DETROIT DIESEL

SERIES 60® Service Information

NUMBER: 1–**60**–07 **S.M. REF.:** Refer to 2.5 **ENGINE:** 60 **DATE:** January 2007

SUBJECT: N3 ELECTRONIC INJECTOR

PUBLICATION: 6SE483

The Series 60 Service Manual has been revised. Engine models built from December 1, 2003 to December 31, 2006 will use the N3 Electronic Unit Injector (EUI). The procedures for removal, inspection and installation of the N3 EUI are revised and are available on Power Service Literature (PSL) and in hard copy format.

DETAILS AND REASON

The revised sections of the Service Manual are shown in Table 1.

Section Number	Changes
2.5.2 Removal	Steps 6, 7 and 8 changed
2.5.3.1 Inspection	Steps 2 and 3 changed
2.5.4 Installation	Step 2 added and Step 4 changed
	Step 9 added and Step 10 changed
	Steps 18 through 27 added
	Figure for Pressure Regulator/Check Valve added

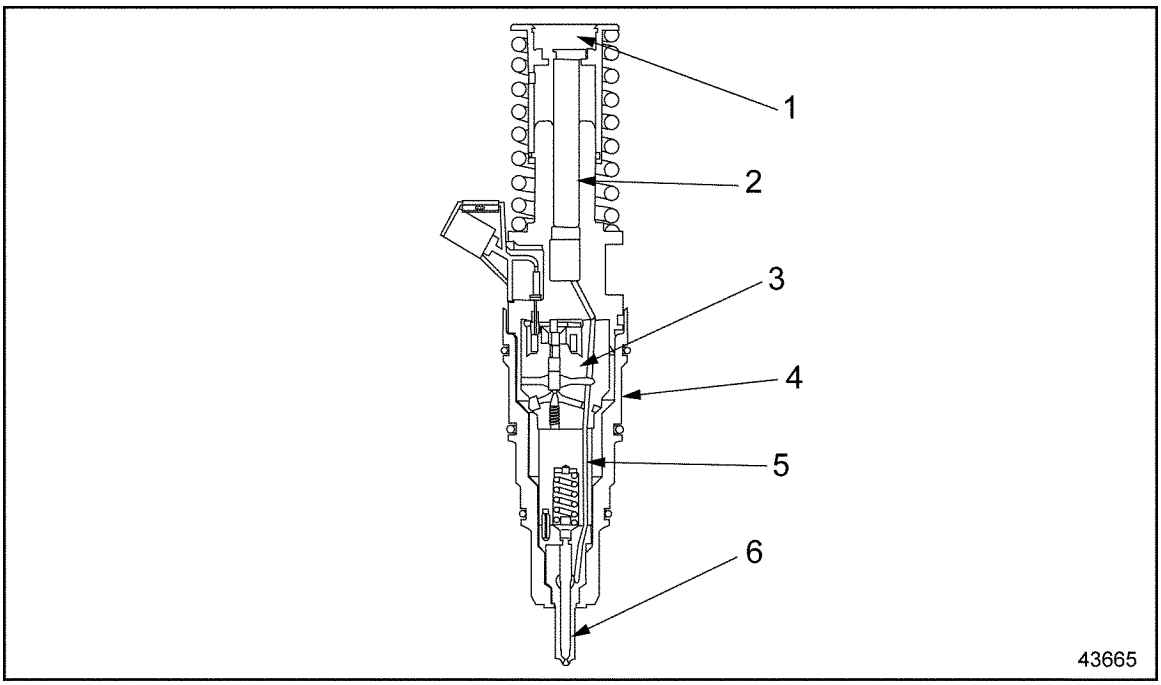
Table 1 Service Manual Revisions

ADDITIONAL SERVICE INFORMATION

Additional service information is available in the Detroit Diesel *Series 60 Service Manual,* 6SE483. The next revision to this manual will include the revised information.

2.5 N3 ELECTRONIC FUEL INJECTOR

Engine models built from December 1, 2003 to December 31, 2006 will use the N3 Electronic Unit Injector (EUI). See Figure 2-1.



1. Injector Follower
2. Plunger
3. Module
4. Injector Nut
5. Injector Spring Cage
6. Nozzle

Figure 2-1 N3 Electronic Unit Injector Cross-Section

The N3 injector is designed as an inline concept. The fuel metering unit or module is positioned under the plunger, so the overall envelope of the N3 is smaller than previous injectors. The N3 has an inwardly opening of solenoid valve which controls beginning of injection and end of injection. The solenoid valve closing point defines the beginning of injection (BOI) and the solenoid valve opening point defines the end of injection (EOI). Pressure is generated by the downward movement of the plunger in combination with the closed solenoid valve. Fuel quantity is metered by the length of time the solenoid valve remains closed. A magnetic core is incorporated into the module. The electrical leads from the core are brought to an external position on the injector through a modular two-pin connector socket.

The advantages of the N3 injector are:

- □ Improved strength.
- □ Reduced external leakage potential.
- □ Compact design.
- □ Reduced weight.

The amount of fuel injected and the beginning of injection timing is determined by the Electronic Control Unit (ECU). The ECU sends a command pulse which activates the injector solenoid. The N3 EUI performs four functions:

- Creates the high-fuel pressure required for efficient injection.
- Meters and injects the exact amount of fuel to handle the load.
- Atomizes the fuel for mixing with the air in the combustion chamber.
- Permits continuous fuel flow for component cooling.

Engine combustion is obtained by injecting, under pressure, a small quantity of accurately metered and finely atomized fuel oil into the cylinder. Metering and timing of the fuel is accomplished by the ECU which actuates the solenoid control valve to stop the free flow of fuel through the injector. When the solenoid control valve closes, fuel is trapped in the injector body and under the plunger. The continuous fuel flow through the injector prevents air pockets in the fuel system and cools those injector parts subjected to high combustion temperatures.

Fuel enters the injector through the fuel inlet opening located around the injector body. See Figure 2-2.

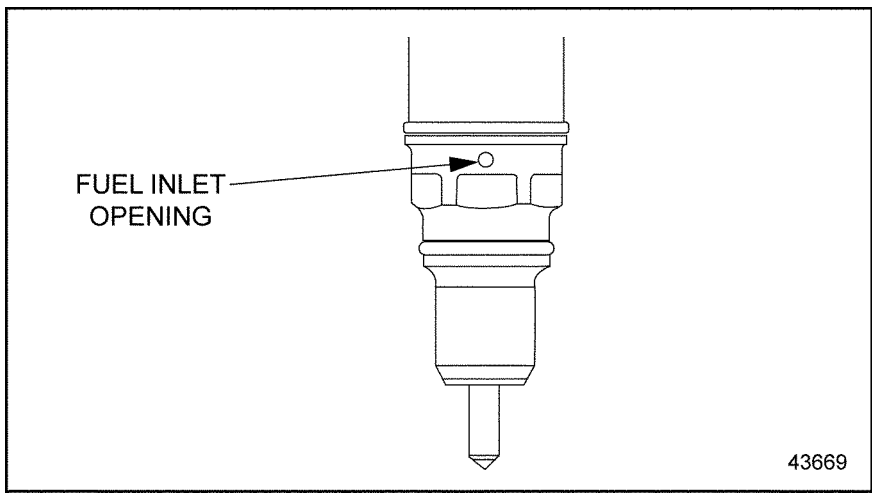


Figure 2-2 N3 Fuel Injector Body

Outlet openings through which the excess fuel oil returns to the fuel return manifold and then back to the fuel tank, are located around the injector nut. See Figure 2-3.

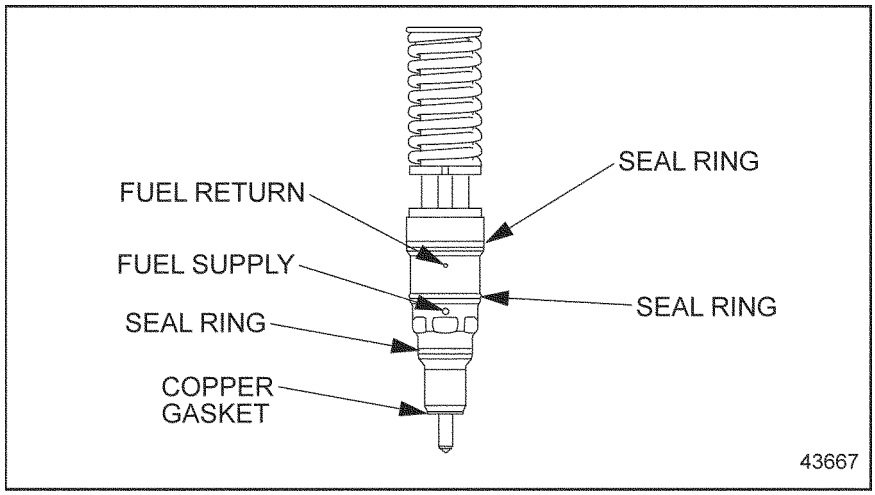


Figure 2-3 N3 Electronic Unit Injector

After entering the nut cavity, the fuel passes through a drilled passage into the module and plunger area. See Figure 2-1.

The plunger operates up and down in the body bore of the injector. The motion of the injector rocker arm is transmitted to the plunger and follower that bears against the follower spring.

As the piston moves approximately two-thirds of the way up in the cylinder on the compression stroke, the injector cam lobe begins to lift causing the injector rocker arm to push down on the follower and the plunger. Just before injection begins, the ECU sends an electronic pulse which turns on the injector solenoid. The energized solenoid creates a magnetic force which closes the control valve and traps fuel under the plunger and passages leading down to the needle valve. The fuel pressure increases as the plunger continues its downward stroke.

This fuel pressure acts on the needle valve. When it creates a force high enough to overcome the valve spring force holding the needle on its seat, the needle valve moves up, allowing the high pressure fuel to spray into the combustion chamber. The high pressure of the fuel passing through the small holes in the nozzle creates a finely atomized spray for combustion within the cylinder.

After the pulse width time has passed, the ECU turns off the current to the injector solenoid. The de-energized solenoid allows a spring to open the control valve, permitting the trapped fuel to spill down, dropping the pressure within the injector. When the pressure is low enough the needle valve closes and ends injection

The beginning of injection and metering of the fuel in relation to the crankshaft position are controlled by the ECU. Injection begins soon after the control valve is closed. The valve closing point known as the injector response time is returned to the ECU. This information is used to monitor and adjust injection timing, thus removing injector-to-injector variation influences on timing. The amount of fuel injected depends on the pulse width stored in the calibration which determines how long the control valve remains closed; the larger the pulse width the longer the valve is closed and the more fuel is injected.

When the injector rocker arm has completed its downward travel the injector follower spring returns it to the starting position. As the plunger moves up fuel enters the injector pumping cavity for another injection cycle. The constant circulation of fuel through the injector renews the fuel supply in the chamber and aids the cooling of the injector.

2.5.1 Replacement of N3 Electronic Unit Injector

To determine if replacement is necessary perform the following procedure. See Figure 2-4.

NOTICE
If the solenoid on N3 Electronic Unit Injector is faulty the injector must be replaced. The solenoid is not repairable.

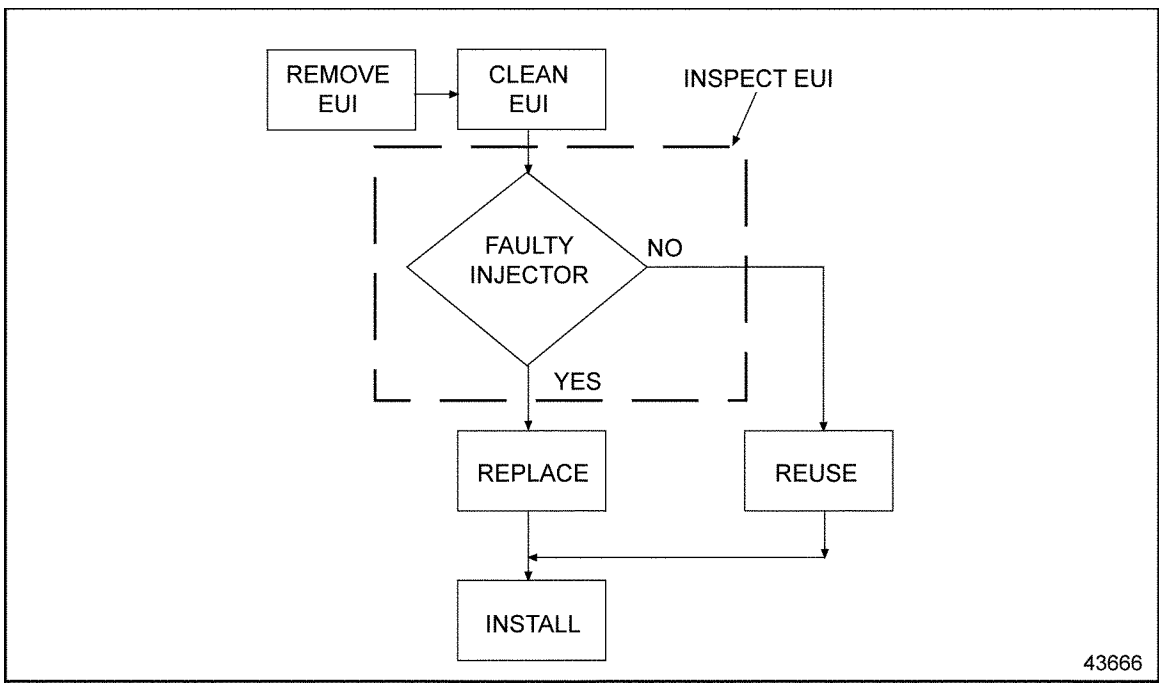


Figure 2-4 Flowchart for Replacement of N3 Electronic Unit Injector

2.5.2 Removal of N3 Electronic Unit Injector

Remove the N3 EUI as follows:

1. Clean the valve rocker cover around its seat on the head, and in the attaching bolt recesses.
   [a] To remove the *one-piece* rocker cover, refer to section 1.6.2.
   [b] To remove the *two-piece* rocker cover, refer to section 1.6.3.
   [c] To remove the *three-piece* rocker cover, refer to section 1.6.5.

WARNING:

EYE INJURY

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 276 kPa (40 psi) air pressure.

NOTICE:

All the fuel must be removed from the cylinder head before removing an injector to prevent the fuel from entering the cylinder and causing hydrostatic lock or washdown. If the head is not thoroughly purged of fuel before an injector is removed, fuel remaining in the fuel manifold will drain into the cylinder filling the piston dome recess. It cannot drain from the dome and, if not removed, can cause hydrostatic lock and bend the connecting rod.

NOTICE:

Do not exceed 276 kPa (40 psi) when blowing compressed air into the cylinder head inlet fitting.

2. Drain the cylinder head fuel gallery by removing the inlet and outlet lines and fuel regulator from the fittings at the rear of the cylinder head. Blow low pressure compressed air into the inlet fitting for 20 to 30 seconds or until all of the fuel is purged from the cylinder head. See Figure 2-5.

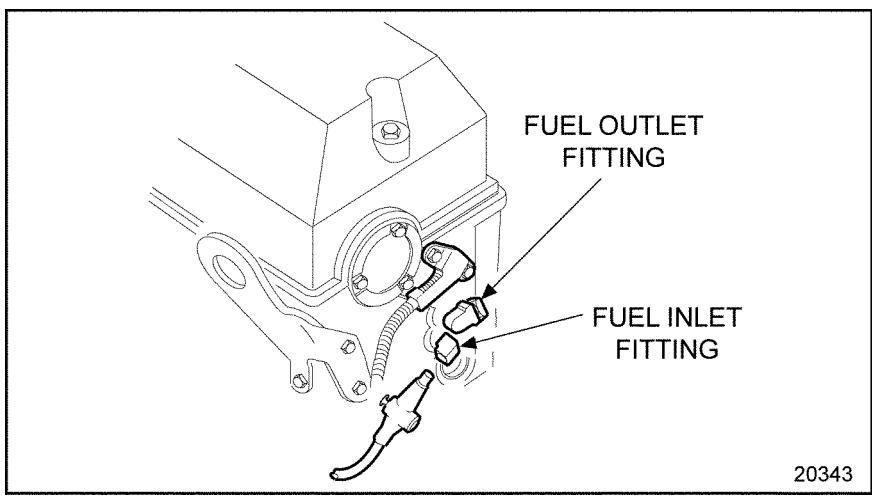


Figure 2-5 Cylinder Head Fuel Fitting Locations

3. Remove the two rocker shaft through-bolts and one nut for each rocker shaft assembly, and lift the rocker shaft assembly off the engine. Refer to section 1.3.2.

4. Disconnect the vehicle battery power before servicing the N3 EUI to prevent failure of the DDEC V ECU.
5. Using injector harness remover J–47383 disengage the locking tang on the harness plug connector. Grasp the connector and gently pull it from the socket.
6. Remove injector hold down bolt and spherical washer. Discard the bolt and spherical washer.

NOTICE:
Extreme care should be used when handling an N3 EUI to avoid costly damage by dropping or otherwise mishandling the N3 EUI.

NOTICE
The N3 EUI must be removed from the cylinder head by applying force on the body surface as shown in Figure 2-6. Removal force must not be applied to any other area on the N3 injector.

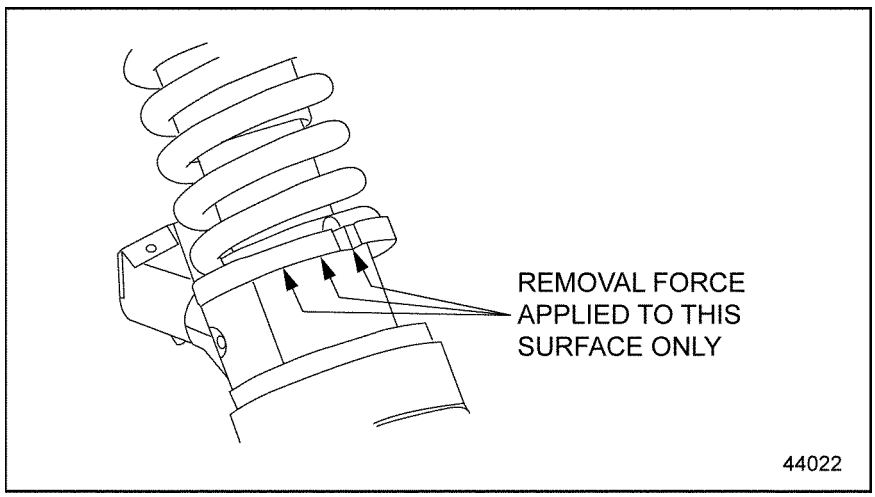


Figure 2-6 N3 Injector Removal Surface

7. Lift the injector from its seat in the cylinder head using the injector remover tool J–47372 Note the cylinder position for each injector removed. See Figure 2-7.

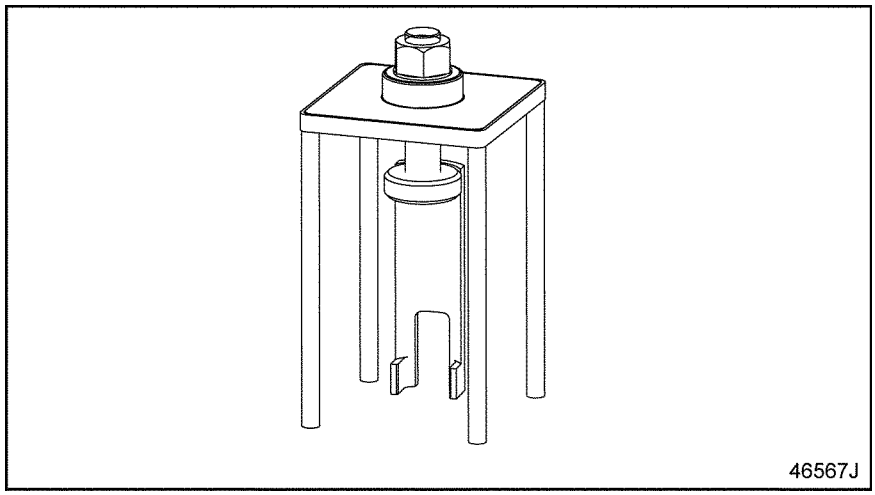


Figure 2-7 Injector Remover Tool

NOTICE:
Avoid cleaning the spray holes to prevent damage and plugging. Do not wire brush.

8. Cover the injector hole in the cylinder head to keep out foreign material. Carefully remove carbon from the injector exterior in the area where the tip joins the nut, using a clean rag with clean diesel fuel.

2.5.3 Disassembly of N3 Electronic Unit Injector

On a Series 60 engine that uses the N3 EUI, only the injector seal rings and injector washer are serviceable. The injector must not be disassembled.

2.5.3.1 Inspection of the N3 Electronic Unit Injector

Inspect the N3 Electronic Unit Injector as follows:

1. Inspect the N3 injector body for visible damage. Replace the injector if damaged.

2. Discard the three injector O-rings. See Figure 2-8.

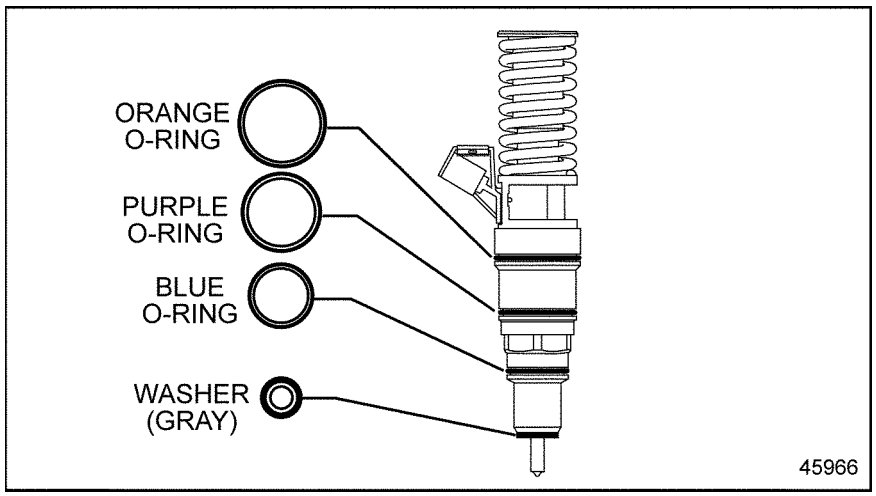


Figure 2-8 N3 Injector Seal Rings

3. Discard the injector washer on the bottom of the injector. See Figure 2-8.

2.5.4 Installation of the N3 Electronic Unit Injector

Install as follows:

1. If the fuel system is contaminated:
   [a] Drain the fuel tanks and refill with clean fuel. Refer to section 14.6.2.
   [b] Replace both filters and clean the fuel/water separator, if equipped. Refer to section14.6.1.
   [c] Inspect the fuel injectors for damage and replace as required.
2. If the oil system is contaminated change the engine oil and filters. Refer to section3.5 for engine oil filter change and refer to section 14.6.1 engine oil change.
3. If the coolant system is contaminated with fuel, flush and reverse flush the system. Refer to section 14.6.4.

NOTICE:
Leftover fuel must be removed from the injector bore before injector installation. If fuel is trapped between the top of the injector hole tube and the lower injector O-ring seal, it may seep down to the injector hole tube seal ring, causing swelling and possible seal leakage.

4. Using a clean lint free rag, wipe up any fuel remaining in the injector tube bore.

NOTICE:
Injector O-ring seals, injector washers and the injector hold down crab bolt are considered one-use items and cannot be reused. Any time an injector is removed, all three injector O-ring seals, injector washers and the injector hold down crab bolt must be replaced with new parts. Failure to replace O-ring seals, injector washer and the injector hold down crab bolt can result in leakage.

5. Check to make sure the injector bore is thoroughly clean. Using brushes J–47374

NOTE:
The injector tube bore should be cleaned and inspected for damage before installation of the N3 Electronic Unit Injector. Refer to section 2.6.1.1.

6. Install a new washer on the injector, ensure the smooth side of the washer faces down into the cylinder head. The stepped side of the washer must face up to the injector.

NOTE:
All external O-rings must be lubricated prior to installation into the cylinder head.

7. Apply a thin coat of clean fuel to the injector seal rings and install them in the injector nut ring grooves. Make sure the seals are properly seated. See Figure 2-9.

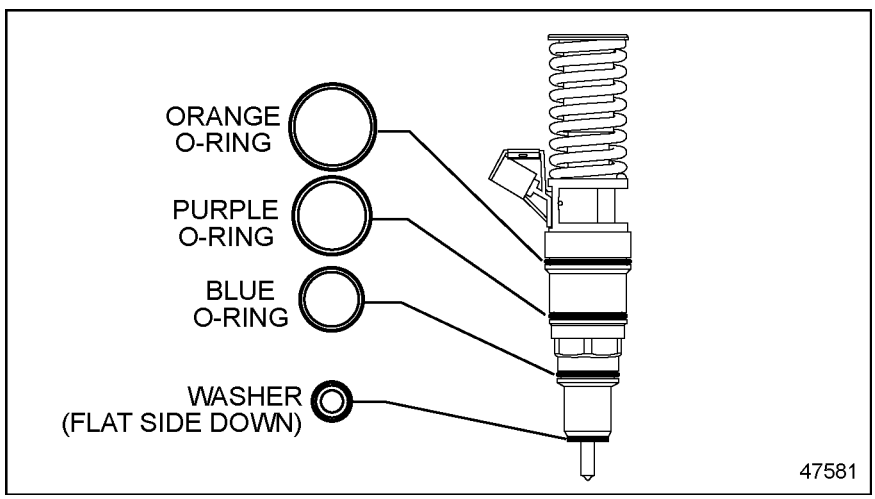
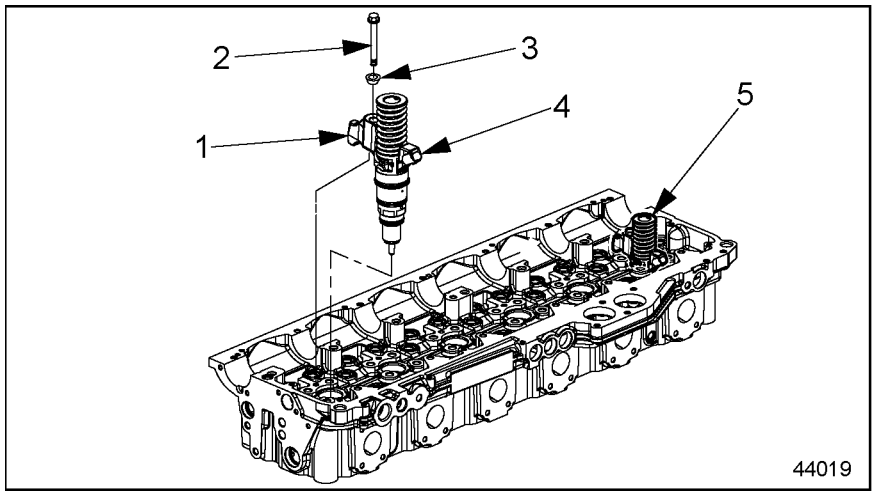


Figure 2-9 N3 Injector Seal Rings

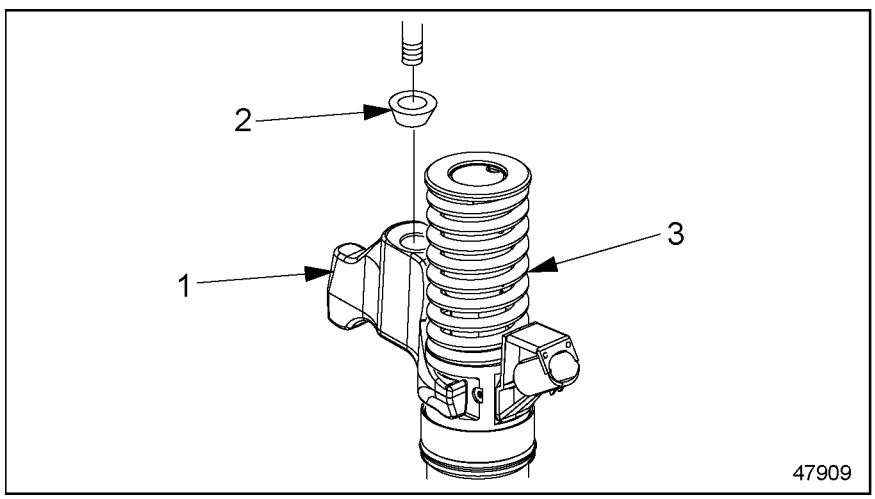
8. Install the injector and hold down clamp as an assembly into its respective injector tube bore, taking care not to damage the injector O-rings. See Figure 2-10.



1. Injector Clamp
2. Bolt
3. Washer
4. N3 Injector
5. N3 Injector Installed

Figure 2-10 N3 Injector and Related Parts

9. Install a new injector hold down clamp spherical washer. The curved side of the washer fits into a corresponding curved cup in the injector hold down clamp. See Figure 2-11.



1. Clamp
2. Washer
3. E3 Injector

Figure 2-11 Injector Washer Installation

10. Install injector assembly with a new bolt . Torque injector assembly using the following procedure:
    [a] Torque the bolt to 50 N·m (37 lb·ft).
    [b] Loosen the bolt 60° (1/6 of a turn, or one bolt flat). Do not fully loosen the bolt.
    [c] Torque the bolt to 35 N·m (26 lb·ft).
    [d] Tighten the bolt 90° (1/4 of a turn).
11. Using injector installer J–47335 install the N3 EUI harness plug into the injector connector making sure the locking tang clicks into place. See Figure 2-12.

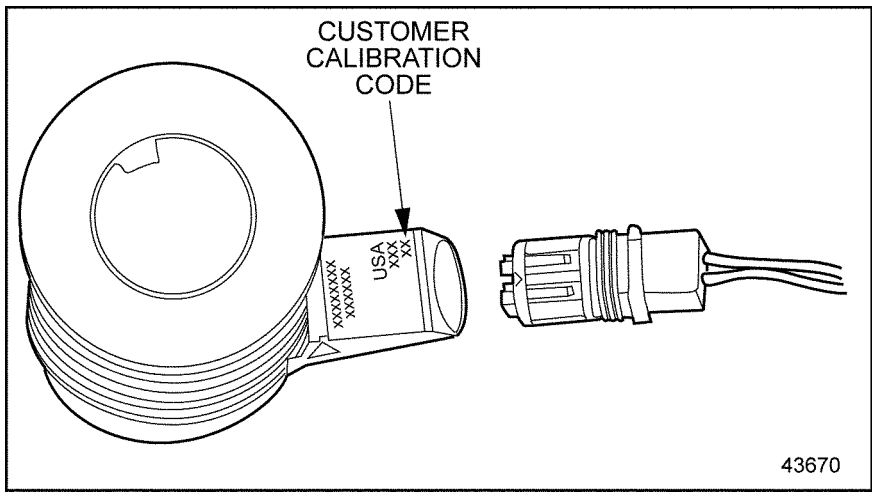
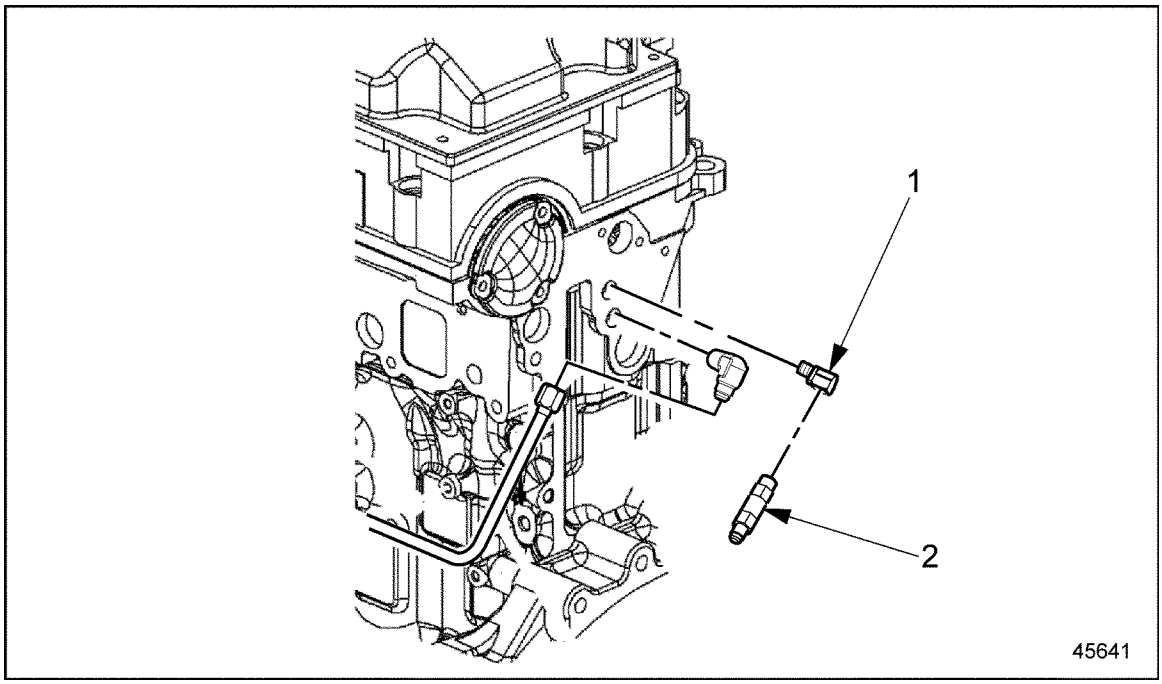


Figure 2-12 N3 Injector and Harness Connection

12. Install the rocker arm shafts, with rocker arms in place. Refer to section 1.3.3.
13. Adjust the intake and exhaust valve clearances and injector height. Refer to section 13.2.
14. Install the inlet fuel line to the fitting at the rear of the cylinder head
15. Record the injector calibration code from the name plate with the proper cylinder location. See Figure 2-12.
16. Install the rocker cover. For one-piece valve rocker cover, refer to section 1.6.8. For two-piece and three piece valve rocker cover, refer to section1.6.9.

17. Flush the injectors and cylinder head fuel passages by removing the pressure regulator/check valve from the 90° elbow in the cylinder head fuel return port. See Figure 2-13.



1. 90° Elbow
2. Pressure Regulator/Check Valve

Figure 2-13 Pressure Regulator/Check Valve

18. Connect a fuel line to the 90° elbow and route it to a separate container.
19. Disconnect the engine sensor harness 68 pin connector from the Electronic Control Unit (ECU), or remove the fuse breaker in the vehicle that powers the ECU.
20. Reconnect battery power.
21. Using the starter, crank the engine three times for 15 seconds each time. Allow sufficient time between cranking periods to allow the starter to cool. Fuel should be flowing out of the return line into the container.
22. Remove the fuel line from the 90° elbow in the cylinder head fuel return port.
23. Install the pressure regulator/check valve and torque to 23 N·m (17 ft·lb). See Figure 2-13.
24. Connect the engine sensor harness to the ECU, or install the fuse breaker in the vehicle to power the ECU.
25. Use DDDL to enter the injector calibration codes. For instructions on entering calibration codes use the DDDL help function.
26. Verify installation of N3 Electronic Unit Injector. Refer to section 12.7.

DETROIT DIESEL
CORPORATION

13400 Outer Drive, West / Detroit, Michigan 48239-4001
Telephone: 313-592-5000
www.detroitdiesel.com