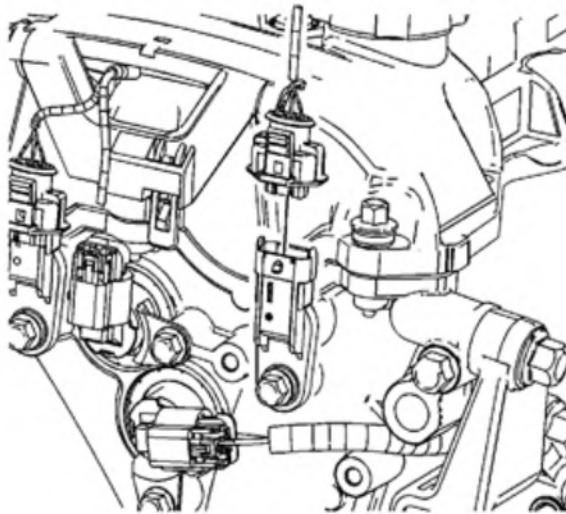
Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust (LP1, LY7)

Removal Procedure

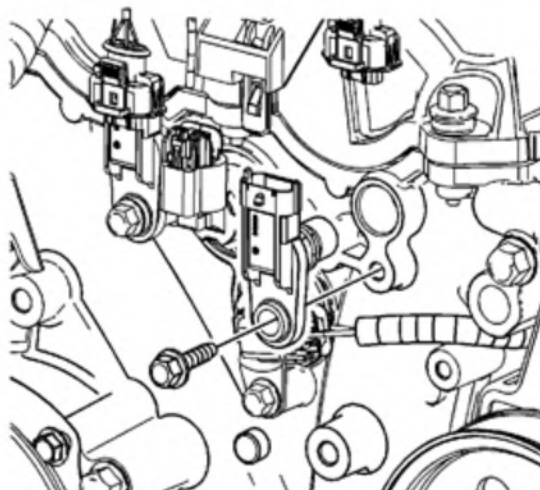
1. Turn the ignition OFF.

Note: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).

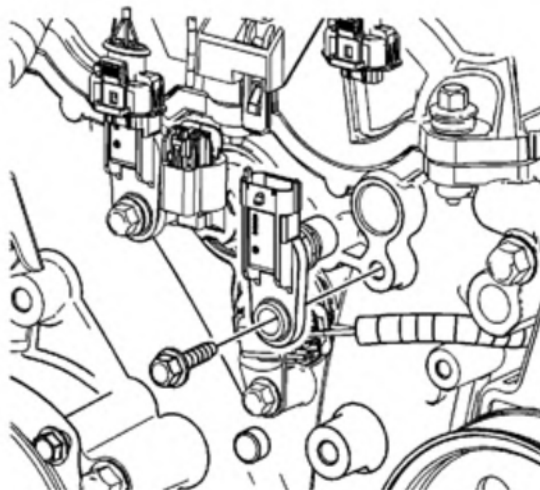


3. Remove the camshaft position (CMP) sensor electrical connector.



4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

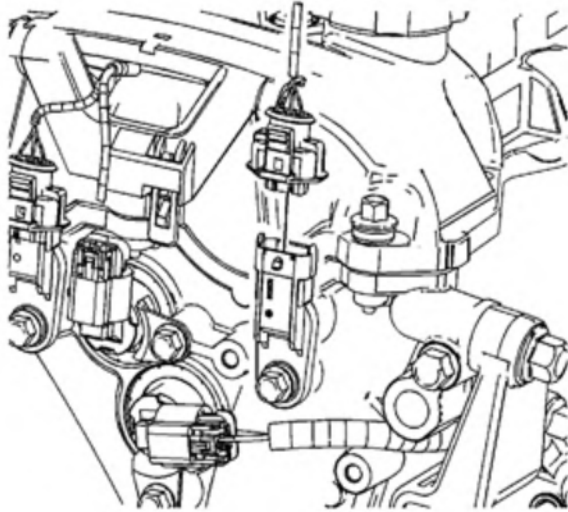
Installation Procedure



1. Install the CMP sensor.

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

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



3. Install the CMP sensor electrical connector.
4. Install the power steering fluid reservoir. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).

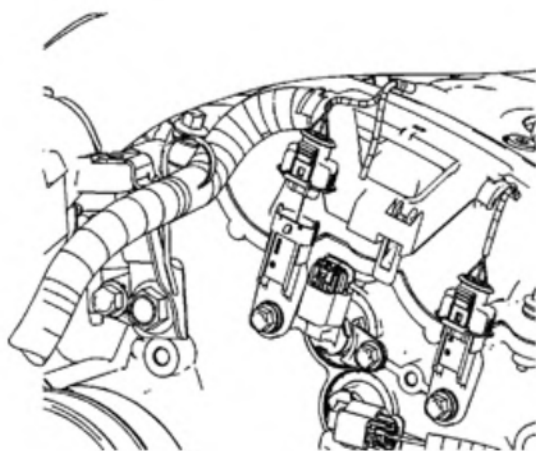
Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake (LP1, LY7)

Removal Procedure

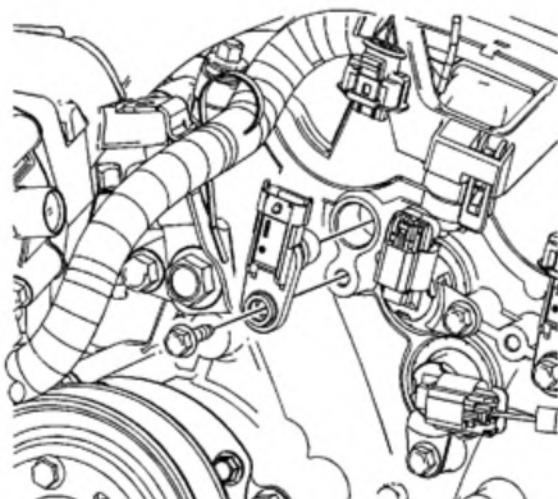
1. Turn the ignition OFF.

Note: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).

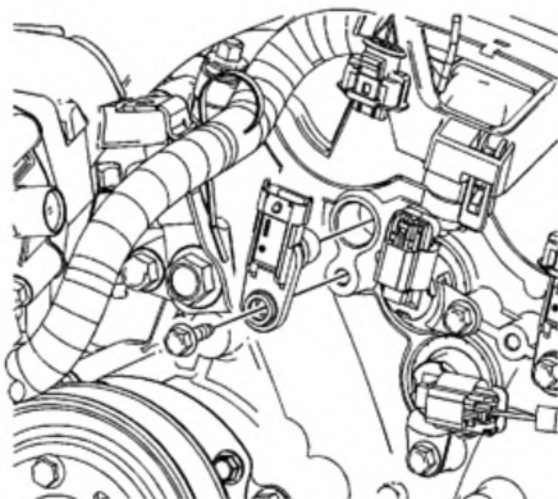


3. Remove the camshaft position (CMP) sensor electrical connector.



4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

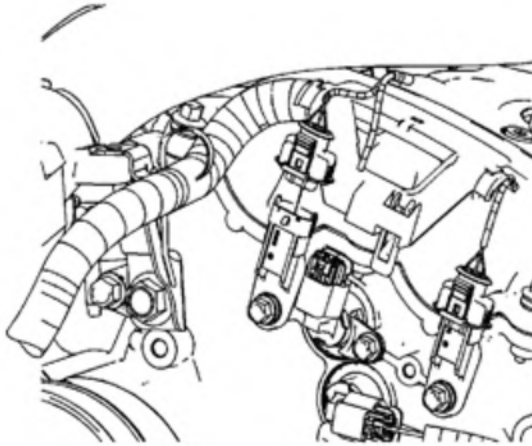
Installation Procedure



1. Install the CMP sensor.

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

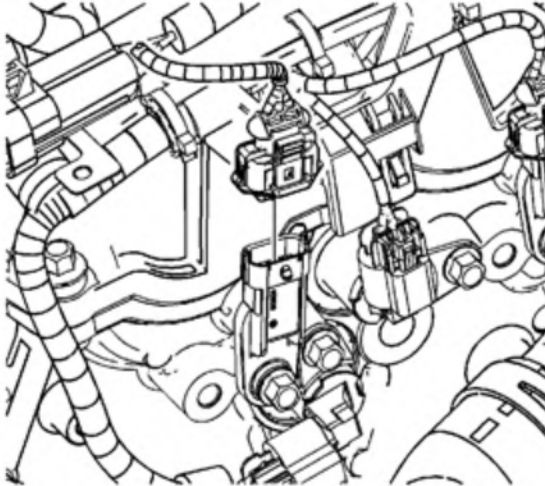
2. Install the CMP sensor bolt and tighten to **10 N·m (89 lb in)**.



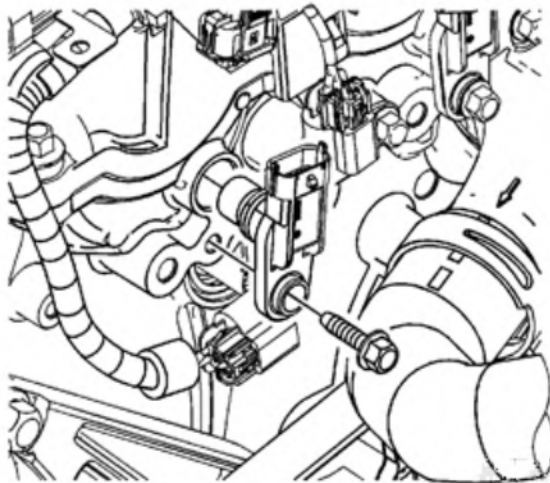
3. Install the CMP sensor electrical connector.
4. Install the power steering fluid reservoir. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).

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

Removal Procedure



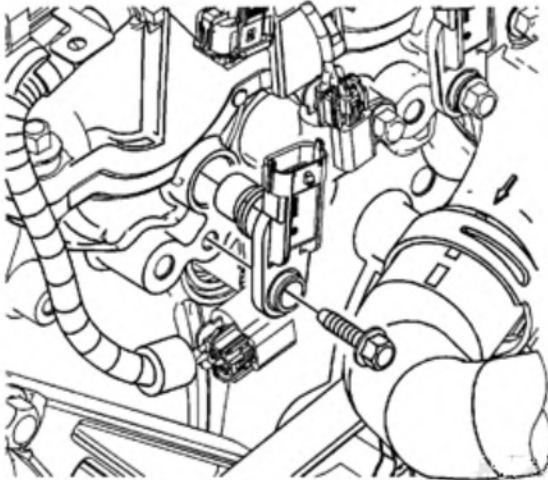
1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).
3. Disconnect the camshaft position (CMP) sensor electrical connector.





4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

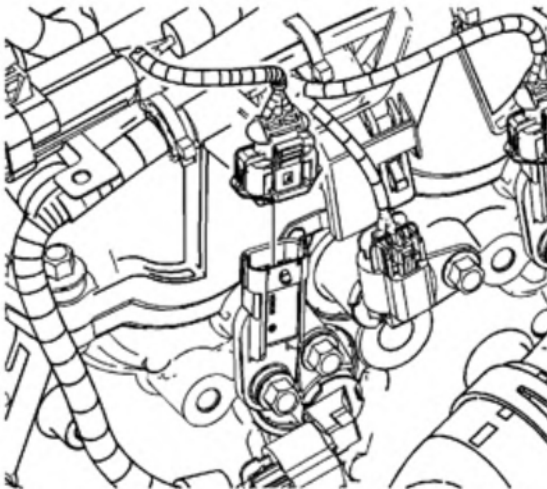
Installation Procedure



1. Install the CMP sensor.

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

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

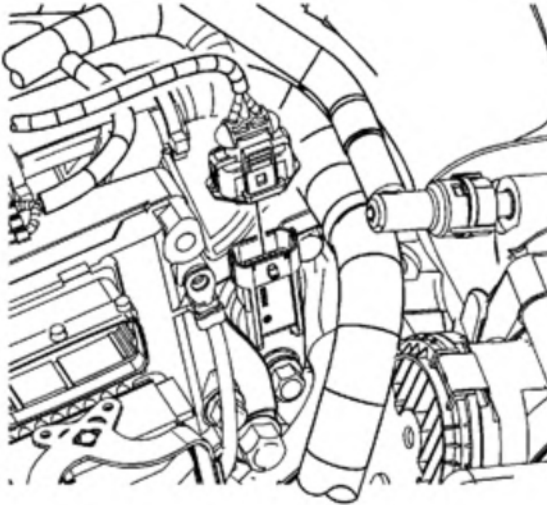




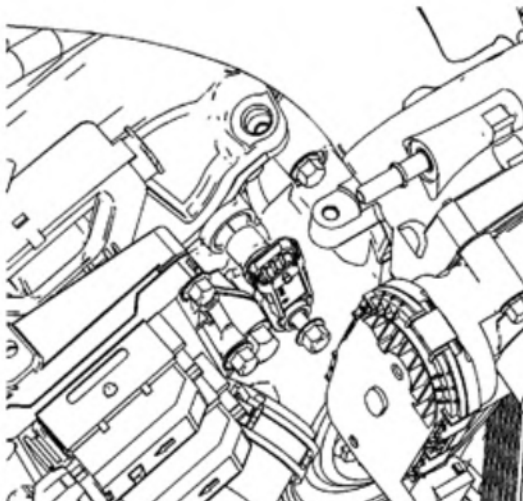
3. Connect the CMP sensor electrical connector.
4. Install the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).

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

Removal Procedure



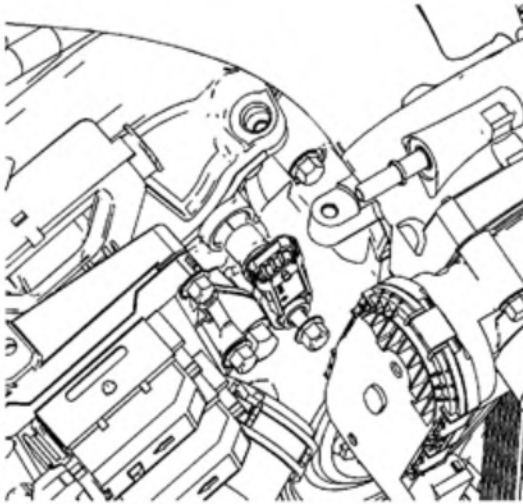
1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).
3. Disconnect the camshaft position (CMP) sensor electrical connector.





4. Remove the CMP sensor bolt.
5. Remove the CMP sensor.

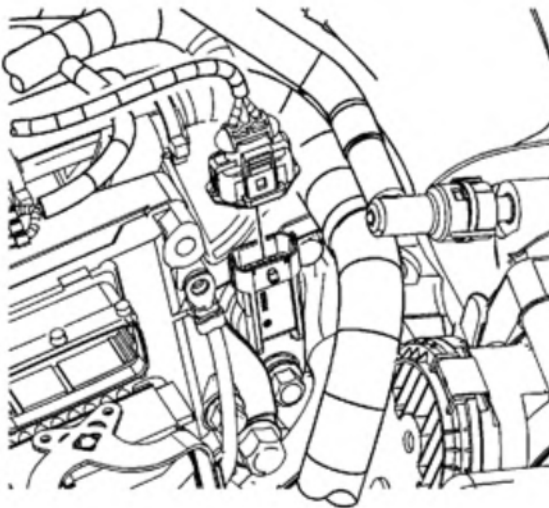
Installation Procedure



1. Install the CMP sensor.

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

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

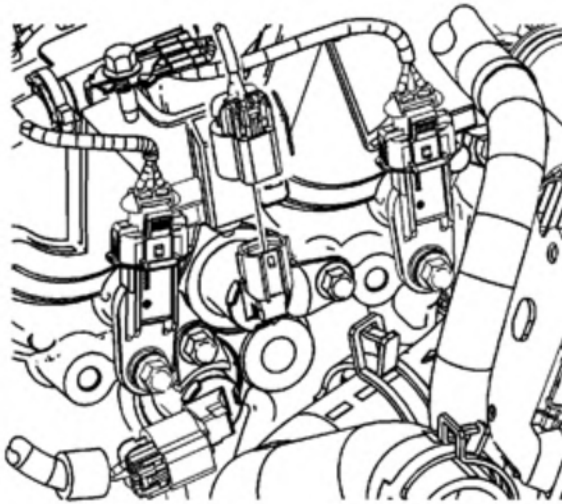




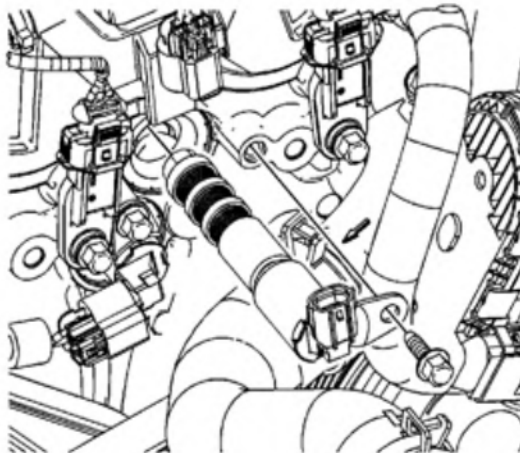
3. Connect the CMP sensor electrical connector.
4. Install the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).

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

Removal Procedure



1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).
3. Disconnect the camshaft position (CMP) actuator valve electrical connector.

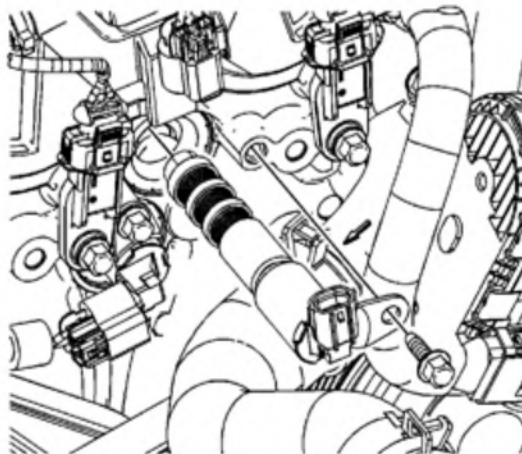




4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

Installation Procedure

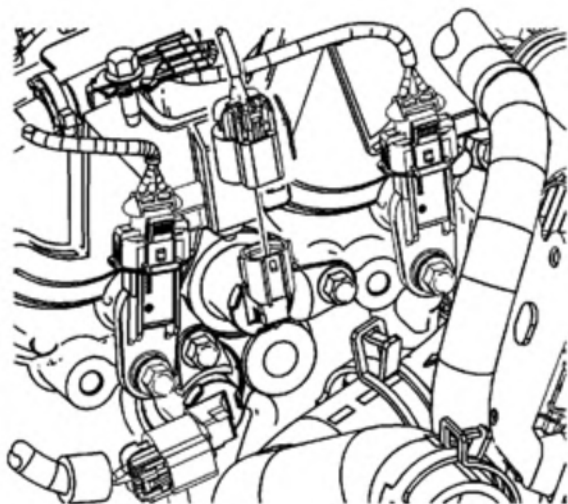
1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.



2. Install the CMP actuator valve.

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

3. Install the CMP actuator valve bolt and tighten to **10 N·m (89 lb in)**.

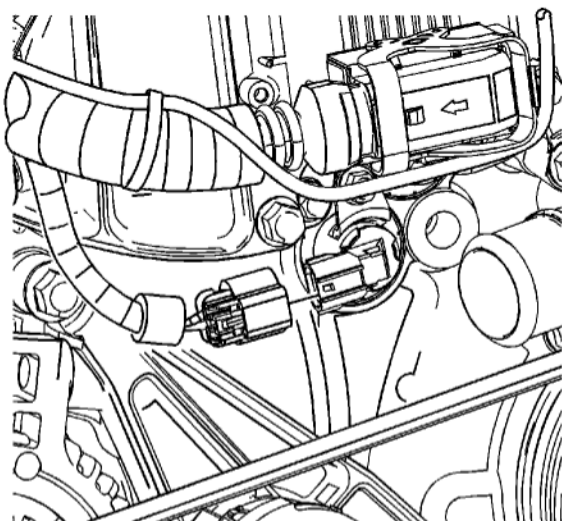




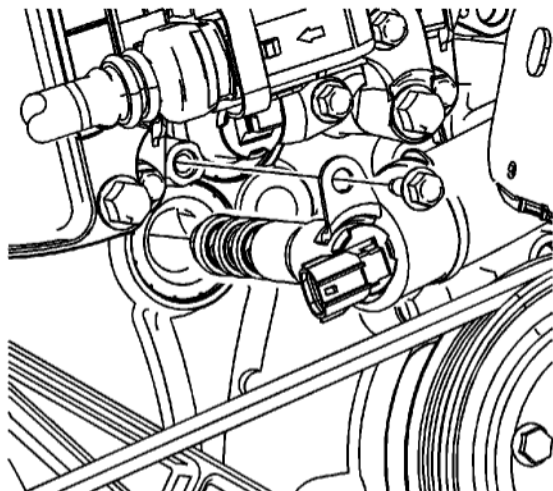
4. Connect the CMP actuator valve electrical connector.
5. Install the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).

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

Removal Procedure



1. Turn the ignition OFF.
2. Remove the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).
3. Disconnect the camshaft position (CMP) actuator valve electrical connector.

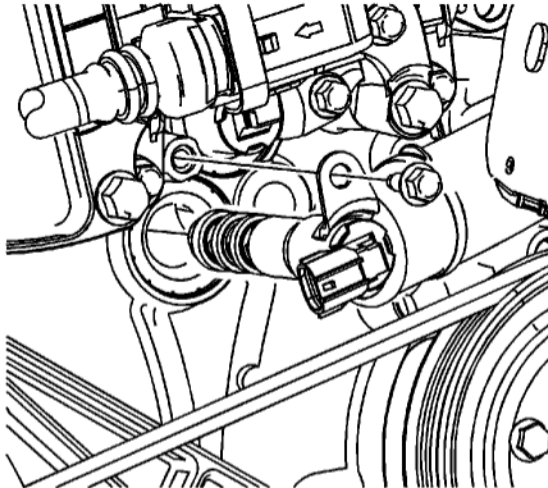




4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

Installation Procedure

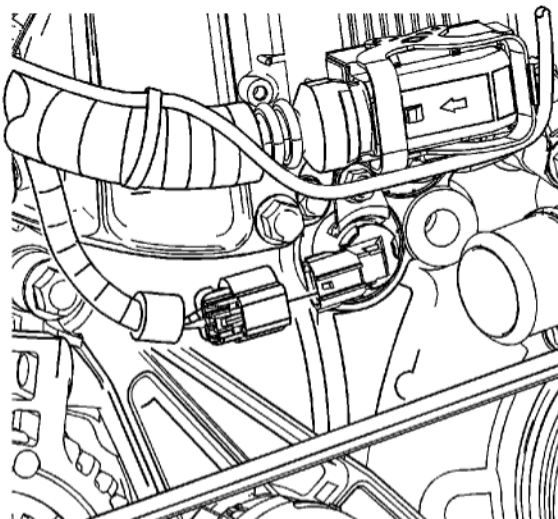
1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.



2. Install the CMP actuator valve.

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

3. Install the CMP actuator valve bolt and tighten to **10 N·m (89 lb in)**.





4. Connect the CMP valve electrical connector.
5. Install the front compartment sight shields as necessary. Refer to [Front Compartment Sight Shields Replacement](#).

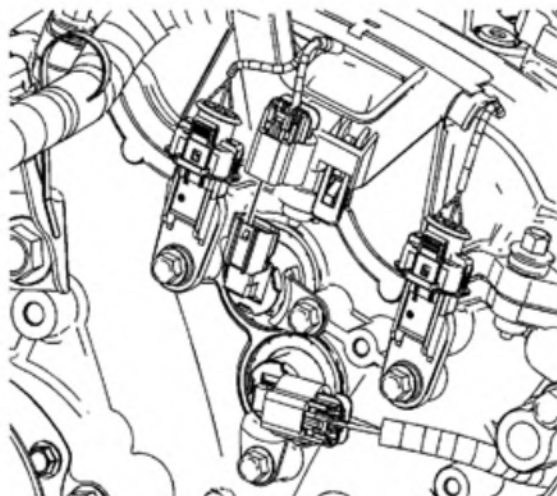
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake (LP1, LY7)

Removal Procedure

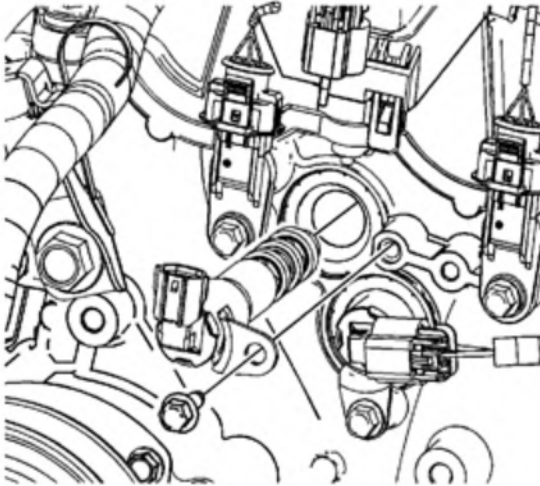
1. Turn the ignition OFF.

Note: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).



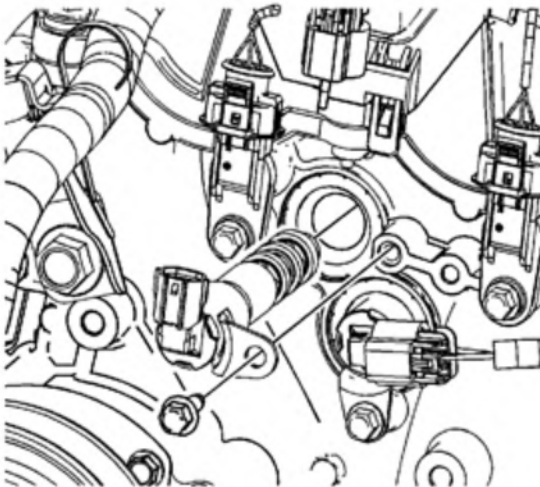
3. Remove the camshaft position (CMP) actuator valve electrical connector.



4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

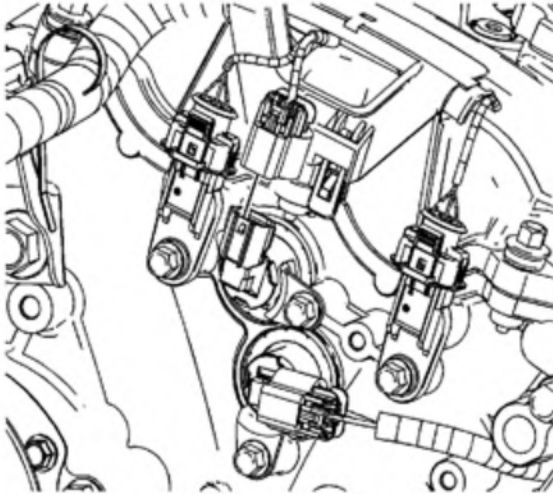
1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.



2. Install the CMP actuator valve.

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

3. Install the CMP actuator valve bolt and tighten to **10 N·m (89 lb in)**.



4. Install the CMP actuator valve electrical connector.
5. Install the power steering fluid reservoir. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).

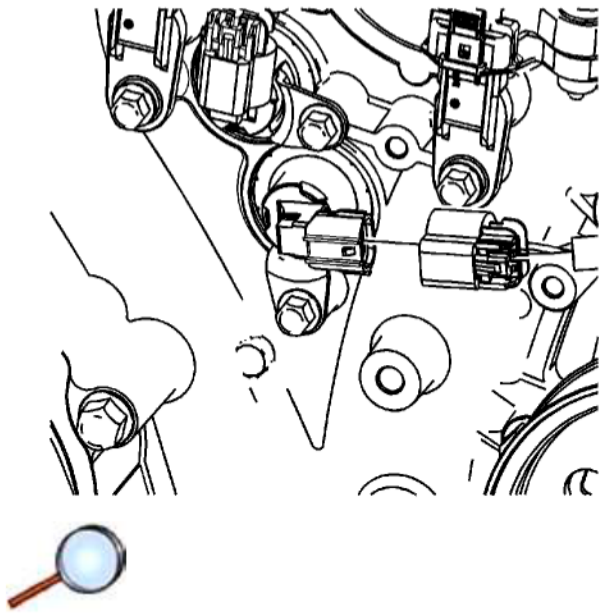
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust (LP1, LY7)

Removal Procedure

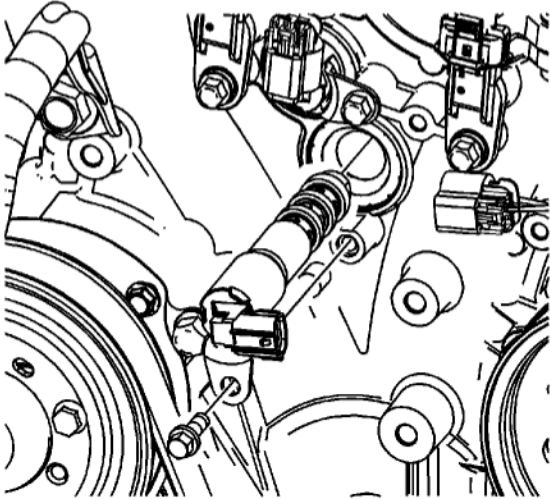
1. Turn the ignition OFF.

Note: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).



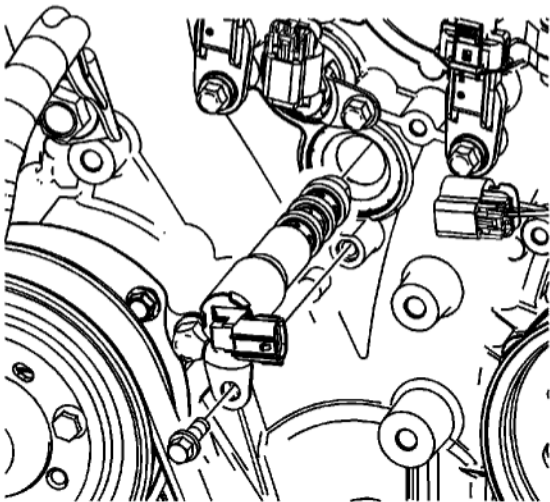
3. Remove the camshaft position (CMP) actuator valve electrical connector.



4. Remove the CMP actuator valve bolt.
5. Remove the CMP actuator valve.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

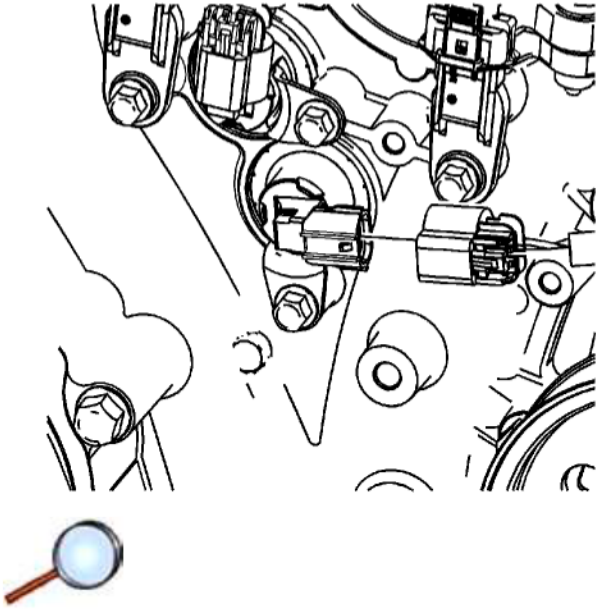
1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.



2. Install the CMP actuator valve.

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

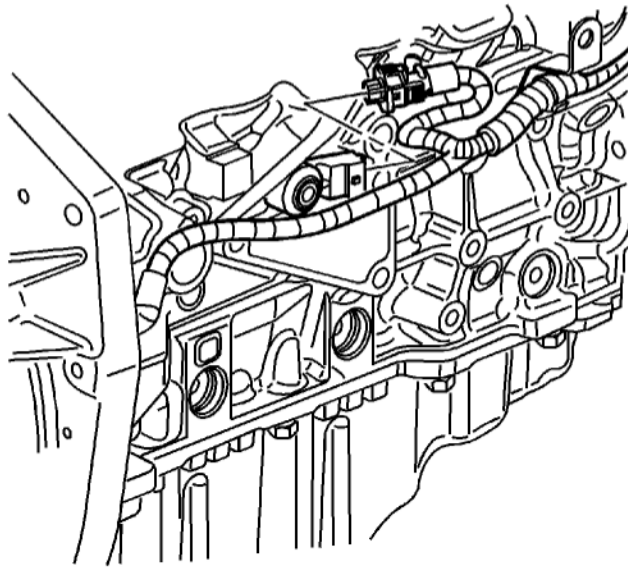
3. Install the CMP actuator valve bolt and tighten to **10 N·m (89 lb in)**.



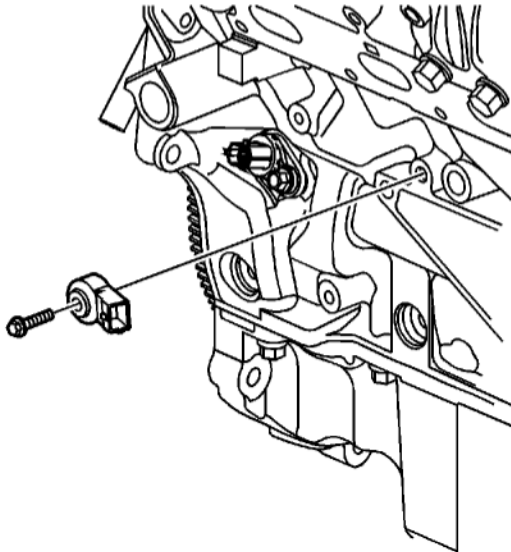
4. Install the CMP actuator valve electrical connector.
5. Install the power steering fluid reservoir. Refer to [Remote Power Steering Fluid Reservoir Replacement](#).

Knock Sensor Replacement - Bank 1

Removal Procedure



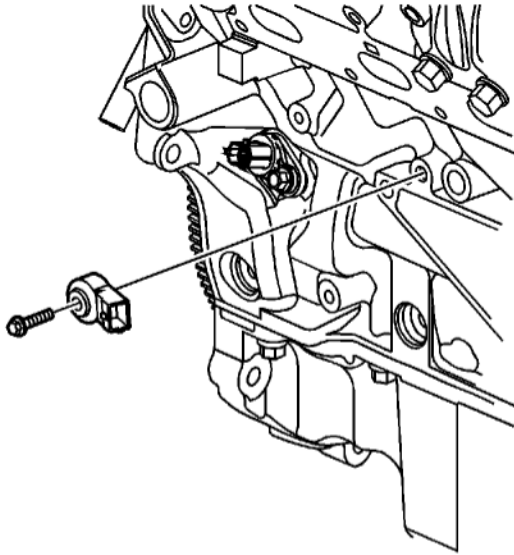
1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Reposition the wiring harness heat shield to obtain access.
4. Remove the knock sensor (KS) electrical connector.



5. Remove the KS bolt.

6. Remove the KS.

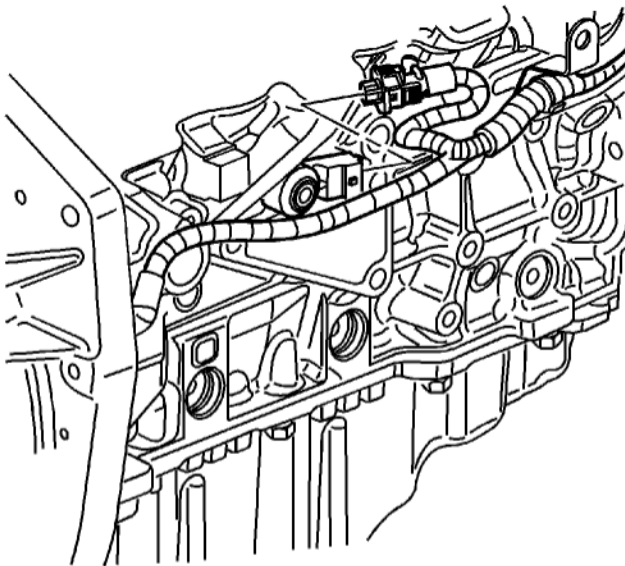
Installation Procedure



1. Install the KS.

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

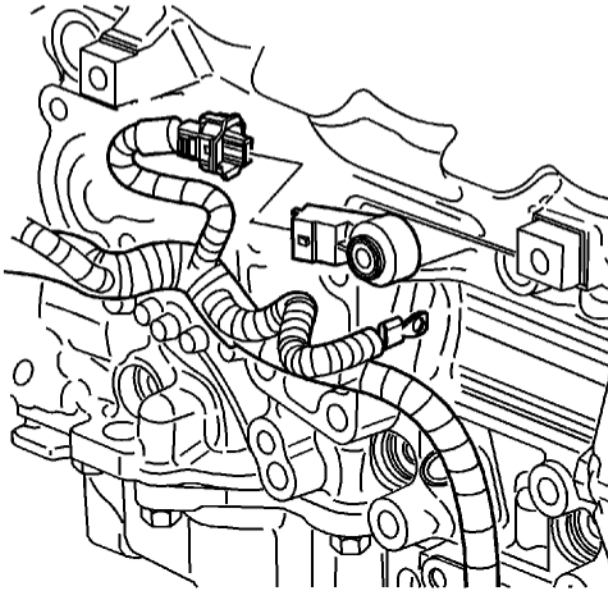
2. Install the KS bolt and tighten to **23 N·m (17 lb ft)**.



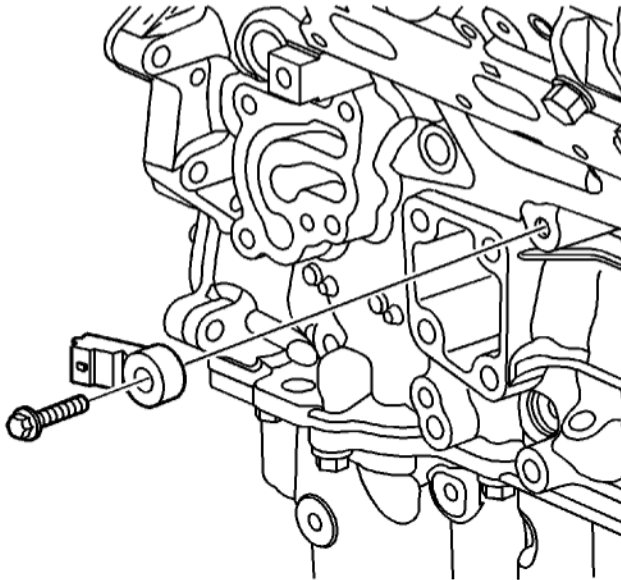
3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the original position.
5. Lower the vehicle.

Knock Sensor Replacement - Bank 2

Removal Procedure



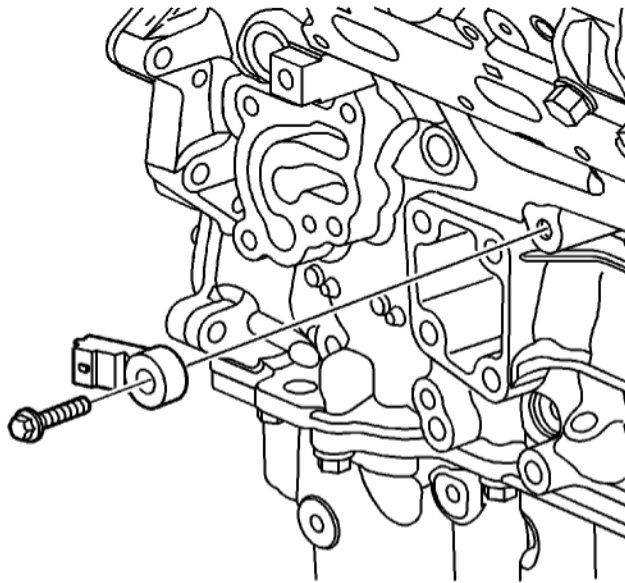
1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the wiring harness heat shield from the oil level indicator tube to gain access.
4. Remove the knock sensor (KS) electrical connector.



5. Remove the KS bolt.

6. Remove the KS.

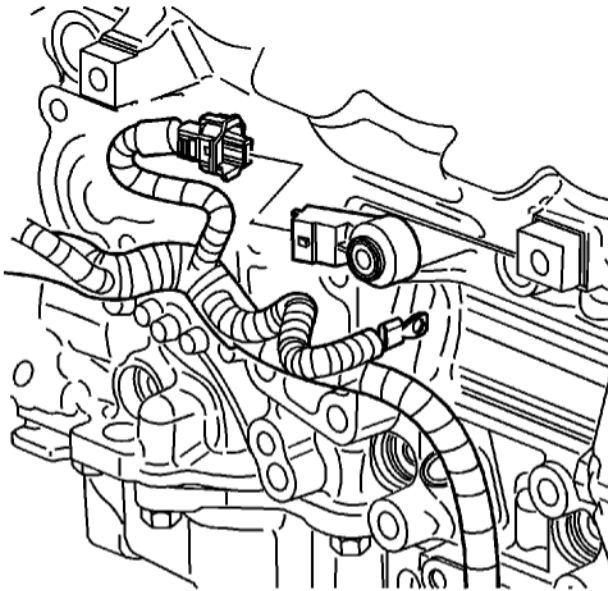
Installation Procedure



1. Install the KS.

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

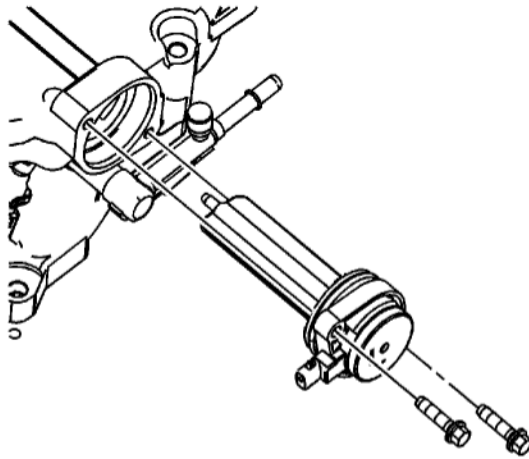
2. Install the KS bolt and tighten to **23 N·m (17 lb ft)**.



3. Install the KS electrical connector.
4. Install the wiring harness heat shield to the oil level indicator tube.
5. Lower the vehicle.

Intake Manifold Runner Control Solenoid Replacement (LP1, LY7)

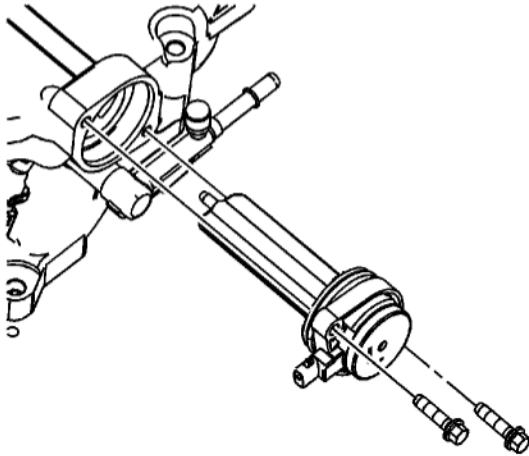
Removal Procedure



Note: DO NOT separate the upper intake manifold from the lower intake manifold.

1. Remove the upper intake manifold with the lower intake manifold. Refer to [Lower Intake Manifold Replacement](#).
2. Remove the intake manifold runner control solenoid bolts.
3. Remove the intake manifold runner control solenoid.

Installation Procedure

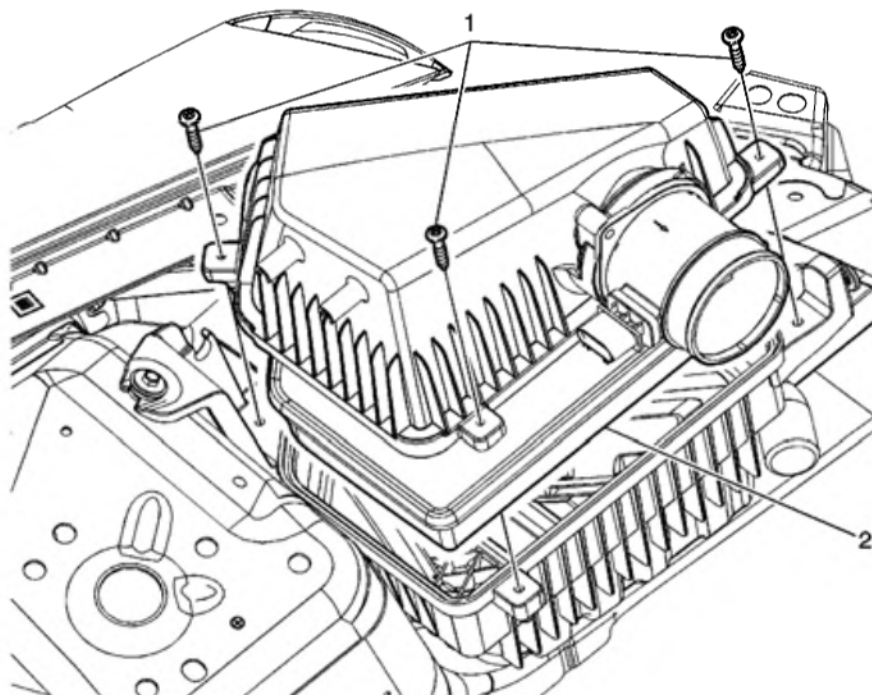


1. Install the intake manifold runner control solenoid.

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

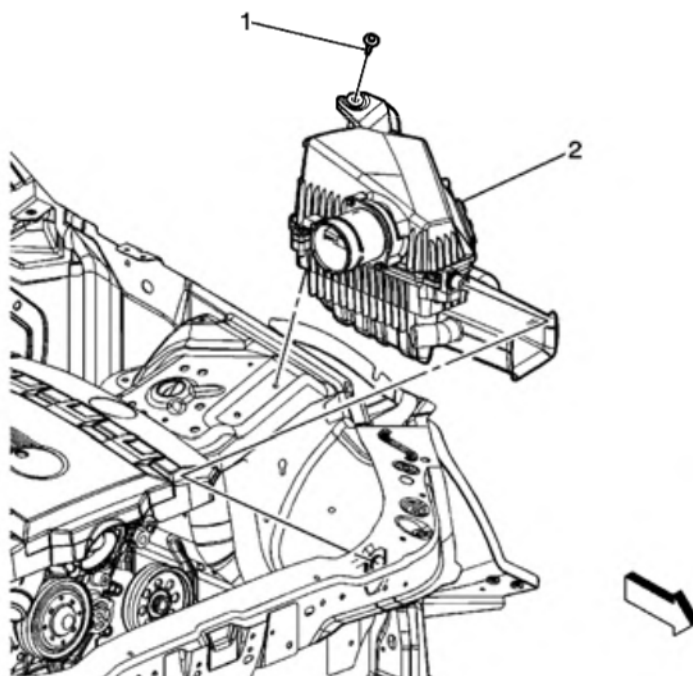
2. Install the intake manifold runner control solenoid bolts and tighten to **10 N·m (89 lb in)**.
3. Install the upper intake manifold. Refer to [Lower Intake Manifold Replacement](#).

Air Cleaner Element Replacement



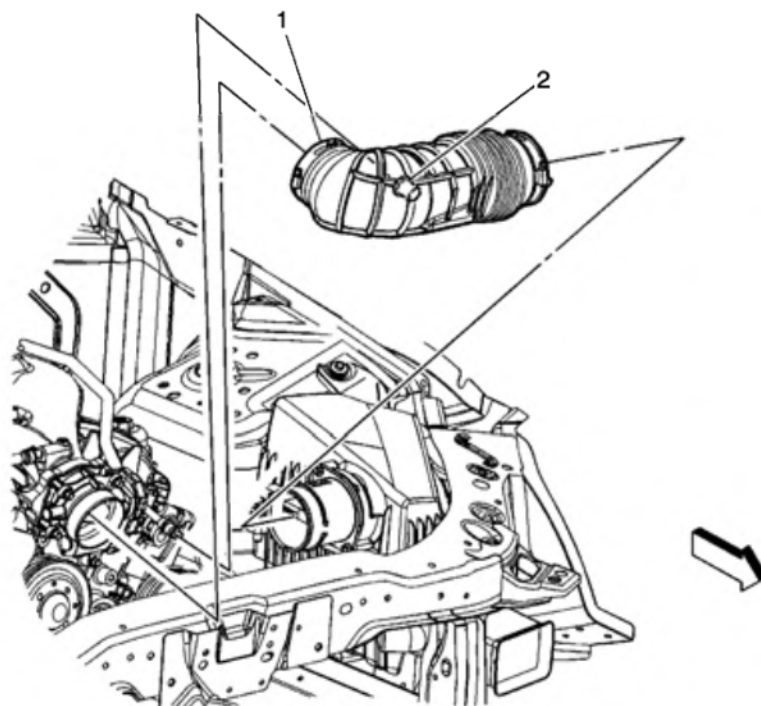
Callout	Component Name
Preliminary Procedures 1. Turn OFF the ignition. 2. Remove the air cleaner duct. Refer to Air Cleaner Outlet Duct Replacement . 3. Disconnect the MAF/IAT sensor harness connector.	
1	Screws (Qty: 3) Caution: Refer to Fastener Caution in the Preface section. Tighten 4 N·m (35 lb in)
2	Air Cleaner Element Procedure 1. Disconnect the sensor wiring harness. 2. Lift the air cleaner cover in order to remove the air cleaner element.

Air Cleaner Assembly Replacement



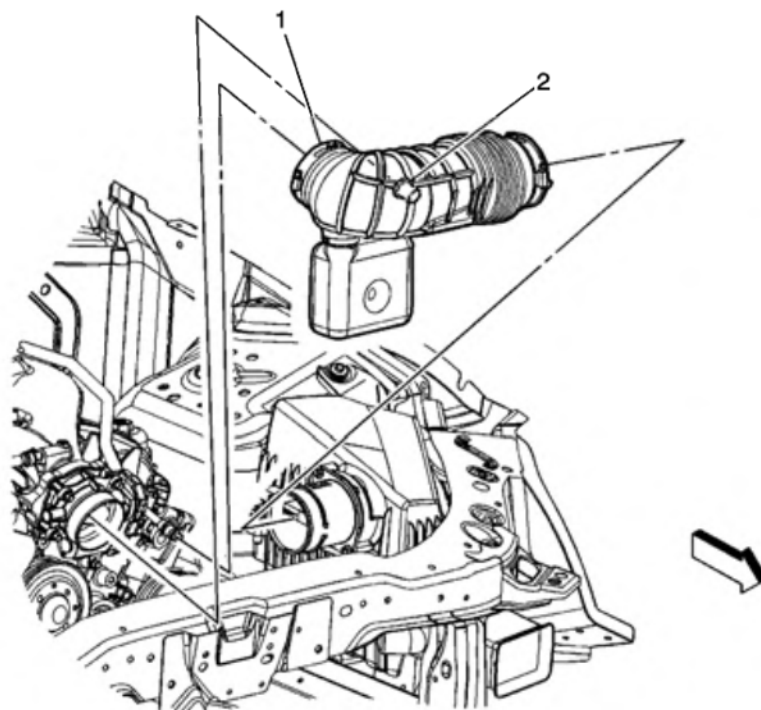
Callout	Component Name
Preliminary Procedures	
1. Remove the sight shield. Refer to Front Compartment Side Sight Shield Replacement. 2. Remove the air cleaner duct. Refer to Air Cleaner Outlet Duct Replacement. 3. Disconnect the MAF/IAT sensor electrical connector.	
1	Bolt Caution: Refer to Fastener Caution in the Preface section. Tighten 9 N·m (80 lb in)
2	Air Cleaner Assembly Procedure 1. Disconnect the electrical connector. 2. Tilt the assembly rear upward while disengaging the air cleaner isolator.

Air Cleaner Outlet Duct Replacement (LLT)



Callout	Component Name
Preliminary Procedure	
Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .	
1	Clamp (Qty: 2) Caution: Refer to Fastener Caution in the Preface section. Tighten 4 N·m (35 lb in)
2	Air Cleaner Duct Procedure Align the air cleaner duct with the PCV vent tube during installation.

Air Cleaner Outlet Duct Replacement (LY7)



Callout	Component Name
Preliminary Procedure	
Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .	
1	Clamp (Qty: 2) Caution: Refer to Fastener Caution in the Preface section. Tighten 4 N·m (35 lb in)
2	Air Cleaner Duct Procedure Align the air cleaner duct with the PCV vent tube during installation.