DDC-SVC-MAN-0037 2008

DD15™ Fuel System Technican's Guide

DETROIT DIESEL
DEMAND PERFORMANCE℠

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CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

CALIFORNIA
Engine Idle Limiting Standard Notice

Vehicles with engines certified by the State of California are equipped with software features making them compliant with the California Engine Idle Regulations. In order to meet this regulation, the engine control strategy is generally configured to automatically shut down the engine after five minutes of continuous idle operation. This shutdown feature is not an engine malfunction and is required to meet the California emission regulations.

ENGINE EXHAUST

Consider the following before servicing engines:

WARNING:

PERSONAL INJURY

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

TRADEMARK INFORMATION

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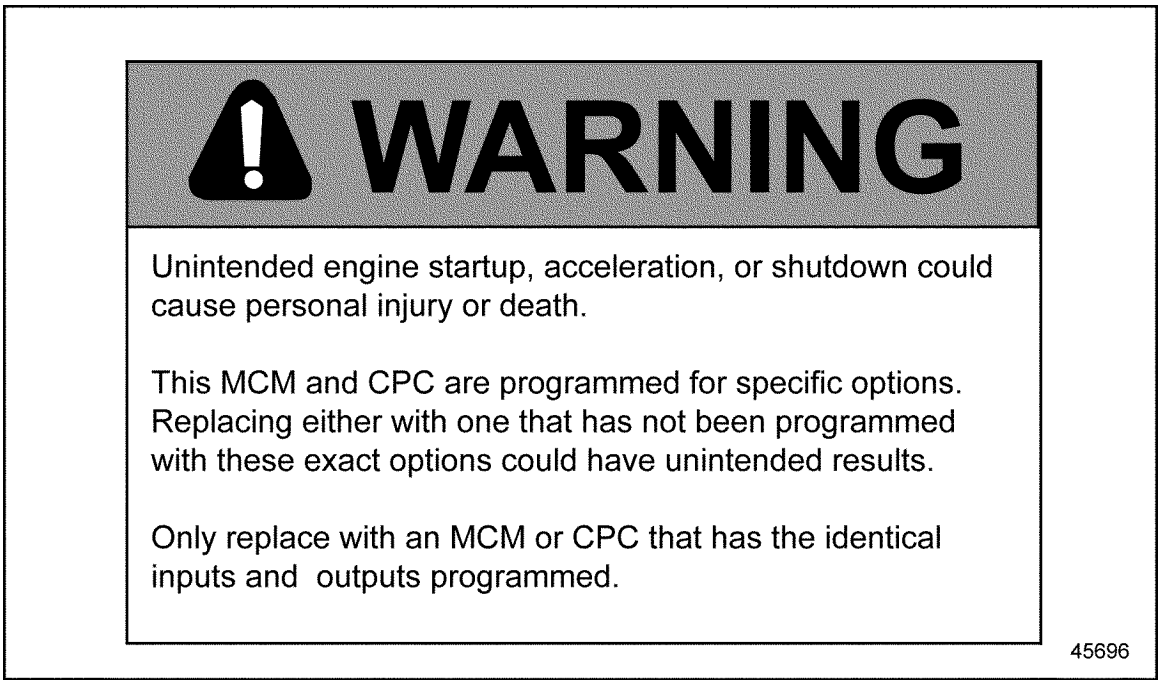
MCM/CPC WARNING



SOFTWARE UPGRADES

NOTE:
These engines are equipped with Daimler software. This software generally assures optimal engine performance. The installation of software upgrades may cause minor changes in features and engine performance.

ABSTRACT

This manual provides instruction for troubleshooting the 2007 Electronic Controls engines.

Specifically covered in this manual are troubleshooting and repair steps that apply to the 2007 HDEP Electronic Controls.

SAFETY INSTRUCTIONS

To reduce the chance of personal injury and/or property damage, the instructions contained in this Troubleshooting Manual must be carefully observed. Proper service and repair are important to the safety of the service technician and the safe, reliable operation of the engine.

If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part number. Do not use a replacement part of lesser quality. The service procedures recommended and described in this manual are effective methods of performing repair. Some of these procedures require the use of specially designed tools. Accordingly, anyone who intends to use a replacement part, procedure or tool which is not recommended, must first determine that neither personal safety nor the safe operation of the engine will be jeopardized by the replacement part, procedure or tool selected.

It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during repair, or the possibility that improper repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is impossible to warn personnel of the possible hazardous consequences that might result from failure to follow these instructions.

A LETTER TO THE TECHNICIANS

Technicians today are required to have computer skills, excellent comprehension of the written word and possess an extensive diagnostic understanding of the various technological systems and components. Technicians today must perform at a higher level of efficiency and competency than their predecessors and at the same time furnish professional quality support.

As the leader in engine computer systems and technology, Detroit Diesel Corporation remains focused on providing excellence in products, service support and training. As products become more and more advanced, technicians must become specialized in multiple areas. This manual is designed with that thought in mind. The Detroit Diesel EPA07 DD15 Fuel System Technician's Guide will provide you with concentrated information that will allow you to excel in 2008 fuel system technology.

REVISION NOTIFICATION

Modifications to this manual are announced in the form of Service Information Bulletins.

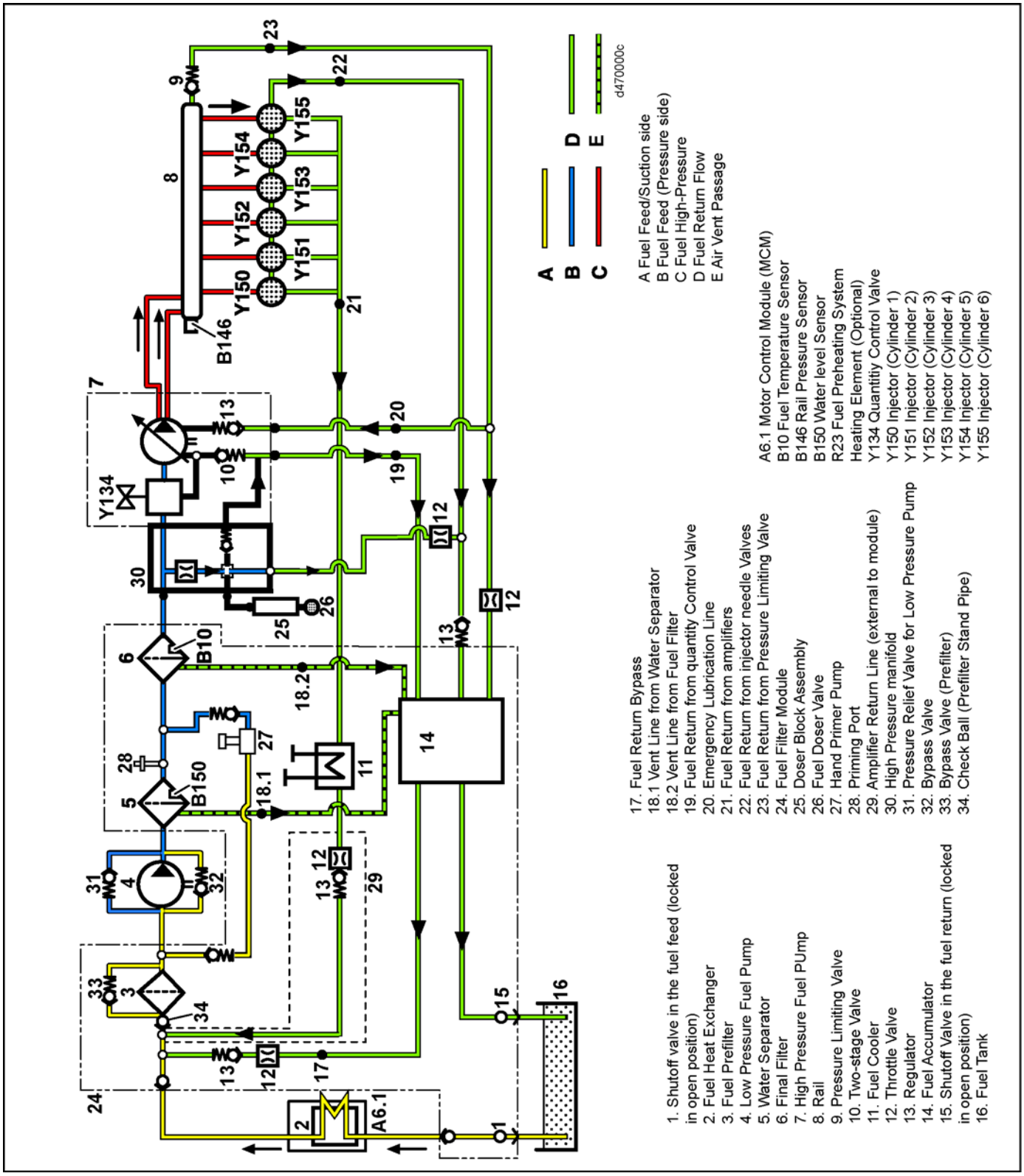
TABLE OF CONTENTS

1 THE FUEL SYSTEM

The fuel supply ensures that the fuel required for combustion is available under all operating conditions in sufficient quantity, in the correct sequence and at the required pressure. Fuel to the individual cylinders is supplied from the Amplified Pressure Common Rail System. Fuel is supplied to the (APCRS) from the fuel low pressure circuit.

The fuel low pressure circuit ensures that the fuel is cleaned and is provided in sufficient quantities and at the required pressure to the APCRS.

The following diagram and flow description are a Version Five fuel system.



The low pressure fuel pump (4), which is a gear pump, supplies fuel to the fuel low pressure circuit. When the engine is started, the fuel pump (4) pulls fuel from the fuel tank (16) and delivers it through the shutoff valve in the fuel feed (1) line to the fuel filter module (24). The shutoff valve in the fuel feed (1) prevents fuel leaking out when disassembling the fuel line between the fuel tank (16) and the fuel filter module (24). The fuel flows from the fuel filter module (24) to the fuel heat exchanger (2) located on the Motor Control Module (MCM) (A6.1). The electronic components of the MCM (A6.1) are cooled via the fuel heat exchanger (2). The fuel in the fuel filter module (24) first passes into the fuel prefilter (3) where large dirt particles greater than 100 micron are filtered out. A check ball which is located at the fuel inlet of the fuel prefilter (3) prevents emptying of the suction line to the fuel tank (16). Below fuel prefilter (3) an optional fuel preheater (R23) can be installed. The fuel preheater (R23) warms the fuel during low outside temperatures ensuring the flowability of the fuel.

The fuel which has been cleaned by the fuel prefilter (3) passes out of the fuel filter module (24) to the low pressure fuel pump (4). From there the fuel is delivered back into the fuel filter module (24) and to the water separator (5). The water inside the fuel is separated out by the water separator (5) and begins to fall into the water accumulator. If the water level in the water accumulator reaches its maximum level, this will be detected by the water level sensor (B150). The MCM (A6.1) transmits an appropriate message for illuminating the indicator lamp. At this point, the indicator lamp will inform the driver that the separated water needs to be drained off. After leaving the water separator (5) the fuel flows through the final filter (6). Both the water separator (5) and final filter (6) elements filter out fine-grained contaminants greater than 2 microns.

A Supply Fuel Temperature Sensor (B10) located on the bottom of the fuel filter module detects the current fuel temperature. The MCM interrupts this information and uses it for fuel mass calculations.

Designed into the water separator (5) and final filter (6) elements is a ventilation bore that allows trapped air to escape. If air is trapped in the water separator (5) or the final filter (6), for example due to replacement of a filter element, the trapped air will escape through the ventilation bore and vent lines (18.1, 18.2) into the fuel accumulator (14). From there the air is then dissipated into the fuel tank (16). Once all of the contaminants have been filtered out by the final filter (6), the fuel is delivered out of the fuel filter module (24) to the quantity control valve (Y134). The high pressure fuel pump (7) pressurizes the fuel up to 900 bar (13,053 psi) and is then fed to the fuel rail (8). The excess fuel from the quantity control valve (Y134) and high pressure fuel pump (7) is routed past the 2-stage valve (10). The excess fuel is then routed to the fuel accumulator (14).

The two-stage valve (10) has a number of tasks:

- It is closed at pressures in the low pressure circuit below 3 bar relative to high pressure pump backflow pressure to ensure best filling under cranking speed where low pressure pump flow is low.
- It guarantees lubrication of the high pressure fuel pump components if the pressure in the low pressure circuit is above 3 bar relative to high pressure pump backflow pressure. The lubrication path is fully open at 3.5 bar.
- It ensures that in overrun conditions the pressure at the inlet to the high pressure pump is limited by opening of the backflow path. This function avoids pressures above burst pressure level of the filter module. If the pressure at the high pressure pump inlet exceeds 4.7 bar relative to backpressure, excess fuel is routed to the return path.

If the maximum rail pressure is exceeded (leakage at 1075 bar, open at 1250 bar), the pressure limiting valve (9) opens and passes the excess fuel to the fuel return. If the system pressure drops below 3 bar (43 psi) due to the opened pressure limiting valve (9), part of the excess fuel is taken from the fuel return from the pressure limiting valve (23) to be used for lubrication of the high pressure fuel pump. The fuel taken for lubrication is fed through the emergency lubrication line (20) and the regulator (13) to the fuel high pressure pump (7). The head pressure required to do this is generated by the throttle valve (12) which is located upstream of the fuel accumulator (14). The excess and warmed fuel from the amplifier circuits of each individual injector is routed through a passage within the cylinder head. This fuel is fed via the amplifier fuel return (21) line through the fuel cooler (11), throttle (12), and finally a regulator (13). This fuel is feed to the fuel filter module in front of the prefiler (3). The fuel cooler (11) serves to lower the temperature of the fuel to about 120°C. The throttle valve (12) in the amplifier fuel return (21) line dampens pressure peaks which occur during activation of the injector amplifiers.

The excess fuel for the injector needle valves is also routed through a bore in the cylinder head. The fuel return from the injector needle valves (22) flows through a regulator (13) and into the fuel accumulator (14). The regulator (13) has the task of regulating back pressure of about 1 bar (14.5 psi) relative to back pressure while the engine is running. From the fuel accumulator (14) part of the returned fuel is delivered directly upstream of the fuel prefilter (3) in the fuel low pressure circuit.

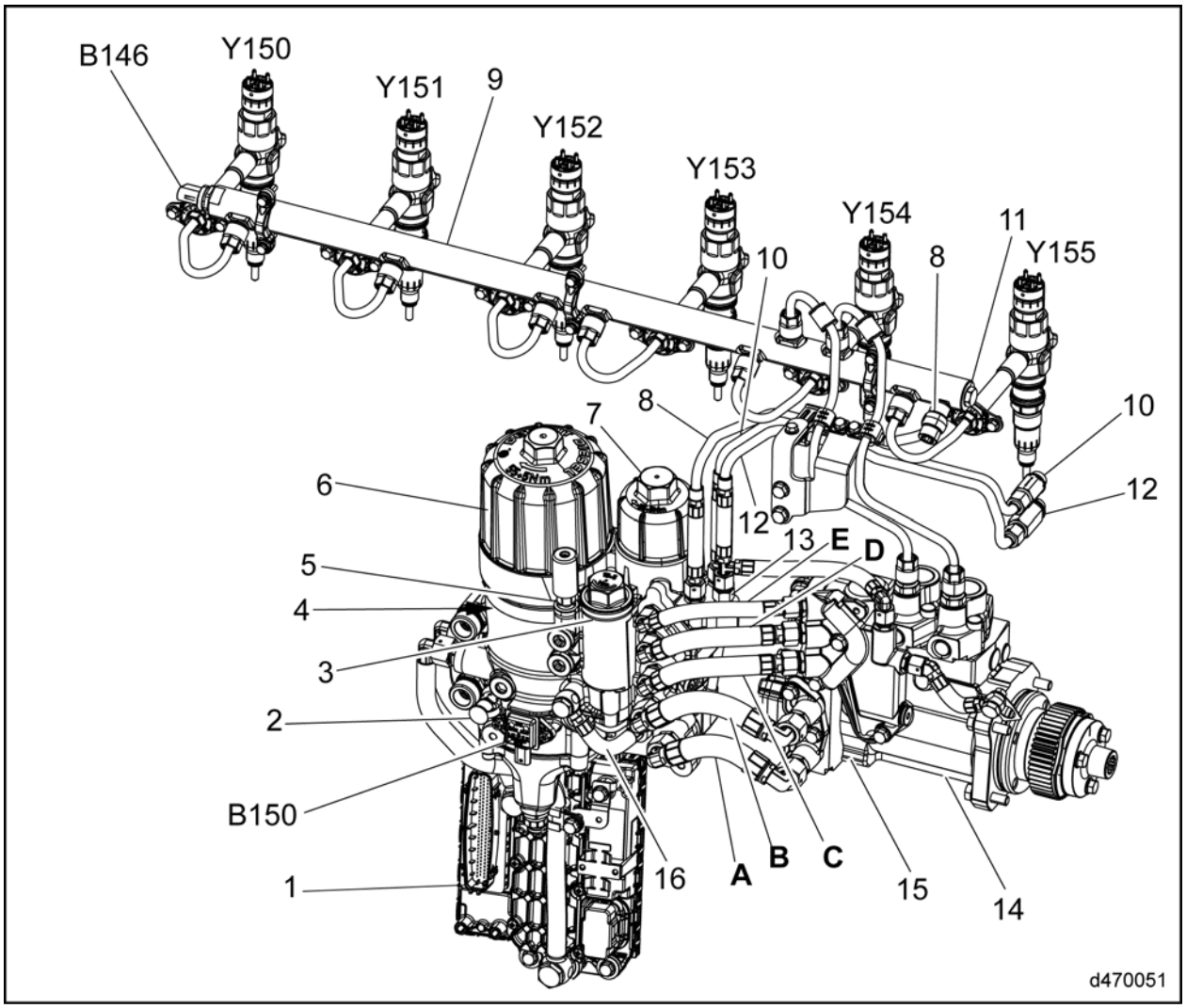
The fuel quantity is determined by the throttle valve (12) and the regulator (13) in the fuel return (17) bypass. This returned fuel leads to a lower suction load for the low pressure fuel pump (4). The remaining fuel from the fuel accumulator (14) is led back to the fuel tank (16). The shutoff valve in the fuel return (15) prevents fuel leaking out when disassembling the fuel line between the fuel tank (16) and the fuel filter module (24).

1.1 AMPLIFIED PRESSURE COMMON-RAIL SYSTEM

The high pressure circuit of the APCRS consists of the following components:

- □ Fuel High Pressure Pump (14)
- □ Rail (9)
- □ Pressure Limiting Valve (11)
- □ Rail Pressure Sensor (B146)
- □ Quantity Control Valve (Y134)
- □ Injector (cylinder 1) (Y150)
- □ Injector (cylinder 2) (Y151)
- □ Injector (cylinder 3) (Y152)
- □ Injector (cylinder 4) (Y153)
- □ Injector (cylinder 5) (Y154)
- □ Injector (cylinder 6) (Y155)

Excess fuel in the fuel high pressure circuit passes through the fuel return line (D), to the fuel return line pressure limiting valve (8) and two fuel return lines of the injectors (12) back into the fuel low pressure circuit.



1. MCM Heat Exchanger
2. Priming Port
3. Fuel Prefilter
4. Fuel Filter Module
5. Hand Primer Pump
6. Water Separator
7. Final Filter
8. Fuel Return from Pressure Limiting Valve
9. Fuel Rail
10. Fuel Return from Injectors Amplifiers
11. Pressure Limiting Valve
12. Fuel Return for Injector Needle Valves
13. Regulator
14. High Pressure Fuel Pump
15. Low Pressure Fuel Pump
16. Amplifier Return Line (External to Module)

B146. Rail Pressure Sensor

B150. Water Level Sensor

A. Low Pressure Fuel Pump Outlet
B. Low Pressure Fuel Pump Inlet
C. High Pressure Fuel Pump Outlet
D. High Pressure Fuel Pump Inlet
E. High Pressure Fuel Pump Emergency Lubrication Line

2 SAFETY

The service procedures recommended by Detroit Diesel and described in this Technicians Guide are effective methods of performing service and repairs. Some of these procedures may require the use of tools specially designed for this purpose.

Accordingly, anyone who intends to use a replacement part, service procedure, or tool that is not recommended by Detroit Diesel must first determine that neither their safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure, or tool selected.

This technician's guide contains various work procedures that must be carefully observed in order to reduce the risk of personal injury during service or repair or the possibility that improper service or repair may damage the fuel system components. It is also important to understand that these work procedures are not exhaustive, because it is impossible for Detroit Diesel to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

WARNING:

PERSONAL INJURY

To avoid injury, use care when working around moving belts and rotating parts on the engine.

A service technician can be severely injured if caught in the pulleys, belts, or rotating parts of an engine that is accidentally started. To avoid personal injury, observe the precautions in this section before starting to work on the engine, no matter what task is being performed.

2.1 GENERAL SAFETY PRECAUTIONS TO OBSERVE WHEN WORKING ON THE SYSTEM

The following safety measure is essential when servicing components of the fuel system.

WARNING:

PERSONAL INJURY

To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Residual high fuel pressure may be present within the circuit.

2.1.1 EXHAUST (START/RUN ENGINE)

Before starting and running the engine, adhere to the following safety precautions:

CAUTION:

EXHAUST FUMES

To avoid injury or injury to bystanders from fumes, engine or vehicle fuel system service operations should be performed in a well ventilated area.

WARNING:

HOT EXHAUST

During parked regeneration the exhaust gases will be extremely HOT and could cause a fire if directed at combustible materials. The vehicle must be parked outside.

WARNING:

PERSONAL INJURY

To avoid injury, never remove any engine component while the engine is running.

WARNING:

PERSONAL INJURY

To avoid injury from hot surfaces, wear protective gloves, or allow engine to cool before removing any component.

WARNING:

PERSONAL INJURY

To avoid injury when removing or installing a heavy engine component, ensure the component is properly supported and securely attached to an adequate lifting device to prevent the component from falling.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

2.1.2 FLUIDS AND PRESSURE

Be extremely careful with fluids under pressure.

WARNING:

FIRE AND TOXICITY

Some pressurized fluid may be trapped in the system. To avoid personal injury, loosen all connections slowly to avoid contact with fluid. When required, spray fluid into a proper container. The engine starting fluid used in DDEC Ether Start Systems contains extremely flammable and toxic substances.

WARNING:

PERSONAL INJURY

To avoid injury from penetrating fluids, do not put your hands in front of fluid under pressure. Fluids under pressure can penetrate skin and clothing.

Fluids under pressure can have enough force to penetrate the skin. These fluids can infect a minor cut or opening in the skin. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can result without immediate medical treatment.

2.1.3 GLASSES

Select appropriate safety glasses for the job. It is especially important to wear safety glasses when using tools such as hammers, chisels, pullers, or punches.

CAUTION:

EYE INJURY

To avoid injury from flying debris, wear a face shield or goggles.

2.1.4 FIRE

Keep a charged fire extinguisher within reach. Be sure you have the correct type of extinguisher for the situation.

Fire Extinguisher	Work Environment
Type A	Wood, Paper, Textile, and Rubbish
Type B	Flammable Liquids
Type C	Electrical Equipment

Fire Extinguisher	Work Environment
Type A	Wood, Paper, Textile, and Rubbish
Type B	Flammable Liquids
Type C	Electrical Equipment

Table 2-1 The Correct Type of Fire Extinguisher

WARNING:

FIRE

To avoid injury from fire caused by heated diesel-fuel vapors:

- **Keep those people who are not directly involved in servicing away from the engine.**
- **Stop the engine immediately if a fuel leak is detected.**
- **Do not smoke or allow open flames when working on an operating engine.**
- **Wear adequate protective clothing (face shield, insulated gloves and apron, etc.).**
- **To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.**

2.1.5 BATTERIES

Electrical storage batteries give off highly flammable hydrogen gas when charging and continue to do so for some time after receiving a steady charge.

Disconnect the battery from the starting system by removing one or both of the battery cables (disconnect negative [ground] cable first). With the electrical circuit disrupted, accidental contact with the starter button will not produce an engine start.

WARNING:

Battery Explosion and Acid Burn

To avoid injury from battery explosion or contact with battery acid, work in a well ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:

- **Flush your skin with water.**
- **Apply baking soda or lime to help neutralize the acid.**
- **Flush your eyes with water.**
- **Get medical attention immediately.**

2.1.6 CLOTHING

Make sure that safe work clothing fits and it is in good condition. Use work shoes that are sturdy and rough soled. Bare feet, sandals, or sneakers are not acceptable foot wear when adjusting and/or servicing an engine. Do not wear rings, wrist watches, bracelets, necklaces, and loose fitting clothing that could catch on moving parts causing serious injury.

WARNING:

PERSONAL INJURY

To avoid injury when working near or on an operating engine, remove loose items of clothing and jewelry. Tie back or contain long hair that could be caught in any moving part causing injury.

2.1.7 AIR

Observe the following caution when using compressed air.

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.

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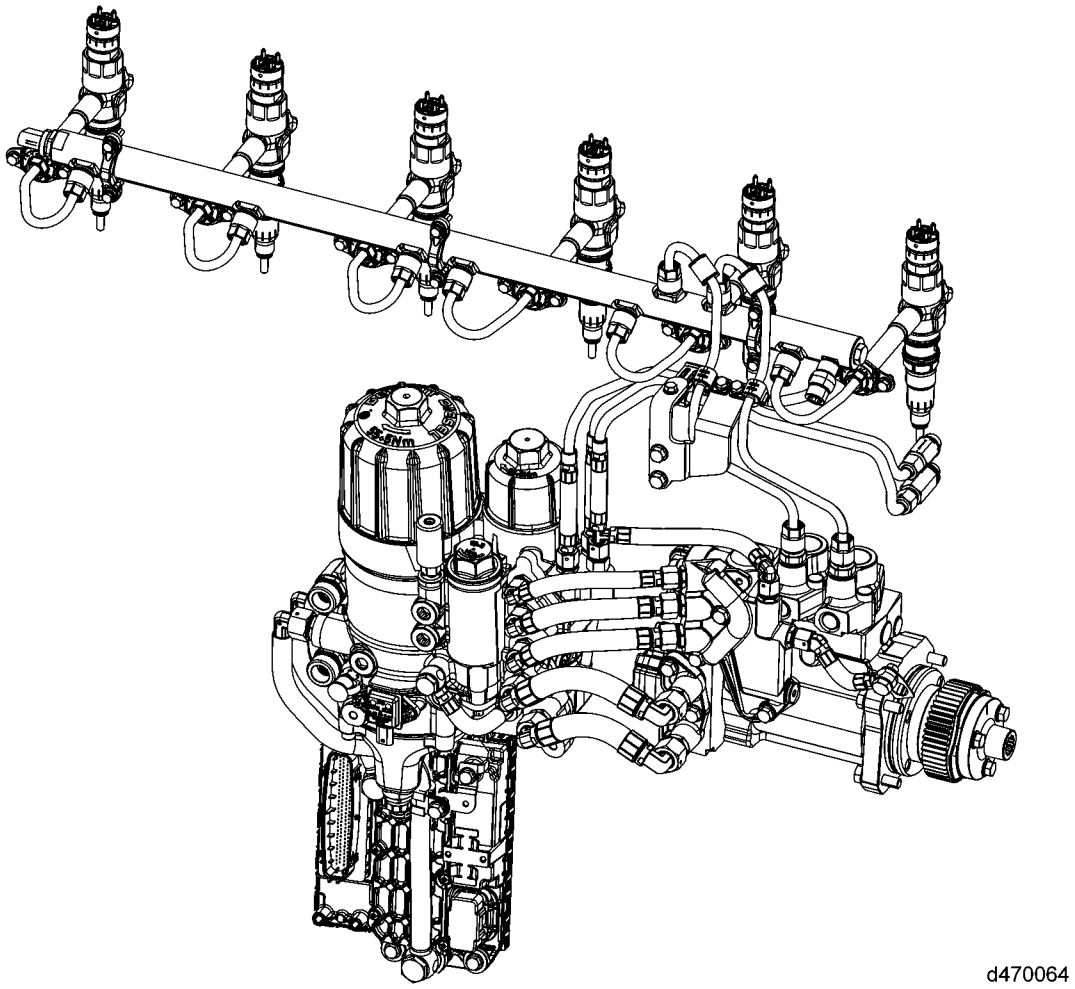
3 FUEL SYSTEM COMPONENTS



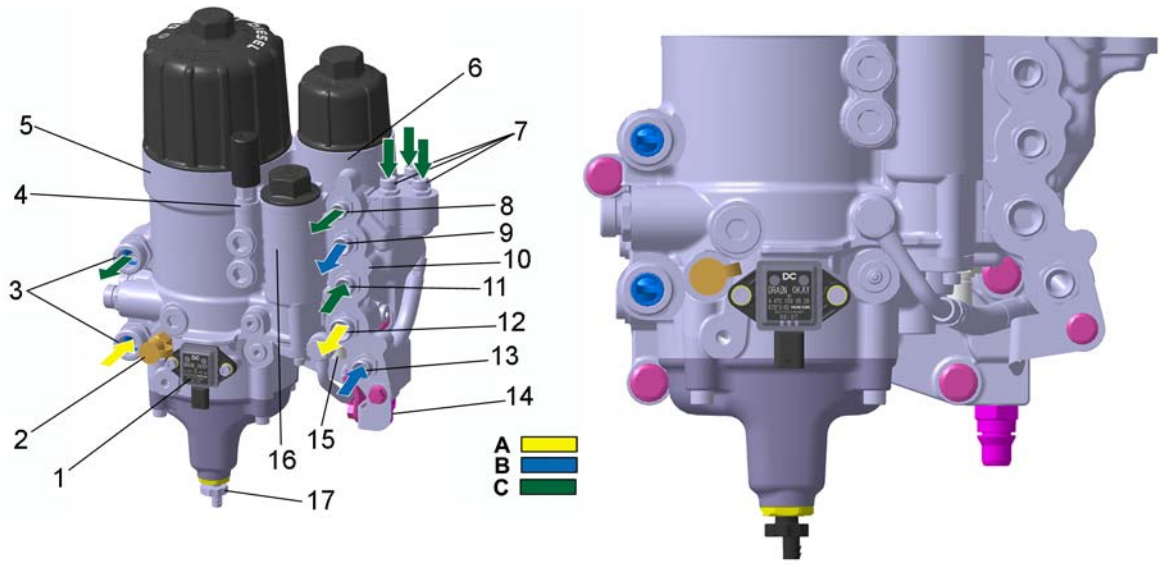
Excess fuel in the fuel high pressure circuit passes through the fuel return line, to the fuel return line pressure limiting valve and two fuel return lines of the injectors back into the fuel low pressure circuit.

3.1 FUEL HEAT EXCHANGER (MOTOR CONTROL MODULE)

d540001

The Motor Control Module (MCM) incorporates a heat exchanger which uses fuel to cool the MCM. The top plate of the heat exchanger incorporates the inlet and outlet fitting for fuel supply entering and exiting the heat exchanger. The bottom section of the heat exchanger is incorporated into the MCM housing and is serviced with the MCM.

3.2 FUEL FILTER MODULE



1. Water-in-Fuel Sensor
2. Fuel Priming Valve
3. Assembly Valves
4. Hand Primer Pump
5. Water Separator
6. Final Filter
7. Return from PLV, Injector Needle and Amplifier
8. Emergency Lubrication Connection for HP Pump
9. Fuel Connection to HP Pump
10. Fuel Accumulator
11. Return Connection from HP Pump
12. Fuel Connection to LP Pump
13. Fuel Connection from LP Pump
14. Amplifier Bracket
15. Supply Fuel Temperature Sensor
16. Fuel Prefilter
17. Mechanical Drain Valve

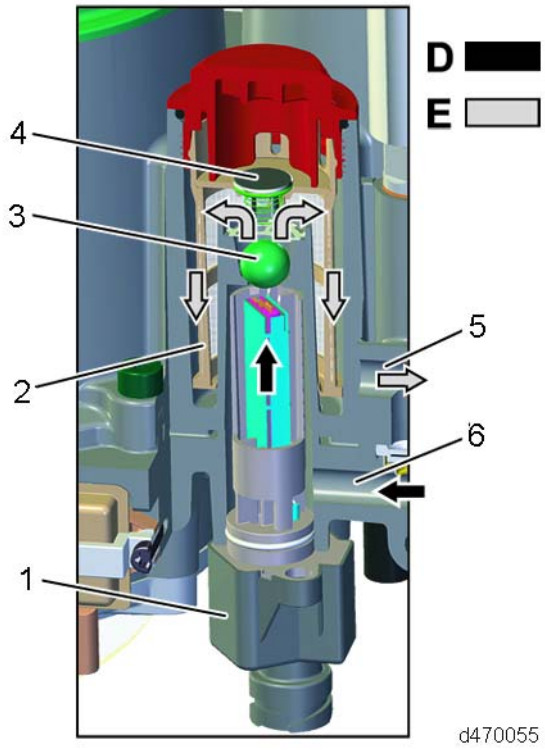
A. Fuel Feed Suction Side
B. Fuel Feed Pressure Side
C. Fuel Return Flow

The fuel filter module is located on the left side of the crankcase. The fuel filter module (1) separates out water in the fuel and filters out dirt particles in two stages. The fuel filter module (1) consists of the following components:

- □ Fuel prefilter (16) where large dirt particles are removed from the fuel.
- □ Water separator (5) with water collector through where water in the fuel is separated.
- □ Final filter (6) where small dirt particles are removed from the fuel.
- □ The fuel accumulator (10) gathers fuel from all return lines and passes it through a bypass valve to either the fuel prefilter (16) or to the fuel tank.
- □ The hand-operated primer pump (4) allows for priming the system when a filter is changed or when the fuel system is run dry.

- The fuel priming valve (2) can also be used after replacing a fuel filter or when the fuel system is run dry.
- Assembly valves (3) which prevents fuel from escaping when disassembling the fuel lines between the fuel tank and the fuel filter module (1).

3.2.1 FUEL PREFILTER



1. Fuel Preheater (if equipped)
2. Filter Element
3. Check Ball
4. Bypass Valve
5. Fuel Outlet
6. Fuel Inlet

D. Unfiltered Fuel

E Prefiltered Fuel.

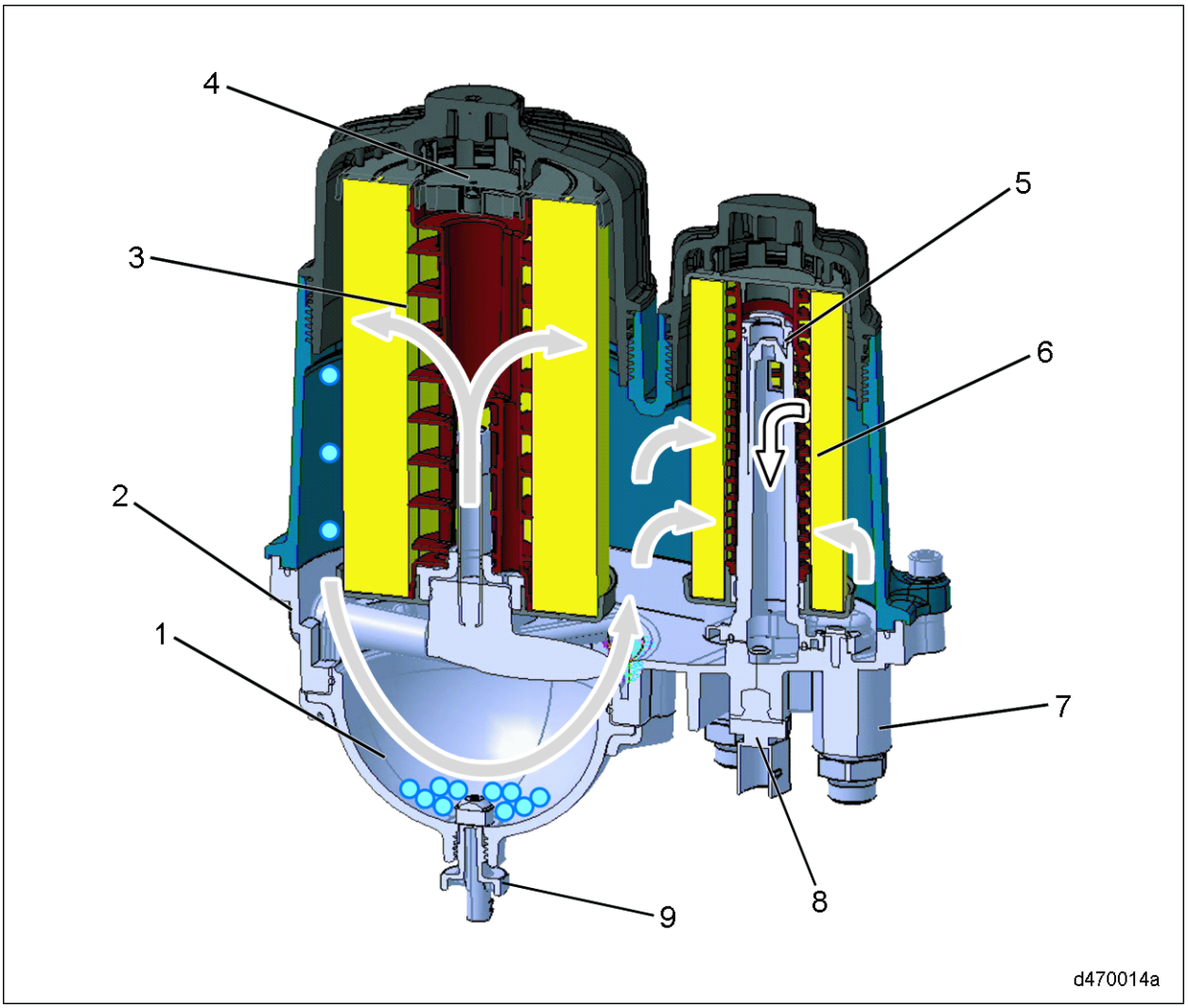
Unfiltered fuel (D) passes through the fuel inlet (6) into the fuel prefilter. The fuel prefilter incorporates an optional fuel preheater (1). The fuel preheater (1) warms the fuel during low temperatures ensuring the flow of the fuel. Fuel entering the prefilter pushes the check ball (3) off its seat allowing flow through the filter element (2) from inside to outside.

The larger dirt particles remain in the filter element (2) and the precleaned fuel (E) flows through the fuel outlet (5) to the low pressure pump. The check ball (3) has the task of preventing fuel from draining out of the fuel inlet circuit when the engine is stopped. If the fuel flow is blocked, the prefilter can be bypassed via the opened bypass valve (4) located at the top of the filter. When removing the filter element (2) a drain to the fuel accumulator is opened so the fuel can flow out of the fuel prefilter housing.

3.2.2 FUEL PREHEATER (IF EQUIPPED)

The fuel preheater is located on the left side of the engine on the fuel filter module. The fuel preheater warms the fuel at low temperatures. The fuel preheater (R23) operates at 13.5 volts and produces 250 Watts of heating. The switch ON temperature for the heater is 37.4°F to 51.8°F (3°C to 11°C). The switch OFF temperature is 62.6°F to 77.0°F (17°C to 25°C). When the heater is activated an initial current surge of less than 30 amps can occur. The normal operating current at 13.5 volts is between 16.7 and 19.4 amps five seconds afer a switch ON condition.

3.2.3 WATER SEPARATOR/COALESCER



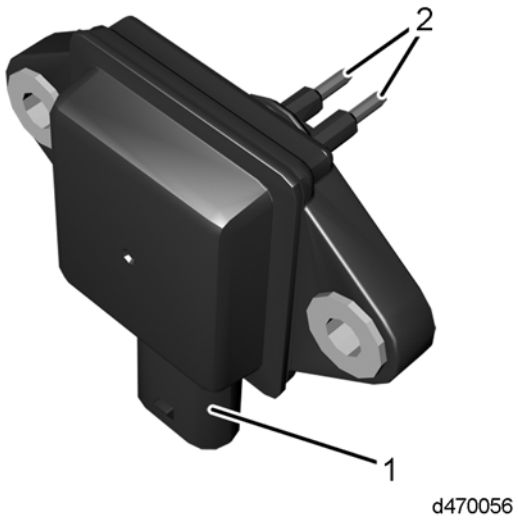
1. Water bowl
2. Fuel In (from feed pump)
3. Water Separator (Coalescer)
4. Air Purge (bore dia 0.4 mm)
5. Fuel Transfer Bore
6. Final Filter
7. Coolant Connection
7. Supply Fuel Temperature Sensor (B10)
9. Mechanical drain valve

The water separator element (3) consists of many layers and has the task of separating out the water contained in the fuel. The water separator element (3) has fuel flowing from inside to the outside. The special construction ensures that small water droplets either remain in the water separator element (3) or bind themselves to already retained water droplets. Small dirt particles are also filtered out due to the construction.

In order to ensure that the water droplets can sink downwards into the water collector (1), it is essential that the flow rate of the fuel is reduced. This is achieved purely by the design of the housing. The flow rate of the fuel is increased again due to the shape of the housing as it flows to the final filter element (6). Water level in the water collector (1) is detected by using a Water-in-Fuel Sensor. If the Motor Control Module (MCM) detects excessive water in the water collector (1) it will transmit an appropriate message to illuminate an indicator lamp.

The driver will need to drain the water using the mechanical drain valve (9). A ventilation bore (4) located above the water separator element (3) serves to divert the trapped air in the water separator (3) and routes it to fuel collector (5) where it can be returned via the fuel return line to the fuel tank. The ventilation bore (4) also guarantees full use of the water separator element (3). When removing the water separator element (3) a drain (9) to the fuel accumulator (5) is opened so that fuel can flow out of the water separator housing.

3.2.4 WATER-IN-FUEL SENSOR



1. Water-in-Fuel Sensor (B150)
2. Sensor Electrode

The Water-in-Fuel Sensor (1) determines the electrical resistance between the two sensor electrodes (2). If the water level increases in the water separator up to the sensor electrodes (2) the electrical resistance drops. This change of resistance is detected by the MCM. If the critical water level is reached, an indicator light on the sensor will illuminate. In order to avoid electrolysis (corrosion of the electrodes), AC voltage is used.

3.2.5 FINAL FILTER

The final filter element (24) consists of many layers. Fuel flow through the filter element is from the outside to inside. The smallest dirt particles are filtered out at a very high separation rate by the final filter element (24). Just like the prefilter and water separator, the final filter housing has a ventilation bore (23). This ventilation bore allows full use of the filter media. When removing the final filter element a drain bore to the fuel accumulator (5) is opened so the fuel can flow out of the fuel filter housing. The cleaned fuel (F) is supplied to the fuel high pressure pump through an overflow bore in the inner dome (25). The high position of the overflow bore in the inner dome (25) ensures that the no unclean fuel can reach the fuel high pressure pump.

3.2.6 FUEL HAND PRIMER

A fuel hand primer (6) is incorporated into the center section of the fuel filter module. The hand primer can be used anytime the system is run out of fuel or after a fuel filter change. Average time to fill the module after a filter change is approximately 3 minutes or 200 to 300 pumps. Fuel for the priming circuit is taken after the prefilter and is deposited between the water separator and final filter.

3.2.7 FUEL PRIMING VALVE

A fuel priming valve (7) is also incorporated into the fuel filter module. This port can be used to prime the fuel system in the event of an engine running out of fuel or after a fuel filter change. The fuel priming valve feeds fuel into the fuel filter module after the water separator, but before the final filter. The design of the fuel priming valve is the same as current production.

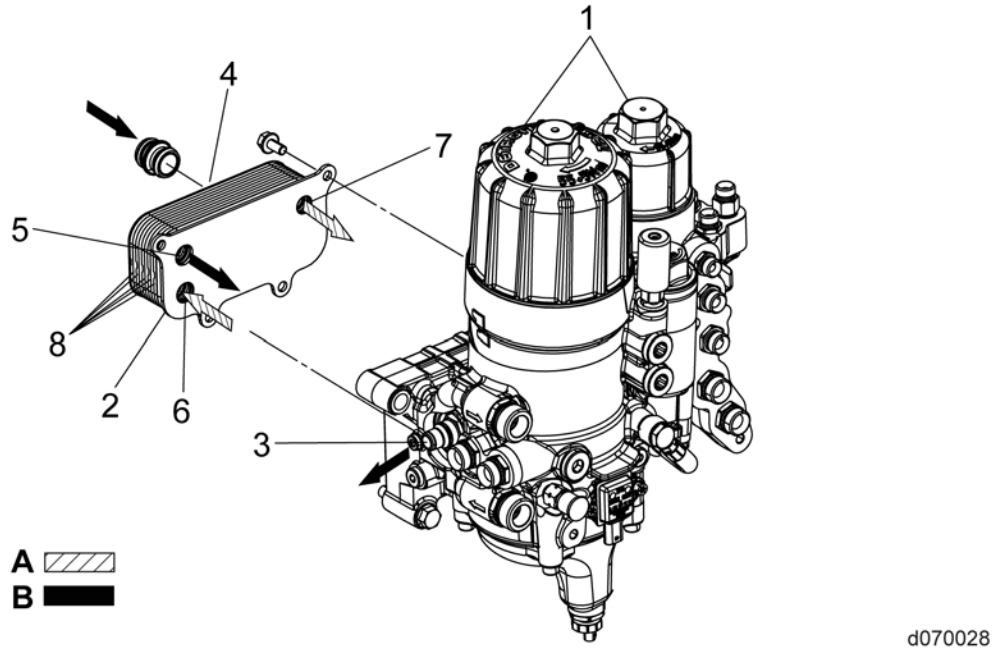
3.2.8 ELEMENT SERVICE INDICATOR

An element service indicator is installed on the fuel filter module between the water in fuel indicator and the fuel preheater. This is a round needle gauge with green, yellow, and red colored ranges displaying the condition of the final filter. The green, yellow, and red ranges are optimized to detect a plugged water separator or final filter at low idle.

3.2.9 SUPPLY FUEL TEMPERATURE SENSOR

The Supply Fuel Temperature Sensor (B10) is located on the left side of the crankcase on the fuel filter module (1). The Motor Control Module (MCM) detects the current temperature of the fuel via the fuel temperature sensor (B10). There is an NTC resistor inside the fuel temperature sensor (B10). NTC stands for "Negative Temperature Coefficient" and means that the electrical resistance falls as the temperature increases.

3.3 FUEL COOLER



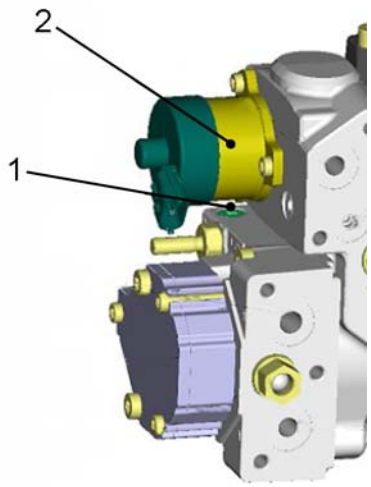
1. Fuel Filter Module
2. Fuel Cooler
3. Coolant Outlet for Fuel Filter Module
4. Coolant Inlet
5. Coolant Outlet
6. Fuel Inlet
7. Fuel Outlet
8. Fuel Cooling ducts

A. Fuel Circuit

B. Cooling Circuit

The fuel cooler (2) is located behind the fuel filter module (1). The fuel cooler (2) cools the warmed fuel which comes from the injector amplifiers to the fuel filter module (1). The fuel cooler (2) is designed as a shell cooler. The warmed fuel from the injector amplifiers flows via the fuel inlet (6) through the fuel cooling ducts (8) to the fuel outlet (7). The cooled fuel then passes from there to the fuel filter housing and mixes with the colder fuel from the low pressure pump. The fuel cooler (2) is supplied coolant through a passage in the block. Coolant exits the fuel cooler and enters the fuel filter module (1) through an internal passage. From there the coolant exits (3) the fuel filter module and returns to the oil/coolant module.

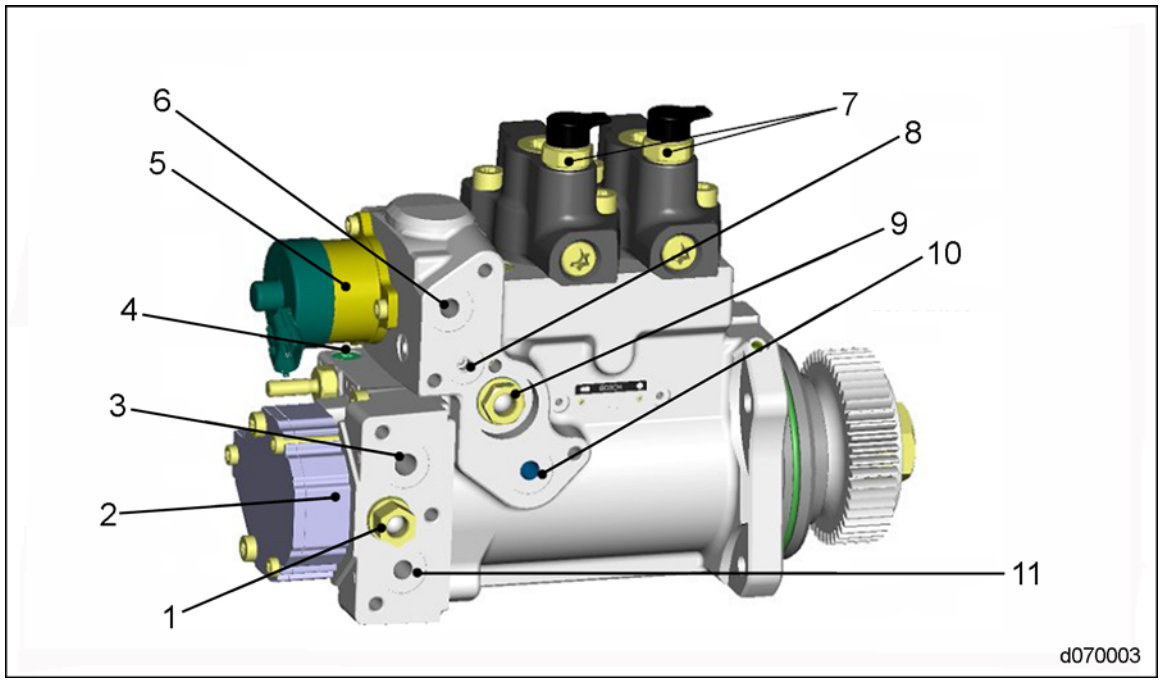
3.4 BYPASS VALVE



1. Bypass Valve
2. Pressure Relief Valve

Located within the plate between the low and high pressure fuel pump is a bypass valve (4) that allows fuel to bypass the stopped gearwheels and continue to the fuel pressure side (B). This valve opens between 0.15 to 0.25 bar (2.2 to 3.6 psi).

3.5 LOW PRESSURE FUEL PUMP



1. Relief Valve for Low Pressure Pump
2. Low Pressure Pump
3. Fuel Inlet from Tank
4. Bypass
5. Quality Control Valve
6. Fuel Inlet from Filter (to High Pressure Pump)
7. Fuel Before Quantity Control Valve
8. Lubrication Fuel
9. Two-stage Valve
10. Fuel Return
11. From Low Pressure Pump

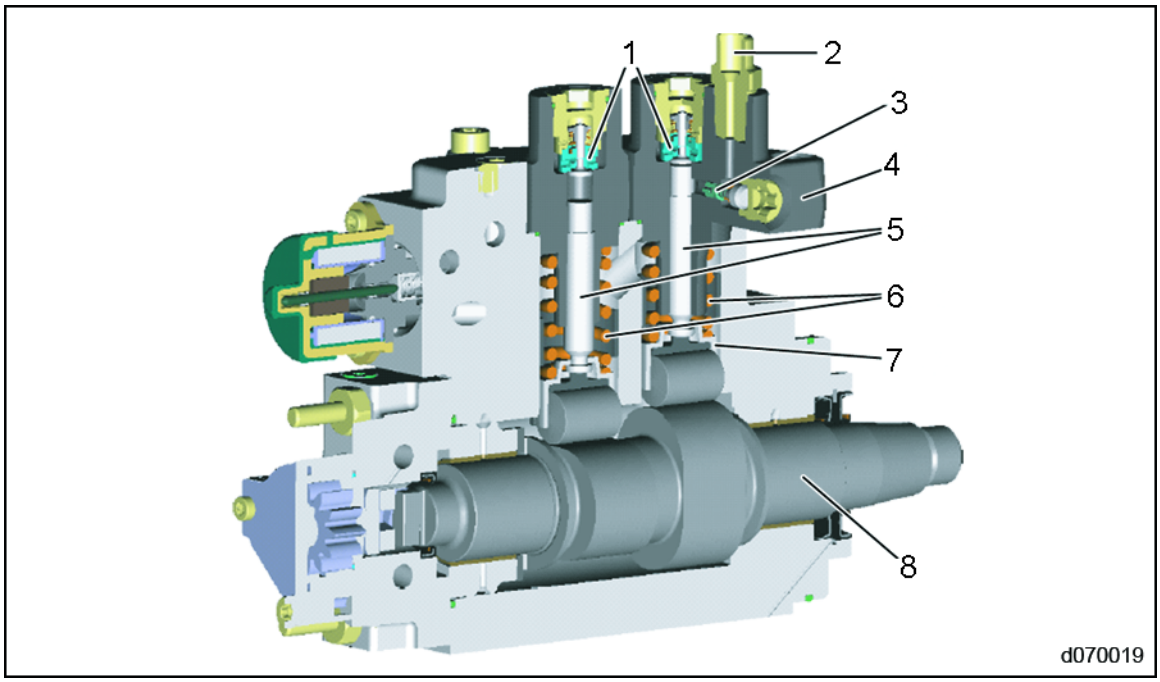
The low pressure fuel pump (2) is mounted on the high pressure fuel pump. The fuel pump (2) pulls fuel from the fuel tank through the fuel heat exchanger for the MCM.

The low pressure fuel pump (2) is designed as a gear pump and is driven by the high pressure fuel pump. As soon as the engine starts and runs, the right gearwheel in the fuel pump is driven by the drive plate on the high pressure fuel pump camshaft. The fuel is suctioned up due to the rotational movement of both gearwheels and the design of the pump chamber.

3.5.1 PRESSURE RELIEF VALVE

A pressure relief valve (1) is incorporated into the low pressure fuel pump. If the system pressure is too high, the pressure relief valve (1) will open allowing the fuel pressure side (B) to be connected to the fuel suction side (A). This will prevent further build-up of fuel pressure. The pressure limiting valve (1) is designed to open at 13 bar absolute (189 psi).

3.6 HIGH PRESSURE PUMP



1. Intake Valve
2. High Pressure Connection
3. High Pressure Valve
4. High Pressure Pump Housing
5. High Pressure Piston
6. Compression Spring
7. Roller Tappet
8. Camshaft

The camshaft (8) for the high pressure fuel pump is driven by the pinion gear drive.

The fuel is compressed by two high pressure pistons (5) and feeds the high pressure connection (9) and corresponding high pressure lines to the rail. The two roller tappets (7) on the double cams of the camshaft (8) are pressed together by two push springs (6) which are offset by 90°. With this configuration, two pressure strokes occur for one camshaft revolution for each high pressure piston (5). If the high pressure piston (5) is in a downward movement, the fuel can flow over the corresponding intake valve (1) into the clearance volume of the high pressure piston (5). If the high pressure piston (5) now changes to an upward movement, the corresponding intake valve (1) is closed by the compression pressure rising and the fuel in compressed until the high pressure valve (3) opens a transfer duct between the high pressure compartment and the corresponding high pressure connection (9). The highly compressed fuel can now flow into the rail. If the high pressure piston (5) again changes to a downward movement, the transfer duct is closed again by the spring-loaded high pressure valve (3) and new fuel can flow through the opened intake valve (1) into the clearance volume.

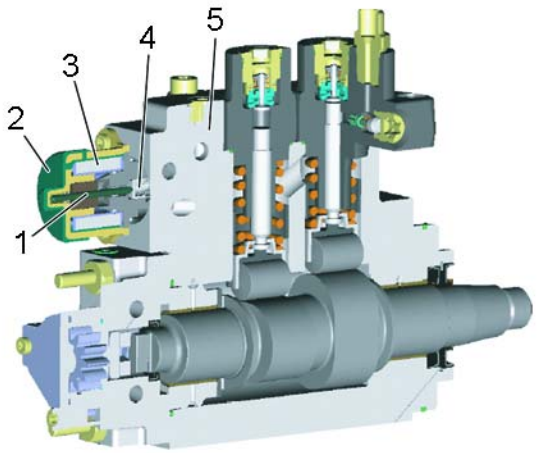
3.6.1 TWO–STAGE VALVE

Internal to the high pressure fuel pump is a two-stage valve. The excess fuel from the quantity control valve (Y134) and high pressure fuel pump (7) is routed past the two-stage valve (10).

The two-stage valve (10) has a number of tasks:

- It is closed at pressures in the low pressure circuit below 3 bar relative to high pressure pump backflow pressure. This will ensure best filling for the pumping elements under cranking speed where low pressure pump flow is low.
- It guarantees lubrication of the high pressure fuel pump components if the pressure in the low pressure circuit is above 3 bar relative to high pressure pump backflow pressure. The lubrication path is fully open at 3.5 bar.
- It ensures that in overrun conditions the pressure at the inlet to the high pressure pump is limited by opening of the backflow path. This function avoids pressures above burst pressure level of the filter module. If the pressure at the high pressure pump inlet exceeds 4.7 bar relative to backpressure, excess fuel is routed to the return path.

3.7 QUALITY CONTROL VALVE



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1. Float Needle
2. Quantity Control Valve
3. Coil
4. Valve Spring
5. High Pressure Pump

The quantity control valve (2) is located on the fuel high pressure pump (5). The quantity control valve has the following tasks:

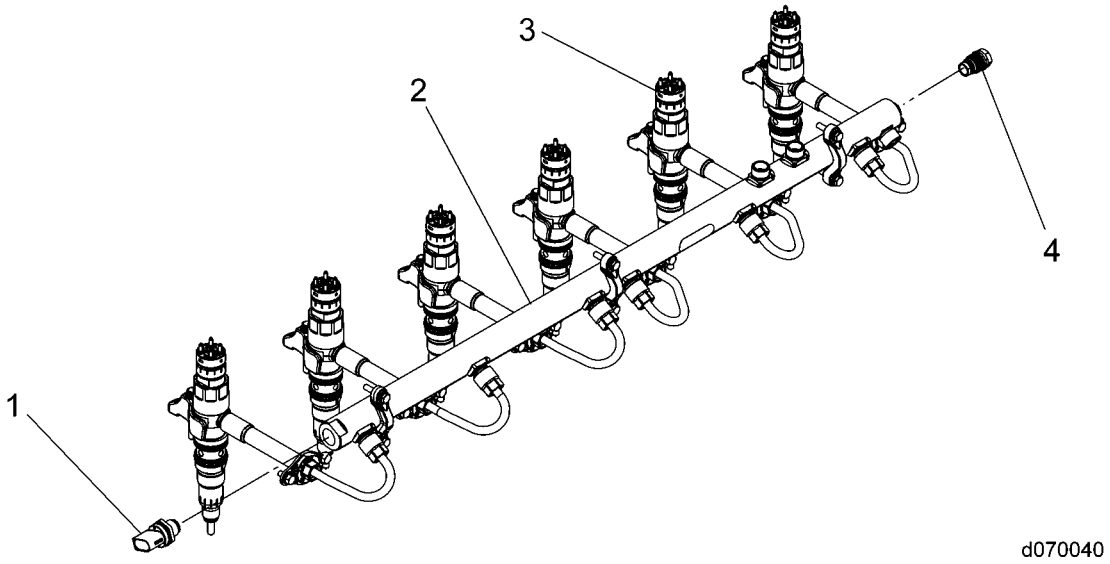
- Regulation of the fuel feed to the high pressure fuel pump (5)
- Regulation of the rail pressure

The MCM actuates the coil (3) of the quantity control valve (Y134) using a pulse width modulated signal. The magnetic field of the coil (3) influences the position of the float needle (1) and thus the flow in the quantity control valve (2). At engine off the float needle (13) is pushed back by the valve spring (4) and the fuel flow is interrupted.

3.8 FUEL RAIL

The fuel rail incorporates the fuel rail pressure sensor and pressure limiting valve. The fuel rail attaches to the side of the camshaft frame with brackets.

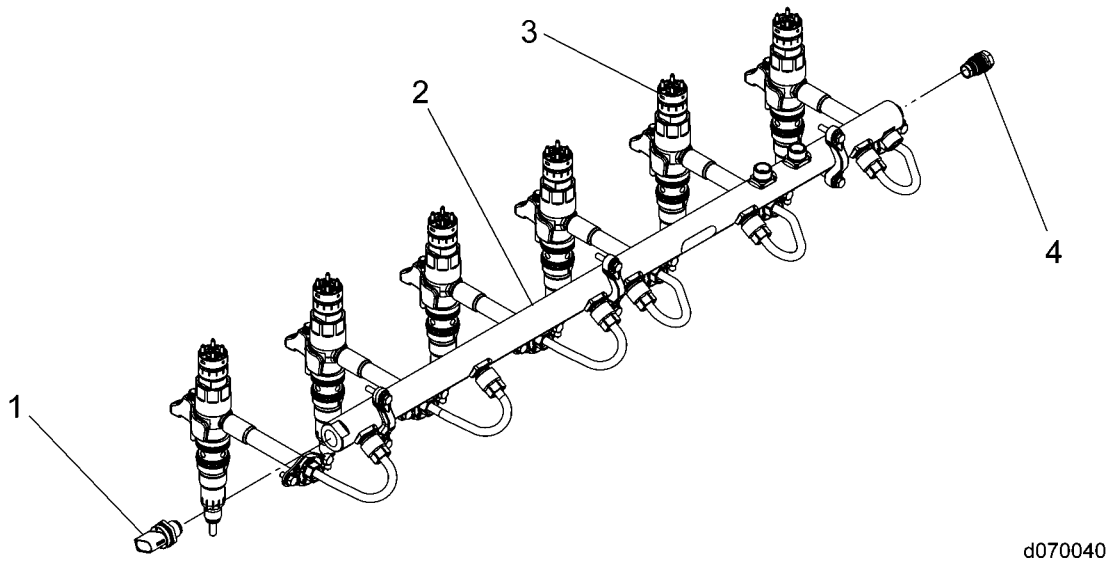
3.8.1 FUEL RAIL PRESSURE SENSOR



1. Fuel Rail Pressure Sensor
2. Fuel Rail
3. Injector
4. Pressure Limiting Valve

The Fuel Rail Pressure Sensor (1) uses a sensor element and a hybrid element. As pressure increases the sensor membrane will distort. There are four pressure-dependent resistances (strain measuring resistors) on the sensor membrane. Its bridge circuit is supplied with voltage by an electronic analysis system which also serves for signal amplification and signal correction. The electronic analysis system itself is supplied a 5 V DC voltage by the MCM. The resistors in the sensor membrane are arranged in a way that when deforming the sensor membrane two resistors will contact and two resistors will expand. Contracting and expanding changes the electrical resistance and in turn has effects upon the measurement voltage, which is being applied to the electronic analysis system. The electronic analysis system amplifies the measurement voltage, compensating for possible temperature fluctuations or balancing out possible manufacturing tolerances and passes the cleaned measurement voltage to MCM.

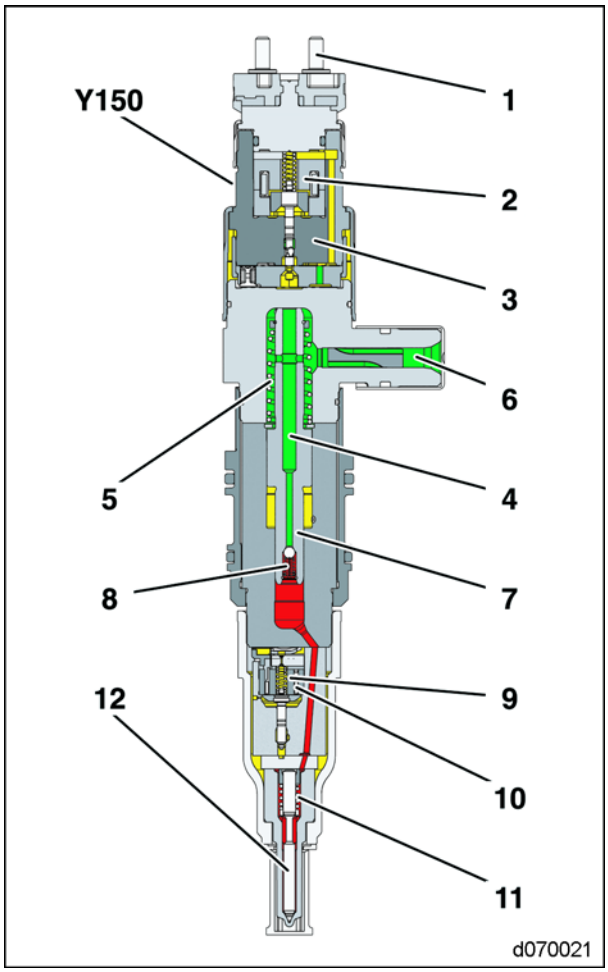
3.8.2 PRESSURE LIMITING VALVE



1. Fuel Rail Pressure Sensor
2. Fuel Rail
3. Injector
4. Pressure Limiting Valve

The pressure limiting valve (4) is a safety element which limits the maximum rail pressure in the injection system to about 1280-1380 bar. If the current rail pressure exceeds the maximum rail pressure of about 1280 -1380 bar, the push spring is pressed together by the pressure plate . A connection is opened at the same time to the cutoff bore, and the excess fuel flows into the return.

3.9 FUEL INJECTORS



1. Electrical Connector
2. Coil
3. Pressure Converter Control Module
4. Pressure Converter Piston
5. Return Spring
6. High Pressure Feed
7. Pressure Converter
8. Check Valve
9. Solenoid Valve
10. Coil
11. Spring
12. Injector Needle

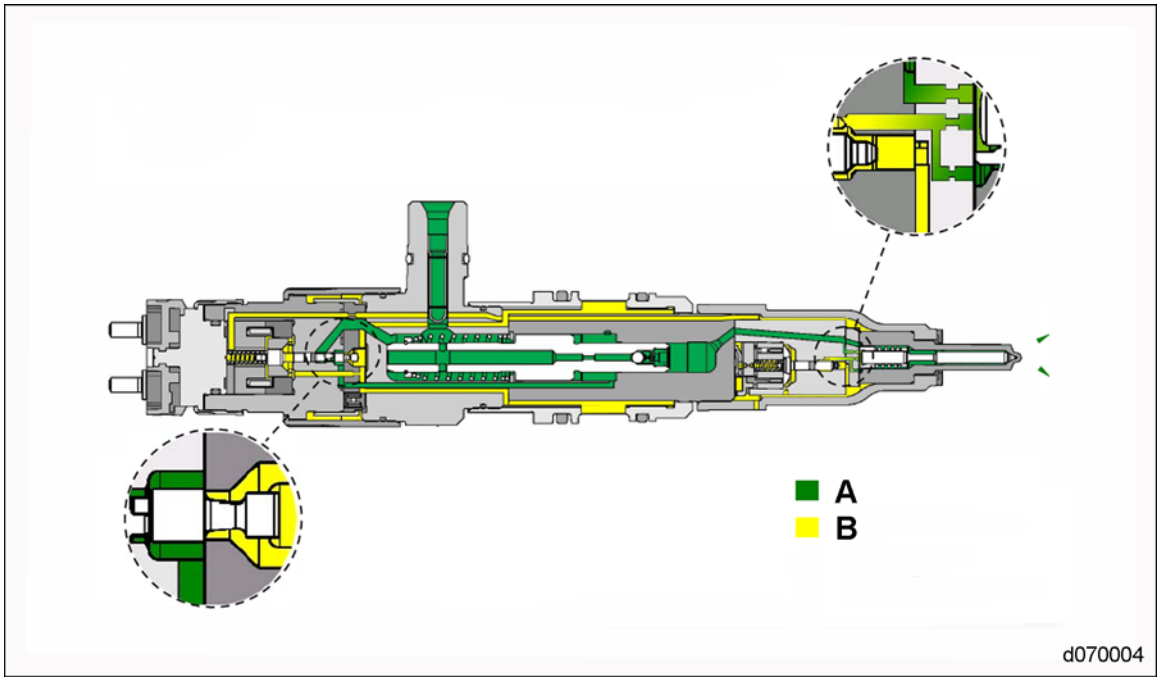
Y150 Injector (Cylinder 1)

The fuel injectors (Y150 to Y155) are fixed by means of a hold down clamp inside the camshaft frame and located centrally between the valves of the respective cylinder. All injectors have a 6-digit code, the injector quantity compensation coding, which is located on the upper side of the injector. This code describes the quantity characterization of the respective injector. If an injector is replaced then this code must be reported to the Motor Control Module (MCM) using DDDL 7.0.

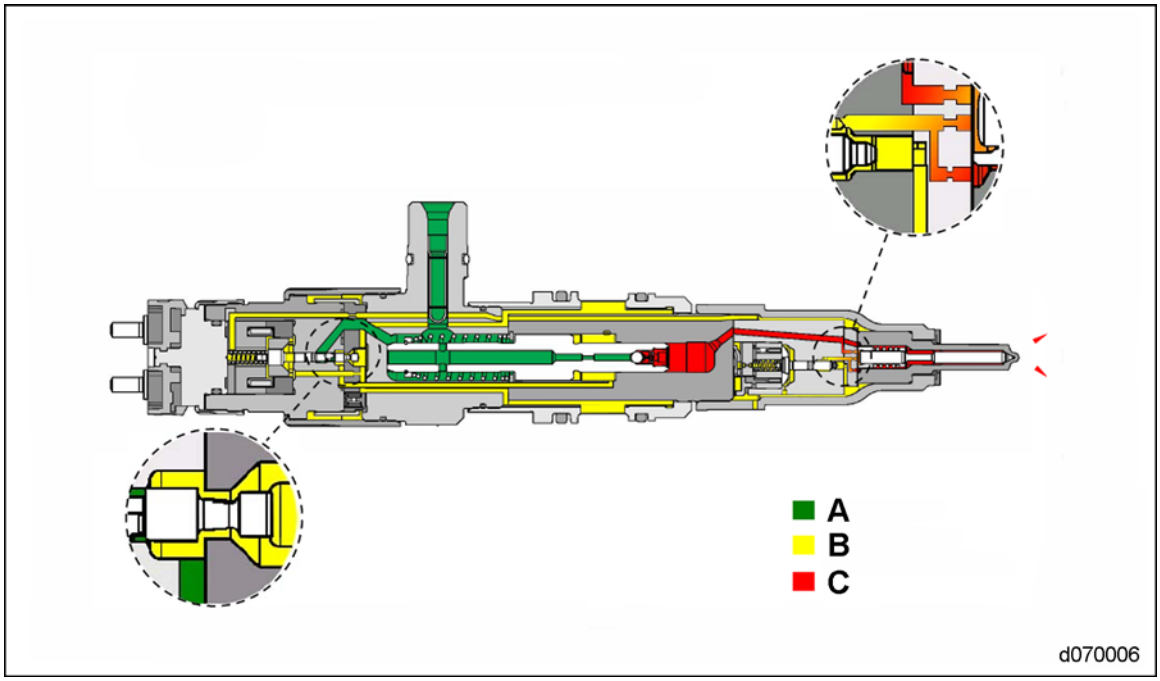
The injectors have the task of injecting the fuel under high pressure into the cylinders. The injection timing, injection period, and the injection variants (e.g. with or without amplification) are established by the MCM.

The injectors are fitted with an amplifier circuit. This allows for two modes of injection: without amplification and with amplification.

In the case of injection without amplification the injection pressure is determined by the rail pressure (about 900 bar).

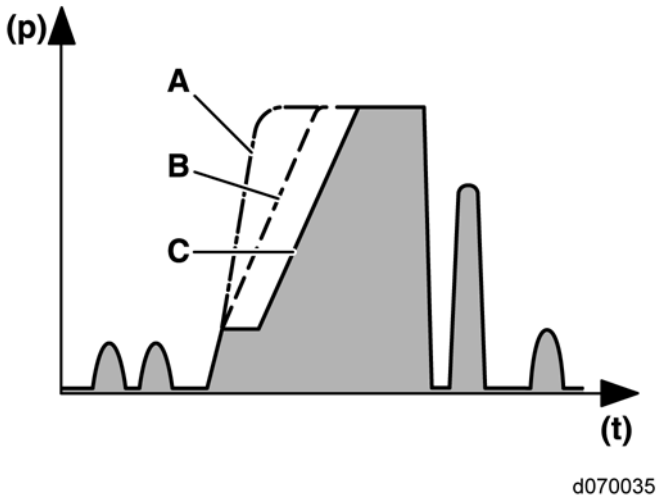


In the case of injection with amplification the injection pressure of up to 2100 bar is generated in the injector



Use of an amplifier within an injector offers the following advantages:

- The leak oil losses in the high pressure area are reduced.
- The pressure load of the high pressure pump, the fuel rail, and the high pressure lines is reduced since only a few components have high pressure applied to them.



A. (Square) Actuation of the amplifier control module before actuation of the needle solenoid valve

B. (Ramp) Actuation of the amplifier control module parallel to actuation of the needle solenoid valve

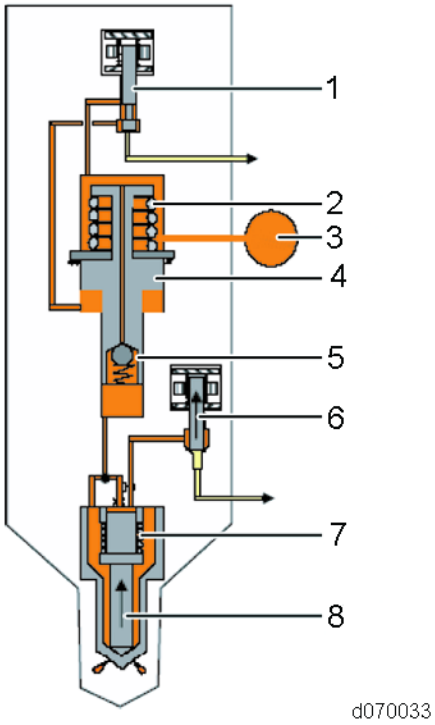
C. (Boot) Actuation of the amplifier control module after actuation of the needle solenoid valve

(p). Injection pressure

(t). Time

- During injection with amplification the injection process is determined by actuation of the needle solenoid valve and the amplifier control module either at other times or simultaneously.

3.9.1 INJECTION WITHOUT AMPLIFICATION

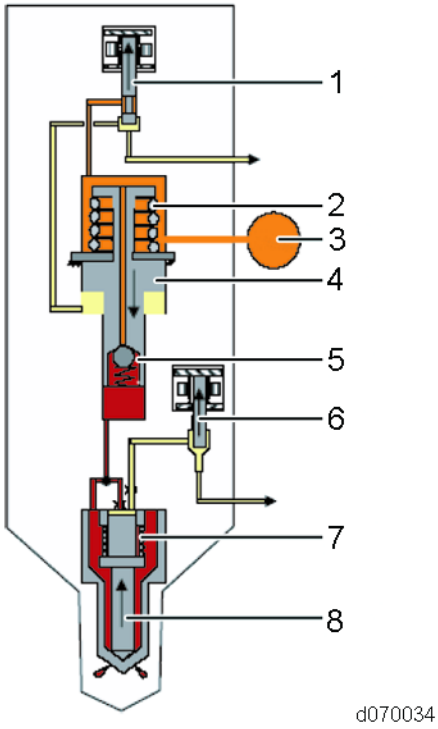


1. Amplifier Control Module
2. Return Spring
3. High Pressure Feed
4. Amplifier
5. Check Valve
6. Needle Solenoid Valve
7. Spring
8. Injector Needle

The amplifier control module (1) is not actuated during this process. The fuel internal to the injector is at rail pressure above and below the amplifier (4) piston.

The compressed fuel from the rail enters the injector needle (8) through the center of the amplifier (4) and through the check valve (5) at the bottom of the amplifier (4). If the MCM actuates the needle solenoid valve (6) then the fuel pressure in the control compartment above the injector needle (8) is allowed to escape through the injector needle return. The injector needle (8) is then lifted due to the rail pressure being greater than the needle spring (7) pressure combined with the reduction of pressure in the control department. The fuel is injected at the specified rail pressure into the respective cylinder. If the MCM deactivates the needle solenoid valve (6), the pressure in the control compartment above the injector needle (8) builds up again. The injector needle (8) is returned to its seat with the aid of the spring (7) and fuel system pressure. At this point the injection process stops.

3.9.2 INJECTION WITH AMPLIFICATION



1. Amplifier Control Module
2. Return Spring
3. High Pressure Feed
4. Amplifier
5. Check Valve
6. Needle Solenoid Valve
7. Spring
8. Injector Needle

Use of an amplifier (3) within an injector offers the following advantages:

- The leak oil losses in the high pressure area are reduced.
- The pressure load of the high pressure pump, the fuel rail, and the high pressure lines is reduced since only a few components have high pressure applied to them.
- During injection with amplification (3) the injection process is determined by actuation of the needle solenoid valve (6) and the amplifier control module (1) either at other times or simultaneously.

Actuation of the amplifier control module (1) before actuation of the needle solenoid valve (6) (Square)

The amplifier control module (1) is actuated before the needle solenoid valve (6). The rail pressure applied below the amplifier (4) is routed to the injector return passage inside the injector. This difference in pressure allows the amplifier (4) to move. The fuel within the amplifier circuit is compressed by the amplifier (4) piston up to a higher fuel pressure level (red). If the MCM actuates the needle solenoid valve (6) the fuel pressure in the control compartment above the injector needle (8) is allowed to escape through the injector needle return. The injector needle (8) is then lifted due to the rail pressure being greater that the needle spring (7) pressure.

The fuel is injected with the fuel pressure increased by the amplifier into the respective cylinder. The level of the fuel pressure is dependent on the point in time of the initial actuation of the amplifier control module (1). If the MCM deactivates the amplifier control module (1), the pressure in the control compartment under the amplifier (4) builds up and the amplifier (4) returns to its starting position. If the MCM deactivates the needle solenoid valve (6), the pressure in the control compartment above the injector needle (8) builds up again. The injector needle (8) is returned to its seat with the aid of the spring (7) and fuel system pressure. At this point the injection process stops.

Actuation of the amplifier control module (1) parallel to actuation of the needle solenoid valve (6) (Ramp)

The amplifier control module (1) and the needle solenoid valve (6) are actuated at the same time by the MCM. The rail pressure applied below the amplifier (3) is routed to the injector return passage inside the injector. This difference in pressure allows the amplifier (3) to move. The injector needle (8) is lifted first by the rail pressure. Next, the fuel within the amplifier circuit is compressed by the amplifier (3) piston up to a higher fuel pressure level (red). Thus, during the complete injection phase the fuel pressure increases. If the MCM deactivates the amplifier control module (1), the pressure in the control compartment under the amplifier (3) builds up and the amplifier (3) returns to its starting position. The amplifier (3) goes back into its starting position. If the MCM deactivates the needle solenoid valve (6), the pressure in the control compartment above the injector needle (8) builds up again. The injector needle (8) is pressed onto its seat with the aid of the spring (7) and the injection process stops.

Actuation of the amplifier control module (1) after actuation of the needle solenoid valve (6) (Boot)

The MCM actuates the needle solenoid valve (6) to allow the fuel pressure in the control compartment above the injector needle (8) to escape through the injector needle return. The injector needle (8) is then lifted due to the rail pressure being greater than the needle spring (7) pressure. The fuel is then injected at the prescribed rail pressure.

After the beginning injection, the rail pressure applied below the amplifier (3) is routed to the injector return passage inside the injector. The fuel within the amplifier circuit is compressed by the amplifier (3) piston up to a higher fuel pressure level (red). If the MCM deactivates the amplifier control module (3), the pressure in the control compartment under the amplifier (3) builds up and the amplifier (3) returns to its starting position. If the MCM deactivates the needle solenoid valve (6), the pressure in the control compartment above the injector needle (8) builds up again. The injector needle (8) is pressed onto its seat with the aid of the spring (7) and the injection process stops.

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4 SYMPTOM BASED DIAGNOSTICS – HARD STARTING

A hard start or no start condition can be caused by many different conditions. Some of these conditions can be related to the fuel system.

4.1 ENGINE WILL ONLY START USING AN EXTERNAL PRIMING SOURCE

Hard starting with external priming source indicates a system that cannot generate the required pressure for the high pressure pump.

1. Using DDL7.0 (latest version), check for stored or active codes and repair if necessary.
2. Check fuel level and correct if necessary.
3. Check for external fuel leakage and repair if necessary. Refer to section 5.1, “External and Internal Low Pressure Fuel Leaks.”
4. Check prefilter cap for proper torque and seating.

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

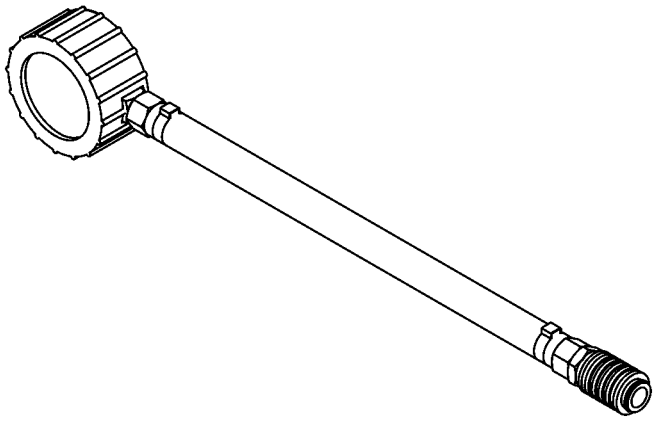
5. Start the engine using an external priming source (remove once the engine is running).

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

6. Install the priming port gauge J-48876 and note the pressure at 600 rpm and 1800 rpm.



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7. If pressure is below 60 psi, turn engine OFF and watch the bleed down rate of the priming port gauge.
8. Does the pressure bleed down to zero within two seconds after engine OFF?
   [a] If yes, remove the high pressure relief valve for the low pressure pump and check for debris. If debris is found, replace pressure relief valve and inspect prefilter for damage or clogged. If debris was not found, remove all three filters and inspect lower seals for leakage. Replace if necessary.
   [b] If no, check flow from the pressure limiting valve (PLV). Refer to section 5.8.2. Refer to "PLV Leakage Flow Test." If no flow noted, go to next step. If flow is noted; replace the PLV.
9. Check for internal or external fuel leaks. Refer to section 5.1, "External and Internal Low Pressure Fuel Leaks."

4.2 FUEL SYSTEM CHECKS FOR NO OR HARD STARTING

Check as follows:

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

1. Check fuel level and correct if necessary.
2. Use DDDL to check for stored or active codes and repair if necessary.
3. Using DDDL, monitor the rail pressure while cranking the engine.
4. During cranking rail pressure should be above 150 bar.
   [a] If rail pressure is not above 150 bar, go to next step.
   [b] If rail pressure is greater than 150 bar, check for other related engine concerns causing a no start condition (i.e. Camshaft Position Sensor failure).
   [c] If the rail pressure reading is not high enough, look for internal leaks. Refer to section 5.1, "Diagnosis External and Internal Low Pressure Fuel Leaks.
5. Use DDDL to monitor quantity control valve current while cranking engine.
   [a] If the current measures less than 2800 mA, go to next step
   [b] If the current measures greater than 2800 mA, check for a short to power between pin 1 of the quantity control valve and pin 1 of the 120–pin MCM connector.
6. Crank engine for 20 seconds and monitor "LPP Outlet" pressure. Refer to "Low Pressure Fuel System Pressures".

[a] If the gauge does not reach 30 psi; go to next step.

[b] If the gauge is above 30 psi, but below 40 psi; go to step 8.

[c] If the gauge is above 40 psi, replace filters.

7. Crank engine for 20 seconds and monitor "LPP Inlet" suction pressure. Refer to section 5.2, "Monitoring Low Pressure Fuel System Pressures."

   [a] If the gauge does not reach -3 in. Hg; go to next step.

   [b] If the gauge is less than or equal to -3 in. Hg; go to step 9.

8. Check for external fuel leakage and repair if necessary. Refer to section 5.1, "Diagnosis External and Internal Low Pressure Fuel Leaks."

9. Check flow from the pressure limiting valve (PLV). Refer to section 5.8.2, "PLV Leakage Flow Test."

   [a] If no flow is noted, go to next step.

   [b] If flow is noted; replace the PLV.

10. Install fuel system tool J-48707 and J-48708. This allows the engine to be isolated from the chassis.

11. Fill the single container with clean fresh fuel and prime the fuel system using the hand primer.

12. Crank the engine for 20 seconds.

13. Does the engine start and run?

    [a] If yes, check for loose connections, kinked fuel lines, or issues related to the fuel tank. Repair or replace as necessary.

    [b] If no, go to next step.

14. Watch the fuel from the J-48708 tank to the inlet of the fuel filter module. Is fuel reaching the fuel filter module?

    [a] If yes, go to step 16.

    [b] If no, go to the next step.

15. Check the following components

    [a] Check for kinked LPP inlet and outlet lines between filter module and pump.

    [b] Remove and inspect the low pressure pump for wear or broken oldham connection.

    [c] Replace fuel filter module and retest system.

16. Watch the return fuel going to the tank.

17. Are there large amounts return fuel as soon as the engine cranks?

    [a] If yes, check the three filter caps for proper torque and seating. If this is OK, go to step 17[b].

    [b] Remove prefilter, coalescer, and final filters. Check for damaged or missing seals at the bottom of the filters.

[c] Check the prescreen for debris.

18. If all steps have been followed and a starting difficulty condition still exists, call the Detroit Diesel Customer Support Center at 313–592–5800 for help and to decide if you need to replace the high pressure pump.

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5 FUEL SYSTEM DIAGNOSTIC TESTS

The diagnostic and testing procedures recommended by Detroit Diesel and described in this chapter are effective methods of performing symptom based diagnostics related to a fault code.

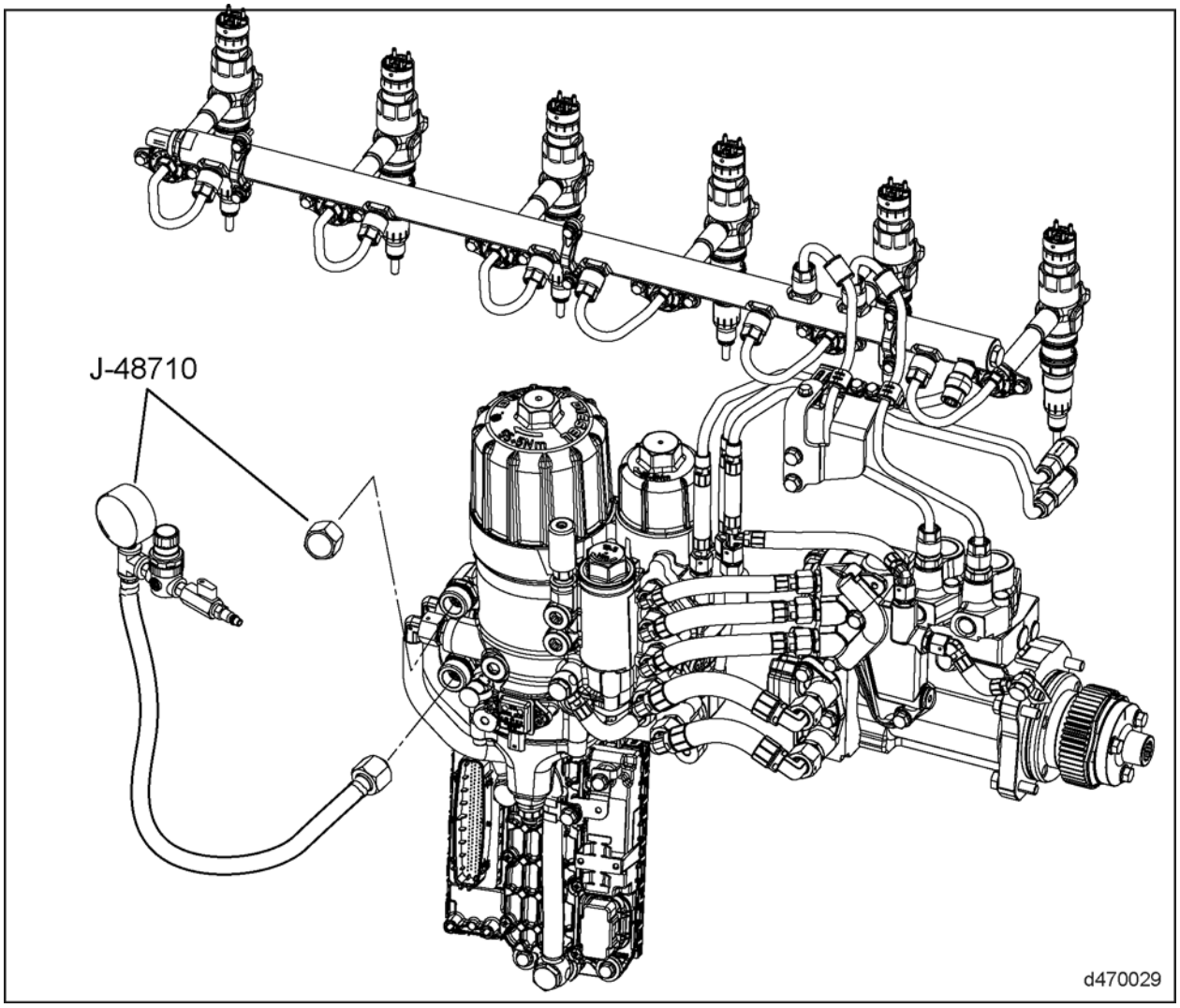
- □ External and Internal Low Pressure Fuel Leaks, refer to section 5.1
- □ Monitoring Low Pressure Fuel System Pressures, refer to section 5.2
- □ Aerated Fuel, refer to section 5.3
- □ High Amplifier/Needle Return Flow (Version 4 Fuel System), refer to section 5.4
- □ High Amplifier/Needle Return Flow (Version 5 Fuel System), refer to section 5.5
- □ Fuel System Leak Detection and Threshold Resetting, refer to section 5.6
- □ Rail Pressure Bleed Off, refer to section 5.7
- □ Pressure Limiting Valve Leakage, refer to section 5.8
- □ Pumping Element concerns, refer to section 5.9
- □ ISC Values, refer to section 5.10
- □ Fuel Filter Life, refer to section 5.11

5.1 EXTERNAL AND INTERNAL LOW PRESSURE FUEL LEAKS

This condition will exist if there is an external or internal leak of the low pressure fuel system. Tool J-48710 is required for this testing.

Test as follows:

1. Remove the fuel feed and return lines from the fuel filter module.
2. Install J-48710 fuel pressure test kit onto the module.



3. Ensure the shutoff valve is in the OFF position.
4. Turn regulator counter-clockwise until it stops. The regulator is now set to zero pressure.
5. Turn the shutoff valve to the ON position.
6. Turn the regulator clockwise to increase pressure in the fuel system.

7. Once the system pressure has reached 30 psi, let the system pressure stabilize for one minute then turn the shutoff valve to the OFF position.
8. Wait 10 minutes, then check the pressure. The system pressure should not drop over 10 minutes.

NOTE:
The fuel cooler and feed line for the amplifier circuit is located behind the fuel filter module. Ensure this area is not overlooked.

NOTE:
When removing J-48710, point the nozzle away from your body and into a container.

[a] If the pressure does not drop (still 30 psi), there are no low pressure fuel leaks. Continue troubleshooting elsewhere.

[b] If the system pressure drops off over 10 minutes, go to the next step.

9. Use a soapy solution and spray all connectors, fittings, and braided hoses.

[a] If no leaks are found, go to next step.

[b] If leaks are found, repair as necessary.

10. Remove oil fill cap and listen for internal air leaks.

[a] If internal leaks are found, remove the rocker cover to locate which injector seal ring is leaking.

[b] If no internal leaks are located, go to next steps

11. Install cooling system pressure testing tool.

[a] If cooling system pressure increases, replace fuel cooler located behind fuel filter module.

[b] If cooling system pressure does not increase, no problem found.

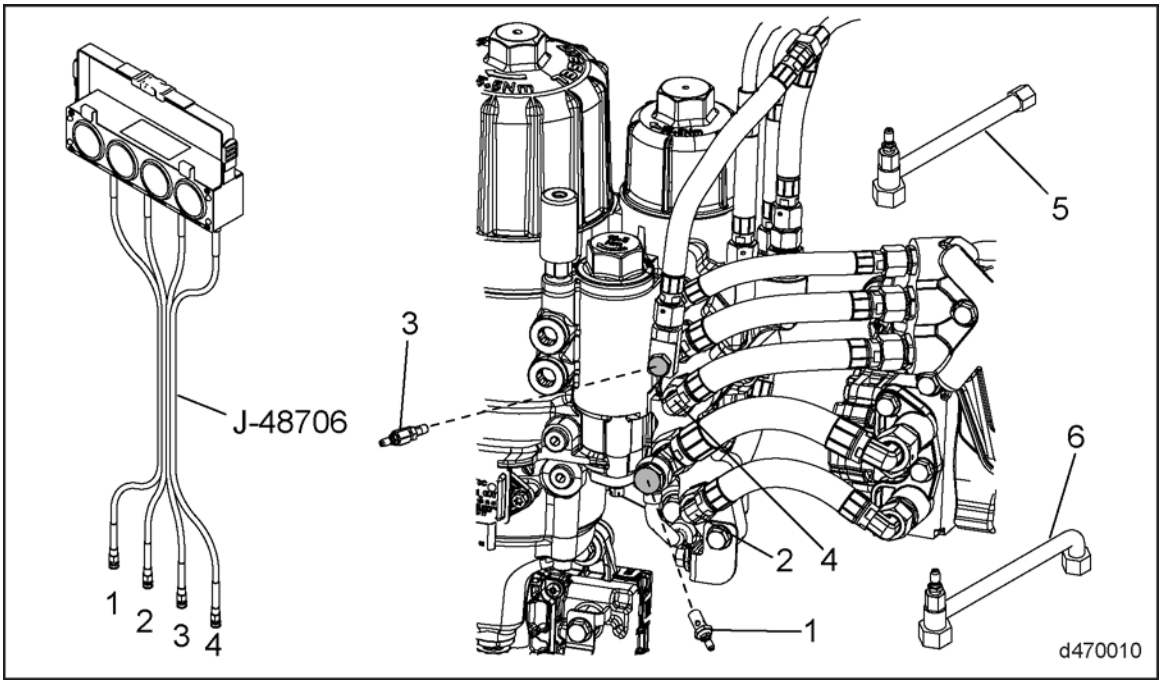
5.2 MONITORING LOW PRESSURE FUEL SYSTEM PRESSURES

Determine if you have Version 4 or Version 5 fuel system to use the following procedures.

5.2.1 LOW PRESSURE (VERSION 4 FUEL SYSTEM)

This procedure will allow the low pressure fuel system to be monitored by using pressure gauges.

1. Drain fuel system. Refer to section 6.1.

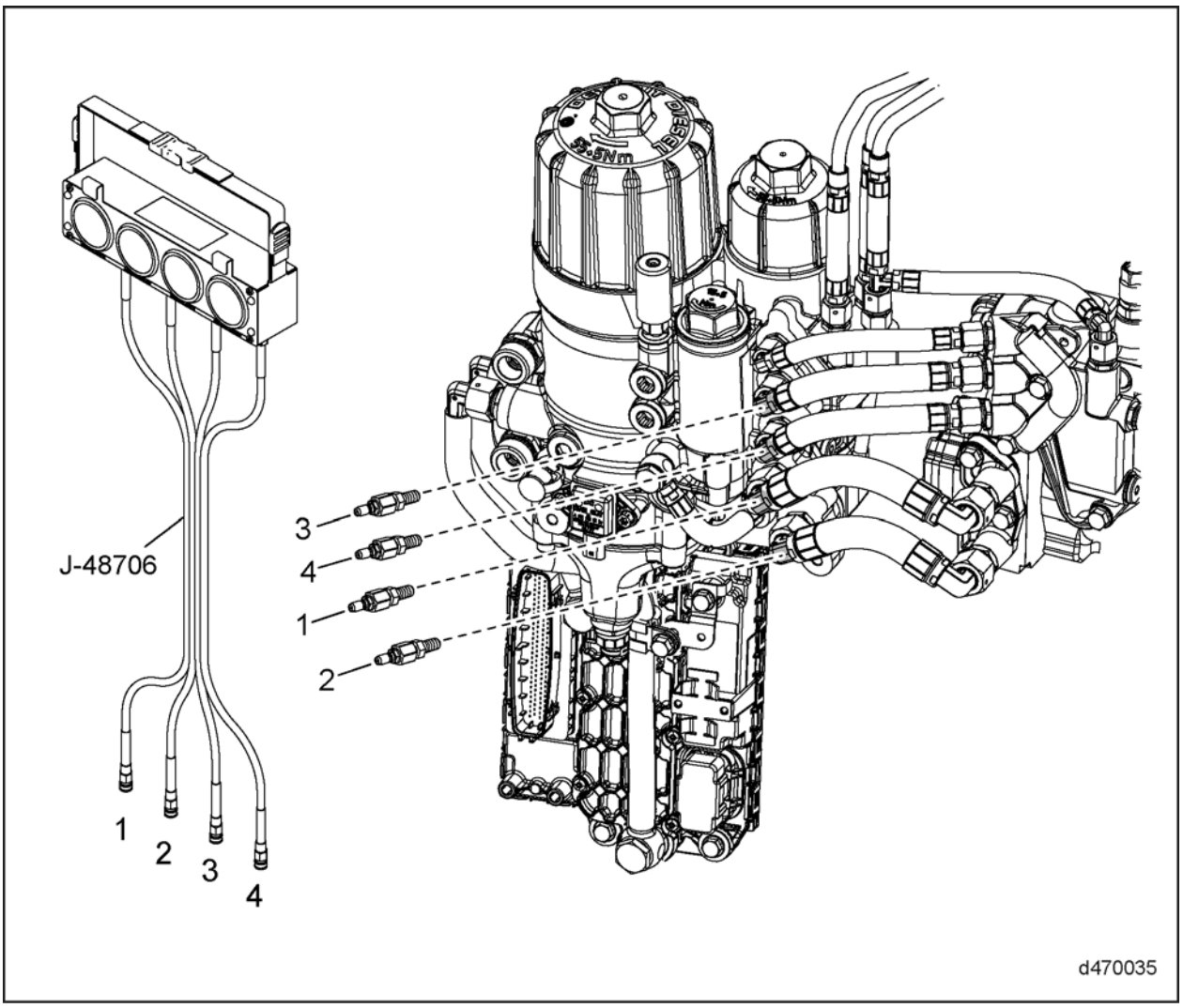


2. Remove the low pressure pump return line (2) and install the test line (6) from kit J-48706.
3. Remove the high pressure pump return line (4) and install the test line (5) from kit J-48706.
4. Remove the banjo bolt from the low pressure pump inlet (1) and install the banjo bolt from kit J-48706.
5. Remove the banjo bolt from the high pressure pump inlet (3) and install the banjo bolt from kit J-48706.
6. Connect the pressure lines to the appropriate connector.
7. Install priming port gauge J-48876.
8. Prime the fuel system.
9. Start the engine; refer to section 5.2.3 and compare the pressures to the tables found there.
10. Remove test equipment.

5.2.2 LOW PRESSURE (VERSION 5 FUEL SYSTEM)

This procedure will allow the low pressure fuel system to be monitored using pressure gauges.

1. Place a towel or container under the fitting for the low pressure pump out to catch any draining fuel.



2. Remove four 8mm plug fitting in each of the four lines: low pressure pump inlet (1), low pressure pump outlet (2), high pressure pump inlet (3), and high pressure pump outlet (4). Store fittings to be reinstalled when testing is complete.
3. Insert four quick disconnect fittings into each of the four fuel line test ports.
4. Torque each fitting to 8 Nm (6 ft/lb).
5. Install priming port gauge J-48876.
6. Prime the fuel system. Refer to section 4.1.
7. Start the engine; refer to section 5.2.3 and compare the pressures to the tables found there.

8. Remove test equipment

5.2.3 FUEL SYSTEM PRESSURES

Normal and abnormal fuel system pressure are listed in the following tables.

Normal System Pressures				
	Cold Engine 600 RPM	**Cold Engine 1800 RPM**	**Warm Engine 600 RPM**	**Warm Engine 1800 RPM**
LPP Inlet (in Hg	-8 to-9	-14	-7.5	-13.5
LPP Outlet (PSI)	78-80	104	73-74	97
HPP Inlet (PSI)	74-76	87	70-71	83
HPP Outlet (PSI)	2.5	4.5	2-2.5	4
Priming Port (PSI)	78-80	101	72-73	94-95

Table 5-1 Normal Fuel System Pressures

Abnormal Fuel System Pressures				
	Coalescer (at or past its useful life)		Final Filter (at or past its useful life)	
	Warm Engine 600 RPM	Warm Engine 1800 RPM	Warm Engine 600 RPM	Warm Engine 1800 RPM
LPP Inlet (in Hg)	-8.5	-13.5	-5.5	-6
LPP Outlet (PSI)	82	122	160+	160+
HPP Inlet (PSI)	72	90	65	66
HPP Outlet (PSI)	3	4	1-2	2
Priming Port (PSI)	75	105	160+	160+
	Restricted Fuel Feed Line to Module		Restricted Fuel Return Line From Module	
	Warm Engine 600 RPM	Warm Engine 1000 RPM	Warm Engine 600 RPM	Warm Engine 1000 RPM
LPP Inlet (in Hg)	-12	-14.5	-4.5	-6.5
LPP Outlet (PSI)	69	80	75	91
HPP Inlet (PSI)	67	75	72	84
HPP Outlet (PSI)	1-2	1-2	4.5	5.5
Priming Port (PSI)	70	80	75	90
	Air in System (connector at line to MCM)			
	Warm Engine 600 RPM			
LPP Inlet (in Hg)	-1 to -5 (oscillating)	—	—	—
LPP Outlet (PSI)	14	—	—	—
HPP Inlet (PSI)	14	—	—	—
HPP Outlet (PSI)	1-2	—	—	—
Priming Port (PSI)	14	—	—	—

Table 5-2 Abnormal System Pressures

5.3 AERATED FUEL

This condition will exist if there is an external leak of the low pressure fuel system, combustion pressure entering the fuel system, or a vehicle fuel system concern.

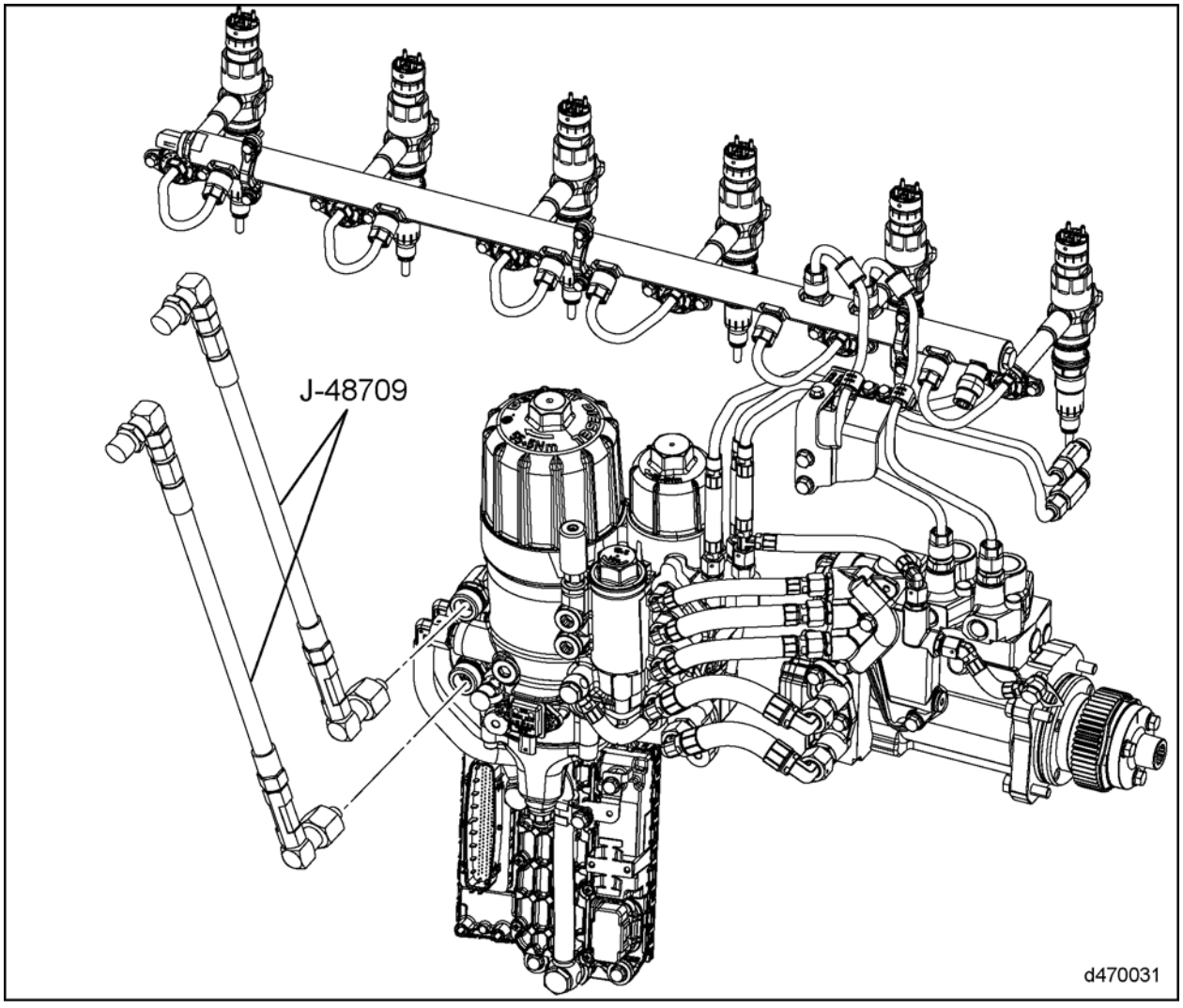
Check as follows

1. Install J-48709 sight glass tools on to fuel filter module.

WARNING:

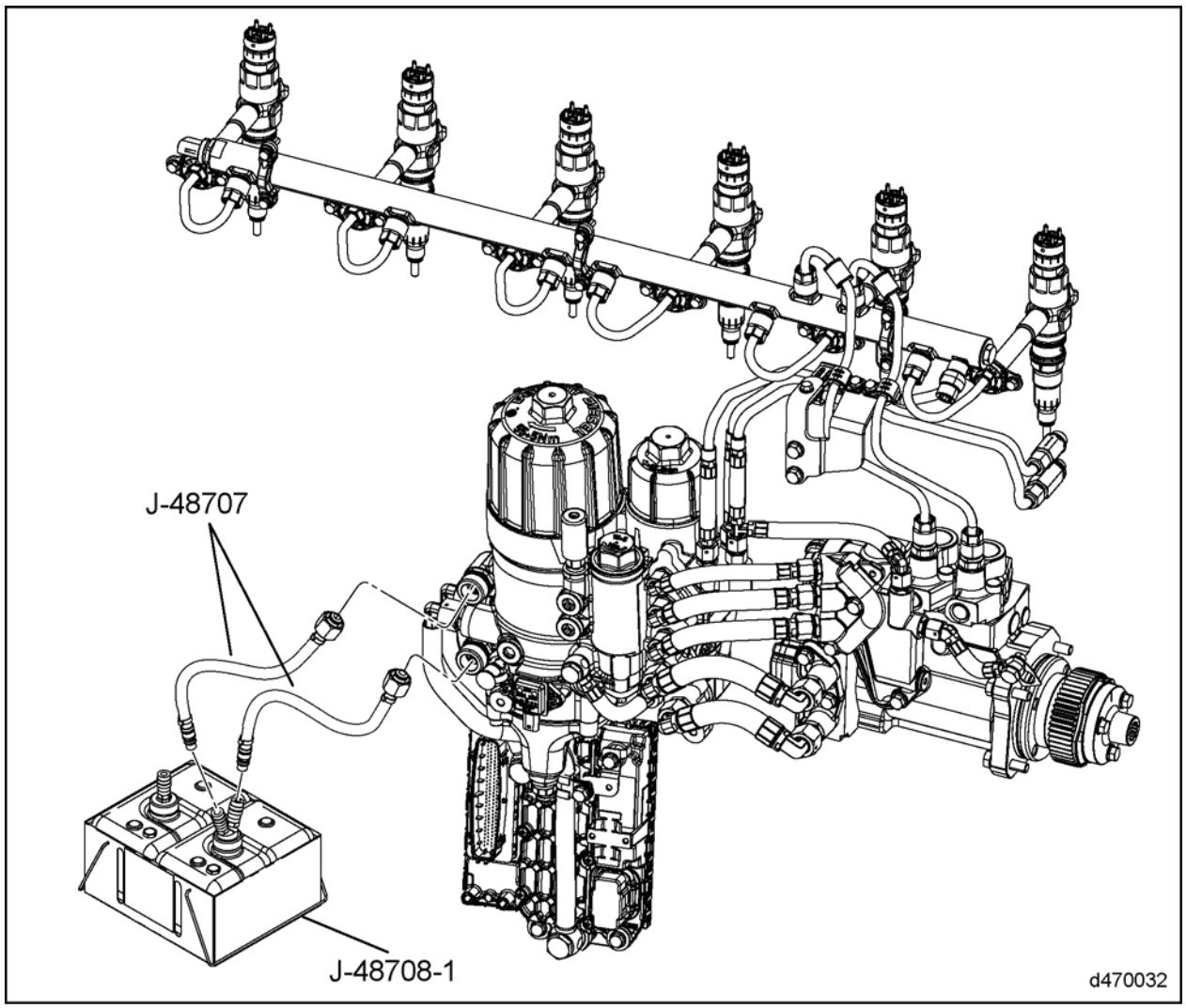
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.



2. Start engine and allow it to reach operating temperature (over 140°F/60°C).

3. At idle and 1800 rpm watch the fuel inlet and outlet sight glasses at the fuel filter module.
   [a] If the fuel is aerated, go to next step.
   [b] If the fuel is not aerated, move to other troubleshooting procedures.
4. Install J-48707 and J-48708. This will allow the engine to be isolated from the chassis.



5. Start engine and allow it to reach operating temperature (over 140°F/60°C).
6. At idle and 1800 rpm watch the fuel inlet and outlet sight glasses at the fuel filter module.
   [a] If the fuel is aerated at idle, go to next step.
   [b] If the fuel is aerated at 1800 RPM only; go to step 8.
   [c] If the fuel is not aerated, inspect the fuel system from the fuel filter module back to the fuel tanks.
7. Install J-48710 to the fuel filter module. Refer to section 5.1, “External and Internal Low Pressure Fuel Leaks” in the “Diagnostic Tests” chapter.

[a] If leaks were found, repair as necessary.

[b] If no leaks were found, go to next step.

8. Using DDDL, run the Compression Test.
9. Note any cylinders that show lower than normal compression
10. Using DDDL, run the Cylinder Compression Test.
11. Note any cylinders that show lower than normal compression.
12. Compare the cylinders that show lower than average torque loss to the cylinders that show lower than normal compression. Example: If cylinder #1 shows low torque loss and low compression, inspect this cylinder first
13. Remove suspect injector.

    [a] If copper washer and injector show signs of blow-by, replace copper washer and replace all fuel filters

    [b] Before installing new injector, inspect injector cup for corrosion. Replace if necessary.

14. Retest the system.

5.4 HIGH AMPLIFIER/NEEDLE RETURN FLOW (VERSION 4 FUEL SYSTEM)

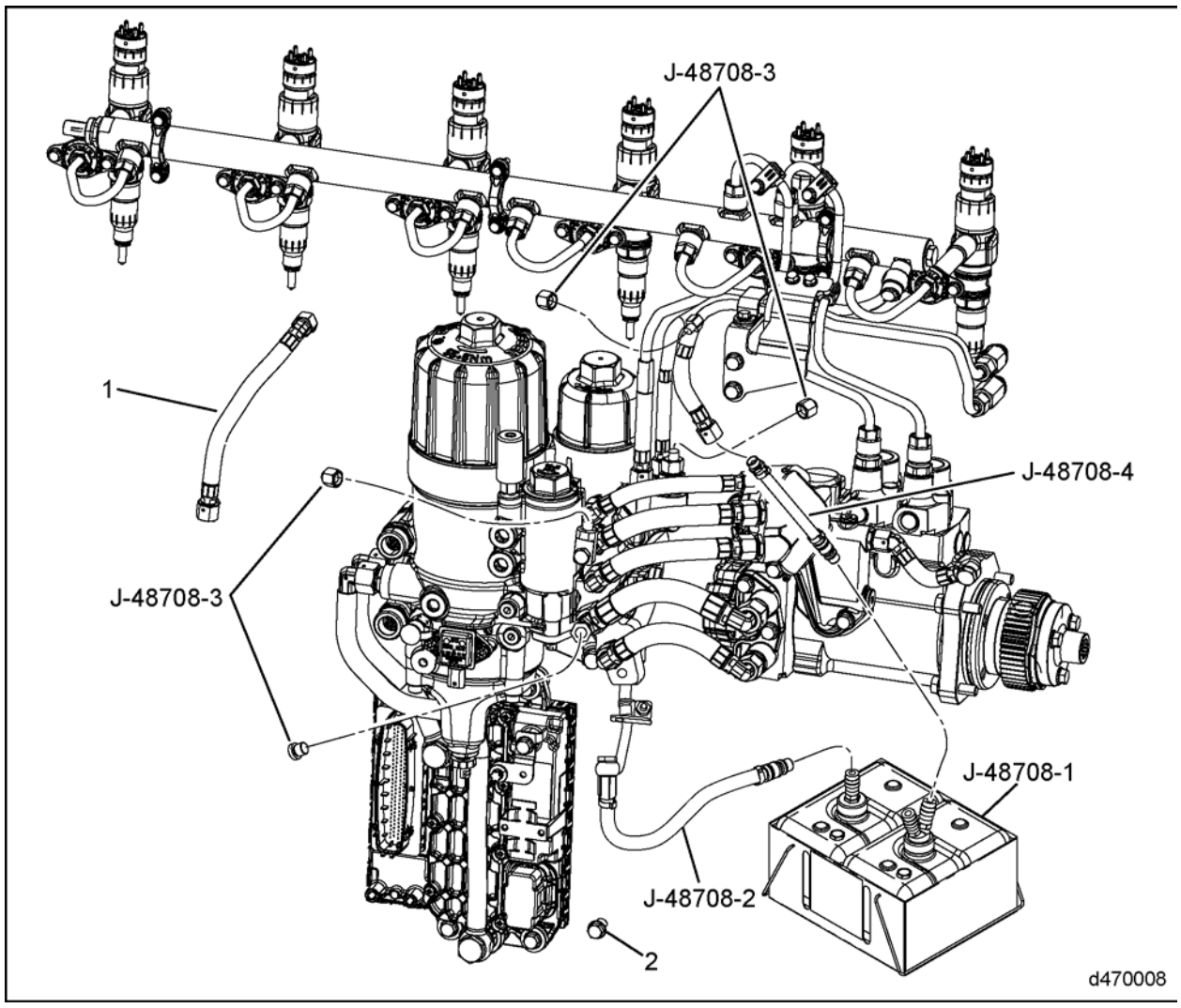
This condition will exist if there is leakage at the flat seat for the amplifier solenoid valve. At idle injector amplifiers are not turned on, thus little to no leakage should be noted out the return line.

NOTE:
When measuring needle/amplifier return flow, both measurements must be completed at the same time, but in separate containers. If these instructions are not followed, incorrect return flow measurements will occur.

First the amplifier measurement must be setup, then the needle measurement must be setup. When this is done, begin the test.

5.4.1 AMPLIFIER MEASUREMENT SETUP

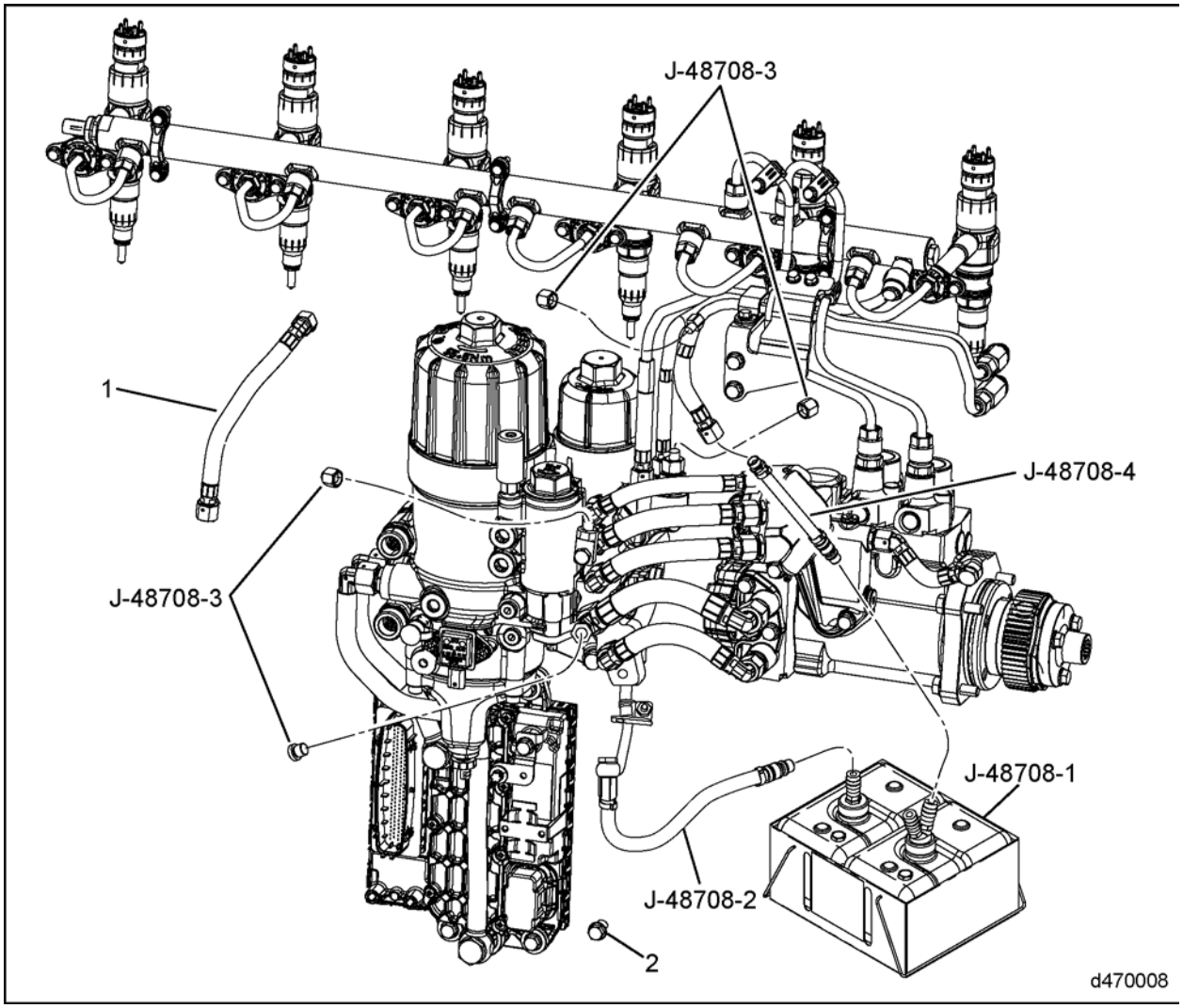
Setup as follows:



1. Drain fuel system.
2. Remove banjo bolt (2) attaching the amplifier return line to the line for the low pressure pump.
3. Remove the bracket attaching the amplifier return line to fuel filter module.
4. Using the short banjo bolt supplied in J-48708, plug the opening in the line to the low pressure pump.
5. Install the banjo bolt line from J-48708 to the amplifier return line. Must use original banjo bolt and seal rings.
6. Attach the opposite end of the clear return line to the J-48708 container.

5.4.2 NEEDLE MEASUREMENT SETUP

Setup as follows:



1. Remove the needle line transfer line (1–shown removed) from the inlet of the high pressure pump to the tee junction at the fuel filter module.
2. Using two caps supplied in the J-48708, cap the banjo bolt fitting at the inlet to the high pressure pump and the tee junction going to the fuel filter module.
3. Remove needle return line from the fuel filter module.
4. Use one cap from J-48708 and cap the fitting at the fuel filter module.
5. Connect needle return line at the module to the clear return line supplied in J-48708.
6. Attach opposite end of the clear return line to the opposite J-48708 container.

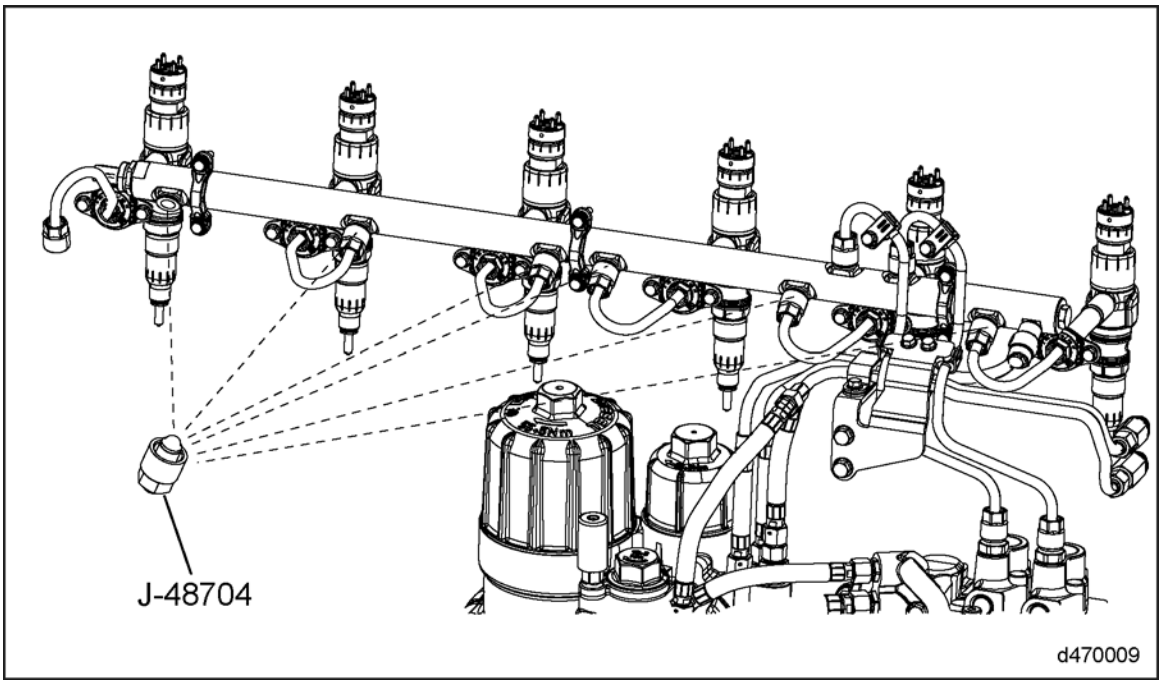
5.4.3 RETURN FLOW TEST

Test as follows:

1. Prime the fuel system.
2. Start the engine.
3. The maximum allowable amplifier leakage rate at idle is .035 liters per hour (1.18 Ounce per hour).
   [a] If the volume is within specifications the system passed, return system to original condition.
   [b] If the volume is out of specification, go to next step.
4. Turn engine OFF and wait two minutes to service any components of the high pressure circuit.

NOTE:
System may contain residual high pressure when engine is turned off. Allow the residual pressure to bleed off for two minutes.

5. Disconnect #1 (or next one in sequence) injector high pressure line.
6. Install J-48708 rail plug on to the fuel rail and torque to 40 Nm (30 ft/lb).



7. Start the engine.
8. Measure the flow from the clear return line to J-48708 container.
9. The maximum allowable leakage rate at idle is .035 liters per hour (1.18 Ounce per hour).
   [a] If the volume is now within specifications, go to next step.
   [b] If the volume is out of specification, remove J-48708 rail plug and reconnect fuel line. Go to step 5.
10. Remove the suspect injector.
   [a] Inspect injector O-rings and replace if necessary. Go to step 1.
   [b] If injector O-rings look OK, replace injector.

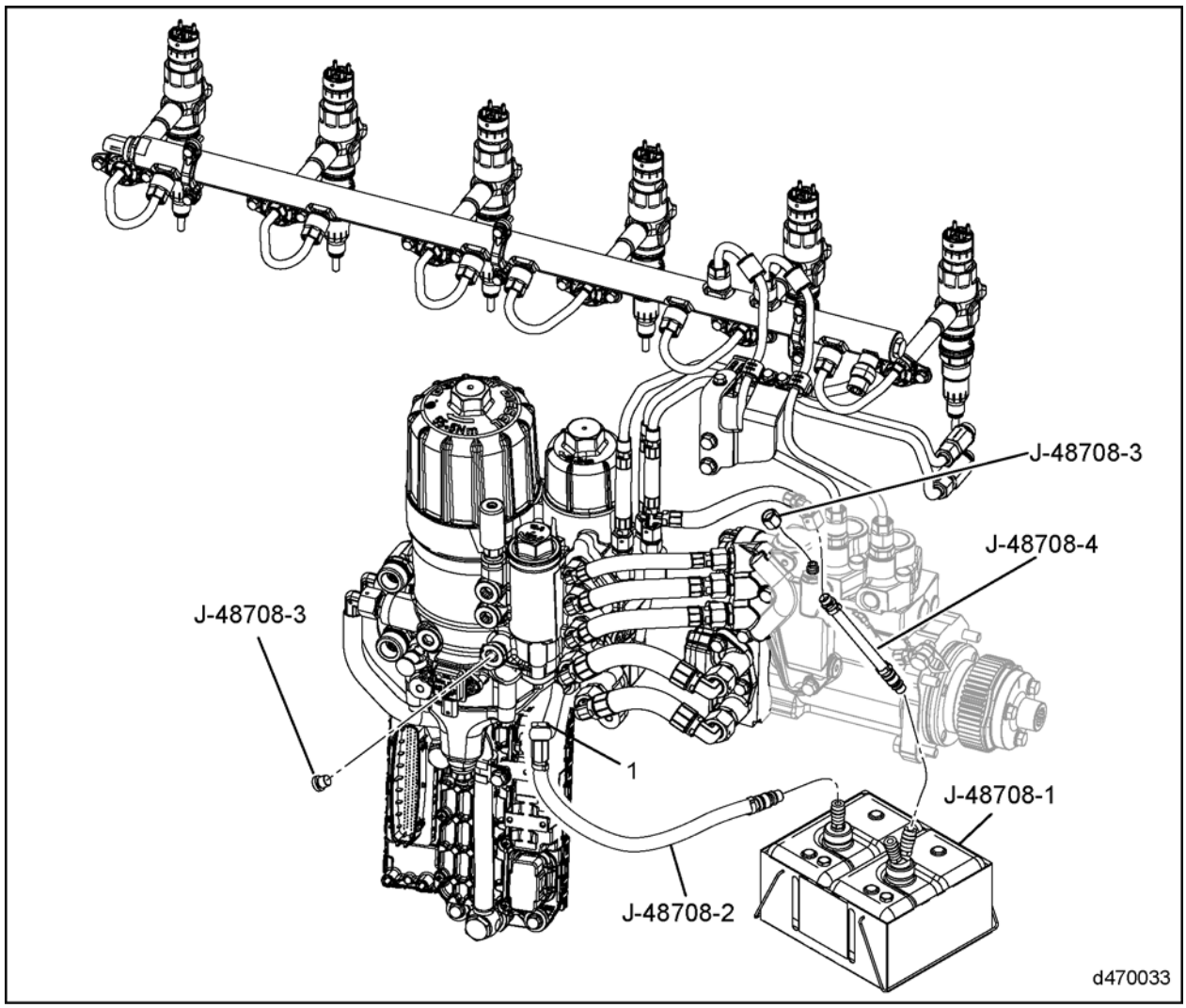
5.5 HIGH AMPLIFIER/NEEDLE RETURN FLOW (VERSION 5 FUEL SYSTEM)

This condition will exist if there is leakage at the flat seat for the amplifier solenoid valve. At idle injector amplifiers are not turned on, thus little to no leakage should be noted out the return line.

NOTE:
When measuring needle/amplifier return flow, both measurements must be completed at the same time, but in separate containers. If these instructions are not followed, incorrect return flow measurements will occur.

5.5.1 AMPLIFIER MEASUREMENT SETUP

Setup as follows:

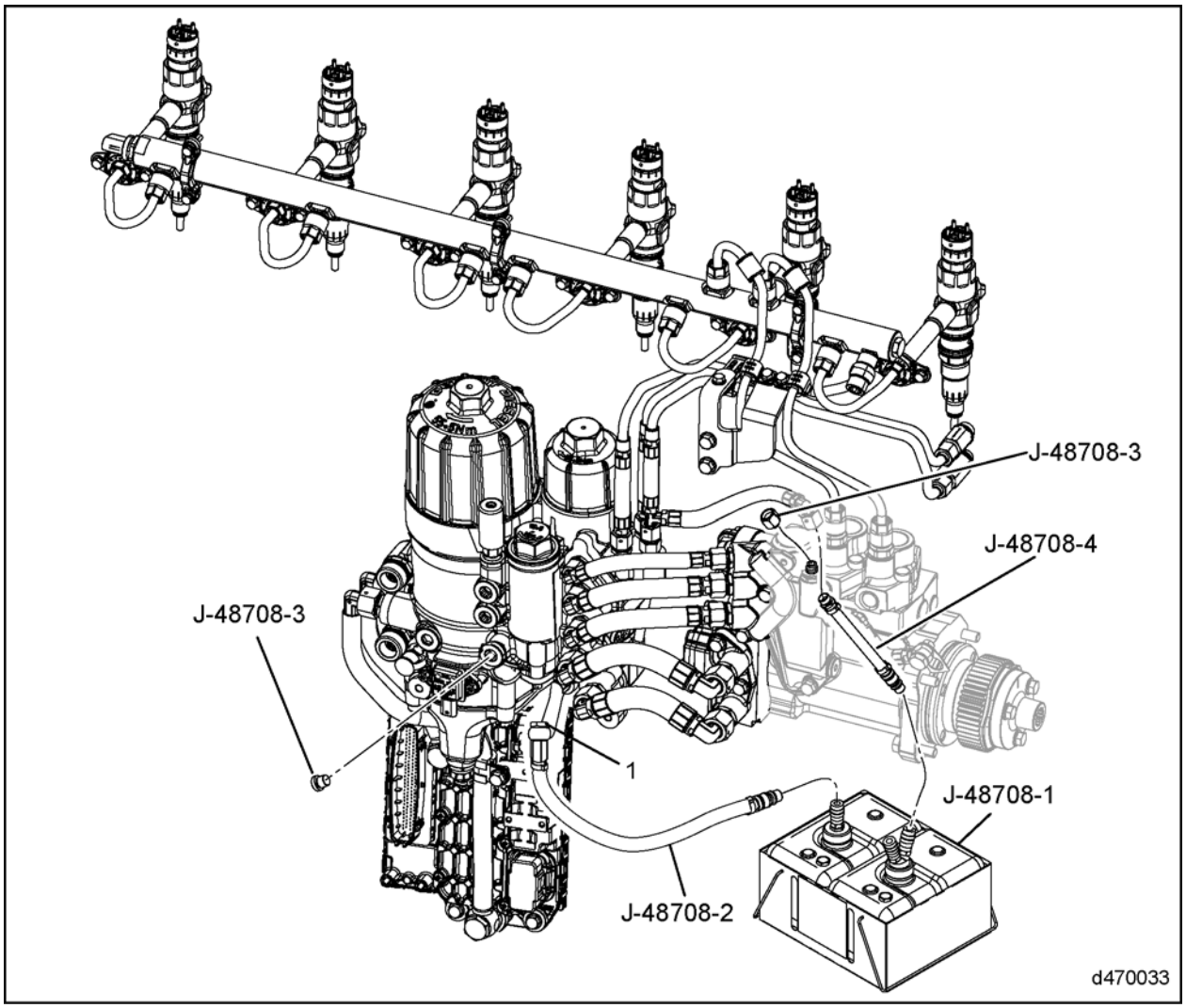


1. Drain fuel system.

2. Remove banjo bolt attaching the amplifier return line (1) to the fuel filter module.
3. Using the short banjo bolt supplied in J-48708, plug the opening in the fuel filter module.
4. Install the banjo bolt line J-48708-2 to the amplifier return (1) line. The original banjo bolt and new seal rings must be used.
5. Attach the opposite end of the clear return line to the J-48708 container.

5.5.2 NEEDLE MEASUREMENT SETUP

Setup as follows:



1. Remove the needle return line from the high pressure manifold located on the high pressure pump.
2. Using one cap supplied in the J-48708, cap the fitting at the high pressure manifold.
3. Connect needle return line to the clear return line J-48708-4 supplied in kit.

4. Attach opposite end of the clear return line J-48708-4 to the opposite J-48708 container.

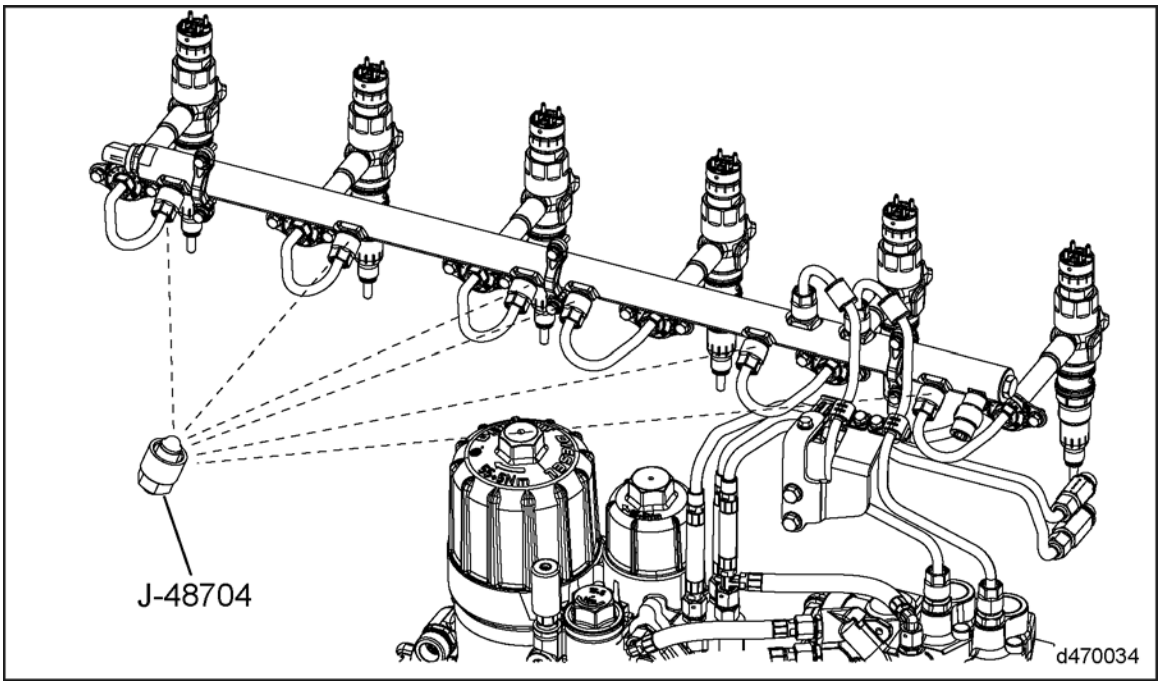
5.5.3 RETURN FLOW TEST

Test as follows:

1. Prime fuel system.
2. Start engine.
3. Measure the amplifier return flow from the clear return line to J-48708 container.
4. The maximum allowable amplifier leakage rate at idle is 15 liters per hour (250mL per 1 minute).
   [a] If the volume is within specifications the system passed, return system to original condition.
   [b] If the volume is out of specification, go to next step.
5. Using DDDL 7.0 read parameters “Idle Speed Balance Values” under “Instrumentation” section for all six cylinders. Refer to “Checking ISC Values”.
6. Turn engine OFF and wait two minutes to service any components of the high pressure circuit.

NOTE:
System may contain residual high pressure when engine is turned off. Allow the residual pressure to bleed off for five minutes.

7. Disconnect #1 (or next one in sequence) injector high pressure line.



8. Install J-48704 rail plug on to the fuel rail and torque to 40 Nm (30 ft/lb).
9. Start engine.
10. Measure the flow from the clear return line to J-48708 container.
11. Check the volume. The maximum allowable leakage rate at idle is 15 liters per hour (250mL per 1 minute).
    [a] If the volume is now within specifications, go to next step.
    [b] If the volume is out of specification, remove J-48704 rail plug and reconnect fuel line. Go to step 9.
12. Remove suspect injector.
    [a] Inspect injector O-rings and replace if necessary. Go to step 4.
    [b] If injector O-rings look OK, replace the injector.

5.6 FUEL SYSTEM LEAK DETECTION AND THRESHOLD RESETTING

This screen will allow a technician to monitor the fuel system leakage, current threshold value and will allow the relearning of the threshold when a repair is completed.

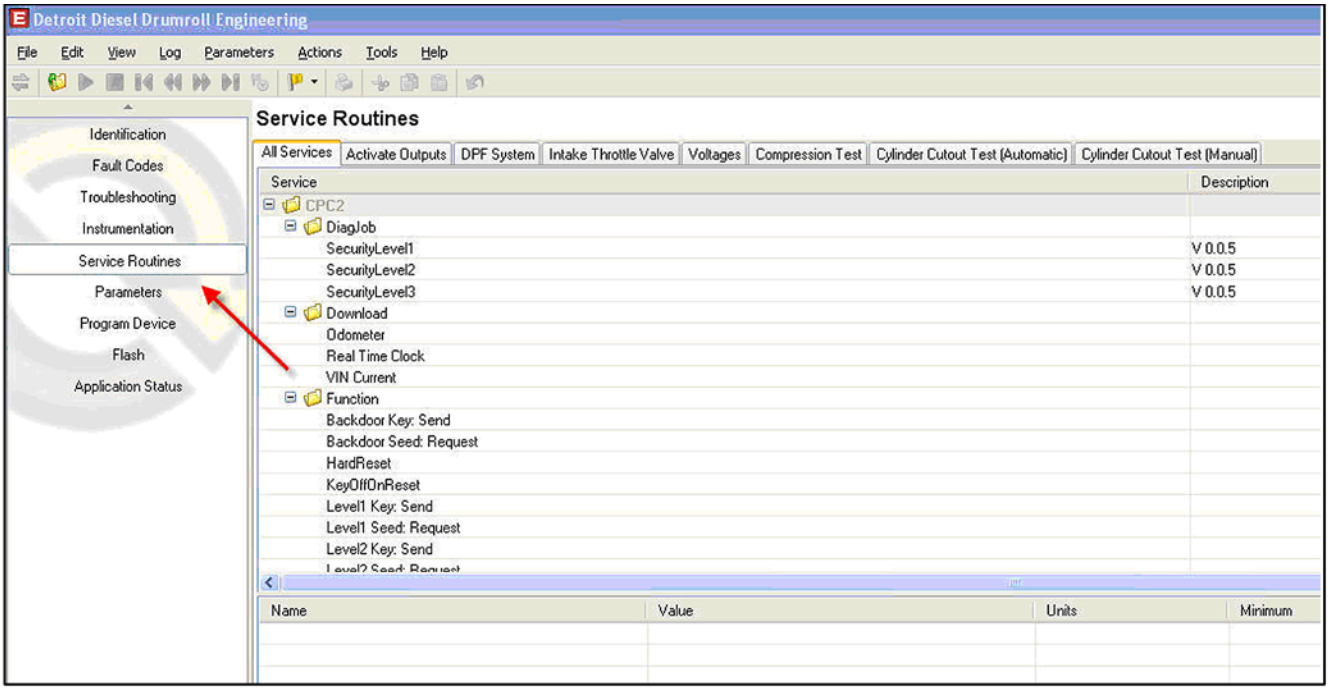
5.6.1 LEAKAGE DETECTION

When the high pressure fuel system, from the pump to injectors, develops an internal or external leak, this will cause the MCM software to compensate for the additional loss. When the leakage rate is greater than a threshold plus and aux value, a code will set. This screen will help determine if a leak has occurred and if the repair has fixed the leakage problem. The parameters within the screen are listed in the following table.

Parameter	Description
HP Leak Counter	This is a counter that increments when: □ HP Leak Actual Value > (HP Leak Leaned Value + 0.303) □ When the counter reaches 5, an error code will set.
HP Leak Learned Value	This value is stored when an engine goes through a learn cycle for the leakage threshold.
HP Leak Learned Counter	This counter will increment each time a learn cycle is completed. It will require 10 learn cycles to be completed.
RPG Compensation	Rail Pressure Governor Compensation is displayed in liters per hour. This value is directly proportional to how the system is compensating for leakages either internal or external. □ A new fuel system with little leakage, RPG Compensation value is around 15 l/h. □ A fuel system with a 9 l/h leakage, RPG Compensation is around 25 – 28 l/h. □ A fuel system with a 45 l/h leakage, RPG Compensation is around 66 l/h.
HP Leak Actual Value	This value is updated when a leak down test is performed. This is the actual leakage value that is calculated by the MCM.
Coolant Temperature	Coolant temperature
Fuel Temperature	Fuel Temperature

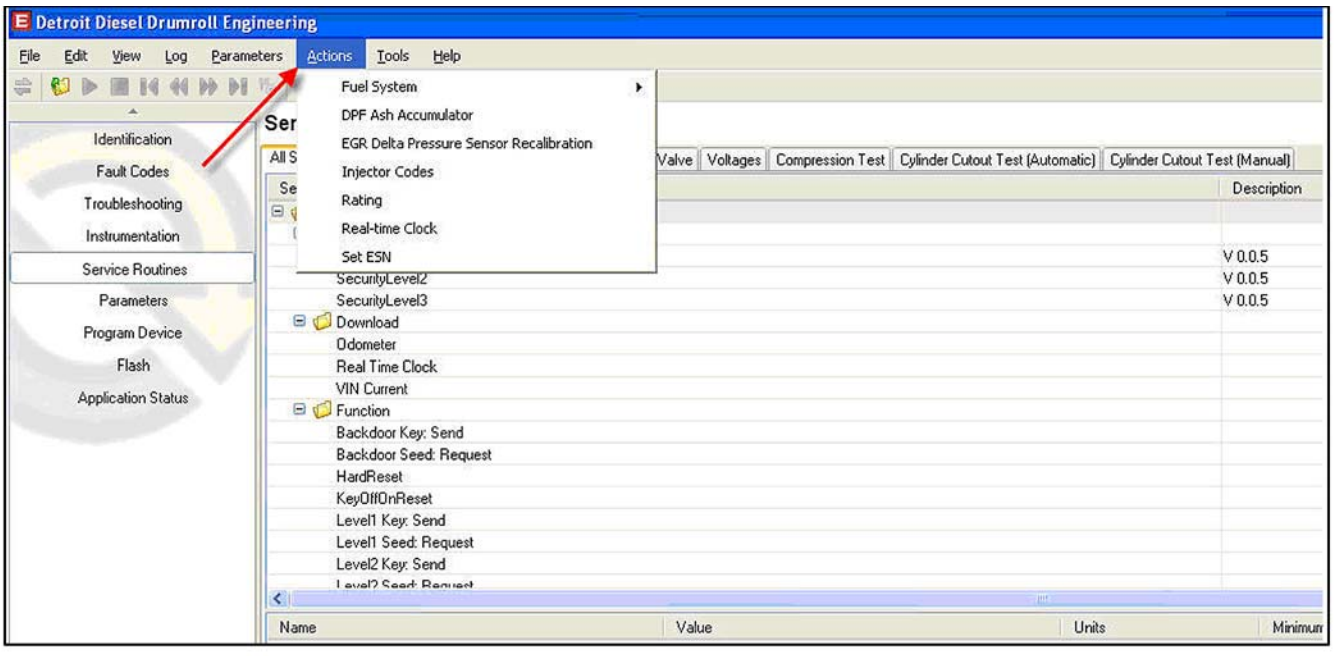
Check for leaks as follows:

1. Install and connect DDDL 7.0.
2. Navigate to the “Service Routines” panel.



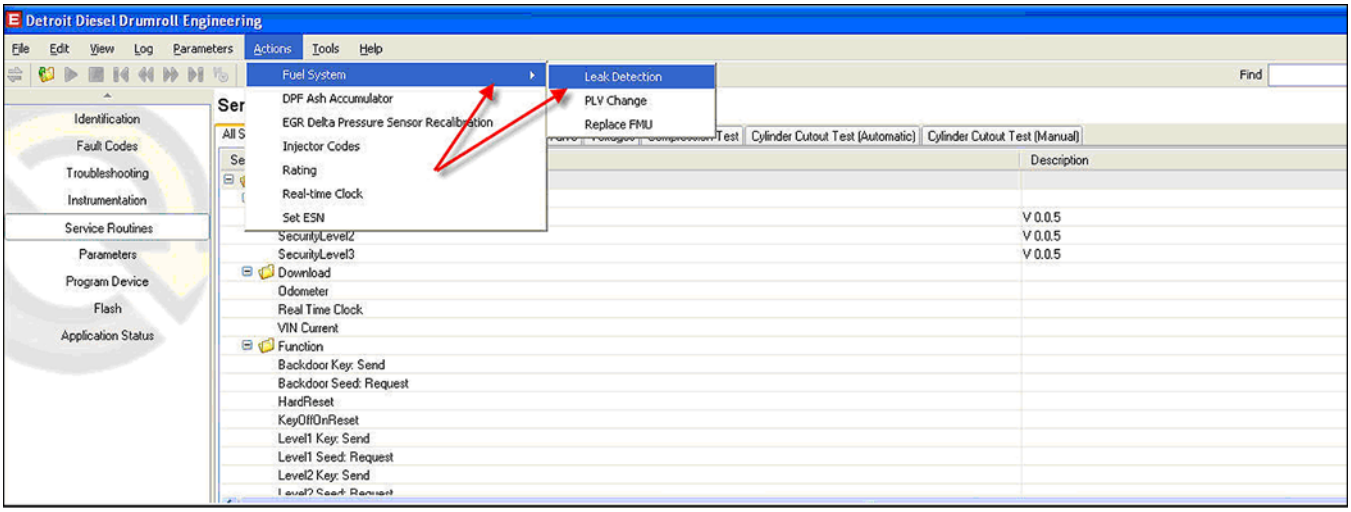
d470039

3. Click on the “Actions” tab located at the top of the screen.



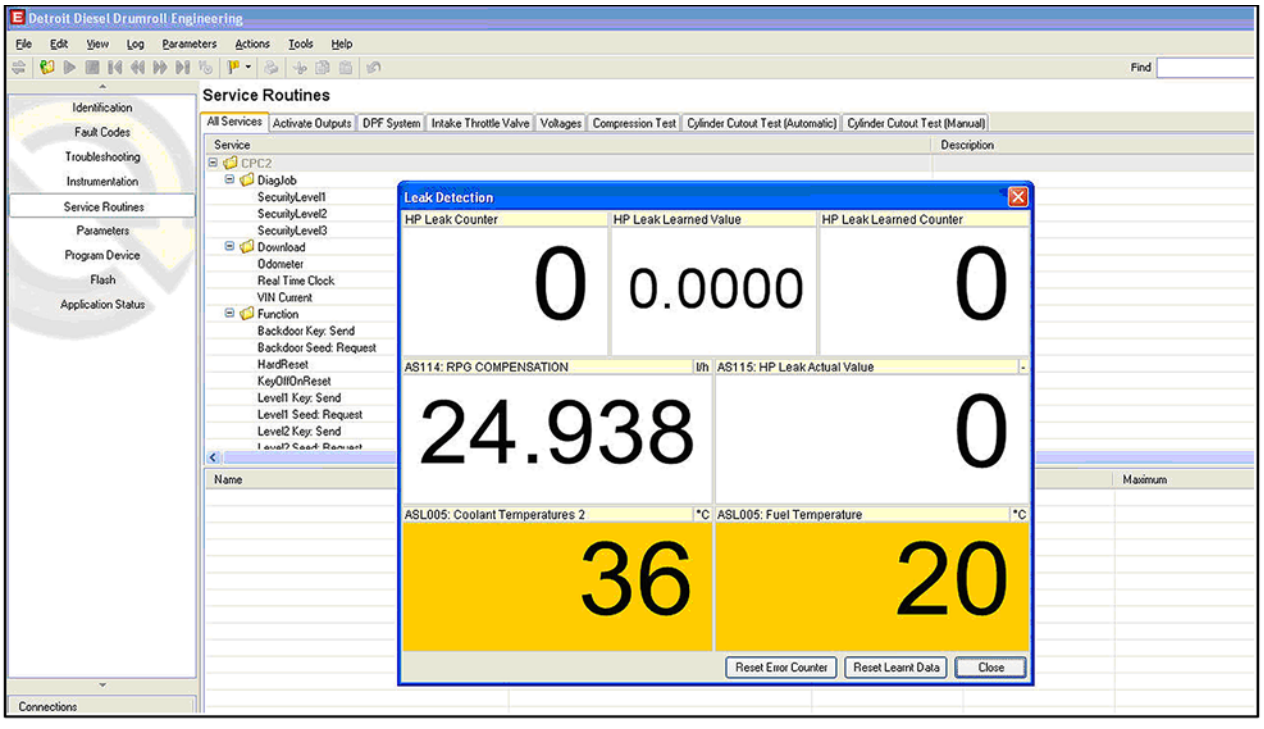
d470040

4. Click on the tab labeled “Fuel System” and then “Leak Detection”.



d470041

5. The dialog box that appears shows the parameters related to fuel system.



d470042

6. Perform a Leak Down Test, refer to section 5.6.2.

5.6.2 PERFORMING A LEAK DOWN TEST

Perform test as follows:

1. Turn ignition ON.
2. While in the “Leak Detection” screen, click the “Reset Error Counter” button.

NOTE:
This will decrement the “HP Leak Counter” by 1. If the leak down test fails, a code will set on next key cycle.

3. Start engine and monitor “Coolant Temperature” and “Fuel Temperature”. Both dialog boxes will turn green when temperature conditions are met.
   [a] Coolant temperature must be between 70°C and 10°C.
   [b] Fuel temperature must be between 35°C and 89°C.
4. When temperature entry conditions are met, increase engine to 1000 RPM for a minimum of 5 minutes.
5. When the 5 minute time at 1000 RPM is reached, decrease engine speed to idle.
6. Turn ignition OFF.
7. Allow system to bleed down for approximately 10 seconds.
8. Turn ignition ON.
9. Reconnect to MCM and CPC.
10. Read the value for “HP Leak Actual Value”.
    [a] If the value is less than 1.5, the system leakage is acceptable.
    [b] If the value is greater than 1.5, the system leakage is unacceptable and should be checked.

5.6.3 THRESHOLD RESETTING

When more than one injector or a high pressure pump is replaced, a relearn of the threshold should occur

Reset the threshold as follows:

1. Turn ignition ON.
2. While in the “Leak Detection” screen, click the “Reset Learned Data” button.

NOTE:
This will clear the “HP Learned Leak Value” and “HP Learned Leak Counter”.

3. Start engine and monitor “Coolant Temperature” and “Fuel Temperature”. Both dialog boxes will turn green when temperature conditions are met.
   □ Coolant temperature must be between 70°C and 100°C.

- □ Fuel temperature must be between 35°C and 89°C.

4. When temperature entry conditions are met, increase engine to 1000 RPM for a minimum of 5 minutes.
5. When the 5 minute time at 1000 RPM is reached, decrease engine speed to idle.
6. Turn ignition OFF.
7. Allow system to bleed down for approximately 10 seconds.
8. Turn ignition ON.
9. Reconnect to MCM and CPC.
10. Read the value for “HP Leak Actual Value”.
    [a] If the value is less than 1.5, the system leakage is acceptable.
    [b] If the value is greater than 1.5, the system leakage is unacceptable and should be checked.
11. At this point “HP Learned Leak Counter” should increment by one.
    [a] If the “HP Learned Leak Counter” did not increment, an entry condition was not met. Go to step 3.
    [b] If the “HP Learned Leak Counter” did increment, complete the relearn process two more times. Go to step 3.

5.7 RAIL PRESSURE BLEED OFF

This procedure, the Rail Pressure Bleed Off (RPBO) test will allow a technician to identify a leak in the high pressure system. A leak in one of the following locations will show a fast bleed down rate over time.

- □ High pressure pump (pumping elements)
- □ Fuel lines from the high pressure pump to fuel rail
- □ Fuel lines to each injector
- □ Leak at the rail pressure sensor
- □ Leaking pressure limiting valve
- □ Internal amplifier or needle leakage

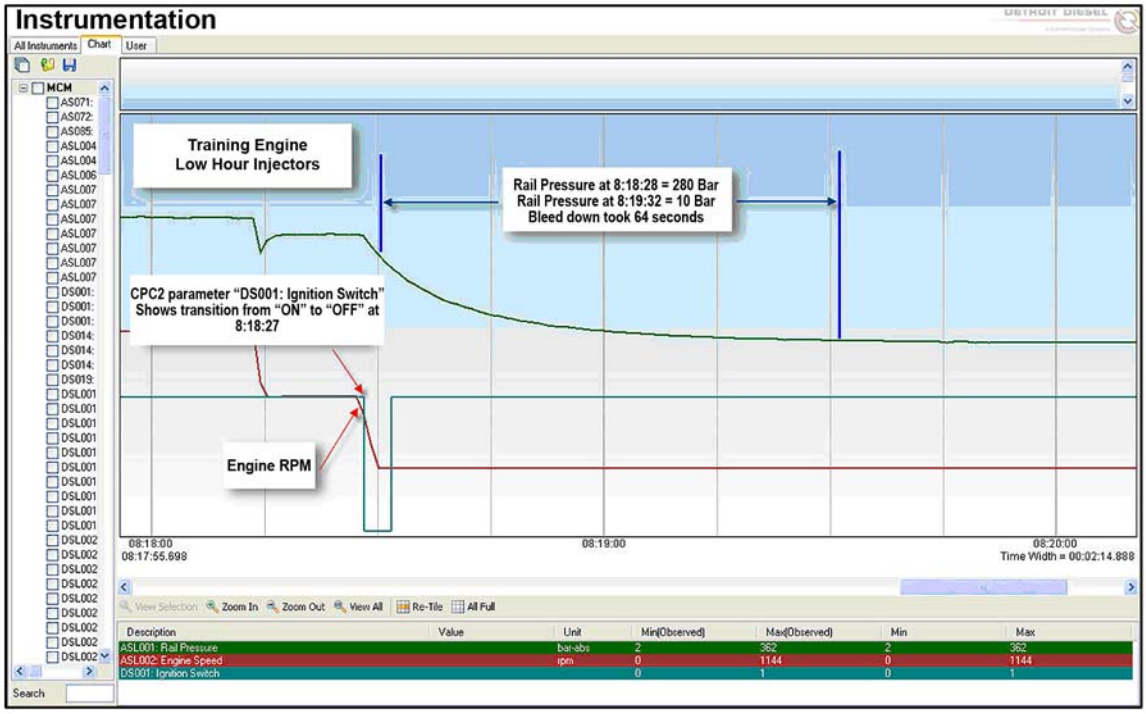
5.7.1 RPBO TEST USING DDDL

Test as follows:

1. Install DDDL hardware.
2. Start DDDL software.
3. Go to “Instrumentation”, “Chart”, and select the parameter “Rail Pressure.”
4. Start engine and bring to operating temperature (over 140°F/60°C).
5. Turn engine OFF.
6. When the engine has stopped, turn ignition ON (key ON, engine OFF). Do not start.

NOTE:
Failure to turn the ignition back ON will cause the MCM to power down before completing the test.

7. Monitor rail pressure trace over time.
8. A normal sealed system should show the characteristics shown in the following illustration.



d470043

[a] Note the time at which rail pressure reaches 280 bar.

[b] Note the time at which rail pressure reaches 10 bar.

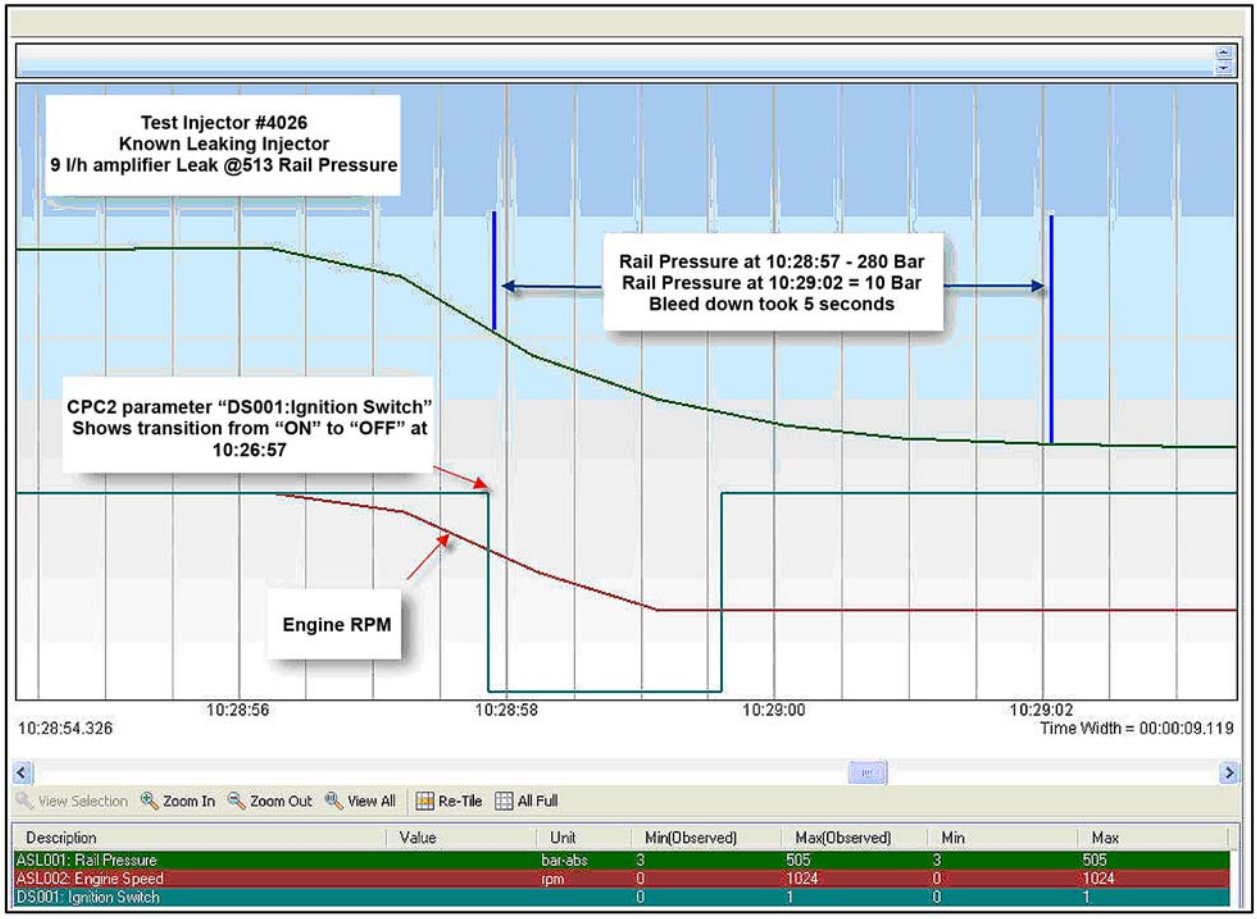
[c] Subtract the two times from each other. Use the following worksheet.

Bleed Down Test Worksheet	
Time at Rail Pressure 10 bar	Seconds
Time at Rail Pressure 280 bar	Seconds
Bleed Down Time	Seconds

If Bleed Down Time is greater than 35 seconds, the system is OK.

If Bleed Down Time is less than 35 seconds, check system for leakage

9. A system that developed a leak in the high pressure system will show the following characteristics.



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10. Return to symptom based diagnostic routine.

5.8 PRESSURE LIMITING VALVE LEAKAGE

There are two procedures that will allow a technician to identify a leaky pressure limiting valve (PLV). A defective PLV can cause the following conditions:

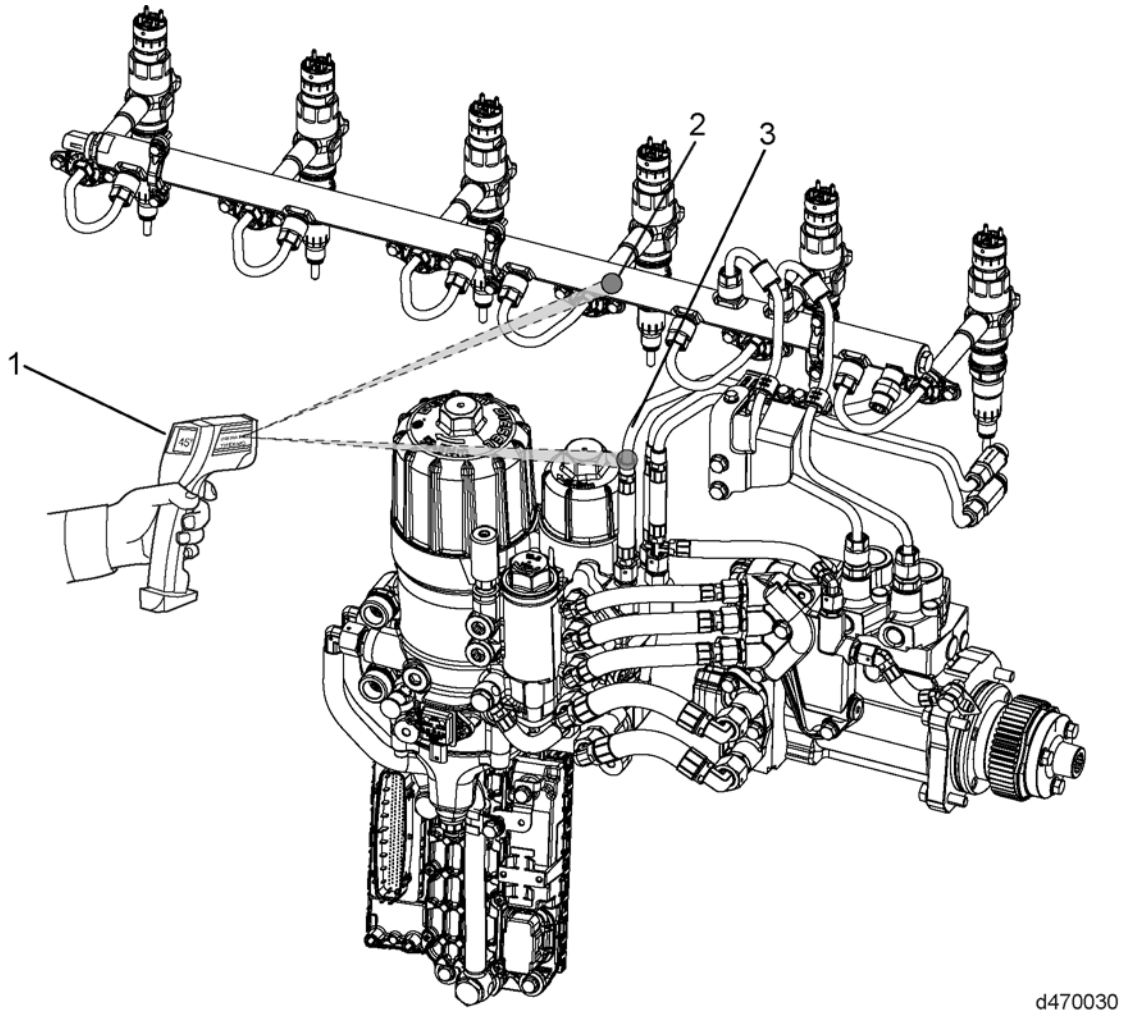
- □ Instable rail pressure (Temperature Test and Flow Test)
- □ Long crank times (Temperature Test and Flow Test)
- □ Codes related to rail pressure deviation (Temperature Test and Flow Test)
- □ No start condition (loose or leaking significantly) (Flow Test)

A flow test is required if a no start condition is occurring and the PLV is main suspect.

5.8.1 PLV LEAKAGE TEMPERATURE TEST

Test as follows:

1. Start the engine.
2. Use an infrared temperature gun (1), measure the surface temperature of the fuel rail (2) between cylinders #4 and #5.



3. Take a second measurement at the solid PLV line just above the connection on the fuel filter module (3).
4. Compare the two values to the examples in the trend chart below.
   - □ If the PLV is **not opening**, the surface temperature at the PLV line will be less than the rail surface temperature.
   - □ If the PLV is **opening**, the surface temperature at the PLV line will be greater than the rail surface temperature

Pressure Limiting Valve Trend Data Examples				
Component	**Normal PLV (cold start)**	**Normal PLV (after drive cycle)**	**Normal PLV (after drive cycle)**	**Leaking PLV**
Fuel Rail Surface Temperature	82-89°F	187°F	168°F	90-97°F
PLV Line Surface Temperature	76-77°F	160°F	155°F	105-108°F

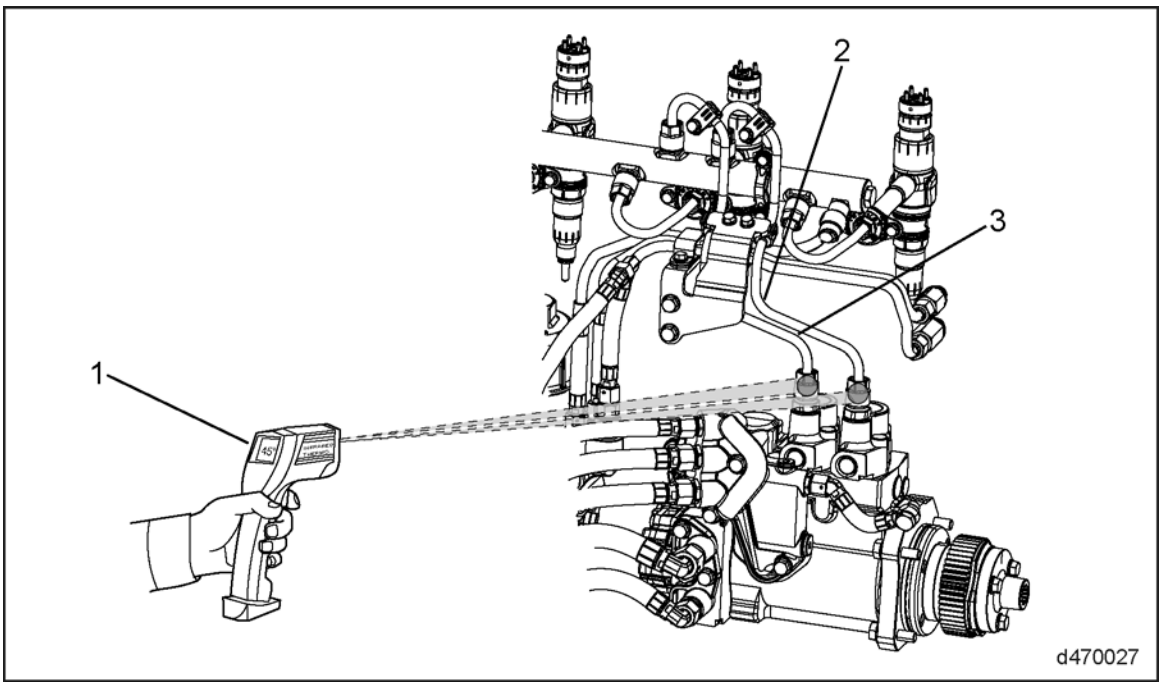
5.8.2 PLV LEAKAGE FLOW TEST

Test as follows:

1. Remove PLV line to the fuel filter module.
2. Install clear hose and fitting J-48708-4 from J-48708 kit.
3. Cap fitting at module.
4. Connect the opposite end to the J-48708 tank.
5. Crank or start engine and note the return flow to the tank.
   [a] If return fuel is noted, replace PLV.
   [b] If no return flow is noted, go to next step.
6. Sweep engine speed from idle to 1800 and note the return flow to the tank.
   [a] If return fuel is noted, replace PLV.
   [b] If no return flow is noted, PLV is not causing the error condition.

5.9 PUMPING ELEMENT CONCERNS

This procedure will allow a technician to identify a pumping element or suction valve concern within the high pressure pump. This test uses an infrared temperature gun (1) to measure the external temperature of the nuts on the high pressure pump. A defective pumping element or suction valve will show a distinct temperature difference between measurements. Pumping element concerns can cause unstable rail pressure, long crank times, and codes related to rail pressure deviation.



Test as follows:

1. Start engine and allow engine to idle for 5 minutes.
2. Using an infrared temperature gun (1), monitor the high pressure line (2, 3) nut temperatures at the high pressure pump.
   [a] If the temperature difference between each line is within 20 degrees, go to next step.
   [b] If temperatures difference is greater than 20 degrees, suspect a failed pumping element or suction valve. Replace pump.
3. Increase engine speed to 1500 rpm and monitor the line nut temperature at the high pressure pump.
   [a] If the temperature difference between each line is within 20 degrees, no trouble found.
   [b] If temperatures difference is greater than 20 degrees, suspect a failed pumping element or suction valve. Replace pump.

5.10 ISC VALUES

Incorporated into the MCM is the ISC software which monitors the crank wheel speed variation per segment and compensates each injector to allow a smoother running engine. When the engine is at or around idle speed, the compensation values can be learned and stored in the EEPROM.

For diagnostic purposes these values can be used to pinpoint a cylinder which is getting close or at its maximum/minimum limit. The limit valves are set to positive (+100) and negative (-100). At the positive value, the MCM software is compensating for an injection rate that is low

On a common rail system this can be caused by an injector fueling issue (such as problems with actuators, lack of amplification or plugged nozzle) or failure of a high pressure supply to a particular injector (such as plugging of inlet particle filter of injector).

On a unit pump system this can be caused by the unit pump, high pressure line, transfer tube, or injector (nozzle). At the negative value, the MCM software is compensating for an injection rate that is high. On a common rail system this can be caused by an injector fueling issue. On a unit pump system this can be caused by the unit pump or injector (nozzle).

If the ISC values are 0, this indicates no compensation is needed. Values of +40 and -40 are not uncommon for a new fuel system. If values reach +70 to +80 and -70 to -80, injection quantities are reaching their limits and should be noted. If values are at +100 and -100, the respective cylinders should be checked.

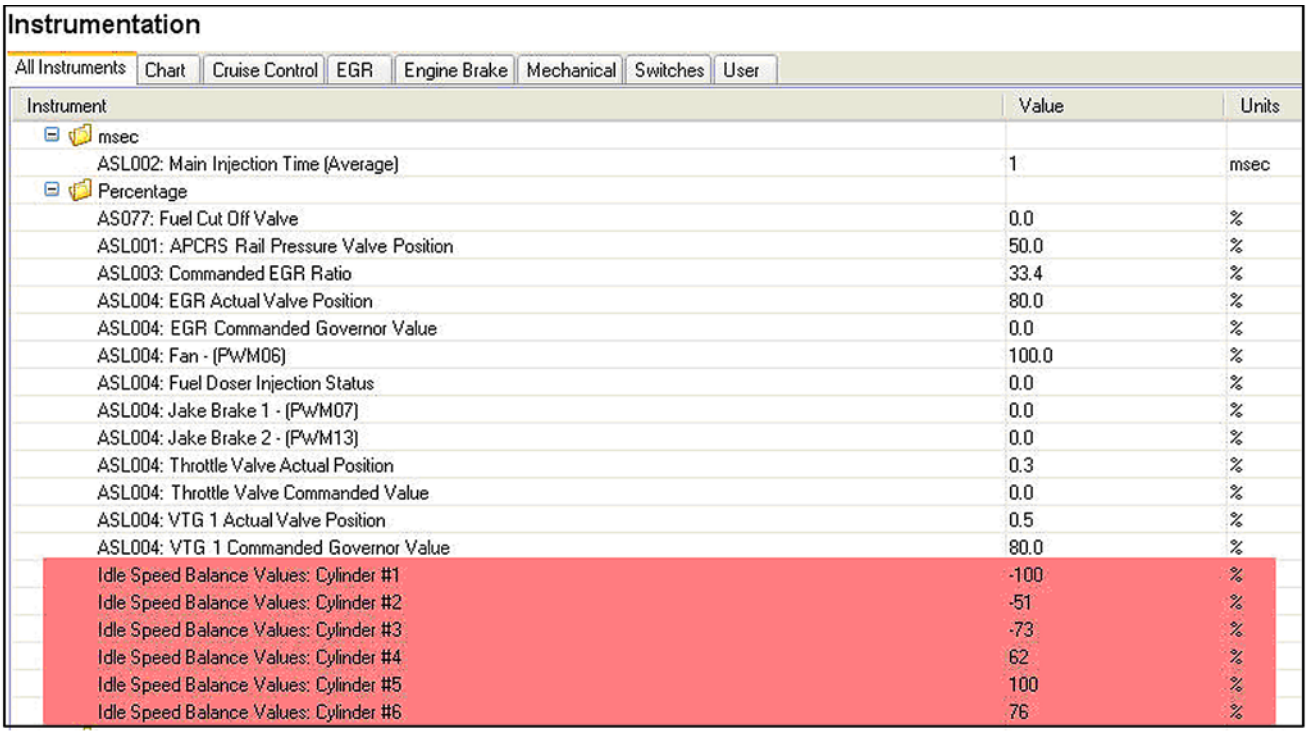
For diagnostics more emphasis needs to be placed on a cylinder in the positive range due to this implies that more fueling is needed to maintain a smooth running engine. The corresponding high positive value would only be compensating for the low performing cylinder.

Example: For a low injection rate (low fueling from injector). The software will try to compensate for this injector by increasing its pulse width to smooth out the engine. The value will go positive until the engine is performing properly. If the value reaches (+100), no more compensation can occur. The injector should be replaced only after a visual inspection of the fuel supply to the injector is checked.

5.10.1 CHECKING ISC VALUES

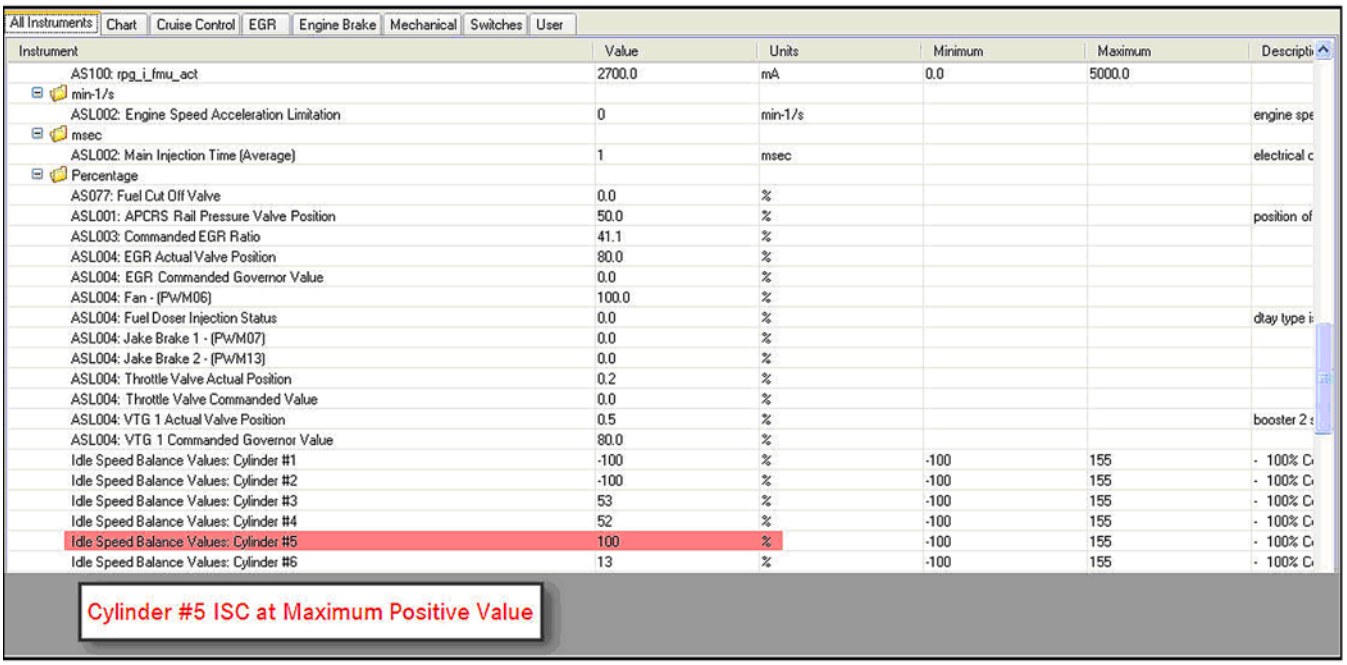
Check as follows:

1. Using DDDL 7.0, go to the “Instrumentation” window and click on the “All Instruments” tab
2. Scroll down to the “MCM” section and locate the parameters “Idle Speed Balance Values: Cylinder #1” thru cylinder 6.



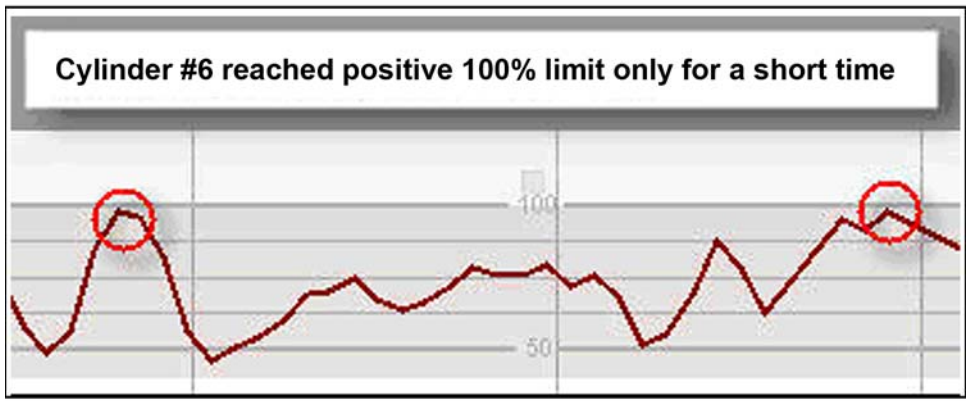
d470045

3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Ensure engine is at idle.
5. Monitor ISC parameters making note of each cylinder that is showing a positive 100% value.



d470046

NOTE:
During the learning process some cylinders may reach the positive 100% limit, but will only stay there for a short period of time. Looking at the parameters using the chart function can help determine an injector that is stuck at the 100% limit compared to an injector that reached the limit for a short time. See the next two illustrations.



d470047

d470048

NOTE:
If all cylinders have not updated within 3 minutes, run the engine to 1200 RPM for 1 minute and return to idle. This will cause the MCM software to relearn the ISC values.

6. Continue to monitor cylinder(s) that reached a positive 100%. If the suspect cylinder is stuck at the limit for longer than 3 minutes, check the following components:
   - □ Fuel line from rail to injector (kinked or plugged)
   - □ Fuel line connection at injector or rail (leaking)
7. If fuel line and connections are OK, replace injector.

5.11 FUEL FILTER LIFE

The fuel system consists of three main filters. The prefilter has the task of filtering material down to 100 micron. The coalescer or water separator has the function of separating out emulsified water, and can be considered to be a 10 micron filter. The final filter is rated at 3-5 micron. Generally the final filter is the filter that reaches the pressure limit first. With the current configuration all filters are changed at the same time. The pressure limits when all filters are to be replaced are listed in the chart that follows.

Filter Pressure Limits			
RPM	**Normal Pressures**	**Replace Filters Using J-48876 Priming Port Gauge**	**Replace Filters Using J-48706 Gauge Set (LPP Outlet Value)**
600 RPM	70-115 PSI	>115 PSI	>115 PSI
1800 RPM	100-150 PSI	>150 PSI	>150 PSI

5.11.1 REPLACING FUEL FILTERS

Replace as follows:

1. Install J-48876 or J-48706 test gauge(s).
2. Start engine.
3. Monitor pressures at 600 RPM.
   [a] If the pressure is >115 psi at the priming port or the LPP Outlet, replace filters.
   [b] If the pressure is <115 psi at the priming port or the LPP Outlet, go to next step.
4. Monitor pressures at 1800 RPM.
   [a] If the pressure is >150 psi at the priming port or the LPP Outlet, replace filters.
   [b] If the pressure is <150 psi at the priming port or the LPP Outlet, filters are OK.
5. Turn OFF engine.
6. Remove J-48876 or J-48706 test gauge(s).

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6 FUEL SYSTEM PROCEDURES

The following procedures should be used when working on the fuel system.

- □ Draining Fuel System Prior to Repairs, refer to section 6.1
- □ Check Pump Timing, refer to section 6.2
- □ Resetting the Pressure Limiting Valve Counter, refer to section 6.3
- □ Resetting Quantity Control Valve Adaptive Values, refer to section 6.4
- □ Fuel System Priming, refer to section 6.5

6.1 DRAINING FUEL SYSTEM PRIOR TO REPAIRS

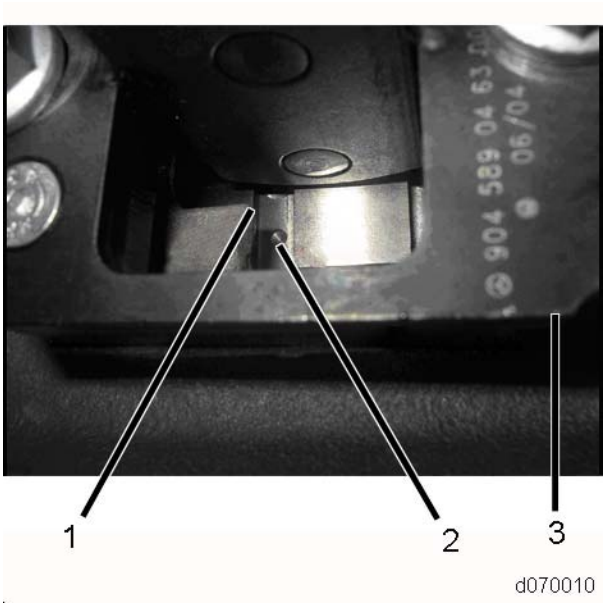
Drain system as follows:

1. Remove the fuel feed line from the fuel filter module.
2. Install J-48710 fuel pressure test kit onto the fuel feed line at the module.
3. Do NOT remove the return line from the module.
4. Use regulator and adjust the system pressure to 50 psi.
5. After one to two minutes the system should be drained of fuel.
6. Remove test equipment.

6.2 CHECK PUMP TIMING

Time the fuel pump as follows:

1. Disconnect the battery power.
2. Install engine barring tool J-46392 to flywheel housing.
3. Rotate the flywheel until the dot that is located inside the tooth is aligned with edge of pointer and install pin.



1. Edge of Pointer
2. Dot Located Inside of Tooth
3. Barring Tool Location

NOTE:
Cylinder No. 1 can be positioned on either the firing stroke or exhaust stroke. Both valves will be closed when cylinder number one is at TDC and the camshaft lobes will be positioned inward.

4. Remove rocker cover and ensure cylinder No. 1 is at top dead center (TDC) in the firing position.
   [a] If cylinder No. 1 is not at TDC firing position, rotate the engine one more revolution and position timing mark as shown in the previous illustration.
5. Remove inspection cover located on flywheel housing.

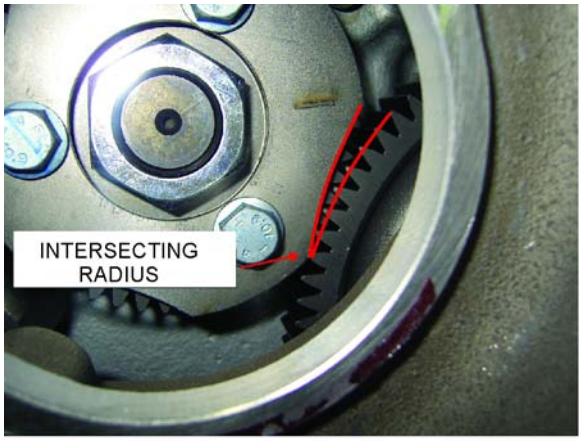
NOTE:
All new pumps factory or service install will be timed at the twelve o'clock position.

6. Using a telescoping mirror check and ensure the hash mark is at the twelve O'clock position.

[a] If the hash mark is not at twelve o'clock position; remove the pump and reinstall at the twelve o'clock position.

7. Using a telescoping mirror compare the radius of the eyebrow to the gear radius.

[a] If the eyebrow radius intersects with the gear radius, the pump is out of time with the gear train. The next illustration show the intersecting radius with the pump installed one tooth off.

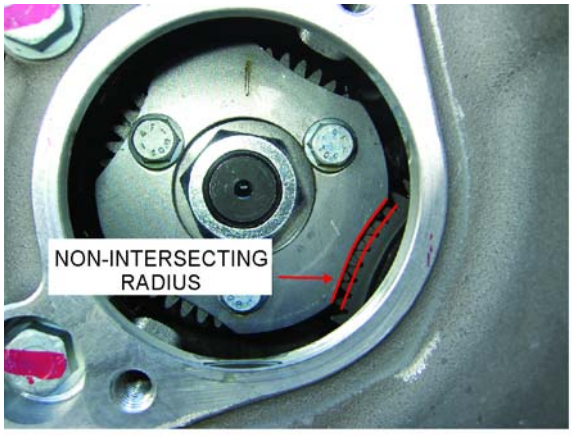


d050013

[b] Remove high pressure pump and inspect for damage.

[c] If no damage is found, reinstall pump at proper timing.

[d] If the eyebrow radius does not intersect with the gear radius, the pump is in time with the gear train.

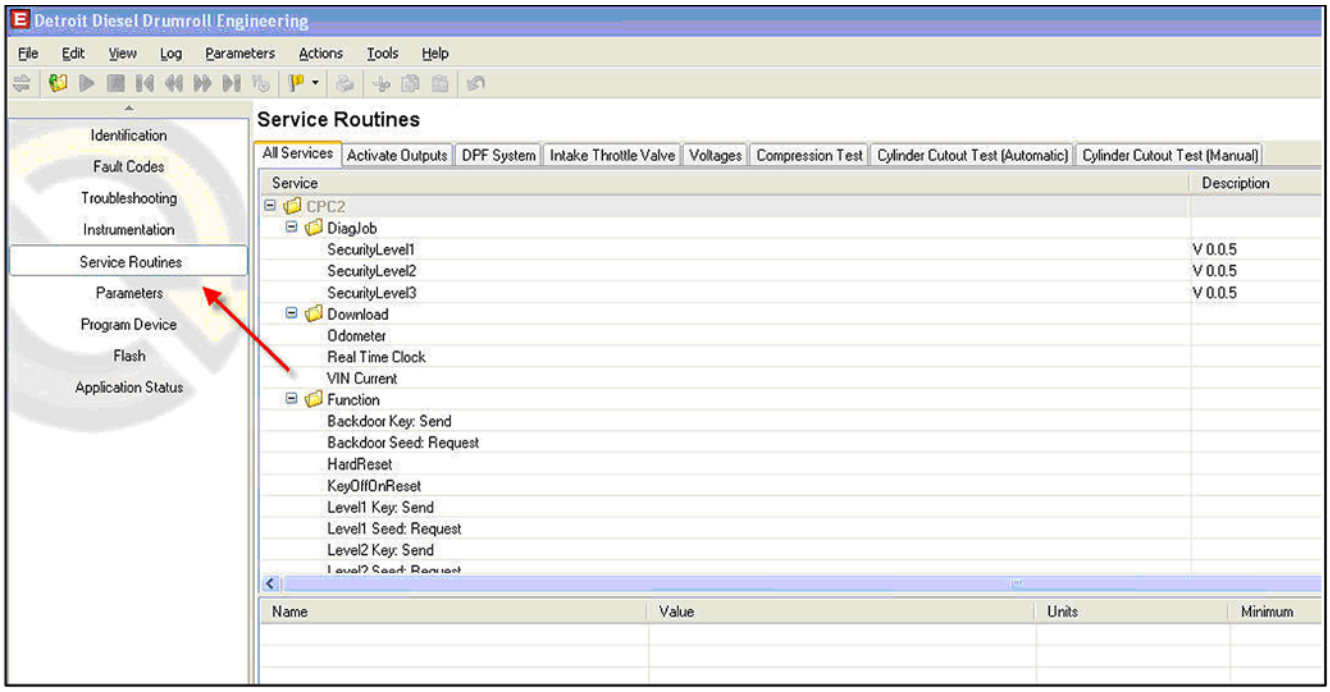


d050014

6.3 RESETTING THE PRESSURE LIMITING VALVE COUNTER

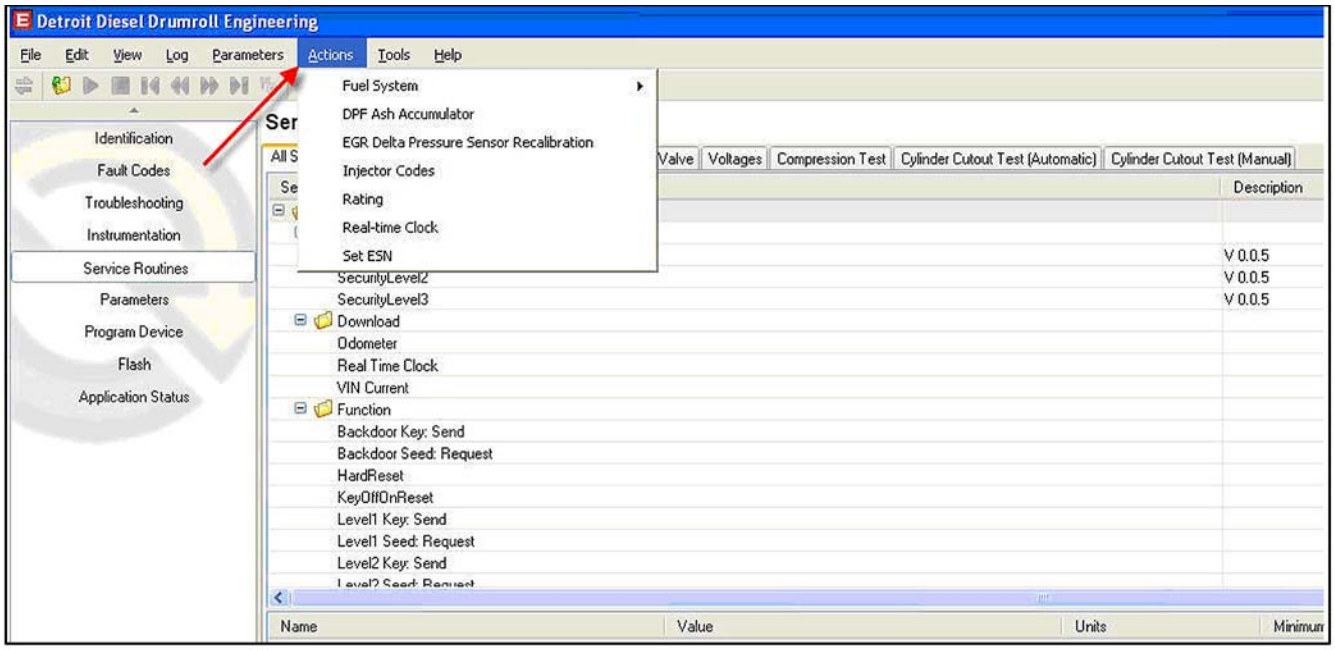
This procedure will allow a technician to retrieve and clear the PLV counter. The counter should be reset ONLY a PLV replacement. If the counter has reached a value of 50 or greater, the PLV should be replaced and the counter reset.

1. Install and connect DDDL 7.0.
2. Navigate to the “Service Routines” panel.



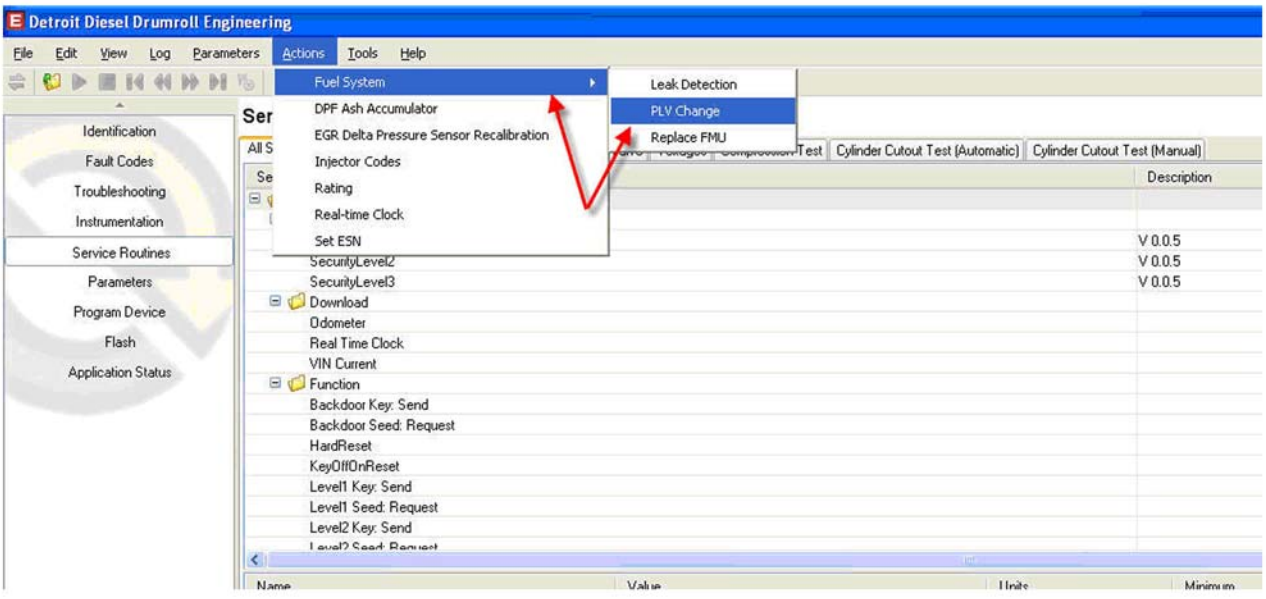
d470039

3. Click on the “Actions” tab located at the top of the screen.



d470040

4. Click on the tab labeled “Fuel System” and then “PLV Change”.

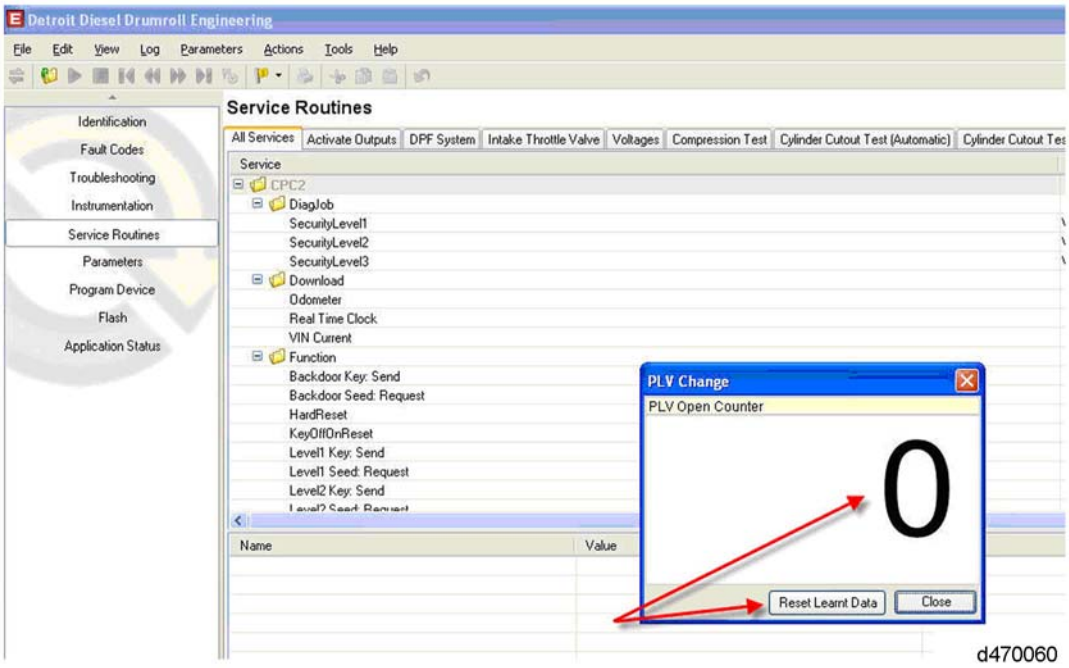


d470059

5. The dialog box that appears shows the current PLV counter, and the ability to reset the counter.

NOTE:
Only reset the counter if the PLV is being replaced.

6. Click the button “Reset Learned Data” to clear the counter.

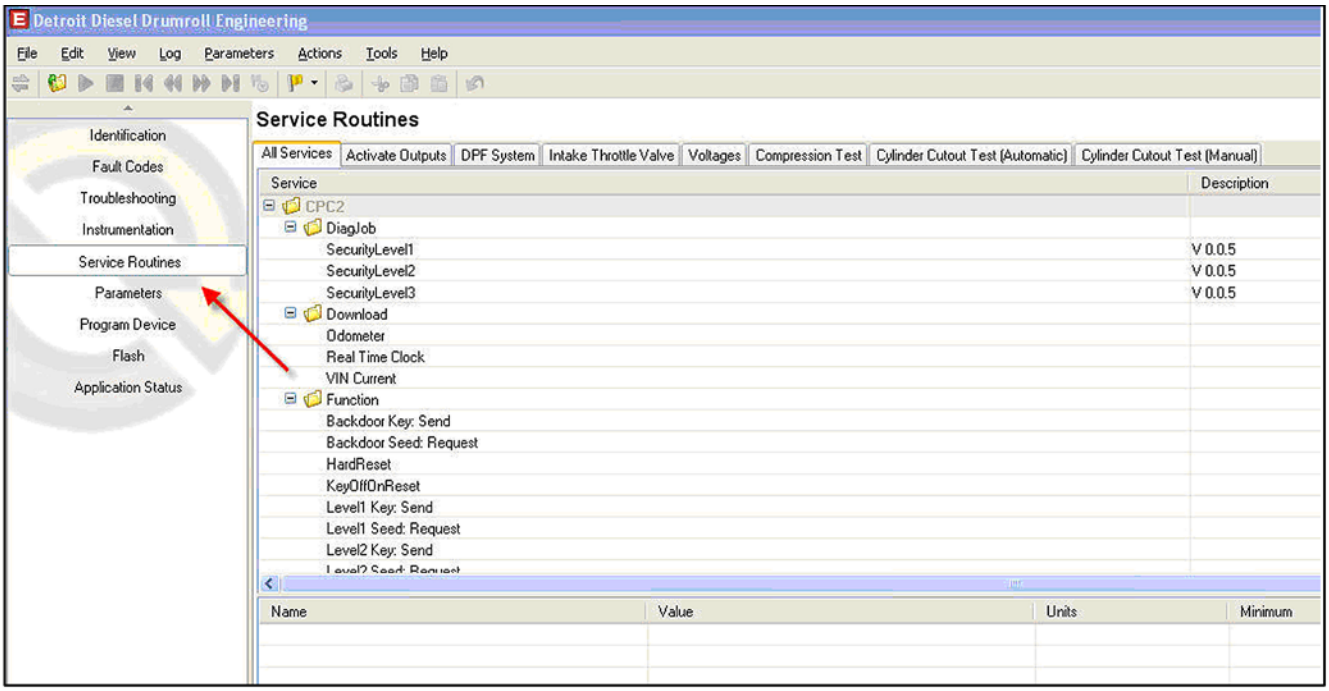


6.4 RESETTING QUANTITY CONTROL VALVE ADAPTIVE VALUES

This procedure will allow a technician to retrieve and clear the Quantity Control Valve adaptive values. The stored values should be reset ONLY when a Quantity Control Valve replacement has occurred.

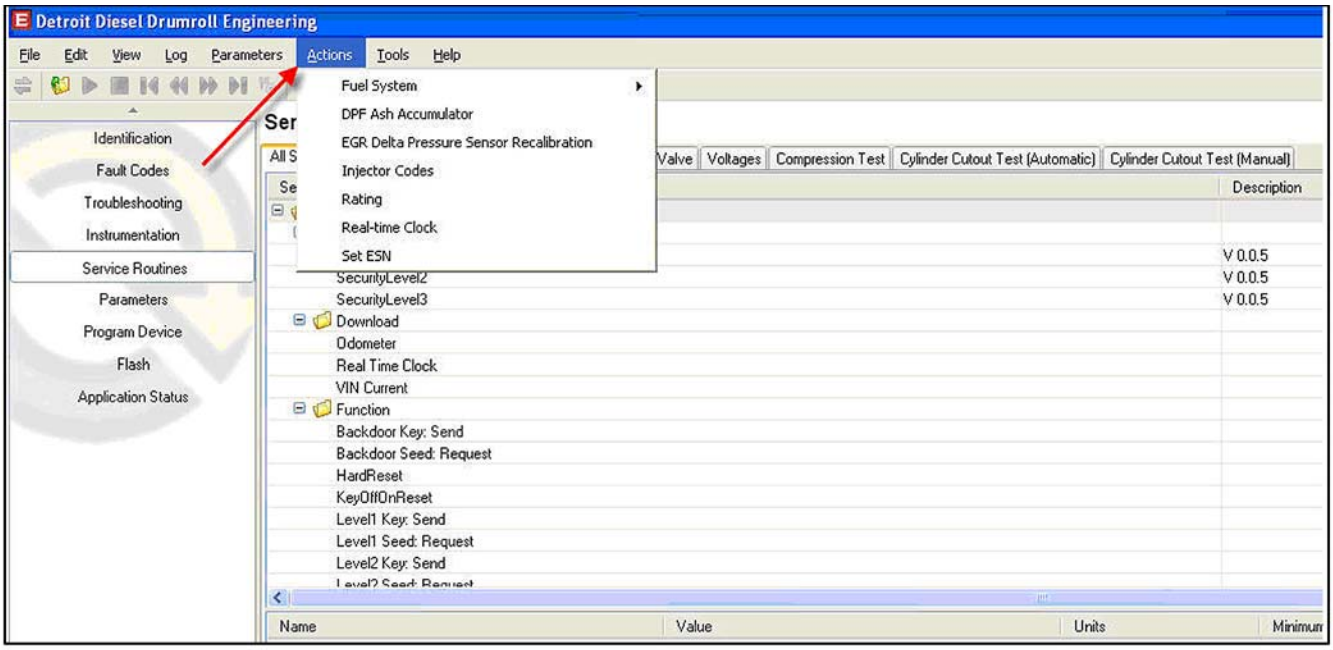
Reset as follows:

1. Install and connect DDDL 7.0.
2. Navigate to the “Service Routines” panel



d470039

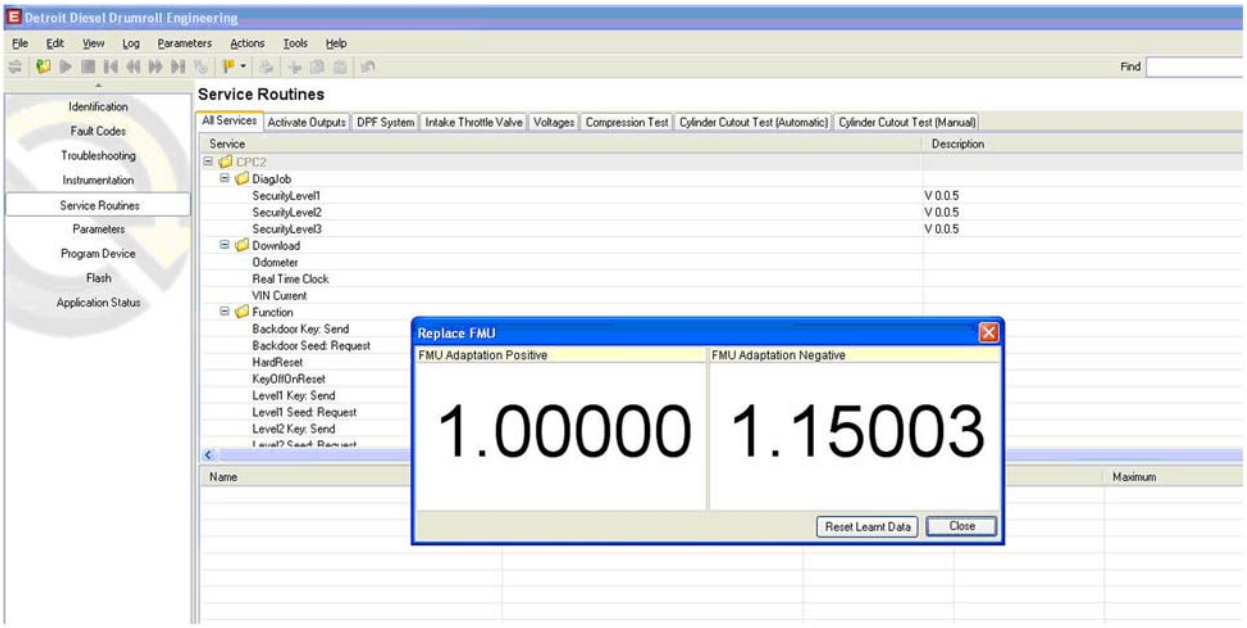
3. Click on the “Actions” tab located at the top of the screen.



d470040

4. Click on the tab labeled “Fuel System” and then “Replace Quantity Control Valve”.

5. The dialog box that appears shows the current quantity control valve adaptive values, and the ability to reset the values.



d470061

NOTE:
Only reset the values if the quantity control valve is being replaced.

6. Click the button “Reset Learned Data” to clear the counter.

6.5 FUEL SYSTEM PRIMING

During service or maintenance of the fuel system air can be introduced, and the system will need to be purged. If the air in the system is not properly purged, longer than normal crank times or electronic service codes related to unstable rail pressure may occur. If a service code is set after work is performed on the fuel system, clear the codes and retest the system.

6.5.1 AFTER FILTER CHANGE (USING J-47912 PRIMING CAN)

Proceed as follows:

1. Ensure priming canister is ¾ full (approximately 9 liters) of fuel.
2. Install fuel priming canister to the priming port on the fuel filter module.
3. Ensure priming canister shutoff valve is closed.
4. Pressurize priming canister to maximum pressure.
5. Open shutoff valve and allow system to fill for 60 seconds.
6. Close shutoff valve.
7. Check for fuel leaks, repair as necessary.
8. Crank engine for 20 seconds.
9. If the engine starts, 12.
10. If engine does not start, allow for a 60 second cool down and repeat steps 4-8. The starting cycle can be repeated up to three times.
11. If engine still fails to start:
    [a] Use DDDL to check for fault codes, repair as necessary.
    [b] Repeat steps 4 through 9.
12. Remove priming canister from filter module.
13. Allow engine to reach operating temperature (140°F/60°C).
14. Increase engine RPM to 1800 for three minutes.
15. Reduce RPM and check for fuel leaks or service codes. Repair or clear if necessary.

6.5.2 AFTER FILTER CHANGE (USING HAND PRIMER ON MODULE)

Proceed as follows:

1. Operate hand primer for three minutes or 250 strokes.
2. Check for leaks, repair as necessary.
3. Crank engine for 20 seconds.
4. If engine starts, go to step 6.
5. If engine does not start, allow for a 60 second cool down and repeat step 3. The starting cycle can be repeated up to three times.
6. If engine still fails to start:
   [a] Use DDDL to check for fault codes, repair as necessary.
   [b] Repeat steps 2 through 3.
7. Allow engine to reach operating temperature (140°F/60°C).
8. Increase engine RPM to 1800 for three minutes.
9. Reduce RPM and check for fuel leaks or service codes. Repair or clear if necessary.

6.5.3 HIGH PRESSURE PUMP CHANGE OR COMPLETELY DRY SYSTEM (USING J-47912 PRIMING CAN)

Proceed as follows:

1. Ensure priming canister is ¾ full (approximately 9 liters) of fuel.
2. Install fuel priming tool to the priming port on the fuel filter module.
3. Ensure priming canister shutoff valve is closed.
4. Pressurize priming canister to maximum pressure.
5. Open shutoff valve and allow system to fill for 2 1/2 minutes.
6. Close shutoff valve.
7. Check for fuel system leaks.
8. Repressurize priming canister to maximum pressure.
9. Open shutoff valve. Pressure in the priming canister will drop.
10. As the system is filling, continue to pump the priming canister for one minute minimum. This process may take an additional 5 – 15 pumps of the priming canister.

NOTE:
If using an electric priming pump, ensure the pump is capable of producing 70 psi.

11. Close shutoff valve.
12. Crank engine for 20 seconds.

13. If engine starts, go to step 16.
14. If engine does not start, allow for a 60 second cool down and repeat steps 8 through 10.
15. If engine still fails to start, use DDDL to check for fault codes, repair as necessary. Begin process again with step 1.
16. Allow engine to reach operating temperature (140F/60C).
17. Increase engine RPM to 1800 for three minutes.
18. Reduce RPM and check for fuel leaks. Repair if necessary.
19. Remove priming canister.
20. Reduce RPM and check for fuel leaks or service codes. Repair or clear if necessary.

6.5.4 PRIMING PORT PRESSURES

Priming Port (J-48876) Pressures				
	Normal Pressures	**Replace Filter**	**Check for Stuck Open High Pressure Relief Valve for the Low Pressure Pump**	**Check for Fuel Aeration**
600 RPM	70-115 PSI	>115 PSI	<60 PSI	<20 PS
1800 RPM	100-150 PSI	>150 PSI	<80 PS	<20 PSI

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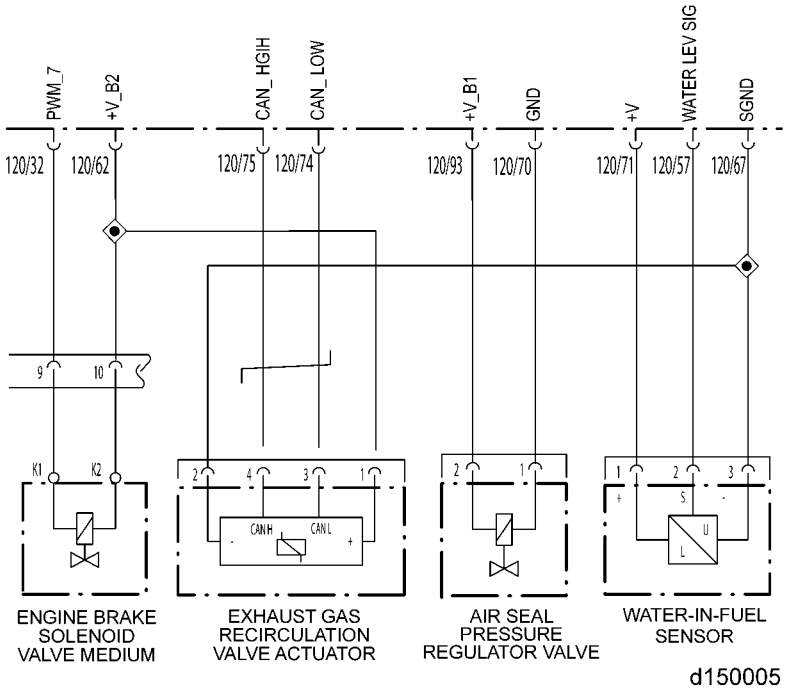
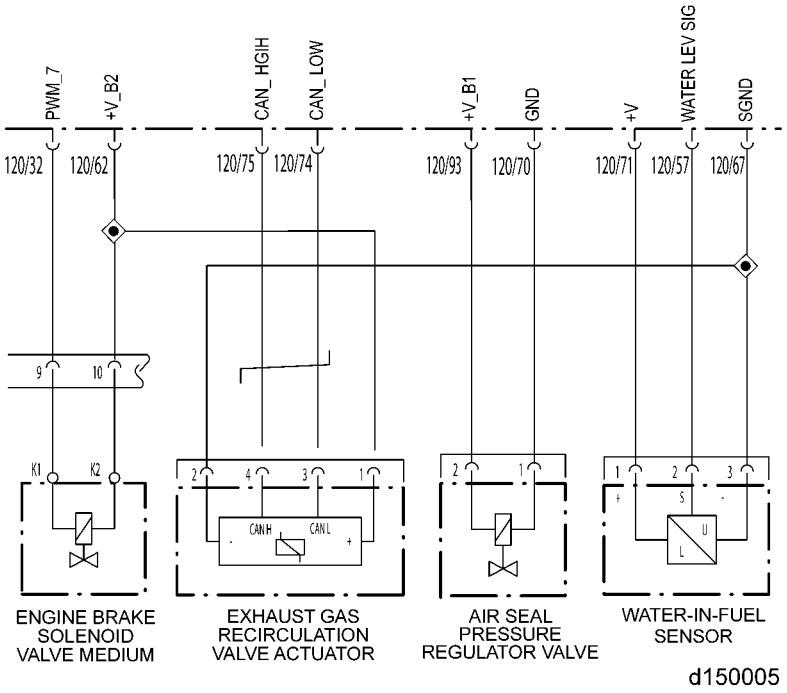
7 SPN 97

This SPN indicates a problem with the Water-in-Fuel Sensor circuit.



7.1 SPN 97/FMI 3

SPN 97/FMI 3 indicates a Water-in-Fuel Sensor open circuit.



Check as follows:

1. Check for multiple codes.
   [a] If any EGR faults are active at the same time, repair the open circuit between pin 67 of the MCM 120-pin connector and pin 3 of the Water-in-Fuel Sensor. Refer to section 7.1.1.
   [b] If only fault 97/3 is active, go to the next step.
2. Disconnect the Water-in-Fuel Sensor.
3. Turn the ignition ON (key ON, engine OFF).
4. Measure the voltage between pins 1 and 3 of the Water-in-Fuel Sensor harness connector.
   [a] If the voltage is between 2.75 and 3.25 volts, go to step 6.
   [b] If the voltage is less than 2.75 volts, go to the next step.
5. Measure the voltage between pin 1 of the Water-in-Fuel Sensor harness connector and ground.
   [a] If the voltage is between 2.75 and 3.25 volts, repair the open circuit between pin 3 of the Water-in-Fuel Sensor harness connector and pin 55 of the MCM 120-pin connector. Refer to section 7.1.1.

[b] If the voltage is less than 2.75 volts, repair the open circuit between pin 1 of the Water-in-Fuel Sensor harness connector and pin 71 of the MCM 120-pin connector. Refer to section 7.1.1.

6. Disconnect the MCM 120-pin connector and measure the resistance between pin 57 and pin 2 of the Water-in-Fuel Sensor harness connector.

   [a] If the resistance is less than 5 Ω, repair the short between pin 2 and 57 of the MCM 120-pin connector. Refer to section 7.1.1.

   [b] If the resistance is greater than 5 Ω, replace the sensor. Refer to section 7.1.1.

7.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

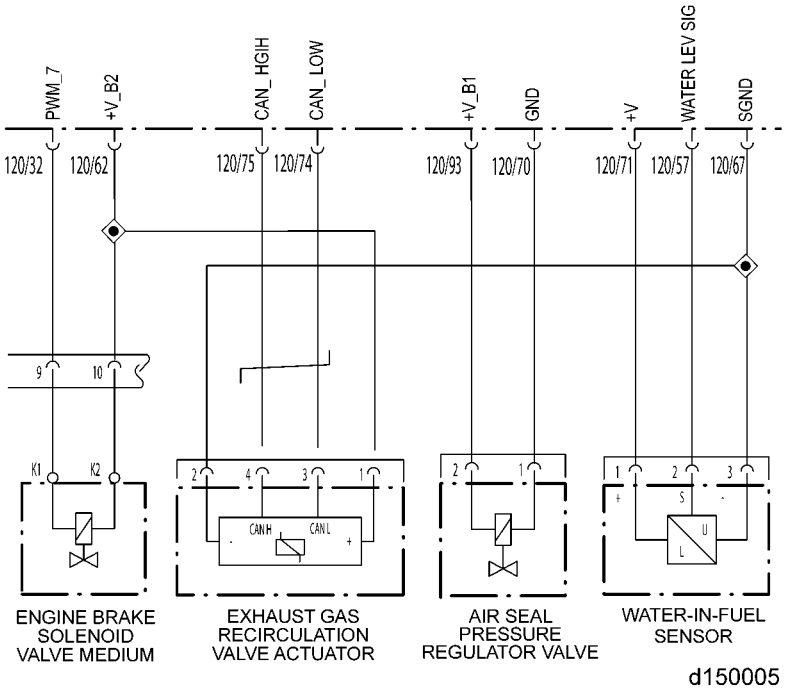
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

7.2 SPN 97/FMI 4

SPN 97/FMI 4 indicates a Water-in-Fuel circuit short to ground.



Check as follows:

1. Check for multiple codes.
   [a] If any EGR faults are active at the same time, repair the open circuit between pin 67 of the MCM 120-pin connector and pin 3 of the Water-in-Fuel Sensor. Refer to section 7.2.1.
   [b] If only fault 97/4 is active, go to the next step.
2. Disconnect the Water-in-Fuel Sensor.
3. Disconnect the MCM 120-pin connector.
4. Measure the resistance between pin 1 of the Water-in-Fuel Sensor connector and ground.
   [a] If resistance is less than 5 Ω, repair short between pin 1 and ground. Refer to section 7.2.1.
   [b] If resistance is greater than 5 Ω, go to the next step.
5. Measure the resistance between pin 2 of the Water-in-Fuel Sensor harness connector and ground.
   [a] If resistance is less than 5 Ω, repair the short circuit between pin 2 of the Water-in-Fuel Sensor harness connector and ground. Refer to section 7.2.1.
   [b] If resistance is greater than 5 Ω, go to the next step.

6. Measure the resistance between pin 3 of the Water-in-Fuel Sensor harness connector and ground.
   [a] If resistance is less than 5 Ω, repair the short circuit between pin 2 of the Water-in-Fuel Sensor harness connector and ground. Refer to section 7.2.1.
   [b] If resistance is greater than 5 Ω, review the previous steps. If the results are the same, contact Detroit Diesel Customer Support Center (313-592-5800).

7.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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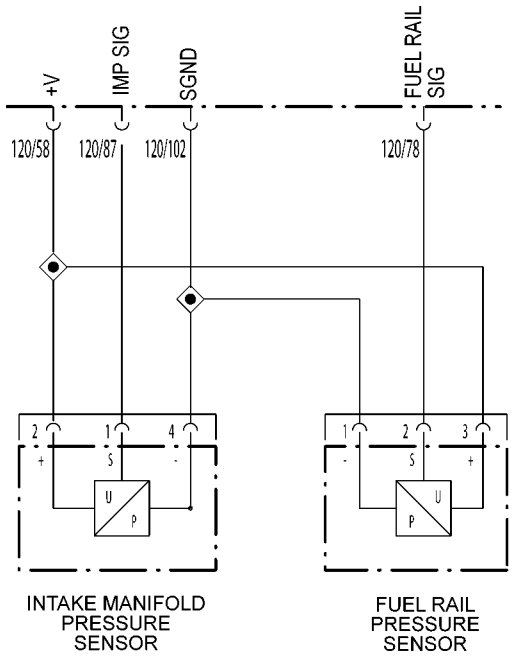
8 SPN 164

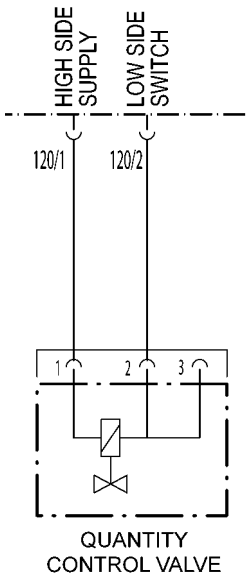
This SPN indicates a problem with the Rail Pressure Governor Sensor circuit or the Quantity Control Valve driver.



8.1 SPN 164/FMI 0

This fault condition indicates a Quantity Control Valve High Side driver error. This condition can occur when:

- □ MCM pin 1 circuit is shorted to ground
- □ Internal short of the Quantity Control Valve



d150002a

Check as follows:

1. Check for multiple codes
   [a] If 164/1 is stored along with 164/0, service 164/1 first.
   [b] If only 164/0 is active, go to the next step.
2. Disconnect the Quantity Control Valve harness connector.
3. Ensure the multi meter (DVOM) resistance is zero.
   [a] If meter can auto zero, perform this function before making a resistance measurement.
   [b] If meter can not auto zero, note the resistance of the leads and subtract it from the measurement taken in step 4
4. Measure the resistance across pins 1 and 2 of the Quantity Control Valve.
   [a] If the resistance is less than 1.3 Ω, replace Quantity Control Valve. Refer to section 8.1.1.
   [b] If the resistance is between 1.3 Ω and 1.4 Ω, go to next step.
5. Disconnect the 120-pin MCM connector and check for corroded, bent or broken pins. Ensure both the MCM and harness connector pins are checked. Repair or replace if needed.

6. Measure the resistance between pin 1 of the Quantity Control Valve harness connector and ground.
   [a] If the resistance is greater than 5 Ω, replace Quantity Control Valve. Refer to section 8.1.1.
   [b] If the resistance is less than 5 Ω, repair the short circuit between pin 1 of the Quantity Control Valve and ground. Refer to section 8.1.1.

8.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

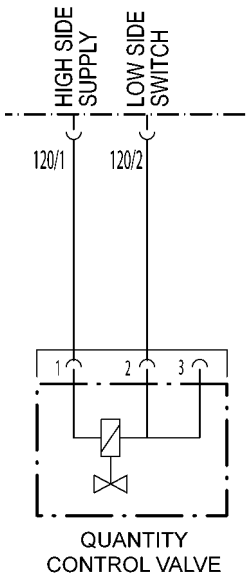
To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

8.2 SPN 164/FMI 1

SPN 164/FMI 1 indicates a Quantity Control Valve Low Side driver error. This condition can occur when:

- □ MCM pin 2 circuit is shorted to power
- □ Internal short of the Quantity Control Valve



Check as follows:

1. Disconnect the Quantity Control Valve harness connector.
2. Ensure the multi meter (DVOM) resistance is zero.
   [a] If meter can auto zero, perform this function before making a resistance measurement
   [b] If meter can not auto zero, note the resistance of the leads and subtract it from the measurement taken in step 3
3. Measure the resistance across pins 1 and 2 of the Quantity Control Valve.
   [a] If the resistance is less than 1.3 Ω, replace Quantity Control Valve. Refer to section 8.2.1.
   [b] If the resistance is between 1.3 Ω and 1.4 Ω, go to the next step.
4. Disconnect the 120-pin MCM connector and check for corroded, bent or broken pins. Ensure both the MCM and harness connector pins are checked. Repair or replace if needed
5. Turn ignition ON.
6. Measure the voltage at pin 2 of the Quantity Control Valve harness connector.
   [a] If the voltage is 0, replace the MCM. Refer to section 8.2.1.

[b] If the voltage is greater than 0, repair the short circuit between pin 2 of the Quantity Control Valve harness connector and battery. Refer to section 8.2.1.

8.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

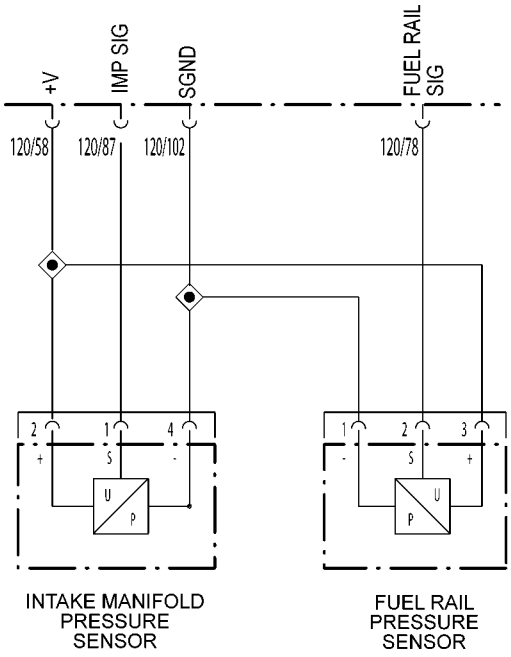
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

8.3 SPN 164/FMI 2

The fault condition is typically related to a signal drift condition with the Rail Pressure Sensor.



Check as follows

1. Check for multiple codes.
   [a] If additional fault codes are present with 164/2, service the additional fault codes first.
   [b] If only 164/2 is present go to the next step.
2. Using DDDL or the DDEC VI break out box, monitor rail pressure sensor voltage.
3. Turn the ignition ON (key ON, engine OFF).
4. Measure the voltage on pin 76 of the 120–pin breakout box.
   [a] If the voltage is greater than or equal to 0.580 volts, replace sensor. Refer to section 8.3.1.
   [b] If the voltage is less than or equal to 0.420 volts; replace sensor. Refer to section 8.3.1.
   [c] If the voltage is between .420 and .580 volts, go to next step.
5. Start the engine and bring it up to operating temperature (over 140°F/60°C).
6. Turn the engine OFF and allow engine to soak for 10 minutes.
7. Turn the ignition ON (key ON, engine OFF) and measure the voltage on pin 76 of the 120–pin breakout box.
   [a] If the voltage is greater than or equal to 0.580 volts, replace sensor. Refer to section 8.3.1.

[b] If the voltage is less than or equal to 0.420 volts; replace sensor. Refer to section 8.3.1.

[c] If the voltage is between .420 and .580 volts, there is no problem.

8.3.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

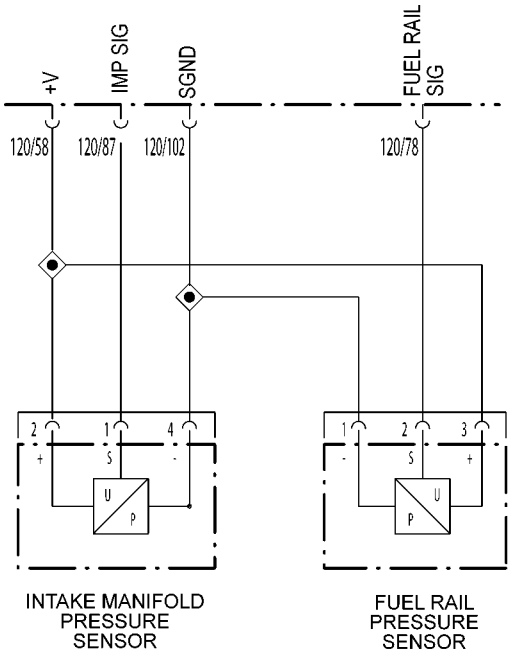
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

8.4 SPN 164/FMI 3

PN 164/FMI 3 indicates the Rail Pressure Governor Sensor circuit failed high (open circuit).



Check as follows:

1. Check for multiple codes.
   [a] If faults for the Intake Manifold Pressure/Temperature Sensor are active at the same time, repair the circuit between pin 58 or pin 102 of the MCM 120-pin Connector and pin 2 or pin 4 of the Intake Manifold Pressure/Temperature Sensor. Refer to section 8.4.1.
   [b] If only fault 164/3 is active, go to the next step.
2. Disconnect the Rail Pressure Governor Sensor connector.
3. Measure the resistance across pins 1 and 2 of the Rail Pressure Governor Sensor.
   [a] If the resistance is greater than XX k Ω, replace Rail Pressure Governor Sensor.
   [b] If the resistance is less than XX k Ω, go to the next step.
4. Turn the ignition ON (key ON, engine OFF).
5. Measure the voltage between pins 1 and 3 of the Rail Pressure Governor Sensor harness connector.
   [a] If the voltage is between 2.75 and 3.25 volts, go to step 7.
   [b] If the voltage is less than 2.75 volts, go to the next step.
6. Measure the voltage between pin 3 of the Rail Pressure Governor Sensor harness connector and ground.

[a] If the voltage is between 2.75 and 3.25 volts, repair the open circuit between pin 1 of the Rail Pressure Governor Sensor harness connector and pin 102 of the 120-pin MCM connector. Refer to section 8.4.1.

[b] If the voltage is less than 2.75 volts, repair the open circuit between pin 3 of the Rail Pressure Governor Sensor harness connector and pin 58 of the MCM 120-pin connector. Refer to section 8.4.1.

7. Disconnect the 120-pin MCM connector and measure the resistance between pin 78 of the MCM 120–pin connector and pin 2 of the Rail Pressure Governor Sensor harness connector.

   [a] If the resistance is less than 5 Ω, repair the short between pin 2 of the Rail Pressure Governor Sensor harness connector and pin 78 of the MCM 120-pin connector. Refer to section 8.4.1.

   [b] If the resistance is greater than 5 Ω, replace the sensor. Refer to section 8.4.1.

8.4.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

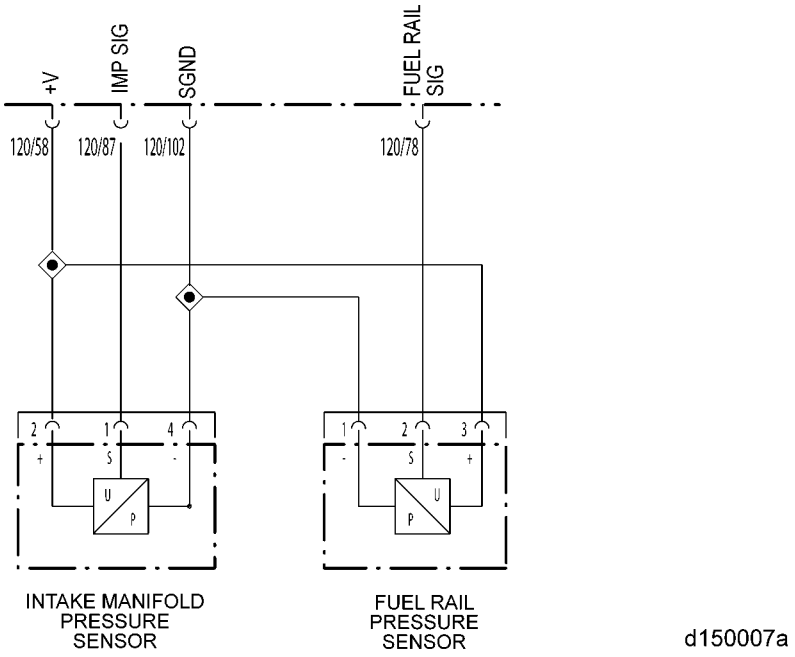
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

8.5 SPN 164/FMI 4

SPN 164/FMI 4 indicates a Rail Pressure Governor Sensor Circuit Failed Low (short to ground).



Check as follows:

1. Check for multiple codes.
   [a] If faults for the Intake Manifold Pressure/Temperature Sensor are active at the same time, repair the circuits between pin 58 or pin 102 of the MCM 120-pin Connector and pin 2 or pin 4 of the Intake Manifold Pressure/Temperature Sensor. Refer to section 8.5.1.
   [b] If only fault 164/4 is active, go to the next step.
2. Disconnect the Rail Pressure Governor Sensor.
3. Disconnect the MCM 120-pin connector.
4. Measure the resistance of pin 1 of the Rail Pressure Governor Sensor connector and ground.
   [a] If resistance is less than 5 Ω, repair short between pin 102 of the 120-pin MCM connector and ground. Refer to section 8.5.1.
   [b] If resistance is greater than 5 Ω, go to the next step.
5. Measure the resistance between pin 2 of the Rail Pressure Governor Sensor harness connector and ground.
   [a] If resistance is less than 5 Ω, repair the short circuit between pin 2 of the Rail Pressure Governor Sensor harness connector and ground. Refer to section 8.5.1.
   [b] If resistance is greater than 5 Ω, go to the next step.

6. Measure the resistance between pin 3 of the Rail Pressure Governor Sensor harness connector and ground.
   [a] If resistance is less than 5 Ω, repair the short circuit between pin 3 of the Rail Pressure Governor Sensor harness connector and ground. Refer to section 8.5.1.
   [b] If resistance is greater than 5 Ω, review steps 4 through 6. If the results are the same, contact Detroit Diesel Customer Support Center (313-592-5800).

8.5.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

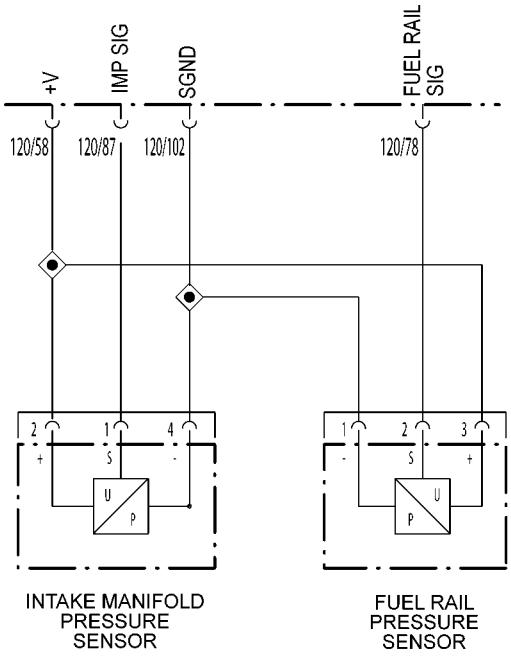
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

8.6 SPN 164/FMI 5

The fault condition is typically Rail Pressure Sensor circuit open or a stuck in range sensor.



Check as follows:

1. Check for multiple codes
   [a] If additional fault codes are present with 615/14, service the additional fault codes first.
   [b] If only 615/14 is present go to the next step.
2. Turn the ignition OFF.
3. Disconnect the Rail Pressure Sensor.
4. Turn the ignition ON (key ON, engine OFF).
5. Check for 5 volt supply at pin 3 of the Rail Pressure Sensor.
   [a] If voltage is correct, replace the Rail Pressure Sensor. Refer to section 8.6.1.
   [b] If no voltage was found, repair the circuit between pin 3 of the Rail Pressure Sensor and pin 58 of the MCM 120 MCM connector. Refer to section 8.6.1.

8.6.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

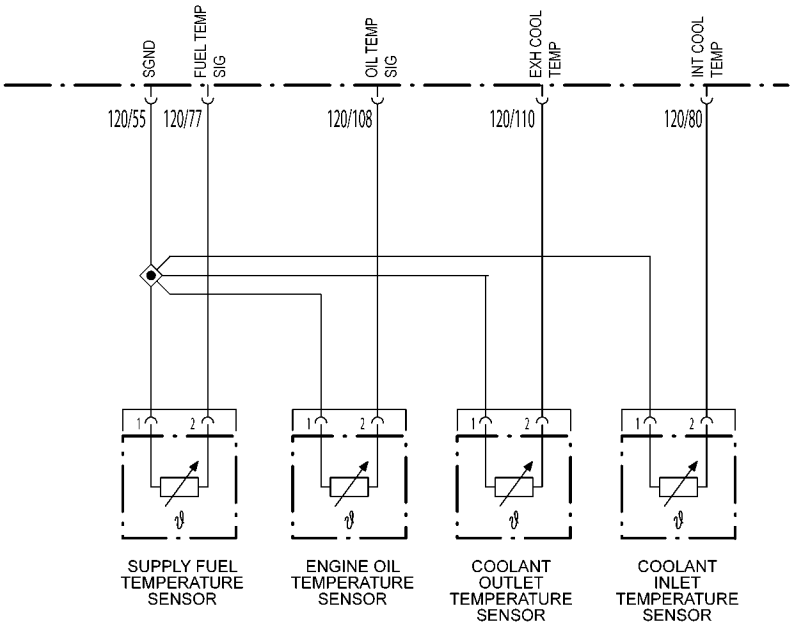
4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

8.7 SPN 164/FMI 7

This SPN indicates there is high pressure pump leakage or the TDC position is wrong (MU341). The fault condition is typically related to a pump that is out of time by +/- 6 degrees or high pressure pump plunger failure. The MCM monitors rail pressure rise and timing then compares it to a calibrated value.

9 SPN 174

SPN 174 indicates the MCM has detected that the fuel temperature is outside the normal operating range.



9.1 SPN 174/FMI 0

SPN 174/FMI 0 indicates the Supply Fuel Temperature Sensor (SFT Sensor) high.

Check as follows:

1. Turn the ignition ON (key ON, engine OFF).
2. Plug in the diagnostic tool and read the active codes.
   [a] If fault 174/3 is active in addition to 174/0, refer to section 9.2.
   [b] If fault 174/4 is active in addition to 174/0, refer to section 9.3.
   [c] If fault 111/1 is active in addition to 174/0, refer to section SPN 111/ FMI
   [d] If only fault code 174/0 is active, go to the next step and repair or replace, as required.
3. Check for coolant loss.
4. Check for blockage in radiator and charge air cooler.
5. Check fan belt condition (slippage).
6. Check for proper location of fan shroud.
7. Check for proper radiator hose condition (no collapsed hoses).
8. Check for proper viscous fan operation
9. Once checks and repairs are done, refer to section 9.1.1.

9.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

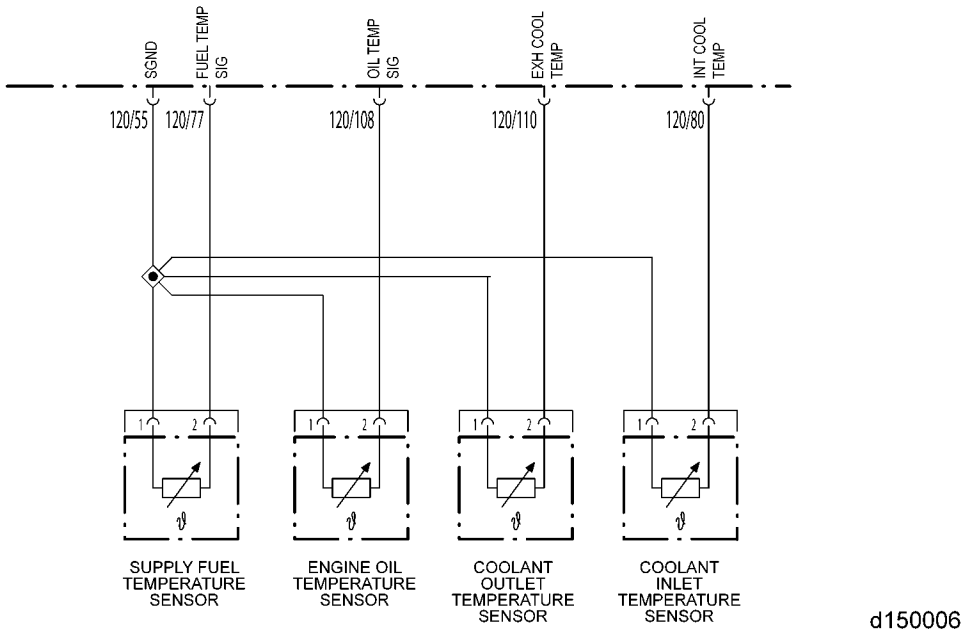
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

9.2 SPN 174/FMI 3

SPN 174/FMI 3 indicates a indicates a Supply Fuel Temperature Sensor (SFT Sensor) open circuit.



Check as follows:

1. Check for multiple codes.
   [a] If faults 174/3, 175/3, and 4076/3 are active at the same time, repair the open circuit between pin 55 of the MCM 120-pin connector and pin 1 of the Supply Fuel Temperature Sensor, (or) pin 1 of the Engine Oil Temperature Sensor, (or) pin1 of the Engine Coolant Inlet Temperature Sensor, (or) pin 1 of the Engine Coolant Outlet Temperature Sensor. Refer to section 9.2.1.
   [b] If only fault 174/3 is active, go to the next step.
2. Disconnect the Supply Fuel Temperature Sensor.
3. Measure the resistance across pins 1 and 2 of the SFT Sensor.
   [a] If the resistance is greater than 2.2k Ω, replace SFT Sensor.
   [b] If the resistance is less than 2.2k Ω, go to the next step.
4. Turn the ignition ON (key ON, engine OFF).
5. Measure the voltage between pins 1 and 2 of the SFT Sensor harness connector.
   [a] If the voltage is between 2.75 and 3.25 volts, go to step 7.
   [b] If the voltage is less than 2.75 volts, go to the next step.
6. Measure the voltage between pin 2 of the SFT Sensor harness connector and ground.

[a] If the voltage is between 2.75 and 3.25 volts, repair the open circuit between pin 1 of the SFT Sensor harness connector and pin 55 of the MCM 120-pin connector. Refer to section 9.2.1.

[b] If the voltage is less than 2.75 volts, repair the open circuit between pin 2 of the SFT Sensor harness connector and pin 77 of the 120-pin MCM connector. Refer to section 9.2.1.

7. Disconnect the 120-pin MCM connector and measure the resistance between pins 1 and 2 of the SFT Sensor harness connector.

   [a] If the resistance is less than 5 Ω, repair the short between pins 55 and 77 of the MCM 120-pin connector. Refer to section 9.2.1.

   [b] If the resistance is greater than 5 Ω, replace the sensor. Refer to section 9.2.1.

9.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

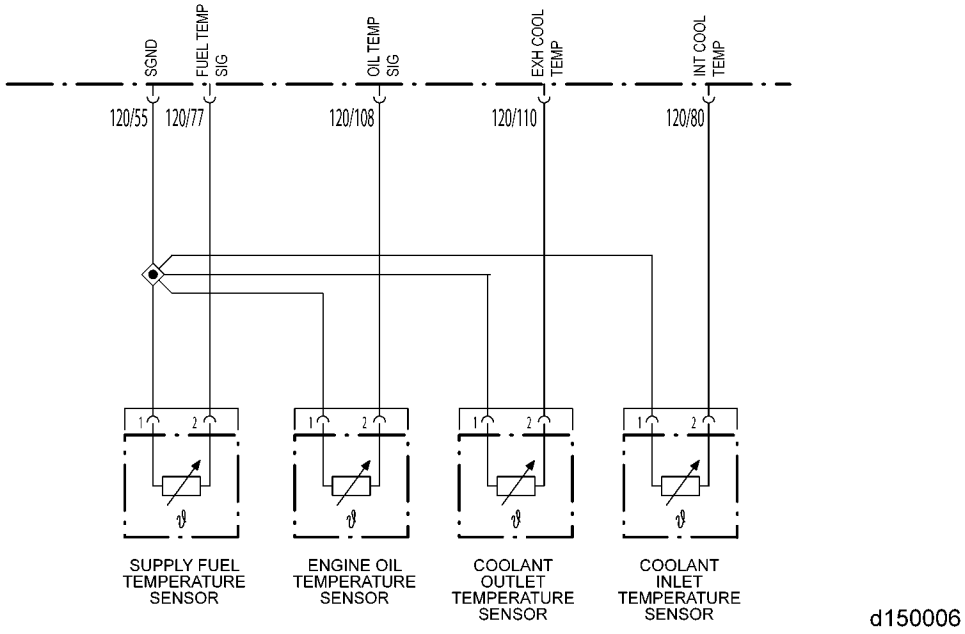
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

9.3 SPN 174/FMI 4

SPN 174, PID 174/FMI 4 indicates a SFT Sensor short circuit to ground.



Check as follows:

1. Disconnect the SFT Sensor.
2. Disconnect the 120-pin MCM connector.
3. Measure the resistance across pins 1 and 2 of the SFT Sensor connector.
   [a] If resistance is less than 5 Ω, repair short between wires 55 and 77 of the 120-pin MCM connector. Refer to section 9.3.1.
   [b] If resistance is greater than 5 Ω, go to the next step.
4. Measure the resistance between pin 1 of the SFT Sensor harness connector and ground.
   [a] If resistance is less than 5 Ω, repair the short circuit between pin 1 of the SFT Sensor harness connector and ground. Refer to section 9.3.1.
   [b] If resistance is greater than 5 Ω, go to the next step.
5. Measure the resistance between pin 2 of the SFT Sensor harness connector and ground.
   [a] If resistance is less than 5 Ω, repair the short circuit between pin 2 of the SFT Sensor harness connector and ground. Refer to section 9.3.1.
   [b] If resistance is greater than 5 Ω, review steps 3 through 5. If the results are the same, contact Detroit Diesel Customer Support Center at 313-592-5800.

9.3.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

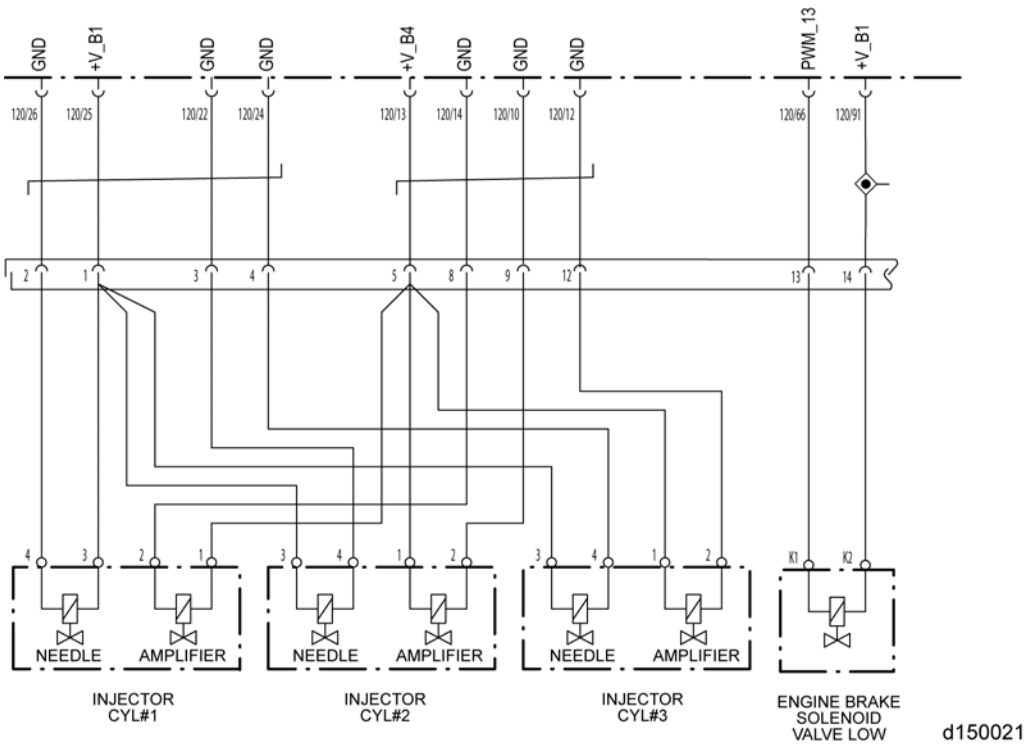
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

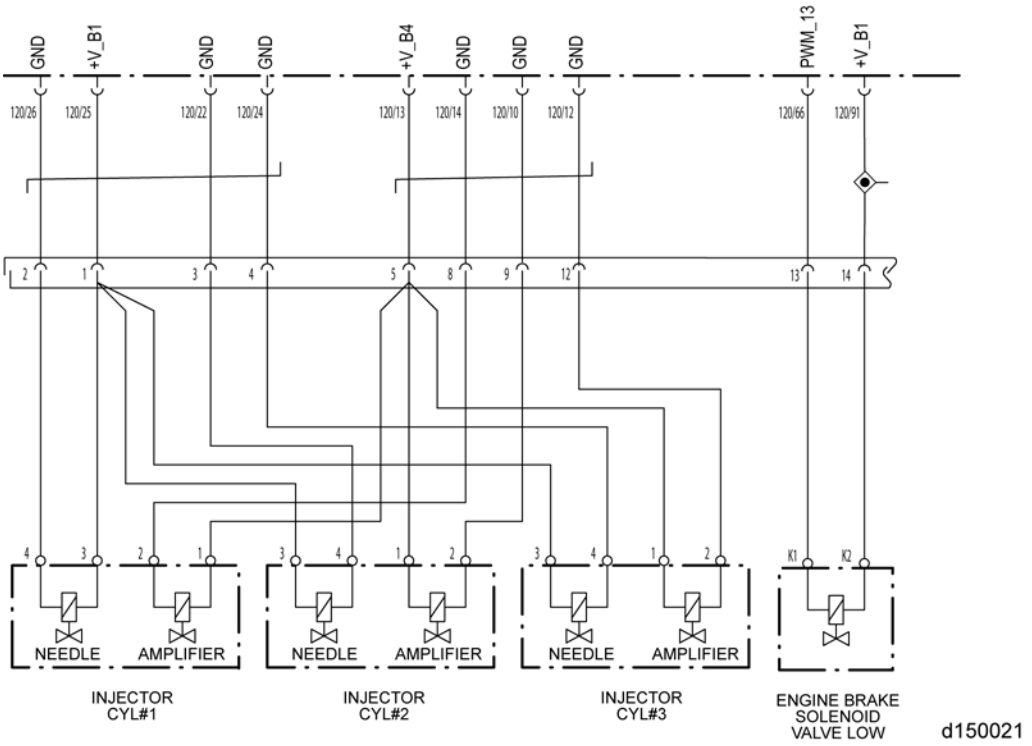
10 SPN 651

This SPN indicates the injector #1 cylinder needle control valve is not operating normally.



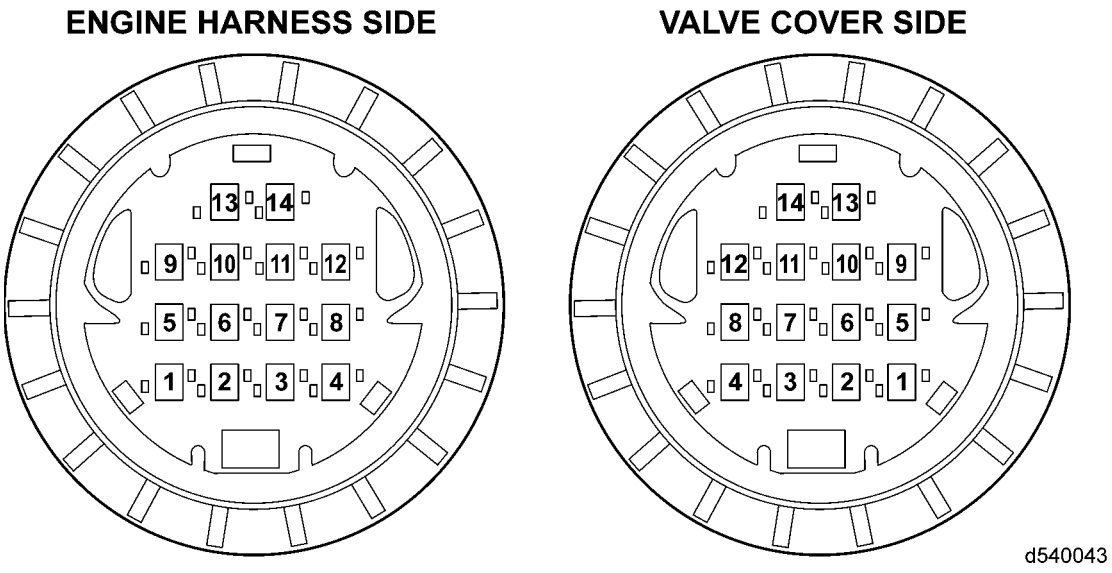
10.1 SPN 651/FMI 14

SPN 651/FMI 14 is typically an open circuit, short to ground or short to power.



Check as follows:

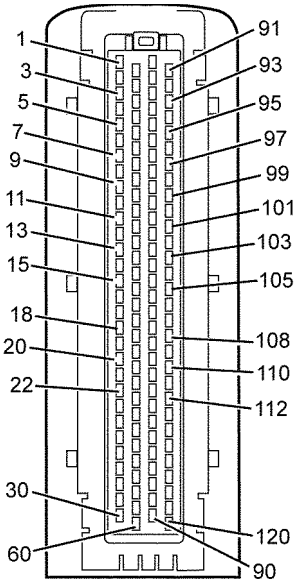
1. Check for multiple codes.
   [a] If fault 168/1 is present along with any other faults, service 168/1 first.
   [b] If 652/14 and 653/14 are present along with 651/14, go to step 2.
   [c] If only 651/14 is present, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the front injector harness 14–pin connector.
4. Inspect the front injector harness 14–pin injector connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 10.1.1.
   [b] If the connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 1 and pin 2 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #1 pins 3 and 4.



[a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 10.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120-pin connector.
7. Measure the resistance between pin 25 of the MCM 120–pin connector and pin 1 of the front injector harness 14–pin connector.



[a] If the resistance is greater then 3 Ω, repair the open between pin 25 of the MCM 120–pin connector and pin 1 of the front injector harness 14–pin connector. Refer to section 10.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 25 of the MCM 120–pin connector.
   [a] If the resistance is less than 3 Ω, repair short to power between battery positive and pin 25 of the MCM 120–pin connector. Refer to section 10.1.1.
   [b] If the resistance is greater than 3 Ω, contact Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.
10. Turn the ignition OFF.
11. Disconnect the front injector harness 14–pin connector.
12. Measure the resistance between pin 1 and pin 2 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #1 pins 3 and 4.
   [a] If the resistance is less than 3 Ω, go to step 18.
   [b] If the resistance is greater than 3 Ω, go to the next step.
13. Remove the upper valve cover.
14. Disconnect injector #1.
15. Measure the resistance between pin 1 of the on the valve cover side of the injector harness and pin 3 of the injector #1 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 10.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 2 of the on the valve cover side of the injector harness and pin 4 of the injector #1 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 10.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 2 of the on the valve cover side of the injector harness and ground.
   [a] If the resistance is less than 3 Ω, replace under valve cover injector harness. Refer to section 10.1.1.
   [b] If the resistance is greater than 3 Ω, replace the injector #1. Refer to section 10.1.1.
18. Measure the resistance between pin 2 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #1 pin 4 and ground.
   [a] If the resistance is greater than 3 Ω, go to step 22.
   [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect the injector #1 connector.

21. Measure the resistance between pin 2 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #1 pin 4 and ground.
    [a] If the resistance is greater than 3 Ω, replace the injector #1. Refer to section 10.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 10.1.1.
22. Disconnect the MCM 120–pin connector.
23. Measure the resistance between pin 2 on the MCM side of the injector harness connector and pin 26 of the MCM 120–pin connector.
    [a] If the resistance is greater than 3 Ω, repair open circuit between pin 2 of the injector harness connector and pin 26 of the MCM 120–pin connector. Refer to section 10.1.1.
    [b] If the resistance is less than 3 Ω, repair short to ground between pin 2 of the injector harness connector and pin 26 of the MCM 120–pin connector. Refer to section 10.1.1.

10.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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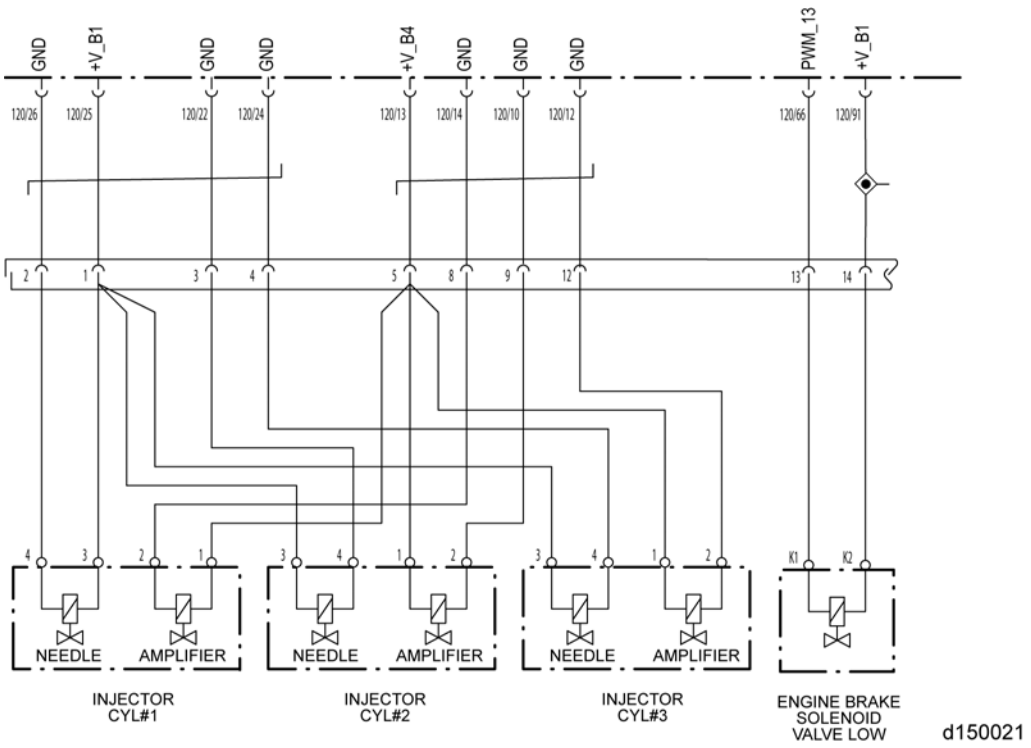
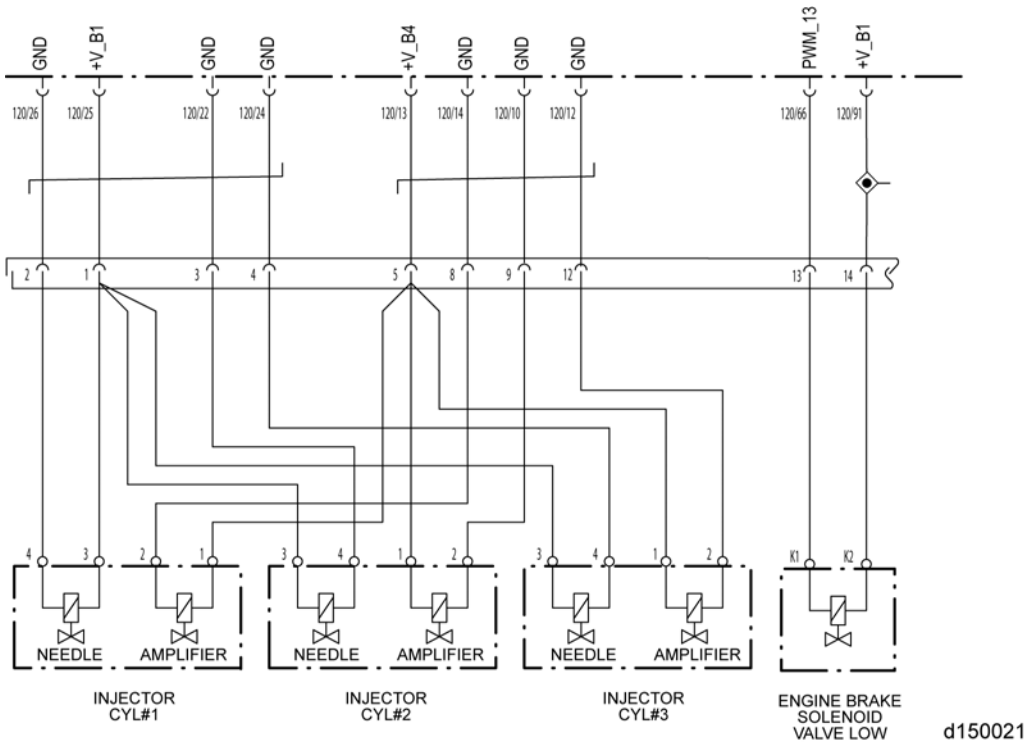
11 SPN 652

This SPN indicates the injector #2 cylinder needle control valve is not operating normally.



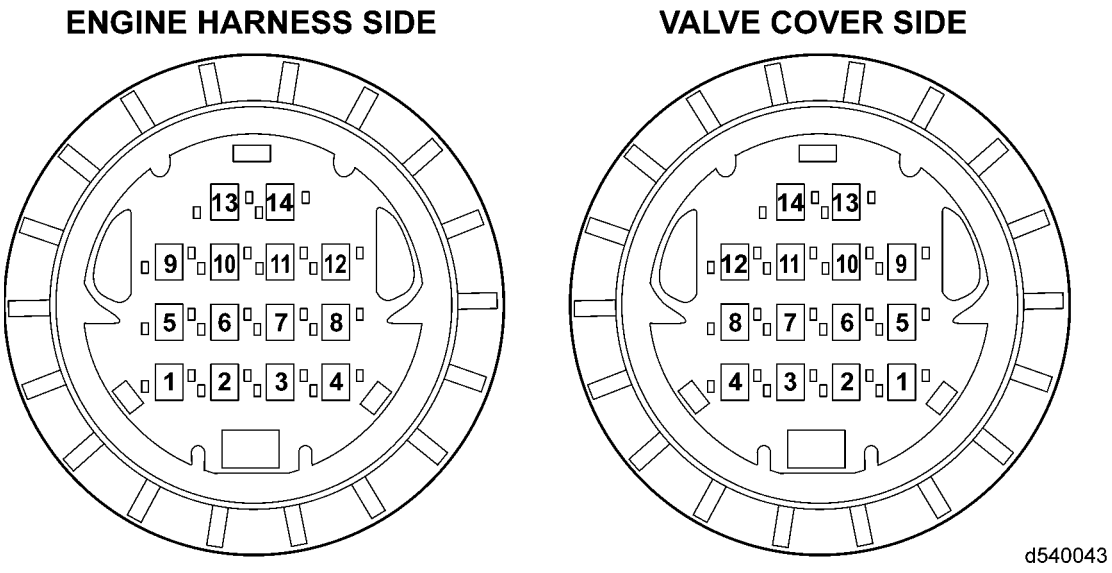
11.1 SPN 652/FMI 14

SPN 652/FMI 14 is typically the injector #2 cylinder needle control valve has an open circuit, short to ground or short to power.



Check as follows:

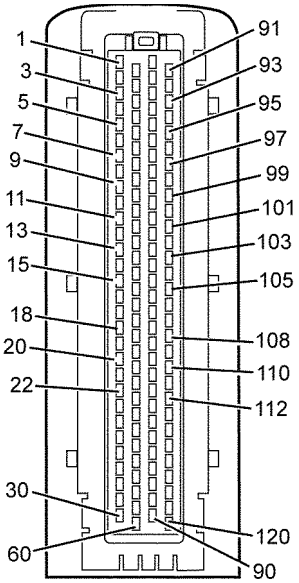
1. Check for multiple codes.
   [a] If fault 168/1 is present along with any other faults, service 168/1 first.
   [b] If 651/14 and 653/14 are present along with 652/14, go to the next step.
   [c] If only 652/14 is present, go to step 10.
2. Turn the ignition OFF
3. Disconnect the front injector harness 14–pin connector.
4. Inspect the front injector harness 14–pin injector connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 11.1.1.
   [b] If the connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 1 and pin 3 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #1 pins 3 and 4.



[a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 11.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120-pin connector.
7. Measure the resistance between pin 25 of the MCM 120–pin connector and pin 1 of the front injector harness 14–pin connector.



[a] If the resistance is greater then 3 Ω, repair the open between pin 25 of the MCM 120–pin connector and pin 1 of the front injector harness 14–pin connector. Refer to section 11.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 25 of the MCM 120–pin connector.
   [a] If the resistance is less than 3 Ω, repair short to power between battery positive and pin 25 of the MCM 120–pin connector. Refer to section 11.1.1.
   [b] If the resistance is greater than 3 Ω, contact Detroit Diesel Customer Support Center for MCM replacement authorization.
10. Turn the ignition OFF.
11. Disconnect the front injector harness 14–pin connector.
12. Measure the resistance between pin 1 and pin 3 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #2 pins 3 and 4.
   [a] If the resistance is less than 3 Ω, go to step 18.
   [b] If the resistance is greater than 3 Ω, go to the next step.
13. Remove the upper valve cover.
14. Disconnect injector #2.
15. Measure the resistance between pin 1 of the on the valve cover side of the injector harness and pin 3 of the injector #2 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 11.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 3 of the on the valve cover side of the injector harness and pin 4 of the injector #2 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 11.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 3 of the on the valve cover side of the injector harness and ground.
   [a] If the resistance is less than 3 Ω, replace under valve cover injector harness. Refer to section 11.1.1.
   [b] If the resistance is greater than 3 Ω, replace the injector #2. Refer to section 11.1.1.
18. Measure the resistance between pin 3 on the valve cover side of the injector harness and ground (if using J-48671-10, measure between injector #2 pin 4 and ground).
   [a] If the resistance is greater than 3 Ω, go to step 22.
   [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect injector #2 connector.

21. Measure the resistance between pin 3 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #2 pin 4 and ground).
    [a] If the resistance is greater than 3 Ω, replace the injector #2. Refer to section 11.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 11.1.1.
22. Disconnect the MCM 120–pin connector.
23. Measure the resistance between pin 3 on the MCM side of the injector harness connector and pin 22 of the MCM 120–pin connector.
    [a] If the resistance is greater than 3 Ω, repair open circuit between pin 3 of the injector harness connector and pin 22 of the MCM 120–pin connector. Refer to section 11.1.1.
    [b] If the resistance is less than 3 Ω, repair short to ground between pin 3 of the injector harness connector and pin 22 of the MCM 120–pin connector. Refer to section 11.1.1.

11.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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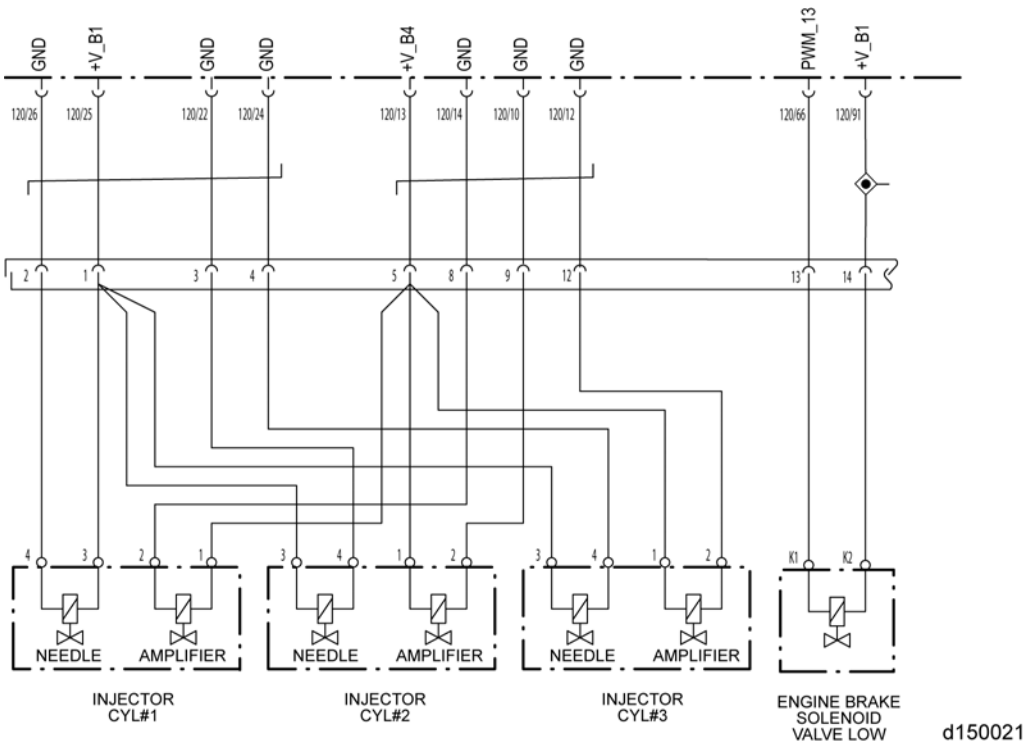
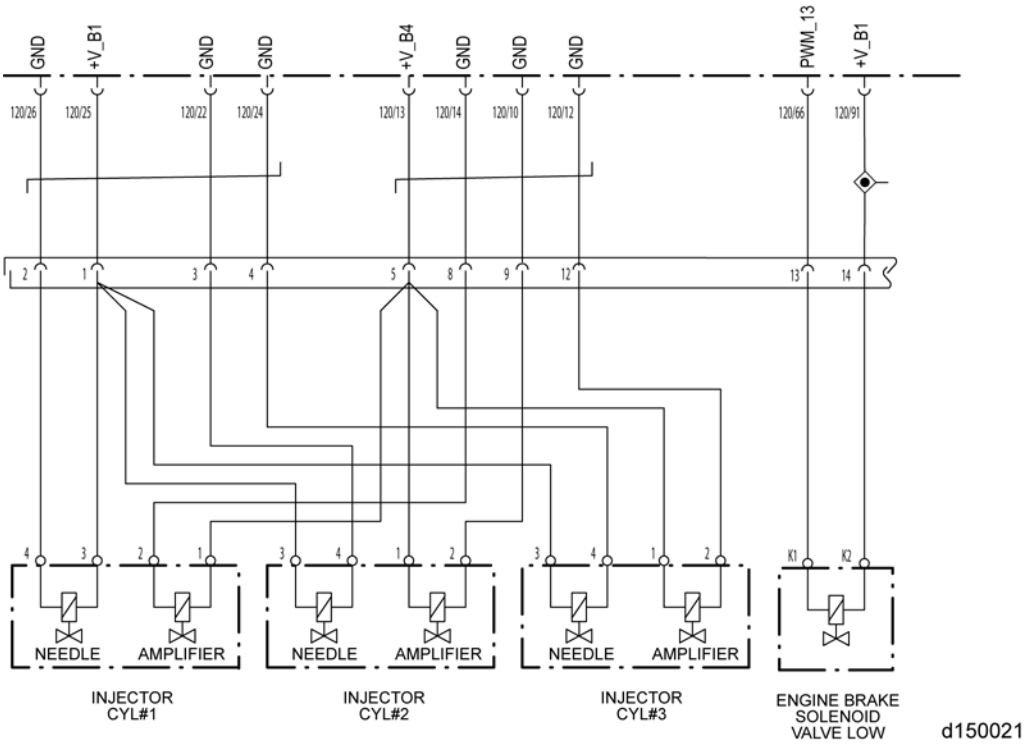
12 SPN 653

This SPN indicates the #3 injector cylinder needle control valve is not operating normally.



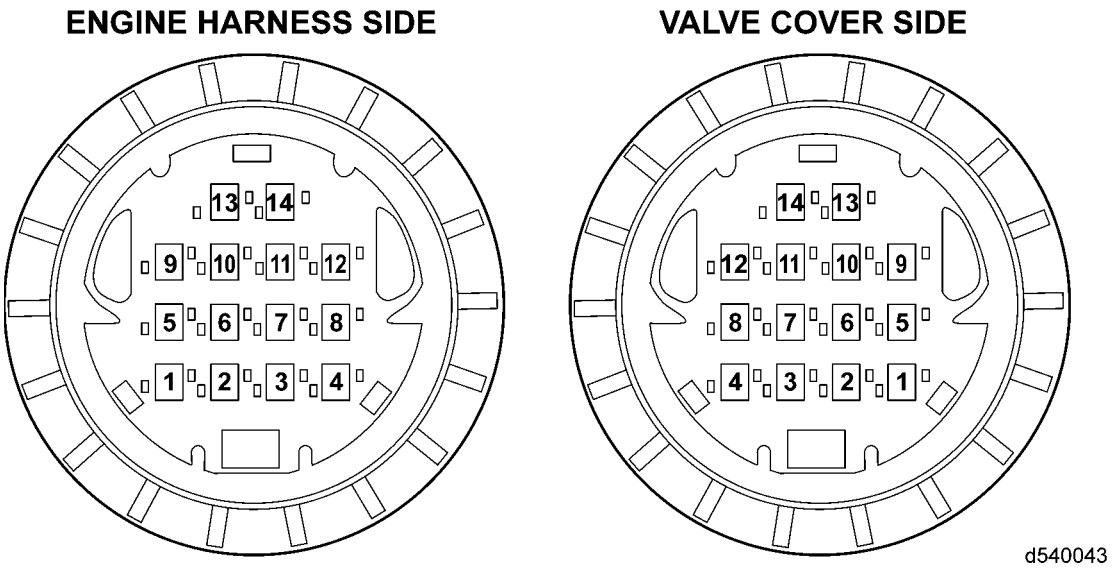
12.1 SPN 653/FMI 14

SPN 653/FMI 14 is typically an open circuit, short to ground or short to power.



Check as follows:

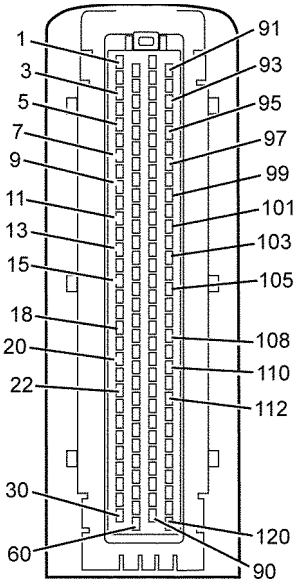
1. Check for multiple codes.
   [a] If fault 168/1 is present along with any other faults, service 168/1 first.
   [b] If 651/14 and 652/14 are present along with 653/14, go to step 2.
   [c] If only 653/14 is present, go to step 10.
2. Turn the ignition OFF
3. Disconnect the front injector harness 14–pin connector.
4. Inspect the front injector harness 14–pin injector connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 12.1.1.
   [b] If the connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 1 and pin 4 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #3 pins 3 and 4.



[a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 12.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120-pin connector
7. Measure the resistance between pin 25 of the MCM 120–pin connector and pin 1 of the front injector harness 14–pin connector.



[a] If the resistance is greater then 3 Ω, repair the open between pin 25 of the MCM 120–pin connector and pin 1 of the front injector harness 14–pin connector. Refer to section 12.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 25 of the MCM 120–pin connector.
   [a] If the resistance is less than 3 Ω, repair short to power between battery positive and pin 25 of the MCM 120–pin connector. Refer to section 12.1.1.
   [b] If the resistance is greater than 3 Ω, contact Detroit Diesel Customer Support Center for MCM replacement authorization.
10. Turn the ignition OFF.
11. Disconnect the front injector harness 14–pin connector.
12. Measure the resistance between pin 1 and pin 4 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #3 pins 3 and 4.
   [a] If the resistance is less than 3 Ω, go to step 18.
   [b] If the resistance is greater than 3 Ω, go to the next step.
13. Remove the upper valve cover.
14. Disconnect the #3 injector.
15. Measure the resistance between pin 1 of the on the valve cover side of the injector harness and pin 3 of the #3 injector harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 12.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 4 of the on the valve cover side of the injector harness and pin 4 of the #3 injector harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 12.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 4 of the on the valve cover side of the injector harness and ground.
   [a] If the resistance is less than 3 Ω, replace under valve cover injector harness. Refer to section 12.1.1.
   [b] If the resistance is greater than 3 Ω, replace the #3 injector. Refer to section 12.1.1.
18. Measure the resistance between pin 4 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #3 pin 4 and ground.
   [a] If the resistance is greater than 3 Ω, go to step 22.
   [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect #3 injector connector.

21. Measure the resistance between pin 4 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #3 pin 4 and ground.
    [a] If the resistance is greater than 3 Ω, replace the #3 injector. Refer to section 12.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 12.1.1.
22. Disconnect the MCM 120–pin connector.
23. Measure the resistance between pin 4 on the MCM side of the injector harness connector and pin 24 of the MCM 120–pin connector.
    [a] If the resistance is greater than 3 Ω, repair open circuit between pin 4 of the injector harness connector and pin 24 of the MCM 120–pin connector. Refer to section 12.1.1.
    [b] If the resistance is less than 3 Ω, repair short to ground between pin 4of the injector harness connector and pin 24 of the MCM 120–pin connector. Refer to section 12.1.1.

12.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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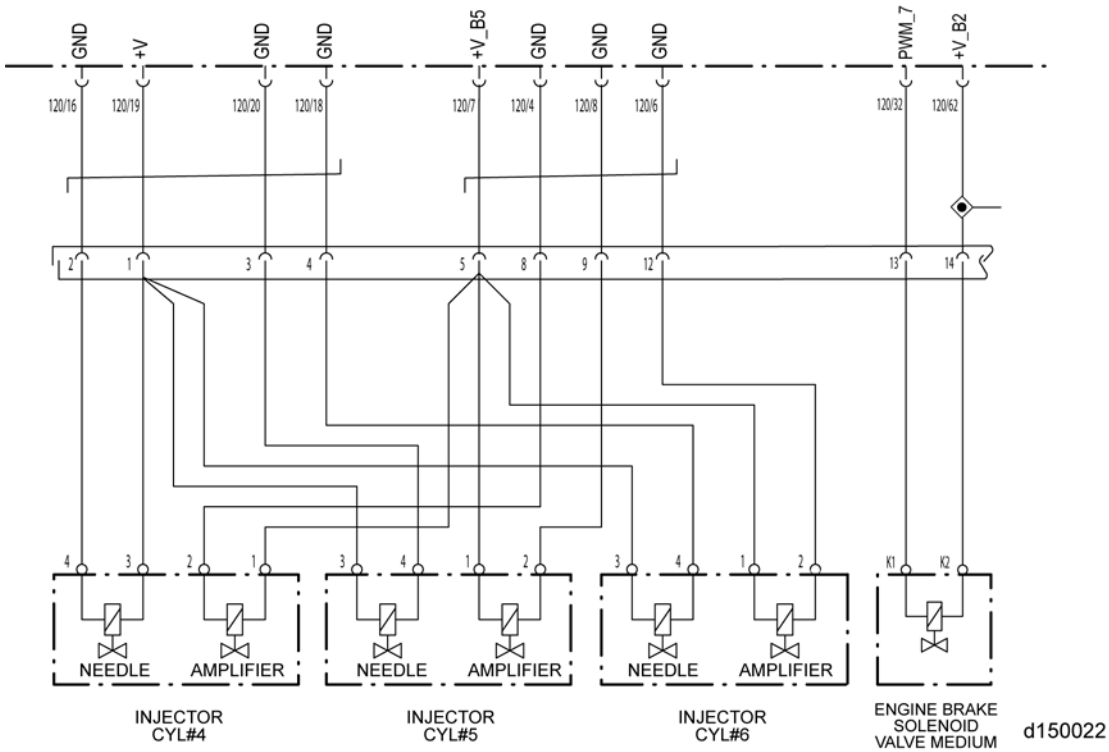
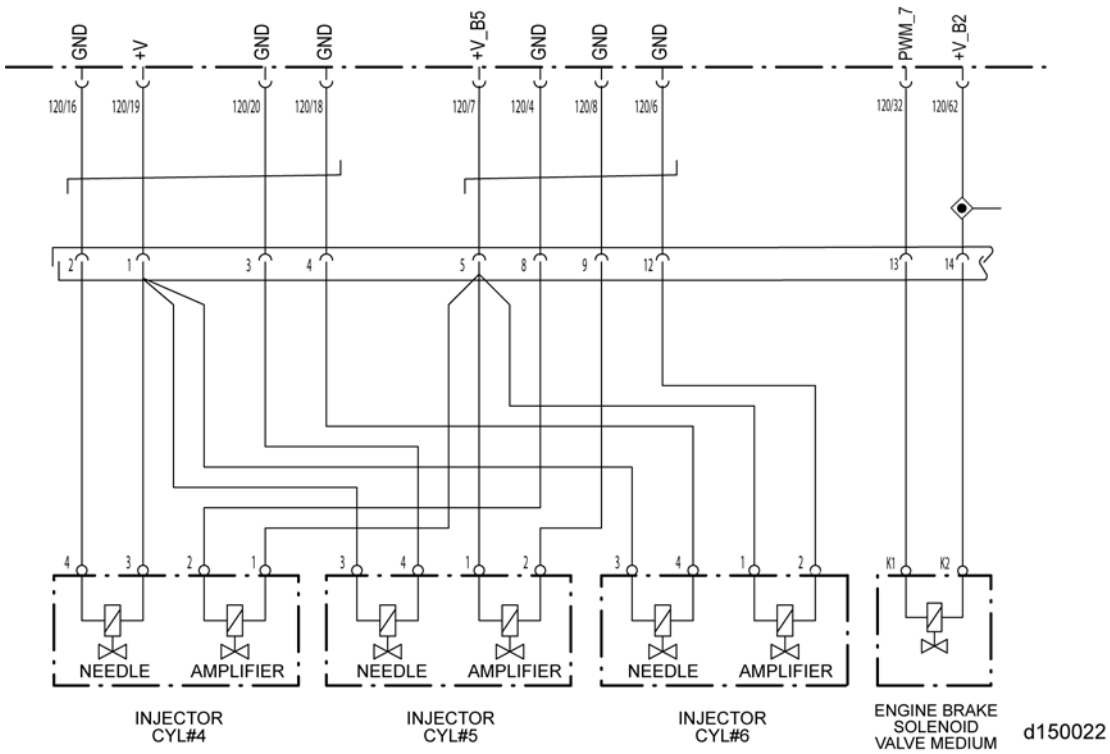
13 SPN 654

This SPN indicates the injector #4 cylinder needle control valve is not operating normally.



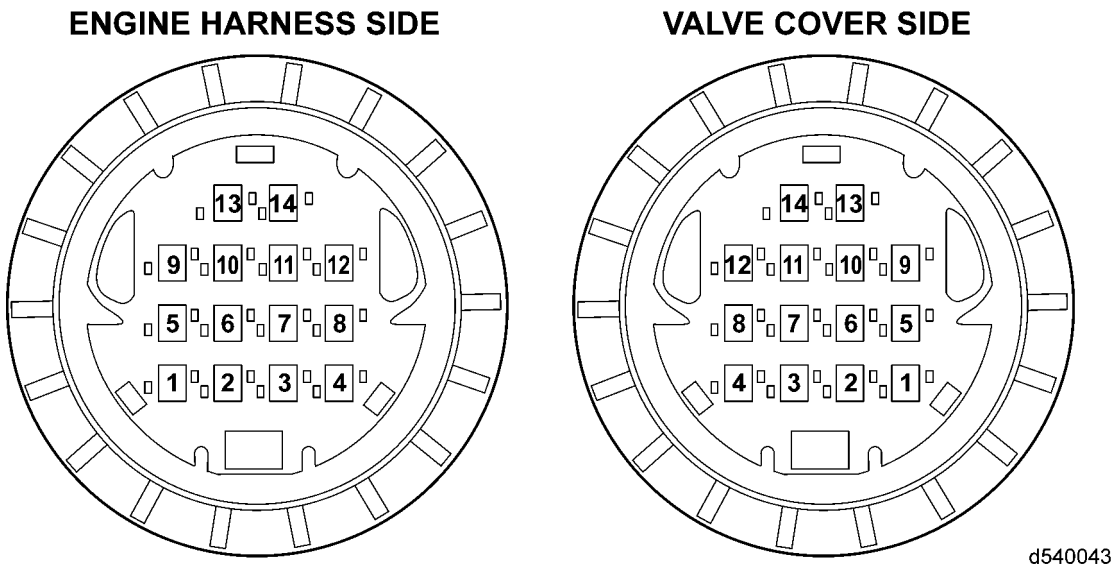
13.1 SPN 654/FMI 14

SPN 654/FMI 14 is typically an open circuit, short to ground or short to power.



Check as follows:

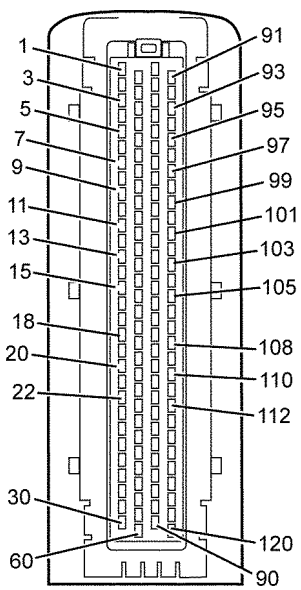
1. Check for multiple codes.
   [a] If fault 168/1 is present along with any other faults, service 168/1 first.
   [b] If 655/14 and 656/14 are present along with 654/14, go to step 2.
   [c] If only 654/14 is present, go to step 10.
2. Turn the ignition OFF
3. Disconnect the rear injector harness 14–pin connector.
4. Inspect the rear injector harness 14–pin injector connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 13.1.1.
   [b] If the connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 1 and pin 2 on the valve cover side of the injector harness (if using J-48671-10, measure between injector #4 pins 3 and 4).



[a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 13.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120-pin connector
7. Measure the resistance between pin 19 of the MCM 120–pin connector and pin 1 of the rear injector harness 14–pin connector.



[a] If the resistance is greater then 3 Ω, repair the open between pin 19 of the MCM 120–pin connector and pin 1 of the rear injector harness 14–pin connector. Refer to section 13.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 19 of the MCM 120–pin connector.
   [a] If the resistance is less than 3 Ω, repair short to power between battery positive and pin 25 of the MCM 120–pin connector. Refer to section 13.1.1.
   [b] If the resistance is greater than 3 Ω, contact Detroit Diesel Customer Support Center for MCM replacement authorization.
10. Turn the ignition OFF.
11. Disconnect the rear injector harness 14–pin connector.
12. Measure the resistance between pin 1 and pin 2 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #4 pins 3 and 4.
   [a] If the resistance is less than 3 Ω, go to step 18.
   [b] If the resistance is greater than 3 Ω, go to the next step.
13. Remove the upper valve cover.
14. Disconnect injector #4.
15. Measure the resistance between pin 1 of the on the valve cover side of the injector harness and pin 3 of the injector #4 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 13.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 2 of the on the valve cover side of the injector harness and pin 4 of the injector #4 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 13.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 2 of the on the valve cover side of the injector harness and ground.
   [a] If the resistance is less than 3 Ω, replace under valve cover injector harness. Refer to section 13.1.1.
   [b] If the resistance is greater than 3 Ω, replace the injector #4. Refer to section 13.1.1.
18. Measure the resistance between pin 2 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #4 pin 4 and ground.
   [a] If the resistance is greater than 3 Ω, go to step 22.
   [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect the injector #4 connector.

21. Measure the resistance between pin 2 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #4 pin 4 and ground.
    [a] If the resistance is greater than 3 Ω, replace the injector #4. Refer to section 13.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 13.1.1.
22. Disconnect the MCM 120–pin connector.
23. Measure the resistance between pin 2 on the MCM side of the injector harness connector and pin 16 of the MCM 120–pin connector.
    [a] If the resistance is greater than 3 Ω, repair open circuit between pin 2 of the injector harness connector and pin 16 of the MCM 120–pin connector. Refer to section 13.1.1.
    [b] If the resistance is less than 3 Ω, repair short to ground between pin 2 of the injector harness connector and pin 16 of the MCM 120–pin connector. Refer to section 13.1.1.

13.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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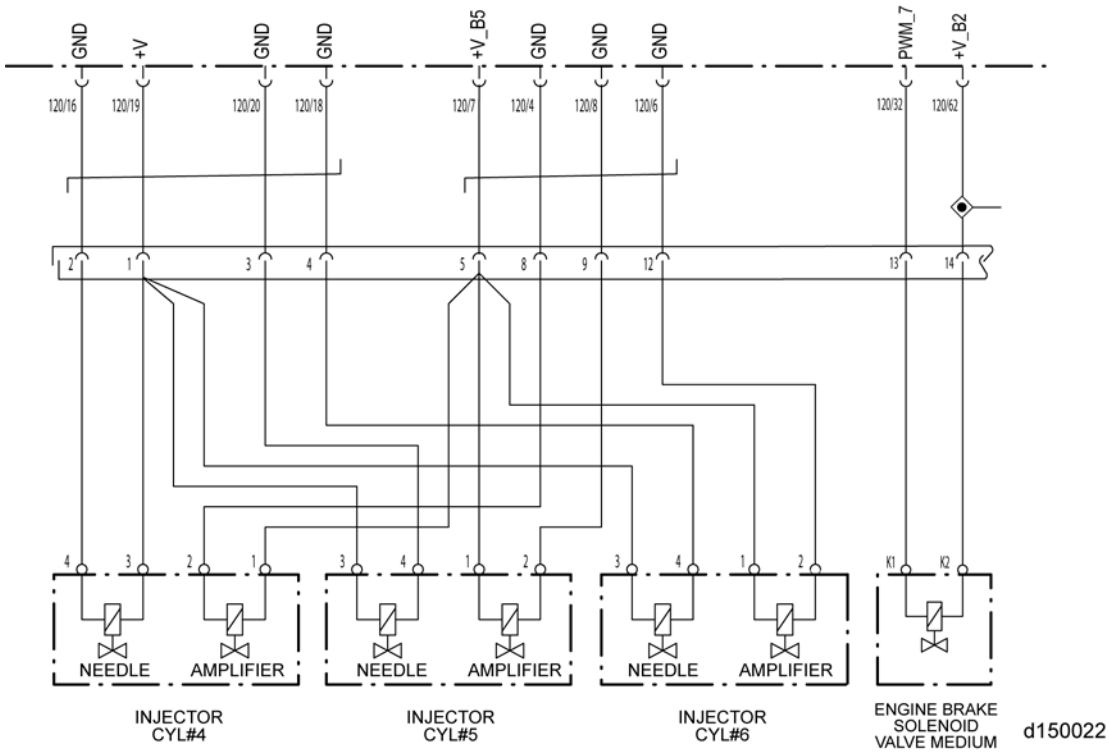
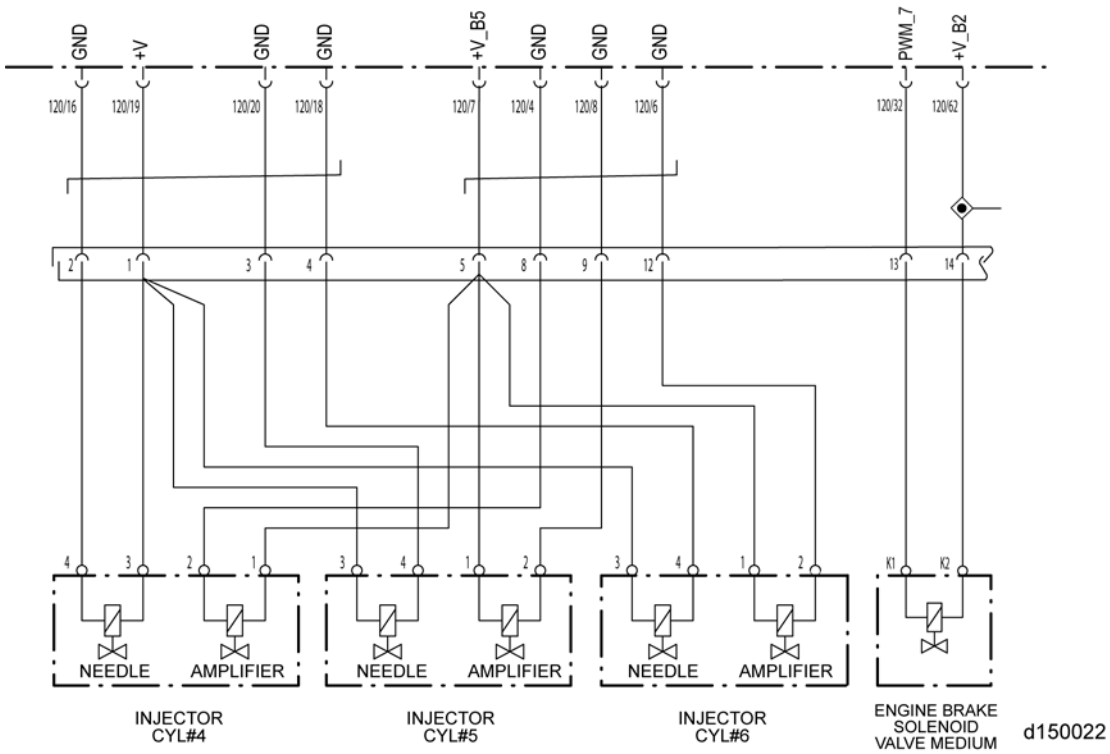
14 SPN 655

This SPN indicates the injector #5 cylinder needle control valve is not operating normally.



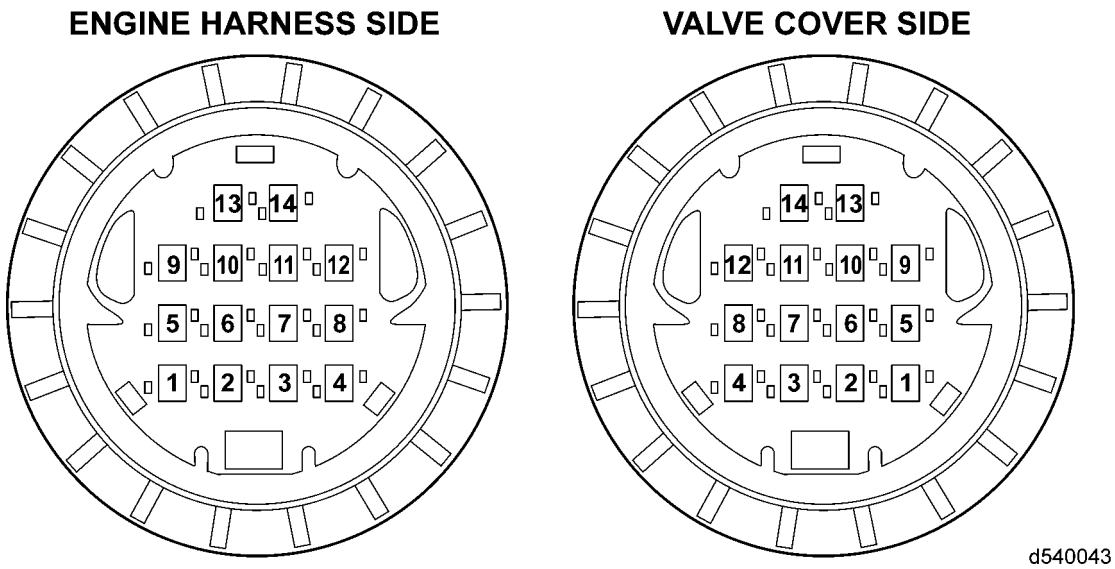
14.1 SPN 655/FMI 14

SPN 655/FMI 14 is typically an open circuit, short to ground or short to power.



Check as follows:

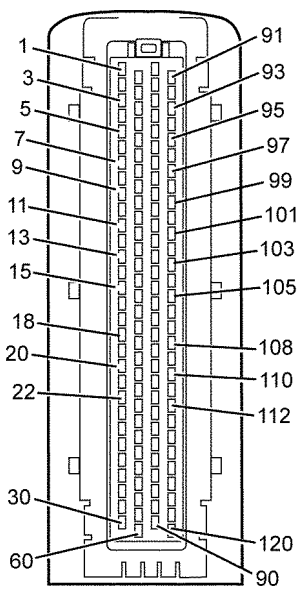
1. Check for multiple codes.
   [a] If fault 168/1 is present along with any other faults, service 168/1 first.
   [b] If 654/14 and 656/14 are present along with 655/14, go to step 2.
   [c] If only 655/14 is present, go to step 10.
2. Turn the ignition OFF
3. Disconnect the rear injector harness 14–pin connector.
4. Inspect the rear injector harness 14–pin injector connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 14.1.1.
   [b] If the connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 1 and pin 3 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #5 pins 3 and 4.



[a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 14.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120-pin connector
7. Measure the resistance between pin 19 of the MCM 120–pin connector and pin 1 of the rear injector harness 14–pin connector.



[a] If the resistance is greater then 3 Ω, repair the open between pin 19 of the MCM 120–pin connector and pin 1 of the rear injector harness 14–pin connector. Refer to section 14.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 19 of the MCM 120–pin connector.
   [a] If the resistance is less than 3 Ω, repair short to power between battery positive and pin 25 of the MCM 120–pin connector. Refer to section 14.1.1.
   [b] If the resistance is greater than 3 Ω, contact Detroit Diesel Customer Support Center for MCM replacement authorization.
10. Turn the ignition OFF.
11. Disconnect the rear injector harness 14–pin connector.
12. Measure the resistance between pin 1 and pin 3 on the valve cover side of the injector harness (if using J-48671-10, measure between injector #5 pins 3 and 4).
   [a] If the resistance is less than 3 Ω, go to step 18.
   [b] If the resistance is greater than 3 Ω, go to the next step.
13. Remove the upper valve cover.
14. Disconnect injector #5.
15. Measure the resistance between pin 1 of the on the valve cover side of the injector harness and pin 3 of the injector #5 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 14.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 3 of the on the valve cover side of the injector harness and pin 4 of the injector #5 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 14.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 3 of the on the valve cover side of the injector harness and ground.
   [a] If the resistance is less than 3 Ω, replace under valve cover injector harness. Refer to section 14.1.1.
   [b] If the resistance is greater than 3 Ω, replace the injector #5. Refer to section 14.1.1.
18. Measure the resistance between pin 3 on the valve cover side of the injector harness and ground (if using J-48671-10, measure between injector #5 pin 4 and ground).
   [a] If the resistance is greater than 3 Ω, go to step 22.
   [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect the injector #5 connector.

21. Measure the resistance between pin 3 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #5 pin 4 and ground.
    [a] If the resistance is greater than 3 Ω, replace the injector #5. Refer to section 14.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 14.1.1.
22. Disconnect the MCM 120–pin connector.
23. Measure the resistance between pin 3 on the MCM side of the injector harness connector and pin 20 of the MCM 120–pin connector.
    [a] If the resistance is greater than 3 Ω, repair open circuit between pin 3 of the injector harness connector and pin 20 of the MCM 120–pin connector. Refer to section 14.1.1.
    [b] If the resistance is less than 3 Ω, repair short to ground between pin 3 of the injector harness connector and pin 20 of the MCM 120–pin connector. Refer to section 14.1.1.

14.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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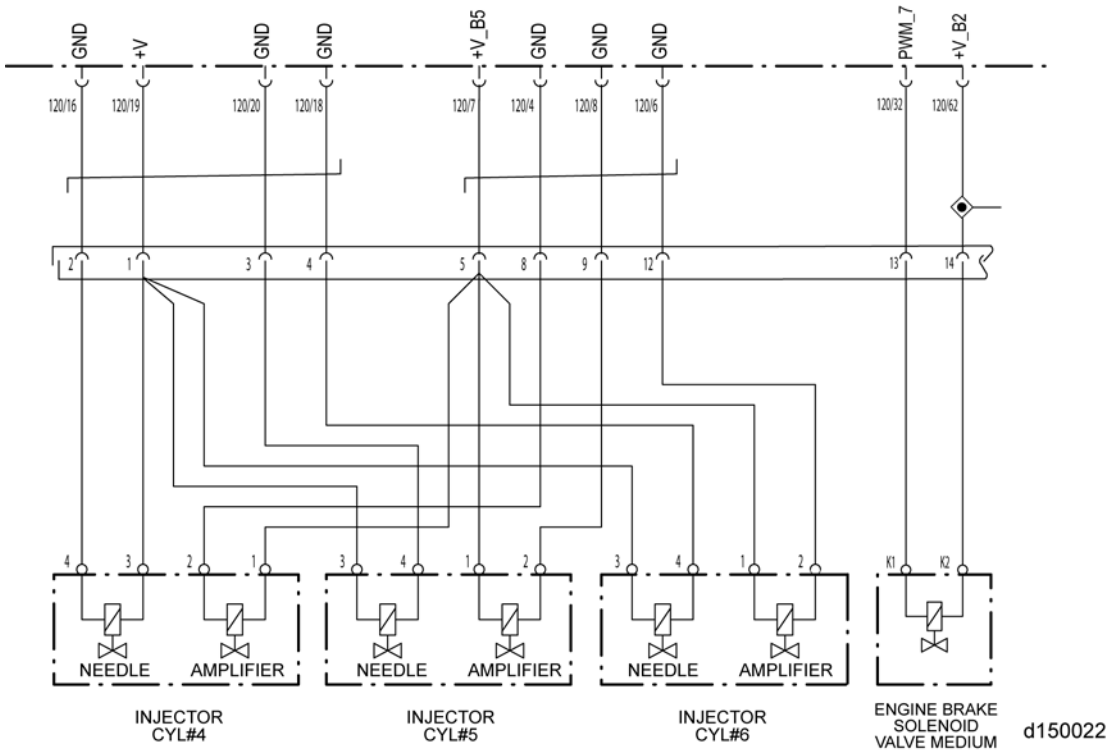
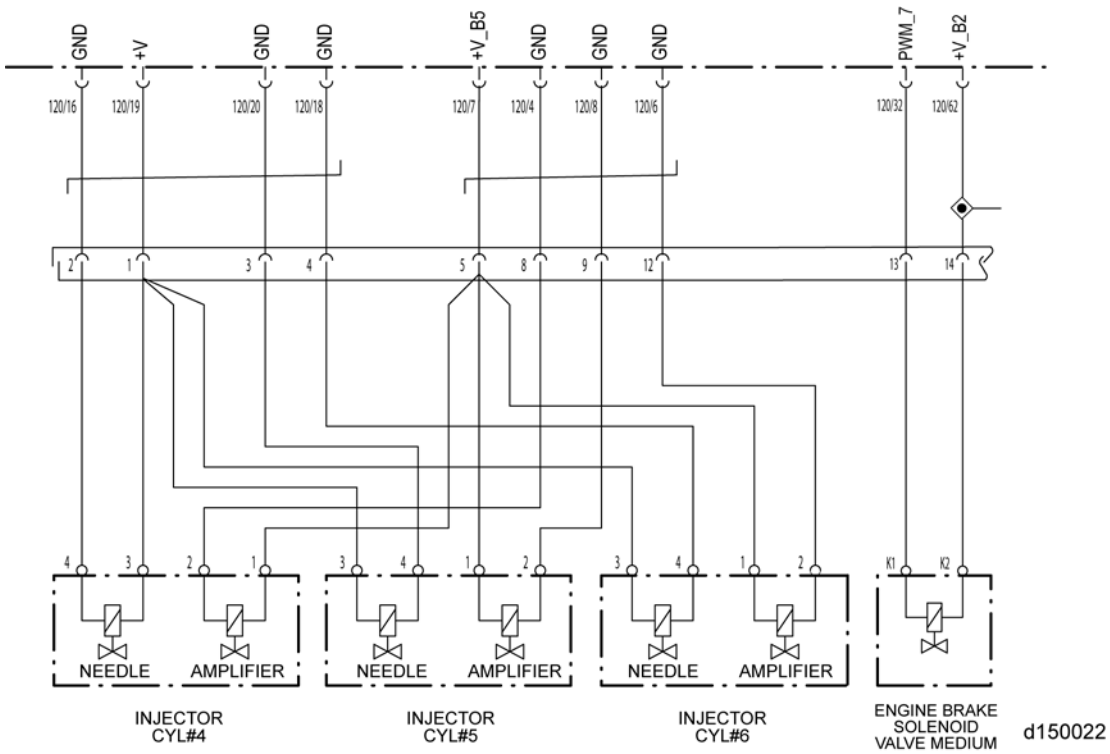
15 SPN 656

This SPN indicates the injector #6 cylinder needle control valve is not operating normally.



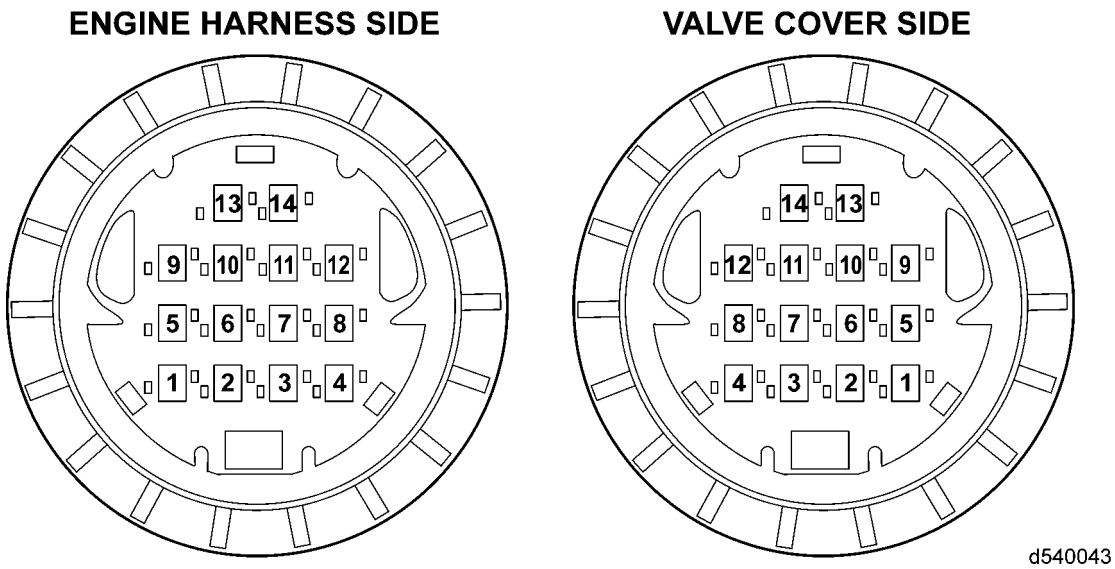
15.1 SPN 656/FMI 14

SPN 656/FMI 14 is typically an open circuit, short to ground or short to power.



Check as follows:

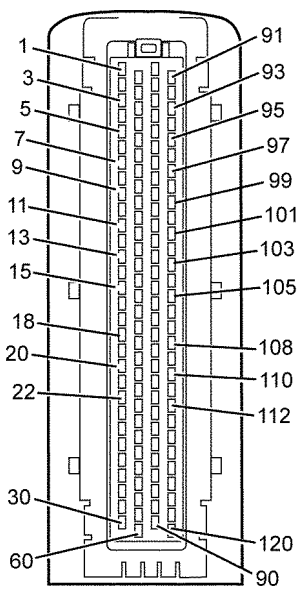
1. Check for multiple codes.
   [a] If fault 168/1 is present along with any other faults, service 168/1 first.
   [b] If 654/14 and 655/14 are present along with 656/14, go to step 2.
   [c] If only 656/14 is present, go to step 10.
2. Turn the ignition OFF
3. Disconnect the rear injector harness 14–pin connector.
4. Inspect the rear injector harness 14–pin injector connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 15.1.1.
   [b] If the connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 1 and pin 4 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #6 pins 3 and 4.



[a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 15.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120-pin connector
7. Measure the resistance between pin 19 of the MCM 120–pin connector and pin 1 of the rear injector harness 14–pin connector.



[a] If the resistance is greater then 3 Ω, repair the open between pin 19 of the MCM 120–pin connector and pin 1 of the rear injector harness 14–pin connector. Refer to section 15.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 19 of the MCM 120–pin connector.
   [a] If the resistance is less than 3 Ω, repair short to power between battery positive and pin 25 of the MCM 120–pin connector. Refer to section 15.1.1.
   [b] If the resistance is greater than 3 Ω, contact Detroit Diesel Customer Support Center for MCM replacement authorization.
10. Turn the ignition OFF.
11. Disconnect the rear injector harness 14–pin connector.
12. Measure the resistance between pin 1 and pin 4 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #6 pins 3 and 4.
   [a] If the resistance is less than 3 Ω, go to step 18.
   [b] If the resistance is greater than 3 Ω, go to the next step.
13. Remove the upper valve cover.
14. Disconnect injector #6.
15. Measure the resistance between pin 1 of the on the valve cover side of the injector harness and pin 3 of the injector #6 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 15.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 4 of the on the valve cover side of the injector harness and pin 4 of the injector #6 harness connector.
   [a] If the resistance is greater than 3 Ω, replace under valve cover injector harness. Refer to section 15.1.1.
   [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 4 of the on the valve cover side of the injector harness and ground.
   [a] If the resistance is less than 3 Ω, replace under valve cover injector harness. Refer to section 15.1.1.
   [b] If the resistance is greater than 3 Ω, replace the injector #6. Refer to section 15.1.1.
18. Measure the resistance between pin 4 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #6 pin 4 and ground.
   [a] If the resistance is greater than 3 Ω, go to step 22.
   [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect the injector #6 connector.

21. Measure the resistance between pin 4 on the valve cover side of the injector harness and ground. If using J-48671–10, measure between injector #6 pin 4 and ground.
    [a] If the resistance is greater than 3 Ω, replace the injector #6. Refer to section 15.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 15.1.1.
22. Disconnect the MCM 120–pin connector.
23. Measure the resistance between pin 2 on the MCM side of the injector harness connector and pin 16 of the MCM 120–pin connector.
    [a] If the resistance is greater than 3 Ω, repair open circuit between pin 4 of the injector harness connector and pin 18 of the MCM 120–pin connector. Refer to section 15.1.1.
    [b] If the resistance is less than 3 Ω, repair short to ground between pin 4 of the injector harness connector and pin 18 of the MCM 120–pin connector. Refer to section 15.1.1.

15.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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16 SPN 679

This SPN indicates that the Pressure Limiting Valve stays open.

16.1 SPN 679/FMI 7

The fault condition is typically related to a Pressure Limiting Valve (PLV) staying open. The pressure limiting valve will open when rail pressure is above 1150 bar. The MCM will command a lower rail pressure trying to force the pressure limiting valve closed. If the pressure limiting valve does not close, a fault code is generated. The condition that caused the PLV to open must be addressed.

Check as follows:

1. Check for multiple codes.
   [a] If additional fault codes are present with 679/7, service the additional fault codes first.
   [b] If only 679/7 is present, go to the next step.
2. Using DDDL, monitor rail pressure at idle.
   [a] If rail pressure is above 900 bar, check for a damaged needle return line and a damaged line (fuel rail to injector). Repair as necessary. Refer to section 16.1.1.
   [b] If rail pressure is below 900 bar, go to next step.
3. Increase engine speed to 1800 rpm and check the rail pressure.
   [a] If rail pressure is above 900 bar, check for a damaged needle return line, a damaged amplifier return line and a damaged line (fuel rail to injector). Repair as necessary. Refer to section 16.1.1.
   [b] If rail pressure is below 900 bar, replace the PLV. Refer to section 16.1.1.

16.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

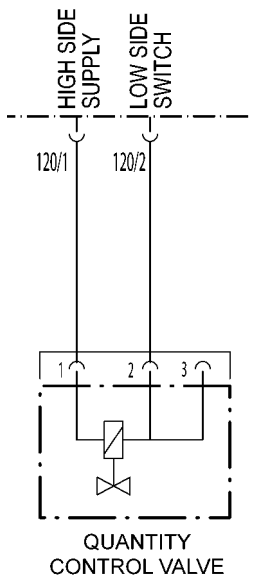
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

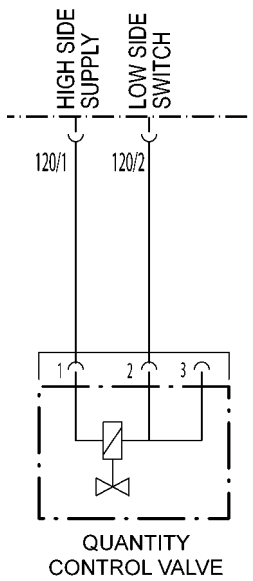
17 SPN 1077

This SPN indicates a quantity control valve error or an internal or external leakage of the high pressure fuel system.



17.1 SPN 1077/FMI 5

SPN 1077/FMI 5 indicates a quantity control valve current too low.



Check as follows:

1. Disconnect the quantity control valve.
2. Measure the resistance across pins 1 and 2 of the quantity control valve.
   [a] If the resistance is greater than 2 Ω, replace quantity control valve. Refer to section 17.1.1.
   [b] If the resistance is less than 2 Ω, go to the next step.
3. Disconnect the MCM 120-pin connector.
4. Measure the resistance between pin 1 of the MCM 120-pin connector and pin 1 of the quantity control valve.
   [a] If the resistance is less than 5 Ω, go to next step.
   [b] If the resistance is greater than 5 Ω, repair the open circuit between pin 1 of the 120 MCM connector and pin 1 of the quantity control valve. Refer to section 17.1.1.
5. Measure the resistance between pin 2 of the MCM 120-pin connector and pin 2 of the quantity control valve.
   [a] If the resistance is less than 5 Ω, call the Detroit Diesel Customer Support Center at 313–592–5800 for authorization to replace the MCM.
   [b] If the resistance is greater than 5 Ω, repair the open circuit between pin 2 of the MCM 120-pin connector and pin 2 of the quantity control valve. Refer to section 17.1.1.

17.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

17.2 SPN 1077/FMI 7

The fault condition is typically related to an internal or external leakage of the high pressure fuel system. The MCM monitors the rail pressure and when rail pressure deviation is greater than 50 bar for five seconds, the MCM sets the code. This fault can occur due to the conditions listed below:

- □ External fuel leakage between the high pressure pump and injectors
- □ High pressure pump (pumping elements)
- □ Injector (amplifier or needle) leakage
- □ Pressure limiting valve leakage (internal)
- □ Fuel filter integrity (loose caps, plugged filters)
- □ Fuel supply issues (fuel level, fuel aeration)
- □ Intermittent loss of engine speed signal

Check as follows:

1. Did 1077/7 code appear after the fuel system was repaired or filter maintenance was performed?
   [a] If YES, the code may be set due to air in the fuel system. Clear code and refer to section 6.5, “Fuel System Priming.”
   [b] If NO, go to next step.
2. Turn the ignition ON (key ON. engine OFF).
3. Check fuel level.
   [a] If fuel level is low, correct and road test vehicle.
   [b] If no leakage was found, go to next step.
4. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes (with the exception of DPF codes) are present along with 1077/7, service the additional fault codes first
   [b] If only 1077/7 is present go to next step.
5. Using DDDL 7.0 check the value of pressure limiting valve (PLV) openings (E2P_RPG_CTR_PLV_OPEN) under “Extended Data Record Number 5th” list.
   [a] If counter is greater than 50, replace PLV and road test vehicle. Refer to PLV repair procedure.
   [b] If counter is less than 50, go to next step.
6. Using DDDL 7.0 monitor engine speed and KW/NW validity signal in chart form ranging from idle to 1800 RPM.
   [a] If engine speed and signal are stable and accurate, go to step 9.
   [b] If engine speed and signal are instable or erratic, go to the next step.

7. Check the following conditions:
   [a] Check for external damage to Crankshaft Position Sensor.
   [b] Check for bent or spread pins on the Crankshaft Position Sensor.
   [c] Remove Crankshaft Position Sensor and inspect sensor for damage or rubbing.
   [d] Check Flywheel teeth for debris or damage.
8. Perform low pressure fuel system pressures test. Refer to section 5.2, “Monitoring Low Pressure Fuel System Pressures.”
9. Inspect fuel system for leaks. Refer to section 5.1, “External and Internal Low Pressure Fuel Leaks.”
   [a] If leaks were found, repair as necessary.
   [b] If no leaks were found, go to next step.
10. Perform diagnosis on pumping elements. Refer to section 5.9, “Pumping Element Concerns.”
11. Perform fuel aeration test. Refer to section 5.3, “Aerated Fuel.”
12. Perform the rail pressure bleed off test using DDDL. Refer to section 5.7.1, “RPBO Test using DDDL.”
    [a] If the RPBO test failed; go to next step.
    [b] If the RPBO test passed, fault condition may be intermittent. Refer to section 17.2.1.
13. Perform pressure limiting valve (PLV) leakage test. Refer to section 5.8, “Pressure Limiting Valve Leakage.”
    [a] If the PLV test passed; go to next step.
    [b] If the PLV test failed; replace pressure limiting valve. Refer to section 17.2.1.
14. Perform amplifier/needle return measurements and flow test. Refer to section 5.4, “High Amplifier/Needle Return Flow.”
    [a] If the amplifier/needle return flow test passed; no problem found.
    [b] If the amplifier/needle return flow test failed; fix as necessary. Refer to section 17.2.1.

17.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

17.3 SPN 1077/FMI 14

The fault condition is typically related to an internal or external leakage of the high pressure fuel system (too high, Leak Down Test). The MCM monitors rail pressure during engine shut down and compares it to a stored learned value. If the bleed down rate has changed, due to leakage, and it is below the learned value, the code will set.

Check as follows:

1. Check for multiple codes.
   [a] If additional fault codes are present with 1077/14, service the additional fault codes first.
   [b] If only 1077/14 is present, go to the next step.
2. Turn the ignition OFF
3. Inspect the following fuel system components for external leakage: high pressure pump, lines to fuel rail, fuel rail, pressure limiting valve (PLV), and fuel lines from rail to injector
   [a] If leakage was found, repair as necessary. Refer to section 17.3.1.
   [b] If no leakage was found, go to next step.
4. Perform PLV leakage test. Refer to section 5.8, “Pressure Limiting Valve Leakage.”
   [a] If the PLV test passed; go to next step.
   [b] If the PLV test failed; replace pressure limiting valve. Refer to section 17.3.1.
5. Perform amplifier/needle return measurements. Refer to section 5.4, “High Amplifier/Needle Return Flow.”
   [a] If the amplifier/needle return flow test passed; no problem found.
   [b] If the amplifier/needle return flow test failed; fix as necessary. Refer to section 17.3.1.

17.3.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

17.4 SPN 1077/FMI 15

The fault condition is typically related to an internal or external leakage of the high pressure fuel system. The MCM monitors the rail pressure and when a leakage rate is greater than 100 l/h, the MCM sets the code. There is no fault reaction (limp home mode) associated to this code. This fault can occur due to the conditions listed below:

- □ External fuel leakage between the high pressure pump and injectors
- □ High pressure pump (pumping elements)
- □ Injector (amplifier or needle) leakage
- □ Pressure limiting valve leakage (internal)

Check as follows:

1. Check for multiple codes
   [a] If additional fault codes are present along with 1077/15, service the additional fault codes first
   [b] If only 1077/15 is present go to step 2
2. Turn the ignition OFF.
3. Inspect the following fuel system components for external leakage: high pressure pump, lines to fuel rail, fuel rail, pressure limiting valve (PLV), and fuel lines from rail to injector.
   [a] If leakage was found, repair and refer to section 17.4.1.
   [b] If no leakage was found, go to next step.
4. Perform rail pressure bleed off test. Refer to section 5.7.1, “RPBO Test using DDDL.”
   [a] If the RPBO test failed; go to next step.
   [b] If the RPBO test passed, no problem found.
5. Perform pressure limiting valve (PLV) leakage test. Refer to section 5.8, “Pressure Limiting Valve Leakage.”
   [a] If the PLV test passed; go to next step.
   [b] If the PLV test failed; replace pressure limiting valve and refer to section 17.4.1.
6. Perform amplifier/needle return measurements. Refer to section 5.4, “High Amplifier/Needle Return Flow.”
   [a] If the amplifier/needle return flow test passed; no problem found.
   [b] If the amplifier/needle return flow test failed; fix as necessary and refer to section 17.4.1.

17.4.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

18 SPN 1323

This SPN indicates that a cylinder #1 misfire has been detected.

18.1 SPN 1323/FMI 13

The fault condition is related to cylinder #1 exhibiting a misfire event. The entry conditions for this code are:

- □ Engine speed is above low idle
- □ All cylinders are active, no fault reactions
- □ Engine speed/torque is steady

This fault can occur due to the conditions listed below:

- □ Cylinder kit failure
- □ Valve train failure
- □ Lash adjustments
- □ Injector
- □ High pressure fuel line (rail to injector)
- □ Debris entering injector (intermittent faults)

Check as follows:

1. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes are present along with 1323/13, service the additional fault codes first.
   [b] If only 1323/13 is present go to next step.
2. Using DDDL 7.0 perform “Compression Test” listed under “Service Routines”.
   [a] If cylinder #1 shows low compression, the issue is related to a mechanical failure/issue for that cylinder. Fix cylinder concern and return to step 1.
   [b] If all cylinders are within 10%, go to next step.
3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Using DDDL 7.0 read parameter “Idle Speed Balance Values: Cylinder #1” under “Instrumentation” section.

NOTE:
For the idle speed balance values to update, the engine speed must be at idle.

   [a] If value for cylinder #1 is at its maximum limit of +100, go to the next step.
   [b] If value for cylinder #1 is less than +100, fault may be intermittent. Obtain information from customer on driving habits, recent repairs, number of occurrences when fault code set, or situations when the code occurred. Try to retest engine within these parameters.
5. Inspect fuel line from rail to injector for damage
   [a] If damage is found, replace if necessary

[b] If no damage was found, replace injector.

18.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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19 SPN 1324

This SPN indicates a cylinder #2 misfire detected.

19.1 SPN 1324/FMI 13

The fault condition is related to cylinder #2 exhibiting a misfire event. The entry conditions for this code are:

- □ Engine speed is above low idle
- □ All cylinders are active, no fault reactions
- □ Engine speed/torque is steady

This fault can occur due to the conditions listed below:

- □ Cylinder kit failure
- □ Valve train failure
- □ Lash adjustments
- □ Injector
- □ High pressure fuel line (rail to injector)
- □ Debris entering injector (intermittent faults)

Check as follows:

1. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes are present along with 1324/13, service the additional fault codes first.
   [b] If only 1324/13 is present go to next step.
2. Using DDDL 7.0 perform “Compression Test” listed under “Service Routines”.
   [a] If cylinder #2 shows low compression, the issue is related to a mechanical failure/issue for that cylinder. Fix cylinder concern and return to step 1.
   [b] If all cylinders are within 10%, go to next step.
3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Using DDDL 7.0 read parameter “Idle Speed Balance Values: cylinder #2” under “Instrumentation” section.

NOTE:
For the idle speed balance values to update, the engine speed must be at idle.

   [a] If value for cylinder #2 is at its maximum limit of +100, go to the next step.
   [b] If value for cylinder #2 is less than +100, fault may be intermittent. Obtain information from customer on driving habits, recent repairs, number of occurrences when fault code set, or situations when the code occurred. Try to retest engine within these parameters.
5. Inspect fuel line from rail to injector for damage.
   [a] If damage is found, replace if necessary. Refer to section 19.1.1.

[b] If no damage was found, replace injector. Refer to section 19.1.1.

19.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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20 SPN 1325

The fault condition is cylinder #3 misfire detected.

20.1 SPN 1325/FMI 13

The fault condition is related to cylinder #3 exhibiting a misfire event. The entry conditions for this code are:

- □ Engine speed is above low idle
- □ All cylinders are active, no fault reactions
- □ Engine speed/torque is steady

This fault can occur due to the conditions listed below:

- □ Cylinder kit failure
- □ Valve train failure
- □ Lash adjustments
- □ Injector
- □ High pressure fuel line (rail to injector)
- □ Debris entering injector (intermittent faults)

Check as follows:

1. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes are present along with 1325/13, service the additional fault codes first.
   [b] If only 1325/13 is present go to next step.
2. Using DDDL 7.0 perform “Compression Test” listed under “Service Routines”.
   [a] If cylinder #3 shows low compression, the issue is related to a mechanical failure/issue for that cylinder. Fix cylinder concern and return to step 1.
   [b] If all cylinders are within 10%, go to next step.
3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Using DDDL 7.0 read parameter “Idle Speed Balance Values: cylinder #3” under “Instrumentation” section.

NOTE:
For the idle speed balance values to update, the engine speed must be at idle.

   [a] If value for cylinder #3 is at its maximum limit of +100, go to the next step.
   [b] If value for cylinder #3 is less than +100, fault may be intermittent. Obtain information from customer on driving habits, recent repairs, number of occurrences when fault code set, or situations when the code occurred. Try to retest engine within these parameters.
5. Inspect fuel line from rail to injector for damage.
   [a] If damage is found, replace if necessary. Refer to section 20.1.1.

[b] If no damage was found, replace injector. Refer to section 20.1.1.

20.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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21 SPN 1326

This SPN indicates that a cylinder #4 misfire has been detected.

21.1 SPN 1326/FMI 13

The fault condition is related to cylinder #4 exhibiting a misfire event. The entry conditions for this code are:

- □ Engine speed is above low idle
- □ All cylinders are active, no fault reactions
- □ Engine speed/torque is steady

This fault can occur due to the conditions listed below:

- □ Cylinder kit failure
- □ Valve train failure
- □ Lash adjustments
- □ Injector
- □ High pressure fuel line (rail to injector)
- □ Debris entering injector (intermittent faults)

Check as follows:

1. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes are present along with 1326/13, service the additional fault codes first.
   [b] If only 1326/13 is present go to next step.
2. Using DDDL 7.0 perform “Compression Test” listed under “Service Routines”.
   [a] If cylinder #4 shows low compression, the issue is related to a mechanical failure/issue for that cylinder. Fix cylinder concern and return to step 1.
   [b] If all cylinders are within 10%, go to next step.
3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Using DDDL 7.0 read parameter “Idle Speed Balance Values: cylinder #4” under “Instrumentation” section.

NOTE:
For the idle speed balance values to update, the engine speed must be at idle.

   [a] If value for cylinder #4 is at its maximum limit of +100, go to the next step.
   [b] If value for cylinder #4 is less than +100, fault may be intermittent. Obtain information from customer on driving habits, recent repairs, number of occurrences when fault code set, or situations when the code occurred. Try to retest engine within these parameters.
5. Inspect fuel line from rail to injector for damage
   [a] If damage is found, replace if necessary

[b] If no damage was found, replace injector.

21.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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22 SPN 1327

This SPN indicates that a cylinder #5 misfire has been detected.

22.1 SPN 1327/13

The fault condition is related to cylinder #5 exhibiting a misfire event. The entry conditions for this code are:

- □ Engine speed is above low idle
- □ All cylinders are active, no fault reactions
- □ Engine speed/torque is steady

This fault can occur due to the conditions listed below:

- □ Cylinder kit failure
- □ Valve train failure
- □ Lash adjustments
- □ Injector
- □ High pressure fuel line (rail to injector)
- □ Debris entering injector (intermittent faults)

Check as follows:

1. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes are present along with 1327/13, service the additional fault codes first.
   [b] If only 1327/13 is present go to next step.
2. Using DDDL 7.0 perform “Compression Test” listed under “Service Routines”.
   [a] If cylinder #5 shows low compression, the issue is related to a mechanical failure/issue for that cylinder. Fix cylinder concern and return to step 1.
   [b] If all cylinders are within 10%, go to next step.
3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Using DDDL 7.0 read parameter “Idle Speed Balance Values: cylinder #5” under “Instrumentation” section.

NOTE:
For the idle speed balance values to update, the engine speed must be at idle.

   [a] If value for cylinder #5 is at its maximum limit of +100, go to the next step.
   [b] If value for cylinder #5 is less than +100, fault may be intermittent. Obtain information from customer on driving habits, recent repairs, number of occurrences when fault code set, or situations when the code occurred. Try to retest engine within these parameters.
5. Inspect fuel line from rail to injector for damage.
   [a] If damage is found, replace if necessary. Refer to section 22.1.1.

[b] If no damage was found, replace injector. Refer to section 22.1.1.

22.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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23 SPN 1328

This SPN indicates that a cylinder #6 misfire has been detected.

23.1 SPN 1328/13

The fault condition is related to cylinder #6 exhibiting a misfire event. The entry conditions for this code are:

- □ Engine speed is above low idle
- □ All cylinders are active, no fault reactions
- □ Engine speed/torque is steady

This fault can occur due to the conditions listed below:

- □ Cylinder kit failure
- □ Valve train failure
- □ Lash adjustments
- □ Injector
- □ High pressure fuel line (rail to injector)
- □ Debris entering injector (intermittent faults)

Check as follows:

1. Using DDDL 7.0, check for multiple codes.
   [a] If additional fault codes are present along with 1328/13, service the additional fault codes first.
   [b] If only 1328/13 is present go to next step.
2. Using DDDL 7.0 perform “Compression Test” listed under “Service Routines”.
   [a] If cylinder #6 shows low compression, the issue is related to a mechanical failure/issue for that cylinder. Fix cylinder concern and return to step 1.
   [b] If all cylinders are within 10%, go to next step.
3. Start and bring engine up to operating temperature (over 140°F/60°C).
4. Using DDDL 7.0 read parameter “Idle Speed Balance Values: cylinder #6” under “Instrumentation” section.

NOTE:
For the idle speed balance values to update, the engine speed must be at idle.

   [a] If value for cylinder #6 is at its maximum limit of +100, go to the next step.
   [b] If value for cylinder #6 is less than +100, fault may be intermittent. Obtain information from customer on driving habits, recent repairs, number of occurrences when fault code set, or situations when the code occurred. Try to retest engine within these parameters.
5. Inspect fuel line from rail to injector for damage.
   [a] If damage is found, replace if necessary. Refer to section 23.1.1.

[b] If no damage was found, replace injector. Refer to section 23.1.1.

23.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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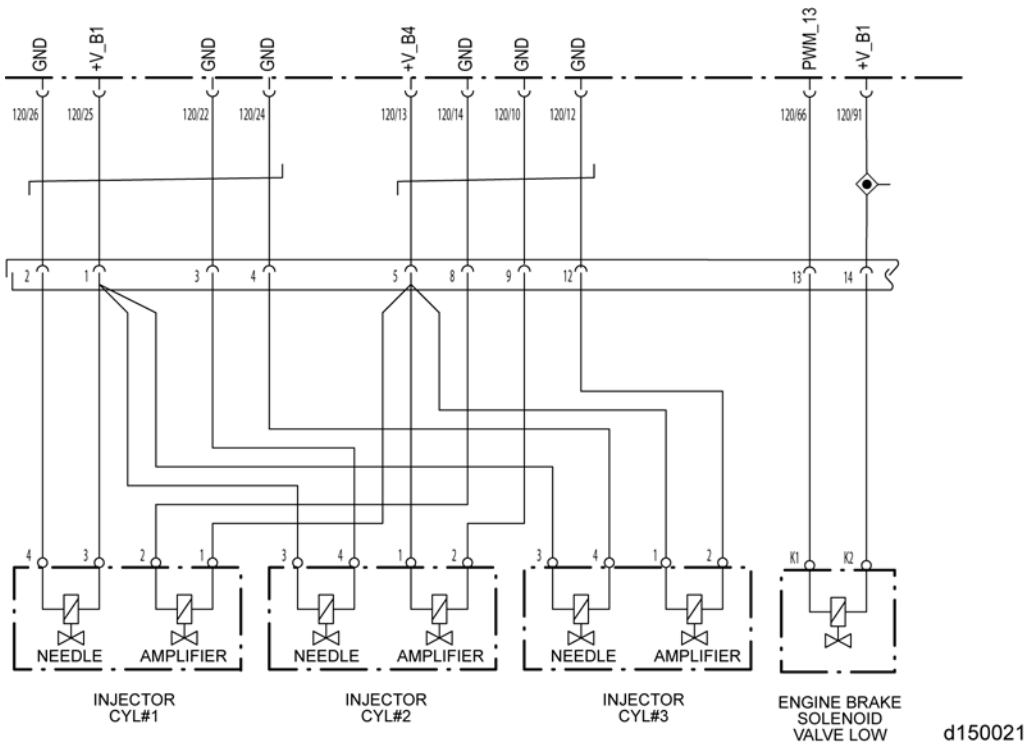
24 SPN 2797

This SPN indicates the injector #1, 2, or 3 needle control valves are not operating normally.



24.1 SPN 2797/FMI 3

This diagnosis is typically injector #1, 2, or 3 needle control valve circuit has a short to battery/power.

Check as follows:

1. Disconnect the Front Injector Harness 14–pin connector.
2. Turn the ignition ON (key ON, engine OFF).
3. Measure the voltage between pin 1 on the MCM side of the Front Injector Harness 14–pin connector and ground.
   [a] If there is voltage present, repair the short to power between pin 1 of the Front Injector Harness 14–pin connector and pin 25 of the 120–pin MCM connector. Refer to section 24.1.1.
   [b] If there is no voltage present, replace the under valve cover injector harness. Refer to section 24.1.1.

24.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

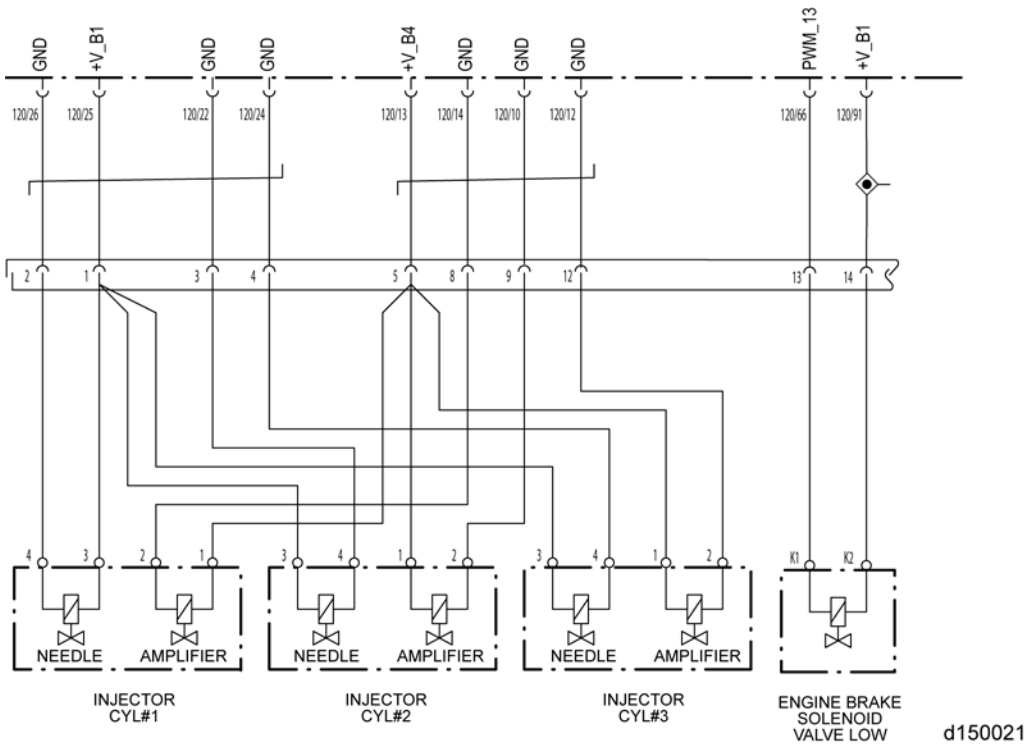
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

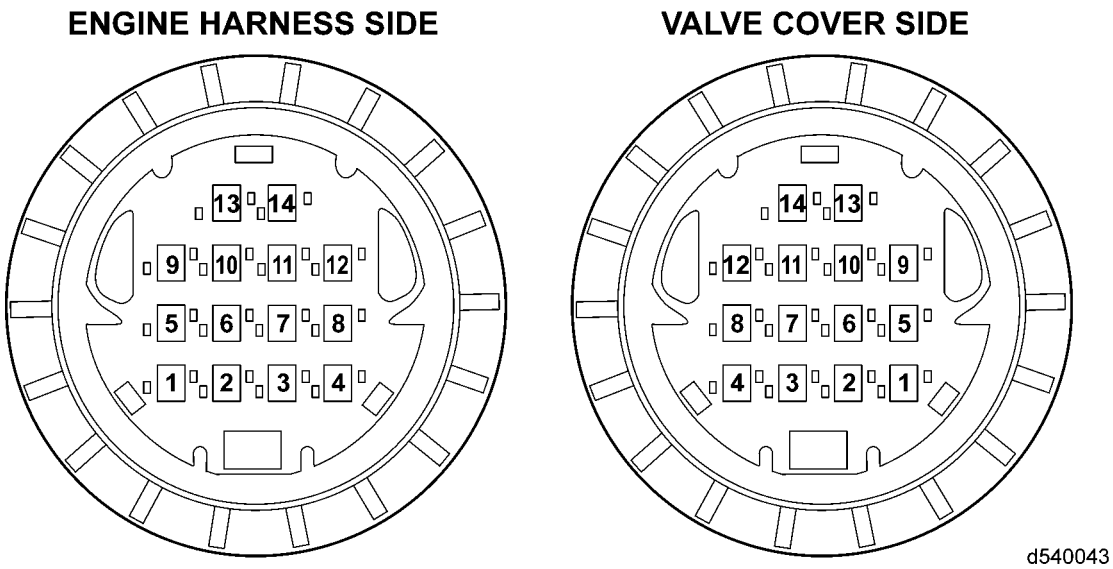
24.2 SPN 2797/FMI 4

This diagnosis is typically injector #1, 2, or 3 needle control valve circuit is shorted to ground.



Check as follows:

1. Disconnect the Front Injector Harness 14–pin connector.
2. Inspect the Front Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary.
   [b] If connector shows no signs of damage, go to the next step.
3. Measure the resistance between pin 1 on the valve cover side of the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #1 pin 3 and ground.



[a] If the resistance is greater than 3 Ω, go to step 11.

[b] If the resistance is less than 3 Ω, go to the next step.

4. Remove the valve cover.
5. Disconnect injector #1.
6. Measure the resistance between pin 1 on the valve cover side of the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #1 pin 3 and ground.

   [a] If the resistance is greater than 3 Ω, replace the #1 injector. Refer to section 24.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
7. Disconnect injector #2.
8. Measure the resistance between pin 1 of the valve cover side on the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #2 pin 3 and ground.

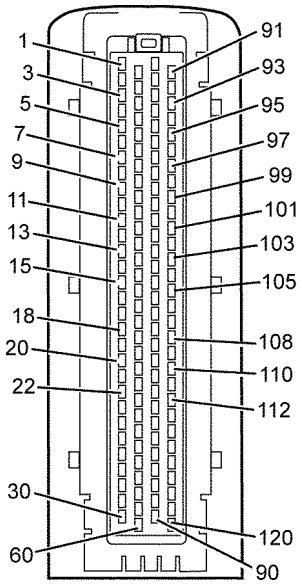
   [a] If the resistance is greater than 3 Ω, replace the #2 injector. Refer to section 24.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
9. Disconnect injector #3.
10. Measure the resistance between pin 1 on the valve cover side of the Front Injector Harness 14–pin connector and ground.

    [a] If the resistance is greater than 3 Ω, replace the #3 injector. Refer to section 24.2.1.

    [b] If the resistance is less than 3 Ω, replace the under valve cover Injector Harness. Refer to section 24.2.1.
11. Disconnect the 120–pin MCM connector.

12. Measure the resistance between pin 25 on the 120–pin MCM connector and ground. If you are using J-48671–10, measure between injector #1 pin 3 and ground.



[a] If the resistance is less than 3 Ω, repair the short to ground between pin 25 of the MCM 120–pin connector and pin 1 of the Front Injector Harness 14–pin connector. Refer to section 24.2.1.

[b] If the resistance is greater than 3 Ω, call the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

24.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

⚠ WARNING:

ENGINE EXHAUST

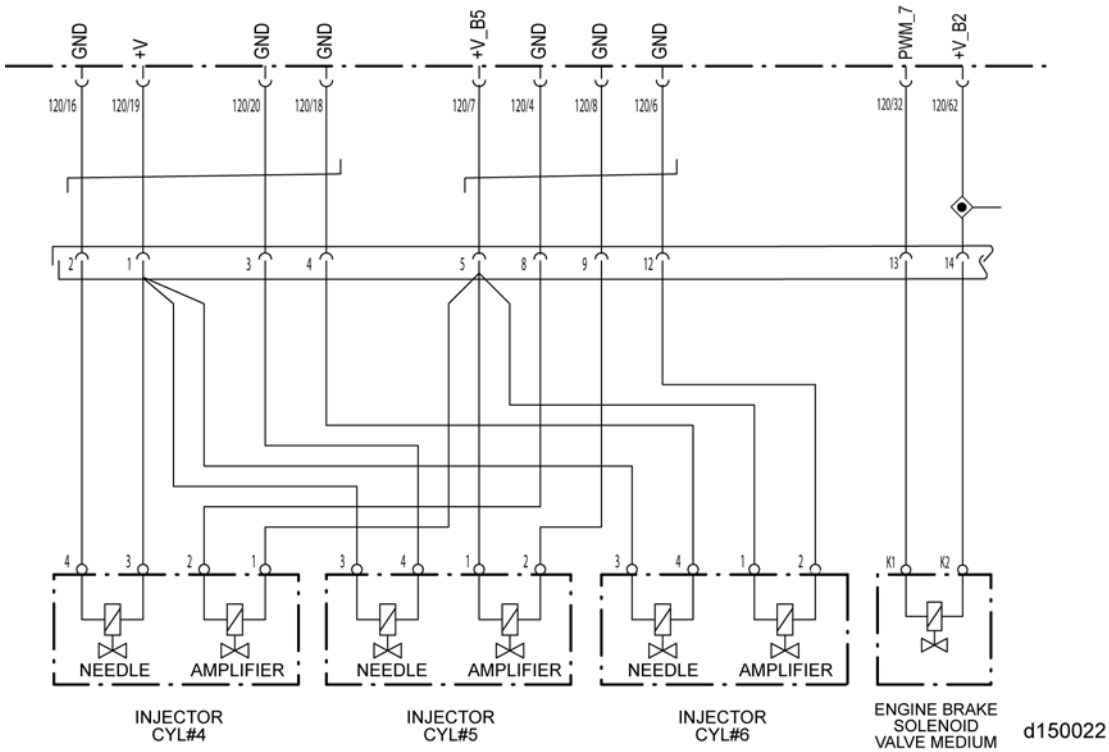
To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).

5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

25 SPN 2798

This SPN indicates injector #4, 5, or 6 needle control valves are not operating normally.



25.1 SPN 2798/FMI 3

This diagnosis is typically injector #4, 5, or 6 needle control valve circuit has a short to battery/power.

Check as follows:

1. Disconnect the Rear Injector Harness 14–pin connector.
2. Turn the ignition ON (key ON, engine OFF).
3. Measure the voltage between pin 1 on the MCM side of the Rear Injector Harness 14–pin connector and ground.
   [a] If there is voltage present, repair the short to power between pin 1 of the Rear Injector Harness 14–pin connector and pin 19 of the 120–pin MCM connector. Refer to section 25.1.1.
   [b] If there is no voltage present, replace the under valve cover injector harness. Refer to section 25.1.1.

25.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

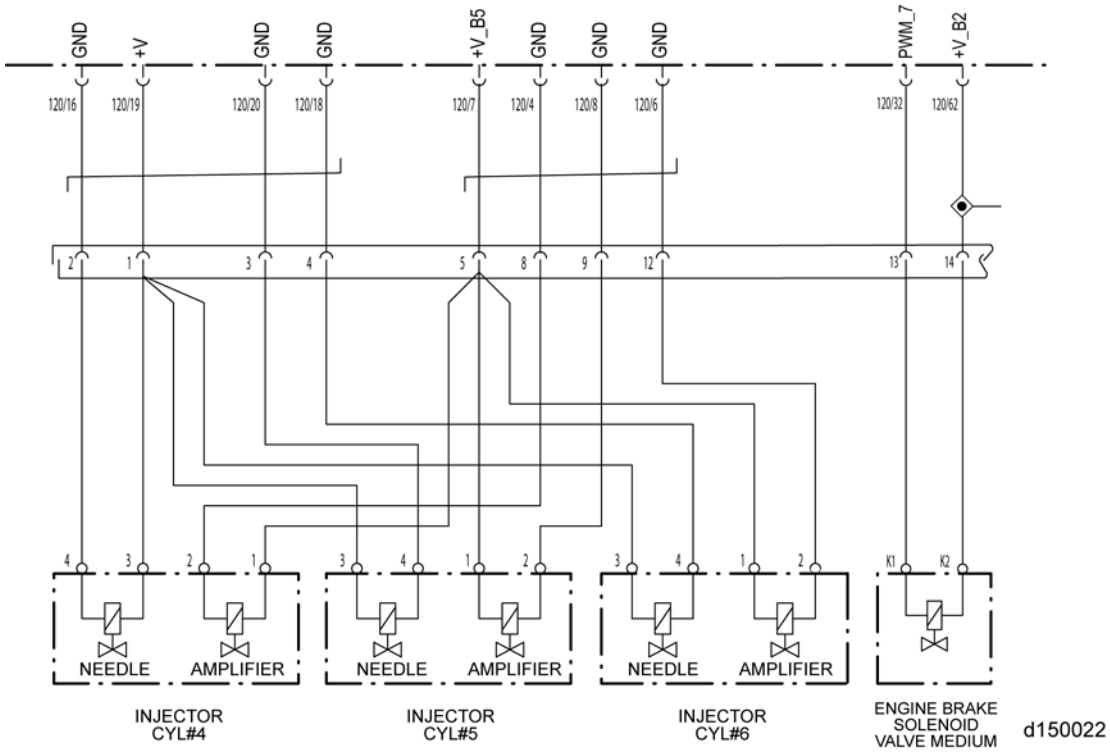
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

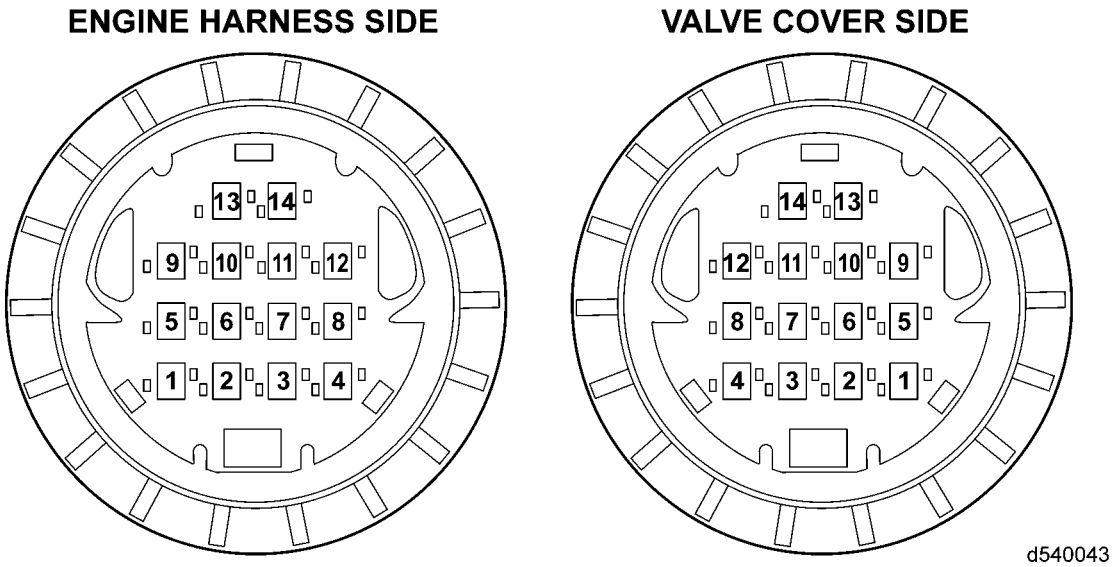
25.2 SPN 2798/FMI 4

This diagnosis is typically injector # 4, 5, or 6 needle control valve circuit is shorted to ground.



Check as follows:

1. Disconnect the Rear Injector Harness 14–pin connector.
2. Inspect the Rear Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary.
   [b] If connector shows no signs of damage, go to the next step.
3. Measure the resistance between pin 1 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #4 pin 3 and ground.



[a] If the resistance is less than 3 Ω, go to step 11.

[b] If the resistance is greater than 3 Ω, go to the next step.

4. Remove the upper valve cover.
5. Disconnect injector #4.
6. Measure the resistance between pin 1 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #4 pin 3 and ground.

   [a] If the resistance is greater than 3 Ω, replace the #4 injector. Refer to section 25.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
7. Disconnect injector #5.
8. Measure the resistance between pin 1 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #5 pin 3 and ground.

   [a] If the resistance is greater than 3 Ω, replace the #5 injector. Refer to section 25.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
9. Disconnect injector #6.
10. Measure the resistance between pin 1 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #6 pin 3 and ground.

    [a] If the resistance is greater than 3 Ω, replace the #6 injector. Refer to section 25.2.1.

    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 25.2.1.
11. Disconnect the 120–pin MCM connector.

12. Measure the resistance between pin 1 on the valve cover side of the Rear Injector Harness 14–pin connector and ground.
    [a] If the resistance is less than 3 Ω, repair the short to ground between pin 19 of the MCM 120–pin connector and pin 1 of the Rear Injector Harness 14–pin connector. Refer to section 25.2.1.
    [b] If the resistance is greater than 3 Ω, call the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

25.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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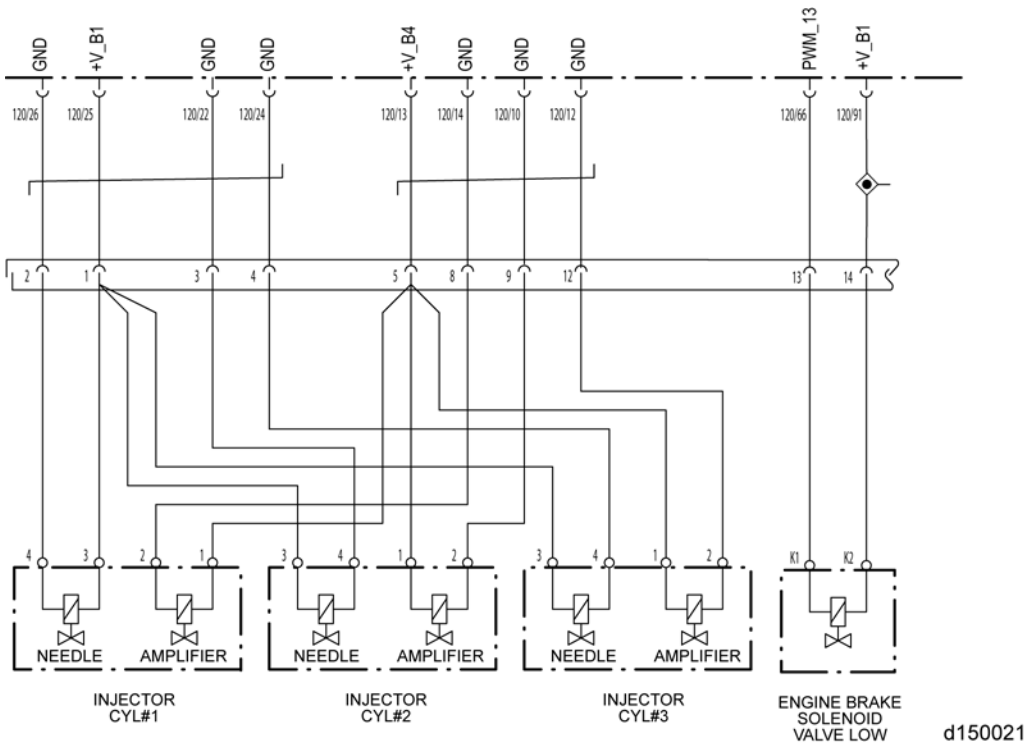
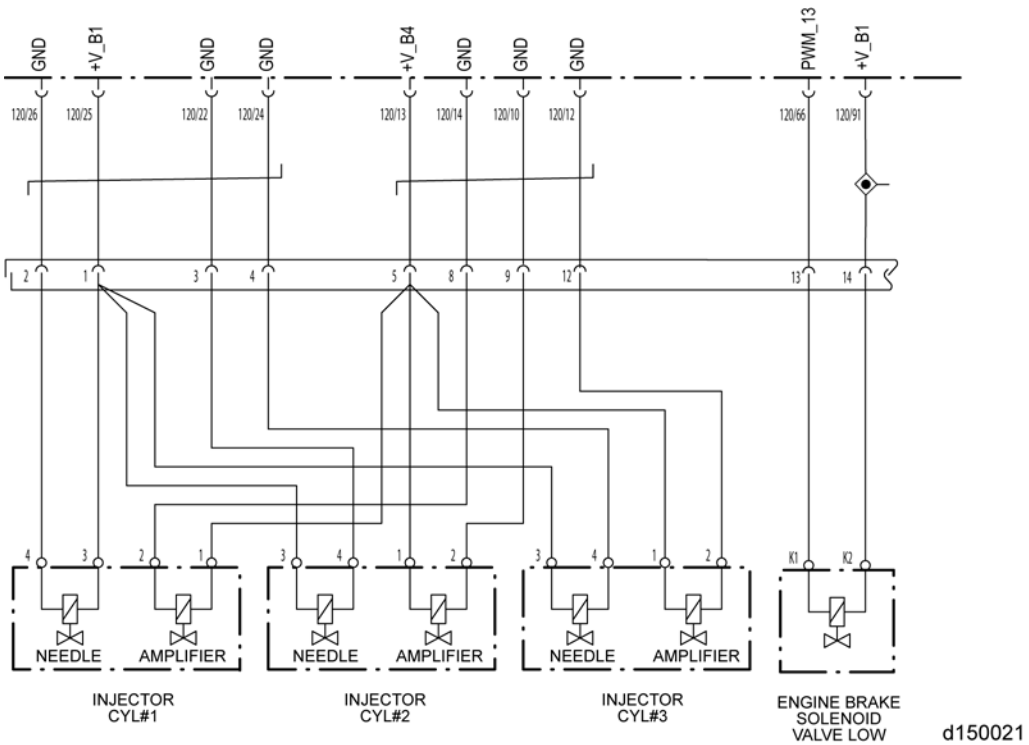
26 SPN 3659

This SPN indicates the injector #1 cylinder amplifier control valve is not operating normally.



26.1 SPN 3659/FMI 14

SPN 3659/FMI 14 is typically an open circuit, short to ground or short to power (cylinder #1).

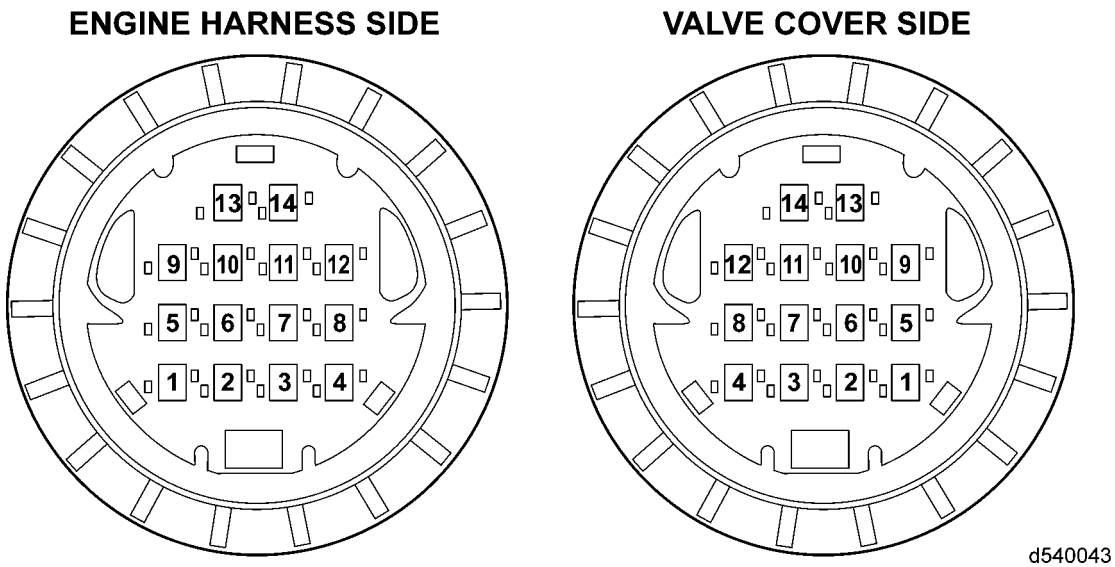


Check as follows:

1. Check for multiple codes.
   [a] If fault code 168/1 is active, service 168/1 first.
   [b] If fault 3660/14 and 3661/14 are active in addition to 3659/14, go to the next step.
   [c] If only fault code 3659/14 is active, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the Front Injector Harness 14–pin connector.
4. Inspect the Front Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 26.1.1.
   [b] If connector shows no signs of damage, go to the next step.
5. Measure the resistance between pins 5 and 8 on the valve cover side of the Front Injector Harness. If using J-48671–10, measure between injector #1 pins 1 and 2.
   [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 26.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120–pin connector.
7. Measure the resistance between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector.



[a] If the resistance is less than 3 Ω, go to the next step.

[b] If the resistance is greater than 3 Ω, repair the open between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector. Refer to section 26.1.1.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 13 of the MCM 120–pin connector.

[a] If the resistance is greater than 3 Ω, contact the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

[b] If the resistance is less than 3 Ω, repair the short to power between battery positive and pin 13 of the MCM 120–pin connector.

10. Turn the ignition OFF.
11. Disconnect the Front Injector Harness 14–pin connector.
12. Measure the resistance between pin 5 and pin 8 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #1 pins 1 and 2.

[a] If the resistance is greater than 3 Ω, go to the next step.

[b] If the resistance is less than 3 Ω, go to step 18.

13. Remove the upper valve cover.
14. Disconnect injector #1.

15. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness and pin 1 of the injector #1 harness connector. If using J-48671–10, measure between injector #1 pin 1 and the injector #1 harness connector pin 1.

    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 26.1.1.

    [b] If the resistance is less than 3 Ω, go to the next step.

16. Measure the resistance between pin 8 on the valve cover side of the Front Injector Harness and pin 2 of the injector #1 harness connector. If using J-48671–10, measure between injector #1 pin 2 and the injector #1 harness connector pin 2.

    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 26.1.1.

    [b] If the resistance is less than 3 Ω, go to the next step.

17. Measure the resistance between pin 8 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #1 pin 2 and ground.

    [a] If the resistance is greater than 3 Ω, replace injector #1. Refer to section 26.1.1.

    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 26.1.1.

18. Measure the resistance between pin 8 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #1 pin 2 and ground.

    [a] If the resistance is greater than 3 Ω, repair the short to ground between pin 14 of the 120–pin MCM connector and pin 8 of the Front Injector Harness 14–pin connector. Refer to section 26.1.1.

    [b] If the resistance is less than 3 Ω, go to the next step.

19. Remove the upper valve cover.

20. Disconnect the injector #1 connector.

21. Measure the resistance between pin 8 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #1 pin 2 and ground.

    [a] If the resistance is greater than 3 Ω, replace injector #1. Refer to section 26.1.1.

    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 26.1.1.

26.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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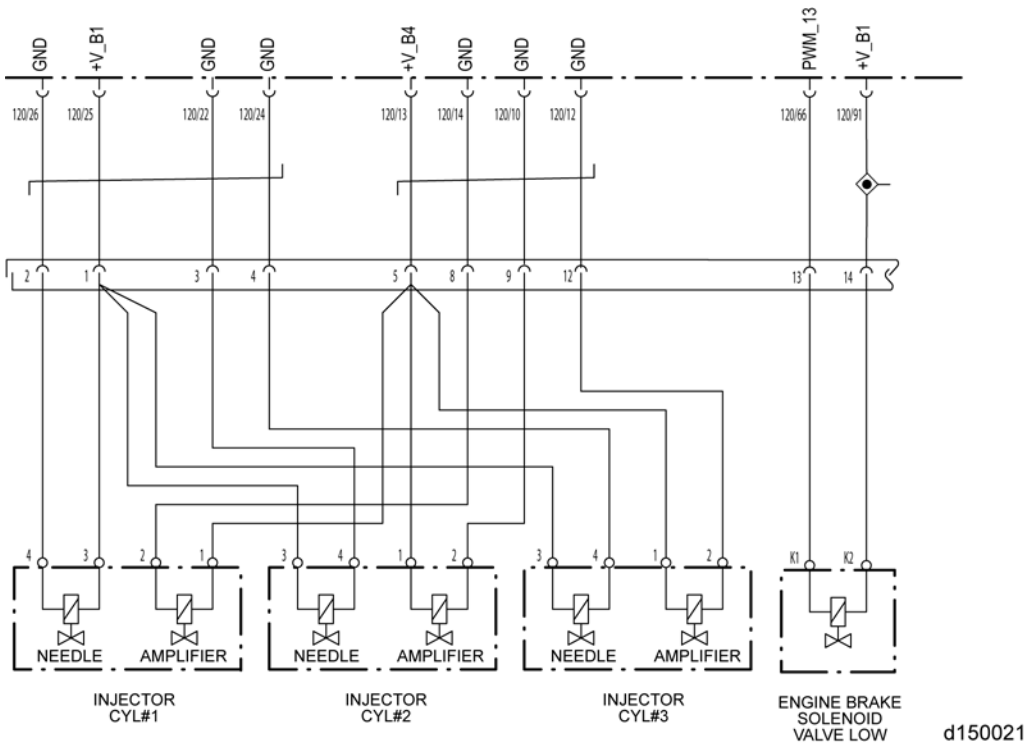
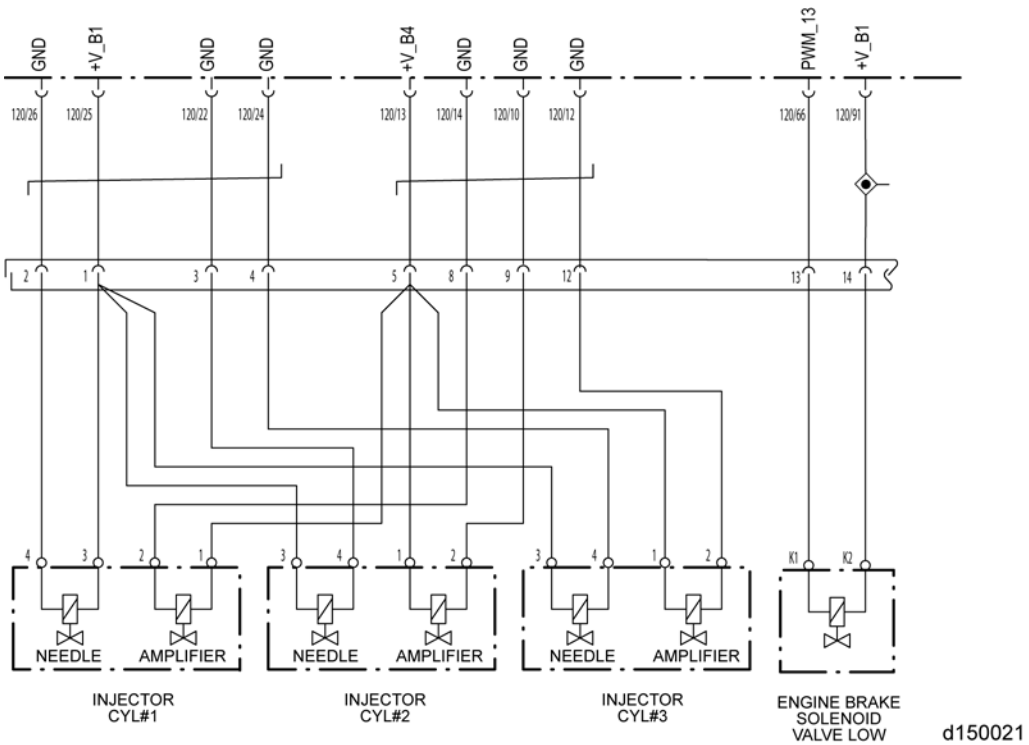
27 SPN 3660

This SPN indicates the injector #2 cylinder amplifier control valve is not operating normally.



27.1 SPN 3660/FMI 14

SPN 3660/FMI 14 is typically an open circuit, short to ground or short to power (injector #2).

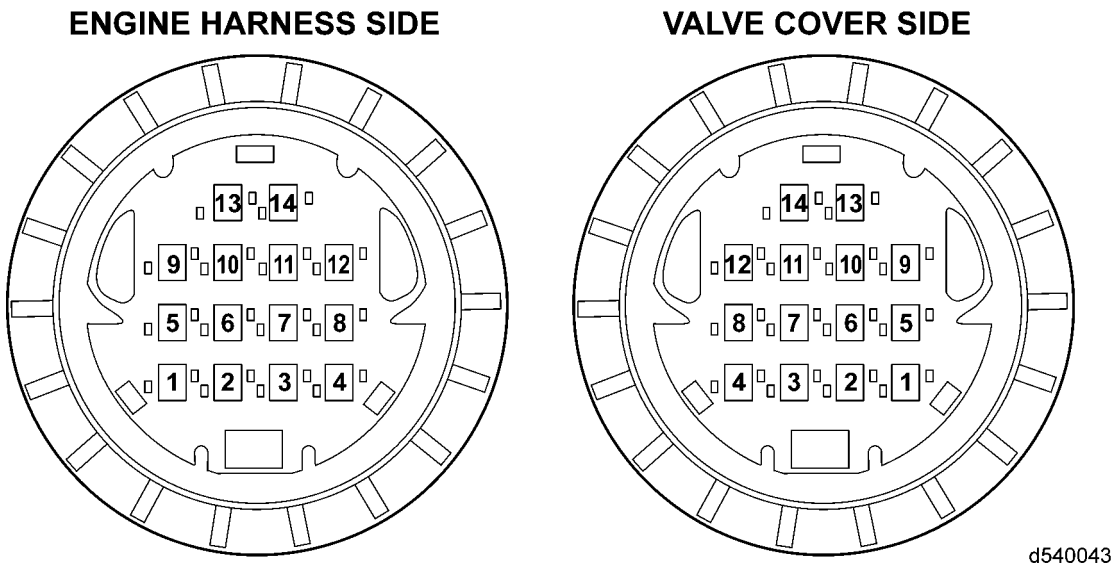


Check as follows:

1. Check for multiple codes.
   [a] If fault code 168/1 is active, service 168/1 first.
   [b] If fault 3659/14 and 3661/14 are active in addition to 3660/14, go to the next step.
   [c] If only fault code 3660/14 is active, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the Front Injector Harness 14–pin connector.
4. Inspect the Front Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 27.1.1.
   [b] If connector shows no signs of damage, go to the next step.
5. Measure the resistance between pins 5 and 9 on the valve cover side of the Front Injector Harness. If using J-48671–10, measure between injector #2 pins 1 and 2.
   [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 27.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120–pin connector.
7. Measure the resistance between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector.



[a] If the resistance is greater than 3 Ω, repair the open between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector. Refer to section 27.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 13 of the MCM 120–pin connector.

[a] If the resistance is greater than 3 Ω, contact the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

[b] If the resistance is less than 3 Ω, repair the short to power between battery positive and pin 13 of the MCM 120–pin connector. Refer to section 27.1.1.

10. Turn the ignition OFF.
11. Disconnect the Front Injector Harness 14–pin connector.
12. Measure the resistance between pin 5 and pin 9 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #2 pins 1 and 2.

[a] If the resistance is greater than 3 Ω, go to the next step.

[b] If the resistance is less than 3 Ω, go to step 18.

13. Remove the upper valve cover.
14. Disconnect injector #2.

15. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness and pin 1 of the injector #2 harness connector. If using J-48671–10, measure between injector #2 pin 1 and the injector #2 harness connector pin 1.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 27.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 9 on the valve cover side of the Front Injector Harness and pin 2 of the injector #2 harness connector. If using J-48671–10, measure between injector #2 pin 2 and the injector #2 harness connector pin 2.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 27.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 9 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #2 pin 2 and ground.
    [a] If the resistance is greater than 3 Ω, replace injector #2. Refer to section 27.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 27.1.1.
18. Measure the resistance between pin 9 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #2 pin 2 and ground.
    [a] If the resistance is greater than 3 Ω, repair the short to ground between pin 10 of the 120–pin MCM connector and pin 9 of the Front Injector Harness 14–pin connector. Refer to section 27.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
19. Remove the upper valve cover.
20. Disconnect the injector #2 connector.
21. Measure the resistance between pin 9 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #2 pin 2 and ground.
    [a] If the resistance is greater than 3 Ω, replace injector #2. Refer to section 27.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 27.1.1.

27.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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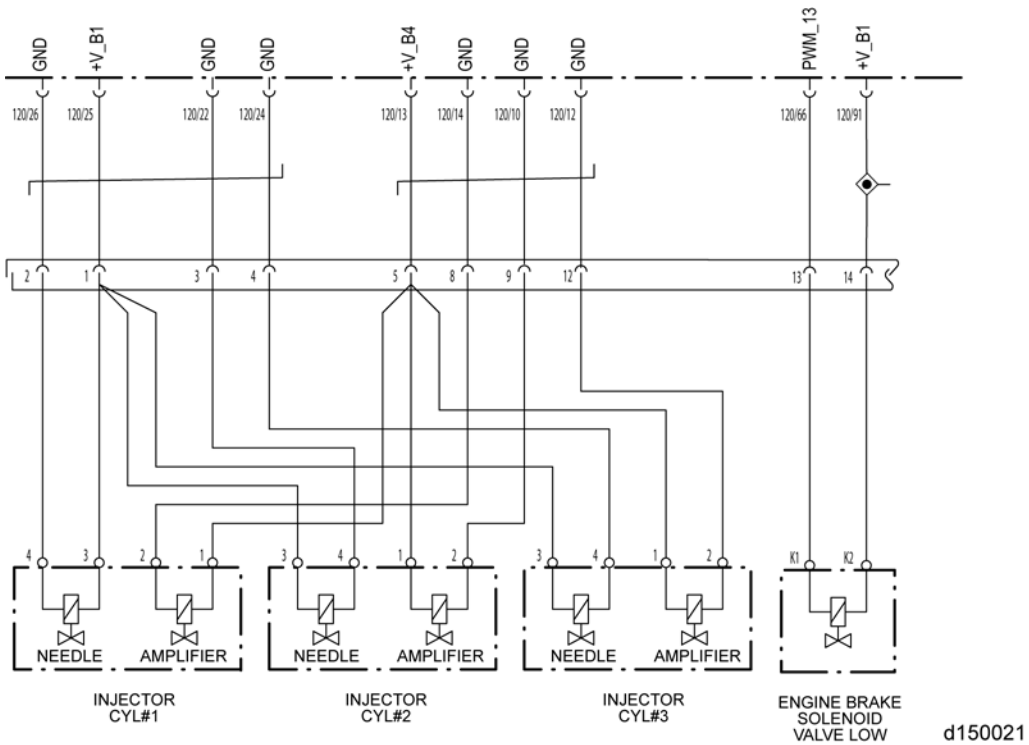
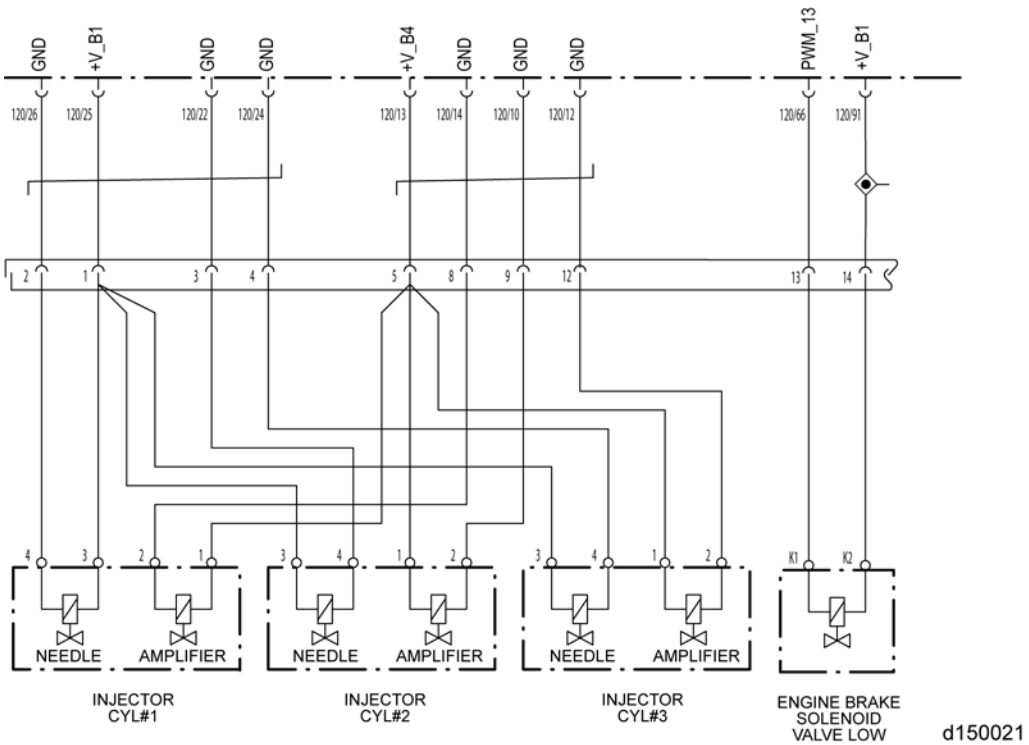
28 SPN 3661

This SPN indicates the injector #3 cylinder amplifier control valve is not operating normally.



28.1 SPN 3661/FMI 14

SPN 3659/FMI 14 is typically an open circuit, short to ground or short to power (cylinder #3).

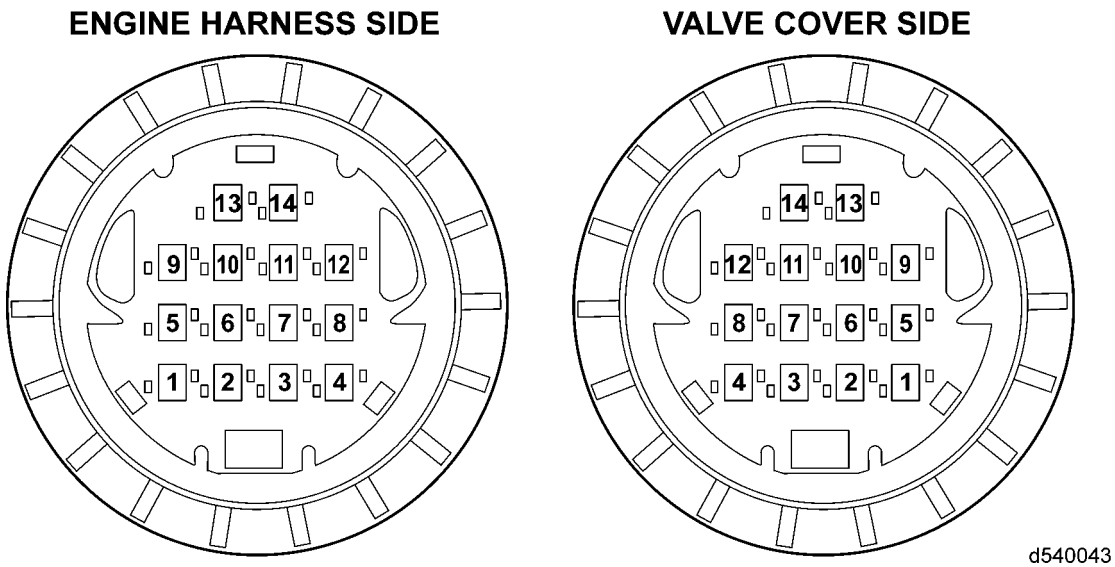


Check as follows:

1. Check for multiple codes.
   [a] If fault code 168/1 is active, service 168/1 first. Refer to section 28.1.1.
   [b] If fault 3659/14 and 3660/14 are active in addition to 3661/14, go to the next step.
   [c] If only fault code 3661/14 is active, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the Front Injector Harness 14–pin connector.
4. Inspect the Front Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 28.1.1.
   [b] If connector shows no signs of damage, go to the next step.
5. Measure the resistance between pins 5 and 12 on the valve cover side of the Front Injector Harness. If using J-48671–10, measure between injector #3 pins 1 and 2.
   [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 28.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120–pin connector.
7. Measure the resistance between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector.



[a] If the resistance is less than 3 Ω, go to the next step.

[b] If the resistance is greater than 3 Ω, repair the open between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector. Refer to section 28.1.1.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 13 of the MCM 120–pin connector.

[a] If the resistance is greater than 3 Ω, contact the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

[b] If the resistance is less than 3 Ω, repair the short to power between battery positive and pin 13 of the MCM 120–pin connector. Refer to section 28.1.1.

10. Turn the ignition OFF.
11. Disconnect the Front Injector Harness 14–pin connector.
12. Measure the resistance between pin 5 and pin 12 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #3 pins 1 and 2.

[a] If the resistance is greater than 3 Ω, go to the next step.

[b] If the resistance is less than 3 Ω, go to step 18.

13. Remove the upper valve cover.
14. Disconnect injector #3.

15. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness and pin 1 of the injector #3 harness connector. If using J-48671–10, measure between injector #3 pin 1 and the injector #3 harness connector pin 1.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 28.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 12 on the valve cover side of the Front Injector Harness and pin 2 of the injector #3 harness connector. If using J-48671–10, measure between injector #3 pin 2 and the injector #3 harness connector pin 2.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 28.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 12 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #3 pin 2 and ground.
    [a] If the resistance is greater than 3 Ω, replace injector #3. Refer to section 28.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 28.1.1.
18. Measure the resistance between pin 12 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #3 pin 2 and ground.
    [a] If the resistance is greater than 3 Ω, repair the short to ground between pin 12 of the 120–pin MCM connector and pin 12 of the Front Injector Harness 14–pin connector. Refer to section 28.1.1.
    [b] If the resistance is less than 3 Ω, go to step 19.
19. Remove the upper valve cover.
20. Disconnect the injector #3 connector.
21. Measure the resistance between pin 12 on the valve cover side of the Front Injector Harness and ground. If using J-48671–10, measure between injector #3 pin 2 and ground.
    [a] If the resistance is greater than 3 Ω, replace injector #3. Refer to section 28.1.1.
    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 28.1.1.

28.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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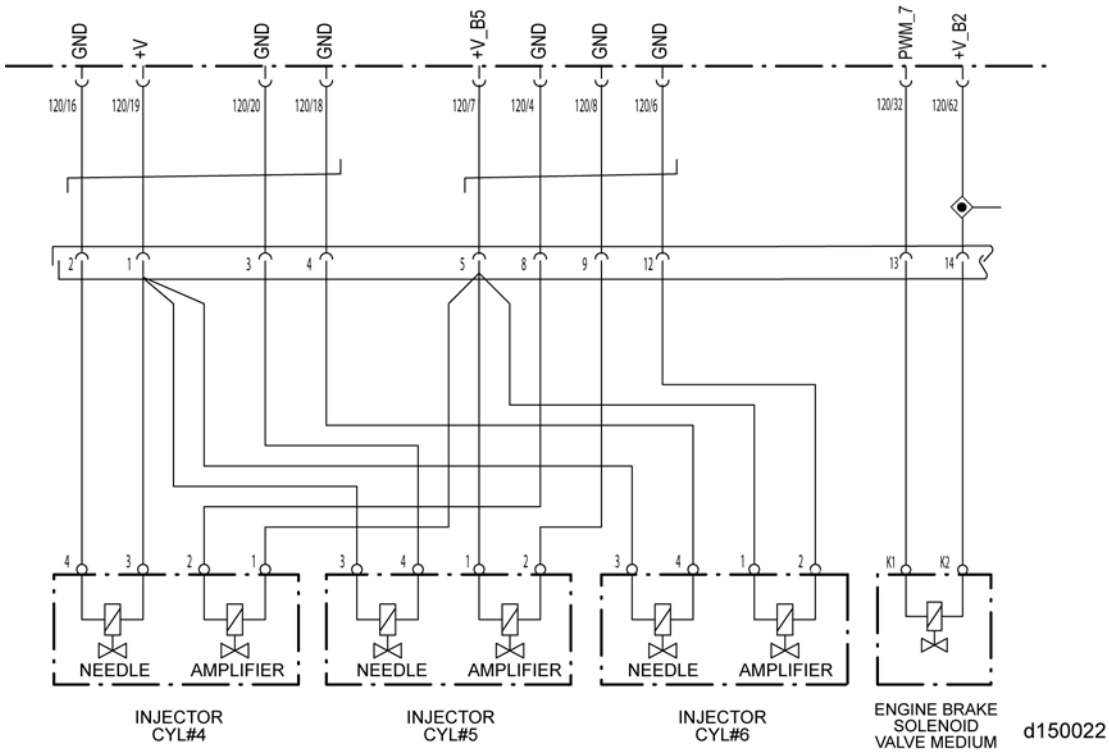
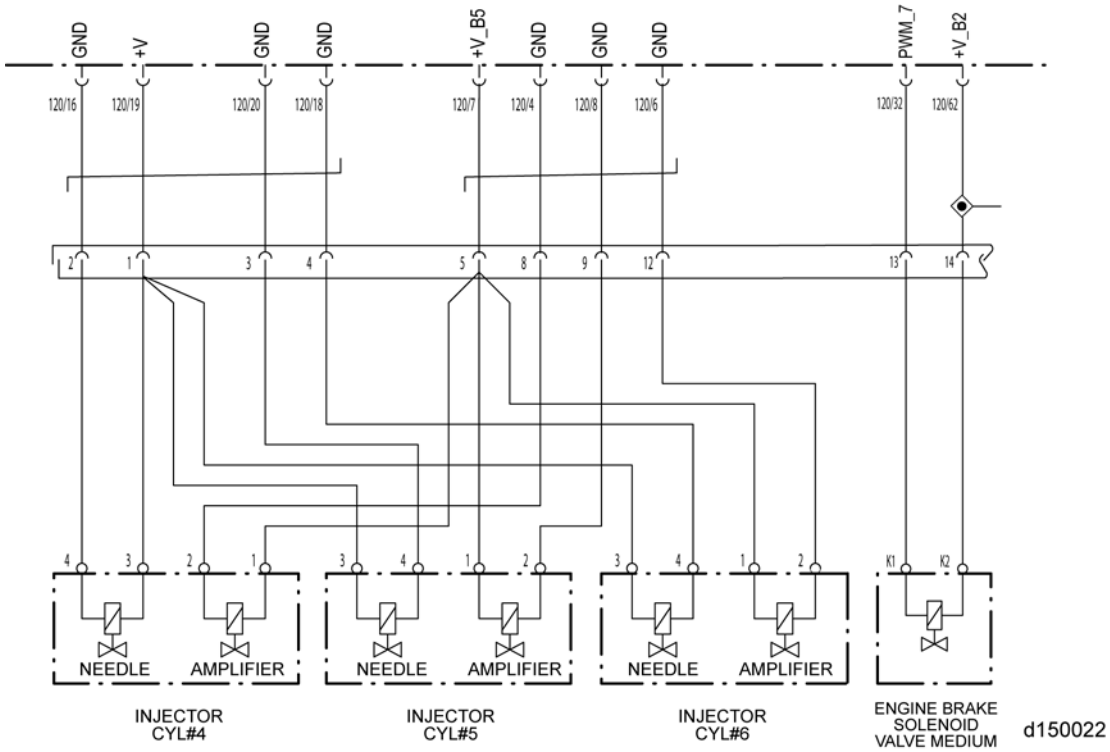
29 SPN 3662

This SPN indicates that the injector #4 cylinder amplifier control valve is not operating normally.



29.1 SPN 3662/FMI 14

This diagnosis is typically an open circuit, short to ground or short to power (cylinder #4).

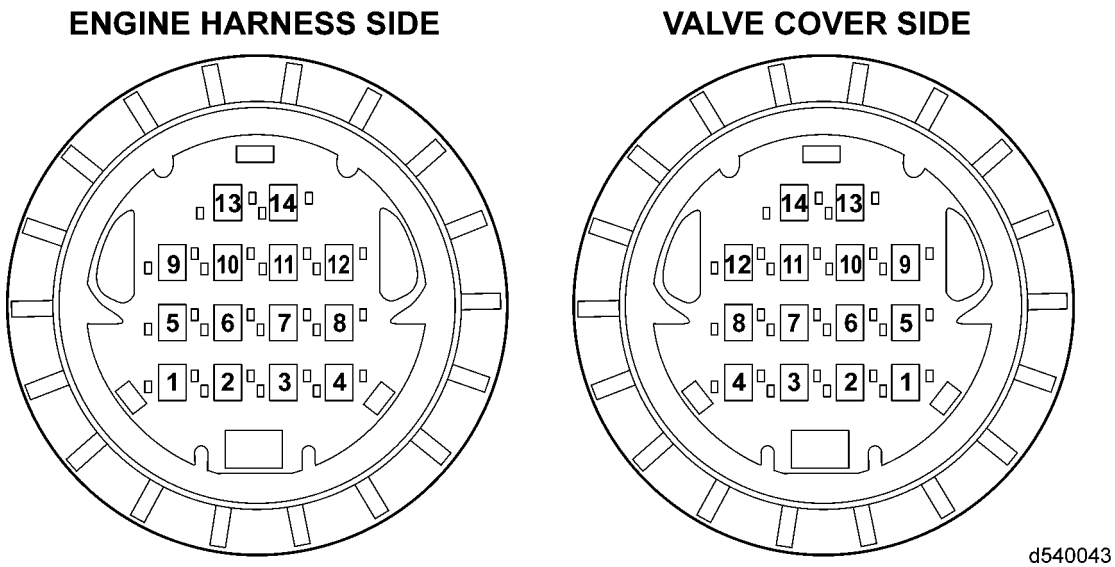


Check as follows:

1. Check for multiple codes.
   [a] If fault code 168/1 is active, service 168/1 first.
   [b] If fault 3663/14 and 3664/14 are active in addition to 3662/14, go to the next step.
   [c] If only fault code 3662/14 is active, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the Rear Injector Harness 14–pin connector.
4. Inspect the Rear Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 29.1.1.
   [b] If connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 5 and pin 8 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #4 pins 1 and 2.
   [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 29.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120–pin connector.
7. Measure the resistance between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 14–pin connector.



[a] If the resistance is greater than 3 Ω, repair the open between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 14–pin connector. Refer to section 29.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 7 of the MCM 120–pin connector.

[a] If the resistance is less than 3 Ω, repair the short to power between battery positive and pin 7 of the 120–pin MCM connector. Refer to section 29.1.1.

[b] If the resistance is greater than 3 Ω, contact the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

10. Turn the ignition OFF.
11. Disconnect the Rear Injector Harness 14–pin connector.
12. Measure the resistance between pin 5 and pin 8 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #4 pins 1 and 2.

[a] If the resistance is greater than 3 Ω, go to step 18.

[b] If the resistance is less than 3 Ω, go to the next step.

13. Remove the upper valve cover.
14. Disconnect injector #4.

15. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness and pin 1 on the #4 injector harness connector. If using J-48671–10, measure between injector #4 pin 1 and pin 1 on the #4 injector harness connector.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 29.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 8 on the valve cover side of the Rear Injector Harness and pin 1 of the injector #4 harness connector. If using J-48671–10, measure between injector #4 pin 2 and the injector #4 harness connector pin 2.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 29.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 8 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #4 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 29.1.1.
    [b] If the resistance is greater than 3 Ω, replace injector #4. Refer to section 29.1.1.
18. Measure the resistance between pin 8 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #4 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, go to the next step.
    [b] If the resistance is greater than 3 Ω, repair the short to ground between pin 4 of the MCM 120–pin connector and pin 8 of the Rear Injector Harness connector. Refer to section 29.1.1.
19. Remove the upper valve cover.
20. Disconnect injector #4 connector.
21. Measure the resistance between pin 8 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #4 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 29.1.1.
    [b] If the resistance is greater than 3 Ω, replace injector #4. Refer to section 29.1.1.

29.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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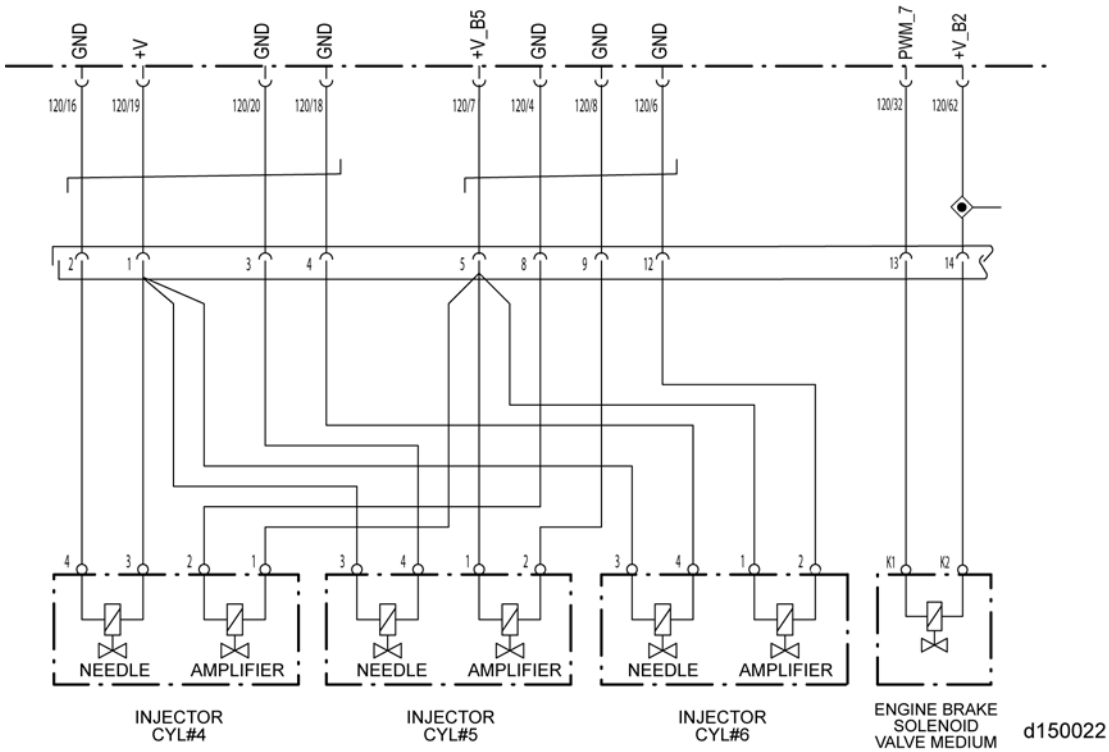
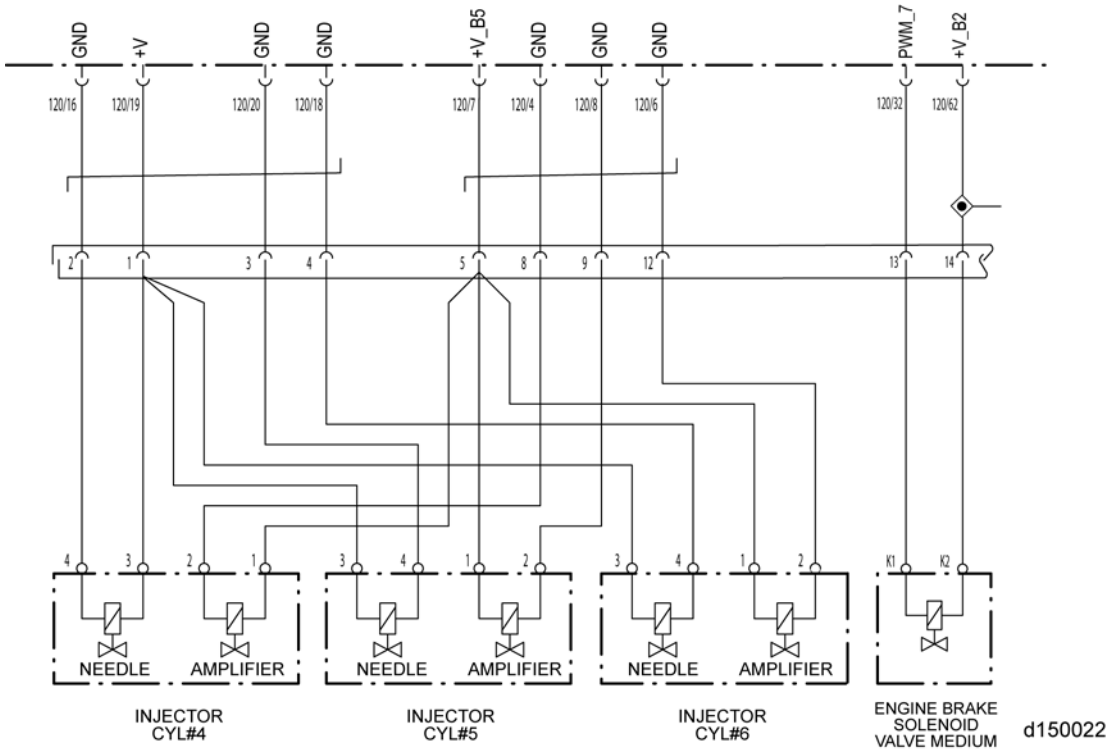
30 SPN 3663

This SPN indicates that the injector #5 cylinder amplifier control valve is not operating normally.



30.1 SPN 3663/FMI 14

This diagnosis is typically an open circuit, short to ground or short to power (cylinder #5).

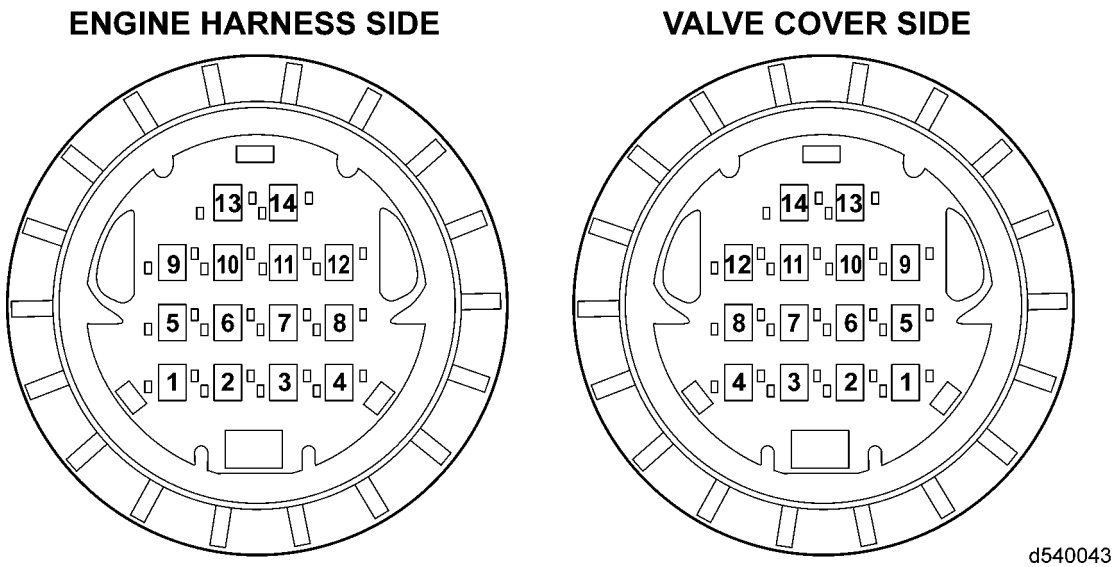


Check as follows:

1. Check for multiple codes.
   [a] If fault code 168/1 is active, service 168/1 first.
   [b] If fault 3662/14 and 3664/14 are active in addition to 3663/14, go to the next step.
   [c] If only fault code 3663/14 is active, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the Rear Injector Harness 14–pin connector.
4. Inspect the Rear Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 30.1.1.
   [b] If connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 5 and pin 7 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #5 pins 1 and 2.
   [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 30.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120–pin connector.
7. Measure the resistance between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 12–pin connector.



[a] If the resistance is greater than 3 Ω, repair the open between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 14–pin connector. Refer to section 30.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 7 of the MCM 120–pin connector.

[a] If the resistance is less than 3 Ω, repair the short to power between battery positive and pin 7 of the 120–pin MCM connector. Refer to section 30.1.1.

[b] If the resistance is greater than 3 Ω, contact the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

10. Turn the ignition OFF.
11. Disconnect the Rear Injector Harness 14–pin connector.
12. Measure the resistance between pin 5 and pin 7 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #5 pins 1 and 2.

[a] If the resistance is greater than 3 Ω, go to step 18.

[b] If the resistance is less than 3 Ω, go to the next step.

13. Remove the upper valve cover.
14. Disconnect injector #5.

15. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness and pin 1 on the injector #5 harness connector. If using J-48671–10, measure between injector #5 pin 1 and pin 1 on the injector #5 harness connector.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 30.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 7 on the valve cover side of the Rear Injector Harness and pin 2 of the injector #5 harness connector. If using J-48671–10, measure between injector #5 pin 2 and the injector #5 harness connector pin 2.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 30.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 7 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #5 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 30.1.1.
    [b] If the resistance is greater than 3 Ω, replace injector #5. Refer to section 30.1.1.
18. Measure the resistance between pin 7 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #5 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, go to the next step.
    [b] If the resistance is greater than 3 Ω, repair the short to ground between pin 4 of the MCM 120–pin connector and pin 7 of the Rear Injector Harness connector. Refer to section 30.1.1.
19. Remove the upper valve cover.
20. Disconnect injector #5 connector.
21. Measure the resistance between pin 7 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #5 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 30.1.1.
    [b] If the resistance is greater than 3 Ω, replace injector #5. Refer to section 30.1.1.

30.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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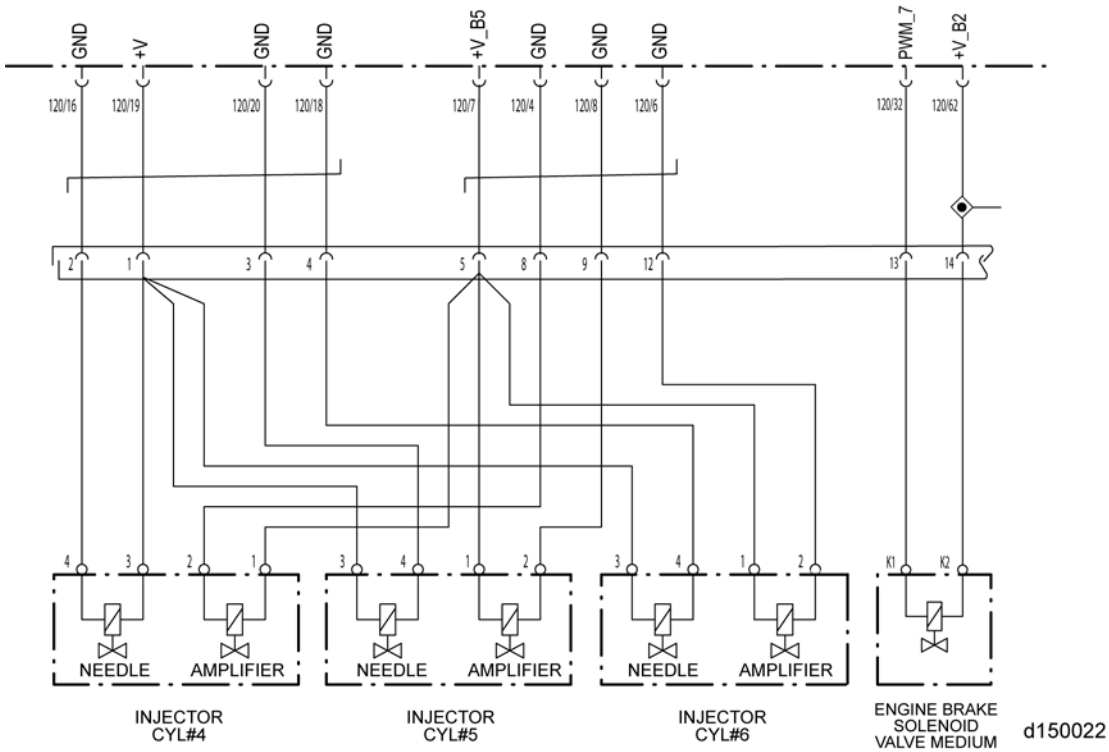
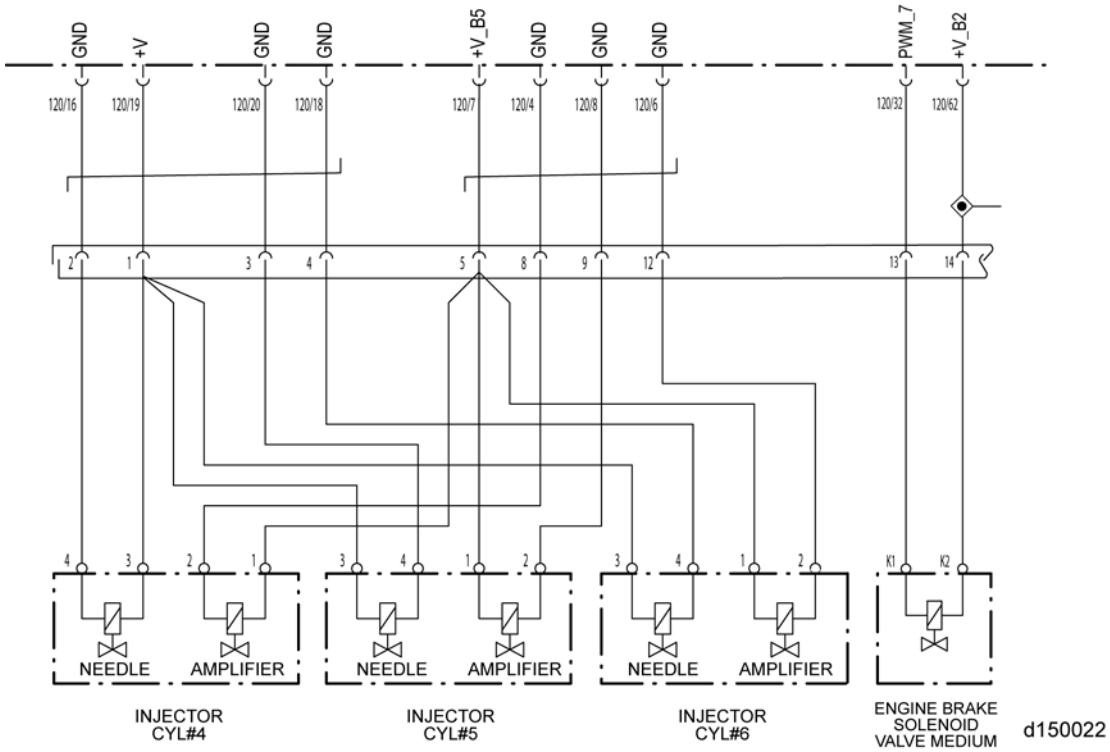
31 SPN 3664

This SPN indicates that the injector #6 cylinder amplifier control valve is not operating normally.



31.1 SPN 3664/FMI 14

This diagnosis is typically an open circuit, short to ground or short to power (cylinder #6).

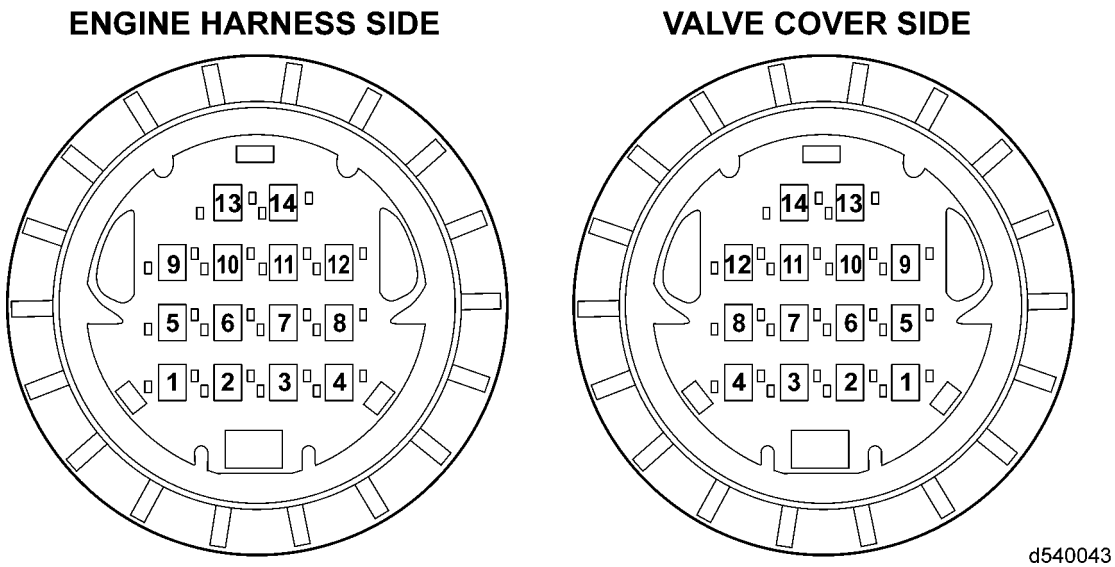


Check as follows:

1. Check for multiple codes.
   [a] If fault code 168/1 is active, service 168/1 first.
   [b] If fault 3662/14 and 3663/14 are active in addition to 3664/14, go to the next step.
   [c] If only fault code 3664/14 is active, go to step 10.
2. Turn the ignition OFF.
3. Disconnect the Rear Injector Harness 14–pin connector.
4. Inspect the Rear Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 31.1.1.
   [b] If connector shows no signs of damage, go to the next step.
5. Measure the resistance between pin 5 and pin 12 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #6 pins 1 and 2.
   [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 31.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

6. Disconnect the MCM 120–pin connector.
7. Measure the resistance between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 14–pin connector.



[a] If the resistance is greater than 3 Ω, repair the open between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 14–pin connector. Refer to section 31.1.1.

[b] If the resistance is less than 3 Ω, go to the next step.

8. Disconnect the negative battery cable.
9. Measure the resistance between the positive battery post and pin 7 of the MCM 120–pin connector.

[a] If the resistance is less than 3 Ω, repair the short to power between battery positive and pin 7 of the 120–pin MCM connector. Refer to section 29.1.1.

[b] If the resistance is greater than 3 Ω, contact the Detroit Diesel Customer Support Center at 313–592–5800 for MCM replacement authorization.

10. Turn the ignition OFF.
11. Disconnect the Rear Injector Harness 14–pin connector.
12. Measure the resistance between pin 5 and pin 12 on the valve cover side of the injector harness. If using J-48671–10, measure between injector #6 pins 1 and 2.

[a] If the resistance is greater than 3 Ω, go to step 18.

[b] If the resistance is less than 3 Ω, go to the next step.

13. Remove the upper valve cover.
14. Disconnect injector #6.

15. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness and pin 1 on the #6 injector harness connector. If using J-48671–10, measure between injector #6 pin 1 and pin 1 on the injector #6 harness connector.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 29.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
16. Measure the resistance between pin 12 on the valve cover side of the Rear Injector Harness and pin 1 of the injector #6 harness connector. If using J-48671–10, measure between injector #6 pin 2 and the injector #6 harness connector pin 2.
    [a] If the resistance is greater than 3 Ω, replace the under valve cover injector harness. Refer to section 31.1.1.
    [b] If the resistance is less than 3 Ω, go to the next step.
17. Measure the resistance between pin 12 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #6 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 31.1.1.
    [b] If the resistance is greater than 3 Ω, replace injector #6. Refer to section 31.1.1.
18. Measure the resistance between pin 12 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #6 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, go to the next step.
    [b] If the resistance is greater than 3 Ω, repair the short to ground between pin 6 of the MCM 120–pin connector and pin 12 of the Rear Injector Harness connector. Refer to section 31.1.1.
19. Remove the upper valve cover.
20. Disconnect injector #6 connector.
21. Measure the resistance between pin 12 on the valve cover side of the Rear Injector Harness and ground. If using J-48671–10, measure between injector #6 pin 2 and ground.
    [a] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 31.1.1.
    [b] If the resistance is greater than 3 Ω, replace injector #6. Refer to section 31.1.1.

31.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

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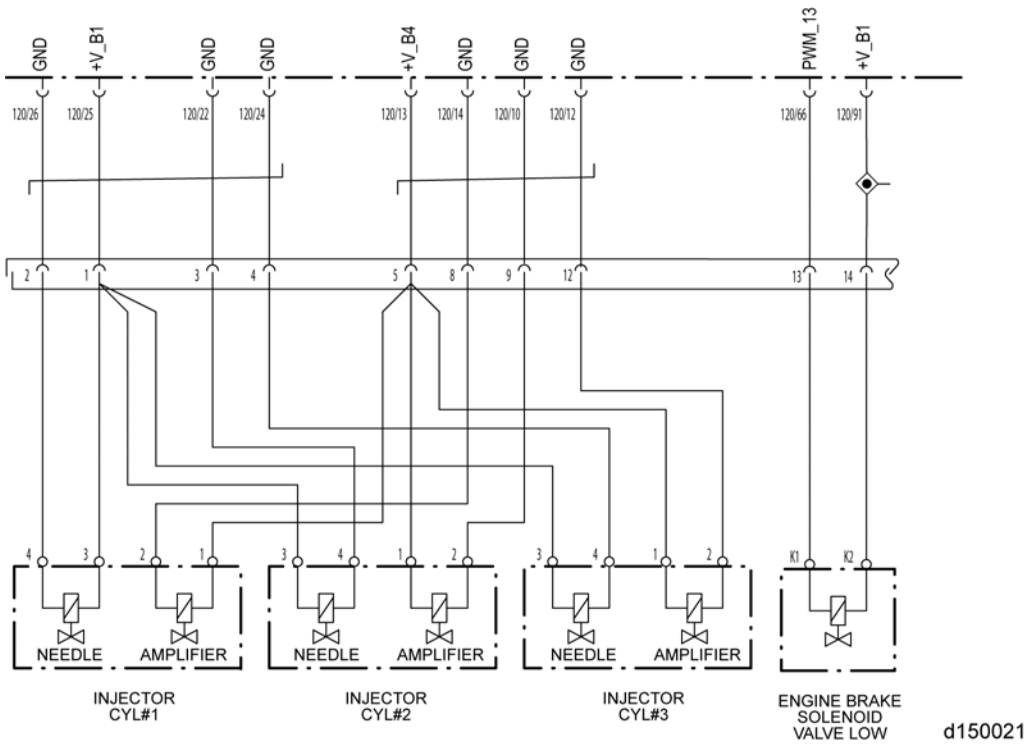
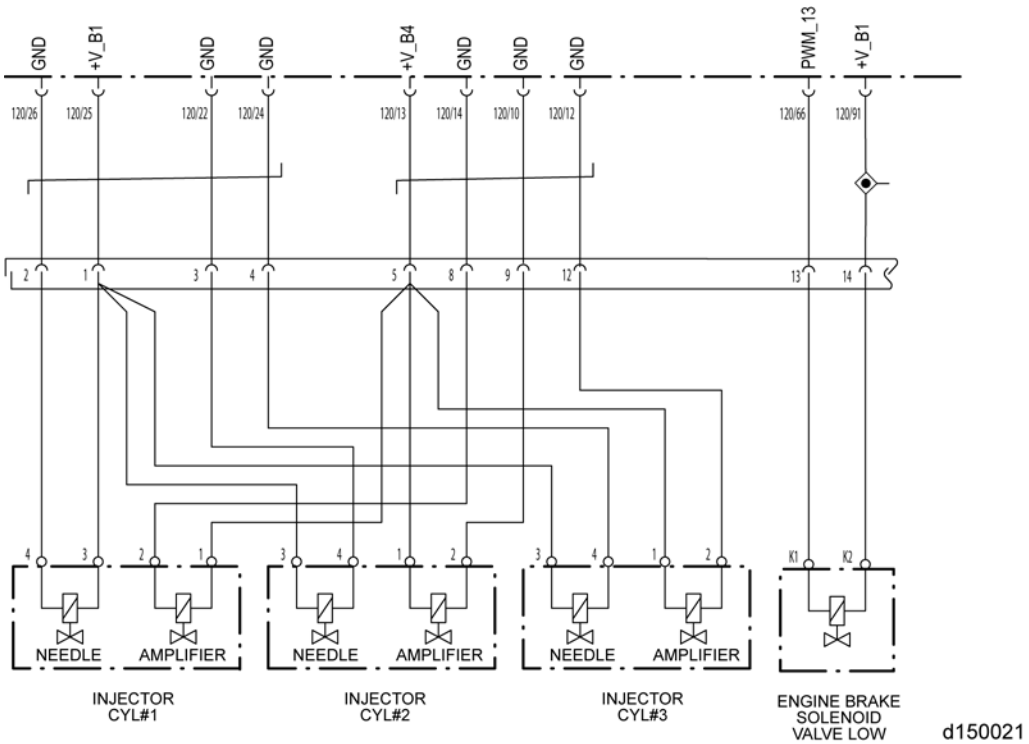
32 SPN 4258

This SPN indicates the Injector #1, 2, or 3 amplifier control valve circuit is outside of normal operating range.



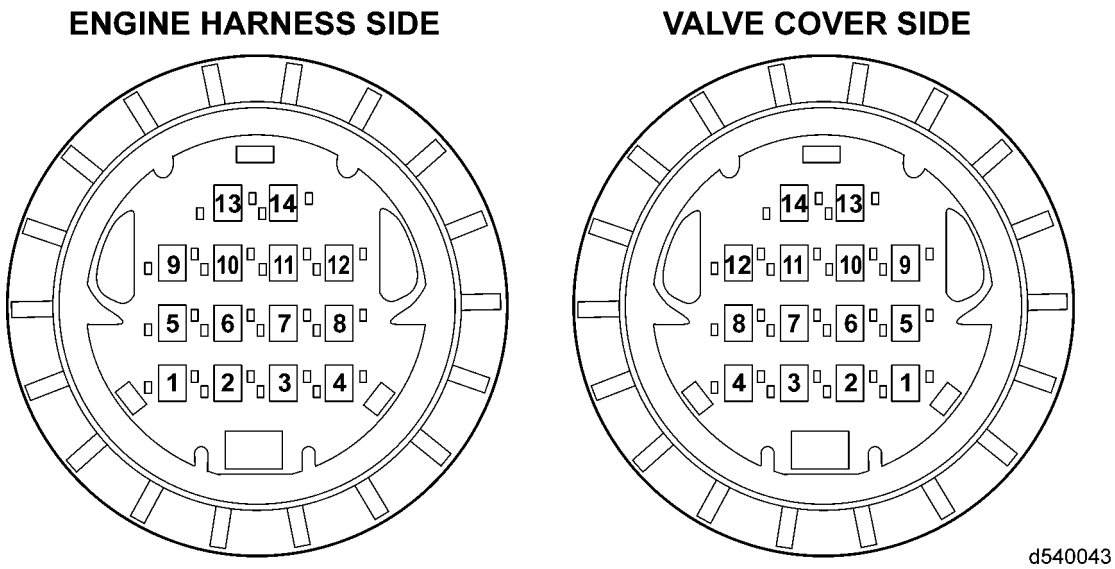
32.1 SPN 4258/FMI 3

This diagnosis is typically injector #1, 2, or 3 amplifier control valve circuit is shorted to battery/power.



Check as follows:

1. Disconnect the Front Injector Harness 14–pin connector.
2. Turn the ignition ON (key ON, engine OFF).
3. Measure the voltage between pin 2 on the MCM side of the Front Injector Harness 14–pin connector and ground.



[a] If there is voltage present, repair the short to power between pin 2 of the Front Injector Harness 14–pin connector and pin 14 of the 120–pin MCM connector. Refer to section 32.1.1.

[b] If there is no voltage present, go to the next step.

4. Measure the voltage between pin 4 on the MCM side of the Front Injector Harness 14–pin connector and ground.

[a] If there is voltage present, repair the short to power between pin 4 of the Front Injector Harness connector and pin 10 of the 120–pin MCM connector. Refer to section 32.1.1.

[b] If there is no voltage present, repair the short to power between pin 6 of the Front Injector Harness connector and pin 12 of the 120–pin MCM connector. Refer to section 32.1.1.

32.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

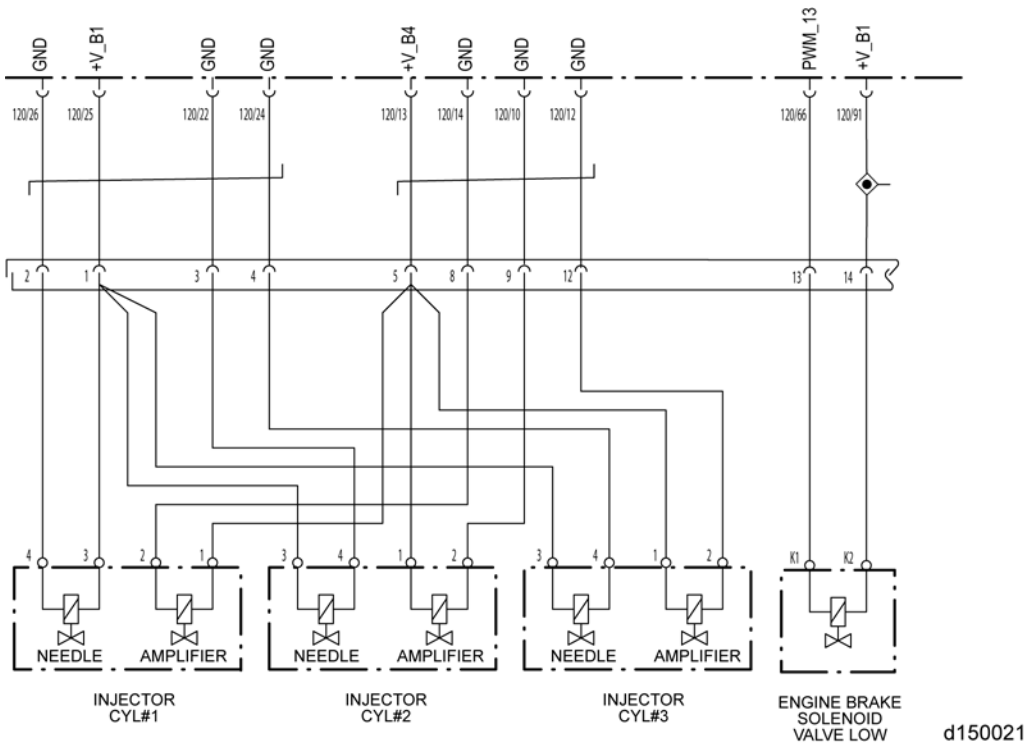
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

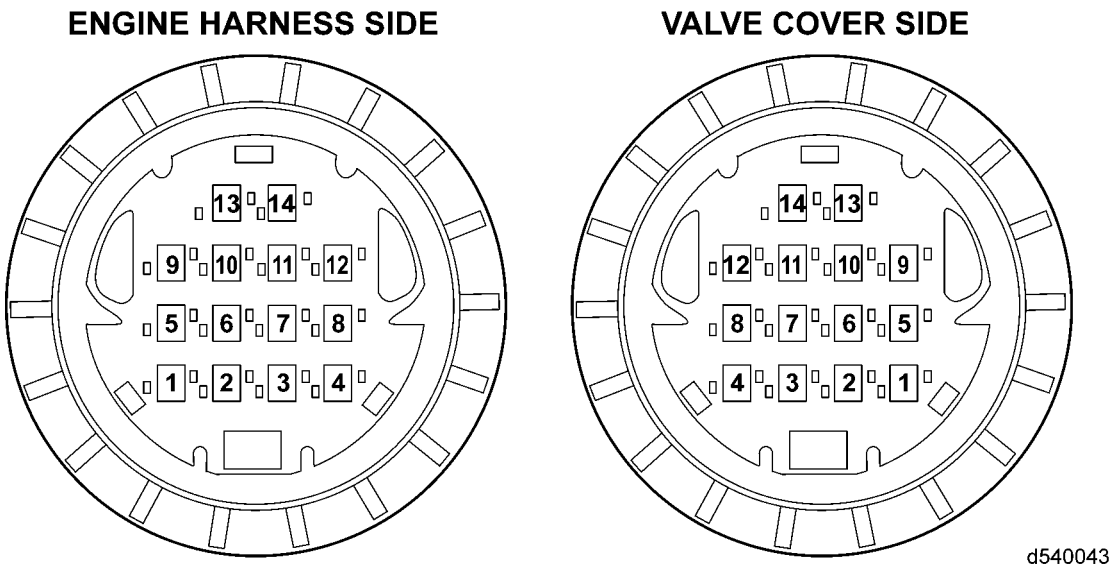
32.2 SPN 4258/FMI 4

This diagnosis is typically injector #1, 2, or 3 amplifier control valve circuit is shorted to ground.



Check as follows:

1. Disconnect the Front Injector Harness 14–pin connector.
2. Inspect the Front Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 32.2.1.
   [b] If connector shows no signs of damage, go to the next step.
3. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #1 pin 1 and ground.



[a] If the resistance is greater than 3 Ω, go to step 11.

[b] If the resistance is less than 3 Ω, go to the next step.

4. Remove the upper valve cover.
5. Disconnect injector #1.
6. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #1 pin 1 and ground.

   [a] If the resistance is greater than 3 Ω, replace injector #1. Refer to section 32.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
7. Disconnect injector #2.
8. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #2 pin 1 and ground.

   [a] If the resistance is greater than 3 Ω, replace injector #2. Refer to section 32.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
9. Disconnect injector #3.
10. Measure the resistance between pin 5 on the valve cover side of the Front Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #3 pin 1 and ground.

    [a] If the resistance is greater than 3 Ω, replace the #3 injector. Refer to section 32.2.1.

    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 32.2.1..
11. Disconnect the 120–pin MCM connector.

12. Measure the resistance between pin 5 of the harness side of the Front Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, go to the next step.
    [b] If the resistance is less than 3 Ω, repair the short to ground between pin 13 of the MCM 120–pin connector and pin 5 of the Front Injector Harness 14–pin connector. Refer to section 32.2.1.
13. Measure the resistance between pin 8 of the harness side of the Front Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, go to the next step.
    [b] If the resistance is less than 3 Ω, repair the short to ground between pin 14 of the MCM 120–pin connector and pin 8 of the Front Injector Harness 14–pin connector. Refer to section 32.2.1.
14. Measure the resistance between pin 9 of the harness side of the Front Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, go to the next step.
    [b] If the resistance is less than 3 Ω, repair the short to ground between pin 10 of the MCM 120–pin connector and pin 9 of the Front Injector Harness 14–pin connector. Refer to section 32.2.1.
15. Measure the resistance between pin 12 of the harness side of the Front Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, replace the MCM.
    [b] If the resistance is less than 3 Ω, repair the short between pin 12 of the MCM 120–pin connector and pin 12 of the Front Injector Harness 14–pin connector.

32.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

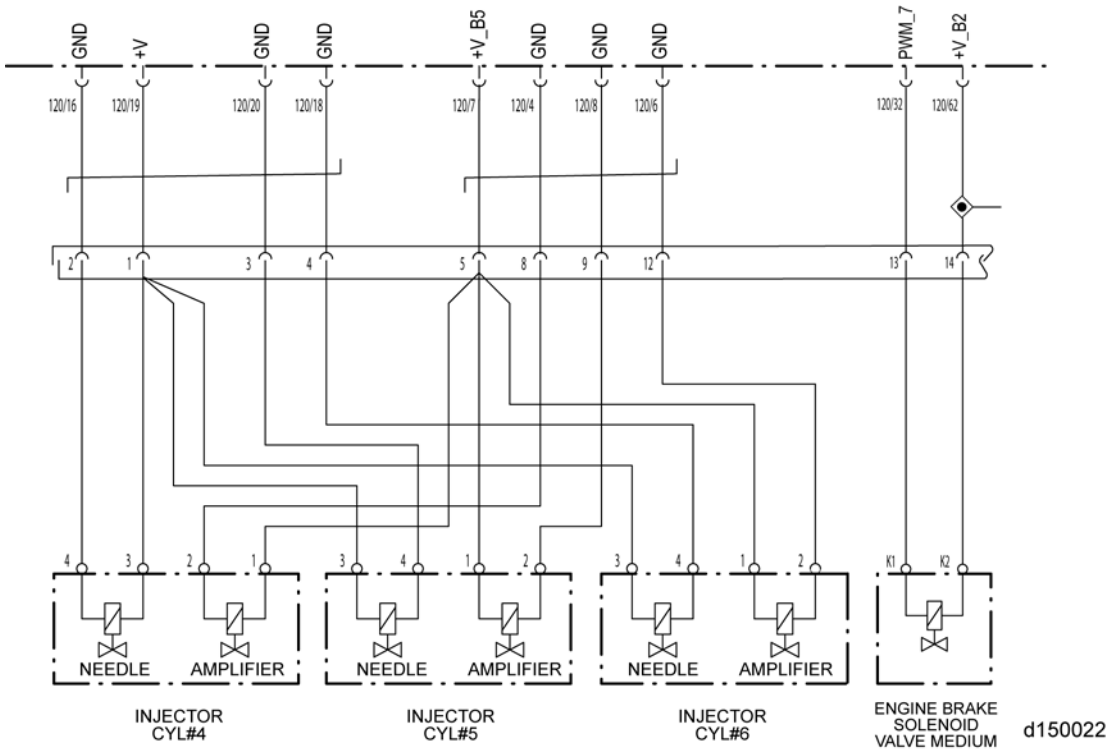
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

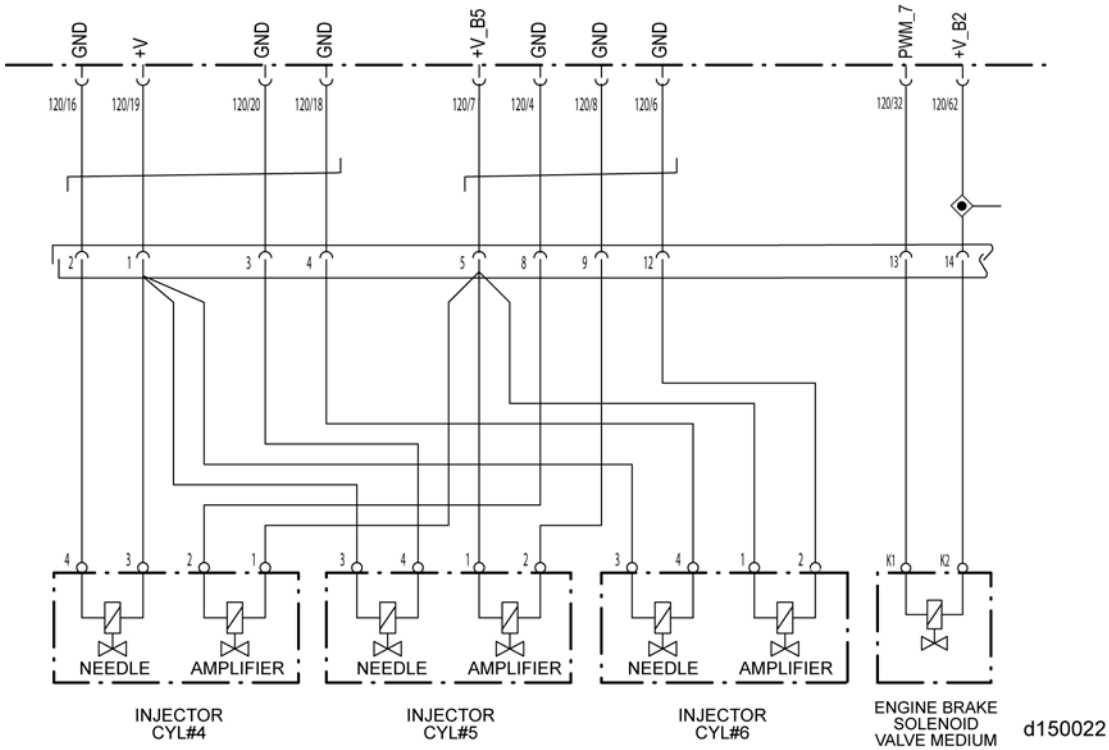
33 SPN 4259

This SPN indicates the injector #4, 5, or 6 amplifier control valve is outside normal operating range.



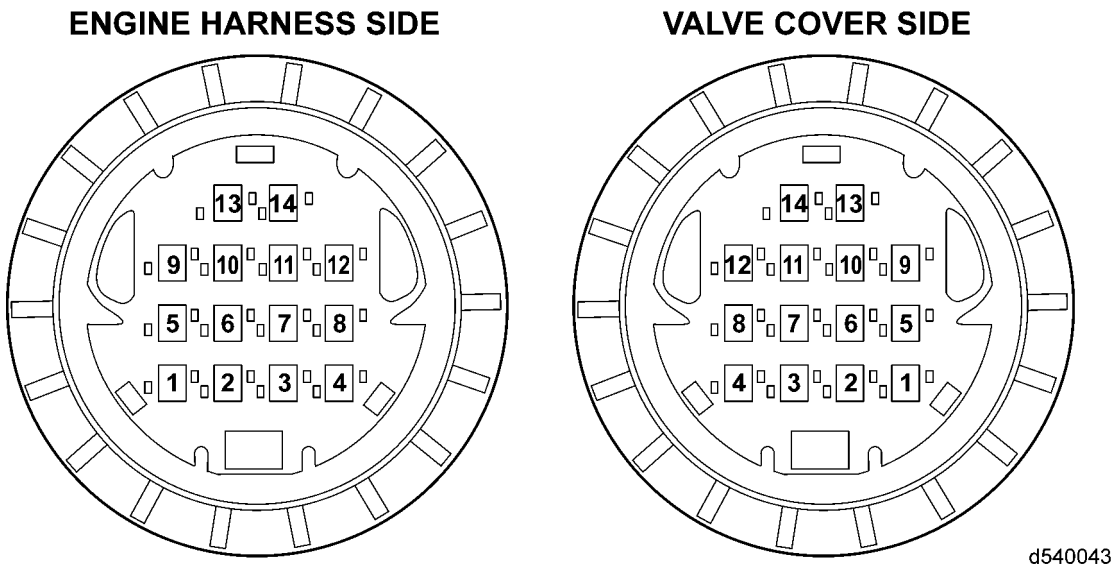
33.1 SPN 4259/FMI 3

This diagnosis is typically injector #4, 5, or 6 amplifier control valve circuit has a short to battery/power.



Check as follows:

1. Disconnect the Rear Injector Harness 14–pin connector.
2. Turn the ignition ON (key ON, engine OFF).
3. Measure the voltage between pin 1 on the MCM side of the Rear Injector Harness 14–pin connector and ground.



[a] If there is voltage present, repair the short to power between pin 1 of the Rear Injector Harness 14–pin connector and pin 4 of the 120–pin MCM connector. Refer to section 33.1.1.

[b] If there is no voltage present, go to step 4.

4. Measure the voltage between pin 8 on the MCM side of the Rear Injector Harness 14–pin connector and ground.

   [a] If there is voltage present, repair the short to power between pin 8 of the Rear Injector Harness connector and pin 8 of the 120–pin MCM connector. Refer to section 33.1.1.

   [b] If there is no voltage present, repair the short to power between pin 12 of the Rear Injector Harness connector and pin 6 of the 120–pin MCM connector. Refer to section 33.1.1.

33.1.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

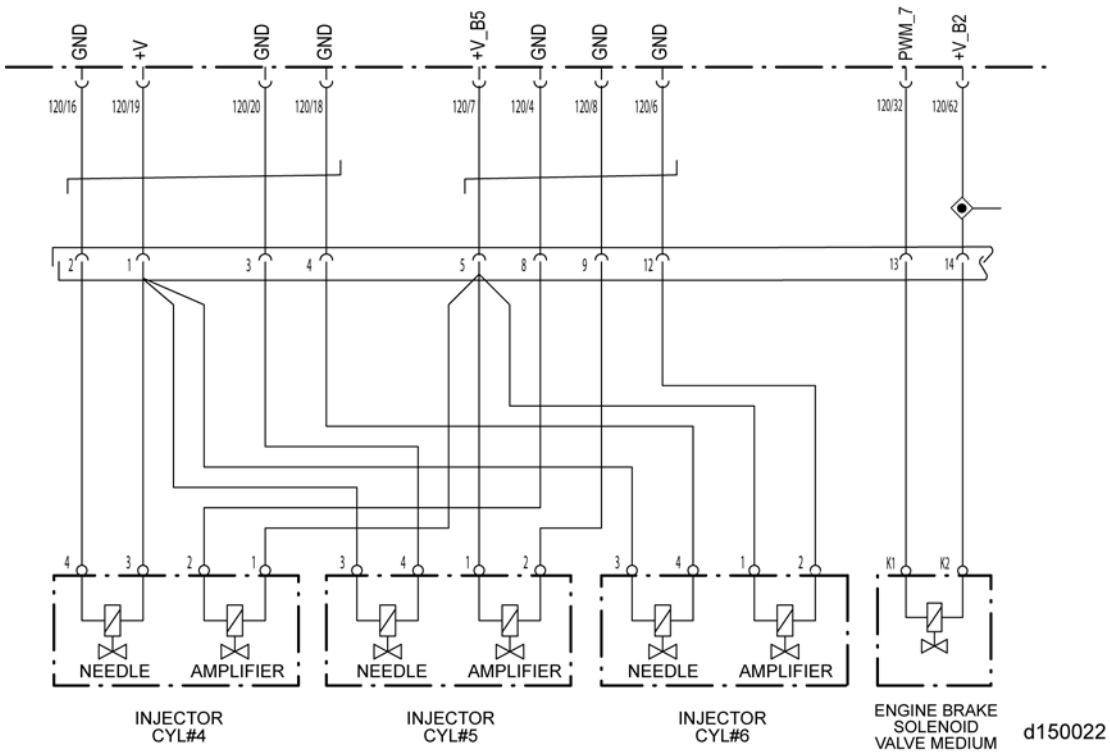
ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

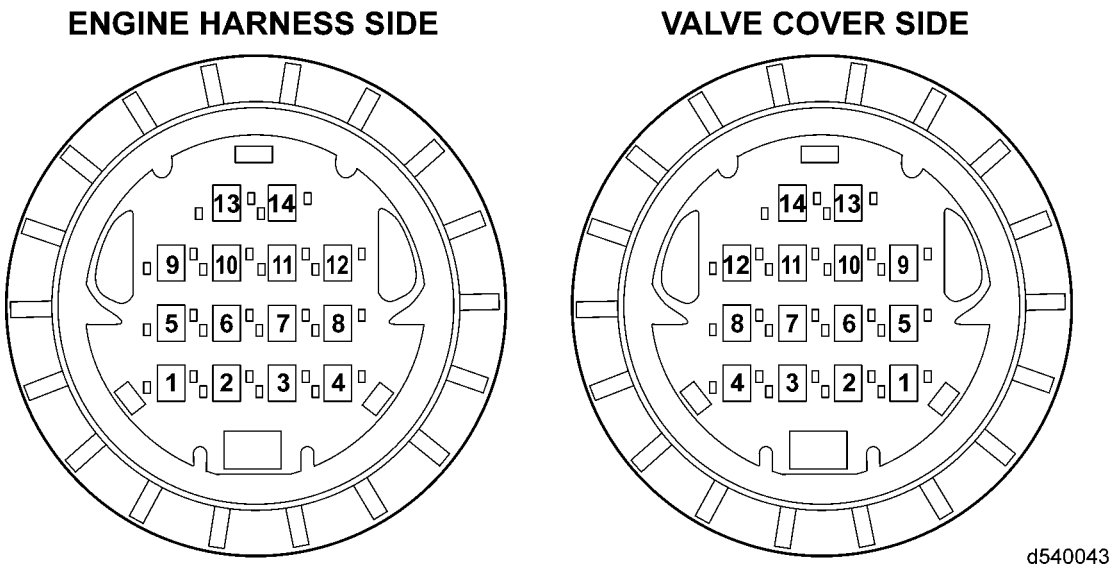
33.2 SPN 4259/FMI 4

This diagnosis is typically injector #4, 5, or 6 amplifier control valve circuit has a short to ground.



Check as follows:

1. Disconnect the Rear Injector Harness 14–pin connector.
2. Inspect the Rear Injector Harness 14–pin connector for bent or spread pins, inspect the connector seal for damage (signs of water or oil intrusion).
   [a] If the water or oil intrusion, bent or spread pins are found, repair as necessary. Refer to section 33.2.1.
   [b] If connector shows no signs of damage, go to the next step.
3. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #4 pin 1 and ground.



[a] If the resistance is greater than 3 Ω, go to step 11.

[b] If the resistance is less than 3 Ω, go to the next step.

4. Remove the upper valve cover.
5. Disconnect injector #4.
6. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #4 pin 1 and ground.

   [a] If the resistance is greater than 3 Ω, replace injector #4. Refer to section 33.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
7. Disconnect injector #5.
8. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #5 pin 1 and ground.

   [a] If the resistance is greater than 3 Ω, replace injector #5. Refer to section 33.2.1.

   [b] If the resistance is less than 3 Ω, go to the next step.
9. Disconnect injector #6.
10. Measure the resistance between pin 5 on the valve cover side of the Rear Injector Harness 14–pin connector and ground. If you are using J-48671–10, measure between injector #6 pin 1 and ground.

    [a] If the resistance is greater than 3 Ω, replace the #6 injector. Refer to section 33.2.1.

    [b] If the resistance is less than 3 Ω, replace the under valve cover injector harness. Refer to section 33.2.1.
11. Disconnect the 120–pin MCM connector.

12. Measure the resistance between pin 5 of the harness side of the Rear Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, go to the next step.
    [b] If the resistance is less than 3 Ω, repair the short to ground between pin 7 of the MCM 120–pin connector and pin 5 of the Rear Injector Harness 14–pin connector. Refer to section 33.2.1.
13. Measure the resistance between pin 8 of the harness side of the Rear Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, go to the next step.
    [b] If the resistance is less than 3 Ω, repair the short to ground between pin 4 of the MCM 120–pin connector and pin 8 of the Rear Injector Harness 14–pin connector. Refer to section 33.2.1.
14. Measure the resistance between pin 9 of the harness side of the Rear Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, go to the next step.
    [b] If the resistance is less than 3 Ω, repair the short to ground between pin 8 of the MCM 120–pin connector and pin 9 of the Rear Injector Harness 14–pin connector. Refer to section 33.2.1.
15. Measure the resistance between pin 12 of the harness side of the Rear Injector Harness 14–pin connector and ground.
    [a] If the resistance is greater than 3 Ω, replace the MCM.
    [b] If the resistance is less than 3 Ω, repair the short between pin 6 of the MCM 120–pin connector and pin 12 of the Rear Injector Harness 14–pin connector.

33.2.1 VERIFY REPAIRS

Verify repairs as follows:

1. Turn ignition OFF.
2. Reconnect any electrical connections that were disconnected to perform the diagnosis.
3. Clear codes with DDDL 7.0 or latest version.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

4. Start and bring engine up to operating temperature (over 140°F/60°C).
5. Verify operation is satisfactory and no warning lamps illuminate. If warning lamps illuminate, troubleshoot the codes. If assistance is required, call the Detroit Diesel Customer Support Center at 313–592–5800.

34 REPAIR PROCEDURES

This section contains the repair procedures for the following:

- High Pressure Fuel Pump, refer to section 34.1
- Quality Control Valve, refer to section 34.2
- Low Pressure Fuel Pump, refer to section 34.3
- Fuel Injectors, refer to section 34.4
- Fuel Injector Wiring Harness, refer to section 34.5
- Fuel Injector Tube, refer to section 34.6
- High Pressure Lines, refer to section 34.7
- Fuel Rail, refer to section 34.9
  - Fuel Rail Pressure Sensor, refer to section 34.9.3
  - Pressure Limiting Valve, refer to section 34.9.5
- Fuel Filter Module, refer to section 34.10.
  - Final Filter, refer to section 34.10.5
  - Prefilter, refer to section 34.10.7
  - Water Separator/Coalescer, refer to section 34.10.9
  - Water-in-Fuel Sensor, refer to section 34.10.11
  - Supply Fuel Temperature Sensor, refer to section 34.10.13
  - Fuel Pre-heater (if equipped), refer to section 34.10.15
  - Fuel Restrictor Gauge (if equipped), refer to section 34.10.17

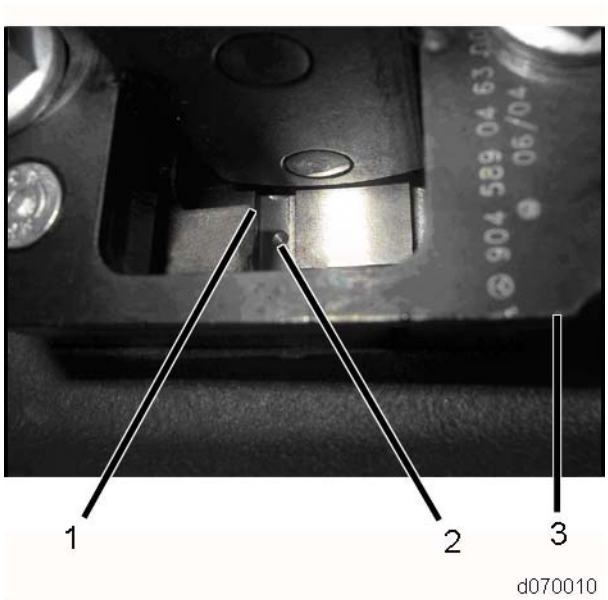
34.1 HIGH PRESSURE FUEL PUMP

The fuel high pressure pump (1) is located at the rear on the left side of the cylinder block and is driven by the pinion gear drive. The high pressure pump supplies the fuel high pressure circuit with fuel and ensures that the fuel required for combustion is available in sufficient quantity and at the required pressure at the fuel injectors, under all conditions.

34.1.1 REMOVAL OF HIGH PRESSURE FUEL PUMP

Remove as follows:

1. Disconnect the batteries.
2. Drain the coolant system.
3. Install engine barring tool to the flywheel housing.
4. Rotate flywheel until the dot that is located inside tooth is aligned with the edge of pointer.



1. Edge of Pointer
2. Dot Located inside of Tooth
3. Barring Tool Location

5. Remove coolant line from the module to air compressor.
6. Disconnect fuel supply line to the doser block assembly.
7. Disconnect the needle return line.
8. Disconnect amplifier return line.
9. Disconnect fuel lines from the fuel filter module on the manifold at the high pressure pump.
10. Remove fuel filter module.

WARNING:

PERSONAL INJURY

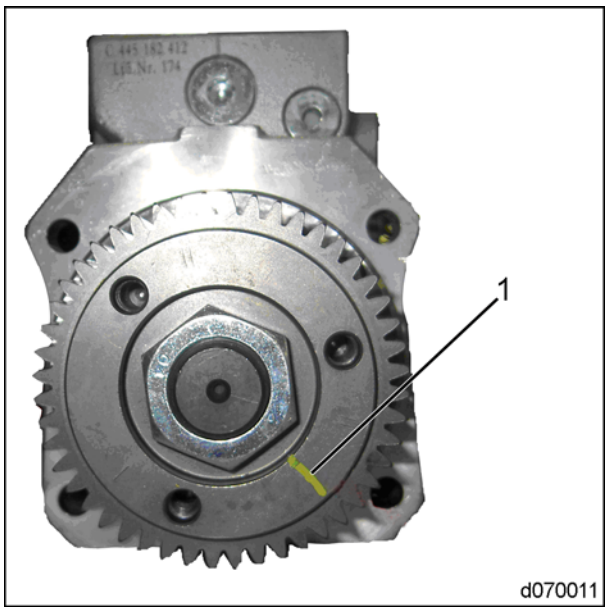
To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Residual high fuel pressure may be present within the circuit.

11. Remove two high pressure lines from the high pressure fuel pump to the fuel rail.
12. Remove upper and lower fuel manifolds from the high pressure fuel pump and discard the gaskets.
13. Disconnect electrical connector for the quantity control valve.
14. Remove two bolts securing the high pressure fuel pump bracket to engine block.
15. Remove two nuts securing high pressure fuel pump to bracket.
16. Remove four bolts securing high pressure fuel pump to cylinder block.
17. Remove high pressure fuel pump.

34.1.2 INSTALLATION OF HIGH PRESSURE PUMP

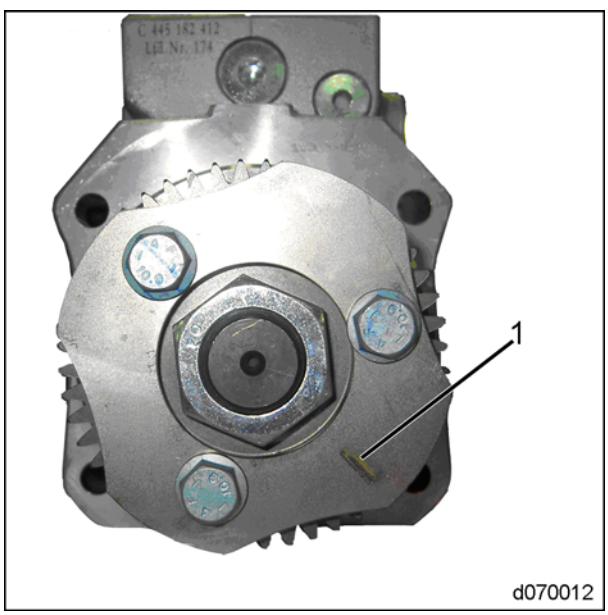
Install as follows:

1. Ensure flywheel is positioned at top dead center (TDC) on cylinder number one.
2. Inspect the high pressure pump:
   [a] If driven gear has been installed from the factory, go to step 11.
   [b] If driven gear has been exchanged from the old pump or is installed new, go to step 3.
3. Install a new high pressure pump into holding fixture W470589014000. Remove locking tooth from the tool.
4. Install key way onto shaft using a brass hammer.
5. Install driven gear onto shaft.
6. Prior to installing the nut mark the gear with paint to show the location of the key way.



1. Paint Mark for Key Way

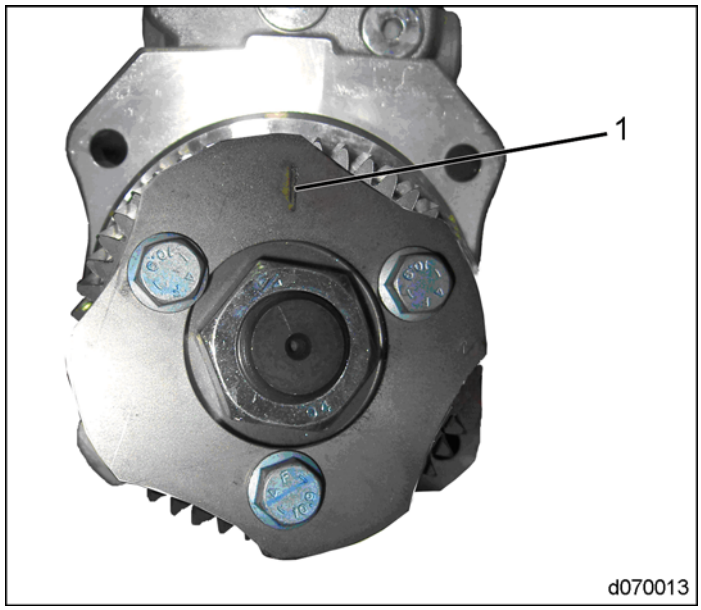
7. Install the nut and locking tooth for tool W470589014000 and using tool J–48669 torque to 250 N·m (184 ft·lb).
8. Position eyebrow plate over gear and align the hash mark on the plate to the paint mark on the gear.



1. Hash Mark Aligned with Key Way

9. Install three eyebrow mounting bolts and torque to 30 N·m (22 ft·lb).

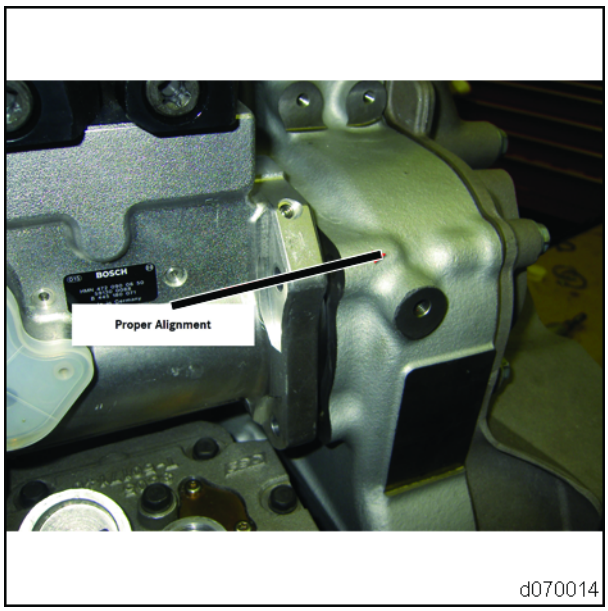
10. If not installed; install the high pressure pump into holding fixture W470589014000. Remove the locking tooth from the tool.
11. Use a non marring strap wrench rotate the gear until the hash mark is at the twelve O'clock position.



1. Hash Mark at the twelve O'clock Position

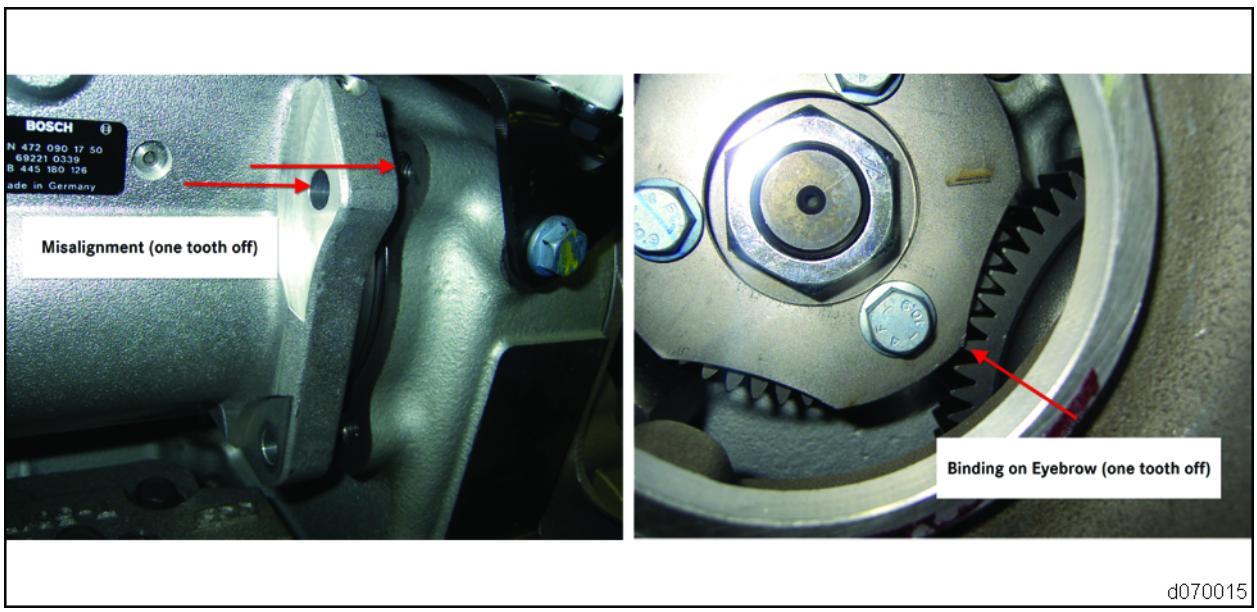
12. Remove strap from pump.
13. Install the high pressure pump and new O-ring.

NOTE:
The pump should slide into the flywheel housing without binding. The bolt hole on the pump housing should align very close with the mounting hole on the flywheel housing.



1. Proper Alignment of the High Pressure Pump to the Flywheel Housing

NOTE:
If the high pressure pump binds when being installed or if there is misalignment in the bolt holes, remove pump and verify timing mark at the twelve O'clock position and reinstall.



NOTICE:
Ensure the correct bolt length is used when the high pressure pump is installed. If an incorrect bolt length (to long) is used the cup plugs installed in the cylinder block can be pushed out into the gear train causing severe damage to the gear train. The correct bolt length is 35 mm (1.37 in.).

14. Install four bolts securing the high pressure pump to the flywheel housing and torque to 60 N·m (44 ft·lb).
15. Install two nuts securing the high pressure fuel pump to bracket and torque to 30 N·m (22 ft·lb).
16. Install two bolts securing high pressure fuel pump bracket to block and torque to 100 N·m (74 ft·lb).
17. Install a new gasket and torque upper fuel manifold bolts of the high pressure fuel pump to 30 N·m (22 ft·lb).
18. Install a new gasket and torque lower fuel manifold bolts of the high pressure fuel pump to 30 N·m (22 ft·lb).
19. Connect quantity control valve connector.
20. Install the fuel lines on fuel filter module.
21. Torque the emergency lubrication line to 35 N·m (26 ft·lb).
22. Torque the fuel inlet for high pressure pump to 45 N·m (33 ft·lb).

23. Torque the fuel return for the high pressure pump to 45 N·m (33 ft·lb).
24. Torque the fuel inlet for the low pressure pump to 45 N·m (33 ft·lb).
25. Torque the fuel return for the low pressure pump to 45 N·m (33 ft·lb).
26. Install the banjo bolts. (Only version four).
27. Torque the amplifier return fitting at the fuel inlet for low pressure pump to 35 N·m (26 ft·lb).
28. Torque the needle return fitting at fuel inlet for high pressure pump to 35 N·m (26 ft·lb).
29. Torque the fuel supply line to doser block assembly 40 N·m (30 ft·lb).
30. Install two high pressure lines from the high pressure pump to the fuel rail and torque fittings to 40 N·m (30 ft·lb).
31. Install fuel filter module.
32. Install coolant line for air compressor.
33. Fill coolant system.
34. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

35. Start and run the engine.
36. When the engine has reached operating temperature 140° F (60° C). Observe pump for any performance problems or leaks.

34.2 QUALITY CONTROL VALVE

The quality control valve is located on the high pressure pump. The quality control valve regulates rail pressure and fuel feed to the high pressure pump.

34.2.1 REMOVAL OF QUALITY CONTROL VALVE

Remove as follows:

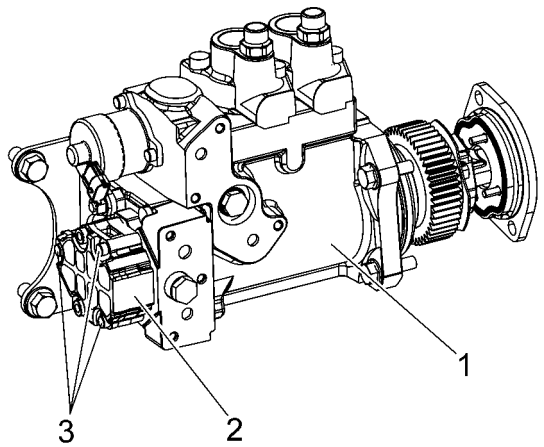
1. Drain the fuel filter module by removing one of the fuel filters or by using the water in fuel drain.
2. Remove the top three fuel lines from the fuel filter module to the high pressure pump.
3. Disconnect the electrical connector from the quantity control valve
4. Remove the three bolts attaching the quantity control valve to the high pressure pump.
5. Remove the quantity control valve
6. Clean the housing on the high pressure fuel pump.

34.2.2 INSTALLATION OF QUANTITY CONTROL VALVE

Install as follows:

1. Lubricate the O-ring seal on the new quantity control valve with clean diesel fuel.
2. Install the new quantity control valve and torque the three attaching bolts to 8 Nm (6 ft/lb).
3. Connect the electrical connector for the quantity control valve.
4. Install the top three fuel lines from the fuel filter module to the high pressure pump.
   [a] Emergency lubrication line to 23 Nm (17 ft/lb).
   [b] Fuel inlet for high pressure pump to 30 Nm (22 ft/lb).
   [c] Fuel return for high pressure pump to 30 Nm (22 ft/lb).
5. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.3 LOW PRESSURE PUMP



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1.High Pressure Pump
2. Low Pressure Pump
3. Bolts

The low pressure fuel pump is mounted on the high pressure fuel pump. The fuel pump pulls fuel from the fuel tank through the fuel heat exchanger for the Motor Control Module (MCM).

34.3.1 REMOVAL OF THE LOW PRESSURE PUMP

Remove as follows:

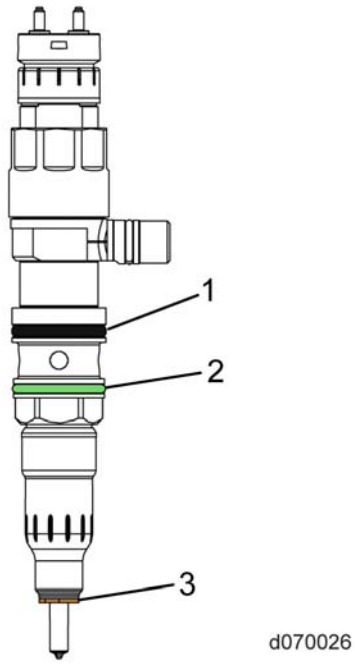
1. Disconnect batteries.
2. Drain fuel filter module by removing one of the fuel filters or by using the water-in fuel-drain.
3. Remove bottom two fuel lines from the fuel filter module to the high pressure pump.
4. Remove three bolts attaching the low pressure pump to the high pressure pump.
5. Remove low pressure pump.
6. Clean housing around the high pressure fuel pump.
7. Inspect the “Oldham” coupling on the high pressure pump and replace high pressure pump if worn or damaged.

34.3.2 INSTALLATION OF THE LOW PRESSURE PUMP

Install as follows:

1. Install low pressure pump to the high pressure pump with new O-rings and torque bolts to 8 Nm (6 ft/lb).
2. Install bottom two fuel lines from the fuel filter module to the high pressure pump.
   [a] Fuel inlet for low pressure pump to 45 Nm (33 ft/lb).
   [b] Fuel return for low pressure pump to 45 Nm (33 ft/lb).
3. Connect batteries.
4. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.4 FUEL INJECTORS



1. Black Seal Installed
2. Green Seal Installed
3. Copper Washer

The injectors are installed with a injector clamp and bolt in the cylinder head and are located between the valves of the respective cylinder.

34.4.1 REMOVAL OF THE INJECTOR

Remove as follows:

1. Steam clean the engine.
2. Disconnect the batteries to prevent failure of the MCM.
3. Remove the rocker cover.

⚠ CAUTION:

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

4. Disconnect the electrical contacts from the injectors.
5. Remove harness with solenoids attached.

6. Disconnect 14–pin injector harness connector.
7. Remove appropriate injector wiring harness. Remove spring clip holding the appropriate injector harness connector to camshaft frame.

WARNING:

PERSONAL INJURY

To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Residual high fuel pressure may be present within the circuit.

8. Disconnect appropriate high pressure line at the camshaft frame and fuel rail. Using fuel line tool J–48770.
9. Remove appropriate injector hold down bolt and clamp.
10. Lift the clamp and injector from its seat in the cylinder head using J-47391 injector removal tool.
11. Remove clamps from injectors and install a tip protector onto the injector nozzle.
12. Cover the injector hole to keep out foreign material.

NOTICE:

Avoid cleaning (wire brushing etc.) the injector tip spray holes to prevent damage and plugging.

13. Carefully remove carbon material from the injector exterior in the area where the tip joins the nut, using a clean rag soaked with clean diesel fuel.

NOTICE:

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

14. Inspect the injector body for visible damage. Replace the injector if damaged.
15. Remove and discard the three injector O-rings and the copper washer.

34.4.2 INSTALLATION OF THE INJECTOR

Install as follows:

NOTE:
Ensure fuel is removed from cylinder head.

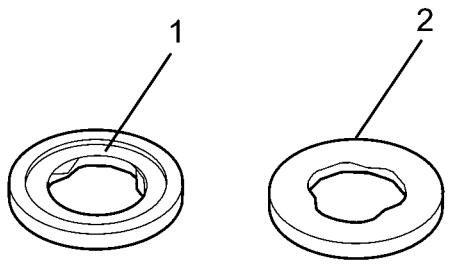
1. If the fuel system is contaminated:
   [a] Drain the fuel tanks and refill with clean fuel.
   [b] Clean the fuel water/separator and replace the fuel filter module filters with new filters.
2. If the coolant system is contaminated with fuel, flush and reverse flush the system.
3. If the oil system is contaminated, change the engine oil and filters.

NOTICE:
Leftover fuel must be removed from the injector bore before injector installation.

NOTICE:
The injector tube bore should be cleaned and inspected for damage before installation of the injector.

4. Check to make sure the injector tube bore is thoroughly clean.
5. Remove injector nozzle tip protector.

NOTICE:
The copper washer must be installed with recess facing injector body. Incorrect installation can cause combustion gasses to enter the fuel system.



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1. Recess side of copper washer
2. Top side of copper washer

6. Install a new copper washer with lip facing down onto the injector.
7. Apply a thin coat of acid free grease or clean engine oil to the injector seal rings and install them in the injector nut ring grooves. Make sure they are properly seated.
8. Install the injector and clamp as an assembly into its respective injector bore. Align the clamp over the bolt hole, install the new bolt into injector clamp and snug then release injector bolt.

NOTE:
If the high pressure lines leak after installation the lines need to be replaced.

9. Install high pressure line to the injectors; finger tighten the cap nuts.
10. Torque the injector clamp bolts to 20 N·m (15 lb·ft) + 90°.

NOTE:
If the isolators were removed from the fuel rail ensure they are installed in the position from which they were removed.

11. Using tool J–48770 torque the high pressure lines to the injector to 40 N·m (29 lb·ft).
12. Install electrical contacts to injector and tighten to 1.5 Nm (1 ft/lb).
13. Finger tighten all screws before final torque is applied.

14. Install injector harness and tighten the allen head mounting screws to 10 Nm (7 ft/lb)
15. Install solenoids and harness together with new O-rings.
16. Install spring clip holding injector harness connector to camshaft frame.
17. Connect 14-pin injector harness connector.
18. Record the injector calibration code from the name plate with the proper cylinder location and enter calibration codes using DDDL service routine.

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19. Install rocker cover and torque bolts in a cross pattern to 20 Nm (15 ft/lb).
20. Connect batteries.

34.5 FUEL INJECTOR WIRING HARNESS

The 14–pin fuel injector harness is the interface between the injectors and the 120–pin MCM connector.

34.5.1 REMOVAL OF FUEL INJECTOR WIRING HARNESS

Remove as follows:

1. Disconnect batteries.
2. Remove rocker cover.
3. Disconnect electrical contacts at the injectors.
4. Disconnect two wiring terminals going to the appropriate Jake® brake solenoid.
5. Disconnect 14-pin injector harness connector.
6. Remove spring clip holding the appropriate injector harness connector to camshaft frame.
7. Remove appropriate injector wiring harness.

34.5.2 INSTALLATION OF FUEL INJECTOR WIRING HARNESS

Install as follows:

1. Install appropriate injector harness and tighten the allen head mounting screws to 10 Nm (7 ft/lb).
2. Install electrical contacts to injector and tighten to 1.5 Nm (1 ft/lb).
3. Connect appropriate Jake® brake solenoid terminals and torque to 1.5 Nm (1 ft/lb).
4. Install spring clip holding injector harness connector to camshaft frame.
5. Connect 14-pin injector harness connector.
6. Install rocker cover and torque bolts in a cross pattern to 20 Nm (15 ft/lb).
7. Connect batteries.

34.6 FUEL INJECTOR TUBE

The bore in the cylinder head is for the fuel injector tube. The injector tube prevents coolant from contaminating the injector and maintains maximum cooling of the injector. The injector tube is a stainless steel tube screwed into the cylinder head. There is an O-ring installed in the cylinder head to create a water and fuel tight seal.

34.6.1 REMOVAL OF FUEL INJECTOR TUBE

Remove as follows:

NOTICE:
Engine coolant must be drained prior to injector tube removal.

1. Drain the engine coolant.
2. Remove injector harness.
3. Remove the injectors.
4. Install tool J-47388–8 into injector tube and align tool with slots in tube and turn counter clockwise to remove.
5. Remove injector tube; discard injector tube O-ring in cylinder head.
6. Inspect the injector tube for cracks or defects. If defective replace injector tube.
7. Clean injector tube threads with a fine wire brush, being careful not to abrade the cylinder head to injector tube sealing surface.
8. Clean the injector tube interior sealing surface, a chemical solvent maybe used for cleaning interior sealing surface.

34.6.2 INSTALLATION OF INJECTOR TUBE

Install as follows:

1. Clean the injector bore of debris.

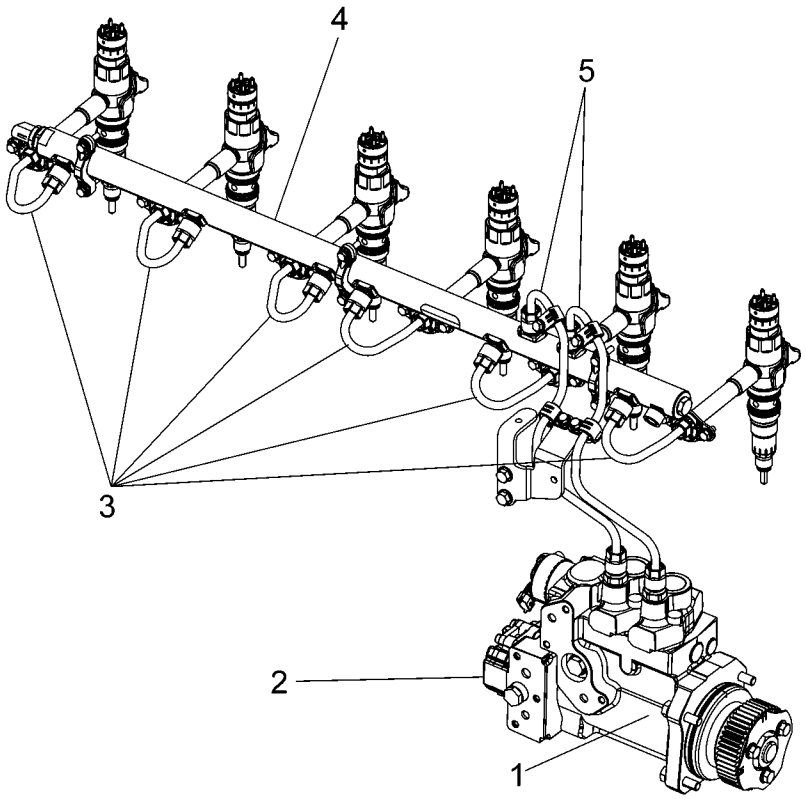
NOTICE
Take extra precautions when cleaning the injector bores to ensure that debris does not enter the fuel system. Do not use power tools to clean the injector bores, use J–47375 hand brush and a rag. Do not use compressed air to blowout debris in the bores.

NOTE:
Replace injector tube O-ring with a new O-ring when injector tube is removed or replaced.

2. Install O-ring in cylinder head, a small amount of silicone based O-ring lubrication will aid in the installation.

3. Coat the threads of the injector tube and tube sealing surface with a high temperature nickel based anti-seize lubricant.
4. Install injector tube onto tool J–47388 and install into injector bore.
5. Torque injector tube to 45 N·m + 5 N·m (33 ft·lb + 3 ft·lb).
6. Release torque approximately 180°.
7. Torque injector tube to 45 N·m + 5 N·m (33 ft·lb + 3 ft·lb). If cylinder head has been removed ensure the tip of the tube is flush with the fire deck.
8. Install any components that were removed for this procedure.
9. Fill and pressure test the cooling system; check for leaks.

34.7 HIGH PRESSURE LINES



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1. High Pressure Pump
2. Low Pressure Pump
3. High Pressure Fuel Lines from Rail to Injector
4. Fuel Rail
5. High Power Fuel Lines from Pump to Rail

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The fuel is compressed by the by the high pressure fuel pump and is sent to the two high pressure lines and then to the fuel rail. The fuel then goes from the rail through the individual high pressure lines to each injector.

34.7.1 REMOVAL OF HIGH PRESSURE LINES

Remove as follows:

WARNING:

PRESSURIZED FUEL

To avoid injury to eye or face, wear a face shield or goggles when conducting a pressure test.

WARNING:

PERSONAL INJURY

To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Residual high fuel pressure may be present within the circuit.

NOTE:
If removing a fuel line from cylinder #1, remove the Intake Manifold Temperature Sensor from the intake manifold first and cover the hole.

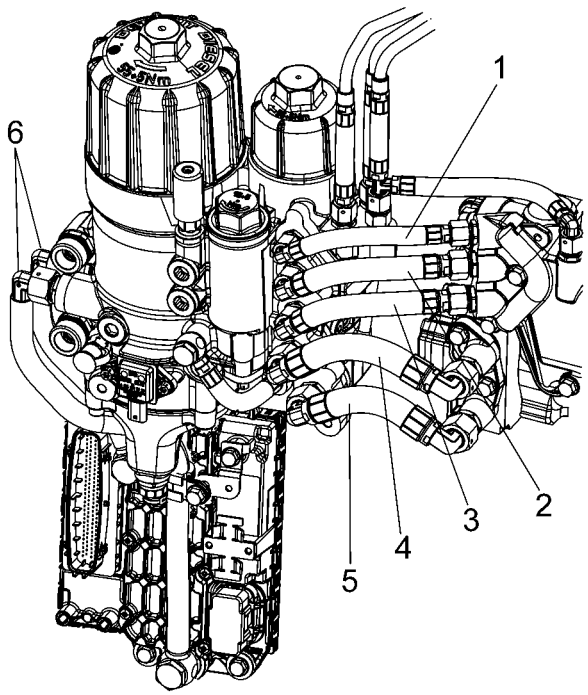
1. Disconnect batteries.
2. Place shop towels under appropriate lines to absorb leaking fuel.
3. Using tool J-48770 loosen injector high pressure line nuts at the fuel rail and camshaft frame and the pump lines at the fuel rail and at the pump.
4. Remove the injector lines from the cam frame seal.
5. Clean the line using compressed solvent and compressed shop air.
6. Inspect the lines for leaks. Lines without leaks can be reused. If there are leaks, change the line.

34.7.2 INSTALLATION OF HIGH PRESSURE LINES

Install as follows:

1. Using tool J-48770, torque the high pressure line nuts at the fuel rail and camshaft frame and/or at the fuel rail and pump to 40 N·m (40 lb·ft).
2. Prime the system using the fuel priming valve or the hand primer. Refer to section 6.5, “Fuel System Priming.”

34.8 LOW PRESSURE LINES



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1. Emergency Pump Lubrication Line
2. High Pressure Pump Inlet
3. High Pressure Pump Outlet
4. Low Pressure Pump Inlet
5. Low Pressure Pump Outlet
6. Filter Module to MCM Cooler Lines

There are six low pressure lines. Four low pressure lines run from the two pumps to the fuel filter module, one from the fuel filter module to the MCM and the emergency pump lubrication line.

34.8.1 REMOVAL OF LOW PRESSURE FUEL PUMP INLET AND OUTLET

Remove as follows:

1. Drain the fuel filter module by removing one of the fuel filters or by using the water in fuel drain.
2. Remove the low pressure fuel pump inlet or outlet lines from the filter module and from the low pressure fuel pump.
3. Clean and inspect the fittings on the filter module and on the low pressure fuel pump for damage.

34.8.2 INSTALLATION OF LOW PRESSURE FUEL PUMP INLET AND OUTLET

Install as follows:

1. Install the low pressure fuel pump inlet or outlet lines to the filter module and to the low pressure fuel pump.

NOTE:
When tightening the fuel line ensure the corresponding fitting is held. This will ensure that the line will not twist or deform.

2. Torque the two attaching nuts to 45 Nm (33 ft/lb).
3. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.8.3 REMOVAL OF HIGH PRESSURE FUEL PUMP INLET AND OUTLET

Remove as follows:

1. Drain the fuel filter module by removing one of the fuel filters or by using the water-in-fuel drain.
2. Remove the high pressure fuel pump inlet or outlet lines from the filter module and from the high pressure fuel pump.
3. Clean and inspect the fittings on the filter module and on the high pressure fuel pump for damage.

34.8.4 INSTALLATION OF HIGH PRESSURE FUEL PUMP INLET AND OUTLET

Install as follows:

1. Install the low pressure fuel pump inlet or outlet lines to the filter module and to the high pressure fuel pump.

NOTE:
When tightening the fuel line ensure the corresponding fitting is held. This will ensure that the line will not twist or deform.

2. Torque the two attaching nuts to 30 Nm (22 ft/lb).
3. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.8.5 REMOVAL OF EMERGENCY LUBRICATION LINE.

Remove as follows:

1. Remove the emergency lubrication line from the filter module and from the high pressure fuel pump
2. Clean and inspect the fittings on the filter module and on the high pressure fuel pump for damage.

34.8.6 INSTALLATION OF EMERGENCY LUBRICATION LINE

Install as follows:

1. Install the emergency lubrication line to the filter module and to the high pressure fuel pump.

NOTE:
When tightening the fuel line ensure the corresponding fitting is held. This will ensure that the line will not twist or deform.

2. Torque the two attaching nuts to 23 Nm (17 ft/lb).
3. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.8.7 REMOVAL OF FILTER MODULE TO MCM COOLER LINES

Remove as follows:

1. Drain the fuel filter module by removing one of the fuel filters or by using the water-in-fuel drain.
2. Remove the fuel line attaching clip from the MCM.

3. Loosen the fittings from the filter module and the banjo bolts at the MCM cooler.
4. Clean and inspect the fittings on the filter module and on the high pressure fuel pump for damage.

34.8.8 INSTALLATION OF FILTER MODULE TO MCM COOLER LINES

Install as follows:

1. Install the lines from the filter module to the MCM cooler.

NOTE:
When tightening the fuel line ensure the corresponding fitting is held. This will ensure that the line will not twist or deform.

2. Torque the two attaching nuts at the filter module to 45 Nm (33 ft/lb).
3. Torque the two attaching banjo bolts at the MCM to 30 Nm (22 ft/lb).
4. Prime system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.9 FUEL RAIL

The fuel rail incorporates the fuel pressure sensor and pressure limiting valve. The fuel rail attaches to the camshaft frame with brackets. The fuel rail pressure sensor is installed at the front of the rail.

34.9.1 REMOVAL OF THE FUEL RAIL

Remove as follows:

1. Steam clean the engine.
2. Disconnect the batteries.
3. Drain the fuel system.
4. Disconnect the fuel rail pressure sensor connector.

NOTE:
When removed the fuel rail feed tubes need to be covered on the ends to ensure debris does not enter the tubes.

5. Remove injector feed tubes with tool J-47495.
6. Remove high pressure fuel lines from the high pressure pump and fuel rail.
7. Remove injector feed tube bracket.
8. Remove bolts and clamps connecting the fuel rail to the camshaft frame and remove fuel rail.
9. Inspect the bolts for damage and wear; replace as necessary.
10. Inspect the fuel rail for damage and wear; replace as necessary.
11. Inspect the fuel feed tubes for damage and wear; replace as necessary.
12. Inspect the rocker arm frame sealing for damage; replace as necessary.

34.9.2 INSTALLATION OF THE FUEL RAIL

Install as follows:

1. Install fuel rail to camshaft frame with six bolts torque bolts to 10 N·m.
2. Install injector feed tube bracket to intake and torque the two bolts to 30 N·m.
3. Remove covers from injector feed tubes.
4. Using tool J–47495 install injector feed tubes to fuel rail torque to 40 N·m. (29.5 lb·ft).
5. Install injector feed tubes to rail and injector torque to 40 N·m. (29.5 lb·ft).
6. Install high pressure fuel lines to the fuel rail and high pressure pump torque lines to 40 N·m (29.5 lb·ft).

7. Install low pressure amplification fuel return line to fuel filter module and cylinder head torque to 35 N·m (25.81 lb·ft).
8. Install pressure limiting valve and banjo bolts.
9. Connect rail pressure sensor.
10. Connect the batteries.

WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

11. Prime the fuel system start the engine and check for leaks. Refer to section 6.5, "Fuel System Priming."

34.9.3 REMOVAL OF THE FUEL RAIL SENSOR

The Fuel Rail Pressure Sensor is mounted on the front end of the fuel rail.

Remove as follows:

WARNING:

PRESSURIZED FUEL

To avoid injury to eye or face, wear a face shield or goggles when conducting a pressure test.

WARNING:

PERSONAL INJURY

To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Residual high fuel pressure may be present within the circuit.

1. Remove connector.
2. Place a small container below the fuel rail pressure sensor to catch escaping fuel.

3. Remove the fuel rail sensor using the appropriate wrench on the hex end of the fuel rail sensor and unscrew the sensor from the fuel rail.

34.9.4 INSTALLATION OF THE FUEL RAIL SENSOR

Install as follows:

1. Install the fuel rail sensor using the appropriate wrench on the hex end of the fuel rail sensor and screw the sensor to the fuel rail; torque to 65-75 Nm (48-55 ft/lb).
2. Install the sensor connector.
3. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.9.5 REMOVAL OF PRESSURE LIMITING VALVE

Remove as follows:

WARNING:

PRESSURIZED FUEL

To avoid injury to eye or face, wear a face shield or goggles when conducting a pressure test.

WARNING:

PERSONAL INJURY

To prevent the escape of high pressure fuel that can penetrate skin, ensure the engine has been shut down for a minimum of 10 minutes before servicing any component within the high pressure circuit. Residual high fuel pressure may be present within the circuit.

1. Place a small container below the pressure limiting valve to catch escaping fuel.
2. Remove the pressure limiting valve from the fuel rail.

34.9.6 INSTALLATION OF PRESSURE LIMITING VALVE

Install as follows:

1. Install the pressure limiting valve and torque to 95-105 Nm (70-77 ft/lb)
2. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.10 FUEL FILTER MODULE

The fuel filter module is located on the left side of the engine block. The fuel filter module separates out the water in the fuel and filters out dirt particles in two stages.

34.10.1 REMOVAL OF FUEL FILTER MODULE

Remove as follows:

1. Drain the coolant.
2. Disconnect and remove the coolant lines from the front and bottom of the module.
3. Drain fuel filter module by using air pressure.
4. Disconnect fuel feed and return lines (to tank) from the fuel filter module.
5. Disconnect remaining fuel lines.
6. Disconnect electrical connectors from sensors and fuel preheater (if equipped).
7. Remove line assemblies from high pressure fuel pump.
8. Remove the four bolts securing the fuel filter module to the cylinder block and remove fuel filter module from engine block.
9. Remove the fuel cooler O-ring seal from the engine block and discard.

34.10.2 DISASSEMBLY OF THE FUEL FILTER MODULE

Disassemble as follows:

1. Remove the fuel cooler from the fuel filter module.
2. Remove the three filter covers using a 36 mm socket.
3. Pull the covers and filters straight up and out of the fuel filter module.
4. Remove the filters from the covers by applying a lateral force to the bottom of the filters. The filter will unsnap from the cover. Discard the filters.
5. Remove the seal rings from the covers and discard seal.
6. Inspect the fuel filter module for cracks or damage ; replace if necessary.
7. Inspect fuel filter sensors; replace if necessary.
8. Inspect the fuel cooler for wear or damage; replace if necessary.
9. Inspect the fuel filter housing and cooler for debris and clean if necessary.

34.10.3 ASSEMBLY OF THE FUEL FILTER MODULE

Assemble as follows:

1. Install new seal rings onto plastic caps and coat with clean engine oil.
2. Install the filters into the plastic caps by snapping the filter into the cap.

NOTE:
The prefilter has slots and the tabs should align with the slot in the plastic cap.

3. Install filters and caps into fuel filter module
4. Turn the cap counter clockwise until a clicking sound is made and then turn the cap clockwise and hand tighten.
5. Torque prefilter cap to 15-20 N·m (11-15 ft·lb).
6. Torque water separator and fuel filter caps to 50-60 N·m (37-44 ft·lb).
7. Install fuel cooler into fuel filter module.

34.10.4 INSTALLATION OF THE FUEL FILTER MODULE

Install as follows:

1. Install a new coolant O-rings onto cylinder block.
2. Install guide studs.
3. Install fuel filter module using care not to damage coolant O-ring seal between cylinder block and fuel cooler.
4. Torque mounting bolts to 60 N·m (44 ft·lb).
5. Connect coolant lines.
6. Install bolt securing the air compressor coolant line to the fuel filter module and torque to 25 N·m (15 ft·lb).
7. Fill engine with coolant and pressure test system to check for a seal leak between fuel cooler and cylinder block.
8. Install fuel lines to fuel filter module and high pressure fuel pump.
9. Torque fuel lines to 25 N·m (18 ft·lb).
10. Connect the electrical connectors from sensors and fuel preheater (if equipped).
11. Prime fuel system and check for leaks. Refer to section 6.5, “Fuel System Priming.”

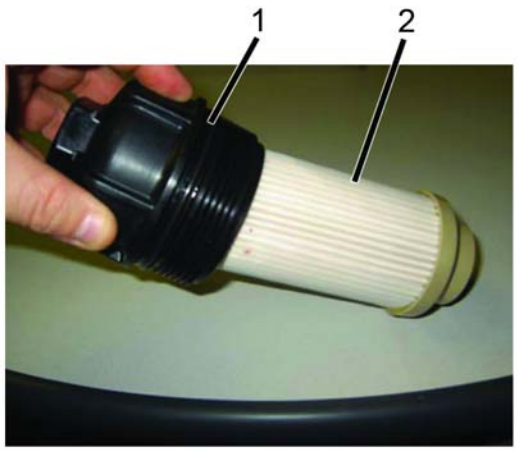
34.10.5 REMOVAL OF FINAL FILTER

Remove the final filter as follows:

1. Using a 36-mm socket, unscrew the final filter cap.

NOTICE:
Do not tilt the final filter when removing it from the housing. Possible damage to the final filter or stand pipe may occur.

2. Pull the cap and final filter straight up and allow the fuel to drain back.
3. Remove the final filter (2) from the plastic cap (1) by placing the filter on a solid surface and apply pressure on the plastic cap at an angle.



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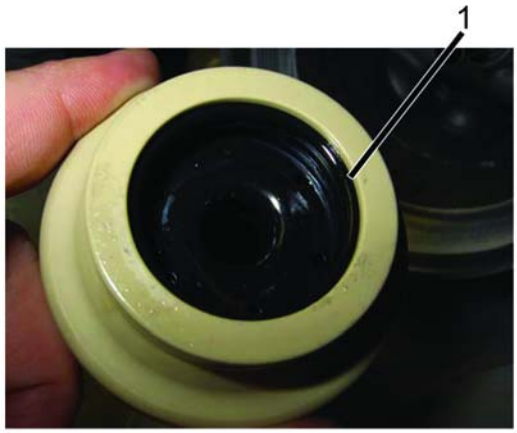
4. Discard the filter.
5. Inspect inside the housing for any large debris and clean if needed.
6. Discard plastic cap seal ring.

34.10.6 INSTALLATION OF THE FINAL FILTER

Install the final filter as follows:

1. Snap new final filter into the plastic cap.
2. Install a new plastic cap seal ring.
3. Apply a light coat of petroleum-based lithium grease to the cap seal ring (1) and to the lower seal on the final filter.



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4. Install the final filter into the fuel filter module.
5. Turn the cap counterclockwise until a “click” sound is made, then turn clockwise and hand tighten.
6. Torque final filter cap to 50-60 N·m (37-44 ft·lb).
7. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”
8. After the engine has started, check for leaks.

34.10.7 REMOVAL OF PREFILTER

Remove prefilter as follows:

1. Using a 36 mm socket, unscrew the prefilter cap.

NOTICE:
Do not tilt the prefilter when removing it from the housing. Possible damage to the prefilter or stand pipe may occur.

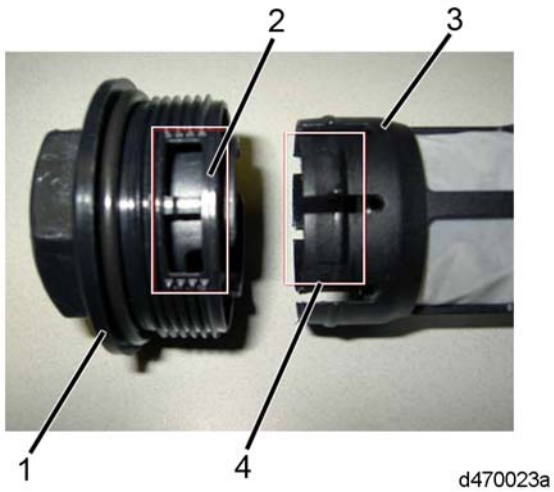
2. Pull the cap and prefilter straight up and out of the fuel filter housing.
3. Remove the prefilter from the plastic cap and discard
4. Discard the prefilter cap seal ring.

34.10.8 INSTALLATION OF PREFILTER

Install as follows:

1. Snap new prefilter (3) into the plastic cap (1).

NOTE:
The prefilter should snap into the cap in two positions. The tabs (4) should align with the slot in the plastic cap (2).



2. Apply a thin coat of petroleum-based lithium grease to the prefilter cap seal ring.
3. Apply a thin coat of petroleum-based lithium grease to the inside and outside of the prefilter bottom seal.
4. Install the prefilter into the fuel filter module.
5. Turn the cap counterclockwise until a “click” sound is made, then turn clockwise and hand tighten.
6. Torque prefilter cap to 15-20 N·m (11-15 lb·ft).
7. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”
8. After the engine has started, check for leaks.

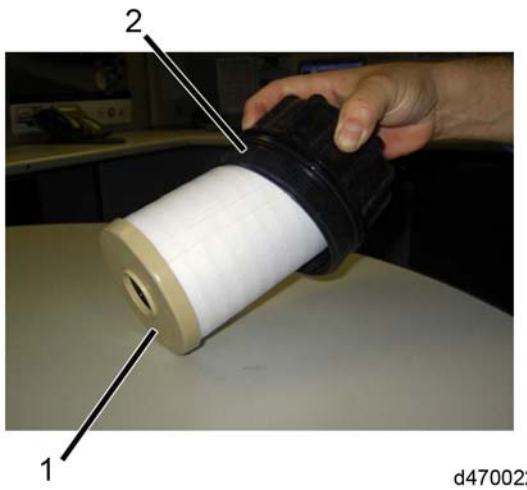
34.10.9 REMOVAL OF THE WATER SEPARATOR/COALESCER

Remove the water separator/coalescer as follows:

1. Using a 36–mm socket, unscrew the coalescer cap.

NOTICE:
Do not tilt the coalescer when removing it from the housing. Possible damage to the coalescer or stand pipe may occur.

2. Pull the cap and coalescer straight up and allow the fuel to drain back.
3. Remove the coalescer (1) from the plastic cap (2) by placing the filter on a solid surface and apply pressure on the plastic cap at an angle.

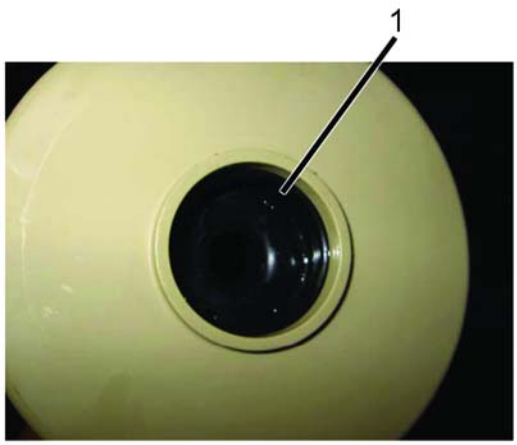


4. Discard the filter.
5. Inspect inside the housing for any large debris and clean it out if needed.
6. Discard plastic cap seal ring.

34.10.10 INSTALLATION OF WATER SEPARATOR/COALESCER

Install as follows:

1. Snap a new coalescer into the plastic cap.
2. Install a new plastic cap seal ring.
3. Apply a light coat of petroleum-based lithium grease to the plastic cap seal ring and to the lower seal (1) on the coalescer filter.



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4. Install the coalescer into the fuel filter module.
5. Turn the cap counterclockwise until a “click” sound is made, then turn clockwise and hand tighten.
6. Torque coalescer cap to 50-60 N·m (37-44 ft·lb).
7. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”
8. After the engine has started, check for leaks.

34.10.11 REMOVAL OF WATER-IN-FUEL SENSOR

The water-in-fuel sensor is located on the left side of the engine mounted on the fuel filter module.

Remove as follows:

1. Drain the fuel filter module using the water drain valve located on the bottom on the bottom of the fuel filter module.
2. Pull gray tab down and disconnect the harness connector from the Water-in-Fuel Sensor.
3. Remove two screws from sensor and remove sensor.

34.10.12 INSTALLATION OF THE WATER-IN-FUEL SENSOR

Install as follows:

1. Lubricate the seal ring on the new sensor with clean fuel.
2. Install water in fuel sensor to fuel filter module.
3. Install two screws to the Water-in-Fuel Sensor and fuel filter module and tighten bolts 9-13 N·m (6.5-9.5 ft·lb).
4. Install harness connector to sensor and push in the gray tab on the connector to lock harness connector.
5. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.10.13 REMOVAL OF THE SUPPLY FUEL TEMPERATURE SENSOR

The Supply Fuel Temperature Sensor is located on the left side of the engine on the fuel filter module.

Remove as follows:

1. Drain the fuel filter module using the water drain valve located on the bottom of the fuel filter module.
2. Unseat the secondary lock on the electrical connector.
3. Push gray tab down and pull harness connector from sensor.
4. Using the appropriate wrench on the hex end of the fuel temperature sensor unscrew the sensor from the fuel filter module.

34.10.14 INSTALLATION OF THE SUPPLY FUEL TEMPERATURE SENSOR

Install as follows:

1. Install the sensor and new gasket on the engine and using the appropriate wrench on the hex end of the sensor tighten the sensor. Torque sensor to 35-45 N·m (26-33 lb·ft).
2. Install harness connector onto sensor and push gray tab to the up position.
3. Seat secondary lock on the electrical connector.
4. Prime the fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.10.15 REMOVAL OF FUEL PREHEATER (IF EQUIPPED)

Remove as follows:

1. Drain the fuel filter module by using the water drain valve located on the bottom of the fuel filter module.
2. Disconnect the electrical connector from the fuel preheater.
3. Remove the two mounting bolts attaching the heater to the module.
4. Remove fuel preheater.

NOTE:
When removing the fuel pre-heater, the check ball assembly may stay attached to the fuel pre-filter. Separate the fuel prefilter from the check ball assembly and inspect all seal rings. Replace if necessary.

34.10.16 INSTALLATION OF FUEL PREHEATER (IF EQUIPPED)

Install as follows:

1. Install check ball assembly into the module (if removed).
2. Install new fuel prefilter and torque mounting bolts to 8-11 Nm (6-8 ft/lb).
3. Install the fuel prefilter electrical connector.
4. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

34.10.17 REMOVAL OF FUEL RESTRICTOR GAUGE (IF EQUIPPED)

Remove as follows:

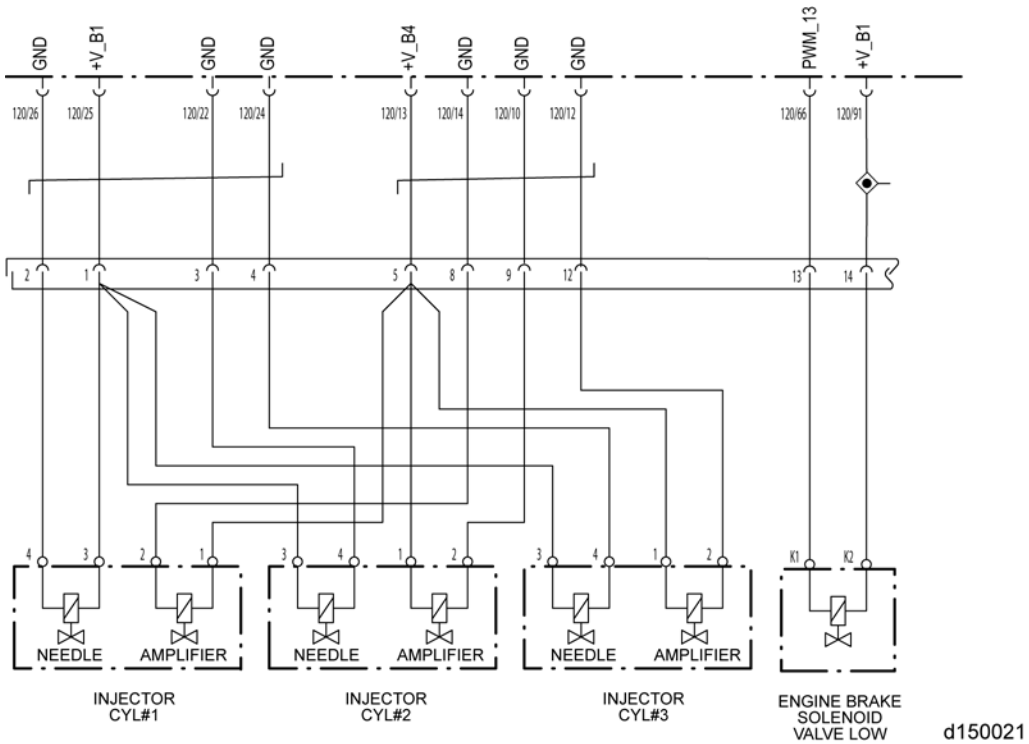
1. Drain the fuel filter module by using the water drain valve located on the bottom of the fuel filter module.
2. Remove the fuel restrictor gauge from the fuel filter module.

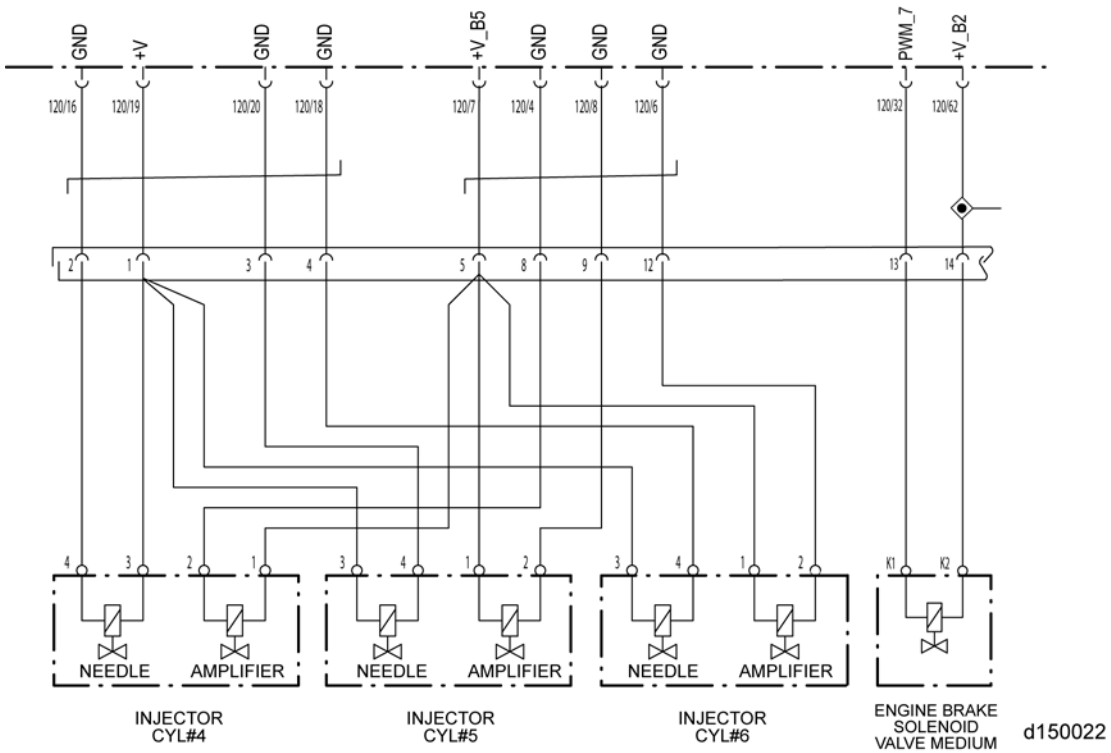
34.10.18 INSTALLATION OF FUEL RESTRICTOR GAUGE (IF EQUIPPED)

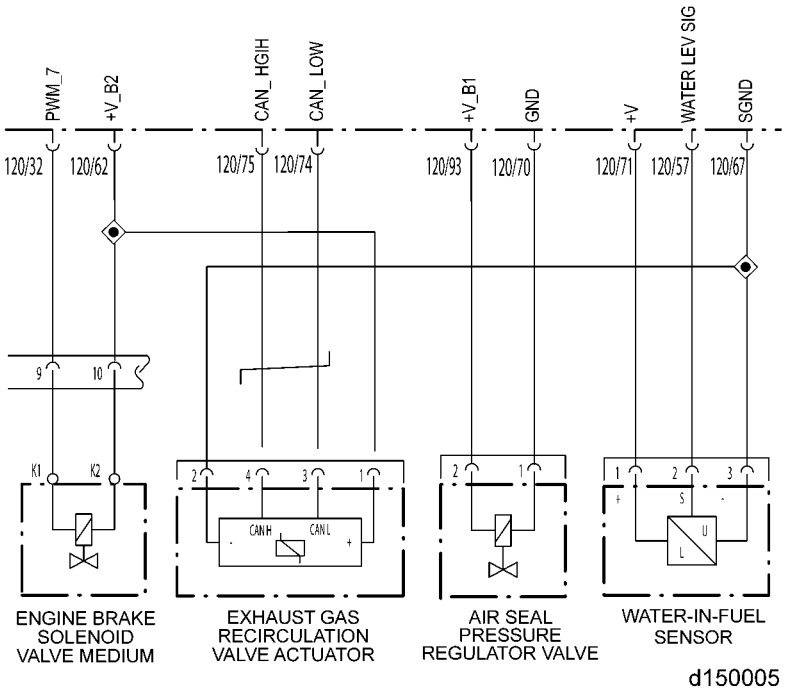
Install as follows:

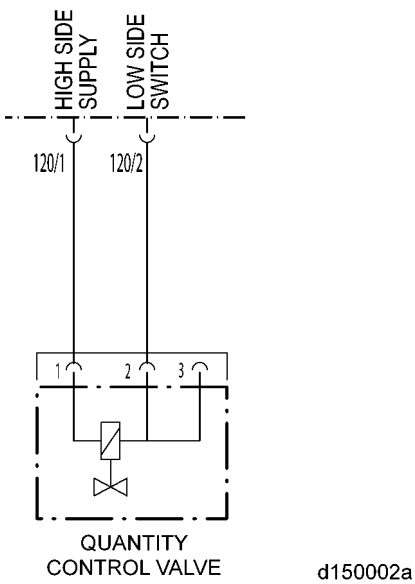
1. Install the fuel restrictor gauge and torque to xx-xx Nm (xx-xx ft/lb).
2. Prime fuel system using fuel priming valve or hand primer. Refer to section 6.5, “Fuel System Priming.”

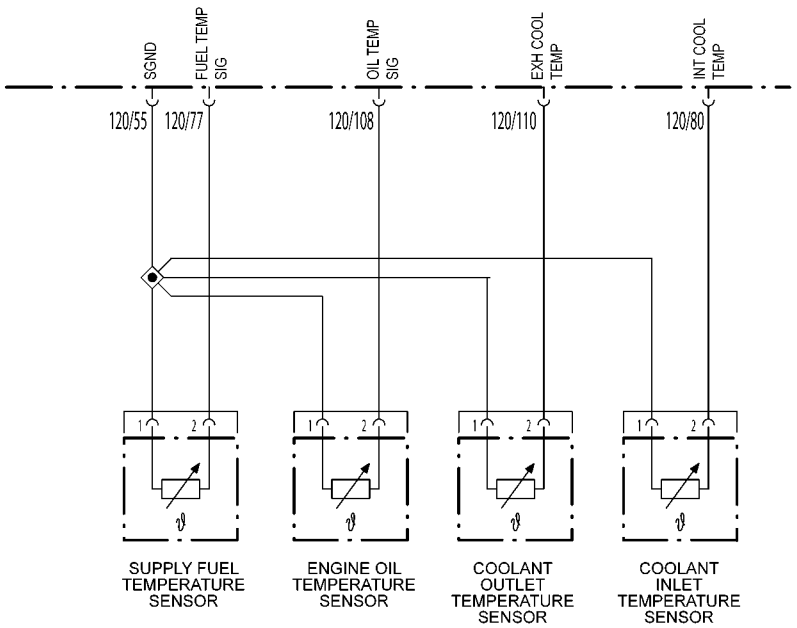
APPENDIX A: WIRING DIAGRAMS











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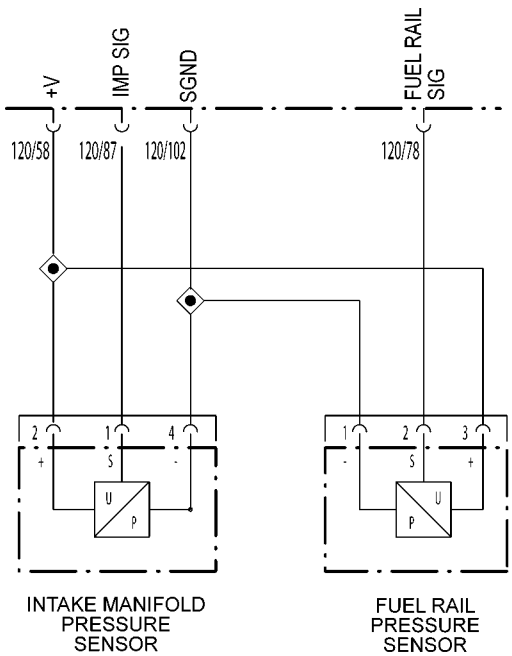

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