

ENGINE

Fuel System

TABLE OF CONTENTS

Fuel System	6C-2
Service Precautions	6C-2
A List of Defective Phenomena	6C-7
Special Tool	6C-7
Trouble Shooting	6C-8
Fuel System Check	6C-9
Special Tool	6C-14
Fuel Filter Assembly	6C-16
Components	6C-16
Removal	6C-16
Installation	6C-16
Fuel Filter Cartridge	6C-17
Removal	6C-17
Installation	6C-17
Special Tool	6C-17
Fuel Injector	6C-18
Components	6C-18
Removal	6C-19
Installation	6C-21
Torque Specifications	6C-25
Special Tool	6C-25
Fuel Supply Pump	6C-26
Components	6C-26
Removal	6C-26
Installation	6C-27
Torque Specifications	6C-30
Fuel Rail	6C-31
Components	6C-31
Removal	6C-31
Disassembly	6C-33
Reassembly	6C-33
Installation	6C-34
Torque Specifications	6C-36
Fuel Sedimenter Switch	6C-37
Inspection	6C-37
Fuel Tank	6C-38
Components	6C-38
Removal	6C-38
Installation	6C-39
Fuel Gauge Unit	6C-40
Components	6C-40
Removal	6C-40
Inspection	6C-40
Installation	6C-41
Tightening Torque Specifications	6C-41

Fuel System

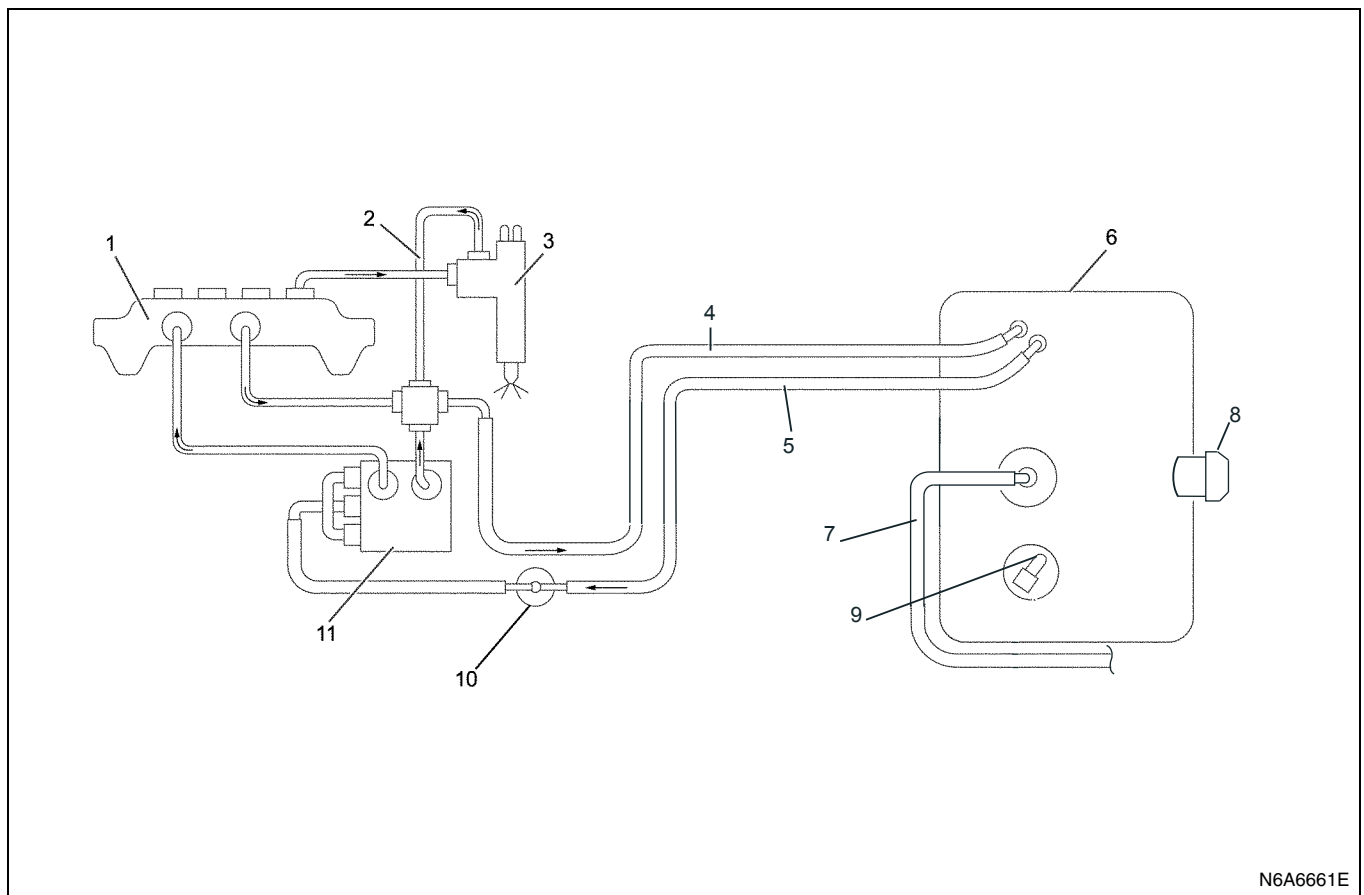
Service Precautions

Parts of the fuel system such as the internal part of the fuel injector, holes and clearances that form passages for fuel are finished to a very high degree of accuracy. They are therefore highly sensitive to foreign matter and the entry of foreign matter could cause damage to the fuel passage. Therefore, effective measures should be taken to prevent the entry of foreign matter.

If water removal agent is used in the fuel then it will absorb moisture in the light oil and may cause rust. Therefore, do not use water removal agent in the fuel tank.

Explanations on Functions and Operation

Fuel System Diagram



N6A6661E

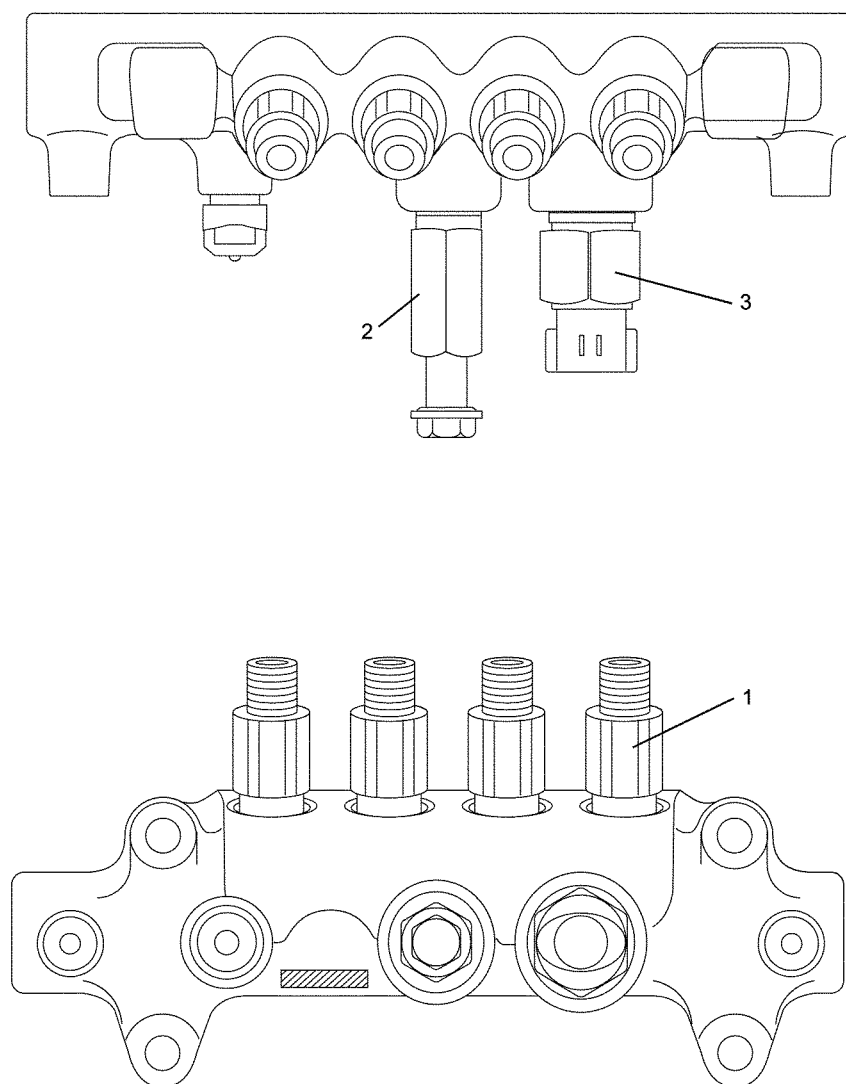
Legend

- | | |
|---------------------|---------------------------------|
| 1. Fuel Rail | 7. Ventilation Hose |
| 2. Leak-off Pipe | 8. Fuel Filler Cap |
| 3. Fuel Injector | 9. Fuel Level Sensor |
| 4. Fuel Return Pipe | 10. Fuel Filter With Sedimenter |
| 5. Fuel Feed Pipe | 11. Fuel Supply Pump |
| 6. Fuel Tank | |

Caution:

- Do not let foreign matter such as sand or dust get into fuel.
- Use gas oil for fuel, not others.

Fuel Rail



N6A6358E

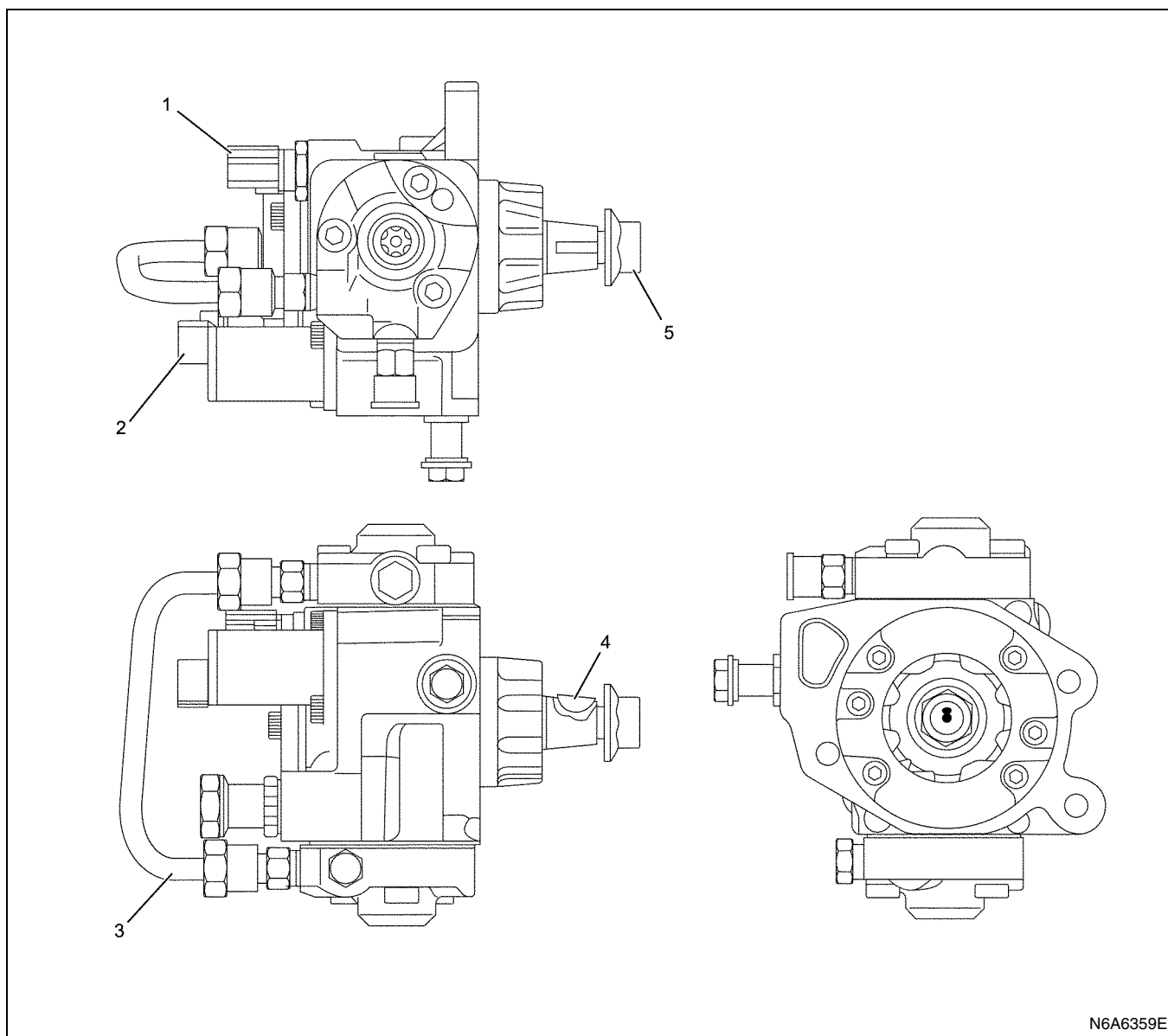
Legend

- 1. Flow Damper
- 2. Pressure Limiter

- 3. Pressure Sensor

6C-4 Fuel System

Fuel Supply Pump

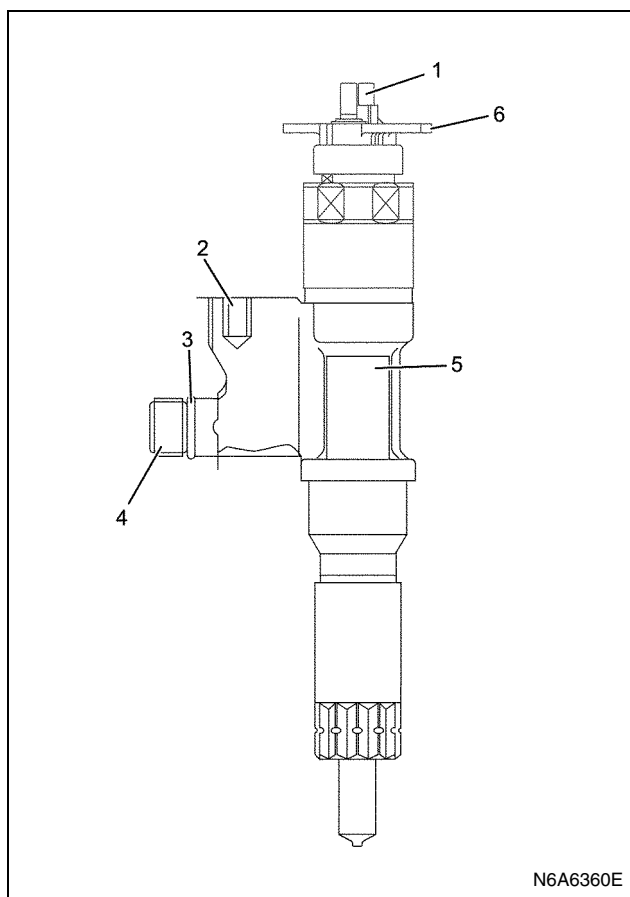


N6A6359E

Legend

- | | |
|---------------------------------|-----------------|
| 1. Fuel Temperature Sensor | 4. Camshaft Key |
| 2. Fuel Rail Pressure Regulator | 5. Camshaft Nut |
| 3. High Pressure Piping | |

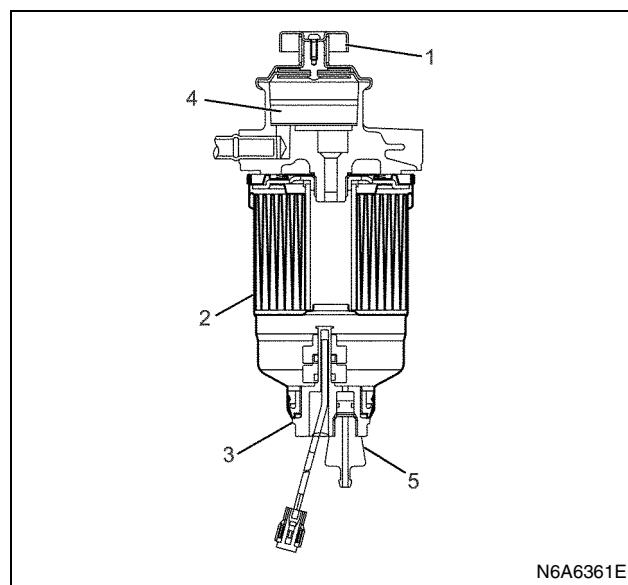
Fuel Injector



Legend

1. Terminal Stud
2. Fuel Leak-off Port
3. O-ring
4. Fuel Inlet Port
5. Injector Parts Number Marking
6. Fuel Injector ID Plate

Fuel Filter

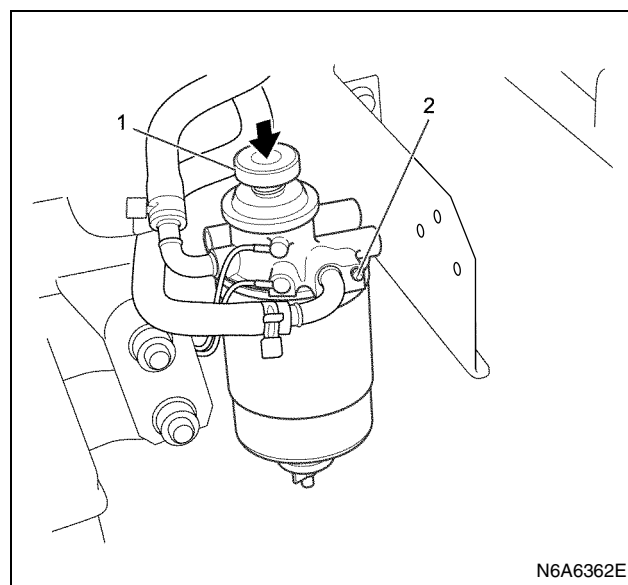


Legend

1. Priming Pump
2. Cartridge
3. Sensor
4. Heater
5. Drain Plug

Functional check

Air bleeding



Legend

1. Priming Pump
2. Air Bleed Plug

1. Before starting the engine
 - a. Fit a tray below the fuel filter (below the air bleed plug).
 - b. Loosen the plug adequately and operate the priming pump more than 20 times until the fuel overflows from the plug hole.

6C-6 Fuel System

- c. Tighten the plug, and operate the priming pump more than 10 times until it is filled with fuel. After waiting for approximately a minute, loosen the plug and bleed off the air in the fuel filter. (This work must be repeated a minimum of three times until no more air comes out from the plug.)
 - d. Tighten the plug firmly and wipe the fuel in the surrounding area. Operate the priming pump (10 to 15 times) till it is filled with fuel and then send fuel to the engine.
2. After starting the engine
 - a. Start the engine by rotating the starter without depressing the accelerator pedal.
 - b. After starting, maintain the idling rotation for 5 seconds.
 - c. Slowly rotate the idling control knob clockwise and maintain it for 3 minutes.
 - d. Fully depress the accelerator pedal and increase the rotations to maximum. (Repeat this operation several times)
 - e. Rotate the idling knob counterclockwise and return to idling mode.

Caution:

If the air bleeding work is insufficient then it could lead to faults in the engine. Therefore, the procedures after starting the engine should always be implemented.

Water drain

A warning lamp will light up if water is collected more than fixed quantity in the sedimenter. If the warning lights up, drain out the water by following operations:

- Fit a tray below the fuel filter.
- Loosen the drain plug.
- Operate the priming pump several times to discharge the water.
- Tighten the drain plug after discharging the water.
- Operate the priming pump several times and check for fuel leakage.
- Check that the warning lamp in the meter is off.

Fuel system vacuum check

Use this procedure to measure the vacuum (negative pressure) discharge side the fuel system.

Important:

The fuel pressure/vacuum gauge assembly (gauge (1)) and the fuel pressure/vacuum gauge adapter (adapter (5)) must be cleaned before connect to the fuel line. Otherwise, foreign material adherent to the tools may damage the fuel supply pump.

1. Disconnect the fuel hose from the fuel filter housing. (fuel supply pump side).

2. Install the adapter.

Special tool

Fuel Pressure/Vacuum Gauge Set:
5-8840-2844-0

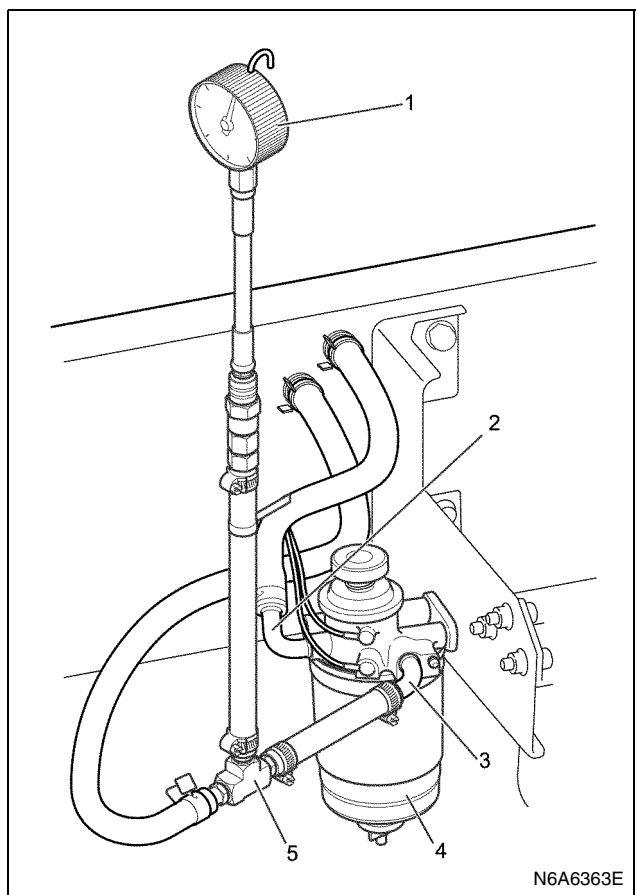
(Fuel pressure/vacuum gauge adapter:
EN-47667)

3. Connect the gauge (1) with hose to the adapter (5).

Special tool

Fuel Pressure/Vacuum Gauge Set:
5-8840-2844-0

(Fuel pressure/vacuum gauge assembly:
J-44638)



Legend

1. Fuel Pressure/Vacuum Gauge Assembly
2. Fuel Pipe (Intake Side)
3. Fuel Pipe (Discharge Side)
4. Fuel Filter
5. Fuel Pressure/Vacuum Gauge Adapter

4. Loosen the air bleeding plug on the supply pump.
5. Use your hand to operate the fuel filter priming pump. Operate the pump until all the air has been bled from the system.
6. Start the engine and allow it to idle.

7. Note the gauge (1) reading. If the reading is normal, go to Step 8. If the fuel vacuum is greater than the specified value, there is a problem in the fuel system. Perform the procedures outlined below.

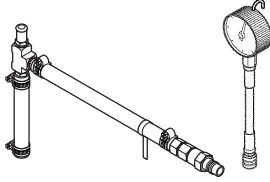
Standard fuel vacuum: Less than 5 inHg

- Replace the cartridge fuel filter element.
- Check the fuel delivery pipe. If it is clogged, it must be replaced.
- Remove the fuel pipe at the fuel filter inlet. Use high-pressure air forced through the fuel pipe to clean the fuel system.

Caution:

- Remove the fuel filler cap before applying high-pressure air.
- Do not perform this procedure if the fuel tank is nearly full (fuel approaching or flowing into the fuel filler neck). The forced air will spray fuel from the fuel filler neck.

Special Tool

Illustration	Tool Number / Description / Remarks
 5884028440	5-8840-2844-0 Fuel Pressure / Vacuum Gauge Set (J-44638 [Fuel Pressure / Vacuum Gauge Assembly] EN-47667 [Suction Side Fuel Pressure / Vacuum Gauge Adapter])

8. Remove the gauge (1) and hose from the adapter (5).
9. Remove the adapter (5).
10. Connect the fuel hose.
11. Use your hand to operate the fuel filter priming pump. Operate the pump until all the air has been bled from the system.
12. Start the engine and allow it to idle.
13. Inspect the fuel system for fuel leakage.

A List of Defective Phenomena

- Problems with starting
- Hunting during idling
- Insufficient horsepower
- Maximum engine speed is too low
- Engine does not stop
- Exhaust gas is blue or black.

6C-8 Fuel System

Trouble Shooting

Problems with starting

Condition	Possible Cause	Correction
Problems with starting	Fuel tank is empty	Fill the tank.
	Air has entered the fuel system.	Bleed the air.
	Fuel line is clogged or damaged. Connection to the fuel line is loose.	Repair or replace the fuel line. Re-tighten the connection.
	Fuel filter element is clogged.	Replace the cartridge.
	Fault in the feed pump	Replace the fuel supply pump.
	Regulating valve is open.	Replace.
	Sticking of the fuel injector nozzle	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Unstable idling

Condition	Possible Cause	Correction
Hunting during idling	Air has entered the fuel system.	Bleed air from the fuel system.
	Leakage or clogging of the fuel system	Repair or replace the fuel system.
	Water particles or foreign matter in the fuel system.	Replace the fuel.
	Fuel filter element is clogged.	Replace the fuel filter element (cartridge).
	Sticking of the fuel injector nozzle	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Insufficient power

Condition	Possible Cause	Correction
Insufficient horsepower	Air has entered the fuel system.	Bleed air from the fuel system.
	Leakage or clogging of the fuel system	Repair or replace the fuel system.
	Water mixes in the fuel system	Replace the fuel.
	Fuel filter element is clogged.	Replace the element or the cartridge.
	Sticking of the fuel injector nozzle	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Maximum engine speed is too low

Condition	Possible Cause	Correction
Maximum engine speed is too low	Fuel line is clogged or damaged.	Repair or replace the fuel line.
	Defective engine control system	Diagnose the engine control system.

Engine does not stop

Condition	Possible Cause	Correction
Engine does not stop	Defective engine control system	Diagnose the engine control system.

Exhaust gas is blue or black

Condition	Possible Cause	Correction
Exhaust gas is blue or black.	Reduction in injection-valve opening pressure or defective atomizing status	Replace the fuel injector.
	Engine control system malfunction	System diagnosis.

Fuel System Check

Description

The common rail fuel system is comprised of two fuel Pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.

The Fuel System Check diagnostic table directs the service technician to the appropriate fuel system diagnosis. The diagnostic table assumes the following conditions are met:

- The batteries are completely charged.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no air in the fuel line.

Diagnostic Aids

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load.
- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted. Perform bleeding of fuel system after refilling.

Step	Action	Value(s)	Yes	No
1	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Diagnostic Trouble Code (DTC) Information of the engine control module with a Tech 2. Are any DTC(s) set?	—	Refer to Applicable DTC in Engine Control Section	Go to Step 2

6C-10 Fuel System

Step	Action	Value(s)	Yes	No
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak: • Fuel supply pump • Fuel rail • Pressure limiter valve • Flow damper valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts Notice: Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel in the engine oil. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 3
3	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. Notice: The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load. 3. Pump the priming pump on the fuel filter until it becomes firm .If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Make sure the fuel tank(s) have adequate fuel and the fuel quality is good (take a sample). 2. Bleed the air from the fuel system as necessary. Refer to Fuel System Air Bleeding in this section. 3. Start the engine and let idle. If the engine does not start, continue to crank. 4. Observe the Differential Fuel Rail Pressure parameter with the Tech 2 while cranking over the engine or running the engine. Is the Differential Fuel Rail Pressure parameter within the specified value?	$\pm 5\text{MPa}$ $\pm(725\text{ psi})$	System OK	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the fuel injector in-line harness connector (H-125) from the cylinder head cover case. 3. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. Important: The fuel vacuum pump/pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 4. Connect the suction side fuel pressure adapter 5-8840-2844-0 (EN-47667) with fuel vacuum/pressure gauge assembly 5-8840-2844-0 (J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 5. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Perform procedure three times. 6. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 7. Crank over the engine (for no longer than 15 seconds) while monitoring the fuel pressure/vacuum gauge. Notice: Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 8	Go to Step 6

6C-12 Fuel System

Step	Action	Value(s)	Yes	No
6	1. Inspect the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 2. Draw fuel from the fuel tank at the fuel line going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0 (J-23738-A) with a clear hose or equivalent) This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 7
7	1. Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in this section. 2. Retest the fuel system vacuum test described in Step 5. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 18	Go to Step 17
8	1. Unclamp or unplug the fuel line from Step 5 and reconnect the fuel line. 2. Prime the priming pump until firmness is felt. 3. Crank over the engine for 5 seconds. 4. Repeat steps 2 and 3 three times to bleed the fuel system. 5. Crank over the engine (for no longer than 15 seconds at a time) while monitoring the fuel pressure/vacuum gauge. Does the vacuum/pressure gauge ever indicate a larger than the specified value?	5 inHg	Go to Step 9	Go to Step 10
9	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect the fuel tank vent hose for a plugged or kinked condition. 3. Inspect the fuel cap for a plugged or kinked condition. 4. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 5. Repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Make sure the fuel injector in-line harness connector (H-125) is disconnected from the cylinder head cover case. 3. Remove the eyebolt from the cylinder head that connects to the leak-off pipe. 4. Connect the fuel adapter 5-8840-2845-0 (J-45873-103) with hose assembly to the cylinder head. Install the hose into a graduated cylinder from the 5-8840-2845-0 (J-45873-100) kit. 5. Remove the eyebolt from the pressure limiter valve that connects to the leak-off pipe. 6. Connect the fuel adapter 5-8840-2845-0 (J-45873-105) with hose assembly to the pressure limiter valve. 7. Crank over the engine for 10 seconds. Make sure the batteries are fully charged and the engine is cranking at normal speed for each test. Notice: Perform this test three times and take the average of the fuel return amount coming from the cylinder head. Is fuel leaking from the pressure limiter valve?	—	Go to Step 15	Go to Step 11
11	Is the average fuel return coming from the cylinder head less than the specified value?	15ml	Go to Step 12	Go to Step 13
12	1. Remove each glow plug from the cylinder head. 2. Inspect the tip of the plugs for wet fuel. Did you find wet fuel on any glow plug?	—	Go to Step 16	Go to Step 17
13	1. Remove the cylinder head cover and injector harness in order to connect the fuel adapter 5-8840-2845-0 (J-45873-101) with hose assembly to each injector leak-off port. Refer to Fuel Injector Replacement in this section. 2. Crank over the engine for 10 seconds. Important: Replacement injector must be programmed. 3. Replace the injector(s) that return fuel more than the specified value. Refer to Fuel Injector Replacement/Fuel Injector ID Code Data Programming in this section. 4. Retest after replacement of the fuel injector(s). Did you complete the replacement?	3ml	Go to Step 18	—

6C-14 Fuel System

Step	Action	Value(s)	Yes	No
14	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
15	Replace the pressure limiter valve. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
16	Important: Replacement injector must be programmed. Replace the appropriate injector(s) that was leaking fuel found at Step. Refer to Fuel Injector Replacement/Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 18	—
17	Important: The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. Replace the fuel supply pump. Refer to Fuel Supply Pump Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
18	1. Reconnect all previously disconnected harness connector(s) or components. 2. Turn OFF the ignition for 30 seconds. 3. Bleed the air from the fuel system. Refer to Fuel System Air Bleeding in this section. 4. Start the engine and let idle. 5. Observe the Differential Fuel Rail Pressure parameter with the Tech 2. Is the Differential Fuel Rail Pressure parameter within the specified value?	± 5 MPa (± 725 psi)	System OK	Go to Step 1

Special Tool

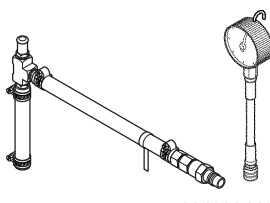
Illustration	Tool Number / Description
 5884028440	5-8840-2844-0 Fuel Pressure / Vacuum Gauge Set (J-44638 [Fuel Pressure / Vacuum Gauge Assembly] EN-47667 [Suction Side Fuel Pressure / Vacuum Gauge Adapter])

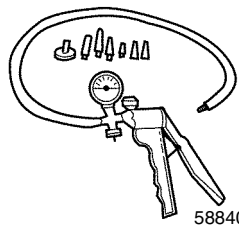
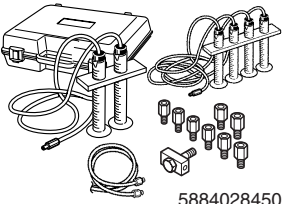
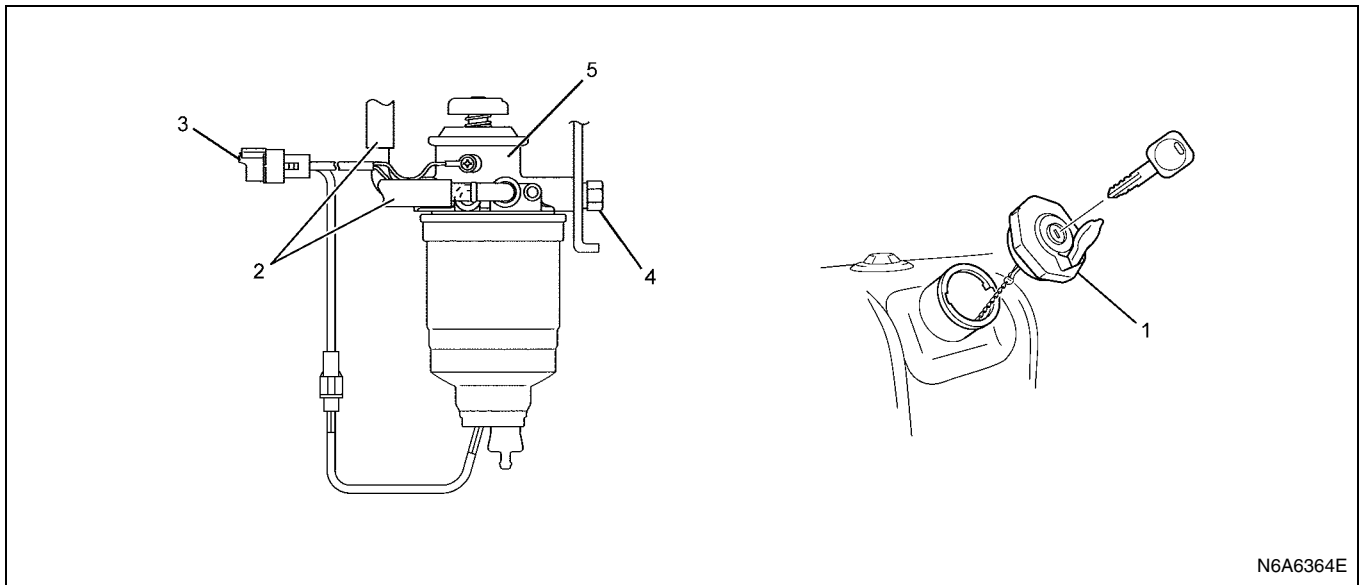
Illustration	Tool Number / Description
 5884002790	5-8840-0279-0 (J-23738-A) Vacuum Pump

Illustration	Tool Number / Description
 5884028450	5-8840-2845-0 Fuel Test Adapter Set (J-45873 / Fuel Test Adapter Kit, J-45873-100 / Fuel Test Adapters)

Fuel Filter Assembly

Components



Legend

- | | |
|------------------------------|-------------------------|
| 1. Filler Cap | 4. Bolt |
| 2. Fuel Hose | 5. Fuel Filter Assembly |
| 3. Fuel Sedimenter Connector | |

Removal

1. Remove the filler cap.
2. Remove the fuel sedimenter connector and the clip on the bracket.
3. Remove the feed hose and the return hose from the fuel filter and plug it so that the fuel does not flow out.
4. Remove the bolts for mounting the fuel filter.
5. Remove the fuel filter assembly.

Installation

1. Install the fuel filter assembly.
2. Install the bolts for mounting the fuel filter.
3. Install the inlet hose and the outlet hose.
4. Install the fuel sedimenter and clip the cable to the bracket.
5. Install the filler cap.
6. Bleed out the air.
 - Refer to "Fuel System/Air bleeding".

Fuel Filter Cartridge

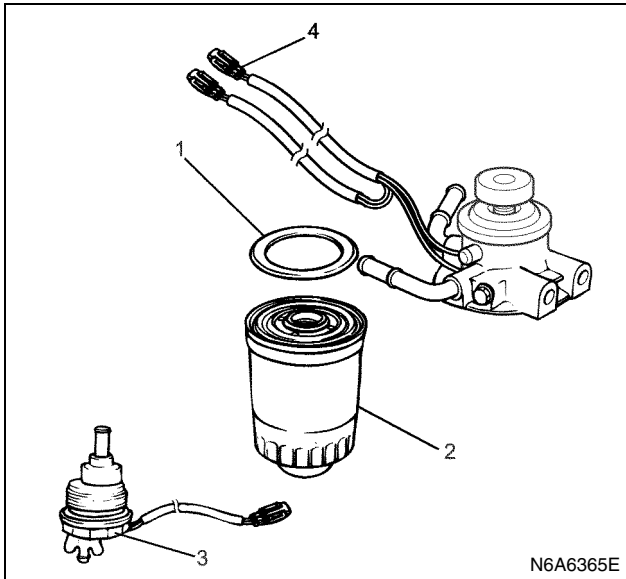
Removal

1. Remove the cartridge using the filter wrench.

Special tool

Filter wrench: 5-8840-0253-0 (J-22700)

2. Remove the sedimenter sensor.



Legend

1. O-Ring
2. Cartridge
3. Sedimeter Sensor
4. Fuel Heater Connector

Installation

1. Assemble the sedimenter sensor in the new cartridge.

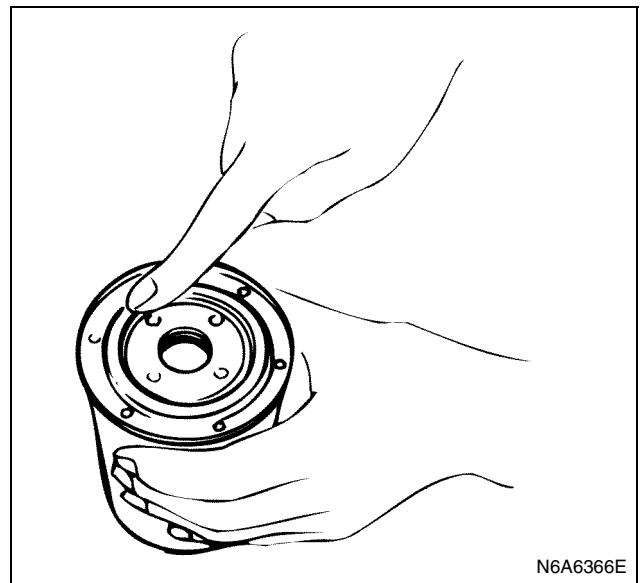
Special Tool

Illustration	Tool Number / Description / Remarks
 5884002530	5-8840-0253-0 (J-22700) Filter Wrench

2. Clean the cartridge mounting surface in the filter body so that the cartridge can be seated securely.
3. Coat a thin layer of fuel on the O-ring in the new cartridge.
4. To simplify air bleed, fill light oil on the new cartridge.
5. Tighten the cartridge until the O-ring touches the sealing surface. During this process take adequate care that the fuel inside does not flow out.
6. Use the filter wrench and tighten rotating by 1/3 to 2/3.

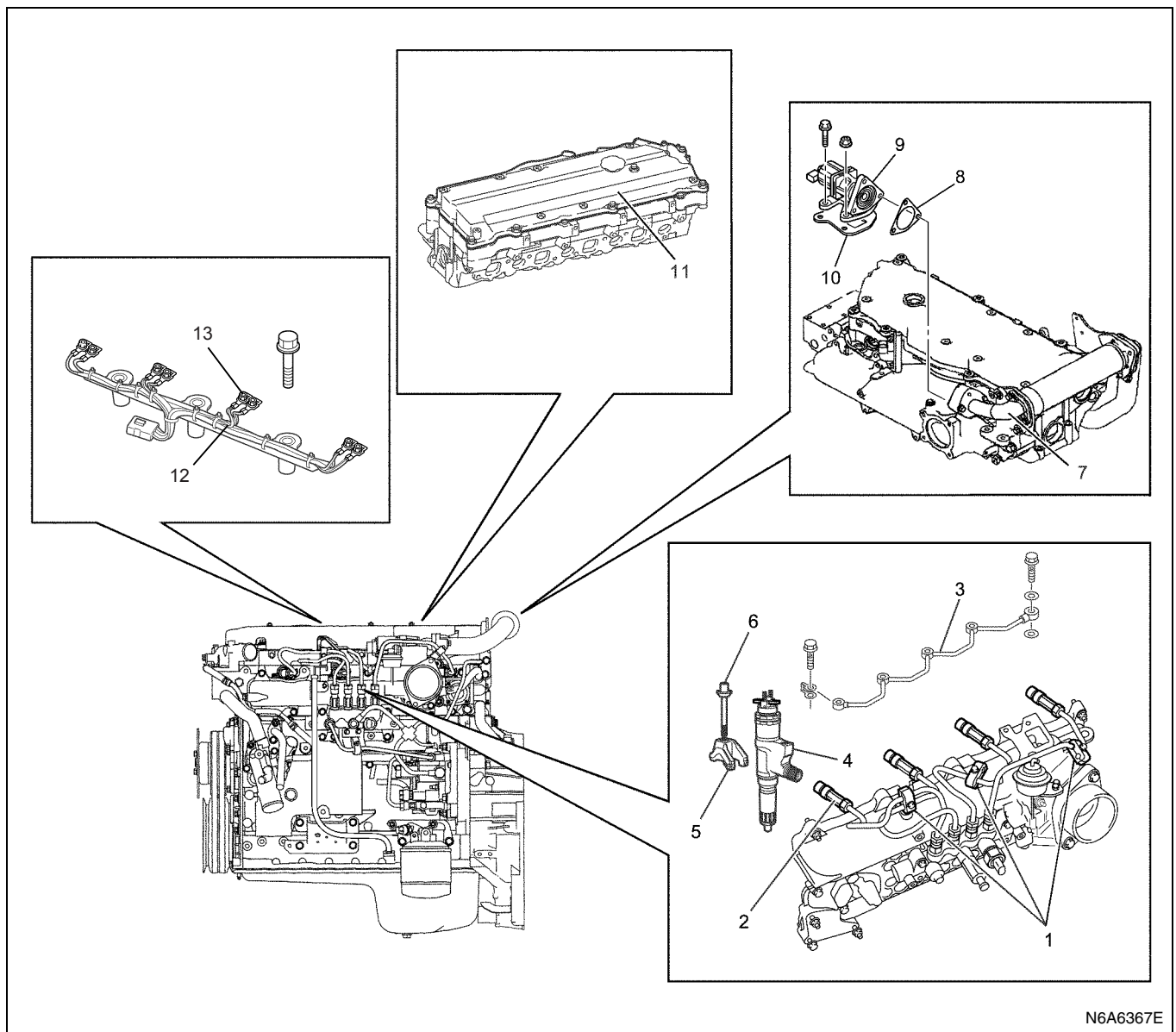
Special tool

Filter wrench: 5-8840-0253-0 (J-22700)



Fuel Injector

Components



N6A6367E

Legend

- | | |
|--------------------------------|-----------------------------------|
| 1. Fuel Injection Pipe Clip | 8. EGR Valve Gasket |
| 2. Fuel Injection Pipe | 9. EGR Valve |
| 3. Fuel Injector Leak-off Pipe | 10. EGR Valve Gasket |
| 4. Fuel Injector | 11. Cylinder Head Cover |
| 5. Fuel Injector Clamp | 12. Fuel Injector Harness Bracket |
| 6. Fuel Injector Clamp Bolt | 13. Fuel Injector Terminal |
| 7. EGR Adapter | |

The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injectors.

The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injectors during the

removal and installation procedure.

Caution:

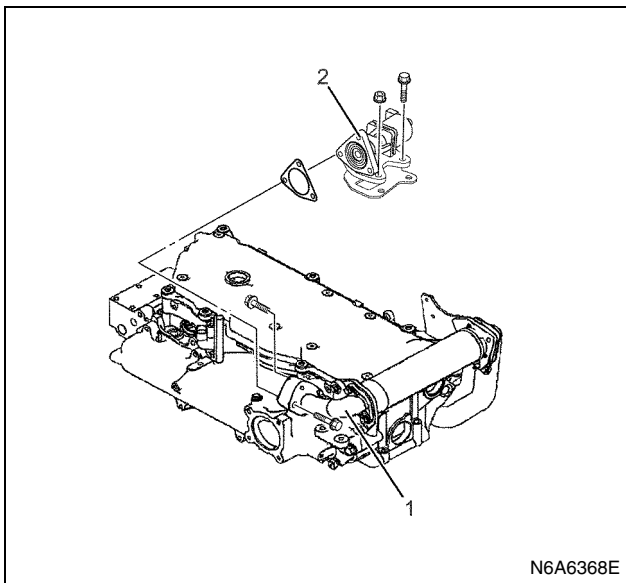
To avoid electric shock;
Set the switch to the 'OFF' position and disconnect battery negative cable before checking or repairing the fuel injector, wiring or/and connectors.

Important:

The Fuel Injector ID Code Data Programming MUST be done when the fuel injector is being replaced. The Fuel Injector ID Code information MUST be recorded before assembling the cylinder head cover.

Removal

1. Remove the engine harness, the throttle position sensor, the EGR valve, the pressure sensor, and all of the fuel injector connectors.
2. Remove the EGR valve and the EGR adapter.
3. Tape the EGR case holes shut to prevent the entry of foreign material.

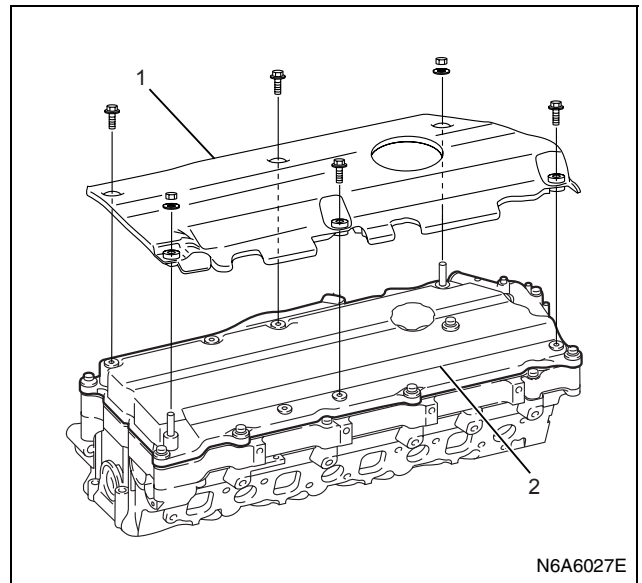


Legend

1. EGR Adapter
2. EGR Valve

4. Remove the sound insulation cover.

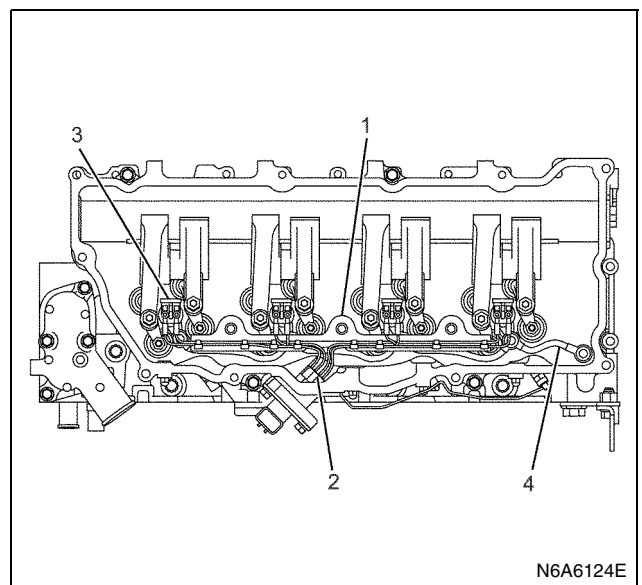
5. Remove the head cover.



Legend

1. Sound Insulation Cover (For Europe)
2. Head Cover

6. Loosen the fuel injector terminal nuts.
7. Loosen the fuel injector harness bracket bolts. Remove the inside connector and the harness bracket.
8. Remove the fuel injector leak-off pipe.
9. Remove the lower cover.

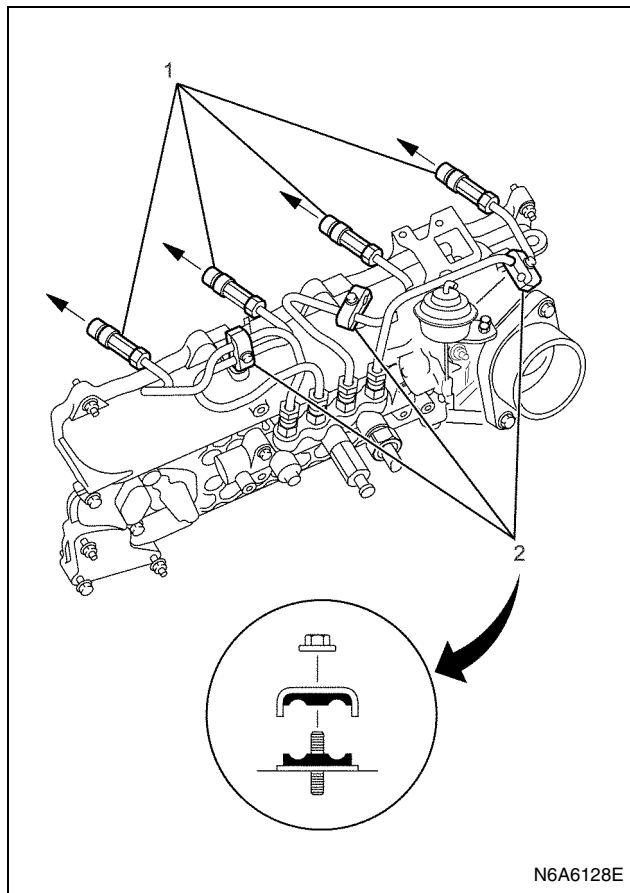


Legend

1. Harness Bracket
2. Harness Connector
3. Fuel Injector Terminal
4. Fuel Leak-off Pipe

6C-20 Fuel System

10. Remove the fuel injection pipe clips and the injection pipes.



Legend

1. Fuel Injection Pipe
2. Pipe Clip

11. Loosen the fuel injector clamp fixing bolts and remove the fuel injectors.

If the fuel injectors are difficult to remove, use the fuel injector remover. Install the fuel injector remover to the leak-off pipe attachment part on the fuel injector. Use a sliding hammer to force the fuel injector clamp off the fuel injector.

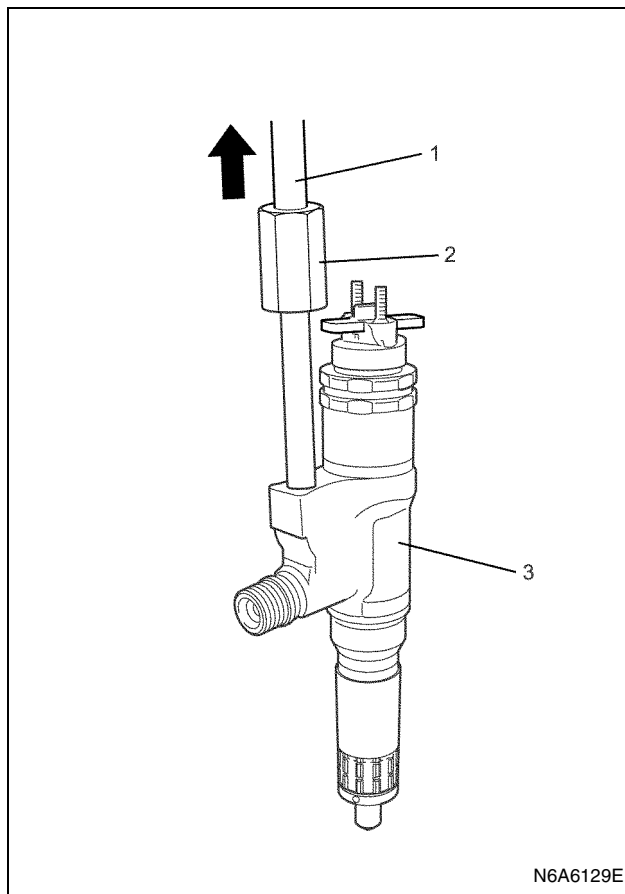
Caution:

Do not remove the fuel injector sleeve.

Special tools

Fuel injector remover: 5-8840-2826-0 (EN-46720)

Sliding hammer: 5-8840-0019-0 (J-23907)



Legend

1. Sliding Hammer
2. Remover
3. Fuel Injector Assembly

12. Mark each fuel injector with the number of the cylinder from which it was removed. Store the fuel injectors in a safe place. Position the fuel injector so that the nozzle is protected.

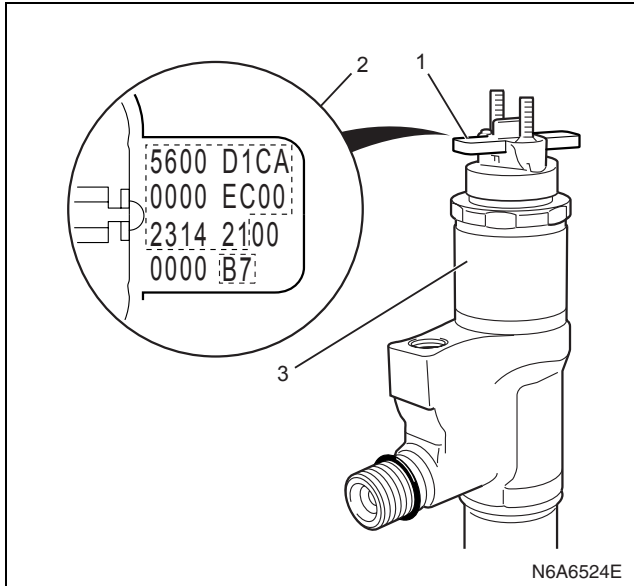
Caution:

- Do not tamper with the electromagnetic portion of the fuel injector. Reduced electromagnetic function will result in injector failure.

Recording from the each fuel injector ID plate

Record 24 figures of each fuel injector ID plate. The correct order for the fuel injector ID code for the following illustration is as follows:

56 00 D1 CA 00 00 EC 00 23 14 21 B7



Legend

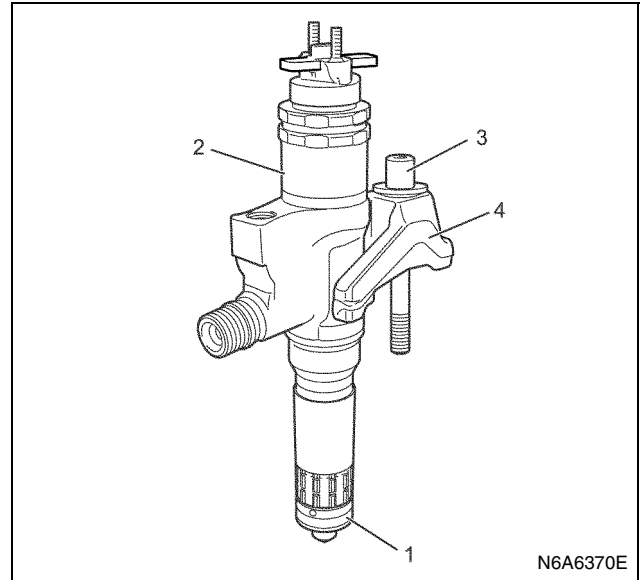
1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

Installation

Important:

Install each of the fuel injectors on its original position. (the cylinder from which it was removed)

1. Install a new gasket and O-ring to each of the fuel injector clamps. Refer to the illustration.



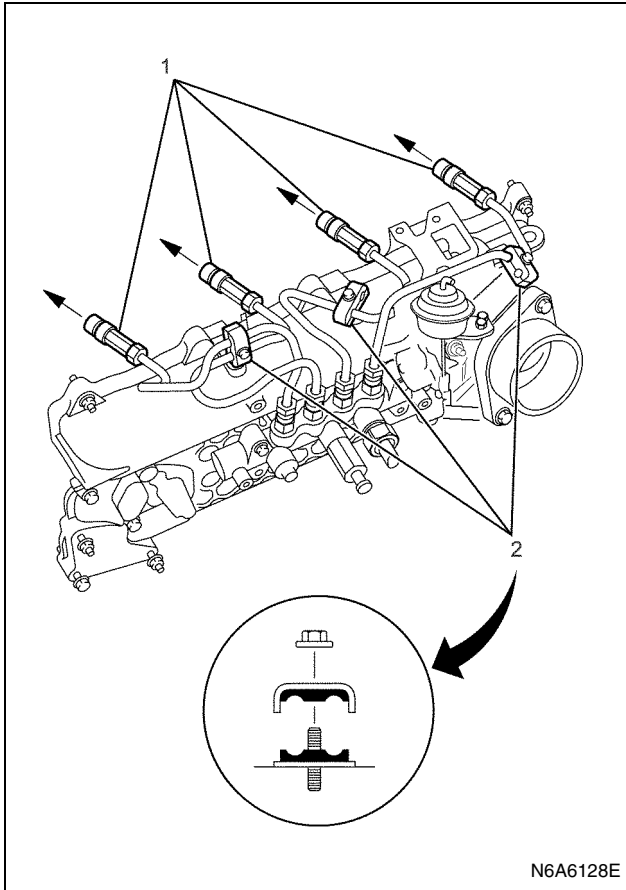
Legend

1. Gasket
2. Fuel Injector
3. Bolt
4. Fuel Injector Clamp

2. Apply molybdenum to the threads and seating surfaces of the clamp bolts.
3. Install the fuel injector clamps to the cylinder head.
4. Temporarily tighten the clamp bolts.
5. Apply a thin coat of engine oil to the outer surface of the fuel injector side sleeve nuts.
6. Install the fuel injection pipes to the position shown in the illustration.
7. Use a spanner to carefully the sleeve nuts until the fuel injection pipes contact the fuel injector and common rail.
8. Tighten the fuel injection pipe clips to the specified torque.

Tighten:

Clips to 6 N·m (0.6 kg·m/52 lb·in)



Legend

- 1. Fuel Injection Pipe
- 1. Pipe Clip

9. Final tighten the injection clamp bolts to the specified torque.

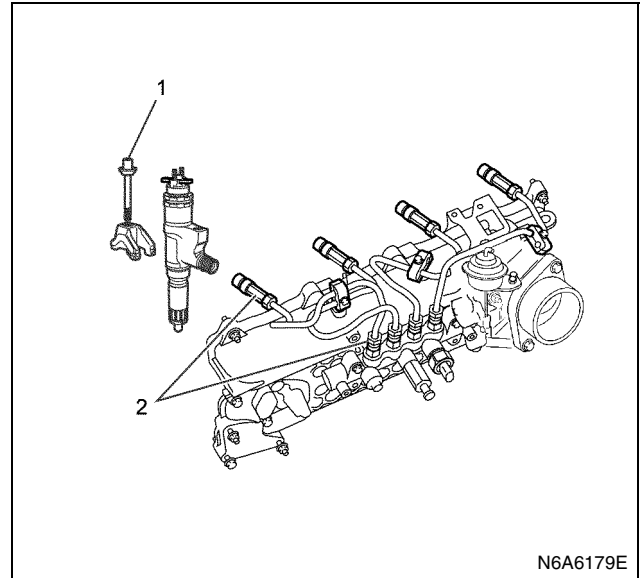
Tighten:

Bolts to 30 N·m (3.1 kg·m/22 lb·ft)

10. Tighten the injection pipes to the specified torque.

Tighten:

Injection pipes to 44 N·m (4.5 kg·m/33 lb·ft)



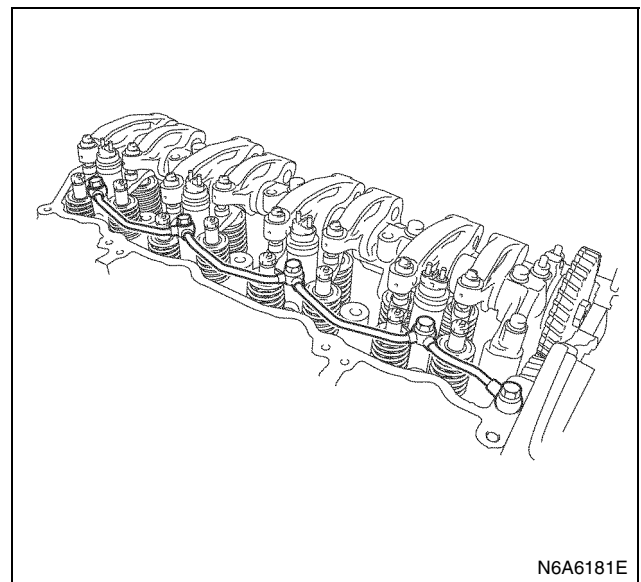
Legend

- 1. Clamp Bolt
- 2. Sleeve Nut

11. Install the nozzle leak-off pipes together with the new gaskets. Tighten the pipes to the specified torque.

Tighten:

Pipes to 12 N·m (1.2 kg·m/104 lb·in)

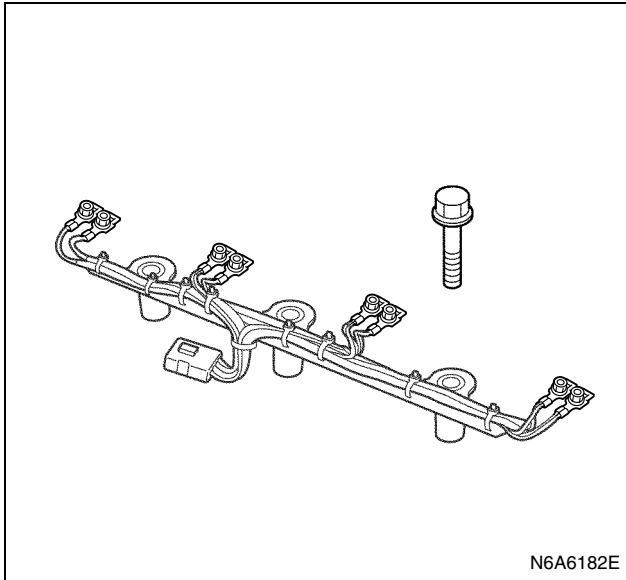


12. Install the fuel injector harness connectors. Work from the inside out.

13. Install the harness bracket and tighten the bolts to the specified torque.

Tighten:

Bolts to 48 N·m (4.9 kg·m/35 lb·ft)



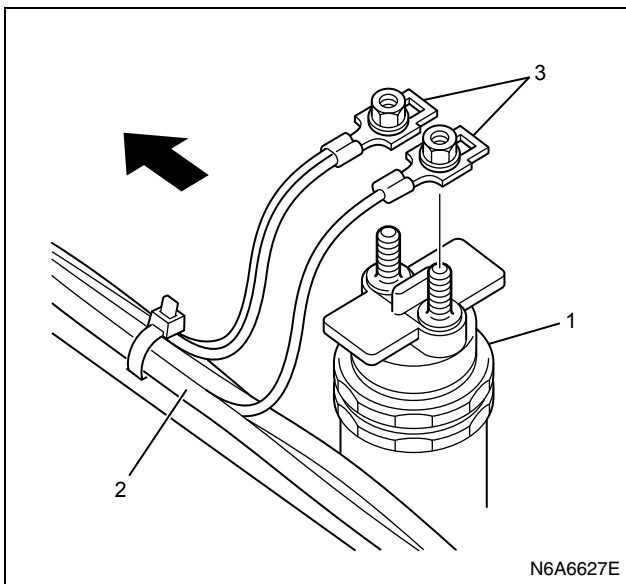
14. Install the fuel injector terminal nuts to the injector.

Tighten:

Nut to 2 N·m (0.2 kg·m/17 lb·in)

Caution:

- Do not overtighten the nuts. Damage to the terminal studs will result.
- The terminal nut with two wires is engine front side.



Legend

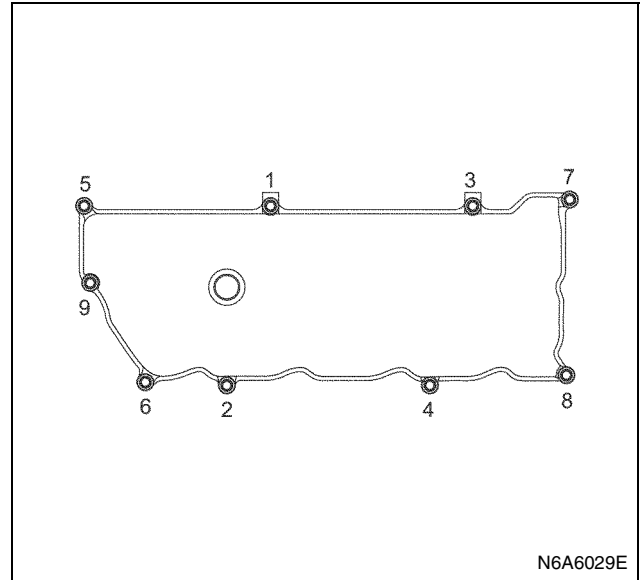
1. Fuel Injector
2. Harness
3. Terminal Nut

15. Install the gasket to the cylinder head cover.

16. Install the cylinder head cover and tighten up according to the order.

Tighten:

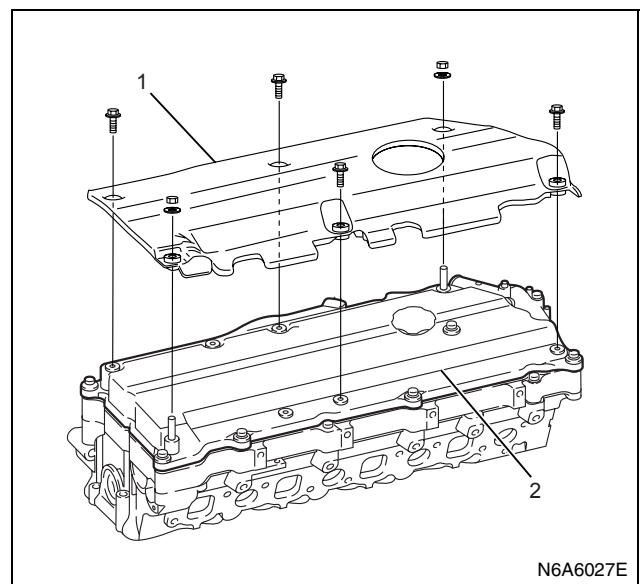
Bolts to 18 N·m (1.8 kg·m/13 lb·ft)



17. Install the sound insulation cover (For Europe).

Tighten:

Bolts to 8 N·m (0.8 kg·m/6 lb·ft)



Legend

1. Sound Insulation Cover (For Europe)
2. Head Cover

18. Install the gasket to the EGR valve and tighten the bolts to the specified torque.

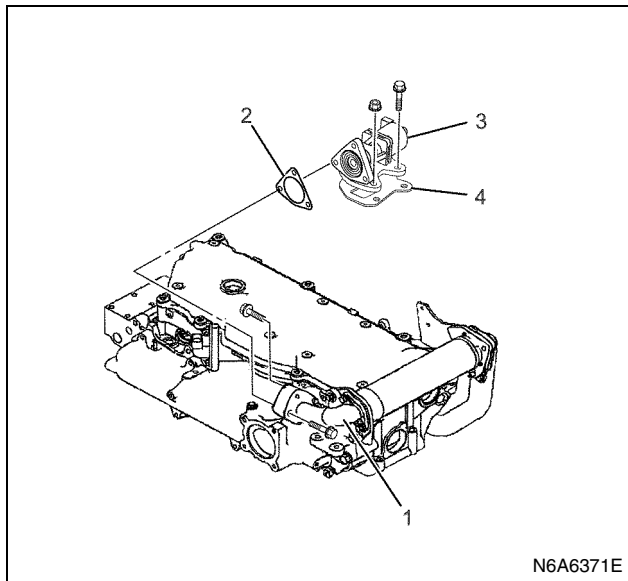
Tighten:

Bolts to 24 N·m (2.4 kg·m/17 lb·ft)

19. Install the gasket to the EGR adapter and tighten the bolts to the specified torque.

Tighten:

Bolts to 24 N·m (2.4 kg·m/17 lb·ft)



Legend

1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

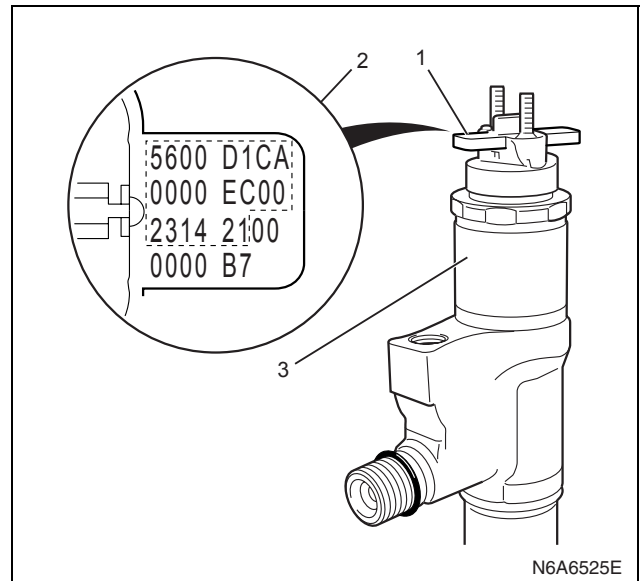
20. Attach the engine harness connectors. Each composite connector should make a loud click when it is securely attached.

Fuel Injector ID Code Data Programming Procedure

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > ID Code Registration.
4. Select replaced cylinder and press Change. Input 22 figures. Then, input in order from the left edge of upper sequence to the right sequence. The correct order for the fuel injector ID code for the following illustration is as follows:
56 00 D1 CA 00 00 EC 00 23 14 21

Important:

The number of places required for input is 22 figures except last 2 figures.



Legend

1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

5. After complete the registration, turn OFF the ignition for 30 second.
6. Turn ON the ignition.
7. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Injector ID Code. At this point, all registered fuel injector ID code data can be verified. Compare the ID code values registered into the ECM and each fuel injector including the last 2 figures. If the registered ID code is incorrect, go back to Step 4 ID Code Registration.
8. Start the engine and let idle.
9. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Notice:

After replacement of the fuel injector, perform the following procedure.

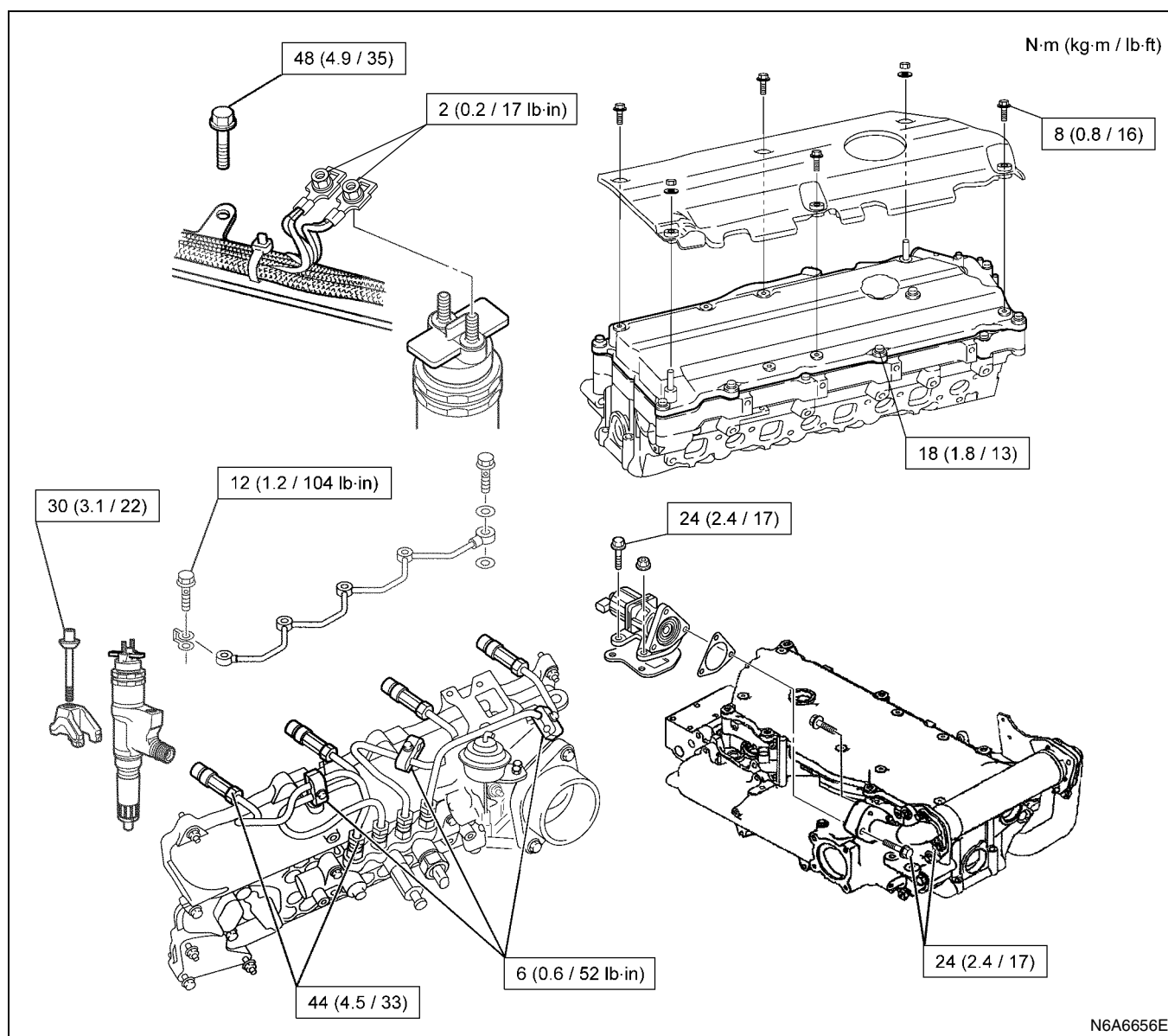
All fuel injectors are replaced:

Remove the fuel injector ID code label on the cylinder head cover.

Any fuel injector(s) is replaced:

Blackout the replaced cylinder fuel injector ID code on the cylinder head cover with a marking pen or equivalent.

Torque Specifications



Special Tool

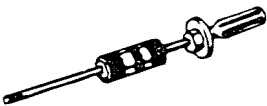
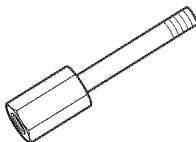
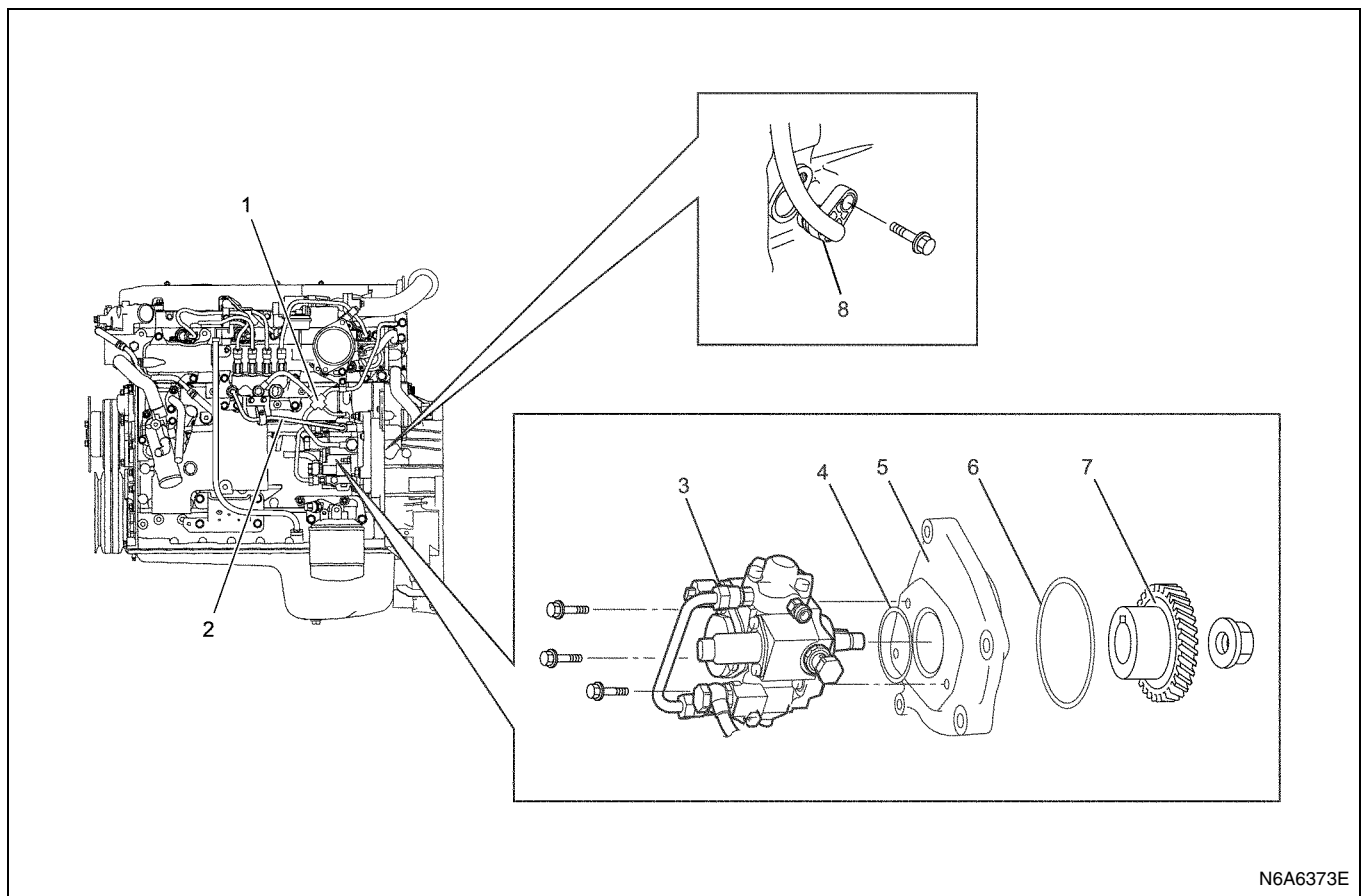
Illustration	Tool Number / Description / Remarks
	5-8840-0019-0 (J-23907) Sliding Hammer
5884000190	

Illustration	Tool Number / Description / Remarks
	5-8840-2826-0 (EN-46720) Fuel Injector Remover
EN46720	

Fuel Supply Pump

Components



Legend

- | | |
|-----------------------|----------------------|
| 1. Fuel Leak-off Pipe | 5. Bracket |
| 2. Fuel Pipe | 6. Bracket O-ring |
| 3. Fuel Supply Pump | 7. Drive Gear |
| 4. O-ring | 8. Oil Drain Adapter |

The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injectors.

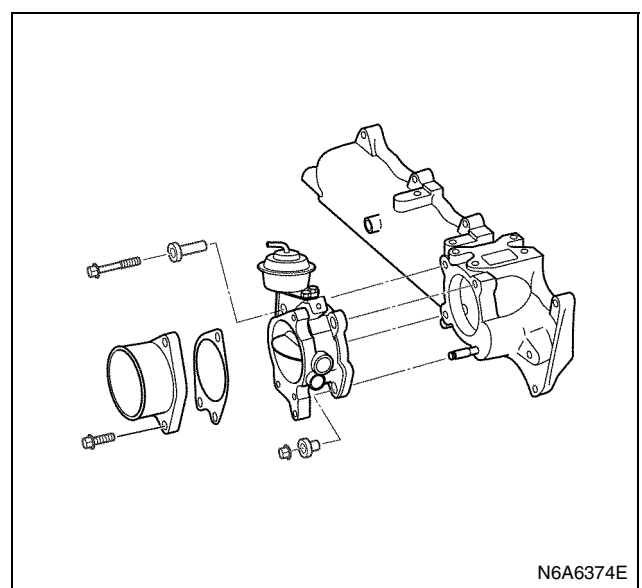
The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injectors during the removal and installation procedure.

Important:

The Fuel supply pump must be timed to the engine.

Removal

1. Remove the intake pipe and the intake throttle valve.
2. Remove the fuel pipe and fuel leak-off pipe.

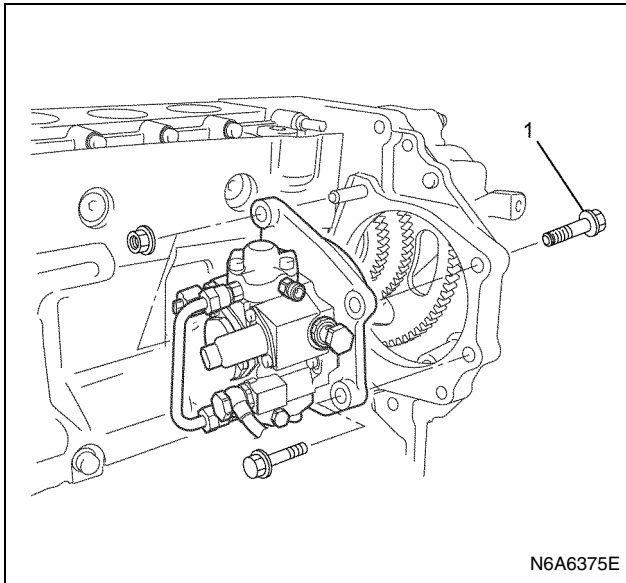


3. Remove the fuel feed hose.

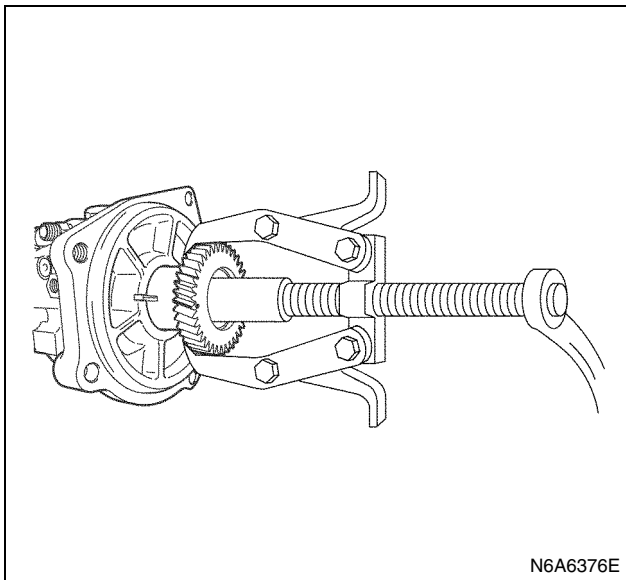
4. Disconnect the fuel temperature sensor and the fuel rail pressure regulator harness connector from the fuel supply pump.
5. Remove the fuel supply pump attachment bolts and nuts, then remove the fuel supply pump.

Notice:

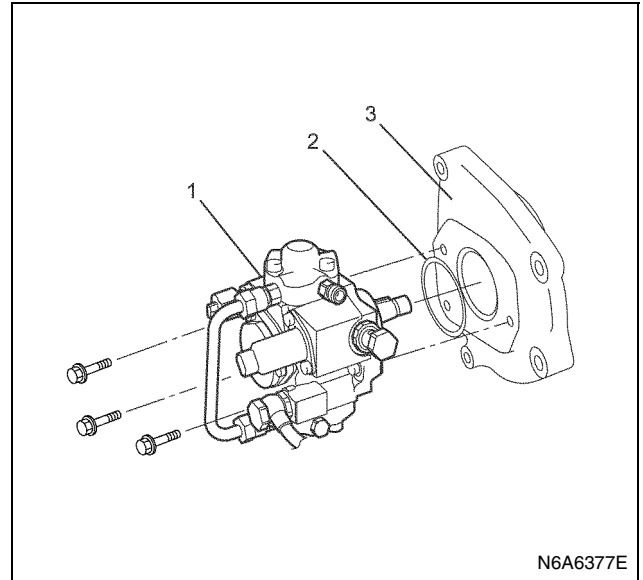
One of the attachment bolt (1) secures the fuel supply pump to the flywheel housing as denoted in the picture below.



6. Use a gear puller to remove the fuel supply pump gear and the O-ring.



7. Loosen the 3 bolts holding the fuel supply pump bracket. Remove the bracket and the O-ring.


Legend

1. Fuel Supply Pump
2. O-ring
3. Fuel Supply Pump Bracket

Installation

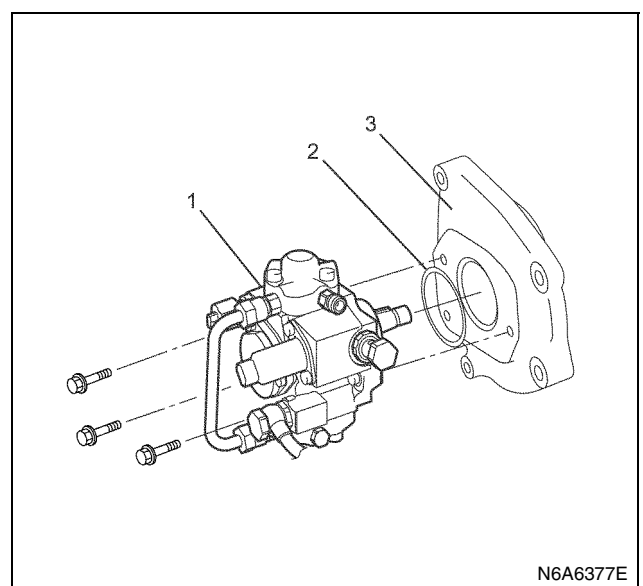
1. Install the O-ring to the fuel supply pump.
2. Install the pump to the bracket and tighten the 3 bolts to the specified torque.

Tighten:

Bolts to 19 N·m (1.9 kg·m/14 lb·ft)

Caution:

Take care not to twist the O-ring.


Legend

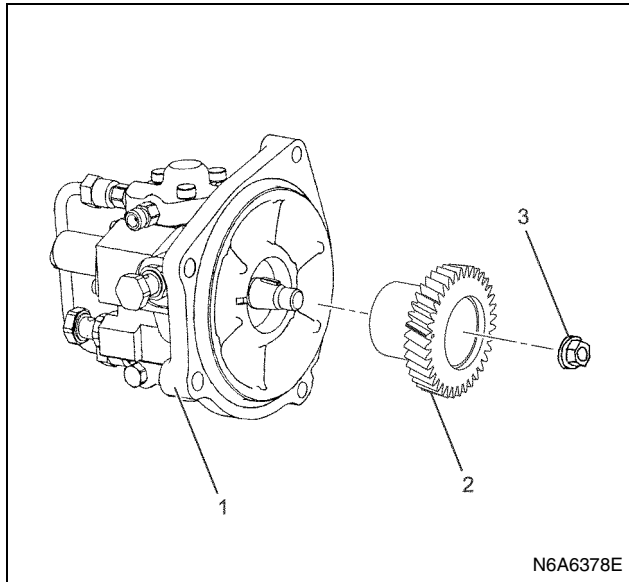
1. Fuel Supply Pump
2. O-ring
3. Fuel Supply Pump Bracket

6C-28 Fuel System

3. Align the fuel supply pump shaft key and gear. Install the gear and tighten the nut to the specified torque.
There is a round alignment mark on the gear (white paint).

Tighten:

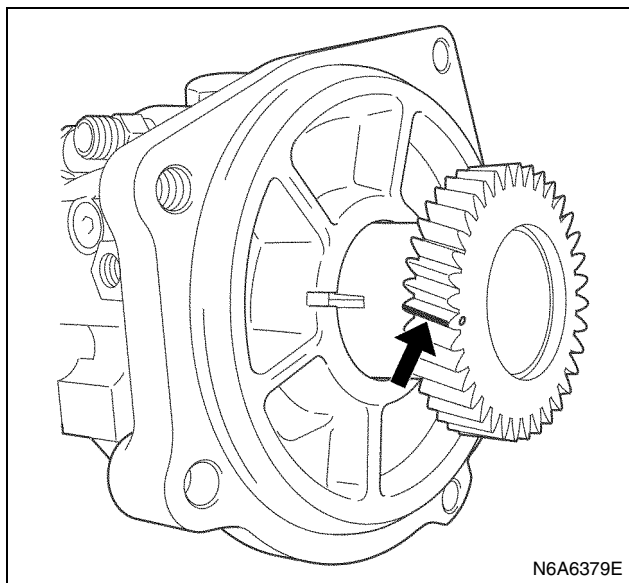
Nut to 64 N·m (6.5 kg·m/47 lb·ft)



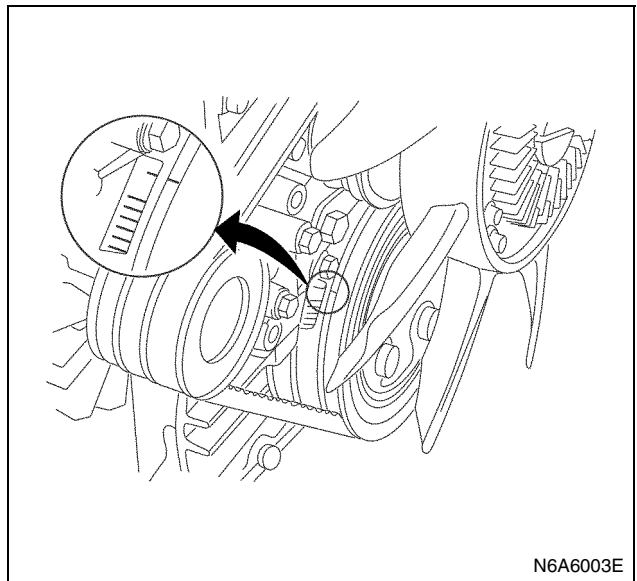
Legend

1. Fuel Supply Pump
2. Fuel Supply Gear
3. Nut

4. Apply white paint to the top of the fuel supply pump gear tooth directly above the stamped 'O' mark. Refer to the illustration.

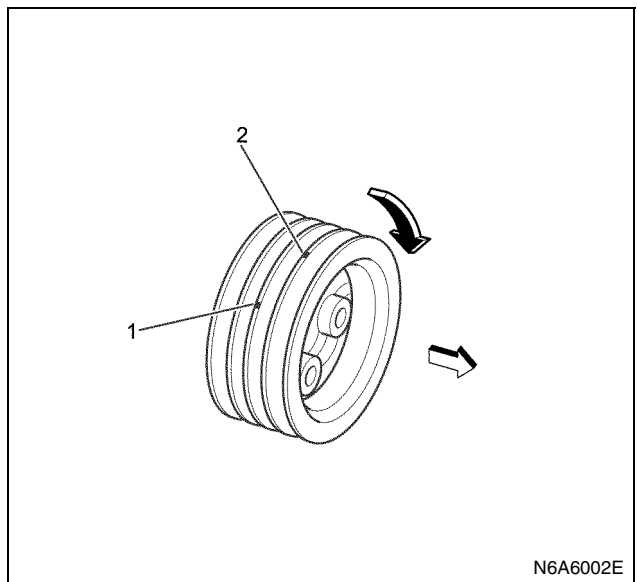


5. Turn the crankshaft in the normal direction of engine rotation until the No. 1 or No. 4 cylinder is at TDC on the compression stroke. Refer to the illustration.



Notice:

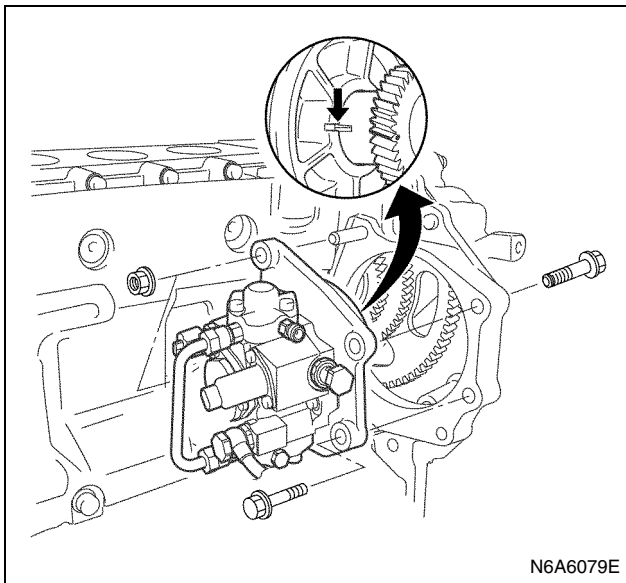
There are 2 timing marks on the crankshaft pulley. Mark (1) is near the front cover and is used to bring the 4HK1-TC engine to TDC. Mark (2) is not applicable to this engine. Be sure to use mark (1) when bringing the engine to TDC.



6. Remove the oil drain adapter.
7. Install the O-ring to the fuel supply pump.
8. Align the slits as shown in the illustration.
9. Insert the stud bolts into the guides and temporarily tighten them.

Caution:

- If the stud bolts (cylinder block side) have been loosened or replaced, apply Loctite 262 to the recessed portion of the bolts.

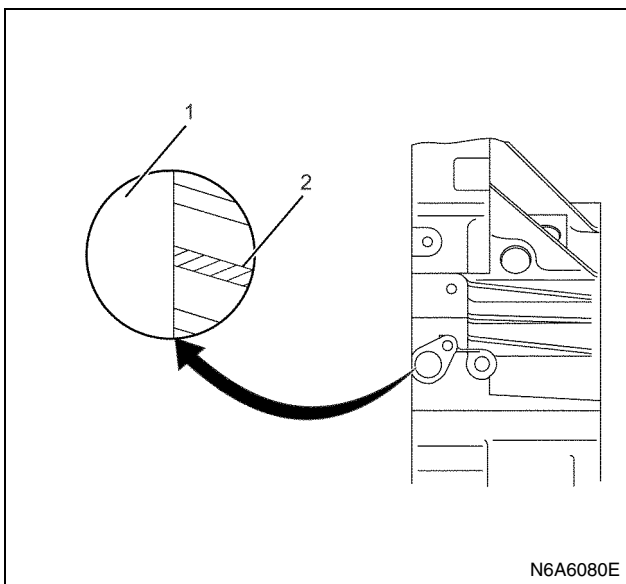


- Check that the round alignment mark (white paint) is positioned as shown in the illustration when viewed from the plug hole. If necessary, reposition the gear.
- Tighten the stud bolts and the nuts to the specified torque.

Tighten:

Nut to 50 N·m (5.1 kg·m/37 lb·ft)

Bolt to 76 N·m (7.7 kg·m/56 lb·ft)



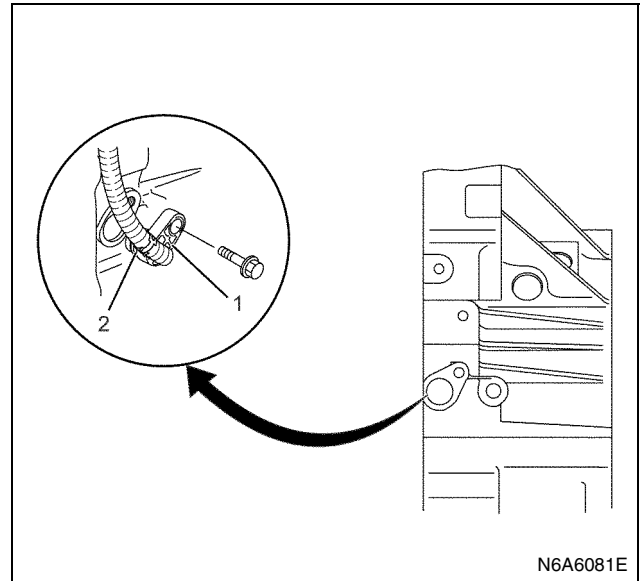
Legend

1. Plug Hole
2. Alignment Mark

10. Apply a light coat of engine oil to the O-ring.
11. Install the oil drain adapter to the plug hole. Tighten the bolt to the specified torque.

Tighten:

Bolt to 8 N·m (0.8 kg·m/69 lb·in)



Legend

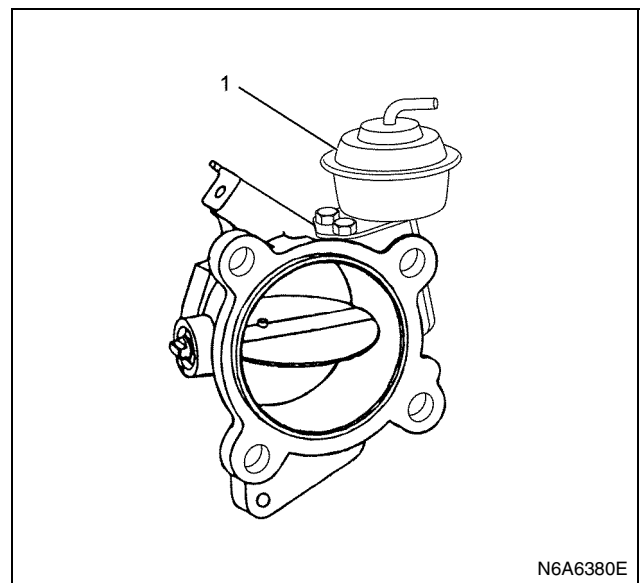
1. Oil Drain Adapter
2. O-ring

12. Connect the fuel temperature sensor and the suction control valve connectors to the fuel supply pump.
13. Install the fuel feed hose.
14. Install the throttle assembly.
 - Coat the fluid gasket and mount within 7 minutes.

Tighten:

Throttle assembly to 24 N·m (2.4 kg·m/17 lb·ft)

- Install the intake throttle valve chamber hose.



Legend

1. Intake Throttle Valve Chamber

15. Install the fuel pipe and fuel leak-off pipe.

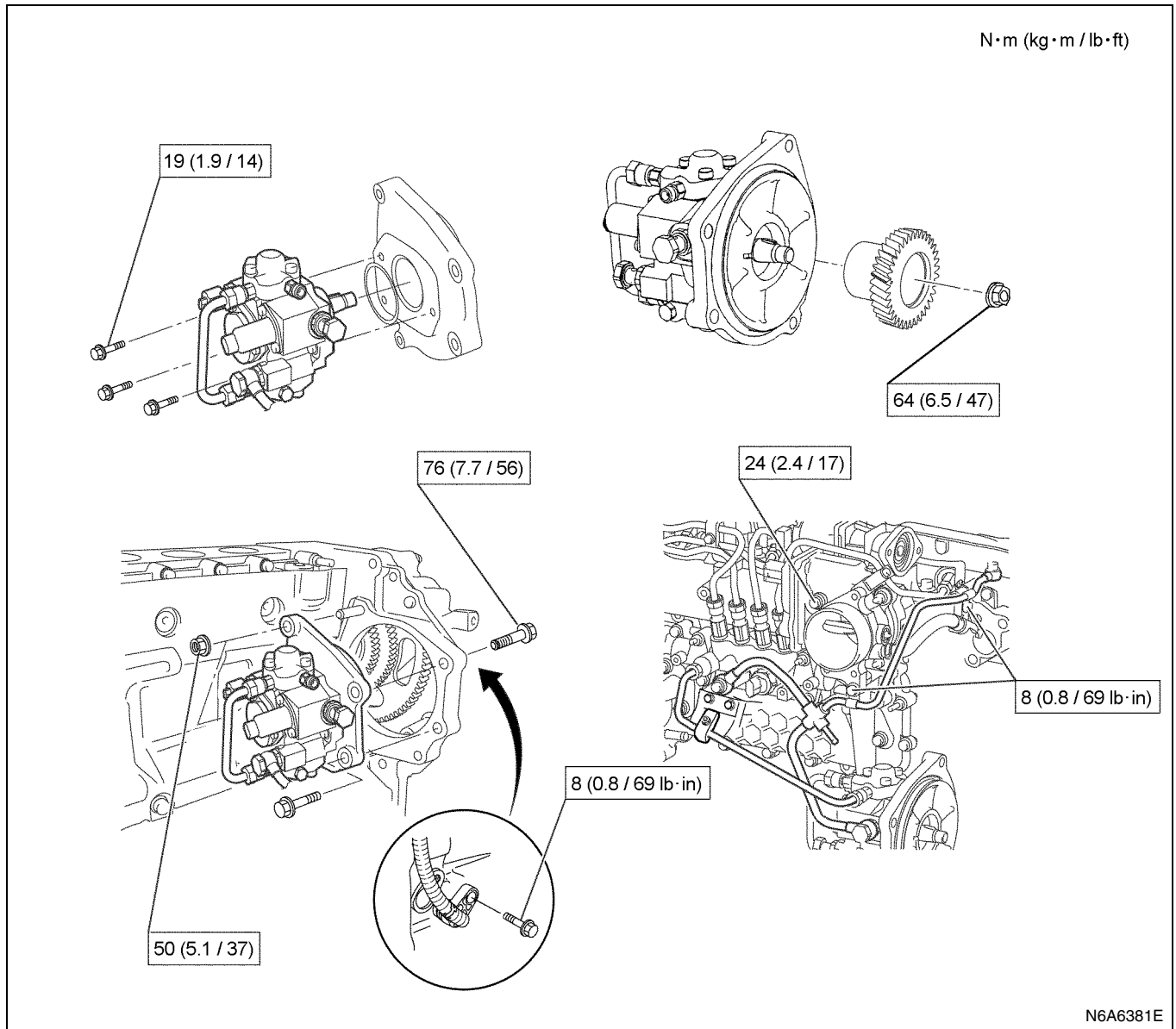
6C-30 Fuel System

Important:

In order to make the fuel supply pump characteristic learn into the ECM, let the engine idle until warm-up. If the fuel system DTC's stored in the meantime, once clear DTC and warm-up the engine again.

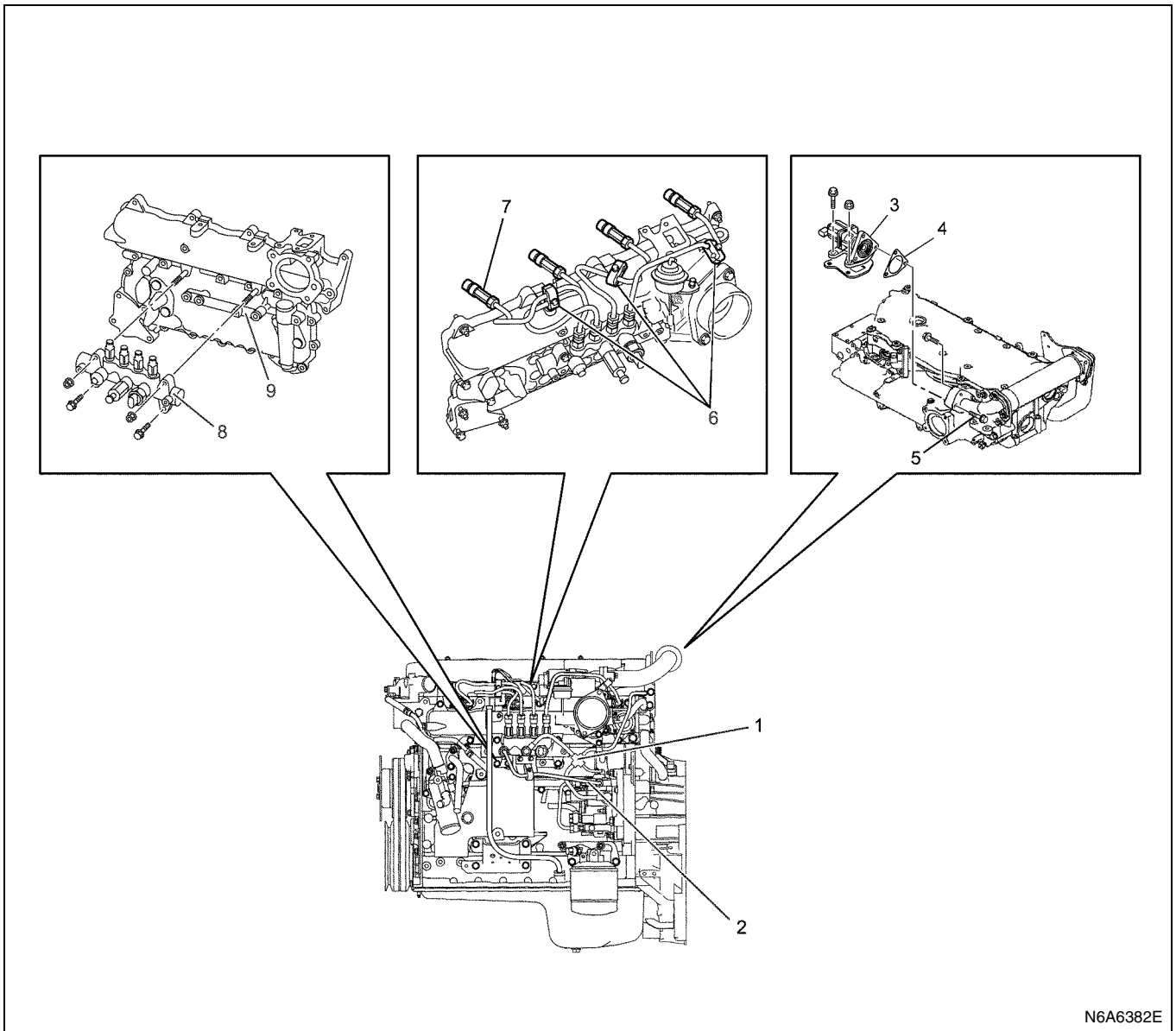
16. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Torque Specifications



Fuel Rail

Components



N6A6382E

Legend

- | | |
|-----------------------|------------------------------|
| 1. Fuel Leak-off Pipe | 6. Injection Pipe Clip |
| 2. Fuel Pipe | 7. Injection Pipe (#1 to #4) |
| 3. EGR Valve | 8. Fuel Rail |
| 4. EGR Valve Gasket | 9. Fuel Rail Bracket |
| 5. EGR Adapter | |

Parts of the fuel system such as the internal part of the fuel injector, holes and clearances that form passages for fuel are finished to a very high degree of accuracy. They are therefore highly sensitive to foreign matter and the entry of foreign matter could cause damage to the fuel passage. Therefore, effective measures should be taken to prevent the entry of foreign matter.

Removal

WARNING:

TO PREVENT LEAKED FUEL FROM CATCHING FIRE, DO NOT WORK WHILE THE ENGINE IS HOT.

Preparation:

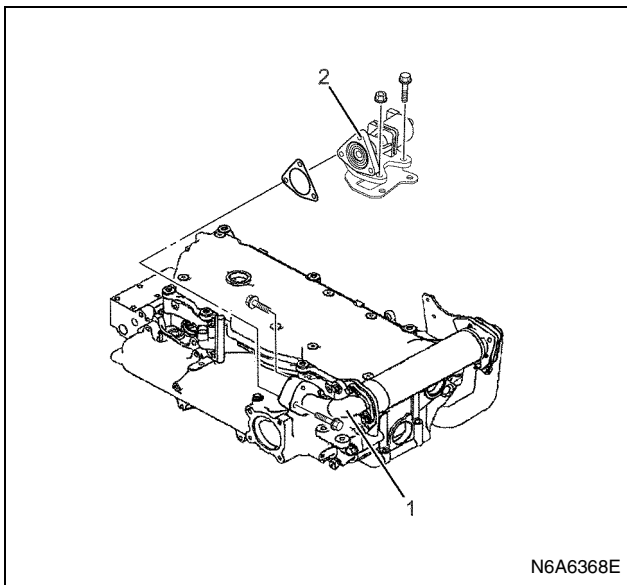
- Pour detergent into a steam cleaner, and thoroughly wash around the sensor and the fuel rail.
- Remove water completely using air blow.

6C-32 Fuel System

Notice:

Make sure that foreign matter will be prevented from getting in.

1. Remove the air intake pipe.
 - Disconnect the connector for the intake air temperature sensor.
2. Remove the fuel leak-off hose from the leak-off pipe.
 - Cover the removed fuel hose, keep it facing upward and secure it using wire, etc.
3. Disconnect the fuel rail pressure sensor harness connectors.
4. Remove the EGR valve and the EGR adapter.
5. Tape the EGR case holes shut to prevent the entry of foreign material.



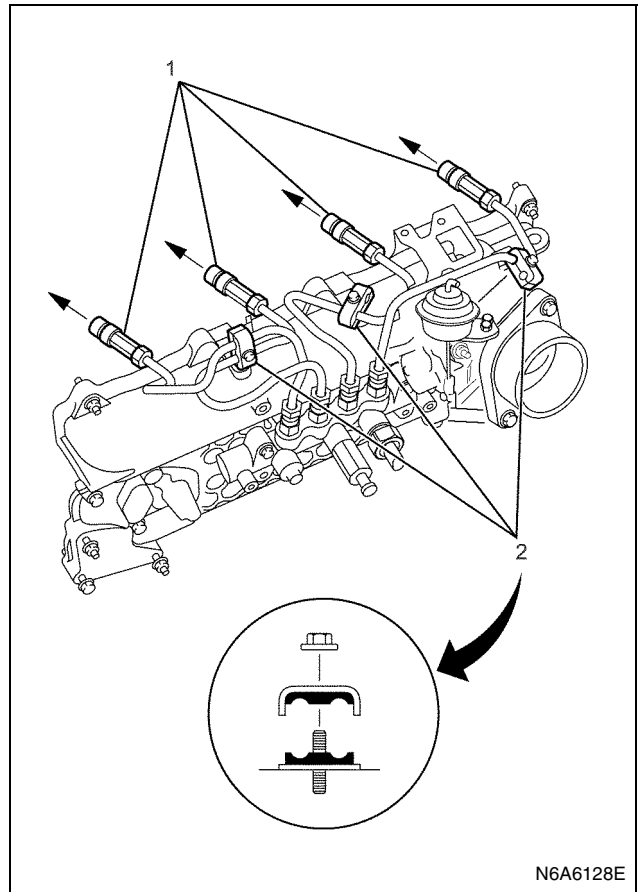
Legend

1. EGR Adapter
2. EGR Valve

6. Remove the injection pipe clip and remove the injection pipes.

Important:

Loosen the injection pipes gradually not to scatter high pressure fuel.



Legend

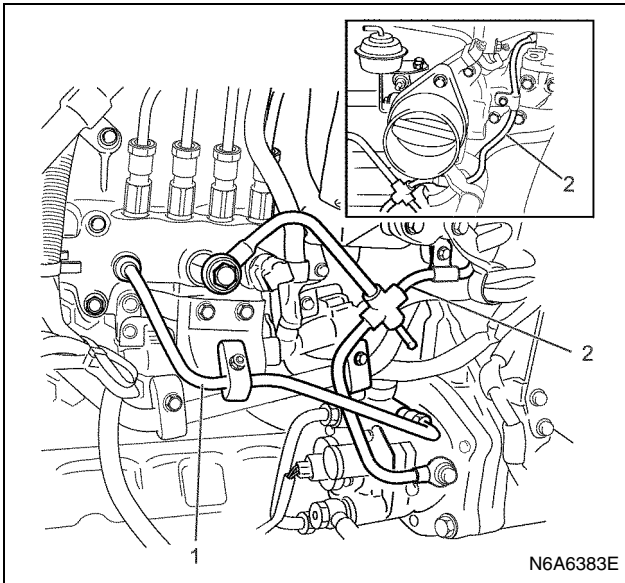
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Remove the fuel pipe.

Important:

Loosen the fuel pipe gradually not to scatter high pressure fuel.

8. Remove the clips and the fuel leak-off pipe.

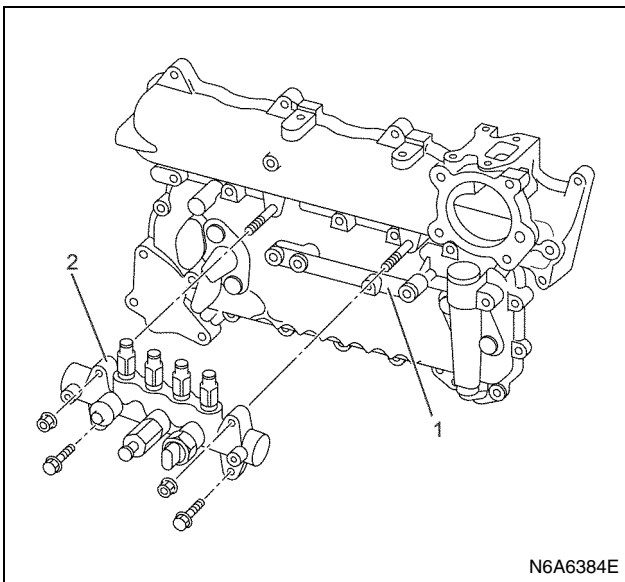


Legend

1. Fuel Pipe
2. Fuel Leak-off Pipe

9. Remove the fuel rail and the fuel rail bracket.

- Do not remove the flow damper.
The dampers should always remain in the fuel rail.
- Take care not to damage the connector unit of the pressure sensor.

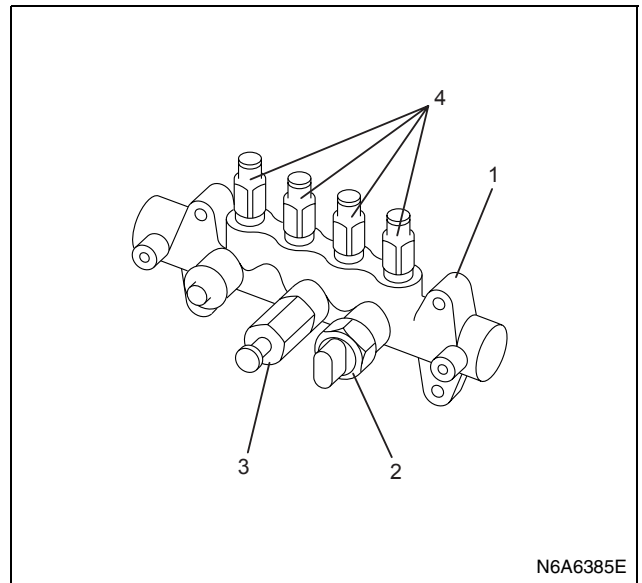


Legend

1. Fuel Rail Bracket
2. Fuel Rail

Disassembly

1. Remove the fuel pressure limiter.
2. Remove the fuel rail pressure sensor.



Legend

1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter
4. Flow Damper

Reassembly

1. Install the fuel pressure limiter.

Tighten:

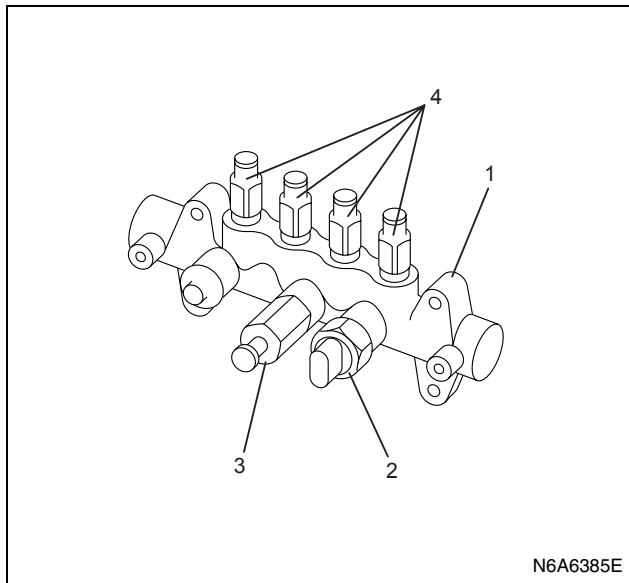
Fuel pressure limiter to 172 N·m (17.5 kg·m/127 lb·ft)

2. Install the fuel rail pressure sensor.

Tighten:

Fuel rail pressure sensor to 98 N·m (10 kg·m/72 lb·ft)

6C-34 Fuel System



Legend

1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter
4. Flow Damper

Installation

1. Tighten the fuel rail bracket using the specified mounting torque.

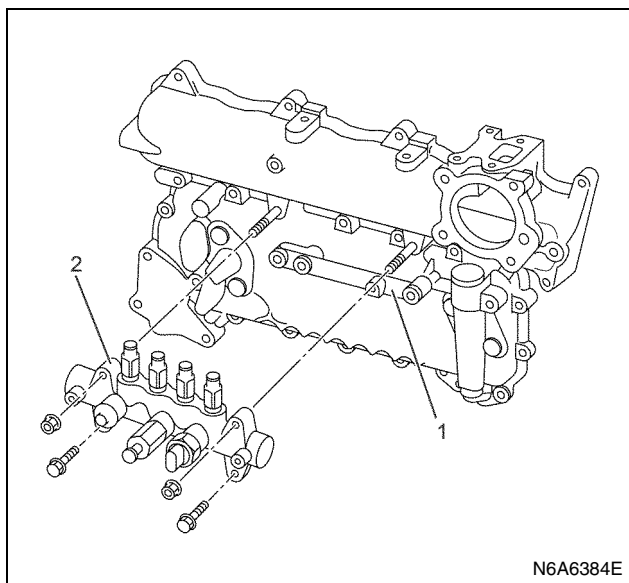
Tighten:

Nuts to 19 N·m (1.9 kg·m/14 lb·ft)

2. Tighten the fuel rail using the specified mounting torque.

Tighten:

Bolts to 19 N·m (1.9 kg·m/14 lb·ft)



Legend

1. Fuel Rail Bracket
2. Fuel Rail

3. Tighten the fuel leak-off pipe (1) using the mounting eyebolt and the clips using the specified torque.

Tighten:

(2) to 18 N·m (1.8 kg·m/13 lb·ft)

(3) to 12 N·m (1.2 kg·m/104 lb·in)

(4) to 8 N·m (0.8 kg·m/69 lb·in)

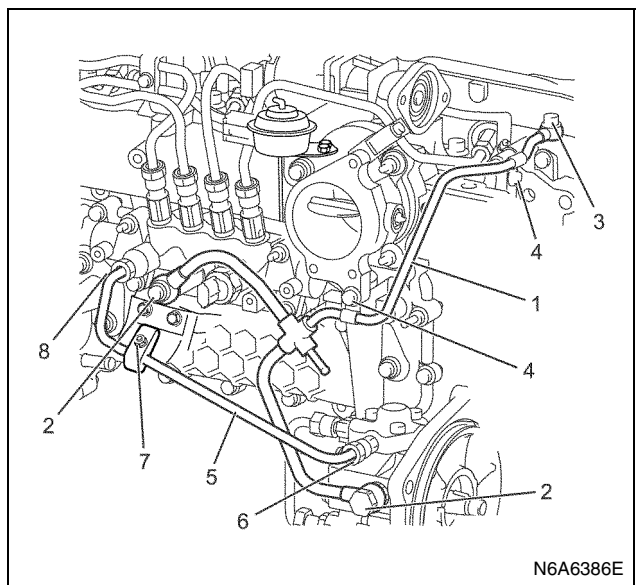
4. Tighten the fuel pipe (5) using the mounting sleeve nut and the clip using the specified torque.

Tighten:

(6) to 44 N·m (4.5 kg·m/33 lb·ft)

(7) to 6 N·m (0.6 kg·m/52 lb·in)

(8) to 44 N·m (4.5 kg·m/33 lb·ft)



5. Install the fuel leak-off hose to the fuel leak-off pipe.

6. Tighten the injection pipe and the clip using the specified mounting torque.

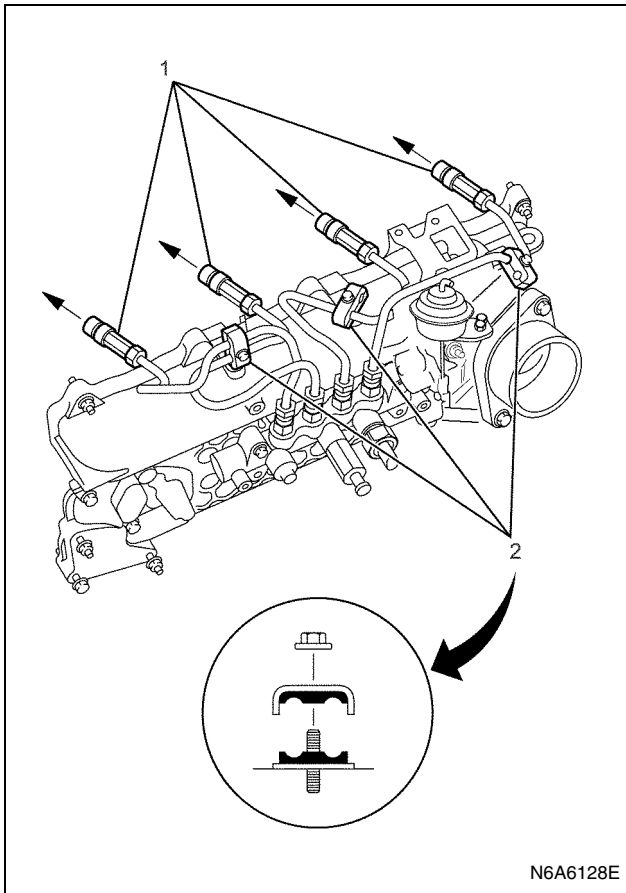
Tighten:

Injection pipe sleeve nut to 44 N·m (4.5 kg·m/33 lb·ft)

Tighten:

Injection pipe clip to 6 N·m (0.6 kg·m/52 lb·in)

- Apply a thin coat of engine oil on the periphery of the sleeve nut on the fuel injector side and assemble.



N6A6128E

Legend

1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Connect the fuel rail pressure (FRP) sensor connector.
8. Install the gasket to the EGR valve and tighten the bolts to the specified torque.

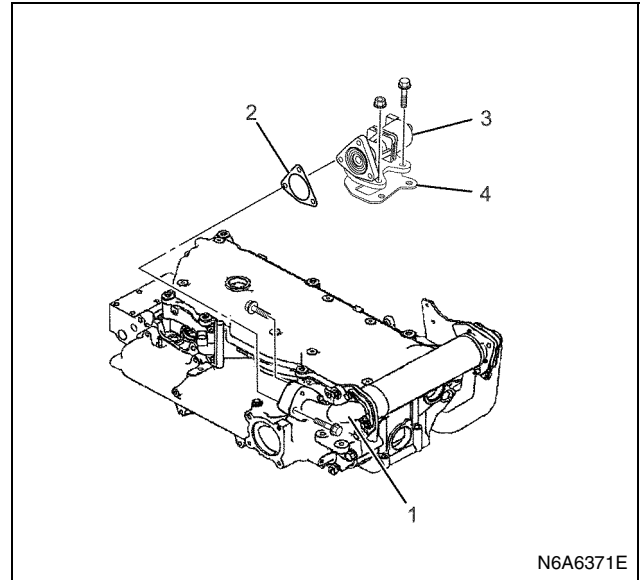
Tighten:

Bolt to 24 N·m (2.4 kg·m/17 lb·ft)

9. Install the gasket to the EGR adapter and tighten the bolts to the specified torque.

Tighten:

Bolt to 24 N·m (2.4 kg·m/17 lb·ft)



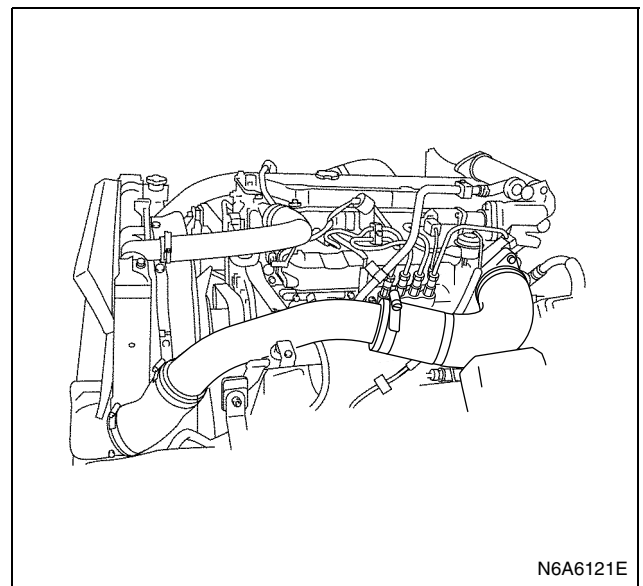
N6A6371E

Legend

1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

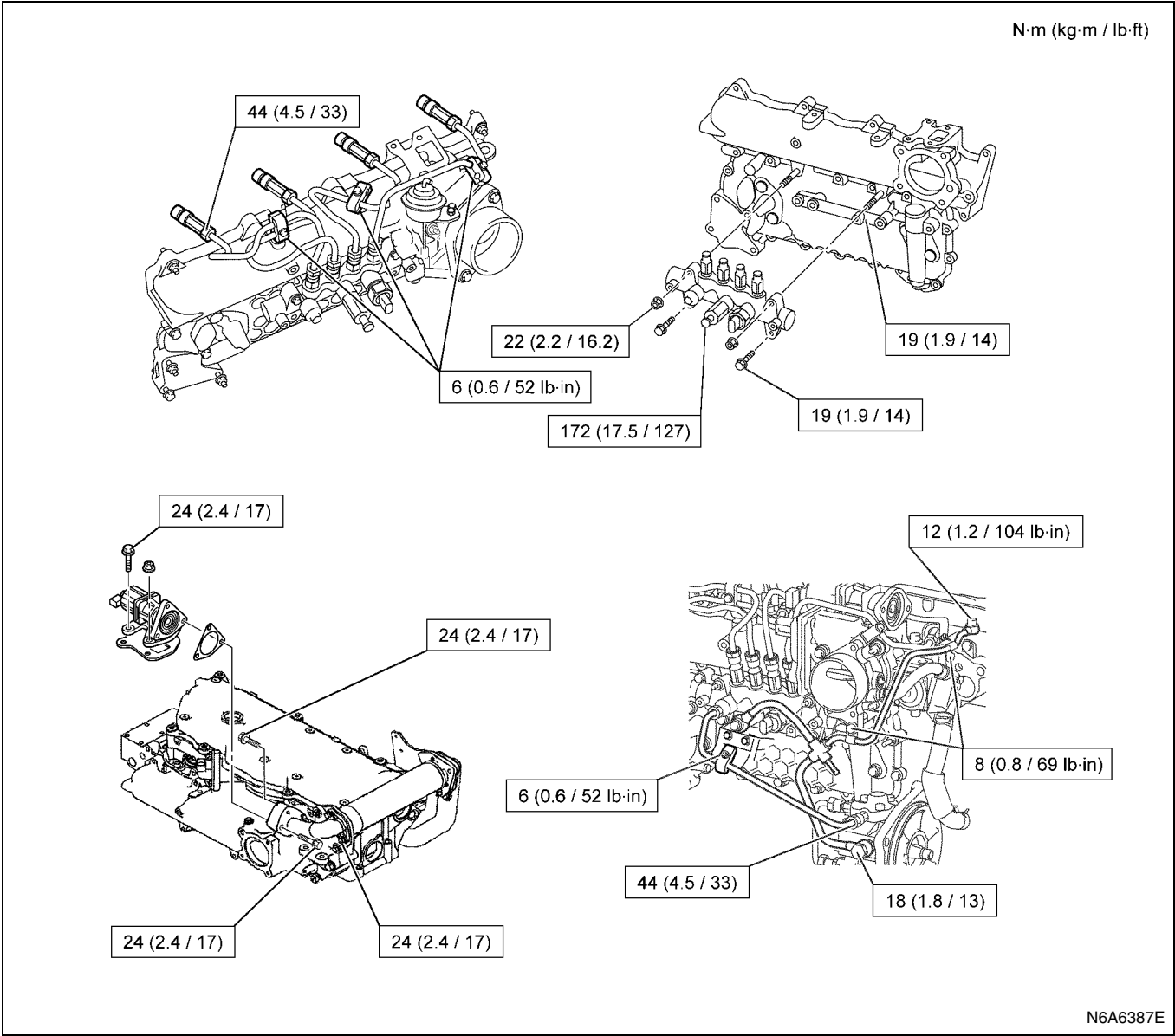
10. Install the air intake duct.

- Connect the connector for the intake air temperature sensor.



N6A6121E

Torque Specifications

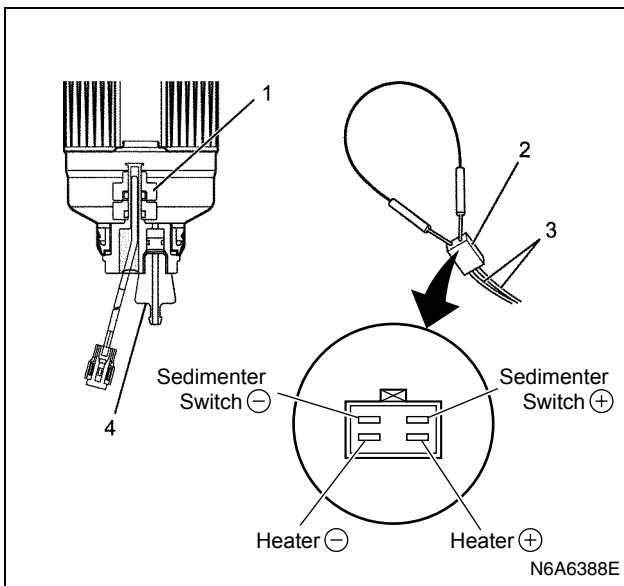


Fuel Sedimenter Switch

Inspection

1. Check that there is continuity between the switch connector terminals when the float in the fuel sedimenter is above the water drain line.
2. Turn on the ignition switch, disconnect the fuel sedimenter connector, and connect the terminals of the connectors on the vehicle side. Confirm that the sedimenter warning lamp lights up.

If abnormalities are detected during the check, replace the switch parts and carry out repairs in case of defective connection between circuits or short circuits.

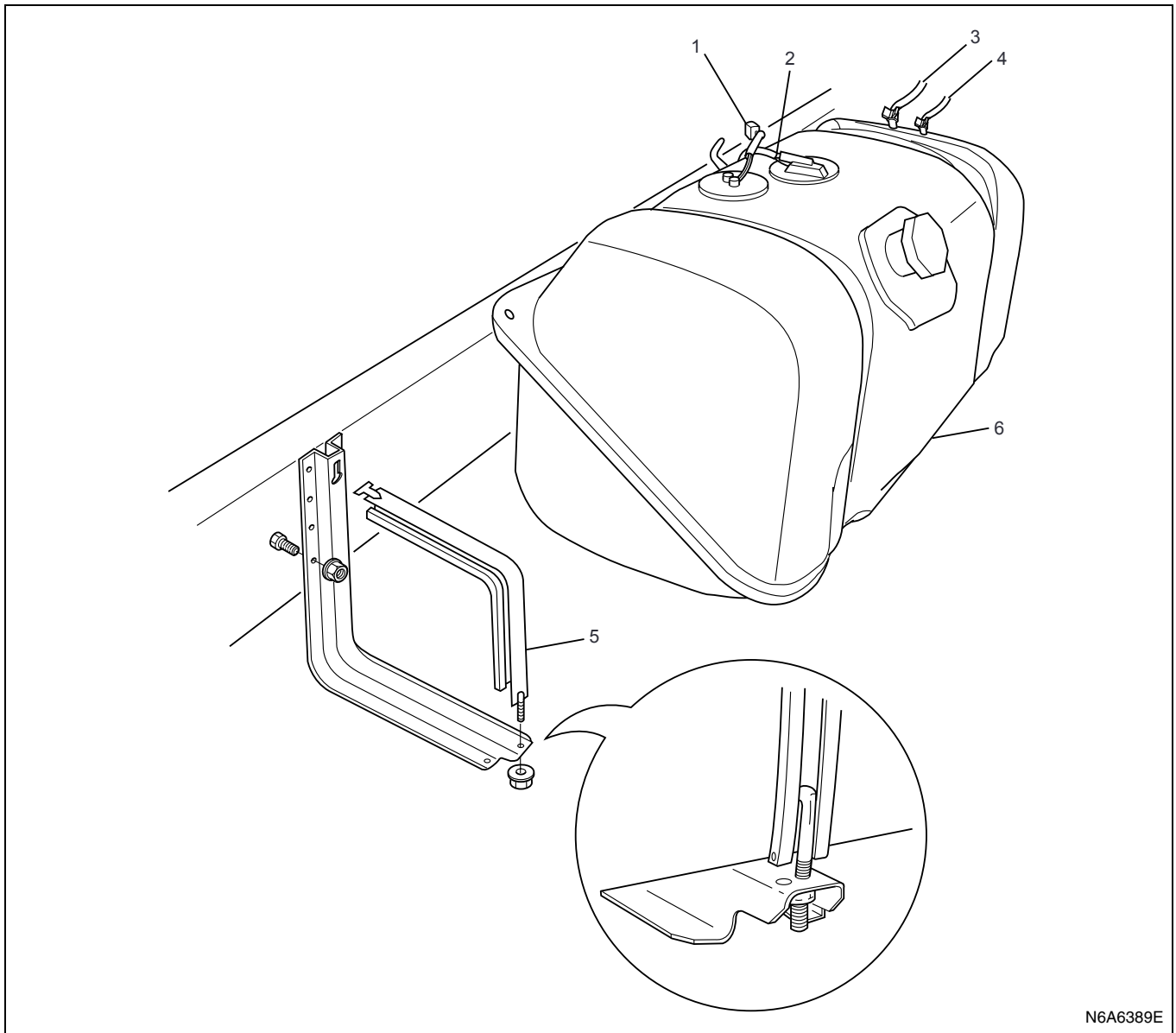


Legend

1. Sensor
2. Connector on The Vehicle Side
3. Harness
4. Drain Cock

Fuel Tank

Components



N6A6389E

Legend

- | | |
|------------------------------|---------------------|
| 1. Fuel Gauge Unit Connector | 4. Fuel Return Hose |
| 2. Evaporated Fuel Hose | 5. Band |
| 3. Fuel Feed Hose | 6. Fuel Tank |

Removal

1. Loosen the fuel filler cap.
2. Drain the fuel from the drain plug.
3. After draining, tighten the drain plug with the specified torque.

Tighten:

20 N·m (2.0 kg·m/15 lb·ft)

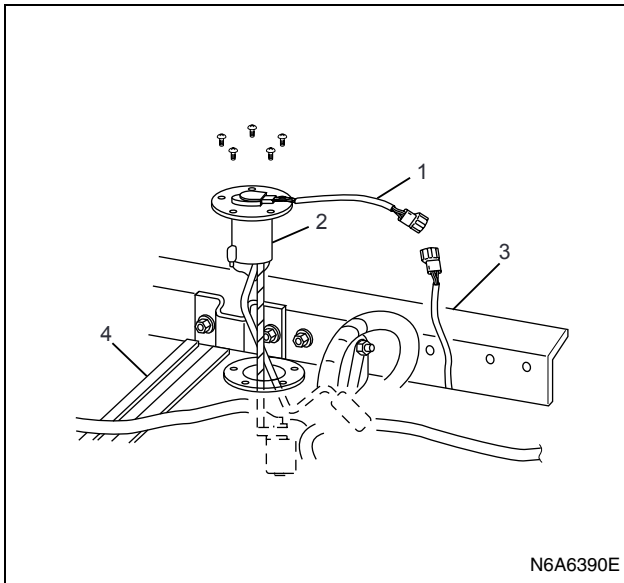
4. Remove the fuel gauge unit connector.
5. Remove the evaporated fuel hose.

6. Remove the fuel feed hose.
7. Remove the fuel return hose.
 - Plug the hose so that fuel does not flow out, and tie it to the frame-side with the opening faced up.
8. Remove the nut of band which installs fuel tank, and remove the band tip in the frame-side.
9. Pull out the fuel tank to the outside.

Caution:

If the fuel tank cannot be pulled out, remove the bracket and pull out the fuel tank downward.

6. Connect the fuel gauge unit connector.


Legend

1. Fuel Gauge Unit Connector
2. Fuel Gauge Unit
3. Cross-member
4. Fuel Tank

Installation

1. Install the fuel tank.

Caution:

When the bracket has been removed while taking out the fuel tank, attach the bracket to the frame and tighten it to the specified torque.

Tighten:

55 N·m (5.6 kg·m/41 lb·ft)

Also, when placing the fuel tank on the bracket, make sure that the rubber part attached on the fuel tank is put onto the bracket.

2. Install the band to the fuel tank and tighten up the nuts with the specified torque.

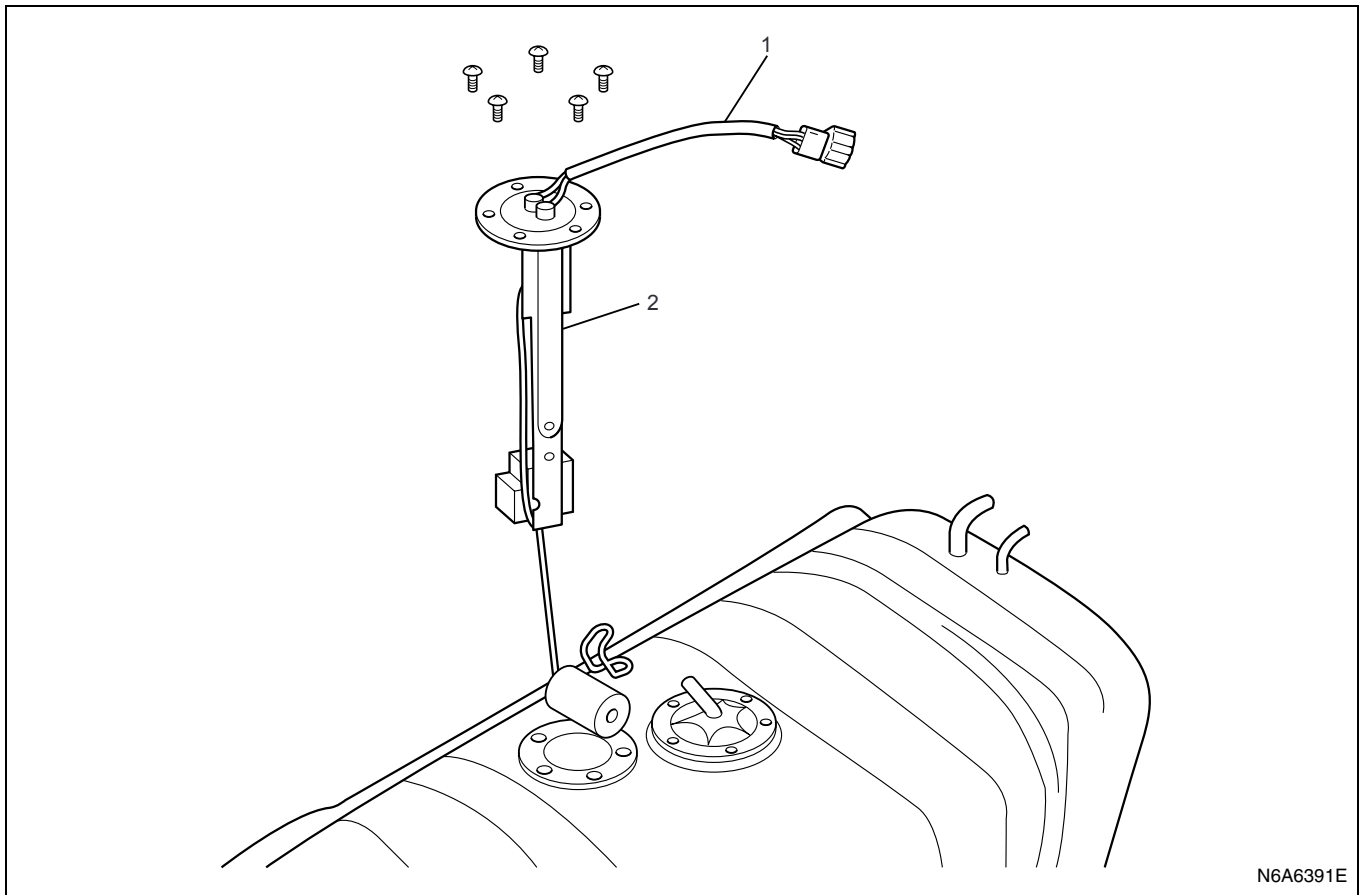
Tighten:

12 N·m (1.2 kg·m/9 lb·ft)

3. Install the fuel return hose.
4. Install the fuel feed hose.
 - Insert the hose into the pipe for more than 25 mm (1.0 in).
5. Install the evaporated fuel hose.
 - Fill the fuel tank with fuel, and tighten the fuel filler cap.
 - Connect the battery earth cable.
 - Make sure there is no fuel leakage from the connector parts of hoses after starting the engine.

Fuel Gauge Unit

Components



Legend

1. Fuel Gauge Unit Connector

2. Fuel Gauge Unit

Removal

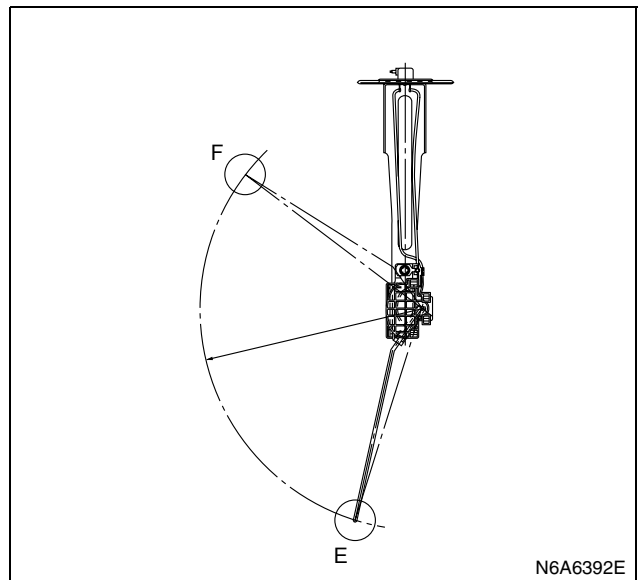
1. Remove the wiring connector from the fuel gauge unit.
2. Remove the installed screw and remove the fuel gauge unit.

Caution:

When removing/installing the fuel gauge unit, take care not to interfere with adjacent parts and not to let the arm etc. deformed. Also, after removing the fuel gauge unit, cover the tank with a cloth to prevent the entry of dust.

Inspection

The fuel tank unit changes the internal resistance according to the float position (fluid level) to operate the indicator of the fuel meter.



1. While moving the float from "E" to "F", measure the resistance between the connector terminals 1J-28 and 2J-28.
2. Check that the fuel level warning lamp comes on when the float is at "E" position. If the result of the inspection is unsatisfactory, replace with a new part.

Installation

Assemble in the reverse order of disassembly.

1. Install the fuel gauge unit.
2. Connect the wiring connector to the fuel gauge unit.

Tightening Torque Specifications

