

Temperature Versus Resistance (Fuel Temperature Sensor)

°C	°F	OHMS
150	302	61
140	284	75
130	266	92
120	248	111
110	230	142
100	212	184
90	194	240
80	176	318
70	158	428
60	140	584
50	122	811
45	113	961
40	104	1,150
35	95	1,377
30	86	1,660
25	77	1,999
20	68	2,450
15	59	3,000
10	50	3,700
5	41	4,587
0	32	5,740
-5	23	7,203
-10	14	9,160
-15	5	11,598
-20	-4	15,000
-30	-22	25,414
-40	-40	45,770

Temperature Versus Resistance (ECT Sensors)

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	77
120	248	100
110	230	132
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

Temperature Versus Resistance (IAT Sensor 1)

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	190
90	194	240
80	176	320
70	158	430
60	140	590
50	122	810
45	113	960
40	104	1150
35	95	1370
30	86	1650
25	77	2000
20	68	2440
15	59	2980
10	50	3660
5	41	4540
0	32	5650
-5	23	7090
-10	14	8970
-15	5	11400
-20	-4	14700
-30	-22	24700
-40	-40	43300

Temperature Versus Resistance (IAT Sensor 2)

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	16
140	284	198
130	266	247
120	248	310
110	230	395
100	212	508
90	194	662
80	176	875
70	158	1171
60	140	1593
50	122	2203
45	113	2608
40	104	3100
35	95	3705
30	86	4448
25	77	5370
20	68	6517
15	59	7954
10	50	9765
5	41	12060
0	32	15000
-5	23	18800
-10	14	23670
-15	5	30100
-20	-4	38480
-30	-22	64630
-40	-40	112500

Temperature Versus Resistance (EGT Sensors)

EGT 1 and 2 Sensors

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
1000	1832	849
900	1652	795
800	1472	738
700	1292	680
600	1112	618
500	932	554
450	842	521
400	752	488
350	662	455
300	572	420
250	482	385
200	392	349
150	302	313
100	212	276
50	122	238
25	77	220
0	32	200
-20	-4	185
-40	-40	170

Temperature Versus Resistance (EGR Temperature Sensors)

EGR Temperature Sensors 1 and 2

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
-40	-40	180000
-30	-22	120900
-20	-4	83910
-10	14	59877
0	32	43796
10	50	32463
20	68	24559
30	86	18925
40	104	14828
50	122	11795
60	140	9510
70	158	7765
80	176	6413
90	194	5353
100	212	4511
110	230	3824
120	248	3269
130	266	2817
140	284	2444
150	302	2135
160	320	1877
170	338	1660
180	356	1476
190	374	1319
200	392	1184
210	410	1068
220	428	967
230	446	879
240	464	802
250	482	735
260	500	675
270	518	622
280		75

290	554	533
300	572	496
310	590	460
320	608	429
330	626	400
340	644	374
350	662	351
360	680	329
370	698	310
380	716	292
390	734	276
400	752	261
410	770	248
420	788	235
430	806	223
440	824	213
450	842	203
460	860	193
470	878	185
480	896	177
490	914	169
500	932	162
510	950	156
520	968	150
530	086	144
540	1004	139
550	1022	134
560	1040	129
570	1058	125
580	1076	120
590	1094	116
600	1112	113
610	1130	109
620	1148	106
630	1166	102
640	1184	99
650	1202	96
660	1220	93
670	1238	91
680	1256	88

690	1274	86
700	1292	84
710	1310	81
720	1328	79
730	1346	77
740	1364	75
750	1382	74
760	1400	72
770	1418	70
780	1436	69
790	1454	67
800	1472	66
810	1490	64
820	1508	63
830	1526	61
840	1544	60
850	1562	59
860	1580	58
870	1598	57
880	1616	56
890	1634	55
900	1652	54

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

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Bolt	9N·m	80 lb in
Air Cleaner Housing Door Screw	4 N·m	35 lb in
Air Cleaner Outlet Duct Clamp	4 N·m	35 lb in
Air Intake Pipe to Turbocharger Clamp	4.6 N·m	41 lb in
Camshaft Position (CMP) Sensor Bolt	10 N·m	89 lb in
Charge Air Cooler Bolt	21 N·m	15 lb ft
Charge Air Cooler Inlet Pipe Clamp	8 N·m	70 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N·m	89 lb in
Crankshaft Position Sensor (CKP) Sensor Spacer Bolt	10 N·m	89 lb in
Electronic Brake Control Module (EBCM) Bracket Bolt	25 N·m	18 lb ft
Engine Coolant Temperature (ECT) Sensor	20 N·m	15 lb ft
Exhaust Differential Pressure Sensor Bracket Bolt	9 N·m	80 lb in
Exhaust Differential Pressure Sensor Pipe Bracket to Exhaust Hanger Bolt/Nut	9 N·m	80 lb in
Exhaust Differential Pressure Sensor Pipe Fitting	45 N·m	33 lb ft
Exhaust Gas Recirculation (EGR) Valve Bolt	25 N·m	18 lb ft
Exhaust Gas Recirculation (EGR) Valve Cooler Bolt	50 N·m	37 lb ft
Exhaust Gas Recirculation (EGR) Valve Cooler Coolant Hose Clamp Nut	24 N·m	18 lb ft
Exhaust Gas Recirculation (EGR) Valve Cooler Rear Bolt	25 N·m	18 lb ft
Exhaust Gas Recirculation (EGR) Valve Cooler Rear Bracket Bolt	25 N·m	18 lb ft
Exhaust Gas Recirculation (EGR) Valve Motor Screw	2 N·m	18 lb in
Exhaust Pipe to Exhaust Gas Recirculation (EGR) Valve Cooler Nut	53 N·m	39 lb ft
Exhaust Temperature Sensor	45 N·m	33 lb ft
Engine Wiring Harness Bracket to Valve Rocker Arm Cover Bolt	24 N·m	18 lb ft
Engine Wiring Harness Clip to Intake Manifold Tube Bolt	4 N·m	35 lb in
Engine Wiring Harness to Glow Plug Nut	1.7 N·m	15 lb in
Engine Wiring Harness to Upper Valve Rocker Arm Cover Bolt	21 N·m	15 lb ft
Engine Harness Lead to Intake Air Heater Nut	10 N·m	89 lb in
Fuel Bundle Nut	16 N·m	12 lb ft
Fuel Cooler Bolt	18 N·m	13 lb ft
Fuel Cooler Bracket Bolt	18 N·m	13 lb ft
Fuel Cooler Nut	40 N·m	30 lb ft
Fuel Feed Pipe Clamp/Clip Bolt/Nut	24 N·m	18 lb ft
Fuel Filter Bracket Bolt	20 N·m	15 lb ft
Fuel Injection Fuel Rail Bolt	25 N·m	18 lb ft

Fuel Injection Pump Adapter Bolt	20 N·m	14 lb ft
Fuel Injection Pump Bolt	21 N·m	15 lb ft
Fuel Injection Pump Gear Nut	70 N·m	52 lb ft
Fuel Injector Bracket Bolt	30 N·m	22 lb ft
Fuel Injector Pipe Fitting	41 N·m	30 lb ft
Fuel Line Bracket Nut	16 N·m	12 lb ft
Fuel Line Bracket to Valve Rocker Arm Cover Bolt	24 N·m	18 lb ft
Fuel Line to Balance Pump Fitting	30 N·m	22 lb ft
Fuel Pipe Clip/Bracket Bolt	24 N·m	18 lb ft
Fuel Pressure Regulator Screws		
┆ First Pass	4 N·m	35 lb in
┆ Final Pass	7 N·m	62 lb in
Fuel Pressure Relief Valve	100 N·m	74 lb ft
Fuel Rail Fuel Feed Pipe Fitting	41 N·m	30 lb ft
Fuel Rail Fuel Feed Pipe Upper Clamp Bolt	24 N·m	18 lb ft
Fuel Rail Fuel Pressure Sensor	70 N·m	52 lb ft
Fuel Return Pipe Clamp/Clip Bolt/Nut	24 N·m	18 lb ft
Fuel Tank Fill Pipe Clamp	2.5 N·m	22 lb in
Fuel Tank Filler Housing to Body Screw	2.3 N·m	20 lb in
Fuel Tank Filler Housing to Fuel Tank Fill Pipe Screw	2.3 N·m	20 lb in
Fuel Tank Ground Strap Bolt	9 N·m	80 lb in
Fuel Tank Shield Bolt	18 N·m	13 lb ft
Fuel Tank Strap Bolt	40 N·m	30 lb ft
Fuel Tank Vent Hose Clamp	2.5 N·m	22 lb in
Fuel Temperature Sensor	22 N·m	16 lb ft
Glow Plug	18 N·m	13 lb ft
Glow Plug Control Module Bolt	10 N·m	89 lb in
Glow Plug Control Module Bracket to Lower Valve Rocker Arm Cover Bolt	10 N·m	89 lb in
Glow Plug Control Module Protector Bolt	10 N·m	89 lb in
Heater Inlet Hose Bracket Nut	9 N·m	80 lb in
Intake Air Heater Bolt/Nut	20 N·m	15 lb ft
Intake Air Temperature (IAT) Sensor	25 N·m	18 lb ft
Intake Air Valve Bolt/Nut	20 N·m	15 lb ft
Manifold Absolute Pressure (MAP) Sensor Bolt	10 N·m	89 lb in
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Screw	8 N·m	70 lb in
Oil Level Indicator Tube Bolt	21 N·m	15 lb ft
Oil Level Indicator Tube Bracket Bolt	21 N·m	15 lb ft
Turbocharger Oil Feed Pipe Bolt	34 N·m	25 lb ft
Turbocharger Vane Control Solenoid Valve Bracket Bolt	23 N·m	18 lb ft
Turbocharger Vane Position Sensor	28 N·m	21 lb ft

Upper Intake Manifold Brace Bolt	24 N·m	18 lb ft
Wheelhouse Liner Bolt	2.5 N·m	22 lb in
Wiring Harness Bracket Bolt	24 N·m	18 lb ft

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Fuel System Specifications

Table 1: [Initial Fuel Injector Return Flow Values](#)

Table 2: [Retesting Fuel Injector Return Flow Values](#)

What Fuel to Use in the United States

Caution: Use of diesel fuel other than Ultra Low Sulfur Diesel (15 ppm sulfur maximum) or engine oil other than low ash CJ-4 oil will cause permanent damage to the DPF and related components.

In the United States, for best results use Number 2-D diesel fuel year-round, above and below freezing conditions, as oil companies blend Number 2-D fuel to address climate differences. Number 1-D diesel fuel may be used in very cold temperatures when the temperature stays below -18°C (0°F). However, the fuel will produce a power and fuel economy loss. The use of Number 1-D diesel fuel in warm or hot climates may result in stalling, poor starting when the engine is hot and may damage the fuel injection system.

It is acceptable to use diesel fuel containing up to 5 percent biodiesel (B5), but the final blended fuel must meet the same specification, ASTM D 975 (Grades No. 2-D or No. 1-D S15 commonly known as Ultra Low Sulfur diesel), as the other fuels used in your vehicle, and the biodiesel used for making this fuel must meet the latest version of ASTM specification D 6751. Biodiesel is produced from vegetable oils or animal fat that have been chemically modified to reduce the possibility of damage to the fuel system and engine. Higher concentration (i.e. greater than B5) biodiesel-containing fuels or the use of unmodified bio-oils blended into diesel fuel at any concentration is not recommended and could damage the fuel system and engine. Such damage could not be covered by your warranty. If there are questions about the biodiesel-containing fuels you are using, contact your fuel supplier.

Because of the cleansing properties of biodiesel, switching from straight diesel to a biodiesel blend can prematurely restrict the fuel filter with normal deposits in the fuel system. A fuel filter replacement might be required sooner than the recommended interval.

Diesel fuel may foam when filling the tank. This can cause the automatic pump nozzle to shut OFF, even though the tank is not full. If this happens, just wait for the foaming to stop and then continue to fill the tank.

What Fuel to Use in Canada

Canadian fuels are blended for seasonal changes. Diesel Type A fuel is blended for better cold weather starting, when it stays below -18°C (0°F). However, the fuel will produce a power and fuel economy loss. The use of Type A diesel fuel in warmer climates may result in stalling, poor starting. Diesel Type B fuel is blended for temperatures above -18°C (0°F). The emission control system requires the use of diesel fuel with ultra low sulfur, 15 ppm, content. Both low and higher sulfur fuels will be available in Canada. Only ultra low sulfur diesel fuels are available in the United States. Diesel-powered trucks must be refueled with ultra low sulfur fuel only. Use of fuels with higher-sulfur content will affect the function of the emission components and may cause reduced performance, excessive smoke and unpleasant odor.

It is acceptable to use diesel fuel containing up to 5 percent biodiesel (B5), but the final blended fuel must meet the same s a, as other fuels used in

your vehicle, and the biodiesel used for making this fuel must meet the latest version of ASTM specification D 6751. Biodiesel is produced from vegetable oils or animal fat that have been chemically modified to reduce the possibility of damage to the fuel system and engine. Higher concentration (i.e. greater than B5) biodiesel-containing fuels or the use of unmodified bio-oils blended into diesel fuel at any concentration is not recommended and could damage the fuel system and engine. Such damage would not be covered by your warranty. If there are questions about the biodiesel-containing fuels you are using, contact your fuel supplier.

Very Cold Weather Operation

If the vehicle is driven in very cold temperatures and can not get a winterized Number 2-D that has been adapted to cold weather or a Number 1-D, use one gallon of kerosene for every 2 gallons of diesel fuel. Once you add kerosene, run the engine for several minutes to mix the fuels. Only add kerosene when the temperature falls below -18°C (0°F), because the fuel economy and lubricating qualities of kerosene is not as good as that of diesel fuel.

In cold weather, the fuel filter may become clogged (waxed). To unclog the filter, move the vehicle to a warm garage area and warm the filter to a temperature between 0-10°C (32-50°F). Replacing the filter is not necessary.

Fuel Specific Gravity Testing

Use a [J 38641-B](#) Diesel Fuel Quality Tester to measure the fuel specific gravity (API Rating). Follow the instructions on the tool to obtain the proper temperature-adjusted value. This information must be accurate for the proper diagnosis of the fuel system.

Fuel Injector Return Flow and Fuel Pressures

The fuel return from the fuel injectors to the tank will vary based on the API value of the fuel. Measure the Fuel API with the Diesel Fuel Quality Tester. For this reason the Fuel System Diagnosis - High Pressure Side values will vary for identifying a fuel injector or fuel pump concern. Use the following tables when referred to by the diagnostic. The first table is to be used during the initial diagnosis to identify the worst fuel injectors. After the fuel injectors that fail the first part of the test are capped off, the return flow from each uncapped fuel injector must be measured again. This is because the fuel system is returning less fuel to the tank, and thus the fuel pressure is higher during the retest. Failure to use the correct table may result in the replacement of good fuel injectors.

Initial Fuel Injector Return Flow Values

API Rating	Maximum Single Fuel Injector Return Flow
30-34	3 ml
35-39	4 ml
40-44	5 ml

Retesting Fuel Injector Return Flow Values

API Rating	Maximum Single Fuel Injector Return Flow
30-34	4 ml
35-39	5 ml
40-44	5 ml

Water in Fuel

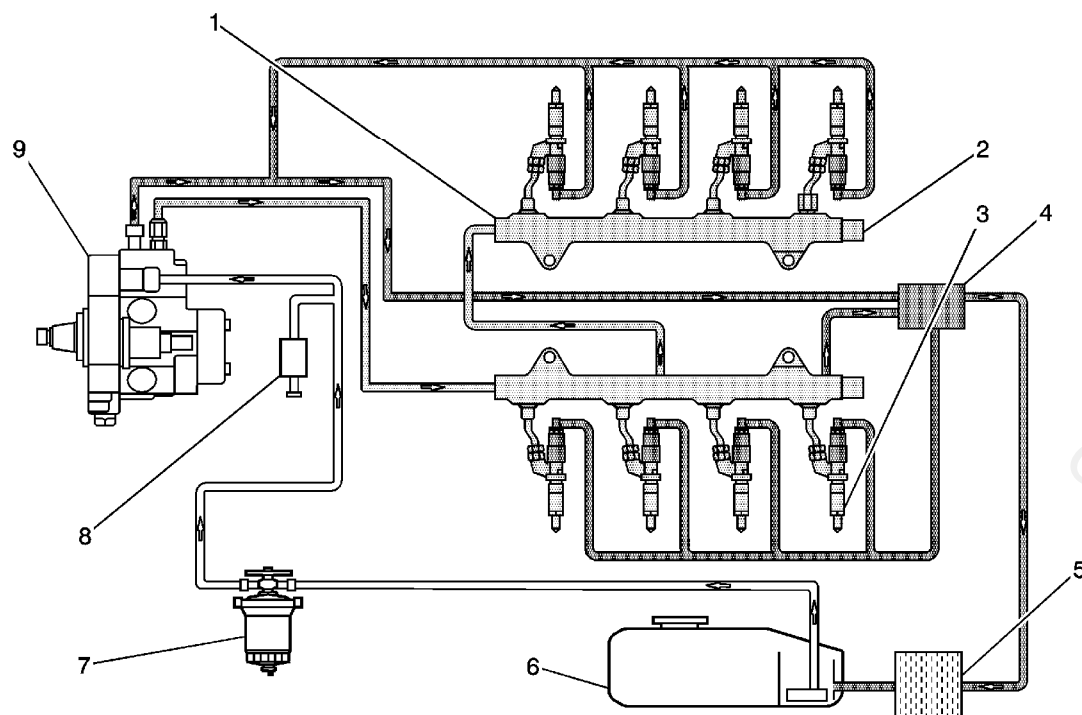
Sometimes, water can be pumped into the fuel tank along with diesel fuel. This can happen if the service station does not regularly inspect and clean their fuel tanks, or the fuel gets contaminated for the service stations suppliers.

If water is pumped into the fuel tank, a water in fuel light will illuminate. If the water in fuel light illuminates, the excess water must be drained from the fuel system on the vehicle.

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Fuel Injection Line Routing Diagram

Fuel System Overview



- (1) Fuel Rail
- (2) Fuel Pressure Sensor
- (3) Fuel Injectors
- (4) Fuel Return Junction Block
- (5) Fuel Cooler
- (6) Fuel Tank
- (7) Fuel Filter/Heater Element Housing
- (8) First Start Fuel Bleeder Valve
- (9) Fuel Injection Pump

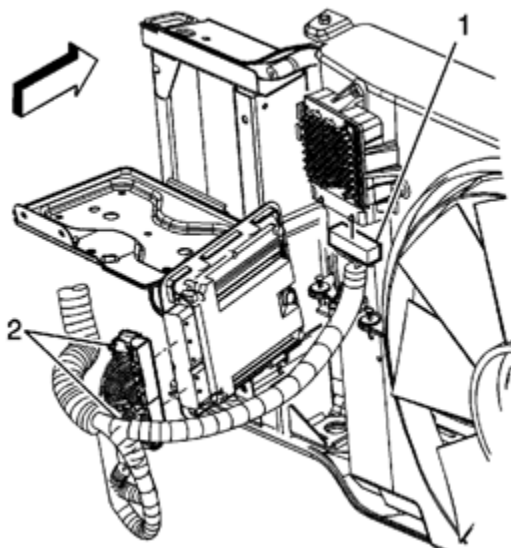
Engine Control Module Replacement

Caution:

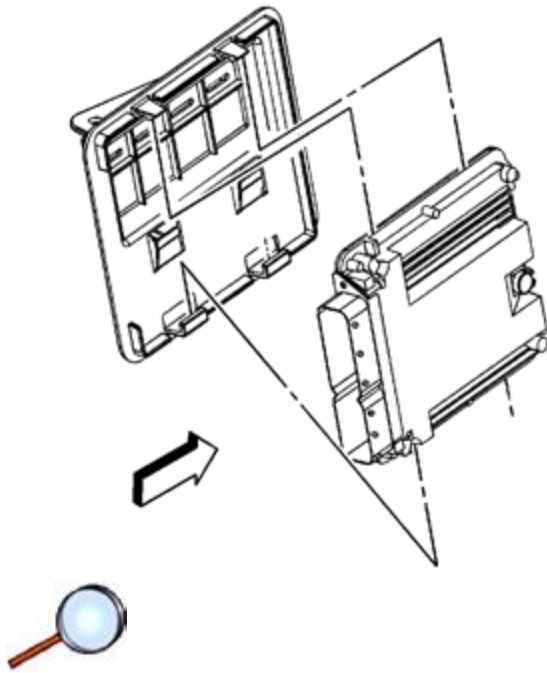
- Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.)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

Note: Before removing the engine control module (ECM), use the scan tool to capture the ECM data. This captured data will then need to be restored into the NEW ECM. Refer to [Control Module References](#).

Removal Procedure

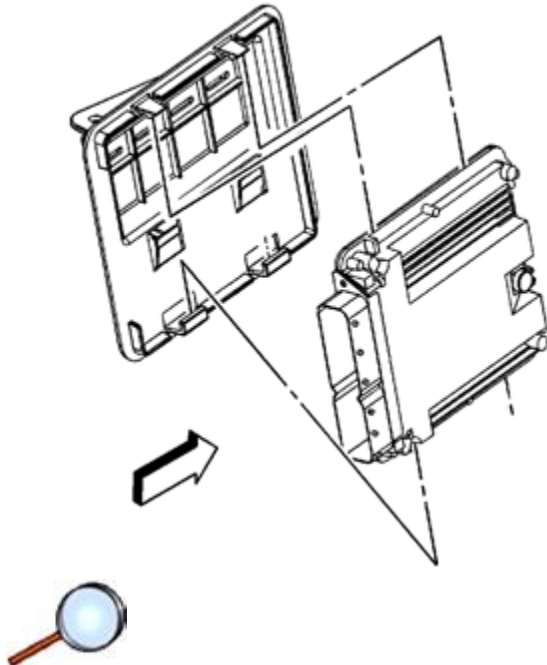


1. Using a scan tool, capture the ECM data.
2. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Disconnect the ECM e

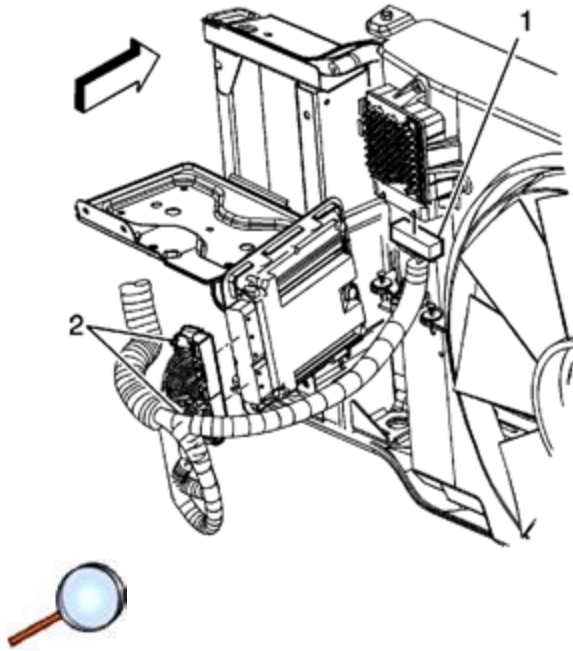


4. Release the ECM upper retaining tabs.
5. Remove the ECM from the bracket.

Installation Procedure



1. Place the bottom edge of the ECM into the bracket lower retainers.
2. Push the ECM towards the bracket until the upper edge of the ECM snaps into place.



3. Connect the ECM electrical connectors (2).
4. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
5. If a NEW ECM was installed, program the ECM. Refer to [Control Module References](#).

High Idle Switch Programming

Before Programming a Control Module

Important: DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors Corporation service bulletin. Programming a control module at any other time will not permanently correct a customer's concern.

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage
 - There is no charging system concern. All charging system concerns must be repaired before programming a control module.
 - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be charged before programming the control module if the battery voltage is low.
 - A battery charger is NOT connected to the vehicle's battery. Incorrect system voltage or voltage fluctuations from a battery charger, may cause programming failure or control module damage.
 - Turn OFF or disable any system that may put a load on the vehicle's battery.
- Twilight sentinel
- Interior lights
- Daytime running lights (DRL)--Applying the parking brake, on most vehicles, disables the DRL system. Refer to the Owner's Manual.
- HVAC systems
- Engine cooling fans, etc.
- The ignition switch is in the proper position. The scan tool prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure, unless instructed to do so.
- All tool connections are secure.
 - The connection at the data link connector (DLC)
 - Voltage supply circuits
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or control module damage may occur.

High Idle Switch Programming

- Using the Tech 2, select Module Setup/PTO Options
- Use soft keys to select desired settings.
- When setting selections are complete, select Reprogram.

Important: The ECM will not operate under the new value until the it has powered down once.

- Turn OFF the ignition until communication with the ECM is lost, as indicated on the scan tool.
- Start the vehicle and confirm the new settings by operating the high idle switch.

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Fuel Injector Flow Rate Programming

Circuit/System Description

The control functions for the fuel injection system are integrated in the engine control module (ECM). Each injector's flow rate information and cylinder position are stored in the memory of both the glow plug control module (GPCM) and the ECM. The fuel injector flow rate programming must be done when any of the following procedures are performed:

- The ECM is replaced
- The GPCM is replaced
- Any fuel injectors are replaced

If the ECM does not communicate, the flow rate information can be retrieved from the GPCM. If both control modules fail to communicate, the fuel injector flow rate information, or injection quantity adjustment (IQA) flow rate numbers, will need to be retrieved from each individual injector.

Before Programming A Control Module

Important: DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors Corporation service bulletin. Programming a control module at any other time will not permanently correct a customers concern.

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage
 - There is no charging system concern. All charging system concerns must be repaired before programming a control module.
 - Battery voltage is between 12-16 volts. The battery must be charged before programming the control module if the battery voltage is low.
 - A battery charger is NOT connected to the vehicle battery. Incorrect system voltage or voltage fluctuations from a battery charger may cause programming failure or control module damage.
 - Turn OFF or disable any of the following systems that may put a load on the vehicle battery:
- Twilight sentinel
- Interior lights
- Daytime running lights (DRL)--Applying the parking brake, on most vehicles, disables the DRL system. Refer to the Owner's Manual.
- HVAC systems
- Engine cooling fans, etc.
- The ignition switch is in the proper position--The scan tool prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure, unless instructed to do so.

- All of the following tool connections are secure:
 - The connection at the data link connector (DLC)
 - The voltage supply circuits
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or control module damage may occur.

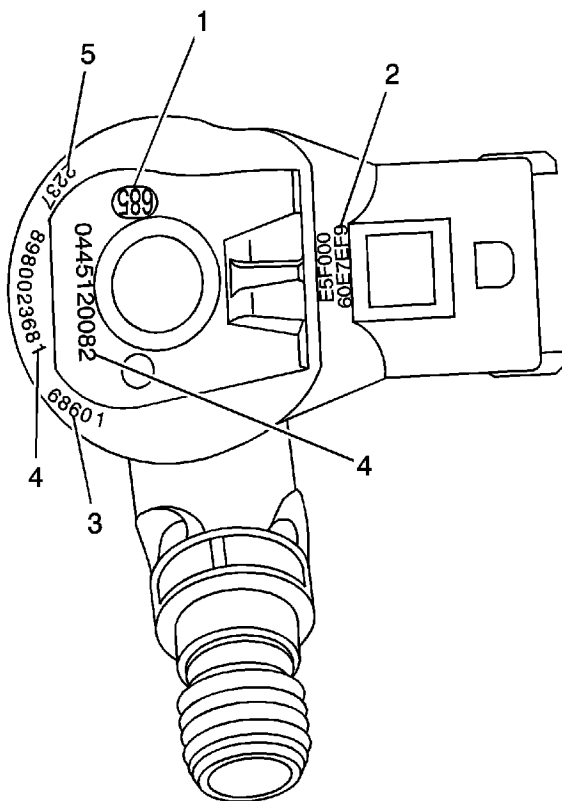
Circuit/System Verification

Review the Display ECM & GPCM Inj. Flow Rates parameter with a scan tool. All cylinders should be programmed with a flow rate number. Both the GPCM and the ECM should be programmed with the same flow rate numbers for the corresponding cylinders.

Circuit/System Testing

Important: If the flow rate number is not available in either control module, the numbers will need to be retrieved from each individual injector.

Fuel Injector Identification Numbers



(1) Manufacturing Plant

- (2) IQA Number
- (3) Manufacturing Date
- (4) Injector Number
- (5) Serial Number

1. With a scan tool installed, enter the vehicle information and select the following options:
 - Engine Control Module
 - Module Setup
 - Injector Flow Rate Programming
 - Display ECM & GPCM Inj. Flow Rates
2. Record all flow rate numbers with the corresponding cylinders from the control modules.

Important: When installing a new fuel injector, ensure that the IQA data number from the yellow IQA Data Tag, shipped with the new injector, is programmed to the correct cylinder

If any injectors are replaced, go to Reprogram Injector Flow Rates parameter and enter the flow rate number of the new injector to the corresponding cylinder. The flow rate numbers will automatically update both control modules.

If the ECM was replaced, go to Copy GPCM Inj. Flow Rates to ECM parameter and reprogram the ECM. This will update the ECM with the GPCM flow rate numbers.

If the GPCM was replaced or the flow rate numbers are not the same for both modules, go to Copy ECM Inj. Flow Rates to GPCM parameter and reprogram the GPCM. This will update the GPCM with the ECM flow rate numbers.

If both control modules were replaced, go to Reprogram Injector Flow Rates parameter and enter the previously recorded flow rate numbers or the numbers retrieved from each individual injector, to the corresponding cylinders.

Repair Instructions

Important: The ECM and the GPCM must be allowed to completely power down after programming is complete.

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Turn ON the ignition, with the engine OFF, and clear the DTCs.
4. Disconnect the scan tool and turn OFF the ignition for 2 minutes.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) and perform the appropriate diagnostic procedure.

OR

If the repair was symptom related, duplicate the conditions under which the customer concern occurred to verify the repair. If the customer concern reoccurs, return to [Symptoms - Vehicle](#) and perform the appropriate symptom diagnostic.

Diesel Particulate Filter (DPF) Service Regeneration

Table 1: [Service Regeneration Successful](#)

Table 2: [Service Regeneration Unsuccessful](#)

Warning: Tailpipe outlet exhaust temperature will be greater than 300°C (572°F) during service regeneration. To help prevent personal injury or property damage from fire or burns, perform the following:

1. Do not connect any shop exhaust removal hoses to the vehicle's tailpipe.
2. Park the vehicle outdoors and keep people, other vehicles, and combustible material away during service regeneration.
3. Do not leave the vehicle unattended.

Warning: To avoid extremely elevated exhaust temperatures, inspect and remove any debris or mud build up at the exhaust cooler located at the tailpipe.

Caution: Due to the elevated engine temperatures created while performing this procedure it is imperative to keep the front of vehicle in an open environment, with the hood open, away from any walls or buildings. This will ensure proper airflow across the radiator.

Note: If you were not referred to this document from another diagnostic, DO NOT perform this procedure.

Conditions for Running

The following conditions must be met in order to enable DPF Service Regeneration:

Note: Do not refuel the vehicle during DPF Service Regeneration.

- DTCs P2463 or P244B are the only active DTCs displayed.
- The battery voltage is greater than 10 volts.
- The engine speed is between 600-1,250 RPM.
- The exhaust gas temperature (EGT) sensors 1 and 2 are less than 400°C (752°F).
- The engine coolant temperature (ECT) sensor 1 is between 70-115°C (158-239°F).
- The brake pedal and accelerator pedal are in the released position.
- The transmission is in Park or Neutral.

Test Procedure

1. Clear all DTCs with a scan tool before proceeding with DPF Service Regeneration.
2. Observe the scan tool DPF Regenerations Completed parameter and record the value.
3. Check the following fluid levels before and after this procedure:
 - Engine oil
 - Engine coolant

- Power steering
 - Transmission
 - Fuel level should be over 15 percent to ensure a successful regeneration.
4. Park the vehicle outside the facility, away from any obstacles, place the transmission in Park and apply the parking brake.
 5. Ensure the hood is open.
 6. Select DPF Service Regeneration in the Output Controls menu and follow the instruction on the scan tool.
 7. Command the DPF Service Regeneration ON with a scan tool.
If the service regeneration failed to start, repair the vehicle for the condition indicated by the scan tool DPF Regen Inhibit Reason parameter. Refer to the Service Regeneration Unsuccessful table.
 8. The DPF Service Regeneration will take approximately 35 minutes consisting of the following:
 - 8.1. 8 minutes for the exhaust system to warm up, with the engine speed slowly increasing to 1,600 RPM, then 2,200 RPM and finally 2,500 RPM
 - 8.2. 20 minutes for the DPF to regenerate at an engine speed between 2,200-2,500 RPM
 - 8.3. 3 minutes for the exhaust system to cool down with the engine speed will slowly returning to 1,400 RPM
 - 8.4. 3 minutes at 800 RPM, then idle speed of 680 RPM
 9. The DPF Service Regeneration will be terminated if any of the following actions are performed:
 - Applying the brake pedal
 - Applying the accelerator pedal
 - Selecting Drive or Reverse
 - Commanding DPF Service Regeneration OFF using the scan tool or disconnecting the scan tool from the vehicle
- Note:**
- The DPF Service Regeneration will terminate if the DPF or ECT temperatures exceed a calibrated threshold.
 - Temporary blue, gray, or white smoke during this procedure may be an indication of a fuel with high sulfur content.
10. After the service regeneration completes, clear all DTCs and turn the ignition OFF for 90 seconds.
If the service regeneration did not complete or aborted, replace the Exhaust Particulate Filter.
 11. Engine running, perform the following within 10 minutes of a successful service regeneration. Operate the vehicle within the following Conditions for Running DTC P2002. Refer to [DTC P2002](#).
If DTC P2002 or P244B sets, replace the Exhaust Particulate Filter.
 12. Verify that the scan tool DPF Regenerations Completed parameter has increased by one.
If the value has not increased by one, refer to Service Regeneration Unsuccessful.

Service Regeneration Successful

DPF Regeneration Parameters	Successful Regeneration
DPF Regeneration Status	Complete

DPF Regeneration Reason	None
DPF Regeneration Inhibit Reason	None

Service Regeneration Unsuccessful

The scan tool DPF Regeneration Inhibit reason parameter will display a reason for not enabling or aborting the DPF service regeneration. Refer to the reasons that are displayed and the corrective action for each reason.

Service Regeneration Unsuccessful

DPF Regeneration Parameters	Unsuccessful Regeneration-- Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
DPF Regeneration Inhibit Reason	APP--The APP position sensor indicated over 1 percent	Ensure the accelerator pedal was not applied during the service regeneration. If the accelerator pedal was not applied, test the accelerator pedal position (APP) sensor.
	BPP Applied--The brake pedal position indicated Applied.	Ensure that the brake pedal was not applied during the service regeneration procedure. If the brake pedal was not applied, test the brake pedal switch.
	Important: The scan tool must remain connected to the data communication link (DCL) during the entire service regeneration procedure. Device Control--The scan tool has interrupted service regeneration. A loss of communication between the scan tool and the vehicle has occurred.	- The scan tool Exit or OFF soft key button was depressed. - Inspect for a poor connection at DCL. - Ignition OFF for 90 seconds, the DPF temperature must be less than 752°F (400°C). Restart the service regeneration.
	DPF Temperature--DPF service regeneration temperatures are less than a calibrated threshold.	- Observe the DTC information. - Test for a degraded diesel oxidation catalyst (DOC). - Test for a skewed exhaust temperature sensor, EGT sensor 1.
	EGT 1 High--EGT sensor 1 temperature range was greater than a calibrated threshold for greater than 1 second.	Replace the DPF and perform the DPF Reset or For Replace The DPF with a scan tool.

	EGT 2 High--EGT sensor 2 temperature range was greater than a calibrated range for 1 second.	Replace the DPF and perform the DPF Reset or For Replace The DPF with a scan tool.
	Ignition Voltage--Battery voltage was less than 10 volts.	Test the battery and charging system for proper operation.
	None	Refer to the DPF Regeneration Status parameter
	Not in Park--Transmission gear selector is not in Park.	Ensure that the transmission gear selector remained in Park during the Service Regeneration procedure. If the gear selector remained in the Park position, test the transmission range switch and circuits.
DPF Regeneration Status	Required or Active	The DPF may be excessively restricted. Replace the DPF and perform the DPF Reset For Replace the DPF with a scan tool.

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Diesel Particulate Filter (DPF) Regeneration Enable

Important: The DPF Regeneration Enable is required when specific service procedures have been performed. Do not perform a DPF Regeneration Enable unless instructed to in the Repair Instruction section of the service procedure. After the system repair perform the following to avoid possible damage to the DPF.

1. Ignition ON, clear all DTCs with a scan tool.
2. Select DPF Regeneration Enable within the Special Function menu.
3. Select ON.

The selection can be confirmed by the DPF Regeneration Reason parameter indicating Device Control.

4. Exit the Special Function Menu. The scan tool can now be removed.

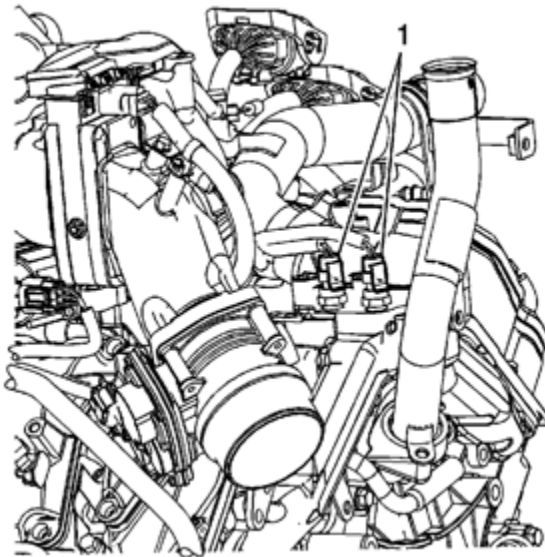
The vehicle will perform an active Regeneration as soon as the engine running conditions are met.

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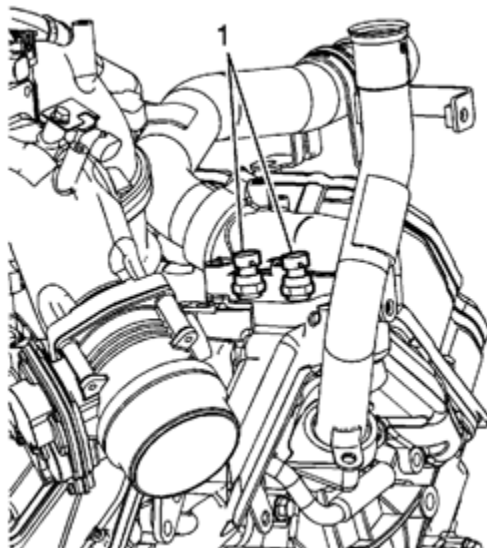
Engine Coolant Temperature Sensor Replacement

Removal Procedure

Caution: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.



1. Drain the cooling system to a level below the engine coolant temperature (ECT) sensors. Refer to [Cooling System Draining and Filling](#).
2. Disconnect the engine wiring harness electrical connector (1) from the appropriate ECT sensor.

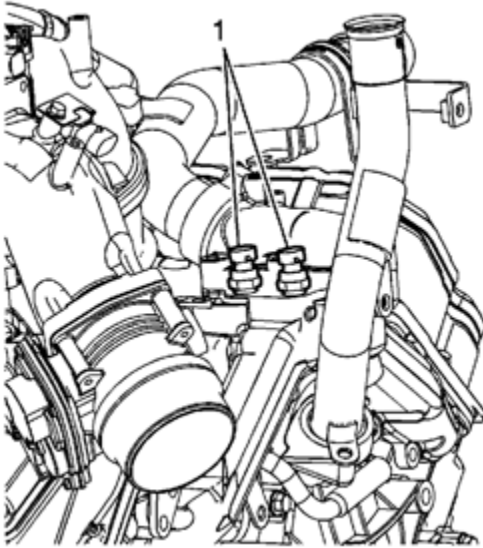




3. Remove the appropriate ECT sensor (1).

Installation Procedure

Caution: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.



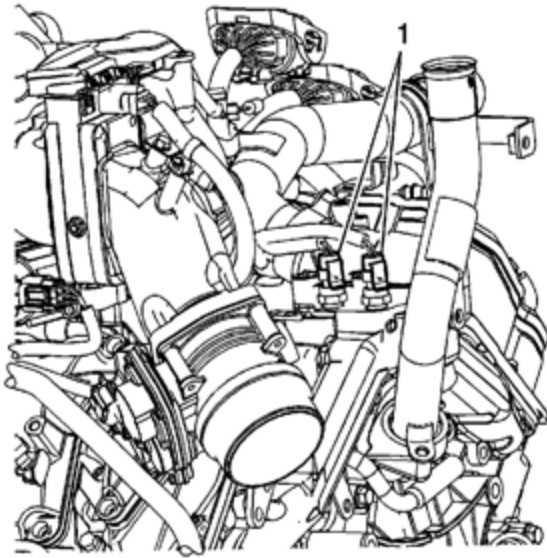
1. If installing the old sensor(s), coat the threads with sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent.

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

2. Install the appropriate ECT sensor (1).

Tighten

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

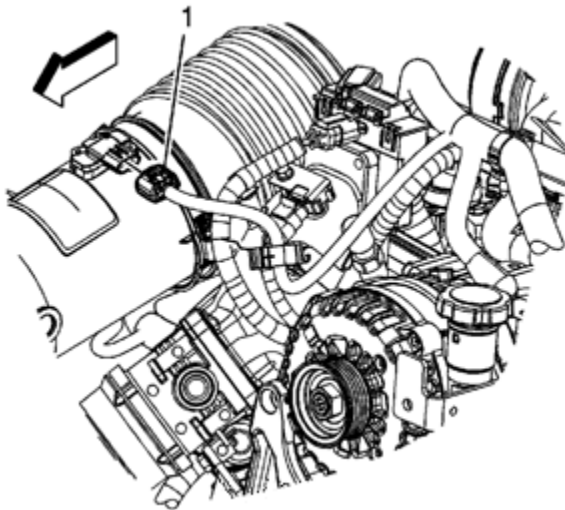


3. Connect the engine wiring harness electrical connector (1) to the appropriate ECT sensor.
4. Fill the cooling system, as necessary. Refer to [Cooling System Draining and Filling](#).

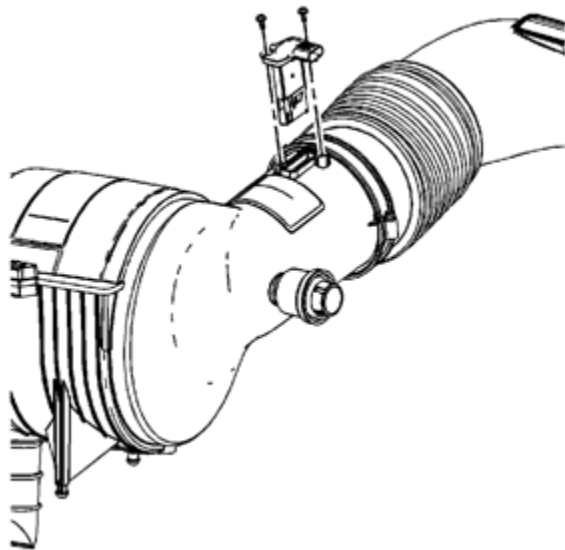
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Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

Removal Procedure



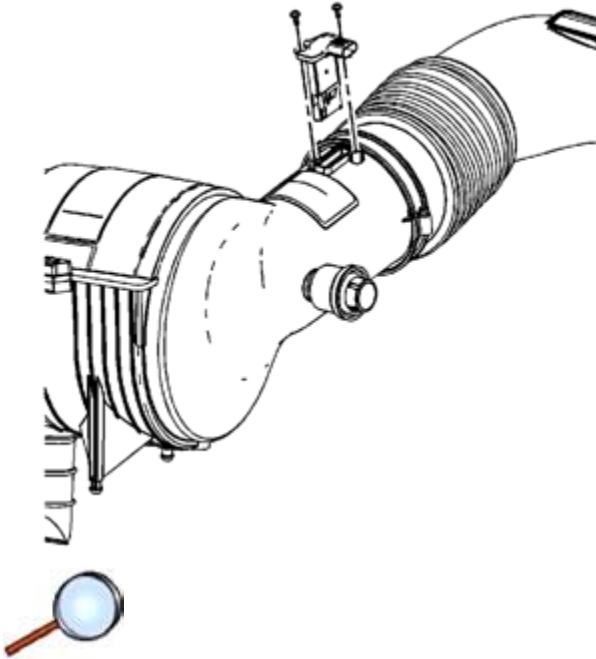
1. Disconnect the engine wiring harness electrical connector (1) from the mass air flow (MAF)/intake air temperature (IAT) sensor.



2. Remove the MAF/IAT sensor TORX® screws.

3. Remove the MAF/IAT sensor.

Installation Procedure



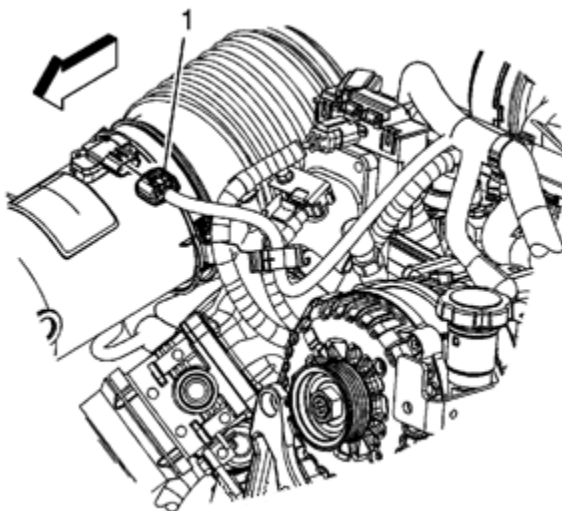
1. Install the MAF/IAT sensor.

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

2. Install the MAF/IAT sensor TORX® screws.

Tighten

Tighten the screws to 8 N·m (70 lb in).



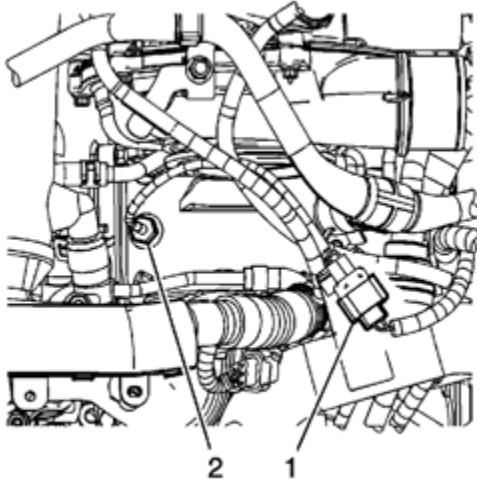


3. Connect the engine wiring harness electrical connector (1) to the MAF/IAT sensor.

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Intake Air Temperature (IAT) Sensor 2 Replacement

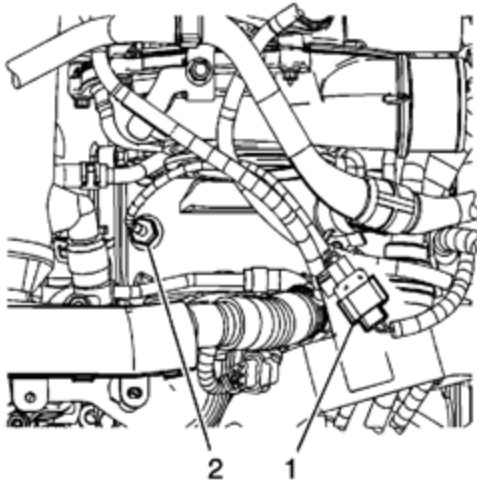
Removal Procedure



1. Remove the air intake pipe. Refer to [Air Intake Pipe Replacement](#).
2. Disconnect the engine wiring harness electrical connector (1) from the intake air temperature (IAT) sensor pigtail.
3. Remove the IAT sensor (2) from the center intake manifold.

Installation Procedure

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



1. Install the IAT sensor (2) to the center intake manifold.

Tighten

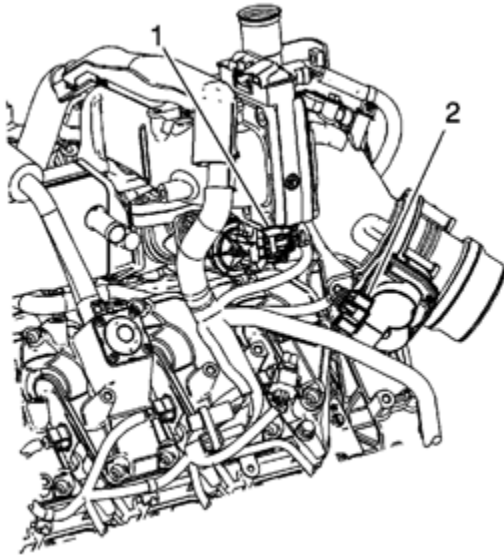
Tighten the sensor to 25 N·m (18 lb ft).

2. Connect the engine wiring harness electrical connector (1) to the IAT sensor pigtail.
3. Install the air intake pipe. Refer to [Air Intake Pipe Replacement](#).

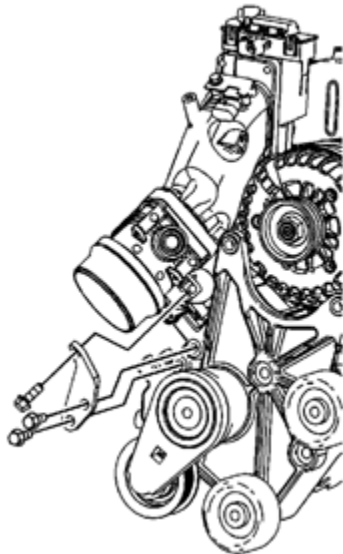
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Intake Air Valve Replacement

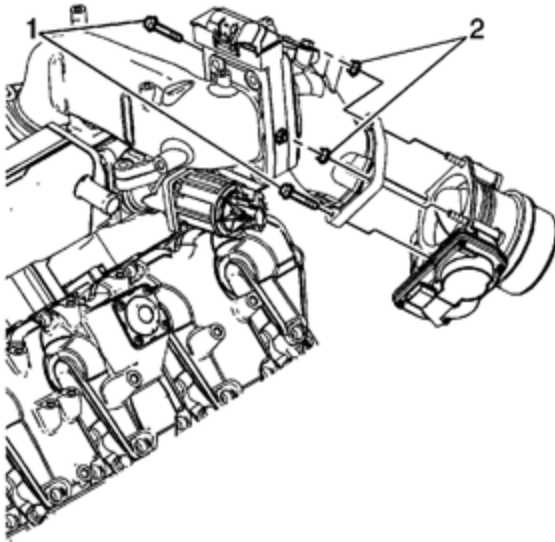
Removal Procedure



1. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
2. Remove the charge air cooler outlet pipe. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
3. Disconnect the engine wiring harness electrical connector (2) from the intake air valve.



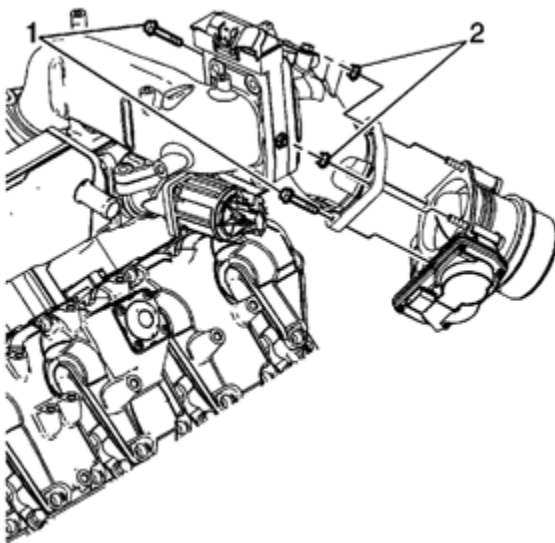
4. Remove the upper intake manifold brace bolts and brace.



5. Remove the intake air valve bolts (1), nuts (2) and valve.

Installation Procedure

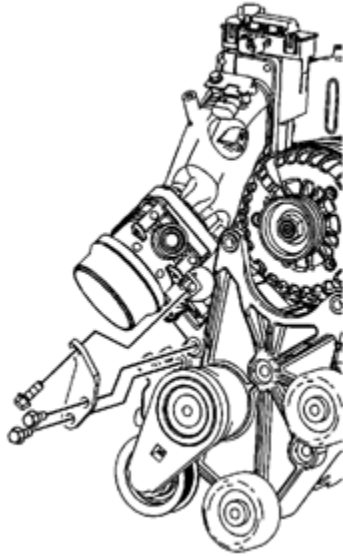
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Position the intake air valve to the intake pipe and install the intake air valve bolts (1) and nuts (2).

Tighten

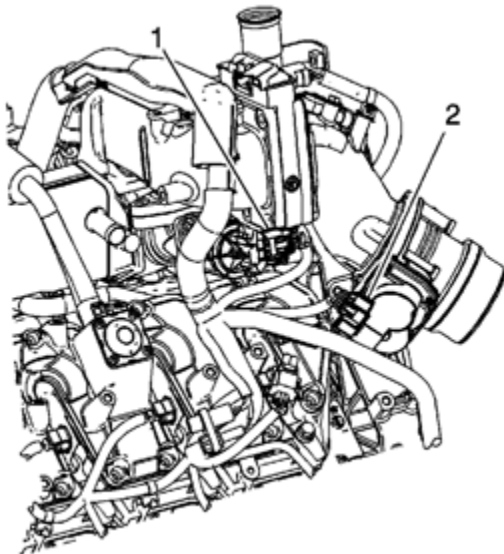
Tighten the bolts to 20 N·m (15 lb ft).



2. Install the upper intake manifold brace and bolts.

Tighten

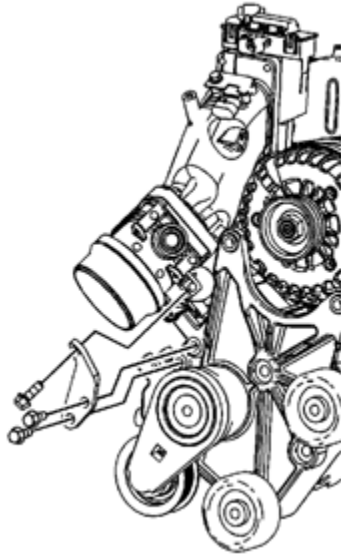
Tighten the bolts to 24 N·m (18 lb ft).



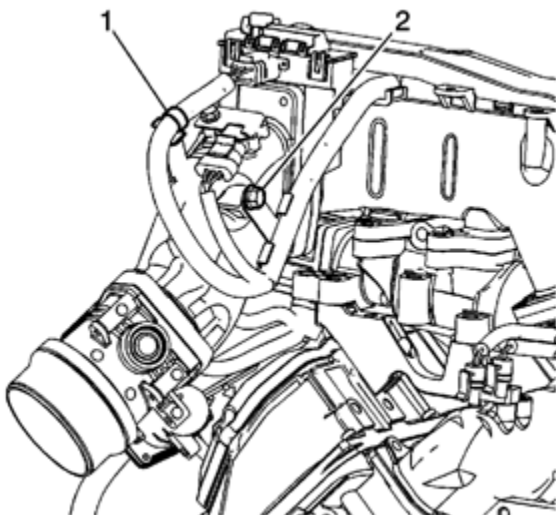
3. Connect the engine wiring harness electrical connector (2) to the intake air valve.
4. Install the charge air cooler outlet pipe. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
5. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

Intake Air Heater Replacement

Removal Procedure

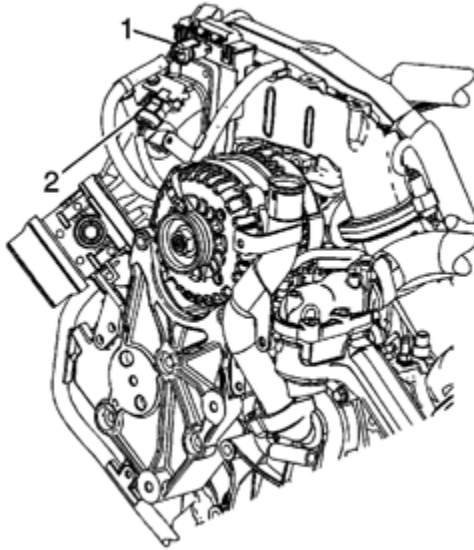


1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
3. Remove the exhaust gas recirculation (EGR) valve motor. Refer to [Exhaust Gas Recirculation Valve Motor Replacement](#).
4. Remove the upper intake manifold brace bolts and brace.

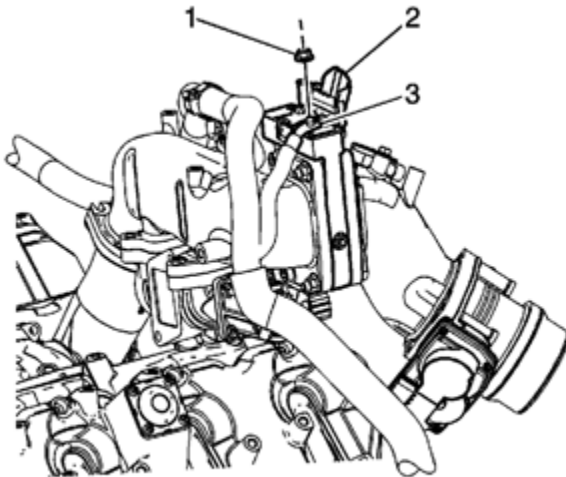




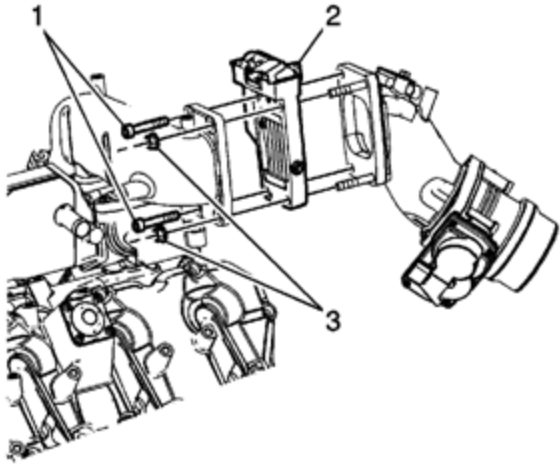
5. Remove the engine wiring harness clip (1) from the intake manifold tube.
6. Remove the engine wiring harness clip bolt (2) from the intake manifold tube.



7. Disconnect the engine wiring harness electrical connector (1) from the intake air heater (IAH).
8. Disconnect the engine wiring harness electrical connector (2) from the manifold absolute pressure (MAP) sensor.
9. Reposition the engine wiring harness branches out of the way.

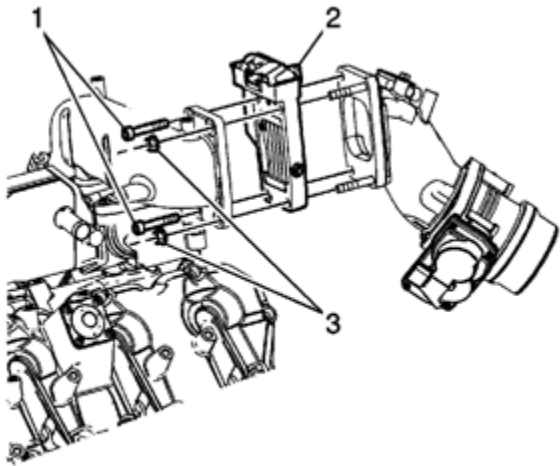


10. Open the IAH harness lead cover (2).
11. Remove the engine wiring harness lead nut (1) from the IAH stud.
12. Remove the engine wiring harness lead (3) from the IAH stud.



13. Remove the IAH bolts (1) and nuts (2).
14. Remove the intake manifold front tube and IAH from the intake manifold rear tube.
15. Remove the IAH (3) from the intake manifold front tube studs.
16. Remove and discard the IAH gasket.

Installation Procedure



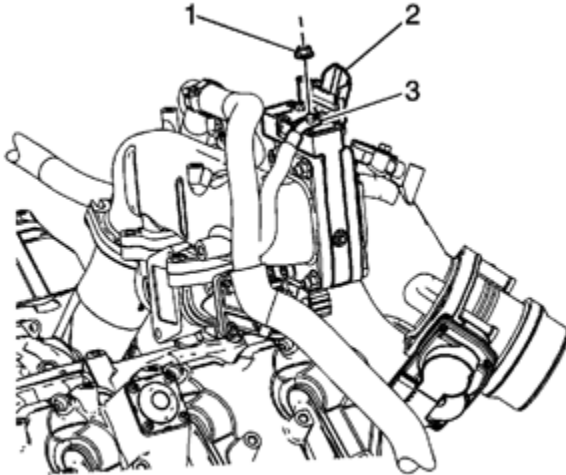
1. Install a NEW IAH gasket.
2. Install the IAH (3) to the intake manifold front tube studs.
3. Install the intake manifold front tube and IAH to the intake manifold rear tube.

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

4. Install the IAH bolts (1) and nuts (2).

Tighten

Tighten the bolts/nuts to 20 N·m (15 lb ft).

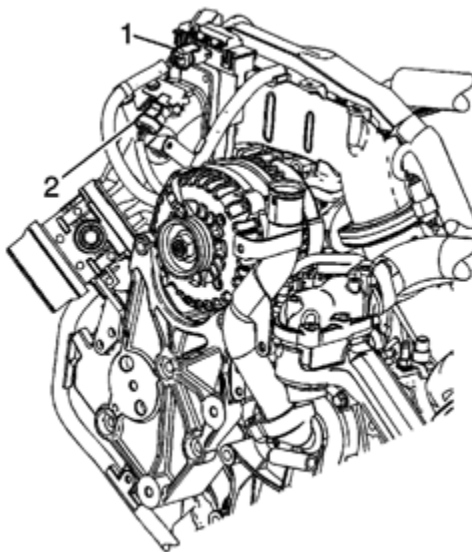


5. Install the engine wiring harness lead (3) to the IAH stud.
6. Install the engine wiring harness lead nut (1) to the IAH stud.

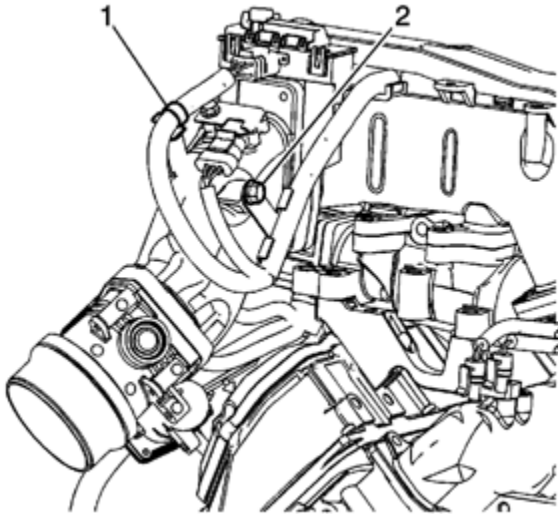
Tighten

Tighten the nut to 10 N·m (89 lb in).

7. Close the IAH harness lead cover (2).



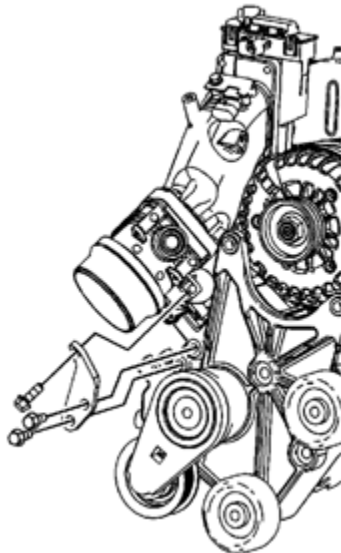
8. Position the engine wiring harness branches.
9. Connect the engine wiring harness electrical connector (2) to the MAP sensor.
10. Connect the engine wiring harness electrical connector (1) to the IAH.



11. Install the engine wiring harness clip (1) to the intake manifold tube.
12. Install the engine wiring harness clip bolt (2) to the intake manifold tube.

Tighten

Tighten the bolt to 4 N·m (35 lb in).



13. Install the upper intake manifold brace and bolts.

Tighten

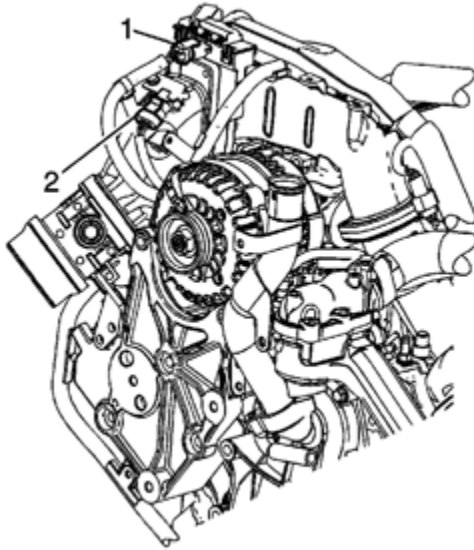
Tighten the bolts to 24 N·m (18 lb ft).

14. Install the EGR valve motor. Refer to [Exhaust Gas Recirculation Valve Motor Replacement](#).
15. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
16. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

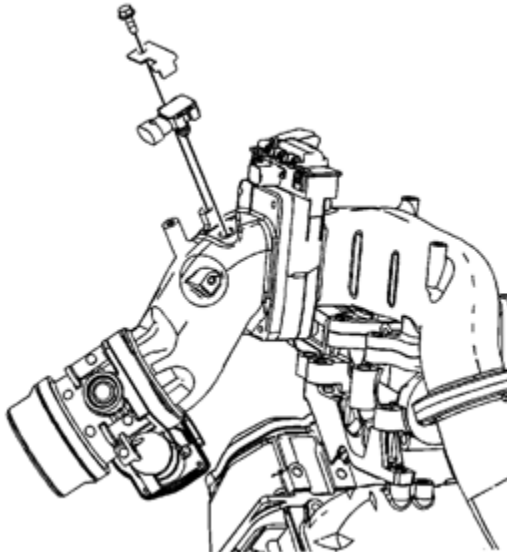
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Manifold Absolute Pressure Sensor Replacement

Removal Procedure

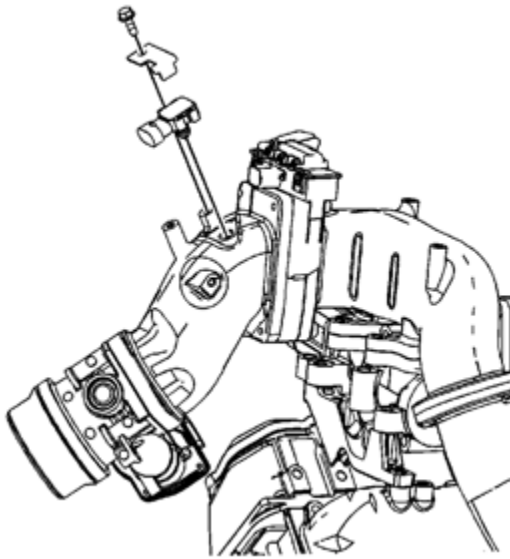


1. Disconnect the engine wiring harness electrical connector (2) from the manifold absolute pressure (MAP) sensor.



2. Remove the MAP sensor bolt.
3. Remove the MAP sensor bracket and sensor.

Installation Procedure



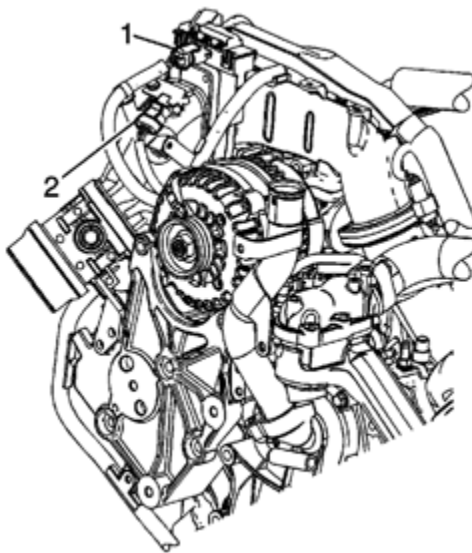
1. Install the MAP sensor and bracket.

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

2. Install the MAP sensor bolt.

Tighten

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





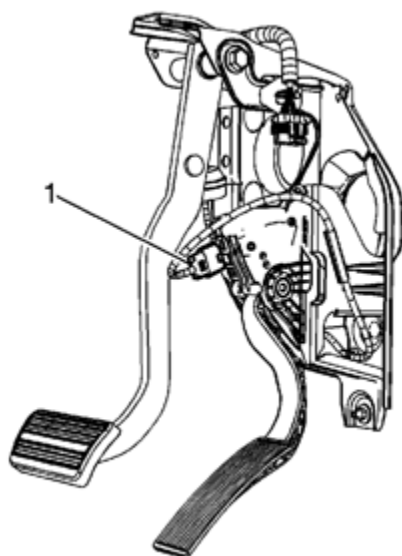
3. Connect the engine wiring harness electrical connector (2) to the MAP sensor.

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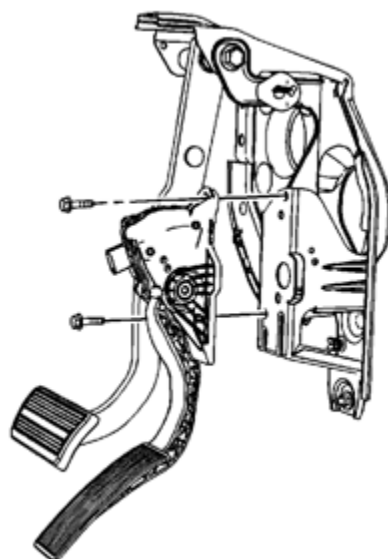
Accelerator Pedal Position Sensor Replacement

Removal Procedure

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.



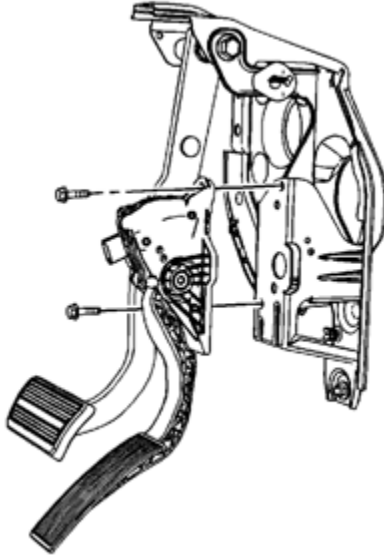
1. Remove the connector position assurance (CPA) retainer.
2. Disconnect the accelerator pedal position (APP) sensor electrical connector (1).





3. Remove the accelerator pedal bolts.
4. Remove the accelerator pedal.

Installation Procedure



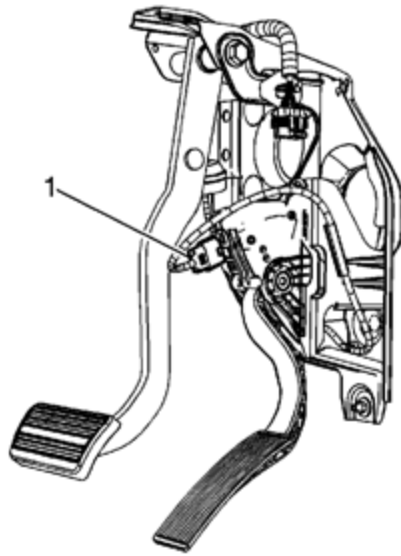
1. Position the accelerator pedal to the accelerator pedal bracket.

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

2. Install the accelerator pedal bolts.

Tighten

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



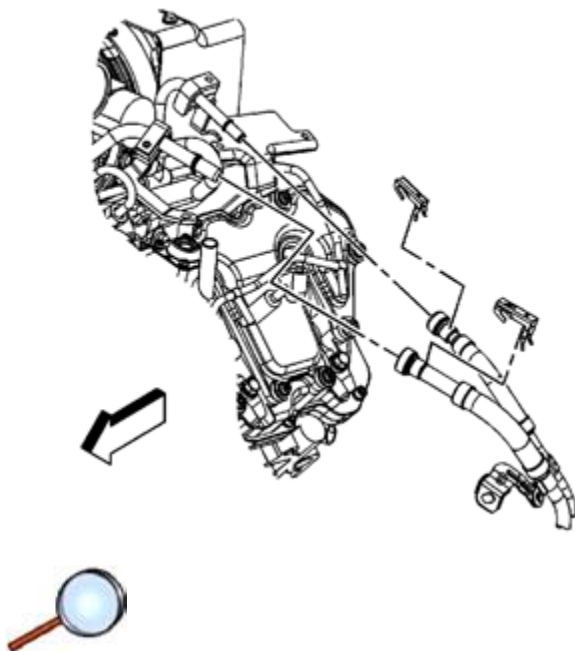
3. Connect the APP sensor electrical connector (1).
4. Install the CPA retainer.
5. Connect a scan tool to the diagnostic port in order to test for proper throttle-opening and throttle-closing range.
6. Operate the accelerator pedal and monitor the throttle angles. The accelerator pedal should operate freely, without binding, between a closed throttle, and a wide open throttle (WOT).
7. Verify that the vehicle meets the following conditions:
 - The vehicle is not in a reduced engine power mode.
 - The ignition is ON.
 - The engine is OFF.
8. Inspect the carpet fit under the accelerator pedal.

Metal Collar Quick Connect Fitting Service

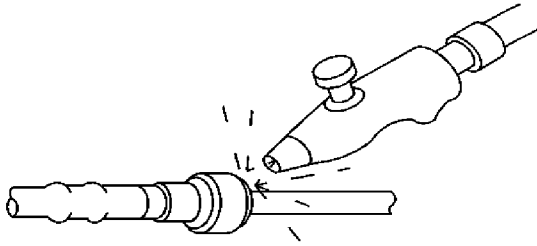
Special Tools

- [J 44581](#) Fuel Line Disconnect Tool
- [J 43178](#) Fuel Line Disconnect Tool
- [J 41769](#) Fuel Disconnect Tool

Removal Procedure

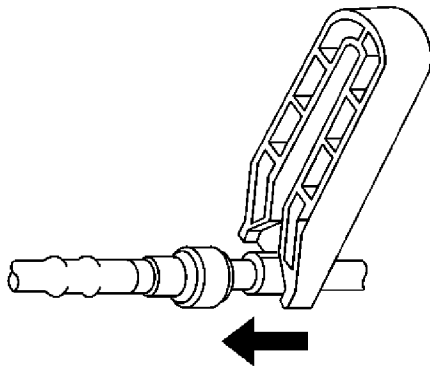


1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the fuel fill cap.
3. Remove the retainers from the fuel feed and return pipe quick connect fittings.

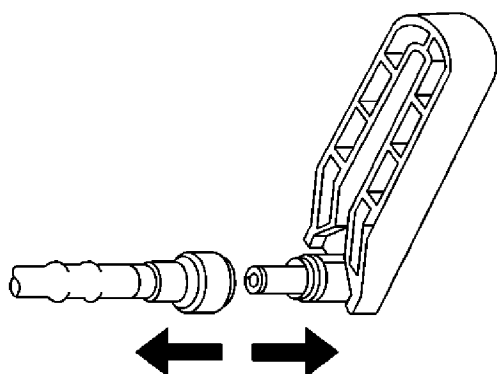


Warning: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

4. Using compressed air, blow any dirt or debris from around the fitting.



5. Using the correct end of [J 44581](#) for the size of the fitting. Insert [J 44581](#) into the female connector, then push inward in order to release the locking tabs.
6. If the vehicle is a cab/chassis, it may be necessary to use [J 43178](#) in order to release the quick connect fittings at the sending unit.
7. If disconnecting the fuel return line, it may be necessary to use [J 41769](#) in order to release the quick connect fitting.



8. Pull the connection apart.
9. Use a clean shop towel in order to wipe off the male end.

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.

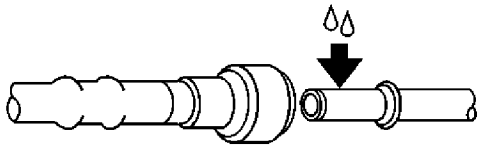
10. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation Procedure

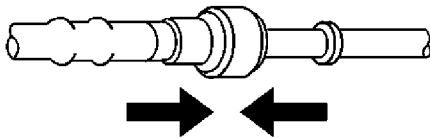
Warning: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.

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

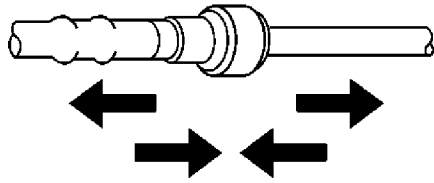
During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.



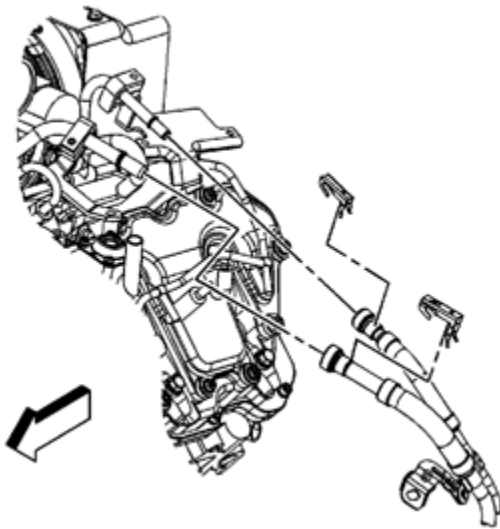
1. Apply a few drops of clean engine oil to the male connection end.



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



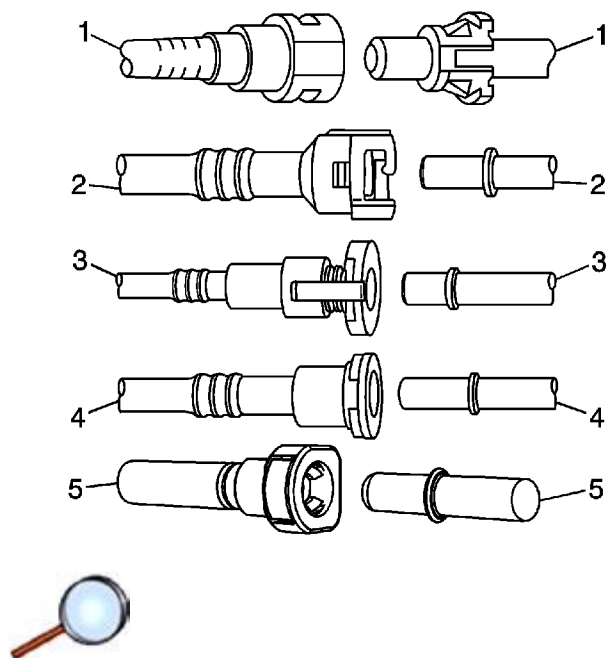
3. Once installed, pull on both sides of the connections in order to make sure the connection is secure.



4. Install the retainers to the fuel feed/return pipes.
5. Install the fuel fill cap.
6. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Plastic Collar Quick Connect Fitting Service

Disconnect Procedure



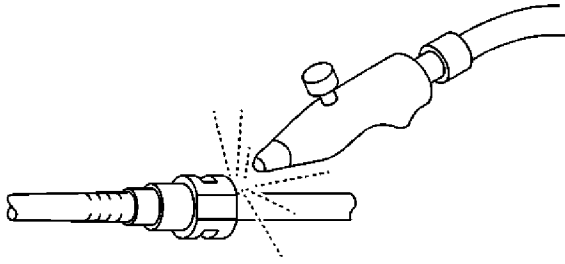
Note: There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.

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

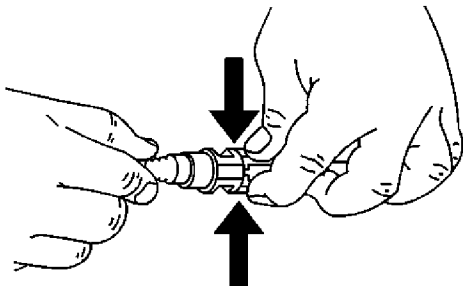
The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

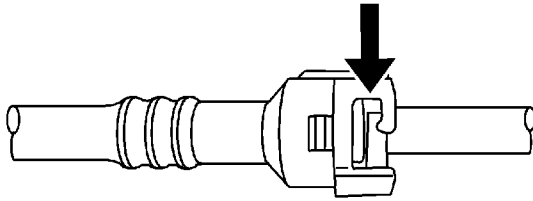
Warning: Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) in the Preface section.



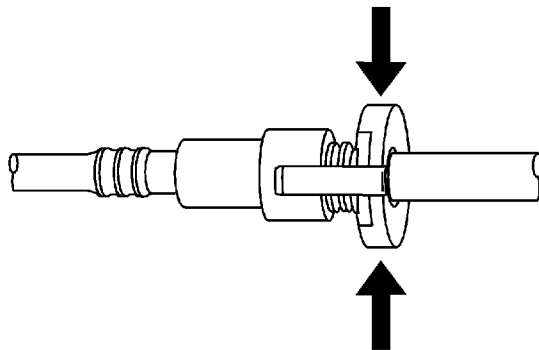
2. Using compressed air, blow any dirt or debris from around the connection.



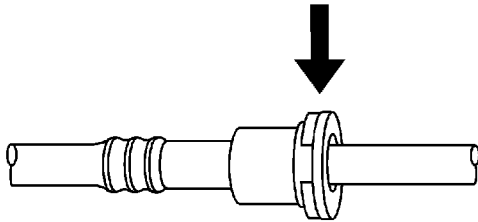
3. This step applies to Bartholomew style connector ONLY. Squeeze the plastic quick connect fitting release tabs.



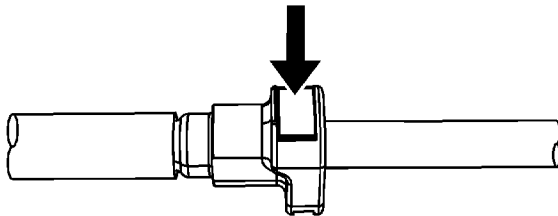
4. This step applies to Release Tab style connector ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.



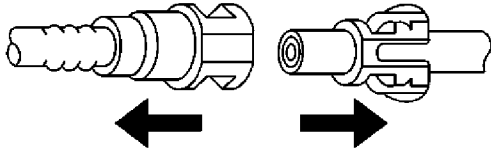
5. This step applies to the Squeeze to Release style connector ONLY. Squeeze where indicated by the arrows shown above on both sides of the plastic ring surrounding the quick connect fitting.



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.



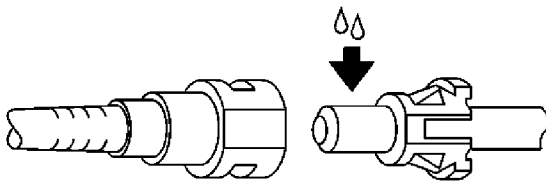
7. This step applies to the Push Down TI style connector ONLY. Release the fitting by pressing on the tab indicated by the arrow.



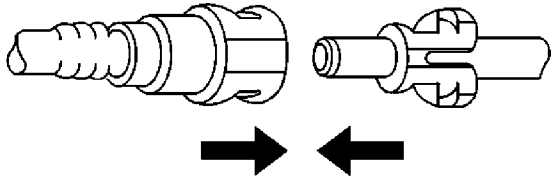
8. Pull the connection apart.

Connect Procedure

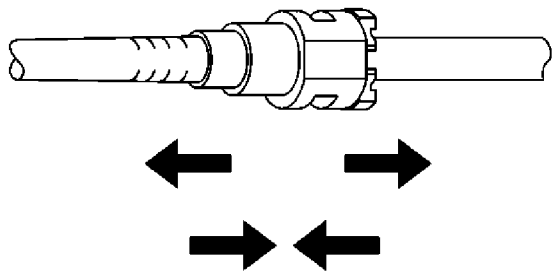
Warning: Refer to [Fuel Pipe Fitting Warning](#) in the Preface section.



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.



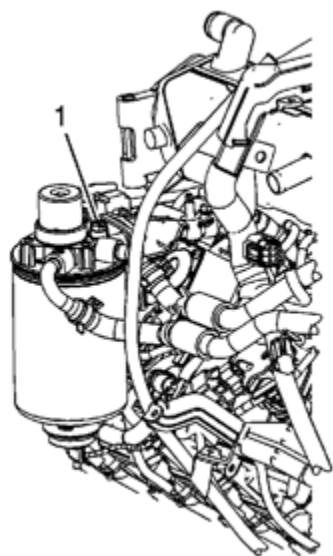
3. Once installed, pull on both sides of the connection in order to make sure the connection is secure.
4. Install the fuel fill cap.
5. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Fuel System Priming

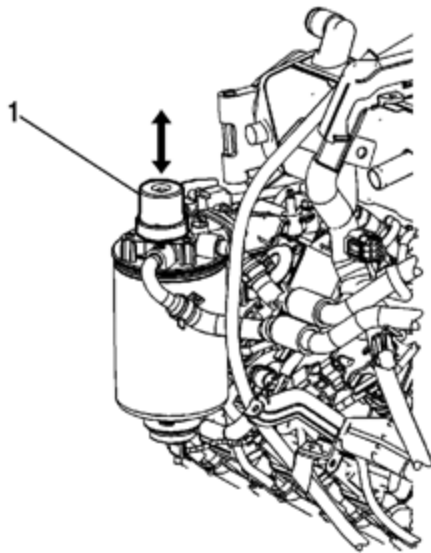
Important: In order for the diesel fuel system to work properly, the fuel lines must be full of fuel and contain no air. If air gets into the fuel lines, it will be necessary to prime the fuel system to eliminate the air before operating the vehicle. Air could have entered the system in one of the following ways:

- The vehicle ran out of fuel.
- The filter was removed for service or replacement.
- The fuel lines were removed or disconnected for servicing.
- The fuel filter water drain cock was opened while the engine was running.

If one or more of the above occurred, air has entered the fuel system and you will need to prime the system prior to operating the vehicle.



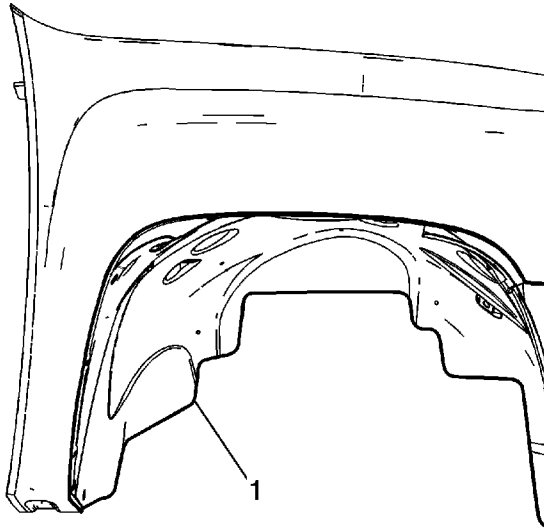
1. Prior to priming the fuel system, ensure that the following has been completed:
 - There is fuel in the fuel tank.
 - The fuel filter has been installed and properly tightened.
 - The fuel lines are properly connected.
 - The fuel filter is cool to the touch.
 - Any dirt or debris has been removed from the fuel filter adapter and vent valve screw.
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Open the vent valve screw (1) by turning the screw counterclockwise several full turns.



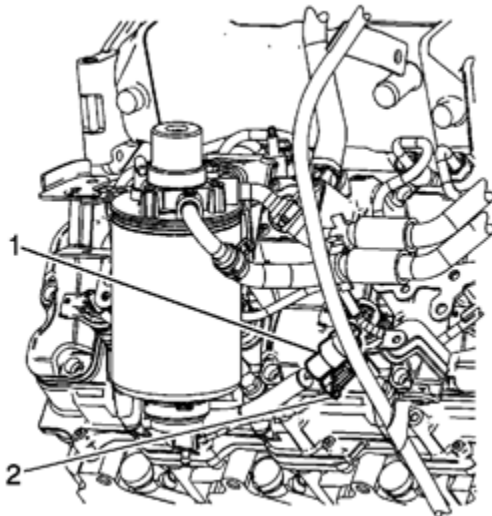
4. Operate the priming pump (1) until a small amount of fuel seeps from the vent valve. Allow the pump to fully return upward between pumps. When fuel is present, the filter is full of fuel and the system is primed.
5. Close the vent valve screw.
6. Clean any fuel which accumulated on the fuel filter adapter.
7. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
8. Start the engine and allow the engine to idle for a few minutes.
9. Check the fuel system for leaks.

Fuel Filter Replacement

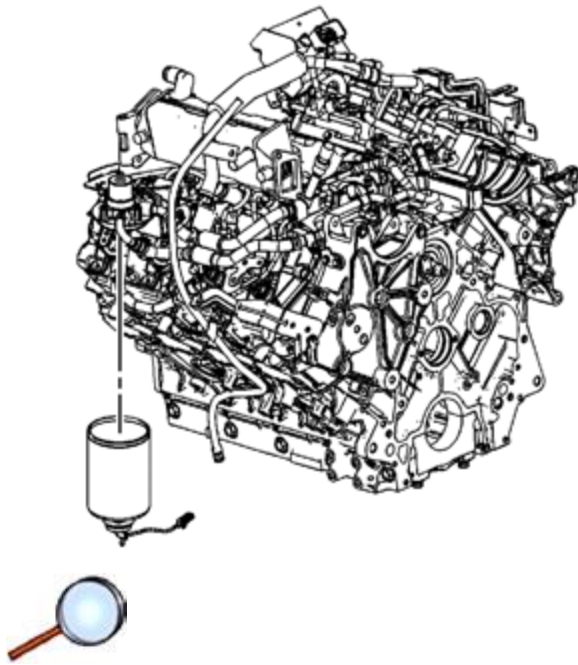
Removal Procedure



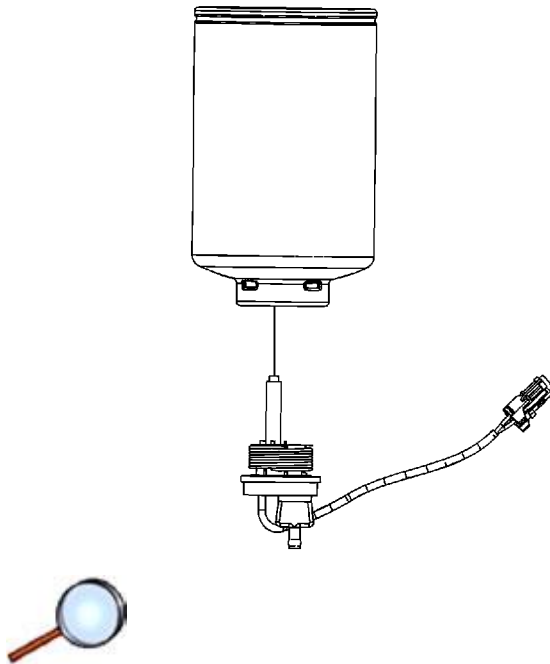
1. Drain the fuel from the fuel filter. Refer to [Water-in-Fuel Draining](#).
2. Remove the right front wheelhouse liner rear bolts/retainers as required to reposition the rear half of the wheelhouse liner (1) in order to access the fuel filter.



3. Disconnect the water-in-fuel sensor wiring pigtail (2) from the engine wiring harness electrical connector.

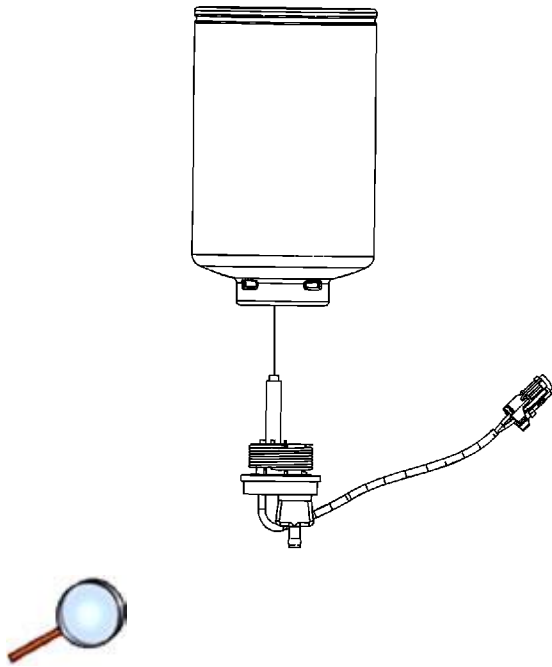


4. Remove the fuel filter from the fuel filter adapter.



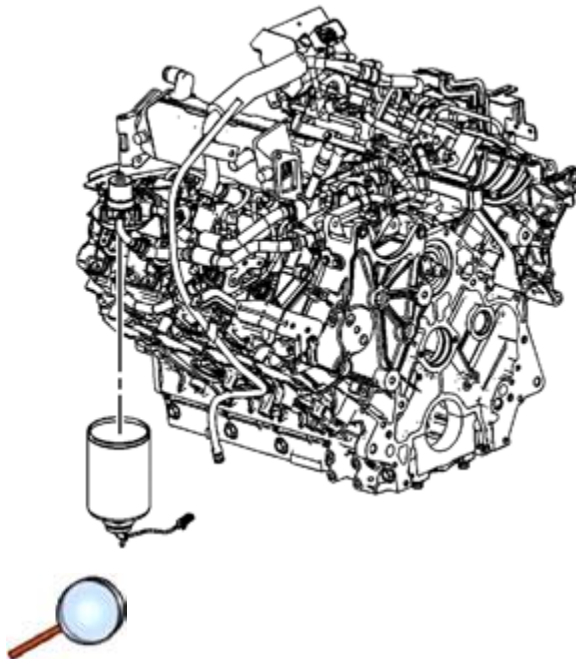
5. Remove the water-in-fuel sensor from the fuel filter.

Installation Procedure

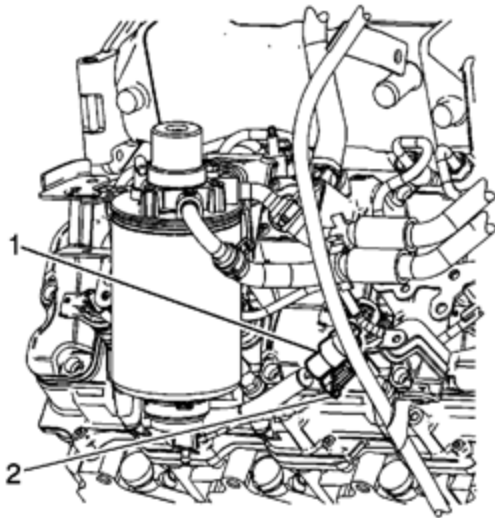


Note: Inspect the fuel heater element housing for contamination. Contamination on the fuel heater element housing may cause leakage at the fuel filter. Coat the fuel filter seal with clean engine oil.

1. Install the water-in-fuel sensor to the NEW fuel filter, and tighten 1/2 turn after the seal contacts the filter.

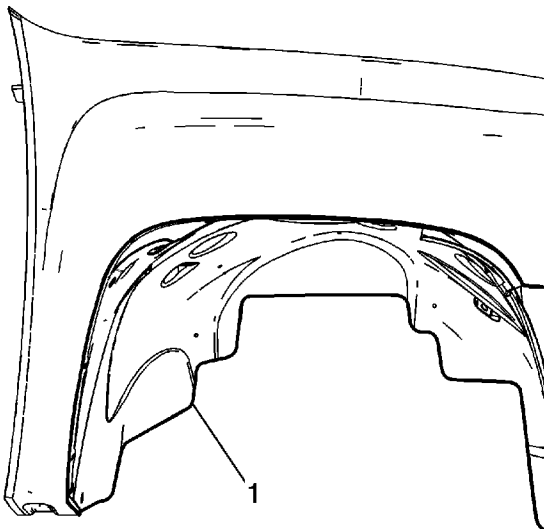


2. Install the NEW fuel filter to the fuel filter adapter, and tighten 1/4 turn after the seal contacts the filter adapter.



3. Connect the water-in-fuel sensor wiring pigtail (2) to the engine wiring harness electrical connector.

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



4. Position the rear half of the wheelhouse liner (1) and install the rear bolts/retainers as required.

Tighten

Tighten the bolts, if required to 2.5 N·m (22 lb in).

5. Prime the fuel system. Refer to [Fuel System Priming](#).

6. Start the engine. If the engine stalls, repeat the above step.
7. Once the engine starts, inspect for fuel leaks.

Fuel Filter Life Reset

This message will appear when a reset is performed either by using the steering wheel controls or following manual procedure.

1. Reset the fuel filter monitor.
2. For vehicles with steering wheel controls, press and hold the select button for 5 seconds while the FUEL FILTER LIFE message is displayed.

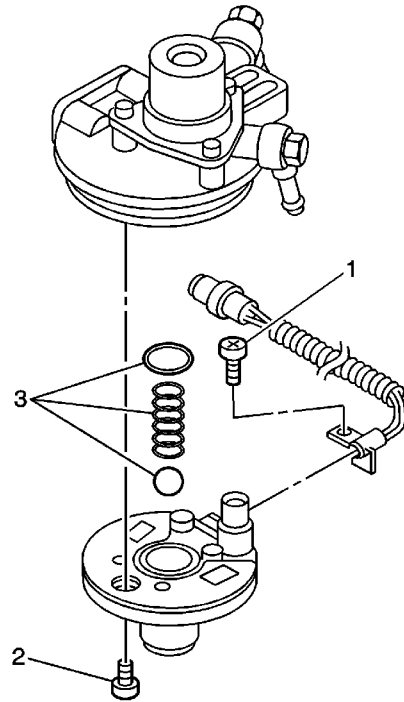
This message will appear on the driver information center (DIC) for ten seconds.

3. For vehicles without steering wheel controls, do the following:
 - 3.1. Without pressing the pedals, turn the ignition key to the ON position without starting the engine.
 - 3.2. Wait 5 seconds.
 - 3.3. Completely press the brake and the accelerator pedals simultaneously and hold for 10 seconds. The system is now reset.
 - 3.4. Turn the ignition key OFF.
4. The next time the engine is started, the message will no longer be displayed.

ALWAYS reset the FUEL FILTER LIFE system after a fuel filter change.

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Fuel Heater Replacement



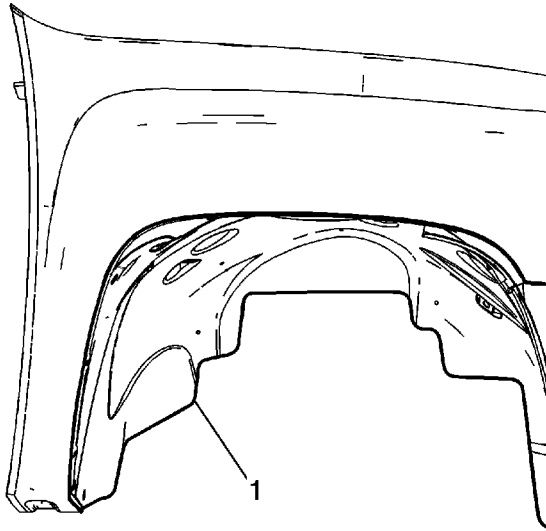
Callout	Component Name
Preliminary Procedure	
Remove the fuel filter assembly from the vehicle. Refer to Fuel Filter Assembly Replacement .	
1	Ground Wire Screw Procedure 1. Disconnect the electrical connector. 2. Hand tighten the ground wire screw until snug.
2	Fuel Heater Screw Procedure Hand tighten the fuel heater screw until snug.
3	Fuel Heater Spring and Seals Procedure

Take note of original spring and seal positions.

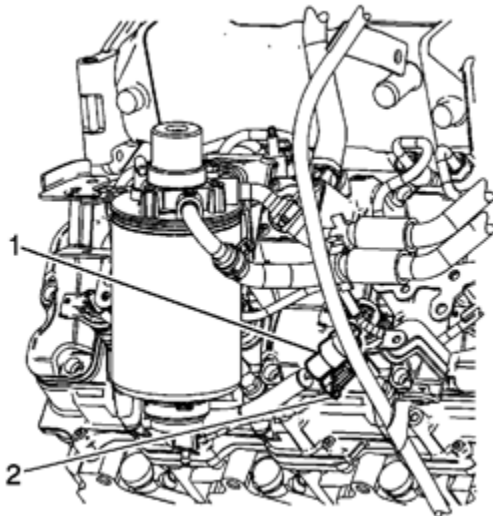
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Water in Fuel Indicator Sensor Replacement

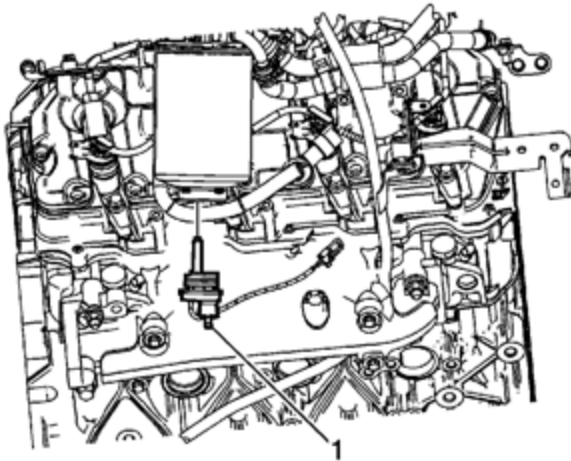
Removal Procedure



1. Drain the fuel from the fuel filter. Refer to [Water-in-Fuel Draining](#).
2. Remove the right front wheelhouse liner rear bolts/retainers as required to reposition the rear half of the wheelhouse liner (1) in order to access the water in fuel sensor.

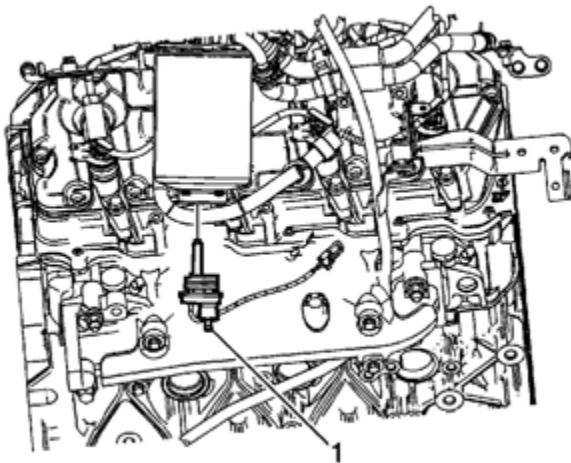


3. Disconnect the water in fuel sensor wiring pigtail (2) from the engine wiring harness electrical connector.

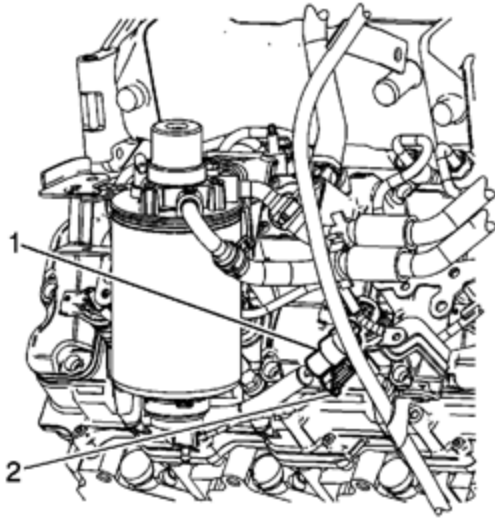


4. Remove the water in fuel sensor (1) from the fuel filter.

Installation Procedure

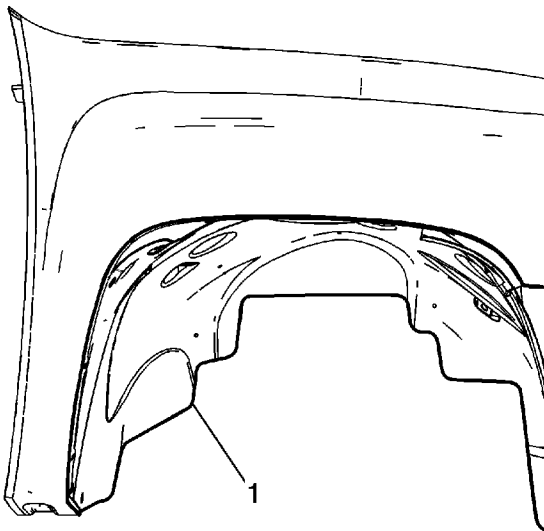


1. Install the water in fuel sensor (1) to the fuel filter, and tighten $\frac{1}{2}$ turn after the seal contacts the filter.



2. Connect the water in fuel sensor wiring pigtail (2) to the engine wiring harness electrical connector.

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



3. Position the rear half of the wheelhouse liner (1) and install the rear bolts/retainers as required.

Tighten

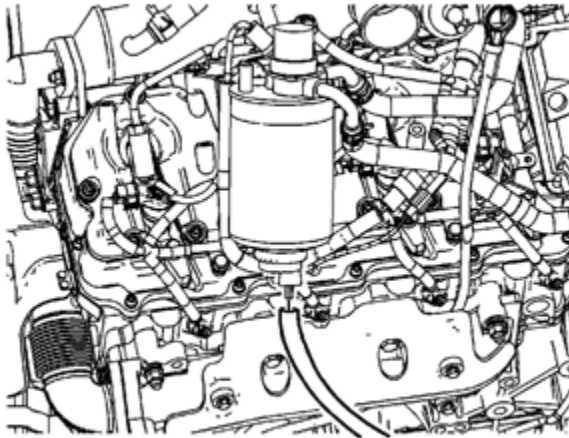
Tighten the bolts, if required to 2.5 N·m (22 lb in).

4. Prime the fuel system. Refer to [Fuel System Priming](#).

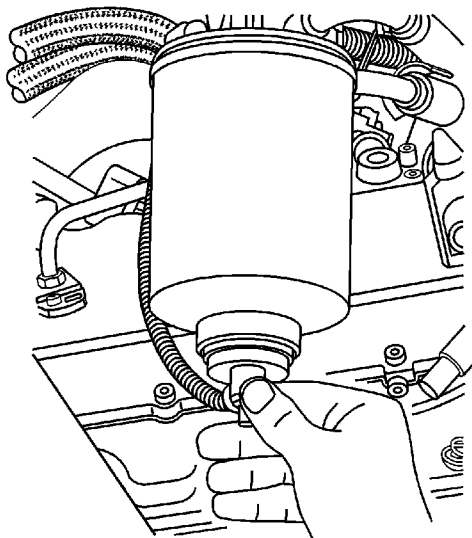
5. Start the engine. If the engine stalls, repeat the above step.
6. Once the engine starts, inspect for fuel leaks.

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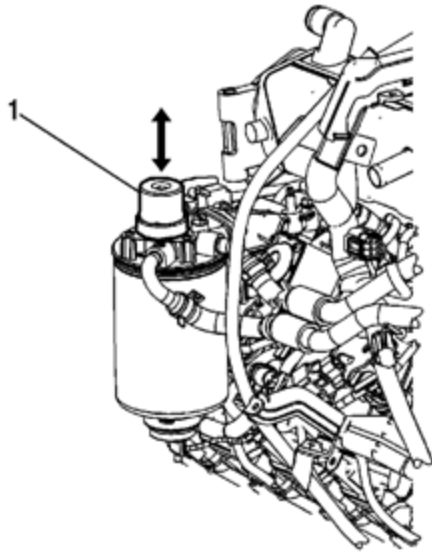
Water-in-Fuel Draining



1. Attach a small piece of hose to the drain onto the water in fuel sensor.
2. Place the other end of the piece of hose into an approved fuel-resistant container.



3. Open the drain 3 or 4 turns or until the water contaminated fuel seeps from the drain.

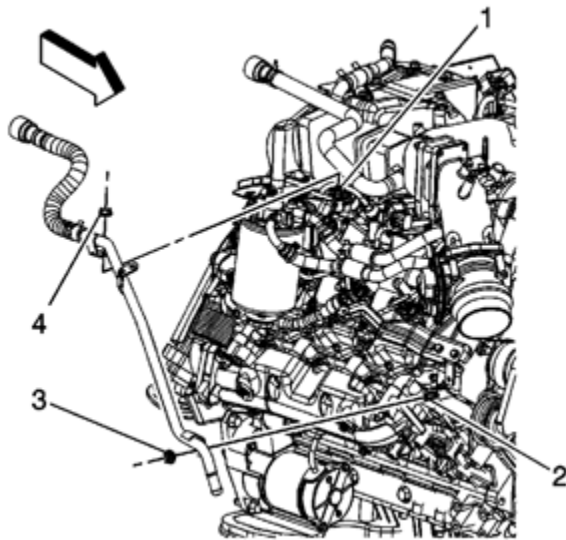


4. Operate the priming pump (1) until only diesel fuel is visible. Allow the pump to fully return upward between pushes.
5. Tighten the drain.
6. Remove the container and hose.

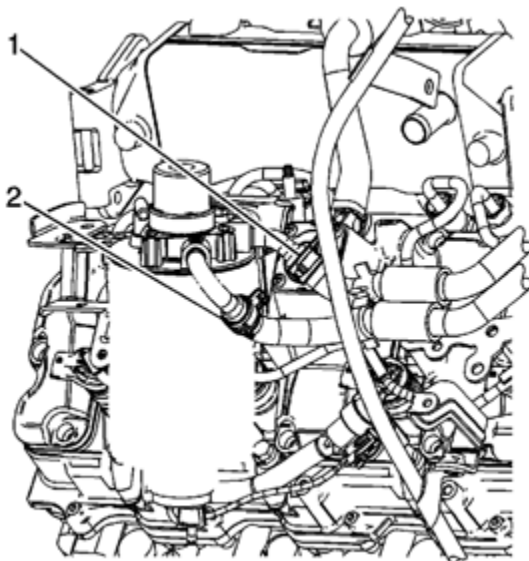
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Fuel Filter Assembly Replacement

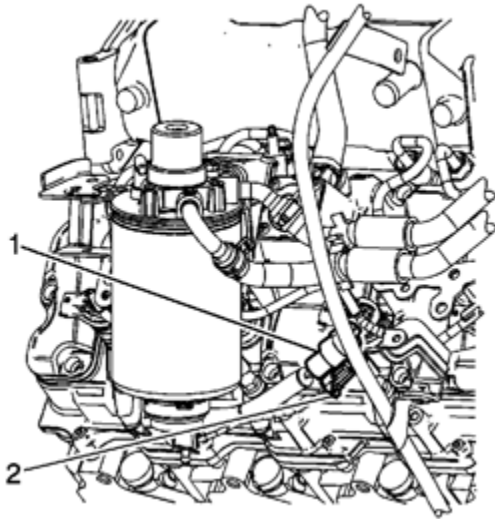
Removal Procedure



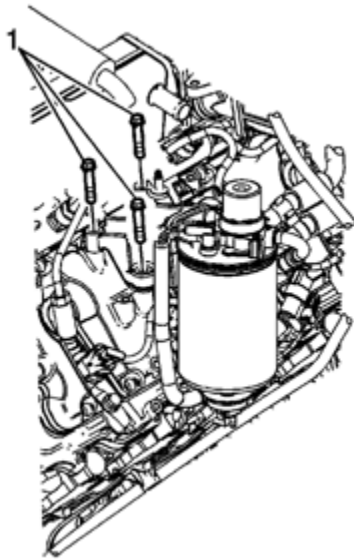
1. Drain the fuel from the fuel filter. Refer to [Water-in-Fuel Draining](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Remove the heater inlet hose bracket nut (4) from the fuel filter adapter stud (1).
4. Remove the heater inlet hose bracket from the stud and position the hose out of the way.



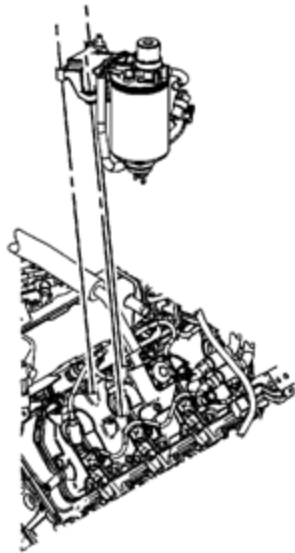
5. Reposition the fuel filter hose clamps (1 and 2).
6. Remove the fuel filter hoses from the fuel filter adapter.



7. Disconnect the fuel filter heater wiring pigtail (1) from the engine wiring harness electrical connector.
8. Disconnect the water in fuel sensor wiring pigtail (2) from the engine wiring harness electrical connector.

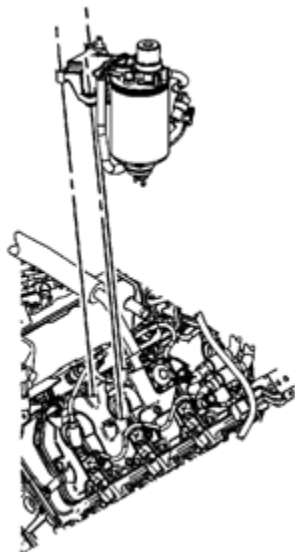


9. Remove the fuel filter bracket bolts (1).



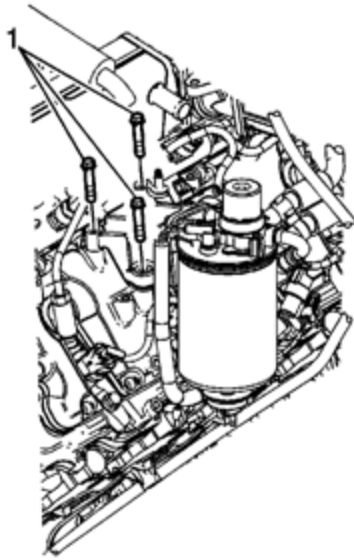
10. Remove the fuel filter and bracket assembly.

Installation Procedure



1. Position the fuel filter and bracket assembly to the upper valve rocker arm cover.

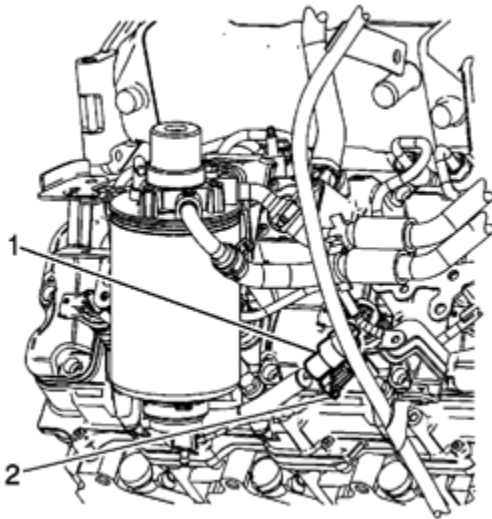
Caution: Refer to [Fastener Caution](#) in the Preface section.



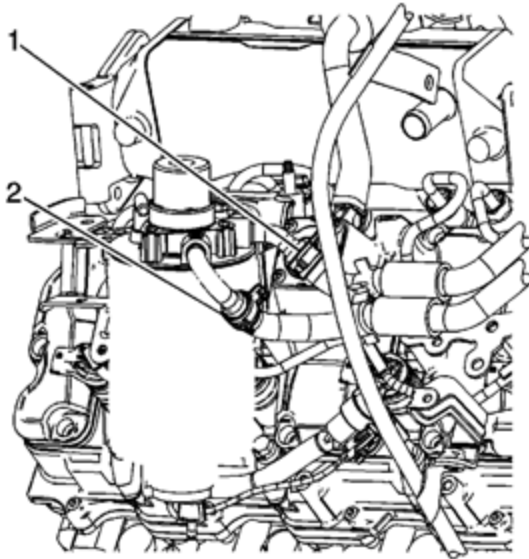
2. Install the fuel filter bracket bolts (1).

Tighten

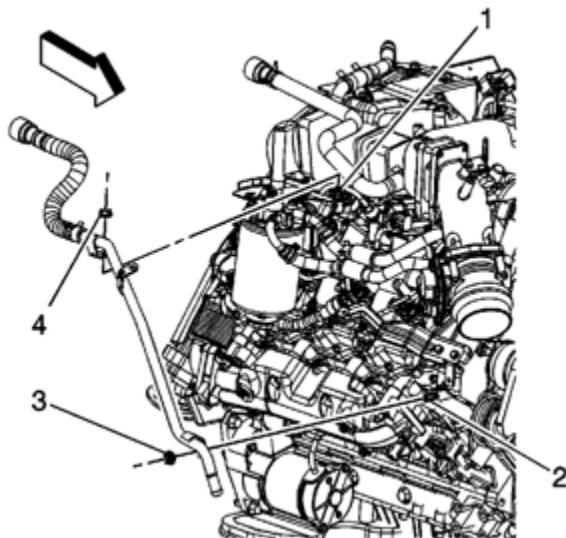
Tighten the bolts to 20 N·m (15 lb ft).



3. Connect the fuel filter heater wiring pigtail (1) to the engine wiring harness electrical connector.
4. Connect the water in fuel sensor wiring pigtail (2) to the engine wiring harness electrical connector.



5. Install the fuel filter hoses to the fuel filter adapter.
6. Position the fuel filter hose clamps (1 and 2).



7. Position the heater inlet hose and install the heater inlet hose bracket to the stud.
8. Install the heater inlet hose bracket nut (4) to the fuel filter adapter stud (1).

Tighten

Tighten the nut to 9 N·m (80 lb in).

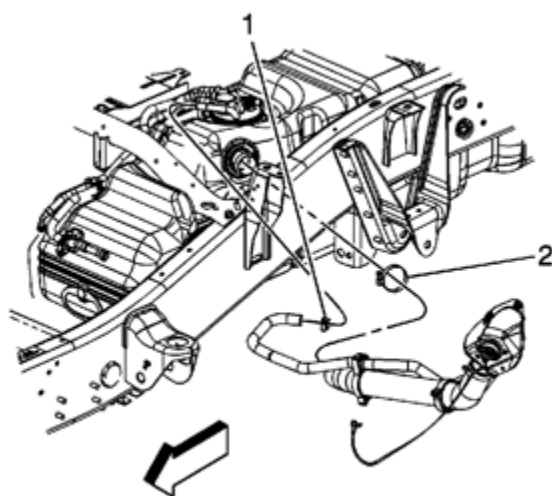
9. Prime the fuel system. Refer to [Fuel System Priming](#).
10. Start the engine. If the engine stalls, repeat the above step.
11. Once the engine starts, inspect for fuel leaks.

Fuel Tank Draining

Tools Required

[J 45004](#) Fuel Tank Siphon Hose

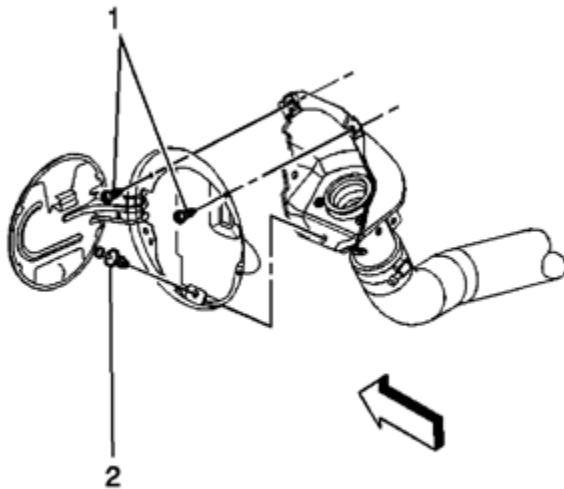
Important: Purge any residual fuel in [J 45004](#) into an approved container prior to use.



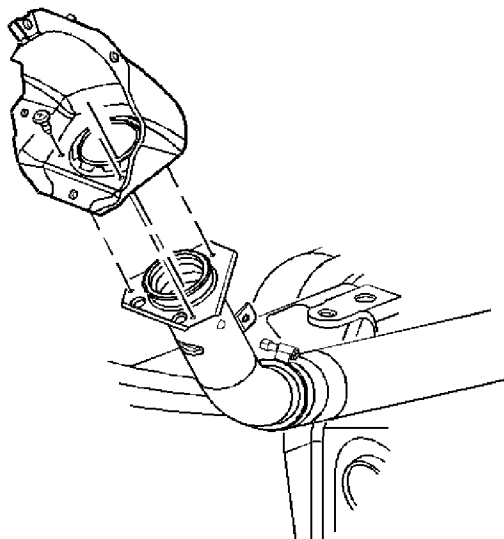
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#) .
2. Remove the fuel fill cap.
3. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
4. Loosen the fuel fill pipe clamp (2).
5. Remove the fuel fill pipe from the fuel tank.
6. Insert the [J 45004](#) hose into the tank.
7. Attach the [J 45004](#) hose to the hose used with the hand or air operated pump device.
8. Using a hand or air operated pump drain as much fuel from the tank as possible.

Fuel Tank Replacement (Pickup)

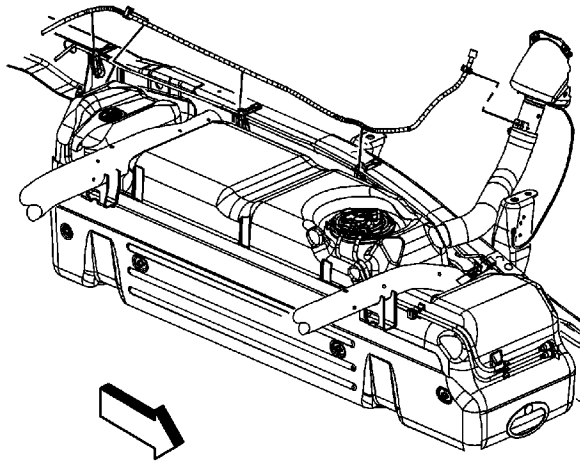
Removal Procedure



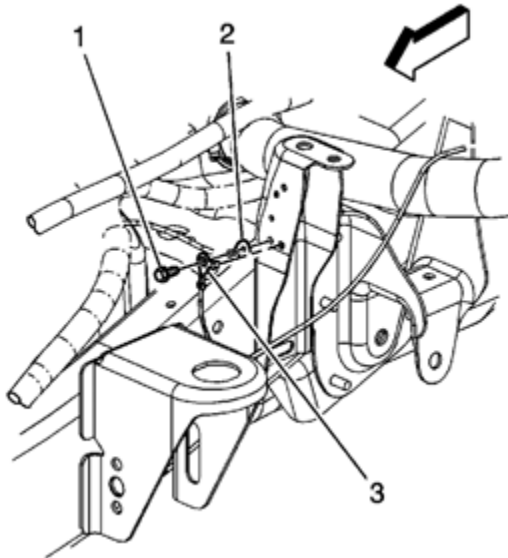
1. Drain the fuel tank. Refer to [Fuel Tank Draining](#).
2. Remove the fuel tank filler housing to body screws (1), and retainer (2).



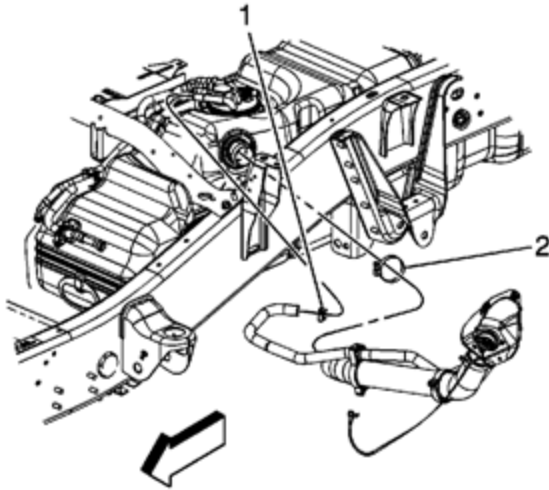
3. Remove the fuel tank filler housing to fuel tank fill pipe screws.
4. Remove the fuel tank



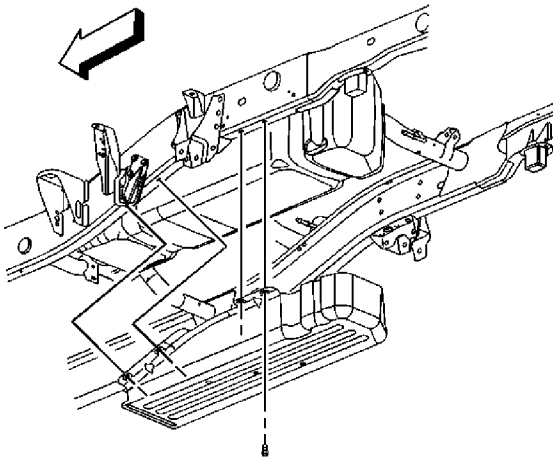
5. Remove the rear axle vent hose from the clip on the fuel fill pipe bracket.
6. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



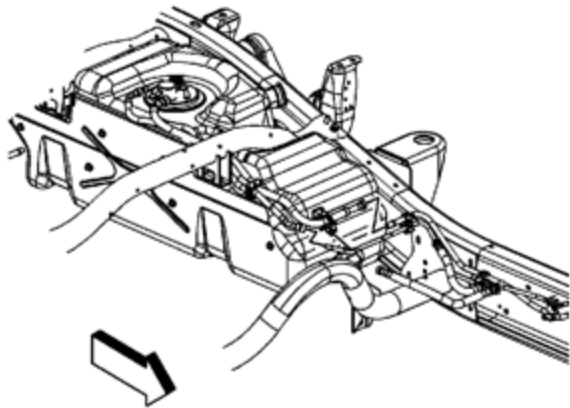
7. Remove the fuel tank ground strap bolt (1).
8. Reposition the fuel tank ground strap (3).



9. Loosen the fill pipe vent hose clamp (1) at the fuel tank.
10. Remove the fill pipe vent hose from the fuel tank.
11. Remove the fill pipe.
12. Remove the fuel system cooler. Refer to [Fuel Cooler Replacement](#).

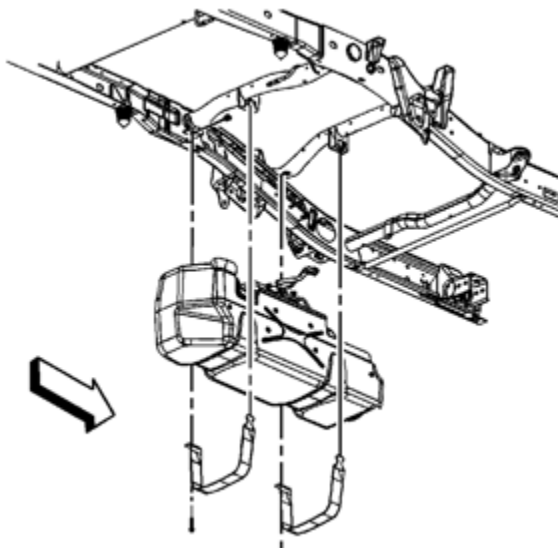


13. If equipped, remove the fuel tank shield bolts.
14. If equipped, remove the fuel tank shield.

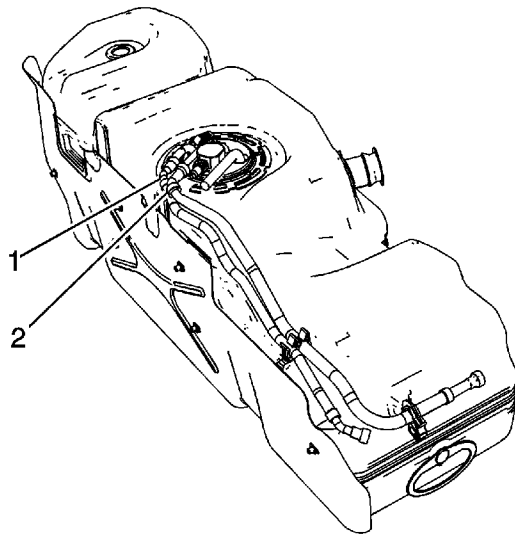


15. Disconnect the fuel feed and return lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
16. Cap the fuel lines in order to prevent possible fuel system contamination.
17. Place a suitable adjustable jack under the fuel tank.

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

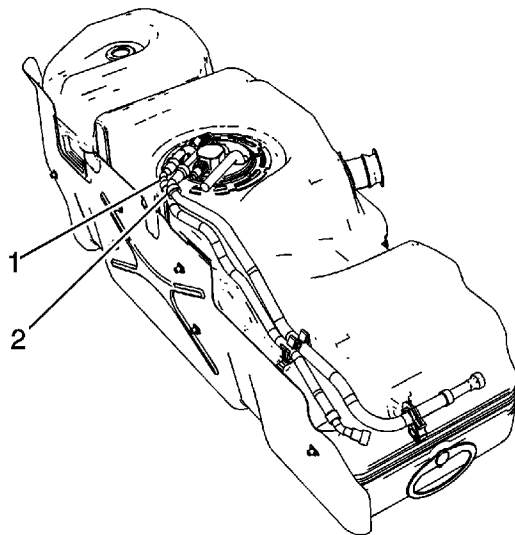


18. Remove the fuel tank strap bolts.
19. Remove the fuel tank straps.
20. Lower the fuel tank until the sending unit electrical connector is accessible.
21. Disconnect the sending unit electrical connector.
22. Completely lower the fuel tank.
23. With the aid of an assistant, place the fuel tank in a suitable work area.

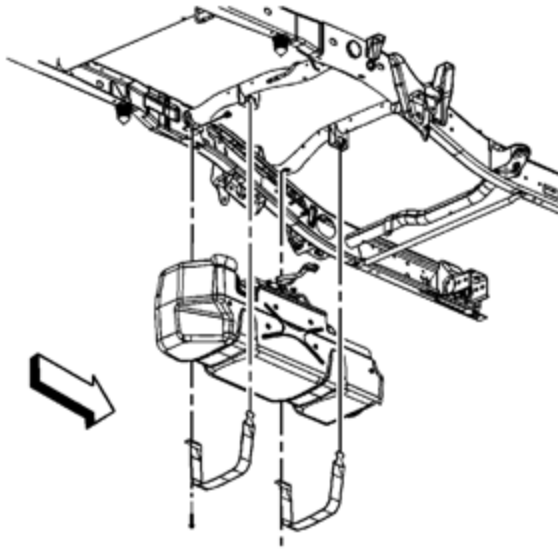


24. If necessary, disconnect and remove the fuel feed (1) and return (2) lines from the sending unit and retaining clips. Refer to [Metal Collar Quick Connect Fitting Service](#).
25. If replacing the fuel tank, remove the sending unit. Refer to [Fuel Sender Assembly Replacement](#).

Installation Procedure



1. If the fuel tank was replaced, install the sending unit. Refer to [Fuel Sender Assembly Replacement](#).
2. Install and connect the fuel feed (1) and return (2) lines to the sending unit and retaining clips. Refer to [Metal Collar Quick Connect Fitting Service](#).



3. With the aid of an assistant, place the fuel tank on the jack.
4. Raise the fuel tank until the sending unit electrical connection can be made.
5. Connect the sending unit electrical connector.
6. Install the fuel tank.

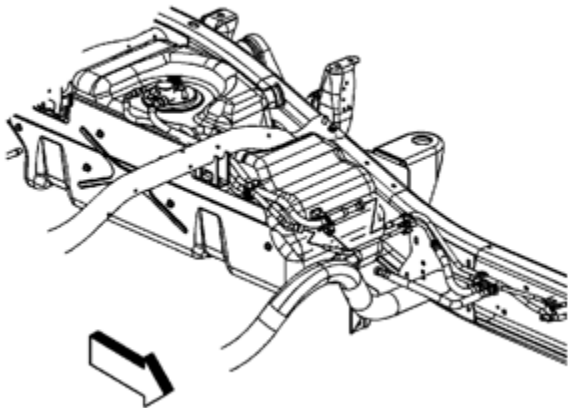
Caution: Refer to [Fastener Caution](#) in the Preface section.

7. Install the fuel tank straps.
8. Install the fuel tank strap bolts.

Tighten

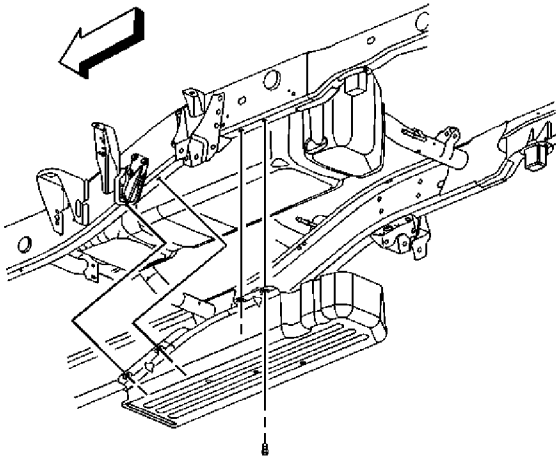
Tighten the bolts to 40 N·m (30 lb ft).

9. Remove the jack from under the fuel tank.





10. Remove the caps from the fuel lines.
11. Connect the fuel feed and return lines to the fuel tank. Refer to [Metal Collar Quick Connect Fitting Service](#).

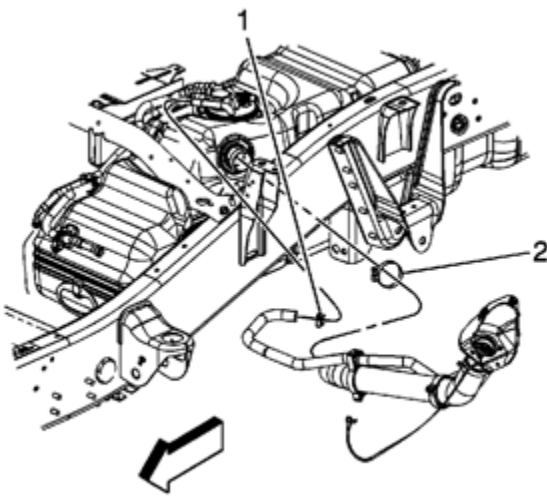


12. If necessary, install the fuel tank shield.
13. If necessary, install the fuel tank shield bolts.

Tighten

Tighten the bolts to 18 N·m (13 lb ft).

14. Install the fuel system cooler. Refer to [Fuel Cooler Replacement](#).



15. Install the fuel tank fill pipe and vent hose to the fuel tank.

16. Tighten the fuel tank fill pipe clamp (2) at the fuel tank.

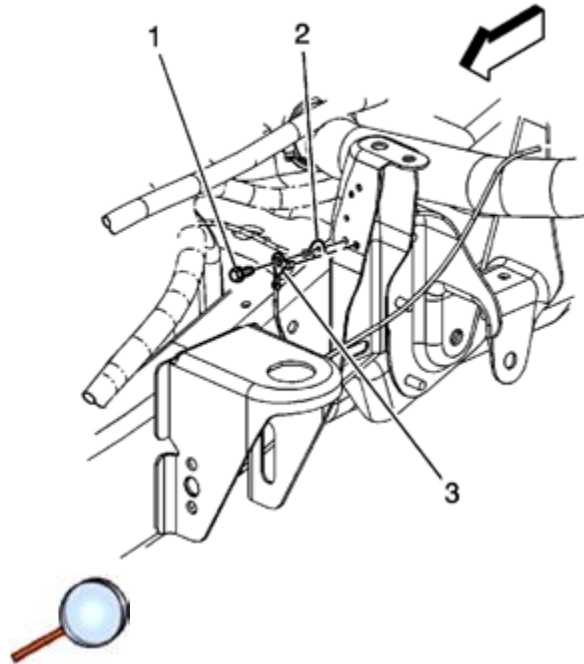
Tighten

Tighten the clamp to 2.5 N·m (22 lb in).

17. Tighten the fuel tank vent hose clamp (1) at the fuel tank.

Tighten

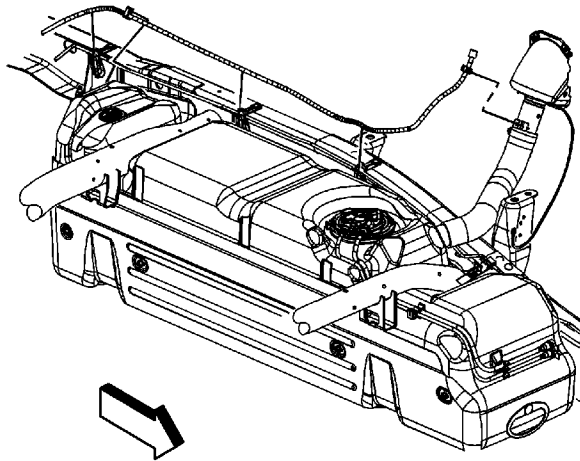
Tighten the clamp to 2.5 N·m (22 lb in).



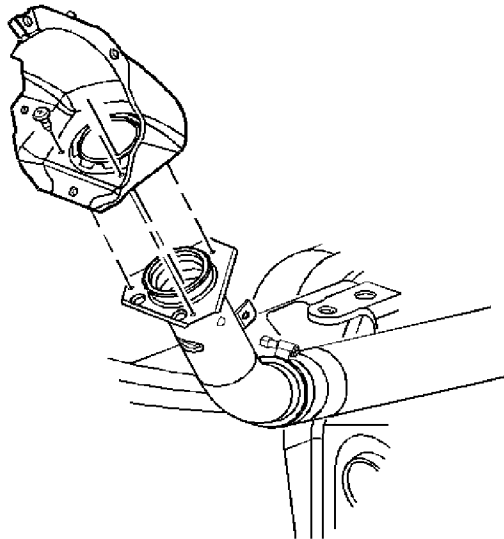
18. Position the fuel tank ground strap (3).
19. Install the fuel tank ground strap bolt (1).

Tighten

Tighten the bolt to 9 N·m (80 lb in).



20. Install the rear axle vent hose to the clip on the fuel fill pipe bracket.
21. Lower the vehicle.

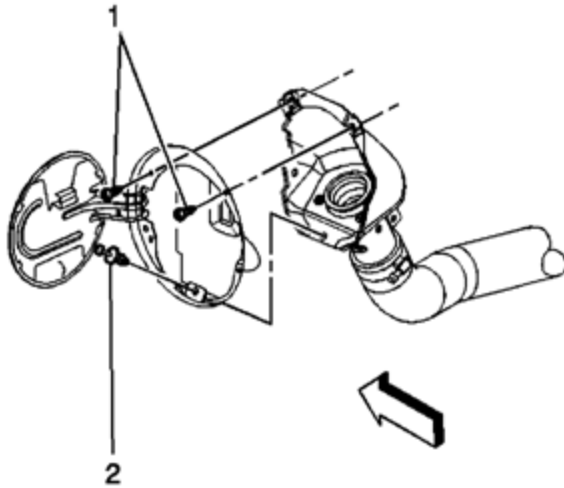


22. Install the fuel tank filler housing.
23. Install the fuel tank filler housing to fuel tank fill pipe screws.

Tighten

Tighten the screws to 2.3 N·m (20 lb in).

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24. Install the fuel tank filler housing to body screws (1), and retainer (2).

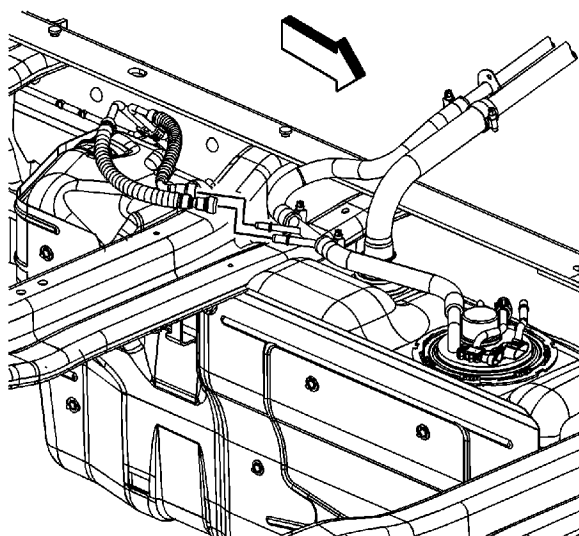
Tighten

Tighten the screws to 2.3 N·m (20 lb in).

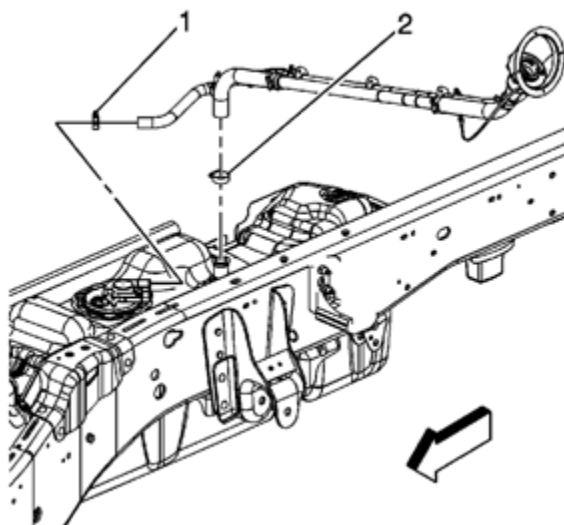
25. Fill the fuel tank.
26. Install the fuel fill cap.
27. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
28. Prime the fuel system. Refer to [Fuel System Priming](#).
29. Start the engine. If the engine stalls, repeat the above step.
30. Once the engine starts, inspect for fuel leaks.

Fuel Tank Replacement (Cab/Chassis - Front)

Removal Procedure

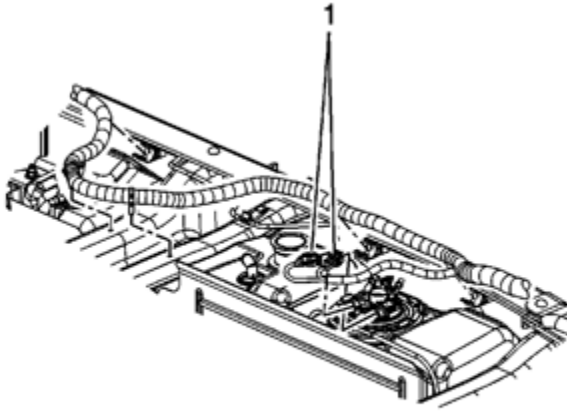


1. Disconnect the fuel feed and pressure balance rear lines. Refer to [Metal Collar Quick Connect Fitting Service](#).

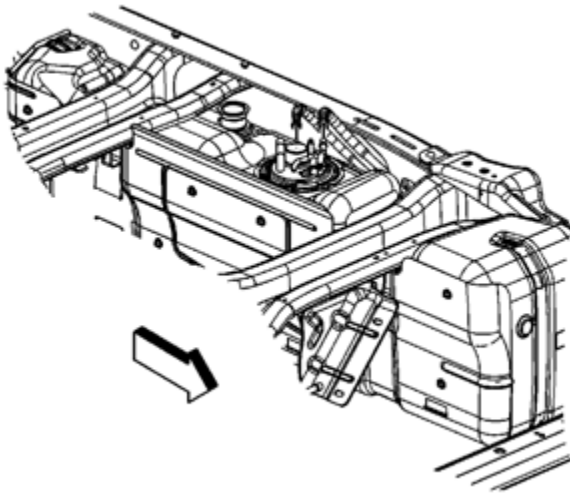


2. Loosen the fuel fill and vent hose clamps (1, 2) at the fuel tank.
3. Remove the fuel fill p

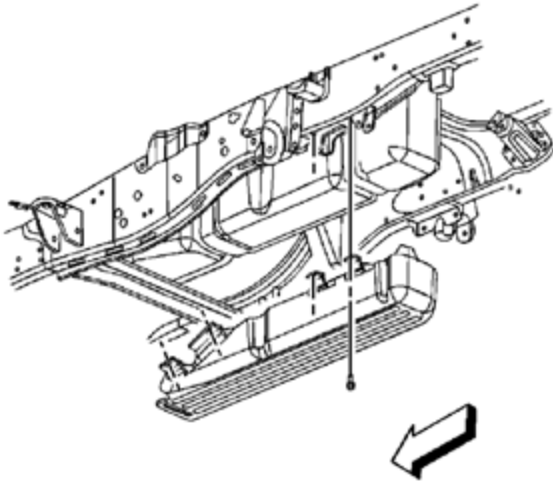
4. Drain the fuel tank. Refer to [Fuel Tank Draining](#).



5. Disconnect the sending unit electrical connectors (1).

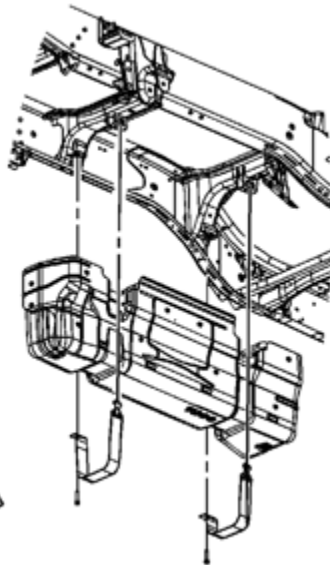


6. Disconnect the fuel feed and return lines from the fuel tank. Refer to [Metal Collar Quick Connect Fitting Service](#).
7. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



8. If necessary, remove the fuel tank shield bolts.
9. If necessary, remove the fuel tank shield.
10. Place a suitable adjustable jack under the fuel tank.

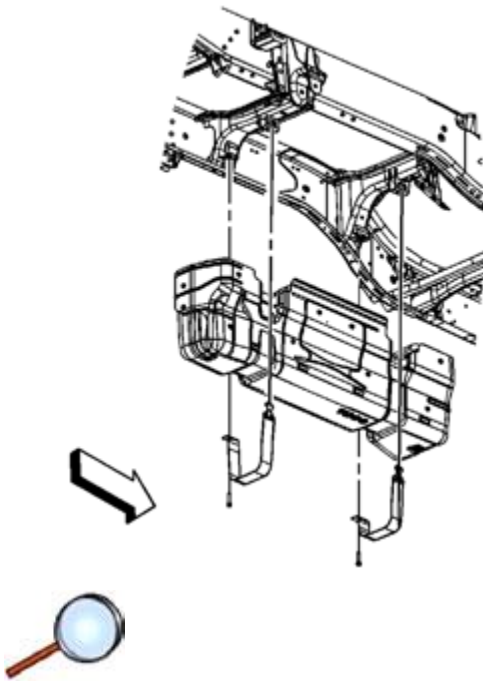
Caution: Refer to [Fuel Tank Strap Fastener Caution](#) in the Preface section.



11. Remove the fuel tank strap bolts.
12. Remove the fuel tank straps.
13. Lower the fuel tank.
14. With the aid of an assistant, place the fuel tank in a suitable work area.
15. Cap the fuel lines on the vehicle in order to prevent possible fuel system contamination.
16. If replacing the fuel tank, remove the sending unit. Refer to [Fuel Sender Assembly](#)

[Replacement](#).

Installation Procedure



1. If the fuel tank was replaced, install the sending unit. Refer to [Fuel Sender Assembly Replacement](#).
2. Remove the caps from the fuel lines.
3. With the aid of an assistant, place the fuel tank on the jack.
4. Raise the fuel tank.

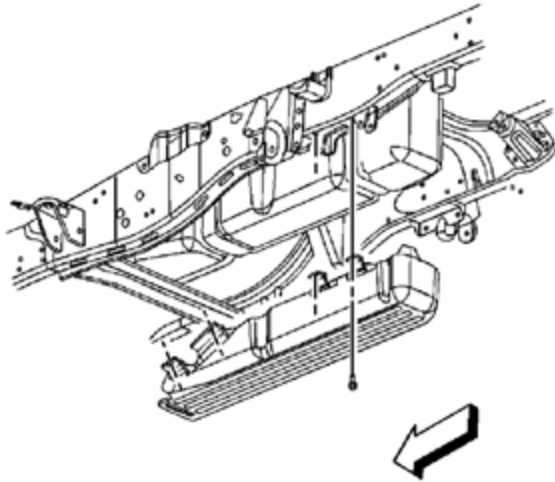
Caution: Refer to [Fastener Caution](#) in the Preface section.

5. Install the fuel tank straps.
6. Install the fuel tank strap bolts.

Tighten

Tighten the bolts to 40 N·m (30 lb ft).

7. Remove the jack from under the fuel tank.

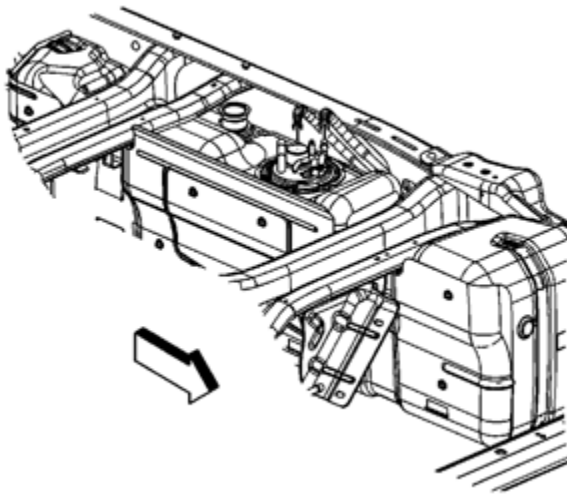


8. If necessary, install the fuel tank shield.
9. If necessary, install the fuel tank shield bolts.

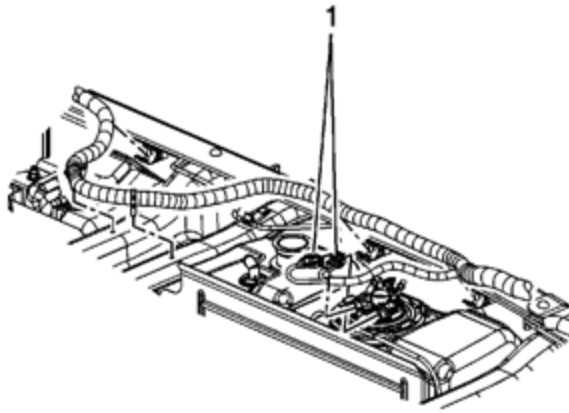
Tighten

Tighten the bolts to 18 N·m (13 lb ft).

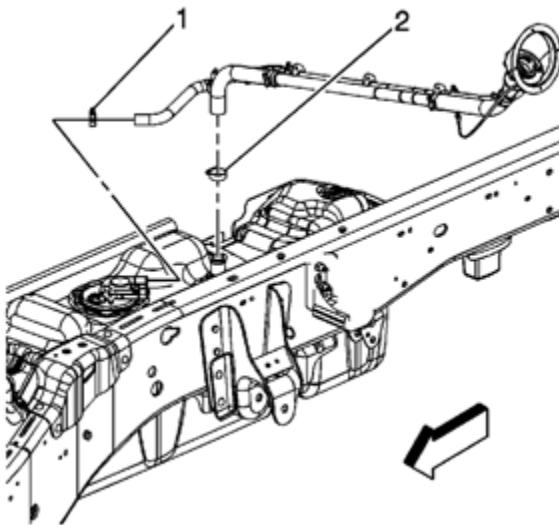
10. Lower the vehicle.



11. Connect the fuel feed and return lines at the fuel tank. Refer to [Metal Collar Quick Connect Fitting Service](#).



12. Connect the sending unit electrical connectors (1).

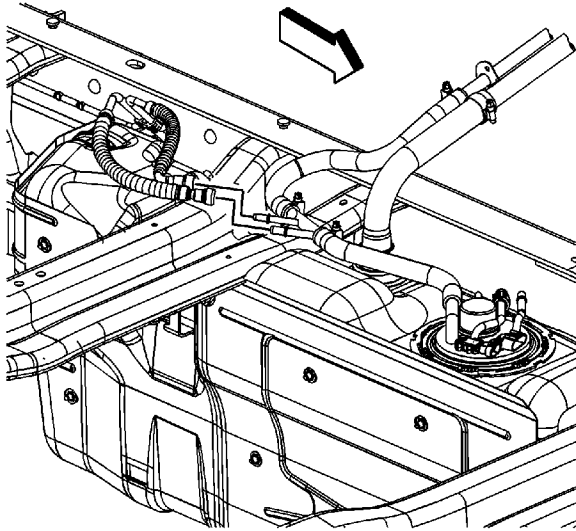


13. Install the fuel fill pipe and vent hose to the tank.
14. Tighten the fuel fill and vent hose clamps (1, 2) at the fuel tank.

Tighten

Tighten the clamps to 2.5 N·m (22 lb in).

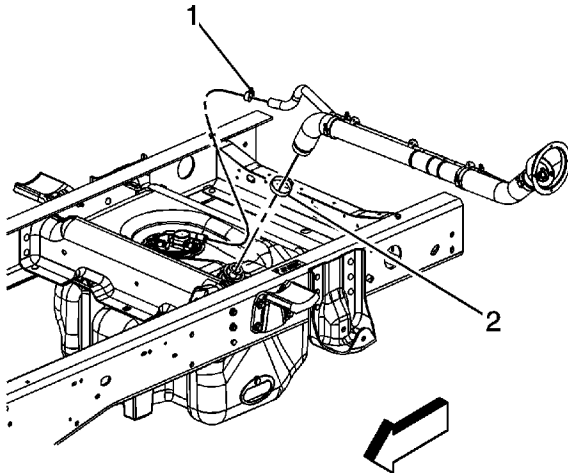
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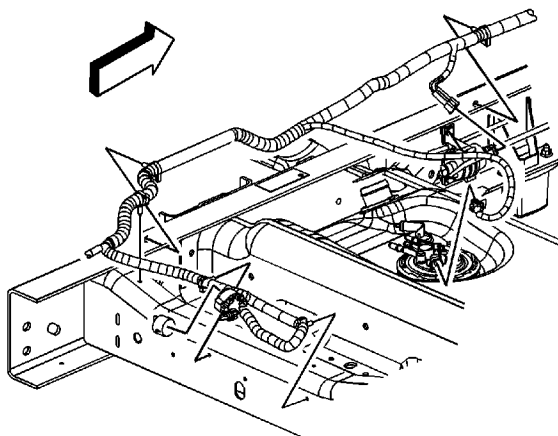
15. Connect the fuel feed and pressure balance rear lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
16. Fill the fuel tank.
17. Install the fuel fill cap.
18. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
19. Prime the fuel system. Refer to [Fuel System Priming](#).
20. Start the engine. If the engine stalls, repeat the above step.
21. Once the engine starts, inspect for fuel leaks.

Fuel Tank Replacement (Cab/Chassis - Rear)

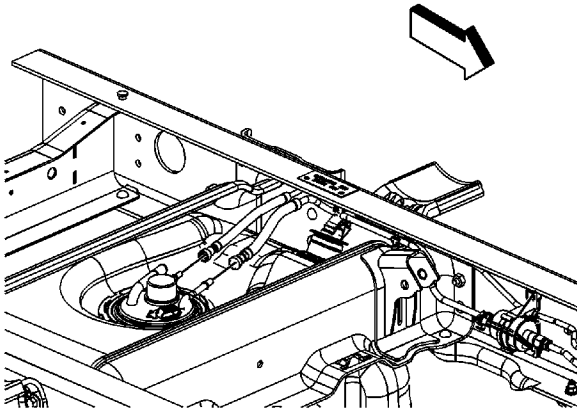
Removal Procedure



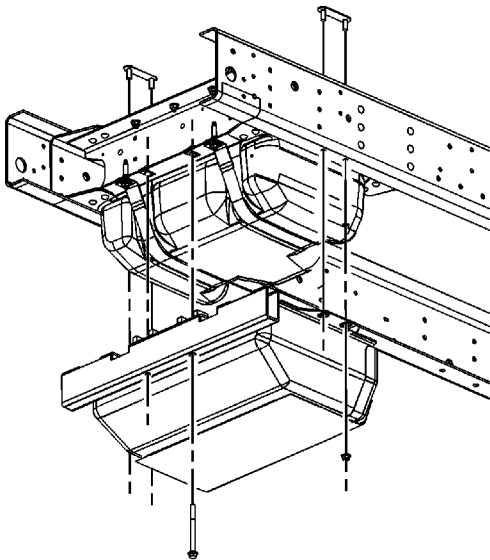
1. Loosen the fuel fill and vent hose clamps (1, 2) at the tank.
2. Remove the fuel fill and vent hose from the tank.
3. Drain the fuel tank. Refer to [Fuel Tank Draining](#).



4. Disconnect the sending unit electrical connector.

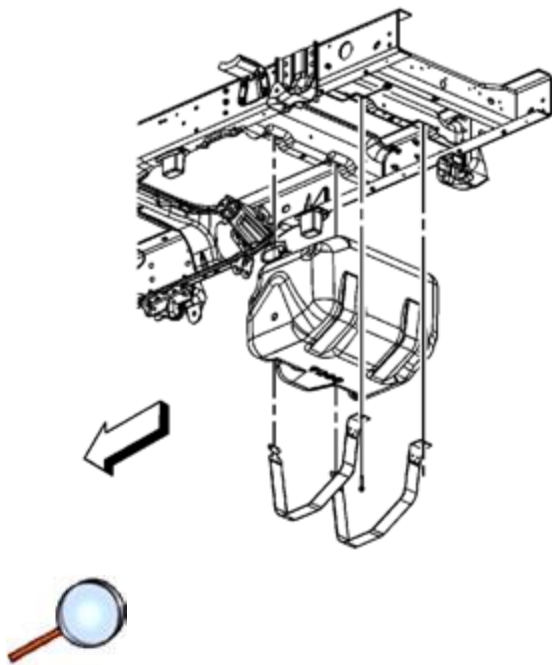


5. Disconnect the fuel feed and return lines from the sending unit. Refer to [Metal Collar Quick Connect Fitting Service](#).
6. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



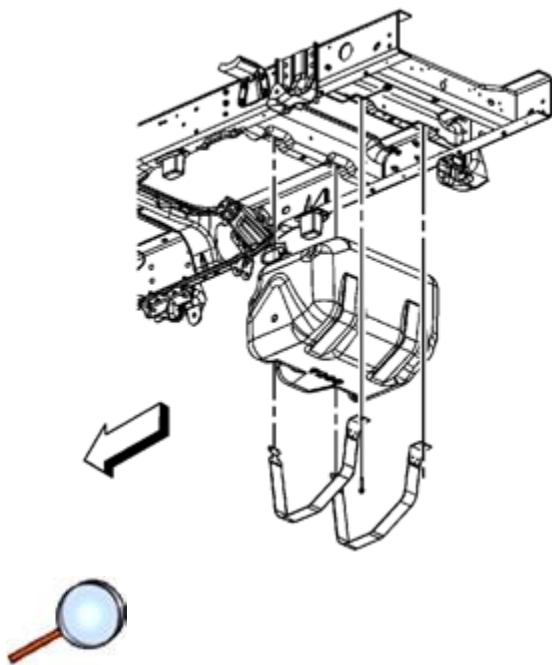
7. If equipped, remove the fuel tank shield bolts.
8. If equipped, remove the fuel tank shield.

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



9. Remove the fuel tank strap bolts.
10. Remove the fuel tank straps.
11. Lower the fuel tank.
12. With the aid of an assistant, place the fuel tank in a suitable work area.
13. Cap the fuel lines in order to prevent possible fuel system contamination.
14. If replacing the fuel tank, remove the sending unit. Refer to [Fuel Sender Assembly Replacement](#).

Installation Procedure



1. If the fuel tank was replaced, install the sending unit. Refer to [Fuel Sender Assembly Replacement](#).

2. Remove the caps from the fuel lines.
3. With the aid of an assistant, place the fuel tank on the jack.
4. Raise the fuel tank.

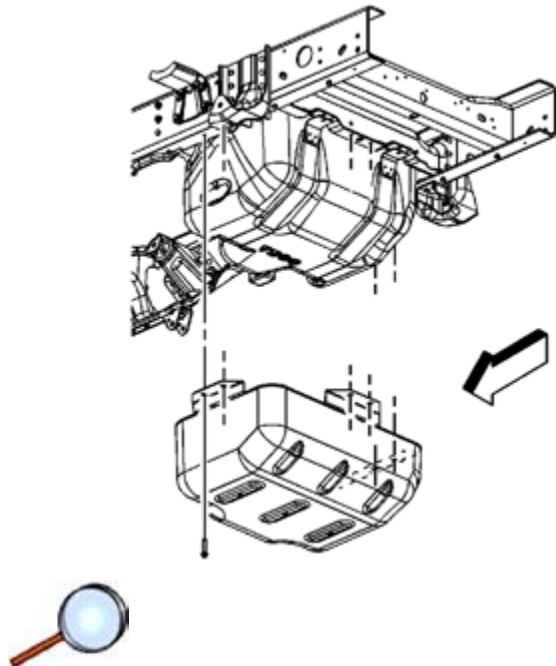
Caution: Refer to [Fastener Caution](#) in the Preface section.

5. Install the fuel tank straps.
6. Install the fuel tank strap bolts.

Tighten

Tighten the bolts to 40 N·m (30 lb ft).

7. Remove the jack from under the fuel tank.

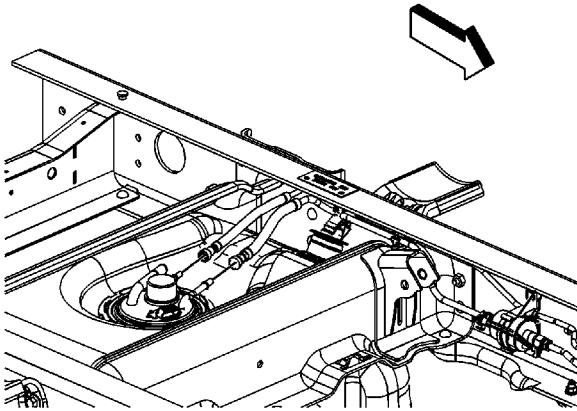


8. If equipped, install the fuel tank cover.
9. If equipped, install the fuel tank cover bolts.

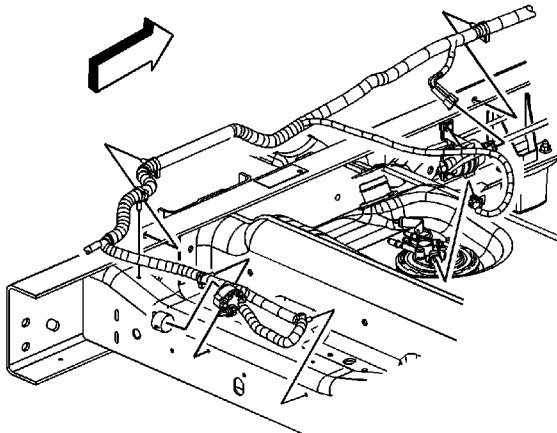
Tighten

Tighten the bolts to 18 N·m (13 lb ft).

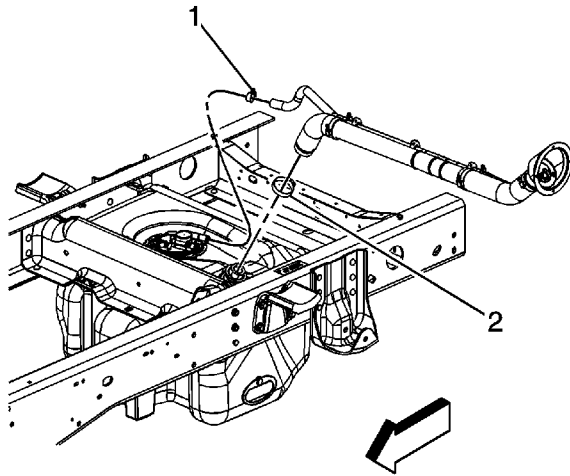
10. Lower the vehicle.



11. Connect the fuel feed and return lines to the sending unit. Refer to [Metal Collar Quick Connect Fitting Service](#).



12. Connect the sending unit electrical connector.



13. Install the fuel fill and vent hose to the tank.
14. Tighten the fuel fill and vent hose clamps (1, 2) at the tank.

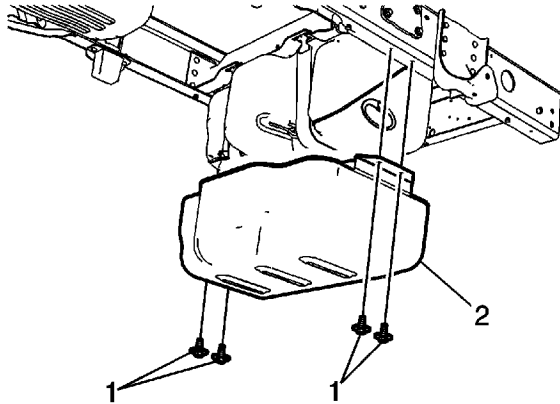
Tighten

Tighten the hose clamps to 2.5 N·m (22 lb in).

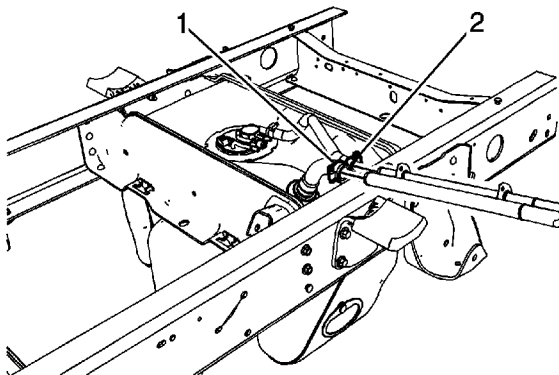
15. Fill the fuel tank.
16. Install the fuel fill cap.
17. Install the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
18. Using a scan tool, command the fuel transfer pump on.
19. Prime the fuel system. Refer to [Fuel System Priming](#).
20. Start the engine. If the engine stalls, repeat the above step.
21. Once the engine starts, inspect for fuel leaks.

Auxiliary Fuel Tank Replacement

Removal Procedure

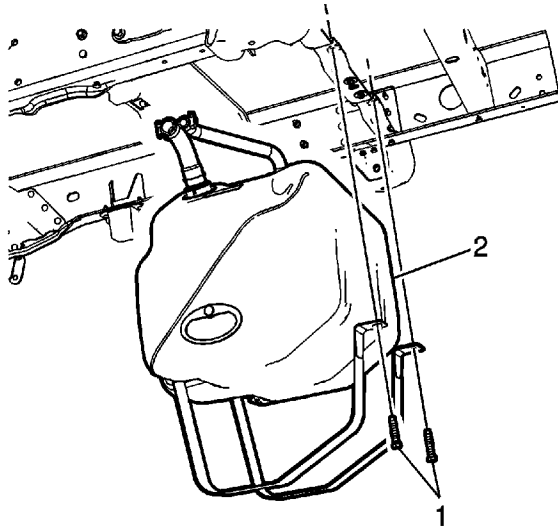


1. Relieve the fuel system pressure. Refer to the [Fuel Pressure Relief](#).
2. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Drain the fuel tank. Refer to [Fuel Tank Draining](#).
4. Remove the fuel tank shield bolts (1) and the fuel tank shield (2).



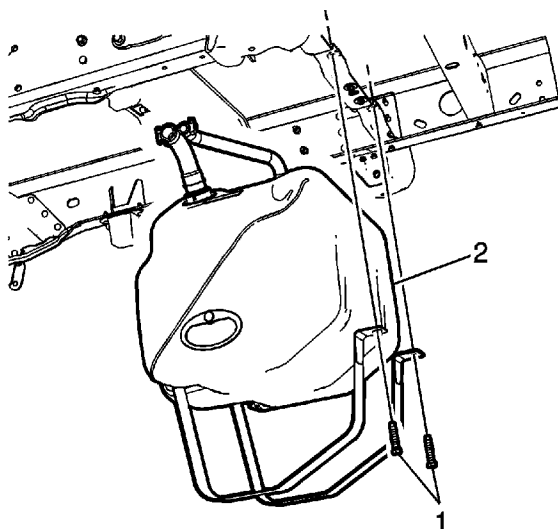
5. Loosen the fuel fill (1) and vent pipe (2) hose clamps.

6. Disconnect the hoses.



7. With the aid of an assistant, support the fuel tank.
8. Disconnect the evaporative emissions lines and the fuel lines. Refer to [Metal Collar Quick Connect Fitting Service](#) and [Plastic Collar Quick Connect Fitting Service](#)
9. Disconnect the electrical connectors.
10. Remove the fuel tank strap bolts (1) and the auxiliary fuel tank (2).
11. Remove the fuel pump module from the fuel tank. Refer to [Fuel Tank Fuel Pump Module Replacement](#).
12. Cap the fuel and EVAP pipes in order to prevent possible fuel system contamination.

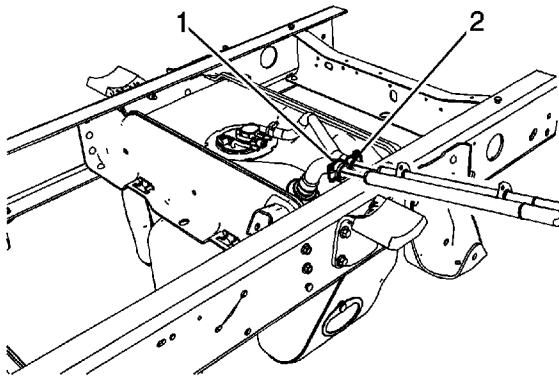
Installation Procedure



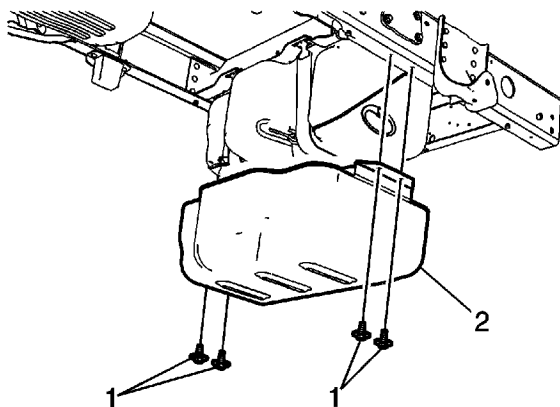
1. Install the fuel pump module to the fuel tank. Refer to [Fuel Tank Fuel Pump Module Replacement](#).
2. Remove the caps from the fuel and EVAP pipes.
3. With the aid of an assistant, support and partially raise the fuel tank.
4. Connect the electrical connectors.
5. Connect the evaporative emissions lines and the fuel lines. Refer to [Metal Collar Quick Connect Fitting Service](#) and [Plastic Collar Quick Connect Fitting Service](#).
6. With the aid of an assistant, support the auxiliary fuel tank.
7. Install the auxiliary fuel tank (1).

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

8. Install the fuel tank strap attaching bolts (2) and tighten to **40 N·m (30 lb ft)**.



9. Connect and tighten the fuel fill (1) and vent pipe (2) hose clamps to **4 N·m (35 lb in)**.



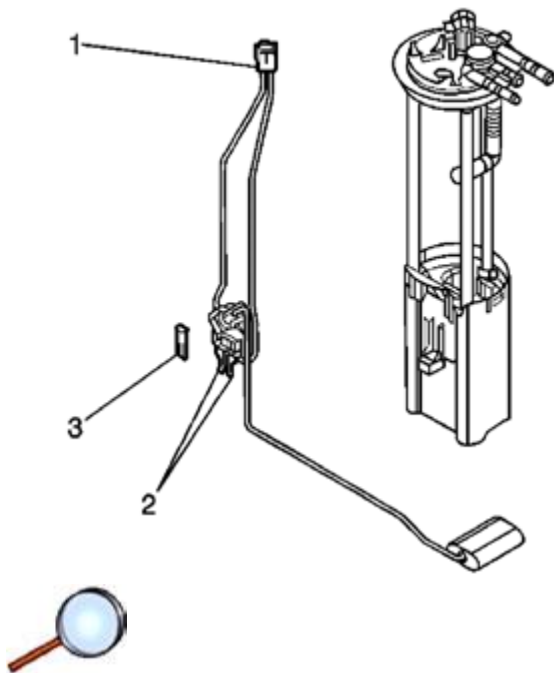


10. Install the fuel tank shield (2) and the fuel tank shield bolts (1) and tighten to **18 N·m (13 lb ft)**.
11. Refill the fuel tank.
12. Install the fuel filler cap.
13. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#) in Engine Electrical.
14. Use the following procedure in order to inspect for leaks:
 - 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.

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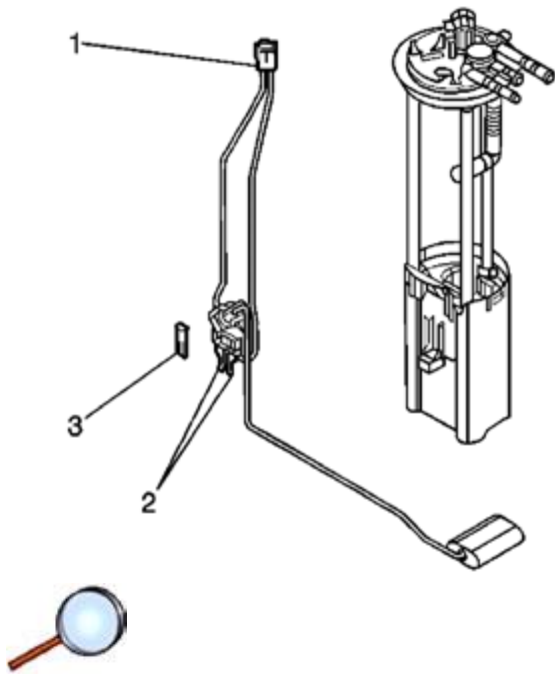
Fuel Level Sensor Replacement (Cab / Chassis - Rear Tank)

Removal Procedure



1. Remove the sending unit. Refer to [Fuel Sender Assembly Replacement](#).
2. Disconnect the fuel level sensor electrical connector (1).
3. Remove the sensor retaining clip (3).
4. Squeeze the locking tangs (2) and remove the fuel level sensor.

Installation Procedure

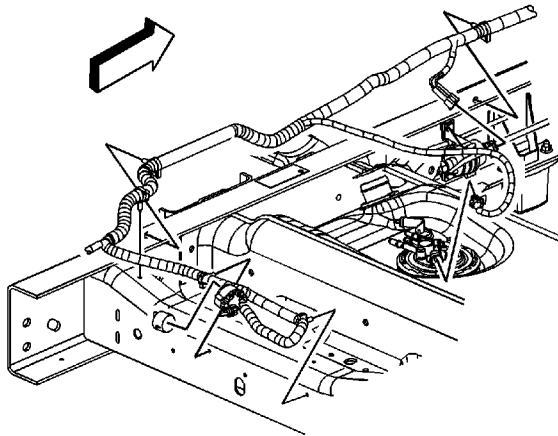


1. Install the fuel level sensor.
2. Install the sensor retaining clip (3).
3. Connect the sensor electrical connector (1).
4. Install the sending unit. Refer to [Fuel Sender Assembly Replacement](#).

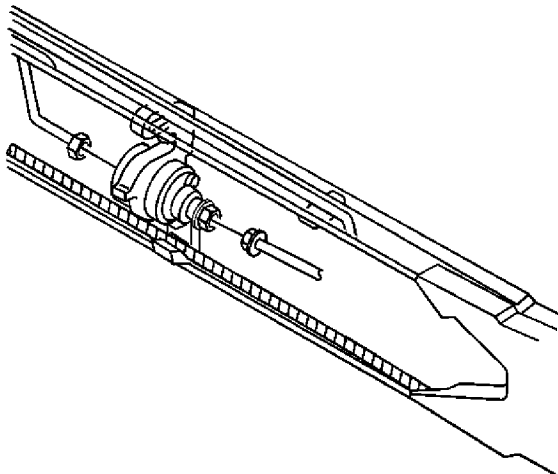
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Fuel Pump Replacement

Removal Procedure

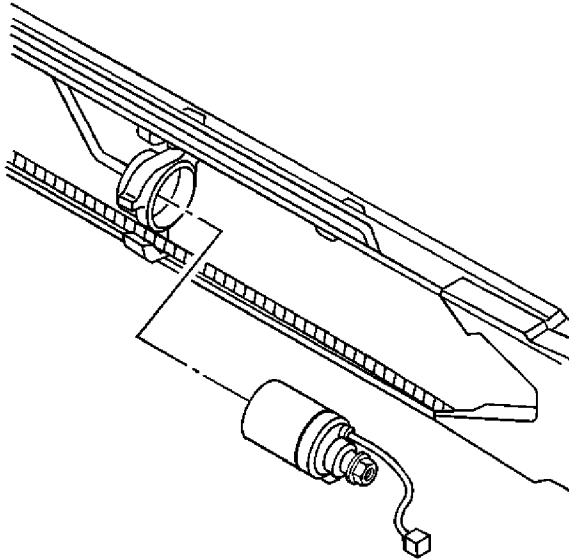


1. Loosen the fuel fill cap to relieve the fuel system pressure.
2. Disconnect the balance pump electrical connector.
3. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



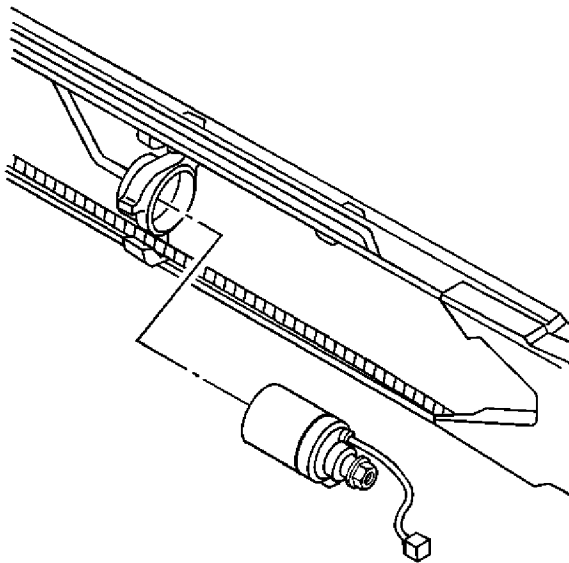
4. Clean the fuel line connections and surrounding areas at the pump before disconnecting to avoid possible fuel system contamination.

5. Disconnect the fuel lines from the pump.



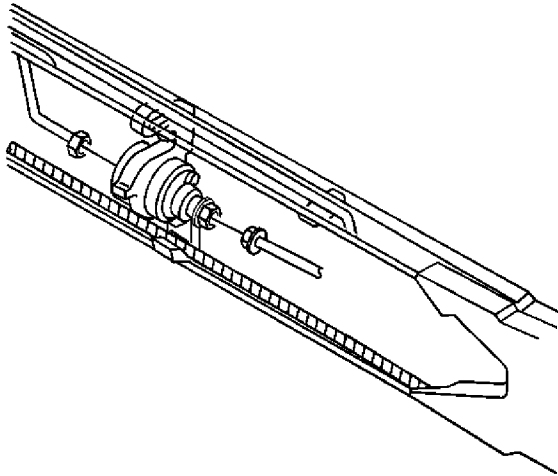
6. Slide the pump out of the bracket.
7. Cap the fuel lines.

Installation Procedure



1. Remove the caps from the fuel lines.
2. Install the NEW fuel line O-rings.
3. Position the new balance pump into the bracket.

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

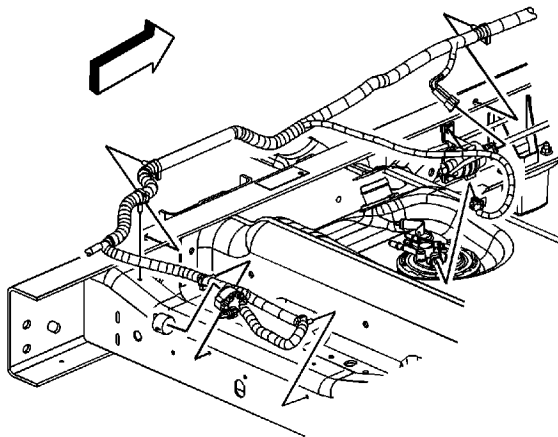


4. Connect the fuel lines to the balance pump. Use a backup wrench to prevent the pump from turning.

Tighten

Tighten the fittings to 30 N·m (22 lb ft).

5. Lower the vehicle.



6. Connect the balance pump electrical connector.
7. Tighten the fuel fill cap.
8. Using a scan tool, command the fuel transfer pump on.
9. Prime the fuel system. Refer to [Fuel System Priming](#).
10. Start the engine. If the engine stalls, repeat the above step.

11. Once the engine starts, inspect for fuel leaks.

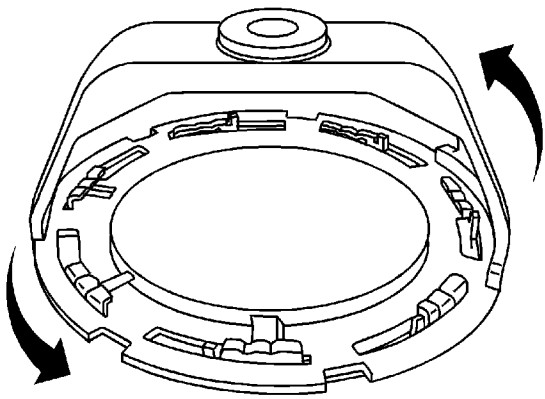
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Fuel Sender Assembly Replacement

Special Tools

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

Removal Procedure



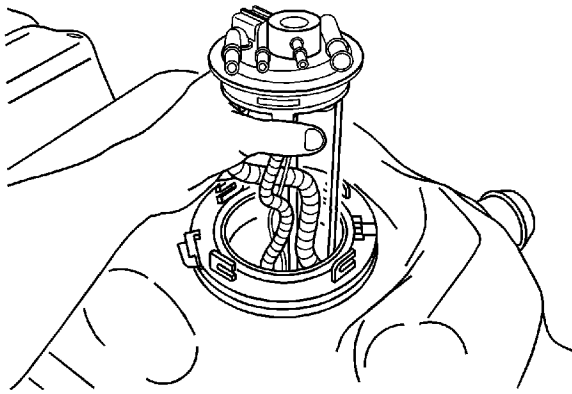
1. Remove the fuel tank. Refer to [Fuel Tank Replacement](#).
2. Disconnect the fuel lines from the sending unit. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).

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

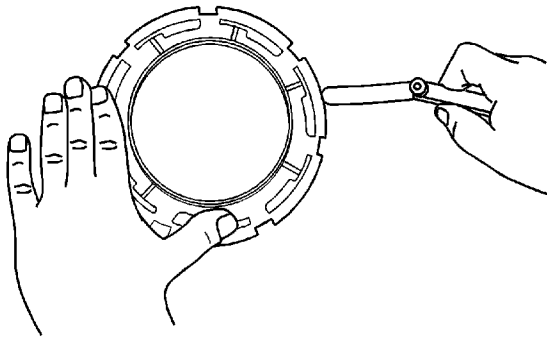
Caution: Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.

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.

3. Use the [J 45722](#) and a long breaker-bar in order to unlock the fuel sender lock ring.



4. Remove the sending unit and seal. Discard the seal.
5. Clean the sending unit sealing surfaces.



Note: Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if they are not damaged or warped.

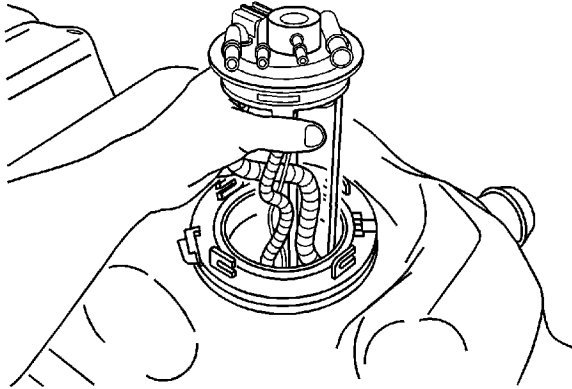
Note: Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.

Note: Check the lock ring for flatness.

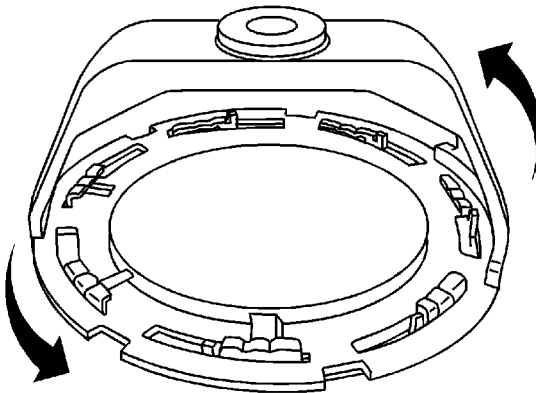
6. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gage at 7 points.

7. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
8. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure



1. Install the sending unit and a NEW seal.



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

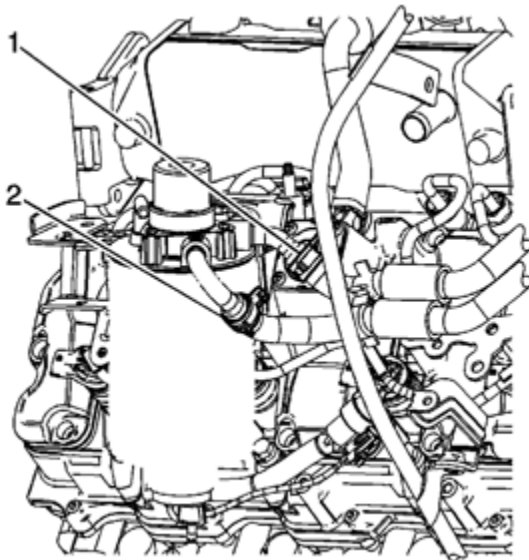
Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

2. Use the [J 45722](#) in order to install the fuel sender lock ring. Turn the fuel sender lock ring in a clockwise direction.
3. Connect the fuel lines to the sending unit. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).
4. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

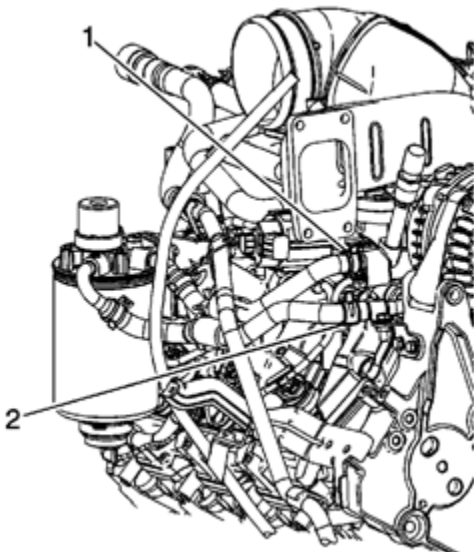
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Fuel Hose Replacement - Fuel Filter / Heater Element Housing to Fuel Feed Block

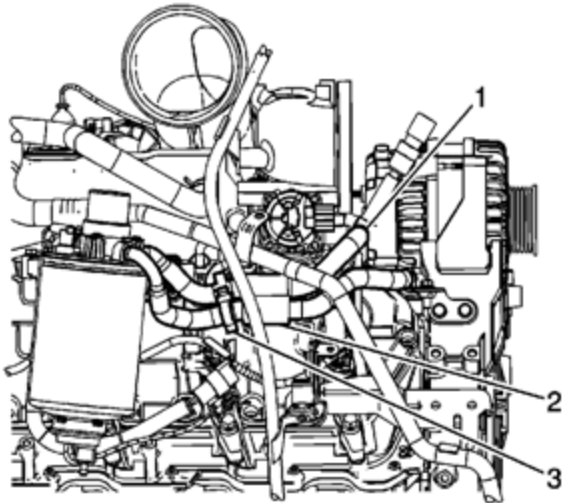
Removal Procedure



1. Reposition the fuel filter hose clamp(s) (1 or 2) at the fuel filter adapter.

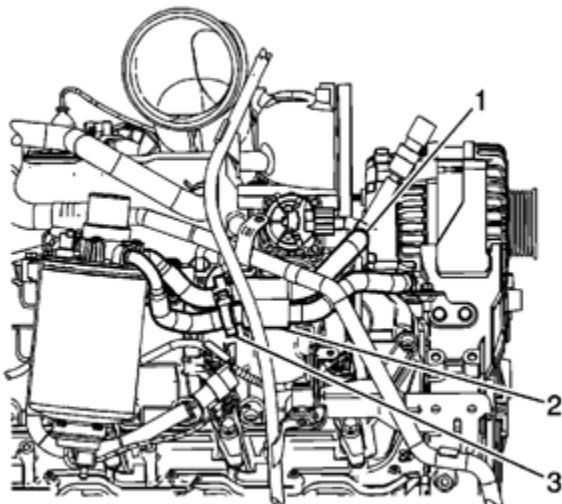


2. Reposition the fuel filter hose clamp(s) (1 or 2) at the fuel injection fuel feed manifold and/or the fuel feed pipe.

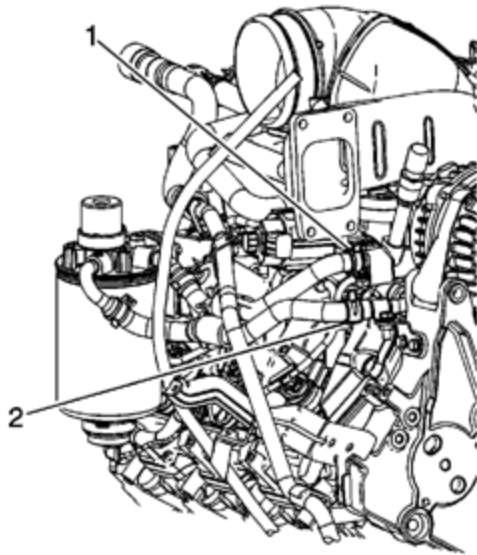


3. Remove the fuel hose retainer (3) from the appropriate fuel filter hose.
4. Remove the fuel filter hose (1) from the fuel filter adapter and the fuel injection fuel feed manifold, if required.
5. Remove the fuel filter hose (2) from the fuel filter adapter and the fuel feed pipe, if required.

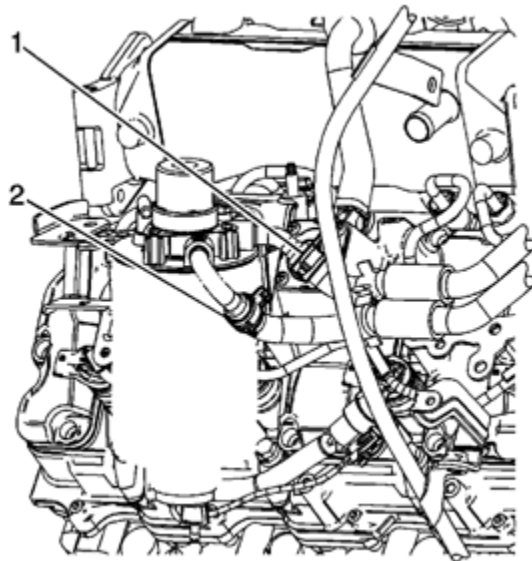
Installation Procedure



1. Install the fuel filter hose (1) to the fuel filter adapter and the fuel injection fuel feed manifold, if required.
2. Install the fuel filter hose (2) from the fuel filter adapter and the fuel feed pipe, if required.
3. Install the fuel hose retainer (3) to the fuel filter hose(s).



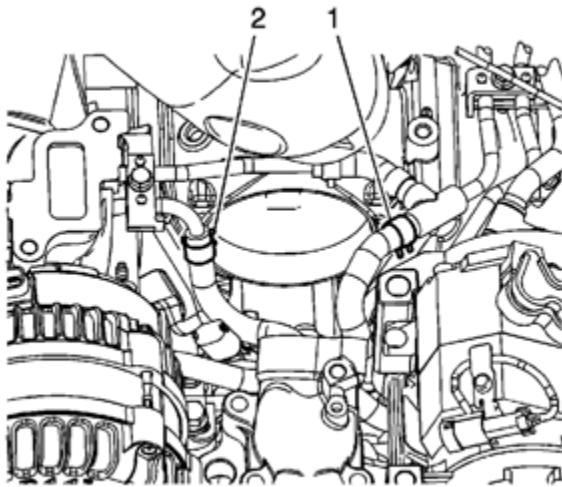
4. Position the fuel filter hose clamp(s) (1 or 2) at the fuel injection fuel feed manifold and/or the fuel feed pipe.



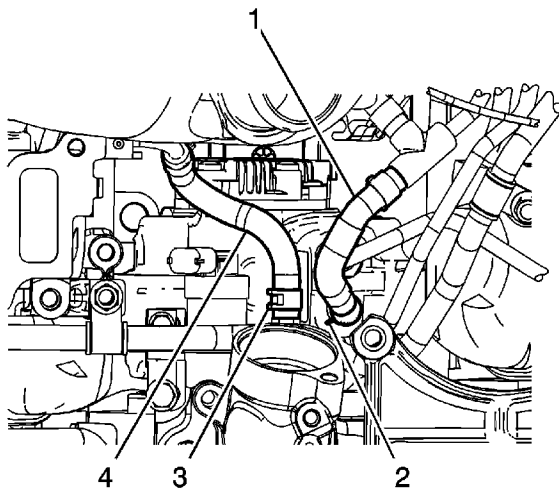
5. Position the fuel filter hose clamp(s) (1 or 2) at the fuel filter adapter.
6. Prime the fuel system. Refer to [Fuel System Priming](#) .
7. Start the engine. If the engine stalls, repeat the above step.
8. Once the engine starts, inspect for fuel leaks.

Fuel Return Hose Replacement - Fuel Return Pipe to Fuel Injection Pump

Removal Procedure

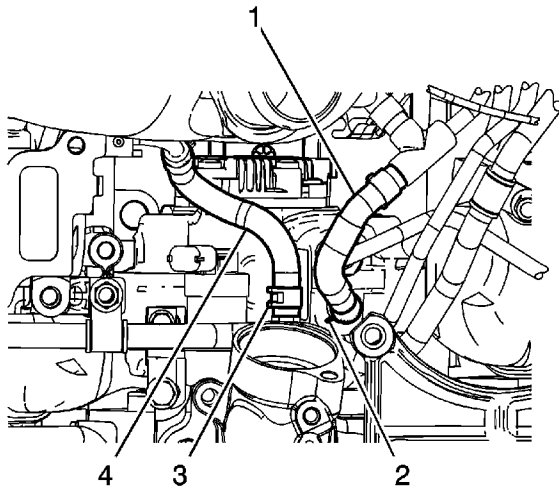


1. Remove the water outlet. Refer to [Water Outlet Tube Replacement](#) .
2. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#) .
3. Reposition the fuel hose clamp (1) at the fuel return pipe.

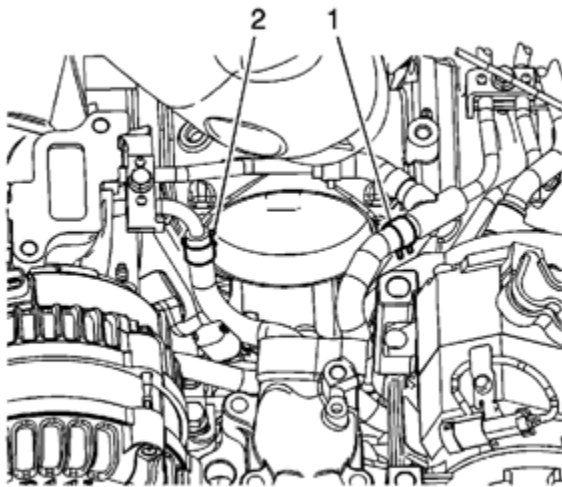


4. Reposition the fuel hose clamp (2) at the fuel injection pump.
5. Remove the fuel hose (1) from the return pipe and injection pump.

Installation Procedure



1. Install the fuel hose (1) to the return pipe and injection pump.
2. Position the fuel hose clamp (2) at the fuel injection pump.



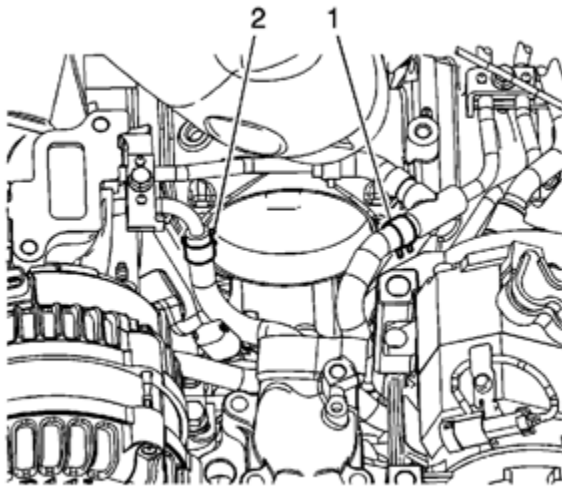
3. Position the fuel hose clamp (1) at the fuel return pipe.
4. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#) .
5. Install the water outlet. Refer to [Water Outlet Tube Replacement](#) .
6. Prime the fuel system. Refer to [Fuel System Priming](#) .
7. Start the engine. If the engine stalls, repeat the above step.

8. Once the engine starts, inspect for fuel leaks.

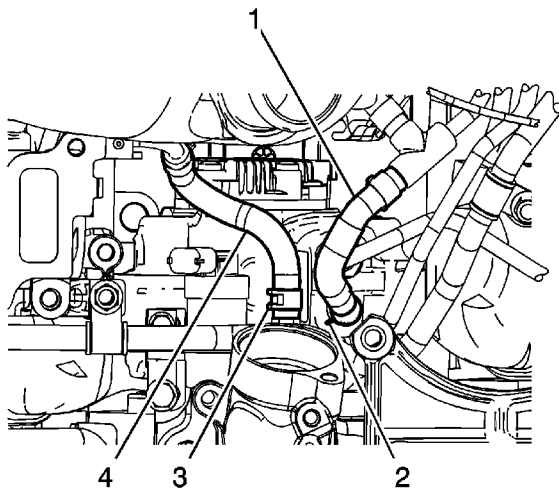
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Fuel Hose Replacement - Fuel Injection Pump to Fuel Feed Block

Removal Procedure

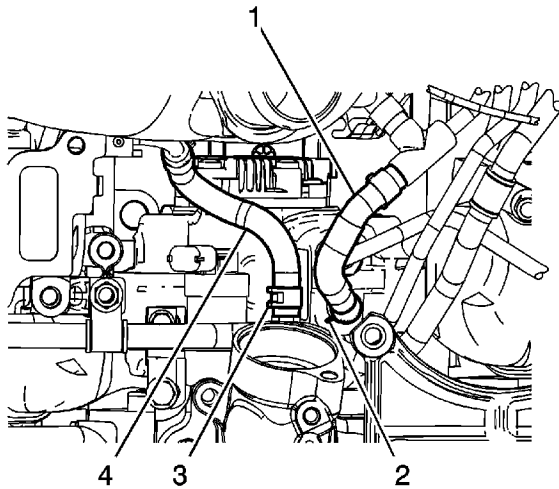


1. Remove the water outlet. Refer to [Water Outlet Tube Replacement](#) .
2. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#) .
3. Reposition the fuel hose clamp (2) at the fuel injection fuel feed manifold.

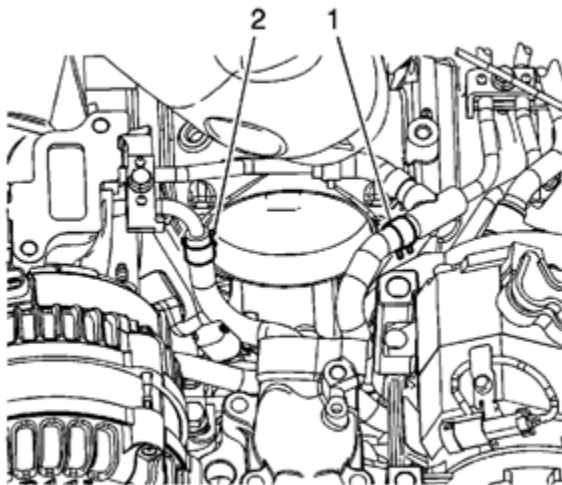


4. Reposition the fuel hose clamp (3) at the fuel injection pump.
5. Remove the fuel hose (4) from the fuel injection fuel feed manifold and injection pump.

Installation Procedure



1. Install the fuel hose (4) to the fuel injection fuel feed manifold and injection pump.
2. Position the fuel hose clamp (3) at the fuel injection pump.



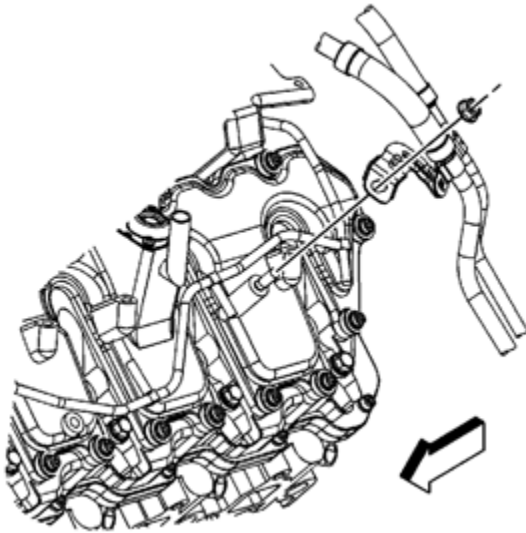
3. Position the fuel hose clamp (2) at the fuel injection fuel feed manifold.
4. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#) .
5. Install the water outlet. Refer to [Water Outlet Tube Replacement](#) .
6. Prime the fuel system. Refer to [Fuel System Priming](#) .
7. Start the engine. If the engine stalls, repeat the above step.

8. Once the engine starts, inspect for fuel leaks.

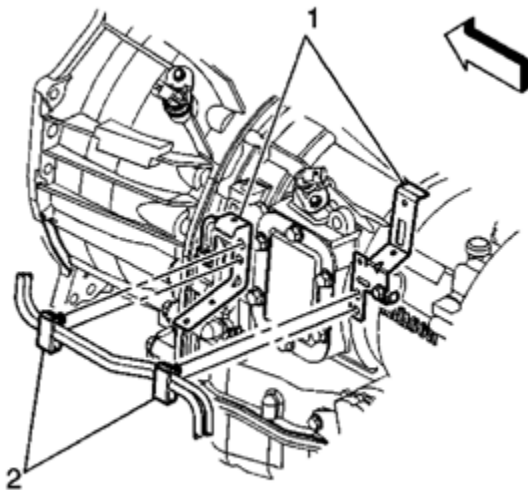
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Fuel Hose / Pipes Replacement - Chassis (Pickup)

Removal Procedure

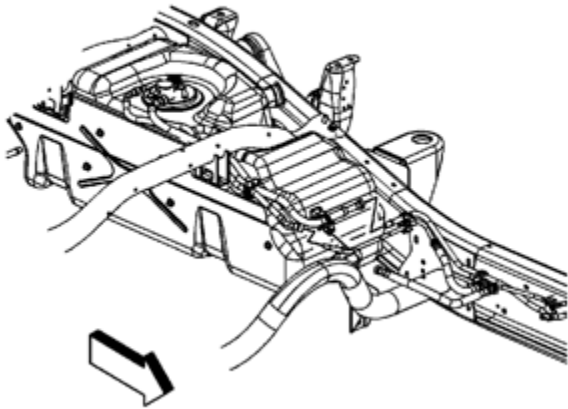


1. Disconnect the fuel feed and return lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
2. Remove the fuel line bracket nut.
3. Remove the fuel line bracket from the stud.
4. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

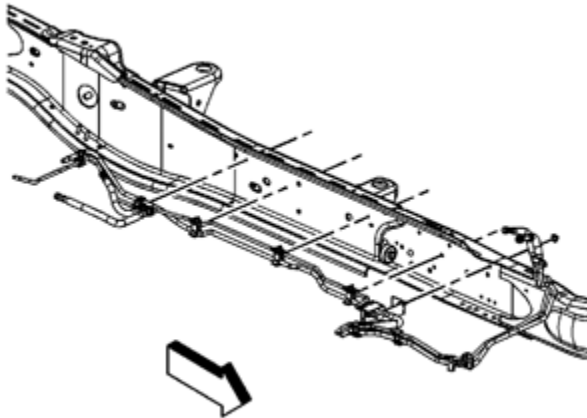


5. Remove the fuel bundle clips (2) from the transmission brackets (1).

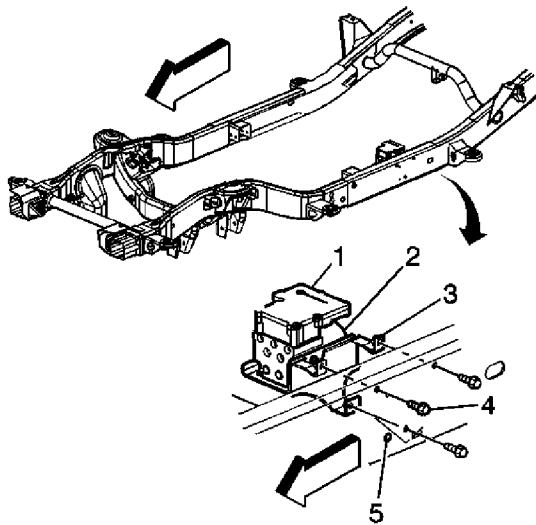
6. Disconnect the chassis harness from the retaining clips.
7. Remove the fuel system cooler, if necessary. Refer to [Fuel Cooler Replacement](#).



8. Disconnect the fuel feed and return lines from the fuel tank lines. Refer to [Plastic Collar Quick Connect Fitting Service](#).

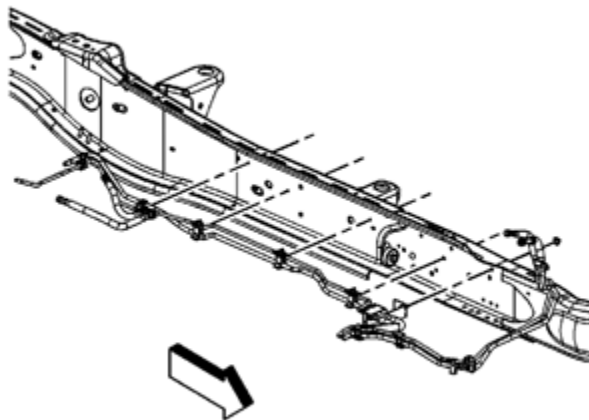


9. Remove the fuel bundle nuts from the chassis.



10. Loosen the electronic brake control module (EBCM) bracket bolts (4).
11. Allow the EBCM to remain loose in order to allow fuel pipe clearance.
12. Remove the fuel bundle using the following procedure:
 - 12.1. Guide the fuel bundle pipes towards the rear of the vehicle to clear the engine.
 - 12.2. Lower the fuel bundle while moving it forward and out.

Installation Procedure



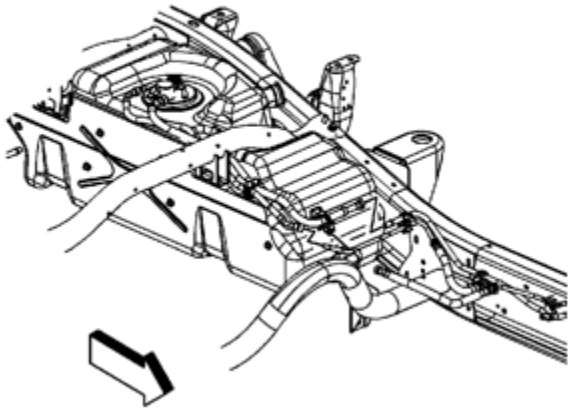
1. Install the fuel pipe bundle using the following procedure:
 - 1.1. Install the fuel bundle to the chassis by guiding the pipes towards the rear of vehicle.

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

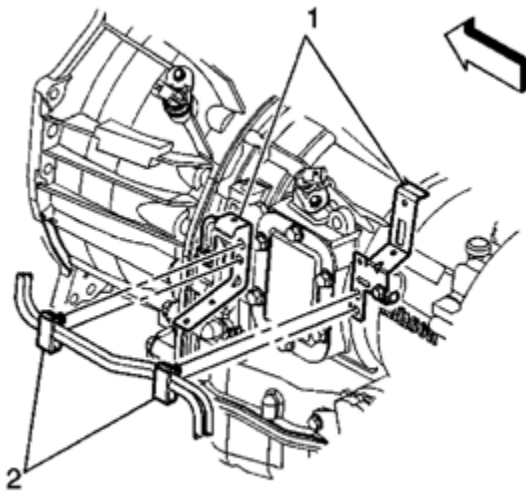
- 1.2. Lift the fuel pipes, while guiding the forward portion of the pipes up towards the engine connections.
2. Install the fuel bundle nuts to the chassis.

Tighten

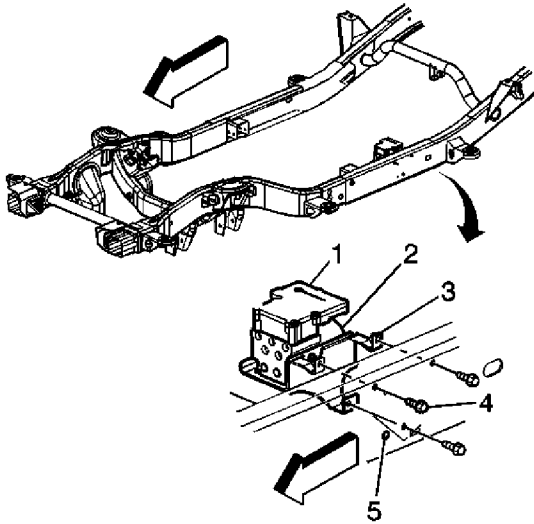
Tighten the nuts to 16 N·m (12 lb ft).



3. Connect the fuel feed and return lines to the fuel tank lines. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Install the fuel system cooler, if necessary. Refer to [Fuel Cooler Replacement](#).



5. Connect the fuel bundle clips (2) to the transmission brackets (1).

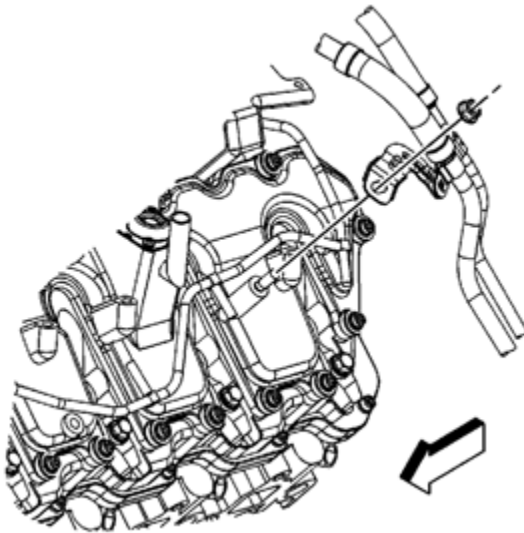


6. Tighten the EBCM bracket bolts (4).

Tighten

Tighten the bolts to 25 N·m (18 lb ft).

7. Lower the vehicle.



8. Install the fuel line bracket to the stud.
9. Install the fuel line bracket nut.

Tighten

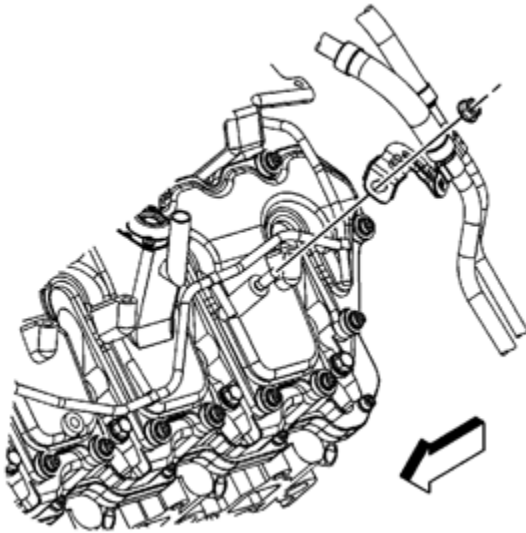
Tighten the nut to 16 N·m (12 lb ft).

10. Connect the fuel feed and return lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
11. Prime the fuel system. Refer to [Fuel System Priming](#).
12. Start the engine. If the engine stalls, repeat the above step.
13. Once the engine starts, inspect for fuel leaks.

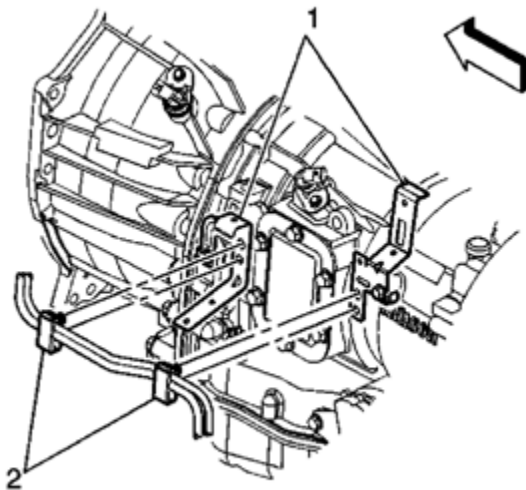
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Fuel Hose / Pipes Replacement - Chassis (Cab / Chassis)

Removal Procedure

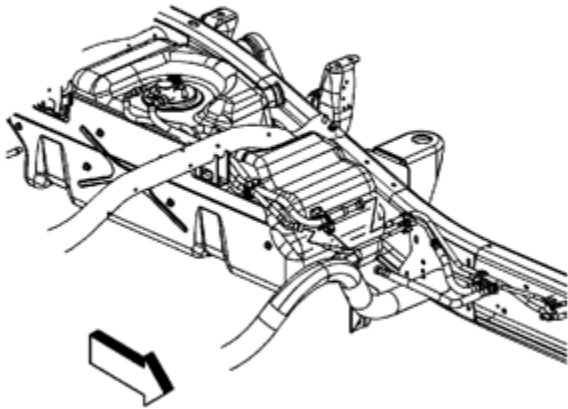


1. Disconnect the fuel feed and return lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
2. Remove the fuel line bracket nut.
3. Remove the fuel line bracket from the stud.
4. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

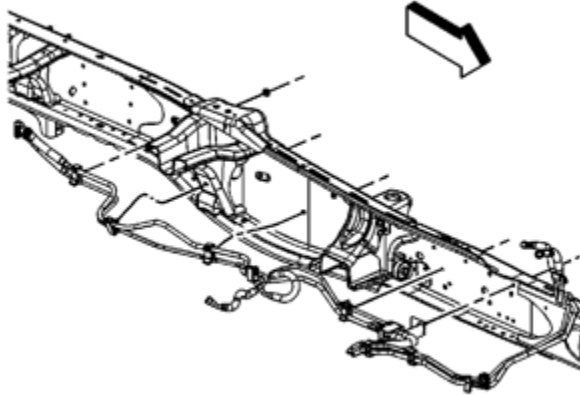


5. Remove the fuel bundle clips (2) from the transmission brackets (1).

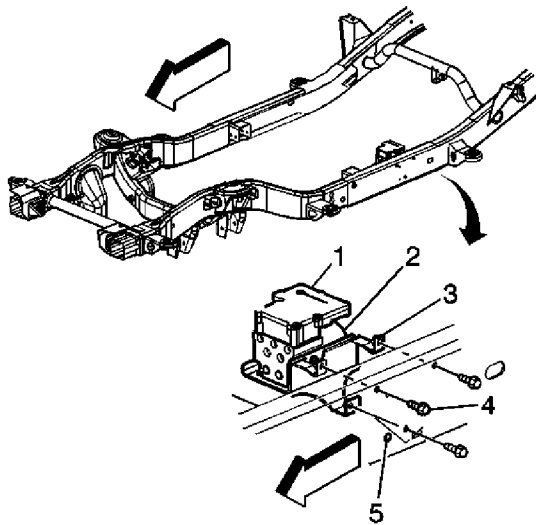
6. Disconnect the chassis harness from the retaining clips.
7. Remove the fuel system cooler, if necessary. Refer to [Fuel Cooler Replacement](#).



8. Disconnect the fuel feed and return lines from the fuel tank lines. Refer to [Plastic Collar Quick Connect Fitting Service](#).

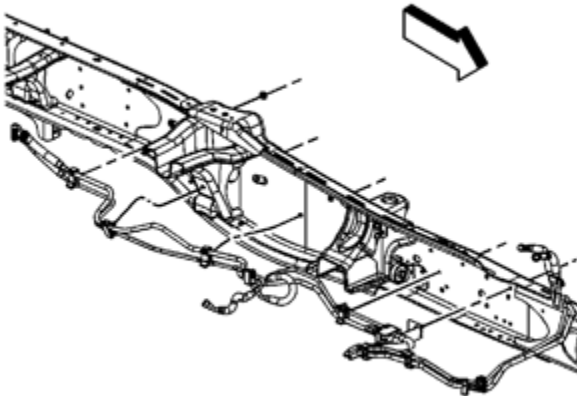


9. Remove the fuel bundle nuts from the chassis.



10. Loosen the electronic brake control module (EBCM) bracket bolts (4).
11. Allow the EBCM to remain loose in order to allow fuel pipe clearance.
12. Remove the fuel bundle using the following procedure:
 - 12.1. Guide the fuel bundle pipes towards the rear of vehicle to clear the engine.
 - 12.2. Lower the fuel bundle while moving it foreword and out.

Installation Procedure



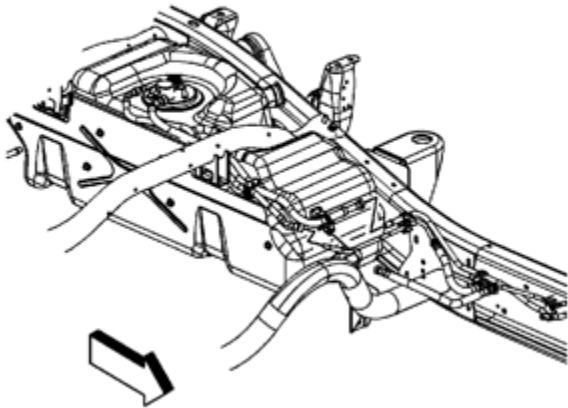
1. Install the fuel pipe bundle using the following procedure:
 - 1.1. Install the fuel bundle to the chassis by guiding the pipes towards the rear of vehicle.

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

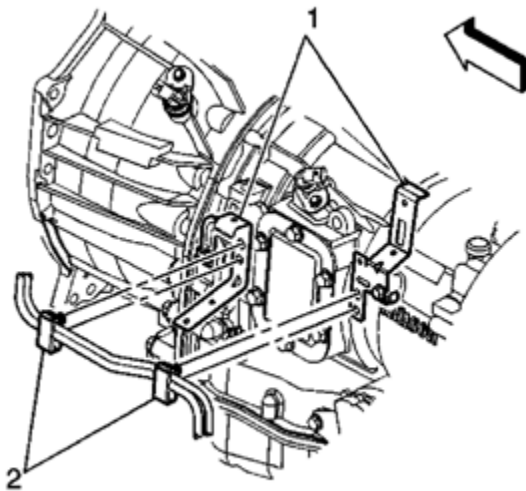
- 1.2. Lift the fuel pipes, while guiding the forward portion of the pipes up towards the engine connections.
2. Install the fuel bundle nuts to the chassis.

Tighten

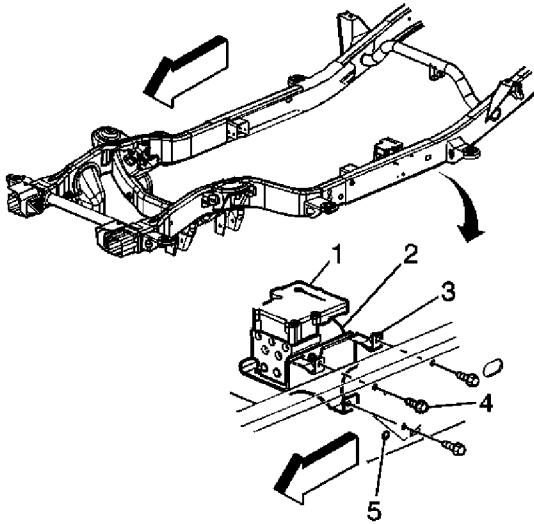
Tighten the nuts to 16 N·m (12 lb ft).



3. Connect the fuel feed and return lines to the fuel tank lines. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Install the fuel system cooler, if necessary. Refer to [Fuel Cooler Replacement](#).



5. Connect the fuel bundle clips (2) to the transmission brackets (1).

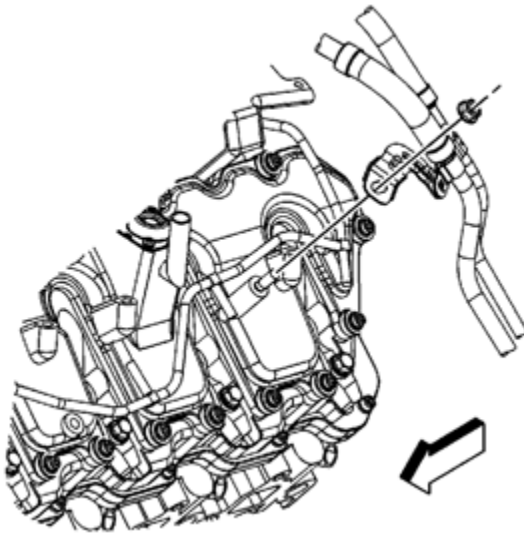


6. Tighten the EBCM bracket bolts (4).

Tighten

Tighten the bolts to 25 N·m (18 lb ft).

7. Lower the vehicle.



8. Install the fuel line bracket to the stud.
9. Install the fuel line bracket nut.

Tighten

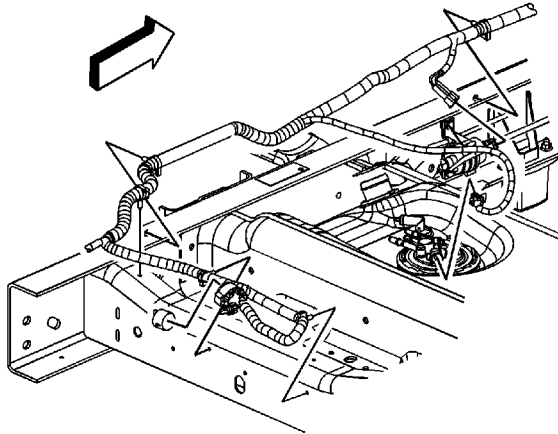
Tighten the nut to 16 N·m (12 lb ft).

10. Connect the fuel feed and return lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
11. Prime the fuel system. Refer to [Fuel System Priming](#).
12. Start the engine. If the engine stalls, repeat the above step.
13. Once the engine starts, inspect for fuel leaks.

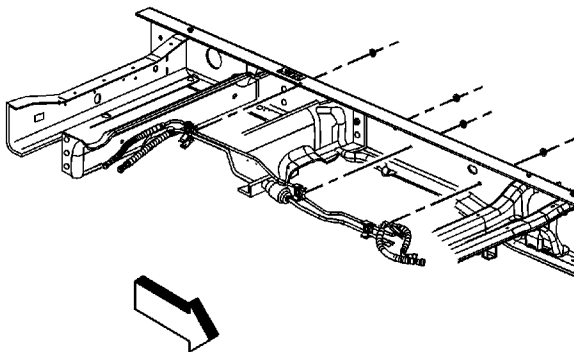
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Fuel Hose / Pipes Replacement - Chassis (Cab / Chassis w / Balance Pump)

Removal Procedure



1. Remove the front and auxiliary fuel tanks. Refer to [Fuel Tank Replacement](#).
2. Disconnect the pressure balance pump electrical connector.

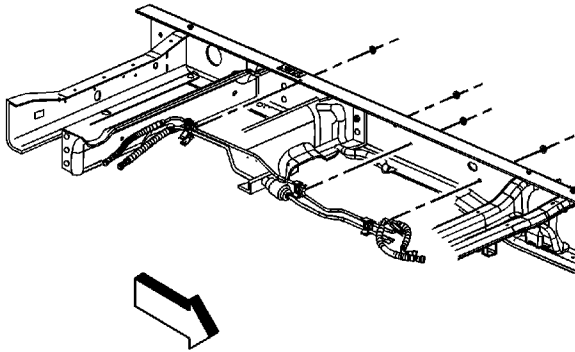


3. Remove the fuel bundle nuts.

4. Remove the fuel bundle.

Installation Procedure

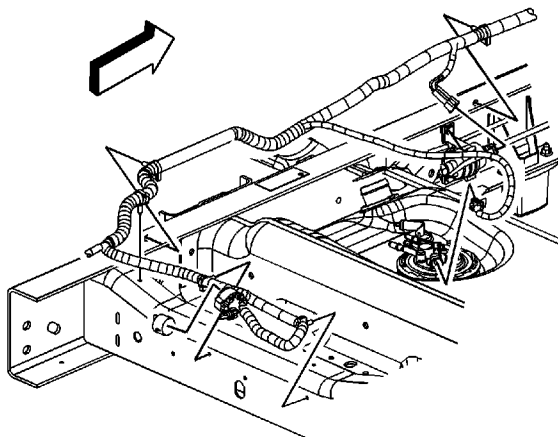
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the fuel bundle.
2. Install the fuel bundle nuts.

Tighten

Tighten the nuts to 16 N·m (12 lb ft).



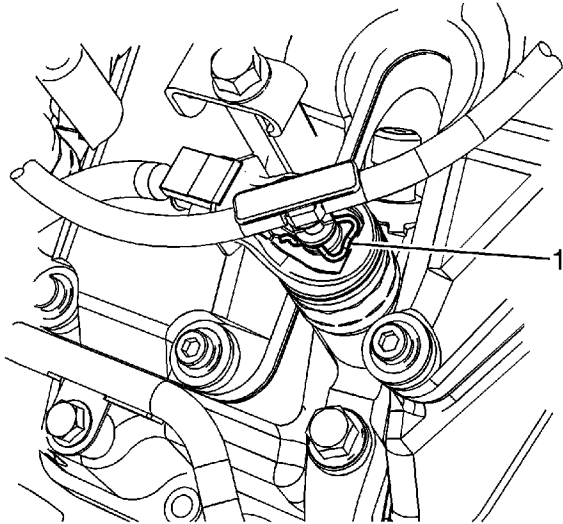


3. Connect the pressure balance pump electrical connector.
4. Install the front and auxiliary fuel tanks. Refer to [Fuel Tank Replacement](#).

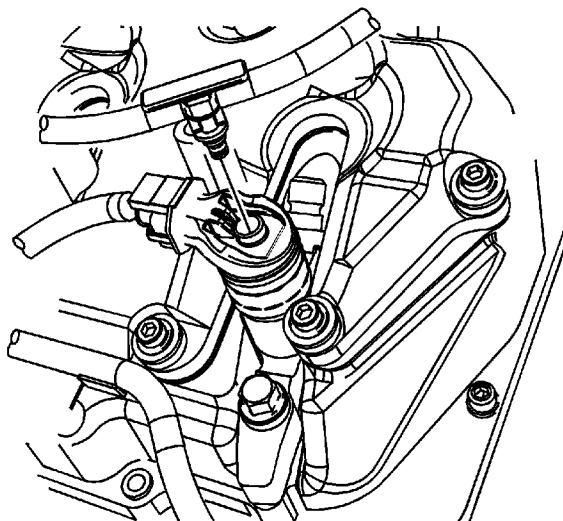
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Fuel Injection Fuel Return Pipe Replacement - Left Side

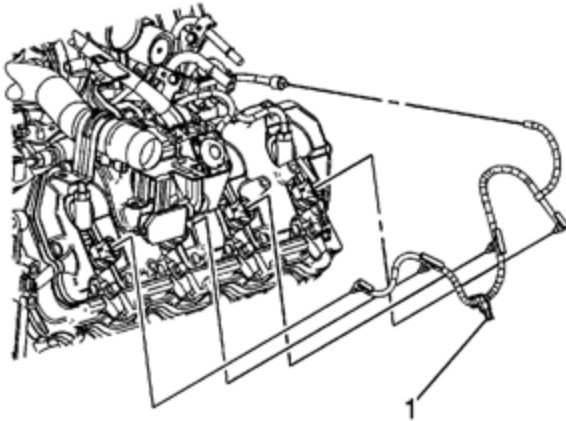
Removal Procedure



1. Remove the glow plug control module. Refer to [Glow Plug Control Module Replacement](#) .
2. Remove the fuel injection fuel return pipe clips (1).



3. Disconnect the fuel injection fuel return pipe from the fuel injectors.

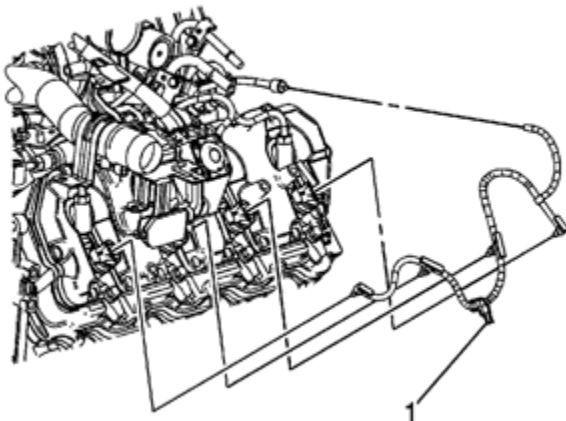


4. Cut the tie strap (1) securing the fuel injection fuel return pipe to the engine wiring harness.
5. Disconnect the fuel injection fuel return pipe from the fuel return pipe.

Important: Note the routing of the fuel injection fuel return pipe under the engine wiring harness.

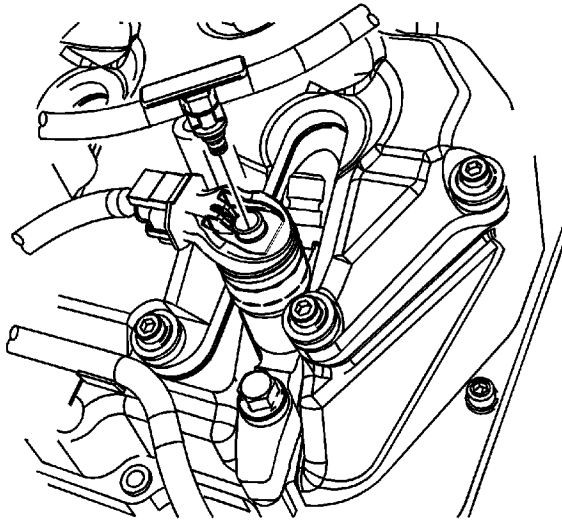
6. Remove the fuel injection fuel return pipe from the engine.

Installation Procedure

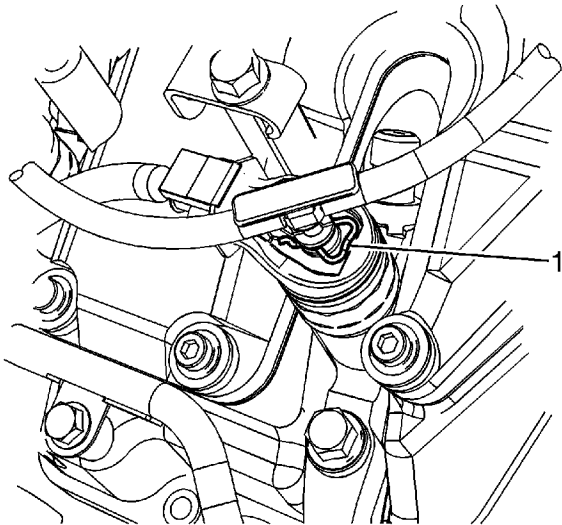


1. Position the fuel injection fuel return pipe to the engine. Ensure to route the fuel injection fuel return pipe under the engine wiring harness.

2. Connect the fuel injection fuel return pipe to the fuel return pipe.
3. Install a NEW tie strap (1) securing the fuel injection fuel return pipe to the engine wiring harness in the location shown.



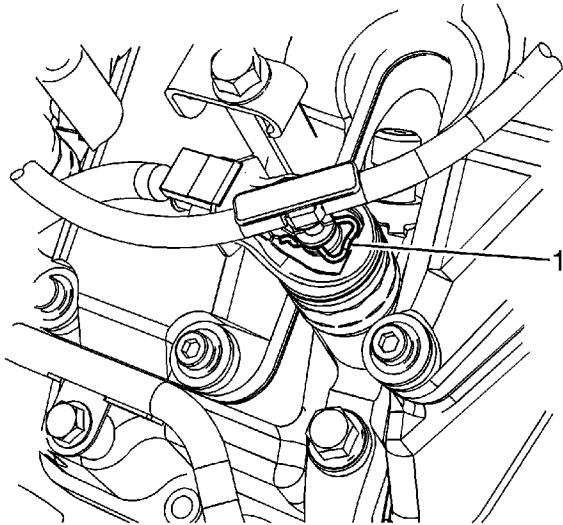
4. Connect the fuel injection fuel return pipe to the fuel injectors.



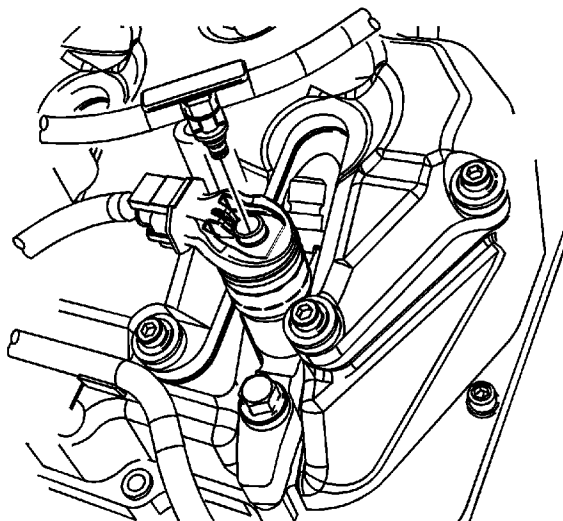
5. Install the fuel injection fuel return pipe clips (1).
6. Install the glow plug control module. Refer to [Glow Plug Control Module Replacement](#) .
7. Prime the fuel system. Refer to [Fuel System Priming](#) .
8. Start the engine. If the engine stalls, repeat the above step.
9. Once the engine starts, inspect for fuel leaks.

Fuel Injection Fuel Return Pipe Replacement - Right Side

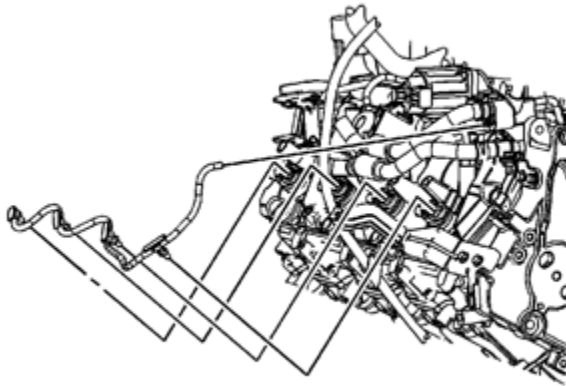
Removal Procedure



1. Remove the fuel filter and bracket. Refer to [Fuel Filter Assembly Replacement](#) .
2. Remove the intake air heater. Refer to [Intake Air Heater Replacement](#) .
3. Remove the fuel injection fuel return pipe clips (1).



4. Disconnect the fuel injection fuel return pipe from the fuel injectors.

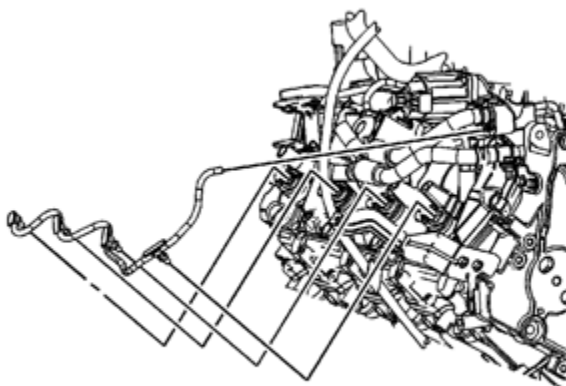


5. Disconnect the fuel injection fuel return pipe from the fuel injection fuel feed manifold.

Important: Note the routing of the fuel injection fuel return pipe under/behind the engine wiring harness.

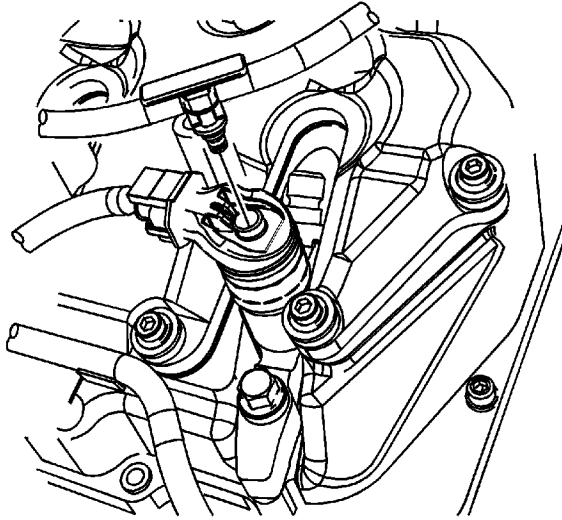
6. Remove the fuel injection fuel return pipe from the engine.

Installation Procedure

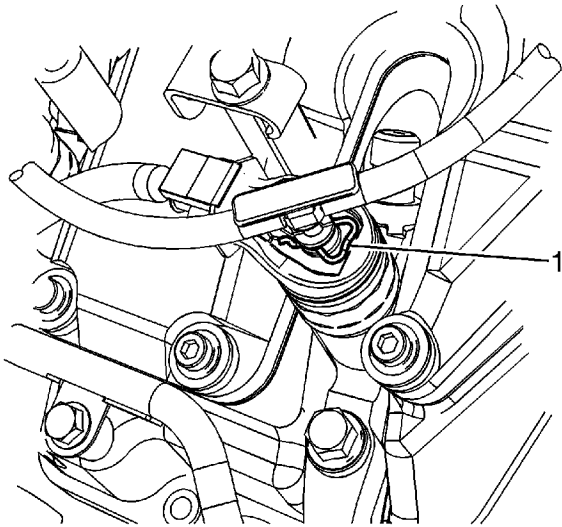


1. Position the fuel injection fuel return pipe to the engine. Ensure to route the fuel injection fuel return pipe under/behind the engine wiring harness.

2. Connect the fuel injection fuel return pipe to the fuel injection fuel feed manifold.



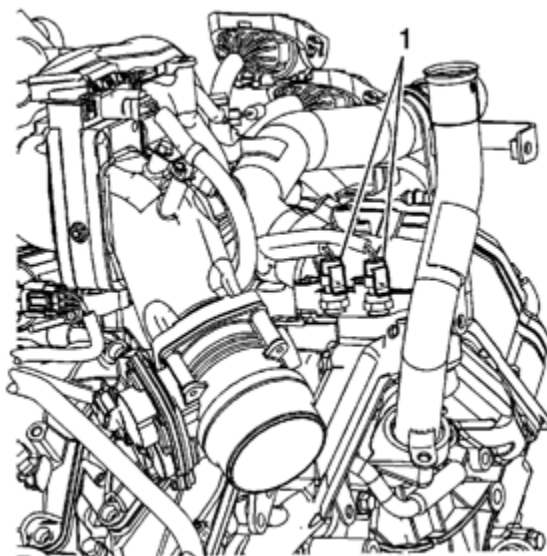
3. Connect the fuel injection fuel return pipe to the fuel injectors.



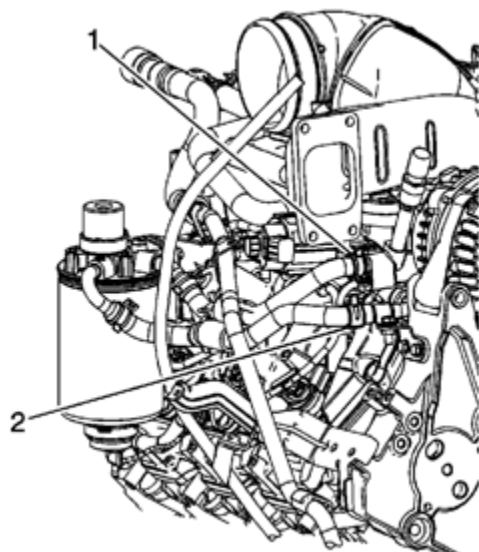
4. Install the fuel injection fuel return pipe clips (1).
5. Install the intake air heater. Refer to [Intake Air Heater Replacement](#) .
6. Install the fuel filter and bracket. Refer to [Fuel Filter Assembly Replacement](#) .
7. Prime the fuel system. Refer to [Fuel System Priming](#) .
8. Start the engine. If the engine stalls, repeat the above step.
9. Once the engine starts, inspect for fuel leaks.

Fuel Feed Pipe Replacement

Removal Procedure

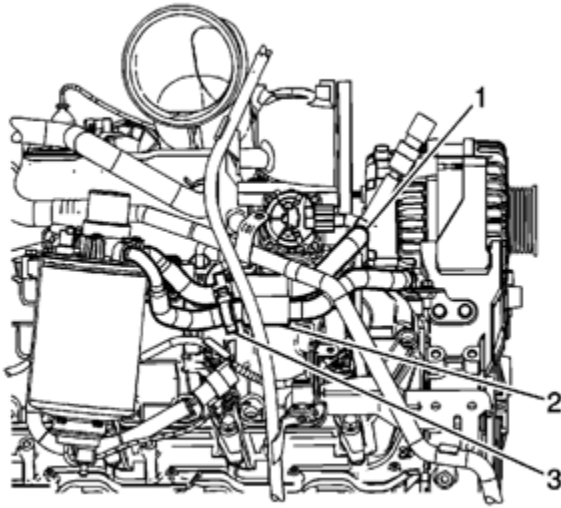


1. Remove the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
2. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
3. Remove the generator. Refer to [Generator Replacement](#).
4. Disconnect the chassis fuel feed pipe quick connect fitting from the fuel feed pipe. Refer to [Metal Collar Quick Connect Fitting Service](#).
5. Disconnect the engine wiring harness electrical connectors (1) from the engine coolant temperature (ECT) sensors, and reposition the wiring out of the way.

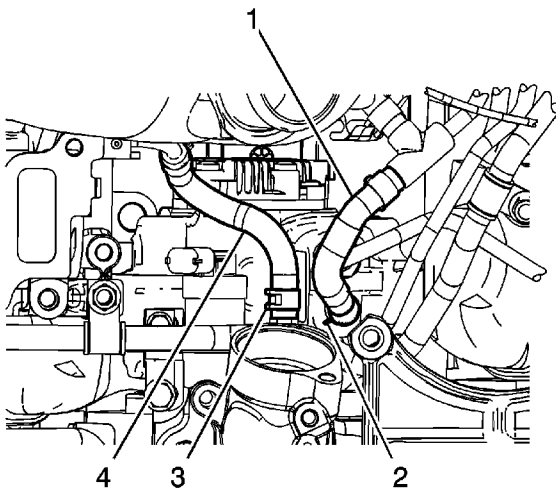




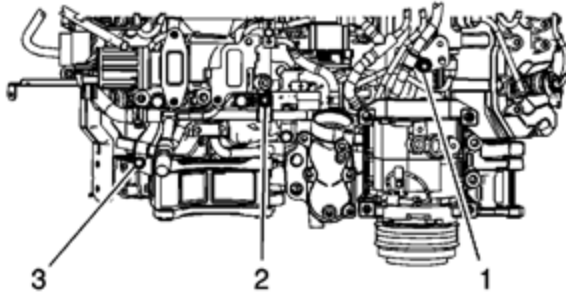
6. Reposition the fuel filter hose clamp (2) at the fuel feed pipe.



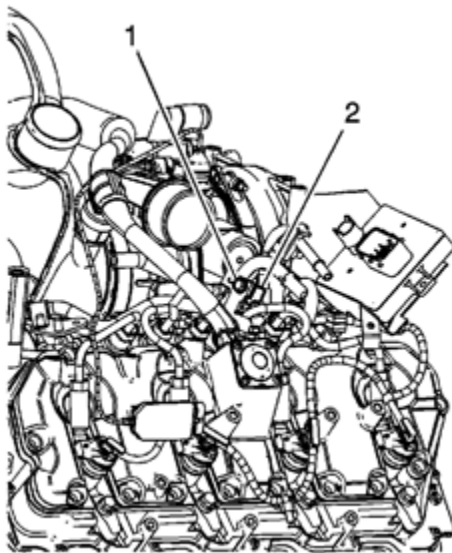
7. Remove the fuel filter hose (2) from the fuel feed pipe.



8. Reposition the fuel hose clamp (2) at the fuel injection pump.
9. Remove the fuel hose (1) from the injection pump and reposition the hose out of the way.

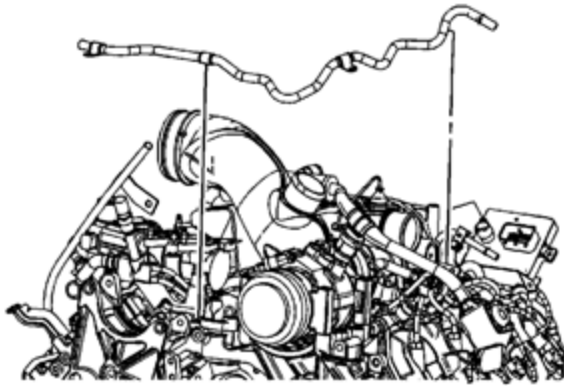


10. Remove the fuel feed pipe clip nuts (1 and 2) and bolt (3).



11. Remove the fuel pipe bracket bolt (1) and fuel feed pipe clip (2).

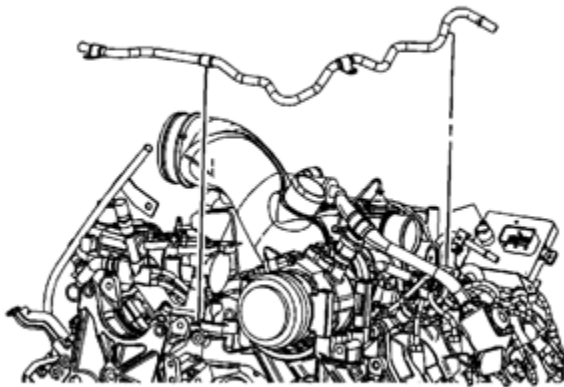
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Note: Note the routing of the fuel feed pipe under the engine wiring harness.

12. Remove the fuel feed pipe.

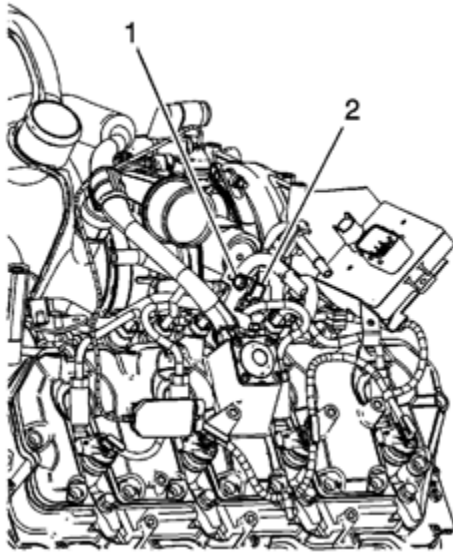
Installation Procedure



Note: Ensure to route the fuel feed pipe under the engine wiring harness as noted during removal.

1. Position and install the fuel feed pipe to the engine.

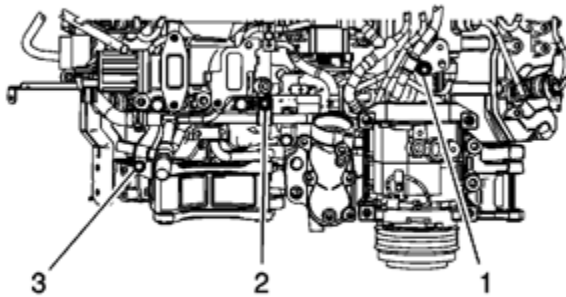
Caution: Refer to [Fastener Caution](#) in the Preface section.



2. Position fuel feed pipe clip (2) behind the fuel pipe bracket and install the bolt (1).

Tighten

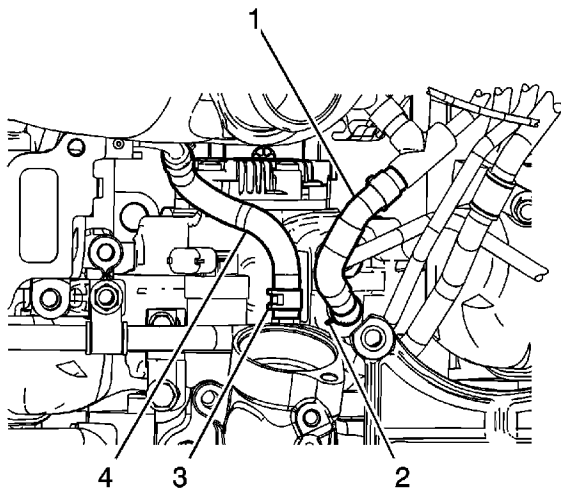
Tighten the bolt to 24 N·m (18 lb ft).



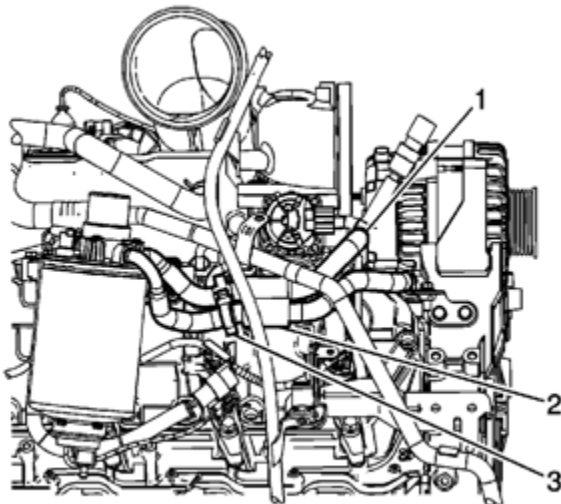
3. Install the fuel feed pipe clip nuts (1 and 2) and bolt (3).

Tighten

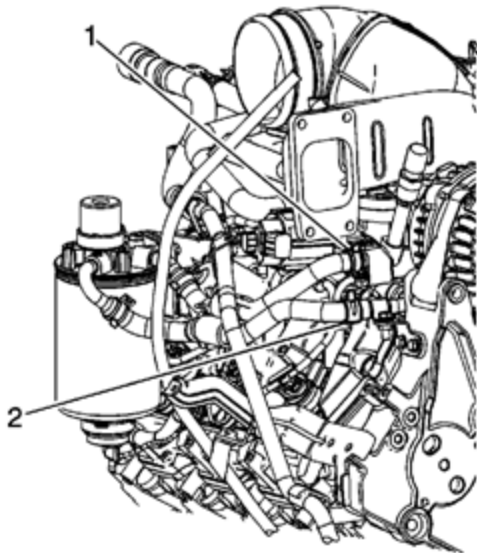
Tighten the bolt/nuts to 24 N·m (18 lb ft).



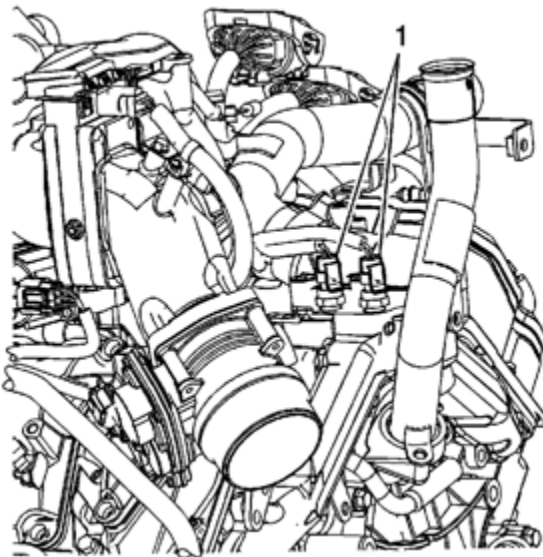
4. Position the fuel hose and install the hose (1) to the injection pump.
5. Position the fuel hose clamp (2) at the fuel injection pump.



6. Install the fuel filter hose (2) to the fuel feed pipe.



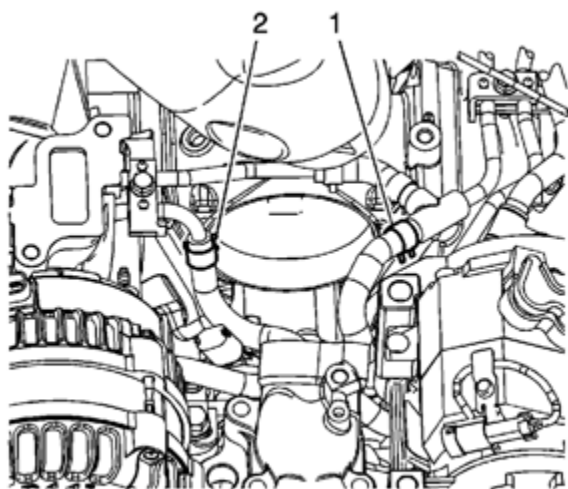
7. Position the fuel filter hose clamp (2) at the fuel feed pipe.



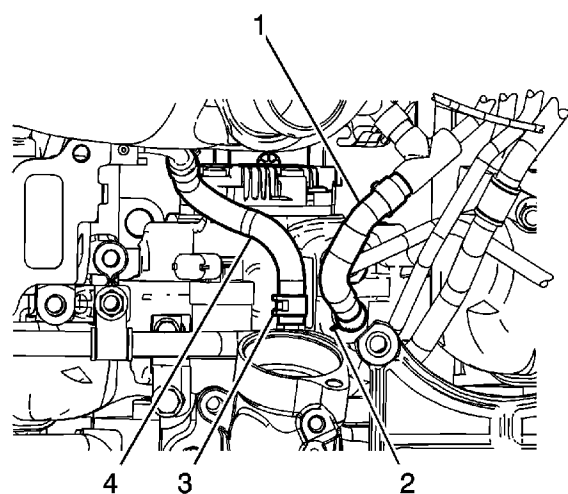
8. Position the engine wiring harness and connect the engine wiring harness electrical connectors (1) to the ECT sensors.
9. Connect the chassis fuel feed pipe quick connect fitting to the fuel feed pipe. Refer to [Metal Collar Quick Connect Fitting Service](#).
10. Install the generator. Refer to [Generator Replacement](#).
11. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
12. Install the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
13. Prime the fuel system. Refer to [Fuel System Priming](#).
14. Start the engine. If the engine stalls, repeat the above step.
15. Once the engine starts, inspect for fuel leaks.

Fuel Return Pipe Replacement

Removal Procedure

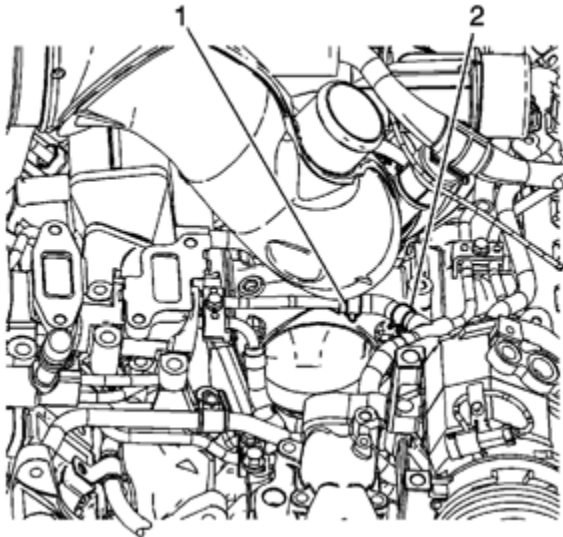


1. Remove the water outlet. Refer to [Water Outlet Tube Replacement](#).
2. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
3. Remove the glow plug control module and bracket. Refer to [Glow Plug Control Module Replacement](#).
4. Remove the fuel temperature sensor. Refer to [Fuel Temperature Sensor Replacement](#).
5. Reposition the fuel hose clamp (1) at the fuel return pipe.



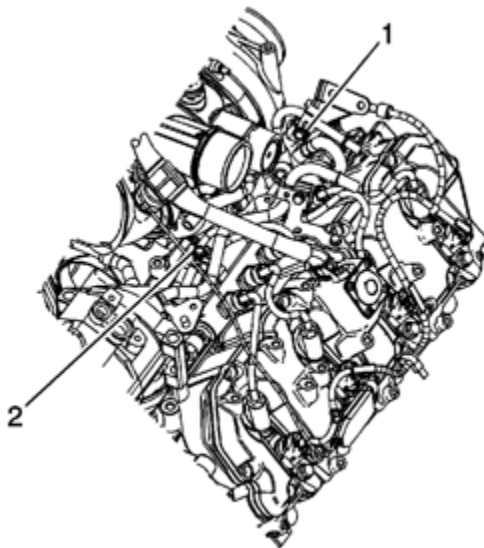


6. Remove the fuel hose (1) from the return pipe.

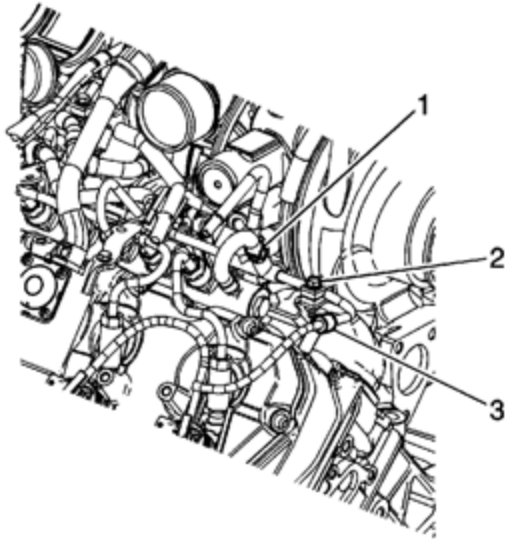


Note: Engine wiring harness shown removed for clarity.

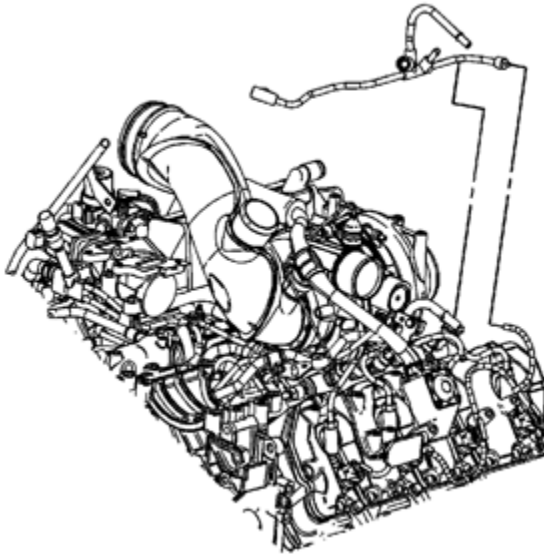
7. Reposition the fuel return hose clamp (2) at the fuel return pipe.



8. Remove the fuel return pipe clip bolt (2) and clip.
9. Remove the fuel return pipe clamp bolt (1) and bracket.



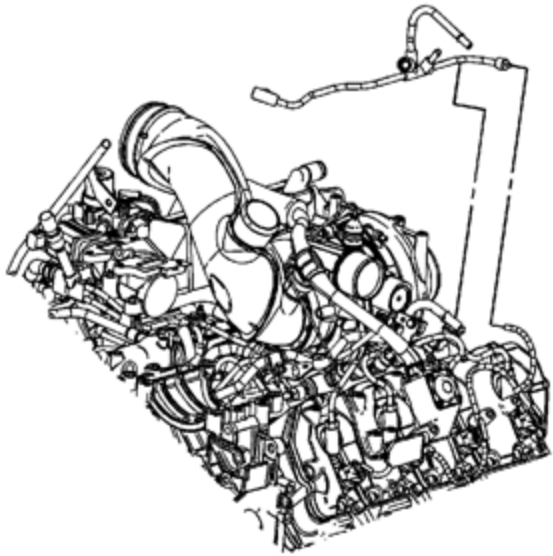
10. Reposition the fuel return hose clamp (1) at the return pipe.
11. Remove the fuel return hose from the return pipe.
12. Remove the fuel return pipe clamp bolt (2) and clamp.
13. Disconnect the fuel injection fuel feed pipe (3) from the fuel return pipe.



Note: Note the routing of the fuel return pipe prior to removal.

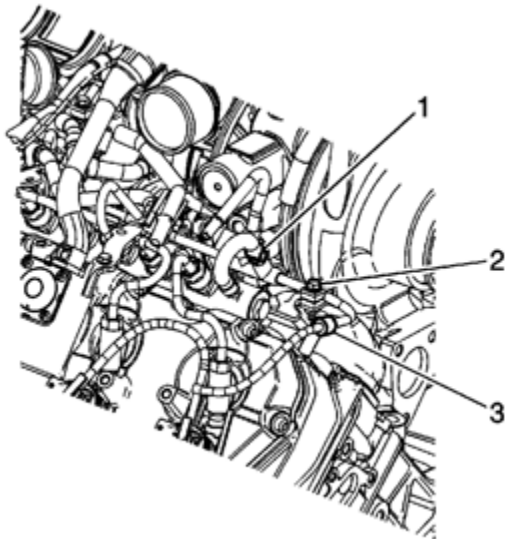
14. Remove the fuel return pipe from the fuel return hose and the vehicle.

Installation Procedure



Note: Ensure to route the fuel return pipe under the wiring harness and noted during removal.

1. Position and install the fuel return pipe to the vehicle and the fuel return hose.



2. Connect the fuel injection fuel feed pipe (3) to the fuel return pipe.

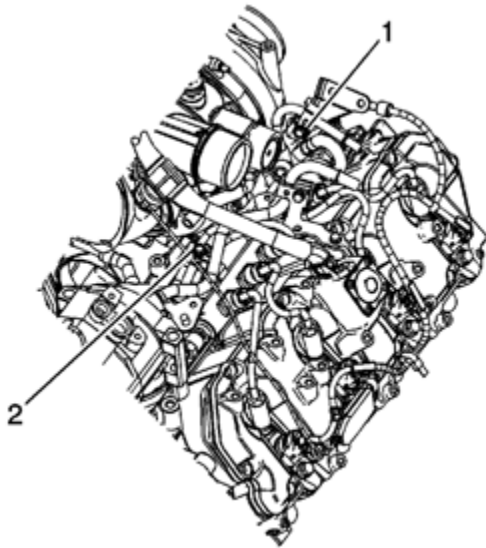
Caution: Refer to [Fastener Caution](#) in the Preface section.

3. Position and install the fuel return pipe clamp and bolt (2).

Tighten

Tighten the bolt to 24 N·m (18 lb ft).

4. Install the fuel return hose to the return pipe.
5. Position the fuel return hose clamp (1) at the return pipe.



6. Install the fuel return pipe bracket, clamp, and bolt (1).

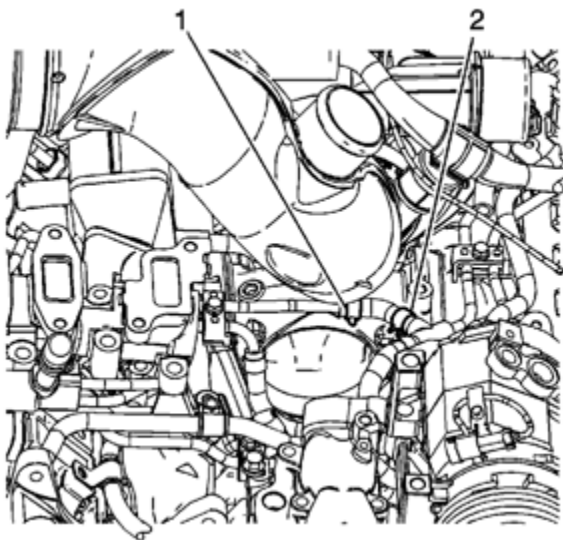
Tighten

Tighten the bolt to 24 N·m (18 lb ft).

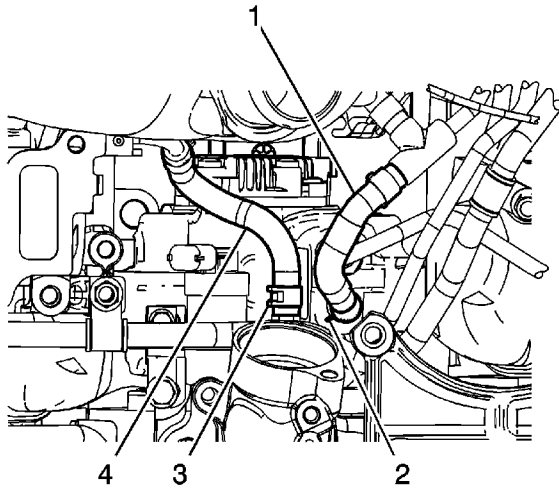
7. Install the fuel return pipe clip and bolt (2).

Tighten

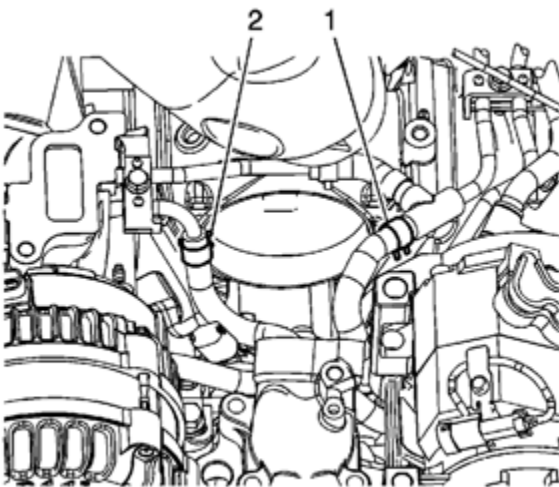
Tighten the bolt to 24 N·m (18 lb ft).



8. Position the fuel return hose clamp (2) at the fuel return pipe.



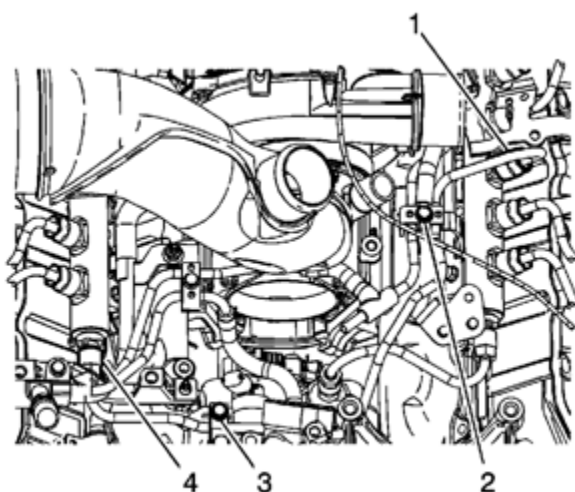
9. Install the fuel hose (1) to the return pipe.



10. Position the fuel hose clamp (1) at the fuel return pipe.
11. Install the fuel temperature sensor. Refer to [Fuel Temperature Sensor Replacement](#).
12. Install the glow plug control module and bracket. Refer to [Glow Plug Control Module Replacement](#).
13. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
14. Install the water outlet. Refer to [Water Outlet Tube Replacement](#).
15. Prime the fuel system. Refer to [Fuel System Priming](#).
16. Start the engine. If the engine stalls, repeat the above step.
17. Once the engine starts, inspect for fuel leaks.

Fuel Injection Fuel Feed Front Pipe Replacement - Right Side

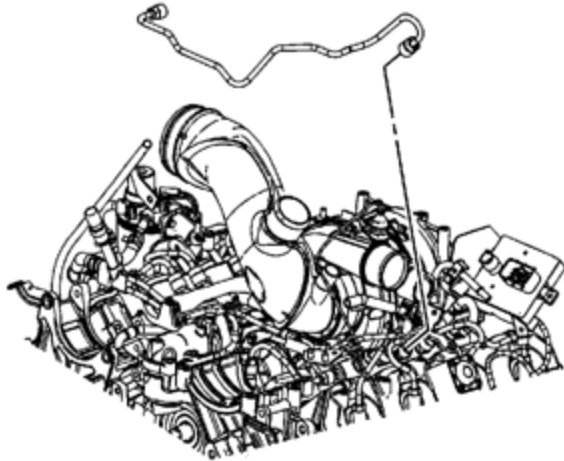
Removal Procedure



1. Remove the fuel feed pipe. Refer to [Fuel Feed Pipe Replacement](#).
2. Remove the exhaust gas recirculation (EGR) valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).

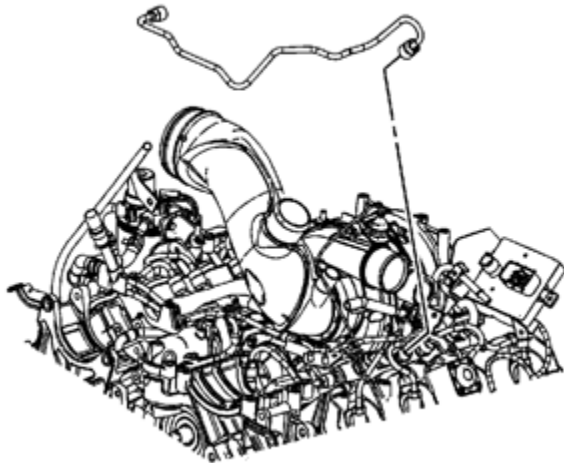
Note: Engine wiring harness shown removed for clarity.

3. Remove the fuel rail fuel feed pipe clamp bolts (2 and 3) and upper clamps.
4. Loosen the fuel rail fuel feed pipe fitting (1) at the left fuel rail.
5. Loosen the fuel rail fuel feed pipe fitting (4) at the right fuel rail.



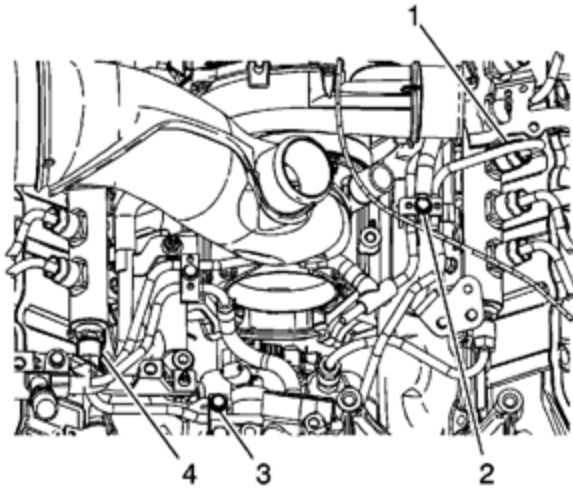
6. Remove the right fuel rail fuel feed pipe.

Installation Procedure



1. Position and install the right fuel rail fuel feed pipe.

Caution: Refer to Fastener Caution in the Preface section.



2. Install the fuel rail fuel feed pipe upper clamps and bolts (2 and 3).

Tighten

Tighten the bolts to 24 N·m (18 lb ft).

3. Tighten the fuel rail fuel feed pipe fitting (4) at the right fuel rail.

Tighten

Tighten the fitting to 41 N·m (30 lb ft).

4. Tighten the fuel rail fuel feed pipe fitting (1) at the left fuel rail.

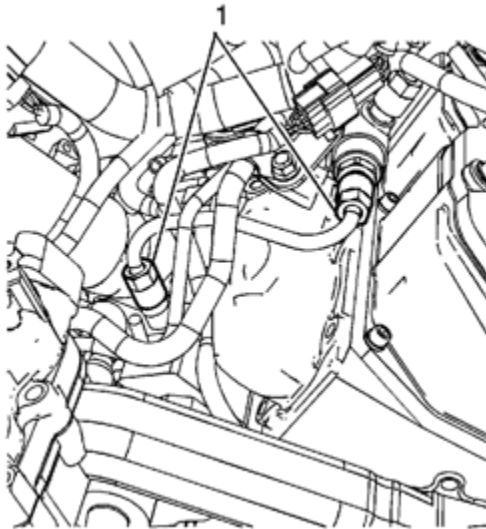
Tighten

Tighten the fitting to 41 N·m (30 lb ft).

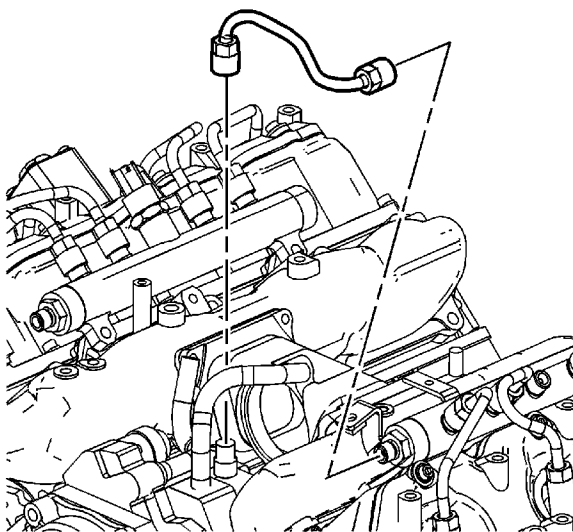
5. Install the EGR valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
6. Install the fuel feed pipe. Refer to [Fuel Feed Pipe Replacement](#).
7. Prime the fuel system. Refer to [Fuel System Priming](#).
8. Start the engine. If the engine stalls, repeat the above step.
9. Once the engine starts, inspect for fuel leaks.

Fuel Injection Fuel Feed Front Pipe Replacement - Left Side

Removal Procedure



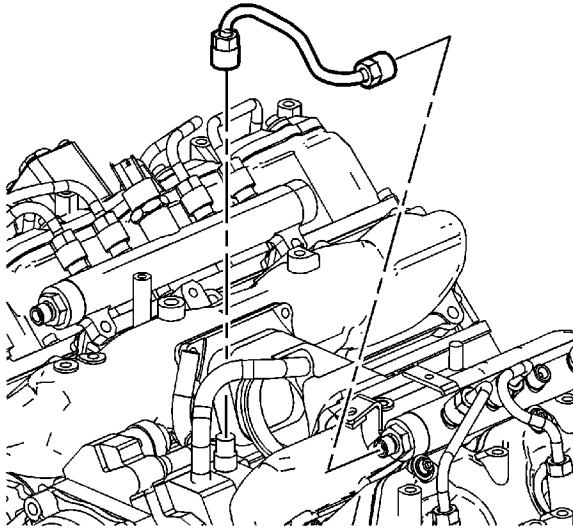
1. Remove the fuel return pipe to fuel injection pump fuel hose. Refer to [Fuel Return Hose Replacement - Fuel Return Pipe to Fuel Injection Pump](#).
2. Loosen the left fuel rail fuel feed pipe fittings (1).



Note: Note the routing of the left fuel rail fuel feed pipe under the fuel feed and return pipes.

3. Remove the left fuel rail fuel feed pipe.

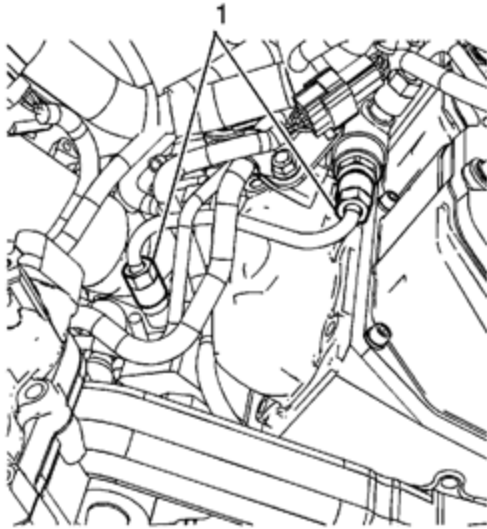
Installation Procedure



Note: Ensure that the routing of the left fuel rail fuel feed pipe is under the fuel feed and return pipes.

1. Position and install the left fuel rail fuel feed pipe.

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



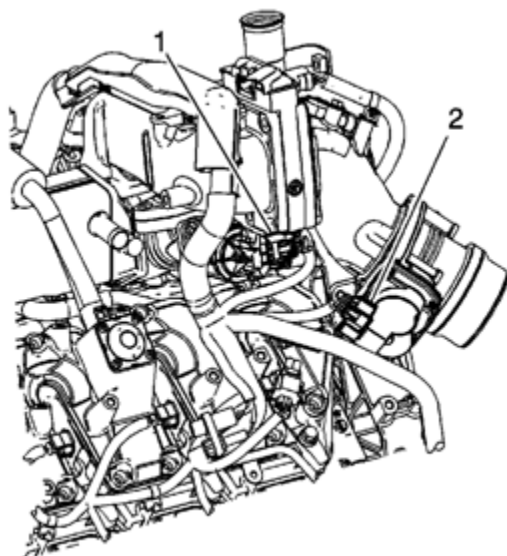
2. Tighten the left fuel rail fuel feed pipe fittings (1).

Tighten

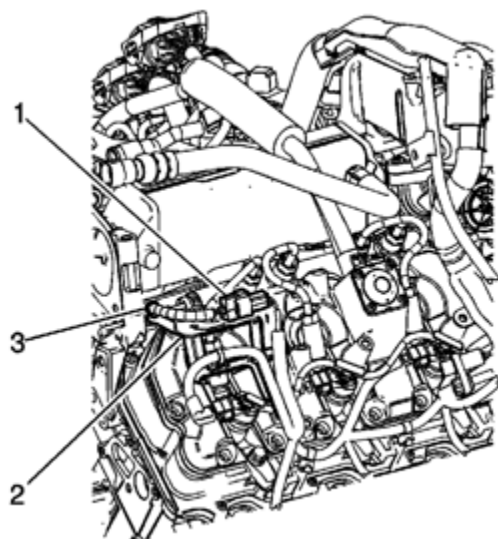
Tighten the fittings to 41 N·m (30 lb ft).

3. Install the fuel return pipe to fuel injection pump fuel hose. Refer to [Fuel Return Hose Replacement - Fuel Return Pipe to Fuel Injection Pump](#).
4. Prime the fuel system. Refer to [Fuel System Priming](#).
5. Start the engine. If the engine stalls, repeat the above step.
6. Once the engine starts, inspect for fuel leaks.

Fuel Injection Fuel Feed Pipe Replacement - Right Side Removal Procedure

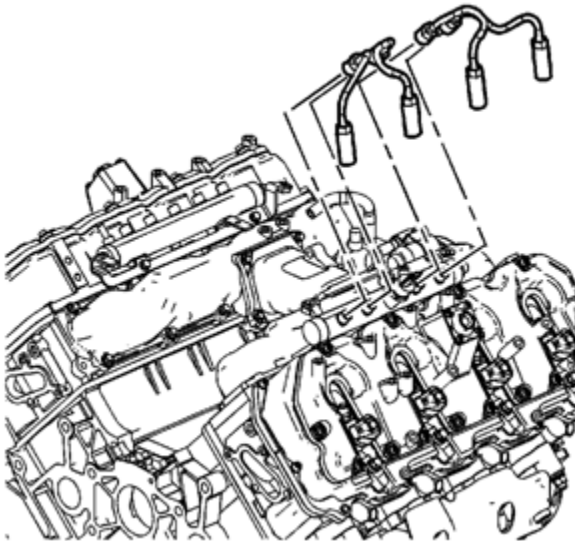


1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
2. Remove the charge air cooler outlet pipe. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
3. Remove the fuel filter assembly. Refer to [Fuel Filter Assembly Replacement](#).
4. Remove the fuel filter/heater element housing to fuel feed block fuel hoses. Refer to [Fuel Hose Replacement - Fuel Filter/Heater Element Housing to Fuel Feed Block](#).
5. Disconnect the engine wiring harness electrical connector (1) from the exhaust gas recirculation (EGR) valve.





6. Disconnect the engine wiring harness electrical connector (1) from the fuel injection fuel rail pressure sensor wiring harness extension electrical connector.
7. Remove the fuel injection fuel rail pressure sensor wiring harness extension retainer (3) from the bracket.
8. Remove the engine wiring harness bracket bolts and remove the bracket (2).
9. Reposition the engine wiring harness slightly in order to access the front fuel injection fuel feed pipe.



10. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
11. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fittings to assist in containing any debris during removal.

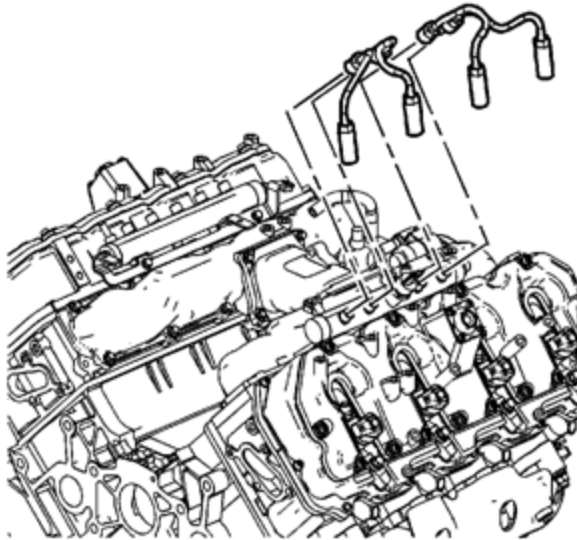
Caution: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

12. Remove the fuel injector pipes.

Installation Procedure

Caution: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

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

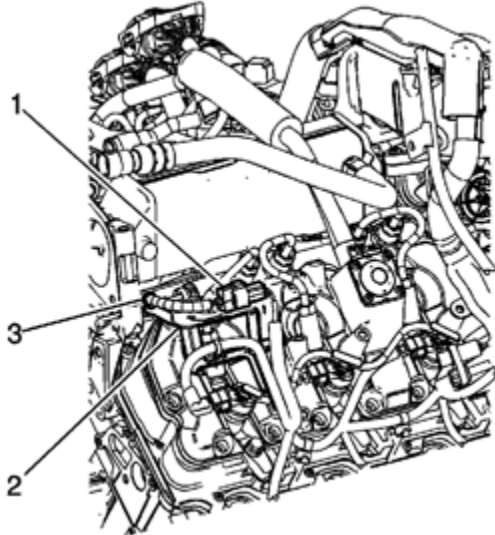


1. Install the fuel injector pipes.

Tighten

Tighten the fittings to 41 N·m (30 lb ft).

2. Reposition the engine wiring harness as necessary.



3. Position the engine wiring harness bracket (2) to the valve rocker arm cover and install the bracket bolts.

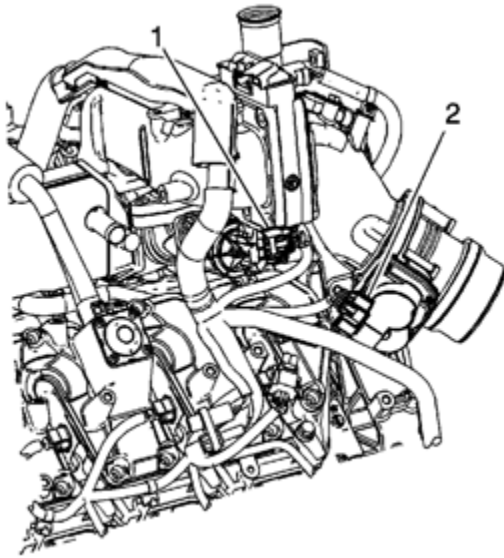
Tighten

Tighten the bolts to 24 N·m (18 lb ft).

4. Connect the engine wiring harness electrical connector (1) to the fuel injection fuel rail

pressure sensor wiring harness extension electrical connector.

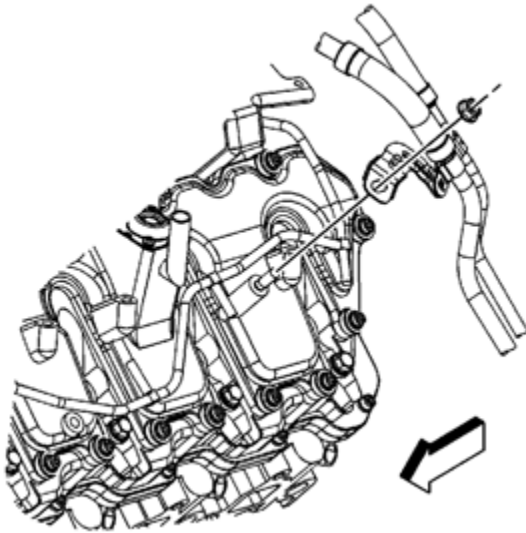
5. Install the fuel injection fuel rail pressure sensor wiring harness extension retainer (3) to the bracket.



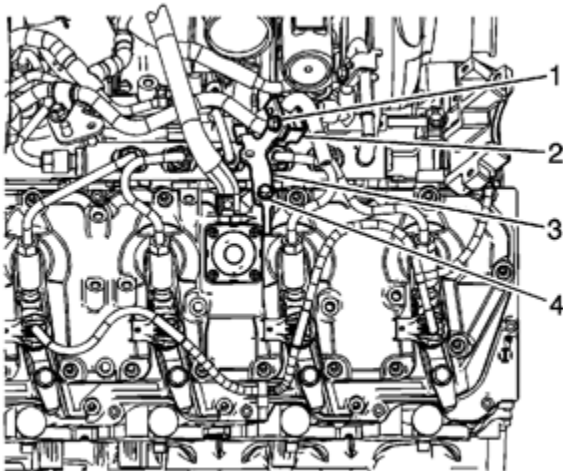
6. Connect the engine wiring harness electrical connector (1) to the EGR valve.
7. Install the fuel filter/heater element housing to fuel feed block fuel hoses. Refer to [Fuel Hose Replacement - Fuel Filter/Heater Element Housing to Fuel Feed Block](#).
8. Install the fuel filter assembly. Refer to [Fuel Filter Assembly Replacement](#).
9. Install the charge air cooler outlet pipe. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
10. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
11. Prime the fuel system. Refer to [Fuel System Priming](#).
12. Start the engine. If the engine stalls, repeat the above step.
13. Once the engine starts, inspect for fuel leaks.

Fuel Injection Fuel Feed Pipe Replacement - Left Side

Removal Procedure

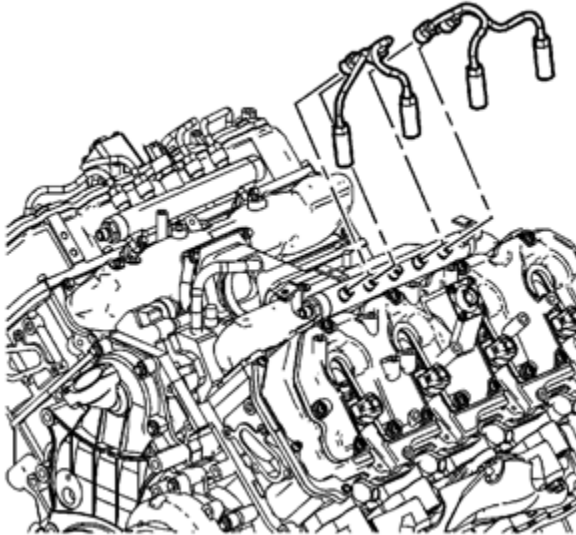


1. Remove the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
2. Remove the water outlet. Refer to [Water Outlet Tube Replacement](#).
3. Remove the glow plug control module and bracket. Refer to [Glow Plug Control Module Replacement](#).
4. Disconnect the chassis fuel feed and return line quick connect fittings from the engine fuel feed and return pipes. Refer to [Metal Collar Quick Connect Fitting Service](#).
5. Remove the fuel line bracket nut.
6. Remove the fuel line bracket from the stud.





7. Remove the engine wiring harness clip from the fuel line bracket.
8. Remove the fuel line bracket bolts (1 and 4), clamp (2), and bracket (3).



9. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
10. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fittings to assist in containing any debris during removal.

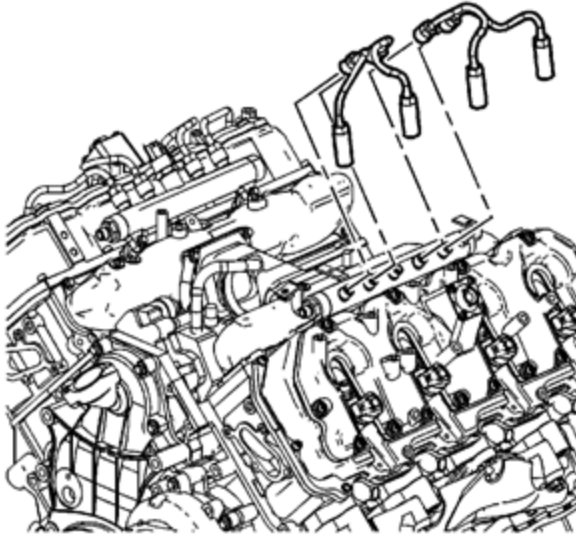
Caution: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

11. Remove the left fuel injector pipes.

Installation Procedure

Caution: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

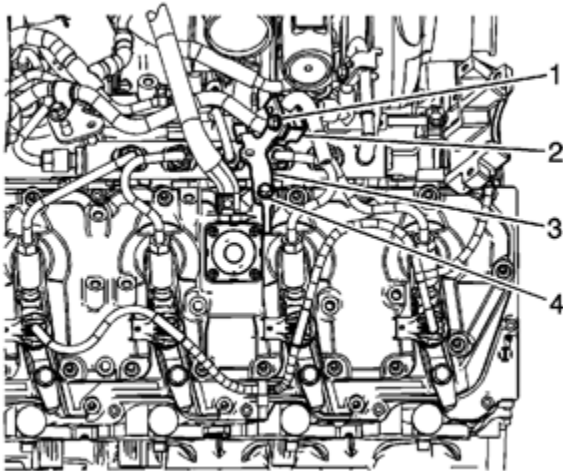
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the fuel injector pipes.

Tighten

Tighten the fittings to 41 N·m (30 lb ft).

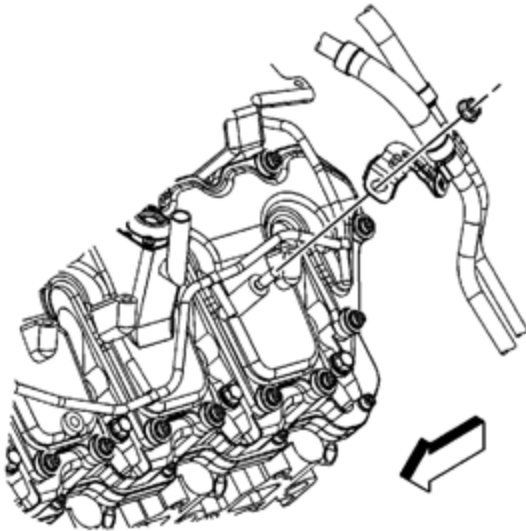


2. Position the fuel line bracket (3) to the valve rocker arm cover, and install the clamp (2) and bolts (1 and 4).

Tighten

Tighten the bolts to 24 N·m (18 lb ft).

3. Install the engine wiring harness clip to the fuel line bracket.



4. Install the fuel line bracket to the stud.
5. Install the fuel line bracket nut.

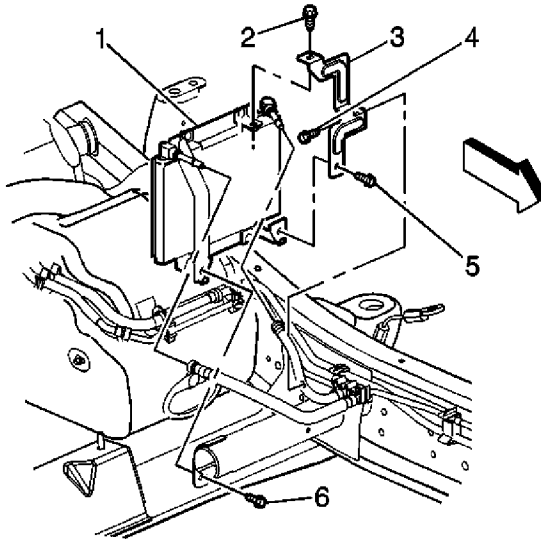
Tighten

Tighten the nut to 21 N·m (15 lb ft).

6. Connect the chassis fuel feed and return line quick connect fittings to the engine fuel feed and return pipes. Refer to [Metal Collar Quick Connect Fitting Service](#).
7. Install the glow plug control module and bracket. Refer to [Glow Plug Control Module Replacement](#).
8. Install the water outlet. Refer to [Water Outlet Tube Replacement](#).
9. Install the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
10. Prime the fuel system. Refer to [Fuel System Priming](#).
11. Start the engine. If the engine stalls, repeat the above step.
12. Once the engine starts, inspect for fuel leaks.

Fuel Cooler Replacement (Pickup)

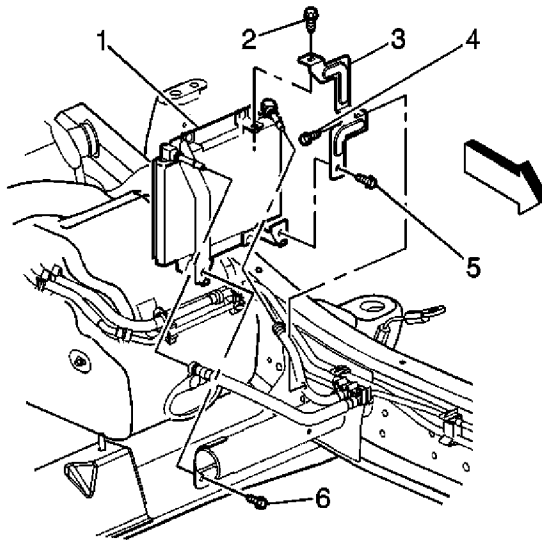
Removal Procedure



1. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the fuel lines at the cooler (1). Refer to [Metal Collar Quick Connect Fitting Service](#).
3. Remove the fuel cooler bolts (4, 6).
4. Remove the fuel cooler (1).
5. Remove the fuel cooler support bracket bolt (2, 5), and bracket (3) from the fuel cooler (1), if necessary.

Installation Procedure

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



1. Install the fuel cooler support bracket (3), and bolts (2, 5) to the fuel cooler (1), if necessary.

Tighten

Tighten the bolts to 18 N·m (13 lb ft).

2. Install the fuel cooler (1) to the chassis and crossover.
3. Install the fuel cooler bolts (4, 6).

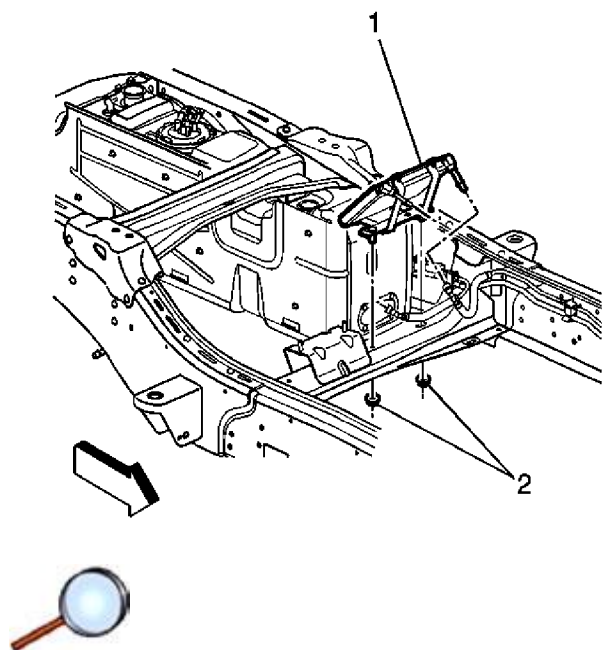
Tighten

Tighten the bolts to 18 N·m (13 lb ft).

4. Connect the fuel lines at the fuel cooler (1). Refer to [Metal Collar Quick Connect Fitting Service](#).
5. Lower the vehicle.
6. Prime the fuel system. Refer to [Fuel System Priming](#).
7. Start the engine. If the engine stalls, repeat the above step.
8. Once the engine starts, inspect for fuel leaks.

Fuel Cooler Replacement (Cab / Chassis)

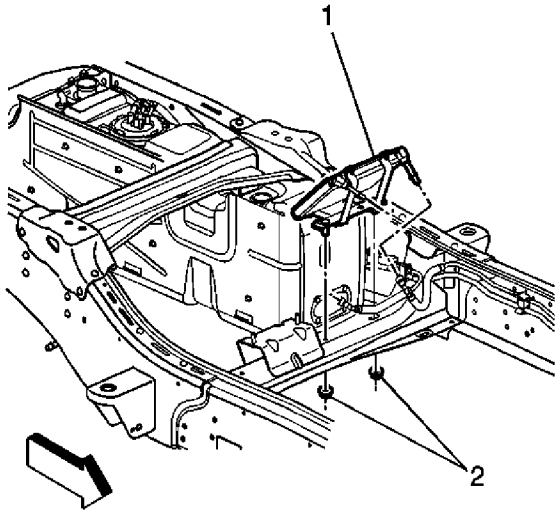
Removal Procedure



1. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the fuel lines at the fuel cooler (1). Refer to [Metal Collar Quick Connect Fitting Service](#).
3. Remove the fuel cooler nuts (2).
4. Remove the fuel cooler (1).

Installation Procedure

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



1. Install the fuel cooler (1).
2. Install the fuel cooler nuts (2).

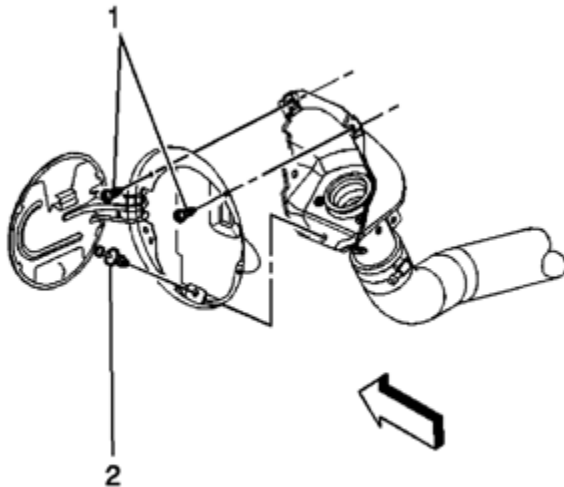
Tighten

Tighten the nuts to 40 N·m (30 lb ft).

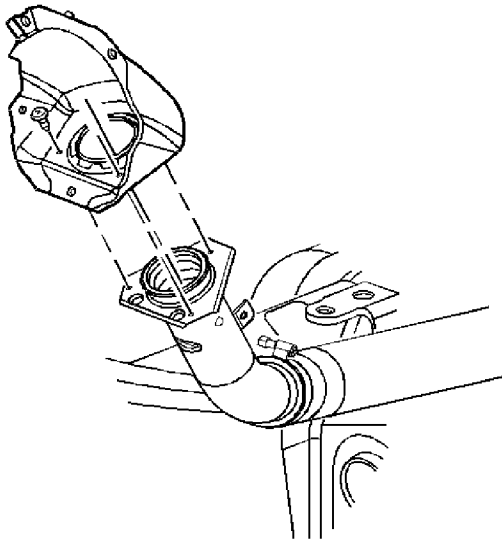
3. Connect the fuel lines at the fuel cooler (1). Refer to [Metal Collar Quick Connect Fitting Service](#).
4. Lower the vehicle.
5. Prime the fuel system. Refer to [Fuel System Priming](#).
6. Start the engine. If the engine stalls, repeat the above step.
7. Once the engine starts, inspect for fuel leaks.

Fuel Tank Filler Hose Replacement (Pickup)

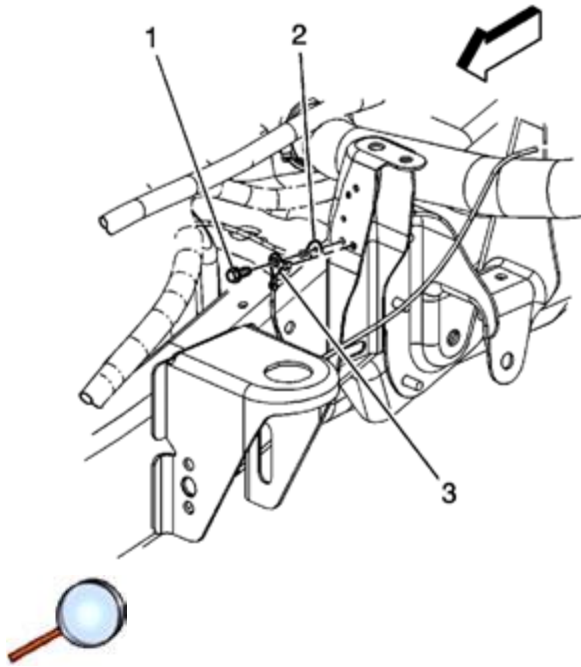
Removal Procedure



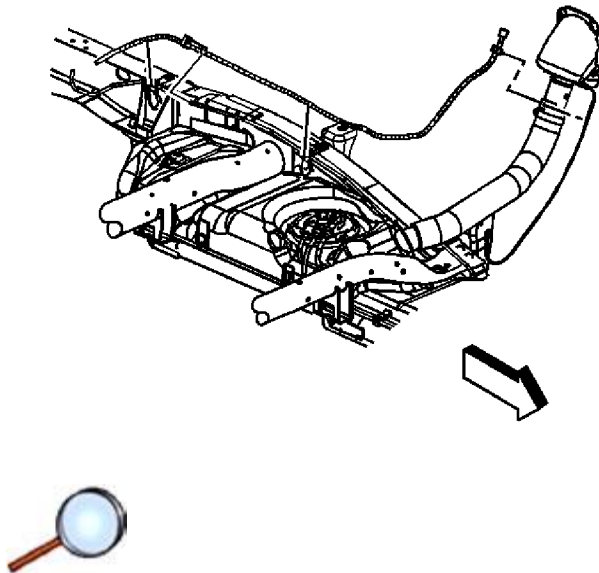
1. Remove the fuel tank filler housing to body screws (1) and retainer (2).



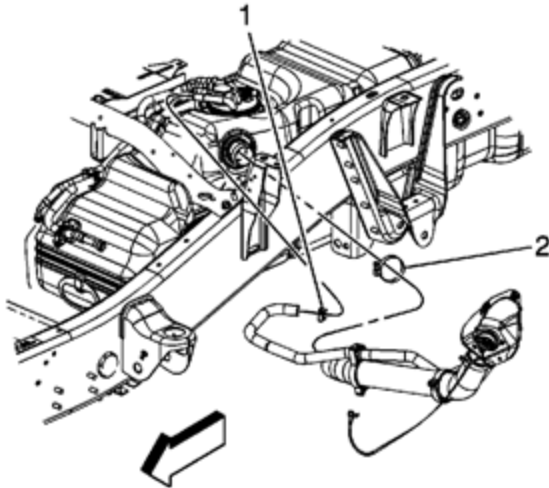
2. Remove the fuel tank filler pipe housing to fuel tank fill pipe screws.
3. Remove the fuel tank filler housing.
4. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



5. Remove the fuel tank ground strap bolt (1).
6. Remove the chassis harness ground strap (2) and fuel tank ground strap (3).

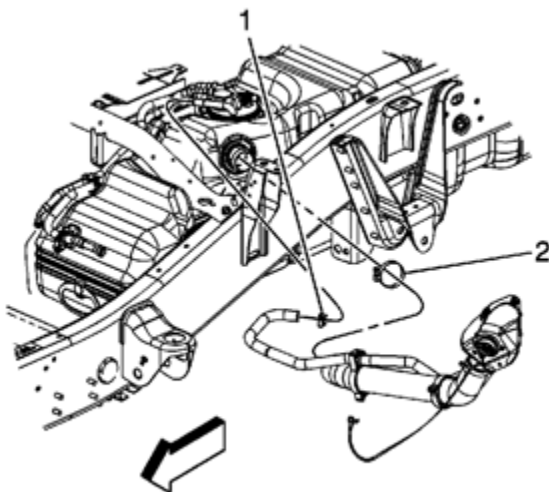


7. Remove the rear axle vent hose from the clip on the fuel fill pipe bracket.



8. Loosen the fuel tank vent hose and fill hose clamps (1, 2).
9. Remove the vent hose from the tank.
10. Remove the fill hose from the tank and the vehicle.
11. Cap the opening on the fuel tank in order to prevent possible fuel system contamination.

Installation Procedure



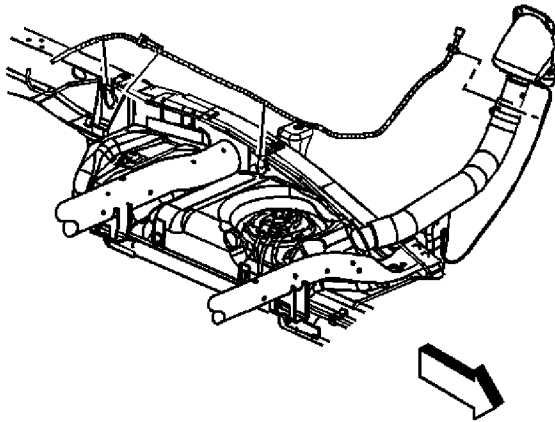
1. Remove the cap from the opening on the fuel tank.
2. Install the fill hose to the vehicle and tank.

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

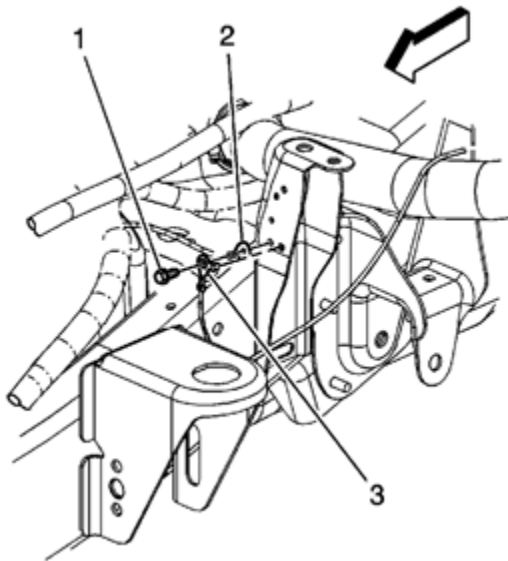
3. Install the vent hose to the tank.
4. Tighten the fuel tank vent hose and fill hose clamps (1, 2).

Tighten

Tighten the clamp to 2.5 N·m (22 lb in).



5. Install the rear axle vent hose to the clip on the fuel fill pipe bracket.

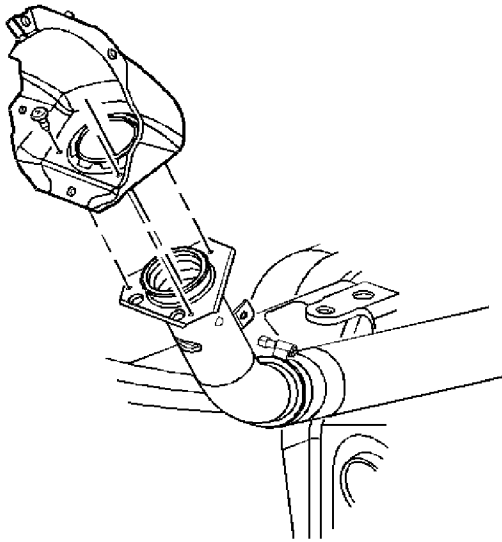


6. Position the chassis harness ground strap (2) and fuel tank ground strap (3).
7. Install the ground strap anti-rotation tab into the frame hole.
8. Install the fuel tank ground strap bolt (1).

Tighten

Tighten the bolt to 9 N·m (80 lb in).

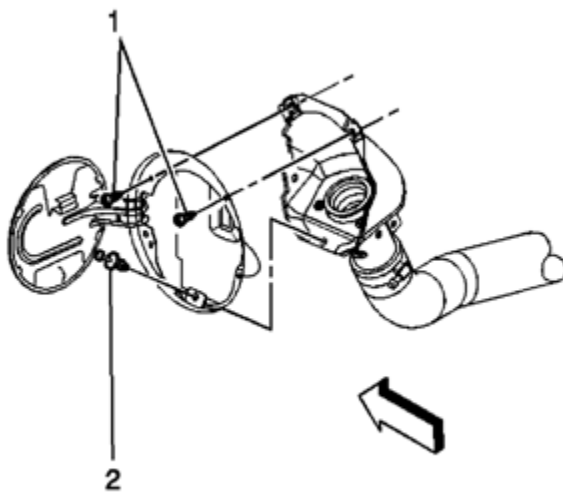
9. Lower the vehicle.



10. Install the fuel tank filler housing.
11. Install the fuel tank filler housing to fuel tank fill pipe screws.

Tighten

Tighten the screws to 2.3 N·m (20 lb in).



12. Install the fuel tank filler housing to body screws (1) and retainer (2).

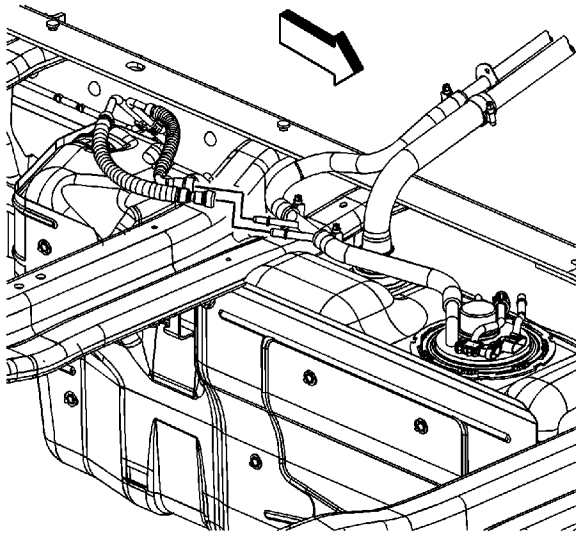
Tighten

Tighten the screws to 2.3 N·m (20 lb in).

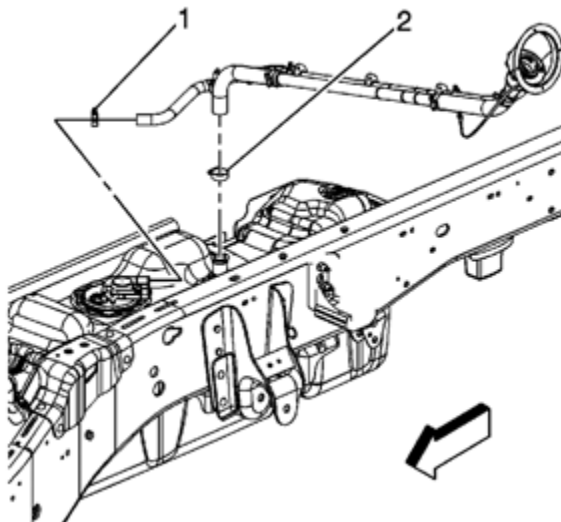
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Fuel Tank Filler Hose Replacement (Cab / Chassis)

Removal Procedure



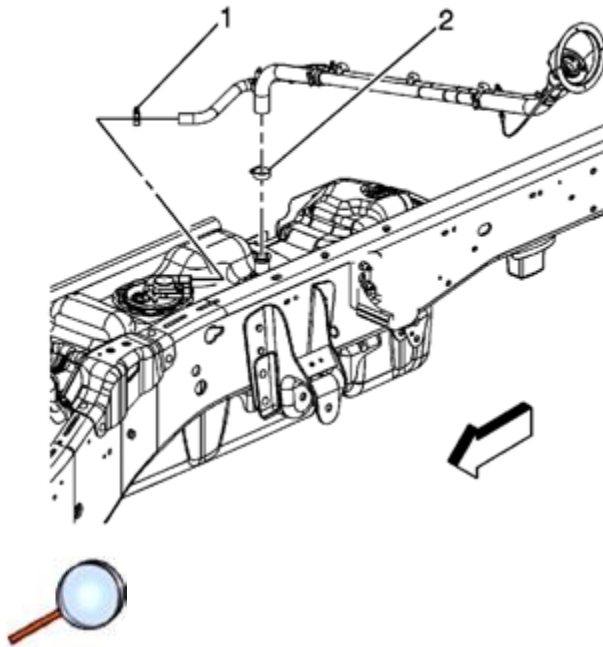
1. Relieve the fuel system pressure.
2. Disconnect the fuel feed and pressure balance rear lines. Refer to [Metal Collar Quick Connect Fitting Service](#).



3. Loosen the fuel fill and vent hose clamps (1, 2) at the tank.
4. Remove the fuel fill and vent hoses from the tank.

5. Cap the fuel and vent holes in the fuel tank in order to prevent possible fuel system contamination.

Installation Procedure



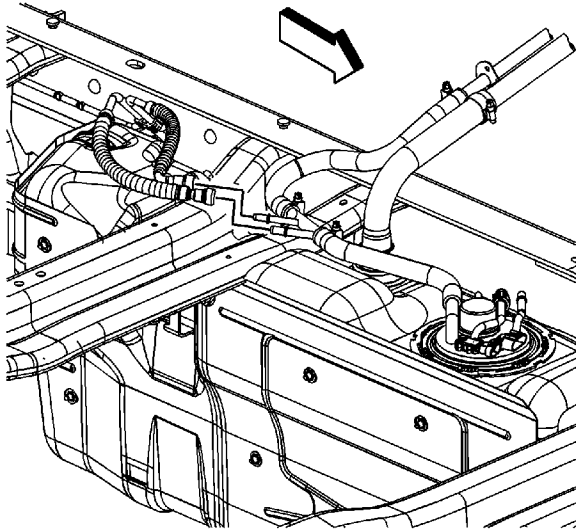
1. Remove the caps from the fuel and vent holes in the fuel tank.

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

2. Install the fuel fill and vent hoses to the tank.
3. Tighten the fuel fill and vent hose clamps (1, 2) at the tank.

Tighten

Tighten the clamp to 2.5 N·m (22 lb in).



4. Connect the fuel feed and pressure balance rear lines. Refer to [Metal Collar Quick Connect Fitting Service](#).

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Fuel System Cleaning

Fungi and other microorganisms can survive and multiply in diesel fuel if water is present. The fungi can be present in any part of the fuel handling system. These fungi grow into long strings and will form into large globules. The growths appear slimy and are usually black, green, or brown. The fungi may grow anywhere in the fuel but are most plentiful where diesel fuel and water meet. As the fuel is agitated, when service station tanks are being filled, fungi are distributed throughout the tank and may be pumped into a vehicle.

Fungi use the fuel as their main energy supply and need only trace amounts of water and minerals. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism. The most common symptom is fuel filter plugging; however, various metal components including the fuel sending unit, pipes, fuel injectors, and injection pump can corrode.

Warning: Avoid physical contact with the biocides in order to avoid personal injury.

If fungi have caused fuel system contamination, use a diesel fuel biocide to sterilize the fuel system. Do not exceed the dosage recommended on the label. Discontinue the use of a biocide when towing a trailer. It is permissible to have biocide in the fuel when starting to tow, but do not add any biocide while towing.

Steam cleaning may be necessary if most of the fungus growth cannot be removed with biocides.

The presence of water or gasoline in diesel fuel may also cause injection pump and nozzle damage.

This procedure checks for the presence of water and gasoline in diesel fuel that may cause injection pump and nozzle damage.

Remove and inspect the fuel filter element.

- If water, gasoline or fungi/bacteria are not present, end the inspection.
- If water or fungi/bacteria are present, proceed to Cleaning Water from the Fuel System.
- If gasoline is present, proceed to Cleaning Gasoline from the Fuel System.

Cleaning Water from the Fuel System

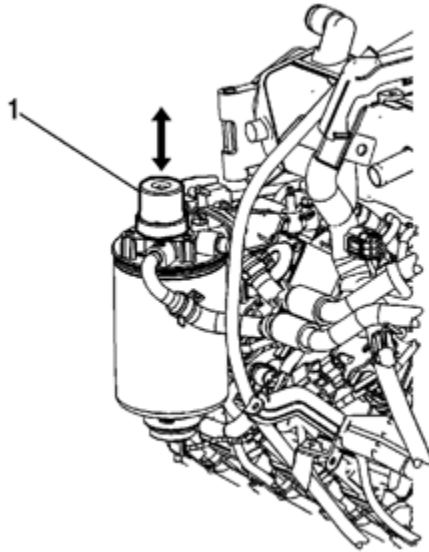
1. Disconnect the negative battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the sending unit. Refer to [Fuel Sender Assembly Replacement](#).
3. Inspect the fuel tank and the fuel sender for rust, fungi or bacteria. If there is rust, replace the rusted components.
4. Clean the inside of the fuel tank and the fuel sender with hot water.
5. Use compressed air in order to dry the fuel tank and the fuel sender.
6. Disconnect the ends of the following lines:
 - The fuel filter inlet line (both ends)
 - The transfer pump pressure line and suction line (if applicable)
 - The fuel filter outlet line (both ends)
 - The fuel filter drain

- The fuel return line (both ends)
- 7. Inspect each of the pipes and lines.
- 8. Replace any rusted pipes.
- 9. Clean the inside of the fuel filter housing.
- 10. Dry the fuel filter housing with compressed air.
- 11. Dry the inside of each line with low pressure air.
- 12. Disconnect the crankshaft position sensor.
- 13. Install a new fuel filter. Refer to [Fuel Filter Replacement](#).
- 14. Install the sending unit Refer to [Fuel Sender Assembly Replacement](#).
- 15. Add clean diesel fuel to the primary tank until the tank is $\frac{1}{4}$ full.
- 16. Reconnect the following lines:
 - The fuel filter inlet line
 - The fuel filter outlet line
 - The transfer pump pressure and suction (both ends) lines
 - The fuel return line (tank end)
- 17. Connect the fuel filter drain to a line that flows into a clean metal container.
- 18. Connect the batteries.
- 19. Operate the fuel system hand primer at the fuel filter until clean fuel flows from the fuel filter drain into a metal container.
- 20. Close the fuel filter drain and remove the bleeder hose.
- 21. Install a hose on the fuel return line near the glow plug relay, and insert other end into a 7.6 liters (2 gallon) metal container.
- 22. Crank the engine for 15 second time intervals, with 1 minute cool-down periods. Continue until 3.8 liters (1 gallon) of fuel has passed into the container.
- 23. Connect the fuel return line.
- 24. Reconnect the crankshaft position sensor.
- 25. Start and run the engine.
- 26. Stop the engine.
- 27. Clean any fuel spillage from the engine.
- 28. Fill the fuel tank and add a biocide, if needed.

Cleaning Gasoline from the Fuel System

1. Drain the fuel tank.
2. Fill the fuel tank to $\frac{1}{4}$ full.
3. Loosen the fuel filter drain and connect the filter to a hose that flows into a metal container.
4. Operate the fuel system hand primer at the fuel filter until clean fuel flows from the fuel filter drain into the metal container.
5. Hand tighten the fuel filter drain and disconnect the hose.
6. Install a hose on the fuel return line near the glow plug relay, and insert the other end into a 7.6 liters (2 gallon) metal container.
7. Crank the engine for 30 second time intervals, with 1 minute cool-down periods. Continue until 3.8 liters (1 gallon) of fuel has passed into the container.
8. Reconnect the fuel return line.
9. Attempt to start and run the engine for 15 minutes. If the engine does not start, operate the hand primer for 30 strokes, or until firm.
10. Stop the engine.
11. Clean any fuel spillage from the engine.
12. Clear the engine of any diagnostic trouble codes (DTCs).

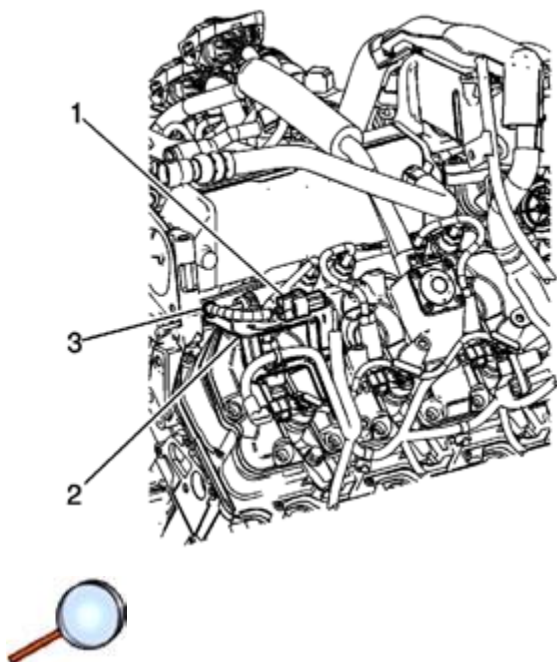
Fuel Feed Pipe and Return Pipe Purging



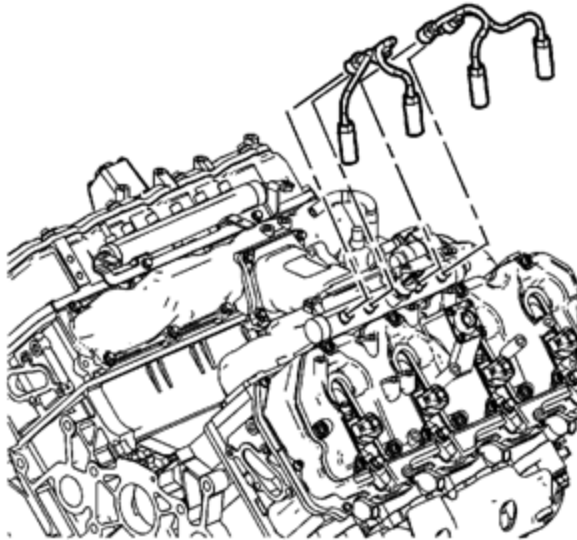
1. Pump the primer (1) located on top of the fuel filter 30 times or until stiff.
2. Attempt to start and run the engine. If the engine does not start, repeat step 1.
3. Allow to run for 5 minutes at idle.
4. Check for fuel leaks.
5. Clear all engine diagnostic trouble codes (DTCs).

Fuel Injection Fuel Rail Assembly Replacement - Bank 1

Removal Procedure



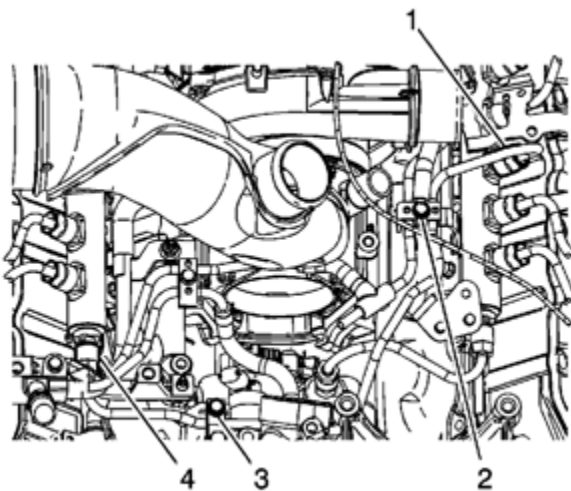
1. Remove the heater outlet pipe. Refer to [Heater Outlet Hose Replacement](#).
2. Remove the fuel filter assembly. Refer to [Fuel Filter Assembly Replacement](#).
3. Remove the turbocharger coolant outlet pipe. Refer to [Turbocharger Coolant Hoses/Pipes Replacement](#).
4. Disconnect the engine wiring harness electrical connector (1) from the fuel injection fuel rail fuel pressure sensor wiring harness extension.
5. Remove the fuel injection fuel rail fuel pressure sensor wiring harness extension clip (3) from the wiring harness bracket.
6. Remove the wiring harness bracket bolts and bracket (2).



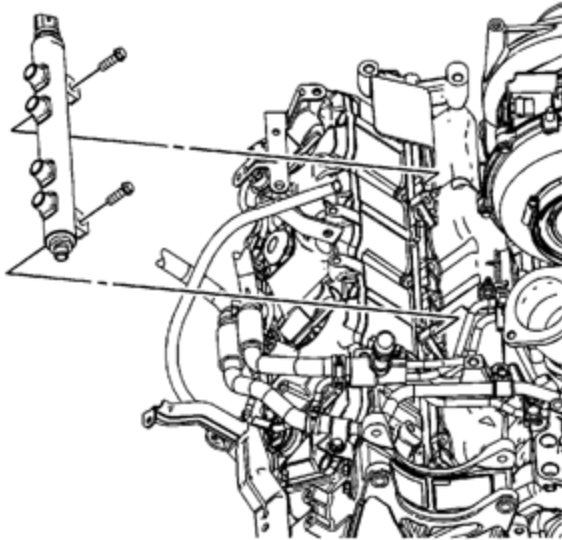
7. Prior to removing the fuel injection fuel feed pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
8. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fittings to assist in containing any debris during removal.

Caution: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

9. Remove the fuel injection fuel feed pipes.



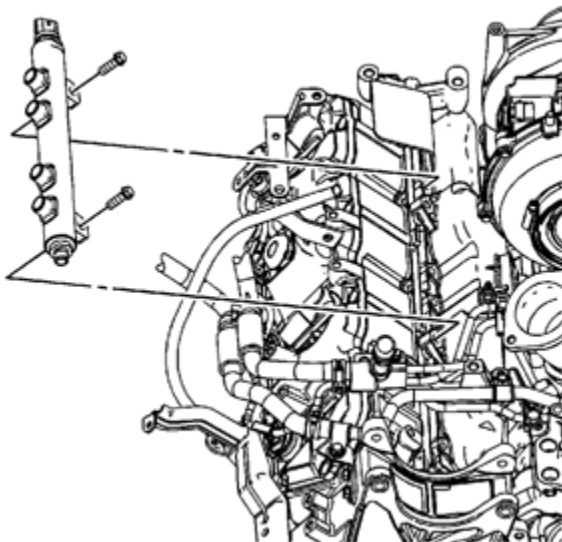
10. Loosen the right fuel rail fuel feed pipe fitting (4) at the fuel rail.



11. Remove the fuel injection fuel rail bolts.
12. Remove the fuel rail.

Installation Procedure

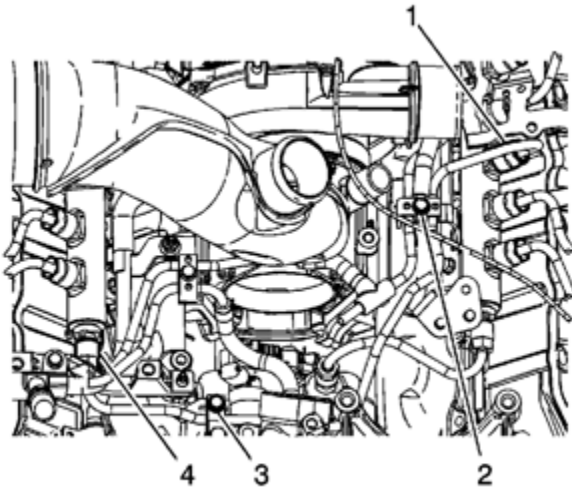
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Position the fuel injection fuel rail to the intake manifold.
2. Install the fuel injection fuel rail bolts.

Tighten

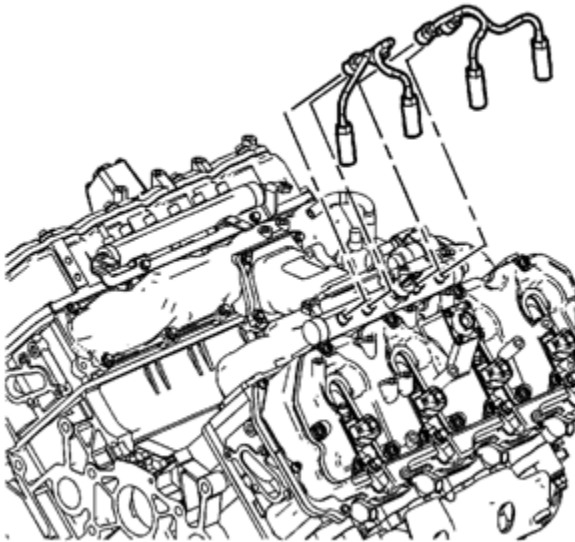
Tighten the bolts to 25 N·m (18 lb ft).



3. Tighten the right fuel rail fuel feed pipe fitting (4) at the fuel rail.

Tighten

Tighten the fittings to 41 N·m (30 lb ft).

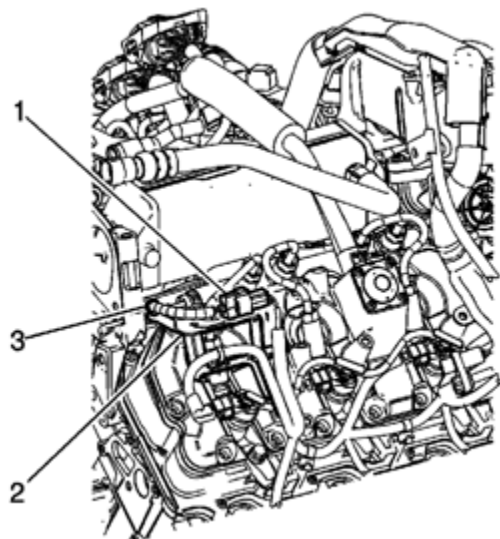


Caution: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

4. Install the fuel injector pipes.

Tighten

Tighten the fittings to 41 N·m (30 lb ft).



5. Position the wiring harness bracket (2) and install the bolts.

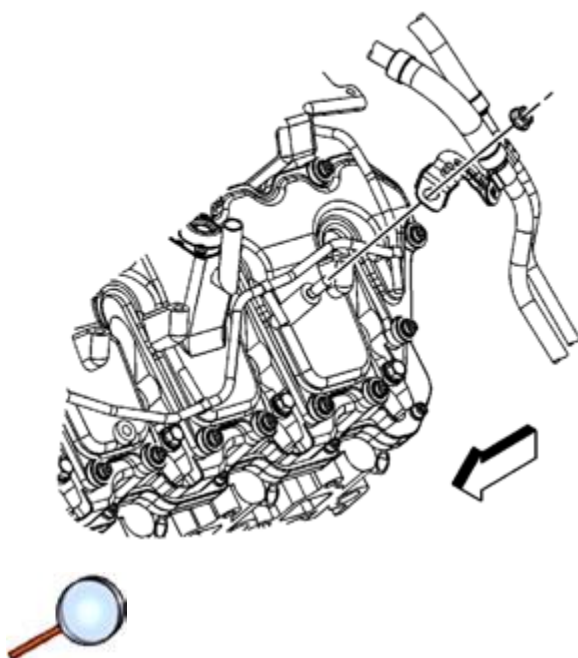
Tighten

Tighten the bolts to 24 N·m (18 lb ft).

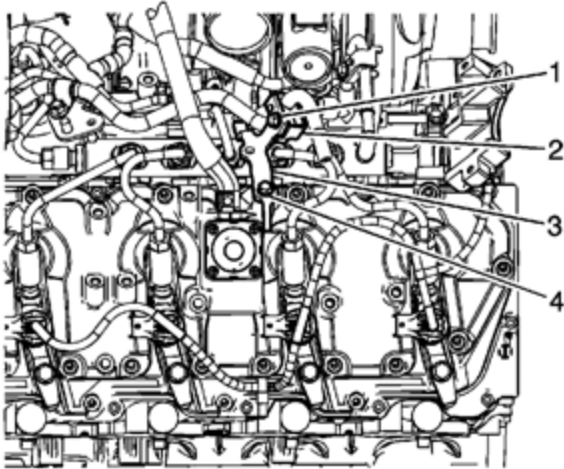
6. Connect the engine wiring harness electrical connector (1) to the fuel injection fuel rail fuel pressure sensor wiring harness extension.
7. Install the fuel injection fuel rail fuel pressure sensor wiring harness extension clip (3) to the wiring harness bracket.
8. Install the turbocharger coolant outlet pipe. Refer to [Turbocharger Coolant Hoses/Pipes Replacement](#).
9. Install the fuel filter assembly. Refer to [Fuel Filter Assembly Replacement](#).
10. Install the heater outlet pipe. Refer to [Heater Outlet Hose Replacement](#).
11. Prime the fuel system. Refer to [Fuel System Priming](#).
12. Start the engine. If the engine stalls, repeat the above step.
13. Once the engine starts, inspect for fuel leaks.

Fuel Injection Fuel Rail Assembly Replacement - Bank 2

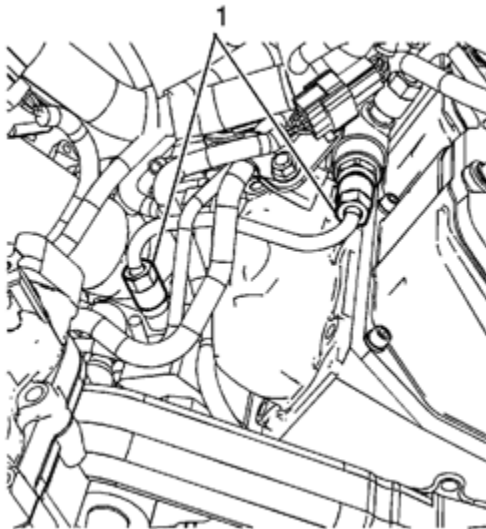
Removal Procedure



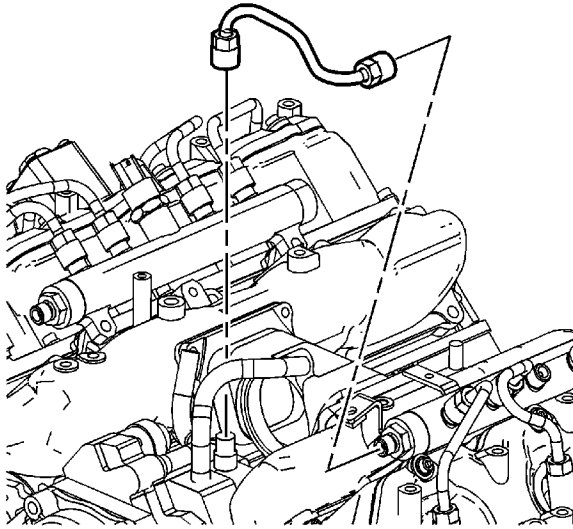
1. Remove the fuel line bracket nut.
2. Remove the fuel line bracket from the stud.
3. Remove the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
4. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
5. Remove the right fuel rail fuel feed pipe. Refer to [Fuel Injection Fuel Feed Front Pipe Replacement - Right Side](#).
6. Remove the fuel return pipe. Refer to [Fuel Return Pipe Replacement](#).



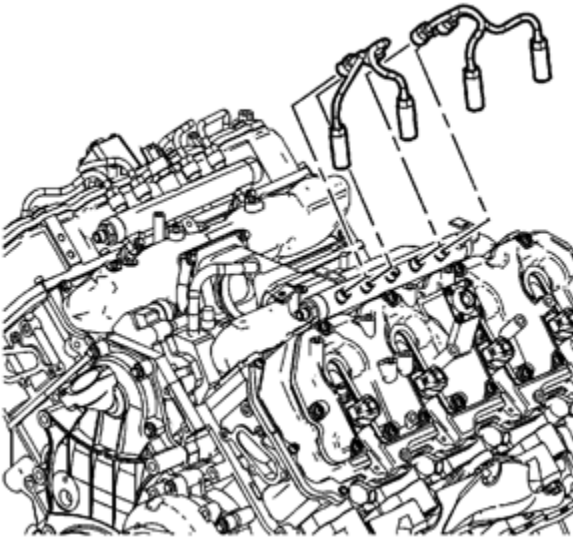
7. Remove the fuel pipe bracket bolt (4) and bracket (3).



8. Loosen the left fuel rail fuel feed pipe fittings (1).



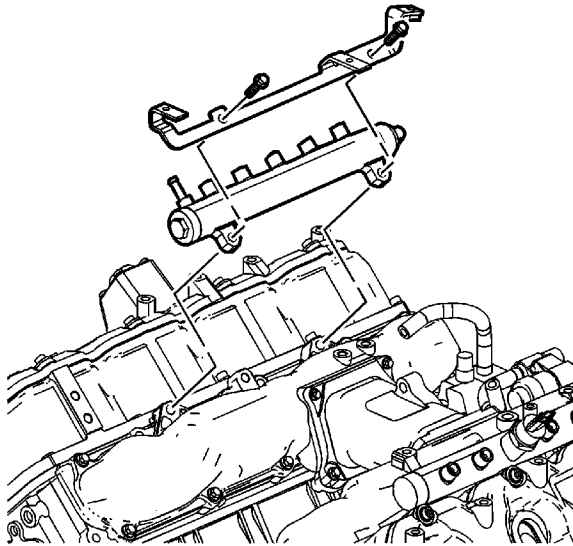
9. Remove the left fuel rail fuel feed pipe.



10. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
11. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fittings to assist in containing any debris during removal.

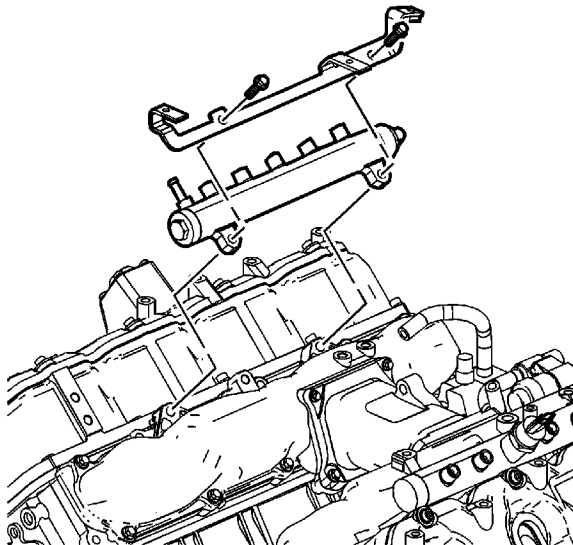
Caution: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

12. Remove the left fuel injection fuel feed pipes.



13. Remove the fuel injection fuel rail bolts.
14. Remove the fuel injection fuel rail and bracket.
15. Reposition the fuel hose clamp at the rail and remove the fuel hose, if required.

Installation Procedure



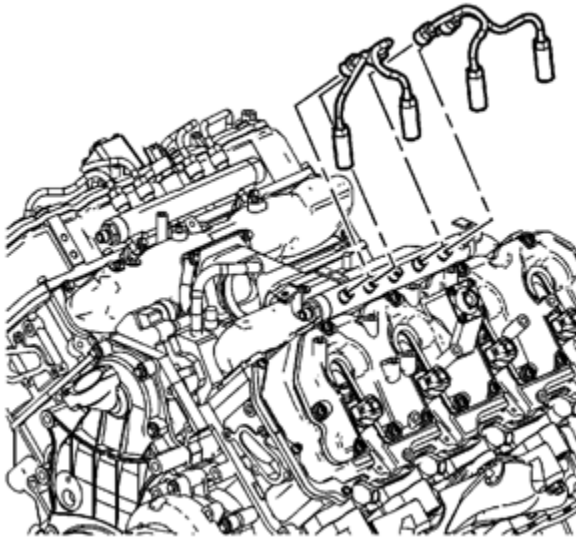
1. Install the fuel hose to the fuel injection fuel rail and position the clamp, if required.
2. Position the fuel injection fuel rail and bracket to the left intake manifold.

Caution: Refer to Fastener Caution in the Preface section.

3. Install the fuel injection fuel rail bolts.

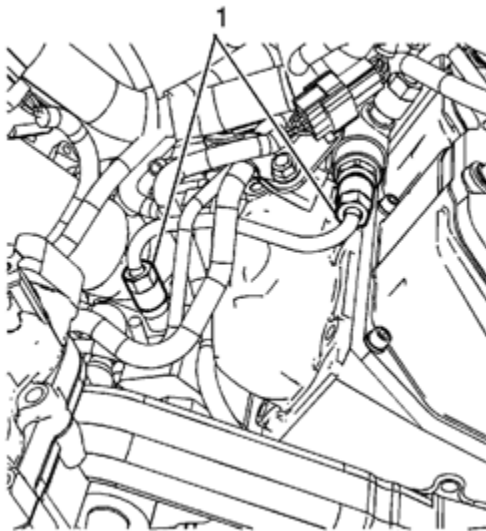
Tighten

Tighten the bolts to 25 N·m (18 lb ft).



Caution: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

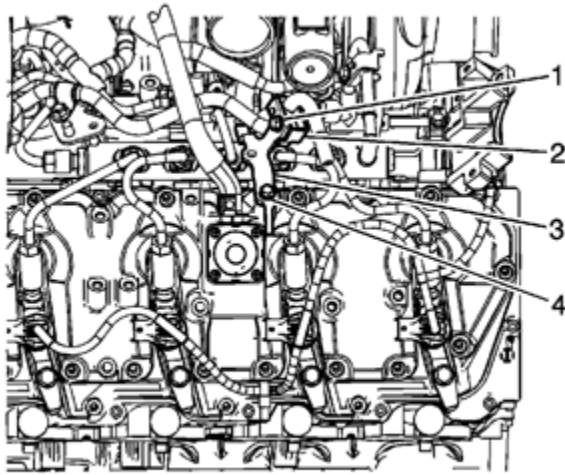
4. Position the fuel injection fuel feed pipes.



5. Tighten the left fuel rail fuel feed pipe fittings (1).

Tighten

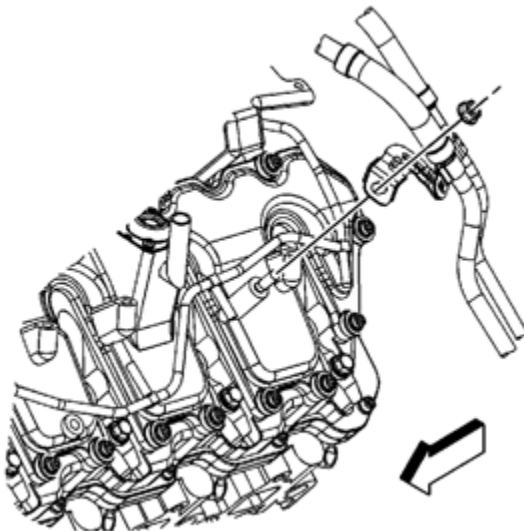
Tighten the fittings to 41 N·m (30 lb ft).



6. Position the fuel pipe bracket (3) and install the bolt (4).

Tighten

Tighten the bolt to 24 N·m (18 lb ft).



7. Install the fuel return pipe. Refer to [Fuel Return Pipe Replacement](#).
8. Install the right fuel rail fuel feed pipe. Refer to [Fuel Injection Fuel Feed Front Pipe Replacement - Right Side](#).

9. Install the PCV hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
10. Install the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
11. Install the fuel line bracket to the stud.
12. Install the fuel line bracket nut.

Tighten

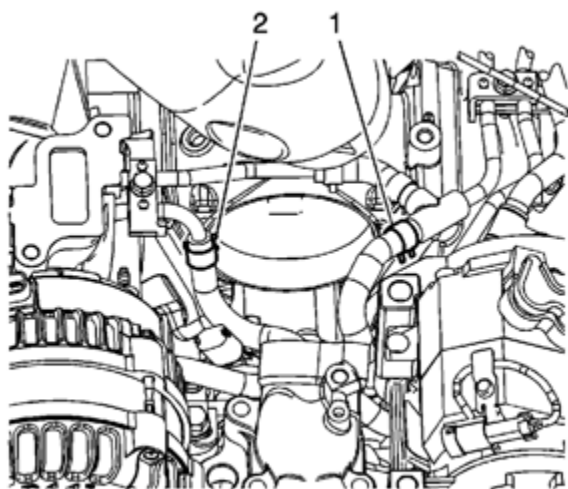
Tighten the nut to 16 N·m (12 lb ft).

13. Prime the fuel system. Refer to [Fuel System Priming](#).
14. Start the engine. If the engine stalls, repeat the above step.
15. Once the engine starts, inspect for fuel leaks.

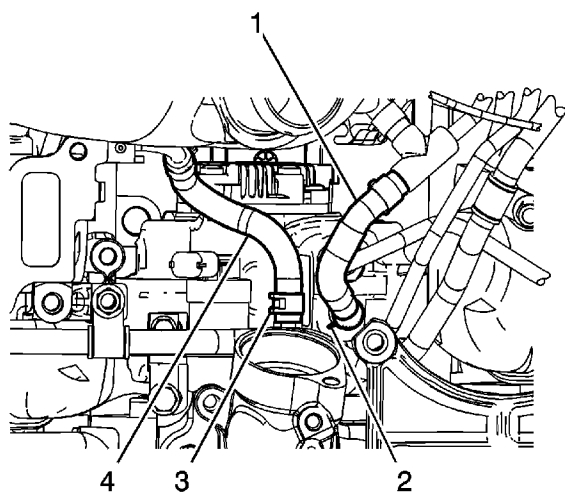
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Fuel Injection Fuel Feed Manifold Replacement

Removal Procedure

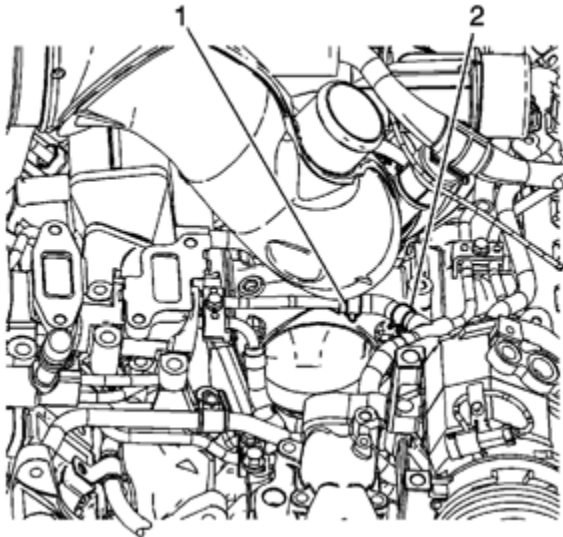


1. Remove the generator. Refer to [Generator Replacement](#).
2. Remove the fuel filter/heater element housing to fuel feed block fuel hose. Refer to [Fuel Hose Replacement - Fuel Filter/Heater Element Housing to Fuel Feed Block](#).
3. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
4. Remove the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
5. Reposition the fuel hose clamp (2) at the fuel injection fuel feed manifold.

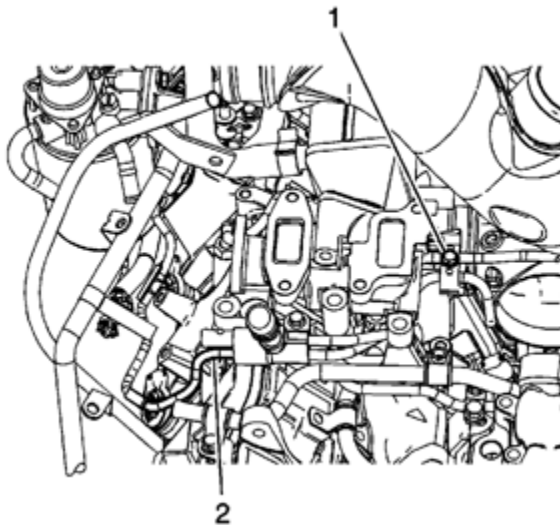




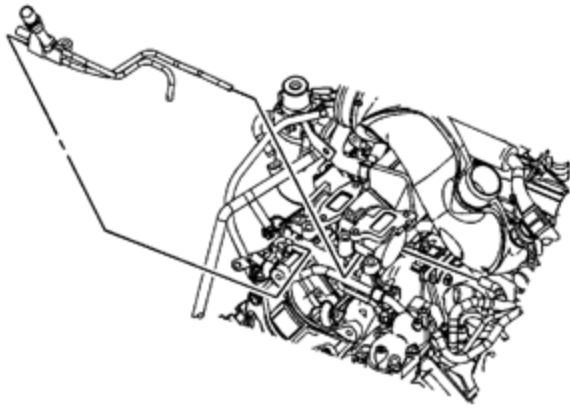
6. Remove the fuel hose (4) from the fuel injection fuel feed manifold.



7. Reposition the fuel return hose clamp (1) at the fuel injection fuel feed manifold.



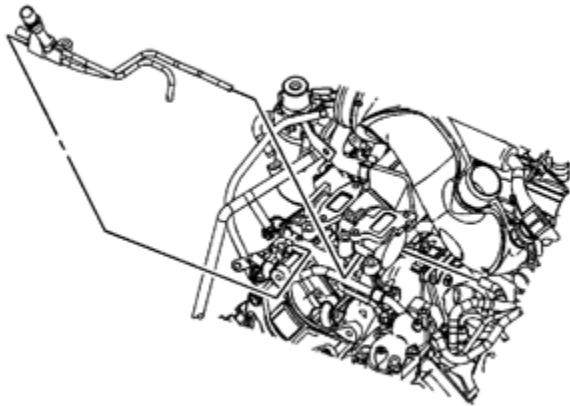
8. Remove the fuel pipe clip bolt (1) and clip.
9. Disconnect the fuel injector fuel feed pipe (2) from the fuel injection fuel feed manifold.



Note: Note the routing of the fuel injection fuel feed manifold pipes under the exhaust gas recirculation (EGR) bracket.

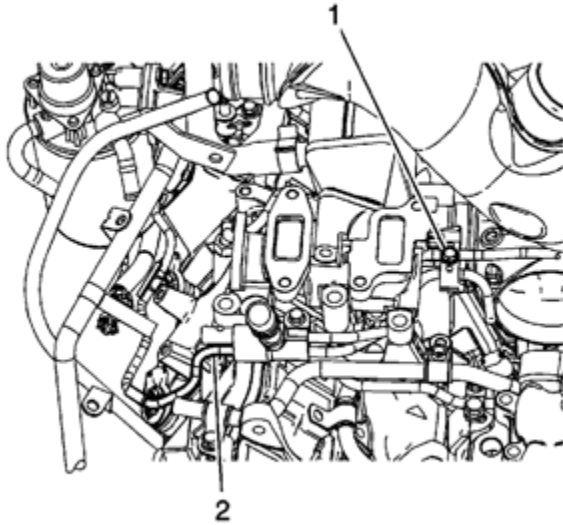
10. Remove the fuel injection fuel feed manifold from the fuel return hose and the vehicle.

Installation Procedure



Note: Ensure to route the fuel injection fuel feed manifold pipes under the EGR bracket.

1. Install the fuel injection fuel feed manifold to the vehicle and the fuel return hose.



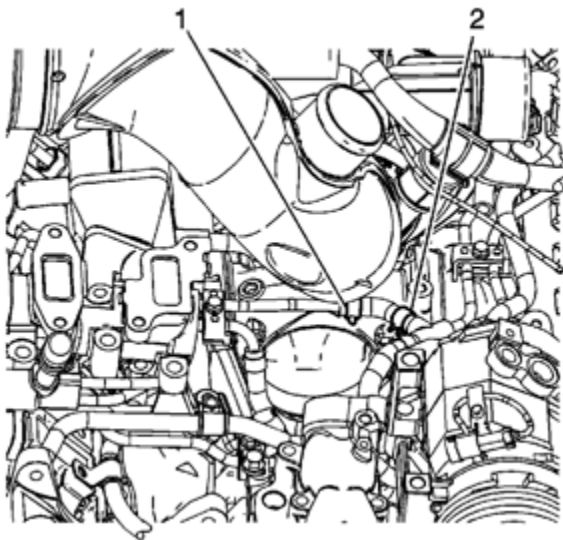
2. Connect the fuel injector fuel feed pipe (2) to the fuel injection fuel feed manifold.

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

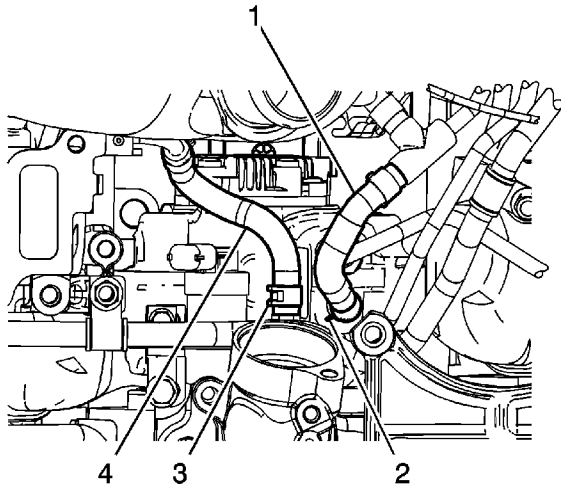
3. Install the fuel pipe clip and bolt (1).

Tighten

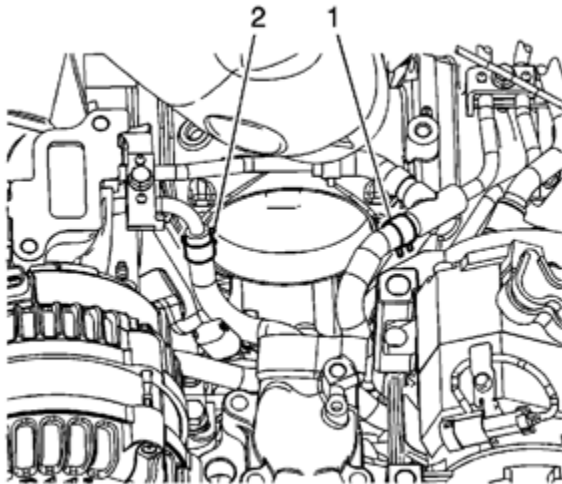
Tighten the bolt to 24 N·m (18 lb ft).



4. Position the fuel return hose clamp (1) at the fuel injection fuel feed manifold.



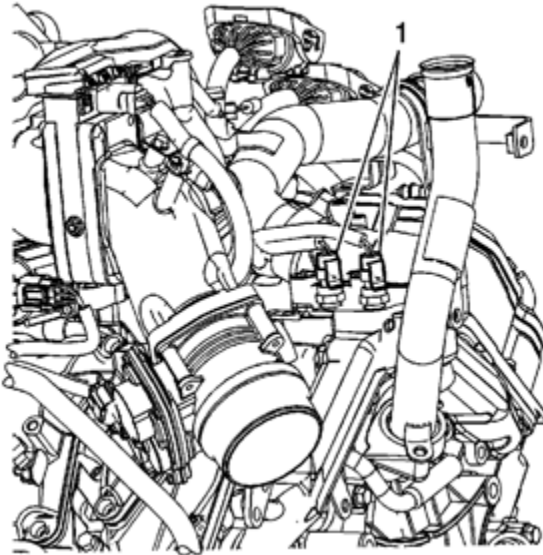
5. Install the fuel hose (4) to the fuel injection fuel feed manifold.



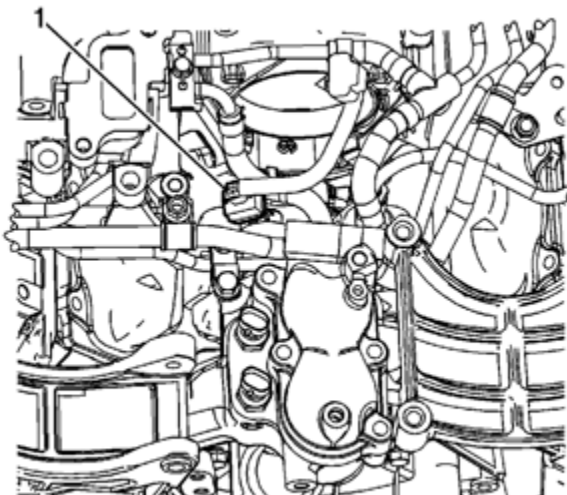
6. Position the fuel hose clamp (2) at the fuel injection fuel feed manifold.
7. Install the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
8. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
9. Install the fuel filter/heater element housing to fuel feed block fuel hose. Refer to [Fuel Hose Replacement - Fuel Filter/Heater Element Housing to Fuel Feed Block](#).
10. Install the generator. Refer to [Generator Replacement](#).
11. Prime the fuel system. Refer to [Fuel System Priming](#).
12. Start the engine. If the engine stalls, repeat the above step.
13. Once the engine starts, inspect for fuel leaks.

Fuel Pressure Regulator Replacement

Removal Procedure

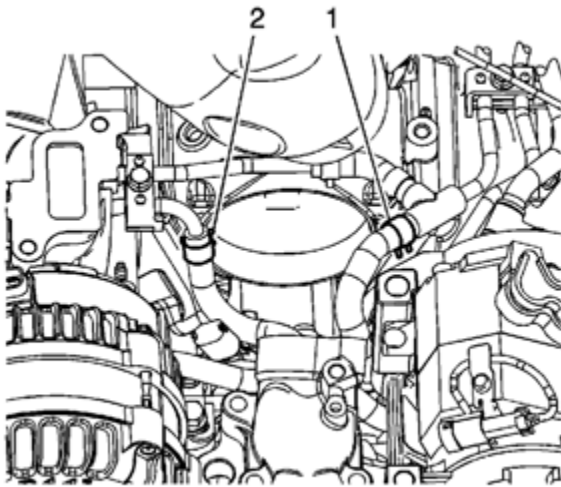


1. Remove the generator. Refer to [Generator Replacement](#).
2. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
3. Remove the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
4. Unbolt and reposition the air conditioning (A/C) compressor (with the hoses attached) to the right side of the engine compartment. Refer to [Air Conditioning Compressor Replacement](#).
5. Disconnect the engine coolant temperature (ECT) sensor electrical connectors (1) and reposition the harness branches.

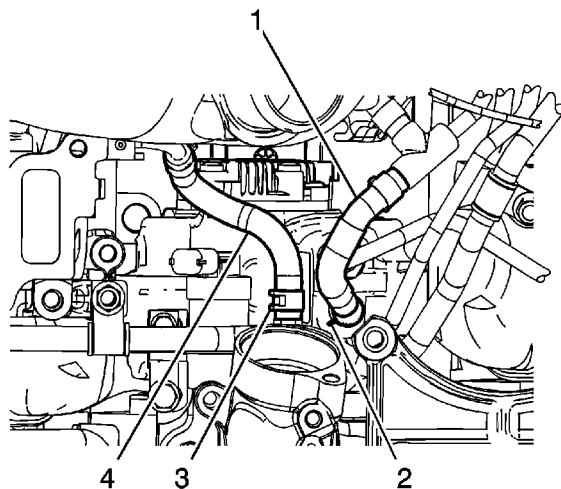




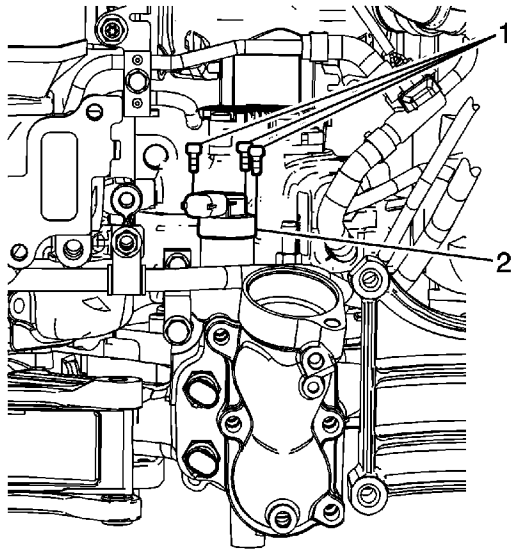
6. Disconnect the wiring harness extension electrical connector (1) from the fuel pressure regulator.



7. Reposition the fuel hose clamp (2) at the fuel injection fuel feed manifold.



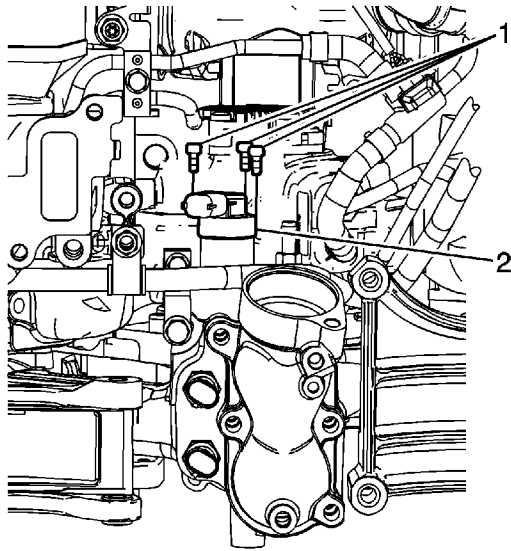
8. Reposition the fuel hose clamp (3) at the fuel injection pump.
9. Remove the fuel hose (4) from the fuel injection fuel feed manifold and injection pump.



10. Clean the fuel pressure regulator and high pressure injection pump thoroughly with solvent, such as GM P/N 12377981 (Canadian P/N 10953463) or equivalent.
11. Using compressed air, thoroughly blow dry the regulator and pump.
12. Remove the 3 fuel pressure regulator screws (1) using a T25 TORX®.
13. Remove the fuel pressure regulator (2).
14. If dirt or debris is found in the bore or seating surfaces of the fuel injection pump, perform the following:
 - Place a clean rag over the bore in order to collect the excess fuel.
 - Bump the engine over in order to flush any debris out of the regulator bore.

Installation Procedure

Note: If the pressure regulator is being re-used, check the O-rings for damage. If the O-rings are damaged, install NEW O-rings.



1. Lubricate and install NEW O-rings onto the regulator. Lubricate the O-rings with clean, NEW engine oil.

Note: If the regulator is installed at an angle the O-rings may be damaged, resulting in possible fuel leakage.

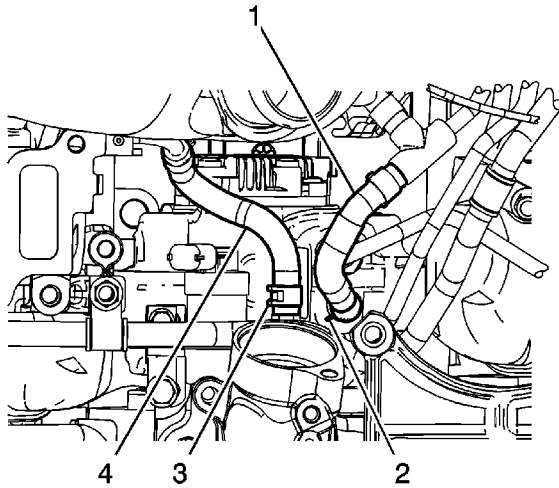
2. Install the fuel pressure regulator (2).

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

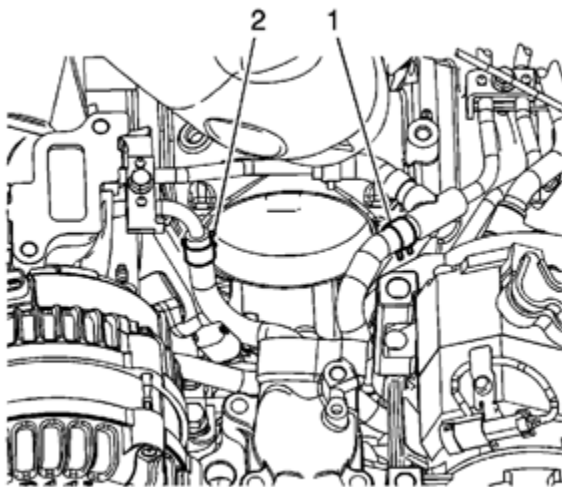
3. Install the 3 fuel pressure regulator screws (1) using a T25 TORX®.

Tighten

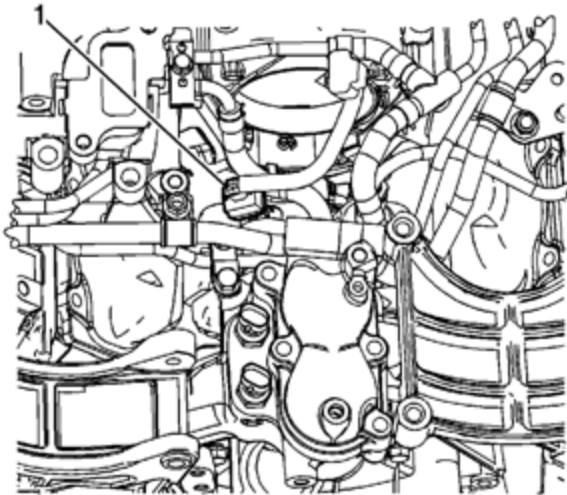
- Tighten the screws a first pass to 4 N·m (35 lb in).
- Tighten the screws a final pass to 7 N·m (62 lb in).



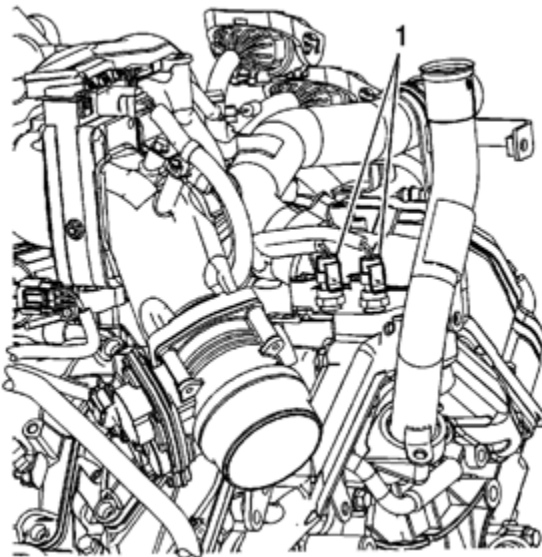
4. Install the fuel hose (4) to the fuel injection fuel feed manifold and injection pump.
5. Position the fuel hose clamp (3) at the fuel injection pump.



6. Position the fuel hose clamp (2) at the fuel injection fuel feed manifold.



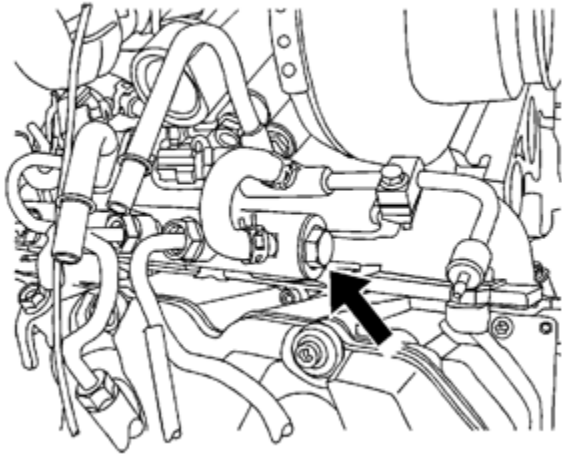
7. Connect the wiring harness extension electrical connector (1) to the fuel pressure regulator.



8. Position the engine wiring harness branches to the ECT sensors and connect the ECT sensor electrical connectors (1).
9. Position and install the A/C compressor. Refer to [Air Conditioning Compressor Replacement](#).
10. Install the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
11. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
12. Install the generator. Refer to [Generator Replacement](#).
13. Prime the fuel system. Refer to [Fuel System Priming](#).
14. Start the engine. If the engine stalls, repeat the above step.
15. Once the engine starts, inspect for fuel leaks.

Fuel Pressure Relief Valve Replacement

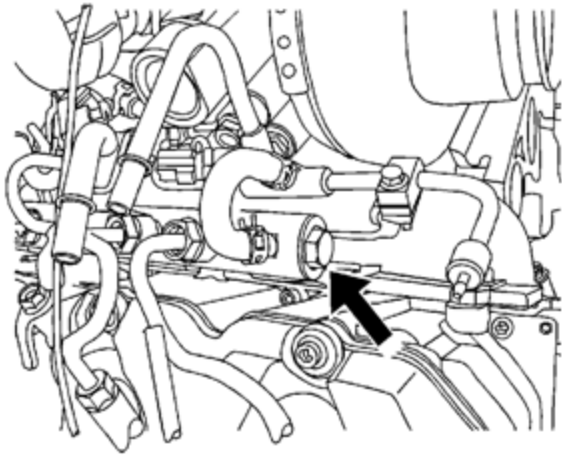
Removal Procedure



1. Remove the glow plug module and bracket. Refer to [Glow Plug Control Module Replacement](#).
2. Remove the fuel pressure relief valve from the left fuel rail.

Installation Procedure

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



1. Install the fuel pressure relief valve to the left fuel rail.

Tighten

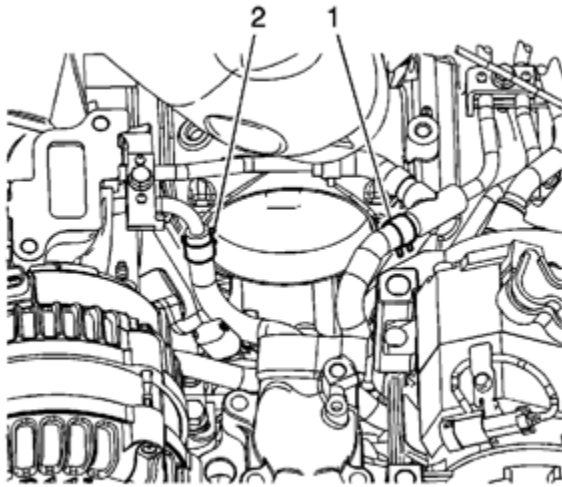
Tighten the valve to 100 N·m (74 lb ft).

2. Install the glow plug module and bracket. Refer to [Glow Plug Control Module Replacement](#).
3. Prime the fuel system. Refer to [Fuel System Priming](#).
4. Start the engine. If the engine stalls, repeat the above step.
5. Once the engine starts, inspect for fuel leaks.

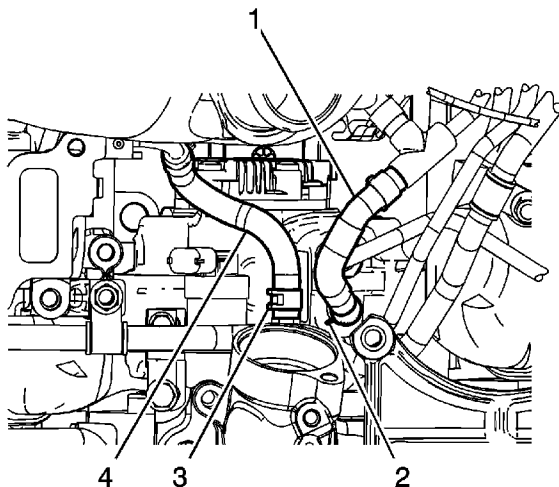
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Fuel Injection Pump Replacement

Removal Procedure

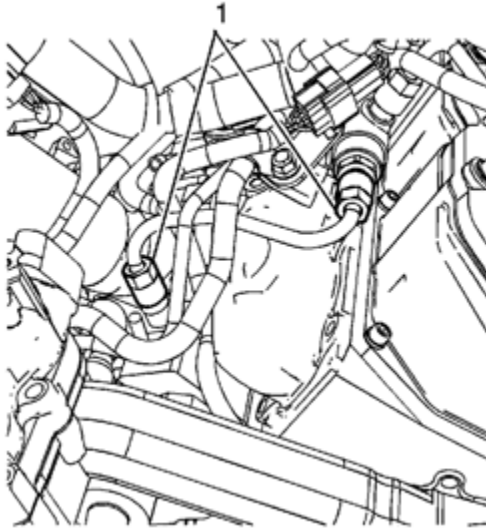


1. Remove the thermostat housing crossover. Refer to [Thermostat Housing Crossover Replacement](#).
2. Remove the center intake manifold. Refer to [Center Intake Manifold Replacement](#).
3. Reposition the fuel hose clamp (1) at the fuel return pipe.
4. Reposition the fuel hose clamp (2) at the fuel injection fuel feed manifold.

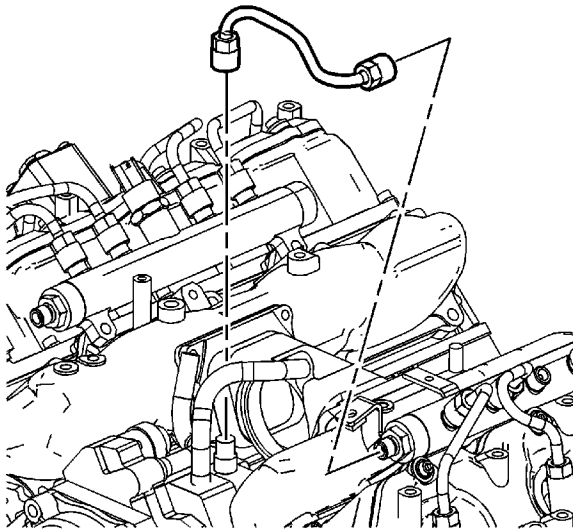




5. Reposition the fuel hose clamp (2) at the fuel injection pump.
6. Reposition the fuel hose clamp (3) at the fuel injection pump.
7. Remove the fuel hose (1) from the return pipe and injection pump.
8. Remove the fuel hose (4) from the fuel injection fuel feed manifold and injection pump.



9. Loosen the left fuel rail fuel feed pipe fittings (1).



10. Remove the left fuel rail fuel feed pipe.

Note: Be careful not to damage any mating surfaces.

11. Remove the fuel injection pump. Refer to [Fuel Injection Pump Removal](#).

Preparing The Fuel Injection Pump

1. Hold the fuel pump by the drive gear in a vice with copper jaw liners.
2. Loosen the gear nut until the nut is even with the end of the gear shaft.
3. Remove the gear from the tapered shaft of the injection pump.
4. Separate the injection pump and adapter by removing the 3 bolts and spacers.
5. Inspect the O-ring for damage on the pump adapter and replace, if necessary. Lubricate the O-ring with clean engine oil.
6. Clean all mating surfaces.

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

7. Install the adapter on the pump.
8. Install the 3 bolts and spacers.

Tighten

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

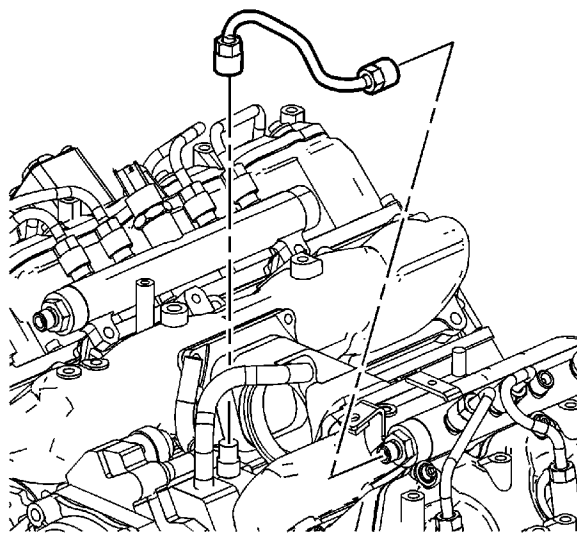
9. Install the gear and nut.

Tighten

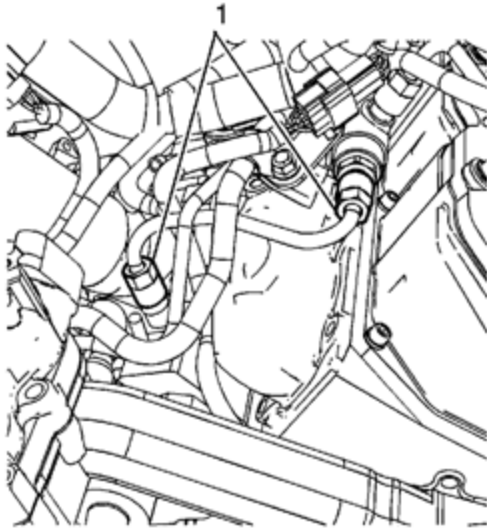
Tighten nut to 70 N·m (52 lb ft).

Installation Procedure

1. Install the fuel injection pump. Refer to [Fuel Injection Pump Installation](#).



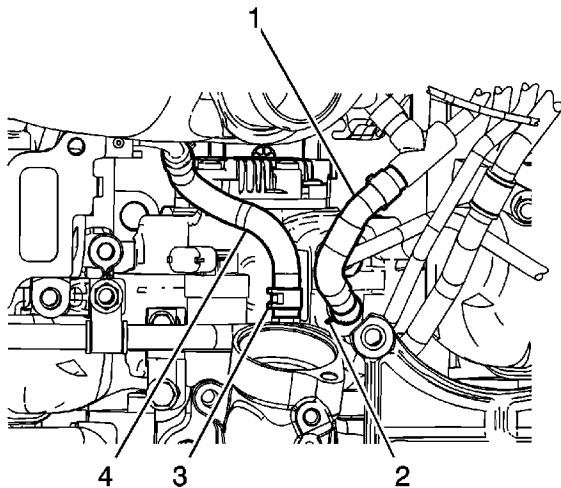
2. Position the left fuel rail fuel feed pipe.



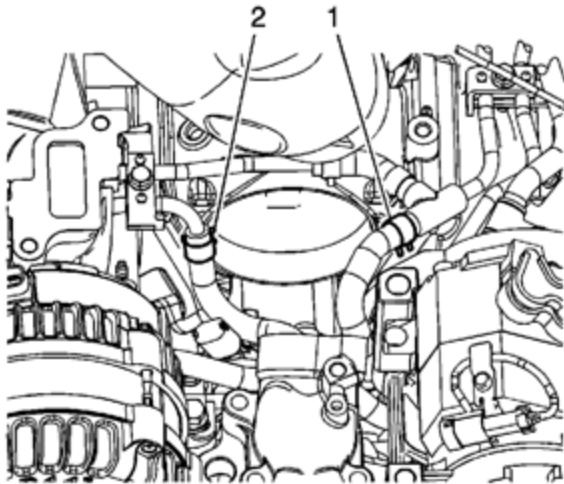
3. Tighten the left fuel rail fuel feed pipe fittings (1).

Tighten

Tighten fittings to 41 N·m (30 lb ft).



4. Install the fuel hose (4) to the fuel injection fuel feed manifold and injection pump.
5. Install the fuel hose (1) from the return pipe and injection pump.
6. Position the fuel hose clamp (3) at the fuel injection pump.
7. Position the fuel hose clamp (2) at the fuel injection pump.



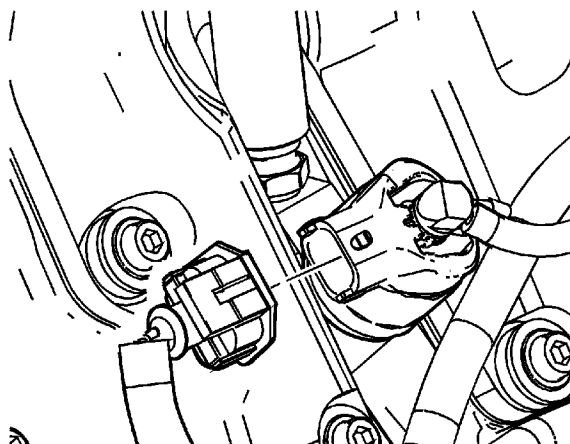
8. Position the fuel hose clamp (2) at the fuel injection fuel feed manifold.
9. Position the fuel hose clamp (1) at the fuel return pipe.
10. Install the center intake manifold. Refer to [Center Intake Manifold Replacement](#).
11. Install the thermostat housing crossover. Refer to [Thermostat Housing Crossover Replacement](#).
12. Prime the fuel system. Refer to [Fuel System Priming](#).
13. Start the engine. If the engine stalls, repeat the above step.
14. Once the engine starts, inspect for fuel leaks.

Fuel Injector Replacement (Right)

Special Tools

- [EN-47909](#) Injector Bore and Sleeve Cleaning Kit
- [J-46594](#) Fuel Injector Puller

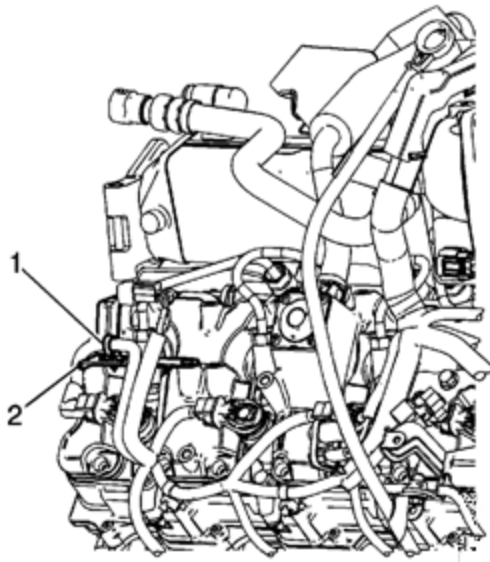
Removal Procedure



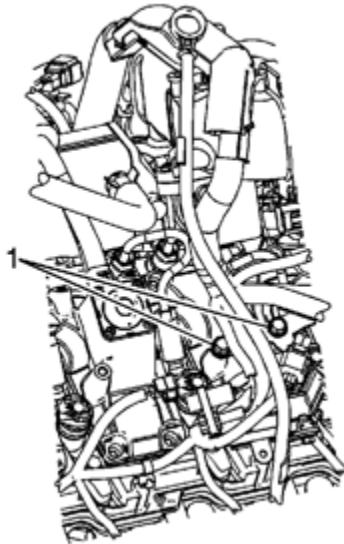
1. Remove the right fuel injection fuel feed pipes. Refer to [Fuel Injection Fuel Feed Pipe Replacement - Right Side](#).
2. Remove the right fuel injection fuel return pipe. Refer to [Fuel Injection Fuel Return Pipe Replacement - Right Side](#).

Caution: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.

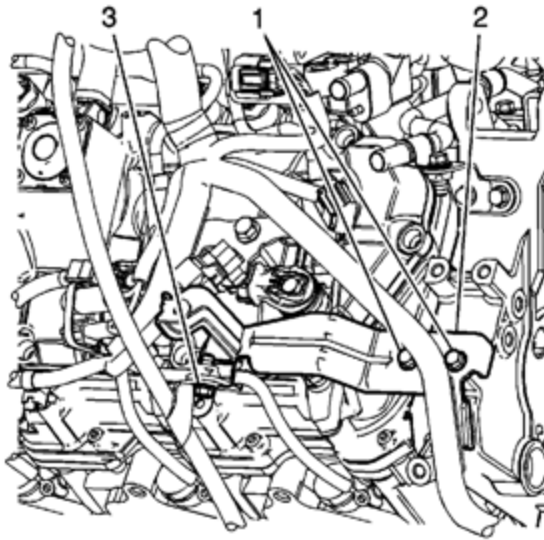
3. Disconnect the engine wiring harness electrical connectors from the fuel injectors.



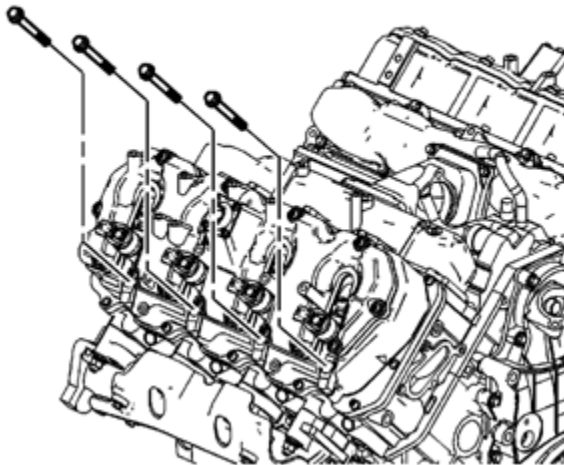
4. Remove the engine wiring harness clip (1) from the wiring harness bracket and remove the bracket (2).



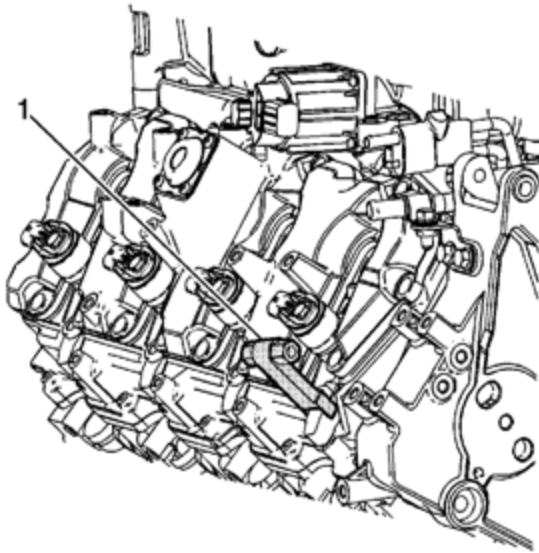
5. Remove the engine wiring harness clips from the wiring harness bracket.
6. Remove the engine wiring harness bracket bolts (1) and bracket.



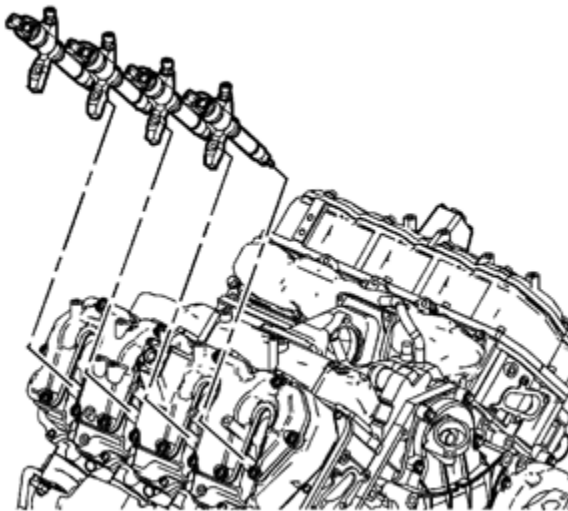
7. Remove the engine wiring harness clip from the oil level indicator tube bracket (2).
8. Remove the oil level indicator tube bolt (3).
9. Remove the oil level indicator tube bracket bolts (1).
10. Remove the oil level indicator tube bracket (2).



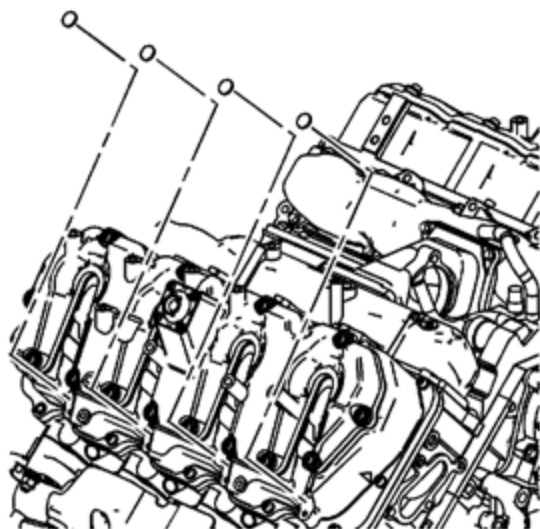
11. Remove the fuel injector bracket bolts.



12. Install the [J-46594](#) (1) into the bolt hole in the fuel injector bracket.
13. Install a flare nut wrench onto the [J-46594](#) and pull back away from the fuel injector, until the injector releases from its seat.
14. Remove the [J-46594](#) .



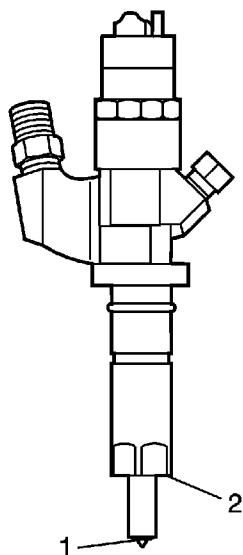
15. Remove the fuel injectors with brackets.



16. If necessary, remove the fuel injector bracket pins.
17. Remove and discard the copper washer from the fuel injector bore.
18. Remove and discard the O-ring from the fuel injector.

Fuel Injector Cleaning and Inspection

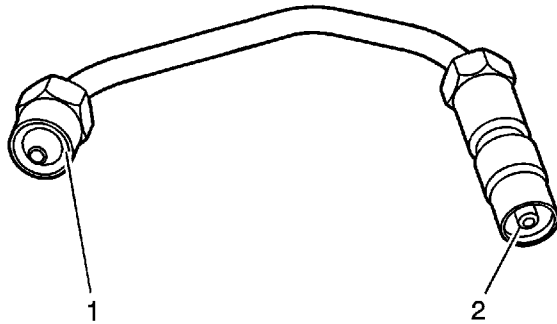
Note: If reusing the old injectors perform the following:



1. Use a soft bristle non-metallic brush and Top Engine Cleaner, GM P/N 1052626 or equivalent, to remove any deposits from the nozzle tip (1) and the copper washer sealing area (2) before re-installation.
2. Inspect the fuel injector nozzle tip (1) for any signs of discoloration (dark yellow, tan or blue)

due to excessive heat.

3. Replace the injector if any damage is found.



4. Clean the fuel injector high pressure line.
5. Inspect the fuel injector line for excessive corrosion or damage to the sealing surfaces (1, 2). Replace the line if any damage is found.

Injector Bore Cleaning

Note: The procedure below will aid in the cleaning of carbon deposits from the injector sleeve during an injector replacement

1. Install the EN-47909-2 Radial Brush (brass), to the EN-47909-1 Handle Assembly.
2. Insert the brush into the injector bore and rotate the handle in order to break loose any carbon deposits from the injector bore walls and the combustion deck hole.

Warning: Wear safety glasses in order to avoid eye damage.

3. Using compressed air, evacuate any debris from the injector bore.
4. Remove the radial brush from the handle assembly.
5. Install the EN-47909-3 Axial Brush (nylon), to the EN-47909-1.
6. Insert the axial brush into the injector bore and rotate the handle while also applying a slight downward pressure, in order to force the brush ends into the bottom corners of the injector bore.

Warning: Wear safety glasses in order to avoid eye damage.

7. Using compressed air, evacuate any debris from the injector bore.

Caution: Do not allow excessive amounts of solvent to go into the cylinder during cleaning. Failure to do so may cause engine damage upon startup.

8. Lightly dampen EN-47909-20 Cotton Swab with Top Engine Cleaner, GM P/N 1052626 (Canadian P/N 993026) or equivalent, and wipe away any deposits from the injector bore.

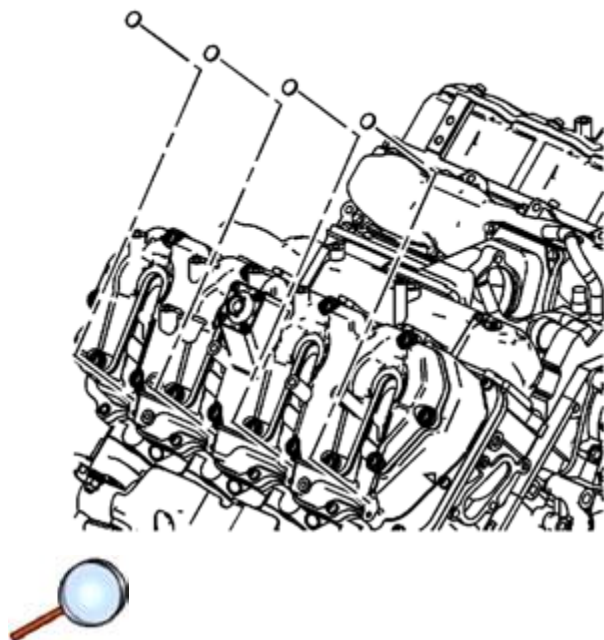
9. Inspect the injector bore for any deposits and repeat brushing if necessary.

Warning: Keep hands and face clear of glow plug holes while cranking. Hot liquid or gases may be expelled during cranking.

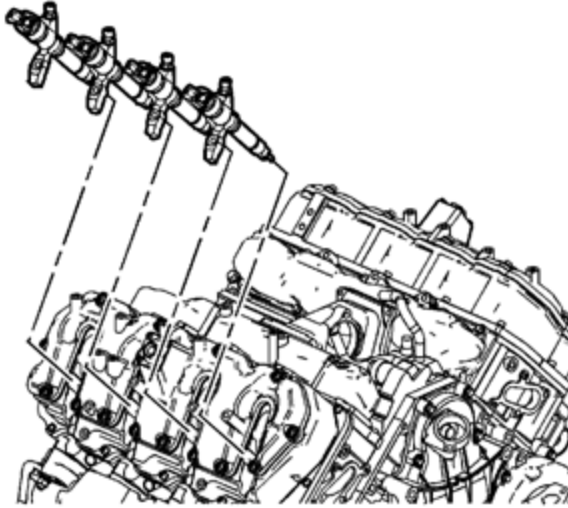
Warning: Wear safety glasses in order to avoid eye damage.

10. If necessary, crank the engine in order to expel any solvent before starting the engine.
 - 10.1. Remove the glow plugs. Refer to [Glow Plug Replacement - Bank 1](#) and/or [Glow Plug Replacement - Bank 2](#).
 - 10.2. Disable the fuel system.
 - 10.3. Disconnect the crankshaft position (CKP) sensor electrical connector.
 - 10.4. Crank the engine in order to expel any excessive solvent.
 - 10.5. Using the cotton swabs supplied with the kit, wipe the injector bore clean of any solvent and/or debris.
 - 10.6. Connect the CKP sensor electrical connector.
 - 10.7. Enable the fuel system.
 - 10.8. Reinstall the glow plugs. Refer to [Glow Plug Replacement - Bank 1](#) and/or [Glow Plug Replacement - Bank 2](#).

Installation Procedure

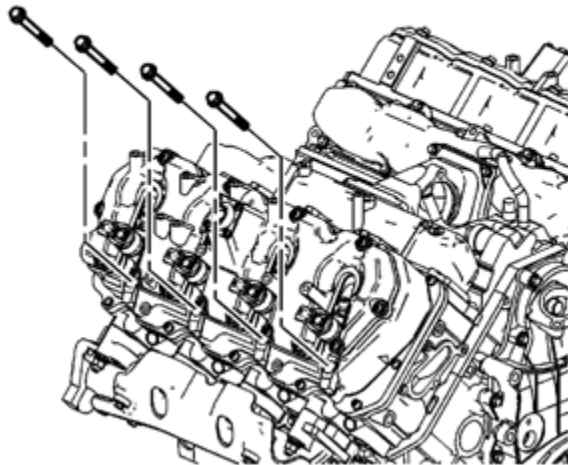


1. Install a NEW copper washer to the fuel injector bore.
2. Install a NEW O-ring onto the fuel injector.
3. If necessary, install the fuel injector bracket pins.



4. Install the fuel injectors with brackets.

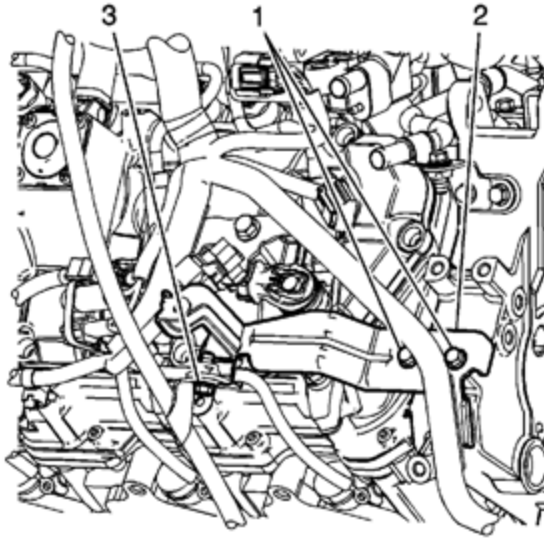
Caution: Refer to [Fastener Caution](#) in the Preface section.



5. Install the fuel injector bracket bolts.

Tighten

Tighten the bolts to 30 N·m (22 lb ft).



6. Position the oil level indicator tube bracket (2) to the generator bracket.
7. Install the oil level indicator tube bracket bolts (1).

Tighten

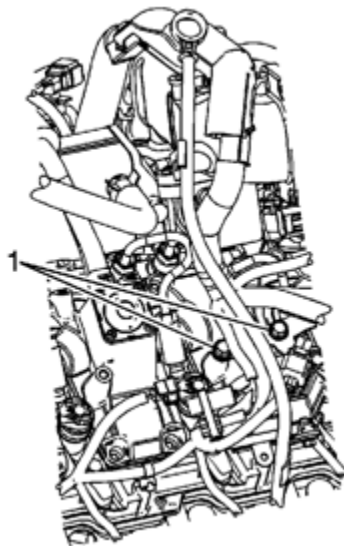
Tighten the bolts to 21 N·m (15 lb ft).

8. Install the oil level indicator tube bolt (3).

Tighten

Tighten the bolt to 21 N·m (15 lb ft).

9. Install the wiring harness clip to the oil level indicator tube bracket (2).



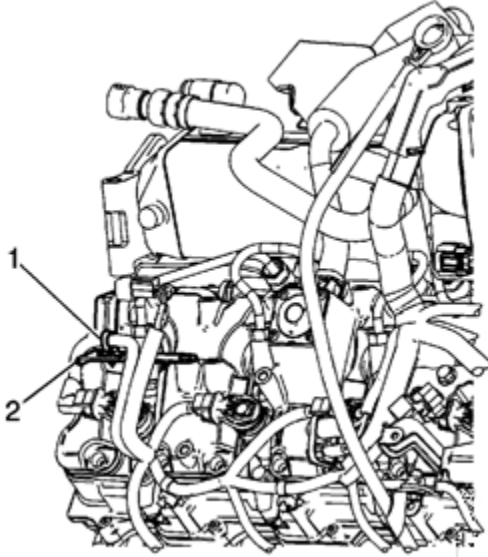
10. Position the engine wiring harness bracket onto the upper valve rocker arm cover and install

the bolts (1).

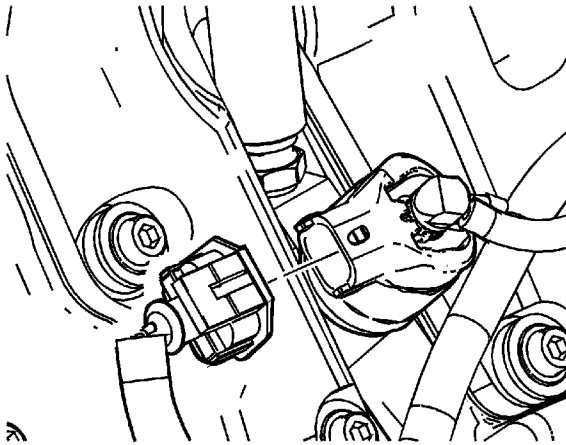
Tighten

Tighten the bolts to 21 N·m (15 lb ft).

11. Install the engine wiring harness clips to the wiring harness bracket.



12. Position the engine wiring harness bracket (2) onto the upper valve rocker arm cover and install the engine wiring harness clip (1) to the wiring harness bracket.



13. Connect the engine wiring harness electrical connectors to the fuel injectors.
14. Install the right fuel injection fuel return pipe. Refer to [Fuel Injection Fuel Return Pipe Replacement - Right Side](#).
15. Install the right fuel injection fuel feed pipes. Refer to [Fuel Injection Fuel Feed Pipe Replacement - Right Side](#).

16. If the fuel injectors were replaced, refer to [Fuel Injector Flow Rate Programming](#).
17. Prime the fuel system. Refer to [Fuel System Priming](#).
18. Start the engine. If the engine stalls, repeat the above step.
19. Once the engine starts, inspect for fuel leaks.

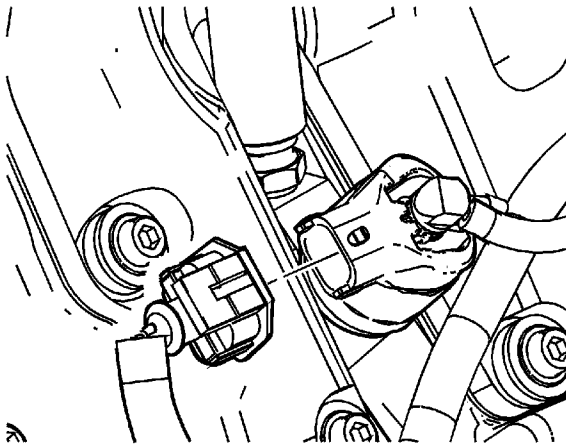
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Fuel Injector Replacement (Left)

Special Tools

- [EN-47909](#) Injector Bore and Sleeve Cleaning Kit
- [J-46594](#) Fuel Injector Puller

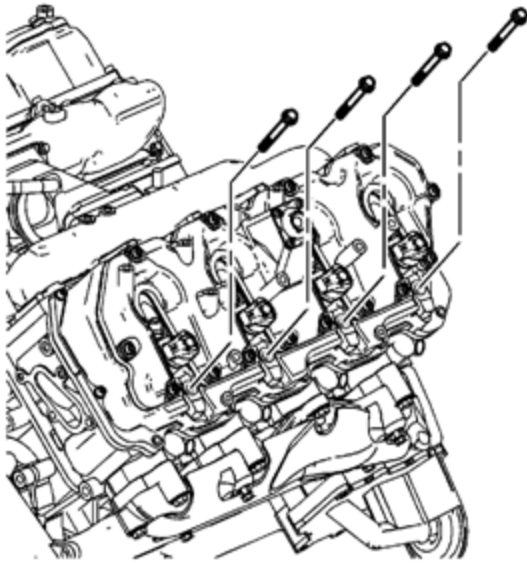
Removal Procedure



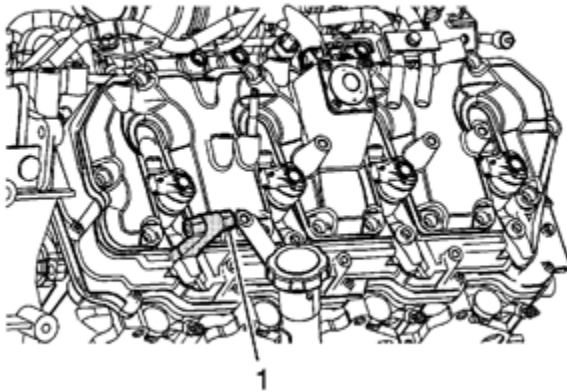
1. Remove the left fuel injection fuel feed pipes. Refer to [Fuel Injection Fuel Feed Pipe Replacement - Left Side](#).
2. Remove the left fuel injection fuel return pipe. Refer to [Fuel Injection Fuel Return Pipe Replacement - Left Side](#).

Caution: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.

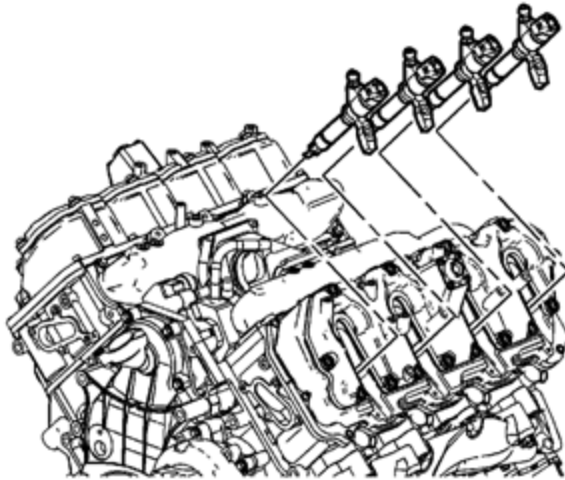
3. Disconnect the engine wiring harness electrical connectors from the fuel injectors.



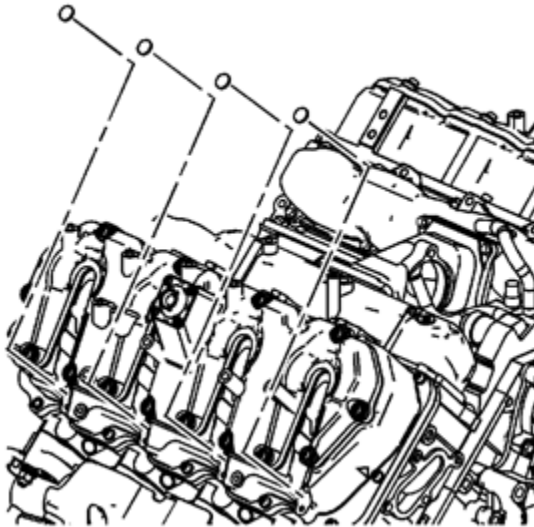
4. Remove the fuel injector bracket bolts.



5. Install the [J-46594](#) (1) into the bolt hole in the fuel injector bracket.
6. Install a flare nut wrench onto the [J-46594](#) and pull back away from the fuel injector, until the injector releases from its seat.
7. Remove the [J-46594](#) .



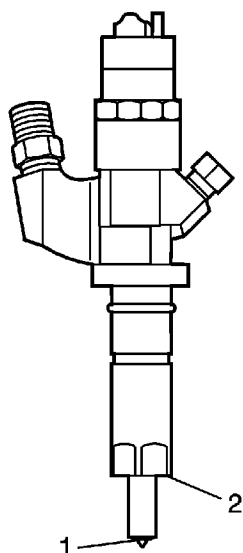
8. Remove the fuel injectors with brackets.



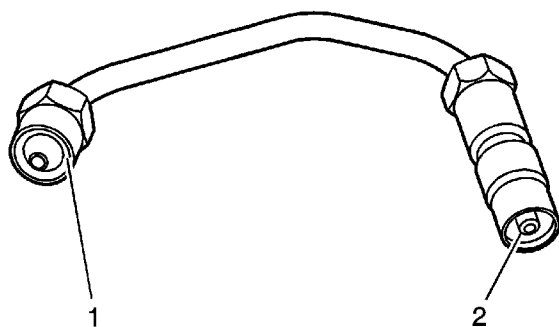
9. If necessary, remove the fuel injector bracket pins.
10. Remove and discard the copper washer from the fuel injector bore.
11. Remove and discard the O-ring from the fuel injector.

Fuel Injector Cleaning and Inspection

Note: If reusing the old injectors perform the following:



1. Use a soft bristle non-metallic brush and Top Engine Cleaner, GM P/N 1052626 or equivalent, to remove any deposits from the nozzle tip (1) and the copper washer sealing area (2) before re-installation.
2. Inspect the fuel injector nozzle tip (1) for any signs of discoloration (dark yellow, tan or blue) due to excessive heat.
3. Replace the injector if any damage is found.



4. Clean the fuel injector high pressure line.
5. Inspect the fuel injector line for excessive corrosion or damage to the sealing surfaces (1, 2). Replace the line if any damage is found.

Injector Bore Cleaning

Note: The procedure below will aid in the cleaning of carbon deposits from the injector sleeve

during an injector replacement

1. Install the EN-47909-2 Radial Brush (brass), to the EN-47909-1 Handle Assembly.
2. Insert the brush into the injector bore and rotate the handle in order to break loose any carbon deposits from the injector bore walls and the combustion deck hole.

Warning: Wear safety glasses in order to avoid eye damage.

3. Using compressed air, evacuate any debris from the injector bore.
4. Remove the radial brush from the handle assembly.
5. Install the EN-47909-3 Axial Brush (nylon), to the EN-47909-1.
6. Insert the axial brush into the injector bore and rotate the handle while also applying a slight downward pressure, in order to force the brush ends into the bottom corners of the injector bore.

Warning: Wear safety glasses in order to avoid eye damage.

7. Using compressed air, evacuate any debris from the injector bore.

Caution: Do not allow excessive amounts of solvent to go into the cylinder during cleaning. Failure to do so may cause engine damage upon startup.

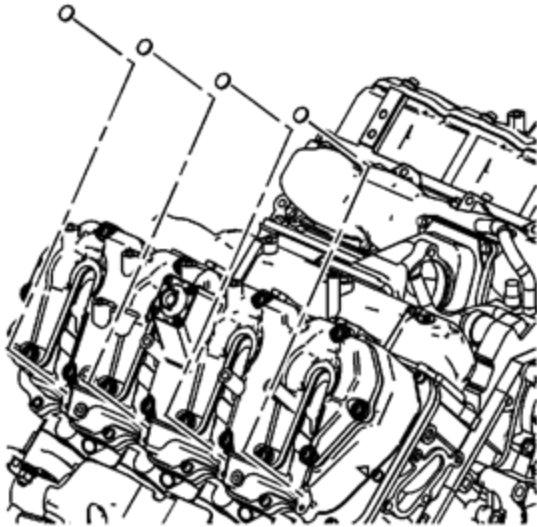
8. Lightly dampen EN-47909-20 Cotton Swab with Top Engine Cleaner, GM P/N 1052626 (Canadian P/N 993026) or equivalent, and wipe away any deposits from the injector bore.
9. Inspect the injector bore for any deposits and repeat brushing if necessary.

Warning: Keep hands and face clear of glow plug holes while cranking. Hot liquid or gases may be expelled during cranking.

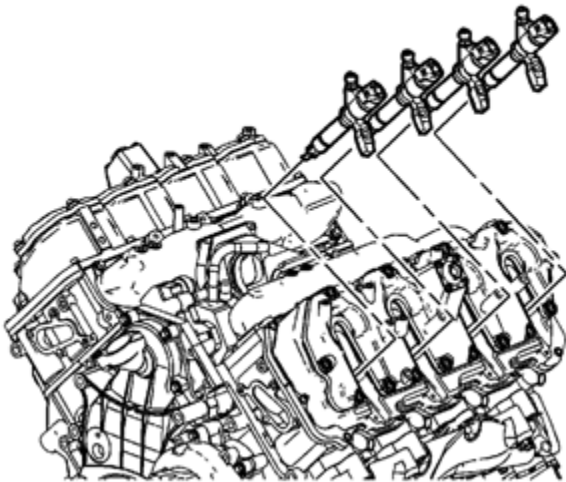
Warning: Wear safety glasses in order to avoid eye damage.

10. If necessary, crank the engine in order to expel any solvent before starting the engine.
 - 10.1. Remove the glow plugs. Refer to [Glow Plug Replacement - Bank 1](#) and/or [Glow Plug Replacement - Bank 2](#).
 - 10.2. Disable the fuel system.
 - 10.3. Disconnect the crankshaft position (CKP) sensor electrical connector.
 - 10.4. Crank the engine in order to expel any excessive solvent.
 - 10.5. Using the cotton swabs supplied with the kit, wipe the injector bore clean of any solvent and/or debris.
 - 10.6. Connect the CKP sensor electrical connector.
 - 10.7. Enable the fuel system.
 - 10.8. Reinstall the glow plugs. Refer to [Glow Plug Replacement - Bank 1](#) and/or [Glow Plug Replacement - Bank 2](#).

Installation Procedure

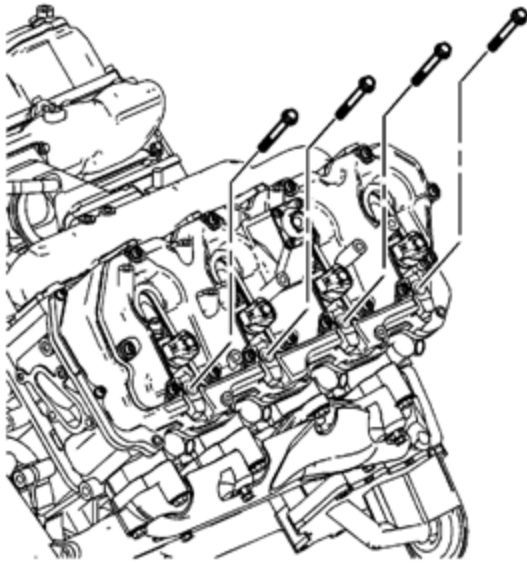


1. Install a NEW copper washer to the fuel injector bore.
2. Install a NEW O-ring onto the fuel injector.
3. If necessary, install the fuel injector bracket pins.



4. Install the fuel injectors with brackets.

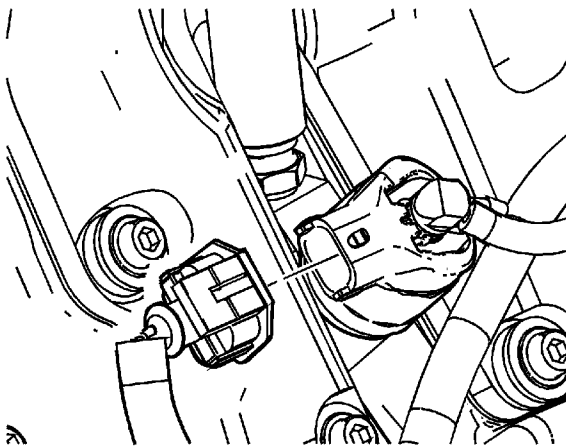
Caution: Refer to [Fastener Caution](#) in the Preface section.



5. Install the fuel injector bracket bolts.

Tighten

Tighten the bolts to 30 N·m (22 lb ft).



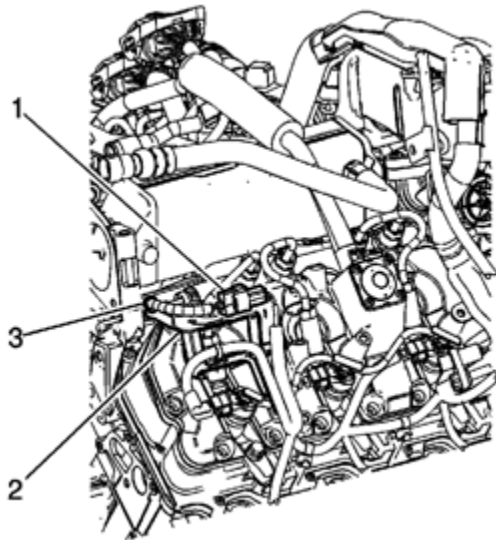
6. Connect the engine wiring harness electrical connectors to the fuel injectors.
7. Install the left fuel injection fuel return pipe. Refer to [Fuel Injection Fuel Return Pipe Replacement - Left Side](#).
8. Install the left fuel injection fuel feed pipes. Refer to [Fuel Injection Fuel Feed Pipe Replacement - Left Side](#).
9. If the fuel injectors were replaced, refer to [Fuel Injector Flow Rate Programming](#).
10. Prime the fuel system. Refer to [Fuel System Priming](#).

11. Start the engine. If the engine stalls, repeat the above step.
12. Once the engine starts, inspect for fuel leaks.

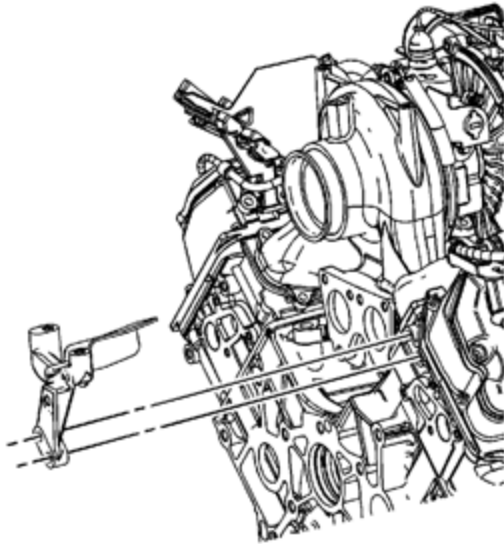
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Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

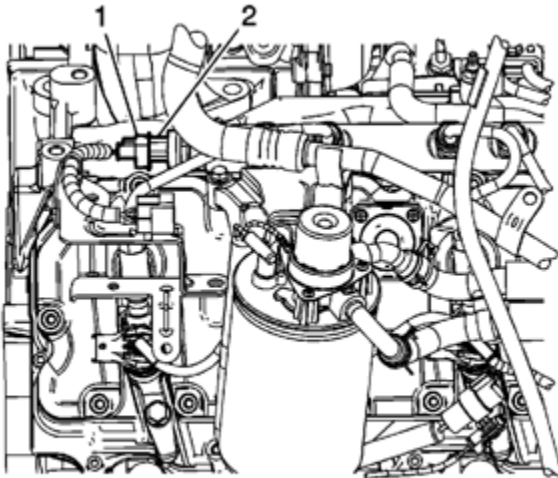
Removal Procedure



1. Remove the exhaust gas recirculation (EGR) valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
2. Remove the right exhaust pipe. Refer to [Exhaust Pipe Replacement - Right Side](#).
3. Disconnect the engine wiring harness electrical connector (1) from the fuel rail fuel pressure sensor wiring harness extension electrical connector.
4. Remove the fuel rail fuel pressure sensor wiring harness extension clip (3) from the wiring harness bracket.



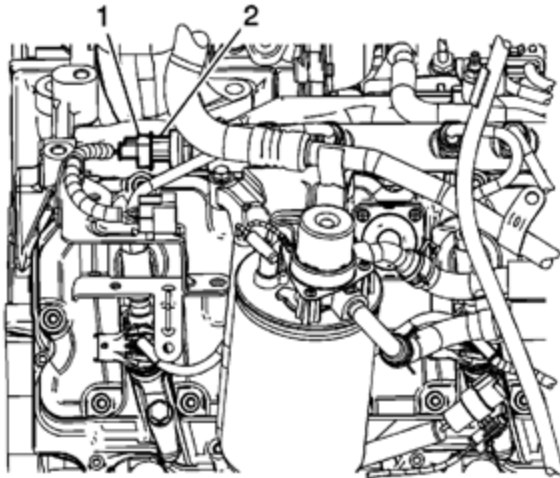
5. Remove the EGR valve cooler rear bracket bolts and bracket.



6. Disconnect the fuel rail fuel pressure sensor wiring harness extension (1) from the fuel rail fuel pressure sensor.
7. Prior to removal, clean the fuel rail fuel pressure sensor and surrounding area thoroughly with solvent, such as GM P/N 12377981 (Canadian P/N 10953463) or equivalent.
8. Using compressed air, thoroughly blow dry the sensor and surrounding area.
9. Remove the fuel rail fuel pressure sensor (2).

Installation Procedure

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

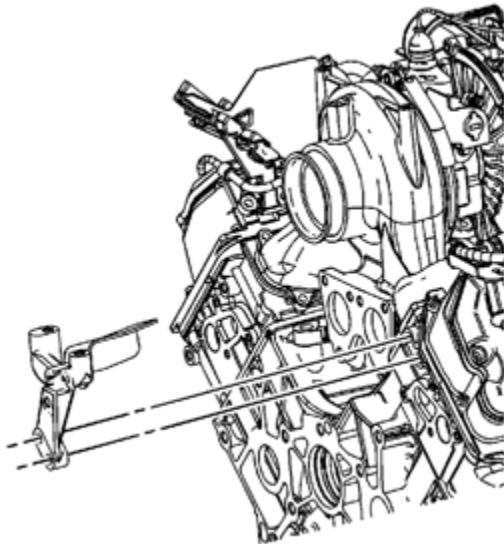


1. Install the fuel rail fuel pressure sensor (2).

Tighten

Tighten the sensor to 70 N·m (52 lb ft).

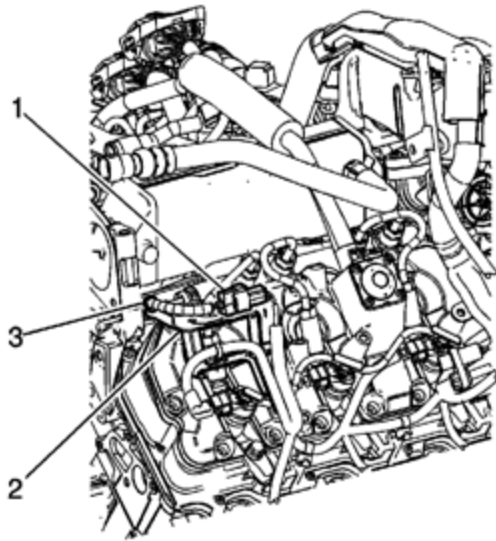
2. Connect the fuel rail fuel pressure sensor wiring harness extension (1) to the fuel rail fuel pressure sensor.



3. Position the EGR valve cooler rear bracket to the cylinder head and install the bolts.

Tighten

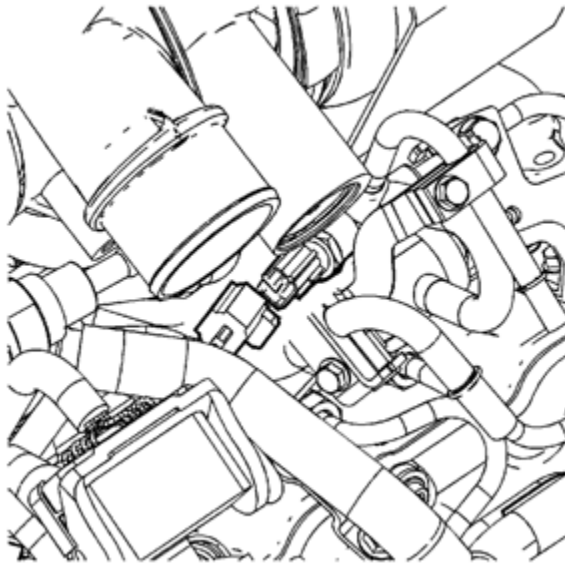
Tighten the bolts to 25 N·m (18 lb ft).



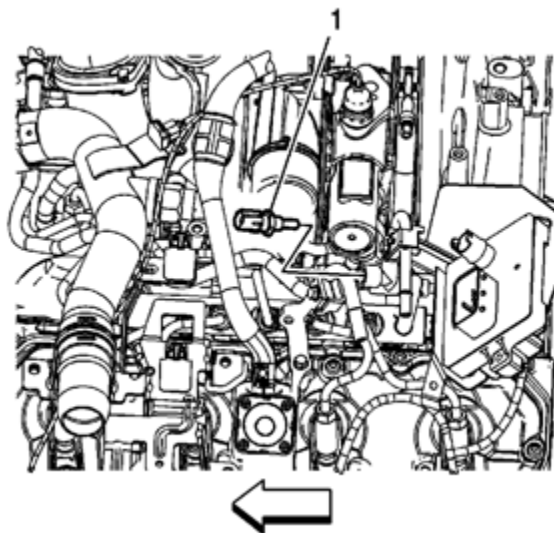
4. Connect the engine wiring harness electrical connector (1) to the fuel rail fuel pressure sensor wiring harness extension electrical connector.
5. Install the fuel rail fuel pressure sensor wiring harness extension clip (3) to the wiring harness bracket.
6. Install the right exhaust pipe. Refer to [Exhaust Pipe Replacement - Right Side](#).
7. Install the EGR valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
8. Prime the fuel system. Refer to [Fuel System Priming](#).
9. Start the engine. If the engine stalls, repeat the above step.
10. Once the engine starts, inspect for fuel leaks.

Fuel Temperature Sensor Replacement

Removal Procedure



1. Remove the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
2. Disconnect the engine wiring harness electrical connector from the fuel temperature sensor.

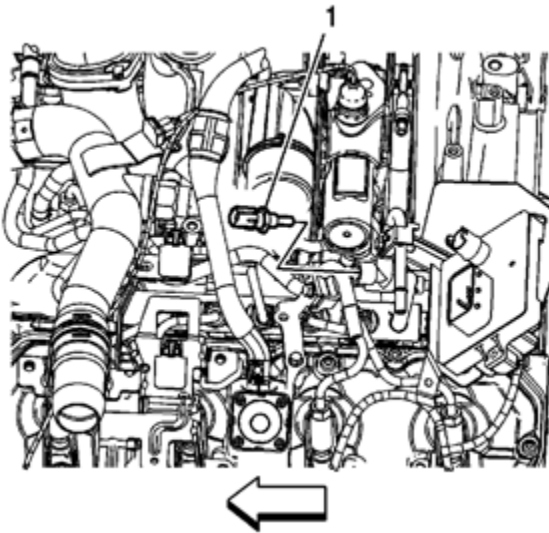


3. Remove the fuel temperature sensor (1) from the fuel return pipe.

Installation Procedure

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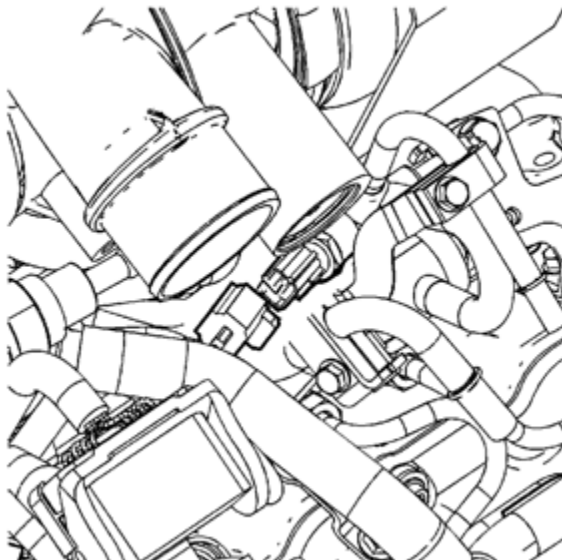
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the fuel temperature sensor (1) to the fuel return pipe.

Tighten

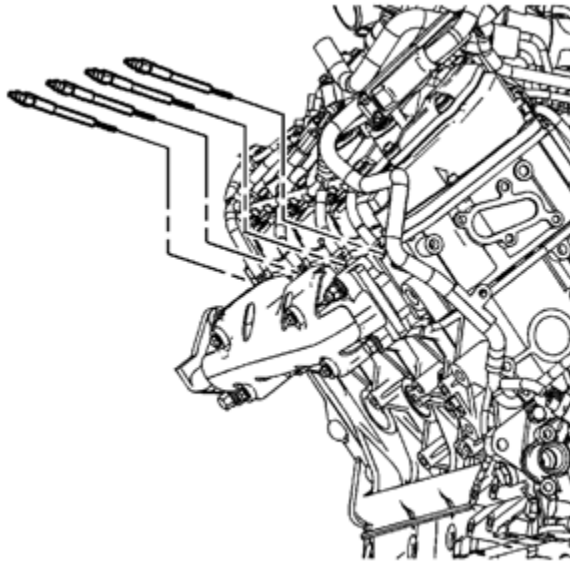
Tighten the sensor to 22 N·m (16 lb ft).



2. Connect the engine wiring harness electrical connector to the fuel temperature sensor.
3. Prime the fuel system. Refer to [Fuel System Priming](#).
4. Start the engine. If the engine stalls, repeat the above step.
5. Once the engine starts, inspect for fuel leaks.

Glow Plug Replacement - Bank 1

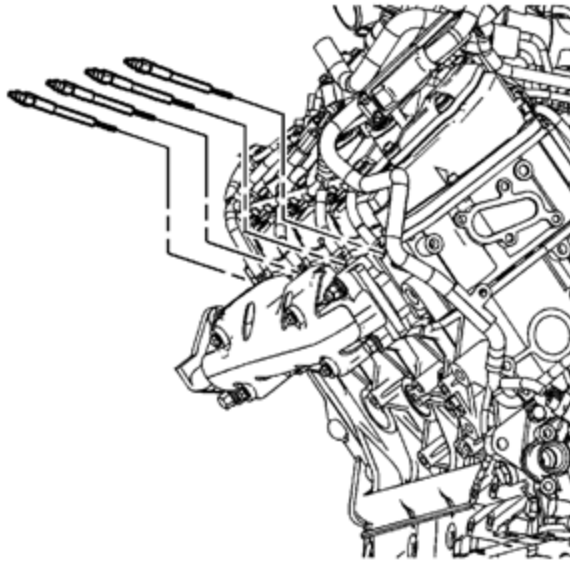
Removal Procedure



1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
3. Remove the engine wiring harness nut(s) from the glow plug(s).
4. Remove the engine wiring harness lead(s) from the glow plug(s).
5. Remove the glow plug(s) from the cylinder head.

Installation Procedure

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



1. Install the glow plug(s) to the cylinder head.

Tighten

Tighten the plug to 18 N·m (13 lb ft).

2. Install the engine wiring harness lead(s) to the glow plug(s).
3. Install the engine wiring harness nut(s) to the glow plug(s).

Tighten

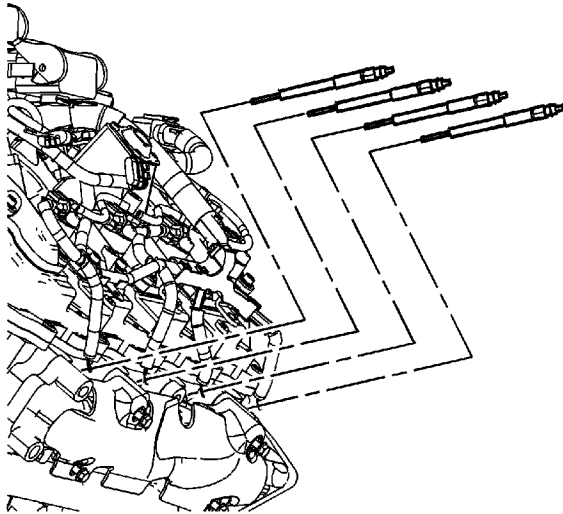
Tighten the nut to 1.7 N·m (15 lb in).

4. Install the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
5. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

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Glow Plug Replacement - Bank 2

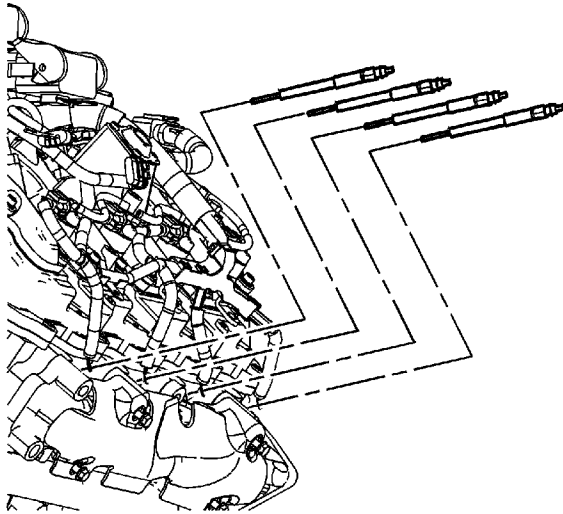
Removal Procedure



1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the left wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).
3. Remove the engine wiring harness nut(s) from the glow plug(s).
4. Remove the engine wiring harness lead(s) from the glow plug(s).
5. Remove the glow plug(s) from the cylinder head.

Installation Procedure

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



1. Install the glow plug(s) to the cylinder head.

Tighten

Tighten the plug to 18 N·m (13 lb ft).

2. Install the engine wiring harness lead(s) to the glow plug(s).
3. Install the engine wiring harness nut(s) to the glow plug(s).

Tighten

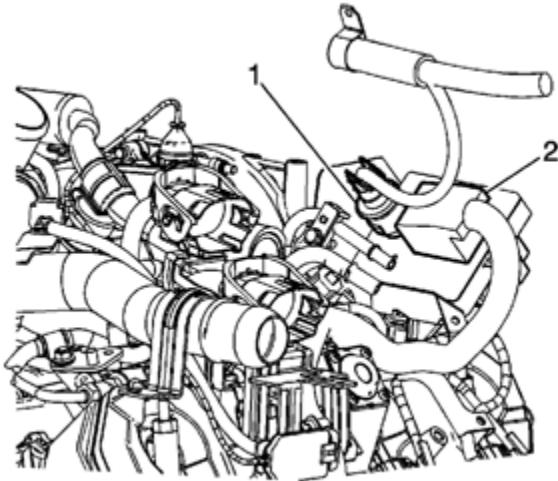
Tighten the nut to 1.7 N·m (15 lb in).

4. Install the left wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).
5. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

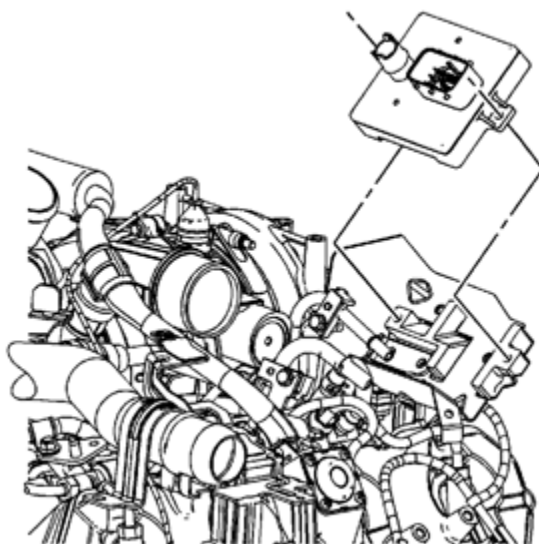
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Glow Plug Control Module Replacement

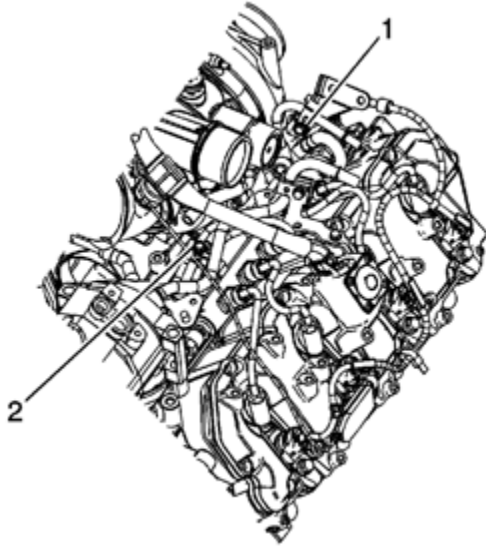
Removal Procedure



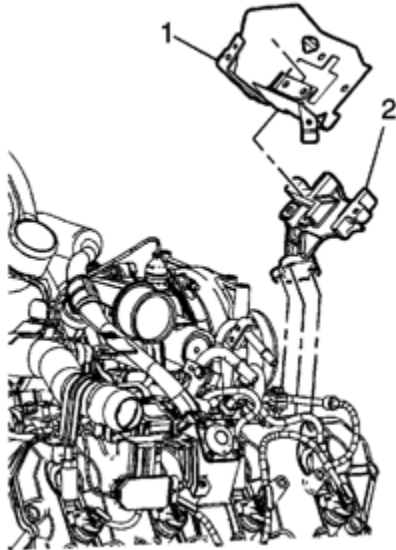
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Disconnect the positive battery cable (1) from the glow plug control module.
3. Disconnect the engine wiring harness electrical connector (2) from the glow plug control module.



4. Remove the glow plug control module bolts and module.



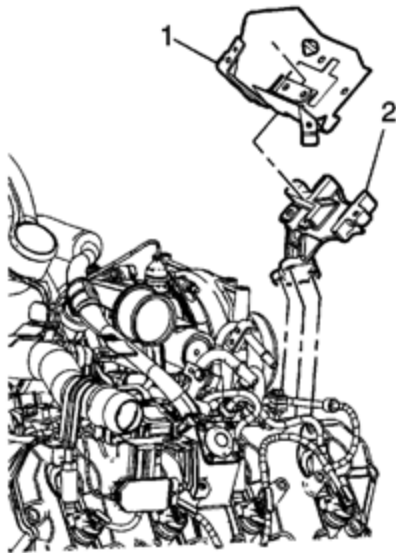
5. Remove the fuel return pipe clamp bolt (1).



6. Remove the glow plug control module protector bolts and protector (1), if required.
7. Remove the glow plug control module bracket and bolts (2), if required.

Installation Procedure

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



1. Position the glow plug control module bracket (2) to the lower valve rocker arm cover and install the bolts, if required.

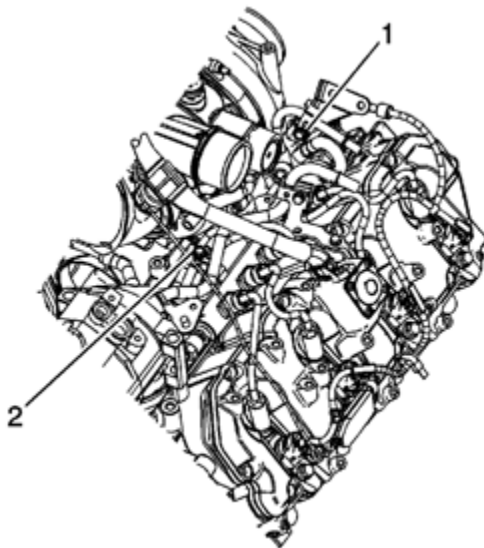
Tighten

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

2. Position the glow plug control module protector (1) and install the bolts, if required.

Tighten

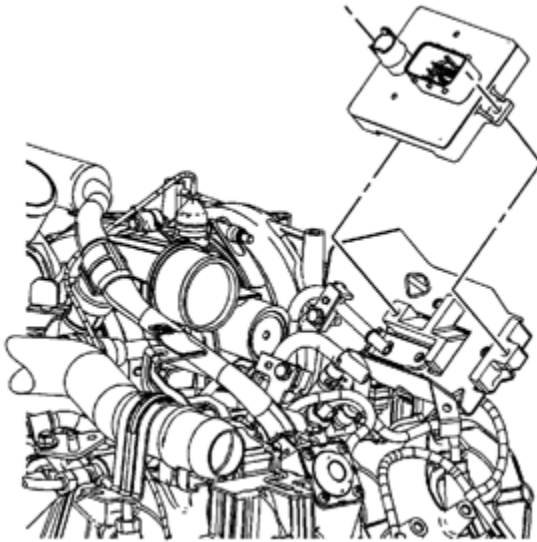
Tighten the bolts to 10 N·m (89 lb in).



3. Install the fuel return pipe clamp bolt (1).

Tighten

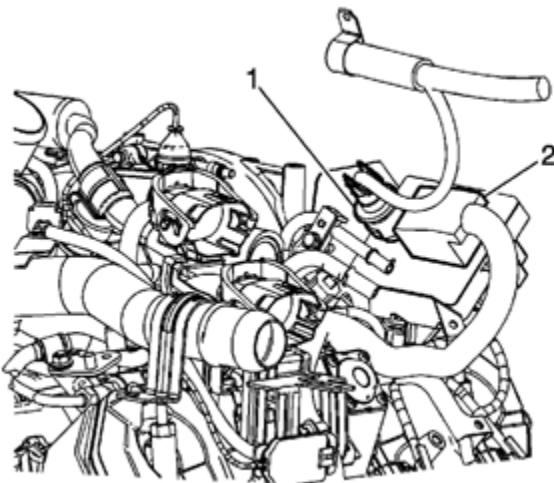
Tighten the bolt to 24 N·m (18 lb ft).



4. Position the glow plug control module onto the bracket and install the bolts.

Tighten

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



5. Connect the engine wiring harness electrical connector (2) to the glow plug control module.
6. Connect the positive battery cable (1) to the glow plug control module.
7. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and](#)

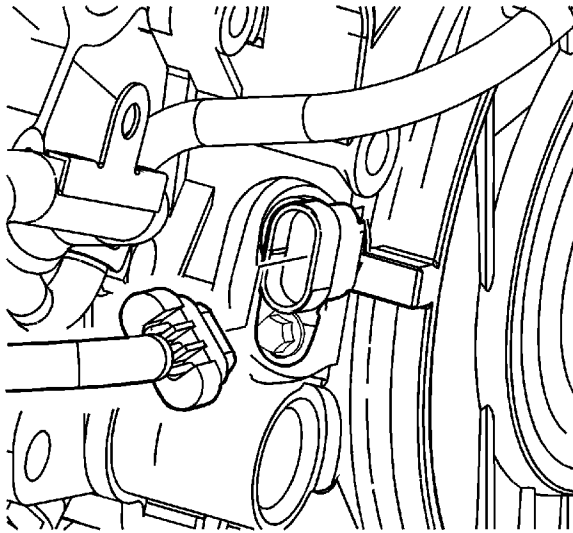
[Connection.](#)

8. If a NEW glow plug control module was installed, program the module. Refer to [Control Module References](#).

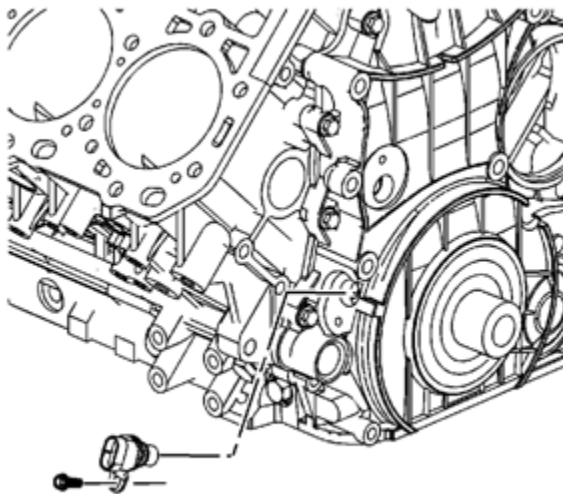
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Crankshaft Position Sensor Replacement

Removal Procedure

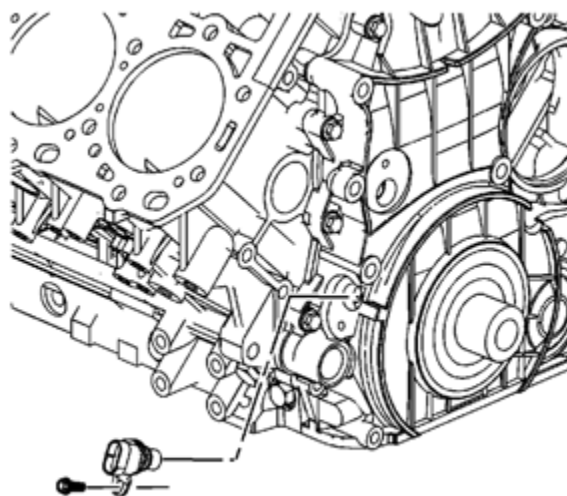


1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
3. Disconnect the crankshaft position (CKP) sensor electrical connector.



4. Remove the CKP sensor bolt.
5. Remove the CKP sensor.
6. If necessary, remove the CKP sensor spacer bolts.
7. If necessary, remove the CKP sensor spacer.

Installation Procedure



1. If necessary, lubricate a NEW CKP spacer O-ring with clean engine oil.
2. If necessary, install the NEW O-ring to the CKP sensor spacer.

Note: The crankshaft position sensor spacers are machined with different timing positions. However, if the crankshaft position sensor spacer requires replacement, replace with a grade "C" spacer.

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

3. If necessary, install the CKP sensor spacer.
4. If necessary, install the CKP sensor spacer bolts.

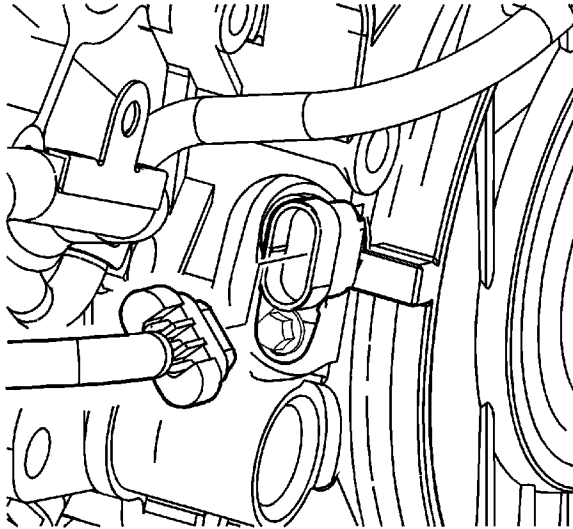
Tighten

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

5. Lubricate a NEW CKP sensor O-ring with clean engine oil.
6. Install the NEW O-ring to the CKP sensor.
7. Install the CKP sensor.
8. Install the CKP sensor bolt.

Tighten

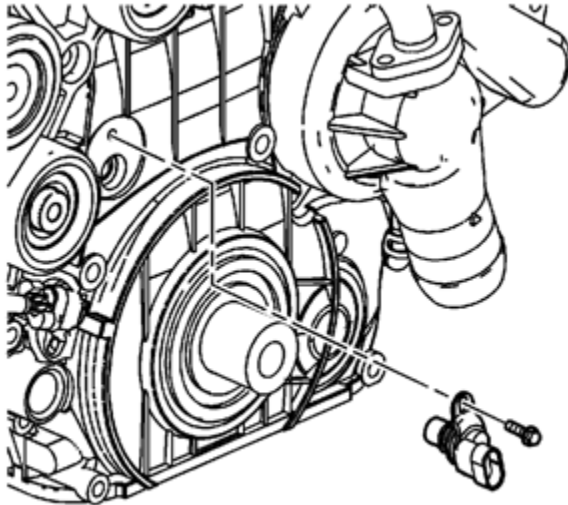
Tighten the bolt to 10 N·m (89 lb in).



9. Connect the CKP sensor electrical connector.
10. Install the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
11. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

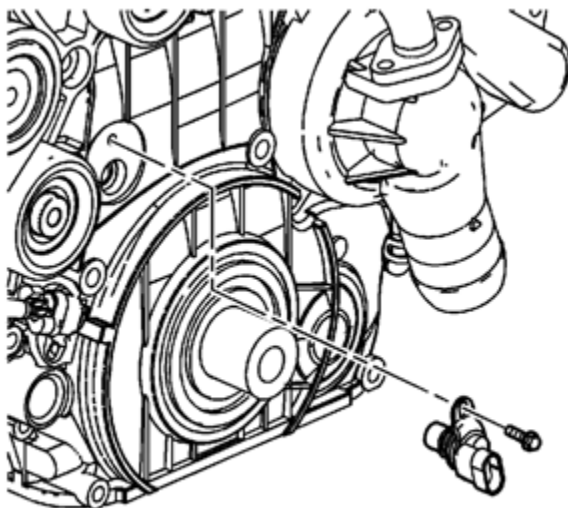
Camshaft Position Sensor Replacement

Removal Procedure



1. Remove the cooling fan pulley. Refer to [Cooling Fan Pulley Replacement](#).
2. Remove the camshaft position (CMP) sensor bolt.
3. Remove the CMP sensor.

Installation Procedure





1. Lubricate the CMP sensor O-ring with clean engine oil.

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

2. Install the CMP sensor.
3. Install the CMP sensor bolt.

Tighten

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

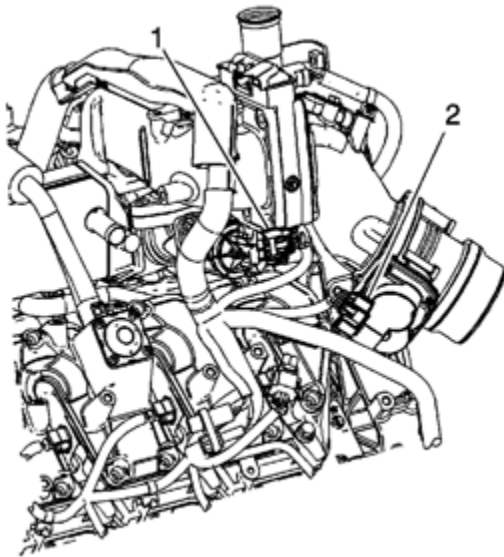
4. Install the cooling fan pulley. Refer to [Cooling Fan Pulley Replacement](#).

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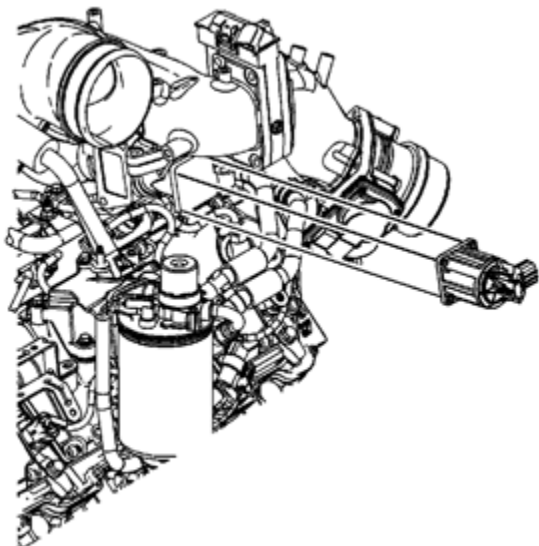
Exhaust Gas Recirculation Valve Motor Replacement

Removal Procedure

Note: There is no gasket between the motor and the valve. However, some vehicles may have a thin metal spacer between the motor and the valve that appears to be a gasket. This spacer is used to correct for production variances in some valves and should be reinstalled with the new motor.



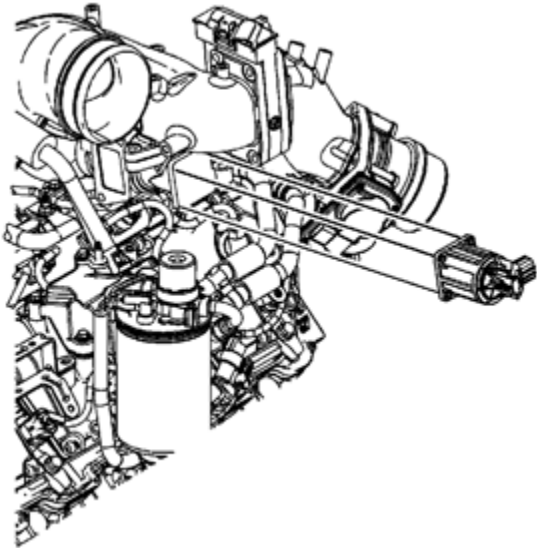
1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
2. Disconnect the engine wiring harness electrical connector (1) from the exhaust gas recirculation (EGR) valve motor.





3. Remove the EGR valve motor screws.
4. Remove the EGR valve motor, and spacer (if equipped) from the EGR valve.

Installation Procedure



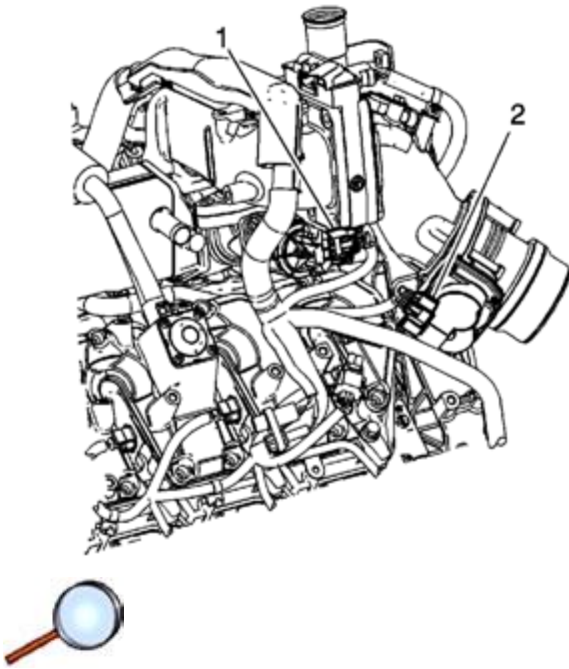
1. Position the EGR spacer (if equipped), and NEW EGR valve motor to the EGR valve.

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

2. Install the EGR valve motor screws.

Tighten

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

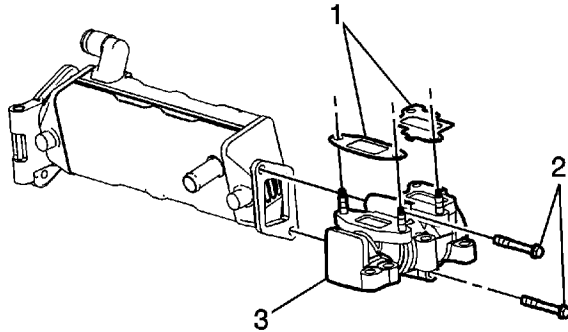


3. Connect the engine wiring harness electrical connector (1) to the EGR valve motor.
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Cycle the ignition to relearn the new EGR valve motor pintle position.

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Exhaust Gas Recirculation Valve Replacement

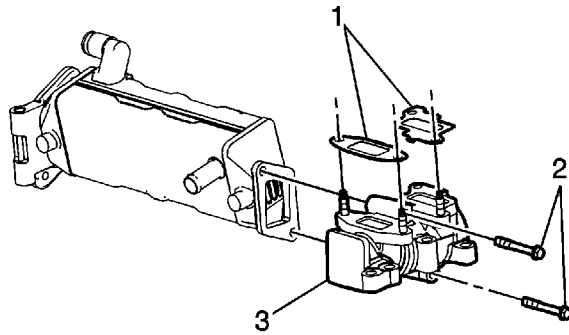
Removal Procedure



1. Remove the exhaust gas recirculation (EGR) valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
2. Remove the EGR valve gaskets (1), if required.
3. Remove the EGR valve bolts (2).
4. Remove the EGR valve (3).
5. Remove and discard the EGR valve to valve cooler gasket.

Installation Procedure

Note: Use a NEW EGR valve gasket when installing the EGR valve.



1. Position a NEW EGR valve gasket to the valve cooler.
2. Position the EGR valve (3) to the valve cooler.

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

3. Install the EGR valve bolts (2).

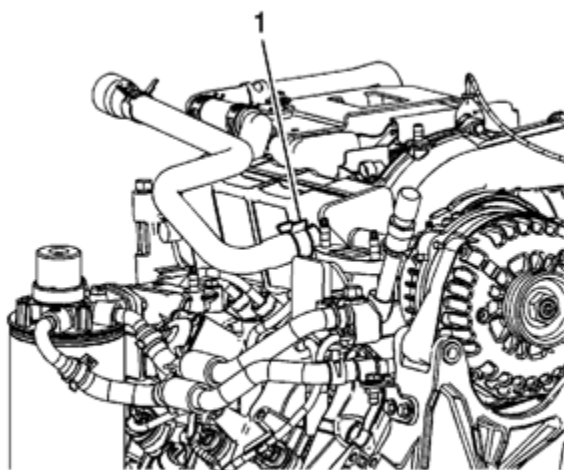
Tighten

Tighten the bolts to 25 N·m (18 lb ft).

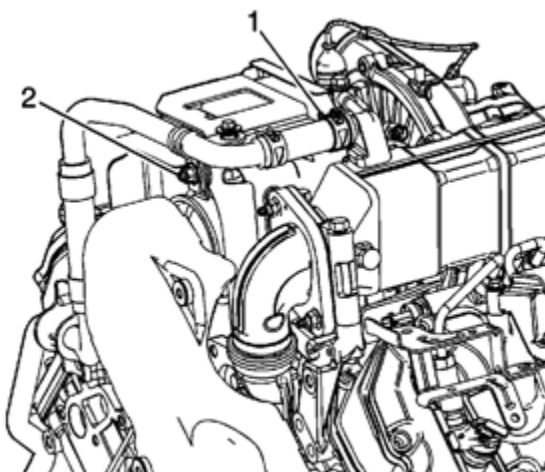
4. Install NEW EGR valve gaskets (1) onto the EGR valve, if required.
5. Install the EGR valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).

Exhaust Gas Recirculation Valve Cooler Replacement

Removal Procedure

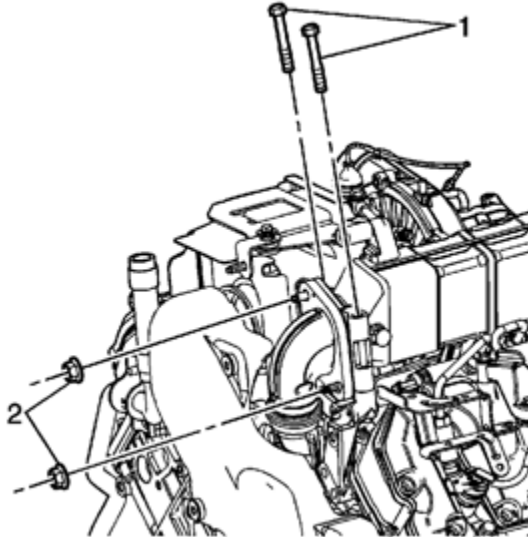


1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
2. Remove the charger air outlet pipe. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
3. Remove the air intake pipe. Refer to [Air Intake Pipe Replacement](#).
4. Remove the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
5. Reposition the heater inlet hose clamp (1) at the exhaust gas recirculation (EGR) valve cooler.
6. Remove the heater inlet hose from the EGR valve cooler and reposition out of the way.

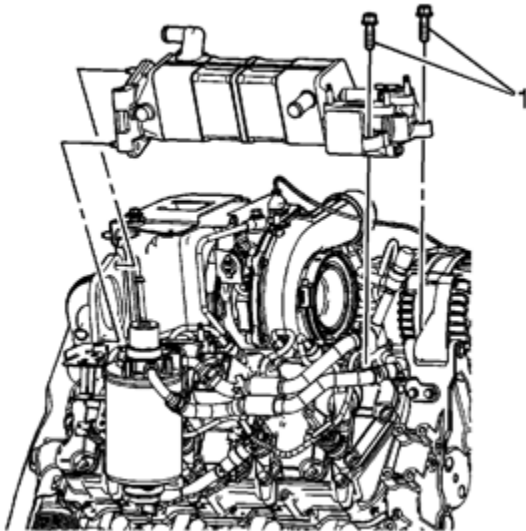




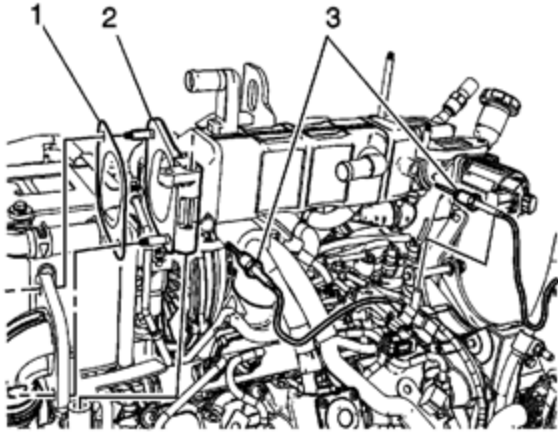
7. Remove the EGR valve cooler coolant hose clamp nut (2).
8. Reposition the EGR valve cooler coolant hose clamp (1).
9. Remove the EGR valve cooler coolant hose from the EGR valve cooler. Reposition the hose out of the way.



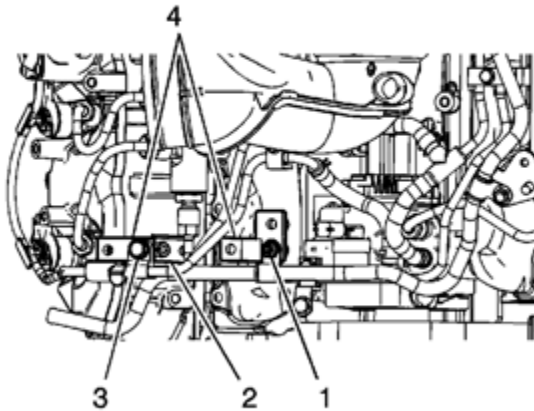
10. Remove the right exhaust pipe to EGR valve cooler nuts (2).
11. Remove the rear EGR valve cooler bolts (1).



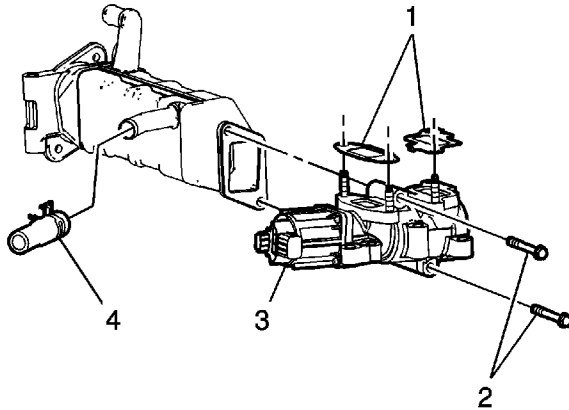
12. Remove the front EGR valve cooler bolts (1).



13. Remove the EGR temperature sensors (3). Refer to [Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 1](#) or [Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 2](#).
14. Remove the EGR valve cooler (2) and gasket (1). Discard the gasket.



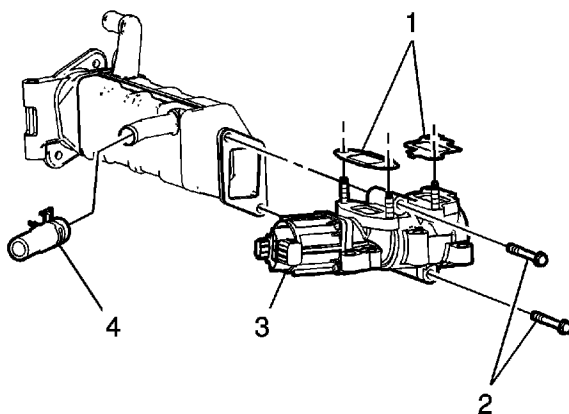
15. If necessary, perform the following steps in order to remove the EGR brackets:
 - 15.1. Remove the fuel injection fuel feed manifold bolt (3).
 - 15.2. Remove the fuel feed pipe nut (1) and reposition the clip.
 - 15.3. Remove the EGR bracket bolt (2).
 - 15.4. Remove the EGR brackets (4).



16. If replacing the EGR valve cooler, perform the following steps:
- 16.1. Reposition the EGR valve cooler hose clamp and remove the hose (4).
 - 16.2. Remove the EGR valve bolts (2).
 - 16.3. Remove the EGR valve (3).
 - 16.4. Remove and discard the EGR valve gaskets (1).

Installation Procedure

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

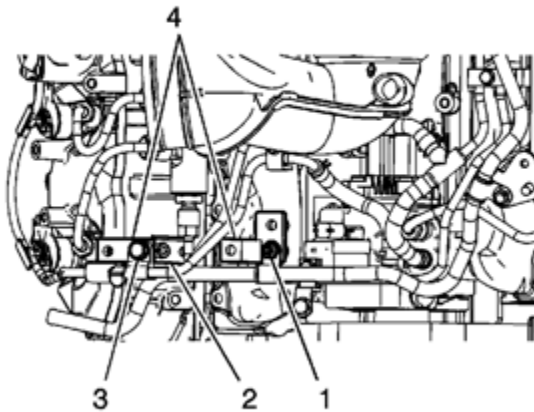


1. If the EGR valve cooler was replaced, perform the following steps:
 - 1.1. Position the EGR valve (3) to the cooler.
 - 1.2. Install the EGR valve bolts (2).

Tighten

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

- 1.3. Install the EGR valve cooler hose (4) and position the hose clamp.
- 1.4. Install NEW EGR valve gaskets (1).



2. If necessary, perform the following steps in order to install the EGR brackets:
 - 2.1. Position the EGR brackets (4).
 - 2.2. Install the EGR bracket bolt (2).

Tighten

Tighten the bolt to 25 N·m (18 lb ft).

- 2.3. Position the clip and install the fuel feed pipe nut (1).

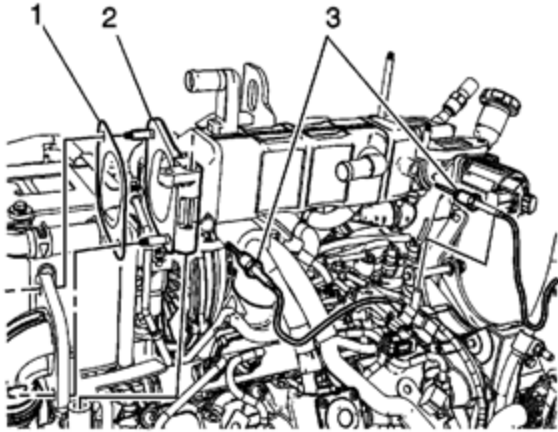
Tighten

Tighten the nut to 25 N·m (18 lb ft).

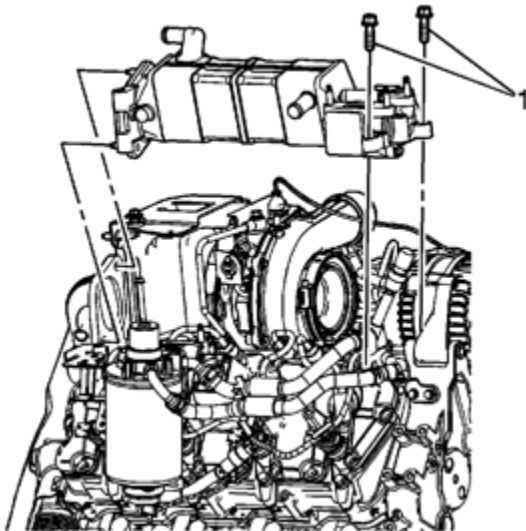
- 2.4. Install the fuel injection fuel feed manifold bolt (3).

Tighten

Tighten the bolt to 25 N·m (18 lb ft).



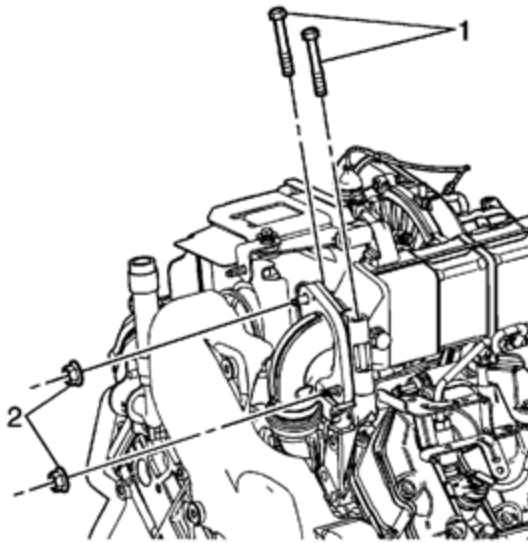
3. Install a NEW EGR valve cooler gasket (1) onto the cooler studs, and install the EGR cooler (2) to the engine.
4. Install the EGR temperature sensors (3). Refer to [Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 1](#) or [Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 2](#).



5. Install the front EGR valve cooler bolts (1).

Tighten

Tighten the bolts to 50 N·m (37 lb ft).



6. Install the rear EGR valve cooler bolts (1).

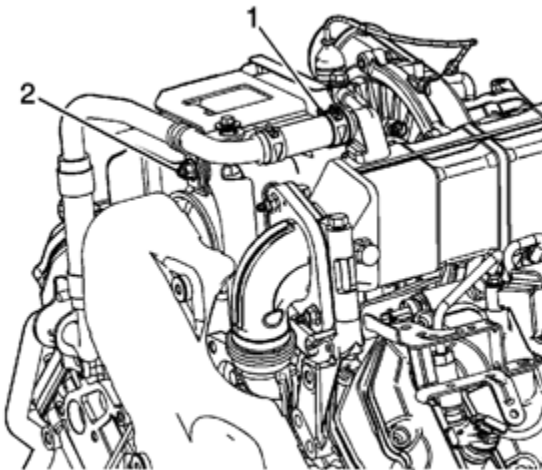
Tighten

Tighten the bolts to 25 N·m (18 lb ft).

7. Install the right exhaust pipe to EGR valve cooler nuts (2).

Tighten

Tighten the nuts to 53 N·m (39 lb ft).

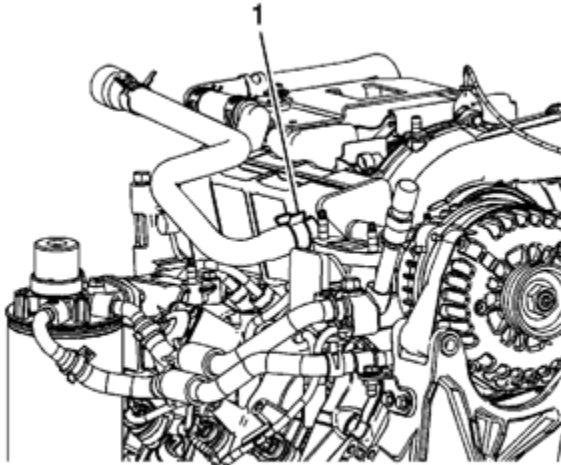


8. Position the EGR valve cooler coolant hose, and install the hose to the EGR valve cooler.
9. Position the EGR valve cooler coolant hose clamp (1).

10. Install the EGR valve cooler coolant hose clamp nut (2).

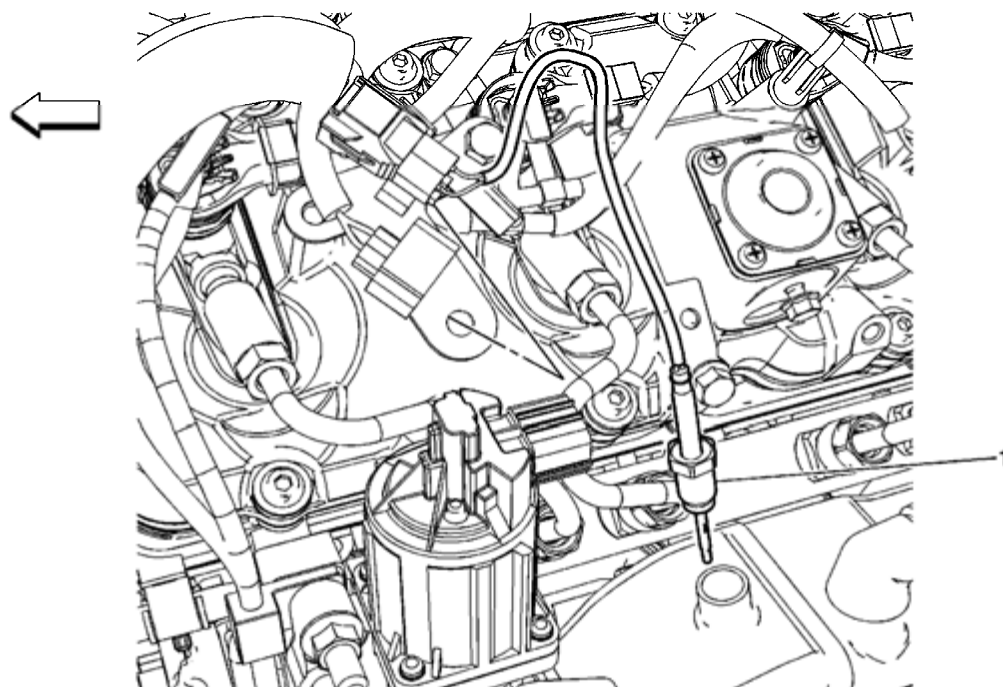
Tighten

Tighten the nut to 24 N·m (18 lb ft).



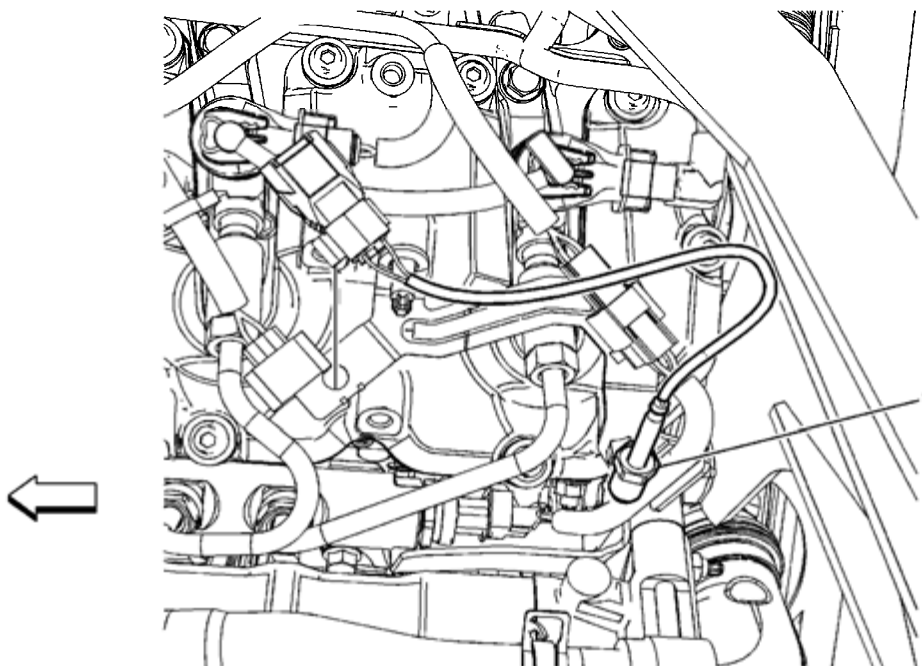
11. Position the heater inlet hose and install the hose to the EGR valve cooler.
12. Position the heater inlet hose clamp (1) at the EGR valve cooler.
13. Install the intake manifold tube. Refer to [Intake Manifold Tube Replacement](#).
14. Install the air intake pipe. Refer to [Air Intake Pipe Replacement](#).
15. Install the charger air outlet pipe. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
16. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).

Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 1



Callout	Component Name
Preliminary Procedures	
1. Remove the engine cover. 2. Remove the air cleaner. Refer to Air Cleaner Assembly Replacement.	
1	EGR Temperature Sensor Assembly Caution: Refer to Fastener Caution in the Preface section. Procedure 1. Disconnect the harness connector. 2. Detach the EGR temperature sensor assembly harness connector from the bracket. Tighten 44 N·m (32 lb ft)

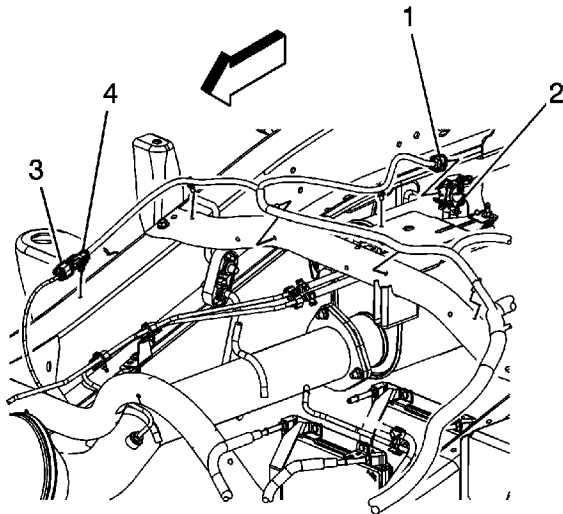
Exhaust Gas Recirculation Valve Temperature Sensor Replacement - Position 2



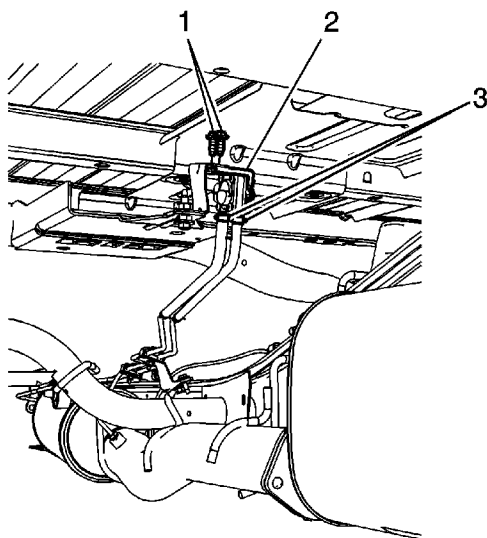
Callout	Component Name
Preliminary Procedures	
1. Remove the engine cover. 2. Remove the air cleaner. Refer to Air Cleaner Assembly Replacement.	
1	EGR Temperature Sensor Assembly Caution: Refer to Fastener Caution in the Preface section. Procedure 1. Disconnect the harness connector. 2. Detach the EGR temperature sensor assembly harness connector from the bracket. Tighten 44 N·m (32 lb ft)

Exhaust Pressure Differential Sensor Replacement (Pickup)

Removal Procedure

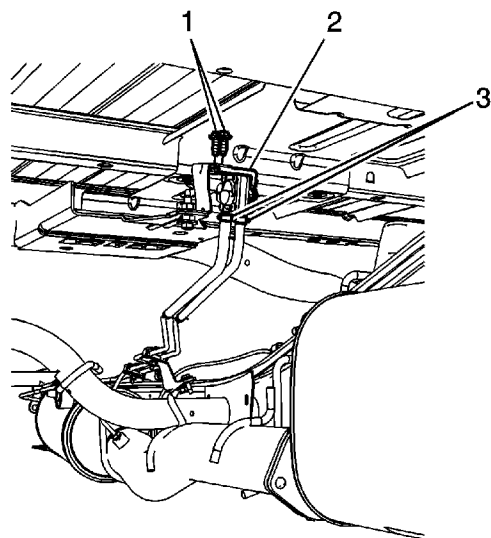


1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the chassis wiring harness electrical connector (1) from the exhaust differential pressure sensor (2).



3. Reposition the exhaust differential pressure sensor pipe assembly hose clamps (3).
4. Remove the exhaust differential pressure sensor pipe assembly hoses from the sensor.
5. Remove the exhaust differential pressure sensor bracket bolts (1).
6. Remove the exhaust differential pressure sensor (2).

Installation Procedure



1. Position the exhaust differential pressure sensor (2) to the bracket.

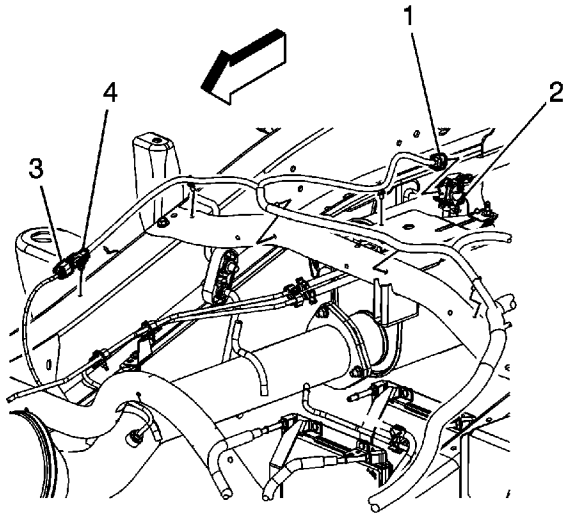
Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the exhaust differential pressure sensor bracket bolts (1).

Tighten

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

3. Install the exhaust differential pressure sensor pipe assembly hoses to the sensor.
4. Position the exhaust differential pressure sensor pipe assembly hose clamps (3).

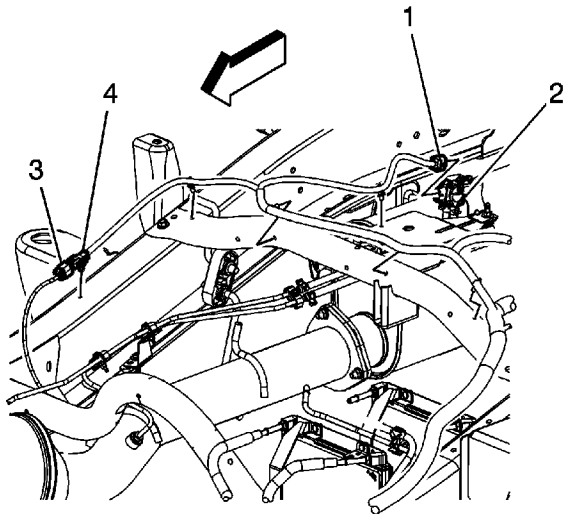


5. Connect the chassis wiring harness electrical connector (1) to the exhaust differential pressure sensor (2).
6. Lower the vehicle.

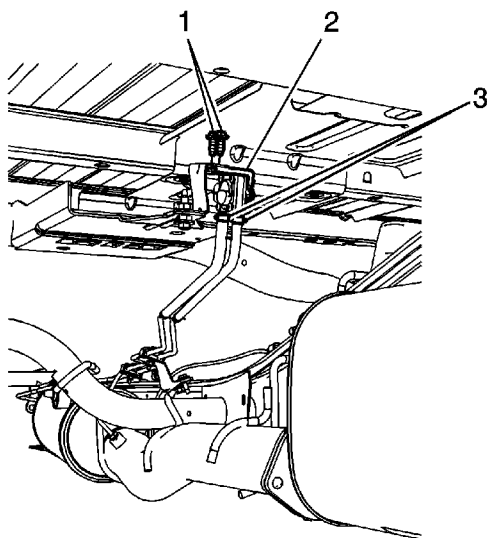
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Exhaust Pressure Differential Sensor Replacement (Cab / Chassis)

Removal Procedure

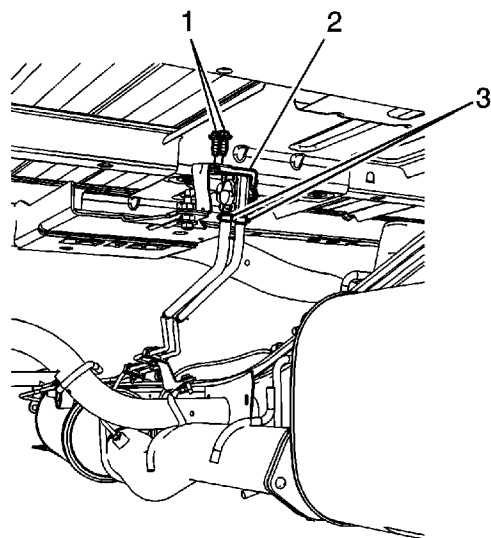


1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the chassis wiring harness electrical connector (1) from the exhaust differential pressure sensor (2).



3. Reposition the exhaust differential pressure sensor pipe assembly hose clamps (3).
4. Remove the exhaust differential pressure sensor pipe assembly hoses from the sensor.
5. Remove the exhaust differential pressure sensor bracket bolts (1).
6. Remove the exhaust differential pressure sensor (2).

Installation Procedure



1. Position the exhaust differential pressure sensor (2) to the bracket.

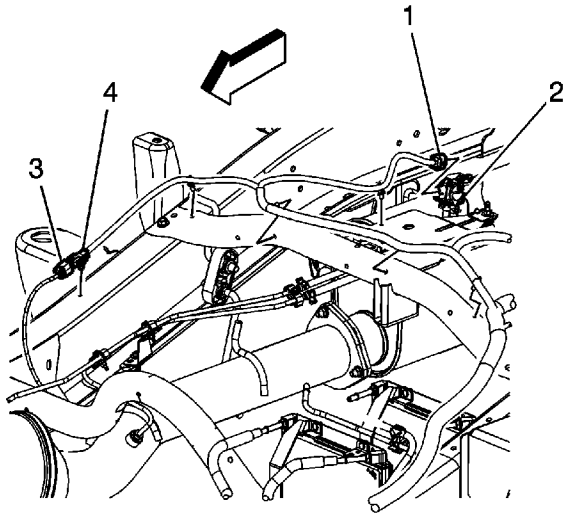
Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the exhaust differential pressure sensor bracket bolts (1).

Tighten

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

3. Install the exhaust differential pressure sensor pipe assembly hoses to the sensor.
4. Position the exhaust differential pressure sensor pipe assembly hose clamps (3).



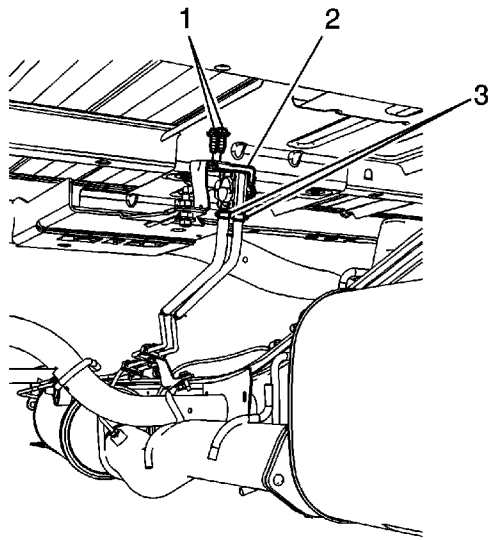
5. Connect the chassis wiring harness electrical connector (1) to the exhaust differential pressure sensor (2).
6. Lower the vehicle.

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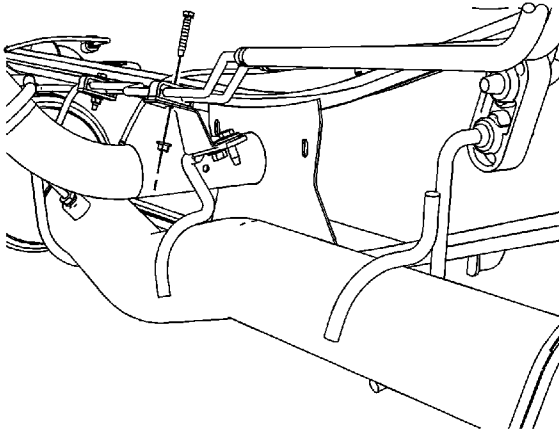
Exhaust Pressure Differential Sensor Pipe Replacement (Pickup)

Removal Procedure

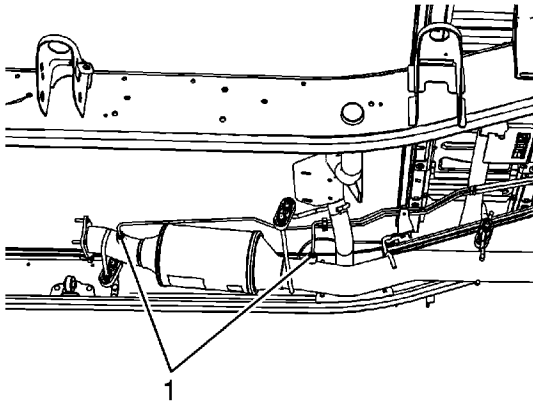
Caution: The exhaust temperature sensor and exhaust pressure differential sensor line fittings may be difficult to remove when the engine exhaust system temperature is below 48°C (120°F). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.



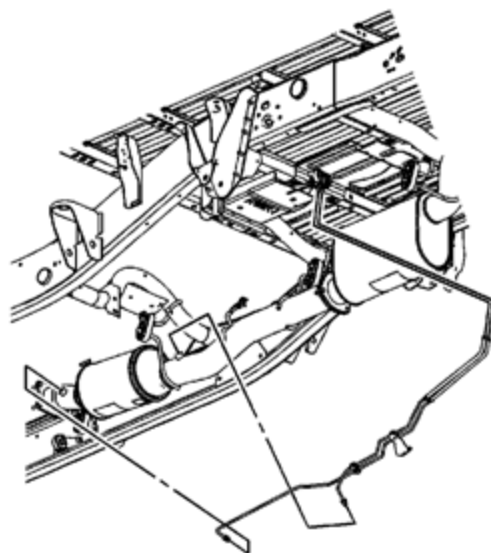
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Reposition the exhaust differential pressure sensor pipe assembly hose clamps (3).
3. Remove the exhaust differential pressure sensor pipe assembly hoses from the sensor.



4. Remove the exhaust differential pressure sensor pipe bracket bolt and nut.



5. Loosen the exhaust differential pressure sensor pipe assembly fittings (1).

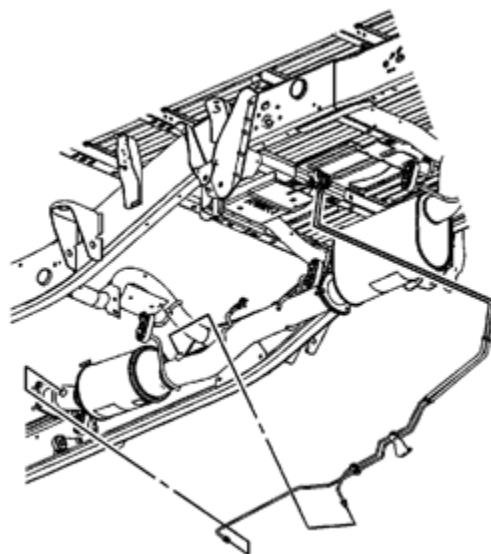


6. Remove the exhaust differential pressure sensor pipe assembly.

Installation Procedure

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

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

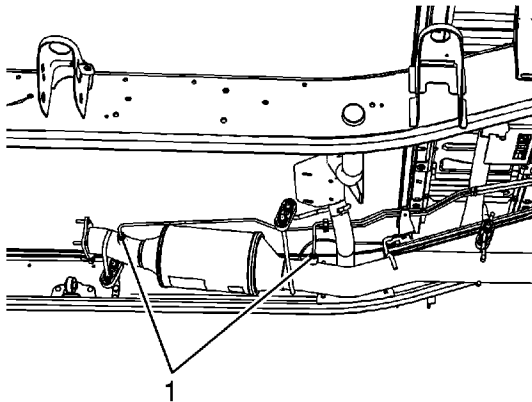




Note: Ensure to route the pipe assembly over the frame crossmember.

2. Position and install the exhaust differential pressure sensor pipe assembly to the vehicle.

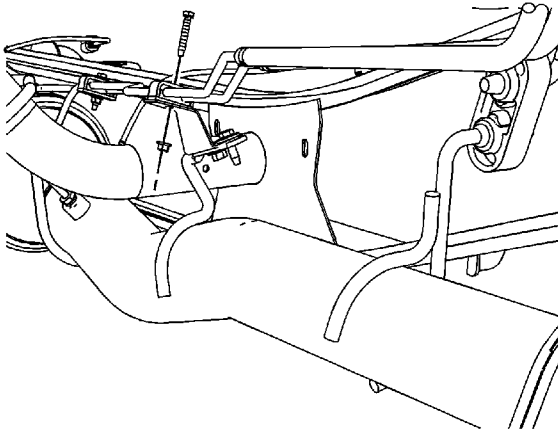
Caution: Refer to [Fastener Caution](#) in the Preface section.



3. Tighten the exhaust differential pressure sensor pipe assembly fittings (1).

Tighten

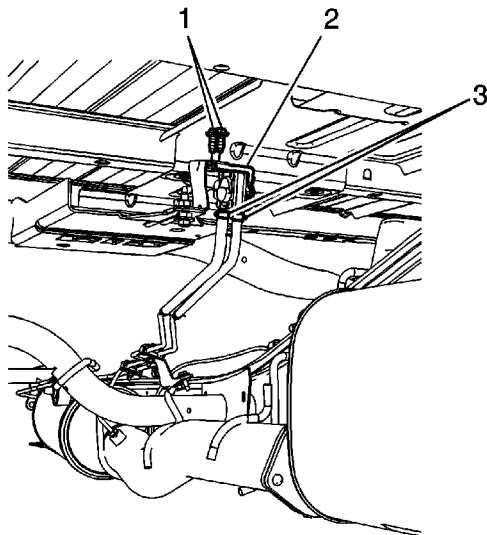
Tighten the fittings to 45 N·m (33 lb ft).



4. Position the exhaust differential pressure sensor pipe bracket to the exhaust hanger and install the bolt and nut.

Tighten

Tighten the bracket bolt/nut to 9 N·m (80 lb in).

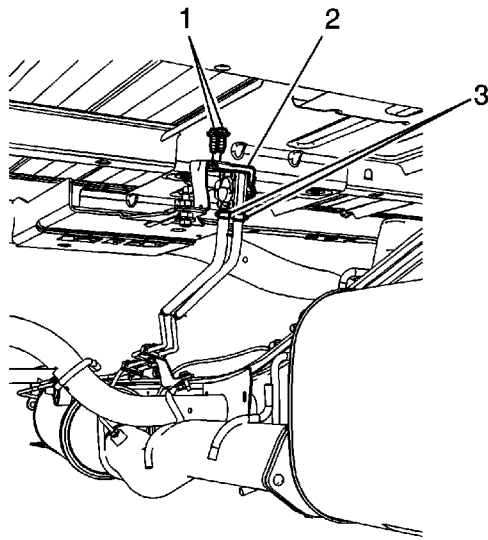


5. Install the exhaust differential pressure sensor pipe assembly hoses to the sensor.
6. Position the exhaust differential pressure sensor pipe assembly hose clamps (3).
7. Lower the vehicle.

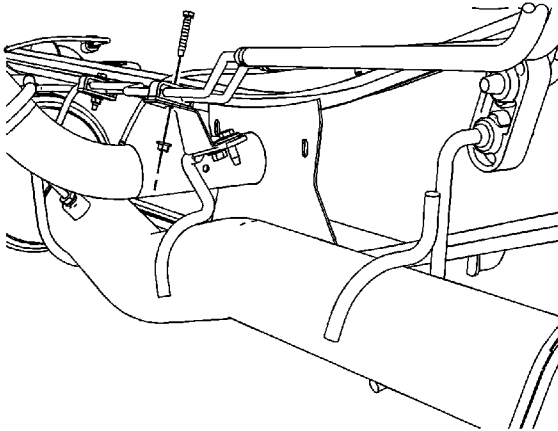
Exhaust Pressure Differential Sensor Pipe Replacement (Cab / Chassis)

Removal Procedure

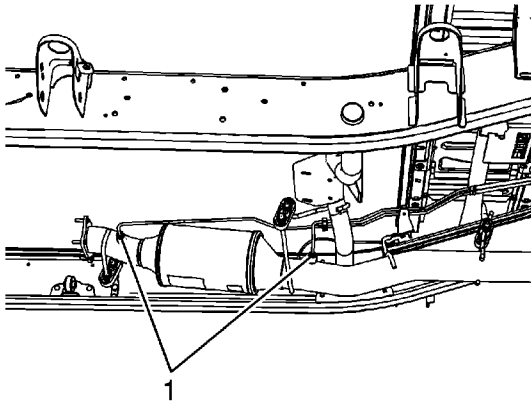
Caution: The exhaust temperature sensor and exhaust pressure differential sensor line fittings may be difficult to remove when the engine exhaust system temperature is below 48°C (120°F). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.



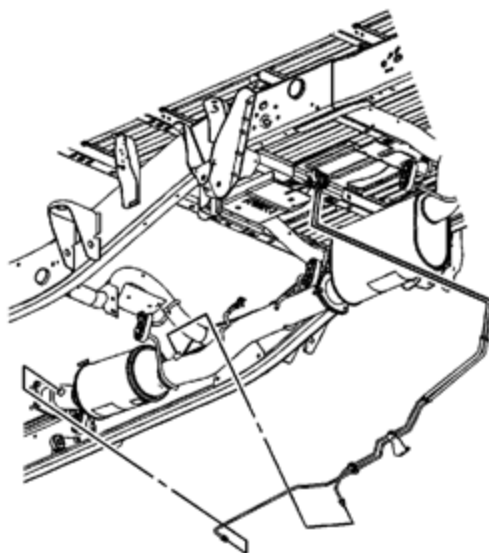
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Reposition the exhaust differential pressure sensor pipe assembly hose clamps (3).
3. Remove the exhaust differential pressure sensor pipe assembly hoses from the sensor.



4. Remove the exhaust differential pressure sensor pipe bracket bolt and nut.



5. Loosen the exhaust differential pressure sensor pipe assembly fittings (1).

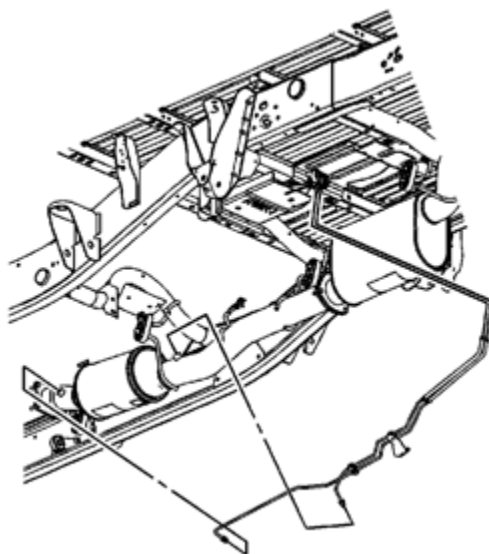


6. Remove the exhaust differential pressure sensor pipe assembly.

Installation Procedure

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

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

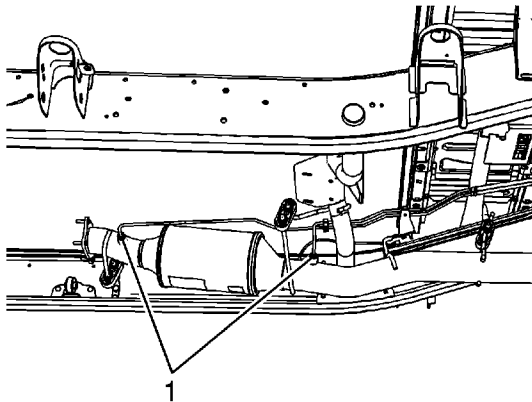




Note: Ensure to route the pipe assembly over the frame crossmember.

2. Position and install the exhaust differential pressure sensor pipe assembly to the vehicle.

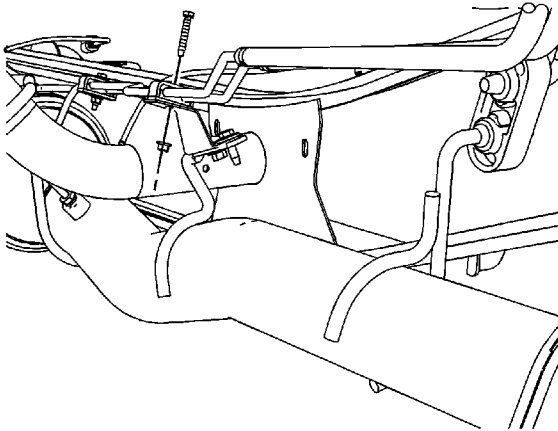
Caution: Refer to [Fastener Caution](#) in the Preface section.



3. Tighten the exhaust differential pressure sensor pipe assembly fittings (1).

Tighten

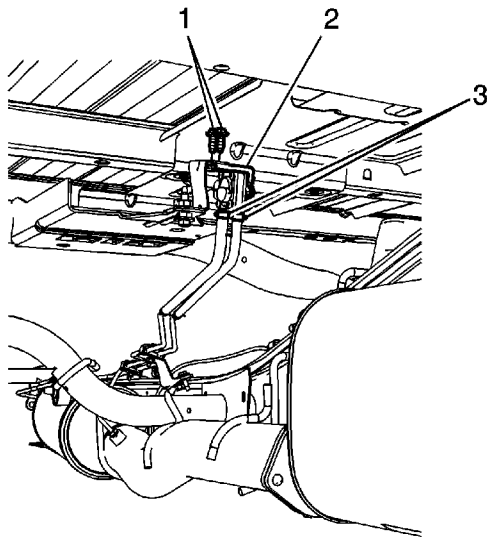
Tighten the fittings to 45 N·m (33 lb ft).



4. Position the exhaust differential pressure sensor pipe bracket to the exhaust hanger and install the bolt and nut.

Tighten

Tighten the bracket bolt/nut to 9 N·m (80 lb in).

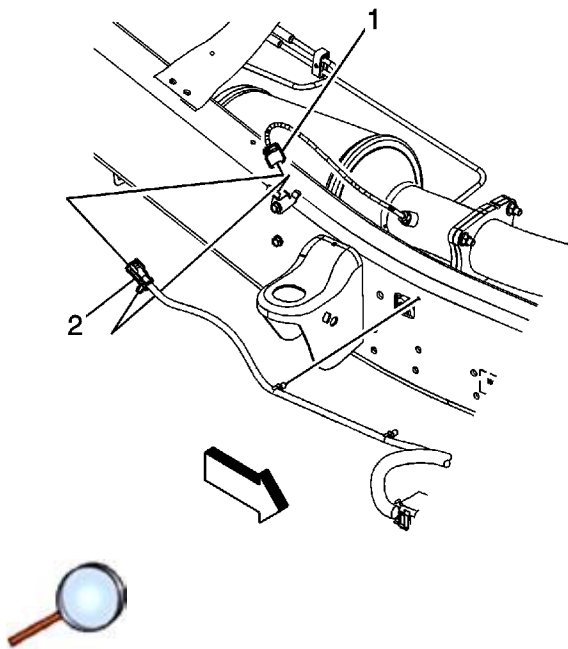


5. Install the exhaust differential pressure sensor pipe assembly hoses to the sensor.
6. Position the exhaust differential pressure sensor pipe assembly hose clamps (3).
7. Lower the vehicle.

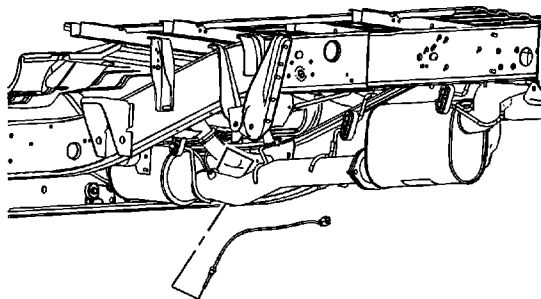
Exhaust Temperature Sensor Replacement - Position 1

Removal Procedure

Caution: The exhaust temperature sensor and exhaust pressure differential sensor line fittings may be difficult to remove when the engine exhaust system temperature is below 48°C (120°F). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.



1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the exhaust temperature sensor electrical connector (1) from the chassis wiring harness electrical connector (2).





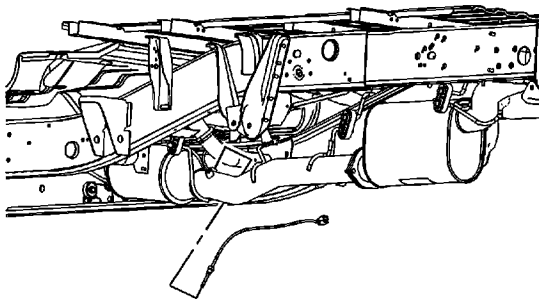
3. Remove the exhaust temperature sensor.

Installation Procedure

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

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

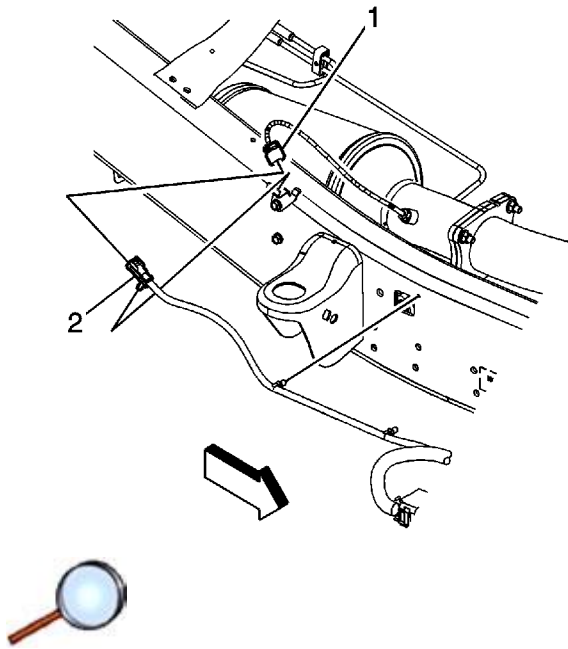
Caution: Refer to [Fastener Caution](#) in the Preface section.



2. Install the exhaust temperature sensor.

Tighten

Tighten the sensor to 45 N·m (33 lb ft).



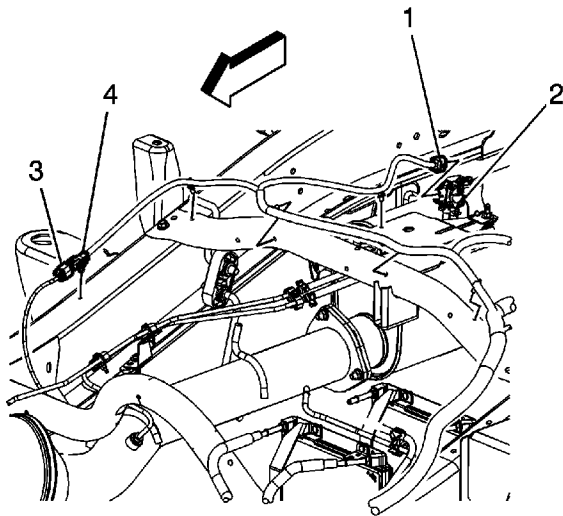
3. Connect the exhaust temperature sensor electrical connector (1) to the chassis wiring harness electrical connector (2).
4. Lower the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

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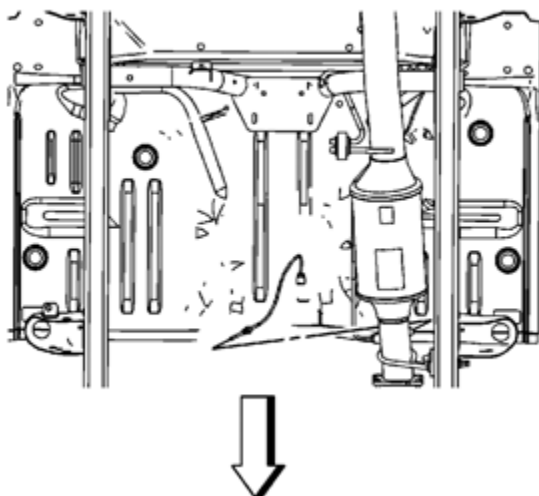
Exhaust Temperature Sensor Replacement - Position 2

Removal Procedure

Caution: The exhaust temperature sensor and exhaust pressure differential sensor line fittings may be difficult to remove when the engine exhaust system temperature is below 48°C (120°F). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.



1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Disconnect the exhaust temperature sensor (3) electrical connector from the chassis wiring harness electrical connector (4).





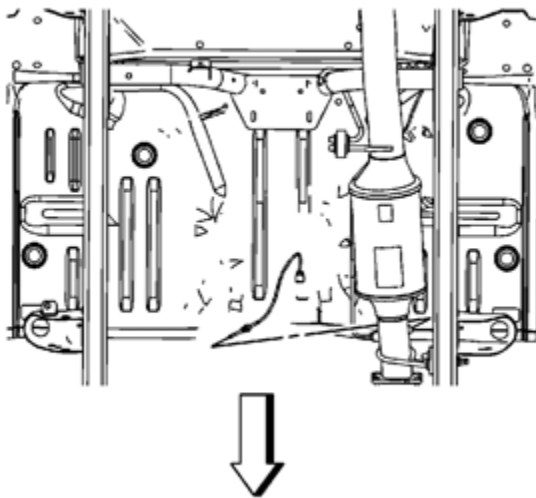
3. Remove the exhaust temperature sensor.

Installation Procedure

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

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

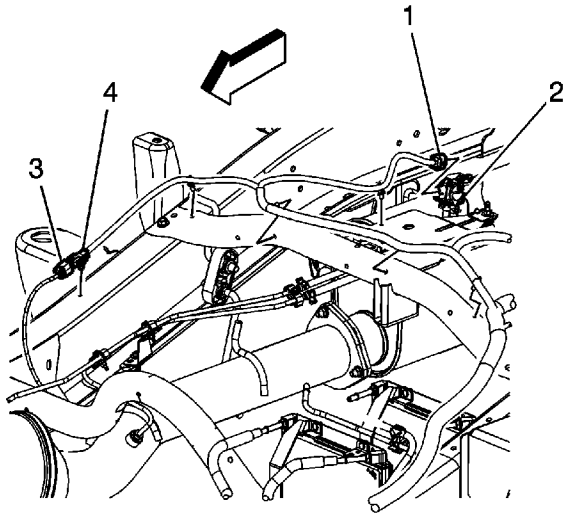
Caution: Refer to [Fastener Caution](#) in the Preface section.



2. Install the exhaust temperature sensor.

Tighten

Tighten the sensor to 45 N·m (33 lb ft).

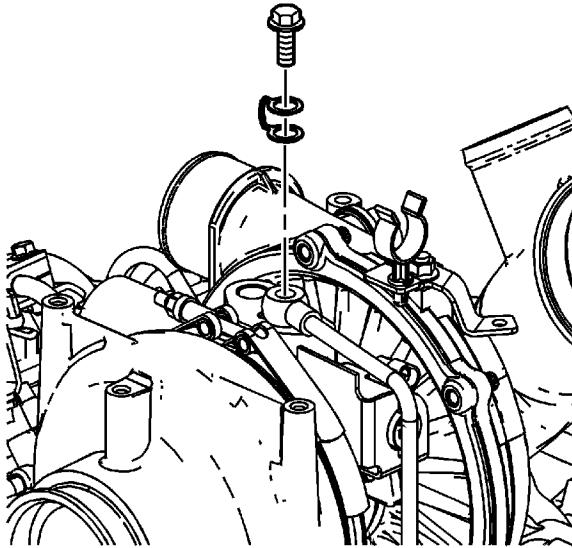


3. Connect the exhaust temperature sensor (3) electrical connector to the chassis wiring harness electrical connector (4).
4. Lower the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

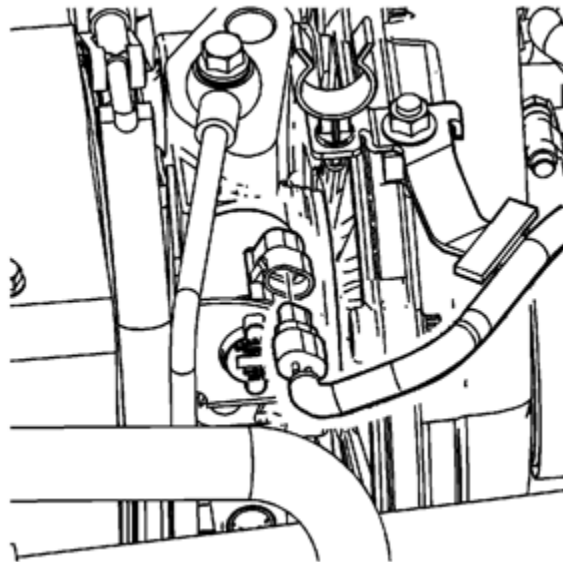
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Turbocharger Control Solenoid Valve Replacement

Removal Procedure

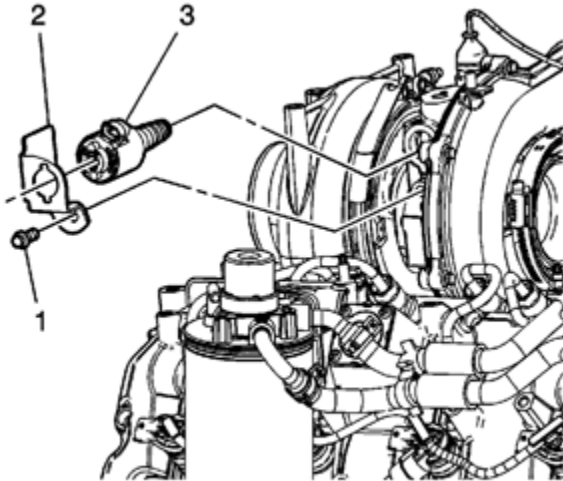


1. Remove the exhaust gas recirculation (EGR) valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
2. Remove the turbocharger oil feed pipe banjo bolt and washer.
3. Reposition the turbocharger oil feed pipe out of the way.



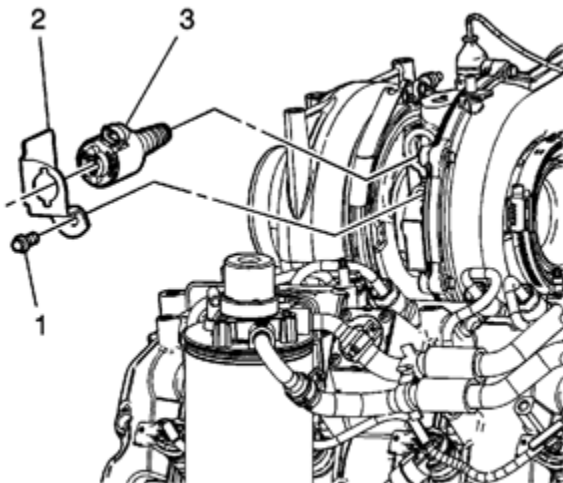
4. Disconnect the engine wiring harness electrical connector from the turbocharger vane control

solenoid valve.



5. Remove the turbocharger vane control solenoid valve bracket bolt (1) and bracket (2).
6. Remove the turbocharger vane control solenoid valve (3) from the turbocharger.

Installation Procedure



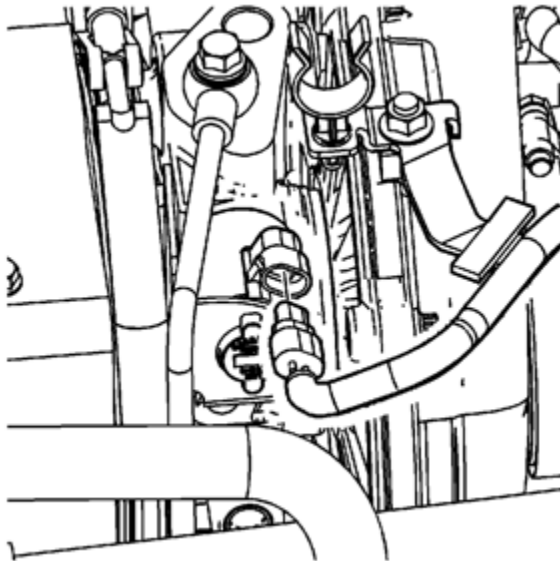
1. Install the turbocharger vane control solenoid valve (3) to the turbocharger.

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

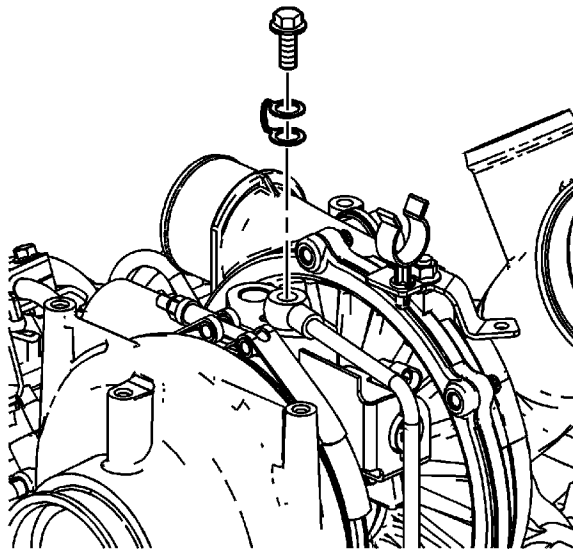
2. Install the turbocharger vane control solenoid valve bracket (2) and bolt (1).

Tighten

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



3. Connect the engine wiring harness electrical connector to the turbocharger vane control solenoid valve.



4. Position the turbocharger oil feed pipe to the turbocharger.
5. Install a NEW turbocharger oil feed pipe washer and the banjo bolt.

Tighten

Tighten the bolt to 34 N·m (25 lb ft).

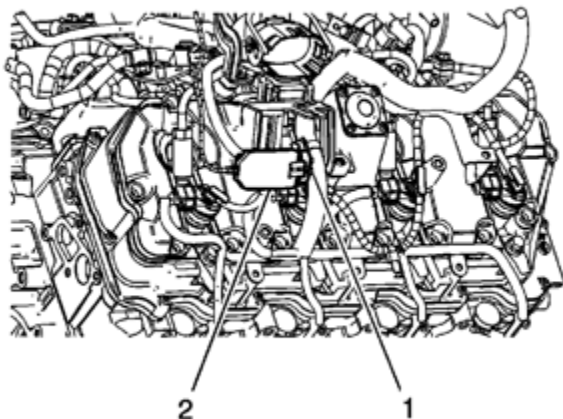
6. Install the EGR valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).

7. Perform the turbocharger learn procedure. Refer to [Turbocharger Learn](#).

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Turbocharger Vane Position Sensor Replacement

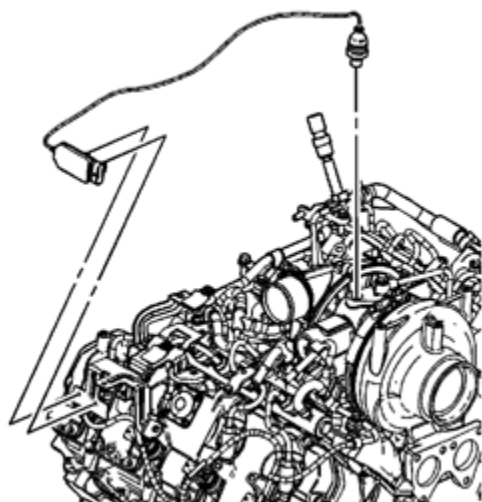
Removal Procedure



1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

Note: Note the routing of the turbocharger vane position sensor pigtail prior to removal.

2. Disconnect the engine wiring harness electrical connector (1) from the turbocharger vane position sensor electrical connector (2).

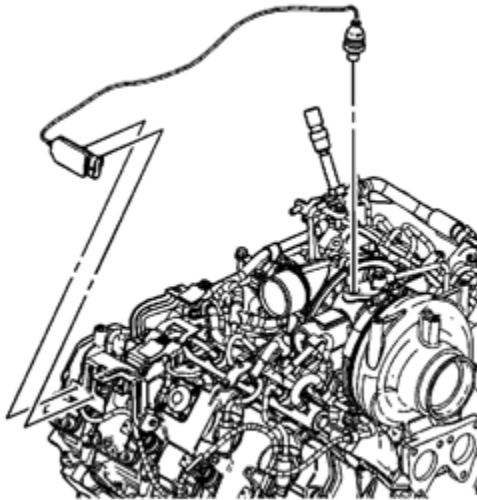




3. Remove the turbocharger vane position sensor electrical connector clips from the wiring harness bracket.
4. Remove the thermal reflective shield/tape from the vane position sensor, if required.
5. Remove the turbocharger vane position sensor from the turbocharger.

Installation Procedure

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

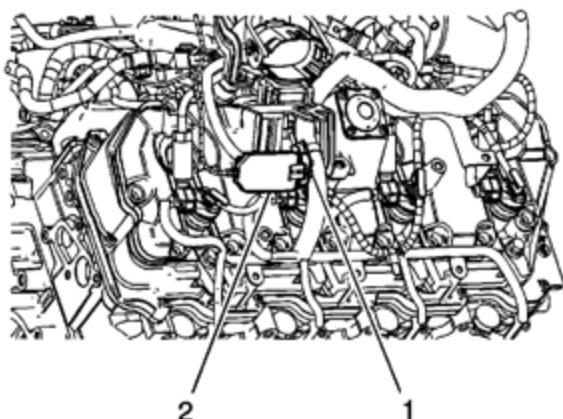


1. Install the turbocharger vane position sensor to the turbocharger.

Tighten

Tighten the sensor to 28 N·m (21 lb ft).

2. Install the turbocharger vane position sensor electrical connector clips to the wiring harness bracket.

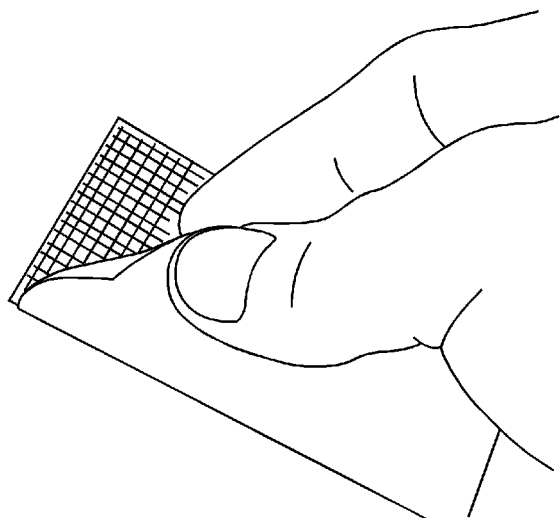


3. Connect the engine wiring harness electrical connector (1) to the turbocharger vane position sensor electrical connector (1).
4. Install the thermal reflective shield/tape, if required, refer to the following procedure.

Thermal Reflective Shield / Tape Installation

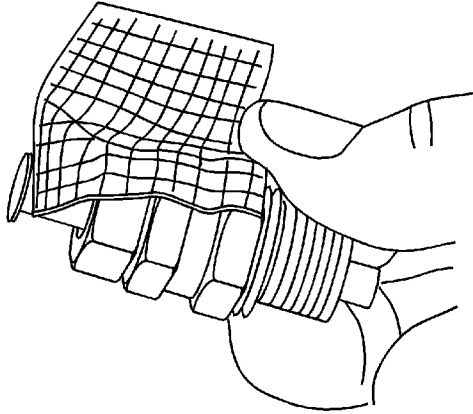
Note:

- Ensure outside surface of sensor body is clean and oil-free prior to beginning the installation procedure. If sensor body surface is oily, use a mild degreaser in order to remove the oil from the surface. Ensure degreased surface is dry prior to beginning the installation.
- The thermal reflective shield and tie strap are to be installed over the vane position sensor AFTER the sensor is installed and torqued in the turbo centerhousing. Graphics below show the sensor prior to the installation process for clarity purposes only.

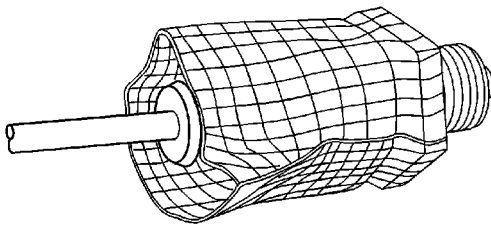




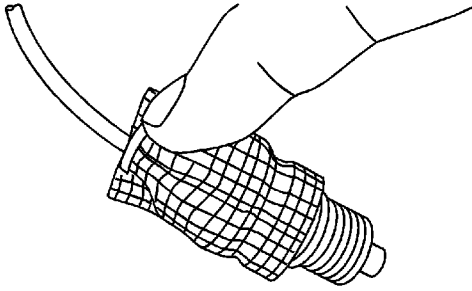
1. Peel off the protective backing from the back side of the thermal reflective shield/tape.



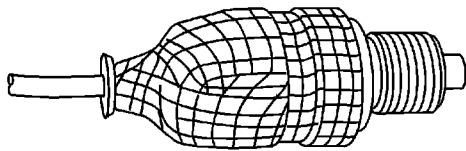
2. With the sticky side of the shield/tape applied against the sensor body, align the bottom edge of the shield/tape with the bottom edge of the hex, and begin wrapping the sensor.



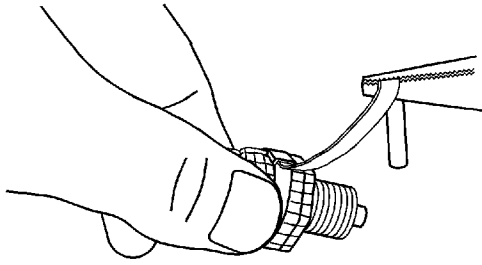
3. Completely wrap the shield/tape around the sensor.



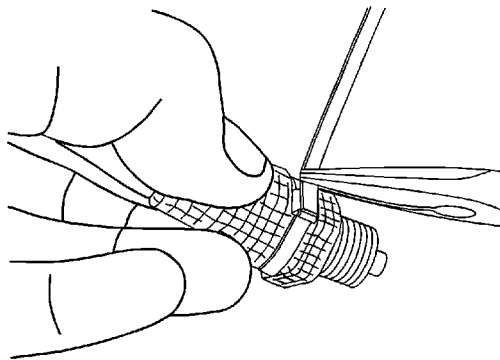
4. Tuck the top of the shield/tape under the head of the brass cable crimp sleeve all around, allowing the shield/tape to fold over and overlap itself at the top.



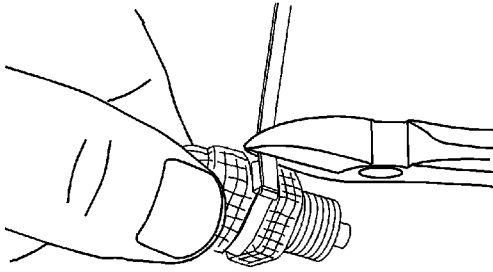
5. The top of the shield/tape is now shown tucked under the head of the brass cable crimp sleeve all around.



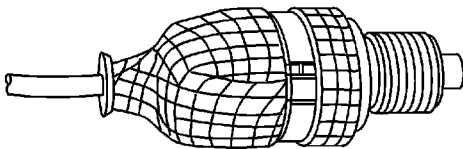
6. Wrap the tie strap around the necked porting of the sensor body just above the hex. Insert the end of the strap in the buckle and tighten by pulling the end with needlenose pliers.



7. Bend the end of the tie strap 180 degrees over the top of the buckle.



8. Cut off the tie strap using side cutters so that the cut end will lie approximately over the center of the buckle. Push down the end of the tie strap over the buckle in order to minimize protrusion of the cut end or any sharp edges.



9. Finished installation is shown.
10. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
11. Perform the turbocharger learn procedure. Refer to [Turbocharger Learn](#).

Turbocharger Learn

The engine control module (ECM) performs the turbocharger learn procedure automatically when the engine coolant temperature (ECT) is least 72°C (162°F). After each ignition cycle, and before the enable criteria have been met, the ECM will use the previously learned value. If the ECM does not have a previously learn value, it will default to a stored calibrated value. The ECM will use this value until the enable criteria have been met. It will then perform this procedure to learn the new value. If the ECM attempts to perform the turbocharger (TC) Learn procedure and fails, DTCs P003A or P2563 may set.

If a TC Learn is not performed after a related turbocharger repair, the ECM will use a stored vane position value that may be invalid. The ECM may then cause a diagnostic to fail and set an invalid DTC. Certain enable criteria must be met for the ECM to perform this procedure.

The turbocharger learn procedure is required when the following service procedures have been performed:

- TC vane position control solenoid valve replacement
- TC vane position sensor replacement
- ECM replacement
- TC replacement
- Any service that disturbs the TC components

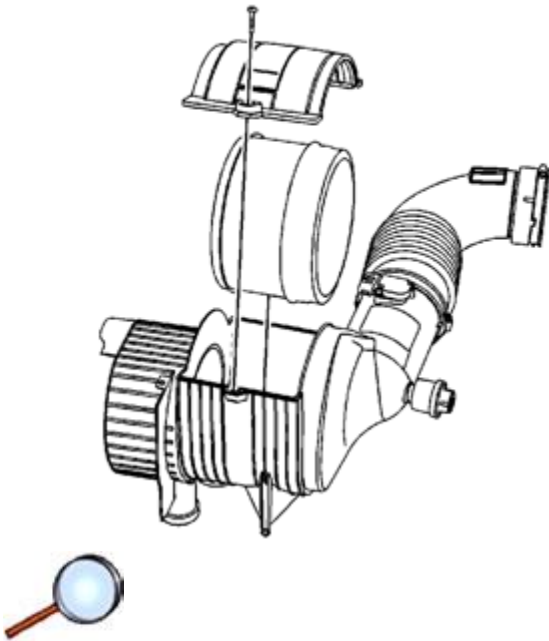
Learn Procedure With the Tech 2

Important: Once the enable conditions have been met the throttle must remain at idle. Do not change the accelerator pedal position (APP) during this procedure.

1. The following conditions must be met for the ECM to perform the turbocharger learn procedure:
 - The A/C is OFF.
 - The vehicle is in Park or Neutral.
 - Start and idle the engine.
 - The engine coolant temperature (ECT) is greater than 40°C (104°F).
2. After the enable conditions have been met and the engine idle is stabilized, enter the TC Learn Output function from the Module Setup Menu. Command the TC Learn ON for at least 5 seconds, then command it OFF. The system should have learned the new turbocharger position. The TC Vane Pos. Lrn This Run Cycle parameter should have toggled from No to Yes.

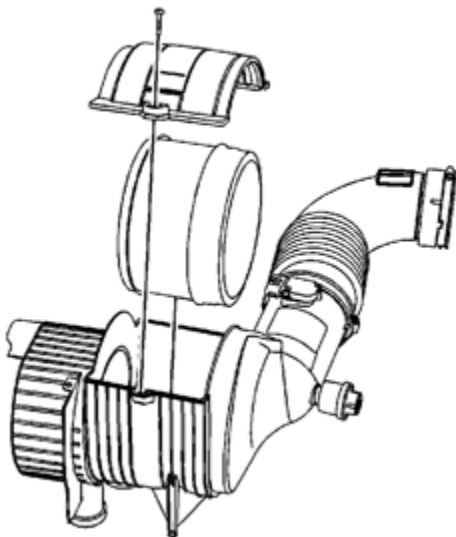
Air Cleaner Element Replacement

Removal Procedure



1. Loosen the screw holding the air cleaner housing door in place.
2. Remove the air cleaner housing door.
3. Remove the air filter element.

Installation Procedure





1. Stand facing the front fender on the passenger side of the vehicle. Insert the element into the housing. Place the palm of your hand on the inboard end of the element, and press the element into position.
2. Press both downward and inboard until the outboard end of the element clicks into place inboard of the locating tab.

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

3. Install the air cleaner housing door and tighten the screw.

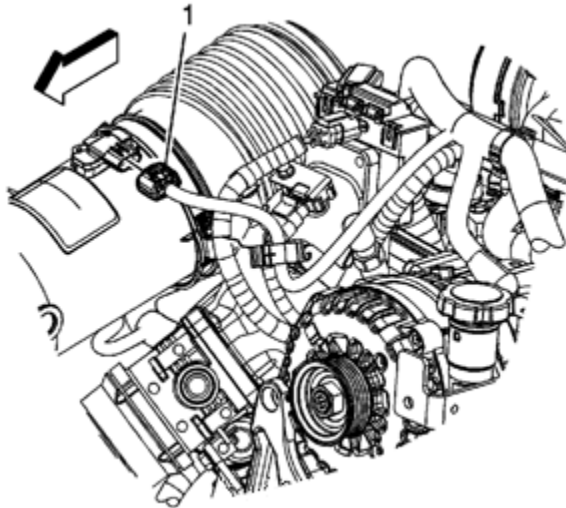
Tighten

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

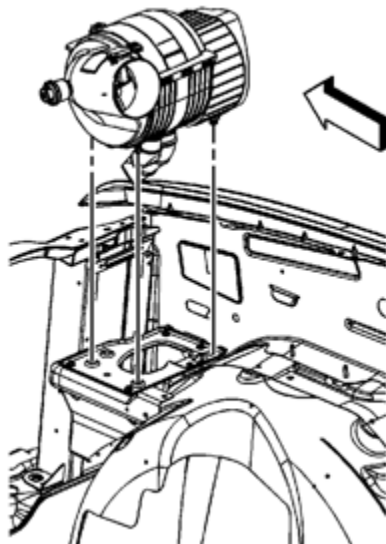
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Air Cleaner Assembly Replacement

Removal Procedure

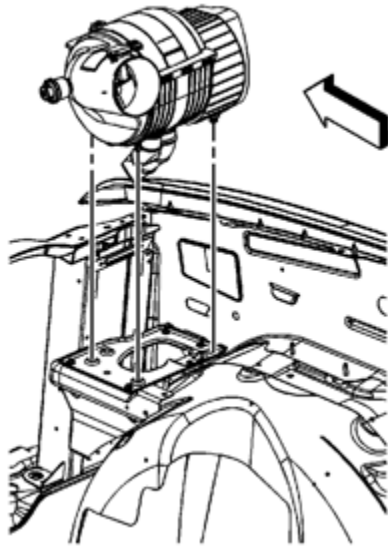


1. Disconnect the engine wiring harness electrical connector (1) from the mass air flow (MAF)/intake air temperature (IAT) sensor.
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .

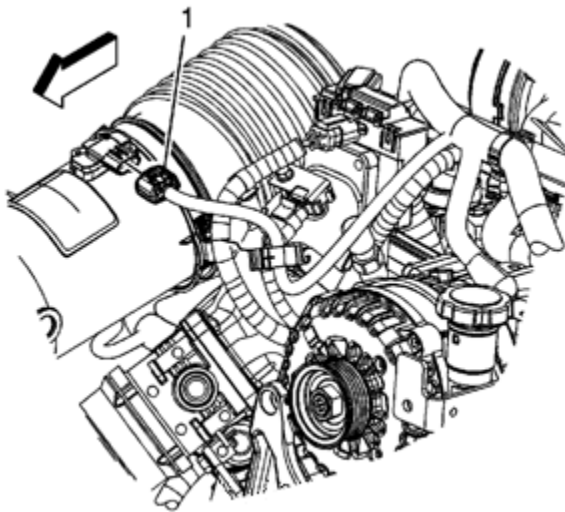


3. Grasp the air cleaner assembly and pull up on the assembly in order to disengage the retaining pins from the grommets.

Installation Procedure



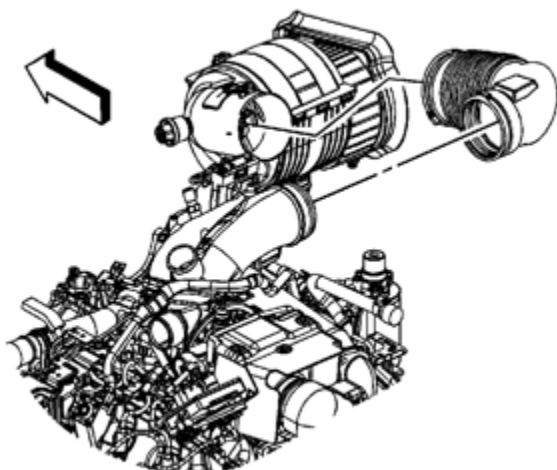
1. Line up the retaining pins with the grommets.
2. Install the air cleaner assembly until the air cleaner is seated fully on the mounts and is up against the fender apron.



3. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
4. Connect the engine wiring harness electrical connector (1) to the MAF/IAT sensor.

Air Cleaner Outlet Duct Replacement

Removal Procedure

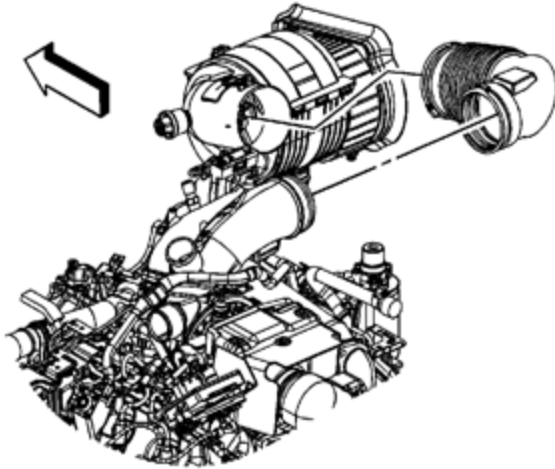


1. Loosen the outlet duct clamps at the air cleaner assembly and the turbocharger.
2. Remove the air cleaner outlet duct.

Installation Procedure

Note: The air cleaner outlet duct must be fully seated against the positive stop feature on the turbocharger inlet and also must be fully seated against the positive stop features on both sides of the air cleaner assembly.

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



1. Install the air cleaner outlet duct.
2. Tighten the outlet duct clamps at the turbocharger and the air cleaner assembly.

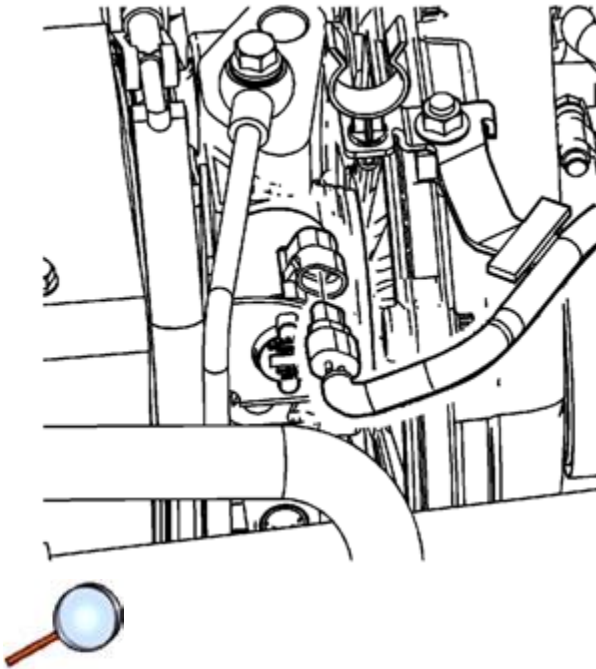
Tighten

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

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Air Intake Pipe Replacement

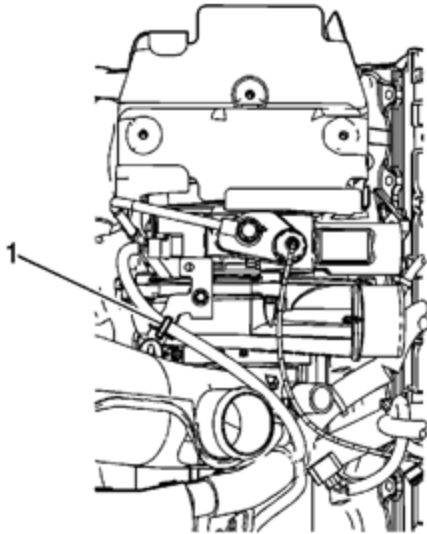
Removal Procedure



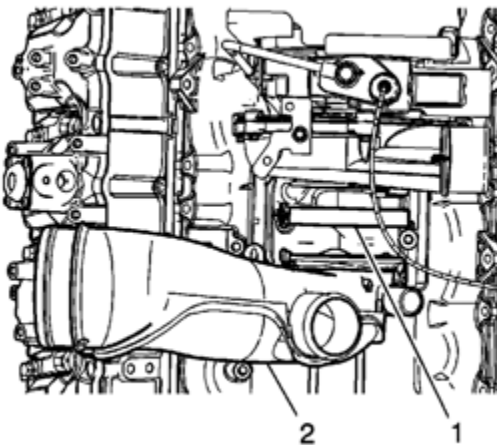
1. Remove the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

Note: It is not necessary to completely remove the PCV hose/pipe from the engine when removing the air intake pipe.

3. Remove the positive crankcase ventilation (PCV) hose/pipe from the air intake pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
4. Disconnect the engine wiring harness electrical connector from the turbocharger control solenoid valve.



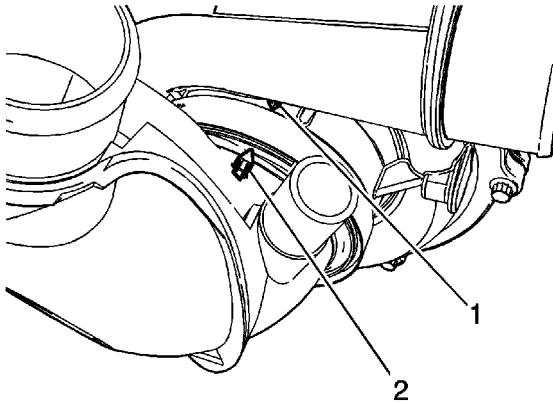
5. Remove the engine wiring harness clip (1) from the bracket on the turbocharger.
6. Reposition the turbocharger control solenoid valve wiring harness extension out of the way.



Note: The clamp for the air intake pipe uses reverse threads.

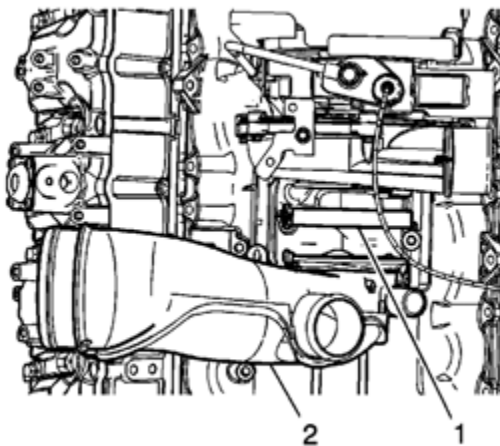
7. Loosen the air intake pipe to turbocharger clamp (1).
8. Remove the air intake pipe (2) from the turbocharger.

Installation Procedure



1. Clean the mating surfaces on the air intake pipe and the turbocharger.
2. Align the arrow (2) on the air intake pipe to the arrow (1) on the turbocharger.

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



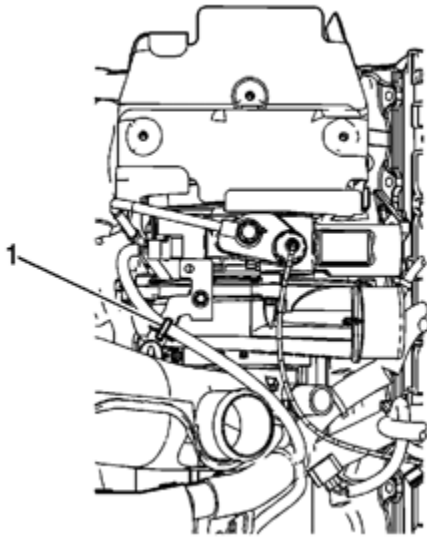
3. Install the air intake pipe (2) into the turbocharger.

Note: The clamp for the air intake pipe uses reverse threads.

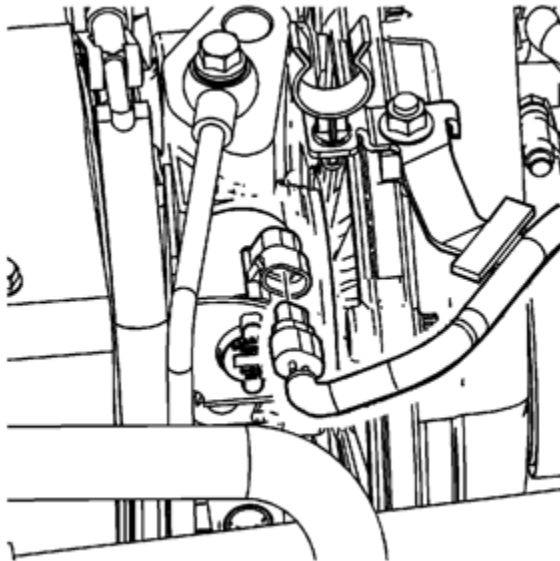
4. Tighten the air intake pipe to turbocharger clamp (1).

Tighten

Tighten the clamp to 4.6 N·m (41 lb in).



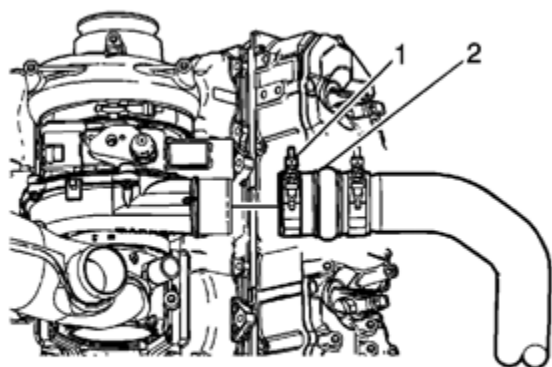
5. Route the turbocharger control solenoid valve wiring harness extension into position.
6. Install the engine wiring harness clip (1) to the bracket on the turbocharger.



7. Connect the engine wiring harness electrical connector to the turbocharger control solenoid valve.
8. Install the PCV hose/pipe to the air intake pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
9. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
10. Install the water outlet tube. Refer to [Water Outlet Tube Replacement](#).

Charge Air Cooler Inlet Pipe Replacement

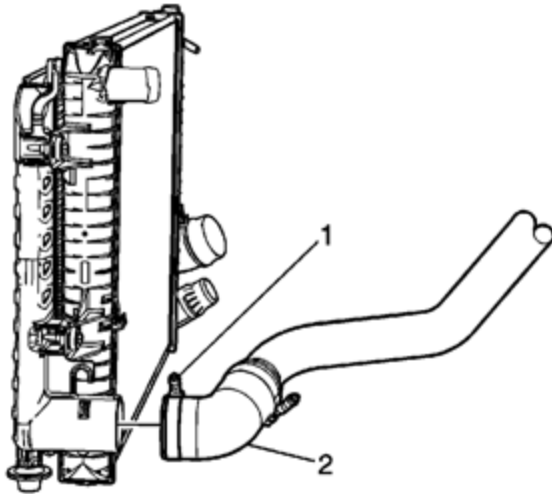
Removal Procedure



1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
2. Loosen the charge air cooler inlet pipe connector clamp (1) at the turbocharger.

Note: Do not use a screwdriver or other tool to pry the connector loose. The connector can be torn or damaged. Loosen the connector by twisting.

3. Remove the charge air cooler inlet pipe connector (2) from the turbocharger.
4. Cover the turbocharger opening with tape in order to prevent possible entry of foreign objects.
5. Remove the wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).

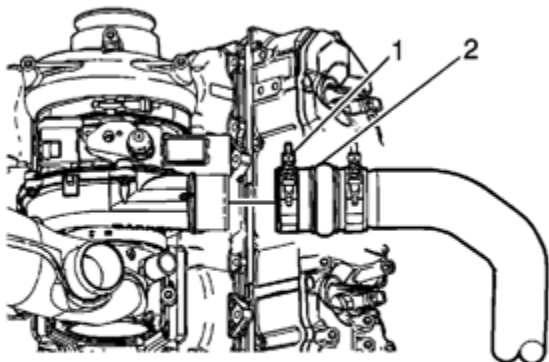


6. Working through the wheelhouse, loosen the charge air cooler inlet pipe connector clamp (1) at the charge air cooler.

Note: Do not use a screwdriver or other tool to pry the connector loose. The connector can be torn or damaged. Loosen the connector by twisting.

7. Remove the charge air cooler inlet pipe connector (2) from the charge air cooler.
8. Lower the vehicle.
9. Remove the charge air cooler inlet pipe from the vehicle.

Installation Procedure



1. Install the charge air cooler inlet pipe to the vehicle.
2. Remove the turbocharger opening cover.

Note: Do not over tighten the charge air cooler connector clamp. If the clamp is overtightened, the connector may become distorted allowing separation of the connector from the pipe. Make sure the charge air cooler pipe is properly orientated.

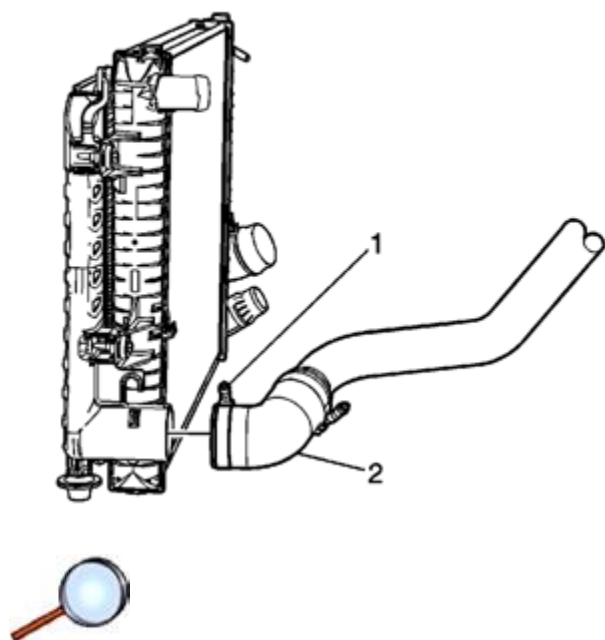
3. Install the charge air cooler inlet pipe connector (2) onto the turbocharger.

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

4. Tighten the charge air cooler inlet pipe to turbocharger connector clamp (1).

Tighten

Tighten the clamp to 8 N·m (70 lb in).



5. Raise and support the vehicle half way. Refer to [Lifting and Jacking the Vehicle](#).

Important: Do not over tighten the charged air cooler pipe connector clamp. If the clamp is overtightened, the connector may become distorted allowing separation of the connector from the pipe. Make sure the charge air cooler pipe is properly orientated.

6. Working through the wheelhouse, install the charge air cooler inlet pipe connector onto the charge air cooler.
7. Tighten the charge air cooler inlet pipe to charge air cooler connector clamp (1).

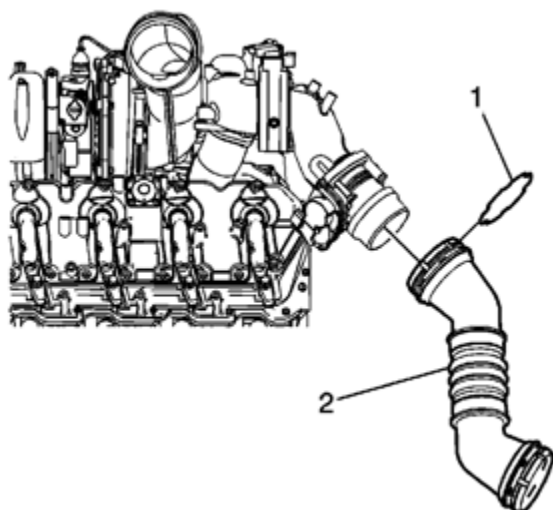
Tighten

Tighten the clamp to 8 N·m (70 lb in).

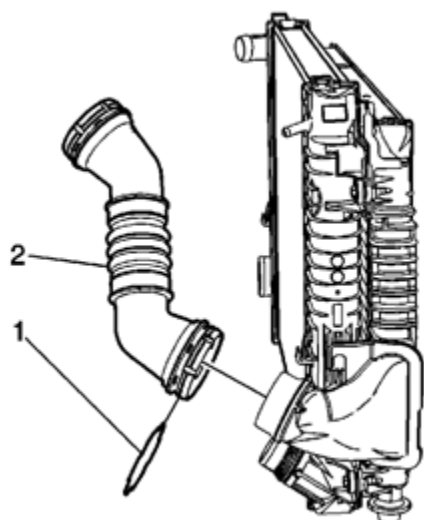
8. Install the wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).
9. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

Charge Air Cooler Outlet Pipe Replacement

Removal Procedure

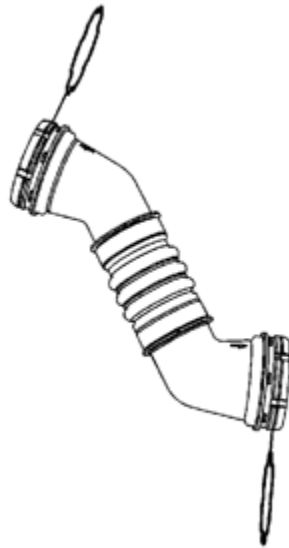


1. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .
2. Using a pick or a small flat-bladed screwdriver, remove and discard the quick connect fitting clip (1) from the charge air cooler outlet pipe.
3. Remove the charge air cooler outlet pipe (2) from the intake air heater.
4. Remove the wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#) .

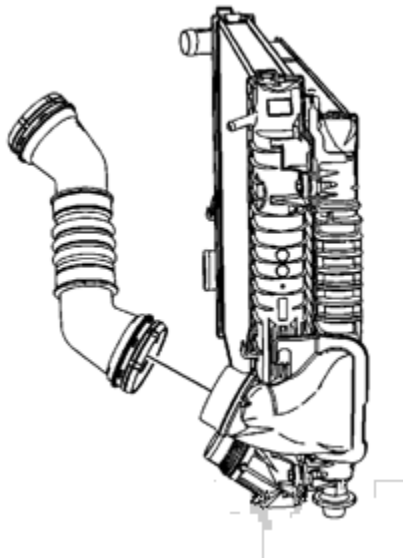


5. Working through the wheelhouse, Using the pick or a small flat-bladed screwdriver, remove and discard the quick connect fitting clip (1) from the charge air cooler outlet pipe.
6. Remove the charge air cooler outlet pipe (2) from the charge air cooler and the vehicle.

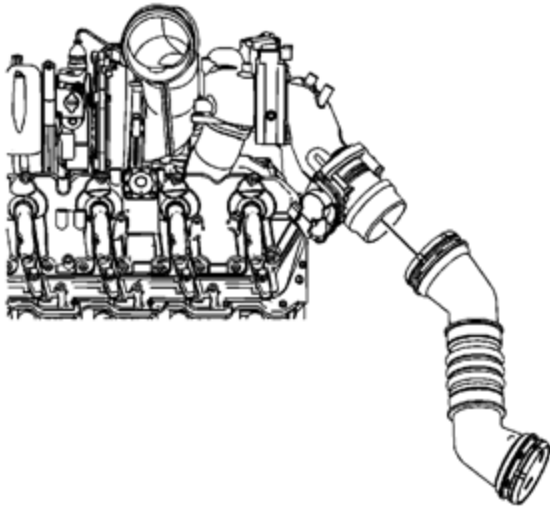
Installation Procedure



1. Install NEW quick connect fitting clips to both ends of the charge air cooler outlet pipe.



2. Working through the wheelhouse, install the charge air cooler outlet pipe onto the charge air cooler.
3. Install the wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#) .

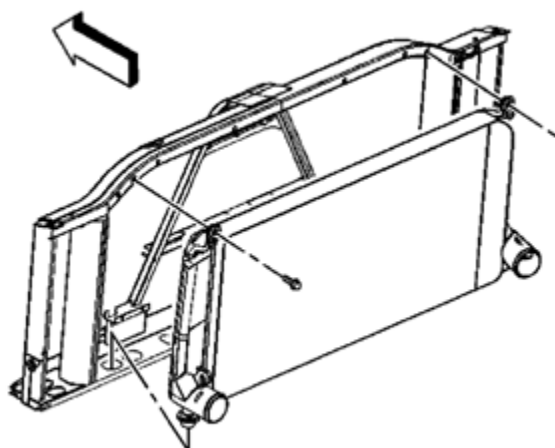


4. Install the charge air cooler outlet pipe onto the intake air valve.
5. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

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Charge Air Cooler Replacement

Removal Procedure

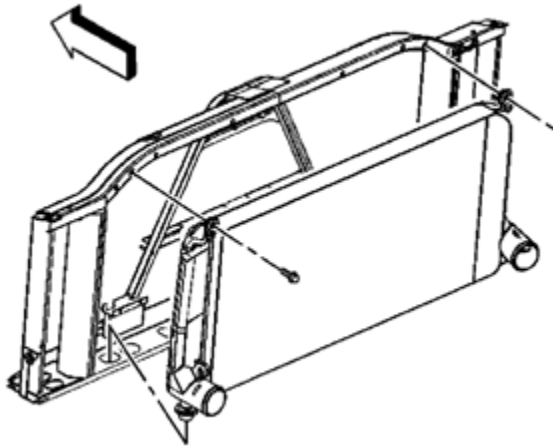


1. Remove the upper tie bar. Refer to [Front End Upper Tie Bar Replacement](#).
2. Remove the charge air cooler inlet and outlet pipes. Refer to [Charge Air Cooler Inlet Pipe Replacement](#) and [Charge Air Cooler Outlet Pipe Replacement](#).
3. Remove the radiator. Refer to [Radiator Replacement](#).
4. Remove the charge air cooler bolts.

Note: Do not damage the charged air cooler fins while removing.

5. Remove the charge air cooler.
 - 5.1. Disengage the bottom mounts from the radiator support.
 - 5.2. Remove the left side from the radiator support.
 - 5.3. Angle up the right side and rotate in order to remove.
6. Clean the charge air cooler by flushing with mild soap and water. Do not use stream pressure to clean.
7. Inspect the charge air cooler for the following damage:
 - Damaged fins
 - Cracked or distorted hose connections
 - Broken or loose welds
 - Leaks in the core or the tank connections
8. Replace the charge air cooler if damage is found.
9. Inspect the charged air cooler mounting insulators and replace if required.

Installation Proce



1. Install the charge air cooler.
 - 1.1. Angle in the left side.
 - 1.2. Slide to the left.
 - 1.3. Move in the right side.

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

- 1.4. Position bottom insulators in the radiator support.
2. Install the charge air cooler bolts.

Tighten

Tighten the bolts to 21 N·m (15 lb ft).

3. Install the radiator. Refer to [Radiator Replacement](#).
4. Install the charge air cooler inlet and outlet pipes. Refer to [Charge Air Cooler Inlet Pipe Replacement](#) and [Charge Air Cooler Outlet Pipe Replacement](#).
5. Install the upper tie bar. Refer to [Front End Upper Tie Bar Replacement](#).