

# Troubleshooting

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## **1204F-E44TA and 1204F-E44TTA Engines**

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MT (Engine)  
MU (Engine)  
MW (Engine)

## Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions correctly.

**Incorrect operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Perkins cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Perkins is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Perkins dealers or Perkins distributors have the most current information available.



**When replacement parts are required for this product Perkins recommends using Perkins replacement parts.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

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**In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.**

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# Troubleshooting Section

## Introduction

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## General Information

### Important Safety Information

Do not perform any procedures in this Troubleshooting Guide until you have read the Operation and Maintenance Manual and you understand this information. Use only proper tools and observe all precautions that pertain to the use of those tools. Failure to follow these procedures can result in personal injury. Also, the following procedures must be observed.

Work safely. Most accidents that involve product operation, maintenance, and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs.

A person must be alert to potential hazards. This person should also have the necessary training, skills, and tools to perform these functions properly.

Safety precautions and warnings are provided in this publication and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons. Perkins cannot anticipate every possible circumstance that might involve a potential hazard.

Therefore, the warnings in this publication and the warnings that are on the product are not all inclusive.

### Overview

These engines are equipped with an electronic control system. The system consists of a computer, sensors, and software. The system performs these functions:

- Control of the engine
- Control of the Selective Catalyst Reduction (SCR) system
- Control of particulate emissions via the Clean Emission Module (CEM)
- Applications control system interface
- Fault detection and reporting

## Electronic Control System

The Electronic Control Module (ECM) is a computer that controls the operation of the engine.

The ECM contains a flash file. The flash file is the software for the ECM. The flash file contains the operating maps. The operating maps define the following characteristics of the engine:

- Horsepower
- Torque curves
- Engine speed (rpm)

Refer to Troubleshooting, "System Overview" for additional information on the electronic control system.

## Application Interface

The ECM interfaces with the machine via software and an electrical connector on the ECM. The software can be configured.

The application control system provides inputs to the electrical connector on the ECM to indicate the status of switches. Correctly configure the ECM to interpret the inputs.

The ECM provides outputs for the application control system via the electrical connector to control lamps, solenoids, and other devices. Correctly configure the ECM in order for the outputs to match the configuration of the application control system.

## Clean Emissions Module (CEM)

The CEM contains these components:

**Diesel Particulate Filter (DPF) (if equipped)** – A DPF may be installed in the exhaust system. The DPF collects soot and ash from the engine exhaust.

**Diesel Oxidation Catalyst (DOC)** – A DOC is installed in the exhaust system. The DOC oxidizes hydrocarbons (HC), carbon monoxide (CO), odor causing compounds, and soluble organic fractions (SOF).

**Selective Catalyst Reduction (SCR) System** – The SCR system is used to reduce NOx emissions from the engine. The SCR system is installed after the CEM in the exhaust.

**Software** – Software in the ECM monitors the DPF (if equipped). The software also controls the amount of Diesel Exhaust Fluid (DEF) being injected into the exhaust stream.

## Fault Detection and Reporting

The ECM monitors inputs from the sensors and inputs from the applications control system. Software in the ECM interprets the inputs. The software determines if the inputs are operating correctly. A diagnostic trouble code is activated when the software detects a problem with an input.

The ECM broadcasts the codes on two data links. The data links are the Data Link and CAN data link. The electronic service tool must communicate on both data links to service the engine. If a fault is suspected with the Data Link, refer to Troubleshooting, "Data Link - Test". If a fault is suspected with the CAN data link, refer to Troubleshooting, "CAN Data Link - Test".

The codes can be displayed on the electronic service tool and optional operator interfaces. Refer to Troubleshooting, "Diagnostic Trouble Codes" for additional information on diagnostic trouble codes and a complete list of codes.

## Troubleshooting

During troubleshooting, refer to the Electrical System Schematic for the application.

During troubleshooting, inspect all harness connections before any component is replaced. If these connections are not clean and secure, continuous electrical faults or intermittent electrical faults can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

Failure of an electrical component may cause the failure of other components. Always attempt to correct the cause of an electrical failure before you replace a component. If wire insulation is punctured, repair the damage.

## Troubleshooting Associated Codes

Certain systems will display multiple codes for troubleshooting. The "Associated Codes" must be used to troubleshoot the system. The codes should be viewed as separate levels of troubleshooting. For example, a "DEF Tank Temperature Low" code may be generated. This main code is not the code that requires troubleshooting.

The system is designed to display the codes for this separate level of troubleshooting as an "Associated Code". The "Associated Code" is the diagnostic or the event code that needs to have the troubleshooting procedure followed.

**The following paragraph is an example of troubleshooting the engine system with "Associated Codes" :**

After connecting the electronic service tool to an engine, the following codes are displayed:

- Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Low - moderate severity
- Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Below Normal

These codes are the result of a diverter valve fault. The Diesel Exhaust Fluid (DEF) is below the expected temperature because the diverter valve has not allowed coolant to circulate through the DEF tank. The troubleshooting procedure to use in this case is the "Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Below Normal" code, which will fix the other issue.

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## Welding Precaution

**Proper welding procedures are necessary in order to avoid damage to the Electronic Control Module (ECM), Dosing Control Unit (DCU), sensors, and associated components. Also consider components that are for the driven equipment. Remove the component that requires welding. When welding on an engine that is equipped with an ECM and removal of the component is not possible, the following procedure must be followed. This procedure provides the minimum amount of risk to the electronic components.**

1. Stop the engine. Remove the electrical power from the ECM.
2. Ensure that the fuel supply to the engine is turned off.
3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, turn the switch to the OFF position.
4. Disconnect all electronic components from the wiring harnesses. Electronic components include the following components:
  - Electronic components for the driven equipment
  - Engine ECM
  - DCU
  - Sensors

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### NOTICE

Do NOT use electrical components (ECM or sensors) or electronic component grounding points for grounding the welder.

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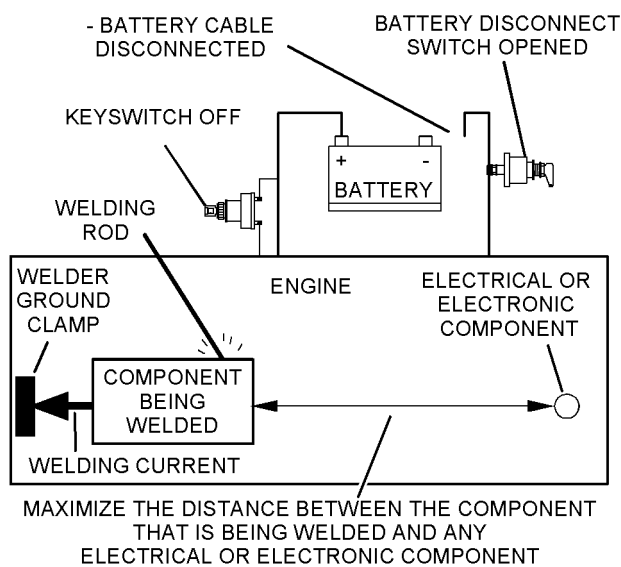


Illustration 1 g01143634

Service welding guide (typical diagram)

5. When possible, connect the welder ground clamp directly to the engine component that will be welded. Place the clamp as close as possible to the weld. A close connection will reduce the possibility of welding current damage to the engine bearings, to the electrical components, and to other components.
6. Protect the wiring harnesses from welding debris and/or from the welding spatter.
7. Use standard welding procedures to weld the materials together.

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## Electronic Service Tools

The electronic service tools are designed to help the service technician perform the following tasks:

- Information access
- System diagnostics
- System calibrations
- System configurations
- Data link communications

## Required Service Tools

Table 1

Required Service Tools	
Part Number	Description
CH11155	Crimp Tool (12-AWG TO 18-AWG)
2900A019	Wire Removal Tool
27610285	Removal Tool
-	Suitable Digital Multimeter

Two short jumper wires are needed to check the continuity of some wiring harness circuits by shorting two adjacent terminals together in a connector. A long extension wire may also be needed to check the continuity of some wiring harness circuits.

## Optional Service Tools

Table 2 lists the optional service tools that can be used when the engine is serviced.

Table 2

Part Number	Description
U5MK1092	Spoon Probe Kit (MULTIMETER)
- or -	Suitable Digital Pressure Indicator or Engine Pressure Group
-	Suitable Battery Load Tester
-	Suitable Temperature Adapter (MULTIMETER)
2900A038	Bypass Harness As
2900A036	Stub as

## Perkins Electronic Service Tool

The Perkins Electronic Service Tool can display the following information:

- Status of all pressure sensors and temperature sensors
- Programmable parameter settings
- Active diagnostic codes and logged diagnostic codes
- Logged events
- Histograms

The Electronic Service Tool can also be used to perform the following functions:

- Diagnostic tests
- Sensor calibrations
- Programming of flash files and injector trim codes

- Parameter programming
- Copy configuration function for ECM replacement
- Data logging
- Graphs (real time)

Table 3 lists the service tools that are required in order to use the Electronic Service Tool.

Table 3

Service Tools for the Use of the Electronic Service Tool	
Part Number	Description
-(1)	Single Use Program License
-(1)	Data Subscription for All Engines
27610164	TIPSS Adapter Kit (Electronic Service Tool to the ECM interface)
27610401	or Perkins CA3 Kit

(1) Refer to Perkins Engine Company Limited.

**Note:** For more information on the Electronic Service Tool and the PC requirements, refer to the documentation that accompanies the software for the Electronic Service Tool.

## Connecting the Electronic Service Tool and the TIPSS Adapter

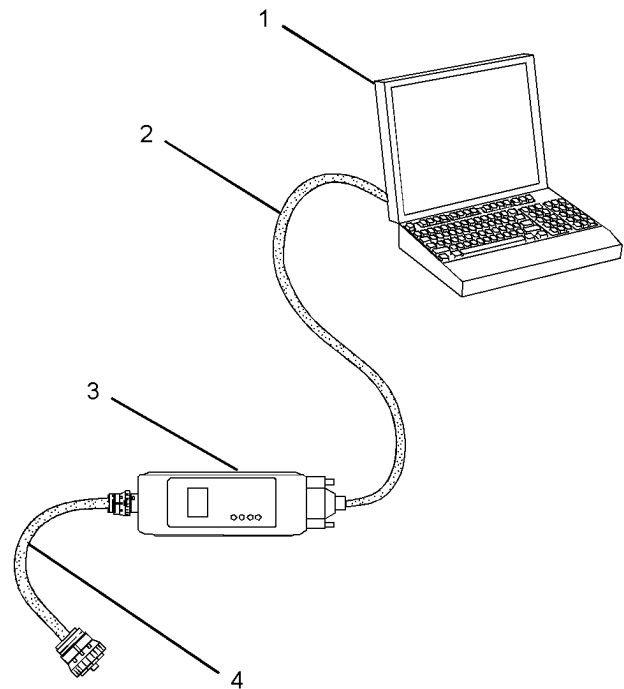


Illustration 2

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- (1) Personal Computer (PC)
- (2) Adapter Cable (Computer Serial Port)
- (3) TIPSS adapter
- (4) Adapter Cable Assembly

**Note:** Items (2), (3) and (4) are part of the TIPSS adapter kit.

Use the following procedure in order to connect the Electronic Service Tool and the TIPSS Adapter.

1. Turn the keyswitch to the OFF position.
2. Connect cable (2) between the "COMPUTER" end of TIPSS adapter (3) and the RS232 serial port of PC (1).

**Note:** The Adapter Cable Assembly (4) is required to connect to the USB port on computers that are not equipped with an RS232 serial port.

3. Connect cable (4) between the "DATA LINK" end of TIPSS adapter (3) and the service tool connector.



4. Place the keyswitch in the ON position. If the Electronic Service Tool and the TIPSS adapter do not communicate with the Electronic Control Module (ECM), refer to the diagnostic procedure Troubleshooting, "Electronic Service Tool Does Not Communicate".

4. Place the keyswitch in the ON position. If the Electronic Service Tool and the CA3 adapter do not communicate with the Electronic Control Module (ECM), refer to the diagnostic procedure Troubleshooting, "Electronic Service Tool Does Not Communicate".

## Connecting the Electronic Service Tool and the CA3 Kit

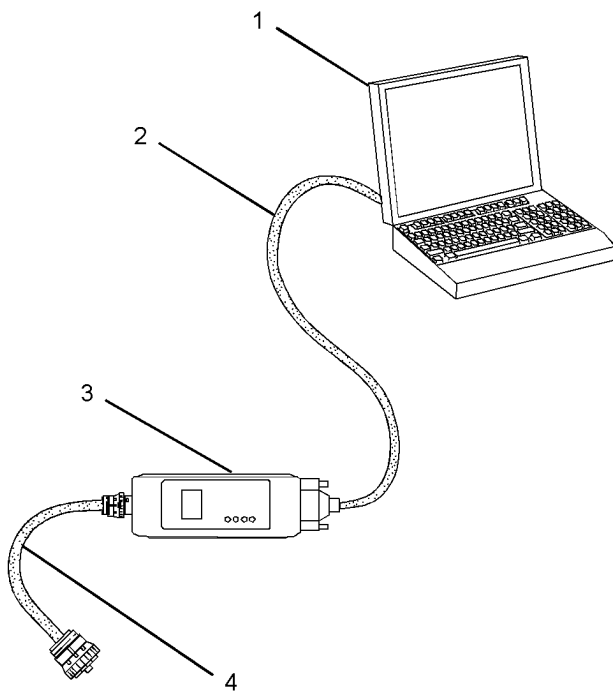


Illustration 3

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- (1) Personal Computer (PC)
- (2) Adapter Cable (Computer Serial Port)
- (3) CA3 adapter
- (4) Adapter Cable Assembly

**Note:** Items (2), (3) and (4) are part of the CA3 kit.

Use the following procedure in order to connect the Electronic Service Tool and the CA3 Adapter.

1. Turn the keyswitch to the OFF position.
2. Connect cable (2) between the "COMPUTER" end of CA3 adapter (3) and a USB port of PC (1).
3. Connect cable (4) between the "DATA LINK" end of CA3 adapter (3) and the service tool connector.

# Electronic System Overview

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## System Overview

The engine is designed for electronic control of most engine operating functions. The electronic system consists of an Electronic Control Module (ECM), the wiring harness, switches, sensors, and fuel injectors. The engine ECM receives information from the sensors and the switches on the engine. The engine ECM processes the information that is collected to control the engine. By altering the fuel delivery with the fuel injectors, the engine ECM controls the speed and the power that is produced by the engine. The aftertreatment system is controlled by the engine ECM.

The following information provides a general description of the control system. Refer to the Systems Operation manual for detailed information about the control system.

## System Operation

### Engine Governor

The ECM governs the engine. The ECM determines the timing, the injection pressure, and the amount of fuel that is delivered to each cylinder. These factors are based on the actual conditions and on the desired conditions at any given time during starting and operation.

For variable speed engines, the ECM uses the throttle position sensor to determine the desired engine speed. The ECM compares the desired engine speed to the actual engine speed. The actual engine speed is determined through interpretation of the signals that are received by the ECM from the engine speed/timing sensors. If the desired engine speed is lower than the actual engine speed, the ECM allows more fuel to be injected, increasing engine speed.

### Timing Considerations

Once the ECM has determined the amount of fuel that is required, the ECM must determine the timing of the fuel injection.

The ECM adjusts timing for optimum engine performance and for the fuel economy. Actual timing and desired timing cannot be viewed with the electronic service tool. The ECM determines the location of top center of the number one cylinder from the signals that are provided by the engine speed/timing sensors. The ECM determines when injection should occur relative to the top dead center position. The ECM then provides the signal to the injector at the correct time.

## Fuel Injection

The common rail fuel system is controlled by the ECM. The ECM gathers data from several sensors on the engine. The ECM then uses this data to adjust the quantity of fuel being delivered as well as the timing of the injection event. The injection event begins when the ECM sends a signal to the injector solenoid to actuate the valve inside the injector. As the valve opens, the fuel flows from the fuel rail, through the fuel line, and into the injector. As the valve opening pressure is reached, the valve is lifted and the fuel is delivered at high pressure into the combustion chamber.

The flash file inside the ECM establishes certain limits on the amount of fuel that can be injected. The "Smoke Limit Fuel" is a limit that is based on the intake manifold pressure. The "Smoke Limit Fuel" is used to control the air/fuel ratio for control of emissions. When the ECM senses a higher intake manifold pressure, the ECM increases the "Smoke Limit Fuel". A higher intake manifold pressure indicates that there is more air in the cylinder. When the ECM increases the "Smoke Limit Fuel", the ECM changes the control signal to the injector. The signal will allow more fuel into the cylinder.

The "Torque Limit Fuel" is a limit that is based on the power rating of the engine and on the engine rpm. The "Torque Limit Fuel" is like the rack stops and the torque spring on a mechanically governed engine. The "Torque Limit Fuel" provides the power curves and the torque curves for a specific engine family and a specific engine rating. All these limits are determined at the factory. These limits cannot be changed.

## Other ECM Functions for Performance

The ECM may also provide enhanced control of the engine for functions such as controlling the cooling fan. Refer to Troubleshooting, "Configuration Parameters" for supplementary information about the systems that can be monitored and controlled by the ECM.

## Programmable Parameters

Certain parameters that affect engine operation may be changed with the electronic service tool. The parameters are stored in the ECM, and the parameters are protected from unauthorized changes by passwords. These parameters are either system configuration parameters or customer parameters.

System configuration parameters are set at the factory. System configuration parameters affect emissions or power ratings. Factory passwords must be obtained and factory passwords must be used to change the system configuration parameters.

Some of the parameters may affect engine operation in an unusual way. An operator might not expect this type of effect. Without adequate training, these parameters may lead to power complaints or performance complaints even though the engine performance is within the specification.

Customer parameters can be used to affect the characteristics of the engine. Limits are set by the factory and by the monitoring system.

Customer passwords may be required to change customer specified parameters.

Refer to Troubleshooting, "Configuration Parameters" for additional information on this subject.

## Passwords

System configuration parameters are protected by factory passwords. Factory passwords are calculated on a computer system that is available only to Perkins dealers and distributors. Since factory passwords contain alphabetic characters, only the electronic service tool can be used to change system configuration parameters.

Customer parameters can be protected by customer passwords. The customer passwords are programmed by the customer. Factory passwords can be used to change customer passwords if customer passwords are lost.

Refer to Troubleshooting, "Customer Passwords"  
and Troubleshooting, "Factory Passwords" for

additional information on this subject.

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## **Component Location**

## **Electronic Control Circuit Diagram**

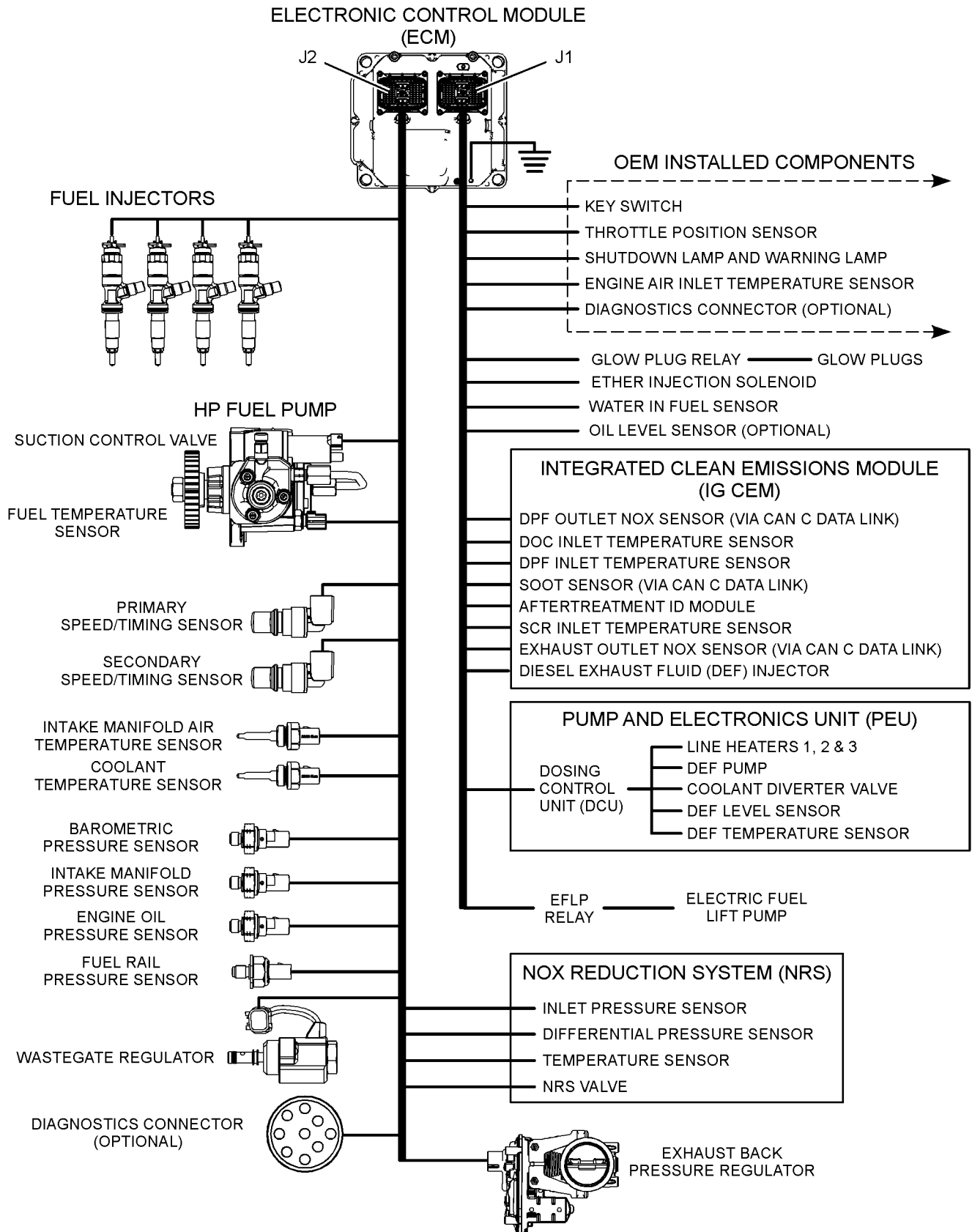


Illustration 4

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Electronic control circuit diagram for an engine with a DOC, DPF, and DEF system

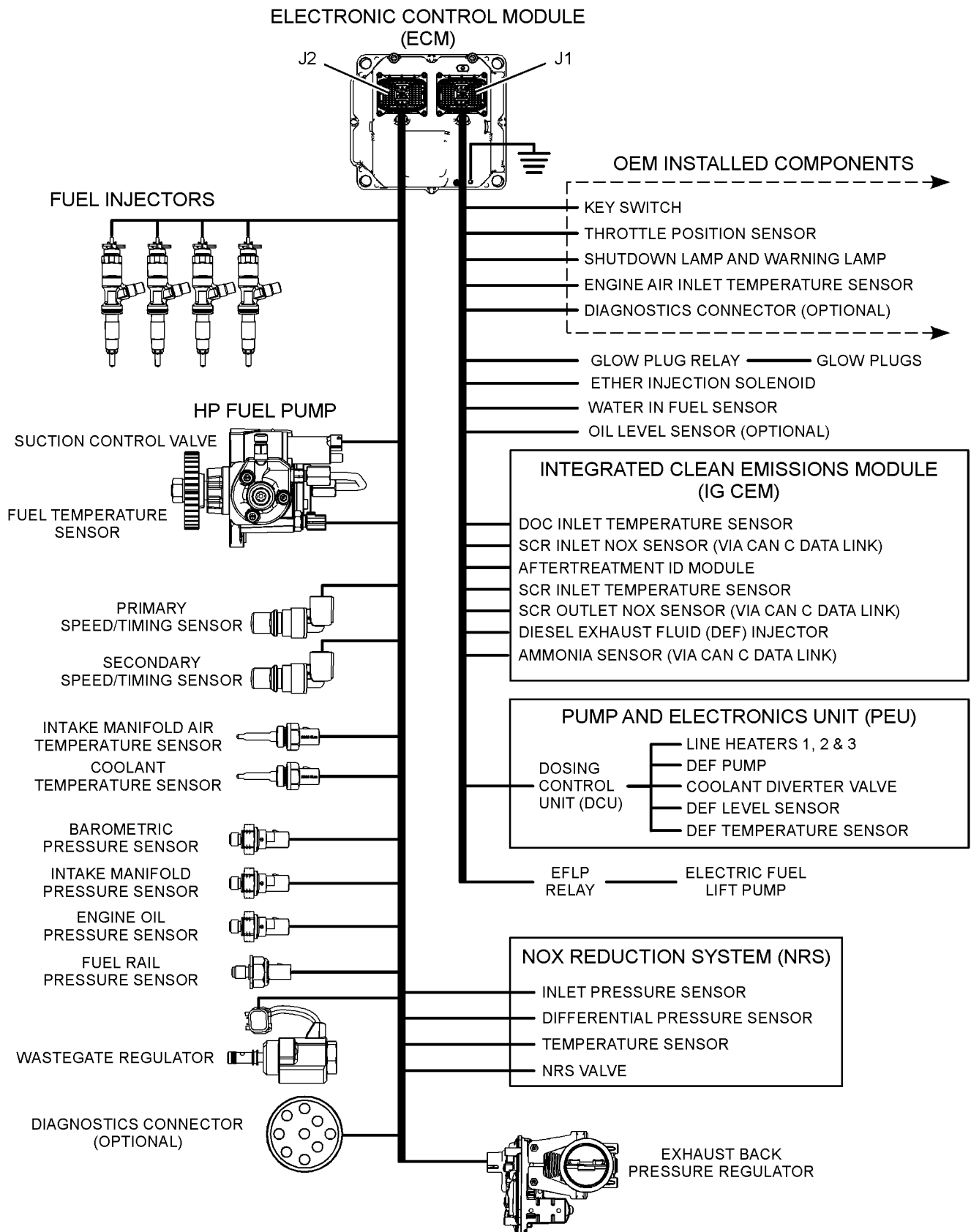


Illustration 5

Electronic control circuit diagram for an engine with a DOC and DEF system

Table 4

Additional Components That May Be Applicable For Certain Applications	
Throttle Position Sensor	Cooling Fan Solenoid
Ambient Air Temperature Sensor	Engine Fan Reversing Solenoid
Coolant Level Sensor	Air Filter Restriction Pressure Sensor
Ether Solenoid	Compression Brake Solenoids

## Sensor Locations

Table 5

Component Name Conversion to the Electronic Service Tool	
Electronic Service Tool Display Component Name	Troubleshooting Guide Component Name
Engine charge air cooler #1 outlet temperature	Charge air cooler outlet temperature
EGR differential pressure	NRS differential pressure sensor
EGR intake pressure (absolute)	NRS intake pressure sensor
EGR temperature	NRS temperature sensor
EGR valve	NRS valve
DPF #1 intake pressure (if equipped)	DPF intake pressure
DPF #1 intake temperature (if equipped)	DPF inlet temperature sensor

**Note:** In the following illustrations, some components have been removed to improve visibility.



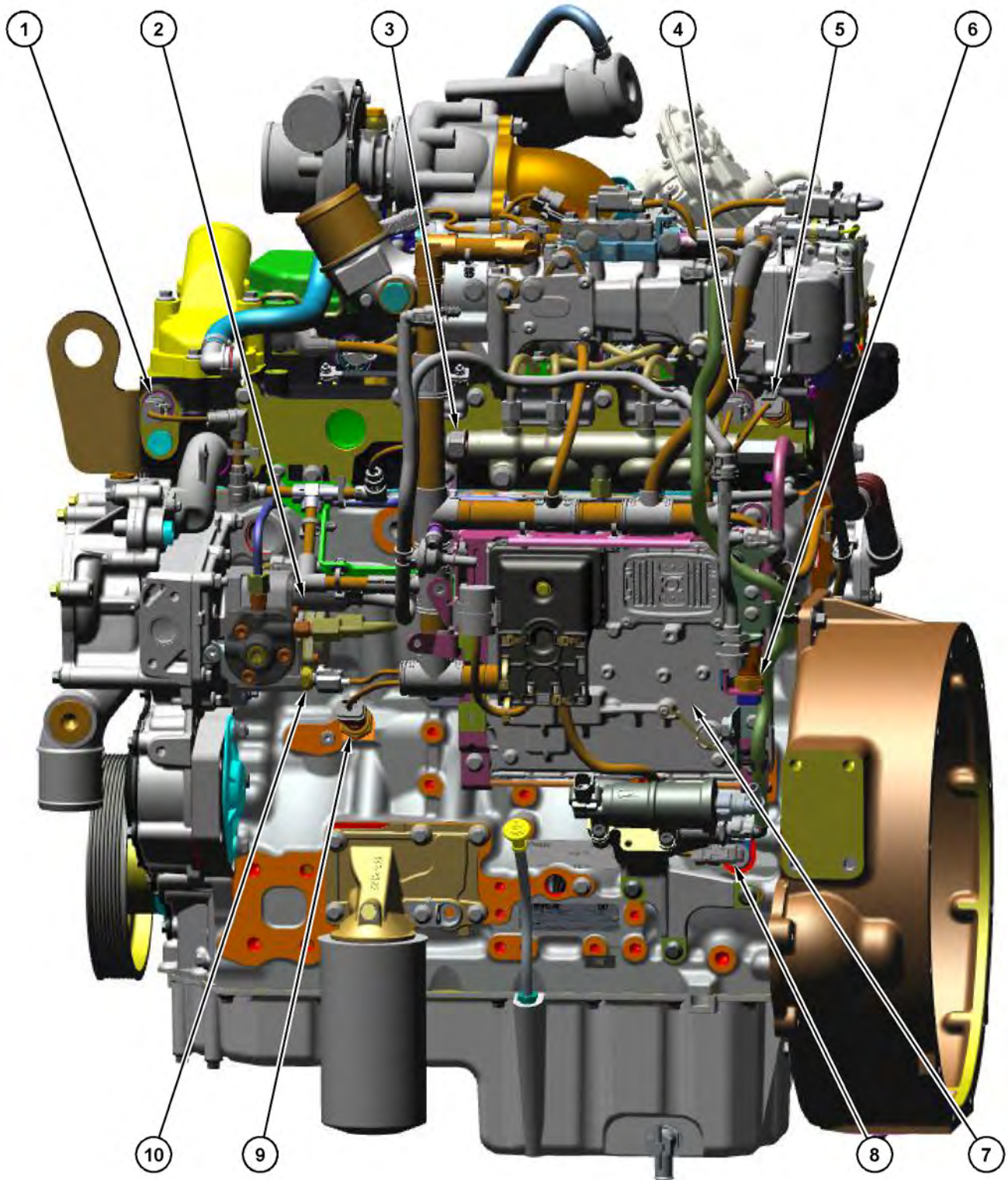


Illustration 6

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Sensor locations on the left side of the engine

- |  |                                     |                              |
|--|-------------------------------------|------------------------------|
| (1) Coolant temperature sensor               | (5) Intake manifold pressure sensor | (9) Oil pressure sensor      |
| (2) Solenoid for the high-pressure fuel pump | (6) Barometric pressure sensor      | (10) Fuel temperature sensor |
| (3) Fuel rail pressure sensor                | (7) Electronic Control Module (ECM) |                              |
| (4) Intake manifold air temperature sensor   | (8) Primary speed/timing sensor     |                              |

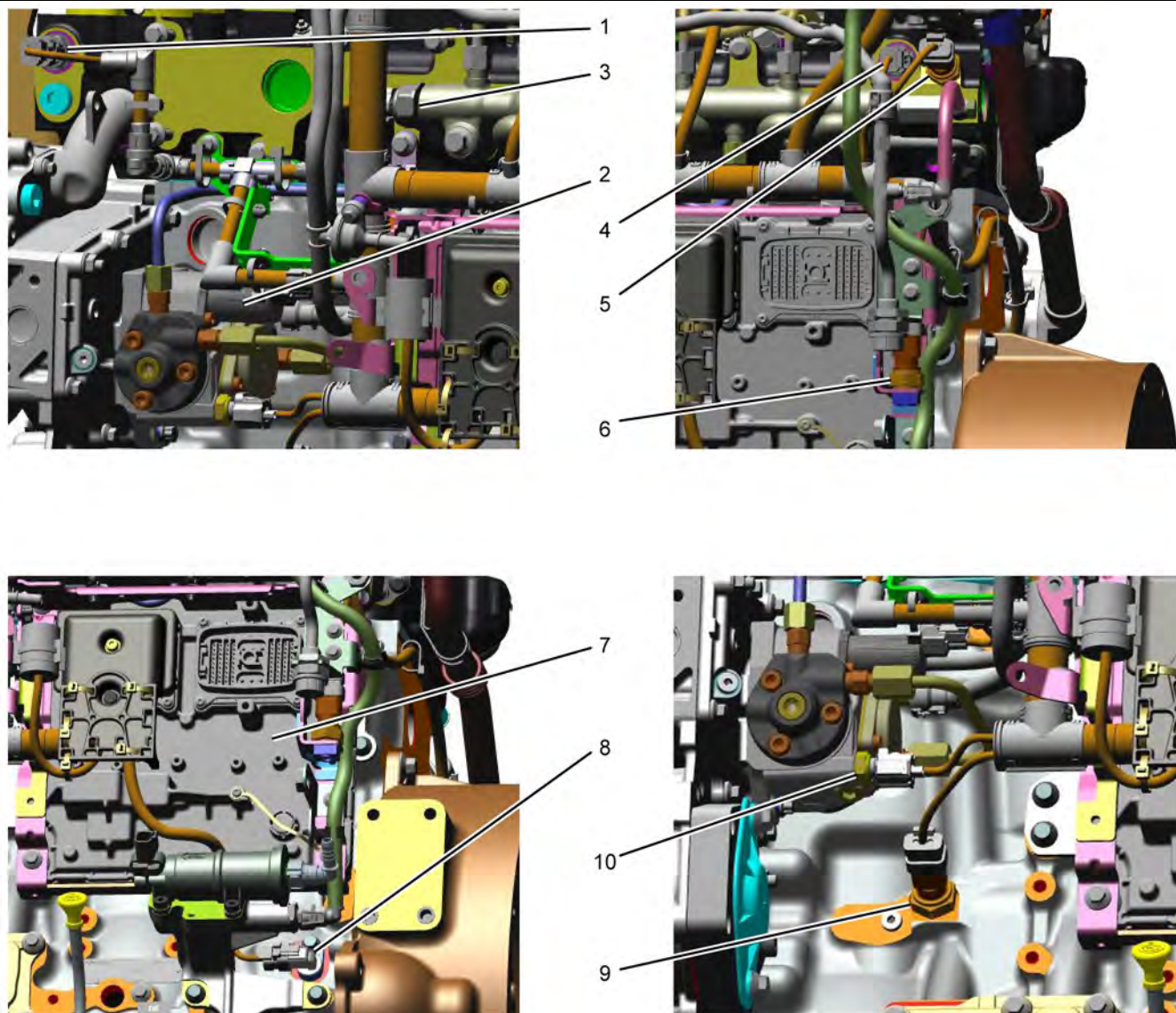


Illustration 7

g03695107

Close up views of sensor locations on the left side of the engine

- |  |                                     |                              |
|--|-------------------------------------|------------------------------|
| (1) Coolant temperature sensor               | (5) Intake manifold pressure sensor | (9) Oil pressure sensor      |
| (2) Solenoid for the high-pressure fuel pump | (6) Barometric pressure sensor      | (10) Fuel temperature sensor |
| (3) Fuel rail pressure sensor                | (7) Electronic Control Module (ECM) |                              |
| (4) Intake manifold air temperature sensor   | (8) Primary speed/timing sensor     |                              |



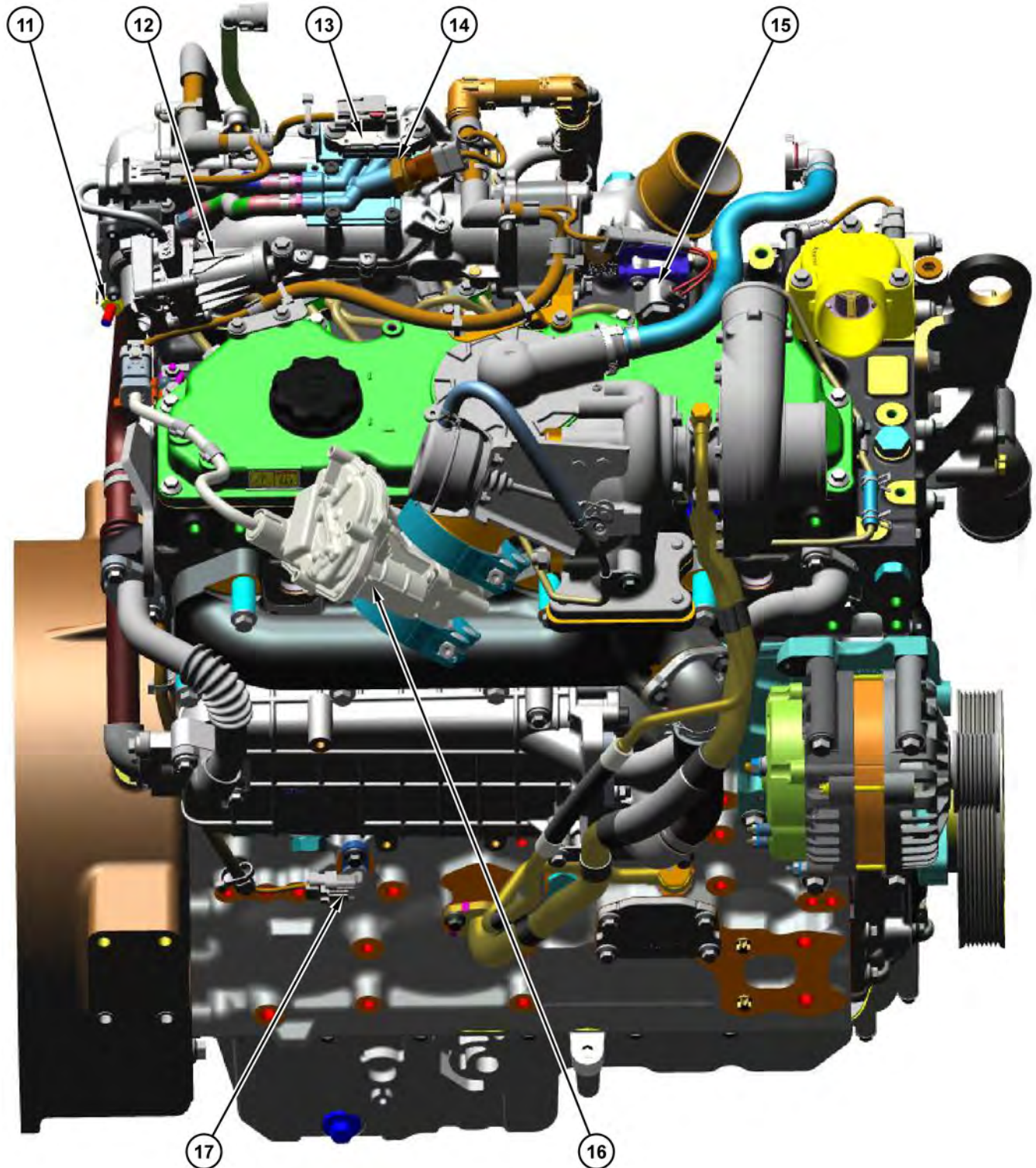


Illustration 8

g03695174

Sensor locations on the right side and top of the engine

- |  |   |                                    |
|--|---|------------------------------------|
| (11) NRS inlet temperature sensor                            | (14) NRS inlet pressure sensor              | (17) Secondary speed/timing sensor |
| (12) NRS valve including a position sensor                   | (15) Wastegate regulator                    |                                    |
| (13) NOx Reduction System (NRS) differential pressure sensor | (16) Exhaust Back Pressure Regulator (EBPR) |                                    |

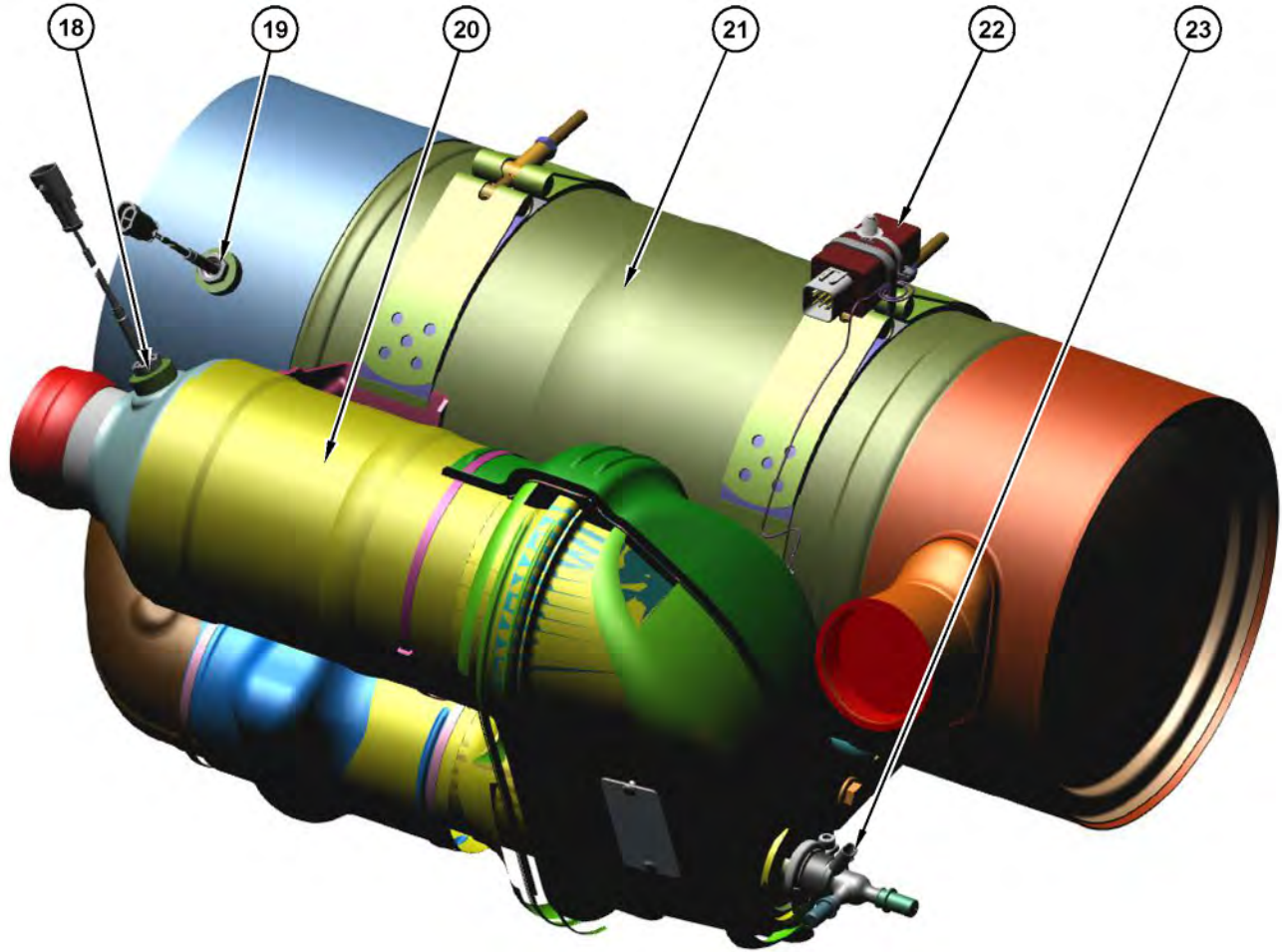


Illustration 9

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Sensors and components on the DOC/SCR aftertreatment

- (18) DOC inlet temperature sensor
- (19) SCR intake temperature sensor
- (20) Diesel Oxidation Catalyst (DOC)

- (21) Selective Catalytic Reduction (SCR) filter
- (22) Aftertreatment ID module

- (23) Diesel Exhaust Fluid (DEF) injector



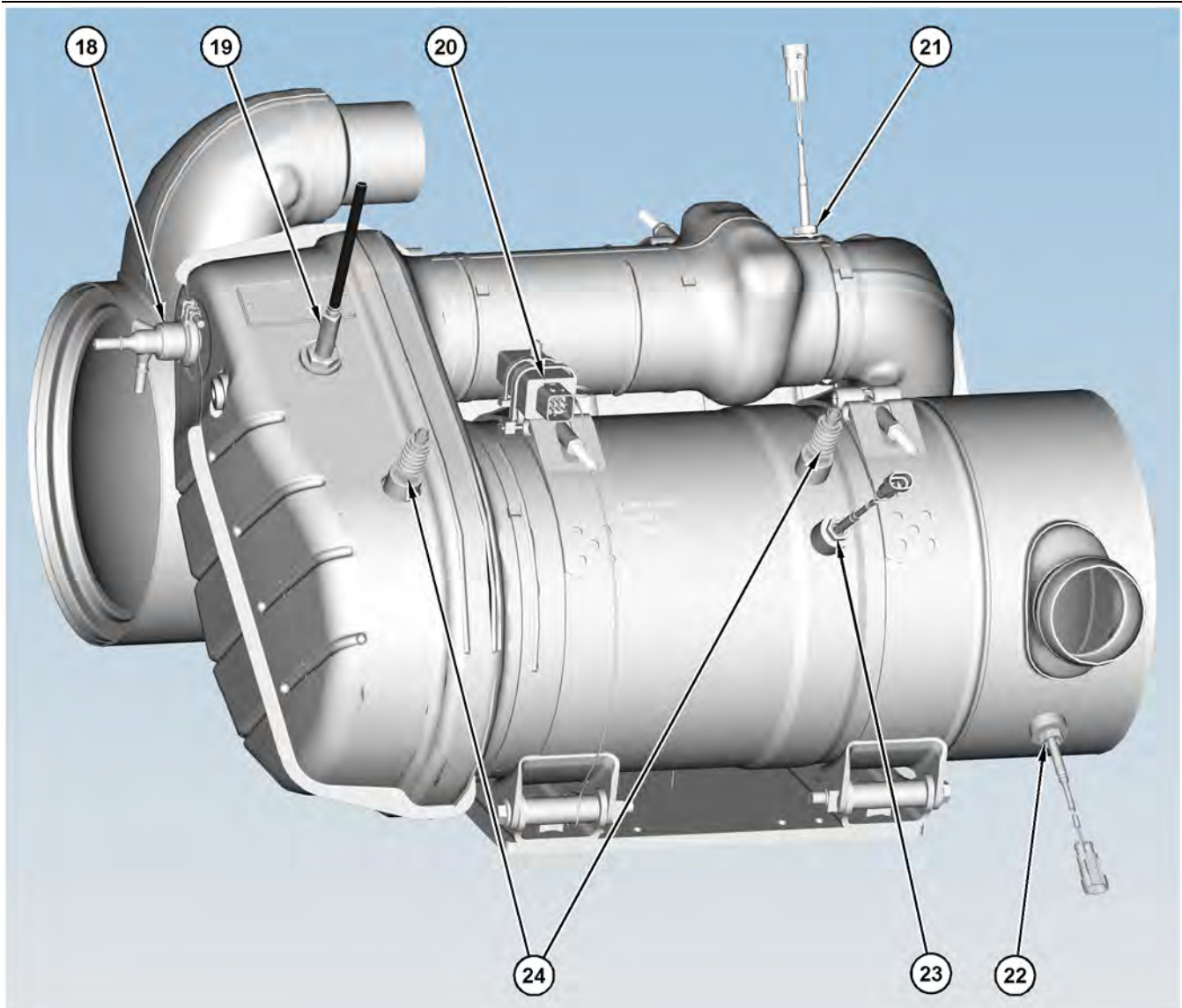


Illustration 10

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## Sensors and components on the DOC/DPF/SCR aftertreatment

(18) DEF injector  
 (19) DPF outlet NOx Sensor  
 (20) Aftertreatment ID module

(21) SCR intake temperature sensor  
 (22) DOC intake temperature sensor  
 (23) DPF intake temperature probe

(24) Soot sensor antennas

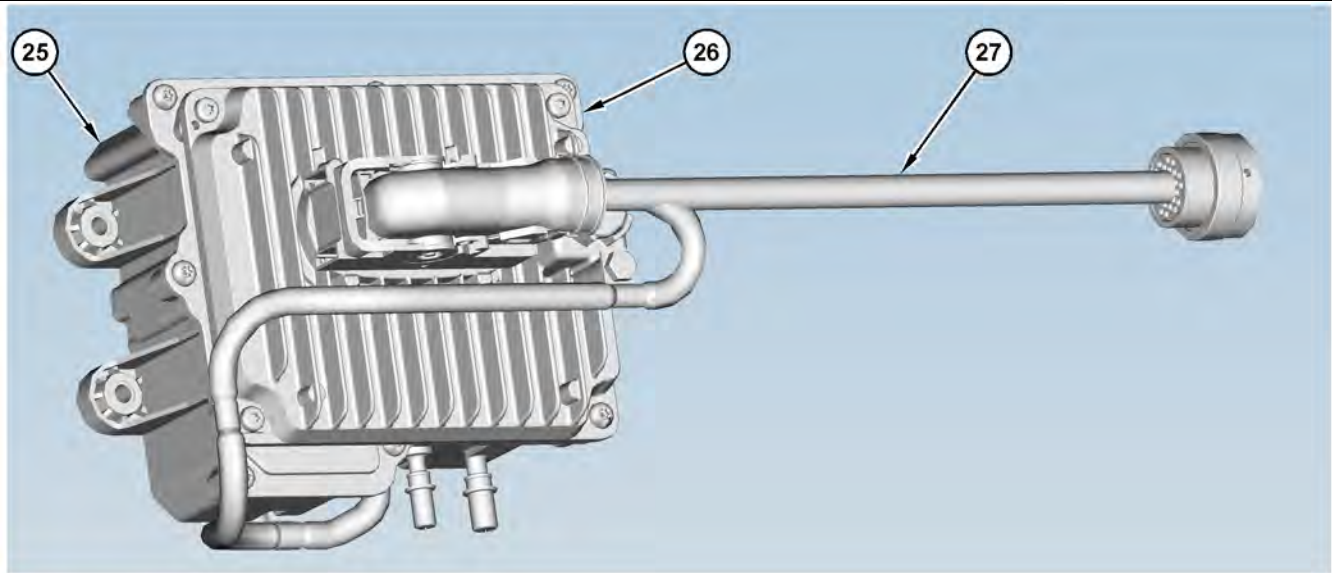


Illustration 11

g03695769

### Components on the Pump and Electronics Unit (PEU)

(25) Diesel Exhaust Fluid (DEF) pump  
 (26) Dosing Control Unit (DCU)

(27) Pump and Electronics Unit (PEU)  
 harness

i06926368

For additional information on the SCR system, refer to Systems Operation/Testing and Adjusting.

## Diesel Particulate Filter Regeneration

### Regeneration

**Note:** This section is only applicable to engines that have a Diesel Particulate Filter (DPF).

The Diesel Particulate Filter (DPF) traps both soot and ash. Regeneration is the removal of soot from the DPF.

For additional information on the regeneration of the DPF, refer to Systems Operation/Testing and Adjusting.

### Selective Catalyst Reduction (SCR)

The SCR system is used to reduce the amount of NO<sub>x</sub> emission from the engine. The SCR system is used during normal engine operation. The SCR catalyst should not have to be cleaned or serviced. A problem with the SCR system will cause a diagnostic or event code to become active.

## Engine Monitoring System

The Electronic Control Module (ECM) provides a comprehensive, programmable engine monitoring system for this engine. The ECM monitors specific engine operating parameters in order to detect abnormal conditions that may develop. The ECM will generate an event code if a specific engine parameter exceeds an acceptable range that is defined by the engine monitoring system. The ECM will react with an action that is dependent on the severity of the condition. For information on event codes, refer to Troubleshooting, "Event Codes".

The following actions may be initiated by the ECM. These actions are dependent on the severity of the condition.

- Illumination of a warning lamp or warning alarm
- Engine derate
- Engine shutdown

Three possible responses may be available for each parameter. Some of the responses are not available for some of the parameters. Refer to Table 6 .

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Table 6

Warning Category Indicator	Severity
(1)	Least Severe
(2)	Moderate Severity
(3)	Most Severe

Use the electronic service tool to perform the following activities for the monitoring system:

- Viewing parameters
- Parameter programming
- Set delay times

The default settings for the parameters are programmed at the factory. To accommodate unique applications and sites, some of the parameters may be reprogrammed with the electronic service tool. Use the electronic service tool to modify the monitoring system parameters.

**Note:** Some parameters do not require a password in order to be changed. Other parameters can be changed with customer passwords. Certain parameters are protected by factory passwords. Some parameters cannot be changed. Some applications do not allow any changes to the programmable monitoring system. Parameters that are protected by factory passwords can only be changed by dealer personnel.

## Viewing or Changing the Settings of the Monitoring System

Use the following procedure in order to view the parameter settings and/or change the parameter settings:

1. Select the “Service/Monitoring System” screen on the electronic service tool.

**Note:** Ensure that you select the correct ECM for the parameters that are being changed before continuing.

2. Highlight the desired parameter. Then click the “Change” button in the lower left corner of the screen.  
The “Change Monitor System” screen will appear.
3. Change the “State” of the parameter.
4. Set the “Trip Point” and the “Delay Time” according to the “Allowed Values” that are displayed in the lower half of the screen.
5. Click the “OK” button.

If a password is required, the “Enter Passwords” screen will appear. Enter the correct passwords and then click the “OK” button.

**Note:** If a factory password is required, the “Enter Factory Passwords” screen will appear. Refer to Troubleshooting, “Factory Passwords” for information on obtaining factory passwords.

The new settings will be effective immediately.

**Note:** Factory passwords are only available to service technicians from an authorized Perkins distributor. Customers of Perkins do not have access to the Factory Password System (FPS).

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## Diagnostic Capabilities

### Diagnostic Codes

The engines Electronic Control Module (ECM) can monitor the circuitry between the ECM and the engines components. The ECM can also monitor the engines operating conditions. If the ECM detects a problem, a code is generated.

There are two categories of codes:

- Diagnostic code
- Event code

**Diagnostic Code** – A diagnostic code indicates an electrical problem such as a short circuit or an open circuit in the engines wiring or in an electrical component.

**Event Code** – An event code is generated by the detection of an abnormal engine operating condition. For example, an event code will be generated if the oil pressure is too low. In this case, the event code indicates the symptom of a problem. Generally, event codes indicate abnormal operating conditions or mechanical problems rather than electrical problems.

Codes can have two different states:

- Active
- Logged

### Active Codes

An active code indicates that a problem is present. Service the active code first. For the appropriate troubleshooting procedure for a particular code, refer to the following troubleshooting procedure:

- Troubleshooting, “Diagnostic Trouble Codes”
- Troubleshooting, “Event Codes”

**Logged Codes**

The codes are logged and stored in the ECM memory. The problem may have been repaired and/or the problem may no longer exist. If the system is powered, an active diagnostic code may be generated whenever a component is disconnected. If the component is reconnected, the code is no longer active but the code may become logged.

Logged codes may not indicate that a repair is needed. The problem may have been temporary. Logged codes may be useful to help troubleshoot intermittent problems. Logged codes can also be used to review the performance of the engine and of the electronic system.

An additional status screen is available for the Enhanced Troubleshooting Indicator ETI. The screen is accessed through the electronic service tool.

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**Electrical Connectors**

**Connectors for the Electronic Control Module (ECM)**

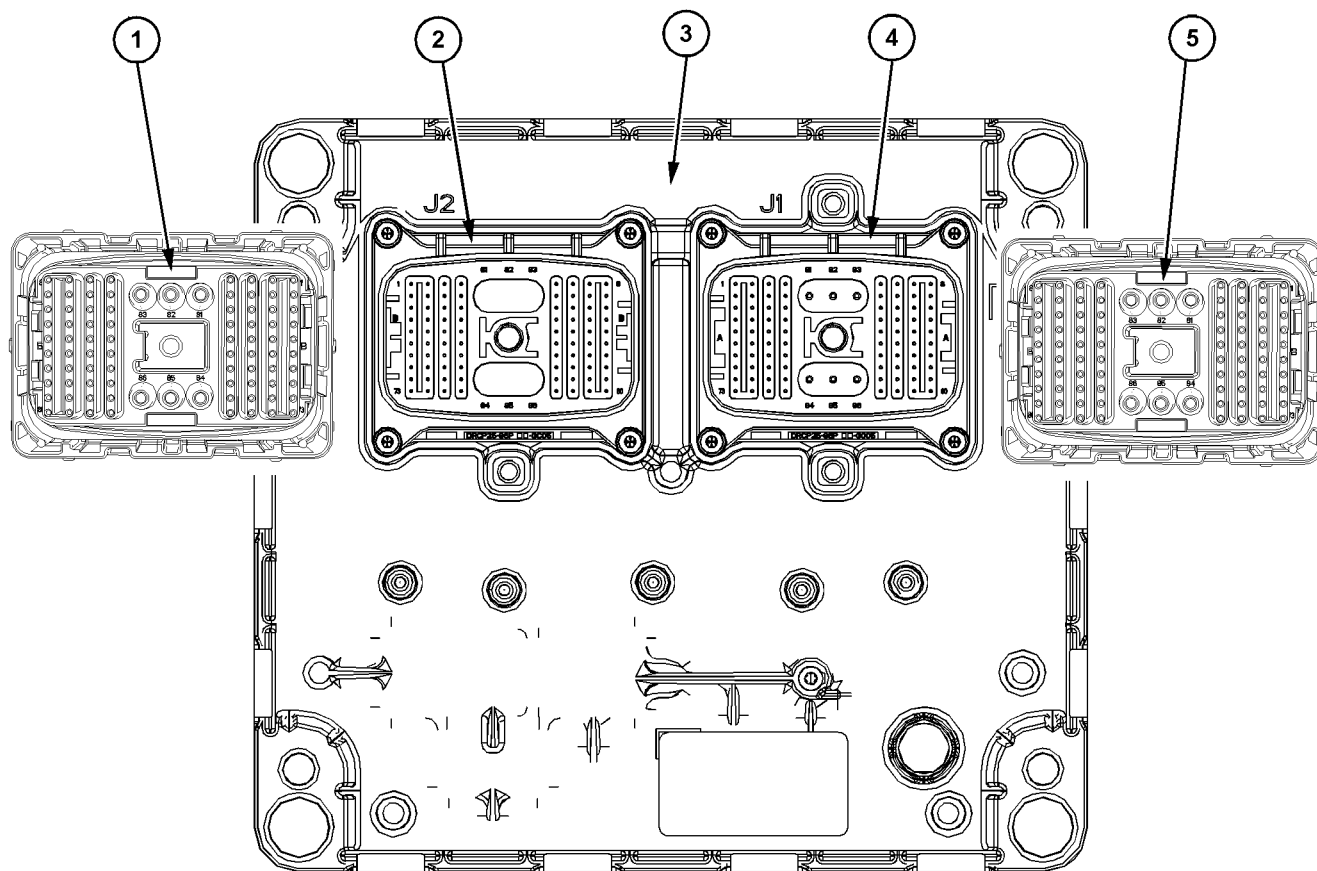


Illustration 12

Locations of the connectors on the engine ECM

- (1) P2 ECM connector (harness side)
- (2) J2 ECM connector (ECM side)
- (3) Engine ECM
- (4) J1 ECM connector (ECM side)
- (5) P1 ECM connector (harness side)

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The Electronic Control Module (ECM) uses connectors that have 86 terminals to interface to the wiring harness.

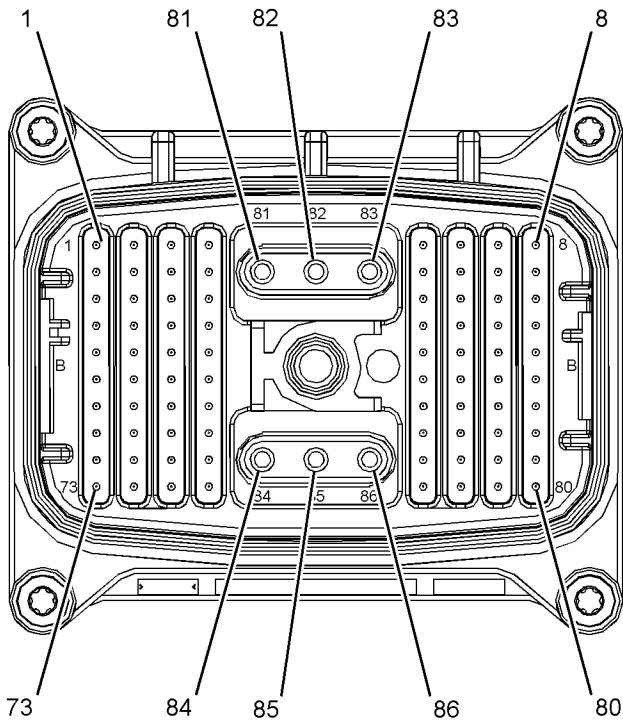


Illustration 13

g03068976

Layout of the ECM connector pins

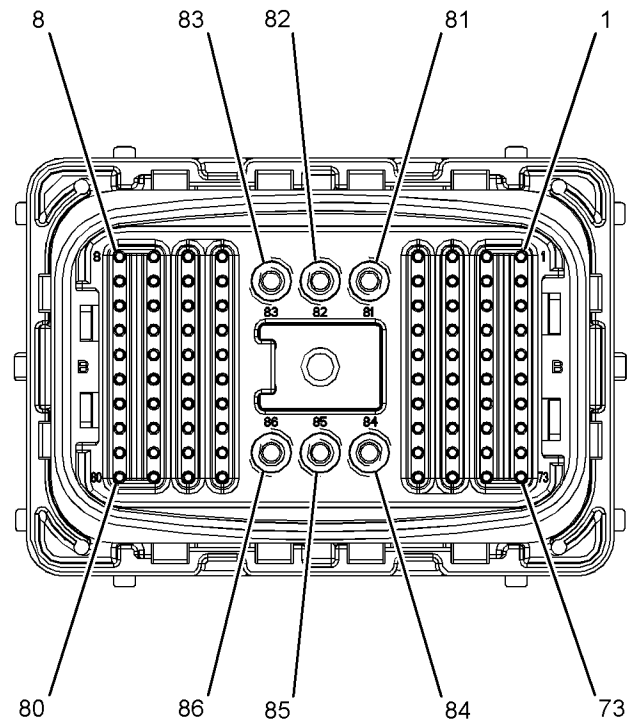


Illustration 14

g03069016

Layout of the harness connector pins

The pins on the harness connectors are not serviceable. If a pin or the connector is damaged, the harness must be replaced.

## Connectors on the Pump and Electronics Unit (PEU)

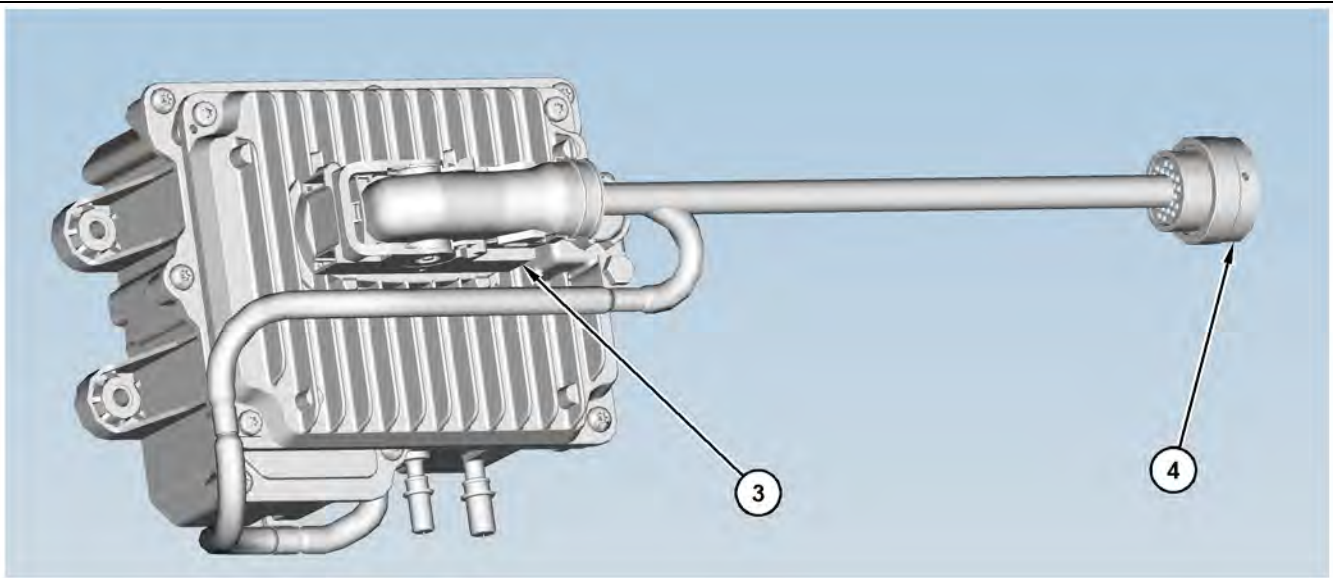


Illustration 15

g03789278

### Locations of the connectors on the PEU

- (3) Connector for the Dosing Control Unit (DCU)      (4) 31-pin interface connector

### Injector Connectors

#### Connectors at the valve cover

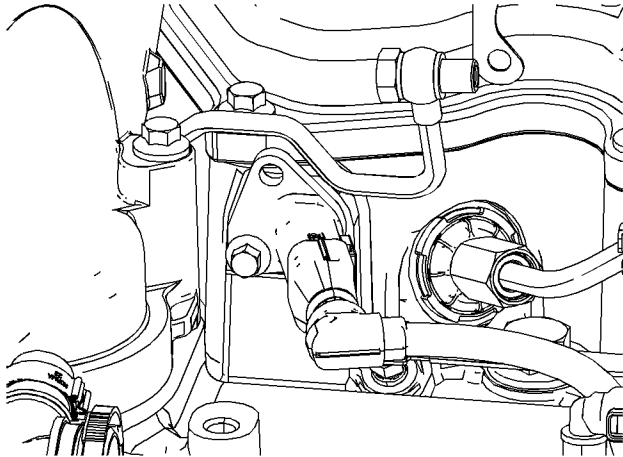


Illustration 16

g03789439

### Sensor Connectors

#### Analog Sensor Connector (active)

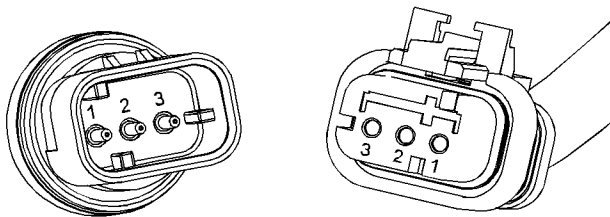


Illustration 17

g01240891

#### Analog Sensor Connector (passive)

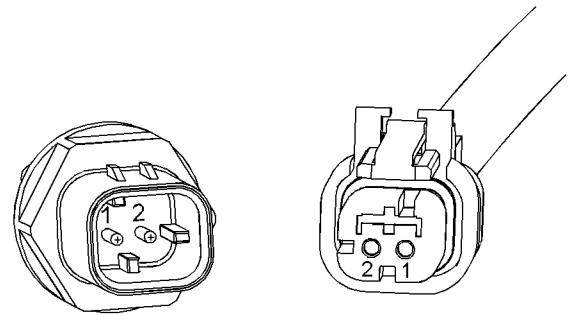


Illustration 18

g01241538

#### Connectors for the Termination Resistor

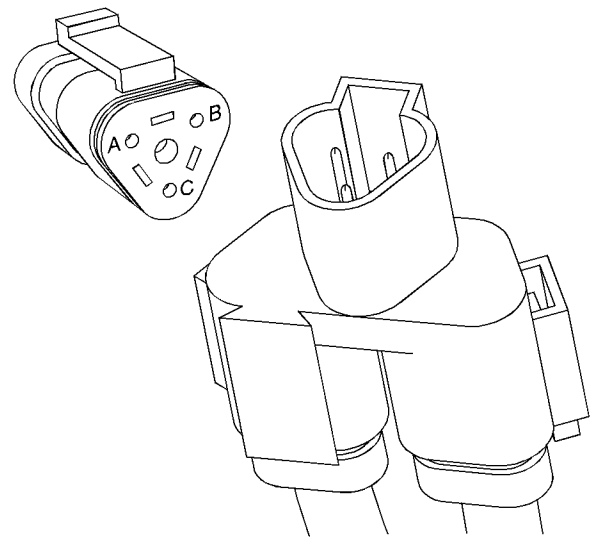


Illustration 19

g01355248

#### Engine Speed/Timing Connector

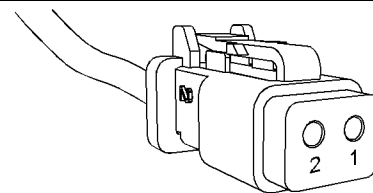


Illustration 20

g01155187

### Ampseal Connector (typical)

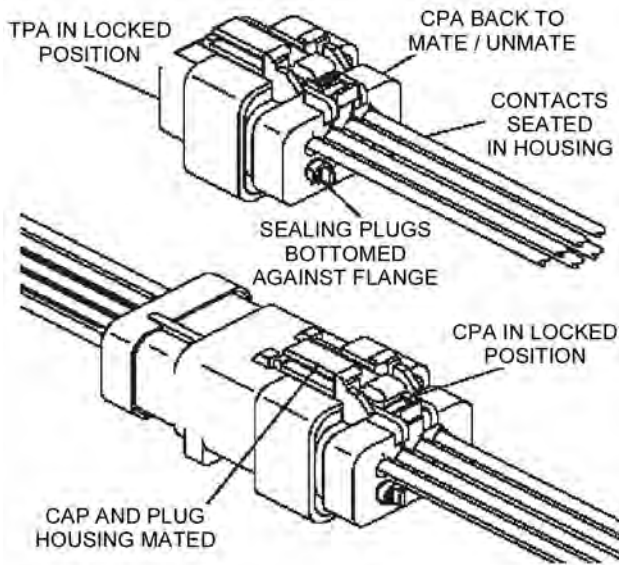


Illustration 21 g02219254

### Deutsch Connectors (typical)

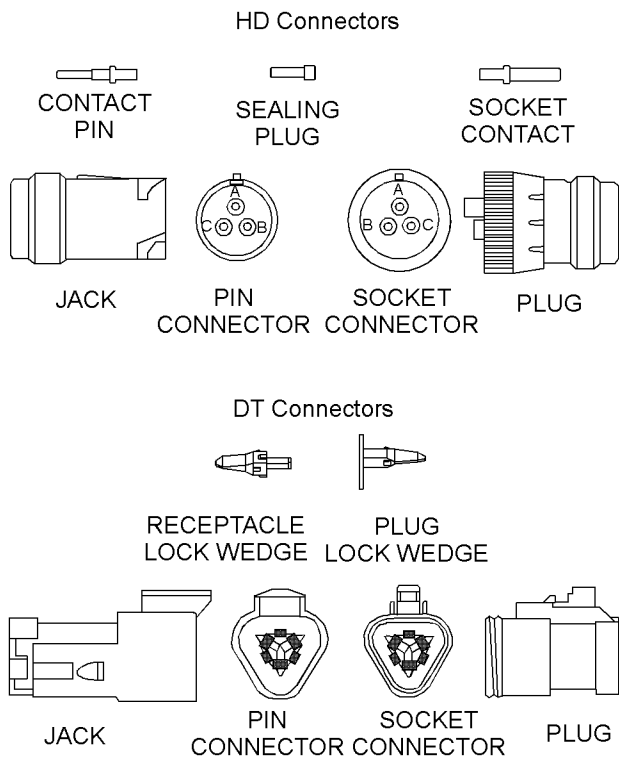


Illustration 22 g02220494

# Configuration Parameters

i07118203

## Configuration Parameters

Use this procedure if the diagnostic code in Table 7 is active.

Table 7

Codes That Relate to Configuration Parameters			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
630-2	268-2	Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	The engine Electronic Control Module (ECM) detects that one or more of the programmable parameters have not been programmed. The ECM may use a default torque map or the ECM may limit the engine to low idle. The code is active only.
Follow the troubleshooting procedure to identify the root cause of the problem.			

The electronic service tool can be used to view certain parameters that can affect the operation of the engine. The electronic service tool can also be used to change certain parameters. Some parameters cannot be changed and some applications do not allow any changes to the programmable monitoring system. The parameters are stored in the Electronic Control Module (ECM). Some of the parameters are protected from unauthorized changes by passwords. Parameters that can be changed have a tattletale number. The tattletale number shows if a parameter has been changed.

The parameters are divided into two different types:

**Customer Specified Parameters** – Customer passwords may be required to change the values of customer specified parameters.

**System Configuration Parameters** – System configuration parameters affect the emissions of the engine or the power of the engine. Factory passwords may be required to change the values of system configuration parameters.

## Configuration Parameters

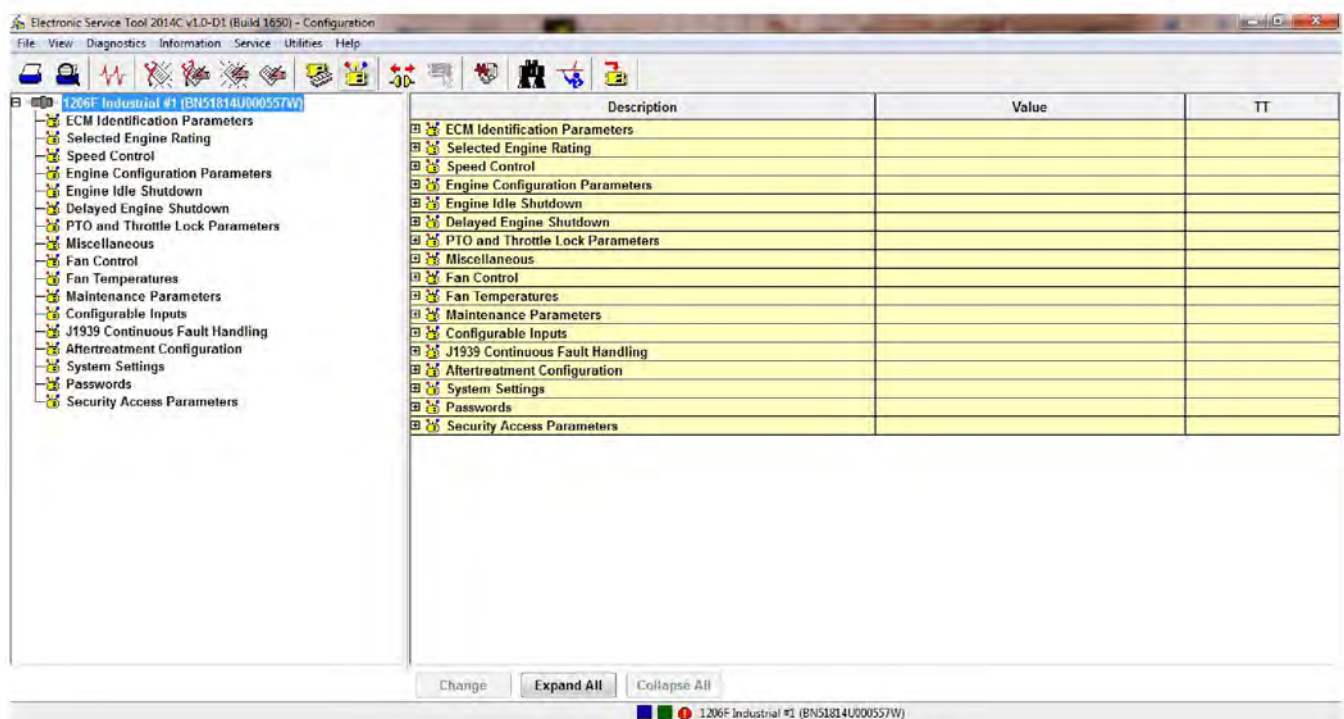


Illustration 23

g03747092

## Typical configuration screen

1. Connect to the electronic service tool.
2. Select the Service tab.
3. Select the Configuration tab to view the configuration parameters.

If an ECM is replaced, the appropriate parameters must be copied from the old ECM. Copy the parameters with the "Copy Configuration" feature of the electronic service tool. The "Copy Configuration" tab is below the "Configuration" tab. Alternatively, the settings can be recorded on paper and then programmed into the configuration screen for the new module.

## NOTICE

Changing the parameters during engine operation can cause the engine to operate erratically and can cause engine damage.

Only change the settings of the parameters when the engine is STOPPED.

## Check Programmable Parameters (630-2/268-2)

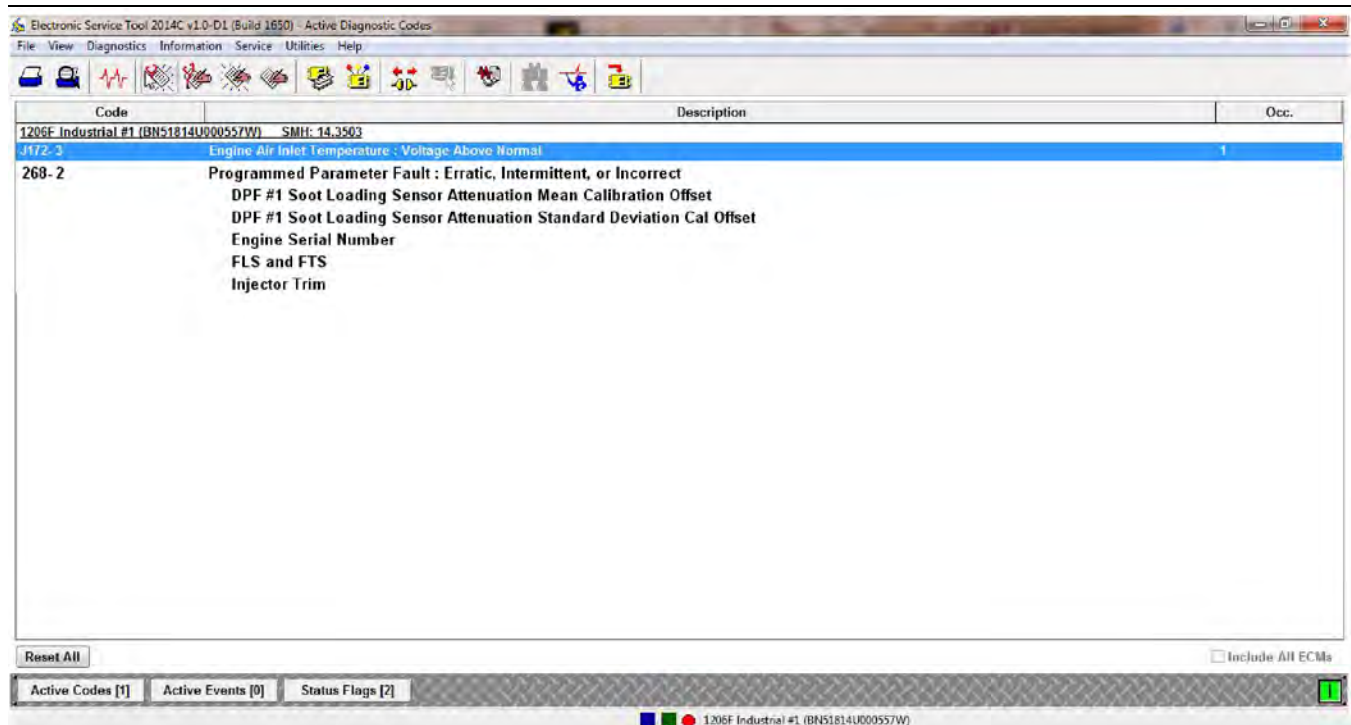


Illustration 24

g03747100

Typical active diagnostic codes screen

If a programmable parameter has not been programmed, the ECM will generate a 268-2 or 630-2 diagnostic code. The programmable parameter that is not programmed will be listed under the code. Illustration 24 shows the parameters that are not programmed under the 268-2 code. The unprogrammed parameters will be set to default. Certain aspects of the engines performance and engine monitoring may be affected.

If “Injector Trim” is displayed below a 268-2 or 630-2 diagnostic code on the electronic service tool, refer to Troubleshooting, “Injector Code - Calibrate”.

## Diagnostic Trouble Codes

i07742521

### Diagnostic Trouble Codes

#### Diagnostic Trouble Codes in J1939 Order

Table 8 lists the diagnostic trouble codes that apply to the engines that are covered in this manual. The codes are listed in J1939 order. Use the electronic service tool to determine the codes that are active or logged. Then refer to the appropriate troubleshooting procedure for more information.

Table 8

List of Diagnostic Trouble Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
27-3 EGR #1 Valve Position : Voltage Above Normal	3407-3 EGR Valve Position Sensor : Voltage Above Normal	Troubleshooting, "Valve Position - Test"
27-4 EGR #1 Valve Position : Voltage Below Normal	3407-4 EGR Valve Position Sensor : Voltage Below Normal	Troubleshooting, "Valve Position - Test"
29-2 Accelerator Pedal Position #2 : Erratic, Intermittent, or Incorrect	774-2 Secondary Throttle Position Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, "Switch Circuits - Test (Multiposition Throttle Switch)"
29-3 Accelerator Pedal Position #2 : Voltage Above Normal	774-3 Secondary Throttle Position Sensor : Voltage Above Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"
29-4 Accelerator Pedal Position #2 : Voltage Below Normal	774-4 Secondary Throttle Position Sensor : Voltage Below Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"
29-8 Accelerator Pedal Position #2 : Abnormal Frequency, Pulse Width, or Period	774-8 Secondary Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed Control - Test (PWM)"
91-2 Accelerator Pedal Position #1 : Erratic, Intermittent, or Incorrect	91-2 Throttle Position Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, "Switch Circuits - Test (Multiposition Throttle Switch)"
91-3 Accelerator Pedal Position #1 : Voltage Above Normal	91-3 Throttle Position Sensor : Voltage Above Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"
91-4 Accelerator Pedal Position #1 : Voltage Below Normal	91-4 Throttle Position Sensor : Voltage Below Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"

(continued)



(Table 8, contd)

91-8 Accelerator Pedal Position #1 : Abnormal Frequency, Pulse Width, or Period	91-8 Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed Control - Test (PWM)"
97-3 Water In Fuel Indicator : Voltage Above Normal	3547-3 Water in Fuel System Switch : Voltage Above Normal	Troubleshooting, "Water in Fuel - Test"
100-3 Engine Oil Pressure : Voltage Above Normal	100-3 Engine Oil Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-4 Engine Oil Pressure : Voltage Below Normal	100-4 Engine Oil Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
105-3 Engine Intake Manifold #1 Temperature : Voltage Above Normal	172-3 Intake Manifold Air Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
105-4 Engine Intake Manifold #1 Temperature : Voltage Below Normal	172-4 Intake Manifold Air Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
107-3 Engine Air Filter 1 Differential Pressure : Voltage Above Normal	582-3 Air Filter Differential Pressure Switch : Voltage Above Normal	Troubleshooting, "Switch Circuits - Test (Air Filter Restriction Switch)"
107-4 Engine Air Filter 1 Differential Pressure : Voltage Below Normal	582-4 Air Filter Differential Pressure Switch : Voltage Below Normal	Troubleshooting, "Switch Circuits - Test (Air Filter Restriction Switch)"
108-3 Barometric Pressure : Voltage Above Normal	3528-3 Barometric Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
108-4 Barometric Pressure : Voltage Below Normal	3528-4 Barometric Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
110-3 Engine Coolant Temperature : Voltage Above Normal	110-3 Engine Coolant Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
110-4 Engine Coolant Temperature : Voltage Below Normal	110-4 Engine Coolant Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
157-3 Engine Injector Metering Rail #1 Pressure : Voltage Above Normal	1797-3 Fuel Rail Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
157-4 Engine Injector Metering Rail #1 Pressure : Voltage Below Normal	1797-4 Fuel Rail Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
157-12 Engine Injector Metering Rail #1 Pressure : Failure	1797-12 Fuel Rail Pressure Sensor : Failure	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
168-3 Battery Potential / Power Input #1 : Voltage Above Normal	168-3 Electrical System Voltage : Voltage Above Normal	Troubleshooting, "Electrical Power Supply - Test"
168-4 Battery Potential / Power Input #1 : Voltage Below Normal	168-4 Electrical System Voltage : Voltage Below Normal	Troubleshooting, "Electrical Power Supply - Test"

(continued)

## Diagnostic Trouble Codes

(Table 8, contd)

172-3 Engine Air Inlet Temperature : Voltage Above Normal	2526-3 Air Inlet Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
172-4 Engine Air Inlet Temperature : Voltage Below Normal	2526-4 Air Inlet Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
174-3 Engine Fuel Temperature 1 : Voltage Above Normal	174-3 Fuel Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
174-4 Engine Fuel Temperature 1 : Voltage Below Normal	174-4 Fuel Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
190-8 Engine Speed : Abnormal Frequency, Pulse Width, or Period	190-8 Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed/Timing - Test"
411-2 Engine Exhaust Gas Recirculation Differential Pressure : Erratic, Intermittent, or Incorrect	3387-2 EGR Differential Pressure Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
411-3 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Above Normal	3387-3 EGR Differential Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
411-4 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Below Normal	3387-4 EGR Differential Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
411-13 Engine Exhaust Gas Recirculation Differential Pressure : Out of Calibration	3387-13 EGR Differential Pressure Sensor : Out of Calibration	Troubleshooting, "Sensor Calibration Required - Test"
412-3 Engine Exhaust Gas Recirculation Temperature : Voltage Above Normal	3386-3 EGR Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
412-4 Engine Exhaust Gas Recirculation Temperature : Voltage Below Normal	3386-4 EGR Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
558-2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	91-0 Throttle Switch not released	Troubleshooting, "Idle Validation - Test"
558-2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	1634-2 Idle Validation Switch #1 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Idle Validation - Test"
626-5 Engine Start Enable Device 1 : Current Below Normal	2417-5 Ether Injection Control Solenoid : Current Below Normal	Troubleshooting, "Ether Starting Aid - Test"
626-6 Engine Start Enable Device 1 : Current Above Normal	2417-6 Ether Injection Control Solenoid : Current Above Normal	Troubleshooting, "Ether Starting Aid - Test"
630-2 Calibration Memory : Erratic, Intermittent, or Incorrect	268-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	Troubleshooting, "Configuration Parameters"

(continued)

(Table 8, contd)

631-2 Calibration Module : Erratic, Intermittent, or Incorrect	253-2 Personality Module : Erratic, Intermittent, or Incorrect	Troubleshooting, "ECM Software - Install"
637-11 Engine Timing Sensor : Other Failure Mode	261-11 Engine Timing Offset fault	Troubleshooting, "Speed/Timing - Test"
639-9 J1939 Network #1 : Abnormal Update Rate	247-9 SAE J1939 Data Link : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
639-14 J1939 Network #1 : Special Instruction	247-14 SAE J1939 Data Link : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
647-5 Engine Fan Clutch Output Device Driver : Current Below Normal	—	Troubleshooting, "Cooling Fan Control - Test (Viscous Clutch Fan)"
647-6 Engine Fan Clutch Output Device Driver : Current Above Normal	—	Troubleshooting, "Cooling Fan Control - Test (Viscous Clutch Fan)"
649-5 Engine Exhaust Back Pressure Regulator Control Command : Current Below Normal	3512-5 Engine Exhaust Back Pressure Regulator : Current Below Normal	Troubleshooting, "Motorized Valve - Test"
649-6 Engine Exhaust Back Pressure Regulator Control Command : -Current Above Normal	3512-6 Engine Exhaust Back Pressure Regulator : Current Above Normal	Troubleshooting, "Motorized Valve - Test"
651-2 Engine Injector Cylinder #01 : Erratic, Intermittent, or Incorrect	1-2 Cylinder #1 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
651-5 Engine Injector Cylinder #01 : Current Below Normal	1-5 Cylinder #1 Injector : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
651-6 Engine Injector Cylinder #01 : Current Above Normal	1-6 Cylinder #1 Injector : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
652-2 Engine Injector Cylinder #02 : Erratic, Intermittent, or Incorrect	2-2 Cylinder #2 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
652-5 Engine Injector Cylinder #02 : Current Below Normal	2-5 Cylinder #2 Injector : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
652-6 Engine Injector Cylinder #02 : Current Above Normal	2-6 Cylinder #2 Injector : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
653-2 Engine Injector Cylinder #03 : Erratic, Intermittent, or Incorrect	3-2 Cylinder #3 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
653-5 Engine Injector Cylinder #03 : Current Below Normal	3-5 Cylinder #3 Injector : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
653-6 Engine Injector Cylinder #03 : Current Above Normal	3-6 Cylinder #3 Injector : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"

(continued)

## Diagnostic Trouble Codes

(Table 8, contd)

654-2 Engine Injector Cylinder #04 : Erratic, Intermittent, or Incorrect	4-2 Cylinder #4 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
654-5 Engine Injector Cylinder #04 : Current Below Normal	4-5 Cylinder #4 Injector : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
654-6 Engine Injector Cylinder #04 : Current Above Normal	4-6 Cylinder #4 Injector : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
676-5 Engine Glow Plug Relay : Current Below Normal	2246-5 Glow Plug Start Aid Relay : Current Below Normal	Troubleshooting, "Glow Plug Starting Aid - Test"
676-6 Engine Glow Plug Relay : Current Above Normal	2246-6 Glow Plug Start Aid Relay : Current Above Normal	Troubleshooting, "Glow Plug Starting Aid - Test"
678-3 ECU 8 Volts DC Supply : Voltage Above Normal	41-3 8 Volt DC Supply : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
678-4 ECU 8 Volts DC Supply : Voltage Below Normal	41-4 8 Volt DC Supply : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
723-8 Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width, or Period	342-8 Secondary Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed/Timing - Test"
1075-5 Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	3666-5 Engine Fuel Supply Lift Pump Relay : Current Below Normal	Troubleshooting, "Fuel Transfer Pump - Test"
1075-6 Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	3666-6 Engine Fuel Supply Lift Pump Relay : Current Above Normal	Troubleshooting, "Fuel Transfer Pump - Test"
1076-5 Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	18-5 Fuel Control Valve : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
1076-6 Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	18-6 Fuel Control Valve : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
1176-3 Engine Turbocharger #1 Compressor Inlet Pressure : Voltage Above Normal	2738-3 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analaog, Active) - Test"
1176-4 Engine Turbocharger #1 Compressor Inlet Pressure : Voltage Below Normal	2738-4 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analaog, Active) - Test"
1188-5 Engine Turbocharger #1 Wastegate Drive : Current Below Normal	526-5 Turbo Wastegate Drive : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
1188-6 Engine Turbocharger #1 Wastegate Drive : Current Above Normal	526-6 Turbo Wastegate Drive : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"

(continued)

(Table 8, contd)

1235-9 J1939 Network #3 : Abnormal Update Rate	5856-9 SAE J1939 Data Link #3 : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
1235-14 J1939 Network #3 : Special Instruction	5856-14 SAE J1939 Data Link #3 : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
1761-2 Aftertreatment #1 DEF Tank Volume : Erratic, Intermittent, or Incorrect	3130-2 Aftertreatment #1 DEF Tank #1 Level Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, "DEF Tank Sensor - Test"
1761-12 Aftertreatment #1 DEF Tank Volume : Failure	3130-12 Aftertreatment #1 DEF Tank #1 Level Sensor : Failure	Troubleshooting, "DEF Tank Sensor - Test"
2791-5 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	3405-5 EGR Valve Control : Current Below Normal	Troubleshooting, "Motorized Valve - Test"
2791-6 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	3405-6 EGR Valve Control : Current Above Normal	Troubleshooting, "Motorized Valve - Test"
2882-2 Engine Alternate Rating Select : Erratic, Intermittent, or Incorrect	1743-2 Engine Operation Mode Selector Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, "Mode Selection - Test"
2970-2 Accelerator Pedal #2 Low Idle Switch : Erratic, Intermittent, or Incorrect	1635-2 Idle Validation Switch #2 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Idle Validation - Test"
3031-12 Aftertreatment #1 DEF Tank Temperature : Failure	3134-12 Aftertreatment #1 DEF Tank #1 Temperature Sensor : Failure	Troubleshooting, "DEF Tank Sensor - Test"
3216-5 Aftertreatment #1 Intake NOx : Current Below Normal	3002-5 Engine Exhaust NOx Level Sensor : Current Below Normal	Troubleshooting, "Electrical Power Supply - Test"
3216-6 Aftertreatment #1 Intake NOx : Current Above Normal	3002-6 Engine Exhaust NOx Level Sensor : Current Above Normal	Troubleshooting, "Electrical Power Supply - Test"
3216-11 Aftertreatment #1 Intake NOx : Other Failure Mode	3002-11 Engine Exhaust NOx Level Sensor : Other Failure Mode	Troubleshooting, "Sensor (Data Link Type) - Test"
3216-12 Aftertreatment #1 Intake NOx : Failure	3002-12 Engine Exhaust NOx Level Sensor : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3226-5 Aftertreatment #1 Outlet NOx : Current Below Normal	3609-5 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Below Normal	Troubleshooting, "Electrical Power Supply - Test"
3226-6 Aftertreatment #1 Outlet NOx : Current Above Normal	3609-6 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Above Normal	Troubleshooting, "Electrical Power Supply - Test"
3226-11 Aftertreatment #1 Outlet NOx : Other Failure Mode	3609-11 Aftertreatment #1 Outlet #1 NOx Level Sensor : Other Failure Mode	Troubleshooting, "Sensor (Data Link Type) - Test"

(continued)

## Diagnostic Trouble Codes

(Table 8, contd)

3226-12 Aftertreatment #1 Outlet NOx : Failure	3609-12 Aftertreatment #1 Outlet #1 NOx Level Sensor : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3242-3 Aftertreatment #1 DPF Intake Gas Temperature : Voltage Above Normal	2452-3 DPF #1 Intake Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3242-4 Aftertreatment #1 DPF Intake Gas Temperature : Voltage Below Normal	2452-4 DPF #1 Intake Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3358-3 Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Above Normal	3385-3 EGR Intake Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3358-4 Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Below Normal	3385-4 EGR Intake Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3358-13 Engine Exhaust Gas Recirculation Inlet Pressure : Out of Calibration	3385-13 EGR Intake Pressure Sensor : Out of Calibration	Troubleshooting, "Sensor Calibration Required - Test"
3360-3 Aftertreatment #1 DEF Controller : Voltage Above Normal	3820-3 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Above Normal	Troubleshooting, "Electrical Power Supply - Test"
3360-4 Aftertreatment #1 DEF Controller : Voltage Below Normal	3820-4 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Below Normal	Troubleshooting, "Electrical Power Supply - Test"
3360-9 Aftertreatment #1 DEF Controller : Abnormal Update Rate	3820-9 Aftertreatment #1 Diesel Exhaust Fluid Controller : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
3360-14 Aftertreatment #1 DEF Controller : Special Instruction	3820-14 Aftertreatment #1 Diesel Exhaust Fluid Controller : Special Instruction	Troubleshooting, "Data link Configuration Status - Test"
3361-5 Aftertreatment #1 DEF Dosing Unit : Current Below Normal	3821-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3361-6 Aftertreatment #1 DEF Dosing Unit : Current Above Normal	3821-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3363-5 Aftertreatment #1 DEF Tank Heater : Current Below Normal	3126-5 Aftertreatment #1 DEF Tank #1 Heater Coolant Diverter Solenoid : Current Be- low Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3363-6 Aftertreatment #1 DEF Tank Heater : Current Above Normal	3126-6 Aftertreatment #1 DEF Tank #1 Heater Coolant Diverter Solenoid : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3509-3 Sensor Supply Voltage 1 : Voltage Above Normal	262-3 5 Volt Sensor DC Power Supply : Volt- age Above Normal	Troubleshooting, "Sensor Supply - Test"

(continued)

(Table 8, contd)

3509-4 Sensor Supply Voltage 1 : Voltage Below Normal	262-4 5 Volt Sensor DC Power Supply : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
3510-3 Sensor Supply Voltage 2 : Voltage Above Normal	2131-3 5 Volt Sensor DC Power Supply #2 : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
3510-4 Sensor Supply Voltage 2 : Voltage Below Normal	2131-4 5 Volt Sensor DC Power Supply #2 : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
3511-3 Sensor Supply Voltage 3 : Voltage Above Normal	3482-3 Sensor Supply #3 : Voltage Above Normal	Troubleshooting, "DEF Pump Sensor Supply - Test"
3511-4 Sensor Supply Voltage 3 : Voltage Below Normal	3482-4 Sensor Supply #3 : Voltage Below Normal	Troubleshooting, "DEF Pump Sensor Supply - Test"
3512-3 Sensor Supply Voltage 4 : Voltage Above Normal	3483-3 Sensor Supply #4 : Voltage Above Normal	Troubleshooting, "Speed/Timing - Test"
3512-4 Sensor Supply Voltage 4 : Voltage Below Normal	3483-4 Sensor Supply #4 : Voltage Below Normal	Troubleshooting, "Speed/Timing - Test"
3516-2 Aftertreatment #1 DEF Concentration : Erratic, Intermittent, or Incorrect (Only 2017- Engines / Engines with DQS Enabled)	3100-2 Aftertreatment #1 DEF Tank Fluid Quality Sensor : Erratic, Intermittent, or Incorrect (Only 2017- Engines / Engines with DQS Enabled)	Troubleshooting, "Sensor (Data Link Type) - Test"
3516-12 Aftertreatment #1 DEF Concentration : Failure	3100-12 Aftertreatment #1 DEF Tank Fluid Quality Sensor : Failure	Troubleshooting, "DEF Concentration Is Incorrect"
3563-3 Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	1785-3 Intake Manifold Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3563-4 Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	1785-4 Intake Manifold Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3563-13 Engine Intake Manifold #1 Absolute Pressure : Out of Calibration	1785-13 Intake Manifold Pressure Sensor : Out of Calibration	Troubleshooting, "Sensor Calibration Required - Test"
4212-5 Engine Cooling Fan Solenoid : Current Below Normal	-	Troubleshooting, "Cooling Fan Control - Test (Hydraulic Driven Fan)"
4212-6 Engine Cooling Fan Solenoid : Current Above Normal	-	Troubleshooting, "Cooling Fan Control - Test (Hydraulic Driven Fan)"
4334-3 Aftertreatment #1 DEF #1 Pressure (absolute) : Voltage Above Normal	3090-3 Aftertreatment #1 DEF Pressure Sensor : Voltage Above Normal	Troubleshooting, "DEF Pump Pressure Sensor - Test"
4334-4 Aftertreatment #1 DEF #1 Pressure (absolute) : Voltage Below Normal	3090-4 Aftertreatment #1 DEF Pressure Sensor : Voltage Below Normal	Troubleshooting, "DEF Pump Pressure Sensor - Test"

(continued)

## Diagnostic Trouble Codes

(Table 8, contd)

4334-20 Aftertreatment #1 DEF #1 Pressure (absolute) : Data Drifted High	3090-20 Aftertreatment #1 DEF Pressure Sensor : Data Drifted High	Troubleshooting, "DEF Pump Pressure Sensor - Test"
4334-21 Aftertreatment #1 DEF #1 Pressure (absolute) : Data Drifted Low	3090-21 Aftertreatment #1 DEF Pressure Sensor : Data Drifted Low	Troubleshooting, "DEF Pump Pressure Sensor - Test"
4354-5 Aftertreatment #1 DEF Line Heater #1 : Current Below Normal	3110-5 Aftertreatment #1 DEF Line Heater #1 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
4354-6 Aftertreatment #1 DEF Line Heater #1 : Current Above Normal	3110-6 Aftertreatment #1 DEF Line Heater #1 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
4355-5 Aftertreatment #1 DEF Line Heater #2 : Current Below Normal	3111-5 Aftertreatment #1 DEF Line Heater #2 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
4355-6 Aftertreatment #1 DEF Line Heater #2 : Current Above Normal	3111-6 Aftertreatment #1 DEF Line Heater #2 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
4356-5 Aftertreatment #1 DEF Line Heater #3 : Current Below Normal	3112-5 Aftertreatment #1 DEF Line Heater #3 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
4356-6 Aftertreatment #1 DEF Line Heater #3 : Current Above Normal	3112-6 Aftertreatment #1 DEF Line Heater #3 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
4360-3 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Above Normal	3105-3 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
4360-4 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Below Normal	3105-4 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
4360-20 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Data Drifted High	3105-20 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Data Drifted High	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
4374-5 Aftertreatment #1 DEF Pump #1 Motor Speed : Current Below Normal	3118-5 Aftertreatment #1 DEF Pump Motor Speed Sensor : Current Below Normal	Troubleshooting, "DEF Pump - Test"
4374-6 Aftertreatment #1 DEF Pump #1 Motor Speed : Current Above Normal	3118-6 Aftertreatment #1 DEF Pump Motor Speed Sensor : Current Above Normal	Troubleshooting, "DEF Pump - Test"
4377-12 Aftertreatment #1 Outlet NH3 : Failure	3138-12 Aftertreatment #1 Outlet NH3 Sensor : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
4380-2 Aftertreatment 1 Outlet NH3 Gas Sensor Power In Range : Erratic, Intermittent, or Incorrect	4592-2 Aftertreatment #1 Outlet NH3 Sensor Power Supply : Erratic, Intermittent, or Incorrect	Troubleshooting, "Electrical Power Supply - Test"
4765-3 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Voltage Above Normal	3956-3 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"

(continued)



(Table 8, contd)

4765-4 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Voltage Below Normal	3956-4 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
4783-3 DPF #1 Mean Soot Signal : Voltage Above Normal	3397-3 DPF #1 Soot Loading Sensor : Voltage Above Normal	Troubleshooting, "Soot Sensor - Test"
4783-4 DPF #1 Mean Soot Signal : Voltage Below Normal	3397-4 DPF #1 Soot Loading Sensor : Voltage Below Normal	Troubleshooting, "Soot Sensor - Test"
4783-12 DPF #1 Mean Soot Signal : Failure	3397-12 DPF #1 Soot Loading Sensor : Failure	Troubleshooting, "Soot Sensor - Test"
4783-21 DPF #1 Mean Soot Signal : Data Drifted Low	3397-21 DPF #1 Soot Loading Sensor : Data Drifted Low	Troubleshooting, "Soot Sensor - Test"
5298-17 Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	2180-1 Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Conversion Efficiency	Troubleshooting, "Diesel Oxidation Catalyst Has Low Conversion Efficiency"
5576-2 Aftertreatment #1 Identification : Erratic, Intermittent, or Incorrect	3468-2 Aftertreatment #1 Identification Number Module : Erratic, Intermittent, or Incorrect	Troubleshooting, "Aftertreatment Identification Module - Test"
5576-8 Aftertreatment #1 Identification : Abnormal Frequency, Pulse Width, or Period	3468-8 Aftertreatment #1 Identification Number Module : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Aftertreatment Identification Module - Test"
5576-14 Aftertreatment #1 Identification : Special Instruction	3468-14 Aftertreatment #1 Identification Number Module : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
5625-3 Engine Exhaust Back Pressure Regulator Position : Voltage Above Normal	3513-3 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Above Normal	Troubleshooting, "Valve Position - Test"
5625-4 Engine Exhaust Back Pressure Regulator Position : Voltage Below Normal	3513-4 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Below Normal	Troubleshooting, "Valve Position - Test"
5706-5 Aftertreatment #1 Diesel Exhaust Fluid Pump Heater : Current Below Normal	3607-5 Aftertreatment #1 DEF Pump Heater Relay : Current Below Normal	Troubleshooting, "DEF Pump - Test"
5706-6 Aftertreatment #1 Diesel Exhaust Fluid Pump Heater : Current Above Normal	3607-6 -Aftertreatment #1 DEF Pump Heater Relay : Current Above Normal	Troubleshooting, "DEF Pump - Test"
5758-11 Aftertreatment #1 Intake Gas Sensor Power Supply : Other Failure Mode	3621-11 Engine Exhaust NOx Level Sensor Power Supply : Other Failure Mode	Troubleshooting, "Electrical Power Supply - Test"
5759-11 Aftertreatment #1 Outlet Gas Sensor Power Supply : Other Failure Mode	3619-11 Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply : Other Failure Mode	Troubleshooting, "Electrical Power Supply - Test"

(continued)

## Diagnostic Trouble Codes

(Table 8, contd)

5965-5 Aftertreatment #1 DEF Control Module Relay Control : Current Below Normal	3838-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Below Normal	Troubleshooting, "Relay - Test (Aftertreatment Power Relay)"
5965-6 Aftertreatment #1 DEF Control Module Relay Control : Current Above Normal	3838-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Above Normal	Troubleshooting, "Relay - Test (Aftertreatment Power Relay)"
5966-5 Aftertreatment #1 DEF Control Module Power Supply : Current Below Normal	3965-5 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Below Normal	Troubleshooting, "DEF Control Module Power - Test"
5966-6 Aftertreatment #1 DEF Control Module Power Supply : Current Above Normal	3965-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Above Normal	Troubleshooting, "DEF Control Module Power - Test"
6309-5 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply 2 : Current Below Normal	3966-5 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Below Normal	Troubleshooting, "DEF Control Module Power - Test"
6309-6 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply 2 : Current Above Normal	3966-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Above Normal	Troubleshooting, "DEF Control Module Power - Test"
7441-3 Aftertreatment Ambient Air Temperature : Voltage Above Normal	4648-3 Aftertreatment Ambient Air Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
7441-4 Aftertreatment Ambient Air Temperature : Voltage Below Normal	4648-4 Aftertreatment Ambient Air Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"

## Diagnostic Trouble Codes in Perkins Data Link (PDL) Code Order

Table 9 lists the diagnostic trouble codes that apply to the engines that are covered in this manual. The codes are listed in PDL code order. Use the electronic service tool to determine the codes that are active or logged. Then refer to the appropriate troubleshooting procedure for more information.

Table 9

List of Diagnostic Trouble Codes		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
1-2 Cylinder #1 Injector : Erratic, Intermittent, or Incorrect	651-2 Engine Injector Cylinder #01 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
1-5 Cylinder #1 Injector : Current Below Normal	651-5 Engine Injector Cylinder #01 : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
1-6 Cylinder #1 Injector : Current Above Normal	651-6 Engine Injector Cylinder #01 : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"

(continued)

(Table 9, contd)

2-2 Cylinder #2 Injector : Erratic, Intermittent, or Incorrect	652-2 Engine Injector Cylinder #02 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
2-5 Cylinder #2 Injector : Current Below Normal	652-5 Engine Injector Cylinder #02 : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
2-6 Cylinder #2 Injector : Current Above Normal	652-6 Engine Injector Cylinder #02 : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
3-2 Cylinder #3 Injector : Erratic, Intermittent, or Incorrect	653-2 Engine Injector Cylinder #03 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
3-5 Cylinder #3 Injector : Current Below Normal	653-5 Engine Injector Cylinder #03 : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
3-6 Cylinder #3 Injector : Current Above Normal	653-6 Engine Injector Cylinder #03 : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
4-2 Cylinder #4 Injector : Erratic, Intermittent, or Incorrect	654-2 Engine Injector Cylinder #04 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
4-5 Cylinder #4 Injector : Current Below Normal	654-5 Engine Injector Cylinder #04 : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
4-6 Cylinder #4 Injector : Current Above Normal	654-6 Engine Injector Cylinder #04 : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
18-5 Fuel Control Valve : Current Below Normal	1076-5 Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
18-6 Fuel Control Valve : Current Above Normal	1076-6 Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
41-3 8 Volt DC Supply : Voltage Above Normal	678-3 ECU 8 Volts DC Supply : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
41-4 8 Volt DC Supply : Voltage Below Normal	678-4 ECU 8 Volts DC Supply : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
91-0 Throttle Switch not released	558-2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, "Idle Validation - Test"
91-2 Throttle Position Sensor : Erratic, Intermittent, or Incorrect	91-2 Accelerator Pedal Position #1 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Switch Circuits - Test (Multiposition Throttle Switch)"
91-3 Throttle Position Sensor : Voltage Above Normal	91-3 Accelerator Pedal Position #1 : Voltage Above Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"
91-4 Throttle Position Sensor : Voltage Below Normal	91-4 Accelerator Pedal Position #1 : Voltage Below Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"

(continued)

## Diagnostic Trouble Codes

(Table 9, contd)

91-8 Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	91-8 Accelerator Pedal Position #1 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed Control - Test (PWM)"
100-3 Engine Oil Pressure Sensor : Voltage Above Normal	100-3 Engine Oil Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-4 Engine Oil Pressure Sensor : Voltage Below Normal	100-4 Engine Oil Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
110-3 Engine Coolant Temperature Sensor : Voltage Above Normal	110-3 Engine Coolant Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
110-4 Engine Coolant Temperature : Voltage Below Normal	110-4 Engine Coolant Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
168-3 Electrical System Voltage : Voltage Above Normal	168-3 Battery Potential / Power Input #1 : Voltage Above Normal	Troubleshooting, "Electrical Power Supply - Test"
168-4 Electrical System Voltage : Voltage Below Normal	168-4 Battery Potential / Power Input #1 : Voltage Below Normal	Troubleshooting, "Electrical Power Supply - Test"
172-3 Intake Manifold Air Temperature Sensor : Voltage Above Normal	105-3 Engine Intake Manifold #1 Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
172-4 Intake Manifold Air Temperature Sensor : Voltage Below Normal	105-4 Engine Intake Manifold #1 Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
174-3 Fuel Temperature Sensor : Voltage Above Normal	174-3 Engine Fuel Temperature 1 : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
174-4 Engine Fuel Temperature 1 : Voltage Below Normal	174-4 Fuel Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
190-8 Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	190-8 Engine Speed : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed/Timing - Test"
247-9 SAE J1939 Data Link : Abnormal Update Rate	639-9 J1939 Network #1 : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
247-14 SAE J1939 Data Link : Special Instruction	639-14 J1939 Network #1 : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
253-2 Personality Module : Erratic, Intermittent, or Incorrect	631-2 Calibration Module : Erratic, Intermittent, or Incorrect	Troubleshooting, "ECM Software - Install"
261-11 Engine Timing Offset fault	637-11 Engine Timing Sensor : Other Failure Mode	Troubleshooting, "Speed/Timing - Test"
262-3 5 Volt Sensor DC Power Supply : Voltage Above Normal	3509-3 Sensor Supply Voltage 1 : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"

(continued)

(Table 9, contd)

262-4 5 Volt Sensor DC Power Supply : Voltage Below Normal	3509-4 Sensor Supply Voltage 1 : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
268-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	630-2 Calibration Memory : Erratic, Intermittent, or Incorrect	Troubleshooting, "Configuration Parameters"
342-8 Secondary Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	723-8 Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed/Timing - Test"
526-5 Turbo Wastegate Drive : Current Below Normal	1188-5 Engine Turbocharger #1 Wastegate Drive : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
526-6 Turbo Wastegate Drive : Current Above Normal	1188-6 Engine Turbocharger #1 Wastegate Drive : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
582-3 Air Filter Differential Pressure Switch : Voltage Above Normal	107-3 Engine Air Filter 1 Differential Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
582-4 Air Filter Differential Pressure Switch : Voltage Below Normal	107-4 Engine Air Filter 1 Differential Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
774-2 Secondary Throttle Position Sensor : Erratic, Intermittent, or Incorrect	29-2 Accelerator Pedal Position #2 : Erratic, Intermittent, or Incorrect	Troubleshooting, "Switch Circuits - Test (Multiposition Throttle Switch)"
774-3 Secondary Throttle Position Sensor : Voltage Above Normal	29-3 Accelerator Pedal Position #2 : Voltage Above Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"
774-4 Secondary Throttle Position Sensor : Voltage Below Normal	29-4 Accelerator Pedal Position #2 : Voltage Below Normal	Troubleshooting, "Speed Control - Test (Analog) / Speed Control - Test (PWM)"
774-8 Secondary Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	29-8 Accelerator Pedal Position #2 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed Control - Test (PWM)"
1634-2 Idle Validation Switch #1 : Erratic, Intermittent, or Incorrect	558-2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, "Idle Validation - Test"
1635-2 Idle Validation Switch #2 : Erratic, Intermittent, or Incorrect	2970-2 Accelerator Pedal #2 Low Idle Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, "Idle Validation - Test"
1743-2 Engine Operation Mode Selector Switch : Erratic, Intermittent, or Incorrect	2882-2 Engine Alternate Rating Select : Erratic, Intermittent, or Incorrect	Troubleshooting, "Mode Selection - Test"
1785-3 Intake Manifold Pressure Sensor : Voltage Above Normal	3563-3 Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1785-4 Intake Manifold Pressure Sensor : Voltage Below Normal	3563-4 Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"

(continued)

## Diagnostic Trouble Codes

(Table 9, contd)

1785-13 Intake Manifold Pressure Sensor : Out of Calibration	3563-13 Engine Intake Manifold #1 Absolute Pressure : Out of Calibration	Troubleshooting, "Sensor Calibration Required - Test"
1797-3 Fuel Rail Pressure Sensor : Voltage Above Normal	157-3 Engine Injector Metering Rail #1 Pres- sure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1797-4 Fuel Rail Pressure Sensor : Voltage Below Normal	157-4 Engine Injector Metering Rail #1 Pres- sure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1797-12 Fuel Rail Pressure Sensor : Failure	157-12 Engine Injector Metering Rail #1 Pres- sure : Failure	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2131-3 5 Volt Sensor DC Power Supply #2 : Voltage Above Normal	3510-3 Sensor Supply Voltage 2 : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
2131-4 5 Volt Sensor DC Power Supply #2 : Voltage Below Normal	3510-4 Sensor Supply Voltage 2 : Voltage Be- low Normal	Troubleshooting, "Sensor Supply - Test"
2246-5 Glow Plug Start Aid Relay : Current Below Normal	676-5 Engine Glow Plug Relay : Current Be- low Normal	Troubleshooting, "Glow Plug Starting Aid - Test"
2246-6 Glow Plug Start Aid Relay : Current Above Normal	676-6 Engine Glow Plug Relay : Current Above Normal	Troubleshooting, "Glow Plug Starting Aid - Test"
2417-5 Ether Injection Control Solenoid : Cur- rent Below Normal	626-5 Engine Start Enable Device 1 : Cur- rent Below Normal	Troubleshooting, "Ether Starting Aid - Test"
2417-6 Ether Injection Control Solenoid : Cur- rent Above Normal	626-6 Engine Start Enable Device 1 : Cur- rent Above Normal	Troubleshooting, "Ether Starting Aid - Test"
2452-3 DPF #1 Intake Temperature Sensor : Voltage Above Normal	3242-3 Aftertreatment #1 DPF Intake Gas Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2452-4 DPF #1 Intake Temperature Sensor : Voltage Below Normal	3242-4 Aftertreatment #1 DPF Intake Gas Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2526-3 Air Inlet Temperature Sensor : Voltage Above Normal	172-3 Engine Air Inlet Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2526-4 Air Inlet Temperature Sensor : Voltage Below Normal	172-4 Engine Air Inlet Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2738-3 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	1176-3 Engine Turbocharger #1 Compressor Inlet Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2738-4 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	1176-4 Engine Turbocharger #1 Compressor Inlet Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"

(continued)

(Table 9, contd)

3002-5 Engine Exhaust NOx Level Sensor : Current Below Normal	3216-5 Aftertreatment #1 Intake NOx : Cur- rent Below Normal	Troubleshooting, "Electrical Power Supply - Test"
3002-6 Engine Exhaust NOx Level Sensor : Current Above Normal	3216-6 Aftertreatment #1 Intake NOx : Cur- rent Above Normal	Troubleshooting, "Electrical Power Supply - Test"
3002-11 Engine Exhaust NOx Level Sensor : Other Failure Mode	3216-11 Aftertreatment #1 Intake NOx : Other Failure Mode	Troubleshooting, "Sensor (Data Link Type) - Test"
3002-12 Engine Exhaust NOx Level Sensor : Failure	3216-12 Aftertreatment #1 Intake NOx : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3090-3 Aftertreatment #1 DEF Pressure Sen- sor : Voltage Above Normal	4334-3 Aftertreatment #1 DEF #1 Pressure (absolute) : Voltage Above Normal	Troubleshooting, "DEF Pump Pressure Sensor - Test"
3090-4 Aftertreatment #1 DEF Pressure Sen- sor : Voltage Below Normal	4334-4 Aftertreatment #1 DEF #1 Pressure (absolute) : Voltage Below Normal	Troubleshooting, "DEF Pump Pressure Sensor - Test"
3090-20 Aftertreatment #1 DEF Pressure Sen- sor : Data Drifted Low	4334-20 Aftertreatment #1 DEF #1 Pressure (absolute) : Data Drifted Low	Troubleshooting, "DEF Pump Pressure Sensor - Test"
3090-21 Aftertreatment #1 DEF Pressure Sen- sor : Data Drifted Low	4334-21 Aftertreatment #1 DEF #1 Pressure (absolute) : Data Drifted Low	Troubleshooting, "DEF Pump Pressure Sensor - Test"
3100-2 Aftertreatment #1 DEF Tank Fluid Quality Sensor : Erratic, Intermittent, or Incorrect (2017- Engines Only / Engines with DQS Enabled)	3516-2 Aftertreatment #1 DEF Concentration : Erratic, Intermittent, or Incorrect (2017- Engines Only / Engines with DQS Enabled)	Troubleshooting, "Sensor (Data Link Type) - Test"
3100-12 Aftertreatment #1 DEF Tank Fluid Quality Sensor : Failure	3516-12 Aftertreatment #1 DEF Concentration : Failure	Troubleshooting, "DEF Concentration Is Incorrect"
3105-3 Aftertreatment #1 SCR Catalyst In- take Gas Temperature Sensor : Volt- age Above Normal	4360-3 Aftertreatment #1 SCR Catalyst In- take Gas Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3105-4 Aftertreatment #1 SCR Catalyst In- take Gas Temperature Sensor : Volt- age Below Normal	4360-4 Aftertreatment #1 SCR Catalyst In- take Gas Temperature : Voltage Be- low Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3105-20 Aftertreatment #1 SCR Catalyst In- take Gas Temperature Sensor : Data Drifted High	4360-20 Aftertreatment #1 SCR Catalyst In- take Gas Temperature : Data Drifted High	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3110-5 Aftertreatment #1 DEF Line Heater #1 : Current Below Normal	4354-5 Aftertreatment #1 DEF Line Heater #1 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3110-6 Aftertreatment #1 DEF Line Heater #1 : Current Above Normal	4354-6 Aftertreatment #1 DEF Line Heater #1 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"

(continued)

## Diagnostic Trouble Codes

(Table 9, contd)

3111-5 Aftertreatment #1 DEF Line Heater #2 : Current Below Normal	4355-5 Aftertreatment #1 DEF Line Heater #2 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3111-6 Aftertreatment #1 DEF Line Heater #2 : Current Above Normal	4355-6 Aftertreatment #1 DEF Line Heater #2 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
3112-5 Aftertreatment #1 DEF Line Heater #3 : Current Below Normal	4356-5 Aftertreatment #1 DEF Line Heater #3 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3112-6 Aftertreatment #1 DEF Line Heater #3 : Current Above Normal	4356-6 Aftertreatment #1 DEF Line Heater #3 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
3118-5 Aftertreatment #1 DEF Pump Motor Speed Sensor : Current Below Normal	4374-5 Aftertreatment #1 DEF Pump #1 Mo- tor Speed : Current Below Normal	Troubleshooting, "DEF Pump - Test"
3118-6 Aftertreatment #1 DEF Pump Motor Speed Sensor : Current Above Normal	4374-6 Aftertreatment #1 DEF Pump #1 Mo- tor Speed : Current Above Normal	Troubleshooting, "DEF Pump - Test"
3126-5 Aftertreatment #1 DEF Tank #1 Heat- er Coolant Diverter Solenoid : Current Below Normal	3363-5 Aftertreatment #1 DEF Tank Heater : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3126-6 Aftertreatment #1 DEF Tank #1 Heat- er Coolant Diverter Solenoid : Current Above Normal	3363-6 Aftertreatment #1 DEF Tank Heater : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3130-2 Aftertreatment #1 DEF Tank #1 Level Sensor : Erratic, Intermittent, or Incorrect	1761-2 Aftertreatment #1 DEF Tank Volume : Erratic, Intermittent, or Incorrect	Troubleshooting, "DEF Tank Sensor - Test"
3130-12 Aftertreatment #1 DEF Tank #1 Level Sensor : Failure	1761-12 Aftertreatment #1 DEF Tank Volume : Failure	Troubleshooting, "DEF Tank Sensor - Test"
3134-12 Aftertreatment #1 DEF Tank #1 Tem- perature Sensor : Failure	3031-12 Aftertreatment #1 DEF Tank Tempera- ture : Failure	Troubleshooting, "DEF Tank Sensor - Test"
3138-12 Aftertreatment #1 Outlet NH3 Sensor : Failure	4377-12 Aftertreatment #1 Outlet NH3 : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3385-3 EGR Intake Pressure Sensor : Volt- age Above Normal	3358-3 Engine Exhaust Gas Recirculation In- let Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3385-4 EGR Intake Pressure Sensor : Volt- age Below Normal	3358-4 Engine Exhaust Gas Recirculation In- let Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3385-13 EGR Intake Pressure Sensor : Out of Calibration	3358-13 Engine Exhaust Gas Recirculation In- let Pressure : Out of Calibration	Troubleshooting, "Sensor Calibration Required - Test"
3386-3 EGR Temperature Sensor : Voltage Above Normal	412-3 Engine Exhaust Gas Recirculation Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"

(continued)



(Table 9, contd)

3386-4 EGR Temperature Sensor : Voltage Below Normal	412-4 Engine Exhaust Gas Recirculation Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3387-2 EGR Differential Pressure Sensor : Erratic, Intermittent, or Incorrect	411-2 Engine Exhaust Gas Recirculation Differential Pressure : Erratic, Intermittent, or Incorrect	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3387-3 EGR Differential Pressure Sensor : Voltage Above Normal	411-3 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3387-4 EGR Differential Pressure Sensor : Voltage Below Normal	411-4 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3387-13 EGR Differential Pressure Sensor : Out of Calibration	411-13 Engine Exhaust Gas Recirculation Differential Pressure : Out of Calibration	Troubleshooting, "Sensor Calibration Required - Test"
3397-3 DPF #1 Soot Loading Sensor : Voltage Above Normal	4783-3 DPF #1 Mean Soot Signal : Voltage Above Normal	Troubleshooting, "Soot Sensor - Test"
3397-4 DPF #1 Soot Loading Sensor : Voltage Below Normal	4783-3 DPF #1 Mean Soot Signal : Voltage Above Normal	Troubleshooting, "Soot Sensor - Test"
3397-12 DPF #1 Soot Loading Sensor : Failure	4783-12 DPF #1 Mean Soot Signal : Failure	Troubleshooting, "Soot Sensor - Test"
3397-21 DPF #1 Soot Loading Sensor : Data Drifted Low	4783-21 DPF #1 Mean Soot Signal : Data Drifted Low	Troubleshooting, "Soot Sensor - Test"
3405-5 EGR Valve Control : Current Below Normal	2791-5 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	Troubleshooting, "Motorized Valve - Test"
3405-6 EGR Valve Control : Current Above Normal	2791-6 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	Troubleshooting, "Motorized Valve - Test"
3407-3 EGR Valve Position Sensor : Voltage Above Normal	27-3 EGR #1 Valve Position : Voltage Above Normal	Troubleshooting, "Valve Position - Test"
3407-4 EGR Valve Position Sensor : Voltage Below Normal	27-4 EGR #1 Valve Position : Voltage Below Normal	Troubleshooting, "Valve Position - Test"
3468-2 Aftertreatment #1 Identification Number Module : Erratic, Intermittent, or Incorrect	5576-2 Aftertreatment #1 Identification : Erratic, Intermittent, or Incorrect	Troubleshooting, "Aftertreatment Identification Module - Test"
3468-8 Aftertreatment #1 Identification Number Module : Abnormal Frequency, Pulse Width, or Period	5576-8 Aftertreatment #1 Identification : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Aftertreatment Identification Module - Test"

(continued)

## Diagnostic Trouble Codes

(Table 9, contd)

3468-14 Aftertreatment #1 Identification Number Module : Special Instruction	5576-14 Aftertreatment #1 Identification : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
3482-3 Sensor Supply #3 : Voltage Above Normal	3511-3 Sensor Supply Voltage 3 : Voltage Above Normal	Troubleshooting, "DEF Pump Sensor Supply - Test"
3482-4 Sensor Supply #3 : Voltage Below Normal	3511-4 Sensor Supply Voltage 3 : Voltage Below Normal	Troubleshooting, "DEF Pump Sensor Supply - Test"
3483-3 Sensor Supply #4 : Voltage Above Normal	3512-3 Sensor Supply Voltage 4 : Voltage Above Normal	Troubleshooting, "Speed/Timing - Test"
3483-4 Sensor Supply #4 : Voltage Below Normal	3512-4 Sensor Supply Voltage 4 : Voltage Below Normal	Troubleshooting, "Speed/Timing - Test"
3513-3 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Above Normal	5625-3 Engine Exhaust Back Pressure Regulator Position : Voltage Above Normal	Troubleshooting, "Valve Position - Test"
3513-4 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Below Normal	5625-4 Engine Exhaust Back Pressure Regulator Position : Voltage Below Normal	Troubleshooting, "Valve Position - Test"
3528-3 Barometric Pressure Sensor : Voltage Above Normal	108-3 Barometric Pressure : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3528-4 Barometric Pressure Sensor : Voltage Below Normal	108-4 Barometric Pressure : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3547-3 Water in Fuel System Switch : Voltage Above Normal	97-3 Water In Fuel Indicator : Voltage Above Normal	Troubleshooting, "Water in Fuel - Test"
3607-5 Aftertreatment #1 DEF Pump Heater Relay : Current Below Normal	5706-5 Aftertreatment #1 Diesel Exhaust Fluid Pump Heater : Current Below Normal	Troubleshooting, "DEF Pump - Test"
3607-6 Aftertreatment #1 DEF Pump Heater Relay : Current Above Normal	5706-6 Aftertreatment #1 Diesel Exhaust Fluid Pump Heater : Current Above Normal	Troubleshooting, "DEF Pump - Test"
3609-5 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Below Normal	3226-5 Aftertreatment #1 Outlet NOx : Current Below Normal	Troubleshooting, "Electrical Power Supply - Test"
3609-6 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Above Normal	3226-6 Aftertreatment #1 Outlet NOx : Current Above Normal	Troubleshooting, "Electrical Power Supply - Test"
3609-11 Aftertreatment #1 Outlet #1 NOx Level Sensor : Other Failure Mode	3226-11 Aftertreatment #1 Outlet NOx : Other Failure Mode	Troubleshooting, "Sensor (Data Link Type) - Test"
3609-12 Aftertreatment #1 Outlet #1 NOx Level Sensor : Failure	3226-12 Aftertreatment #1 Outlet NOx : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"

(continued)

(Table 9, contd)

3619-11 Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply : Other Failure Mode	5759-11 Aftertreatment #1 Outlet Gas Sensor Power Supply : Other Failure Mode	Troubleshooting, "Electrical Power Supply - Test"
3621-11 Engine Exhaust NOx Level Sensor Power Supply : Other Failure Mode	5758-11 Aftertreatment #1 Intake Gas Sensor Power Supply : Other Failure Mode	Troubleshooting, "Electrical Power Supply - Test"
3666-5 Engine Fuel Supply Lift Pump Relay : Current Below Normal	1075-5 Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	Troubleshooting, "Fuel Transfer Pump - Test"
3666-6 Engine Fuel Supply Lift Pump Relay : Current Above Normal	1075-6 Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	Troubleshooting, "Fuel Transfer Pump - Test"
3820-3 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Above Normal	3360-3 Aftertreatment #1 DEF Controller : Voltage Above Normal	Troubleshooting, "Electrical Power Supply - Test"
3820-4 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Below Normal	3360-4 Aftertreatment #1 DEF Controller : Voltage Below Normal	Troubleshooting, "Electrical Power Supply - Test"
3820-9 Aftertreatment #1 Diesel Exhaust Fluid Controller : Abnormal Update Rate	3360-9 Aftertreatment #1 DEF Controller : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
3820-14 Aftertreatment #1 Diesel Exhaust Fluid Controller : Special Instruction	3360-14 Aftertreatment #1 DEF Controller : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
3821-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Below Normal	3361-5 Aftertreatment #1 DEF Dosing Unit : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3821-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Above Normal	3361-6 Aftertreatment #1 DEF Dosing Unit : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3838-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Below Normal	5965-5 Aftertreatment #1 DEF Control Module Relay Control : Current Below Normal	Troubleshooting, "Relay - Test (Aftertreatment Power Relay)"
3838-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Above Normal	5965-6 Aftertreatment #1 DEF Control Module Relay Control : Current Above Normal	Troubleshooting, "Relay - Test (Aftertreatment Power Relay)"
3956-3 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature Sensor : Voltage Above Normal	4765-3 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3956-4 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature Sensor : Voltage Below Normal	4765-4 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
3965-5 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Below Normal	5966-5 Aftertreatment #1 DEF Control Module Power Supply : Current Below Normal	Troubleshooting, "DEF Control Module Power - Test"

(continued)

## Diagnostic Trouble Codes

(Table 9, contd)

3965-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Above Normal	5966-6 Aftertreatment #1 DEF Control Module Power Supply : Current Above Normal	Troubleshooting, "DEF Control Module Power - Test"
3966-5 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Below Normal	6309-5 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply 2 : Current Below Normal	Troubleshooting, "DEF Control Module Power - Test"
3966-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Above Normal	6309-6 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply 2 : Current Above Normal	Troubleshooting, "DEF Control Module Power - Test"
4592-2 Aftertreatment #1 Outlet NH3 Sensor Power Supply : Erratic, Intermittent, or Incorrect	4380-2 Aftertreatment 1 Outlet NH3 Gas Sensor Power In Range : Erratic, Intermittent, or Incorrect	Troubleshooting, "Electrical Power Supply - Test"
4648-3 Aftertreatment Ambient Air Temperature Sensor : Voltage Above Normal	7441-3 Aftertreatment Ambient Air Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
4648-4 Aftertreatment Ambient Air Temperature Sensor : Voltage Below Normal	7441-4 Aftertreatment Ambient Air Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
5856-9 SAE J1939 Data Link #3 : Abnormal Update Rate	1235-9 J1939 Network #3 : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
5856-14 SAE J1939 Data Link #3 : Special Instruction	1235-14 J1939 Network #3 : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"

# Event Codes

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## Event Codes

Event codes are generated when abnormal operating conditions exist. A further explanation of event codes and the engine monitoring system is described after Table 11 .

### Event Codes in J1939 Code Order

Table 10 is a list of the event codes for the engine. The event codes are listed in order of J1939 codes. The event codes are cross-referenced with the appropriate procedure that can be used to troubleshoot the code.

Table 10

Event Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
97-15 Water In Fuel Indicator : High - least severe (1)	E232 (1) High Fuel/Water Separator Water Level	Troubleshooting, "Fuel Contains Water"
97-16 Water In Fuel Indicator : High - moderate severity (2)	E232 (2) High Fuel/Water Separator Water Level	Troubleshooting, "Fuel Contains Water"
98-1 Engine Oil Level : Low - most severe (3)	E171 (3) Low Engine Oil Level	Troubleshooting, "Oil Level Is Low"
98-18 Engine Oil Level : Low - moderate severity (2)	E171 (2) Low Engine Oil Level	Troubleshooting, "Oil Level Is Low"
100-1 Engine Oil Pressure : Low - most severe (3)	E360 (3) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
100-17 Engine Oil Pressure : Low - least severe (1)	E360 (1) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
100-18 Engine Oil Pressure : Low - moderate severity (2)	E360 (2) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
102-16 Engine Intake Manifold #1 Pressure : High - moderate severity (2)	E1044 (2) High Intake Manifold Pressure	Troubleshooting, "Intake Manifold Air Pressure Is High"
102-18 Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	E1045 (2) Low Intake Manifold Pressure	Troubleshooting, "Intake Manifold Air Pressure Is Low"

(continued)

## Event Codes

(Table 10, contd)

Event Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
105-0 Engine Intake Manifold #1 Temperature : High - most severe (3)	E539 (3) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
105-15 Engine Intake Manifold #1 Temperature : High - least severe (1)	E539 (1) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
105-16 Engine Intake Manifold #1 Temperature : High - moderate severity (2)	E539 (2) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
107-15 Engine Air Filter 1 Differential Pressure : High - least severe (1)	E583 (1) High Engine Air Filter #1 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
107-16 Engine Air Filter 1 Differential Pressure : High - moderate severity (2)	E583 (2) High Engine Air Filter #1 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
110-0 Engine Coolant Temperature : High - most severe (3)	E361 (3) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
110-15 Engine Coolant Temperature : High - least severe (1)	E361 (1) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
110-16 Engine Coolant Temperature : High - moderate severity (2)	E361 (2) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
111-1 Engine Coolant Level : Low - most severe (3)	E2143 (3) Low Engine Coolant Level	Troubleshooting, "Coolant Level Is Low"
111-17 Engine Coolant Level : Low - least severe (1)	E2143 (1) Low Engine Coolant Level	Troubleshooting, "Coolant Level Is Low"
111-18 Engine Coolant Level : Low - moderate severity (2)	E2143 (2) Low Engine Coolant Level	Troubleshooting, "Coolant Level Is Low"
157-16 Engine Injector Metering Rail #1 Pressure : High - moderate severity (2)	E396 (2) High Fuel Rail Pressure	Troubleshooting, "Fuel Rail Pressure Problem"
157-18 Engine Injector Metering Rail #1 Pressure : Low - moderate severity (2)	E398 (2) Low Fuel Rail Pressure	Troubleshooting, "Fuel Rail Pressure Problem"
174-16 Engine Fuel Temperature 1 : High - moderate severity (2)	E363 (2) High Fuel Supply Temperature	Troubleshooting, "Fuel Temperature Is High"
190-0 Engine Speed : High - most severe (3)	E362 (3) Engine Overspeed	Troubleshooting, "Engine Overspeeds"

(continued)

(Table 10, contd)

Event Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
190-15 Engine Speed : High - least severe (1)	E362 (1) Engine Overspeed	Troubleshooting, "Engine Overspeeds"
412-15 Engine Exhaust Gas Recirculation Temperature : High - least severe (1)	E1092 (1) High EGR Temperature	Troubleshooting, "NRS Exhaust Gas Temperature Is High"
412-16 Engine Exhaust Gas Recirculation Temperature : High - moderate severity (2)	E1092 (2) High EGR Temperature	Troubleshooting, "NRS Exhaust Gas Temperature Is High"
593-31 Engine Idle Shutdown has Shutdown Engine	E1171 (1) Engine Idle Shutdown Occurred	This code indicates that an engine idle shutdown has occurred. This code does not represent a fault.
594-31 Engine Idle Shutdown Driver Alert Mode	E1172 (3) Engine Idle Shutdown Pending	This code indicates that an engine idle shutdown is about to occur. This code does not represent a fault.
649-7 Engine Exhaust Back Pressure Regulator Control Command : Not Responding Properly	E1263 (2) Engine Exhaust Back Pressure Regulator Not Responding to Command	Troubleshooting, "Motorized Valve - Test"
1239-0 Engine Fuel Leakage 1 : High - most severe (3)	E499 (3) Fuel Rail #1 Pressure Leak	Troubleshooting, "Fuel Rail Pressure Problem"
1639-17 Fan Speed : Low - least severe (1)	E1363 (1) Low Engine Cooling Fan Speed	Troubleshooting, "Cooling fan Speed - Test"
1761-1 Aftertreatment #1 DEF Tank Volume : Low - most severe (3)	E954 (3) Low Aftertreatment #1 DEF Tank #1 Level	Troubleshooting, "DEF Tank Level Is Low"
1761-17 Aftertreatment #1 DEF Tank Volume : Low - least severe (1)	E954 (1) Low Aftertreatment #1 DEF Tank #1 Level	Troubleshooting, "DEF Tank Level Is Low"
1761-18 Aftertreatment #1 DEF Tank Volume : Low - moderate severity (2)	E954 (2) Low Aftertreatment #1 DEF Tank #1 Level	Troubleshooting, "DEF Tank Level Is Low"
2659-7 Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	E1319 (2) EGR Mass Flow Rate Not Responding	Troubleshooting, "NRS Mass Flow Rate Problem"
2791-7 Engine Exhaust Gas Recirculation (EGR) Valve Control : Not Responding Properly	E1121 (2) EGR Valve Control Not Responding to Command	Troubleshooting, "Motorized Valve - Test"
3031-7 Aftertreatment #1 DEF Tank Temperature : Not Responding Properly	E1441 (2) Aftertreatment #1 DEF Tank Temperature Not Responding	Troubleshooting, "DEF Tank Temperature Is Low"

(continued)

## Event Codes

(Table 10, contd)

Event Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
3031-16 Aftertreatment #1 DEF Tank Temperature : High - moderate severity (2)	E960 (2) High Aftertreatment #1 DEF Tank #1 Temperature	Troubleshooting, "DEF Tank Temperature Is High"
3031-18 Aftertreatment #1 DEF Tank Temperature : Low - moderate severity (2)	E1398 (2) Low Aftertreatment #1 DEF Tank #1 Temperature	Troubleshooting, "DEF Tank Temperature Is Low"
3216-7 Aftertreatment #1 Intake NOx : Not Responding Properly	E1431 (2) Invalid Aftertreatment #1 Intake NOx Level	Troubleshooting, "NOx Sensor - Test"
3217-16 Aftertreatment #1 Intake O2 : High - moderate severity (2)	E1407 (2) High Aftertreatment #1 Intake O2 Concentration	Troubleshooting, "Clean Emissions Module Has High Oxygen Level"
3226-7 Aftertreatment #1 Outlet NOx : Not Responding Properly	E1432 (2) Invalid Aftertreatment #1 Outlet #1 NOx Level	Troubleshooting, "NOx Sensor - Test"
3227-16 Aftertreatment #1 Outlet O2 : High - moderate severity (2)	E1408 (2) High Aftertreatment #1 Outlet O2 Concentration	Troubleshooting, "Clean Emissions Module Has High Oxygen Level"
3242-17 Aftertreatment #1 DPF Intake Gas Temperature : Low - least severe (1)	E1014 (1) Low DPF #1 Intake Temperature	Troubleshooting, "Diesel Particulate Filter Temperature Is Low"
3242-18 Aftertreatment #1 DPF Intake Gas Temperature : Low - moderate severity (2)	E1014 (2) Low DPF #1 Intake Temperature	Troubleshooting, "Diesel Particulate Filter Temperature Is Low"
3516-15 Aftertreatment #1 DEF Concentration : High - least severe (1)	E1365 (1) High Aftertreatment #1 DEF Concentration	Troubleshooting, "DEF Concentration Is Incorrect"
3516-18 Aftertreatment #1 DEF Concentration : Low - moderate severity (2)	E1364 (2) Low Aftertreatment #1 DEF Concentration	Troubleshooting, "NOx Conversion is Low"
3719-0 DPF #1 Soot Loading Percent : High - most severe (3)	E995 (3) High DPF #1 Soot Loading	Troubleshooting, "Diesel Particulate Filter Collects Excessive Soot"
3719-16 DPF #1 Soot Loading Percent : High - moderate severity (2)	E995 (2) High DPF #1 Soot Loading	Troubleshooting, "Diesel Particulate Filter Collects Excessive Soot"
4334-16 Aftertreatment #1 DEF #1 Pressure (absolute) : High - moderate severity (2)	E930 (2) High Aftertreatment #1 DEF Pressure	Troubleshooting, "DEF Pressure Is High"
4334-18 Aftertreatment #1 DEF #1 Pressure (absolute) : Low - moderate severity (2)	E931 (2) Low Aftertreatment #1 DEF Pressure	Troubleshooting, "DEF Pressure Is Low"

(continued)



(Table 10, contd)

Event Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
4360-16 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	E946 (2) High Aftertreatment #1 SCR Catalyst Intake Gas Temperature	Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature"
4360-17 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - least severe (1)	E947 (1) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature"
4360-18 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	E947 (2) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature"
4364-2 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	E1410 (2) Invalid Aftertreatment #1 SCR Conversion Efficiency	Troubleshooting, "NOx Sensor - Test"
4364-18 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	E1309 (2) Low Aftertreatment #1 SCR Catalyst Conversion Efficiency	Troubleshooting, "NOx Conversion Is Low"
4765-17 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Low - least severe (1)	E2165 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Intake Gas Temperature	Troubleshooting, "Diesel Oxidation Catalyst Has Incorrect Inlet Temperature"
5246-0 Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	E1389 (3) Aftertreatment #1 SCR Operator Inducement	Troubleshooting, "SCR Warning System Problem"
5246-15 Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	E1389 (1) Aftertreatment #1 SCR Operator Inducement	Troubleshooting, "SCR Warning System Problem"
5246-16 Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	E1389 (2) Aftertreatment #1 SCR Operator Inducement	Troubleshooting, "SCR Warning System Problem"
5298-17 Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	E2180 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Conversion Efficiency	Troubleshooting, "Diesel Oxidation Catalyst Has Low Conversion Efficiency"
5392-31 Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	E1370 (2) Aftertreatment #1 DEF Dosing Unit Loss of Prime	Troubleshooting, "DEF Pressure Does Not Respond"
5571-0 High Pressure Common Rail Fuel Pressure Relief Valve : High - most severe (3)	E1264 (2) High Pressure Common Rail Fuel Pressure Relief Valve Active	Troubleshooting, "Fuel Rail Pressure Problem"
5588-14 Proprietary Network #2 : Special Instruction	E1132 (2) Inconsistent Configuration Detected	Troubleshooting, "Data Link Configuration Status - Test"

(continued)

## Event Codes

(Table 10, contd)

Event Codes		
J1939 Code and Description	PDL Code and Description	Troubleshooting Procedure
7105-31 Aftertreatment #1 Inconsistent Configuration Detected	E1598 (2) Aftertreatment #1 Inconsistent Configuration Detected	Troubleshooting, "NOx Conversion Is Low"
7343-31 SCR Operator Inducement Override Renewal Required	E1598 (2) Engine Emissions Operator Inducement Emergency Override Renewal Required	Troubleshooting, "SCR Inducement Emergency Override"
7440-31 Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	E1645 (1) Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	Troubleshooting, "Diesel Particulate Filter Collects Excessive Soot"

## Event Codes in Perkins Data Link (PDL) Code Order

Table 11 is a list of the event codes for the engine. The event codes are listed in order of PDL codes. The event codes are cross-referenced with the appropriate procedure that can be used to troubleshoot the code.

Table 11

Event Codes		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
E171 (2) Low Engine Oil Level	98-18 Engine Oil Level : Low - moderate severity (2)	Troubleshooting, "Oil Level Is Low"
E171 (3) Low Engine Oil Level	98-1 Engine Oil Level : Low - most severe (3)	Troubleshooting, "Oil Level Is Low"
E232 (1) High Fuel/Water Separator Water Level	97-15 Water In Fuel Indicator : High - least severe (1)	Troubleshooting, "Fuel Contains Water"
E232 (2) High Fuel/Water Separator Water Level	97-16 Water In Fuel Indicator : High - moderate severity (2)	Troubleshooting, "Fuel Contains Water"
E360 (1) Low Engine Oil Pressure	100-17 Engine Oil Pressure : Low - least severe (1)	Troubleshooting, "Oil Pressure Is Low"
E360 (2) Low Engine Oil Pressure	100-18 Engine Oil Pressure : Low - moderate severity (2)	Troubleshooting, "Oil Pressure Is Low"
E360 (3) Low Engine Oil Pressure	100-1 Engine Oil Pressure : Low - most severe (3)	Troubleshooting, "Oil Pressure Is Low"
E361 (1) High Engine Coolant Temperature	110-15 Engine Coolant Temperature : High - least severe (1)	Troubleshooting, "Coolant Temperature Is High"

(continued)

(Table 11, contd)

Event Codes		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
E361 (2) High Engine Coolant Temperature	110-16 Engine Coolant Temperature : High - moderate severity (2)	Troubleshooting, "Coolant Temperature Is High"
E361 (3) High Engine Coolant Temperature	110-0 Engine Coolant Temperature : High - most severe (3)	Troubleshooting, "Coolant Temperature Is High"
E362 (1) Engine Overspeed	190-15 Engine Speed : High - least severe (1)	Troubleshooting, "Engine Overspeeds"
E362 (3) Engine Overspeed	190-0 Engine Speed : High - most severe (3)	Troubleshooting, "Engine Overspeeds"
E363 (2) High Fuel Supply Temperature	174-16 Engine Fuel Temperature 1 : High - moderate severity (2)	Troubleshooting, "Fuel Temperature Is High"
E396 (2) High Fuel Rail Pressure	157-16 Engine Injector Metering Rail #1 Pressure : High - moderate severity (2)	Troubleshooting, "Fuel Rail Pressure Problem"
E398 (2) Low Fuel Rail Pressure	157-18 Engine Injector Metering Rail #1 Pressure : Low - moderate severity (2)	Troubleshooting, "Fuel Rail Pressure Problem"
E499 (3) Fuel Rail #1 Pressure Leak	1239-0 Engine Fuel Leakage 1 : High - most severe (3)	Troubleshooting, "Fuel Rail Pressure Problem"
E539 (1) High Intake Manifold Air Temperature	105-15 Engine Intake Manifold #1 Temperature : High - least severe (1)	Troubleshooting, "Intake Manifold Air Temperature Is High"
E539 (2) High Intake Manifold Air Temperature	105-16 Engine Intake Manifold #1 Temperature : High - moderate severity (2)	Troubleshooting, "Intake Manifold Air Temperature Is High"
E539 (3) High Intake Manifold Air Temperature	105-0 Engine Intake Manifold #1 Temperature : High - most severe (3)	Troubleshooting, "Intake Manifold Air Temperature Is High"
E583 (1) High Engine Air Filter #1 Differential Pressure	107-15 Engine Air Filter 1 Differential Pressure : High - least severe (1)	Troubleshooting, "Inlet Air Is Restricted"
E583 (2) High Engine Air Filter #1 Differential Pressure	107-16 Engine Air Filter 1 Differential Pressure : High - moderate severity (2)	Troubleshooting, "Inlet Air Is Restricted"
E930 (2) High Aftertreatment #1 DEF Pressure	4334-16 Aftertreatment #1 DEF #1 Pressure (absolute) : High - moderate severity (2)	Troubleshooting, "DEF Pressure Is High"
E931 (2) Low Aftertreatment #1 DEF Pressure	4334-18 Aftertreatment #1 DEF #1 Pressure (absolute) : Low - moderate severity (2)	Troubleshooting, "DEF Pressure Is Low"

(continued)

## Event Codes

(Table 11, contd)

Event Codes		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
E946 (2) High Aftertreatment #1 SCR Catalyst Intake Gas Temperature	4360-16 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature"
E947 (1) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	4360-17 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - least severe (1)	Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature"
E947 (2) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	4360-18 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature"
E954 (1) Low Aftertreatment #1 DEF Tank #1 Level	1761-17 Aftertreatment #1 DEF Tank Volume : Low - least severe (1)	Troubleshooting, "DEF Tank Level Is Low"
E954 (2) Low Aftertreatment #1 DEF Tank #1 Level	1761-18 Aftertreatment #1 DEF Tank Volume : Low - moderate severity (2)	Troubleshooting, "DEF Tank Level Is Low"
E954 (3) Low Aftertreatment #1 DEF Tank #1 Level	1761-1 Aftertreatment #1 DEF Tank Volume : Low - most severe (3)	Troubleshooting, "DEF Tank Level Is Low"
E960 (2) High Aftertreatment #1 DEF Tank #1 Temperature	3031-16 Aftertreatment #1 DEF Tank Temperature : High - moderate severity (2)	Troubleshooting, "DEF Tank Temperature Is High"
E995 (2) High DPF #1 Soot Loading	3719-16 DPF #1 Soot Loading Percent : High - moderate severity (2)	Troubleshooting, "Diesel Particulate Filter Collects Excessive Soot"
E995 (3) High DPF #1 Soot Loading	3719-0 DPF #1 Soot Loading Percent : High - most severe (3)	Troubleshooting, "Diesel Particulate Filter Collects Excessive Soot"
E1014 (1) Low DPF #1 Intake Temperature	3242-17 Aftertreatment #1 DPF Intake Gas Temperature : Low - least severe (1)	Troubleshooting, "Diesel Particulate Filter Temperature Is Low"
E1014 (2) Low DPF #1 Intake Temperature	3242-18 Aftertreatment #1 DPF Intake Gas Temperature : Low - moderate severity (2)	Troubleshooting, "Diesel Particulate Filter Temperature Is Low"
E1044 (2) High Intake Manifold Pressure	102-16 Engine Intake Manifold #1 Pressure : High - moderate severity (2)	Troubleshooting, "Intake Manifold Air Pressure Is High"
E1045 (2) Low Intake Manifold Pressure	102-18 Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	Troubleshooting, "Intake Manifold Air Pressure Is Low"
E1092 (1) High EGR Temperature	412-15 Engine Exhaust Gas Recirculation Temperature : High - least severe (1)	Troubleshooting, "NRS Exhaust Gas Temperature Is High"

(continued)

(Table 11, contd)

Event Codes		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
E1092 (2) High EGR Temperature	412-16 Engine Exhaust Gas Recirculation Temperature : High - moderate severity (2)	Troubleshooting, "NRS Exhaust Gas Temperature Is High"
E1121 (2) EGR Valve Control Not Responding to Command	2791-7 Engine Exhaust Gas Recirculation (EGR) Valve Control : Not Responding Properly	Troubleshooting, "Motorized Valve - Test"
E1132 (2) Inconsistent Configuration Detected	5588-14 Proprietary Network #2 : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
E1171 (1) Engine Idle Shutdown Occurred	593-31 Engine Idle Shutdown has Shutdown Engine	This code indicates that an engine idle shutdown has occurred. This code does not represent a fault.
E1172 (3) Engine Idle Shutdown Pending	594-31 Engine Idle Shutdown Driver Alert Mode	This code indicates that an engine idle shutdown is about to occur. This code does not represent a fault.
E1263 (2) Engine Exhaust Back Pressure Regulator Not Responding to Command	649-7 Engine Exhaust Back Pressure Regulator Control Command : Not Responding Properly	Troubleshooting, "Motorized Valve - Test"
E1264 (2) High Pressure Common Rail Fuel Pressure Relief Valve Active	5571-0 High Pressure Common Rail Fuel Pressure Relief Valve : High - most severe (3)	Troubleshooting, "Fuel Rail Pressure Problem"
E1309 (2) Low Aftertreatment #1 SCR Catalyst Conversion Efficiency	4364-18 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	Troubleshooting, "NOx Conversion Is Low"
E1319 (2) EGR Mass Flow Rate Not Responding	2659-7 Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	Troubleshooting, "NRS Mass Flow Rate Problem"
E1363 (1) Low Engine Cooling Fan Speed	1639-17 Fan Speed : Low - least severe (1)	Troubleshooting, "Cooling fan Speed - Test"
E1364 (2) Low Aftertreatment #1 DEF Concentration	3516-18 Aftertreatment #1 DEF Concentration : Low - moderate severity (2)	Troubleshooting, "DEF Concentration Is Incorrect"
E1365 (1) High Aftertreatment #1 DEF Concentration	3516-15 Aftertreatment #1 DEF Concentration : High - least severe (1)	Troubleshooting, "DEF Concentration Is Incorrect"
E1370 (2) Aftertreatment #1 DEF Dosing Unit Loss of Prime	5392-31 Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	Troubleshooting, "DEF Pressure Does Not Respond"
E1389 (1) Aftertreatment #1 SCR Operator Inducement	5246-15 Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	Troubleshooting, "SCR Warning System Problem"

(continued)

## Event Codes

(Table 11, contd)

Event Codes		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
E1389 (2) Aftertreatment #1 SCR Operator Inducement	5246-16 Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	Troubleshooting, "SCR Warning System Problem"
E1389 (3) Aftertreatment #1 SCR Operator Inducement	5246-0 Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	Troubleshooting, "SCR Warning System Problem"
E1398 (2) Low Aftertreatment #1 DEF Tank #1 Temperature	3031-18 Aftertreatment #1 DEF Tank Temperature : Low - moderate severity (2)	Troubleshooting, "DEF Tank Temperature Is Low"
E1407 (2) High Aftertreatment #1 Intake O2 Concentration	3217-16 Aftertreatment #1 Intake O2 : High - moderate severity (2)	Troubleshooting, "Clean Emissions Module Has High Oxygen Level"
E1408 (2) High Aftertreatment #1 Outlet O2 Concentration	3227-16 Aftertreatment #1 Outlet O2 : High - moderate severity (2)	Troubleshooting, "Clean Emissions Module Has High Oxygen Level"
E1410 (2) Invalid Aftertreatment #1 SCR Conversion Efficiency	4364-2 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	Troubleshooting, "NOx Sensor - Test"
E1431 (2) Invalid Aftertreatment #1 Intake NOx Level	3216-7 Aftertreatment #1 Intake NOx : Not Responding Properly	Troubleshooting, "NOx Sensor - Test"
E1432 (2) Invalid Aftertreatment #1 Outlet #1 NOx Level	3226-7 Aftertreatment #1 Outlet NOx : Not Responding Properly	Troubleshooting, "NOx Sensor - Test"
E1441 (2) Aftertreatment #1 DEF Tank Temperature Not Responding	3031-7 Aftertreatment #1 DEF Tank Temperature : Not Responding Properly	Troubleshooting, "DEF Tank Temperature Is Low"
E1598 (2) Engine Emissions Operator Inducement Emergency Override Renewal Required	7343-31 SCR Operator Inducement Override Renewal Required	Troubleshooting, "SCR Inducement Emergency Override"
E1645 (1) Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	7440-31 Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	Troubleshooting, "Diesel Particulate Filter Collects Excessive Soot"
E2143 (2) Low Engine Coolant Level	111-18 Engine Coolant Level : Low - moderate severity (2)	Troubleshooting, "Coolant Level Is Low"
E2143 (3) Low Engine Coolant Level	111-1 Engine Coolant Level : Low - most severe (3)	Troubleshooting, "Coolant Level Is Low"
E2165 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Intake Gas Temperature	4765-17 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Low - least severe (1)	Troubleshooting, "Diesel Oxidation Catalyst Has Incorrect Inlet Temperature"
E2180 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Conversion Efficiency	5298-17 Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	Troubleshooting, "Diesel Oxidation Catalyst Has Low Conversion Efficiency"

## Parts of the Event Code

**Event Code** – “E” identifies the code as an event code. “XXX(X)” represents a numeric identifier for the event code. The fourth “(X)” assigns one of three levels to the active event code according to the severity of the abnormal system condition. Next is a code description. Refer to the following example:

- E360(1) Low Oil Pressure
- E360(2) Low Oil Pressure
- E360(3) Low Oil Pressure

The definition for the levels of severity for an event are defined below:

**Level 1** – Level 1 alerts the operator that an engine system requires attention. The operator should check that the involved system condition or the operator should perform maintenance on the involved system at the earliest possible time.

**Level 2** – Level 2 requires a change in the operation of the engine or the performance of a maintenance procedure. Failure to correct the problem that caused this warning may result in damaged the engine components.

**Level 3** – Level 3 requires an immediate safe shutdown of the engine to avoid damage to the engine or injury to personnel around the engine. The problem that caused the event must be corrected before engine operation can resume.

## Active Event Codes

An active event code represents a problem with engine operation. **Correct the problem as soon as possible.**

Active event codes are listed in ascending numerical order. The code with the lowest number is listed first.

Illustration 25 is an example of the operating range of a sensor.

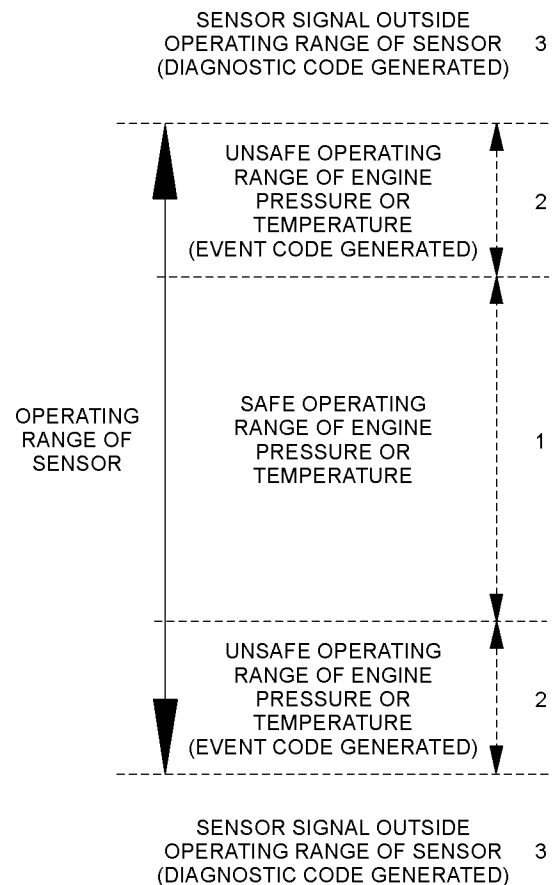


Illustration 25

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### Example of the typical operating range of a sensor

- (1) This area represents the normal operating range of the engine parameter.
- (2) In these areas, the engine is operating in an unsafe operating range of the monitored parameter. An event code will be generated for the monitored parameter. The sensor circuit does not have an electronic problem.
- (3) In these areas, the signal from the sensor is outside of the operating range of the sensor. The sensor circuit has an electronic problem. A diagnostic code will be generated for the sensor circuit. Refer to Troubleshooting, “Diagnostic Trouble Codes” for additional information on diagnostic codes.

## Logged Event Codes

When the Electronic Control Module (ECM) generates an event code, the ECM logs the code in permanent memory. The ECM has an internal diagnostic clock. The ECM will record the following information when an event code is generated:

- The hour of the first occurrence of the code
- The hour of the last occurrence of the code
- The number of occurrences of the code

Logged events are listed in chronological order. The most recent event code is listed first.

This information can be helpful for troubleshooting intermittent problems. Logged codes can also be used to review the performance of the engine.

## Clearing Event Codes

A code is cleared from memory when one of the following conditions occur:

- The code does not recur for 100 hours.
- A new code is logged and there are already ten codes in memory. In this case, the oldest code is cleared.
- The service technician manually clears the code.

Always clear logged event codes after investigating and correcting the problem which generated the code.

## Troubleshooting

For the basic troubleshooting of the engine, perform the following steps to diagnose a malfunction:

1. Obtain the following information about the complaint:
  - The event and the time of the event
  - Determine the conditions for the event. The conditions will include the engine rpm and the load.
  - Determine if there are any systems that were installed by the dealer or by the customer that could cause the event.
  - Determine whether any additional events occurred.
2. Verify that the complaint is not due to normal engine operation. Verify that the complaint is not due to error of the operator.
3. Narrow the probable cause. Consider the operator information, the conditions of operation, and the history of the engine.
4. Perform a visual inspection. Inspect the following items:
  - Fuel supply
  - Oil level
  - Oil supply
  - Wiring
  - Connectors

Be sure to check the connectors. This step is important for problems that are intermittent. Refer to Troubleshooting, "Electrical Connectors - Inspect".

If these steps do not resolve the problem, refer to Table 11 or Table 10 for the procedure to troubleshoot the event code.



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# Symptom Troubleshooting

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## Acceleration Is Poor or Throttle Response Is Poor

### Probable Causes

- Diagnostic codes
- Parameters in the Electronic Control Module (ECM)
- Throttle Signal
- Air intake and exhaust system
- Turbocharger or turbochargers
- Fuel supply
- Valve lash
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

### Recommended Actions

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#### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

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**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

**Note:** If the problem only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high engine speed, full load, and engine operating temperature. Troubleshooting the symptoms under other conditions can give misleading results.

## Symptom Troubleshooting

Table 12

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>Note:</b> Certain diagnostic codes and/or event codes may cause poor performance. Refer to in the electronic service tool.</p> <p><b>A.</b> Use the electronic service tool to check for active or logged codes.</p> <p><b>B.</b> Use the electronic service tool to check the histogram information if the engine has been derated.</p> <p><b>Note:</b> If the histograms contain engine derates and no diagnostic codes are present, then the engine is operating normally.</p>	Engine Derate or Diagnostic Codes	<p><b>Result:</b> A diagnostic code is present.</p> <p><b>Repair:</b> Troubleshoot the code and then reset the histogram.</p> <p><b>Result:</b> A diagnostic code is not present. Proceed to Test Step 2.</p>
<p><b>2. Parameters in the Electronic Control Module (ECM)</b></p> <p><b>A.</b> Use the electronic service tool to verify that the correct parameters are being used. Refer to Troubleshooting, "Configuration Parameters" for additional information.</p>	Parameters	<p><b>Result:</b> The parameters are not correct.</p> <p><b>Repair:</b> Input the correct parameters. Refer to Troubleshooting, "Configuration Parameters" for additional information.</p> <p><b>Result:</b> The parameters are correct.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Throttle Signal</b></p> <p><b>A.</b> Monitor the status for "Throttle Position" on the electronic service tool. Verify that the status for "Throttle Position" is stable and that the engine is able to reach high idle speed.</p>	Throttle signal	<p><b>Result:</b> The throttle signal is stable.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The throttle signal is not stable.</p> <p><b>Repair:</b> Make the necessary repairs, Refer to the appropriate circuit test for the type of speed control that is installed.</p>
<p><b>4. Air Intake and Exhaust System</b></p> <p><b>A.</b> Observe the check engine lamp. Check for an air filter restriction indicator, if equipped. Replace a plugged air filters. Refer to the Operation and Maintenance Manual.</p> <p><b>B.</b> Check the air inlet and exhaust system for restrictions and/or leaks.</p>	Restrictions	<p><b>Result:</b> There are restrictions in the air inlet or exhaust system.</p> <p><b>Repair:</b> Make the necessary repairs, Refer to Systems Operation/Testing and Adjusting, "Air Inlet and Exhaust System - Inspect" for additional information.</p> <p><b>Result:</b> There are no restrictions in the air inlet or exhaust system.</p> <p>For engines with a single turbocharger, proceed to Test Step 5. For engines with two turbochargers, proceed to Test Step 6.</p>

(continued)

(Table 12, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Turbocharger</b></p> <p>This Test Step is applicable to engines with a single turbocharger.</p> <p><b>Note:</b> The turbocharger that is installed on the engine is a non-serviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Ensure that the mounting bolts for the turbocharger are tight.</p> <p><b>B.</b> Check that the oil drain for the turbocharger is not blocked or restricted.</p> <p><b>C.</b> Check that the compressor housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged.</p> <p><b>D.</b> Check that the turbine housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged.</p> <p><b>E.</b> Check that the turbine blades rotate freely in the turbocharger.</p> <p><b>F.</b> Ensure that the wastegate on the turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect". If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p>	<p>Turbocharger</p>	<p><b>Result:</b> There is a fault on the turbocharger.</p> <p><b>Repair:</b> Repair the turbocharger or replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The turbocharger is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>6. Turbochargers</b></p> <p>This Test Step is applicable to engines with twin turbochargers.</p> <p><b>Note:</b> The turbochargers that are installed on the engine are non-serviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Ensure that the mounting bolts for the turbochargers are tight.</p> <p><b>B.</b> Check that the oil drains for the turbochargers are not blocked or restricted.</p> <p><b>C.</b> Check that the compressor housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged.</p> <p><b>D.</b> Check that the turbine housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged.</p> <p><b>E.</b> Check that the turbine blades rotate freely in the turbochargers.</p>	<p>Turbochargers</p>	<p><b>Result:</b> There is a fault on one of the turbochargers.</p> <p><b>Repair:</b> Repair the faulty turbocharger or replace the faulty turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The turbochargers are OK.</p> <p>Proceed to Test Step 7.</p>

(continued)

## Symptom Troubleshooting

(Table 12, contd)

Troubleshooting Test Steps	Values	Results
<p><b>F.</b> Ensure that the wastegate on the high-pressure turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect". If the wastegate actuator is faulty, replace the high-pressure turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p>		
<p><b>7. Fuel Supply</b></p> <p><b>A.</b> Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only.</p> <p><b>B.</b> Ensure that the vent in the fuel cap is not filled with debris.</p> <p><b>C.</b> Ensure that the fuel supply valve (if equipped) is in the full OPEN position.</p> <p><b>D.</b> If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).</p> <p><b>E.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>F.</b> Check for fuel supply lines that are restricted.</p> <p><b>G.</b> Check that the low-pressure fuel lines are tight and secured properly.</p> <p><b>H.</b> Check that the Electric Fuel Lift Pump (EFLP) is operating. If the EFLP is suspect, refer to Troubleshooting, "Fuel Transfer Pump - Test".</p> <p><b>I.</b> Replace the in-line fuel filter that is upstream of the primary fuel filter.</p> <p><b>J.</b> Replace the primary and secondary fuel filters.</p> <p><b>K.</b> Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>L.</b> Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Air in Fuel - Test".</p> <p><b>M.</b> Ensure that the fuel system has been primed. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p>	Fuel system	<p><b>Result:</b> The fuel supply is not OK.</p> <p><b>Repair:</b> Repair the fuel system or replace the fuel system components, as necessary.</p> <p><b>Result:</b> The fuel supply is OK.</p> <p>Proceed to Test Step 8.</p>

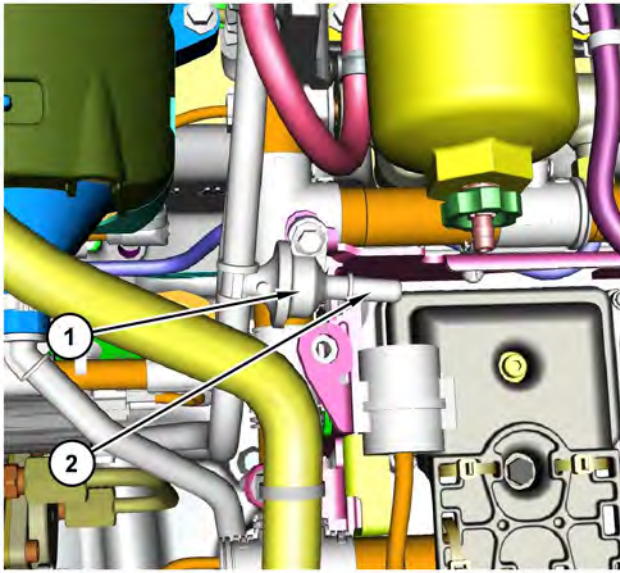


Illustration 26 g03700009  
**Transfer Pump Inlet Regulator (TPIR) components**  
 (1) Transfer Pump Inlet Regulator (TPIR)  
 (2) TPIR return port

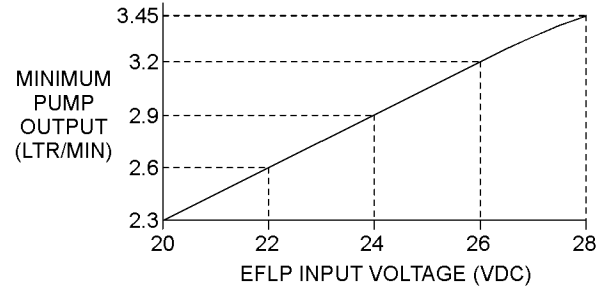


Illustration 28 g02485897  
**Minimum TPIR flow rate in a 24 VDC system**

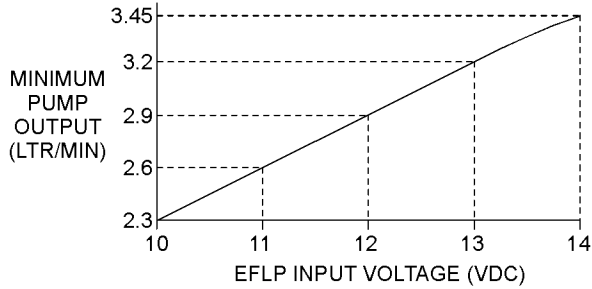


Illustration 27 g02485896  
**Minimum TPIR flow rate in a 12 VDC system**

Table 13

Troubleshooting Test Steps	Values	Results
<p><b>8. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p>Refer to Illustration 26 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 27 or 28 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	<p>TPIR flow rate</p>	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 10.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 9.</p>

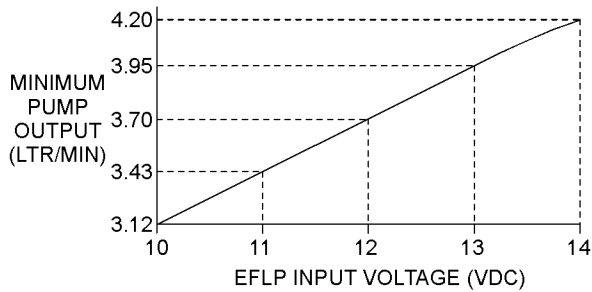


Illustration 29 g02527498  
Minimum EFLP flow rate in a 12 VDC system

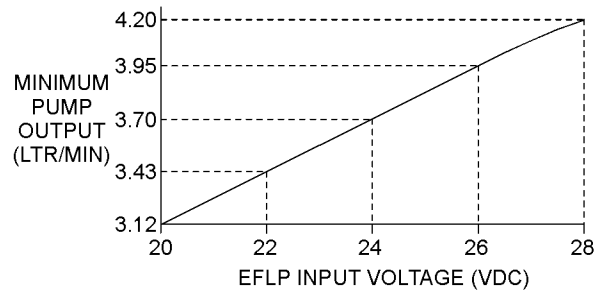


Illustration 30 g02527518  
Minimum EFLP flow rate in a 24 VDC system

Table 14

Troubleshooting Test Steps	Values	Results
<p><b>9. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 29 or 30 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked..</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, proceed to Test Step 11.</p>
<p><b>11. Valve Lash</b></p> <p><b>Note:</b> The valve lash can affect the performance of the engine.</p> <p><b>A.</b> Check the valve lash.</p>	Valve lash	<p><b>Result:</b> The valve lash is not correct.</p> <p><b>Repair:</b> Check the valve lash. Refer to Systems Operation, Testing, and Adjusting, "Engine Valve Lash - Inspect" for the correct procedure.</p> <p><b>Result:</b> The valve lash is correct.</p> <p>Proceed to Test Step 12.</p>

(continued)

## Symptom Troubleshooting

(Table 14, contd)

Troubleshooting Test Steps	Values	Results
<p><b>12. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Faulty piston</li> <li>· Faulty piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> <li>· Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 13.</p>
<p><b>13. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic "Cylinder Cut Out Test".</p> <p><b>Note:</b> If the compression test that was performed in Test Step 12 was satisfactory, the "Cylinder Cut Out Test" will identify any faulty injectors.</p>	Electronic Unit Injectors	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p>Repeat the automatic "Cylinder Cut Out Test". If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 14.</p>
<p><b>14. Individual Malfunctioning Cylinders</b></p> <p><b>A.</b> With the engine speed at a fast idle, use the electronic service tool to perform the manual "Cylinder Cut Out Test".</p> <p>As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine.</p> <p>If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.</p>	Cylinders	<p><b>Result:</b> The test indicates a faulty cylinder.</p> <p><b>Repair:</b> Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.</p> <p><b>Result:</b> The test indicates that all cylinders are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>



i06151955

## **Alternator Problem** (Charging Problem and/or Noisy Operation)

### **Probable Causes**

- Alternator drive belt and tensioner
- Alternator mounting bracket
- Alternator drive pulley
- Alternator bearings
- Alternator
- Charging circuit

### **Recommended Actions**

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 15

Troubleshooting Test Steps	Values	Results
<p><b>1. Condition of the Alternator Drive Belts</b></p> <p><b>A.</b> Inspect the condition of the alternator drive belts.</p> <p><b>B.</b> Check the belt tension. If the engine is equipped with an automatic belt tensioner, check the automatic belt tensioner.</p> <p>Excessive belt tension can result in damage to the alternator.</p>	Drive Belt	<p><b>Result:</b> The alternator drive belts are in good condition and the belt tension is correct.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The alternator drive belts are not in good condition or the belt tension is incorrect.</p> <p><b>Repair:</b> If the alternator drive belts are worn or damaged, replace the belts. Refer to Disassembly and Assembly for the correct procedure.</p> <p>If necessary, replace the automatic belt tensioner. Refer to Disassembly and Assembly for the correct procedure.</p>
<p><b>2. Alternator Mounting Bracket</b></p> <p><b>A.</b> Inspect the alternator mounting bracket for cracks and distortion.</p>	Alternator Mounting Bracket	<p><b>Result:</b> The alternator mounting bracket is cracked and distorted.</p> <p>Repair the mounting bracket or replace the mounting bracket.</p> <p><b>Note:</b> The repair/replacement will ensure that the alternator drive belt and the alternator drive pulley are in alignment.</p> <p><b>Result:</b> The alternator mounting bracket is OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Condition of the Alternator Drive Pulley</b></p> <p><b>A.</b> Check the condition of the alternator drive pulley. Look for deep grooves that have been worn into the pulley by the belt. Check that the nut for the pulley has not become loose.</p>	Alternator Drive Pulley	<p><b>Result:</b> There is excessive wear on the alternator drive pulley.</p> <p><b>Repair:</b> Replace the pulley.</p> <p><b>Result:</b> The alternator drive pulley nut was loose.</p> <p><b>Repair:</b> Tighten the nut.</p> <p><b>Result:</b> There is not excessive wear on the alternator drive pulley.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Wear of the Alternator Bearings</b></p> <p><b>A.</b> Check the alternator bearings for signs of wear.</p>	Alternator Bearings	<p><b>Result:</b> The alternator bearings are OK.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The alternator bearings are not OK.</p> <p><b>Repair:</b> Repair the alternator or replace the alternator, as needed. Refer to Disassembly and Assembly for the correct procedure.</p>

(continued)

(Table 15, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Operation of the Alternator or Regulator</b></p> <p><b>A.</b> Verify that the alternator or the regulator is operating correctly. Refer to Systems Operation, Testing and Adjusting, "Charging System - Test" for the proper testing procedures.</p>	Regulator and Alternator	<p><b>Result:</b> The regulator and alternator are operating correctly.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> The regulator and alternator are not operating correctly.</p> <p><b>Repair:</b> Repair the alternator and regulator or replace the alternator and regulator, as needed. Refer to Disassembly and Assembly for the correct procedure.</p>
<p><b>6. Inspection of the Charging Circuit</b></p> <p><b>A.</b> Inspect the battery cables, wiring, and connections in the charging circuit.</p>	Charging Circuit	<p><b>Result:</b> The charging circuit is not working correctly.</p> <p><b>Repair:</b> Clean all connections and tighten all connections. Replace any faulty parts.</p> <p><b>Result:</b> The charging circuit is working correctly.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06151975

## Battery Problem

### Probable Causes

- Charging circuit
- Batteries
- Auxiliary device

### Recommended Actions

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 16

Troubleshooting Test Steps	Values	Results
<p><b>1. Charging Circuit</b></p> <p><b>A.</b> Check that the battery charging circuit is operating correctly. Refer to Troubleshooting, "Alternator Problem".</p>	Charging circuit	<p><b>Result:</b> The charging circuit is not OK.</p> <p><b>Repair:</b> Repair the charging circuit, as necessary.</p> <p><b>Result:</b> The charging circuit is OK.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Batteries</b></p> <p><b>A.</b> Verify that the battery or batteries are no longer able to hold a charge. Refer to Systems Operation/Testing and Adjusting, "Battery - Test".</p>	Battery	<p><b>Result:</b> One of the batteries is not OK.</p> <p><b>Repair:</b> Replace the faulty battery. Refer to the Operation and Maintenance Manual.</p> <p><b>Result:</b> The battery or batteries are OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Auxiliary Device</b></p> <p><b>A.</b> Check if an auxiliary device has drained the battery or batteries by being left in the ON position.</p>	Auxiliary Device	<p><b>Result:</b> The battery or batteries have been drained by an auxiliary device being left in the ON position.</p> <p><b>Repair:</b> Charge the battery or batteries. Verify that the battery or batteries are able to maintain a charge. Refer to Systems Operation/Testing and Adjusting for the correct procedure.</p> <p><b>Result:</b> The battery or batteries have not been drained by an auxiliary device being left in the ON position.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i08473211

## Belt Tensioner Noise

### Probable Causes

- Belt condition and assembly alignment
- Belt tensioner

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 17

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Condition of the Belt and the Assembly Alignment</b></p> <p><b>A.</b> Check for debris or rust in all pulleys and grooves.</p> <p><b>B.</b> Check the belt for worn patches, contamination, paint, or debris.</p> <p><b>C.</b> Visibly check the alignment between the following components:</p> <ul style="list-style-type: none"> <li>• Refrigerant Compressor</li> <li>• Belt Tensioner</li> <li>• Alternator</li> <li>• Idler Pulley</li> <li>• Crank Pulley</li> </ul>	<p>Auxiliary assembly</p>	<p><b>Result:</b> There is rust or debris present.</p> <p><b>Repair:</b> Remove the rust or debris from the pulley grooves.</p> <p><b>Result:</b> The alternator drive belts are worn, damaged, or contaminated.</p> <p><b>Repair:</b> Replace the belts. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install.</p> <p><b>Result:</b> There is visible misalignment between the components</p> <p><b>Repair:</b> Remove the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install. Loosen the fixtures for the driven components and adjust the position as required. Tighten the fixtures. Refer to Disassembly and Assembly for the correct procedure. Reinstall the belt. Refer to Disassembly and Assembly for the correct procedure. Run the engine to test the system.</p> <p><b>Result:</b> The alignment is visibly correct.</p> <p>Proceed to Test Step 2.</p>

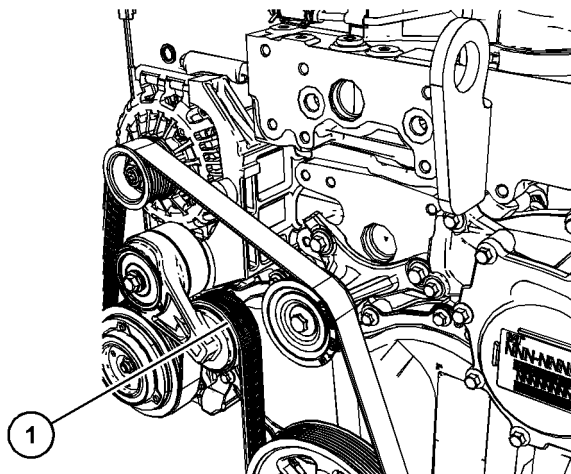


Illustration 31

g06276401

(1) Belt tensioner wheel (typical example)

## Symptom Troubleshooting

Table 18

Troubleshooting Test Steps	Values	Results
<p><b>2. Spray Water on the Belt</b></p> <p><b>Note:</b> Best results are achieved when the engine is running. Only perform this step with the engine running if the conditions are safe. If necessary, stop the engine.</p> <p><b>A.</b> Spray water on the belt in the area around the tensioner. This will reduce the friction between the pulleys and the belt.</p> <p><b>B.</b> Run the engine and check for noise.</p>	Noise	<p><b>Result:</b> The noise is reduced or eliminated and returns when the belt dries. There may be an issue with the alignment of the system.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The noise is worse or louder. The belt may be slipping. There maybe an issue with the tension of the system. Proceed to Test Step 4.</p>

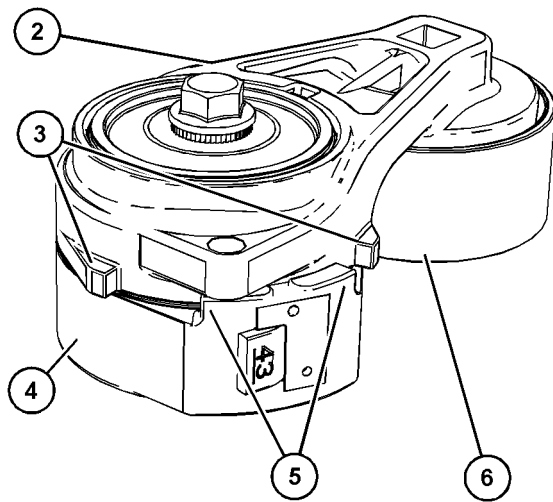


Illustration 32

g06276469

## Typical view of the tensioner

- (2) Arm
- (3) Arm case stops
- (4) Spring case
- (5) Spring case stops
- (6) Pulley

Table 19

Troubleshooting Test Steps	Values	Results
<p><b>3. On-Engine Inspection of the Belt Tensioner</b></p> <p><b>A.</b> Determine if the belt is tracking toward either side of pulley (6).</p> <p><b>B.</b> Check the alignment between the following components:</p> <ul style="list-style-type: none"> <li>• Refrigerant Compressor</li> <li>• Belt Tensioner</li> <li>• Alternator</li> <li>• Idler Pulley</li> <li>• Crank Pulley</li> </ul>	<p>Inspection</p>	<p><b>Result:</b> The witness mark created by the belt on the pulley is considerably wider than the belt or the belt is tracking away from the pulley center.</p> <p><b>Repair:</b> Remove and reinstall the components. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>Result:</b> There is visible misalignment between the components.</p> <p><b>Repair:</b> Remove the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install. Loosen the fixtures for the driven components and adjust the position as required. Tighten the fixtures. Refer to Disassembly and Assembly for the correct procedure. Reinstall the belt. Refer to Disassembly and Assembly for the correct procedure. Run the engine to test the system.</p>
<p><b>4. On-Engine Inspection of the Belt Tensioner</b></p> <p><b>A.</b> Leave the belt and tensioner installed. Determine if arm case stops (3) are contacting or very close to spring case stops (5).</p>	<p>Inspection</p>	<p><b>Result:</b> The arm case stops (3) are contacting or very close to spring case stops (5).</p> <p><b>Repair:</b> Check that the correct belt is installed. If necessary, replace the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install.</p> <p>The arm case stops (3) are not contacting or very close to spring case stops (5).</p> <p>Proceed to Test Step 5.</p>

## Symptom Troubleshooting

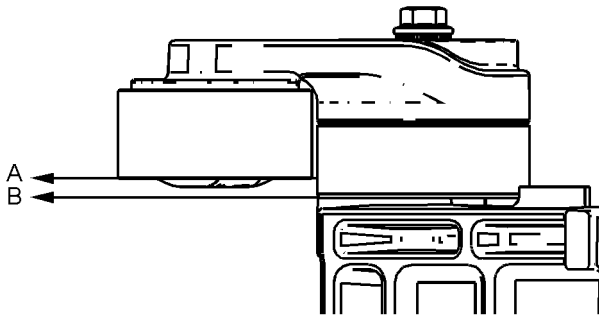


Illustration 33

g06276750

Table 20

Troubleshooting Test Steps	Values	Results
<p><b>5. Remove the Belt and Tensioner for Inspection</b></p> <p><b>A.</b> Remove the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install .</p> <p><b>B.</b> Use a suitable tool to move the tensioner arm over the full range of movement between stops (3) and (5).</p> <p><b>C.</b> Turn pulley (6). Check that the pulley turns smoothly and quietly.</p> <p><b>Note:</b> New bearings may not turn as freely as used bearings.</p> <p><b>D.</b> Ensure that the pulley surface (A) is parallel to the tensioner mounting surface (B). Refer to Illustration 33 (typical example).</p> <p><b>E.</b> Remove the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.</p> <p><b>F.</b> Check for evidence of metal-to-metal contact between arm (2) and spring case (4).</p> <p><b>G.</b> Inspect arm (2) and spring case (4) for cracks and damage.</p> <p><b>H.</b> Inspect arm case stops (3), spring case stops (5), and locator pin (7) for damage.</p> <p><b>I.</b> Inspect the tensioner for excessive bearing wear.</p>		<p><b>Result:</b> The tensioner does not move smoothly over the full range.</p> <p><b>Repair:</b> Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.</p> <p><b>Result:</b> Pulley (6) does not spin smoothly or the pulley makes a noise when spinning.</p> <p><b>Repair:</b> Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.</p> <p><b>Result:</b> The pulley surface is not parallel to the mounting surface.</p> <p><b>Repair:</b> Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.</p> <p><b>Result:</b> There is evidence of metal-to-metal contact between (2) and spring case (4).</p> <p><b>Repair:</b> Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.</p> <p><b>Result:</b> There is evidence of damage to any part of the belt tensioner.</p> <p><b>Repair:</b> Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.</p>



i08198179

## Clean Emissions Module Has High Oxygen Level

Table 21

Diagnostic Trouble Codes			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3217-16	E1407 (2)	Aftertreatment #1 Intake O2 : High - moderate severity (2)	The Engine Out NOx Sensor is reading a higher than expected level of Oxygen (O2).
3227-16	E1408 (2)	Aftertreatment #1 Outlet O2 : High - moderate severity (2)	The Tailpipe Out NOx Sensor is reading a higher than expected level of Oxygen (O2).
Follow the troubleshooting procedure to identify the root cause of the problem.			

### Diesel Oxidation Catalyst (DOC)/Selective Catalytic Reduction (SCR) Aftertreatment

The SCR intake NOx sensor is located in the exhaust pipe between the Exhaust Back Pressure Regulator (EBPR) and the DOC inlet. The SCR outlet NOx sensor is located in the exhaust tail pipe.

### DOC/Diesel Particulate Filter (DPF)/SCR Aftertreatment

The SCR intake NOx sensor is located in the Clean Emissions Module (CEM) after the DPF. The SCR outlet NOx sensor is located in the exhaust tail pipe.

The exhaust system has two NOx sensors that measure O2 and NOx. The inlet sensor monitors the NOx and O2 entering the SCR catalyst. The outlet sensor monitors the NOx and O2 exiting the SCR catalyst.

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 22

Troubleshooting Test Steps	Values	Results
<p><b>1. Check if NOx Sensors are Installed</b></p> <p><b>A.</b> Locate the appropriate NOx Sensor.</p> <p><b>B.</b> Check if the sensor is installed correctly.</p>	Correctly Installed / Not installed correctly	<p><b>Result:</b> The sensor is not installed correctly.</p> <p><b>Repair:</b> Install the sensor correctly.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The sensor is installed correctly.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for an Exhaust Leak Between the Turbocharger and the Tailpipe</b></p> <p><b>A.</b> Check for disconnected exhaust pipes.</p> <p><b>B.</b> Check for broken/loose joints.</p>	Leak found	<p><b>Result:</b> An exhaust leak is found between the turbo and the tail pipe.</p> <p><b>Repair:</b> Repair the exhaust leak.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Perform the Aftertreatment System Functional Test</b></p> <p><b>A.</b> Reset all active codes and clear all logged codes.</p> <p><b>B.</b> Use the electronic service tool to perform the "Aftertreatment System Functional Test" to verify that the fault is eliminated.</p>	Test passed	<p><b>Result:</b> The "Aftertreatment System Functional Test" passed.</p> <p>The NOx sensing system is fully functional and the fault has been eliminated.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The "Aftertreatment System Functional Test" did not pass and the diagnostic code is still present.</p> <p><b>Repair:</b> Ensure that the latest engine software is installed. Refer to Troubleshooting, for the correct procedure.</p> <p>Replace the sensor.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i07704970

## Coolant Contains Oil

### Probable Causes

- Engine oil cooler
- Cylinder head gasket
- Cylinder head
- Cylinder block

### Recommended Actions

Complete the procedure in the order in which the steps are listed.

Table 23

Troubleshooting Test Steps	Values	Results
<p><b>1. Engine Oil Cooler</b></p> <p><b>A.</b> Drain the coolant from the cooling system. Drain the lubricating oil from the engine. Refer to the Operation and Maintenance Manual for more information.</p> <p><b>B.</b> Check for leaks in the engine oil cooler. Refer to Systems Operation, Testing, and Adjusting, "Cooling System" for the correct procedure.</p>	Oil Cooler	<p><b>Result:</b> A leak is found in the engine oil cooler.</p> <p><b>Repair:</b> Install a new oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove" and Disassembly and Assembly, "Engine Oil Cooler - Install" for the correct procedure.</p> <p>Flush the cooling system. Refer to the Operation and Maintenance Manual for the correct procedure. Refill the cooling system with the correct coolant. Refer to the Operation and Maintenance Manual for the recommended coolant and capacities.</p> <p>After the leak has been repaired, refill the engine with oil of the correct specification . Refer to the Operation and Maintenance Manual for the correct oil capacity and viscosity.</p> <p><b>Result:</b> A leak was not found in the engine oil cooler.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Cylinder Head Gasket</b></p> <p><b>A.</b> Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".</p> <p><b>B.</b> Inspect the cylinder head gasket for faults and any signs of leakage.</p>	Cylinder head gasket	<p><b>Result:</b> The cylinder head gasket shows signs of damage or leakage.</p> <p><b>Repair:</b> Install a new cylinder head gasket and install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install" .</p> <p><b>Result:</b> The cylinder head gasket does not show signs of damage or leakage.</p> <p>Proceed to Test Step 3.</p>

(continued)

## Symptom Troubleshooting

(Table 23, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Cylinder Head</b></p> <p><b>A.</b> Check for cracks in the cylinder head. Perform a leak test on the cylinder head. Refer to System Operation, Testing and Adjusting, "Cylinder Head - Inspect" for the correct procedure.</p>	Cylinder head	<p><b>Result:</b> A fault was found in the cylinder head.</p> <p><b>Repair:</b> Repair the cylinder head or replace the cylinder head. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".</p> <p>Refill the engine with oil of the correct specification . Refer to the Operation and Maintenance Manual for the correct oil capacity and viscosity.</p> <p><b>Result:</b> A fault was not found in the cylinder head.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Cylinder Block</b></p> <p><b>A.</b> Inspect the top face of the cylinder block for faults and signs of leakage. Refer to Systems Operation, Testing, and Adjusting, "Cylinder Block - Inspect" for the correct procedure.</p>	Cylinder block	<p><b>Result:</b> A fault was found in the cylinder block.</p> <p><b>Repair:</b> Repair the cylinder block or replace the cylinder block. Inspect the top deck. Refer to the Reuse and Salvage Guidelines for the proper inspection procedure.</p> <p>Refill the engine with oil of the correct specification . Refer to the Operation and Maintenance Manual for the correct oil capacity and viscosity.</p> <p><b>Result:</b> No fault was found in the cylinder block.</p> <p>Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i07694339

## Coolant Level Is Low

This procedure is only applicable to engines that have a coolant level sensor.

This procedure covers the following diagnostic code:

Table 24

Diagnostic Trouble Codes for Low Coolant Level			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
111-1	E2143-3	Engine Coolant Level : Low - Level 3	The engine has been running for 60 seconds. The engine coolant level has fallen below the coolant level sensor for the specified delay time. Engine will shutdown if engine shutdowns are enabled in the Electronic Service Tool. The code is logged.
111-17	E2143-1	Engine Coolant Level : Low - Level 1	The engine has been running for 60 seconds. The engine coolant level has fallen below the coolant level sensor for the specified delay time. A warning is displayed. The code is logged.
111-18	E2143-2	Engine Coolant Level : Low - Level 2	The engine has been running for 60 seconds. The engine coolant level has fallen below the coolant level sensor for the specified delay time. Engine power is derated. The code is logged.

## Probable Causes

- Low Coolant Level and/or Coolant Leakage
- Coolant level sensor

## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 25

Troubleshooting Test Steps	Values	Results
<p><b>1. Low Coolant Level and/or Coolant Leakage</b></p> <p><b>A.</b> Inspect the coolant level.</p>	Coolant level	<p><b>Result:</b> The engine coolant level is OK.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The engine coolant level is not OK.</p> <p><b>Repair:</b> Troubleshoot the cause of the incorrect coolant level.</p> <p>Check for the correct mixture of antifreeze and water. Refer to Operation and Maintenance Manual.</p> <p>Check the cooling system for leaks. Refer to Systems Operation, Testing and Adjusting, "Cooling System - Test" for the correct procedure. Repair any leaks immediately.</p> <p>Check the NRS cooler for leaks. Refer to Testing and Adjusting, "Exhaust Cooler (NRS) - Test".</p> <p>Check for air in the cooling system. Refer to Systems Operation, Testing and Adjusting, "Testing the Cooling System" for the correct procedure.</p>
<p><b>2. Faulty Sensor</b></p> <p><b>A.</b> If an electrical fault with the coolant level sensor is suspected, refer to Troubleshooting, "Coolant Level - Test" for information on troubleshooting the coolant level sensor.</p>	Coolant level sensor	<p><b>Result:</b> The coolant level sensor is not operating correctly.</p> <p><b>Repair:</b> Replace the coolant level sensor.</p> <p><b>Result:</b> The coolant level sensor is operating correctly.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Coolant Temperature Is High

Use this procedure in order to troubleshoot high coolant temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. Use the electronic service tool in order to view the current trip points for these codes.

Table 26

<b>Diagnostic Trouble Codes for High Coolant Temperature</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description</b> (code descriptions may vary)	<b>Comments</b>
110-15	E361 (1)	Engine Coolant Temperature : High - least severe	<p>The coolant temperature has been at 109° C (228° F) for 10 seconds.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 185 seconds.</p> <p>There are no electrical faults or battery faults on the circuit.</p>
110-16	E361 (2)	Engine Coolant Temperature : High - moderate severity	<p>The coolant temperature has been at 111° C (232° F) for 10 seconds.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 185 seconds.</p> <p>There are no electrical faults or battery faults on the circuit.</p> <p>The engine will be derated.</p>
110-0	E361 (3)	Engine Coolant Temperature : High - most severe	<p>The coolant temperature has been at 114° C (237° F) for 10 seconds.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 185 seconds.</p> <p>There are no electrical faults or battery faults on the circuit.</p> <p>The engine will be derated.</p> <p>The engine may shut down.</p>

## Probable Causes

- Diagnostic codes
- Coolant level
- Coolant temperature sensor
- Radiator and hoses
- Radiator cap and pressure relief valve
- Water temperature regulator
- Engine cooling fan
- Quality of coolant
- Coolant pump
- NRS cooler
- Cylinder head gasket

## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 27

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Use the electronic service tool to check for diagnostic codes that relate to the temperature in the cooling system.</p>	Diagnostic Codes	<p><b>Result:</b> Diagnostic codes are not present.</p> <p>Return the unit to service.</p> <p><b>Result:</b> Diagnostic codes are present.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Coolant Level</b></p> <p><b>A.</b> Check the coolant level.</p>	Engine coolant level	<p><b>Result:</b> The engine coolant level is low.</p> <p><b>Repair:</b> Check the cooling system for leaks. Refer to Troubleshooting, "Coolant Level is Low" for additional information. Repair any leaks immediately.</p> <p><b>Result:</b> The engine coolant level is OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Coolant Temperature Sensor</b></p> <p><b>A.</b> Compare the reading for the coolant temperature on the electronic service tool to the reading for the coolant temperature on a calibrated test gauge.</p>	Coolant temperature sensor	<p><b>Result:</b> The temperature sensor is not accurate.</p> <p><b>Repair:</b> Troubleshoot the circuit and the coolant temperature sensor. Refer to Troubleshooting, "Sensor Signal (Analog, Passive) - Test".</p> <p><b>Result:</b> The temperature sensor is reading accurately.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Radiator and Hoses</b></p> <p><b>A.</b> Check the radiator fins for dirt, debris, and/or damage.</p> <p><b>B.</b> Check for collapsed hoses and/or other restrictions.</p> <p><b>C.</b> Check the radiator for internal blockage.</p> <p>Ensure that the radiator size is sufficient. An undersized radiator does not have enough area for the effective release of heat. An undersized radiator may cause the engine to run at a temperature that is higher than normal. The normal temperature is dependent on the ambient temperature.</p>	Radiator and hoses	<p><b>Result:</b> The radiator fins are blocked or damaged.</p> <p><b>Repair:</b> Remove any dirt and/or debris and straighten any bent fins.</p> <p><b>Result:</b> The radiator has internal blockage.</p> <p><b>Repair:</b> Remove the blockage.</p> <p><b>Result:</b> The radiator fins are not damaged and the radiator does not have an internal blockage.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Radiator Cap and Pressure Relief Valve</b></p> <p><b>A.</b> Pressure-test the cooling system. Refer to Systems Operation, Testing, and Adjusting, "Cooling System" for the correct procedure.</p> <p><b>B.</b> Check that the seating surfaces of the pressure relief valve and the radiator cap are clean and undamaged.</p> <p><b>C.</b> Check operation of the pressure relief valve and/or the water temperature regulator.</p>	Radiator cap	<p><b>Result:</b> The pressure relief valve and/or the water temperature regulator are not operating correctly.</p> <p><b>Repair:</b> Clean the components or replace the components.</p> <p><b>Result:</b> The pressure relief valve and/or the water temperature regulator are operating correctly.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Symptom Troubleshooting

(Table 27, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Water Temperature Regulator</b></p> <p><b>A.</b> Check the water temperature regulator for correct operation. Refer to Systems Operation, Testing, and Adjusting, "Cooling System" for the proper procedure.</p>	Water Temperature Regulator	<p><b>Result:</b> The water temperature regulator is not operating correctly.</p> <p><b>Repair:</b> Replace the water temperature regulator. Refer to Disassembly and Assembly, "Water Temperature Regulator - Remove and Install".</p> <p><b>Result:</b> The water temperature regulator is operating correctly.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Engine Cooling Fan</b></p> <p><b>A.</b> Check that the cooling fan is operating correctly.</p> <p><b>B.</b> Check the engine cooling fan for damage.</p>	Fan	<p><b>Result:</b> The cooling fan is not operating correctly.</p> <p><b>Repair:</b> Make sure that the cooling fan is being driven correctly. Make sure that the belt tensioner is operating correctly</p> <p><b>Result:</b> The fan is damaged.</p> <p><b>Repair:</b> Repair the fan or replace the fan, as necessary. Refer to Disassembly and Assembly, "Fan - Remove and Install".</p> <p><b>Result:</b> The fan is OK.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Quality of Coolant</b></p> <p><b>A.</b> Check the quality of the coolant. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations - Coolant".</p>	Coolant	<p><b>Result:</b> The coolant is not of an acceptable quality.</p> <p><b>Repair:</b> Drain and refill the coolant system with coolant of the correct quality. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations - Coolant".</p> <p><b>Result:</b> The coolant is of an acceptable quality.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Inspection of the Coolant Pump</b></p> <p><b>A.</b> Inspect the impeller of the coolant pump for damage and/or erosion.</p> <p><b>B.</b> Make sure that the drive gear is not loose on the drive shaft of the coolant pump.</p>	Coolant pump	<p><b>Result</b> The coolant pump is damaged or not operating correctly.</p> <p><b>Repair:</b> If necessary, replace the coolant pump. Refer to Disassembly and Assembly, "Water Pump - Remove" and Disassembly and Assembly, "Water Pump - Install".</p> <p><b>Result</b> The coolant pump is not damaged and the pump is operating correctly.</p> <p>Proceed to Test Step 10.</p>

(continued)



(Table 27, contd)

Troubleshooting Test Steps	Values	Results
<p><b>10. NRS Cooler</b></p> <p><b>A.</b> Switch off the engine and allow the engine to cool to below normal working temperature. Remove the pressure cap for the coolant system. Perform a leak test on the cooling system and the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, "Cooling System - Test". Refer to the subsection "Testing The Radiator And Cooling System For Leaks" .</p>	<p>NRS cooler</p>	<p><b>Result:</b> The leak test fails.</p> <p><b>Repair:</b> Check the NRS cooler. Perform a leak test on the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, "Exhaust Cooler (NRS) - Test".</p> <p>If necessary, install a replacement NRS cooler. Confirm that the fault has been eliminated.</p> <p><b>Result:</b> The leak test is passed.</p> <p>Proceed to Test Step 11.</p>
<p><b>11. Cylinder Head Gasket</b></p> <p><b>A.</b> Switch off the engine and allow the engine to cool to below normal working temperature. Remove the pressure cap for the coolant system. Perform a leak test on the cooling system and the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, "Cooling System - Test". Refer to the subsection "Testing The Radiator And Cooling System For Leaks" .</p>	<p>Cylinder Head gasket</p>	<p><b>Result:</b> The leak test fails.</p> <p><b>Repair:</b> Check the cylinder head gasket. Refer to the recommended action for the cylinder head gasket within Troubleshooting, "Oil Contains Coolant".</p> <p>Check the cylinder head for flatness. Refer to the recommended action for checking flatness of the cylinder head within Systems Operation, Testing, and Adjusting, "Cylinder Head - Inspect".</p> <p><b>Result:</b> The leak test is passed.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06050803

## Coolant Temperature Is Low

Use this procedure in order to troubleshoot a low coolant temperature.

### Probable Causes

- Extreme ambient temperatures
- Cooling system fault
- Coolant temperature sensor
- Water temperature regulator

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

### WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

## Symptom Troubleshooting

Table 28

Troubleshooting Test Steps	Values	Results
<p><b>1. Make Sure the Engine is Correctly Equipped for Ambient Conditions</b></p> <p><b>A.</b> Ensure that the engine is correctly equipped for the ambient conditions.</p>	Engine operation	<p><b>Result:</b> The engine is equipped for the ambient conditions.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The engine is not equipped for ambient conditions.</p> <p><b>Repair:</b> Refer to the Operation and Maintenance Manual for more information regarding equipment required for cold-weather operation.</p>
<p><b>2. Inspect the Cooling System</b></p> <p><b>A.</b> Check the coolant level.</p> <p><b>B.</b> Check for signs of a coolant leak.</p> <p><b>Note:</b> If the coolant temperature sensor is not immersed in coolant, a false reading can occur.</p>	Engine coolant level	<p><b>Result:</b> The engine coolant level is OK.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The engine coolant level is not OK.</p> <p><b>Repair:</b> Check the cooling system for leaks. Refer to Troubleshooting, "Coolant Level is Low" for additional information. Repair any leaks.</p>
<p><b>3. Faulty Coolant Temperature Sensor</b></p> <p><b>A.</b> Check the reading of the coolant temperature on the electronic service tool. The temperature should rise steadily as the engine is warmed. Ensure that the temperature is as expected.</p>	Faulty coolant temperature sensor	<p><b>Result</b> The coolant temperature is as expected.</p> <p><b>Repair:</b> A failed coolant temperature sensor has been detected. Replace the temperature sensor.</p> <p><b>Result</b> The coolant temperature is as expected.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Engine Coolant System</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Start the engine.</p> <p><b>D.</b> Monitor the "Engine Coolant Temperature" in the status screen</p>	Coolant temperature	<p><b>Result:</b> The coolant temperature comes up to operational temperature.</p> <p>Return the unit to service.</p> <p><b>Result</b> The coolant temperature does not come up to operational levels.</p> <p><b>Repair:</b> Test the water temperature regulator. Refer to Systems Operation, Testing, and Adjusting, "Water Temperature Regulator - Test". If the test fails, replace the water temperature regulator. Refer to Disassembly and Assembly, "Water Temperature Regulator - Remove and Install".</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i06033231

## Crankcase Breather Ejects Oil

The crankcase breather canister includes a pressure relief valve that prevents a build-up of excessive pressure in the breather canister.

In normal operation of the engine, the pressure relief valve remains closed. If there is evidence of oil staining on the cylinder head behind the breather canister, perform the following procedure in order to diagnose the fault.

### Probable Causes

- Breather filter
- Breather hoses
- Excessive blow-by

### Recommended Actions

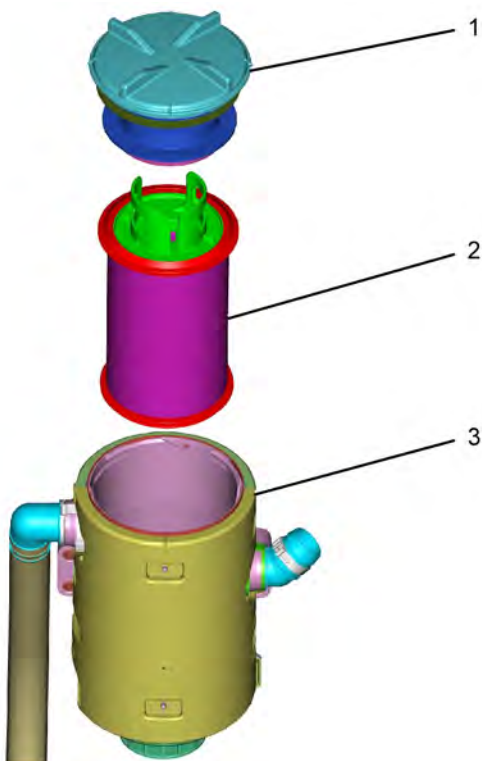


Illustration 34

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Typical breather canister

- (1) Breather canister cap
- (2) Filter element
- (3) Breather canister

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 29

Troubleshooting Test Steps	Values	Results
<p><b>1. Breather Filter</b></p> <p><b>A.</b> Check that filter element (2) is correctly installed and that the element is not damaged.</p> <p><b>B.</b> Check for restrictions or blockages in breather canister (3).</p> <p><b>Note:</b> In cold ambient conditions, ice can form in the outlets of the breather canister.</p>	Filter	<p><b>Result:</b> The filter element (2) is not correctly installed or the element is damaged.</p> <p><b>Repair:</b> Install the filter element correctly or replace the filter element.</p> <p><b>Result:</b> There are restrictions or blockages in the breather canister.</p> <p><b>Repair:</b> Clean the interior of the breather canister.</p> <p><b>Result:</b> The breather is clean and operating correctly.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Breather Hoses</b></p> <p><b>A.</b> Make sure that the oil return hose from the breather canister is not pinched or blocked.</p> <p><b>B.</b> Make sure that the breather outlet hose from the breather canister is not pinched or blocked.</p>	Hoses	<p><b>Result:</b> One or more of the hoses is pinched or blocked.</p> <p><b>Repair:</b> Clear the hose or replace the hose.</p> <p><b>Result:</b> All of the hoses are clear.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Excessive Blow-by</b></p> <p><b>Note:</b> Excessive blow-by increases the flow of fumes through the breather system and can cause the breather filter to block. The pressure relief valve may then open.</p> <p><b>A.</b> Check the engine for excessive blow-by.</p>	Blow-by	<p><b>Result:</b> There is excessive blow-by.</p> <p><b>Repair:</b> Replace the breather filter.</p> <p>Investigate the cause of the excessive blow-by. Refer to Troubleshooting, "Oil Consumption Is Excessive".</p> <p><b>Result:</b> The blow-by is not excessive.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Crankcase Fumes Disposal Tube Has Oil Draining

A discharge of condensation from the breather is normal. The discharge is normally clear but can contain soot. Although the discharge can contain oil vapor, any liquid oil must be limited to 0.5 g (0.02 oz) per hour. An oil discharge in excess of 0.5 g (0.02 oz) must be investigated.

### Probable Causes

- Breather filter
- Engine oil level
- One-way valve
- Excessive blow-by

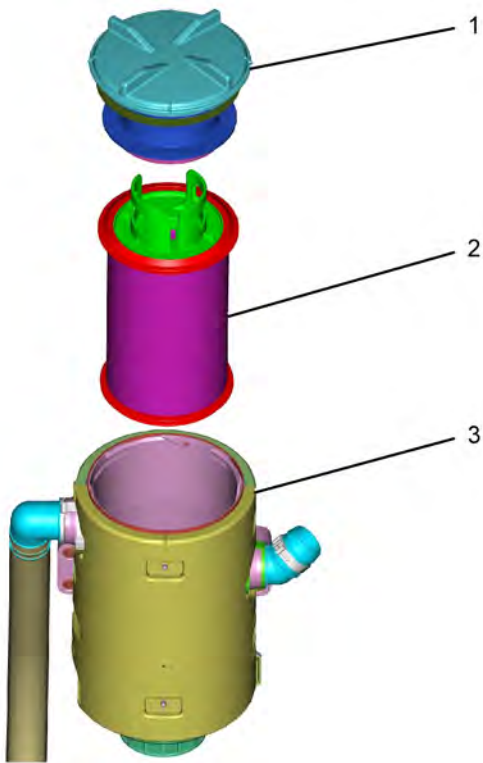


Illustration 35

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**Typical breather canister**

- (1) Breather canister cap
- (2) Filter element
- (2) Breather canister

Table 30

Troubleshooting Test Steps	Values	Results
<p><b>1. Breather Filter</b></p> <p><b>A.</b> Check that filter element (2) is correctly installed and that the element is not damaged.</p> <p><b>B.</b> Check for restrictions or blockages in breather canister (3).</p> <p><b>Note:</b> If a new filter element blocks before the service period is completed, the blockage can indicate a fault in the engine.</p> <p><b>Note:</b> In cold ambient conditions, ice can form in the outlets of the breather canister.</p>	<p>Filter</p>	<p><b>Result:</b> The filter element (1) is not correctly installed or the element is damaged.</p> <p><b>Repair:</b> Install the filter element correctly or replace the filter element.</p> <p><b>Result:</b> There are restrictions or blockages in the breather canister.</p> <p><b>Repair:</b> Clean the interior of the breather canister.</p> <p><b>Result:</b> The breather is clean and operating correctly.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Engine Oil Level</b></p> <p><b>A.</b> Check the oil level in the engine.</p>	<p>Oil level</p>	<p><b>Result:</b> The engine oil level is high.</p> <p><b>Repair:</b> Check for contamination of the oil with fuel or coolant. Refer to Troubleshooting, "Oil Contains Fuel" or Troubleshooting, "Oil Contains Coolant".</p> <p>If the engine oil is not contaminated, remove the excess oil.</p> <p><b>Result:</b> The engine oil level is correct.</p> <p>Proceed to Test Step 3.</p>

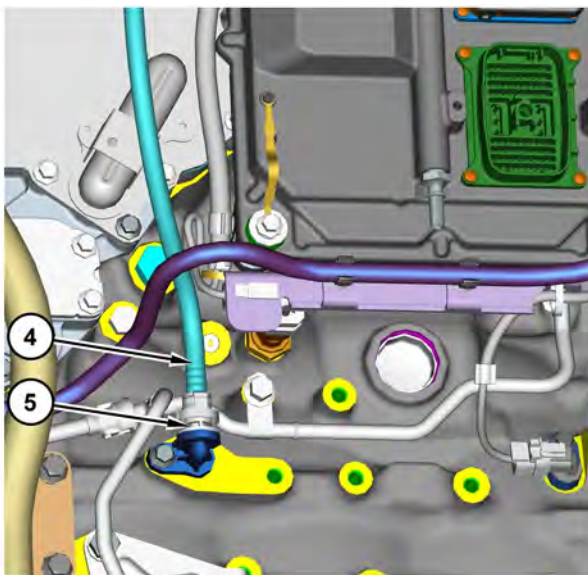


Illustration 36

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- (4) Breather drain hose
- (5) One-way valve

Table 31

Troubleshooting Test Steps	Values	Results
<p><b>3. One-way Valve</b></p> <p><b>A.</b> Disconnect breather drain hose (4) from one-way valve (5) and then remove the one-way valve from the engine. Refer to Disassembly and Assembly, "Crankcase Breather - Remove".</p> <p><b>B.</b> Use a suitable cleaning solution to flush the one-way valve.</p> <p><b>C.</b> Connect a low-pressure air supply breather drain hose side of the one-way valve. The air must flow freely through the valve.</p> <p><b>D.</b> Connect a low-pressure air supply crankcase side of the one-way valve. The valve must block the airflow.</p>	One-way valve	<p><b>Result:</b> The one-way valve does not operate correctly.</p> <p><b>Repair:</b> Install a replacement valve. Refer to Disassembly and Assembly, "Crankcase Breather - Install".</p> <p><b>Result:</b> The one-way valve operates correctly.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Excessive Blow-by</b></p> <p><b>Note:</b> Excessive blow-by increases the flow of fumes through the breather system and can cause oil discharge from the fumes disposal tube.</p> <p><b>A.</b> Check the engine for excessive blow-by.</p>	Blow-by	<p><b>Result:</b> There is excessive blow-by.</p> <p><b>Repair:</b> Replace the breather filter.</p> <p>Investigate the cause of the excessive blow-by. Refer to Troubleshooting, "Oil Consumption Is Excessive".</p> <p><b>Result:</b> The blow-by is not excessive.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06154889

## Cylinder Is Noisy

### Probable Causes

- Diagnostic codes
- Fuel quality
- Valve train components
- Low compression (cylinder pressure)
- Injectors
- Pistons and connecting rods

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 32

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM).</p> <p><b>B.</b> Use the electronic service tool to check for active or logged codes.</p>	Codes	<p><b>Result:</b> A diagnostic trouble code is active or logged.</p> <p><b>Repair:</b> Troubleshoot the active or logged codes.</p> <p><b>Result:</b> A diagnostic trouble code is not active or logged.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Fuel Quality</b></p> <p><b>A.</b> Check the fuel quality. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>B.</b> Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine.</p>	Fuel	<p><b>Result:</b> The fuel quality is not OK.</p> <p><b>Repair:</b> Drain the fuel system and replace the fuel filters. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter (Water Separator) Element - Replace" and Operation and Maintenance Manual, "Fuel System Filter - Replace".</p> <p>Fill the fuel system with fuel that meets the standard in the Operation and Maintenance Manual, "Fluid Recommendations".</p> <p>Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime".</p> <p>Verify that the procedure has eliminated the noise.</p> <p><b>Result:</b> The fuel quality is OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Valve Train Components</b></p> <p><b>A.</b> Check the valve lash. Refer to Troubleshooting, "Valve Lash Is Excessive".</p> <p><b>B.</b> Check for damage to valve train components. Remove the valve cover from the engine. Check the following items for damage:</p> <ul style="list-style-type: none"> <li>· Valve springs</li> <li>· Rocker shaft</li> <li>· Bridges</li> <li>· Pushrods</li> <li>· Camshaft followers</li> <li>· Hydraulic lifters</li> </ul> <p>Refer to the Disassembly and Assembly for additional information.</p>	Valve train	<p><b>Result:</b> Valve train components are damaged.</p> <p><b>Repair:</b> Make the necessary repairs, Verify that the repair has eliminated the noise.</p> <p><b>Result:</b> The valve train components are not damaged.</p> <p>Proceed to Test Step 4.</p>

(continued)



(Table 32, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Faulty piston</li> <li>· Faulty piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> <li>· Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic "Cylinder Cut Out Test".</p> <p><b>Note:</b> If the compression test that was performed in Test Step 4 was satisfactory, the "Cylinder Cut Out Test" will identify any faulty injectors.</p>	Electronic Unit Injectors	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p>Repeat the automatic "Cylinder Cut Out Test". If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Pistons and Connecting Rods</b></p> <p><b>A.</b> Inspect the pistons for damage and wear.</p> <p><b>B.</b> Inspect the connecting rod bearings for damage and wear.</p>	Pistons	<p><b>Result:</b> One or more components are worn or damaged.</p> <p><b>Repair:</b> Replace any worn or damaged parts.</p> <p>Verify that the repair has eliminated the noise.</p> <p><b>Result:</b> All components are OK.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i08421062

## DEF Concentration Is Incorrect

Table 33

Diagnostic Trouble Codes for DEF Concentration Is Incorrect			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3516-12	3100-12	Aftertreatment 1 Diesel Exhaust Fluid Concentration : Failure	The Diesel Emissions Fluid (DEF) concentration cannot be determined. The engine warning lamp will come on.
3516-16	E1365 (2)	Aftertreatment #1 DEF Concentration : High - moderate severity (2)	The Diesel Exhaust Fluid (DEF) has a high concentration.
3516-18	E1364 (2)	Aftertreatment #1 DEF Concentration : Low - moderate severity (2)	The Diesel Exhaust Fluid (DEF) has a low concentration.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 34

Required Tools			
Tool	Part Number	Part Description	Qty
A	T400195	Refractometer	1
B	T401199	Kit - Test	1
C	T402192	Adapter	1
D	N/A	Test Strips (DEF Fluid)	1

During troubleshooting of a certain code, other codes may become active or logged because of the troubleshooting steps, tripping the anti-tampering element of the diagnostics. Clear these codes after completion of the troubleshooting and only perform troubleshooting if a code has become persistent.

During troubleshooting, refer to the Electrical Schematic for the application.

Inspect all harness connections before any component is replaced. If these connections are not clean and secure, continuous electrical faults or intermittent electrical faults can occur. Check that the wires are pushed into the connections completely. Make sure that the connections are tight before other tests are performed.

Failure of an electrical component may cause the failure of other components. Always attempt to correct the cause of an electrical failure before you replace a component. If wire insulation is punctured, repair the damage. Seal the damaged wires with silicone sealant. Cover the sealant with two layers of electrical tape.

Follow the Test Steps as directed by the results of each step.

Table 35

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	<p>Software and Publications</p>	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Determine the Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Download the "Warranty Report" from the ECM before troubleshooting or clearing any diagnostic trouble codes.</p> <p><b>C.</b> Determine the diagnostic trouble code that is active.</p>	<p>Diagnostic trouble code</p>	<p><b>Result:</b> A 1235-9 (5856-9) code is active or logged.</p> <p><b>Note:</b> Troubleshoot the associated code before continuing with this procedure Refer to Troubleshooting, CAN Data Link - Test.</p> <p><b>Result:</b> One of the codes in Table 33 is active.</p> <p>Proceed to Test Step 3.</p>

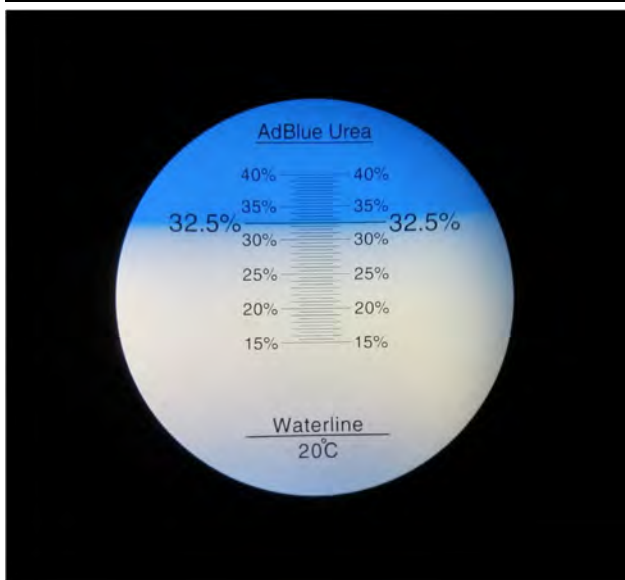


Illustration 37 g03370573  
 Typical refractometer reading for DEF in good condition



Illustration 38 g06549965  
 Typical example of a good test strip result

## Symptom Troubleshooting

Table 36

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the DEF Quality</b></p> <p><b>A.</b> Use Tooling A to measure the Diesel Exhaust Fluid (DEF) quality.</p> <p><b>B.</b> Use Tooling D to measure the DEF hydrocarbon contamination level.</p> <p>Refer to Systems Operation, Testing and Adjusting, "Diesel Exhaust Fluid Quality - Test" for the correct procedure.</p> <p>Refer to Illustration 37 for an example of a good refractometer result. Refer to Illustration 38 for an example of a good test strip result.</p>	DEF quality standards	<p><b>Result:</b> The DEF quality is within the acceptable range, the DEF is free from hydrocarbons and one of the codes listed in Table 33 is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The DEF quality is not within the acceptable range or Tooling D has indicated the presence of hydrocarbon contamination.</p> <p><b>Repair:</b> Drain the DEF fluid from the tank. Refill the tank with DEF that meets ISO 22241 quality standards. Refer to Operation and Maintenance Manual, "Diesel Exhaust Fluid Tank - Flush" for the correct procedure.</p> <p>Proceed to Test Step 5.</p>
<p><b>4. Check the Installation Status of the DEF Quality Sensor</b></p> <p><b>A.</b> Use the electronic service tool to check the "Aftertreatment #1 DEF Quality Sensor Installation Status" .</p>	Sensor installation status	<p><b>Result:</b> The installation status is set to "Not Installed" .</p> <p>Use the electronic service tool to change the "Aftertreatment #1 DEF Quality Sensor Installation Status" to "Installed" .</p> <p>Run the engine for 10 minutes</p> <p>Repeat this procedure from Test Step 2.</p> <p><b>Result:</b> The installation status is set to "Installed" and one of the codes listed in Table 33 is still active.</p> <p><b>Repair :</b> Repair the DEF Tank header sensor with the DEF Manifold Sensor Kit. Refer to Disassembly and Assembly, Manifold (DEF Heater) Sensor - Disassemble (Temperature, Level, Quality DEF Manifold Sensor) and Manifold (DEF Heater) Sensor -Assemble (Temperature, Level, Quality DEF Manifold Sensor).</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Perform an "Aftertreatment System Functional Test"</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Use the electronic service tool to perform the "Aftertreatment System Functional Test"</p>	Diagnostic codes	<p><b>Result:</b> The test completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The test did not complete successfully and additional diagnostic codes are active. Troubleshoot the additional diagnostic codes. Refer to Troubleshooting, Diagnostic Trouble Codes or Troubleshooting, Event Codes for more information.</p>

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## DEF Pressure Does Not Respond

Table 37

Diagnostic Trouble Codes			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5392-31	E1370 (2)	Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	The Electronic Control Module (ECM) detects one of the following conditions: DEF system pressure was not within the acceptable limits during priming. DEF system pressure deviated from the acceptable limits after the system had successfully primed.
Follow the troubleshooting procedure to identify the root cause of the problem.			

## Symptom Troubleshooting

Table 38

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Associated Diagnostic Codes</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Use the electronic service tool to check for active diagnostic codes.</p> <p>Check specifically for diagnostic codes relating to the DEF system.</p>	Diagnostic codes	<p><b>Result:</b> There are associated diagnostic codes.</p> <p><b>Repair:</b> Troubleshoot the associated diagnostic codes. Refer to Troubleshooting, Diagnostic Trouble Codes or refer to Troubleshooting, Event Codes.</p> <p><b>Result:</b> There are no associated diagnostic codes.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the DEF Pressure</b></p> <p><b>A.</b> Connect to the electronic service tool</p> <p><b>B.</b> Start the engine.</p> <p><b>C.</b> Allow the engine to run for at least 2 minutes whilst monitoring "DEF Pressure" on the electronic service tool.</p>	Gauge position	<p><b>Result:</b> The DEF pressure is less than 260 kPa (38 psi).</p> <p><b>Repair:</b> Troubleshoot the cause of low DEF pressure. Refer to Troubleshooting, DEF Pressure Is Low.</p> <p><b>Result:</b> The DEF pressure is greater than 950 kPa (138 psi).</p> <p><b>Repair:</b> Troubleshoot the cause of high DEF pressure. Refer to Troubleshooting, DEF Pressure Is High.</p> <p><b>Result:</b> The DEF pressure is between 260 kPa (38 psi) and 950 kPa (138 psi).</p> <p><b>Repair:</b> Allow the engine to run for at least 2 minutes.</p> <p>If the DEF system primes successfully, and the 5392-31 E1370 (2) diagnostic is no longer active, return the engine to service.</p> <p>If the 5392-31 E1370 (2) diagnostic code is still active, contact the Dealer Solutions Network (DSN).</p>

i08481008

# DEF Pressure Is High

Table 39

Diagnostic Trouble Codes for DEF Pressure Is High			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4334-16	E930 (2)	Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : High - moderate severity (2)	The DCU detects that the DEF pump pressure is above the acceptable range. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the fault.			

Table 40

Required Tools			
Tool	Part Number	Part Description	Qty
A	T400921	Protection Kit	1

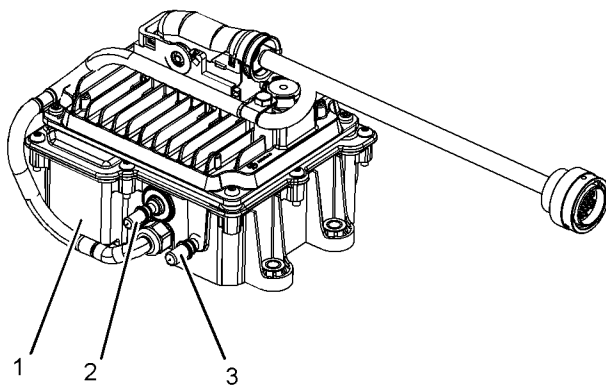


Illustration 39 g03790973  
 Typical view of the Pump and Electronics Unit (PEU)  
 (1) DEF Pump  
 (2) DEF pressure line connector  
 (3) DEF suction line connection

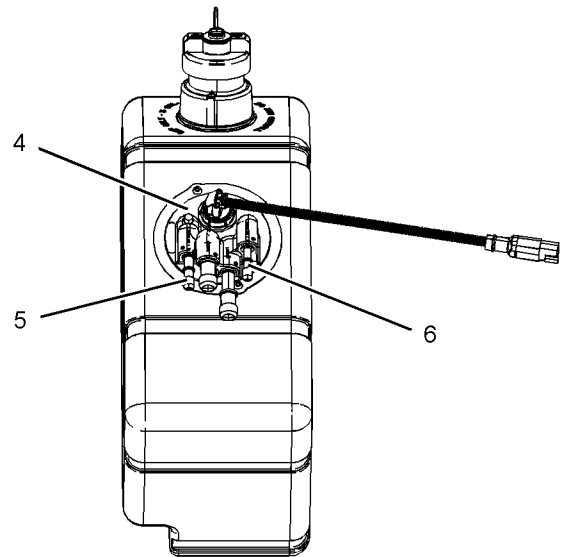


Illustration 40 g03790991  
 Typical view of the DEF tank  
 (4) DEF tank header unit  
 (5) DEF suction line connection  
 (6) DEF return Line connection

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 41

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the DEF Lines for Restrictions</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position for 15 minutes.</p> <p><b>Note:</b> The keyswitch must be OFF until the "Wait to Disconnect" lamp switches off to allow the DEF pump to purge, reset the code, and reset the Diesel Exhaust Fluid Controller (DCU).</p> <p><b>B.</b> Remove the DEF pressure line from the DEF pump connection (2) and the DEF injector. Install Tooling (A) on the DEF pump and injector connections.</p> <p><b>C.</b> Remove the DEF return line from the DEF tank header connection (6) and the DEF injector. Install Tooling (A) on the DEF tank header and injector connections.</p> <p><b>D.</b> Inspect the DEF pressure line and the DEF return line for restrictions and/or obstructions. If necessary, use low-pressure air.</p> <p><b>E.</b> Inspect the DEF return pipe in the DEF tank header for restrictions and/or obstructions.</p> <p><b>Note:</b> Possible obstructions are ice, DEF deposits, or debris.</p>	DEF suction line restriction	<p><b>Result:</b> An obstruction was found in a DEF line.</p> <p><b>Repair:</b> Flush line with deionized water or clean low-pressure air. If necessary, replace the line.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> An obstruction was found in the DEF tank header return pipe.</p> <p><b>Repair:</b> Remove the DEF tank header from the DEF tank. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.</p> <p>Flush the return pipe with deionized water or clean low-pressure air. If necessary, replace the DEF tank header.</p> <p>Install the DEF tank header in the DEF tank. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> An obstruction was not found.</p> <p>Proceed to Test Step 3.</p>

(continued)



(Table 41, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check for a Restriction in the DEF Pump</b></p> <p><b>Note:</b> If necessary, move the engine to an area where the ambient temperature is at least 10° C (50° F) to perform this step. Make sure that the DEF temperature is at least 10° C (50° F) before performing this step. The DEF system will not prime if the temperature is too low.</p> <p><b>A.</b> Connect the DEF pressure line to DEF pump connection (2). Place the other end of the DEF pressure line into a suitable container to collect the DEF.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Run the engine and check that DEF is flowing from the DEF pressure line into the container. <b>Note:</b> Do not run the engine for more than 120 seconds.</p> <p><b>C.</b> Turn the keyswitch to the OFF position. Remove the DEF pressure line from the container immediately to prevent the DEF being sucked back into the line when the DEF system purges.</p>	<p>DEF pump restriction</p>	<p><b>Result:</b> DEF did not flow from the DEF pressure line into the container.</p> <p><b>Repair:</b> Replace the DEF pump. Refer to the Disassembly and Assembly manual for the correct procedure.</p> <p><b>Note:</b> If this repair is part of a warranty claim, refer to Special Instruction, M0119435 Proceed to Test Step 7.</p> <p><b>Result:</b> DEF flowed from the pressure line into the container.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check for a Restriction in the DEF Injector</b></p> <p><b>Note:</b> If necessary, move the engine to an area where the ambient temperature is at least 10° C (50° F) to perform this step. The DEF system will not prime if the ambient temperature is too low.</p> <p><b>A.</b> Connect the DEF pressure line and the DEF return line to the DEF injector. Place the other end of the DEF return line into a suitable container to collect the DEF.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Run the engine and check that DEF is flowing from the DEF pressure line into the container. <b>Note:</b> Do not run the engine for more than 120 seconds.</p> <p><b>C.</b> Turn the keyswitch to the OFF position. Remove the DEF pressure line from the container immediately to prevent the DEF being sucked back into the line when the DEF system purges.</p>	<p>DEF injector restriction</p>	<p><b>Result:</b> DEF did not flow from the DEF return line into the container.</p> <p><b>Repair:</b> Install a replacement DEF injector. Refer to Disassembly and Assembly for the correct procedure. Proceed to Test Step 5.</p> <p><b>Result:</b> DEF flowed from the return line into the container.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Symptom Troubleshooting

(Table 41, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Perform a DEF Dosing System Accuracy Test</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove the DEF injector. Refer to Disassembly and Assembly, "DEF Injector and Mounting - Remove and Install".</p> <p><b>Note:</b> Leave all lines connected to the DEF injector.</p> <p><b>C.</b> Install the DEF injector into Tooling B and Tooling C.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Connect to the electronic service tool.</p> <p><b>F.</b> Perform the "DEF Dosing System Accuracy Test" . Refer to Testing and Adjusting, "Aftertreatment SCR System Dosing Test" for the correct procedure.</p> <p><b>Note:</b> This test takes approximately 7 to 8 minutes and includes the following phases:</p> <ul style="list-style-type: none"> <li>· Priming of the DEF system.</li> <li>· The dosing test which will take 6 minutes.</li> <li>· Purging of the DEF system.</li> </ul> <p>If the dosing test only runs for 1 minute, repeat the test a further 5 times.</p>	<p>105 mL (3.6 fl oz) to 130 mL (4.4 fl oz)</p>	<p><b>Result:</b> The amount of DEF collected was less than 105 mL (3.6 fl oz) or greater than 130 mL (4.4 fl oz). Proceed to Test Step 6.</p> <p><b>Result:</b> The amount of DEF collected is within 105 mL (3.6 fl oz) to 130 mL (4.4 fl oz). Proceed to Test Step 7.</p>
<p><b>6. Install a Replacement DEF Pump Filter</b></p> <p><b>A.</b> Install a new DEF pump filter. Refer to the Operation and Maintenance Manual, "Diesel Exhaust Fluid Filter - Clean/Replace".</p> <p><b>B.</b> Turn the keyswitch to the OFF position until the wait-to-disconnect lamp switches off.</p> <p><b>Note:</b> The keyswitch must be OFF until the wait-to-disconnect lamp switches off to allow the DEF pump to purge, reset the code, and reset the DCU.</p> <p><b>C.</b> Use the electronic service tool to check for active diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> The active diagnostic code has been eliminated. Proceed to Test Step 7.</p> <p><b>Result:</b> The active diagnostic code is still present. Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Perform a "Aftertreatment System Functional Test"</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Perform the "Aftertreatment System Functional Test" .</p>	<p>Functional test</p>	<p><b>Result:</b> The test was successful. Return the unit to service.</p> <p><b>Result:</b> The test was not successful. There are extra codes. <b>Repair:</b> Troubleshoot the additional codes. Refer to Troubleshooting, "Diagnostic Trouble Codes". Repeat Test Step 5.</p> <p><b>Result:</b> The test was not successful. There are no additional codes. Contact the Dealer Solutions Network (DSN).</p>

i08134317

## DEF Pressure Is Low

Table 42

Diagnostic Trouble Codes for DEF Pressure Is Low			
J1939 Code	PDL Code	Code Description	Comments
4334-18	E931 (2)	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Low - moderate severity (2)	Diesel Exhaust Fluid (DEF) system pressure dropped below the acceptable threshold during dosing
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 43

Required Tools			
Tool	Part Number	Part Description	Qty
A	T402192	Tool Gp	1

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 44

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the DEF Tank Filling Procedure</b></p> <p><b>A.</b> Ensure that the engine has been stopped before the DEF tank is filled.</p> <p>Refer to Operation and Maintenance Manual, "Diesel Exhaust Fluid - Fill" for the correct procedure.</p> <p><b>Note:</b> If the DEF tank is filled with the engine running, diagnostic codes 4334-16 (E930 (2)) or 4334-18 (E931 (2)) may become active .</p>	Filling procedure	<p><b>Result:</b> The DEF tank has been filled using the correct procedure.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The correct procedure has not been used to fill the DEF tank.</p> <p><b>Repair:</b> Use the correct procedure to fill the DEF tank.</p> <p>Refer to Operation and Maintenance Manual, "Diesel Exhaust Fluid - Fill" for the correct procedure.</p>
<p><b>3. Clean the DEF Tank Filler Screen</b></p> <p><b>A.</b> Clean dirt and debris from around the tank cap before removing the cap. Blockages can be caused by a build-up of dirt and debris around the cap.</p> <p><b>Note :</b> A blocked DEF filler cap can also cause a 5392-31 ( E1370 (2)) code.</p> <p><b>B.</b> Clean the DEF filler screen. Refer to Operation and Maintenance Manual, DEF Filler Screen - Clean.</p> <p><b>C.</b> If necessary, replace the DEF tank filler screen or the DEF tank filler cap.</p> <p><b>D.</b> Use the electronic service tool to perform an "Aftertreatment System Functional Test" .</p>	DEF filler cap	<p><b>Result:</b> The "Aftertreatment System Functional Test" was successful. The diagnostic code is no longer active.</p> <p>Return the engine to service.</p> <p><b>Result:</b> The "Aftertreatment System Functional Test" was not successful. The diagnostic code is still active.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 44, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the DEF Level</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Check the current position of the DEF gauge. Turn the keyswitch to the OFF position.</p> <p><b>C.</b> Clean dirt and debris from around the tank filler cap before removing the cap. Add DEF to the DEF tank. Refer to Operation and Maintenance Manual, Diesel Exhaust Fluid - Fill for the correct procedure.</p> <p><b>D.</b> Turn the keyswitch to the ON position. Check for a change in the gauge position.</p> <p><b>E.</b> If the gauge is in the full position, drain DEF from the tank and look for a change in the gauge position.</p>	Gauge position	<p><b>Result:</b> The gauge did not move by adding or removing fluid to the tank.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The gauge moved by adding or removing fluid to the tank.</p> <p>Proceed to Test Step 6.</p>
<p><b>5. Check the Electrical Connection at the DEF Tank Header</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the electrical connections to the DEF tank header. Refer to Troubleshooting, "Electrical Connectors - Inspect" for further information.</p> <p><b>C.</b> Inspect the connections for corrosion or loose wires.</p>	Electrical connections	<p><b>Result :</b> The electrical connections are free of corrosion and loose wires.</p> <p><b>Repair :</b> Repair the DEF Tank header sensor with the DEF Manifold Sensor Kit. Refer to Disassembly and Assembly, Manifold (DEF Heater) Sensor - Disassemble (Temperature, Level, Quality DEF Manifold Sensor) and Manifold (DEF Heater) Sensor -Assemble (Temperature, Level, Quality DEF Manifold Sensor).</p> <p>Proceed to Test Step 12.</p> <p><b>Result :</b> The electrical connections are not free of corrosion or loose wires.</p> <p><b>Repair :</b> Make the necessary repairs.</p> <p>Proceed to Test Step 12.</p>
<p><b>6. Check the Diesel Exhaust Fluid (DEF) for Contamination</b></p> <p><b>A.</b> Check the DEF for contamination. Refer to Testing and Adjusting, "Diesel Exhaust Fluid Quality - Test" for the correct procedure.</p>	DEF quality standards	<p><b>Result:</b> The DEF is contaminated.</p> <p><b>Repair:</b> If the DEF is contaminated with oil-based fluid, the DEF tank must be flushed. Refer to Systems Operating, Testing and Adjusting "Diesel Exhaust Fluid Tank - Flush"</p> <p>After flush procedure completed, proceed to Test Step 12.</p> <p><b>Result:</b> The DEF is not contaminated.</p> <p>Proceed to Test Step 7.</p>

(continued)

## Symptom Troubleshooting

(Table 44, contd)

Troubleshooting Test Steps	Values	Results
<p><b>7. Replace the DEF Pump Filter</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position until the wait-to-disconnect lamp switches off.</p> <p><b>Note:</b> The keyswitch must be OFF until the "Wait to Disconnect" lamp switches off to allow the DEF pump to purge, reset the code, and reset the Diesel Exhaust Fluid Controller (DCU).</p> <p><b>B.</b> Replace the DEF pump filter. Refer to Operation and Maintenance Manual, Diesel Exhaust Fluid Filter - Clean/Replace.</p> <p><b>C.</b> Use the electronic service tool to perform an "Aftertreatment System Functional Test" .</p>	DEF filter	<p><b>Result:</b> The "Aftertreatment System Functional Test" was successful. The diagnostic code is no longer active.</p> <p>Return the engine to service.</p> <p><b>Result:</b> The "Aftertreatment System Functional Test" was not successful. The diagnostic code is still active.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Inspect the Lines for Leaks</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Perform the "DEF Dosing System Verification Test" to pressurize the system. Refer to Troubleshooting, "Service Tool Features" for more information.</p> <p><b>D.</b> Inspect all the DEF lines for disconnected lines or leaks.</p>	Leaks	<p><b>Result:</b> A leaking or disconnected line was found.</p> <p><b>Repair:</b> Repair or replace the faulty DEF line.</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> A leaking or disconnected line was not found.</p> <p>Proceed to Test Step 9.</p>

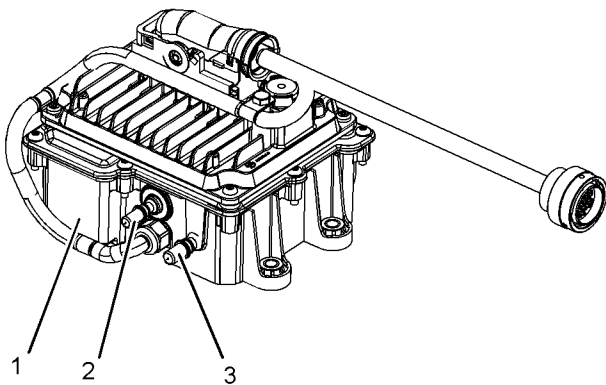


Illustration 41

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Typical view of the Pump and Electronics Unit (PEU)

- (1) DEF Pump
- (2) DEF Pressure line connection
- (3) DEF suction line connection

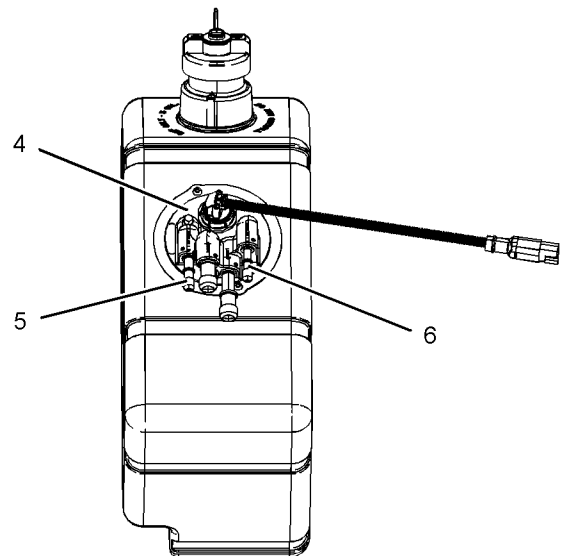


Illustration 42

g03790991

Typical view of the DEF tank

- (4) DEF tank header unit
- (5) DEF suction line connection
- (6) DEF return line connection

Table 45

Troubleshooting Test Steps	Values	Results
<p><b>9. Check for Suction Line Restrictions</b></p> <p><b>A.</b> Disconnect the suction line from DEF pump connection (3) and DEF tank header connection (5).</p> <p><b>B.</b> Inspect the suction line for obstructions.</p> <p>Possible obstructions are ice, DEF deposits, debris, or kinked lines.</p>	Restrictions	<p><b>Result:</b> An obstruction was found.</p> <p><b>Repair:</b> Flush the line with water or low-pressure air or replace the suction line.</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> An obstruction was not found.</p> <p>Install the suction line.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Check for a Leaking DEF Injector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position for 15 minutes.</p> <p><b>Note:</b> The keyswitch must be OFF until the "Wait to Disconnect" lamp switches off to allow the DEF pump to purge, reset the code, and reset the Diesel Exhaust Fluid Controller (DCU).</p> <p><b>B.</b> Remove the injector from the Clean Emissions Module (CEM). Make sure the DEF, and electrical lines are still connected.</p> <p><b>C.</b> Insert the DEF injector into Tooling (A).</p> <p><b>D.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>E.</b> Connect to the electronic service tool.</p> <p><b>F.</b> Perform the "DEF Dosing System Verification Test" to pressurize the system and inspect the injector for leakage.</p>	Leakage	<p><b>Result:</b> DEF is leaking from the DEF injector nozzle.</p> <p><b>Repair:</b> Replace the DEF injector. Proceed to Test Step 12.</p> <p><b>Result:</b> DEF is not leaking from the DEF injector nozzle.</p> <p>Proceed to Test Step 11.</p>
<p><b>11. Flush DEF Tank and Replace the DEF Tank Header Filter</b></p> <p><b>A.</b> Carry out a diesel exhaust fluid tank flush. Refer to Operation and Maintenance Manual, Diesel Exhaust Fluid Tank - Flush.</p> <p><b>B.</b> Replace the DEF tank header filters. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install.</p>	DEF tank header	<p><b>Result:</b> The DEF tank has been flushed and the DEF tank header filters have been replaced.</p> <p>Proceed to Test Step 12.</p>
<p><b>12. Perform an Aftertreatment System Functional Test</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Perform the "Aftertreatment System Functional Test" .</p>	Test successful	<p><b>Result:</b> The test is successful.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The test is not successful. There are more codes.</p> <p><b>Repair:</b> Troubleshoot the additional codes. Confirm that the fault has been eliminated.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

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## DEF Tank Level Is Low

Table 46

Diagnostic Trouble Codes for DEF Tank Level Is Low			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1761-1	E954 (3)	Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - most severe (3)	The DEF tank is 0%. The Emissions System Malfunction lamp is on and the Action lamp flashes. The code is logged. The engine may shut down.
1761-17	E954 (1)	Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - least severe (1)	The level fluid in the Diesel Exhaust Fluid (DEF) tank is less than 14%. The Emissions System Malfunction lamp comes on. The code is logged.
1761-18	E954 (2)	Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - moderate severity (2)	The level fluid in the DEF tank is less than 8%. The Emissions System Malfunction lamp is on and the Action lamp flashes. The code is logged. The engine is derated.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 47

Associated Diagnostic Trouble Codes	
J1939 Code	PDL Code
5392-31	E1370
1761-2	E3130

**Note:** If active 1761 diagnostic codes are present, this may be due to an issue with the DEF pump which is causing a loss of prime. Operate the machine for several minutes and check to see if the DEF levels recover.

**Note:** Troubleshoot any electrical diagnostic codes associated with the DEF header or CAN C data link before performing the procedure detailed below.

Complete the procedure in the order in which the steps are listed.

**Note:** Before starting the troubleshooting steps, please ensure that the DEF system (including tank and lines) is fully thawed and is at least half full of DEF.



Table 48

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure. Start the engine and wait for 2 minutes. If the fault is cleared, return the engine to service. If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the DEF Fluid Level</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>B.</b> Check the current position of the DEF gauge. <b>Note:</b> The gauge may take up to 60 seconds to show the correct DEF level.</p> <p><b>C.</b> Turn the keyswitch to the OFF position.</p> <p><b>D.</b> Clean dirt and debris from around the cap before removing the cap.</p> <p><b>E.</b> Add DEF to the DEF tank.</p> <p><b>Note:</b> Only use DEF that meets ISO 22241 quality standards.</p> <p><b>F.</b> Turn the keyswitch to the ON position. <b>Note:</b> The gauge may take up to 60 seconds to show the correct DEF level.</p> <p><b>G.</b> Check for a change in the gauge position.</p>	Gauge position	<p><b>Result:</b> The gauge did not move by adding DEF to the tank.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The gauge moved by adding DEF to the tank.</p> <p>Turn the keyswitch to the OFF position until the "Wait to Disconnect" lamp switches off to allow the DEF pump to purge, reset the code, and reset the DEF Control Unit (DCU). Return the unit to service.</p>

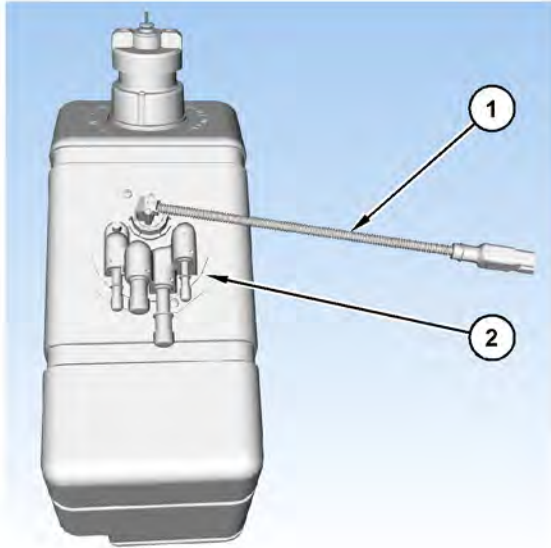


Illustration 43

g03700612

- (1) DEF tank header electrical connector
- (2) DEF tank header

Table 49

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Electrical Connection at the DEF Tank Header</b></p> <p><b>A.</b> Inspect electrical connector (1) to the DEF tank header. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p>Check for corrosion or loose wires.</p>	<p>Electrical connections</p>	<p><b>Result:</b> The electrical connectors are free of corrosion and are not loose.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The electrical connections are corroded and/or loose.</p> <p><b>Repair:</b> Make the necessary repairs to the connectors. Turn the keyswitch to the OFF position until the "Wait to Disconnect" lamp switches off to allow the DEF pump to purge, reset the code, and reset the Dosing Control Unit (DCU).</p> <p>Use the electronic service tool to perform the "Aftertreatment System Functional Test" to ensure that the repair eliminates the fault.</p> <p>Repeat this procedure from Test Step 1.</p>

(continued)

(Table 49, contd)

<p><b>4. Check the DEF Level Measurement</b></p> <p><b>A.</b> Operate the machine to agitate the DEF in the tank</p>	<p>Gauge position</p>	<p><b>Result:</b> The gauge did not move.</p> <p><b>Repair :</b> Repair the DEF Tank header sensor with the DEF Manifold Sensor Kit. Refer to Disassembly and Assembly, Manifold (DEF Heater) Sensor - Disassemble (Temperature, Level, Quality DEF Manifold Sensor) and Manifold (DEF Heater) Sensor -Assemble (Temperature, Level, Quality DEF Manifold Sensor).</p> <p><b>Result:</b> The gauge moved.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Inspect the DEF Tank Header</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove tank header (2) from the DEF tank. Refer to Disassembly and Assembly, "Manifold (DEF Heater) - Remove and Install".</p> <p><b>C.</b> Inspect the DEF tank header for damage and check for a stuck float.</p>	<p>Proper operation of the float</p>	<p><b>Result:</b> The float was not operating correctly.</p> <p><b>Repair:</b> Repair the float if possible. If the float cannot be repaired, replace the DEF tank header. Refer to the Disassembly and Assembly manual for the correct procedure.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The float was operating correctly.</p> <p><b>Repair :</b> Repair the DEF Tank header sensor with the DEF Manifold Sensor Kit. Refer to Disassembly and Assembly, Manifold (DEF Heater) Sensor - Disassemble (Temperature, Level, Quality DEF Manifold Sensor) and Manifold (DEF Heater) Sensor -Assemble (Temperature, Level, Quality DEF Manifold Sensor).</p> <p>Return the unit to service.</p>

If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

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## DEF Tank Temperature Is High

Table 50

Diagnostic Trouble Code for DEF Tank Temperature Is High			
J1939 Code	PDL Code	Description (code descriptions may vary)	Notes
3031-16	E960 (2)	Catalyst Tank Temperature : High - moderate severity (2)	The temperature of the Diesel Exhaust Fluid (DEF) in the DEF tank has exceeded the parameter programmed in the ECM. The code is logged. The engine is derated.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 51

Associated Diagnostic Trouble Codes	
J1939 Code	PDL Code
110-0	E361 (1)
110-15	E361 (2)
110-16	E361 (3)

Table 52

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Associated Codes</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Determine if an associated code is present.</p>	Associated code	<p><b>Result:</b> An associated code is present.</p> <p><b>Repair:</b> Troubleshoot the associated code. Refer to Troubleshooting, "Diagnostic Trouble Codes" for the correct procedure.</p> <p>After the repairs have been made, proceed to Test Step 6.</p> <p><b>Result:</b> An associated code is not present.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. High Ambient Air Temperature</b></p> <p><b>A.</b> Determine if the ambient air temperature is within the design specifications for the cooling system.</p>	Ambient Air temperature	<p><b>Result:</b> The ambient air temperature is not within the design specifications for the system.</p> <p><b>Repair:</b> Verify the fan under the DEF tank is plugged in and working (if equipped). Contact the Dealer Solutions Network (DSN) for advice on modifications to make the system suitable for local conditions.</p> <p>After repairs have been made, proceed to Test Step 6.</p> <p><b>Result:</b> The ambient air temperature is within the design specifications.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Electrical Connections</b></p> <p><b>A.</b> Inspect the electrical connections to the coolant diverter valve. Inspect all electrical connections to the Diesel Exhaust Fluid (DEF) tank header. Refer to Troubleshooting, "Electrical Connectors - Inspect" for further information.</p> <p><b>B.</b> Inspect for corrosion or loose wires.</p>	Corrosion	<p><b>Result:</b> The connections are free of corrosion and are not loose.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The connections are corroded and/or are loose.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p>Proceed to Test Step 6.</p>

(continued)

(Table 52, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Coolant Supply and Return Lines for Correct Installation</b></p> <p><b>A.</b> Inspect the coolant supply and return lines from the engine to the DEF tank, including the coolant diverter valve. Make sure that the coolant is flowing in the correct direction through all components.</p>	Correct installation	<p><b>Result:</b> The lines are installed correctly.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The lines are not installed correctly.</p> <p><b>Repair:</b> Correctly install the lines. Proceed to Test Step 6.</p>
<p><b>5. Check the Coolant Diverter Valve Solenoid for Proper Operation</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the wiring harness connector from the coolant diverter valve.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Connect to the electronic service tool.</p> <p><b>E.</b> Start the engine. Allow the engine to warm to operating temperature.</p> <p><b>F.</b> Use the electronic service tool to monitor the “DEF Tank Temperature”. Ensure that the DEF tank temperature is responding correctly.</p> <p><b>G.</b> Turn the keyswitch to the OFF position.</p>	Temperature rise	<p><b>Result:</b> The DEF tank temperature did not increase.</p> <p>Connect the coolant diverter valve to the wiring harness.</p> <p>Contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> The DEF tank temperature increased.</p> <p><b>Repair:</b> The coolant diverter valve is not operating correctly. Replace the coolant diverter valve. Refer to Disassembly and Assembly, “Solenoid Valve (DEF Heater Coolant) - Remove and Install”.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Replace the DEF</b></p> <p><b>A.</b> Replace the DEF. Refer to Operation and Maintenance Manual, “Diesel Exhaust Fluid Tank - Flush” for the correct procedure.</p>	DEF	<p><b>Result:</b> The DEF has been replaced.</p> <p>Return the unit to service.</p>

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## DEF Tank Temperature Is Low

Table 53

Diagnostic Trouble Code for DEF Tank Temperature Is Low			
J1939 Code	PDL code	Code Description (code descriptions may vary)	Comments
3031-7	E1441 (2)	Aftertreatment #1 DEF Tank Temperature : Not Responding Properly	The temperature of the Diesel Exhaust Fluid (DEF) is not responding as expected during the defrosting period. The code is logged. The engine is derated.
3031-18	E1398 (2)	Catalyst Tank Temperature : Low - moderate severity (2)	The temperature of the Diesel Exhaust Fluid (DEF) in the DEF tank is below the parameter programmed in the ECM after a heat cycle. The code is logged. The engine is derated.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Complete the procedure in the order in which the steps are listed.

Table 54

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Associated Diagnostic Trouble Codes</b></p> <p><b>A.</b> Use the electronic service tool to confirm if a diagnostic code is present.</p>	Diagnostic Trouble Codes	<p><b>Result:</b> A diagnostic code other than those codes listed in Table 53 is active.</p> <p><b>Repair:</b> Troubleshoot the associated code. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> One of the diagnostic codes listed in Table 53 is active.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Coolant Level of the Engine</b></p> <p><b>A.</b> Determine if the engine coolant level is full.</p>	Coolant Level	<p><b>Result:</b> The coolant level is full.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The coolant level is not full.</p> <p><b>Repair:</b> Add coolant to the system.</p> <p>Determine the cause of low coolant. Refer to Troubleshooting, "Low Coolant Level" for additional information.</p> <p>If adding coolant does not correct the fault, proceed to Test Step 3.</p>

(continued)

(Table 54, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Engine Coolant Temperature</b></p> <p><b>A.</b> Start the engine. Allow the engine to warmup to normal operating temperature.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Select the Status Parameters tab.</p> <p><b>D.</b> Check the coolant temperature.</p> <p>The temperature should be greater than 50° C (122° F).</p>	Coolant temperature	<p><b>Result:</b> The coolant temperature is greater than 50° C (122° F).</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The coolant temperature is less than 50° C (122° F).</p> <p><b>Repair:</b> Refer to Troubleshooting, “Coolant Temperature Is Low” for troubleshooting information.</p>
<p><b>4. Check for Coolant Leaks</b></p> <p><b>A.</b> Check for coolant leaks in the supply and return lines to the DEF tank header.</p>	Leaks	<p><b>Result:</b> There are no leaks in the supply or return lines.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> There are leaks in the supply or return lines.</p> <p><b>Repair:</b> Repair the leaks and refill the coolant system.</p> <p>If the fault is still present, proceed to Test Step 5.</p>
<p><b>5. Inspect the Coolant Lines for Restrictions and Obstructions</b></p> <p><b>A.</b> Disconnect the coolant lines between the engine and the DEF tank.</p> <p><b>B.</b> Check for a restriction or obstruction in the coolant lines.</p>	Restrictions	<p><b>Result:</b> There is a restriction in a line.</p> <p><b>Repair:</b> Repair or replace the lines with the restrictions.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The coolant lines are OK.</p> <p>Reconnect the coolant lines.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Electrical Connection at the DEF Tank Header</b></p> <p><b>A.</b> Inspect electrical connector for DEF tank header . Refer to Troubleshooting, “Electrical Connectors - Inspect” for further information.</p> <p>Check for corrosion or loose wires.</p>	Electrical connections	<p><b>Result:</b> The electrical connector is not corroded or loose.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> The electrical connector is corroded and/or loose.</p> <p><b>Repair:</b>Make the necessary repairs to the connectors. Cycle the keyswitch. Use the electronic service tool to perform the “Aftertreatment System Functional Test” to verify that the repair eliminates the fault.</p> <p>Proceed to Test Step 8.</p>

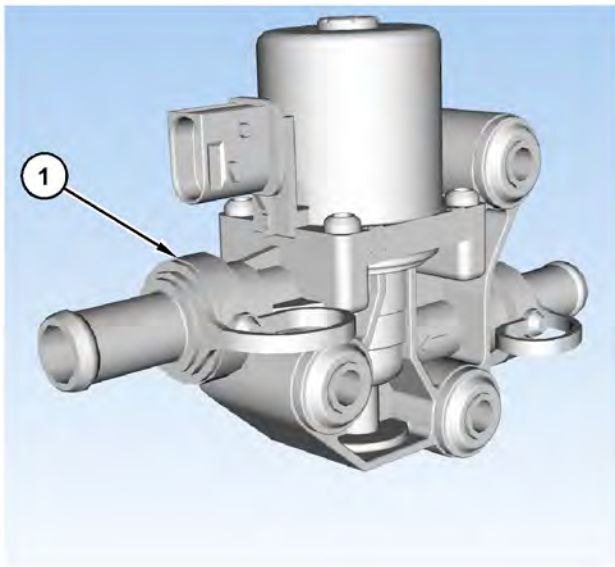


Illustration 44  
(1) Coolant diverter valve

g03701177



Table 55

Troubleshooting Test Steps	Values	Results
<p><b>7. Check the DEF Coolant Diverter Valve Solenoid Operation</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Start the engine.</p> <p><b>C.</b> Connect to the electronic service tool.</p> <p><b>D.</b> Set the status of the coolant diverter valve to OPEN using the “DEF Coolant Diverter Valve Solenoid Override” for 20 minutes.</p> <p><b>Note:</b> The DEF tank temperature must be within 5° C (9° F) of ambient air temperature prior to performing this override.</p> <p><b>E.</b> Monitor the “DEF Tank Temperature” and make sure that there is a temperature increase of at least 3° C (5.4° F).</p>	Temperature rise	<p><b>Result:</b> The DEF tank temperature increased by at least 3° C (5.4° F).</p> <p>Return the unit to service.</p> <p><b>Result:</b> The DEF tank temperature did not increase by at least 3° C (5.4° F).</p> <p><b>Repair:</b> Replace coolant diverter valve.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the DEF Coolant Diverter Valve Solenoid Operation</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Start the engine.</p> <p><b>C.</b> Connect to the electronic service tool.</p> <p><b>D.</b> Set the status of the coolant diverter valve to OPEN using the “DEF Coolant Diverter Valve Solenoid Override” for 20 minutes.</p> <p><b>Note:</b> The “DEF Coolant Diverter Valve Solenoid Override” will only run for 5 minutes. Repeat the override four times.</p> <p><b>Note:</b> The DEF tank temperature must be within 5° C (9° F) of ambient air temperature prior to performing this override.</p> <p><b>E.</b> Monitor the “DEF Tank Temperature” and make sure that there is an increase of at least 3° C (5.4° F).</p>	Temperature rise	<p><b>Result:</b> The DEF tank temperature increased by at least 3° C (5.4° F).</p> <p>Return the unit to service.</p> <p><b>Result:</b> The DEF tank temperature did not increase by at least 3° C (5.4° F).</p> <p><b>Repair :</b> Repair the DEF Tank header sensor with the DEF Manifold Sensor Kit. Refer to Disassembly and Assembly, Manifold (DEF Heater) Sensor - Disassemble (Temperature, Level, Quality DEF Manifold Sensor) and Manifold (DEF Heater) Sensor -Assemble (Temperature, Level, Quality DEF Manifold Sensor).</p> <p>Repeat this Test Step.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i06155905

## Diesel Oxidation Catalyst Has Incorrect Inlet Temperature

This procedure is only applicable to engines that have a Diesel Particulate Filter (DPF).

Table 56

Diagnostic Trouble Code for DOC Has Incorrect Inlet Temperature			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4765-17	E2165 (1)	Aftertreatment #1 Diesel Oxidation Catalyst In-take Gas Temperature : Low - least severe (1)	ECM detects that the DOC inlet temperature is below the acceptable range during HC dosing. The code is logged.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

Table 57

Associated Codes	
J1939 Codes	PDL Codes
649-5	3512-5
649-6	3512-6
649-7	E1263 (2)
5625-3	3513-3
5625-4	3513-4


**WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

Complete the procedure in the order in which the steps are listed.

Table 58

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Trouble Codes</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Check for associated diagnostic trouble codes.</p>	Diagnostic trouble codes	<p><b>Result:</b> A 4765-17 code is active or recently logged.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> An associated code other than 4765-17 is active or recently logged.</p> <p><b>Repair:</b> Troubleshoot the logged or active code. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> No codes are active or recently logged.</p> <p>Proceed to Test Step 3.</p>
<p><b>2. Check the Exhaust System</b></p> <p><b>A.</b> Check the exhaust system for gas leaks between the Exhaust Back Pressure Regulator (EBPR) and the Clean Emissions Module (CEM).</p> <p><b>B.</b> Check for missing or damaged exhaust system insulation.</p> <p><b>C.</b> Make sure that the exhaust piping between the EBPR and the CEM is no longer than 1.83 m (6 ft).</p>	Exhaust System	<p><b>Result:</b> The exhaust system has a gas leak.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The exhaust system insulation is damaged or missing.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The exhaust piping between the EBPR and the CEM is longer than 1.83 m (6 ft).</p> <p><b>Repair:</b> Review and correct the routing of the exhaust system. If necessary, contact the Dealer Solutions Network (DSN) for further advice.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Exhaust System Temperature</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Run the engine.</p> <p><b>C.</b> For engines with a DPF, perform the "Manual Hydrocarbon Dosing Capability Test" .</p> <p>For engines without a DPF, perform the "Aftertreatment Regeneration System Test" .</p>	Test	<p><b>Result:</b> The test completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The test failed. Associated diagnostic trouble codes are active.</p> <p><b>Repair:</b> Troubleshoot the logged or active code. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> The test failed. An error code is generated by the electronic service tool.</p> <p><b>Repair:</b> Troubleshoot the error code. Refer to Troubleshooting, "Service Tool Error Identifiers".</p> <p><b>Result:</b> The test failed. No associated diagnostic trouble codes are active.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i08481014

## Diesel Oxidation Catalyst Has Low Conversion Efficiency

Table 59

Diagnostic Trouble Code for DOC Has Low Conversion Efficiency			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5298-17	E2180 (1)	Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	ECM detects that the DOC outlet temperature is below the acceptable range during HC dosing. The code is logged.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

Complete the procedure in the order in which the steps are listed.

Table 60

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Trouble Codes</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Check for diagnostic trouble codes.</p>	Diagnostic trouble codes	<p><b>Result:</b> A 5298-17 or E2180 code is active or recently logged.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A reoccurrence of 5298-17 or E2180 code is active or recently logged. The code has previously been rectified.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> An associated code other than 5298-17 or E2180 is active or recently logged.</p> <p><b>Repair:</b> Troubleshoot the logged or active code. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> No codes are active or recently logged.</p> <p>Proceed to Test Step 3.</p>
<p><b>2. Check the Exhaust System</b></p> <p><b>A.</b> Check the exhaust system for evidence of oil between the Exhaust Back Pressure Regulator (EBPR) and the Clean Emissions Module (CEM).</p>	Exhaust System	<p><b>Result:</b> Oil is present in the exhaust system.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Exhaust System Contains Oil".</p> <p><b>Result:</b> There is no oil in the exhaust system.</p> <p><b>Repair:</b> Use the electronic service tool to perform the "HC Dosing Capability Test". Proceed to Test Step 3.</p>

(continued)

(Table 60, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Recover the Aftertreatment System</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Run the engine.</p> <p><b>C.</b> Perform the "Aftertreatment Recovery Procedure".</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p>	Test	<p><b>Result:</b> The "Aftertreatment Recovery Procedure" completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The "Aftertreatment Recovery Procedure" failed. An error code is generated by the electronic service tool.</p> <p><b>Repair:</b> Troubleshoot the error code. Refer to Troubleshooting, "Service Tool Error Identifiers".</p> <p><b>Result:</b> The "Aftertreatment Recovery Procedure" failed. No error codes are generated.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check for High Sulfur Fuel</b></p> <p><b>A.</b> Ensure that the correct specification of fuel is being used. Refer to the Operation and Maintenance Manual for the correct specification.</p> <p><b>Note:</b> If fuel with a high sulfur content is used, this fault will reoccur and a replacement CEM may be required.</p>	Fuel	<p><b>Result:</b> High sulfur fuel is in use.</p> <p><b>Repair:</b> Drain the fuel tank, flush the fuel lines, and replace the fuel filters.</p> <p>Refill the fuel system with fuel of the correct specification.</p> <p>Start the engine and use the electronic service tool to perform the "Aftertreatment Recovery Procedure". If the procedure is successful, return the unit to service. If the procedure fails, contact the Dealer Solutions Network (DSN).</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p> <p><b>Result:</b> The fuel is the correct specification.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i08693830

## Diesel Particulate Filter Collects Excessive Soot (If Equipped)

This procedure is only applicable to engines that have a Diesel Particulate Filter (DPF) installed.

If the soot load becomes excessive, the ECM activates the applicable code.

## Symptom Troubleshooting

Table 61

<b>Diagnostic Trouble Codes for Excessive Soot Load</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
3719-16	E995 (2)	High Diesel Particulate Filter #1 Soot Loading - Level 2	The estimated soot load is above 116 percent. Engine power is gradually derated as the soot load increases. The emissions system failure lamp will flash.
3719-0	E995 (3)	High Diesel Particulate Filter #1 Soot Loading - Level 3	The estimated soot load is above 127 percent. Engine power is derated 100 percent. The emissions system failure lamp will flash and a warning horn will sound.
7440-31	E1645 (1)	Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	The exhaust gas pressure is too low to support DPF regeneration (if equipped).

The Electronic Control Module (ECM) uses the soot sensors to monitor the soot load in the Diesel Particulate Filter (DPF). An excessive accumulation of soot in the DPF can be caused by the following faults:

- Faulty soot sensor system
- Oil in the exhaust system
- Faulty injectors
- A mechanical fault in a cylinder
- Low exhaust gas pressure
- A faulty exhaust back pressure regulator
- A fault in the NOx Reduction System (NRS)
- Fuel with a high sulfur content

Table 62

<b>Required Tools</b>			
<b>Tool</b>	<b>Part Number</b>	<b>Part Description</b>	<b>Qty</b>
A	T40-0025	Attenuator	1

Engine operation must be kept to a minimum to minimize the amount of soot that is created. Follow the troubleshooting procedure to minimize the amount of engine operation.

Table 63

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Trouble Codes</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Connect the electronic service tool.</p> <p>Check for active diagnostic trouble codes.</p>		<p><b>Result:</b> A 3719-xx (E995) code is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 7440-31 E1645 code is active.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> A code other than the codes listed in Table 61 is active.</p> <p><b>Repair:</b> Diagnose and rectify the fault before continuing with this procedure. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p>
<p><b>2. Visually Inspect the Soot Sensor System</b></p> <p><b>A.</b> Inspect the coaxial cables between the soot sensor and the antennas for damage.</p> <p><b>B.</b> Make sure that the antenna connectors are correctly tightened to 1.2 N·m (10.6 lb in).</p>	<p>Soot sensor</p>	<p><b>Result:</b> The soot sensor cables are damaged.</p> <p><b>Repair:</b> Replace the soot sensor.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> Other corrective actions were performed.</p> <p>Start the engine and then use the electronic service tool to perform the "Aftertreatment Regeneration System Test" .</p> <p>Stop the engine and then check for a 3719 (E995) code.</p> <p>If the 3719 (E995) code has been eliminated, proceed to Test Step 9.</p> <p>If the 3719 (E995) code is still present, proceed to Test Step 3.</p> <p><b>Result:</b> No corrective actions were performed.</p> <p>Proceed to Test Step 3.</p>

(continued)

## Symptom Troubleshooting

(Table 63, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Test the Soot Sensor System</b></p> <p><b>A.</b> Disconnect the soot antenna connectors and install Tooling A.</p> <p><b>B.</b> Perform the "DPF Soot Loading Sensor Functional Test" on the electronic service tool by selecting the following menus:</p> <ul style="list-style-type: none"> <li>· "Diagnostics"</li> <li>· "Diagnostic Tests"</li> <li>· "DPF Soot Loading Sensor Functional Test"</li> </ul> <p><b>C.</b> Disconnect the coaxial cables from the attenuator.</p>	Soot sensor	<p><b>Result:</b> The "DPF Soot Loading Sensor Functional Test" fails. The fault is in the soot sensor or a coaxial cable.</p> <p><b>Repair:</b> Replace the soot sensor. Ensure that the antenna connectors are tightened to a torque of 1.2 N·m (10.6 lb in) Repeat the "DPF Soot Loading Sensor Functional Test" and confirm that the test is successful.</p> <p>Use the electronic service tool to perform the "Aftertreatment Regeneration System Test" . If necessary, diagnose any reported fault codes and then proceed to Test Step 9.</p> <p><b>Result:</b> The "DPF Soot Loading Sensor Functional Test" is successful.</p> <p><b>Repair:</b> Remove the two soot antennas from the DPF. Refer to Disassembly and Assembly, "Soot Antenna - Remove and Install".</p> <p>Inspect the soot antennas for damaged or bent probes. Replace a damaged antenna.</p> <p>Install the two soot antennas. Refer to Disassembly and Assembly, "Soot Antenna - Remove and Install". Ensure that the antenna connectors are tightened to a torque of 1.2 N·m (10.6 lb in). Proceed to Test Step 4.</p>
<p><b>4. Check for Oil in the Exhaust System</b></p> <p><b>A.</b> Remove the flexible exhaust pipe. Refer to Disassembly and Assembly, "Flexible Exhaust Pipe - Remove and Install".</p> <p><b>B.</b> Inspect the exhaust system and Clean Emissions Module (CEM) inlet for oil deposits.</p>	Exhaust system	<p><b>Result:</b> Oil deposits are present in the exhaust system.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Exhaust System Contains Oil".</p> <p><b>Result:</b> No oil deposits are found in the exhaust system.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check for Engine Faults</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Use the electronic service tool to perform the "Cylinder Cutout Test" .</p>	Engine	<p><b>Result:</b> The "Cylinder Cutout Test" fails.</p> <p><b>Repair:</b> Investigate the cause of the fault and rectify. If necessary, contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> The "Cylinder Cutout Test" is successful.</p> <p>Proceed to Test Step 6.</p>

(continued)



(Table 63, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Investigate Cause of 7440-31 (E1645) Code</b></p> <p><b>Note:</b> Diagnostic code 7440-31 (E1645) indicates that the exhaust gas pressure is too low to promote DPF regeneration.</p> <p><b>A.</b> Check the exhaust system from the engine to the CEM for gas leaks.</p> <p><b>B.</b> Check the sensors on the CEM for signs of gas leaks.</p> <p><b>C.</b> Check that the exhaust system insulation is correctly installed.</p>	Diagnostic code	<p><b>Result:</b> Exhaust gas leaks are found in the exhaust system or the CEM.</p> <p><b>Repair:</b> Rectify the gas leak or make sure that the CEM sensors are correctly installed.</p> <p>Proceed to Test Step 9.</p> <p><b>Result:</b> Exhaust system insulation is missing or damaged.</p> <p><b>Repair:</b> Repair the exhaust system insulation.</p> <p>Proceed to Test Step 9.</p> <p><b>Result:</b> There are no exhaust gas leaks and the insulation is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the Exhaust Back Pressure Regulator and the NRS system</b></p> <p><b>A.</b> Use the Electronic service tool to check for diagnostic codes that are associated with the Exhaust Back Pressure Regulator (EBPR) or the NRS system.</p>	EBPR and NRS systems	<p><b>Result:</b> A diagnostic code is present that is associated with the EBPR or the NRS system.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Diagnostic Trouble Codes" for information on troubleshooting the code.</p> <p><b>Result:</b> There are no diagnostic codes present for the EBPR or the NRS system.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check for High Sulfur Fuel</b></p> <p><b>A.</b> Ensure that the correct specification of fuel is being used. Refer to the Operation and Maintenance Manual for the correct specification.</p> <p><b>Note:</b> If fuel with a high sulfur content is used, this fault will reoccur and a replacement CEM may be required.</p>	Fuel	<p><b>Result:</b> High sulfur fuel is in use.</p> <p><b>Repair:</b> Drain the fuel tank, flush the fuel lines, and replace the fuel filters.</p> <p>Refill the fuel system with fuel of the correct specification.</p> <p>Start the engine and use the electronic service tool to perform the "Aftertreatment Sulfation Recovery Procedure".</p> <p><b>Result:</b> The fuel is the correct specification.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>9. Prepare the Unit for Service</b></p> <p><b>A.</b> Start the engine and use the electronic service tool to perform the "Manual Diesel Particulate Filter Regeneration."</p>	DPF	<p><b>Result:</b> The soot content of the DPF returns to normal.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The soot content of the DPF remains high.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06155916

## Diesel Particulate Filter Temperature Is Low (If Equipped)

This procedure is only applicable to engines that have a Diesel Particulate Filter (DPF) installed.

The Electronic Control Module (ECM) monitors the temperature at the intake of the Diesel Particulate Filter (DPF). The ECM activates the following code when the conditions are met.

Complete the procedure in the order in which the steps are listed.

Table 64

Diagnostic Trouble Codes for Diesel Particulate Filter Temperature Is Low			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3242-17	E1014 (1)	Particulate Trap Intake Gas Temperature : Low - least severe (1)	The temperature at the intake of the DPF is below the trip point that is calculated by the ECM. The trip point varies depending on engine operating conditions.  The code is logged. The code remains active until electrical power to the ECM is cycled.
3242-18	E1014 (2)	Particulate Trap Intake Gas Temperature : Low - moderate severity (2)	The temperature sensor is not correctly installed.  Engine power is derated 30%. The code is logged. The code remains active until electrical power to the ECM is cycled.

Table 65

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Trouble Codes</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Connect the electronic service tool.</p> <p>Check for active diagnostic trouble codes.</p>	<p>Diagnostic trouble codes</p>	<p><b>Result:</b> A 3242-17 (E1014(1))code is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 3242-18 (E1014(2))code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> A code other than those listed in Table 64 is active.</p> <p><b>Repair:</b> Diagnose and rectify the fault before continuing with this procedure. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p>
<p><b>2. Visually Inspect the Insulation on the Exhaust Duct (if equipped)</b></p> <p><b>A.</b> Check the insulation on the exhaust duct between the engine and the Clean Emissions Module (CEM). Make sure that insulation is not missing or damaged.</p>	<p>Insulation</p>	<p><b>Result:</b> The insulation is missing or damaged.</p> <p><b>Repair:</b> Replace the insulation.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The insulation is not missing or damaged.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check for Exhaust Back Pressure Regulator Faults</b></p> <p><b>A.</b> Use the electronic service tool to check for any active diagnostic trouble codes that are associated with the Exhaust Back Pressure Regulator (EBPR).</p>	<p>EBPR</p>	<p><b>Result:</b> There are active diagnostic trouble codes that are associated with the EBPR.</p> <p><b>Repair:</b> Investigate and rectify any faults. Refer to Troubleshooting, "Motorized Valve - Test".</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> There are no active diagnostic trouble codes that are associated with the EBPR.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

## Symptom Troubleshooting

(Table 65, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Sensor Installation</b></p> <p><b>A.</b> Check that the temperature sensor is correctly installed and is not loose.</p>	Sensor installation	<p><b>Result:</b> The temperature sensor is not correctly installed or is loose.</p> <p><b>Repair:</b> Install the temperature sensor and tighten to the recommended torque. Refer to Disassembly and Assembly, "Temperature Sensor (DPF) - Remove and Install".</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The temperature sensor is correctly installed and is not loose.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check for Engine Faults</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Use the electronic service tool to check that the fault has been eliminated.</p>	Diagnostic	<p><b>Result:</b> The fault has been eliminated.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The fault is still present.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06155974

## Engine Cranks but Does Not Start

### Probable Causes

- Diagnostic codes
- Visible faults
- Air intake and exhaust system
- Speed/timing sensor
- Low-pressure fuel system
- Transfer Pump Inlet Regulator (TPIR)
- EFLP flow rate
- Return fuel lines
- High-pressure fuel system
- Starting aids
- Low compression (cylinder pressure)

### Recommended Actions

#### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 66

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Use the electronic service tool to check for active or logged codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A diagnostic code is present.</p> <p><b>Repair:</b> Troubleshoot the code and then reset the histogram.</p> <p><b>Result:</b> A diagnostic code is not present. Proceed to Test Step 2.</p>
<p><b>2. Visible Faults</b></p> <p><b>A.</b> Check that the fuel supply valve (if equipped) is in the OPEN position.</p> <p><b>B.</b> Check for the correct level of fuel, oil, and coolant.</p> <p><b>C.</b> Check for water in the primary fuel filter/water separator.</p> <p><b>D.</b> If the ambient temperature is below 0 °C (32 °F), check the specification of engine oil and oil for the machine.</p> <p><b>E.</b> Visually inspect the engine for the following faults:</p> <ul style="list-style-type: none"> <li>• Missing components</li> <li>• Damaged components</li> <li>• Damaged electrical cables or loose electrical cables</li> <li>• Oil leaks</li> <li>• Fuel leaks</li> <li>• All fuel filters are correctly installed.</li> </ul> <p><b>F.</b> Check that the battery voltage is correct.</p> <p><b>G.</b> Use the electronic service tool to check the average cranking speed of the engine.</p>	<p>Visible faults</p>	<p><b>Result:</b> The fuel supply valve (if equipped) is not in the OPEN position.</p> <p><b>Repair:</b> Move the fuel supply valve to the OPEN position.</p> <p><b>Result:</b> The level of fuel, oil, or coolant is not correct.</p> <p><b>Repair:</b> Replenish any fluids with an incorrect level.</p> <p><b>Result:</b> Water is present in the primary fuel filter/water separator.</p> <p><b>Repair:</b> Drain any water from the primary fuel filter/water separator.</p> <p><b>Result:</b> The correct specification of engine oil and oil for the machine is not in use.</p> <p><b>Repair:</b> Replenish the system with oil of the correct specification for the ambient conditions.</p> <p><b>Result:</b> Battery voltage is low.</p> <p><b>Repair:</b> Check the batteries. Refer to Troubleshooting, "Battery Problem".</p> <p><b>Result:</b> The cranking speed is less than 150 rpm.</p> <p><b>Repair:</b> Investigate the cause of the low cranking speed and rectify, as necessary.</p> <p><b>Note:</b> The following step is only applicable to engines that have a Diesel Particulate Filter (DPF).</p> <p>If the DPF frequently collects excessive soot prior to this fault, there may be a faulty cylinder in the engine. Proceed to Test Step 12.</p> <p><b>Result:</b> All checks are OK.</p> <p>Proceed to Test Step 3.</p>

(continued)

## Symptom Troubleshooting

(Table 66, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Air Intake and Exhaust System</b></p> <p><b>A.</b> Check the air filter restriction indicator, if equipped.</p> <p><b>B.</b> Check the air intake and exhaust systems for the following defects:</p> <ul style="list-style-type: none"> <li>· Blockages</li> <li>· Restrictions</li> <li>· Damage to lines or hoses</li> </ul>	Air and Exhaust System restrictions	<p><b>Result:</b> The air filter is restricted.</p> <p><b>Repair:</b> Replace the air filter.</p> <p><b>Result:</b> There are system restrictions.</p> <p><b>Repair:</b> Refer to Systems Operation/Testing and Adjusting, "Air Inlet and Exhaust System" for additional information on the air inlet and exhaust systems.</p> <p><b>Result:</b> The air intake and exhaust system is OK.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Speed/Timing Sensors</b></p> <p><b>A.</b> Crank the engine and observe the engine speed on the electronic service tool status screen. Refer to Troubleshooting, "Speed/Timing - Test" for additional information.</p> <p>Upon initial cranking, the status for engine speed may indicate that the engine speed signal is abnormal. This message will be replaced with an engine speed once the ECM is able to calculate a speed from the signal.</p>	Speed/timing sensor	<p><b>Result:</b> The speed/timing sensors are not operating correctly.</p> <p><b>Repair:</b> Test the speed/timing sensors. Refer to Troubleshooting, "Speed/Timing - Test".</p> <p><b>Result:</b> The speed/timing sensors are operating correctly.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Low-Pressure Fuel System</b></p> <p><b>A.</b> Visually check the fuel tank for fuel. <b>Note:</b> The fuel gauge may be faulty.</p> <p><b>B.</b> If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).</p> <p><b>C.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>D.</b> Check for fuel supply lines that are restricted or not correctly installed.</p> <p><b>E.</b> Replace the in-line fuel filter that is installed upstream of the Electric Fuel Lift Pump (EFLP).</p> <p><b>F.</b> Check that the EFLP is operating correctly.</p> <p><b>G.</b> Check for air in the fuel system and that the fuel system is primed.</p> <p><b>H.</b> Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p>	Low-pressure fuel system	<p><b>Result:</b> The fuel tank level is low.</p> <p><b>Repair:</b> Fill the fuel tank.</p> <p><b>Result:</b> The fuel contains solidified wax.</p> <p><b>Repair:</b> Replace the fuel with fuel of the correct specification for the ambient conditions.</p> <p><b>Result:</b> There are fuel supply lines that are restricted or not correctly installed.</p> <p><b>Repair:</b> Install the fuel lines correctly. Replace any damaged or restricted fuel lines.</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p><b>Result:</b> The EFLP is not operating correctly.</p> <p><b>Repair:</b> Investigate the fault with the EFLP. Refer to Troubleshooting, "Fuel Transfer Pump - Test".</p> <p><b>Result:</b> There is air in the fuel system.</p> <p><b>Repair:</b> Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The diesel fuel is contaminated.</p>

(continued)

(Table 66, contd)

Troubleshooting Test Steps	Values	Results
		<p><b>Repair:</b> Drain the fuel tank and the fuel system.</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p>Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The low-pressure fuel system is OK.</p> <p>Proceed to Test Step 6.</p>

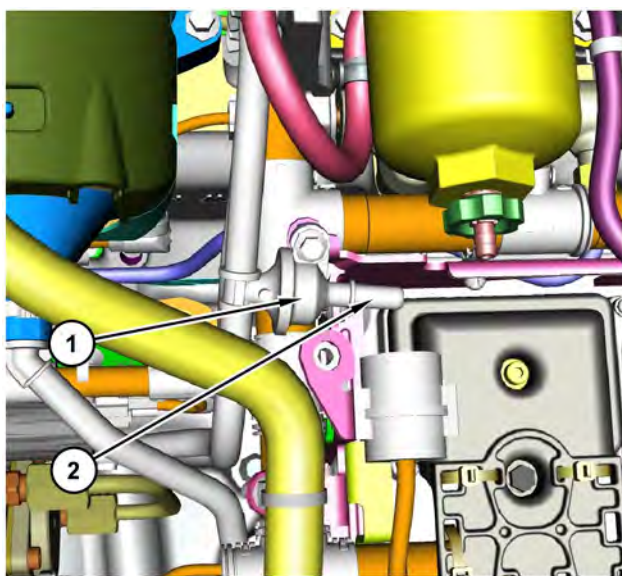


Illustration 45 g03700009  
**Transfer Pump Inlet Regulator (TPIR) components**  
 (1) Transfer Pump Inlet Regulator (TPIR)  
 (2) TPIR return port

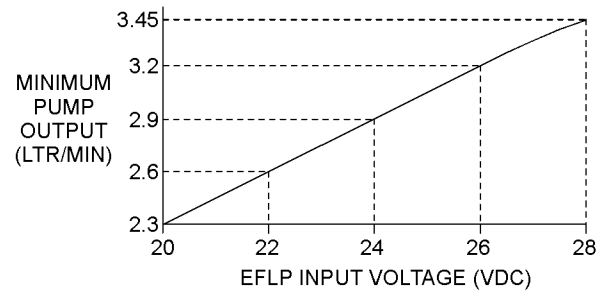


Illustration 47 g02485897  
**Minimum TPIR flow rate in a 24 VDC system**

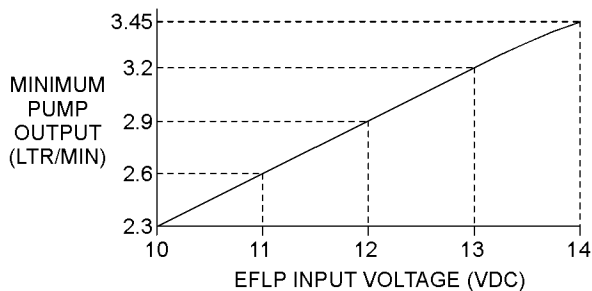


Illustration 46 g02485896  
**Minimum TPIR flow rate in a 12 VDC system**

Table 67

Troubleshooting Test Steps	Values	Results
<p><b>6. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p>Refer to Illustration 45 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 46 or 47 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	<p>TPIR flow rate</p>	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 7.</p>

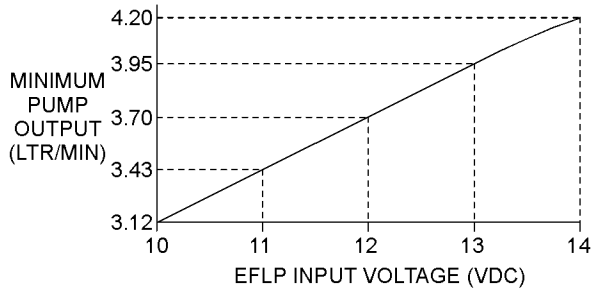


Illustration 48 g02527498  
Minimum EFLP flow rate in a 12 VDC system

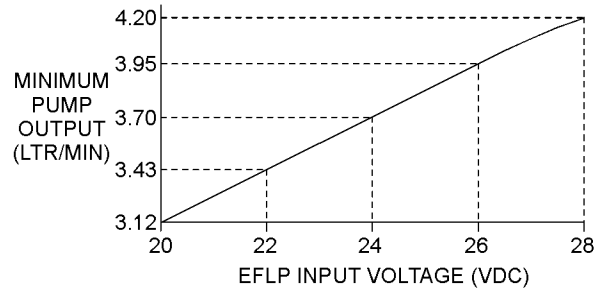


Illustration 49 g02527518  
Minimum EFLP flow rate in a 24 VDC system



Table 68

Troubleshooting Test Steps	Values	Results
<p><b>7. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 48 or 49 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, proceed to Test Step 9.</p>

(continued)

## Symptom Troubleshooting

(Table 68, contd)

Troubleshooting Test Steps	Values	Results
<p><b>9. High-Pressure Fuel System</b></p> <p><b>A.</b> Use the electronic service tool to check the absolute fuel rail pressure while the engine is cranking at a minimum speed of 150 rpm.</p>	High-pressure fuel system	<p><b>Result:</b> The absolute fuel rail pressure is less than 25 MPa (3625 psi).</p> <p><b>Repair:</b> Check for fuel leaks in the high-pressure fuel system. Rectify any fuel leaks and then recheck the pressure in the fuel rail.</p> <p>Use the electronic service tool to perform a solenoid test on the fuel injection pump. Refer to Troubleshooting, "Solenoid Valve - Test".</p> <p>Check the Pressure Limiting Valve (PLV) in the fuel rail for leakage. If the valve is leaking, replace the valve and recheck the pressure in the fuel rail.</p> <p>Check for fuel in the engine oil system. If fuel is suspected in the oil system, take an engine oil sample for analysis. Refer to the Operation and Maintenance Manual, "Engine Oil Sample - Obtain".</p> <p>If the analysis confirms that there is fuel in the engine oil system, investigate the cause.</p> <p><b>Result:</b> The absolute fuel rail pressure is greater than 25 MPa (3625 psi).</p> <p><b>Repair:</b> Use the electronic service tool to make sure that the status of the electronic unit injectors is not "Disabled".</p> <p>If the injectors are disabled but the injectors have not been intentionally disabled, proceed to Test Step 12.</p> <p>Use the electronic service tool to perform an injector solenoid test. Refer to Troubleshooting, "Injector Solenoid - Test". If the engine will not start, proceed to Test Step 10.</p>
<p><b>10. Electronic Control Module (ECM)</b></p> <p><b>A.</b> Make sure that the latest flash file for the application is installed in the ECM.</p>	ECM	<p><b>Result:</b> Installation of the latest flash file does not eliminate the fault.</p> <p><b>Repair:</b> Contact the Dealer Solutions Network (DSN).</p> <p><b>Note:</b> This consultation can greatly reduce the repair time.</p> <p>If the DSN recommends the use of a test ECM, install a test ECM. Refer to Troubleshooting, "Test ECM Mode".</p> <p>Attempt to start the engine. If the engine will not start, install the original ECM and then proceed to Test Step 11.</p> <p>If the engine starts normally, reconnect the suspect ECM and then verify that the fault returns when the suspect ECM is installed.</p> <p>If the engine will not start with the suspect ECM, replace the ECM and then check that the engine starts normally.</p>

(continued)

(Table 68, contd)

Troubleshooting Test Steps	Values	Results
<p><b>11. High-Pressure Fuel Pump</b></p> <p><b>A.</b> Check the timing of the high-pressure fuel pump. Refer to Systems Operation, Testing, and Adjusting, "Fuel Injection Timing - Check".</p>	HP fuel pump	<p><b>Result:</b> The timing of the high-pressure fuel pump is incorrect.</p> <p><b>Repair:</b> Correct the timing of the high-pressure fuel pump. Refer to Disassembly and Assembly, "Fuel Injection Pump - Remove" and Disassembly and Assembly, "Fuel Injection Pump - Install".</p> <p>With the high-pressure fuel pump correctly timed, check that the engine starts normally.</p> <p>If the engine will not start, proceed to Test Step 12.</p> <p><b>Result:</b> The timing of the high-pressure fuel pump is correct.</p> <p><b>Repair:</b> Replace the high-pressure fuel pump. Refer to Disassembly and Assembly, "Fuel Injection Pump - Remove" and Disassembly and Assembly, "Fuel Injection Pump - Install".</p> <p>Check that the engine starts normally.</p> <p>If the engine will not start, proceed to Test Step 12.</p>
<p><b>12. Starting Aids</b></p> <p><b>A.</b> Check the operation of the glow plugs. Refer to Troubleshooting, "Glow Plug Starting Aid - Test".</p> <p><b>B.</b> Check the operation of the ether starting aid. Refer to Troubleshooting, "Ether Starting Aid - Test".</p>	Glow plugs	<p><b>Result:</b> One or more of the glow plugs are faulty.</p> <p><b>Repair:</b> Replace any faulty glow plugs. Refer to Disassembly and Assembly, "Glow Plug - Remove and Install".</p> <p>Check that the engine starts normally.</p> <p>If the engine will not start, proceed to Test Step 13.</p> <p><b>Result:</b> The ether starting aid is faulty.</p> <p><b>Repair:</b> Diagnose the ether system. Refer to Troubleshooting, "Ether Starting Aid - Test".</p> <p>Check that the engine starts normally.</p> <p>If the engine will not start, proceed to Test Step 13.</p>
<p><b>13. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Faulty piston</li> <li>· Faulty piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> </ul>

(continued)

## Symptom Troubleshooting

(Table 68, contd)

Troubleshooting Test Steps	Values	Results
		Damaged cylinder head <b>Result:</b> The results of the compression test are OK. Contact the Dealer Solutions Network (DSN).

i06156000

## Engine Does Not Crank

Use this procedure to troubleshoot an engine that will not crank.

Complete the procedure in the order in which the steps are listed.

Table 69

Troubleshooting Test Steps	Values	Results
<b>1. Inspection of the Batteries and Battery Cables</b>  <b>A.</b> Inspect the main power switch, battery posts, and battery cables for loose connections and for corrosion. If the battery cables are corroded, remove the battery cables and clean the battery cables. Tighten any loose connections.  <b>B.</b> Inspect the batteries.  <b>C.</b> Charge the batteries. Refer to Systems Operation, Testing and Adjusting, "Battery - Test".	Batteries	<b>Result</b> The batteries and cables are OK.  Proceed to Test Step 2.  <b>Result</b> The batteries and cables are not OK.  <b>Repair:</b> Make the necessary repairs.
<b>2. Switches and/or Circuit Breakers (if applicable)</b>  <b>A.</b> Check any switches and/or circuit breakers that may prevent engine cranking. For additional information, refer to the machine electrical schematic.	Switches and/or circuit breakers	<b>Result</b> The switches and/or circuit breakers are OK.  Proceed to Test Step 3.  <b>Result</b> The switches and/or circuit breakers are not OK.  <b>Repair:</b> Make the necessary repairs.
<b>3. Starting Motor Solenoid and Starting Circuit</b>  <b>A.</b> Test the operation of the starting motor circuit. Refer to Systems Operation, Testing, and Adjusting, "Electrical System" for additional information.	Starting motor solenoid and circuit	<b>Result</b> The starting motor solenoid and circuit are OK.  Proceed to Test Step 4.  <b>Result</b> The starting motor solenoid and circuit are not OK.  <b>Repair:</b> Make the necessary repairs.

(continued)

(Table 69, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Inspect the Starter Pinion and Flywheel Ring Gear</b></p> <p><b>A.</b> Test the operation of the starting motor.</p> <p><b>B.</b> Check the pinion clearance. Inspect the pinion and the flywheel ring gear for damage. Refer to Systems Operation, Testing, and Adjusting, "Electrical System" for additional information.</p>	<p>Starter pinion and flywheel ring gear</p>	<p><b>Result</b> The starter pinion and flywheel ring gear are OK.</p> <p>Proceed to Test Step 5.</p> <p><b>Result</b> The starter pinion and flywheel ring gear are not OK.</p> <p><b>Repair:</b> Make the necessary repairs.</p>
<p><b>5. Inspect Engine Accessories and the Transmission (if applicable)</b></p> <p><b>A.</b> Ensure free movement of the driveline.</p> <p><b>B.</b> Remove and inspect any engine accessories that may lock up the engine.</p> <p>The following list identifies engine accessories that may lock up the engine:</p> <ul style="list-style-type: none"> <li>· Hydraulic pump that is driven from the rear gear group</li> <li>· Air compressor</li> <li>· Engine oil pump</li> <li>· Other components that are driven by the engine</li> </ul>	<p>Engine accessories and transmission</p>	<p><b>Result</b> The engine accessories and transmission are OK.</p> <p>Proceed to Test Step 6.</p> <p><b>Result</b> The engine accessories and transmission are not OK.</p> <p><b>Repair:</b> Make the necessary repairs.</p>
<p><b>6. Hydraulic Cylinder Lock</b></p> <p><b>A.</b> If an injector has been replaced, evacuate any fluids from the cylinder and attempt to start the engine. Fuel will flow from the cylinder head into the cylinders when a unit injector is removed.</p> <p><b>B.</b> If the engine will not start, check for fluid in the cylinders (hydraulic cylinder lock) by removing the individual unit injectors. Check for damaged seals. Determine the type of fluid that locked up the cylinder.</p> <p><b>C.</b> If there was a coolant leak, determine the cause of the leak. Check the exhaust (NRS) cooler for leaks. Refer to Testing and Adjusting, "Exhaust Cooler (NRS) - Test".</p> <p><b>D.</b> If there was excessive fuel in the cylinder, replace the seals and reinstall the injector. Drain any excess fuel from the cylinder head.</p> <p><b>E.</b> If a mechanical problem is suspected, disassemble the engine. Refer to the Disassembly and Assembly manual. Inspect the internal components for the following conditions:</p> <ul style="list-style-type: none"> <li>· Seizure</li> <li>· Broken components</li> <li>· Bent components</li> </ul>	<p>Hydraulic cylinder lock</p>	<p><b>Result</b> The engine has a hydraulic cylinder lock.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p><b>Result</b> The engine does not have a hydraulic cylinder lock.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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i06010812

## Engine Has Early Wear

### Probable Causes

- Incorrect maintenance intervals and/or incorrect oil
- Contaminated engine oil
- Leaks in air intake system
- Dirt in fuel
- Low oil pressure

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 70

Troubleshooting Test Steps	Values	Results
<p><b>1. Incorrect Maintenance Intervals and/or Incorrect Oil</b></p> <p><b>A.</b> Use engine oil that is recommended and change the engine oil at the interval that is recommended by the engines Operation and Maintenance Manual.</p>	Maintenance intervals	<p><b>Result:</b> The engine oil was not changed at the interval that is recommended by the Operation and Maintenance Manual.</p> <p><b>Repair:</b> Use the recommended grade of oil.</p> <p>Change the engine oil at the interval that is recommended. Repair or replace any damaged parts.</p> <p><b>Result:</b> The engine oil was changed at the interval that is recommended by the engines Operation and Maintenance Manual.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Contaminated Engine Oil</b></p> <p><b>A.</b> Obtain an oil analysis. The analysis will identify oil contamination.</p> <p><b>B.</b> Check the oil filter bypass valve.</p> <p><b>Note:</b> If the oil filter bypass valve is open, the oil will not be filtered.</p>	Contamination	<p><b>Result:</b> The oil is contaminated.</p> <p><b>Repair:</b> Determine the reason for any contamination of the engine oil and make the necessary repairs. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the engines Operation and Maintenance Manual.</p> <p><b>Result:</b> The oil filter bypass valve is open.</p> <p><b>Repair:</b> Replace the oil filter element. Refer to the Operation and Maintenance Manual.</p> <p>Check the oil filter bypass valve for a weak spring or for a broken spring. If the spring is broken, replace the spring. Verify that the oil bypass valve is operating correctly.</p> <p><b>Result:</b> The oil is not contaminated.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Leaks in Air Intake System</b></p> <p><b>Note:</b> A leak in the air intake system may allow unfiltered air into the engine.</p> <p><b>A.</b> Inspect the air intake system for streaks which may indicate a leakage of unfiltered air. Inspect all of the gaskets and the connections. Refer to Systems Operation, Testing, and Adjusting, "Air Inlet and Exhaust System" for more information.</p>	Air leak	<p><b>Result:</b> There are air leaks.</p> <p><b>Repair:</b> Repair any leaks.</p> <p><b>Result:</b> There are no air leaks.</p> <p>Proceed to Test Step 4.</p>

(continued)

## Symptom Troubleshooting

(Table 70, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Dirt in Fuel</b></p> <p><b>A.</b> Remove the fuel filters. Inspect the fuel filters for contamination.</p> <p><b>Note:</b> Contaminants in the fuel such as hydrogen sulfide and sulfur can lead to the formation of acids in the crankcase.</p> <p><b>B.</b> Obtain a fuel analysis.</p>	Fuel and fuel filters	<p><b>Result:</b> The fuel has contamination.</p> <p><b>Repair:</b> Determine the cause of any contamination and make the necessary repairs.</p> <p>Install new fuel filters. Refer to the Operation and Maintenance Manual.</p> <p><b>Result:</b> The fuel is not contaminated.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Low Oil Pressure</b></p> <p><b>Note:</b> Engine oil that is contaminated with another liquid can cause low engine oil pressure. High engine oil level can be an indication of contamination.</p> <p><b>A.</b> Obtain an analysis of the engine oil.</p> <p><b>B.</b> Check the inlet screen on the suction tube and remove any material that may be restricting engine oil flow.</p> <p><b>Note:</b> The inlet screen of the suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure.</p> <p><b>Note:</b> When some components of the engine show wear in a short time, the cause can be a restriction in a passage for engine oil. An indicator for the engine oil pressure may indicate sufficient pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the engine oil supply to the component. Refer to Systems Operation/Testing and Adjusting, "Lubrication System" for additional information.</p>	Oil pressure	<p><b>Result:</b> Analysis indicates that the oil is contaminated.</p> <p><b>Repair:</b> Replace the oil and the oil filter. Refer to the Operation and Maintenance Manual.</p> <p><b>Result:</b> The inlet tube has a restriction.</p> <p><b>Repair:</b> Clear the obstruction. Verify the repair.</p> <p><b>Result:</b> The oil pressure is low.</p> <p>Refer to Troubleshooting, "Oil Pressure Is Low" for the testing procedure. Repair any identified faults.</p> <p><b>Result:</b> The oil pressure is normal.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i07119342

- Pistons and connecting rods
- Crankshaft

## Engine Has Mechanical Noise (Knock)

### Probable Causes

- Active codes and logged codes
- Electrical connections
- Fuel injection
- Fuel quality
- Lubrication
- Engine accessory
- Valve train components

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.



Table 71

Troubleshooting Test Steps	Values	Results
<p><b>1. Active Codes and Logged Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p>	Codes	<p><b>Result:</b> There are active codes.</p> <p><b>Repair:</b> Troubleshoot any active codes before continuing with this procedure.</p> <p><b>Result:</b> There are no active codes.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Electrical Connections</b></p> <p><b>A.</b> Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the fuel injector connectors.</p>	Connectors	<p><b>Result:</b> There are suspect connectors.</p> <p><b>Repair:</b> Repair connectors that are suspect or replace connectors that are suspect.</p> <p>Perform the "Wiggle Test" on the electronic service tool.</p> <p><b>Result:</b> There are no suspect connectors.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Fuel Injection</b></p> <p><b>A.</b> Perform the "Fuel System Verification Test" in the "Diagnostic Tests" under the "Diagnostics" menu.</p>	Fuel system verification test	<p><b>Result:</b> The test was successful.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The test was not successful.</p> <p><b>Repair:</b> Diagnose and repair the fault.</p> <p>Reset all active codes and clear all logged codes.</p> <p>Verify that the repair eliminated the fault.</p>
<p><b>4. Fuel Quality</b></p> <p><b>A.</b> Refer to Operation and Maintenance Manual for information on the correct characteristics of the fuel for the engine. If necessary, obtain a fuel analysis to confirm that the correct fuel is being used for the engine. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test" for the correct procedure.</p>	Fuel	<p><b>Result:</b> The fuel quality is OK.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The fuel quality is not OK.</p> <p><b>Repair:</b> Replace the fuel. Verify that the repair eliminated the fault.</p>

(continued)

## Symptom Troubleshooting

(Table 71, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Lubrication</b></p> <p><b>A.</b> Check for sufficient lubrication of the valve components.</p> <p><b>B.</b> Check for blocked oil passages. Oil passages must be clean. Clean any oil passages that are suspect. Refer to the Disassembly and Assembly for additional information.</p> <p><b>C.</b> Inspect the engine oil filters for ferrous material.</p> <p><b>D.</b> Obtain an oil analysis.</p> <p><b>Note:</b> The analysis will contribute to a better understanding of oil contamination and the origin of the contamination.</p>	Lubrication	<p><b>Result:</b> The oil passages are not blocked and the engine has sufficient lubrication.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> The oil passages are blocked or the engine does not have sufficient lubrication.</p> <p><b>Repair:</b> Make the necessary repairs, Verify that the repair eliminated the fault.</p>
<p><b>6. Engine Accessory</b></p> <p><b>A.</b> If the source of the noise is an engine accessory, remove and inspect the suspect item.</p>	Engine accessory	<p><b>Result</b> An engine accessory is the source of the noise.</p> <p><b>Repair:</b> Repair and/or replace the engine accessory, if necessary.</p> <p><b>Result</b> An engine accessory is not the source of the noise.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Valve Train Components</b></p> <p><b>A.</b> Check the valve lash. Refer to Troubleshooting, "Valve Lash Is Excessive".</p> <p><b>B.</b> Check for damage to valve train components. Remove the valve cover from the suspect cylinders. Check the following items for damage:</p> <ul style="list-style-type: none"> <li>· Camshaft</li> <li>· Valve springs</li> <li>· Camshaft followers</li> <li>· Rocker shaft</li> <li>· Valve bridges</li> <li>· Pushrods</li> <li>· Injectors</li> </ul> <p>Refer to Disassembly and Assembly for additional information.</p> <p><b>C.</b> Check for valves that do not move freely. Remove the cylinder head and inspect the valves. Refer to Disassembly and Assembly for additional information.</p>	Valve train	<p><b>Result:</b> The valve train components are not damaged.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The valve train components are damaged.</p> <p><b>Repair:</b> Make the necessary repairs, Verify that the repair eliminated the fault.</p>

(continued)

(Table 71, contd)

Troubleshooting Test Steps	Values	Results
<p><b>8. Pistons and Connecting Rods</b></p> <p>A. Inspect the pistons for damage and wear.</p> <p>B. Inspect the connecting rod bearings for damage and wear.</p>	Pistons and connecting rods	<p><b>Result:</b> One or more components are worn or damaged.</p> <p>Replace any worn or damaged parts.</p> <p>Verify that the repair has eliminated the noise.</p> <p><b>Result:</b> All components are OK.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Crankshaft</b></p> <p>A. Inspect the crankshaft and the related components. Look for worn thrust plates and wear on the crankshaft.</p> <p>B. Inspect the connecting rod bearings and the bearing surfaces on the crankshaft. Make sure that the bearings are in the correct position.</p>	Crankshaft	<p><b>Result:</b> The crankshaft or the related components are damaged or worn.</p> <p><b>Repair:</b> Repair or replace any damaged parts. Verify that the repair eliminated the fault.</p> <p><b>Result:</b> All components are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Engine Misfires, Runs Rough or Is Unstable

**Note:** If the fault is intermittent and the fault cannot be duplicated, refer to Troubleshooting, "Power Is Intermittently Low or Power Cutout Is Intermittent".

**Note:** If the fault only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high rpm, full load, and engine operating temperature. Troubleshooting the symptoms under other conditions can give misleading results.

### Probable Causes

- Diagnostic codes
- Fuel supply
- Transfer Pump Inlet Regulator (TPIR)
- Electric Fuel Lift Pump (EFLP)
- Return fuel lines
- Throttle position sensor
- CAN data link
- High-pressure fuel pump
- Low compression (cylinder pressure)

- Electronic unit injectors
- Individual malfunctioning cylinder

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 72

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Use the electronic service tool to check for active or logged codes.</p>	Codes	<p><b>Result:</b> There are active codes.</p> <p><b>Repair:</b> Troubleshoot any active codes before continuing with this procedure.</p> <p><b>Result:</b> There are no active codes.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Fuel Supply</b></p> <p><b>A.</b> Visually check the fuel tank for fuel. The fuel gauge may be faulty.</p> <p><b>B.</b> Ensure that the vent in the fuel cap is not filled with debris.</p> <p><b>C.</b> Ensure that the fuel supply valve (if equipped) is in the full OPEN position.</p> <p><b>D.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>E.</b> Check for fuel supply lines that are restricted.</p> <p><b>F.</b> Check that the Electric Fuel Lift Pump (EFLP) is operating. If the EFLP is suspect, refer to Troubleshooting, "Relay - Test (Electric Fuel Lift Pump)".</p> <p><b>G.</b> Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Air in Fuel - Test".</p> <p><b>H.</b> Obtain a fuel analysis to confirm that the correct fuel is being used. Refer to Systems Operation/Testing and Adjusting, "Fuel Quality - Test" for the correct procedure.</p>	Fuel supply	<p><b>Result:</b> There is air in the fuel system.</p> <p><b>Repair:</b> Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The fuel quality is not OK.</p> <p><b>Repair:</b> Replace the fuel. Replace the in line fuel filter that is upstream of the EFLP. Replace the primary and secondary fuel filters. Verify that the repair eliminated the fault.</p> <p><b>Result:</b> The fuel quality is OK.</p> <p>Proceed to Test Step 3.</p>

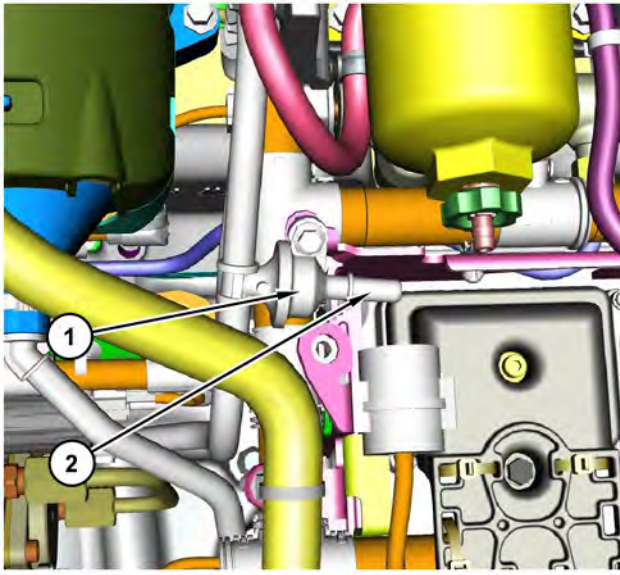


Illustration 50 g03700009  
**Transfer Pump Inlet Regulator (TPIR) components**  
 (1) Transfer Pump Inlet Regulator (TPIR)  
 (2) TPIR return port

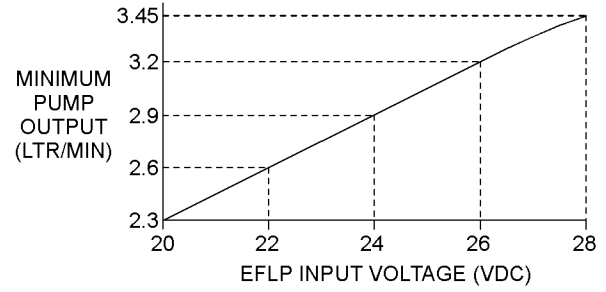


Illustration 52 g02485897  
**Minimum TPIR flow rate in a 24 VDC system**

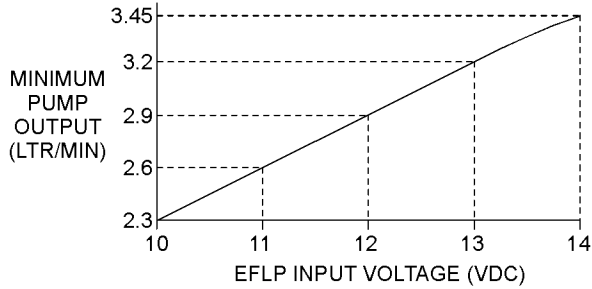


Illustration 51 g02485896  
**Minimum TPIR flow rate in a 12 VDC system**

Table 73

Troubleshooting Test Steps	Values	Results
<p><b>3. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p>Refer to Illustration 50 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 51 or 52 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	<p>TPIR flow rate</p>	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 4.</p>

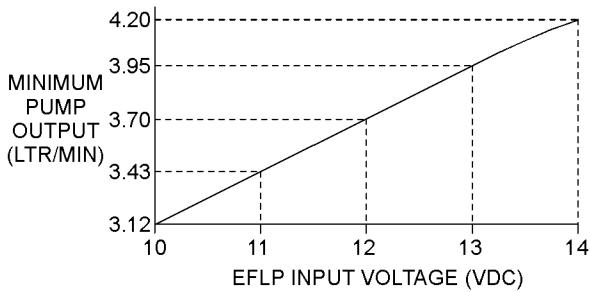


Illustration 53 g02527498  
Minimum EFLP flow rate in a 12 VDC system

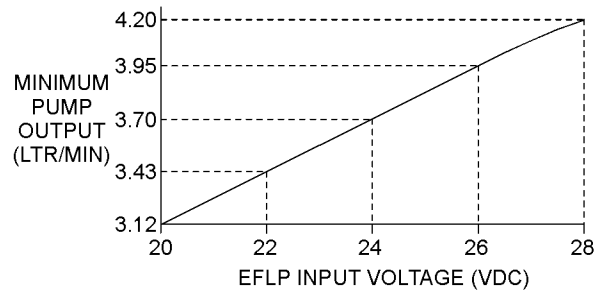


Illustration 54 g02527518  
Minimum EFLP flow rate in a 24 VDC system

Table 74

Troubleshooting Test Steps	Values	Results
<p><b>4. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 53 or 54 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, proceed to Test Step 6.</p>
<p><b>6. Throttle Signal</b></p> <p><b>A.</b> Use the electronic service tool and observe the signal for the throttle. Make sure that the throttle response is smooth and progressive.</p>	Throttle	<p><b>Result:</b> The throttle signal is erratic.</p> <p><b>Repair:</b> Refer to the appropriate circuit test for the type of throttle that is installed.</p> <p><b>Result:</b> The throttle response is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the CAN Data Link</b></p> <p><b>Note:</b> The requested engine speed signal is sent to the engine ECM through the CAN data link.</p> <p><b>A.</b> Use the electronic service tool to check for diagnostic codes that are related to the CAN data link.</p>	Throttle	<p><b>Result:</b> The CAN data link is suspect.</p> <p><b>Repair:</b> Test the CAN data link. Refer to Troubleshooting, "CAN Data Link - Test".</p> <p><b>Result:</b> The CAN data link is OK.</p> <p>Proceed to Test Step 8.</p>

(continued)

## Symptom Troubleshooting

(Table 74, contd)

Troubleshooting Test Steps	Values	Results
<p><b>8. High-Pressure Fuel Pump SCV</b></p> <p><b>A.</b> Use the electronic service tool to perform a solenoid test on the fuel injection pump. Refer to Troubleshooting, "Solenoid Valve - Test".</p>	HP fuel pump	<p><b>Result:</b> The solenoid valve test fails.</p> <p><b>Repair:</b> Replace the HP fuel pump SCV and solenoid assembly.</p> <p><b>Result:</b> The solenoid valve test passes successfully.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. High-Pressure Fuel Pump</b></p> <p><b>Note:</b> The fuel injection pump that is installed by the factory is a nonserviceable item. If any fault occurs within the fuel injection pump, the fuel injection pump must be replaced.</p> <p><b>A.</b> Use the electronic service tool to select the correct screen to display any diagnostic trouble codes that relate to the fuel injection pump.</p>	HP fuel pump	<p><b>Result:</b> There are diagnostic codes associated with the high-pressure fuel pump.</p> <p><b>Repair:</b> Diagnose the codes. Refer to Troubleshooting, "Troubleshooting with a Diagnostic Code".</p> <p>If necessary, replace the high-pressure fuel pump.</p> <p><b>Result:</b> The high-pressure fuel pump is OK.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Faulty piston</li> <li>· Faulty piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> <li>· Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 11.</p>

(continued)



(Table 74, contd)

Troubleshooting Test Steps	Values	Results
<p><b>11. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic “Cylinder Cut Out Test” .</p> <p><b>Note:</b> If the compression test that was performed in Test Step 9 was satisfactory, the “Cylinder Cut Out Test” will identify any faulty injectors.</p>	Electronic Unit Injectors	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”.</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.</p> <p>Repeat the automatic “Cylinder Cut Out Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”.</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 12.</p>
<p><b>12. Individual Malfunctioning Cylinders</b></p> <p><b>A.</b> With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cut Out Test” .</p> <p>As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine.</p> <p>If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.</p>	Cylinders	<p><b>Result:</b> The test indicates a faulty cylinder.</p> <p><b>Repair:</b> Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.</p> <p><b>Result:</b> The test indicates that all cylinders are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Engine Overspeeds

This procedure covers the following diagnostic trouble codes:

Table 75

Diagnostic Trouble Codes for Engine Overspeed			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
190-15	E362 (1)	Engine Overspeed Warning - Level 1	The engine has exceeded the value that is programmed into the Electronic Control Module (ECM) for 0.6 seconds.  There are no diagnostic trouble codes for the speed/timing sensors.  The engine has been running for at least 3 seconds.
190-0	E362 (3)	Engine Overspeed Warning - Level 3	The engine has exceeded the value that is programmed into the Electronic Control Module (ECM) for 0.6 seconds.  There are no diagnostic trouble codes for the speed/timing sensors.  The engine has been running for at least 3 seconds. The engine may shut down.

The ECM limits the flow of fuel in order to prevent the engine speed from exceeding the value that is programmed into the ECM. When the engine speed has dropped to less than the value that is programmed into the ECM, the 190-x (E362) code will be reset.

If the engine speed exceeds the value that is programmed into the ECM, the ECM illuminates the warning lamp and a 190-x (E362) code is logged. Factory passwords are required in order to clear the code. No troubleshooting is required.

The history of engine overspeeds can be viewed on the electronic service tool.

## Probable Causes

- Proceeding down steep grades (if applicable)
- Diagnostic codes
- Turbocharger or turbochargers
- Combustible gases or liquid in the Intake air

## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 76

Troubleshooting Test Steps	Values	Results
<p><b>1. Proceeding Down Steep Grades (If Applicable)</b></p> <p>Engaging the engine brakes on a steep grade may be necessary. Not all applications have engine brakes.</p> <p><b>A.</b> Make sure that the operator understands the correct operation of the machine while using the engine brakes.</p>	Steep grades	<p><b>Result:</b> Steep grades are the cause of the overspeed.</p> <p><b>Repair:</b> Control the engine speed during steep grades.</p> <p><b>Result:</b> Steep grades are not the cause of the overspeed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Diagnostic Codes</b></p> <p><b>A.</b> Download the Warranty Report and the Product Status Report with Histograms before performing any troubleshooting or clearing any diagnostic codes.</p> <p><b>Note:</b> The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed.</p> <p><b>B.</b> Use the electronic service tool to check for active or logged codes.</p>	Diagnostic codes	<p><b>Result:</b> A diagnostic code is not active or logged.</p> <p>Return the unit to service.</p> <p><b>Result:</b> At least one of the diagnostic codes listed in Table 75 is active or recently logged.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Turbocharger or Turbochargers</b></p> <p><b>Note:</b> The turbocharger or turbochargers that are installed on the engine are non-serviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Check for any oil that may be leaking into the intake air.</p>	Turbocharger	<p><b>Result:</b> A turbocharger is leaking oil into the intake air.</p> <p><b>Repair:</b> Replace the faulty turbocharger.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> A turbocharger is not leaking oil into the intake air.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Combustible Gases or Liquid in the Intake Air</b></p> <p><b>A.</b> Check for combustible gases in the surrounding atmosphere.</p> <p><b>B.</b> Check for combustible liquid in the air intake.</p>	Air quality	<p><b>Result:</b> The atmosphere has combustible gases.</p> <p><b>Repair:</b> Do not operate the engine in an environment with combustible gases.</p> <p><b>Result:</b> There is combustible liquid in the air intake.</p> <p><b>Repair:</b> Remove the liquid. Investigate and rectify the cause of liquid ingestion</p> <p><b>Result:</b> The intake air does not contain combustible gases.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

## Symptom Troubleshooting

(Table 76, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the Aftertreatment System for Oil</b></p> <p><b>A.</b> Remove excess oil from the piping with a clean cloth.</p> <p><b>B.</b> Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p><b>C.</b> Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours.</p> <p><b>D.</b> Check the quantity of drained oil in the container.</p>	CEM	<p><b>Result</b> The volume of drained oil is greater than 1.0 L (1.05669 qt).</p> <p><b>Repair:</b> Install a replacement CEM. Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p>Return the unit to service.</p> <p><b>Result</b> The volume of drained oil is less than 1.0 L (1.05669 qt).</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Recover the Aftertreatment System</b></p> <p><b>A.</b> Clean any remaining oil from the piping and the CEM inlet with a clean cloth.</p> <p><b>B.</b> Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p><b>C.</b> Run the engine at high idle with no load for a minimum of 20 minutes.</p> <p><b>Note:</b> During the following step, there are two versions of the "Aftertreatment Recovery Procedure". One version is for engines with a DPF. The other version is for engines without a DPF. Ensure that the correct procedure is used.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p> <p><b>D.</b> Use the electronic service tool to perform the "Aftertreatment Recovery Procedure". While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.</p>	CEM	<p><b>Result:</b> The "Aftertreatment Recovery Procedure" completes with a soot load of less than 80% and no smoke from the exhaust.</p> <p>Return the unit to service.</p> <p><b>Result</b> The "Aftertreatment Recovery Procedure" completes with a soot load of more than 80% or smoke from the exhaust.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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**Recommended Actions**

Complete the procedure in the order in which the steps are listed.

**Engine Shutdown Occurrence**

**Note:** The engine is stopped immediately when an emergency stop button is pressed.

**Probable Causes**

- Operator
- Fuel
- Mechanical Failure

Table 77

Troubleshooting Test Steps	Values	Results
<p><b>1. Operator</b></p> <p>A. Determine the events that caused the engine to stall.</p> <p>B. Delay engine shutdown may not have completed.</p>	Operator	<p><b>Result:</b> The operator is operating the engine correctly.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The operator is not operating the engine correctly.</p> <p><b>Repair:</b> Make sure that the operator has the information required to operate the engine correctly.</p>
<p><b>2. Fuel</b></p> <p>A. The engine has run out of fuel.</p>	Fuel	<p><b>Result:</b> The engine is out of fuel.</p> <p><b>Repair:</b> Make sure the fuel gauge is providing an accurate reading.</p> <p>Make sure that the operator knows that the engine requires an adequate fuel supply.</p> <p>Verify that the issue is eliminated.</p> <p><b>Result:</b> The engine is not out of fuel.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Mechanical Failure</b></p> <p>A. Check for a mechanical failure.</p>	Mechanical failure	<p><b>Result:</b> A mechanical failure has occurred.</p> <p><b>Repair:</b> Diagnose and then repair the fault.</p> <p>Verify that the repair eliminated the fault.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

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## Engine Shutdown Occurs Intermittently

**Note:** Use this procedure only if the engine shuts down completely during operation.

### Probable Causes

- Active codes and logged codes
- Electrical connections
- Unstable fuel supply
- Switches
- Circuit protection
- Engine speed/timing

Table 78

Associated Diagnostic Trouble Codes	
J1939 Code	PDL Code
3719-0	E995 (3)
3719-16	E995 (2)
5246-0	E1389 (3)

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 79

Troubleshooting Test Steps	Values	Results
<p><b>1. Active Codes and Logged Codes</b></p> <p><b>A.</b> Certain diagnostic codes and/or event codes may cause an engine shutdown. Connect the electronic service tool and check for active codes and for logged codes.</p> <p><b>B.</b> Use the electronic service tool to check for associated diagnostic trouble codes. Refer to Table 78</p>	Codes	<p><b>Result:</b> There are associated diagnostic trouble codes active or logged.</p> <p><b>Repair:</b> Troubleshoot any active or logged associated diagnostic trouble codes before continuing with this procedure.</p> <p><b>Result:</b> There are no associated diagnostic trouble codes active or logged.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Electrical Connections</b></p> <p><b>A.</b> Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the fuel injector connectors.</p>	Connectors	<p><b>Result:</b> There are suspect connectors.</p> <p><b>Repair:</b> Perform the "Wiggle Test" on the electronic service tool.</p> <p>Repair or replace connectors that are suspect.</p> <p><b>Result:</b> There are no suspect connectors.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Electrical Connections</b></p> <p><b>A.</b> Check the power and ground connections to the ECM. Refer to Troubleshooting, "Electrical Power Supply - Test".</p>	Electrical Connectors	<p><b>Result:</b> The electrical connections are OK.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The electrical connections are not OK.</p> <p><b>Repair:</b> Repair or replace the damaged connectors. Verify that the repair eliminated the fault.</p>
<p><b>4. Unstable Fuel Supply</b></p> <p><b>A.</b> Inspect the fuel system. Refer to Systems Operation/Testing and Adjusting, "Fuel System - Inspect" for additional information.</p> <p>Cold weather adversely affects the characteristics of the fuel. Refer to the engine Operation and Maintenance Manual, "Cold Weather Operation" for further information.</p> <p><b>B.</b> Check fuel quality. Check the fuel tank for debris or foreign objects which may block the fuel supply.</p>	Fuel	<p><b>Result:</b> The fuel quality is OK.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The fuel quality is not OK.</p> <p><b>Repair:</b> Replace the fuel. Verify that the repair eliminated the fault.</p>
<p><b>5. Switches</b></p> <p><b>A.</b> Check the keyswitch input to the ECM.</p> <p><b>B.</b> Check any engine shutdown switches and associated wiring.</p>	Switches	<p><b>Result:</b> The shutdown switches and wiring are OK.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> The shutdown switches and wiring are not OK.</p> <p><b>Repair:</b> Make the necessary repairs, Verify that the repair eliminated the fault.</p>

(continued)

(Table 79, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Circuit Protection</b></p> <p><b>A.</b> Inspect the wires and connectors to all circuit protection for the engine.</p> <p><b>B.</b> Check the device for circuit protection.</p>	Circuit protection	<p><b>Result</b> The circuit protection device is tripped.</p> <p><b>Repair:</b> Reset the circuit breakers if the circuit breakers are tripped. If necessary, replace blown fuses. Prior to returning the engine to service, determine the condition that caused the circuit breaker to trip or the fuse to blow. Make the necessary repairs.</p> <p><b>Result</b> The circuit protection device is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>8. Engine Speed/Timing Sensors</b></p> <p><b>A.</b> Inspect the connectors for the engine speed/timing sensors.</p> <p><b>B.</b> Crank the engine. If the engine starts and no speed timing codes are logged, the speed timing circuit is operating correctly.</p>	Speed/Timing	<p><b>Result:</b> The Speed/Timing sensor circuit is not operating correctly.</p> <p><b>Repair:</b> Test the speed/timing circuit. Refer to Troubleshooting, "Speed/Timing ` - Test". Verify that the repair eliminated the fault.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

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## Engine Stalls at Low RPM

### Probable Causes

- Diagnostic codes
- Accessory equipment
- Power mode control (if equipped)
- Fuel supply
- Low compression (cylinder pressure)
- Electronic unit injectors

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 80

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM) . If necessary, refer to Troubleshooting, "Electronic Service Tools".</p> <p><b>B.</b> Check if any codes are active or logged.</p>	Diagnostic code	<p><b>Result:</b> A code is active or logged.</p> <p><b>Repair:</b> Troubleshoot any codes before continuing with this procedure.</p> <p><b>Result:</b> A code is not active or logged.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Accessory Equipment</b></p> <p><b>A.</b> Check all accessory equipment for faults that may create excessive load on the engine.</p>	Accessories	<p><b>Result:</b> An engine accessory is creating an excessive load.</p> <p><b>Repair:</b> Repair or replace the engine accessory.</p> <p><b>Result:</b> An engine accessory is not creating an excessive load.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Power Mode Control (If Equipped)</b></p> <p><b>A.</b> Check whether the power mode control is using the Perkins data link or the CAN data link and then use the appropriate test. Refer to Troubleshooting, "Data Link - Test" or Troubleshooting, "CAN Data Link - Test".</p> <p><b>B.</b> Check the engine wiring harness for defects. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p>	Power mode control	<p><b>Result:</b> There is a fault in the data link.</p> <p><b>Repair:</b> Repair the data link, as necessary.</p> <p><b>Result:</b> There is a wiring fault.</p> <p><b>Repair:</b> Repair or replace the wiring, as necessary.</p> <p><b>Result:</b> The data link and the wiring are OK.</p> <p>Proceed to Test Step 4.</p>

(continued)



(Table 80, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Fuel Supply</b></p> <p><b>A.</b> Ensure that the vent in the fuel cap is not filled with debris.</p> <p><b>B.</b> Ensure that the fuel supply valve (if equipped) is in the full OPEN position.</p> <p><b>C.</b> If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).</p> <p><b>D.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>E.</b> Check for fuel supply lines that are restricted.</p> <p><b>F.</b> Replace the in-line fuel filter that is installed upstream of the Electric Fuel Lift Pump (EFLP).</p> <p><b>G.</b> Check that the EFLP is operating correctly.</p> <p><b>H.</b> Replace the primary and secondary fuel filters.</p> <p><b>I.</b> Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>J.</b> Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Air in Fuel - Test".</p>	<p>Fuel system</p>	<p><b>Result:</b> The vent in the fuel cap is blocked.</p> <p><b>Repair:</b> Install a replacement fuel cap.</p> <p><b>Result:</b> The fuel contains solidified wax.</p> <p><b>Repair:</b> Replace the fuel with fuel of the correct specification for the ambient conditions.</p> <p><b>Result:</b> There are fuel supply lines that are restricted.</p> <p><b>Repair:</b> Replace any damaged or restricted fuel lines.</p> <p>The EFLP is suspect. Refer to Troubleshooting, "Fuel Transfer Pump - Test".</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p><b>Result:</b> There is air in the fuel system.</p> <p><b>Repair:</b> Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The diesel fuel is contaminated.</p> <p><b>Repair:</b> Drain the fuel tank and the fuel system.</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p>Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The fuel supply is OK.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	<p>Cylinder compression</p>	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p>Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>• Loose glow plugs</li> <li>• Faulty piston</li> <li>• Faulty piston rings</li> <li>• Worn cylinder bores</li> <li>• Worn valves</li> <li>• Faulty cylinder head gasket</li> <li>• Damaged cylinder head</li> </ul>

(continued)

## Symptom Troubleshooting

(Table 80, contd)

Troubleshooting Test Steps	Values	Results
		<p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic “Cylinder Cut Out Test” .</p> <p><b>Note:</b> If the compression test that was performed in Test Step 5 was satisfactory, the “Cylinder Cut Out Test” will identify any faulty injectors.</p>	Electronic Unit Injectors	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” .</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install” .</p> <p>Repeat the automatic “Cylinder Cut Out Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install” .</p> <p><b>Result:</b> All injectors are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Engine Top Speed Is Not Obtained

**Note:** If this fault occurs only under load, refer to Troubleshooting, “Acceleration Is Poor or Throttle Response Is Poor” .

### Probable Causes

- Diagnostic codes
- ECM parameters
- Accessory and/or parasitic loads
- Flash file
- Throttle signal
- Air intake and exhaust system
- Turbocharger or turbochargers
- Fuel supply
- Transfer Pump Inlet Regulator (TPIR)
- Electric Fuel Lift Pump (EFLP)
- Return fuel lines

- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinders

Table 81

Associated Diagnostic Trouble Codes	
J1939 Code	PDL Code
157-18	E398 (2)

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 82

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Use the electronic service tool to check for active or logged codes.</p>	Diagnostic codes	<p><b>Result:</b> There are active or logged codes.</p> <p><b>Repair:</b> Troubleshoot any codes before continuing with this procedure.</p> <p><b>Result:</b> There are no active or logged codes.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. ECM Parameters</b></p> <p><b>A.</b> Use the electronic service tool to verify that the correct engine parameters are being used. Refer to Troubleshooting, "Configuration Parameters" for additional information.</p> <p><b>B.</b> If applicable, verify that all parameters for any parasitic loads are correct.</p>	Parameters	<p><b>Result:</b> The parameters are not configured correctly.</p> <p><b>Repair:</b> Correctly configure the parameters.</p> <p>Verify that the configuration change eliminated the fault.</p> <p><b>Result:</b> The parameters are configured correctly.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Accessory and/or Parasitic Loads</b></p> <p><b>A.</b> Check all accessory equipment for problems that may create excessive load on the engine.</p> <p><b>B.</b> Check for any excess parasitic load on the engine.</p>	Parasitic loads	<p><b>Result:</b> There is an excessive load on the engine.</p> <p><b>Repair:</b> Diagnose and repair the fault.</p> <p>Verify that the repair eliminated the fault.</p> <p><b>Result:</b> There is not an excessive load on the engine.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Flash File</b></p> <p><b>A.</b> Verify that the latest flash file is installed in the Electronic Control Module (ECM). Refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>B.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Flash file	<p><b>Result:</b> The latest flash file is not installed in the ECM.</p> <p><b>Repair:</b> Install the latest flash file. Verify that the repair eliminated the fault.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest flash file is installed in the ECM.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Throttle Signal</b></p> <p><b>A.</b> Use the electronic service tool and observe the throttle signal. Make sure that the throttle reaches the 100% raw position and the calibrated position.</p>	CAN data link	<p><b>Result:</b> The throttle signal is erratic or does not reach the 100% raw position or the calibrated position.</p> <p><b>Repair:</b> Refer to the appropriate circuit test for the type of throttle that is installed.</p> <p><b>Result:</b> The throttle signal is OK.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Symptom Troubleshooting

(Table 82, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Air Intake and Exhaust System</b></p> <p><b>A.</b> Check the air filter restriction indicator, if equipped.</p> <p><b>B.</b> Check the air inlet and exhaust system for restrictions and/or leaks.</p>	Restrictions	<p><b>Result:</b> The air filter is plugged.</p> <p><b>Repair:</b> Clean or replace the air filter. Refer to the Operation and Maintenance Manual for further information.</p> <p><b>Result:</b> There are restrictions in the air inlet or exhaust system.</p> <p><b>Repair:</b> Make the necessary repairs, Verify that the repair eliminated the fault.</p> <p><b>Result:</b> There are no restrictions in the air inlet or exhaust system.</p> <p>Proceed to Test Step 5.</p>
<p><b>7. Turbocharger or Turbochargers</b></p> <p><b>A.</b> Check for the correct operation of the turbocharger or turbochargers.</p>	Turbocharger	<p><b>Result:</b> A turbocharger is not operating correctly.</p> <p><b>Repair:</b> Repair or replace the faulty turbocharger. Verify that the repair eliminated the fault.</p> <p><b>Result:</b> The turbocharger is operating correctly.</p> <p>Proceed to Test Step 8.</p>

 **WARNING**

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

**NOTICE**

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

Table 83

Troubleshooting Test Steps	Values	Results
<p><b>8. Fuel Supply</b></p> <p><b>A.</b> Check for leaks from the high-pressure fuel lines.</p> <p><b>B.</b> Ensure that the vent in the fuel cap is not filled with debris.</p> <p><b>C.</b> Ensure that the fuel supply valve (if equipped) is in the full OPEN position.</p> <p><b>D.</b> If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).</p> <p><b>E.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>F.</b> Check for fuel supply lines that are restricted.</p> <p><b>G.</b> Replace the in-line fuel filter that is installed upstream of the Electric Fuel Lift Pump (EFLP).</p> <p><b>H.</b> Replace the primary and secondary fuel filters.</p> <p><b>I.</b> Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>J.</b> Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Air in Fuel - Test".</p>	<p>Fuel system</p>	<p><b>Result:</b> There is a leak from a high-pressure fuel line.</p> <p><b>Repair:</b> Replace the high-pressure fuel line. Refer to Disassembly and Assembly, "Fuel injection lines - Remove" and Disassembly and Assembly, "Fuel injection lines - Install".</p> <p><b>Result:</b> The vent in the fuel cap is blocked.</p> <p><b>Repair:</b> Install a replacement fuel cap.</p> <p><b>Result:</b> The fuel contains solidified wax.</p> <p><b>Repair:</b> Replace the fuel with fuel of the correct specification for the ambient conditions.</p> <p><b>Result:</b> There are fuel supply lines that are restricted.</p> <p><b>Repair:</b> Replace any damaged or restricted fuel lines.</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p><b>Result:</b> There is air in the fuel system.</p> <p><b>Repair:</b> Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The diesel fuel is contaminated.</p> <p><b>Repair:</b> Drain the fuel tank and the fuel system.</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p>Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p> <p><b>Result:</b> The fuel supply is OK.</p> <p>Proceed to Test Step 9.</p>

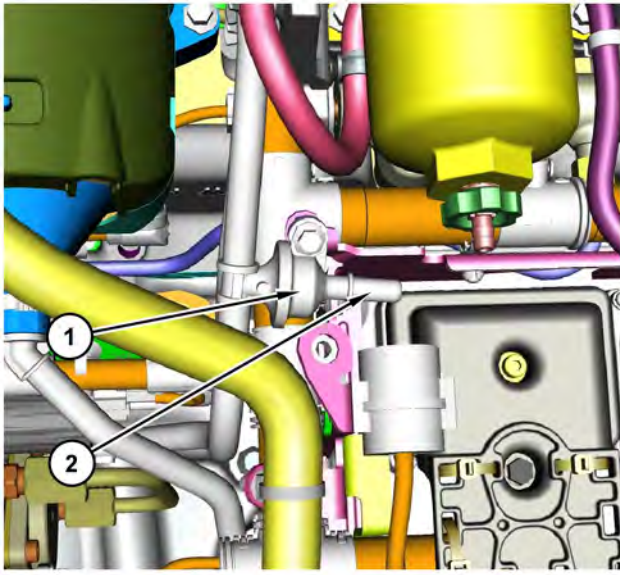


Illustration 55 g03700009

**Transfer Pump Inlet Regulator (TPIR) components**

- (1) Transfer Pump Inlet Regulator (TPIR)
- (2) TPIR return port

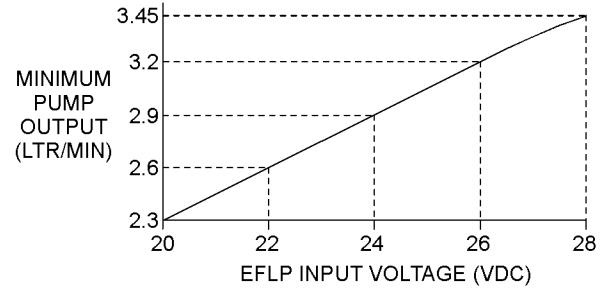


Illustration 57 g02485897

**Minimum TPIR flow rate in a 24 VDC system**

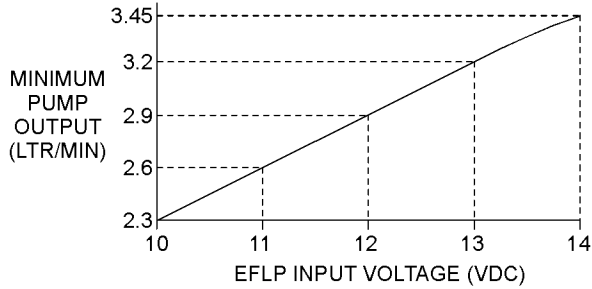


Illustration 56 g02485896

**Minimum TPIR flow rate in a 12 VDC system**

Table 84

Troubleshooting Test Steps	Values	Results
<p><b>9. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p>Refer to Illustration 55 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 56 or 57 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	<p>TPIR flow rate</p>	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 11.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 10.</p>

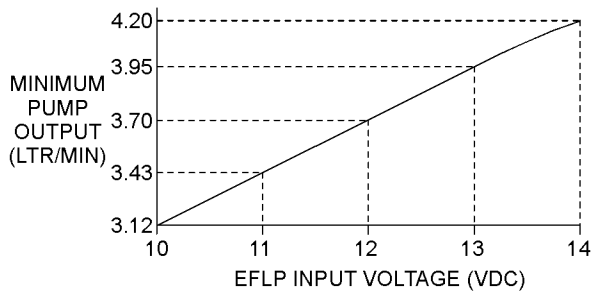


Illustration 58 g02527498  
 Minimum EFLP flow rate in a 12 VDC system

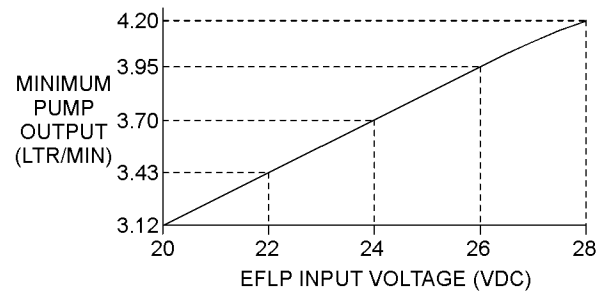


Illustration 59 g02527518  
 Minimum EFLP flow rate in a 24 VDC system

## Symptom Troubleshooting

Table 85

Troubleshooting Test Steps	Values	Results
<p><b>10. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 58 or 59 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 8.</p>
<p><b>11. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, proceed to Test Step 12.</p>
<p><b>12. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>• Loose glow plugs</li> <li>• Faulty piston</li> <li>• Faulty piston rings</li> <li>• Worn cylinder bores</li> <li>• Worn valves</li> <li>• Faulty cylinder head gasket</li> <li>• Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 13.</p>

(continued)



(Table 85, contd)

Troubleshooting Test Steps	Values	Results
<p><b>13. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic “Cylinder Cut Out Test” .</p> <p><b>Note:</b> If the compression test that was performed in Test Step 9 was satisfactory, the “Cylinder Cut Out Test” will identify any faulty injectors.</p>	<p>Electronic Unit Injectors</p>	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”.</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.</p> <p>Repeat the automatic “Cylinder Cut Out Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”.</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 14.</p>
<p><b>14. Individual Malfunctioning Cylinders</b></p> <p><b>A.</b> With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cut Out Test” .</p> <p>As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine.</p> <p><b>Note:</b> If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.</p>	<p>Cylinders</p>	<p><b>Result:</b> The test indicates a faulty cylinder.</p> <p><b>Repair:</b> Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.</p> <p><b>Result:</b> The test indicates that all cylinders are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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### Recommended Actions

**Note:** When performing the following procedure, do not stand near the engine. The vibration may indicate an imminent component failure.

**Note:** Complete the procedure in the order in which the steps are listed.

## Engine Vibration Is Excessive

Refer to Systems Operation, Testing and Adjusting for additional information on determining the cause of this condition.

### Probable Causes

- Driven equipment
- Engine supports
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

## Symptom Troubleshooting

Table 86

Troubleshooting Test Steps	Values	Results
<p><b>1. Driven Equipment</b></p> <p><b>A.</b> Inspect the mounting bolts for the driven equipment. Inspect the alignment and the balance of the driven equipment.</p> <p><b>B.</b> Inspect the coupling.</p>	Driven equipment	<p><b>Result</b> The driven equipment and the alignment are not OK.</p> <p><b>Repair:</b> Repair or replace the driven equipment.</p> <p><b>Result:</b> The driven equipment and the alignment are OK.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Engine Supports</b></p> <p><b>A.</b> Inspect the mounts and the brackets while you run the engine through the speed range. Look for mounts and brackets that are loose and/or broken.</p> <p><b>B.</b> Check the alignment of the following before operating the engine under load for any length of time:</p> <ul style="list-style-type: none"> <li>· Mounts</li> <li>· Coupling</li> </ul>	Engine supports	<p><b>Result:</b> The mounts and brackets are loose and/or broken.</p> <p>Replace the mounts and brackets that are loose and/or broken.</p> <p><b>Result:</b> The mounts and brackets are not loose and/or broken.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Faulty piston</li> <li>· Faulty piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> <li>· Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 86, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic “Cylinder Cutout Test” .</p> <p><b>Note:</b> If the compression test that was performed in Test Step 3 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.</p>	<p>Electronic Unit Injectors</p>	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”.</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”.</p> <p>Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”.</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Individual Malfunctioning Cylinders</b></p> <p><b>A.</b> With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cutout Test” .</p> <p>As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine.</p> <p><b>Note:</b> If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.</p>	<p>Cylinders</p>	<p><b>Result:</b> The test indicates a faulty cylinder.</p> <p><b>Repair:</b> Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.</p> <p><b>Result:</b> The test indicates that all cylinders are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06157547

## Exhaust Has Excessive Black Smoke

### Engines without a Diesel Particulate Filter (DPF).

If excessive black smoke is caused by an engine fault, some smoke will be visible at the exhaust pipe outlet. Perform the following procedure to diagnose the cause of the black smoke.

### Engines with a Diesel Particulate Filter (DPF).

If excessive black smoke is caused by an engine fault, the smoke will only be visible when the Diesel Particulate Filter (DPF) has also failed. Perform the following procedure to diagnose the cause of the black smoke and then investigate the failure of the DPF.

**Note:** A faulty DPF will allow some smoke to be visible. In this situation, there may not be a fault in the engine.

### Probable Causes

- Diagnostic codes
- Parameters in the Electronic Control Module (ECM)
- Air intake system or exhaust system
- Valve lash
- Turbocharger or turbochargers
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

## Recommended Actions

**Note:** Complete the procedure in the order in which the steps are listed.

Table 87

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Use the electronic service tool to check for active or logged codes.</p>	Engine Derate or Diagnostic Codes	<p><b>Result:</b> A diagnostic code is present.</p> <p><b>Repair:</b> Troubleshoot the code.</p> <p><b>Result:</b> A diagnostic code is not present. Proceed to Test Step 2.</p>
<p><b>2. Parameters in the Electronic Control Module (ECM)</b></p> <p><b>A.</b> Use the electronic service tool to verify that the correct parameters are being used. Refer to Troubleshooting, "Configuration Parameters" for additional information.</p>	Parameters	<p><b>Result:</b> The parameters are not correct.</p> <p><b>Repair:</b> Input the correct parameters. Refer to Troubleshooting, "Configuration Parameters" for additional information.</p> <p><b>Result:</b> The parameters are correct.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Air Intake and Exhaust System</b></p> <p><b>A.</b> Observe the check engine lamp. Check for an air filter restriction indicator, if equipped. Replace a plugged air filters. Refer to the Operation and Maintenance Manual.</p> <p><b>B.</b> Check the air inlet and exhaust system for restrictions and/or leaks.</p>	Restrictions	<p><b>Result:</b> There are restrictions in the air inlet or exhaust system.</p> <p><b>Repair:</b> Make the necessary repairs. Refer to Systems Operation/Testing and Adjusting, "Air Inlet and Exhaust System - Inspect" for additional information.</p> <p><b>Result:</b> There are no restrictions in the air inlet or exhaust system.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Valve Lash</b></p> <p><b>A.</b> Check the valve lash.</p>	Valve lash	<p><b>Result:</b> The valve lash is incorrect.</p> <p><b>Repair:</b> Check the valve lash. Refer to Systems Operation, Testing, and Adjusting, "Engine Valve Lash - Inspect" for the correct procedure.</p> <p><b>Result:</b> The valve lash is correct.</p> <p>For engines with a single turbocharger, proceed to Test Step 5.</p> <p>For engines with twin turbochargers, proceed to Test Step 6.</p>

(continued)

(Table 87, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Turbocharger</b></p> <p><b>Note:</b> This Test Step is only applicable to engines with a single turbocharger.</p> <p><b>Note:</b> The turbocharger that is installed on the engine is a non-serviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Ensure that the mounting bolts for the turbocharger are tight.</p> <p><b>B.</b> Check that the oil drain for the turbocharger is not blocked or restricted.</p> <p><b>C.</b> Check that the compressor housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged.</p> <p><b>D.</b> Check that the turbine housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged.</p> <p><b>E.</b> Check that the turbine blades rotate freely in the turbocharger.</p> <p><b>F.</b> Ensure that the wastegate on the turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect". If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p>	<p>Turbocharger</p>	<p><b>Result:</b> There is a fault in the turbocharger.</p> <p><b>Repair:</b> Repair the turbocharger or replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The turbocharger is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>6. Turbochargers</b></p> <p><b>Note:</b> This Test Step is only applicable to engines with twin turbochargers.</p> <p><b>Note:</b> The turbochargers that are installed on the engine are non-serviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Ensure that the mounting bolts for the turbochargers are tight.</p> <p><b>B.</b> Check that the oil drains for the turbochargers are not blocked or restricted.</p> <p><b>C.</b> Check that the compressor housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged.</p> <p><b>D.</b> Check that the turbine housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged.</p> <p><b>E.</b> Check that the turbine blades rotate freely in the turbochargers.</p>	<p>Turbocharger</p>	<p><b>Result:</b> There is a fault in one of the turbochargers.</p> <p><b>Repair:</b> Repair the turbocharger or replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The turbochargers are OK.</p> <p>Proceed to Test Step 7.</p>

(continued)

## Symptom Troubleshooting

(Table 87, contd)

Troubleshooting Test Steps	Values	Results
<p><b>F.</b> Ensure that the wastegate on the high-pressure turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect". If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p>		
<p><b>7. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Faulty piston</li> <li>· Faulty piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> <li>· Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 8.</p>

(continued)

(Table 87, contd)

Troubleshooting Test Steps	Values	Results
<p><b>8. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic "Cylinder Cut Out Test" .</p> <p><b>Note:</b> If the compression test that was performed in Test Step 7 was satisfactory, the "Cylinder Cut Out Test" will identify any faulty injectors.</p>	<p>Electronic Unit Injectors</p>	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p>Repeat the automatic "Cylinder Cut Out Test" . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Individual Malfunctioning Cylinders</b></p> <p><b>A.</b> With the engine speed at a fast idle, use the electronic service tool to perform the manual "Cylinder Cut Out Test" .</p> <p>As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine.</p> <p>If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.</p>	<p>Cylinders</p>	<p><b>Result:</b> The test indicates a faulty cylinder.</p> <p>Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.</p> <p><b>Result:</b> The test indicates that all cylinders are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Exhaust Has Excessive White Smoke

**Note:** Some white smoke may be present during cold start-up conditions and during acceleration after a prolonged period at low idle. If the white smoke persists, there may be a fault.

### Probable Causes

- Diagnostic codes
- ECM Flash file
- Glow plugs
- Ether injection
- Coolant temperature

- Cooling system
- Fuel quality
- Valve lash
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

## Recommended Actions

Table 88

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM) . Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Determine if a code is active or logged.</p>	Diagnostic codes	<p><b>Result:</b> A code is active or logged.</p> <p><b>Repair:</b> Troubleshoot any active codes before continuing with this procedure.</p> <p><b>Result:</b> A code is not active or logged.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. ECM Flash File</b></p> <p><b>A.</b> Verify that the latest flash file is installed in the ECM.</p>	Flash file	<p><b>Result:</b> The latest flash file is not installed.</p> <p><b>Repair:</b> Install the latest flash file. Refer to Troubleshooting, "ECM Software - Install" for the correct procedure. Verify that the repair eliminates the fault.</p> <p><b>Result:</b> The latest flash file is installed.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Glow Plugs</b></p> <p><b>Note:</b> Faulty glow plugs will only affect the production of white smoke when the ambient temperature is between 5° C (41° F) and -25° C (-13° F).</p> <p><b>A.</b> Check operation of glow plugs. Verify that the glow plugs are operating correctly. Refer to Troubleshooting, "Glow Plug Starting Aid - Test".</p> <p><b>B.</b> Check the configuration screen on the electronic service tool in order to verify that ether injection is not enabled.</p>	Glow plugs	<p><b>Result:</b> The glow plugs are not operating correctly.</p> <p><b>Repair:</b> Make the necessary repairs. Verify that the repair corrected the fault.</p> <p><b>Result:</b> The glow plugs are operating correctly.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Ether Injection</b></p> <p><b>Note:</b> A faulty ether starting aid will only affect the production of white smoke when the ambient temperature is below -25° C (-13° F).</p> <p><b>A.</b> Use the electronic service tool to test the ether starting aid.</p>	Glow plugs	<p><b>Result:</b> The ether starting aid is faulty.</p> <p><b>Repair:</b> Test the ether system. Refer to Troubleshooting, "Ether Starting Aid - Test".</p> <p><b>Result:</b> The ether starting aid is operating correctly.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Coolant Temperature</b></p> <p><b>A.</b> Check that the water temperature regulator is operating correctly. Refer to Systems Operation, Testing, and Adjusting, "Water Temperature Regulator - Test".</p>	Coolant temperature	<p><b>Result:</b> The water temperature regulator is not operating correctly.</p> <p><b>Repair:</b> Replace the water temperature regulator. Verify that the repair corrected the fault.</p> <p><b>Result:</b> The water temperature regulator is operating correctly.</p> <p>Proceed to Test Step 6.</p>

(continued)



(Table 88, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Cooling System</b></p> <p><b>A.</b> Check for an internal coolant leak into the cylinder and/or the exhaust. Refer to Systems Operation/Testing and Adjusting, "Cooling System".</p>	Internal coolant leak	<p><b>Result:</b> There is an internal coolant leak.</p> <p><b>Repair:</b> Make the necessary repairs. Verify that the repair eliminated the fault.</p> <p><b>Result:</b> There is not an internal coolant leak.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Fuel Quality</b></p> <p><b>A.</b> Check the fuel quality. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>B.</b> Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine.</p>	Fuel	<p><b>Result:</b> The fuel quality is not OK.</p> <p><b>Repair:</b> Drain the fuel system and replace the fuel filters. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter (Water Separator) Element - Replace" and Operation and Maintenance Manual, "Fuel System Filter - Replace".</p> <p>Fill the fuel system with fuel that meets the standard in the Operation and Maintenance Manual, "Fluid Recommendations".</p> <p>Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime".</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> The fuel quality is OK.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Valve Lash</b></p> <p><b>Note:</b> The valve lash can affect the performance of the engine.</p> <p><b>A.</b> Check the valve lash.</p>	Valve lash	<p><b>Result:</b> The valve lash is not set correctly.</p> <p><b>Repair:</b> Check the valve lash. Refer to Systems Operation, Testing, and Adjusting, "Engine Valve Lash - Inspect" for the correct procedure.</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> The valve lash is correct.</p> <p>Proceed to Test Step 9.</p>

(continued)

## Symptom Troubleshooting

(Table 88, contd)

Troubleshooting Test Steps	Values	Results
<p><b>9. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>• Loose glow plugs</li> <li>• Faulty piston</li> <li>• Faulty piston rings</li> <li>• Worn cylinder bores</li> <li>• Worn valves</li> <li>• Faulty cylinder head gasket</li> <li>• Damaged cylinder head</li> </ul> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Electronic Unit Injectors</b></p> <p><b>A.</b> Use the electronic service tool to perform the automatic "Cylinder Cut Out Test".</p> <p><b>Note:</b> If the compression test that was performed in Test Step 9 was satisfactory, the "Cylinder Cut Out Test" will identify any faulty injectors.</p>	Electronic Unit Injectors	<p><b>Result:</b> A faulty injector is indicated.</p> <p><b>Repair:</b> Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove".</p> <p>Install new electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p>Repeat the automatic "Cylinder Cut Out Test". If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> All injectors are OK.</p> <p>Proceed to Test Step 11.</p>

(continued)

(Table 88, contd)

Troubleshooting Test Steps	Values	Results
<p><b>11. Individual Malfunctioning Cylinders</b></p> <p><b>A.</b> With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cut Out Test” .</p> <p>As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine.</p> <p><b>Note:</b> If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.</p>	<p>Cylinders</p>	<p><b>Result:</b> The test indicates a faulty cylinder.</p> <p><b>Repair:</b> Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance.</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> The test indicates that all cylinders are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>12. Check the Aftertreatment System for Oil or Fuel</b></p> <p><b>A.</b> Remove excess oil or fuel from the piping with a clean cloth.</p> <p><b>B.</b> Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”.</p> <p><b>C.</b> Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours.</p> <p><b>D.</b> Check the quantity of drained oil or fuel in the container.</p>	<p>CEM</p>	<p><b>Result</b> The volume of drained oil or fuel is greater than 1.0 L (1.05669 qt).</p> <p><b>Repair:</b> Install a replacement CEM. Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”.</p> <p>Return the unit to service.</p> <p><b>Result</b> The volume of drained oil or fuel is less than 1.0 L (1.05669 qt).</p> <p>Proceed to Test Step 13.</p>
<p><b>13. Recover the Aftertreatment System</b></p> <p><b>A.</b> Clean any remaining oil or fuel from the piping and the CEM inlet with a clean cloth.</p> <p><b>B.</b> Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”.</p> <p><b>C.</b> Run the engine at high idle with no load for a minimum of 20 minutes.</p> <p><b>Note:</b> During the following step, there are two versions of the “Aftertreatment Recovery Procedure” . One version is for engines with a DPF. The other version is for engines without a DPF. Ensure that the correct procedure is used.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p> <p><b>D.</b> Use the electronic service tool to perform the “Aftertreatment Recovery Procedure” . While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.</p>	<p>CEM</p>	<p><b>Result:</b> The “Aftertreatment Recovery Procedure” completes with a soot load of less than 80% and no smoke from the exhaust.</p> <p>Return the unit to service.</p> <p><b>Result</b> The “Aftertreatment Recovery Procedure” completes with a soot load of more than 80% or smoke from the exhaust.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Exhaust System Contains Coolant

Use the following procedure to troubleshoot a problem with coolant in the exhaust system.

### Probable Causes

- NOx Reduction System (NRS) cooler
- Cylinder head gasket
- Cylinder head
- Cylinder block

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

**Note:** After the repair has been made, the electronic service tool must be used to perform an "Aftertreatment System Functional Test". The test will verify the correct functionality of both NOx sensors and the catalysts.

Table 89

Troubleshooting Test Steps	Values	Results
<p><b>1. NRS cooler</b></p> <p><b>A.</b> Check the NRS cooler for leaks by utilizing the "On Engine Test Procedure". Refer to Systems Operation, Testing, and Adjusting, "Exhaust Cooler (NRS) - Test".</p>	NRS cooler	<p><b>Result :</b> The NRS cooler has a leak.</p> <p><b>Repair:</b> Replace the NRS cooler. Refer to the Disassembly and Assembly manual for the correct procedure.</p> <p>Proceed to Step 5.</p> <p><b>Result :</b> The NRS cooler does not have a leak.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Cylinder Head Gasket</b></p> <p><b>A.</b> Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".</p> <p><b>B.</b> Inspect the cylinder head gasket for faults and any signs of leakage.</p>	Cylinder head gasket	<p><b>Result:</b> The cylinder head gasket does not show signs of damage or leakage.</p> <p><b>Repair:</b> Install a new cylinder head gasket and install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".</p> <p><b>Result:</b> The cylinder head gasket shows signs of damage or leakage.</p> <p>Proceed to Test Step 3.</p>

(continued)

(Table 89, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Cylinder Head</b></p> <p><b>A.</b> Check for cracks in the cylinder head. Perform a leak test on the cylinder head. Refer to System Operation, Testing and Adjusting, "Cylinder Head - Inspect" for the correct procedure.</p>	Cylinder head	<p><b>Result:</b> A fault was found in the cylinder head.</p> <p><b>Repair:</b> Repair the cylinder head or replace the cylinder head. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".</p> <p><b>Result:</b> A fault was not found in the cylinder head.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Cylinder Block</b></p> <p><b>A.</b> Inspect the top face of the cylinder block for faults and signs of leakage. Refer to Systems Operation, Testing, and Adjusting, "Cylinder Block - Inspect" for the correct procedure.</p>	Cylinder block	<p><b>Result:</b> A fault was found in the cylinder block.</p> <p><b>Repair:</b> Repair the cylinder block or replace the cylinder block. Inspect the top deck. Refer to the Reuse and Salvage Guidelines for the proper inspection procedure.</p> <p><b>Result:</b> No fault was found in the cylinder block.</p> <p>Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>5. Perform an "Aftertreatment System Functional Test"</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Navigate to "Diagnostics Tests" .</p> <p><b>D.</b> Perform the "Aftertreatment System Functional Test" .</p>	System test	<p><b>Result :</b> The test is successful.</p> <p>Return the engine to service.</p> <p><b>Result :</b> The test is not successful.</p> <p>There are additional diagnostic codes.</p> <p><b>Repair:</b> Troubleshoot the additional codes. Refer to Troubleshooting, "Diagnostic Trouble Codes" or Troubleshooting, "Event Codes"for the correct procedure.</p>

i08481018

## Exhaust System Contains Oil

### Probable Causes

- Extended idle times
- Failed turbocharger seals
- Worn valve guide seals or faulty valve guide seals
- Worn valve guides
- Worn piston rings

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 90

Troubleshooting Test Steps	Values	Results
<p><b>1. Extended Idle Times</b></p> <p>A. Extended idle times will allow oil to pass into the exhaust system.</p>	Idle times	<p><b>Result</b> The idle times are extensive.</p> <p><b>Repair:</b> Reduce the idle times.</p> <p>Proceed to Test Step 6.</p> <p><b>Result</b> The idle times are not extensive.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Failed Turbocharger Seals</b></p> <p>A. Check the inlet manifold and the exhaust manifold for oil.</p>	Turbo seals	<p><b>Result:</b> Oil is present in the inlet or exhaust manifold.</p> <p><b>Repair:</b> Replace the turbocharger. Verify the repair.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> Oil is not present in the inlet or exhaust manifold.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Worn Valve Guide Seals or Faulty Valve Guide Seals</b></p> <p>A. Inspect the valve guide seals for wear and for damage.</p>	Valve guide seals	<p><b>Result:</b> The valve guide seals are damaged.</p> <p><b>Repair:</b> Replace the valve guide seals. Verify the repair.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> The valve guide seals are not damaged.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Worn Valve Guides</b></p> <p>A. Inspect the valve guides for wear. Refer to the Specification manual for the maximum permissible wear of the valve guides.</p>	Valve guides	<p><b>Result:</b> The valve guides are worn.</p> <p><b>Repair:</b> If necessary, recondition the cylinder head. Verify the repair.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> The valve guides are not worn.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Worn Piston Rings</b></p> <p>A. Remove the pistons. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Remove".</p> <p>B. Remove the piston rings from the pistons. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Disassemble"</p> <p>C. Inspect the pistons and piston rings for wear or damage. Refer to the "Specifications" manual for further information.</p>	Piston rings	<p><b>Result</b> The piston rings are worn.</p> <p><b>Repair:</b> Replace the piston rings. Verify the repair.</p> <p>Proceed to Test Step 6.</p> <p><b>Result</b> The piston rings are not worn.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

(Table 90, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Check the Aftertreatment System for Oil</b></p> <p><b>A.</b> Remove excess oil from piping with a clean cloth.</p> <p><b>B.</b> Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p><b>C.</b> Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours.</p> <p><b>D.</b> Check the quantity of drained oil in the container.</p>	<p>CEM</p>	<p><b>Result</b> The volume of drained oil is greater than 1.0 L (1.05669 qt).</p> <p><b>Repair:</b> Install a replacement CEM. Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p>Return the unit to service.</p> <p><b>Result</b> The volume of drained oil is less than 1.0 L (1.05669 qt).</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Recover the Aftertreatment System</b></p> <p><b>A.</b> Clean any remaining oil from the piping and the CEM inlet with a clean cloth.</p> <p><b>B.</b> Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p><b>C.</b> Run the engine at high idle with no load for a minimum of 20 minutes.</p> <p><b>Note:</b> During the following step, there are two versions of the "Aftertreatment Recovery Procedure". One version is for engines with a DPF. The other version is for engines without a DPF. The correct procedure is automatically selected.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p> <p><b>D.</b> Use the electronic service tool to perform the "Aftertreatment Recovery Procedure". While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.</p>	<p>CEM</p>	<p><b>Result:</b> The "Aftertreatment Recovery Procedure" completes with a soot load of less than 80% and no smoke from the exhaust.</p> <p>Return the unit to service.</p> <p><b>Result</b> The "Aftertreatment Recovery Procedure" completes with a soot load of more than 80% or smoke from the exhaust.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06061494

## Exhaust Temperature Is High

The Electronic Control Module (ECM) monitors the temperature sensor in the outlet from the low-pressure turbocharger.

Certain operating conditions may cause the exhaust temperature to increase to a level that may damage engine components. If a high exhaust temperature occurs, the ECM derates the engine in order to reduce the exhaust temperature. The engine is derated only to a level that allows the exhaust temperature to return to an acceptable level.

## Probable Causes

- Inlet system leak
- Engine operating conditions
- Failed exhaust back pressure valve
- High altitude
- Obstructed Air-to-Air Aftercooler (ATAAC)

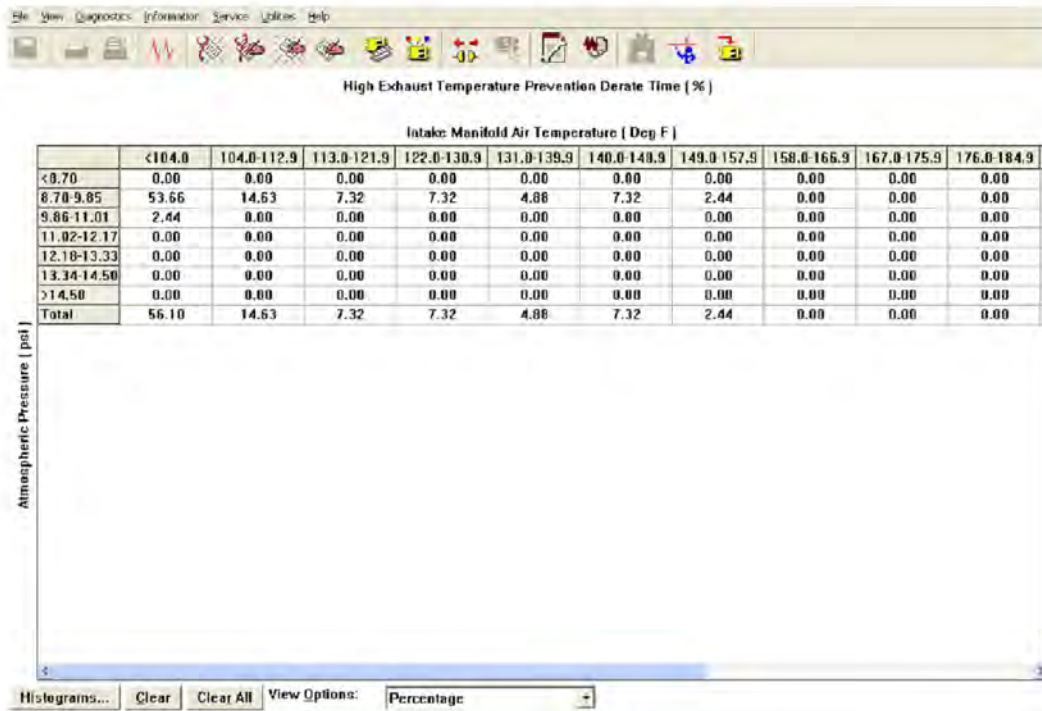


Illustration 60

g03795585

Example of an electronic service tool screenshot of the histogram. This histogram is populated when the engine system has calculated a condition in which high exhaust temperatures are present. A diagnostic code will not be logged when the system calculates a high exhaust temperature condition. The engine will be derated in order to protect the engine system. This situation is normal under most circumstances and no additional troubleshooting is necessary.

**Note:** Information from this histogram is to be used with active and logged diagnostic trouble codes. This histogram is for information only.

Complete the procedure in the order in which the steps are listed.



Table 91

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Inlet System Leakage</b></p> <p><b>A.</b> Apply a light load to the engine and check for leakage from the inlet system downstream of the low-pressure turbocharger.</p>	Boost leaks	<p><b>Result:</b> Leakage was found.</p> <p><b>Repair:</b> Repair the leaks. Return the unit to service.</p> <p><b>Result:</b> Leakage was not found.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Engine Operating Conditions</b></p> <p><b>A.</b> Use the electronic service tool to check the histograms. Use the histograms to determine if the high exhaust temperature was due to normal operation.</p> <p>If possible, interview the operator. Determine if the engine is being operated under heavy load. Ensure that the engine is being operated at an acceptable engine speed.</p> <p>If derates are suspected, reset the histogram and return the unit to service. If the histogram repopulates without fault codes, the derating of the engine was under normal engine operation.</p>	Normal operation	<p><b>Result:</b> The code was logged during a heavy load.</p> <p><b>Repair:</b> Reduce the load on the engine. Return the unit to service.</p> <p><b>Result:</b> The code was not logged during a heavy load.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Exhaust Back Pressure Regulator (EBPR)</b></p> <p><b>A.</b> Check the EBPR for correct operation. Refer to Troubleshooting, "Motorized Valve - Test" for the correct troubleshooting procedure.</p> <p><b>Note:</b> An EBPR that has failed in the closed position can cause high exhaust temperatures.</p>	Failed exhaust back pressure regulator	<p><b>Result:</b> The exhaust back pressure regulator has failed.</p> <p><b>Repair:</b> Repair or replace the valve. Return the unit to service.</p> <p><b>Result:</b> The exhaust back pressure regulator has not failed.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Engine Operating Altitude</b></p> <p><b>A.</b> Check the engine operating altitude.</p> <p><b>Note:</b> High altitudes can cause high exhaust temperatures, consider the operational altitude when troubleshooting a high exhaust temperature. High exhaust temperatures are associated with high operational altitudes.</p> <p>When operating below 5500ft and the ambient temperature is below 30° C (85° F), altitude should not cause a high exhaust temperature derate.</p>	High operational altitudes	<p><b>Result:</b> The engine was operating at high altitudes.</p> <p>The high exhaust temperature was due to high altitudes. Return the unit to service.</p> <p><b>Result:</b> The engine was not operating at high altitudes.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check for an Obstructed Air-to-Air Aftercooler (ATAAC)</b></p> <p><b>A.</b> The intake manifold air temperature can increase if the flow through the ATAAC is obstructed. Check the ATAAC for obstructions or debris. Ensure that the flow of air or coolant through the ATAAC is adequate.</p>	Obstructed aftercooler	<p><b>Result:</b> The engine ATAAC was obstructed.</p> <p><b>Repair:</b> Clear any obstructions. Return the unit to service.</p> <p>If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).</p>

i06157556

## Fuel Consumption Is Excessive

### Probable Causes

- Diagnostic codes
- Misreading of fuel level
- Fuel leakage
- Fuel quality
- Quality of oil
- Coolant temperature
- Prolonged operation at idle speed
- Air intake and exhaust system
- Cooling fan
- Reduced pressure of intake air
- Excessive valve lash
- Failure of the primary speed/timing sensor

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 92

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>Note:</b> Certain diagnostic codes and/or event codes may cause high fuel consumption.</p> <p><b>A.</b> Use the electronic service tool to check for active or logged codes.</p>	Diagnostic codes	<p><b>Result:</b> A diagnostic code is present.</p> <p><b>Repair:</b> Troubleshoot the code and then verify that the fuel consumption is normal.</p> <p><b>Result:</b> A diagnostic code is not present. Proceed to Test Step 2.</p>
<p><b>2. Misreading of Fuel Level</b></p> <p><b>Note:</b> Misreading of the fuel gauge can give a false indication of fuel consumption.</p> <p><b>A.</b> Monitor the fuel consumption over a period of 50 engine hours.</p>	Fuel level	<p><b>Result:</b> Fuel consumption is normal for the operating conditions.</p> <p>Return the unit to service.</p> <p><b>Result:</b> Fuel consumption is high for the operating conditions.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Fuel Leakage</b></p> <p><b>A.</b> Check the engine for signs of fuel leakage.</p>	Fuel leaks	<p><b>Result:</b> Evidence of a fuel leak is found.</p> <p><b>Repair:</b> Repair or replace the component that is leaking fuel.</p> <p><b>Result:</b> No evidence of a fuel leak is found.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Fuel Quality</b></p> <p><b>Note:</b> The grade of the fuel affects the rate of fuel consumption. Refer to the engines Operation and Maintenance Manual for additional information.</p> <p>Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.</p> <p><b>A.</b> Check the fuel quality. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>B.</b> Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine.</p>	Fuel quality	<p><b>Result:</b> The fuel quality does not meet specifications.</p> <p><b>Repair:</b> Drain the fuel system and replace the fuel filters. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter (Water Separator) Element - Replace" and Operation and Maintenance Manual, "Fuel System Filter - Replace".</p> <p>Fill the fuel system with fuel that meets the standard in the Operation and Maintenance Manual, "Fluid Recommendations".</p> <p>Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime".</p> <p><b>Result:</b> The fuel quality meets specifications.</p> <p>Proceed to Test Step 5.</p>

(continued)

## Symptom Troubleshooting

(Table 92, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Quality of Oil</b></p> <p><b>Note:</b> The nominal viscosity of the lubricating oil that is used in the engine will affect the rate of fuel consumption. The viscosity of lubricating oil is defined by the SAE grade of the lubricating oil. The grade of the lubricating oil must be correct for the ambient conditions. Lubricating oil for high ambient temperatures will affect fuel consumption in cold ambient temperatures.</p> <p><b>A.</b> Check that the engine oil meets the required specification. Refer to "Engine Oil" in the Operation and Maintenance Manual, "Refill Capacities".</p>	Engine oil quality	<p><b>Result:</b> The engine oil does not meet the required specification.</p> <p><b>Repair:</b> Drain and fill the oil system with oil of an acceptable quality. Refer to the applicable sections in the Operation and Maintenance Manual.</p> <p><b>Result:</b> The engine oil meets the required specification.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Coolant Temperature</b></p> <p><b>Note:</b> The operating temperature of the engine will affect the rate of fuel consumption. Operation of the engine below the correct temperature will increase fuel consumption. Failure of the water temperature regulator can prevent the engine from operating at the correct temperature.</p> <p><b>A.</b> Check that the water temperature regulator is operating correctly. Refer to Systems Operation, Testing, and Adjusting, "Water Temperature Regulator - Test".</p>	Coolant temperature	<p><b>Result:</b> The water temperature regulator is not operating correctly.</p> <p><b>Repair:</b> Replace the water temperature regulator. Verify that the repair corrected the fault.</p> <p><b>Result:</b> The water temperature regulator is operating correctly.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Prolonged Operation at Idle Speed</b></p> <p><b>Note:</b> Prolonged operation of the engine at idle speed increases fuel consumption.</p> <p><b>A.</b> Check for extended periods of engine operation at idle speed.</p>	Extended idle operation	<p><b>Result:</b> The engine is operating at idle speed for extended periods.</p> <p>When possible, stop the engine to conserve fuel.</p> <p><b>Result:</b> The engine is not operating at idle speed for extended periods.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Air Intake and Exhaust System</b></p> <p><b>A.</b> Check the air filter restriction indicator, if equipped.</p> <p><b>B.</b> Check the air intake and exhaust systems for the following defects:</p> <ul style="list-style-type: none"> <li>· Blockages</li> <li>· Restrictions</li> <li>· Damage to lines or hoses</li> </ul>	Air and Exhaust System restrictions	<p><b>Result:</b> The air filter is restricted.</p> <p><b>Repair:</b> Replace the air filter.</p> <p><b>Result:</b> There are system restrictions.</p> <p><b>Repair:</b> Refer to Systems Operation/Testing and Adjusting, "Air Inlet and Exhaust System" for additional information on the air inlet and exhaust systems.</p> <p><b>Result:</b> The air intake and exhaust system is OK.</p> <p>Proceed to Test Step 9.</p>

(continued)

(Table 92, contd)

Troubleshooting Test Steps	Values	Results
<p><b>9. Cooling Fan</b></p> <p><b>Note:</b> Excessive operation of the cooling fan or damage to the cooling fan will increase fuel consumption.</p> <p><b>A.</b> Check the operation and condition of the cooling fan.</p>	Cooling fan	<p><b>Result:</b> The cooling fan is operating excessively.</p> <p><b>Repair:</b> Repair or replace the faulty cooling fan components.</p> <p><b>Result:</b> The cooling fan is damaged excessively.</p> <p><b>Repair:</b> Repair or replace the faulty cooling fan components.</p> <p><b>Result:</b> The cooling fan is not operating excessively and is not damaged.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Reduced Pressure of Intake Air</b></p> <p><b>Note:</b> If the air pressure is lower than normal, the same power can only be achieved by the following:</p> <ul style="list-style-type: none"> <li>· Higher engine speed</li> <li>· Injection of more fuel</li> </ul> <p>Either of these conditions will increase the fuel consumption.</p> <p><b>A.</b> Check all pipes from the outlets of the turbocharger compressor to the inlet manifold for leaks.</p> <p><b>B.</b> Check for the correct operation of the wastegate in the turbocharger.</p>	Intake air	<p><b>Result:</b> There is a leak in the intake air system.</p> <p><b>Repair:</b> Repair the leak or replace the component that is causing the leak.</p> <p><b>Result:</b> The turbocharger wastegate is not operating correctly.</p> <p><b>Repair:</b> Replace the turbocharger.</p> <p><b>Result:</b> The air intake system and the wastegate are OK.</p> <p>Proceed to Test Step 11.</p>
<p><b>11. Excessive Valve Lash</b></p> <p><b>A.</b> Check for excessive valve lash.</p>	Valve lash	<p><b>Result:</b> The valve lash is incorrect.</p> <p><b>Repair:</b> Check the valve lash. Refer to Systems Operation, Testing, and Adjusting, "Engine Valve Lash - Inspect" for the correct procedure.</p> <p><b>Result:</b> The valve lash is correct.</p> <p>Proceed to Test Step 12.</p>
<p><b>12. Failure of the Primary Speed/Timing Sensor</b></p> <p><b>A.</b> Crank the engine and observe the engine speed on the electronic service tool status screen.</p> <p>Upon initial cranking, the status for engine speed may indicate that the engine speed signal is abnormal. This message will be replaced with an engine speed once the ECM is able to calculate a speed from the signal.</p>	Primary Speed/ Timing Sensor	<p><b>Result:</b> The primary speed/timing sensor is not operating correctly.</p> <p><b>Repair:</b> Test the primary speed/timing sensor. Refer to Troubleshooting, "Speed/Timing - Test".</p> <p><b>Result:</b> The primary speed/timing sensor is operating correctly.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06157567

## Fuel Contains Water

This procedure covers the following diagnostic code:

Table 93

Diagnostic Trouble Code for Water in Fuel			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
97-15	E232 (1)	Water In Fuel Indicator : High - least severe (1)	Water has been detected in the fuel that is contained in the fuel/water separator bowl. The water has been present for at least 40 seconds.  The warning lamp will come on.
97-16	E232 (2)	Water In Fuel Indicator : High - moderate severity (2)	Water has been detected in the fuel that is contained in the fuel/water separator bowl. The water has been present for at least 60 minutes.  The warning lamp will come on.  The engine will be derated at 17.5% per second up to a maximum of 35%.

**Note:** Visual identification of water in the bowl may be impossible. Water may turn dark yellow in color in the fuel system. The similarity in color would prevent the ability to differentiate the water from the fuel.

### Recommended Actions

**Note:** Complete the procedure in the order in which the steps are listed.

Table 94

Troubleshooting Test Steps	Values	Results
<p><b>1. Drain the Fuel/Water Separator Bowl</b></p> <p><b>A.</b> Turn the ignition key to the OFF position.</p> <p><b>B.</b> Drain the fuel/water separator bowl. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter/Water Separator - Drain".</p> <p><b>C.</b> If necessary, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime".</p> <p><b>D.</b> Turn the ignition key to the ON position. Do not start the engine. Wait for 1 minute.</p>	Fuel/water separator	<p><b>Result:</b> The "Water-In-Fuel" warning disappears within 1 minute.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The "Water-In-Fuel" warning remains on.</p> <p>Proceed to Test Step 3.</p>
<p><b>2. Confirm that there is no Water in the Fuel</b></p> <p><b>A.</b> Run the engine for 5 minutes.</p>	Water in fuel	<p><b>Result:</b> The "Water-In-Fuel" warning does not reappear within the 5 minutes.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The "Water-In-Fuel" warning reappears within the 5 minutes.</p> <p><b>Repair:</b> The fuel supply is contaminated with water. Drain the fuel tank and then fill the fuel tank with clean fuel.</p> <p>Repeat the procedure from Test Step 1.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>
<p><b>3. Water-In-Fuel Switch</b></p> <p><b>A.</b> Check the operation of the Water-In-Fuel switch. Refer to Troubleshooting, "Water In Fuel - Test".</p>	Water in fuel switch	<p><b>Result:</b> The Water-In-Fuel switch circuit required a repair.</p> <p>Repeat the procedure from Test Step 1.</p> <p><b>Result</b> The Water-In-Fuel switch is OK.</p> <p><b>Repair:</b> The fuel supply is contaminated with water. Drain the fuel tank and then fill the fuel tank with clean fuel.</p> <p>Repeat the procedure from Test Step 1.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i08473851

## Fuel Rail Pressure Problem

Use this procedure to troubleshoot abnormal fuel rail pressure or use this procedure if any of the following diagnostic trouble codes are active. Refer to Troubleshooting, "Diagnostic Trouble Codes" for information about the codes.

## Symptom Troubleshooting

Table 95

Diagnostic Trouble Codes for Fuel Rail Pressure Problem			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
157-16	E396 (2)	Engine Injector Metering Rail #1 Pressure: High - moderate severity (2)	No other 157-XX or 1797-XX codes are active. 3509-XX or 262-XX codes are not active. 3510-XX or 2131-XX codes are not active. No codes for the high-pressure fuel pump or the injectors are active. The fuel rail pressure is above an acceptable level. The code is logged. Engine power is derated.
157-18	E398 (2)	Engine Injector Metering Rail #1 Pressure: Low - moderate severity (2)	No other 157-XX or 1797-XX codes are active. 3509-XX or 262-XX codes are not active. 3510-XX or 2131-XX codes are not active. No codes for the high-pressure fuel pump or the injectors are active. The fuel rail pressure is below an acceptable level. The code is logged. Engine power is derated.
1239-0	E499 (3)	Engine Fuel Leakage 1: High - most severe (3)	3509-XX or 262-XX codes are not active. 3510-XX or 2131-XX codes are not active. There is a probable fuel leak from the high-pressure fuel system. The amount of leakage is a calculated parameter. The code is logged. The engine will stop.
5571-0	E1264 (2)	High Pressure Common Rail Fuel Pressure Relief Valve : Active	3509-XX or 262-XX codes are not active. 3510-XX or 2131-XX codes are not active. The pressure limiting valve in the fuel rail is open. This code is a calculated parameter. The code is logged.

### Probable Causes

- Diagnostic codes
- Electrical connectors
- Fuel filters
- Fuel rail pressure sensor
- High fuel rail pressure
- Transfer Pump Inlet Regulator (TPIR)
- Transfer Pump Inlet Regulator (TPIR) return
- Return fuel lines
- Low fuel rail pressure
- Transfer Pump Inlet Regulator (TPIR)
- Transfer Pump Inlet Regulator (TPIR) Return
- Electric Fuel Lift Pump (EFLP)
- Return fuel lines

### Recommended Actions



**Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.**



Table 96

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, “Electronic Service Tools”, if necessary.</p> <p><b>B.</b> Download the Warranty Report and the Product Status Report (PSR) with Histograms before diagnosing the fault.</p> <p><b>Note:</b> The downloaded information will be required by the Dealer Solutions Network (DSN) if diagnostic assistance is needed.</p> <p><b>C.</b> Determine if a diagnostic code is active or recently logged.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> One of the codes in Table 95 is present.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A code other than the codes in Table 95 is present.</p> <p><b>Repair:</b> Troubleshoot the code. Refer to the applicable procedure.</p>
<p><b>2. Create an Electronic Service Tool Snapshot</b></p> <p><b>A.</b> Select “Snapshot Viewer” on the electronic service tool, using menus: Information -&gt; Snapshot -&gt; Viewer</p> <p><b>B.</b> Select the event code and then click “View Graph” .</p> <p><b>C.</b> Select the following parameter and then click OK.</p> <ul style="list-style-type: none"> <li>· Engine Speed</li> </ul> <p><b>D.</b> Select Save to “File to save” a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph.</p> <p><b>Note:</b> The downloaded information will be required by the Dealer Solutions Network (DSN) if diagnostic assistance is needed.</p>	<p>Diagnostic Codes</p>	<p><b>Result:</b> The electronic service tool snapshot was successfully saved.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The electronic service tool snapshot was not successfully saved.</p> <p>Contact the DSN for guidance.</p>
<p><b>3. Electrical Connectors</b></p> <p><b>A.</b> Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the connector on the Fuel Rail Pressure Sensor and on the Suction Control Valve for the High-Pressure Fuel Pump.</p>	<p>Connectors</p>	<p><b>Result:</b> There are suspect connectors.</p> <p><b>Repair:</b> Use the electronic service tool to perform the “Wiggle Test” .</p> <p>Repair or replace connectors that are suspect.</p> <p><b>Result:</b> There are no suspect connectors.</p> <p>Proceed to Test Step 4.</p>

(continued)

## Symptom Troubleshooting

(Table 96, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Fuel Filters</b></p> <p><b>A.</b> Replace the in-line fuel filter that is upstream of the electric fuel lift pump (if equipped). Refer to the Operation and Maintenance Manual for further information. If an in-line fuel filter is not installed, replace the fuel strainer on the fuel tank pickup pipe. Refer to the documentation for the machine.</p> <p><b>B.</b> Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p><b>C.</b> If equipped, check the Fuel Tank Breather and replace if necessary.</p>	Fuel filters	<p><b>Result:</b> The filters have been replaced and the fault is eliminated.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The filters have been replaced and the fault is still present.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Fuel Rail Pressure Sensor</b></p> <p><b>A.</b> Make sure that the engine has been stopped for at least 10 minutes. Use the electronic service tool to check the status of the "Fuel Rail Pressure" .</p>	Pressure sensor	<p><b>Result:</b> The "Fuel Rail Pressure (absolute)" is more than 5,000 kPa (725 psi).</p> <p><b>Repair:</b> Test the fuel rail pressure sensor. Refer to Troubleshooting, "Sensor Signal (analog, Active) - Test".</p> <p>Use the electronic service tool to perform the "Fuel Rail Pressure Test". If the test fails, replace the fuel pressure sensor. Refer to Disassembly and Assembly, "Fuel Pressure Sensor - Remove and Install".</p> <p>Confirm that the fault has been eliminated.</p> <p><b>Result:</b> The "Fuel Rail Pressure (absolute)" is less than 5,000 kPa (725 psi).</p> <p>For a high fuel rail pressure symptom, proceed to Test Step 6.</p> <p>For a low fuel rail pressure symptom, proceed to Test Step 11.</p>
<p><b>6. High-Pressure Fuel Pump Calibration</b></p> <p><b>A.</b> Use the electronic service tool to perform the "High Pressure Fuel Pump Calibration" .</p>	Fuel system	<p><b>Result:</b> Fuel rail pressure is normal after performing the "High Pressure Fuel Pump Calibration" .</p> <p>Use the electronic service tool to perform the "Fuel Rail Pressure Test" . If the "Fuel Rail Pressure Test" is successful, return the unit to service.</p> <p>If the "Fuel Rail Pressure Test" generates additional diagnostic codes, troubleshoot the additional codes. Refer to Troubleshooting, Diagnostic Trouble Codes or Troubleshooting, Event Codes.</p> <p><b>Result:</b> Fuel rail pressure is still high after performing the "High Pressure Fuel Pump Calibration" .</p> <p>Run the engine for a minimum of 30 minutes.</p> <p>Proceed to Test Step 7.</p>

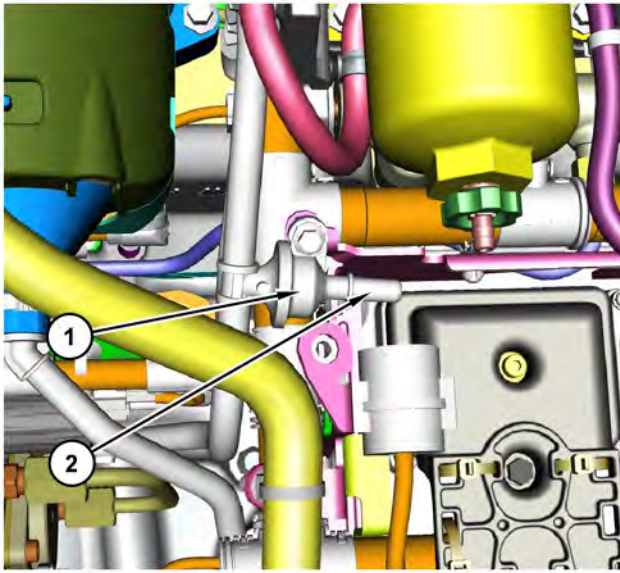


Illustration 61 g03700009  
**Transfer Pump Inlet Regulator (TPIR) components**  
 (1) Transfer Pump Inlet Regulator (TPIR)  
 (2) TPIR return port

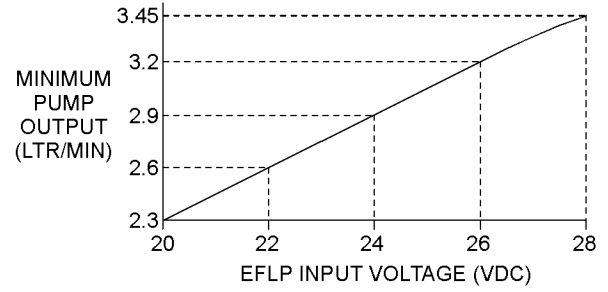


Illustration 63 g02485897  
**Minimum TPIR flow rate in a 24 V system**

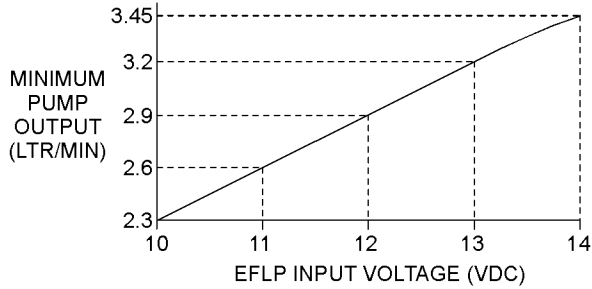


Illustration 62 g02485896  
**Minimum TPIR flow rate in a 12 V system**

Table 97

Troubleshooting Test Steps	Values	Results
<p><b>7. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p><b>Note:</b> When performing the following fuel system tests, the Electric Fuel Lift Pump (EFLP) will only operate for 2 minutes unless the engine is running. If necessary, cycle the keyswitch to reactivate the pump.</p> <p>Refer to Illustration 61 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 62 or 63 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	<p>TPIR flow rate</p>	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 9.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 8.</p>

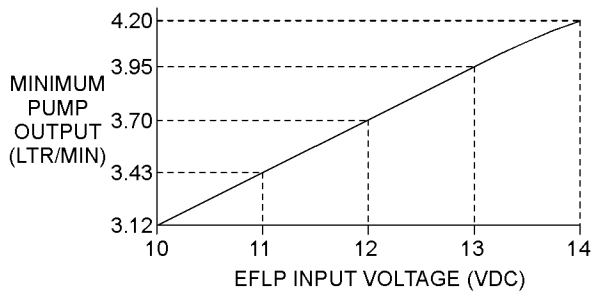


Illustration 64 g02527498  
Minimum EFLP flow rate in a 12 V system

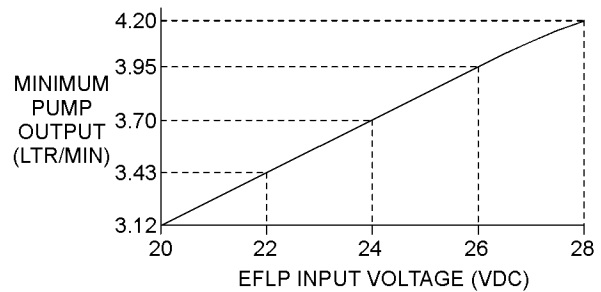


Illustration 65 g02527518  
Minimum EFLP flow rate in a 24 V system

Table 98

Troubleshooting Test Steps	Values	Results
<p><b>8. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 64 or 65 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Transfer Pump Inlet Regulator (TPIR) Return Test</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> Check that the Electric Fuel Lift Pump (EFLP) is operating correctly.</p>	TPIR return line	<p><b>Result:</b> The TPIR return line is blocked or kinked.</p> <p><b>Repair:</b> Clear the TPIR return line or replace the line</p> <p>Confirm that the fault is eliminated.</p> <p><b>Result:</b> The EFLP is not operating correctly.</p> <p>Refer to Troubleshooting, "Fuel Transfer Pump - Test".</p> <p><b>Result:</b> The TPIR return line and the EFLP are OK.</p> <p>Proceed to Test Step 10.</p>

(continued)

## Symptom Troubleshooting

(Table 98, contd)

Troubleshooting Test Steps	Values	Results
<p><b>10. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, contact the DSN and provide the Warranty Report, PSR and Snapshot Data as saved in steps 1 and 2.</p>
<p><b>11. Low Fuel Rail Pressure</b></p> <p><b>A.</b> Visually check the fuel tank for fuel.</p> <p><b>Note:</b> The fuel gauge may be faulty.</p> <p><b>B.</b> Inspect the high-pressure fuel system for leaks.</p> <p><b>C.</b> Use the electronic service tool to perform the “High Pressure Fuel Pump Calibration” .</p> <p><b>D.</b> If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).</p> <p><b>E.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>F.</b> Check for fuel supply lines that are restricted or not correctly installed.</p> <p><b>G.</b> Replace the in-line fuel filter that is installed upstream of the Electric Fuel Lift Pump (EFLP).</p> <p><b>H.</b> Check that the EFLP is operating correctly.</p> <p><b>I.</b> Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p><b>J.</b> Check for air in the fuel system and that the fuel system is primed.</p> <p><b>K.</b> Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”.</p> <p><b>L.</b> Use the electronic service tool to perform the “Fuel Rail Pressure Relief Valve Test” .</p> <p><b>Note:</b> This test will identify excessive leakage through the Pressure Limiting Valve (PLV) in the fuel rail.</p>	Low-pressure fuel system	<p><b>Result:</b> There is a leak from the high-pressure fuel system.</p> <p><b>Repair:</b> Rectify any fuel leaks.</p> <p><b>Result:</b> The fuel contains solidified wax.</p> <p><b>Repair:</b> Replace the fuel with fuel of the correct specification for the ambient conditions.</p> <p><b>Result:</b> There are fuel supply lines that are restricted or not correctly installed.</p> <p><b>Repair:</b> Install the fuel lines correctly. Replace any damaged or restricted fuel lines.</p> <p><b>Result:</b> The EFLP is not operating correctly.</p> <p><b>Repair:</b> Investigate the fault with the EFLP. Refer to Troubleshooting, “Fuel Transfer Pump - Test”.</p> <p><b>Result:</b> There is air in the fuel system.</p> <p><b>Repair:</b> Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”.</p> <p><b>Result:</b> The diesel fuel is contaminated.</p> <p><b>Repair:</b> Drain the fuel tank and the fuel system.</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p>Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”.</p> <p><b>Result:</b> “Fuel Rail Pressure Relief Valve Test” fails</p> <p><b>Repair:</b> Replace the Fuel Rail Pressure Relief Valve. Refer to Disassembly &amp; Assembly, “Relief Valve (Fuel) - Remove and Install”.</p>

(continued)

(Table 98, contd)

Troubleshooting Test Steps	Values	Results
		<p><b>Result:</b> "Fuel Rail Pressure Relief Valve Test" passes</p> <p><b>Repair:</b> The Fuel Rail Pressure Relief Valve is operating correctly and should not be replaced.</p> <p><b>Result:</b> The low-pressure fuel system is OK.</p> <p>Before performing the following fuel system tests, the engine must be run for a minimum of 30 minutes.</p> <p>Proceed to Test Step 12.</p>

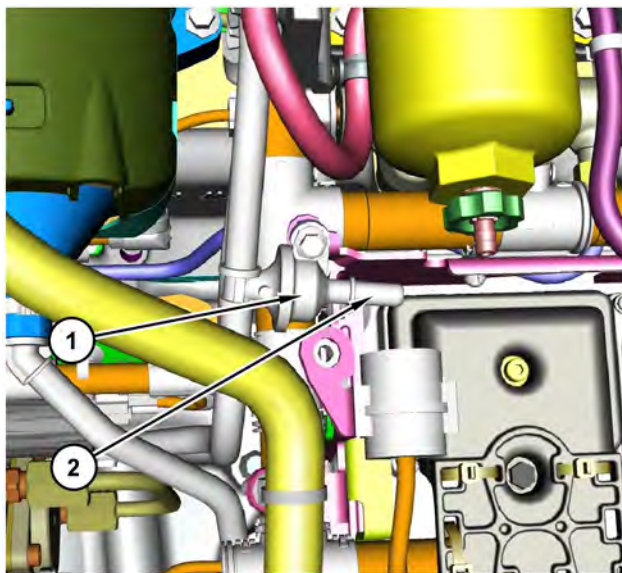


Illustration 66 g03700009  
**Transfer Pump Inlet Regulator (TPIR) components**  
 (1) Transfer Pump Inlet Regulator (TPIR)  
 (2) TPIR return port

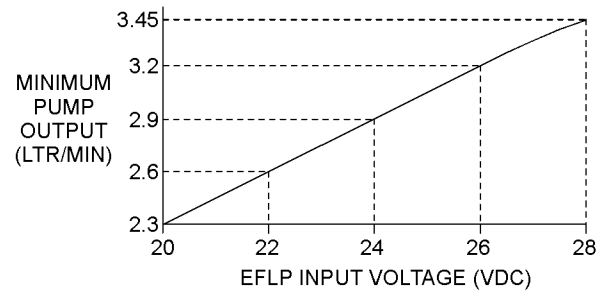


Illustration 68 g02485897  
**Minimum TPIR flow rate in a 24 V system**

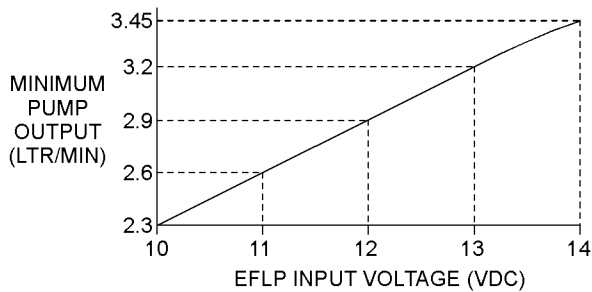


Illustration 67 g02485896  
**Minimum TPIR flow rate in a 12 V system**

## Symptom Troubleshooting

Table 99

Troubleshooting Test Steps	Values	Results
<p><b>12. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p><b>Note:</b> When performing the following fuel system tests, the Electric Fuel Lift Pump (EFLP) will only operate for 2 minutes unless the engine is running. If necessary, cycle the keyswitch to reactivate the pump.</p> <p>Refer to Illustration 66 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 67 or 68 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	TPIR flow rate	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 14.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 13.</p>
<p><b>13. Transfer Pump Inlet Regulator (TPIR) Return Test</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> Check that the Electric Fuel Lift Pump (EFLP) is operating correctly.</p>	TPIR return line	<p><b>Result:</b> The TPIR return line is blocked or kinked.</p> <p><b>Repair:</b> Clear the TPIR return line or replace the line</p> <p>Confirm that the fault is eliminated.</p> <p><b>Result:</b> The EFLP is not operating correctly.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Fuel Transfer Pump - Test".</p> <p><b>Result:</b> The TPIR return line and the EFLP are OK.</p> <p>Proceed to Test Step 14.</p>



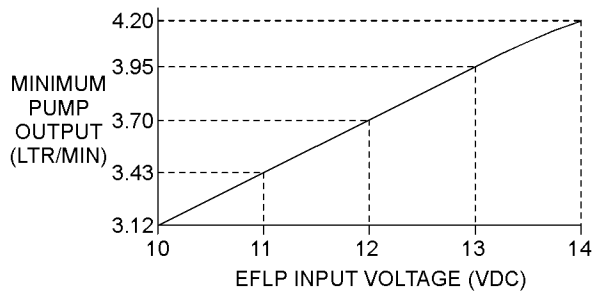


Illustration 69 g02527498

Minimum EFLP flow rate in a 12 V system

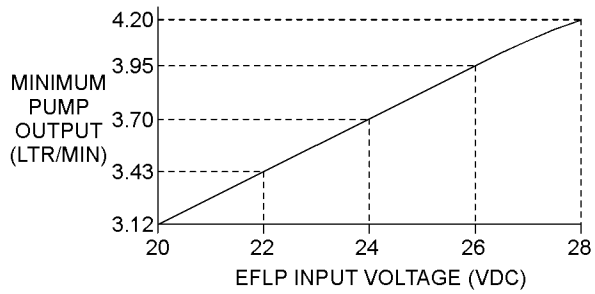


Illustration 70 g02527518

Minimum EFLP flow rate in a 24 V system

Table 100

Troubleshooting Test Steps	Values	Results
<p><b>14. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 69 or 70 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 15.</p>
<p><b>15. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, contact the DSN and provide the Warranty Report, PSR and Snapshot Data as saved in steps 1 and 2.</p>

i06160419

## Fuel Temperature Is High

If either of the following diagnostic trouble codes are active, perform the procedure that follows:

Table 101

Diagnostic Trouble Codes for Fuel Temperature Is High			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
174-16	E363 (2)	Engine Fuel Temperature 1 : High - moderate severity (2)	<p>The temperature of the low-pressure fuel in the high-pressure fuel pump is high.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been operating for at least 185 seconds.</p> <p>There are no other faults in the electrical system.</p> <p>The warning lamp will come on.</p> <p>The engine may be derated by 20%.</p> <p>The warning lamp will go off when the temperature drops below the trip point for 15 seconds.</p>

### Probable causes

- Incorrect position of fuel shut-off valves
- Fuel level in tank
- Return fuel cooler
- Return fuel lines
- Location of the fuel tank

**Note:** The procedures have been listed in order of probability. Complete the procedure in the order in which the steps are listed.

Table 102

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Codes Active or Logged Diagnostic codes.</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Use the electronic service tool to check for active or logged codes.</p>	Diagnostic Active or Logged codes	<p><b>Result:</b> A diagnostic code is active or logged other than a 174-16 (E363 (2)) code.</p> <p><b>Repair:</b> Troubleshoot the active or logged code.</p> <p><b>Result:</b> A 174-16 (E363 (2)) diagnostic code is active or logged.</p> <p>Proceed to Test Step 2.</p>

(continued)

## Symptom Troubleshooting

(Table 102, contd)

<p><b>2. Fuel Shut-off Valves</b></p> <p><b>A.</b> Check the position of any fuel shut-off valves in the feed lines between the fuel tank and the engine.</p> <p><b>B.</b> Check the position of any fuel shut-off valves in the return lines between the engine and the fuel tank.</p>	Fuel valves	<p><b>Result:</b> A fuel shut-off valve is not fully open.</p> <p><b>Repair:</b> Move all shut-off valves to the fully open position.</p> <p><b>Result:</b> All shut-off valves are in the fully open position.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Fuel Level in Tank</b></p> <p><b>Note:</b> If the level in the fuel tank is low, the hot return fuel can raise the temperature in the fuel tank.</p> <p><b>A.</b> Check the fuel level in the tank.</p>	Fuel level	<p><b>Result:</b> The fuel level in the tank is low.</p> <p><b>Repair:</b> Replenish the fuel tank at the earliest opportunity.</p> <p><b>Result:</b> The fuel level in the tank is OK.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Return Fuel Cooler</b></p> <p><b>A.</b> Check that the fins on the return fuel cooler are not blocked with dirt or debris. Make sure that the fins are not bent or missing.</p>	Return fuel cooler	<p><b>Result:</b> The fins on the return fuel cooler are blocked with dirt or debris.</p> <p><b>Repair:</b> Clean the return fuel cooler.</p> <p><b>Result:</b> The fins on the return fuel cooler are bent or missing.</p> <p><b>Repair:</b> Install a replacement return fuel cooler.</p> <p><b>Result:</b> The return fuel cooler is OK.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Return Fuel Lines</b></p> <p><b>A.</b> Check the return fuel lines for blockages or restrictions.</p>	Return fuel lines	<p><b>Result:</b> A return fuel line is blocked or restricted.</p> <p><b>Repair:</b> Clear the fuel line or replace the line.</p> <p><b>Result:</b> The return fuel lines are OK.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Location of the Fuel Tank</b></p> <p><b>A.</b> Make sure that the fuel tank is not close to a heat source.</p>	Fuel tank location	<p><b>Result:</b> The fuel tank is close to a heat source.</p> <p><b>Repair:</b> Shield the fuel tank from the heat source.</p> <p><b>Result:</b> The fuel tank is not close to a heat source.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06160422

## Inlet Air Is Restricted

Use this procedure in order to troubleshoot a high differential pressure for the air inlet system. Use this procedure if one of the following event codes are active. Refer to Troubleshooting, "Event Codes" for information about event codes. Access the engine monitoring system on the electronic service tool in order to view the current trip points for these codes. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Table 103

<b>Diagnostic Trouble Codes for Inlet Air Is Restricted</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description</b> (Code descriptions may vary)	<b>Comments</b>
107-15	E583(1)	Engine Air Filter 1 Differential Pressure : High - least severe (1)	The air filter differential pressure is above the trip point pressure for the delay time. The code is logged.
107-16	E583(2)	Engine Air Filter 1 Differential Pressure : High - moderate severity (2)	The air filter differential pressure is above the trip point pressure for the delay time. The code is logged. The engine power is derated.

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 104

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Air Filter Element</b></p> <p>A. Check the air intake system for plugged air filters or for damaged air filters. If the engine is equipped with an air intake pre-cleaner, verify the proper operation of the air intake pre-cleaner.</p>	Plugged air filter	<p><b>Result:</b> The air filter is clogged.</p> <p><b>Repair:</b> Clean or replace the air filter. Verify that the problem is resolved.</p> <p><b>Result:</b> The air filter is not clogged.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Air Inlet Piping</b></p> <p>A. Check the air inlet piping for damage or restrictions.</p>	Damaged air inlet piping	<p><b>Result:</b> The air inlet piping is damaged or has restrictions.</p> <p><b>Repair:</b> Repair the piping or replace the piping. Verify that the problem is resolved.</p> <p><b>Result:</b> The air inlet piping does not have damage or restrictions.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Enclosure Ventilation</b></p> <p>A. Check that the engine has been installed in an enclosure that is sufficiently ventilated.</p>	Enclosure ventilation	<p><b>Result:</b> The engine does not have sufficient ventilation.</p> <p><b>Repair:</b> Repair the ventilation for the enclosure. Verify that the fault is resolved.</p> <p><b>Result:</b> The engine has sufficient ventilation.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06160442

## Intake Manifold Air Pressure Is High

The Electronic Control Module (ECM) monitors the intake manifold air pressure. The following event is associated with high intake manifold air pressure:

Table 105

Diagnostic Trouble Code for Intake Manifold Air Pressure Is High			
J1939 Code	PDL Code	Code Description (Code descriptions may vary)	Comments
102-16	E1044 (2)	Engine Intake Manifold #1 Pressure : High - moderate severity (2)	This pressure is a variable value that is calculated by the ECM. The resulting value is dependent on the operating conditions of the engine.

### Probable Causes

- Turbocharger wastegate
- Wastegate regulator

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 106

Troubleshooting Test Steps	Values	Results
<p><b>1. Turbocharger Wastegate</b></p> <p><b>Note:</b> On engines with a single turbocharger, the wastegate is attached to the turbocharger. On engines with twin turbochargers, the wastegate is attached to the high-pressure turbocharger.</p> <p><b>A.</b> Check the operation of the wastegate on the turbocharger.</p> <p><b>B.</b> Check the operation of the wastegate actuator on the turbocharger. Refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect".</p>	<p>Turbocharger wastegate</p>	<p><b>Result:</b> Operation of the turbocharger wastegate is suspect.</p> <p><b>Repair:</b> Disconnect the output rod in the wastegate actuator from the lever that operates the wastegate.</p> <p>Operate the wastegate lever by hand and check for full and free movement.</p> <p>Check that the output rod in the wastegate actuator is biased towards the retracted position.</p> <p>Connect the output rod in the wastegate actuator to the lever that operates the wastegate.</p> <p>If the wastegate is not operating correctly, replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> There is a suspected fault in the wastegate or the wastegate actuator.</p> <p><b>Repair:</b> Replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The wastegate and the wastegate actuator operate correctly.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Wastegate Regulator</b></p> <p><b>A.</b> Use the electronic service tool to check for diagnostic trouble codes that relate to the wastegate regulator.</p>	<p>Wastegate regulator</p>	<p><b>Result:</b> Diagnostic codes are present that relate to the wastegate regulator.</p> <p><b>Repair:</b> Rectify the cause of any related codes. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> There are no diagnostic codes that relate to the wastegate regulator.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Intake Manifold Air Pressure Is Low

The Electronic Control Module (ECM) monitors the intake manifold air pressure. The following event is associated with low intake manifold air pressure:

Table 107

Diagnostic Trouble Code for Low Intake Manifold Air Pressure			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Notes
102-18	E1045 (2)	Engine Intake Manifold #1 Pressure : Low - moderate severity	This pressure is a variable value that is calculated by the ECM. The resulting value is dependent on the operating conditions of the engine.

## Probable Causes

- Intake air filter
- Air intake system
- Wastegate regulator
- Low battery voltage
- Turbocharger or turbochargers

## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 108

Troubleshooting Test Steps	Values	Results
<b>1. Intake Air Filter</b>  <b>A.</b> Check the air filter restriction indicator, if equipped.  <b>B.</b> Ensure that the air filter is clean and serviceable.	Air filter	<b>Result:</b> The air filter is blocked.  <b>Repair:</b> Replace the air filter element. Refer to the Operation and Maintenance Manual, "Engine Air Cleaner Element - Replace".  <b>Result:</b> The air filter is OK.  Proceed to Test Step 2.
<b>2. Air Intake System</b>  <b>A.</b> Check the air intake system for the following defects: <ul style="list-style-type: none"> <li>• Blockages</li> <li>• Restrictions</li> <li>• Damage to the air intake ducts and hoses</li> <li>• Loose connections and air leaks</li> </ul>	Air intake	<b>Result:</b> The air intake system is blocked, restricted, damaged, or loose.  <b>Repair:</b> Make all necessary repairs to the air intake system.  <b>Result:</b> The air intake system is OK.  Proceed to Test Step 3.

(continued)



(Table 108, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Wastegate Regulator</b></p> <p><b>A.</b> Use the electronic service tool to check for diagnostic codes that relate to the wastegate regulator.</p>	Wastegate regulator	<p><b>Result:</b> Diagnostic codes are present that relate to the wastegate regulator.</p> <p><b>Repair:</b> Rectify the cause of any related codes. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> There are no diagnostic codes that relate to the wastegate regulator.</p> <p>For engines that have a single turbocharger, proceed to Test Step 4.</p> <p>For engines that have twin turbochargers, proceed to Test Step 5.</p>
<p><b>4. Turbocharger</b></p> <p><b>Note:</b> The turbocharger that is installed on the engine is a nonserviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Check that the compressor housing for the turbocharger is free of dirt and debris.</p> <p><b>B.</b> Check that the turbine housing for the turbocharger is free of dirt and debris.</p> <p><b>C.</b> Check that the turbine blades rotate freely in the turbocharger.</p>	Turbocharger	<p><b>Result:</b> There is a fault in the turbocharger.</p> <p><b>Repair:</b> Replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The turbocharger is OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>5. Turbochargers</b></p> <p><b>Note:</b> The turbochargers that are installed on the engine are nonserviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Check that the compressor housings for the turbochargers are free of dirt and debris.</p> <p><b>B.</b> Check that the turbine housings for the turbochargers are free of dirt and debris.</p> <p><b>C.</b> Check that the turbine blades rotate freely in the turbochargers.</p>	Turbocharger	<p><b>Result:</b> There is a fault in a turbocharger.</p> <p><b>Repair:</b> Replace the faulty turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".</p> <p><b>Result:</b> The turbochargers are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Intake Manifold Air Temperature Is High

The Electronic Control Module (ECM) monitors the intake manifold air for excessive temperature. The following event codes are associated with high intake manifold air temperature:

Table 109

Diagnostic Trouble Codes for High Intake Manifold Air Temperature			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
105-15	E539 (1)	Engine Intake Manifold #1 Temperature : High - least severe (1)	The engine has been running for 3 minutes. No other 105 (172) codes are active. 168 codes are not active. Code 412-16 (E1092 (2)) is not active. The intake manifold air temperature exceeds the value that is programmed into the ECM for 8 seconds. The code is logged. This code will be reset when the temperature is less than 122° C (252° F) for 4 seconds.
105-16	E539 (2)	Engine Intake Manifold #1 Temperature : High - Moderate Severity (2)	The engine has been running for 3 minutes. No other 105 (172) codes are active. 168 codes are not active. Code 412-16 (E1092 (2)) is not active. The intake manifold air temperature exceeds the value that is programmed into the ECM for 8 seconds. The engine will be derated. The code is logged. This code will be reset when the temperature is less than 124° C (255° F) for 20 seconds.
105-0	E539 (3)	Engine Intake Manifold #1 Temperature : High - most severe (3)	The engine has been running for 3 minutes. No other 105 (172) codes are active. 168 codes are not active. Code 412-16 (E1092 (2)) is not active. The intake manifold air temperature exceeds the value that is programmed into the ECM for 8 seconds. The engine will be shut down. The code is logged. This code will be reset when the temperature is less than 124° C (255° F) for 20 seconds.

## Probable Causes

- Coolant level
- Air-to-air aftercooler (ATAAC)
- Cooling fan
- Air inlet and exhaust system
- Ambient temperature
- Altitude
- Running condition

## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 110

Troubleshooting Test Steps	Values	Results
<p><b>1. Coolant Level</b></p> <p><b>A.</b> Check that the coolant is filled to the correct level.</p> <p><b>Note:</b> If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow.</p>	Coolant	<p><b>Result:</b> The coolant level is low.</p> <p><b>Repair:</b> Fill the coolant system to the correct level. Refer to the Operation and Maintenance Manual, "Coolant Level - Check".</p> <p><b>Result:</b> The coolant level is OK.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Air-to-Air Aftercooler (ATAAC)</b></p> <p><b>A.</b> Check the ATAAC for debris or damage.</p> <p><b>Note:</b> Debris between the fins of the ATAAC core restricts air flow through the core.</p>	ATAAC	<p><b>Result:</b> The ATAAC has excessive debris or is damaged.</p> <p><b>Repair:</b> Clear the debris from the ATAAC or replace the ATAAC.</p> <p><b>Result:</b> The ATAAC is OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Cooling Fan</b></p> <p><b>A.</b> Check the operation of the cooling fan.</p> <p><b>Note:</b> A fan that is not turning at the correct speed can result in insufficient airflow through the aftercooler core.</p>	Cooling fan	<p><b>Result:</b> The cooling fan is not operating correctly.</p> <p><b>Repair:</b> Investigate the cause of the incorrect fan operation</p> <p><b>Result:</b> The cooling fan is operating correctly.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Air Intake and Exhaust System</b></p> <p><b>A.</b> Check the air intake and exhaust system for the following defects:</p> <ul style="list-style-type: none"> <li>• Blockages</li> <li>• Restrictions</li> <li>• Damage to the air intake ducts and hoses</li> <li>• Loose connections and air leaks</li> </ul>	Air intake and exhaust	<p><b>Result:</b> The air intake or exhaust system is blocked, restricted, damaged, or loose.</p> <p><b>Repair:</b> Make all necessary repairs to the air intake system.</p> <p><b>Result:</b> The air intake and exhaust system is OK.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Exhaust Back Pressure Regulator (EBPR)</b></p> <p><b>A.</b> Check for the correct operation of the exhaust back pressure regulator.</p>	EBPR	<p><b>Result:</b> The EBPR is suspect.</p> <p><b>Repair:</b> Investigate the EBPR. Refer to Troubleshooting, "Motorized Valve - Test".</p> <p><b>Result:</b> The EBPR is OK.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Symptom Troubleshooting

(Table 110, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Ambient Temperature</b></p> <p><b>A.</b> Check for a high ambient temperature.</p> <p><b>Note:</b> When outside temperatures are too high, there is insufficient temperature difference between the outside air and the intake air.</p>	Ambient Temperature	<p><b>Result:</b> The ambient air temperature is high.</p> <p><b>Repair:</b> Operate the engine at reduced speed or reduced power.</p> <p><b>Result:</b> The ambient air temperature is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Altitude</b></p> <p><b>A.</b> Check for operation at high altitude.</p> <p><b>Note:</b> The cooling capacity of the ATAAC is reduced as the engine is operated at higher altitudes.</p>	Altitude	<p><b>Result:</b> The engine is being operated at high altitude.</p> <p><b>Repair:</b> Operate the engine at reduced speed or reduced power.</p> <p><b>Result:</b> The engine is not being operated at high altitude.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Running Condition</b></p> <p><b>A.</b> Check that the engine is not operating in the lug condition.</p> <p><b>Note:</b> When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system.</p>	Running condition	<p><b>Result:</b> The engine is operating in the lug condition.</p> <p><b>Repair:</b> Reduce the load on the engine or, if possible, increase the power rating of the engine.</p> <p><b>Result:</b> The engine is not operating in the lug condition.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## NOx Conversion Is Low

Table 111

Diagnostic Trouble Codes for NOx Conversion Is Low			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4364-18	E1309 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	The SCR System is not able to reduce NOx in the exhaust system.
7105-31	E1585 (2)	Aftertreatment #1 Inconsistent Configuration Detected	Data received from the NOx sensor is not compatible with the engine software.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 112

Required Tools			
Tool	Part Number	Part Description	Qty

(Table 112, contd)

A	T400195	Refractometer	1
B	T401199	Kit - Test	1

(continued)

(continued)

(Table 112, contd)

C	T402192	Adapter	1
D	N/A	Test Strips (DEF Fluid)	1
E	N/A	Wired Borescope/5.5 mm HD Camera	1

Table 113

<b>Associated Diagnostic Trouble Codes</b>	
<b>J1939 Code</b>	<b>PDL Code</b>
102-16	E1044 (2)
102-18	E1045 (2)
412-15	E1092 (1)
412-16	E1092 (2)
3516-12	3100-12
3516-16	E1365 (2)
3516-18	E1364 (2)
4364-2	E1410 (2)
4360-16	E946 (2)
4360-17	E947 (1)
4360-18	E947 (2)
4765-17	E2165 (1)
5298-17	2180-1

Complete the procedure in the order in which the steps are listed.

## Symptom Troubleshooting

Table 114

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Determine the Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Download the "Warranty Report" from the ECM before troubleshooting or clearing any diagnostic trouble codes.</p> <p><b>C.</b> Determine the diagnostic trouble code that is active.</p>	Diagnostic trouble code	<p><b>Result:</b> An associated code is active or logged. Refer to Table 113 .</p> <p><b>Note:</b> Troubleshoot associated codes before continuing with this procedure.</p> <p>Refer to Troubleshooting, "Diagnostic Trouble Codes" and Troubleshooting, "Event Codes" for further information.</p> <p><b>Result:</b> A 7105-31 (E1585 (2)) code is active or logged.</p> <p>Proceed to Test Step 15.</p> <p><b>Result:</b> A 4364-18 (E1309 (2)) code is active or logged.</p> <p>Proceed to Test Step 3.</p>

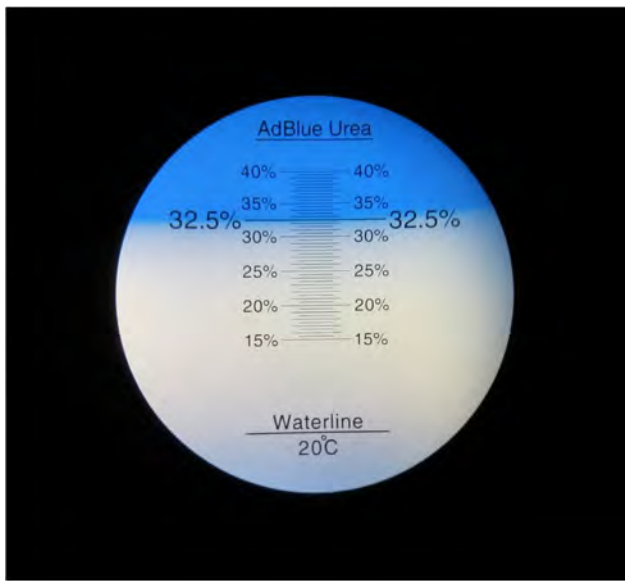


Illustration 71 g03370573  
Typical refractometer reading for DEF in good condition

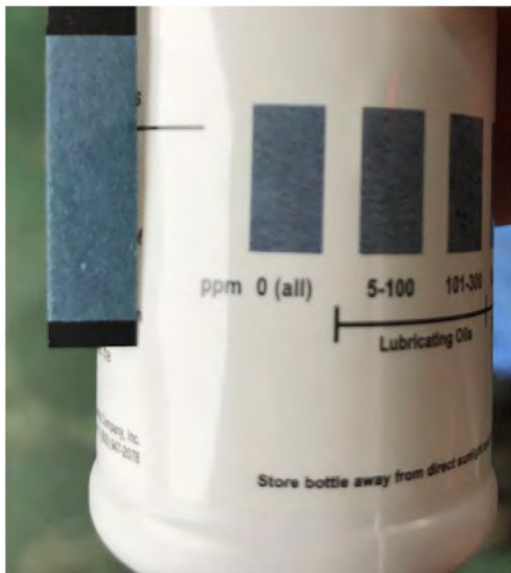


Illustration 72 g06549965  
Typical example of a good test strip result

Table 115

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the DEF Quality</b></p> <p><b>A.</b> Use Tooling A to measure the Diesel Exhaust Fluid (DEF) quality.</p> <p><b>B.</b> Use Tooling D to measure the DEF hydrocarbon contamination level.</p> <p>Refer to Systems Operation, Testing and Adjusting, "Diesel Exhaust Fluid Quality - Test" for the correct procedure.</p> <p>Refer to Illustration 71 for an example of a good refractometer result. Refer to Illustration 72 for an example of a good test strip result.</p>	<p>DEF quality standards</p>	<p><b>Result:</b> The DEF quality is within the acceptable range, the DEF is free from hydrocarbons and a 4364-18 (E1309 (2)) code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The DEF quality is not within the acceptable range or Tooling D has indicated the presence of hydrocarbon contamination.</p> <p><b>Repair:</b> Drain the DEF fluid from the tank. Refill the tank with DEF that meets ISO 22241 quality standards. Refer to Operation and Maintenance Manual, "Diesel Exhaust Fluid Tank - Flush" for the correct procedure.</p> <p>Proceed to Test Step 11.</p>

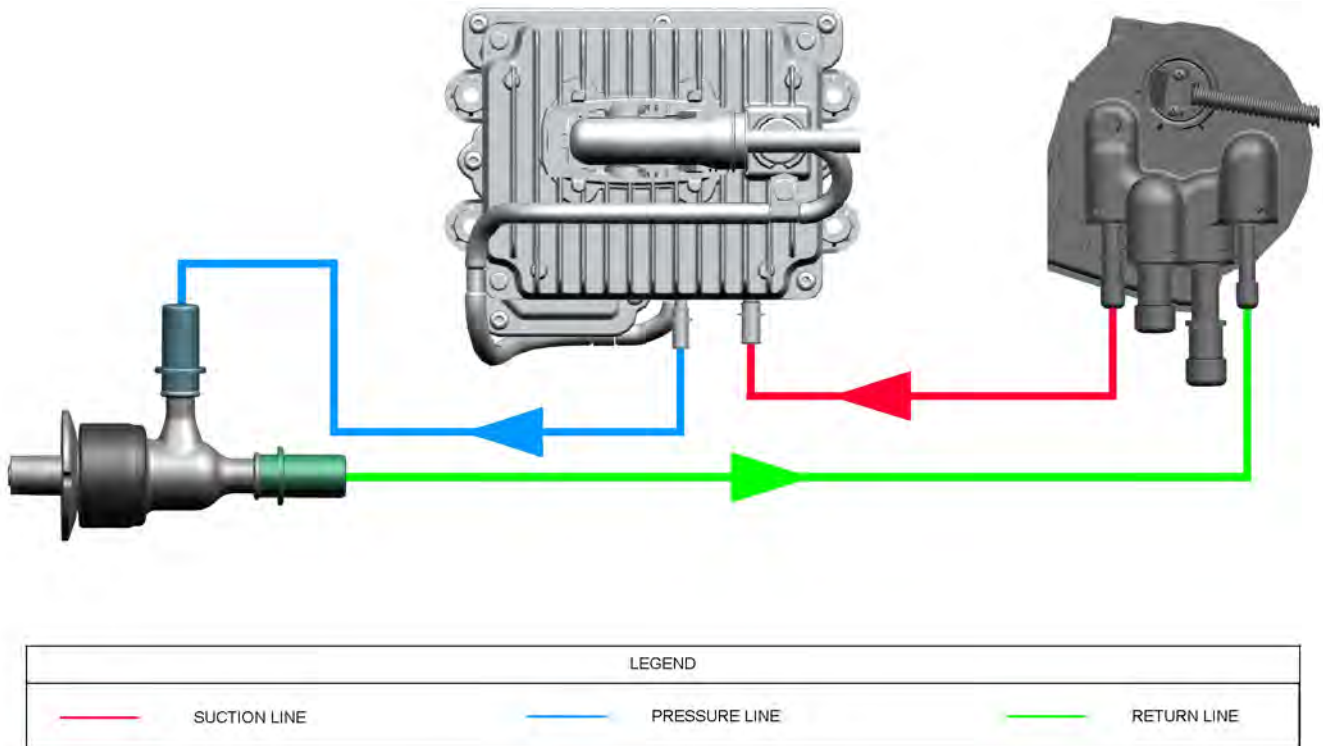


Illustration 73  
DEF line routing between components

g06179695



Table 116

Troubleshooting Test Steps	Values	Results
<p><b>4. Inspect All the DEF Lines and the DEF Injector</b></p> <p><b>A.</b> Ensure that all DEF lines are correctly connected to the DEF tank header, the DEF pump, and the DEF Injector. Refer to Illustration 73 for the correct connections.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool to perform the “DEF Dosing Verification Test” to pressurize the system. Refer to Troubleshooting, “Service Tool Features” for more information.</p> <p><b>D.</b> Visually inspect all DEF lines from the DEF tank to the DEF injector. Look for pinched, damaged, or disconnected lines.</p> <p><b>E.</b> Inspect the lines for leakage.</p> <p><b>F.</b> Inspect the DEF injector for external leaks and leakage through the electrical connector.</p> <p><b>G.</b> Turn the keyswitch to the OFF position.</p>	Leaks	<p><b>Result:</b> The lines are not connected correctly.</p> <p><b>Repair:</b> Install new DEF lines in the correct positions.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> The lines are leaking, damaged, pinched, or disconnected.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> The DEF injector is leaking externally.</p> <p>Install a replacement DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> The lines are not leaking, damaged, pinched, or disconnected. The DEF injector is not leaking. All DEF lines are correctly connected.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check for Exhaust Leaks</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Check the exhaust system for leaks or damage.</p> <p><b>C.</b> Check all exhaust connections from the turbo outlet to the SCR outlet (tailpipe outlet).</p> <p><b>D.</b> Check for damage to the exhaust system insulation.</p>	Leaks	<p><b>Result:</b> Exhaust leaks are found.</p> <p><b>Repair:</b> Repair or replace the component that is causing an exhaust leak.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> There were no exhaust leaks found.</p> <p>Proceed to Test Step 6.</p>



Illustration 74 g06550303  
Example of a DEF injector dripping during the prime phase



Illustration 76 g06550349  
Example of a good injector spray pattern



Illustration 75 g06550304  
Example of the DEF dosed quantity



Illustration 77 g06550358  
Example of a poor DEF injector spray pattern

Table 117

Troubleshooting Test Steps	Values	Results
<p><b>6. Perform a DEF Dosing System Accuracy Test by Volume</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove the DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p><b>Note:</b> Leave all lines connected to the DEF injector.</p> <p><b>C.</b> Install the DEF injector into Tooling B and Tooling C.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Connect to the electronic service tool.</p> <p><b>F.</b> Perform the “DEF Dosing System Accuracy Test” . Refer to Systems Operation, Testing and Adjusting, Aftertreatment SCR System Dosing Test for the correct procedure.</p> <p><b>Note:</b> This test takes approximately 7 to 8 minutes and includes the following phases:</p> <ul style="list-style-type: none"> <li>• Priming of the DEF system.</li> <li>• The dosing test which will take 6 minutes.</li> <li>• Purging of the DEF system.</li> </ul> <p>The test may need to be performed at least twice as the first test may be required to clear DEF deposits from the DEF injector tip.</p> <p>If the test only runs for 1 minute, repeat the test a further 5 times.</p> <p>Check for evidence of DEF injector drips during prime phase, the quantity of DEF dosed into the container and the DEF injector spray pattern during dosing phase.</p> <p>Refer to Illustration 74 for an example of the DEF injector dripping during the prime phase.</p> <p>Refer to Illustration 75 for an example of the DEF dosed quantity.</p> <p>Refer to Illustration 76 for an example of a good DEF injector spray pattern.</p> <p>Refer to Illustration 77 for an example of a poor DEF injector spray pattern.</p>	<p>105 mL (3.6 fl oz) to 130 mL (4.4 fl oz)</p>	<p><b>Result:</b> The amount of DEF collected was less than 105 mL (3.6 fl oz) and/or the DEF Injector was observed to drip during the priming phase of the test sequence, <b>or</b> DEF Injector Spray pattern was not even.</p> <p><b>Repair:</b> Install a new DEF injector to the DEF lines and the electrical connector. Do not install the DEF injector to the SCR mixer at this stage. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p>Proceed to Test Step 10.</p> <p><b>Result:</b> The amount of DEF collected is within 105 mL (3.6 fl oz) to 130 mL (4.4 fl oz).</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the Electrical Connectors</b></p> <p><b>A.</b> Thoroughly inspect the connectors that are associated with the CAN C data link circuit. Verify that the connectors are free of debris, free of corrosion, and securely connected.</p> <p><b>B.</b> Perform a 45 N (10 lb) pull test on all the wires associated with the CAN C data link circuit.</p>	<p>Electrical connectors</p>	<p><b>Result:</b> The connectors were connected correctly and did not have corrosion or moisture.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The connectors were not connected correctly or the connectors have corrosion or moisture.</p> <p><b>Repair:</b> Repair the connectors and/or the wiring. Replace parts, if necessary. <b>The DCU connector is not serviceable.</b></p> <p>Proceed to Test Step 10.</p>

(continued)

Symptom Troubleshooting

(Table 117, contd)

Troubleshooting Test Steps	Values	Results
<p><b>8. Check the Wires for Damage to the Insulation</b></p> <p><b>A.</b> Carefully inspect each wire for signs of abrasion, nicks, and cuts. Inspect the wires for the following conditions:</p> <ul style="list-style-type: none"> <li>• Exposed insulation</li> <li>• Rubbing of a wire against the engine</li> <li>• Rubbing of a wire against a sharp edge</li> </ul> <p><b>B.</b> Check all the fasteners for the harness and the strain relief components on the ECM to verify that the harness is correctly secured. Also check all the fasteners to verify that the harness is not compressed. Pull back the harness sleeves to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This condition damages the wires that are inside the harness.</p>	<p>Wire Insulation</p>	<p><b>Result:</b> There is damage to the harness.</p> <p><b>Repair:</b> Replace the harness. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p>Proceed to Test Step 9.</p> <p><b>Result:</b> The wires are free of abrasion, nicks, and cuts and the harness is correctly clamped.</p> <p>Proceed to Test Step 9.</p>



Illustration 78

g06550819

Typical view of a NOx sensor and control module

Table 118

Troubleshooting Test Steps	Values	Results
<p><b>9. Inspect the Inlet and Outlet NOx Sensors and the Ammonia Sensor (If Equipped)</b></p> <p><b>A.</b> Remove the suspect NOx sensor or ammonia sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>B.</b> Inspect the removed sensor for visible damage.</p>	<p>Sensor damage</p>	<p><b>Result:</b> The removed sensor is damaged.</p> <p><b>Repair:</b> Install a replacement sensor. Refer to Disassembly and Assembly for the correct procedure. Proceed to Test Step 10.</p> <p><b>Result:</b> The removed sensor is not damaged.</p> <p><b>Repair:</b> Clean the sensor using only a soft brush.  <b>Note:</b> Do not use abrasive materials or fluids to clean the sensor.</p> <p>Reinstall the sensor. Refer to Disassembly and Assembly for the correct procedure. Proceed to Test Step 10.</p>



Illustration 79 g06550823  
 Typical example of DEF deposits in the Selective Catalytic Reduction (SCR) mixer



Illustration 80 g06550824  
 Typical example of DEF deposits in the SCR mixer



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Illustration 81

g06550826

Typical example of a clear SCR mixer

Table 119

Troubleshooting Test Steps	Values	Results
<p><b>10. Perform the Aftertreatment Recovery Procedure</b></p> <p><b>A.</b> Use Tooling E to inspect the interior of the SCR mixer of the Clean Emissions Module (CEM) for blockage caused by deposits. Remove the DEF Injector to gain access. Refer to Illustration 79 and Illustration 80 for examples of deposits/blockage in the SCR mixer. Refer to Illustration 81 for an example of a clear mixer. Reinstall the DEF injector to the SCR mixer after this check is complete.</p> <p>Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>Note:</b> During the following step, there are two versions of the “Aftertreatment Recovery Procedure” . One version is for engines with a Diesel Particulate Filter (DPF). The other version is for engines without a DPF. Ensure that the correct procedure is used.</p> <p><b>C.</b> Perform the “Aftertreatment Recovery Procedure” .</p> <p><b>Note:</b> The “Aftertreatment Recovery Procedure” may need to be repeated up 3 times if deposits were observed in the SCR mixer to ensure that all deposits are removed from the system. If no deposits are observed in the SCR mixer, only perform the “Aftertreatment Recovery Procedure” once.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p>	<p>Test successful</p>	<p><b>Result:</b> The “Aftertreatment Recovery Procedure” completed successfully and no further evidence of deposits in the SCR mixer.</p> <p>Proceed to Test Step 11.</p> <p><b>Result:</b> The “Aftertreatment Recovery Procedure” was not successful.</p> <p>Contact the Dealer Solutions Network (DSN). Provide a full Product Status Report (PSR) with histograms and the regeneration history.</p>
<p><b>11. Perform an “Aftertreatment System Functional Test”</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Use the electronic service tool to perform the “Aftertreatment System Functional Test”</p>	<p>Test successful</p>	<p><b>Result:</b> The test completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> A 4364-18 (E1309 (2)) with no ETI is active.</p> <p>Proceed to Test Step 10.</p> <p><b>Result:</b> A 4364-18 (E1309 (2)) with an ETI code of 1 is active.</p> <p>Proceed to Test Step 12.</p>

(continued)

## Symptom Troubleshooting

(Table 119, contd)

Troubleshooting Test Steps	Values	Results
<p><b>12. Check the Coolant Level</b></p> <p><b>A.</b> Check the coolant level in the engine cooling system. Refer to Operation and Maintenance Manual, Coolant Level - Check.</p>	Coolant level	<p><b>Result:</b> The coolant level is low and a leak is identified.</p> <p><b>Repair:</b> Repair the coolant leak and fill the coolant system to the correct level.</p> <p><b>Result:</b> The coolant level is low and no leaks are identified.</p> <p><b>Repair:</b> Fill the coolant system to the correct level.</p> <p><b>Result:</b> The coolant level is correct.</p> <p>Proceed to Test Step 13.</p>
<p><b>13. Inspect the NOX Reduction System (NRS) Cooler</b></p> <p><b>A.</b> Perform a leak test on the NRS cooler. Refer to Systems Operation, Testing and Adjusting, Exhaust Cooler (NRS) - Test.</p>	NRS cooler leak	<p><b>Result:</b> An internal leak is identified in the NRS cooler.</p> <p><b>Repair:</b> Install a replacement NRS cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install.</p> <p>Use the electronic service tool to perform the "Aftertreatment System Functional Test" .</p> <p>If the "Aftertreatment System Functional Test" is successful, return the unit to service.</p> <p>If the "Aftertreatment System Functional Test" fails, contact the DSN.</p> <p>The NRS cooler does not have any internal leaks and the fault is still present.</p> <p>Proceed to Test Step 14.</p>
<p><b>14. Perform the "Air System Motor Valves Verification Test"</b></p> <p><b>A.</b> Operate the engine for enough time to allow the engine to reach normal operating temperature.</p> <p><b>B.</b> Use the electronic service tool to perform the "Air System Motor Valves Verification Test" .</p>	Test passed	<p><b>Result:</b> The "Air System Motor Valves Verification Test" is successful.</p> <p>Return the engine to service.</p> <p><b>Result:</b> An E1263 (2) or E1121 (2) code is still active, replace the suspect valve. Refer to Disassembly and Assembly for more information.</p> <p>If a fault is still present, contact the DSN.</p>
<p><b>15. Check the Compatibility of the NOx Sensors</b></p> <p><b>A.</b> Check for correct part numbers of both the Tailpipe Out and Engine Out NOx sensors that are fitted.</p>	NOx sensors	<p><b>Result:</b> The NOx sensors are not an approved part.</p> <p><b>Repair:</b> Replace the NOx sensors with approved parts.</p> <p><b>Result:</b> The NOx sensors are an approved part and the fault is still present.</p> <p>Contact the DSN.</p>



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## NRS Exhaust Gas Temperature Is High

This procedure covers the following diagnostic trouble codes:

Table 120

Diagnostic Codes for NRS Exhaust Gas Temperature Is High			
J1939 Code	PDL Code	Description (code descriptions may vary)	Notes
412-15	E1092 (1)	Engine Exhaust Gas Recirculation Temperature : High - least severe	<p><b>Engines equipped with a Diesel Particulate Filter (DPF) :</b> The exhaust gas temperature in the NRS has reached 178° C (352° F) for 8 seconds.</p> <p><b>Engines not equipped with a DPF :</b> The exhaust gas temperature in the NRS has reached 198° C (388° F) for 8 seconds.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 180 seconds.</p> <p>There are no electrical faults on the circuit.</p>
412-16	E1092 (2)	Engine Exhaust Gas Recirculation Temperature : High - moderate severity	<p><b>Engines equipped with a DPF :</b> The exhaust gas temperature in the NRS has reached 180° C (356° F) for 8 seconds.</p> <p><b>Engines not equipped with a DPF :</b> The exhaust gas temperature in the NRS has reached 190° C (374° F) for 8 seconds.</p> <p>The engine will be derated.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 180 seconds.</p> <p>There are no electrical faults on the circuit.</p>

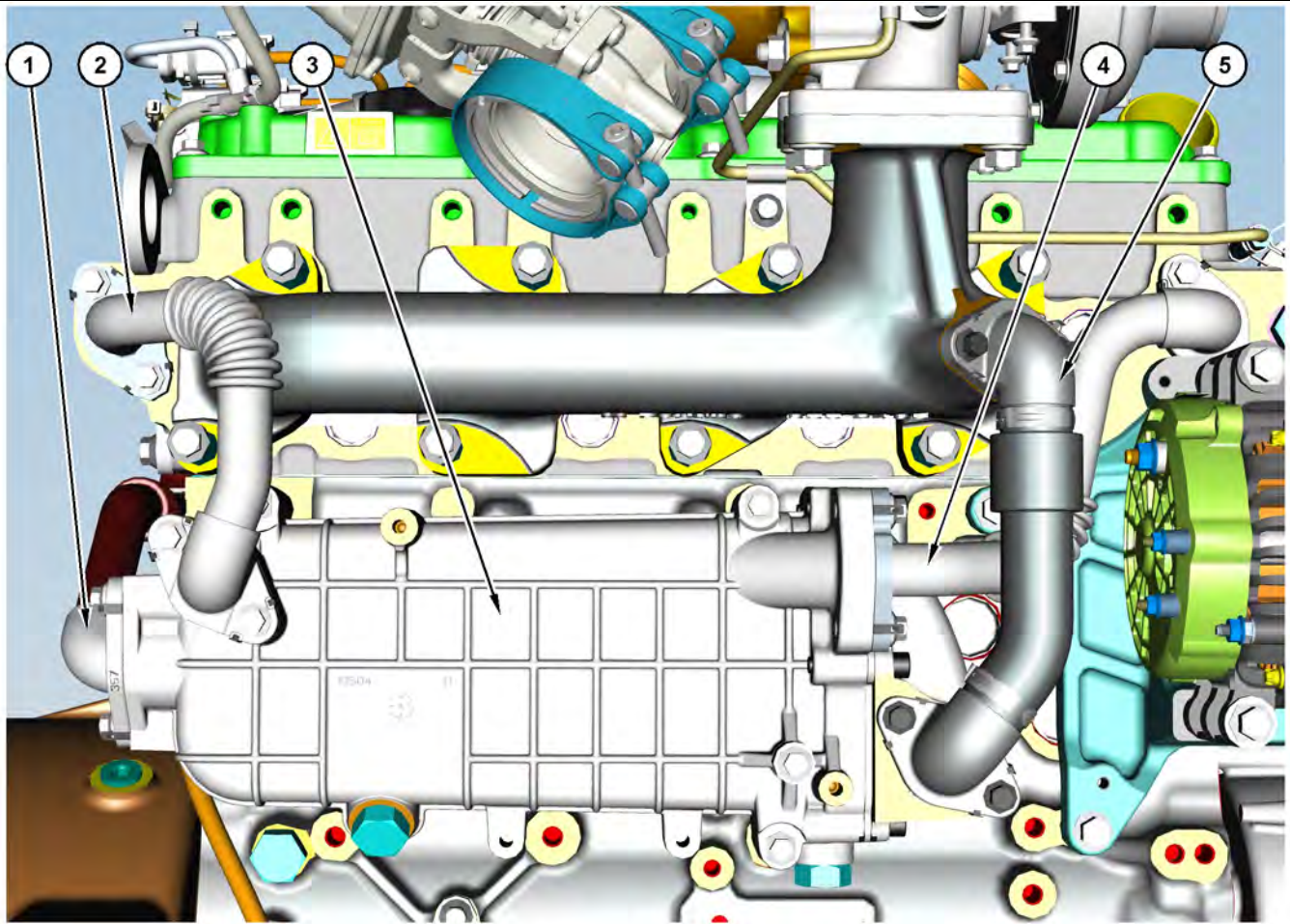


Illustration 82

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Components of the NRS cooler

- (1) NRS Exhaust outlet pipe
- (2) Coolant inlet pipe
- (3) NRS cooler
- (4) Coolant outlet pipe
- (5) NRS Exhaust inlet pipe

Table 121

Associated Codes		
J1939 Code	PDL Code	Description (code descriptions may vary)
110-15	E361 (1)	Engine Coolant Temperature : High - least severe
110-16	E361 (2)	Engine Coolant Temperature : High - moderate severity
110-0	E361 (3)	Engine Coolant Temperature : High - most severe

**Recommended Actions**

**NOTICE**

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

**Probable Causes**

- Diagnostic codes
- Coolant leak or low coolant level
- NRS cooler

Table 122

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Download the Warranty Report and the Product Status Report with Histograms before troubleshooting or clearing any diagnostic codes.</p> <p><b>Note:</b> The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed.</p> <p><b>B.</b> Use the electronic service tool to check for active or logged codes.</p>	Diagnostic codes	<p><b>Result:</b> A 412-X (E1092) code and a 110-X (E361) code are present.</p> <p><b>Repair:</b> Rectify the 110-X (E361) code. Refer to Troubleshooting, "Coolant Temperature Is High".</p> <p><b>Result:</b> A 412-X (E1092) code is present.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check Coolant Level</b></p> <p><b>A.</b> Check the coolant level. Refer to the Operation and Maintenance Manual, Coolant Level - Check.</p>	Coolant level	<p><b>Result:</b> The coolant level is low or a leak is identified.</p> <p><b>Repair:</b> Repair the coolant leak and replenish the coolant system.</p> <p><b>Result:</b> The coolant level is correct.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Inspect the NRS Cooler for Leaks</b></p> <p>Refer to Illustration 82 .</p> <p><b>A.</b> Perform a leak test on the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, "Exhaust Cooler (NRS) - Test".</p>	NRS cooler	<p><b>Result:</b> The NRS cooler has internal leakage.</p> <p><b>Repair:</b> Replace the NRS cooler. Refer to Disassembly and Assembly, "Exhaust Cooler (NRS) - Remove and Install".</p> <p>Use the electronic service tool to clear all related diagnostic codes and then run the engine and ensure that the fault has been eliminated.</p> <p><b>Result:</b> The NRS cooler has no internal leakage. The fault is still present.</p> <p><b>Engines not equipped with a DPF :</b> Replace the NRS cooler. Refer to Disassembly and Assembly, "Exhaust Cooler (NRS) - Remove and Install".</p> <p><b>Engines equipped with a DPF :</b> Contact the Dealer Solutions Network (DSN).</p>

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## NRS Mass Flow Rate Problem

This procedure covers the following diagnostic trouble code:

## Symptom Troubleshooting

Table 123

<b>Diagnostic Trouble Code for NRS Mass Flow Rate Problem</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description</b>	<b>Comments</b>
2659-7	E1319 (2)	Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	Actual mass flow through the NOx Reduction System (NRS) does not match the desired mass flow. The Electronic Control Module (ECM) has been powered for at least 2 seconds. The engine is running. There are no active codes for the 5 VDC supply. There are no active 27, 157, 411, 1188, 2791, 3358 or 3563 codes. 412-3 or 412-4 codes are not active.



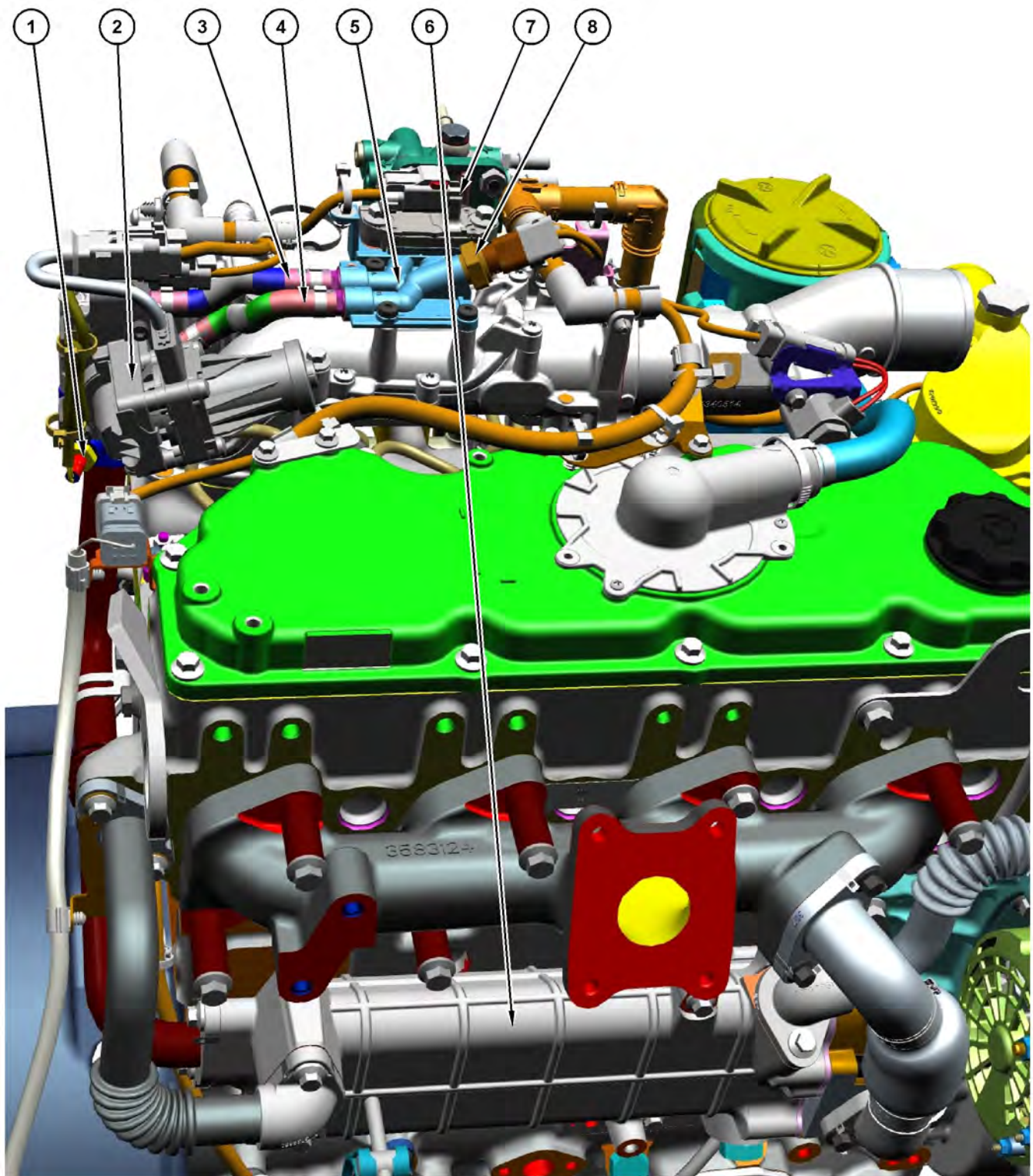


Illustration 83

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- (1) NRS inlet temperature sensor
- (2) NRS mixer
- (3) Pipe for the NRS differential pressure sensor

- (4) Pipe for the NRS inlet pressure sensor
- (5) Manifold for the NRS pressure sensors
- (6) NRS cooler
- (7) NRS differential pressure sensor

- (8) NRS inlet pressure sensor

Table 124

Associated Codes	
J1939 Code	CDL Code
412-15	E1092 (1)
412-16	E1092 (2)

## Probable Causes

- Diagnostic codes
- Electrical connectors and harness
- Air inlet and exhaust system
- NRS inlet pressure sensor and sensor pipes
- NRS temperature sensor
- NRS mixer
- NRS cooler

## Recommended Actions

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### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

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**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 125

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Use the electronic service tool to check for active or logged codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> An associated code is active or logged.</p> <p><b>Repair:</b> Troubleshoot associated codes before continuing with this procedure. Refer to Troubleshooting, Event Codes for further information.</p> <p><b>Result:</b> A diagnostic code for the NRS valve is active or logged.</p> <p><b>Repair:</b> Rectify the NRS valve code. Refer to Troubleshooting, "Motorized Valve - Test".</p> <p><b>Result:</b> A 2659-7 (E1319 (2)) code is active with no ETI code active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 2659-7 (E1319 (2)) code is active with an ETI code of 1 active.</p> <p>Proceed to Test Step 7.</p>
<p><b>2. Inspect the Electrical Connectors and the Harness</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the connectors for the components in the NRS system. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in any suspect connector and the connections at the ECM.</p> <p><b>D.</b> Check that the ground connection on the ECM and the negative terminal on the battery are correctly installed.</p> <p><b>E.</b> Check the ground connection on the ECM for abrasions and pinch points.</p> <p><b>F.</b> Check the screws for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>G.</b> Check the harness for abrasion and pinch points from the NRS components to the ECM.</p> <p><b>H.</b> Check that any suspect connector is installed correctly.</p>	<p>Connectors and harness</p>	<p><b>Result:</b> An electrical connector or a cable is not correctly installed.</p> <p><b>Repair:</b> Install the connector or cable correctly.</p> <p><b>Result:</b> The harness is faulty.</p> <p>Install a replacement harness.</p> <p><b>Result:</b> The harness and connectors are OK.</p> <p>Proceed to Test Step 3.</p>

(continued)

## Symptom Troubleshooting

(Table 125, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Air Inlet and Exhaust System</b></p> <p><b>A.</b> Check the air inlet system for leaks and for restrictions.</p> <p><b>B.</b> Check the exhaust system for leaks and for restrictions.</p> <p><b>C.</b> Test the exhaust back pressure regulator. Refer to Troubleshooting, "Motorized Valve - Test".</p>	Air inlet and exhaust system	<p><b>Result:</b> The air inlet system has a leak or is restricted.</p> <p><b>Repair:</b> Clear any restrictions in the air inlet system.</p> <p>Repair any air leaks in the air inlet system.</p> <p><b>Result:</b> The exhaust system has a leak or is restricted.</p> <p><b>Repair:</b> Clear any restrictions in the exhaust system.</p> <p>Repair any air leaks in the exhaust system.</p> <p>If the fault is still present, proceed to Test Step 4.</p>
<p><b>4. Check the NRS Inlet Pressure Sensor and Sensor Pipes</b></p> <p>Refer to Illustration 83 .</p> <p><b>A.</b> Check pipe (4) for the NRS inlet pressure sensor for leaks, restrictions, or blockage.</p> <p><b>B.</b> Check pipe (3) for the NRS differential pressure sensor for leaks or any restriction.</p> <p><b>C.</b> Test the exhaust back pressure regulator. Refer to Troubleshooting, "Motorized Valve - Test".</p>	Pressure sensor and pipes	<p><b>Result:</b> There is a leak, a restriction, or a blockage in one of the sensor pipes.</p> <p><b>Repair:</b> If a pipe has a leak or a restriction, replace the pipe.</p> <p>If a pipe is blocked with soot or condensates, remove the pipe and clear the blockage with an air line that is set at a maximum pressure of 200 kPa (29 psi). If the blockage is cleared, install the pipe. If the blockage cannot be cleared, replace the pipe.</p> <p><b>Result:</b> The NRS inlet pressure sensor is blocked.</p> <p><b>Repair:</b> Replace the NRS inlet pressure sensor.</p> <p><b>Result:</b> There are no leaks, restrictions, or blockages in the sensor or the pipes.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the NRS Temperature Sensor</b></p> <p>Refer to Illustration 83 .</p> <p><b>A.</b> Remove temperature sensor (1) from NRS mixer (2). Refer to Disassembly and Assembly, "Temperature Sensor (Cooled Exhaust Gas) - Remove and Install".</p> <p><b>B.</b> Check the sensor probe for excessive deposits.</p> <p><b>C.</b> Test the exhaust back pressure regulator. Refer to Troubleshooting, "Motorized Valve - Test".</p>	Temperature sensor	<p><b>Result:</b> The probe on the temperature sensor has excessive deposits.</p> <p><b>Repair:</b> Carefully remove the deposits from the sensor probe. Make sure that the sensor probe is not damaged.</p> <p>If the deposits cannot be easily removed, replace the temperature sensor. Refer to Disassembly and Assembly, "Temperature Sensor (Cooled Exhaust Gas) - Remove and Install".</p> <p><b>Result:</b> The probe on the temperature sensor does not have excessive deposits.</p> <p>Proceed to Test Step 6.</p>

(continued)



(Table 125, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Inspect the NRS Mixer</b></p> <p><b>A.</b> Inspect the NRS mixer for cracks, holes, or damage.</p>	NRS mixer	<p><b>Result:</b> The NRS mixer is defective.</p> <p><b>Repair:</b> Replace the NRS mixer. Refer to Disassembly and Assembly, "Inlet Air Control - Remove" and Disassembly and Assembly, "Inlet Air Control - Install".</p> <p><b>Result:</b> There are no visible faults on the NRS mixer.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Check the Coolant Level</b></p> <p><b>A.</b> Check the coolant level.</p> <p><b>B.</b> Check for leaks from the coolant system.</p>	Coolant level	<p><b>Result :</b> The coolant level is low or a coolant leak is identified.</p> <p>Rectify any coolant leaks and fill the coolant system to the correct level.</p> <p><b>Result :</b> The coolant level is normal and there are no coolant leaks.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Inspect the NRS Cooler</b></p> <p><b>A.</b> Perform a leak test on the NRS cooler. Refer to System Operation, Testing, Adjusting, Exhaust Cooler (NRS) - Test.</p>	NRS cooler	<p><b>Result :</b> The NRS Cooler has internal leakage or fouling.</p> <p><b>Repair:</b> Replace the NRS Cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install.</p> <p><b>Result :</b> The NRS Cooler has no internal leakage or fouling. The fault is still present.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Oil Consumption Is Excessive

### Probable Causes

- Misreading oil level
- Oil leaks
- Engine crankcase breather
- Oil level
- Air intake and exhaust system
- Turbocharger or turbochargers
- Low compression (cylinder pressure)

## Symptom Troubleshooting

Table 126

Troubleshooting Test Steps	Values	Results
<p><b>1. Misreading Oil Level</b></p> <p><b>A.</b> Accurately measure the consumption of oil and fuel over a period of 50 engine hours.</p>	Oil level	<p><b>Result:</b> The oil consumption is less than 0.08% of the fuel consumption.</p> <p>Oil consumption is within specification. Return the unit to service</p> <p><b>Result:</b> The oil consumption is greater than 0.08% of the fuel consumption.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Oil Leaks</b></p> <p><b>A.</b> Check for evidence of oil leaks on the engine.</p> <p><b>B.</b> Check for evidence of oil in the coolant.</p>	Oil leaks	<p><b>Result:</b> An oil leak is identified.</p> <p><b>Repair:</b> Rectify the cause of the oil leak.</p> <p><b>Result:</b> Oil is present in the coolant.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Coolant Contains Oil".</p> <p>No oil leaks are identified</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Engine Crankcase Breather</b></p> <p><b>A.</b> Check the engine crankcase breather for blockage or restrictions.</p> <p><b>B.</b> Check for excessive oil from the outlet of the breather.</p>	Breather	<p><b>Result:</b> The engine crankcase breather is blocked or restricted.</p> <p><b>Repair:</b> Clear the blockage or restriction.</p> <p><b>Result:</b> Excessive oil is ejected from the outlet of the breather.</p> <p><b>Repair:</b> Investigate the cause of the excessive oil content in the breather flow. If the breather filter element is saturated with oil, replace the filter.</p> <p><b>Result:</b> No oil is ejected through the breather.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Oil Level</b></p> <p><b>A.</b> Check for a high oil level in the engine.</p>	Oil level	<p><b>Result:</b> The oil level in the engine is high.</p> <p><b>Repair:</b> Make sure that the oil is not contaminated with fuel. Refer to Troubleshooting, "Oil Contains Fuel".</p> <p>Make sure that the oil is not contaminated with coolant. Refer to Troubleshooting, "Oil Contains Coolant".</p> <p>Remove the excess oil.</p> <p><b>Result:</b> The oil level is OK.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 126, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Air Intake and Exhaust System</b></p> <p><b>A.</b> Check the air filter restriction indicator, if equipped.</p> <p>Check the air intake and the exhaust system for the following defects:</p> <ul style="list-style-type: none"> <li>· Signs of dirt ingress</li> <li>· Blockages</li> <li>· Restrictions</li> <li>· Damage to the air intake and exhaust lines and hose</li> </ul>	<p>Air intake and exhaust system</p>	<p><b>Result:</b> The air filter restriction indicator has operated or the air filter is blocked.</p> <p><b>Repair:</b> Make sure that the air filter is clean and serviceable. If necessary, replace the air filter.</p> <p><b>Result:</b> The air intake or the exhaust system is blocked, restricted, or damaged.</p> <p><b>Repair:</b> Repair the air intake or the exhaust system, as required.</p> <p><b>Result:</b> The air intake or the exhaust system is OK.</p> <p>For engines that have a single turbocharger, proceed to Test Step 6.</p> <p>For engines that have two turbochargers, proceed to Test Step 7.</p>
<p><b>6. Turbocharger</b></p> <p><b>Note:</b> This step is only applicable to engines that have a single turbocharger.</p> <p><b>Note:</b> The turbocharger that is installed on this engine is a non-serviceable item. If any mechanical fault exists, then the turbocharger must be replaced.</p> <p><b>A.</b> Check that the oil drain for the turbocharger is not blocked or restricted.</p> <p><b>B.</b> Remove the turbocharger compressor outlet duct to check for evidence of a turbocharger internal oil leak.</p>	<p>Turbocharger</p>	<p><b>Result:</b> The oil drain for the turbocharger is blocked or restricted.</p> <p><b>Repair:</b> Remove the blockage or restriction. If necessary, replace the oil drain line.</p> <p><b>Result:</b> The turbocharger has an internal oil leak.</p> <p><b>Repair:</b> Replace the turbocharger. If equipped, check the front face of the Diesel Particulate Filter (DPF) for contamination with oil.</p> <p>If oil is found on the inlet face of the DPF, refer to Troubleshooting, "Exhaust System Contains Oil".</p> <p>Check that the repairs have eliminated the faults.</p> <p><b>Result:</b> The turbocharger is OK.</p> <p>Proceed to Test Step 8.</p>

(continued)

## Symptom Troubleshooting

(Table 126, contd)

Troubleshooting Test Steps	Values	Results
<p><b>7. Turbochargers</b></p> <p><b>Note:</b> This step is only applicable to engines that have two turbochargers.</p> <p><b>Note:</b> The turbochargers that are installed on this engine are non-serviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced.</p> <p><b>A.</b> Check that the oil drains for the turbochargers are not blocked or restricted.</p> <p><b>B.</b> Remove the turbocharger compressor outlet ducts to check for evidence of a turbocharger internal oil leak.</p>	Turbochargers	<p><b>Result:</b> The oil drain for a turbocharger is blocked or restricted.</p> <p><b>Repair:</b> Remove the blockage or restriction. If necessary, replace the oil drain line.</p> <p><b>Result:</b> A turbocharger has an internal oil leak.</p> <p><b>Repair:</b> Replace the faulty turbocharger. If equipped, check the front face of the Diesel Particulate Filter (DPF) for contamination with oil.</p> <p>If oil is found on the inlet face of the DPF, refer to Troubleshooting, "Exhaust System Contains Oil".</p> <p>Check that the repairs have eliminated the faults.</p> <p><b>Result:</b> The turbochargers are OK.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Low Compression (Cylinder Pressure)</b></p> <p><b>A.</b> Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".</p>	Cylinder compression	<p><b>Result:</b> The results of the compression test are outside the specifications.</p> <p><b>Repair:</b> Investigate the cause and rectify any faults.</p> <p><b>Note:</b> Possible causes of low compression are shown in the following list:</p> <ul style="list-style-type: none"> <li>· Loose glow plugs</li> <li>· Worn piston</li> <li>· Worn piston rings</li> <li>· Worn cylinder bores</li> <li>· Worn valves</li> <li>· Faulty cylinder head gasket</li> <li>· Damaged cylinder head</li> </ul> <p><b>Result:</b> The results of the compression test are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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**Recommended Actions**

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

**Oil Contains Coolant****Probable Causes**

- Engine oil cooler
- Engine water pump
- Cylinder head and gasket
- Cylinder block

Table 127

Troubleshooting Test Steps	Values	Results
<p><b>1. Engine Oil Cooler</b></p> <p><b>A.</b> Drain the engine lubricating oil and coolant from the engine.</p> <p><b>B.</b> Inspect the oil cooler for signs of damage or leaks. Refer to Systems Operation, Testing and Adjusting, Engine Oil Cooler - Inspect for more information.</p>	Oil cooler	<p><b>Result:</b> There is evidence of leaks from the oil cooler or damage to the oil cooler.</p> <p><b>Repair:</b> Install a new oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove" and Disassembly and Assembly, "Engine Oil Cooler - Install" for the correct procedure.</p> <p>Refill the engine oil and coolant. Refer to Operation and Maintenance Manual for the correct procedure.</p> <p><b>Result:</b> There is no evidence of damage or leaks.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Engine Water Pump</b></p> <p><b>A.</b> Inspect the water pump for signs of damage or leaks. Refer to Systems Operation, Testing and Adjusting, Water Pump - Inspect for more information.</p>	Water pump	<p><b>Result:</b> There is evidence of leaks from the water pump or damage to the water pump.</p> <p><b>Repair:</b> Install a new water pump. Refer to Disassembly and Assembly, "Water Pump - Remove" and Disassembly and Assembly, "Water Pump - Install" for the correct procedure.</p> <p>Refill the engine oil and coolant. Refer to Operation and Maintenance Manual for the correct procedure.</p> <p><b>Result:</b> There is no evidence of damage or leaks.</p> <p>Proceed to Test Step 3.</p>

(continued)

## Symptom Troubleshooting

(Table 127, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Cylinder Head and Gasket</b></p> <p><b>A.</b> Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove" for the correct procedure. Inspect the cylinder head gasket for faults and any signs of leakage.</p> <p><b>B.</b> Check the cylinder head for flatness. Refer to Systems Operation, Testing and Adjusting, "Cylinder Head - Inspect" for the correct procedure.</p> <p><b>C.</b> Check the mating face of the cylinder head for faults and signs of leakage. If a fault is found, replace the cylinder head. If signs of leakage are found, determine the cause of the leakage. Refer to Systems Operation, Testing and Adjusting, "Cylinder Head - Inspect" for the correct procedure.</p> <p><b>D.</b> Check the internal core plugs in the cylinder head for signs of leakage.</p>	Cylinder head and gasket	<p><b>Result:</b> The cylinder head gasket is faulty or shows signs of leakage.</p> <p><b>Repair:</b> Check for faults in the corresponding areas of the cylinder head and cylinder block.</p> <p><b>Result:</b> The cylinder head is not within specification for flatness.</p> <p><b>Repair:</b> Install a new cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install" for the correct procedure.</p> <p><b>Result:</b> The cylinder head shows signs of a fault or leakage.</p> <p><b>Repair:</b> Install a new cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install" for the correct procedure.</p> <p><b>Result:</b> An internal core plug in the cylinder head shows signs of leakage.</p> <p><b>Repair:</b> Replace the faulty core plug.</p> <p><b>Result:</b> The cylinder head is OK.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Cylinder Block</b></p> <p><b>A.</b> Inspect the top face of the cylinder block for faults and signs of leakage.</p>	Cylinder block	<p><b>Result:</b> The top face of the cylinder block has a fault.</p> <p><b>Repair:</b> Replace the cylinder block.</p> <p><b>Result:</b> The top face of the cylinder block shows signs of leakage.</p> <p><b>Repair:</b> Determine the cause of the leakage. Refer to Systems Operation, Testing and Adjusting, "Cylinder Block - Inspect" for the correct procedure.</p> <p><b>Result:</b> The cylinder block is OK.</p> <p><b>Repair:</b> Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".</p> <p>Remove the oil filter element. Install a new engine oil filter element. Fill the engine with clean engine oil to the correct level. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change" for more information.</p> <p>Fill the cooling system. Refer to the Operation and Maintenance Manual for more information.</p> <p>If coolant is found in the oil again, contact the Dealer Solutions Network (DSN).</p>

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Table 128

## Oil Contains Fuel

### Measuring Fuel Dilution

Diesel fuel is chemically similar to the lubricants that are used in diesel engines. A slow fuel leak will blend the fuel into the oil. Normal operating temperatures may cause volatile parts of the fuel to vaporize. The fuel that remains in the oil is less volatile.

A closed cup flash test can be performed in order to detect fuel dilution. The flash test is designed to measure the volatile parts of the fuel that are remaining in the oil. Detecting less volatile fuel is difficult. The lack of volatility reduces the accuracy of the flash test.

**Since the flash test does not accurately detect fuel dilution, do not use the flash test as the only measure of fuel dilution.** Instead, verify the dilution by the following methods:

- Gas chromatograph fuel dilution test
- Oil viscosity

The test that uses a gas chromatograph is designed to measure fuel dilution in crankcase oils. The gas chromatograph can identify the small chemical differences between diesel fuel and lubricating oil. Even though the gas chromatograph provides a more accurate measure of fuel dilution, always verify the results with the viscosity test.

A significant level of fuel dilution reduces oil viscosity. If an unacceptable level of fuel dilution is suspected, the kinematic viscosity of the oil must be measured.

Fuel dilution that is greater than 4 percent will usually cause viscosity that is less than the specified viscosity grade. If the oil is still within the specified viscosity grade, fuel dilution is unlikely to have reached an unacceptable level. Use the following chart to determine if viscosity has reached the minimum acceptable level. The guidelines of viscosity in the chart are slightly less than the limits of the SAE viscosity grades. However, these guidelines still provide adequate engine protection.

Viscosity Grade	Minimum Oil Viscosity at 100 °C with Fuel Dilution Greater Than 4% as Measured by a Gas Chromatograph	Action
0W-40 5W-40 10W-40 15W-40	12.0 cSt	Investigate the cause of fuel dilution or reduce the engine oil change interval.
0W-30 5W-30 10W-30	9.0 cSt	

### Verifying Fuel Dilution

Always verify fuel dilution by the combination of a viscosity test and a gas chromatograph test that gives a result in excess of 4 percent.

### Probable Causes

- Fuel injector seals
- Fuel injector tip
- Shaft seal for the high-pressure fuel pump

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

#### WARNING

**Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.**

#### NOTICE

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

## Symptom Troubleshooting

Table 129

Troubleshooting Test Steps	Values	Results
<p><b>1. Fuel Injector Seals</b></p> <p><b>A.</b> Check for signs of damage to the seals for the fuel injectors.</p>	Fuel injector seals	<p><b>Result:</b> Injector seals are damaged.</p> <p><b>Repair:</b> Replace any damaged injector seals.</p> <p>Drain and refill the engine oil. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change".</p> <p><b>Result:</b> All injector seals are OK.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Fuel Injector Tip</b></p> <p><b>A.</b> Check for signs of damage to the fuel injectors. Check the fuel injector tip for cracks or breakage.</p>	Fuel injector tip	<p><b>Result:</b> A fuel injector is damaged.</p> <p><b>Repair:</b> Replace the fuel injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p>Drain and refill the engine oil. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change".</p> <p><b>Result:</b> All fuel injectors are OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Shaft Seal for the High Pressure Fuel Pump</b></p> <p><b>A.</b> Check for fuel leakage around the shaft seal for the high-pressure fuel pump.</p>	HP fuel pump shaft seal	<p><b>Result:</b> Fuel is leaking past the shaft seal for the high-pressure fuel pump.</p> <p><b>Repair:</b> There is a restriction in the return line to the fuel tank. Investigate the cause of the restriction and then repair the fuel line.</p> <p>Replace the high-pressure fuel pump. Refer to Disassembly and Assembly, "Fuel Injection Pump - Remove" and Disassembly and Assembly, "Fuel Injection Pump - Install".</p> <p>Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information.</p> <p>Replace the Transfer Pump Inlet Regulator (TPIR).</p> <p>Inspect the return pipe from the high-pressure fuel pump to the fuel tank. replace any pipes that have been damaged or distorted by hot fuel.</p> <p>Drain and refill the engine oil. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change".</p> <p><b>Result:</b> The shaft seal for the high-pressure fuel pump is OK.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>



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## Oil Level Is Low

This procedure is only applicable to engines with an oil level switch.

Use this procedure if one of the following event codes is active.

Table 130

Diagnostic Trouble Codes for Oil Level Is Low			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
98-18	E173 (2)	Engine Oil Level : Low - moderate severity (2)	The engine oil level has dropped below the level of the switch for the time specified in the ECM. The code is logged. The engine is derated.
98-1	E173 (3)	Engine Oil Level : Low - most severe (3)	The engine oil level has dropped below the level of the switch for the time specified in the ECM. The code is logged. The engine is derated and may shut down.

### Probable Causes

- Low engine oil level
- Problem with an electrical connection or with the wiring

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 131

Troubleshooting Test Steps	Values	Results
<p><b>1. Low Engine Oil Level</b></p> <p><b>A.</b> Check the engine oil level. Refer to the Operation and Maintenance Manual, "Engine Oil Level - Check".</p>	Engine oil level	<p><b>Result:</b> The engine oil level is low.</p> <p><b>Repair:</b> Add engine oil, as necessary.</p> <p>If engine oil consumption is considered excessive, refer to Troubleshooting, "Oil Consumption Is Excessive".</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Electrical Connections or Wiring</b></p> <p><b>A.</b> Inspect the electrical connectors and all of the wiring for the switch. Refer to Troubleshooting, "Electrical Connectors - Inspect" and refer to the electrical Schematic.</p>	Electrical connectors and wiring	<p><b>Result:</b> There is a fault in an electrical connection or the wiring.</p> <p><b>Repair:</b> Repair or replace the faulty item.</p> <p><b>Result:</b> The electrical connections and wiring are OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Test the Oil Level Switch</b></p> <p><b>Note:</b> The engine oil level switch must be closed in order for the engine to operate. The switch is normally open. The switch must be submerged in fluid in order to become closed.</p> <p><b>A.</b> Disconnect the switch and remove the switch.</p> <p><b>B.</b> Connect an ohmmeter to the switch terminals and measure the resistance. The correct resistance for the normally open switch is greater than 20,000 Ohms.</p> <p><b>C.</b> Continue to monitor the ohmmeter and submerge the switch in water. The correct resistance for the closed switch is less than five Ohms.</p>	Oil level switch	<p><b>Result:</b> The correct results are not obtained or if the switch does not close.</p> <p><b>Repair:</b> Replace the switch.</p> <p><b>Result:</b> The correct results are obtained and the switch closes correctly.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Oil Pressure Is Low

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### NOTICE

Do not operate the engine with low oil pressure. Engine damage will result. If measured oil pressure is low, discontinue engine operation until the fault is corrected.

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**Note:** Severe slopes can cause low oil pressure. If the machine is operated on severe slopes, the oil level in the engine crankcase must be at the "FULL" mark on the dipstick. Refer to the Operation and Maintenance Manual for details.

The Electronic Control Module (ECM) monitors the engine oil pressure. The following events are associated with low engine oil pressure:

Table 132

<b>Diagnostic Codes for Low Engine Oil Pressure</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
100-17	E360 (1)	Engine Oil Pressure : Low - least severe (1)	<p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 10 seconds.</p> <p>There are no diagnostic trouble codes for the oil pressure sensor.</p> <p>There are no diagnostic trouble codes for the 5 VDC supply.</p> <p>Refer to Illustration 84 for the trip point for the oil pressure.</p>
100-18	E360 (2)	Engine Oil Pressure : Low - moderate severity (2)	<p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 10 seconds.</p> <p>There are no diagnostic trouble codes for the oil pressure sensor.</p> <p>There are no diagnostic trouble codes for the 5 VDC supply.</p> <p>The engine will be derated.</p> <p>Refer to Illustration 85 for the trip point for the oil pressure.</p>
100-1	E360 (3)	Engine Oil Pressure : Low - most severe (3)	<p>The ECM has been powered for at least 2 seconds.</p> <p>The engine has been running for at least 10 seconds.</p> <p>There are no diagnostic trouble codes for the oil pressure sensor.</p> <p>There are no diagnostic trouble codes for the 5 VDC supply.</p> <p>The engine will be derated.</p> <p>Refer to Illustration 86 for the trip point for the oil pressure.</p>

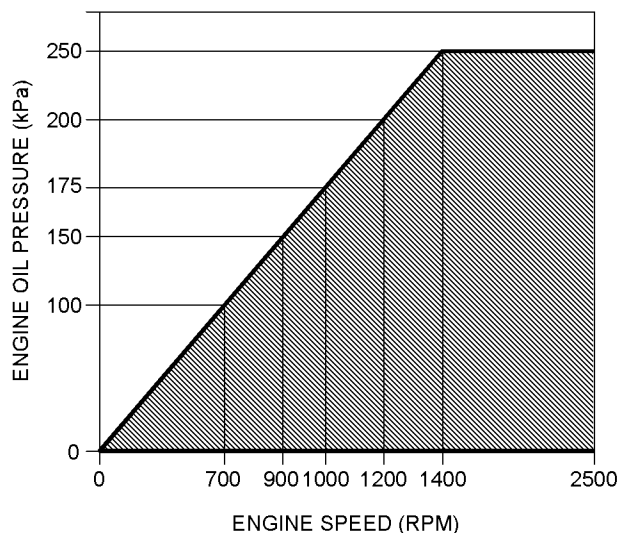


Illustration 84

g02856758

Diagnostic code 100-17 Engine Oil Pressure versus Engine Speed

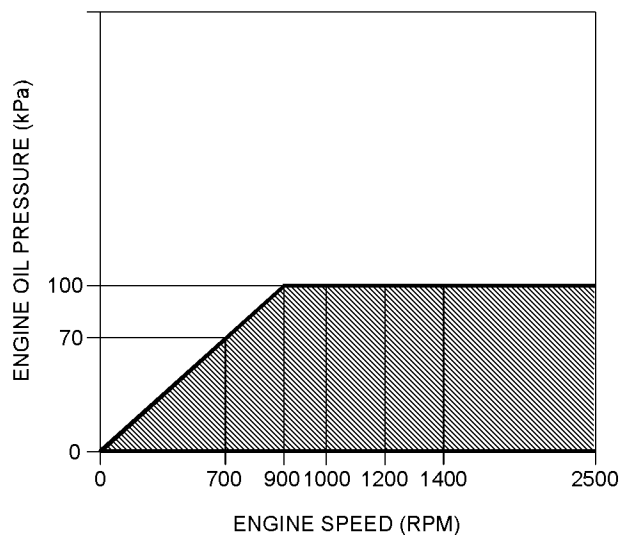


Illustration 86

g02856760

Diagnostic code 100-1 Engine Oil Pressure versus Engine Speed

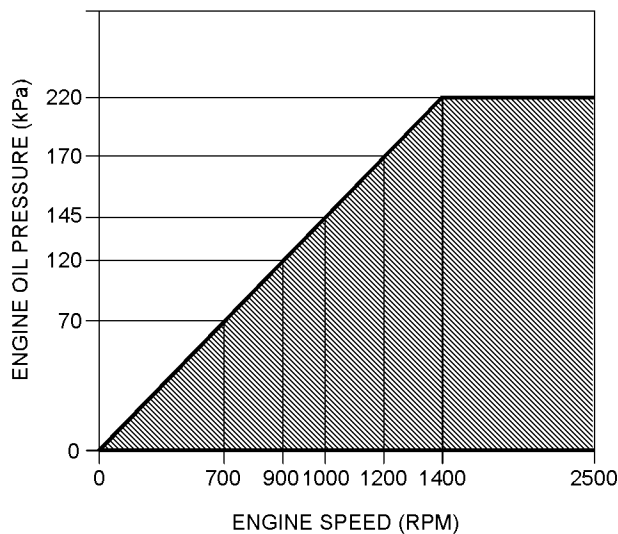


Illustration 85

g02856759

Diagnostic code 100-18 Engine Oil Pressure versus Engine Speed

## Probable Causes

- Engine oil level
- Oil specification
- Aerated oil
- Engine oil pressure
- Engine oil filter
- Engine oil cooler
- Fuel in the engine oil
- Piston cooling jets
- Engine oil suction tube
- Engine oil pump pressure relief valve
- Engine oil pump
- Bearing clearance

## Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

Table 133

Troubleshooting Test Steps	Values	Results
<p><b>1. Engine Oil Level</b></p> <p>A. Check the engine oil level.</p>	Oil level	<p><b>Result:</b> The engine oil level is low.</p> <p><b>Repair:</b> Fill the oil system to the full mark on the dipstick.</p> <p><b>Result:</b> The engine oil level is OK.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Oil Specification</b></p> <p>A. Check that engine oil of the correct specification is being used. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations".</p>	Oil specification	<p><b>Result:</b> An incorrect specification of engine oil is being used.</p> <p><b>Repair:</b> Drain the oil system and refill the oil system with engine oil of the correct specification. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".</p> <p><b>Result:</b> The engine contains oil of the correct specification.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Aerated Oil</b></p> <p>A. Sample the engine oil for aeration.</p> <p><b>Note:</b> Foamy oil on the dipstick is a good indication of aeration.</p>	Aeration	<p><b>Result:</b> The oil is aerated.</p> <p>Proceed to Test Step 9.</p> <p><b>Result:</b> The oil is not aerated.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Engine Oil Pressure</b></p> <p>A. Check the actual engine oil pressure with a calibrated test gauge. Compare the oil pressure reading from the electronic service tool to the pressure on the test gauge.</p>	Oil pressure	<p><b>Result:</b> The oil pressure reading from the electronic service tool and the pressure on the test gauge are different.</p> <p><b>Repair:</b> Install a new oil pressure transmitter. Refer to Disassembly and Assembly, "Engine Oil Pressure Sensor - Remove and Install".</p> <p><b>Result:</b> The oil pressure reading from the electronic service tool and the pressure on the test gauge are similar.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Engine Oil Filter</b></p> <p>A. Remove the engine oil filter. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change".</p> <p>B. Inspect the engine oil filter for evidence of blockage.</p>	Oil filter	<p><b>Result:</b> The oil filter is blocked.</p> <p><b>Repair:</b> Investigate the cause of the filter blockage.</p> <p>Install a new oil filter. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change" for further information.</p> <p><b>Result:</b> The oil filter is OK.</p> <p><b>Repair:</b> Install a new oil filter. Refer to the Operation and Maintenance Manual, "Engine Oil and Filter - Change" for further information.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Symptom Troubleshooting

(Table 133, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Engine Oil Cooler</b></p> <p><b>A.</b> Check the oil cooler for signs of damage or restrictions.</p>	Oil cooler	<p><b>Result:</b> The oil cooler has signs of damage or restriction.</p> <p><b>Repair:</b> Install a new oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove" and Disassembly and Assembly, "Engine Oil Cooler - Install".</p> <p><b>Result:</b> The oil cooler is OK.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Fuel in the Engine Oil</b></p> <p><b>A.</b> Check fuel contamination of the engine oil. Refer to Troubleshooting, "Oil Contains Fuel".</p>	Oil contamination	<p><b>Result:</b> The oil contains fuel.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Oil Contains Fuel".</p> <p><b>Result:</b> The oil is not contaminated.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Piston Cooling Jets</b></p> <p><b>A.</b> Inspect the piston cooling jets for cracks, damage, or missing jets.</p>	Piston cooling jets	<p><b>Result:</b> A piston cooling jet is cracked, damaged, or missing.</p> <p><b>Repair:</b> Install a new piston cooling jet. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install".</p> <p><b>Result:</b> The piston cooling jets are OK.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Engine Oil Suction Tube</b></p> <p><b>A.</b> Check the inlet screen on the oil suction tube and remove any material that may be restricting oil flow.</p> <p><b>B.</b> Check the joints of the oil suction tube for cracks or a damaged joint.</p> <p><b>Note:</b> Cracks or damage may allow air leakage into the supply to the oil pump.</p>	Oil suction tube	<p><b>Result:</b> The inlet screen on the oil suction tube is blocked with debris.</p> <p><b>Repair:</b> Remove the debris from the inlet screen. Attempt to identify the source of the debris.</p> <p><b>Result:</b> The oil suction tube is cracked.</p> <p><b>Repair:</b> Install a new oil suction tube.</p> <p><b>Result:</b> The oil suction tube is OK.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Engine Oil Pump Pressure Relief Valve</b></p> <p><b>A.</b> Inspect the components of the pressure relief valve for excessive wear or damage.</p>	Oil pump PRV	<p><b>Result:</b> A component in the pressure relief valve is not within specification.</p> <p><b>Repair:</b> Repair or replace the pressure relief valve, as necessary. Refer to Disassembly and Assembly, "Engine Oil Relief Valve - Remove and Install".</p> <p><b>Result:</b> The pressure relief valve is OK.</p> <p>Proceed to Test Step 11.</p>

(continued)

(Table 133, contd)

Troubleshooting Test Steps	Values	Results
<p><b>11. Engine Oil Pump</b></p> <p><b>A.</b> Inspect the components of the engine oil pump for excessive wear.</p>	<p>Oil pump</p>	<p><b>Result:</b> A component in the oil pump is not within specification.</p> <p><b>Repair:</b> Repair the oil pump or replace the oil pump, if necessary. Refer to Disassembly and Assembly, "Engine Oil Pump - Remove" and Disassembly and Assembly, "Engine Oil Pump - Install".</p> <p><b>Result:</b> The oil pump is OK.</p> <p>Proceed to Test Step 12.</p>
<p><b>12. Bearing Clearance</b></p> <p><b>A.</b> Inspect the engine components for excessive bearing clearance or damaged bearings. Inspect the following components for excessive bearing clearance:</p> <ul style="list-style-type: none"> <li>· Crankshaft main bearings</li> <li>· Connecting rod bearings</li> <li>· Camshaft front bearing</li> <li>· Idler gear bearing</li> </ul>	<p>Bearing clearance</p>	<p><b>Result:</b> An engine bearing is not within specification.</p> <p><b>Repair:</b> Install a new bearing. Refer to Disassembly and Assembly.</p> <p><b>Result:</b> All engine bearings are within specification.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Power Is Intermittently Low or Power Cutout Is Intermittent

**Note:** Use this procedure only if the engine does not shut down completely.

### Probable Causes

- Diagnostic codes
- Electrical connectors
- ECM connection
- Intake manifold pressure
- Fuel supply
- Transfer Pump Inlet Regulator (TPIR) flow
- Transfer Pump Inlet Regulator (TPIR) return
- Electric Fuel Lift Pump (EFLP) flow
- Return fuel lines

## Recommended Actions

### NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 134

Troubleshooting Test Steps	Values	Results
<p><b>1. Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Download the Warranty Report and the Product Status Report with Histograms before performing any troubleshooting or clearing any diagnostic codes.</p> <p><b>Note:</b> The downloaded information will be required by the Technical Communicator if troubleshooting assistance is needed.</p> <p><b>C.</b> Use the electronic service tool to check for active or logged codes.</p>	Diagnostic codes	<p><b>Result:</b> There are active or logged codes.</p> <p><b>Repair:</b> Troubleshoot any codes before continuing with this procedure.</p> <p><b>Result:</b> There are no active or logged codes.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Electrical Connectors</b></p> <p><b>A.</b> Check all electrical connectors for damage. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>B.</b> Make sure that all the connector seals are in place and that the connectors have been correctly installed.</p>	Electrical connectors	<p><b>Result:</b> An electrical connector is damaged.</p> <p><b>Repair:</b> Repair the electrical connector or replace the electrical connector.</p> <p><b>Result:</b> A connector seal is displaced or missing or an electrical connector is not correctly installed.</p> <p><b>Repair:</b> Repair the electrical connector or replace the electrical connector.</p> <p><b>Result:</b> All electrical connectors are OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. ECM Connection</b></p> <p><b>A.</b> Check that the P2/J2 connector is correctly installed.</p> <p><b>Note:</b> If a fault is suspected with the ECM power or ground connections, refer to Troubleshooting, "Electrical Power Supply - Test".</p>	ECM connection	<p><b>Result:</b> An ECM connector is not correctly installed.</p> <p><b>Repair:</b> Repair the electrical connector or replace the electrical connector.</p> <p><b>Result:</b> Both ECM connectors are correctly installed.</p> <p>Proceed to Test Step 4.</p>

(continued)



(Table 134, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Intake Manifold Pressure</b></p> <p><b>A.</b> Use the electronic service tool to verify the intake manifold pressure.</p> <p>Turn the start switch to the ON position.</p> <p>The intake manifold pressure must read <math>0 \pm 0.5</math> kPa (<math>0 \pm 0.07</math> psi).</p>	Intake manifold	<p><b>Result:</b> The intake manifold pressure does not read <math>0 \pm 0.5</math> kPa (<math>0 \pm 0.07</math> psi).</p> <p><b>Repair:</b> Refer to Troubleshooting, "Intake Manifold Air Pressure Is Low".</p> <p><b>Result:</b> The intake manifold pressure reads <math>0 \pm 0.5</math> kPa (<math>0 \pm 0.07</math> psi).</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Fuel Supply</b></p> <p><b>A.</b> Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only.</p> <p><b>B.</b> Ensure that the vent in the fuel cap is not filled with debris.</p> <p><b>C.</b> Ensure that the fuel supply valve (if equipped) is in the full OPEN position.</p> <p><b>D.</b> If the temperature is below <math>0</math> °C (<math>32</math> °F), check for solidified fuel (wax).</p> <p><b>E.</b> Check the primary filter/water separator for water in the fuel.</p> <p><b>F.</b> Check for fuel supply lines that are restricted.</p> <p><b>G.</b> Check that the low-pressure fuel lines are tight and secured properly.</p> <p><b>H.</b> Check that the Electric Fuel Lift Pump (EFLP) is operating correctly.</p> <p><b>I.</b> Replace the in-line fuel filter that is upstream of the primary fuel filter.</p> <p><b>J.</b> Replace the primary and secondary fuel filters.</p> <p><b>K.</b> Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, "Fuel Quality - Test".</p> <p><b>L.</b> Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, "Air in Fuel - Test".</p> <p><b>M.</b> Ensure that the fuel system has been primed. Refer to Systems Operation, Testing, and Adjusting, "Fuel System - Prime".</p>	Fuel system	<p><b>Result:</b> The fuel supply is not OK.</p> <p><b>Repair:</b> Repair the fuel system or replace the fuel system components, as necessary.</p> <p><b>Result:</b> The fuel supply is OK.</p> <p>Proceed to Test Step 6.</p>

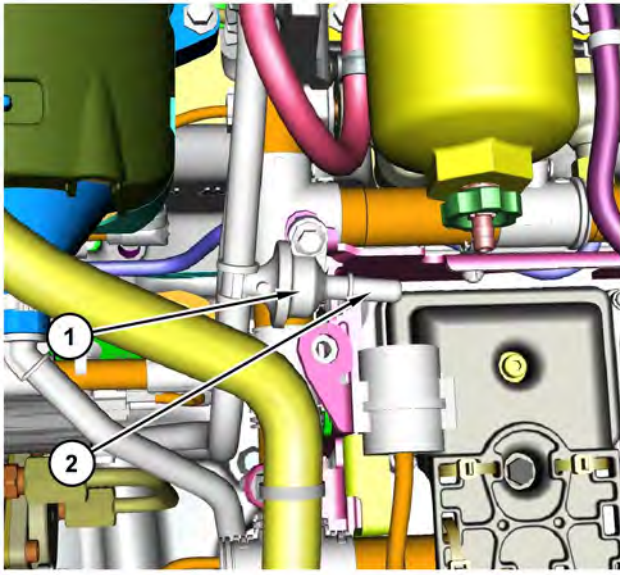


Illustration 87 g03700009  
**Transfer Pump Inlet Regulator (TPIR) components**  
 (1) Transfer Pump Inlet Regulator (TPIR)  
 (2) TPIR return port

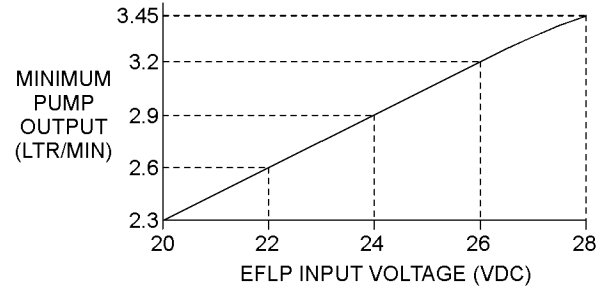


Illustration 89 g02485897  
**Minimum TPIR flow rate in a 24 VDC system**

Before performing the following fuel system tests, the engine must be run for a minimum of 30 minutes.

**Note:** When performing the following fuel system tests, the Electric Fuel Lift Pump (EFLP) will only operate for 2 minutes unless the engine is running. If necessary, cycle the keyswitch in order to reactivate the pump.

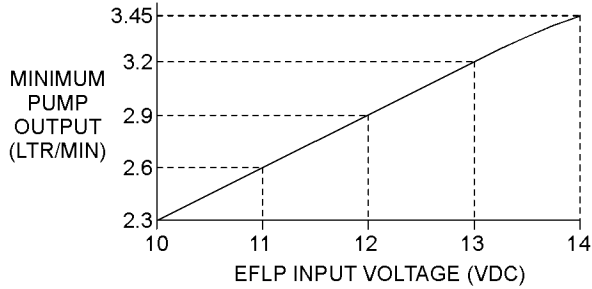


Illustration 88 g02485896  
**Minimum TPIR flow rate in a 12 VDC system**

Table 135

Troubleshooting Test Steps	Values	Results
<p><b>6. Transfer Pump Inlet Regulator (TPIR) Flow Test</b></p> <p>Refer to Illustration 87 .</p> <p><b>A.</b> Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line.</p> <p><b>B.</b> Connect a temporary drain line to the drain port on the TPIR.</p> <p><b>C.</b> Place the end of the temporary drain line into a suitable calibrated container.</p> <p><b>D.</b> With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading.</p> <p><b>E.</b> With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line.</p> <p><b>F.</b> Refer to Illustration 88 or 89 for the minimum acceptable flow rate.</p> <p><b>G.</b> Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.</p>	<p>TPIR flow rate</p>	<p><b>Result:</b> The fuel flow is greater than the minimum limit.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The fuel flow is less than the minimum limit.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Transfer Pump Inlet Regulator (TPIR) Return Test</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> Check that the Electric Fuel Lift Pump (EFLP) is operating correctly.</p> <p><b>C.</b> Make sure that the fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	<p>TPIR return</p>	<p><b>Result:</b> A fuel line is blocked or kinked.</p> <p><b>Repair:</b> Clear the fuel line or replace the fuel line.</p> <p><b>Result:</b> The EFLP is not operating correctly.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Fuel Transfer Pump - Test".</p> <p><b>Result:</b> All fuel lines are OK and the EFLP appears to be operating correctly.</p> <p>Proceed to Test Step 8.</p>

Symptom Troubleshooting

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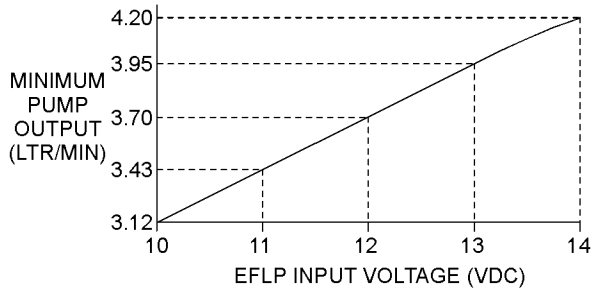


Illustration 90

g02527498

Minimum EFLP flow rate in a 12 VDC system

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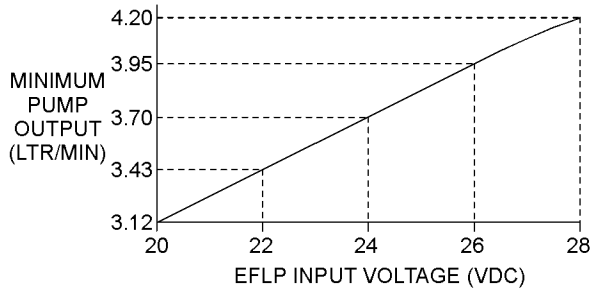


Illustration 91

g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 136

Troubleshooting Test Steps	Values	Results
<p><b>8. EFLP Flow Test at the Primary Fuel Filter Inlet</b></p> <p><b>A.</b> Make sure the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the fuel inlet connection from the primary fuel filter head.</p> <p><b>C.</b> Install a suitable blank on the fuel inlet port on the primary fuel filter head.</p> <p><b>D.</b> Place the open end of the fuel inlet line in a suitable calibrated container.</p> <p><b>E.</b> With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result.</p> <p><b>F.</b> With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result.</p> <p><b>G.</b> Check the recorded voltage and fuel flow on the graph in Illustration 90 or 91 .</p>	EFLP flow	<p><b>Result:</b> The fuel flow is below the minimum value for the recorded voltage.</p> <p><b>Repair:</b> Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install".</p> <p><b>Result:</b> The fuel flow is above the minimum value for the recorded voltage.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Check the Return Fuel Lines</b></p> <p><b>A.</b> Make sure that the TPIR return line is not blocked or kinked.</p> <p><b>B.</b> If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.</p>	Return lines	<p><b>Result:</b> The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked.</p> <p><b>Repair:</b> Clear or replace the blocked line.</p> <p><b>Result:</b> The TPIR return line and the fuel lines between the EFLP and the TPIR are clear.</p> <p><b>Repair:</b> Replace the EFLP.</p> <p>If the fault is still present, contact the Dealer Solutions Network.</p>

i08481027

## SCR Catalyst Has Incorrect Inlet Temperature

Table 137

Diagnostic Trouble Code for SCR Catalyst Has Incorrect Inlet Temperature			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4360-16	E946 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	The aftertreatment Selective Catalytic Reduction (SCR) catalyst intake gas temperature sensor has detected that the SCR intake temperature is above the normal operating range.
4360-17	E947 (1)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - least severe (1)	This diagnostic code is only applicable to engines that have a Diesel Particulate Filter (DPF). The Electronic Control Module (ECM) detects that the SCR catalyst intake temperature is below the acceptable range. The code is logged.
4360-18	E947 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	The aftertreatment SCR catalyst intake gas temperature sensor has detected that the SCR intake temperature is far below the normal operating range.
Follow the troubleshooting procedure to identify the root cause of the fault.			

Complete the procedure in the order in which the steps are listed.

Table 138

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Trouble Codes</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>B.</b> Connect to the electronic service tool.</p> <p><b>C.</b> Check for associated diagnostic trouble codes.</p>	Diagnostic trouble codes	<p><b>Result:</b> A 4360-16 (E946 (2)) code is active or recently logged.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 4360-17 (E947 (1)), or 4360-18 (E947 (2)) code is active or recently logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> An associated code other than listed in Table 137 is active or recently logged.</p> <p><b>Repair:</b> Troubleshoot the logged or active code. Refer to Troubleshooting, "Diagnostic Trouble Codes".</p> <p><b>Result:</b> No codes are active or recently logged.</p> <p>For engines that have a DPF, proceed to Test Step 4.</p> <p>For engines that do not have a DPF, proceed to Test Step 5.</p>
<p><b>2. Check for Cause of High Temperature</b></p> <p><b>A.</b> Check for evidence of an exothermic event in the DOC and DPF (if applicable).</p> <p><b>B.</b> Check for evidence of excessive fuel reaching the DOC or DPF (if applicable)</p>	High temperature	<p><b>Result:</b> There has been an exothermic event in the DOC or DPF.</p> <p><b>Repair:</b> Replace the Clean Emissions Module (CEM).</p> <p><b>Result:</b> There is evidence of excessive fuel reaching the DOC or DPF.</p> <p><b>Repair:</b> Investigate the cause of the excess fuel.</p> <p><b>Result:</b> There is no evidence of an exothermic event or fuel in the aftertreatment module.</p> <p><b>Repair:</b> Perform the "Aftertreatment Recovery Procedure" . Monitor the SCR inlet temperature.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p> <p>If the SCR inlet temperature is abnormal, install a replacement SCR temperature sensor. Refer to Disassembly and Assembly, Temperature Sensor (Exhaust) - Remove and Install (Selective Catalytic Reduction (SCR) Temperature Sensor).</p>

(continued)

## Symptom Troubleshooting

(Table 138, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Exhaust System</b></p> <p><b>A.</b> Check the exhaust system for gas leaks between the Exhaust Back Pressure Regulator (EBPR) and the exhaust tail pipe.</p> <p><b>B.</b> Check for gas leaks around the following items in the Clean Emissions Module (CEM):</p> <ul style="list-style-type: none"> <li>• Soot antennas (if equipped)</li> <li>• Temperature sensors</li> <li>• SCR inlet NOx sensor</li> <li>• DEF injector</li> </ul> <p><b>C.</b> Check for signs of internal exhaust gas leaks on the outer casing of the CEM.</p> <p><b>D.</b> Check for missing or damaged exhaust system insulation.</p> <p><b>E.</b> Make sure that the exhaust piping between the EBPR and the CEM is no longer than 1.83 m (6 ft).</p> <p><b>F.</b> Make sure that the cooling air flow over the CEM is not excessive for the ambient conditions.</p>	Exhaust System	<p><b>Result:</b> The exhaust system or the CEM has a gas leak.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p>For engines that have a DPF, proceed to Test Step 4.</p> <p>For engines that do not have a DPF, proceed to Test Step 5.</p> <p><b>Result:</b> The exhaust system insulation is damaged or missing.</p> <p><b>Repair:</b> Make the necessary repairs.</p> <p>For engines that have a DPF, proceed to Test Step 4.</p> <p>For engines that do not have a DPF, proceed to Test Step 5.</p> <p><b>Result:</b> Review and correct the routing of the exhaust system. If necessary, consult the Dealer Solutions Network (DSN) for further advice.</p> <p>For engines that have a DPF, proceed to Test Step 4.</p> <p>For engines that do not have a DPF, proceed to Test Step 5.</p> <p><b>Result:</b> There is excessive cooling air flow over the CEM.</p> <p><b>Repair:</b> Reduce the cooling air flow. If necessary, consult the Dealer Solutions Network (DSN) for further advice.</p> <p>For engines that have a DPF, proceed to Test Step 4.</p> <p>For engines that do not have a DPF, proceed to Test Step 5.</p>
<p><b>4. Check the SCR Catalyst Temperature</b></p> <p><b>Note:</b> This test step is only applicable to engines that have a DPF.</p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Run the engine.</p> <p><b>C.</b> Perform the “Manual Hydrocarbon Dosing Capability Test” .</p>	Manual hydrocarbon dosing capability test	<p><b>Result:</b> The “Manual Hydrocarbon Dosing Capability Test” completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The “Manual Hydrocarbon Dosing Capability Test” failed. An error identifier is generated by the electronic service tool.</p> <p><b>Repair:</b> Troubleshoot the error identifier. Refer to Troubleshooting, “Service tool Error Identifiers”. Repeat Test Step 3.</p> <p><b>Result:</b> The “Manual Hydrocarbon Dosing Capability Test” failed. No error identifiers are generated.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)



(Table 138, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Recover the Aftertreatment</b></p> <p><b>Note:</b> This test step is only applicable to engines that do not have a DPF.</p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Run the engine.</p> <p><b>C.</b> Perform the "Aftertreatment Recovery Procedure".</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p>	Aftertreatment recovery procedure	<p><b>Result:</b> The "Aftertreatment Recovery Procedure" completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The "Aftertreatment Recovery Procedure" failed. A diagnostic code is generated by the electronic service tool.</p> <p><b>Repair:</b> Troubleshoot the diagnostic code. Refer to Troubleshooting, "Service tool Error Identifiers". Repeat Test Step 3.</p> <p><b>Result:</b> The "Aftertreatment Recovery Procedure" failed. No diagnostic codes are generated.</p> <p>Contact the Dealer Solutions Network.</p>

i07743210

## SCR Warning System Problem

### Operator Level Inducement

Inducements are engine derates or other actions intended to prompt the operator to repair or maintain the emission control system.

Inducement strategies are control actions required by EPA/ARB Tier 4 and EU Stage IV regulations. An inducement strategy ensures prompt correction of various failures in the engine NOx emission control system. The strategy requires actions to limit engine performance and defines required the following indications when the control actions are imposed:

- Lamps
- Messages
- Audible alarms

Table 139

Diagnostic Trouble Codes for SCR Warning System Problem			
J1939 Code	PDL Code	Description (code descriptions may vary)	Notes
5246-15	E1389 (1)	Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	This code is a Level 1 inducement associated with an emission activated fault. The Emissions System Malfunction Lamp is on.

(continued)

## Symptom Troubleshooting

(Table 139, contd)

<b>Diagnostic Trouble Codes for SCR Warning System Problem</b>			
5246-16	E1389 (2)	Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	This code is a Level 2 inducement associated with an emission activated fault. The Emissions System Malfunction Lamp is on and the Action Lamp is flashing. The engine is derated.
5246-0	E1389 (3)	Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	This code is a Level 3 inducement associated with an emission activated fault. The Emissions System Malfunction lamp is on, the Action lamp is flashing, and the warning horn may sound. The engine is derated. The engine may stop.

**Associated Codes**

Troubleshoot any associated diagnostic codes listed in Table 140 that are present. Refer to "Inducement Type" in Table 140 for the correct Inducement table.

Table 140

<b>Associated Codes</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Inducement Type</b>
1235-9	5856-9	J1939 Network #3 : Abnormal Update Rate	DEF Quality/Tampering/Dosing Interruption
1235-14	5856-14	J1939 Network #3 : Special Instruction	DEF Quality/Tampering/Dosing Interruption
1761-1	E954 (3)	Catalyst Tank Level : Low - most severe (3)	DEF Tank Level Inducement
1761-12	3130-12	Catalyst Tank Level : Failure	DEF Tank Level Inducement
1761-17	E954 (1)	Catalyst Tank Level : Low - least severe (1)	DEF Tank Level Inducement
1761-18	E954 (2)	Catalyst Tank Level : Low - moderate severity (2)	DEF Tank Level Inducement
2659-7	E1319 (2)	Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	NRS Inducement
2791-5	3405-5	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	NRS Inducement
2791-6	3405-6	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	NRS Inducement
3031-12	3096-12	Catalyst Tank Temperature : High : Failure	DEF Quality/Tampering/Dosing Interruption
3031-16	E960 (2)	Catalyst Tank Temperature : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
3031-18	E1398 (2)	Catalyst Tank Temperature : Low - moderate severity	DEF Quality/Tampering/Dosing Interruption
3216-5	3002-5	Aftertreatment 1 Intake NOx : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3216-6	3002-6	Aftertreatment 1 Intake NOx : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3216-7	E1431 (2)	Aftertreatment #1 Intake NOx : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3216-11	3002-11	Aftertreatment #1 Intake NOx : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption

(continued)

(Table 140, contd)

3216-12	3002-12	Aftertreatment #1 Intake NOx : Failure	DEF Quality/Tampering/Dosing Interruption
3217-16	E1407 (2)	Aftertreatment #1 Intake O2 : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
3226-5	3609-5	Aftertreatment 1 Outlet NOx : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3226-6	3609-6	Aftertreatment 1 Outlet NOx : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3226-7	E1432 (2)	Aftertreatment #1 Outlet NOx : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3226-11	3609-11	Aftertreatment #1 Outlet NOx : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
3226-12	3609-12	Aftertreatment #1 Outlet NOx : Failure	DEF Quality/Tampering/Dosing Interruption
3227-16	E1408 (2)	Aftertreatment #1 Outlet O2 : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
3242-3	2452-3	Aftertreatment #1 DPF Intake Gas Temperature : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
3242-4	2452-4	Aftertreatment #1 DPF Intake Gas Temperature : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
3360-3	3820-3	Catalyst Tank Controller : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
3360-4	3820-4	Catalyst Tank Controller : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
3361-5	3821-5	Catalyst Dosing Unit : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3361-6	3821-6	Catalyst Dosing Unit : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3361-7	3821-7	Catalyst Dosing Unit : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3363-5	3126-5	Catalyst Tank Heater : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3363-6	3126-6	Catalyst Tank Heater : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3516-2	3100-2	Aftertreatment #1 DEF Concentration : Erratic, Intermittent, or Incorrect	DEF Quality/Tampering/Dosing Interruption
3516-12	3100-12	Aftertreatment #1 DEF Concentration : Failure	DEF Quality/Tampering/Dosing Interruption
3516-18	E1364 (2)	Aftertreatment 1 Diesel Exhaust Fluid Concentration : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
3563-3	1785-3	Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
3563-4	1785-4	Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
4334-3	3090-3	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
4334-4	3090-4	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
4334-16	E930 (2)	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption

(continued)

## Symptom Troubleshooting

(Table 140, contd)

4334-18	E931 (2)	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4354-5	3110-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4354-6	3110-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
4355-5	3111-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4355-6	3111-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
4356-5	3112-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4356-6	3112-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
4360-3	3105-3	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
4360-4	3105-4	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
4360-16	E946 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4360-18	E947 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4364-2	E1410 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	DEF Quality/Tampering/Dosing Interruption
4364-18	E1309 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4374-5	3118-5	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4374-6	3118-6	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
5392-31	E1370 (2)	Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	DEF Quality/Tampering/Dosing Interruption
5588-14	1132-14	Proprietary Network #2 : Special Instruction	DEF Quality/Tampering/Dosing Interruption
5758-11	3621-11	Engine Exhaust NOx Level Sensor Power Supply: Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
5759-11	3619-11	Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
5965-5	3838-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit Relay : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
5965-6	3838-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit Relay : Current Above Normal	DEF Quality/Tampering/Dosing Interruption

**Engine Emissions Operator Inducement Service  
Mode Override**

This override allows the service technician to disable the inducement to troubleshoot problems. Factory passwords are required to activate this override. Once the override is activated, navigation to other electronic service tool functions is possible. Usually, the “Engine Emissions Operator Inducement Service Mode Override” will not need to be activated because the service tests performed in the applicable troubleshooting procedure will automatically reset the inducement. The “Engine Emissions Operator Inducement Service Mode Override” is located in the “Diagnostic Tests”, “System Troubleshooting Section” of the engine ECM.

Table 141

Troubleshooting Test Steps	Values	Results
<p><b>1. Connect the Electronic Service Tool</b></p> <p><b>A.</b> Connect the electronic service tool.</p> <p><b>B.</b> Activate the Service Inducement Override in the electronic service tool. Refer to Service Override Mode listed below for details pertaining to the Service Override.</p>	Service Inducement Override	<p><b>Result:</b> The Service Inducement Override has been activated.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Associated Codes</b></p> <p><b>A.</b> Use the electronic service tool to check for associated diagnostic codes.</p>	Associated Codes	<p><b>Result:</b> Associated codes are logged or active.</p> <p>Troubleshoot the associated codes. Refer to Troubleshooting, “Diagnostic Trouble Codes” or Troubleshooting, “Event Codes” for the proper procedure.</p>

## DEF Tank Level Inducement

### DEF Tank Level Fault Occurrence

Two options are available but only one option will be enabled.

#### Option 1

If the DEF level falls below 20%, an amber indicator will illuminate below the DEF level gauge on the panel. To avoid further inducements, add DEF to the DEF tank.

If the DEF level falls below 14%, the Emissions System Malfunction lamp will illuminate. The amber indicator next to the DEF level gauge on the panel will remain lit.

If the DEF level is reading 3.5%, the Emissions System Malfunction lamp will flash. The amber indicator below the DEF level gauge on the panel will remain lit. The engine may be derated by 25% torque.

When the DEF tank is empty, the following indications will be present:

- The Emissions System Malfunction lamp will flash
- The Shutdown lamp will be on

- The engine will be derated by 50% torque. After 5 minutes in this condition the engine will then stop or be restricted to low idle.
- The amber indicator below the DEF level gauge on the panel will be lit.

## Symptom Troubleshooting

Table 142

Option 1					
-	Normal operation	Initial indication	Level 1	Level 2	Level 3
<b>J1939 Code</b>	-	-	1761-17	1761-18	1761-1
<b>PDL Code</b>	-	-	E954 (1)	E954 (2)	E954 (3)
<b>Inducement Trigger</b>	Above 20 percent	Below 20 percent	Below 14 percent	3.5 Percent reading	Empty tank
<b>Inducement</b>	None	None	None	25 percent torque de-rate	50 percent torque de-rate for 5 minutes followed by shutdown or idle only.
<b>Notification</b>	None	Low-level lamp illuminated	Low-level lamp illuminated Emission malfunction lamp on solid	Low-level lamp illuminated Emission malfunction lamp flashing	Low-level lamp illuminated Emission malfunction lamp flashing Stop lamp on solid

**Option 2**

If the DEF level falls below 20%, an amber indicator will illuminate below the DEF level gauge on the panel. To avoid further inducements, add DEF to the DEF tank.

If the DEF level falls below 14%, the Emissions System Malfunction lamp will illuminate. The amber indicator next to the DEF level gauge on the panel will remain lit.

If the DEF level is below 8%, the Emissions System Malfunction lamp will flash. The amber indicator below the DEF level gauge on the panel will remain lit.

When the DEF level has reached 3.5%, the engine enters a 5 minute cool down period and will be derated by 50% torque. The following indications will be present:

- The Emissions System Malfunction lamp will flash
- The Shutdown lamp will be on
- The amber indicator below the DEF level gauge on the panel will be lit.

Table 143

World-Wide DEF Level Option 2					
-	Normal operation	Initial indication	Level 1	Level 2	Level 3
<b>J1939 Code</b>	-	-	1761-17	1761-18	1761-1
<b>PDL Code</b>	-	-	E954 (1)	E954 (2)	E954 (3)
<b>Inducement Trigger</b>	Above 20 percent	Below 20 percent	Below 14 percent	Below 8 percent	3.5 Percent reading

(continued)

(Table 143, contd)

<b>Inducement</b>	None	None	None	None	The engine will enter a 5 minute cool down period where and will be derated by 50% torque.
<b>Notification</b>	None	Low-level lamp illuminated	Low-level lamp illuminated Emission malfunction lamp on solid	Low-level lamp illuminated Emission malfunction lamp flashing	Low-level lamp illuminated Emission malfunction lamp flashing Stop lamp on solid

## Tampering/Dosing Interruption

The Emissions System Malfunction lamp will illuminate for a fault resulting from SCR system tampering or an SCR system fault. If the fault is the result of system tampering, a first occurrence will result in a level 1 inducement for a duration of 2.5 hours. Repeat occurrences will result in a level 1 inducement duration of 5 minutes.

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. For a fault resulting from SCR system tampering or an SCR system fault, the Emissions System Malfunction lamp will flash.

The duration for a level 2 inducement is always 70 minutes for the first occurrence. Repeat occurrences will result in a level 2 inducement duration of 5 minutes.

If a fault condition exists for the entire duration of inducement level 2, the strategy advances to inducement level 3. The Emissions System Malfunction lamp will flash and the Shutdown lamp will be on. The engine will be restricted to low idle or will stop. After the final inducement, the keyswitch can be cycled once which will allow 20 minutes of engine run time with full torque. After 20 minutes, the engine will allow idle only or will stop until the fault has been resolved. The override can only be used once.

The system must be fault-free for 40 hours before the system resets to zero. If the fault is intermittent and returns within 40 hours, the repeat inducement timings will be triggered.

## Timeline For First Fault Occurrence

Table 144

World-Wide					
DEF Quality Tampering and Dosing Interruption					
-	Normal operation	Level 1	Level 2	Level 3	Override
<b>J1939 Code</b>	-	5246-15	5246-16	5246-0	-
<b>PDL Code</b>	-	E1389 (1)	E1389 (2)	E1389 (3)	-
<b>Inducement Time First occurrence</b>	None	2.5 Hours	70 minutes	<b>Shut down or idle Until fault heals</b>	Cycling the keyswitch will give 20 minutes of full power
The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered. The override can only be used once					
<b>Repeat Inducement time</b>	None	5 minutes	5 minutes	<b>Shut down or idle Until fault heals</b>	Cycling the keyswitch will give 20 minutes of full power
<b>Inducement</b>	None	None	None		
<b>Notification</b>	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will be on solid	Emission malfunction lamp will flash

## NRS Inducement

The Emissions System Malfunction lamp will illuminate for a fault resulting from an impeded NOx Reduction System (NRS). A first occurrence will result in a level 1 inducement for a duration of 35 hours. Repeat occurrences will result in a level 1 inducement duration of 48 minutes.

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. The Emissions System Malfunction lamp will flash for a fault resulting from an impeded NRS. The duration for a level 2 inducement is always 60 minutes for the first occurrence. Repeat occurrences will result in a level 2 inducement duration of 60 minutes.

If a fault condition exists for the entire duration of inducement level 2, the strategy advances to inducement level 3. The Emissions System Malfunction lamp will flash and the Shutdown lamp will be on. The engine will be restricted to low idle or will stop. After the final inducement, the keyswitch can be cycled once which will allow 20 minutes of engine run time with full torque. After 20 minutes, the engine will allow idle only or will stop until the fault has been resolved. The override can only be used once.

The system must be fault-free for 40 hours before the system resets to zero. If the fault is intermittent and returns within 40 hours, the repeat inducement timings will be triggered.



## Timeline For First Fault Occurrence

Table 145

World-Wide					
NOx Reduction System Fault					
-	Normal operation	Level 1	Level 2	Level 3	Override
<b>J1939 Code</b>	-	5246-15	5246-16-	5246-0	-
<b>PDL Code</b>	-	E1389 (1)	E1389 (2)	E1389 (3)	-
<b>Inducement Time First occurrence</b>	None	35 Hours	60 minutes	<b>Shut down or idle Until fault heals</b>	Cycling the keyswitch will give 20 minutes of full power
The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered. The override can only be used once.					
<b>Repeat Inducement time</b>	None	48 minutes	60 minutes	<b>Shut down or idle Until fault heals</b>	Cycling the keyswitch will give 20 minutes of full power
<b>Inducement</b>	None	None	None		
<b>Notification</b>	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will activate	Emission malfunction lamp will flash

i06026810

## Valve Lash Is Excessive

### Probable Causes

- Lubrication
- Valve train components

### Recommended Actions

**Note:** The procedures have been listed in order of probability. Complete the procedures in order.

## Symptom Troubleshooting

Table 146

Troubleshooting Test Steps	Values	Results
<p><b>1. Lubrication</b></p> <p><b>A.</b> Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install" for the correct procedure.</p> <p><b>B.</b> Crank the engine and check the lubrication in the valve compartment. Ensure that there is adequate engine oil flow in the valve compartment. The passages for the engine oil must be clean.</p> <p><b>Note:</b> Do not run the engine with the valve mechanism cover removed.</p>	Lubrication	<p><b>Result:</b> The oil flow to the valve mechanism is insufficient.</p> <p><b>Repair:</b> Make sure that the passages for the engine oil are clear.</p> <p><b>Result:</b> The oil flow to the valve mechanism is OK.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Valve Train Components</b></p> <p><b>A.</b> Inspect the following components of the valve train for abnormal or excessive wear, straightness, and cleanliness:</p> <ul style="list-style-type: none"> <li>· Rocker arms</li> <li>· Valve bridges</li> <li>· Pushrods</li> <li>· Hydraulic lifters</li> <li>· Camshaft</li> <li>· Valve stems</li> <li>· Rocker shafts</li> </ul>	Valve train components	<p><b>Result:</b> A valve train component is worn, bent, or not clean.</p> <p><b>Repair:</b> Repair or replace the component. Refer to Disassembly and Assembly.</p> <p><b>Note:</b> If the camshaft is replaced, new valve lifters must also be installed.</p> <p><b>Result:</b> All the valve train components are OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

## Circuit Tests

i06163188

### Aftertreatment Identification Module - Test

This procedure covers the following codes:

Table 147

Diagnostic Trouble Codes for the Aftertreatment Identification Module			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5576-2	3468-2	Aftertreatment #1 Identification Number Module: Erratic, Intermittent, or Incorrect	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The installed Clean Emissions Module (CEM) is not a certified match with the engine.</p> <p>There are no other active diagnostic codes for the aftertreatment identification module.</p> <p>There are no active 5 V supply diagnostic codes.</p> <p>The ECM has been powered for 2 seconds.</p> <p><b>“This is a violation of the emissions regulations, and may result in severe fines and/or legal action if not corrected immediately.” Do not operate the engine with the active fault.</b></p> <p>Engine power is derated.</p>
5576-8	3468-8	Aftertreatment #1 Identification Number Module: Abnormal Frequency Pulse Width or Period	<p>The ECM detects the following conditions:</p> <p>No signal is detected from the aftertreatment identification module.</p> <p>There are no active 5 V supply diagnostic codes.</p> <p>The ECM has been powered for 2 seconds.</p> <p><b>Do not continue to operate the engine with the active fault.</b></p> <p>Engine power is derated.</p>

The aftertreatment identification module communicates with the engine ECM to ensure that the correct Integrated Clean Emissions Module (IGCEM) is installed.

If the total operating hours of the engine are greater than 100, the aftertreatment identification module will cease to send the signal. The diagnostic codes that are listed in Table 147 will be disabled.

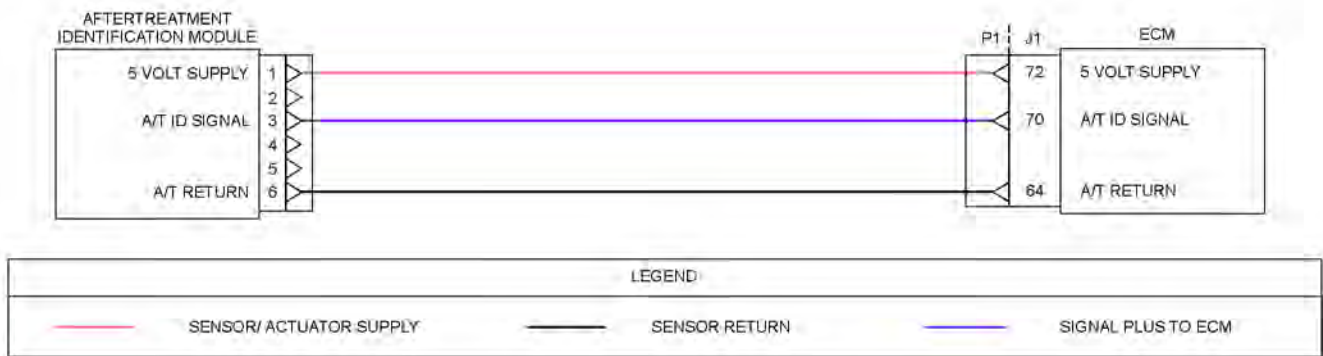


Illustration 92

g03671526

Schematic for the aftertreatment identification module

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Complete the procedure in the order in which the steps are listed.

Table 148

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Dosing Control Unit (DCU) . Refer to Troubleshooting, “Electronic Service Tools”, if necessary.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Look for “-2” or “ -8” active or logged codes.</p>	Diagnostic code	<p><b>Result:</b> A 5576-2 or 3468-2 diagnostic code is active. Proceed to Test Step 6.</p> <p><b>Result:</b> A 5576-8 or 3468-8 diagnostic code is active. Proceed to Test Step 2.</p>
<p><b>2. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Inspect the P1/J1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.</p> <p><b>B.</b> Inspect the connector for the aftertreatment identification module. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the aftertreatment identification module.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness for abrasion and pinch points from the after-treatment identification module back to the ECM.</p>	Connectors and wiring	<p><b>Result:</b> There is a fault with the harness and connectors.</p> <p><b>Repair:</b> Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 3.</p>

(continued)

(Table 148, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Measure the Voltage to the Aftertreatment Identification Module</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the aftertreatment identification module from the harness.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage at the harness connector for the aftertreatment identification module from terminal 1 to terminal 6.</p>	4.84 to 5.16 VDC.	<p><b>Result:</b> The supply voltage is out of the nominal range.</p> <p><b>Repair:</b> Replace the harness. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> The supply voltage is correct.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Signal Wire for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the aftertreatment ID module. Disconnect the P1 connector on the engine ECM.</p> <p><b>C.</b> Check the resistance between pin 70 on the P1 connector and terminal 3 on the harness connector for the aftertreatment identification module.</p>	Less than 2 Ohms	<p><b>Result:</b> The measured resistance is more than 2 Ohms.</p> <p><b>Repair:</b> Replace the harness. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is less than 2 Ohms</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 148, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the Signal Wire for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Use a suitable multimeter to measure the resistance between P1:70 and all other terminals on the P1 connector.</p>	<p>Greater than 100 Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is less than 100 Ohms.</p> <p><b>Repair:</b> Replace the wiring between the aftertreatment identification module and the ECM. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are greater than 100 Ohms.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Manually Enter the “Aftertreatment Identification Information”</b></p> <p><b>A.</b> Record the “IGCEM serial number” and the “configuration group” from the IGCEM Identification Plate. The identification plate is on the end cover of the IGCEM.</p> <p><b>B.</b> Contact the Dealer Solutions Network (DSN) for a list of approved RF and CEM configurations for the engine.</p> <p><b>C.</b> Verify that the IGCEM is a certified match with the engine.</p> <p><b>D.</b> Establish communication between the electronic service tool and the ECM . If necessary, refer to Troubleshooting, “Electronic Service Tools”.</p> <p><b>E.</b> Navigate to the “Aftertreatment Configuration” page.</p> <p><b>F.</b> Program the “Factory Installed Aftertreatment #1 Identification Number” with the serial number from the IGCEM Identification Plate.</p> <p><b>G.</b> Program the “DPF #1 Soot Loading Sensing System Configuration Code” with the “configuration group” from the IGCEM Identification Plate.</p> <p><b>Note:</b> The code is automatically cleared.</p>	<p>Manual programming</p>	<p><b>Result:</b> The IGCEM is not a certified match to the engine.</p> <p><b>Repair:</b> Replace the IGCEM with a certified match to the engine. Refer to Disassembly and Assembly for removal and installation procedures. When the new IGCEM is installed, the aftertreatment identification module will begin communicating with the ECM and the diagnostic code will be cleared.</p> <p><b>Note:</b> The engine ECM will only communicate with the IGCEM if the total operating hours of the engine are less than 100. If the hours are greater than 100, the IGCEM information must be programmed into the ECM by using the electronic service tool.</p> <p><b>Result:</b> The IGCEM is a certified match to the engine.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i07746285

## CAN Data Link - Test

Use this procedure if a fault is suspected in the CAN data links. Also, use this procedure if one of the following diagnostic codes is active:

Table 149

Diagnostic Trouble Codes for the CAN Data Link Circuit			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
639-9	247-9	J1939 Network #1 : Abnormal Update Rate	Another controller has incorrectly stopped transmitting an expected J1939 message or another controller has incorrectly started transmitting a conflicting J1939 message. The ECM will log the diagnostic code. The engine will not start.
1235-9	5856-9	J1939 Network #3 : Abnormal Update Rate	The Pump and Electronics Unit (PEU), the ammonia sensor, the soot sensor, or a NOx sensor has incorrectly stopped or started transmitting a data request. The ECM will log the diagnostic code.
3360-9	3820-9	Aftertreatment #1 DEF Controller : Abnormal Update Rate	The Dosing Control Unit (DCU) has incorrectly stopped or started transmitting a data request. This diagnostic code applies to the CAN A datalink. The ECM will log the diagnostic code.

**The following background information is related to this procedure:**

The CAN data links are also known as J1939 data links. A data link is an industry standard for sending data between different devices in the same application.

High-speed data is transferred via the data links. The data links cannot be accurately tested without complicated equipment. The data links require a resistance of 60 Ohms between the two wires to transmit the data correctly. This resistance is made up of two 120 Ohm resistors. The two resistors are known as "Terminating Resistors". The terminating resistors should be at opposite ends of a data link circuit. If this resistance is not present, then the data will be intermittent or unreadable.

**Note:** The wiring for a J1939 data link is a shielded twisted-pair cable. If the wiring is damaged, the replacement type must be shielded twisted-pair cable.

Circuit Tests

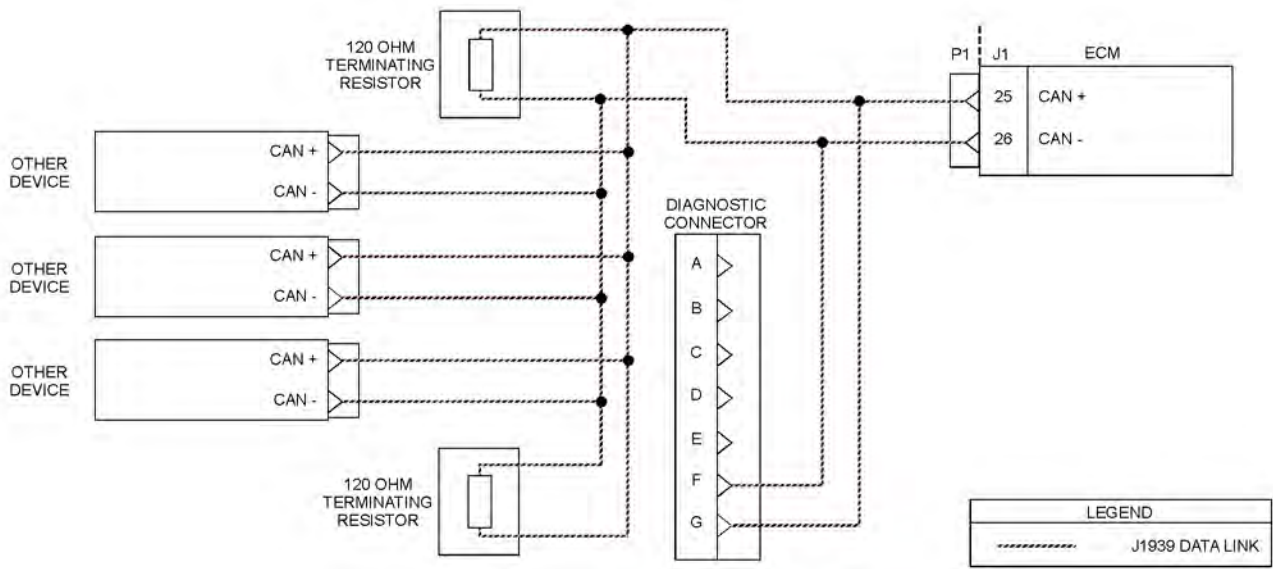


Illustration 93

g03705249

Typical example of the schematic for the CAN A data link

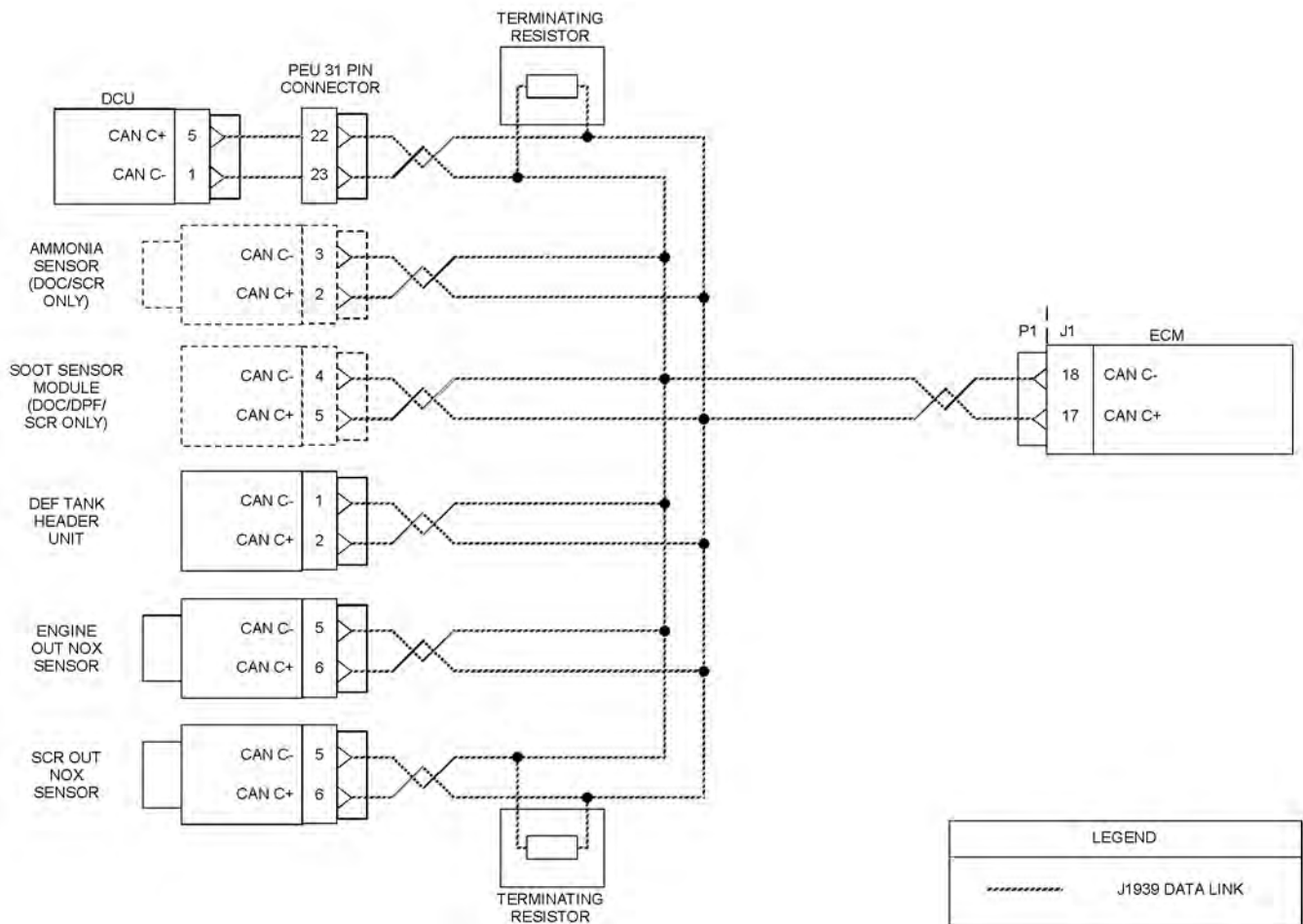


Illustration 94

g03705266

Typical example of the schematic for the CAN C data link



Table 150

Troubleshooting Test Steps	Values	Results
<p><b>1. Use the “System Communication Status to Check the Status of the Other Devices on the Suspect CAN Data Link”</b></p> <p><b>A.</b> In the electronic service tool, click the “Diagnostics” tab on the tool bar.</p> <p><b>B.</b> Select the “System Communication Status” option from the drop-down list.</p> <p><b>Note:</b> The <b>Aftertreatment #1 Intake NOx Level Sensor</b> is displayed as <b>Aftertreatment #1 Information #1</b> in some versions of software.</p>	<p>Component Identified</p>	<p><b>Result:</b> One or more of the devices on the suspect data link is not visible on the electronic service tool.</p> <p><b>Repair:</b> Thoroughly inspect the electrical connectors for the suspect devices Refer to Troubleshooting, “Electrical Connectors - Inspect”. Check the power supply to the suspect devices. If necessary, refer to Troubleshooting, “Electrical Power Supply - Test”. Inspect the wiring between any suspect devices and the ECM for abrasions and pinch points. If necessary, repair the wiring.</p> <p>If the suspect device is the DCU, check the ignition key-switch line between the DCU and the ECM, and between the DCU and tank header unit for continuity. Make any necessary repairs. If necessary, refer to Troubleshooting, “DEF Control Module Power - Test” for the correct procedure to check between DCU and ECM.</p> <p>To check between the DCU and the DEF tank header unit, use the following procedure:</p> <p><b>A.</b> Disconnect the harness at the DEF tank header.</p> <p><b>B.</b> Disconnect the harness at the DEF tank header. Turn the keyswitch to the ON position.</p> <p><b>C.</b> Measure the voltage between terminals 3 and 4.</p> <p><b>D.</b> Turn the keyswitch to the OFF position.</p> <p>If the fault has been resolved, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> All devices are visible on the electronic service tool.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Data Link Terminating Resistance</b></p> <p><b>A.</b> Disconnect the P1 connector from the ECM.</p> <p><b>B.</b> Measure the resistance between P1:25 and P1:26.</p> <p><b>C.</b> Measure the resistance between the P1:17 and P1:18.</p>	<p>Between 50 Ohms and 70 Ohms</p>	<p><b>Result:</b> The resistance is less than 50 Ohms - there is a short circuit in the harness.</p> <p><b>Repair:</b> Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all the seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The resistance is between 110 and 130 Ohms - one of the terminating resistors may have failed.</p> <p><b>Repair:</b> Locate the two terminating resistors and remove the two terminating resistors from the harness. Depending on the application, one or both of the terminating resistors may be located in other ECMs on the data link. Measure the resistance of the two terminating resistors.</p>

(continued)

(Table 150, contd)

Troubleshooting Test Steps	Values	Results
		<p>If one of the terminating resistors is incorrect, replace the faulty terminating resistor.</p> <p>If the two terminating resistors are between 110 and 130 Ohms, proceed to Test Step 4.</p> <p><b>Result:</b> The resistance is greater than 150 Ohms.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The resistance is between 50 and 70 Ohms</p> <p>The resistance is correct. The fault may be in the connection to other devices on the data link.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Data Link Wiring</b></p> <p><b>A.</b> Disconnect each of the connectors that connect other devices on the data link.</p> <p><b>B.</b> Use a multimeter to measure the resistance between P1:25 and each of the CAN+ pins on other devices on the CAN A data link.</p> <p><b>C.</b> Use a multimeter to measure the resistance between P1:25 and pin (G) on the diagnostic connector.</p> <p><b>D.</b> Use a multimeter to measure the resistance between P1:26 and each of the CAN- pins on other devices on the CAN A data link.</p> <p><b>E.</b> Use a multimeter to measure the resistance between P1:26 and pin (F) on the diagnostic connector.</p> <p><b>F.</b> Use a multimeter to measure the resistance between P1:17 to each of the CAN+ pins on other devices on the CAN C data link.</p> <p><b>G.</b> Use a multimeter to measure the resistance between P1:18 to each of the CAN- pins on other devices on the CAN C data link.</p>	<p>Less than 2 Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is greater than 2 Ohms - there is an open circuit or high resistance in the wiring.</p> <p><b>Repair:</b> Repair the connectors or the harness and/or replace the connectors or the harness.</p> <p>Ensure that all seals are correctly in place and ensure that the connectors are correctly connected.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair has eliminated the fault.</p> <p><b>Result:</b> All measured resistances are less than 2 Ohms.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Other Devices on the CAN Data Link</b></p> <p><b>A.</b> Use the appropriate service tools to diagnose other devices on the data link.</p>	<p>Other devices are OK</p>	<p><b>Result:</b> At least one of the other devices is not operating correctly.</p> <p><b>Repair:</b> Use the appropriate service tools to repair other devices on the data link.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The other devices are operating correctly.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i07178078

## Coolant Level - Test

**This test procedure is only applicable on applications that have a coolant level sensor installed.**

Use this procedure to troubleshoot any suspect faults with the circuit for the coolant level sensor.

The coolant level sensor monitors the engine coolant level to warn the operator when the coolant level is low.

When the probe is not immersed in coolant, a voltage is sent to the sensor signal wire. When this condition is detected by the Electronic Control Module (ECM), an event code is activated.

If applicable and prior to troubleshooting any faults with the coolant level sensor, use the electronic service tool to check the installation status for the sensor. The coolant level sensor configuration parameter must be set to "Installed" in order for the ECM to monitor the signal from the sensor. Not all applications have the parameter available.

The activation of an event code and/or a warning lamp is probably caused by a low coolant level. The other possible cause is a fault in the wiring harness, a connector, or the sensor.

During the following procedure, refer to the electrical schematic for the application.

Complete the procedure in the order in which the steps are listed.

Table 151

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Coolant Level</b></p> <p><b>A.</b> Remove electrical power from the ECM.</p> <p><b>B.</b> Check the coolant level. Refer to the Operation and Maintenance Manual for the correct procedure to check the coolant level.</p>	<p>Coolant level</p>	<p><b>Result:</b> The coolant level is low.</p> <p><b>Repair:</b> Add coolant according to the procedure in the Operation and Maintenance Manual.</p> <p>There may be a leak in the cooling system. Identify the source of the coolant leak. Repair the leak. Refer to Systems Operation/Testing and Adjusting, "Cooling System" for additional information.</p> <p><b>Result:</b> The coolant is at the correct level.</p> <p>For applications that have a "Coolant Level Sensor" parameter, proceed to Test Step 2. For applications that do not have a "Coolant Level Sensor" parameter, proceed to Test Step 3.</p>
<p><b>2. Verify that the "Coolant Level Sensor" Parameter is Programmed Correctly</b></p> <p>This Test Step is only applicable to applications that have a "Coolant Level Sensor" parameter.</p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Establish communication with the ECM.</p> <p><b>C.</b> Verify that the "Coolant Level Sensor" parameter is programmed to "Installed" .</p> <p><b>D.</b> Remove electrical power from the ECM.</p>	<p>Parameter programmed</p>	<p><b>Result:</b> The "Coolant Level Sensor" parameter is not programmed correctly.</p> <p><b>Repair:</b> Program the "Coolant Level Sensor" parameter to "Installed" .</p> <p>Verify that the repair eliminates the fault.</p> <p><b>Result:</b> The "Coolant Level Sensor" parameter is programmed correctly.</p> <p>Proceed to Test Step 3.</p>

(continued)

(Table 151, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Supply Voltage at the Sensor Connector</b></p> <p><b>A.</b> Disconnect the coolant level sensor at the sensor connector.</p> <p><b>B.</b> Restore electrical power to the ECM.</p> <p><b>C.</b> Measure the voltage between terminals A (sensor supply) and B (sensor return) at the harness connector for the coolant level sensor.</p> <p><b>D.</b> Remove electrical power from the ECM.</p>	<p>8.0 ± 0.5 VDC</p>	<p><b>Result:</b> The voltage measurement is not correct for the application.</p> <p><b>Repair:</b> The sensor supply voltage is not reaching the sensor. There is a fault in the circuit for the sensor supply. Repair the wiring between the sensor and the ECM.</p> <p><b>Result:</b> The voltage measurement is correct for the application.</p> <p>The correct supply voltage is reaching the sensor. Proceed to Test Step 4.</p>
<p><b>4. Short the Signal Wire to Ground and Monitor the Status for "Coolant Level"</b></p> <p><b>A.</b> Fabricate a jumper wire that is long enough to create a short circuit between two terminals at the coolant level sensor harness connector. Crimp connector pins to each end of the jumper wire.</p> <p><b>B.</b> Install the jumper wire between terminals B (sensor return) and C (sensor signal) on the harness connector for the coolant level sensor.</p> <p><b>C.</b> Restore electrical power to the ECM.</p> <p><b>D.</b> Monitor the status of "Coolant Level" on the electronic service tool while the jumper wire is installed. Wait at least 30 seconds for activation of the status indicator.</p> <p><b>E.</b> Remove the jumper wire. Connect the harness connector for the coolant level sensor.</p>	<p>Status change</p>	<p><b>Result:</b> The status changes from "LOW" to "OK" when the jumper wire is installed. The ECM and the wiring harness to the coolant level sensor are OK.</p> <p><b>Repair:</b> Replace the coolant level sensor. Verify that the repair eliminates the fault.</p> <p><b>Result:</b> The status does not change from "LOW" to "OK" when the jumper wire is installed.</p> <p><b>Repair:</b> The fault is between the ECM and the sensor connector. Repair the wiring. Verify that the repair eliminates the fault.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

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## Cooling Fan Control - Test (Hydraulic Driven Fan)

This procedure is only applicable to engines with a hydraulic driven fan.

Use this procedure to troubleshoot the electrical system if a problem is suspected with the engine fan control solenoids. Use this procedure if one of the diagnostic codes in Table 152 is active.

Table 152

<b>Diagnostic Codes for Cooling Fan Control</b>		
<b>J1939 Code</b>	<b>Code Description</b> (code descriptions may vary)	<b>Comments</b>
4212-5	Engine Cooling Fan Solenoid : Current Below Normal	The Electronic Control Module (ECM) detects an open circuit in the circuit for the engine fan control solenoid. The ECM sends minimum current to the fan control solenoid. The code is logged.
4212-6	Engine Cooling Fan Solenoid : Current Above Normal	The ECM detects a short circuit to ground in the circuit for the engine fan control solenoid. The ECM sends minimum current to the fan control solenoid. The code is logged.

The ECM monitors engine coolant temperature, intake manifold air temperature, and hydraulic oil temperature. The ECM monitors the sensors to determine the correct speed for the engine cooling fan.

The ECM controls the speed of the fan by controlling the current to the engine fan control solenoid. The engine fan control solenoid controls the amount of pressure to the fan motor by allowing oil to bypass the fan motor. The fan pump drives the fan. When the ECM outputs minimum current to the engine fan control solenoid, less oil is bypassed. The fan motor will now drive the fan at a higher rpm. When the ECM outputs maximum current to the engine fan control solenoid, more oil is bypassed. The fan motor will now drive the fan at a lower rpm.

If the ECM detects a system fault, the ECM provides minimum current to the solenoid. Minimum current ensures a maximum fan speed while the fault condition exists.

An override is available in the electronic service tool. The override allows the fan to be manually changed from the minimum to the maximum rpm.

During the following procedure, refer to the electrical schematic for the application.

Complete the procedure in the order in which the steps are listed.

Table 153

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Verify that the solenoid connectors are free of debris and connected securely.</p> <p><b>C.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>D.</b> Restore the electrical power to the ECM.</p> <p><b>E.</b> Select diagnostic tests on the electronic service tool.</p> <p><b>F.</b> Select the "Override Parameters" screen.</p> <p><b>G.</b> Activate the fan override.</p> <p><b>H.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. Wait at least 30 seconds in order for the diagnostic code to become active.</p> <p><b>I.</b> Disable the fan override.</p>	Active Diagnostic Codes	<p><b>Result:</b> No diagnostic codes are active.</p> <p>The problem may have been related to a faulty connection in the harness. Carefully inspect the connectors and wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>Result:</b> A 4212-6 code is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 4212-5 code is active.</p> <p>Proceed to Test Step 3.</p>
<p><b>2. Disconnect the Connector for the Engine Fan Control Solenoid in Order to Create an Open Circuit</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Disconnect the connector for the engine fan control solenoid.</p> <p><b>C.</b> Restore the electrical power to the ECM.</p> <p><b>D.</b> Activate the fan override.</p> <p><b>E.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. Wait at least 30 seconds in order for the diagnostic code to become active.</p> <p><b>F.</b> Disable the fan override.</p>	Short circuit	<p><b>Result:</b> A 4212-6 code remains active. There is a short circuit between the harness connector for the engine fan control solenoid and the ECM.</p> <p><b>Repair:</b> Repair the connectors or wiring and/or replace the connectors or wiring. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p> <p><b>Result:</b> A 4212-6 code was active before disconnecting the connector. A 4212-5 or code became active after disconnecting the connector.</p> <p><b>Repair:</b> Replace the engine fan control solenoid. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>
<p><b>3. Create a Short at the Connector for the Engine Fan Control Solenoid</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Fabricate a jumper wire that is long enough to create a short between the terminals of the connector for the engine fan control solenoid. Crimp connector pins to each end of the jumper wire.</p> <p><b>C.</b> Install the jumper wire between terminal 1 (engine fan control solenoid) and terminal 2 (solenoid return) on the harness side of the connector.</p> <p><b>D.</b> Restore the electrical power to the ECM.</p>	Open Circuit	<p><b>Result:</b> The 4212-5 or code remains active with the jumper in place.</p> <p><b>Repair:</b> Repair the connectors or wiring and/or replace the connectors or wiring. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p> <p><b>Result:</b> A 4212-6 or code is active when the jumper wire is installed. A 4212-5 or code is active when the jumper wire is removed.</p> <p><b>Repair:</b> Replace the engine fan control solenoid. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p>

(continued)

(Table 153, contd)

Troubleshooting Test Steps	Values	Results
<p>E. Activate the fan override.</p> <p>F. Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. Wait at least 30 seconds in order for the diagnostic code to become active.</p> <p>Disable the fan override. Remove the jumper wire.</p>		If the fault is still present, contact the Dealer Solutions Network (DSN).

i07381356

## Cooling Fan Control - Test (Viscous Clutch Fan)

This procedure is only applicable to engines with a viscous clutch driven fan.

Use this procedure to troubleshoot the electrical system if a problem is suspected with the engine fan control solenoids. Use this procedure if one of the diagnostic codes in Table 154 is active.

Table 154

Diagnostic Codes for Cooling Fan Control		
J1939 Code	Code Description (code descriptions may vary)	Comments
647-5	Engine Fan Clutch Output Device Driver : Current Below Normal	The Electronic Control Module (ECM) detects an open circuit in the circuit for the engine fan control solenoid. The ECM sends minimum current to the fan control solenoid. The code is logged.
647-6	Engine Fan Clutch Output Device Driver : Current Above Normal	The ECM detects a short circuit to ground in the circuit for the engine fan control solenoid. The ECM sends minimum current to the fan control solenoid. The code is logged.

The following background information is related to this procedure:

### Viscous Clutch Cooling Fan Solenoid

The viscous clutch cooling fan solenoid controls the engagement of the clutch that drives the engine cooling fan. The ECM determines the desired fan speed based on the ATAAC temperature and the coolant temperature. The viscous clutch cooling fan solenoid is controlled by a PWM signal from the ECM.



Table 155

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Verify that the solenoid connectors are free of debris and connected securely.</p> <p><b>C.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>D.</b> Restore the electrical power to the ECM.</p> <p><b>E.</b> Select diagnostic tests on the electronic service tool.</p> <p><b>F.</b> Select the "Override Parameters" screen.</p> <p><b>G.</b> Activate the fan override.</p> <p><b>H.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. Wait at least 30 seconds in order for the diagnostic code to become active.</p> <p><b>I.</b> Disable the fan override.</p>	Active Diagnostic Codes	<p><b>Result:</b> No diagnostic codes are active.</p> <p>The problem may have been related to a faulty connection in the harness. Carefully inspect the connectors and wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>Result:</b> A 647-6 code is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 647-5 code is active.</p> <p>Proceed to Test Step 3.</p>
<p><b>2. Disconnect the Connector for the Engine Fan Control Solenoid in Order to Create an Open Circuit</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Disconnect the connector for the engine fan control solenoid.</p> <p><b>C.</b> Restore the electrical power to the ECM.</p> <p><b>D.</b> Activate the fan override.</p> <p><b>E.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. Wait at least 30 seconds in order for the diagnostic code to become active.</p> <p><b>F.</b> Disable the fan override.</p>	Short circuit	<p><b>Result:</b> A 647-6 code remains active. There is a short circuit between the harness connector for the engine fan control solenoid and the ECM.</p> <p><b>Repair:</b> Repair the connectors or wiring and/or replace the connectors or wiring. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p> <p><b>Result:</b> A 647-6 code was active before disconnecting the connector. A 647-5 code became active after disconnecting the connector.</p> <p><b>Repair:</b> Replace the engine fan control solenoid. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>
<p><b>3. Create a Short at the Connector for the Engine Fan Control Solenoid</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Fabricate a jumper wire that is long enough to create a short between the terminals of the connector for the engine fan control solenoid. Crimp connector pins to each end of the jumper wire.</p> <p><b>C.</b> Install the jumper wire between terminal 1 (engine fan control solenoid) and terminal 2 (solenoid return) on the harness side of the connector.</p> <p><b>D.</b> Restore the electrical power to the ECM.</p>	Open Circuit	<p><b>Result:</b> The 647-5 code remains active with the jumper in place.</p> <p><b>Repair:</b> Repair the connectors or wiring and/or replace the connectors or wiring. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p> <p><b>Result:</b> A 647-6 code is active when the jumper wire is installed. A 647-5 code is active when the jumper wire is removed.</p> <p><b>Repair:</b> Replace the engine fan control solenoid. Reset all active codes and clear all logged codes. Verify that the fault is resolved.</p>

(continued)

(Table 155, contd)

Troubleshooting Test Steps	Values	Results
<p>E. Activate the fan override.</p> <p>F. Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. Wait at least 30 seconds in order for the diagnostic code to become active.</p> <p>Disable the fan override. Remove the jumper wire.</p>		If the fault is still present, contact the Dealer Solutions Network (DSN).

i06925581

## Cooling Fan Speed - Test

Use this procedure to troubleshoot the electrical system if a problem is suspected with the cooling fan speed sensor. Also use this procedure if the diagnostic code in Table 156 is active or easily repeated.

Table 156

Diagnostic Code Table for Cooling Fan Speed			
J1939 Code	PDL Code	Code Description	Comments
1639-17	E1363 (1)	Fan Speed : Low - least severe (1)	The code is logged.

The engine cooling fan speed sensor provides a signal to the Electronic Control Module (ECM). The ECM controls fan speed by varying the current to the fan control solenoid.

The engine cooling fan speed sensor receives a supply voltage from the ECM. The sensor outputs a frequency that is directly proportional to fan speed.

During the following procedure, refer to the electrical schematic for the application.

Table 157

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	Tachometer Kit	1

Complete the procedure in the order in which the steps are listed.

Table 158

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Status of the Engine Fan Speed</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Access the "Fan Override Test" under the "Diagnostics" menu.</p> <p><b>E.</b> Start the "Fan Override Test" on Cat ET. Set the fan speed to 500 rpm.</p> <p><b>F.</b> Use Tooling (A) to determine the actual speed of the fan.</p> <p><b>G.</b> Compare the engine fan speed that is reported by the electronic service tool to the actual engine fan speed that is reported by Tooling (A).</p> <p><b>H.</b> Deactivate the "Fan Override Test" .</p> <p><b>I.</b> Turn the keyswitch to the OFF position.</p>	<p>Fan Speed</p>	<p><b>Result:</b> The engine fan speed is within <math>\pm 50</math> rpm.</p> <p>The sensor is operating correctly. There may be an intermittent electrical problem in a connector or in the harness. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>Result:</b> The engine fan speed is not within <math>\pm 50</math> rpm.</p> <p>Proceed to Test Step 2.</p>

(continued)

(Table 158, contd)

<p><b>2. Check the Sensor Supply Voltage at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the sensor connector from the wiring harness.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the sensor supply voltage between terminal 2 and terminal 3.</p>	<p>Supply Voltage</p>	<p><b>Result:</b> The supply voltage is not reaching the sensor.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Sensor Supply - Test".</p> <p><b>Result:</b> The supply voltage is reaching the sensor.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Signal Frequency at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove the wire from terminal 1 on the sensor side of the connector. Connect the sensor connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Access the "Fan Override Test" under the "Diagnostics" menu on the electronic service tool.</p> <p><b>E.</b> Start the "Fan Override Test" on the electronic service tool. Set the fan speed to 800 rpm.</p> <p><b>F.</b> Use a multimeter to measure the frequency between the signal wire from the sensor and engine ground.</p> <p><b>G.</b> Deactivate the "Fan Override Test" .</p> <p><b>H.</b> Turn the keyswitch to the OFF position.</p> <p><b>I.</b> Restore all connectors and wiring to the original configuration.</p>	<p>Sensor Frequency</p>	<p><b>Result:</b> The frequency is approximately 80 Hz.</p> <p>The engine cooling fan speed sensor is generating the correct signal.</p> <p><b>Repair:</b> Repair the harness or replace the harness.</p> <p>Verify that the fault is resolved.</p> <p><b>Result:</b> The frequency is not approximately 80 Hz.</p> <p><b>Repair:</b> Replace the fan speed sensor.</p> <p>Verify that the fault is resolved.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i06163220

## Data Link - Test

Use this procedure if the electronic service tool will not communicate with the ECM through the data link.

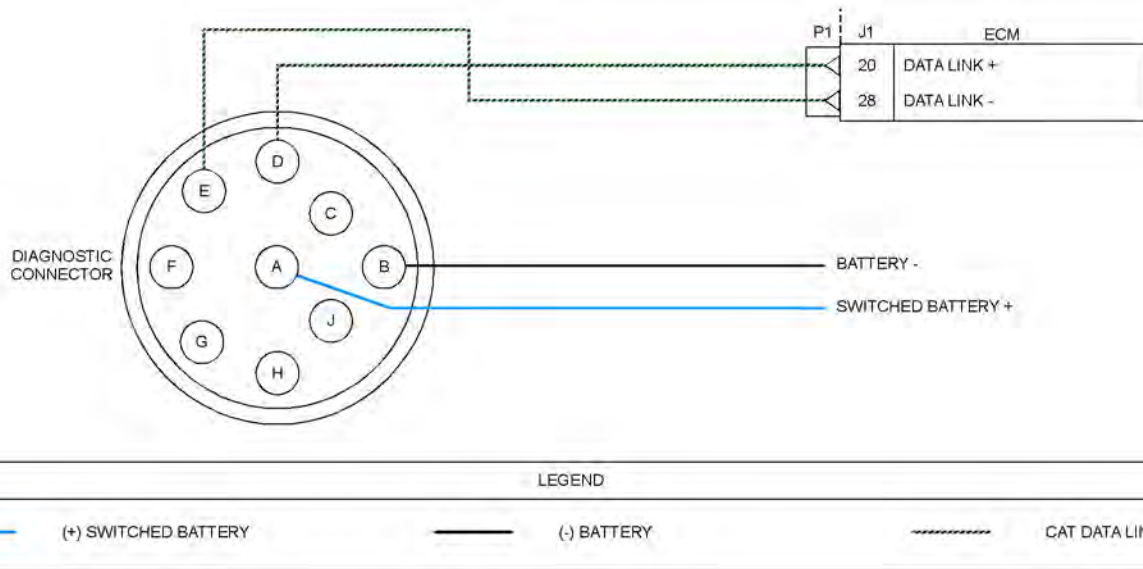


Illustration 95

g03805325

Schematic of the diagnostic connector and the data link connector for a diagnostic connector that is mounted off engine

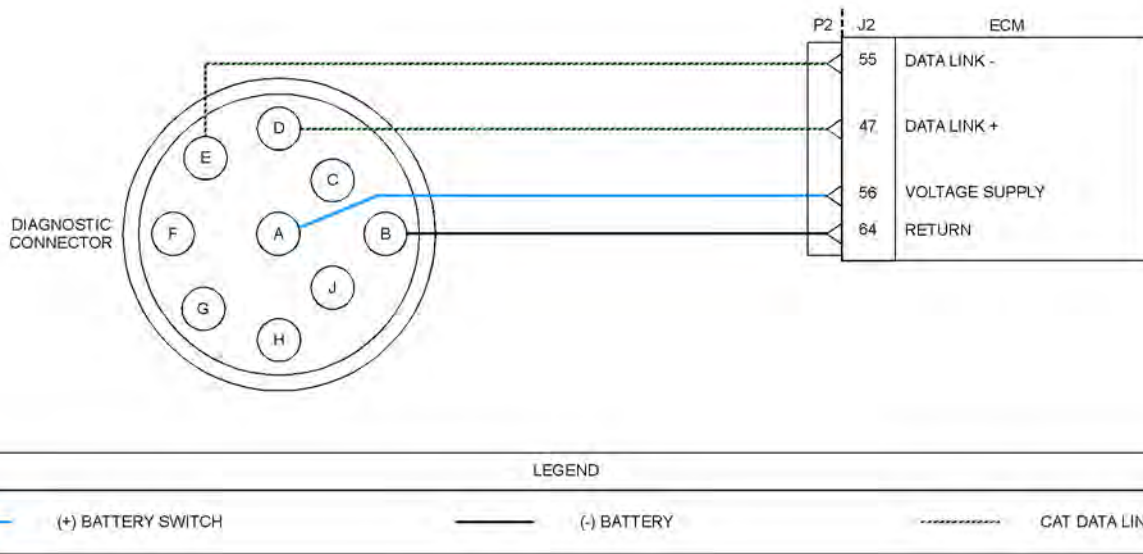


Illustration 96

g03705767

Schematic of the diagnostic connector and the data link connector for an engine mounted diagnostic connector

Table 159

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the connectors in the circuit for the data link. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link.</p> <p><b>D.</b> Check the screw for the P1 and P2 ECM connectors for correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check all of the wiring associated with the data link for abrasions and pinch points.</p>	<p>Damaged wire or connector</p>	<p><b>Result:</b> A damaged wire or damaged connector was found.</p> <p><b>Repair:</b> Repair the damaged wire or the damaged connector.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault.</p> <p><b>Result:</b> A damaged wire or damaged connector was not found.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Determine the Type of Fault in the Data Link</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector that is on the engine harness or on the application.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p>	<p>Power to the comms adapter</p>	<p><b>Result:</b> The power lamp illuminates on the communications adapter. The communications adapter is currently receiving the correct voltage.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The power lamp is not illuminated on the communications adapter. The communications adapter is not currently receiving the correct voltage.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Battery Voltage at the Diagnostic Connector</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Use a multimeter in order to measure the voltage from pin A (battery+) and pin B (ground) of the diagnostic connector.</p>	<p>11.0 VDC and 13.5 VDC for a 12 VDC system. 22.0 VDC and 27.0 VDC for a 24 VDC system.</p>	<p><b>Result:</b> The voltage is between 22.0 VDC and 27.0 VDC for a 24 V system. The voltage is between 11.0 VDC and 13.5 VDC for a 12 V system. The diagnostic connector is currently receiving the correct voltage.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The voltage is not between 22.0 VDC and 27.0 VDC for a 24 V system. The voltage is not between 11.0 VDC and 13.5 VDC for a 12 V system. The diagnostic connector is not currently receiving the correct voltage.</p> <p>Proceed to Test Step 4.</p>

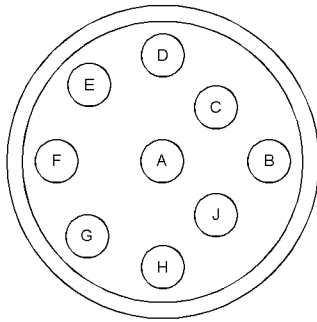


Illustration 97

g03705906

Typical view of the diagnostic connector from the wire side

- (A) Switched battery +
- (B) Battery ground (GND)
- (D) Data link +
- (E) Data link -

Table 160

Troubleshooting Test Steps	Values	Results
<p><b>4. Bypass the Wiring for the Diagnostic Connector</b></p> <p><b>A.</b> Disconnect the wires from pin A and pin B of the diagnostic connector.</p> <p><b>Note:</b> If the diagnostic connector is mounted on the engine, perform steps B to D. If the diagnostic connector is mounted off the engine, perform step E.</p> <p><b>B.</b> Disconnect the wires from P2:56 and P2:64.</p> <p><b>C.</b> Fabricate a jumper wire in order to connect pin A of the diagnostic connector to P2:56.</p> <p><b>D.</b> Fabricate a jumper wire in order to connect pin B of the diagnostic connector to P2:64.</p> <p><b>E.</b> Fabricate a jumper wire in order to connect pin "A" of the diagnostic connector to battery+ and pin "B" to the battery-.</p> <p><b>F.</b> Connect the electronic service tool to the diagnostic connector that is on the engine harness or on the application.</p> <p><b>G.</b> Turn the keyswitch to the ON position. The power lamp should illuminate on the communications adapter.</p>	<p>Other devices are OK</p>	<p><b>Result:</b> The power lamp is illuminated. The fault is in the harness.</p> <p><b>Repair:</b> Repair the faulty harness or replace the faulty harness.</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The power lamp is not illuminated.</p> <p>Proceed to Test Step 6.</p>
<p><b>5. Check the Data Link Connections</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the communications adapter from the diagnostic connector.</p> <p><b>C.</b> If the diagnostic connector is installed on the application, disconnect connector P1 from the ECM. Check the resistance between P1:20 and pin "D" on the diagnostic connector. Check the resistance between P1:28 and pin "E" on the diagnostic connector.</p> <p><b>D.</b> If the diagnostic connector is installed on the engine, disconnect P2 from the ECM. Check the resistance between P2:47 and pin "D" on the diagnostic connector. Check the resistance between P2:55 and pin "E" on the diagnostic connector.</p>	<p>Less than 10 Ohms</p>	<p><b>Result:</b> The resistances are less than 10 Ohms.</p> <p>Proceed to Test Step 6.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault.</p> <p><b>Result:</b> At least one of the resistances is greater than 10 Ohms.</p> <p><b>Repair :</b> Repair the connectors and/or the harness, or replace the connectors and/or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly connected.</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p>
<p><b>6. Change the Electronic Service Tool Components</b></p> <p><b>A.</b> If another electronic engine is available, connect the electronic service tool to the other engine. Ensure that the same cables are used.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Determine if the electronic service tool operates correctly on the other engine.</p> <p><b>C.</b> If another engine is not available, obtain a replacement communications adapter and a replacement set of cables. Ensure that the cables for the electronic service tool are a complete set.</p>	<p>Power to the comms adapter</p>	<p><b>Result:</b> The original electronic service tool works on another engine.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> A different electronic service tool works on the original engine while the engine is being tested.</p> <p><b>Repair:</b> Send the faulty electronic service tool for repairs.</p>

(continued)



(Table 160, contd)

Troubleshooting Test Steps	Values	Results
<p><b>D.</b> Install the replacement communications adapter and the set of cables for the electronic service tool and connect to the diagnostic connector.</p> <p><b>E.</b> Turn the keyswitch to the ON position.</p> <p><b>F.</b> If changing the communications adapter or the cables allows the electronic service tool to operate correctly, perform steps G to H.</p> <p><b>G.</b> Replace the components from the new set of cables with components from the original set of cables. Replace one component at a time.</p> <p><b>H.</b> Apply power to the electronic service tool after each of the components is replaced. Use this method to identify the faulty component.</p> <p><b>I.</b> If changing the cables does not allow the electronic service tool to operate correctly, connect another electronic service tool.</p> <p><b>J.</b> Turn the keyswitch to the ON position.</p>		

 **WARNING**

**Batteries give off flammable fumes which can explode.**

**To avoid injury or death, do not strike a match, cause a spark, or smoke in the vicinity of a battery.**

**NOTICE**

Do not connect the bypass harness to the battery until the in-line fuse has been removed from the Battery + line. If the fuse is not removed before connection to the battery, a spark may result.

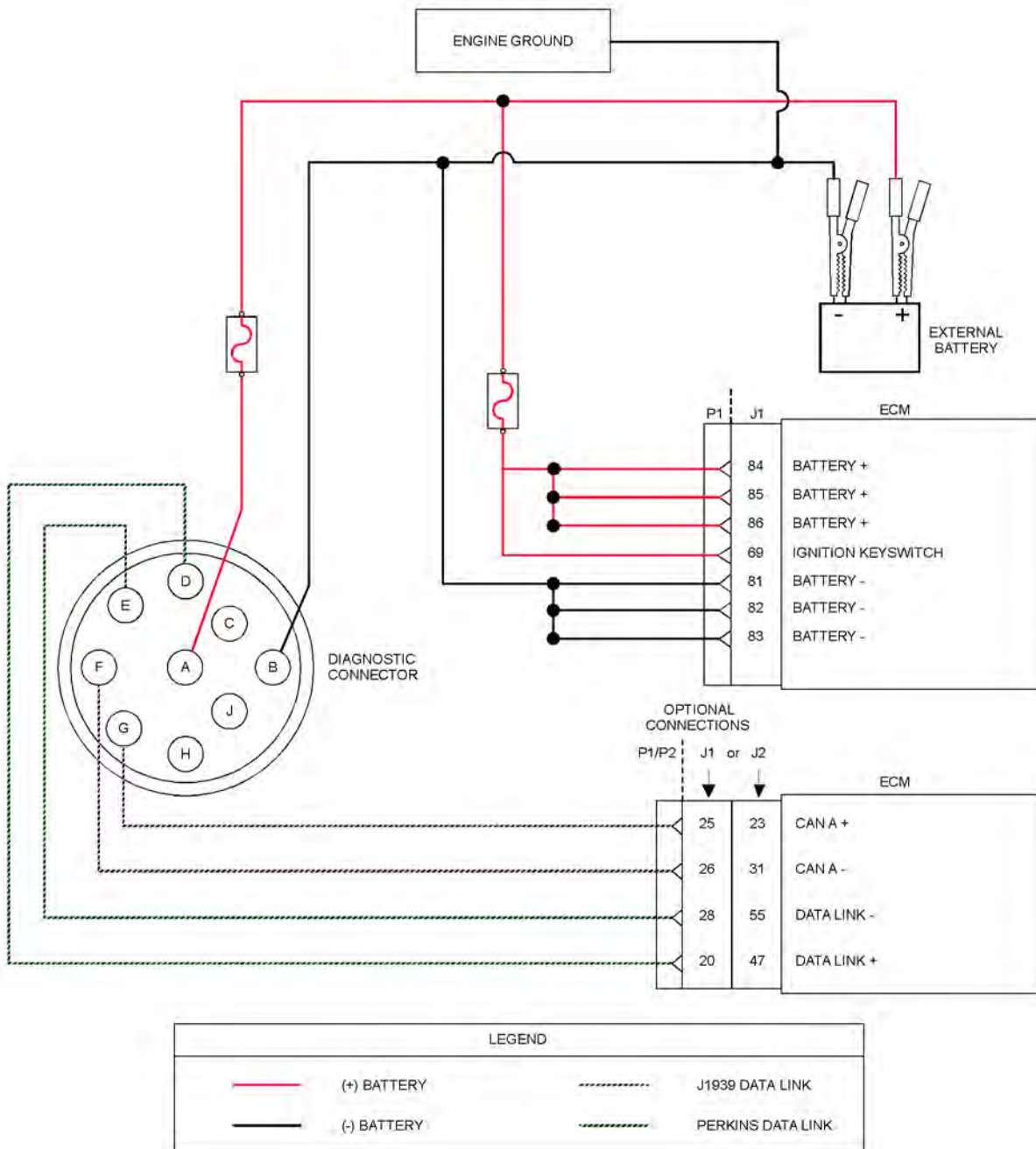


Illustration 98  
Schematic of the bypass harness connector

g03732687

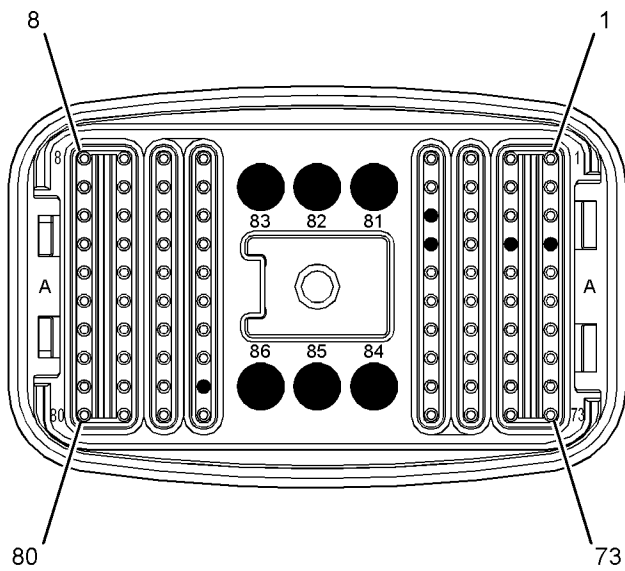


Illustration 99

g03134740

Typical view of the pin locations on connector P1 for the bypass harness

- (20) Data link +
- (25) J1939 (CAN) +
- (26) J1939 (CAN) -
- (28) Data link -
- (69) Keyswitch
- (81) Battery ground (GND)
- (82) Battery ground (GND)
- (83) Battery ground (GND)
- (84) Battery +
- (85) Battery +
- (86) Battery +

Table 161

Troubleshooting Test Steps	Values	Results
<p><b>7. Connect an Electronic Service Tool and the ECM to another Battery</b></p> <p><b>Note:</b> Refer to Illustration 98 for details of the bypass harness.</p> <p><b>A.</b> Connect the battery wires from the bypass harness of the electronic service tool to a different battery that is not on the engine.</p>	<p>Bypass harness</p>	<p><b>Result:</b> The electronic service tool is operating correctly.</p> <p><b>Repair :</b> Refer to Troubleshooting, "Electrical Power Supply - Test".</p> <p><b>Result:</b> The electronic service tool is not operating correctly.</p> <p><b>Repair:</b> Make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, "Flash Programming".</p> <p>Remove all temporary jumpers and reconnect all connectors.</p> <p>Contact the Dealer Solutions Network (DSN).</p> <p><b>Note:</b> This consultation can greatly reduce the repair time.</p> <p>If the DSN recommends the use of a test ECM, install a test ECM. Refer to Troubleshooting, "Replacing the ECM".</p> <p>Use the electronic service tool to recheck the system for active diagnostic codes.</p> <p>If the fault is eliminated with the test ECM, reconnect the suspect ECM.</p> <p>If the fault returns with the suspect ECM, replace the ECM.</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p>If the fault is still present, contact the DSN.</p>

i08134332

## Data Link Configuration Status - Test

Use this procedure to troubleshoot a diagnostic code for a special instruction. Use this procedure if one of the following diagnostic codes are active.

**Note:** Some of the following codes may not be applicable for certain applications.

Table 162

Diagnostic Trouble Codes for the Data Link Configuration Status			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
639-14	247-14	J1939 Network #1 : Special Instruction	The data received from the CAN A data bus is not in the correct format. The code is logged.
1235-14	5856-14	J1939 Network #3 : Special Instruction	The data received from the CAN C data bus is not in the correct format. The code is logged.
3360-14	3820-14	Aftertreatment #1 DEF Controller : Special Instruction	The data received from the DCU is not in the correct format. The warning lamp is illuminated.
5576-14	3468-14	Aftertreatment #1 Identification : Special Instruction	The data received from the aftertreatment ID module is not in the correct format. The code is logged.
5588-14	E1132 (2)	Proprietary Network #2 : Special Instruction	The data received from the DCU is incompatible. The warning lamp will come on. The code is logged.

Complete the procedure in the order in which the steps are listed.

Table 163

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for an Associated -9 Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM) for the engine.</p> <p><b>B.</b> Check for active diagnostic codes.</p>	Associated Trouble code	<p><b>Result:</b> An associated -9 code is logged.</p> <p><b>Repair:</b> Repair all associated -9 codes before continuing with this procedure. Refer to Troubleshooting, "CAN Data Link - Test".</p> <p>If a -14 code is still present after resolving the -9 code, proceed to Test Step 2.</p> <p><b>Result:</b> An associated -9 code is not logged.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Personality Module Code for Compatibility with the Application</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Select the ECM connection that is related to the logged code.</p> <p><b>C.</b> Check if the personality module code is valid for the application.</p>	Compatible personality module	<p><b>Result:</b> The code is valid for the application.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The code is not valid for the application.</p> <p><b>Repair:</b> Obtain the correct flash file and update the ECM. Reset all active codes and clear all logged codes. Return the unit to service.</p>

(continued)

## Circuit Tests

(Table 163, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p> <p><b>D.</b> Ensure that the software installed is for the correct system voltage (12 V or 24 V).</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 4.</p>
<p><b>3. Check that the Latest Available Software is Installed</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM and the Dosing Control Unit (DCU).</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p>	Software	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Turn the keyswitch to the on position.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 4.</p> <p><b>Result:</b> The latest software is installed. The software is for the correct system voltage.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Configuration Parameters</b></p> <p><b>A.</b> Check the configuration parameters to ensure that the parameters are programmed correctly. Refer to Troubleshooting, "Configuration Parameters".</p> <p><b>B.</b> Select the ECM connection that is related to the logged code.</p>	Correct configuration parameters	<p><b>Result:</b> The configuration parameters are programmed correctly.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The configuration parameters are not programmed correctly.</p> <p><b>Repair:</b> Program the parameters to function with the other modules on the data link. Reset all active codes and clear all logged codes. Return the unit to service.</p>
<p><b>5. Check for Compatibility with Any Other ECM on the Data Link</b></p> <p><b>A.</b> Use the as shipped information found in SIS web TMI to determine if any other ECM or display on the data link are incompatible.</p> <p><b>B.</b> Select the ECM connection that is related to the logged code.</p>	Compatible ECM	<p><b>Result:</b> The ECMs are not compatible.</p> <p><b>Repair:</b> Replace the incompatible ECM with the correct module. Reset all active codes and clear all logged codes. Return the unit to service.</p> <p>If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).</p>

i07066603

## DEF Control Module Power - Test

This procedure covers the following diagnostic codes:

Table 164

Diagnostic Trouble Codes for the DEF Control Module Power Supply			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5966-5	3965-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit : Current Below Normal	A low current condition has been detected on the keyswitch circuit between the engine ECM and the DCU.
5966-6	3965-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit : Current Above Normal	A high current condition has been detected on the keyswitch circuit between the engine ECM and the DCU.
6309-5	3966-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit (KSW sinking dout) : Current Below Normal	A low current condition has been detected on the keyswitch circuit between the engine ECM and the DCU.
6309-6	3966-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit (KSW sinking dout) : Current Above Normal	A high current condition has been detected on the keyswitch circuit between the engine ECM and the DCU.

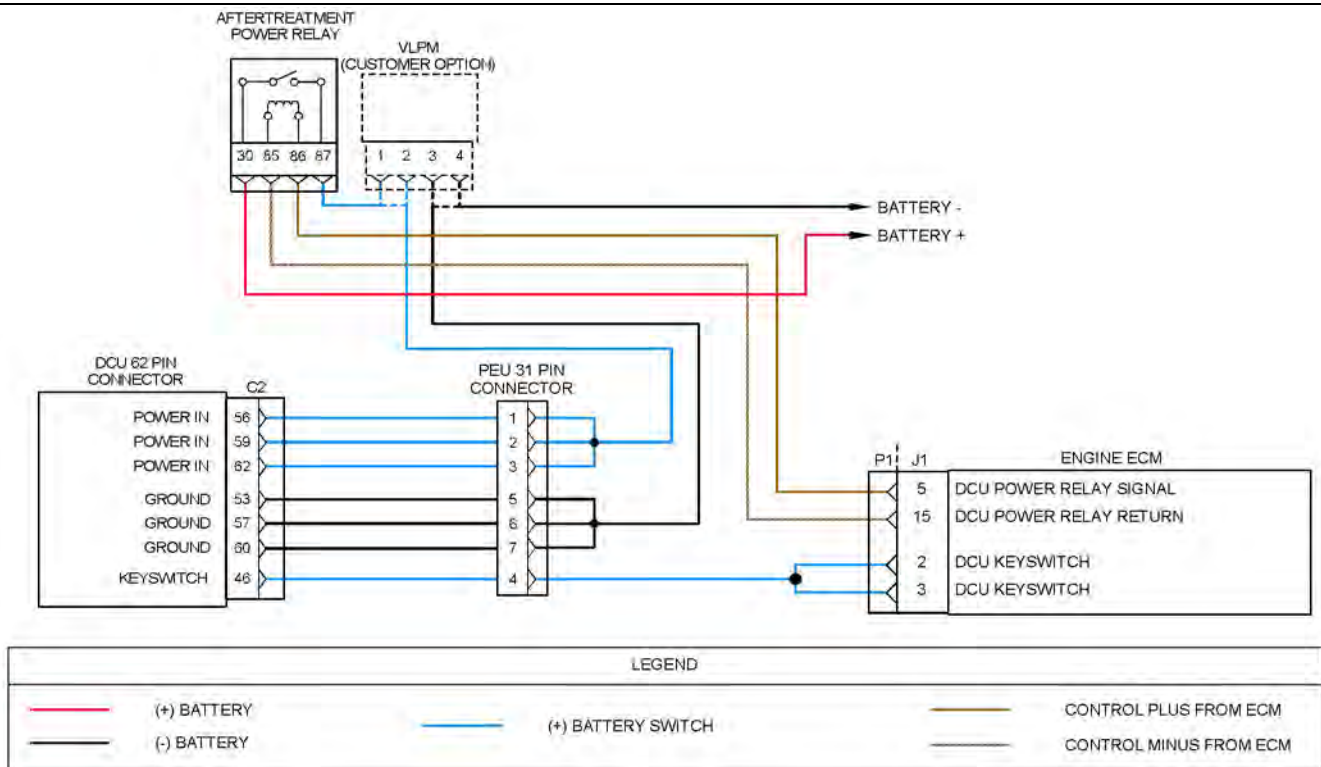


Illustration 100

Schematic for the DCU electrical power supply circuit

Not all connectors are shown. Refer to the electrical schematic.

g06206536

Table 165

Troubleshooting Procedure for the DCU Keyswitch Signal		
Troubleshooting Test Steps	Value	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the connectors in the circuit for the DEF control module.</p> <p>Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires that are associated with the DEF control module power circuit.</p> <p><b>D.</b> Check the screw for the P1 ECM connector for correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check all the wiring associated with the DEF Control module power circuit for abrasions and pinch points.</p>	Damaged wire or connector	<p><b>Result:</b> A damaged wire or damaged connector was found.</p> <p><b>Repair:</b> Repair the damaged wire or the damaged connector.</p> <p>Use the electronic service tool to clear all logged diagnostic codes.</p> <p>Use the electronic service tool to perform the "Aftertreatment System Functional Test" to verify that the repair eliminates the fault.</p> <p><b>Result:</b> A damaged wire or damaged connector was not found.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Determine the Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Download the "Warranty Report" from the ECM before troubleshooting or clearing any diagnostic trouble codes.</p> <p><b>C.</b> Determine the diagnostic trouble code that is active.</p>	Diagnostic Trouble Code	<p><b>Result:</b> A -5 diagnostic code is active.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> A -6 diagnostic code is active.</p> <p>Proceed to Test Step 5.</p>
<p><b>3. Create a Short Circuit at the 31-Pin Connector</b></p> <p><b>A.</b> Disconnect the 31-pin connector.</p> <p><b>B.</b> Fabricate a jumper wire. Install the jumper wire between terminal 4 on the 31-pin connector (ECM side) and a suitable ground.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to check for active diagnostic codes.</p> <p><b>Note:</b> Other diagnostic codes will be active with the DCU connector disconnected. Disregard all other codes and only look for diagnostic codes that relate to the DCU keyswitch.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Diagnostic codes	<p><b>Result:</b> A -6 diagnostic code is active with the jumper installed.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> A -5 diagnostic code is active with the jumper installed.</p> <p>Remove the jumper wire. Proceed to Test Step 4.</p>

(continued)



(Table 165, contd)

<p><b>4. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Disconnect the P1 connector from the ECM.</p> <p><b>B.</b> Measure the resistance between terminal 4 on the 31-pin connector (ECM side) and P1:2.</p> <p><b>C.</b> Measure the resistance between terminal 4 on the 31-pin connector (ECM side) and P1:3.</p>	Less than 2 Ohms	<p><b>Result:</b> Both resistance measurements are less than 2 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> At least one of the resistance measurements is greater than 2 Ohms.</p> <p><b>Repair:</b> Replace the wiring between the 31-pin connector and the ECM.</p>
<p><b>5. Create an Open Circuit at the 31 Pin Connector</b></p> <p><b>A.</b> Disconnect the 31-pin connector.</p> <p><b>B.</b> Remove the wire from terminal 4 of the 31-pin connector on the engine ECM side of the connector.</p> <p><b>C.</b> Reconnect the 31-pin connector.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Use the electronic service tool to check for active diagnostic codes.</p> <p><b>F.</b> Turn the keyswitch to the OFF position.</p>	Diagnostic codes	<p><b>Result:</b> A -5 diagnostic code is active with the wire disconnected.</p> <p>Reconnect the disconnected wire. Proceed to Test Step 8.</p> <p><b>Result:</b> The -6 diagnostic code is still active with the wire disconnected.</p> <p>Reconnect the disconnected wire. Proceed to Test Step 6.</p>
<p><b>6. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Disconnect the P1 connector from the ECM.</p> <p><b>B.</b> Measure the resistance between P1:2 and all other terminals on the P1 connector except P1:3.</p> <p><b>C.</b> Measure the resistance between P1:3 and all other terminals on the P1 connector apart from P1:2.</p>	Greater than 1 K Ohms	<p><b>Result:</b> All resistance measurements are greater than 1 K Ohms.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> At least one of the resistance measurements is less than 1 K Ohms.</p> <p><b>Repair:</b> Replace the wiring between the 31-pin connector and the ECM.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p>

(continued)

(Table 165, contd)

<p><b>7. Check the Wiring for a Short to Ground</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P1 connector from the ECM.</p> <p><b>C.</b> Measure the resistance between P1:2 and a known ground source.</p> <p><b>D.</b> Measure the resistance between P1:3 and a known ground source.</p>	<p>Greater than 1 K Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is less than 1 K Ohms. There is a short to ground in the wiring between the 31-pin connector and the ECM.</p> <p><b>Repair:</b> Replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> Both resistance measurements are greater than 1 K Ohms.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check if a Replacement PEU Eliminates the Fault</b></p> <p><b>A.</b> Make sure that the latest flash file for the application is installed in the DCU.</p> <p><b>B.</b> Contact the Dealer Solutions Network (DSN). <b>Note:</b> This consultation can greatly reduce the repair time.</p> <p><b>C.</b> If the DSN recommends the use of a replacement PEU, install a replacement PEU.</p> <p><b>D.</b> Turn the keyswitch to the ON position. Use the electronic service tool to verify that the repair eliminates the fault.</p>	<p>Fault eliminated</p>	<p><b>Result:</b> The fault is eliminated with the replacement PEU.</p> <p><b>Repair:</b> Reconnect the suspect PEU. If the fault returns with the suspect PEU, permanently install the replacement PEU.</p> <p><b>Result:</b> The fault is still present with the replacement PEU.</p> <p>Do not use the replacement PEU. Contact the DSN.</p>

i07561352

## DEF Line Heater - Test

The Dosing Control Unit (DCU) monitors the voltage and current flow to the Diesel Exhaust Fluid (DEF) line heaters. Refer to Table 166 . Faults are notified to the engine Electronic Control Module (ECM) over the J1939 data bus.

The engine ECM sets a diagnostic trouble code if the current flow through a circuit is incorrect. A -5 code indicates that the current flow through the circuit is low and there is an open circuit. A -6 code indicates that the current flow through the circuit is high and there is a short in the circuit.

Table 166 lists the diagnostic codes for incorrect current flow.

**Note:** Sometimes a -5 code may be generated for a high current condition or a -6 code may be generated for a low current condition. If either code is active for one of the DEF line heaters, follow the troubleshooting for both codes.

Table 166

Diagnostic Trouble Codes for DEF Line Heater			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4354-5	3110-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Below Normal	This code indicates that there is a fault in the #1 (suction) line heater circuit that is probably an open circuit.
4354-6	3110-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Above Normal	This code indicates that there is a fault in the #1 (suction) line heater circuit that is probably a short circuit.
4355-5	3111-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Below Normal	This code indicates that there is a fault in the #2 (delivery) line heater circuit that is probably an open circuit.
4355-6	3111-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Above Normal	This code indicates that there is a fault in the #2 (delivery) line heater circuit that is probably a short circuit.
4356-5	3112-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Below Normal	This code indicates that there is a fault in the #3 (return) line heater circuit that is probably an open circuit.
4356-6	3112-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Above Normal	This code indicates that there is a fault in the #3 (return) line heater circuit that is probably a short circuit.

Follow the troubleshooting procedure to identify the root cause of the fault.

**Note:** Refer to Troubleshooting, “Component Location” for the locations of the components listed in this procedure.

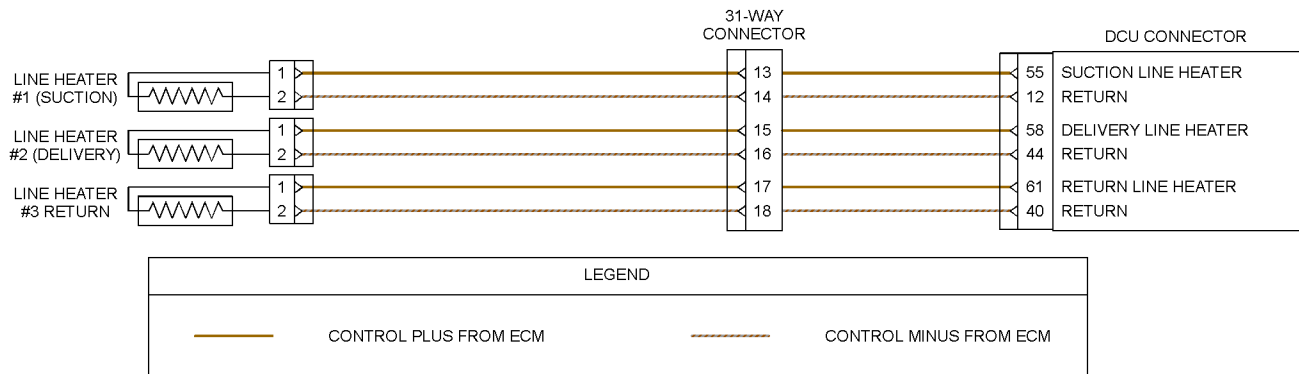


Illustration 101

g03828378

Schematic diagram of the DEF line heater circuit

Table 167

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Battery Voltage</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Use a suitable multimeter to measure the battery voltage.</p>	<p>At least 12.5 V for a 12 V system At least 25V for a 24V system</p>	<p><b>Result:</b> The battery voltage is lower than the expected range.</p> <p><b>Repair:</b> Refer to Troubleshooting, Battery Problem to investigate the cause of low battery voltage.</p> <p><b>Result:</b> The battery voltage is within the expected range.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Thoroughly inspect the 31-pin connector for the PEU. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>B.</b> Thoroughly inspect the connectors for the DEF line heaters. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the 31-pin connector and the DEF line heater connectors that are associated with the active diagnostic code.</p> <p><b>D.</b> Ensure that the DCU connector is securely connected and locked in place.</p> <p><b>E.</b> Check the harness for corrosion, abrasion, and pinch points from the DEF line heaters to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to override each DEF line heater.</p> <p><b>E.</b> Verify if any of the diagnostic codes that are listed in Table 166 are active.</p> <p><b>F.</b> Turn the keyswitch to the OFF position.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A -5 diagnostic code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> A -6 diagnostic is active.</p> <p>Proceed to Test Step 7.</p>

(continued)

(Table 167, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Create a Short Circuit at the Harness Connector for the DEF Line Heater</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect line heater.</p> <p><b>C.</b> Fabricate a jumper wire that is 150 mm (6 inch) long.</p> <p><b>D.</b> Install the wire between the two pins on the harness connector for the suspect line heater to create a short circuit.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Use the electronic service tool to override the suspect line heater.</p> <p><b>F.</b> Check for active diagnostic codes.</p> <p><b>G.</b> Remove the jumper wire from the connector for the line heater.</p>	Open circuit	<p><b>Result:</b> A -5 diagnostic code was active before installing the jumper. A -6 diagnostic code is active when the jumper is installed - There is a fault in the line heater.</p> <p><b>Repair:</b> Temporarily connect a replacement for the suspect line heater to the harness.</p> <p>Turn the keyswitch to the ON position. Use the electronic service tool to override the suspect line heater and check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed.</p> <p>If the fault is eliminated, reconnect the suspect line heater. If the fault returns, permanently install the replacement line heater. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>Result:</b> A -5 diagnostic code is still active with the jumper installed.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the 31-pin connector and the connector for the suspect line heater.</p> <p><b>C.</b> Use a multimeter to check the resistance between the supply terminal on the 31-pin connector and the supply terminal on the line heater harness connector. Refer to Illustration 101 .</p> <p><b>D.</b> Use a multimeter to check the resistance between the return terminal on the 31-pin connector and the return terminal on the line heater harness connector. Refer to Illustration 101 .</p> <p><b>E.</b> Reconnect the connectors.</p>	Less than 2 Ohms	<p><b>Result:</b> One of the measured resistances is greater than 2 Ohms - There is a fault in the wiring between the 31-pin connector and the suspect line heater.</p> <p><b>Repair:</b> Replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are less than 2 Ohms.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Circuit Tests

(Table 167, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Check the Wiring for a Short to Supply Voltage</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect line heater.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use a multimeter to measure the voltage between the line heater supply terminal on the harness connector and a known ground source. The measurement should indicate battery voltage.</p> <p><b>E.</b> Use a multimeter to measure the voltage between the line heater ground terminal on the harness connector and a known ground source. The measurement should indicate 0V.</p>	<p>Battery voltage for the supply terminal</p> <p>0V for the line heater ground terminal</p>	<p><b>Result:</b> At least one of the measurements does indicate the expected value. There is a short in the wiring between the 31-pin connector and the suspect line heater.</p> <p><b>Repair:</b> Replace the faulty wiring.</p> <p><b>Result:</b> The voltage measurements indicate the expected values.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Create an Open Circuit at the DEF Line Heater</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect line heater.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Use the electronic service tool to override the suspect line heater.</p> <p><b>D.</b> Check for active diagnostic codes.</p>	<p>Short circuit</p>	<p><b>Result:</b> A -6 diagnostic code was active before disconnecting the line heater. A -5 diagnostic code is active with the line heater disconnected.</p> <p><b>Repair:</b> Temporarily connect a replacement for the suspect valve to the harness.</p> <p>Turn the keyswitch to the ON position. Use the electronic service tool to override the suspect line heater and check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed.</p> <p>If the fault is eliminated, reconnect the suspect line heater. If the fault returns, permanently install the replacement line heater. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>Result:</b> A -6 diagnostic code is still active with the line heater disconnected.</p> <p>Proceed to Test Step 8.</p>

(continued)

(Table 167, contd)

Troubleshooting Test Steps	Values	Results
<p><b>8. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the 31-pin connector and the connector for the suspect line heater.</p> <p><b>C.</b> Use a multimeter to check the resistance between the suspect supply terminal on the 31-pin connector and all other terminals on the connector. Refer to Illustration 101 .</p> <p><b>D.</b> Use a multimeter to check the resistance between the suspect return terminal on the 31-pin connector and all other terminals on the connector. Refer to Illustration 101 .</p> <p><b>E.</b> Reconnect the connectors.</p>	Greater than 100 Ohms	<p><b>Result:</b> At least one of the resistance measurements is less than 100 Ohms - The fault is in the wiring between the 31-pin connector and the suspect line heater.</p> <p><b>Repair:</b> Repair the faulty harness or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 100 Ohms.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Check the Wiring for a Short to Ground</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect line heater.</p> <p><b>C.</b> Use a multimeter to measure the resistance between the line heater supply terminal on the harness connector and a known ground source.</p>	Greater than 1 k Ohm	<p><b>Result:</b> The measured resistance is less than 1 k Ohm. There is a short to ground in the wiring for the suspect line heater.</p> <p><b>Repair:</b> Replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is greater than 1 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i08134327

## DEF Pump - Test

The Dosing Control Unit (DCU) monitors and controls the Diesel Exhaust Fluid (DEF) pump via voltages, current, and PWM signals.

The DCU sets a diagnostic trouble code if an error is detected in one or more of these parameters.

A -5 code indicates that the current flow through the circuit is low and there is an open in the circuit. A -6 code indicates that the current flow through the circuit is high and there is a short in the circuit. These codes can be activated only when the DCU is sending a command to the DEF pump.

Table 168 lists the diagnostic codes for the DEF pump circuit.

Table 168

Diagnostic Trouble Codes for the DEF Pump			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4374-5	3118-5	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Below Normal	This code indicates low current to the DEF pump motor. The code is logged.
4374-6	3118-6	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Above Normal	This code indicates high current to the DEF pump motor. The code is logged.
5706-5	3607-5	Aftertreatment #1 Diesel Exhaust Fluid Pump Heater : Current Below Normal	This code indicates low current to the DEF pump heater. The code is logged.
5706-6	3607-6	Aftertreatment #1 Diesel Exhaust Fluid Pump Heater : Current Above Normal	This code indicates high current to the DEF pump heater. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 169

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Determine the Diagnostic Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the engine Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools"</p> <p><b>B.</b> Establish communication between the electronic service tool and the Dosing Control Unit (DCU).</p> <p><b>C.</b> Look for active codes.</p>	Diagnostic Trouble Codes	<p><b>Result:</b> There is an active or logged XXXX-5 or XXXX-6 diagnostic code.</p> <p>Proceed to Test Step 3.</p>

(continued)



(Table 169, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Battery Voltage</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Use a suitable multimeter to measure the battery voltage.</p>	<p>At least 12.5 V for a 12 V system</p> <p>At least 25V for a 24V system</p>	<p><b>Result:</b> The battery voltage is lower than the expected range.</p> <p><b>Repair:</b> Refer to Troubleshooting, Battery Problem to investigate the cause of low battery voltage.</p> <p><b>Result:</b> The battery voltage is within the expected range.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Thoroughly inspect the 31-pin connector for the PEU. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>B.</b> Thoroughly inspect the connectors for the coolant diverter valve and the DEF injector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the 31-pin and solenoid connectors associated with the diagnostic code.</p> <p><b>D.</b> Ensure that the DCU connector is securely connected and locked in place.</p> <p><b>E.</b> Check the harness for corrosion, abrasion, and pinch points from the solenoids to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes.</p> <p>Use the electronic service tool to perform the "Aftertreatment System Functional Test" to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the DEF Pressure</b></p> <p><b>A.</b> Connect to the electronic service tool. If necessary, refer to Troubleshooting, Electronic Service Tools.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool to check the "DEF Pressure" parameter.</p>	<p>-10 kPa (-1.5 psi) to 10 kPa (1.5 psi)</p>	<p><b>Result:</b> The DEF pressure is between -10 kPa (-1.5 psi) and 10 kPa (1.5 psi).</p> <p><b>Repair:</b> Start the engine and allow the DEF system to prime. Stop the engine and wait for the wait-to disconnect lamp to switch off. Turn the keyswitch to the ON position. Check for an active 4334-20 or 4334-21 diagnostic code. If the diagnostic code is no longer active, return the engine to service. If the diagnostic code is still active, proceed to Test Step 6.</p>

(continued)

(Table 169, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Replace the Pump and Electronics Unit (PEU)</b></p> <p><b>Note:</b> The PEU is a non-serviceable unit. If a fault is suspected in the PEU, the unit must be replaced.</p> <p><b>A.</b> Turn the keyswitch to the OFF position. Wait until the wait-to-disconnect lamp switches off.</p> <p><b>B.</b> Isolate the power to the DCU.</p> <p><b>C.</b> Replace the PEU.</p>	Diagnostic Trouble Codes	<p><b>Result:</b> The PEU was replaced.</p> <p>Proceed to Test Step 7.</p>
<p><b>6. Perform a DEF Dosing System Verification Test</b></p> <p><b>A.</b> Turn the keyswitch to the "ON" position. Do not start the engine.</p> <p><b>B.</b> Connect to the "Diesel Exhaust Fluid Controller #1 ECM" using the electronic service tool.</p> <p><b>C.</b> Perform the "DEF Dosing System Verification Test" .</p>	Diagnostic codes	<p><b>Result:</b> The code did not return.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The code returned.</p> <p>Contact the Dealer Solution Network (DSN).</p>

i08134328

## DEF Pump Pressure Sensor - Test

Table 170 lists the diagnostic codes for the Diesel Exhaust Fluid (DEF) pump pressure sensor circuit.

Table 170

Diagnostic Trouble Codes for the DEF Pump Pressure Sensor			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4334-3	3090-3	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Above Normal	There is excessive voltage on the signal wire between the Diesel Exhaust Fluid Controller (DCU) and the DEF pump. or There is an open circuit on the supply, signal, or return wire. The code is logged.
4334-4	3090-4	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Below Normal	There is low voltage on the signal wire between the DCU and the DEF pump pressure sensor. The code is logged.
4334-20	3090-20	Aftertreatment #1 DEF #1 Pressure (absolute) : Data Drifted High	The signal from the DEF pump pressure sensor is above 10 kPa (1.5 psi) when the DEF system is not primed.
4334-21	3090-21	Aftertreatment #1 DEF #1 Pressure (absolute) : Data Drifted Low	The signal from the DEF pump pressure sensor is below -10 kPa (-1.5 psi) when the DEF system is not primed.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Complete the procedure in the order in which the steps are listed.

Table 171

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure. Start the engine and wait for 2 minutes. If the fault is cleared, return the engine to service. If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Connect to the electronic service tool. If necessary, refer to Troubleshooting, Electronic Service Tools.</p> <p><b>B.</b> Check for active diagnostic codes.</p>	Diagnostic codes	<p><b>Result:</b> A -3 or -4 diagnostic code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> A -20 or -21 diagnostic code is active.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the DEF Pressure</b></p> <p><b>A.</b> Connect to the electronic service tool. If necessary, refer to Troubleshooting, Electronic Service Tools.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool to check the "DEF Pressure" parameter.</p>	-10 kPa (-1.5 psi) to 10 kPa (1.5 psi)	<p><b>Result:</b> The DEF pressure is between -10 kPa (-1.5 psi) and 10 kPa (1.5 psi).</p> <p><b>Repair:</b> Start the engine and allow the DEF system to prime. Stop the engine and wait for the wait-to disconnect lamp to switch off. Turn the keyswitch to the ON position. Check for an active 4334-20 or 4334-21 diagnostic code. If the diagnostic code is no longer active, return the engine to service. If the diagnostic code is still active, proceed to Test Step 4.</p>
<p><b>4. Replace the Pump and Electronics Unit (PEU)</b></p> <p><b>Note:</b> The PEU is a non-serviceable unit. If a fault is suspected in the PEU, the unit must be replaced.</p> <p><b>A.</b> Replace the PEU. Refer to Disassembly and Assembly, Diesel Exhaust Fluid Pump - Remove and Install.</p>	PEU fault	<p><b>Result:</b> The PEU was replaced.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 171, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the DEF Pressure</b></p> <p><b>A.</b> Connect to the electronic service tool. If necessary, refer to Troubleshooting, Electronic Service Tools.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool to check the “DEF Pressure” parameter.</p>	<p>–10 kPa (–1.5 psi) to 10 kPa (1.5 psi)</p>	<p><b>Result:</b> The DEF pressure is between –10 kPa (–1.5 psi) and 10 kPa (1.5 psi).</p> <p><b>Repair:</b> Start the engine and allow the DEF system to prime. Stop the engine and wait for the wait-to disconnect lamp to switch off. Turn the keyswitch to the ON position. Check for an active 4334–20 or 4334–21 diagnostic code. If the diagnostic code is no longer active, proceed to Test Step 6. If the diagnostic code is still active, contact the Dealer Solutions Network (DSN).</p>
<p><b>6. Perform a DEF Dosing System Verification Test</b></p> <p><b>A.</b> Turn the keyswitch to the “ON” position. Do not start the engine.</p> <p><b>B.</b> Connect the electronic service tool.</p> <p><b>C.</b> Perform the “DEF Dosing Verification Test” .</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> The code did not return. Return the unit to service.</p> <p><b>Result:</b> The code returned. Contact the Dealer Solutions Network (DSN).</p>

i06831676

## DEF Pump Sensor Supply - Test

Table 172 lists the diagnostic codes for the Diesel Exhaust Fluid (DEF) pump sensor circuit.

Table 172

Diagnostic Trouble Codes for the DEF Pump Sensor Supply			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3511-3	3482-3	Sensor Supply #3: Voltage Above Normal	An open circuit has been detected in the 5VDC supply to the DEF pump.
3511-4	3482-4	Sensor Supply #3: Voltage Below Normal	A short circuit has been detected in the 5VDC supply to the DEF pump.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Complete the procedure in the order in which the steps are listed.

Table 173

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Connect to the electronic service tool. If necessary, refer to Troubleshooting, Electronic Service Tools.</p> <p><b>B.</b> Check for active diagnostic codes.</p>	Diagnostic codes	<p><b>Result:</b> One of the diagnostic codes listed in Table 172 is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> None of the previous diagnostic codes are active.</p> <p>Return the engine to service.</p>
<p><b>2. Replace the Pump and Electronics Unit (PEU)</b></p> <p><b>Note:</b> The PEU is a non-serviceable unit. If a fault is suspected, the PEU must be replaced.</p> <p><b>A.</b> Replace the PEU.</p>	PEU fault	<p><b>Result:</b> The PEU was replaced.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Perform a DEF Dosing System Verification Test</b></p> <p><b>A.</b> Turn the keyswitch to the "ON" position. Do not start the engine.</p> <p><b>B.</b> Connect the electronic service tool.</p> <p><b>C.</b> Perform the "DEF Dosing Verification Test".</p>	Diagnostic codes	<p><b>Result:</b> The code did not return.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The code returned.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i08134324

## DEF Tank Sensor - Test

Use this procedure to troubleshoot the electrical system if a fault is suspected with the sensors. Use this procedure if any of the diagnostic codes in Table 174 are active or easily repeated.

Table 174

<b>Diagnostic Codes Table</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description</b>	<b>Comments</b>
1761-2	3130-2	Aftertreatment #1 Diesel Exhaust Fluid Tank Level: Erratic Intermittent or Incorrect	The ECM detects that the DEF Level measurement received from the DEF Tank Sensor is not within the acceptable range. or The DEF Level measurement received from the DEF Tank Sensor has shown an invalid drop in level measurement within a monitoring window. The code is logged if the DEF level measurement does not resolve into acceptable measurement range after a time delay.
1761-12	3130-12	Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Failure	The ECM detects a failure of the level sensor. The code is logged.
3031-12	3134-12	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Failure	The ECM detects a failure of the temperature sensor. The code is logged.
3516-2	3100-2 (Only 2017- Engines / Engines with DQS enabled)	Aftertreatment #1 DEF Concentration : Erratic, Intermittent, or Incorrect (Only 2017- Engines / Engines with DQS enabled)	The ECM detects that the DEF Quality measurement received from the DEF Tank Sensor over the datalink is not within the acceptable range. or The DEF Quality measurement received from the DEF Tank Sensor has shown an invalid quality measurement within a monitoring window. The code is logged if the DEF quality measurement does not resolve into acceptable measurement range after a time delay.
3516-12	3100-12	Aftertreatment #1 DEF Concentration : Failure	The ECM detects a failure of the quality sensor. The code is logged.

Battery voltage is routed to terminal 4 of the tank header unit. The return is routed to terminal 3 of the tank header unit. The temperature and level signals are routed through the CAN C data link on terminal 2 (CAN C+) and terminal 1 (CAN C-). The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

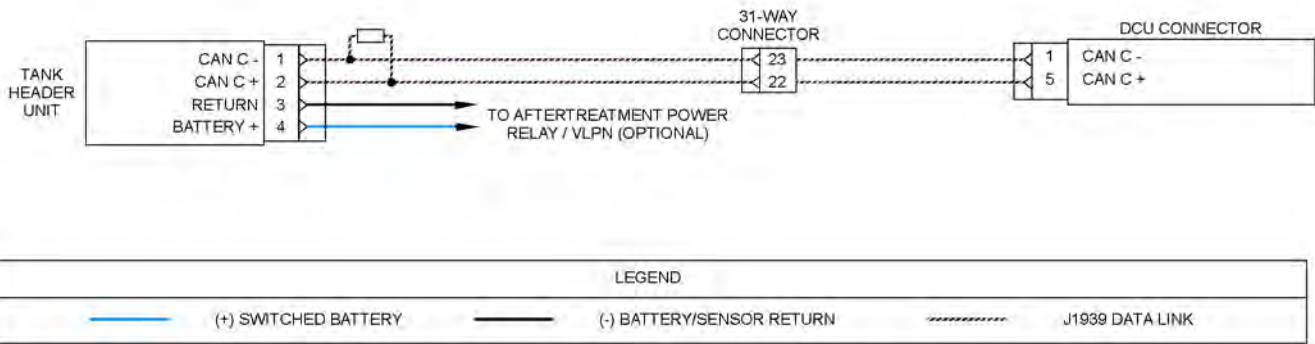


Illustration 102

g06439743

Schematic for the DEF tank header unit

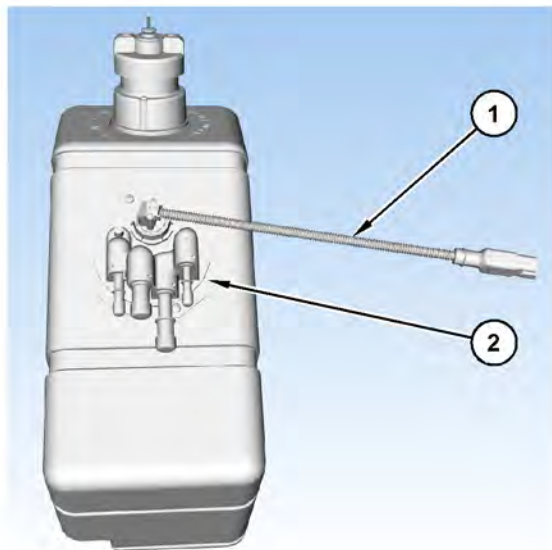


Illustration 103

g03700612

- (1) DEF tank header electrical connector
- (2) DEF tank header

**If possible, the machine should be on a level surface before the following procedure is performed.**

**The tank header unit houses the DEF tank temperature and the DEF tank level sensors. From 2017 onwards, the tank header unit also houses a DEF quality sensor. The sensors are not serviceable individually.**

Complete the procedure in the order in which the steps are listed.

Table 175

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the Diesel Exhaust Fluid Controller (DCU) . Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Look for active or logged codes.</p>	<p>Diagnostic code</p>	<p><b>Result:</b> A -12 diagnostic code is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> A 1761-2 (3130-2) code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> A 3516-2 (3100-2) code is active.</p> <p>Proceed to Test Step 5.</p>
<p><b>2. Check for Battery Voltage at the DEF Tank Header</b></p> <p><b>A.</b> Disconnect the harness at the DEF tank header.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Measure the voltage between terminals 3 and 4.</p> <p><b>D.</b> Turn the keyswitch to the OFF position.</p>	<p>Battery voltage</p>	<p><b>Result:</b> The measured voltage is less than 9.5V during cranking.</p> <p><b>Repair:</b> Investigate the cause of the incorrect voltage. Refer to Troubleshooting, "Electrical Power Supply - Test".</p> <p><b>Result:</b> The measured voltage is greater than 9.5V during cranking.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Ensure that the Application is on a Level Gradient</b></p> <p><b>A.</b> If necessary, move the application to a level gradient.</p> <p><b>B.</b> Wait at least 2 minutes. Turn the keyswitch to the ON position.</p> <p><b>C.</b> Connect to the electronic service tool.</p> <p><b>D.</b> Use the electronic service tool to check the DEF level measurement.</p> <p><b>Note:</b> Use the electronic service tool for this step and not a gauge on the application.</p>	<p>DEF Level</p>	<p><b>Result:</b> The DEF level indicates a value between 0 percent and 100 percent.</p> <p>Return the engine to service.</p> <p><b>Result:</b> The DEF level indicates "Conditions Not Met" 2 minutes after the application has been moved to a level gradient.</p> <p>Proceed to Test Step 4.</p>

(continued)



(Table 175, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Flush the DEF Tank and Refill the DEF Tank</b></p> <p><b>A.</b> Turn the keyswitch to the OFF and ensure that the “Wait to Disconnect” lamp has switched off.</p> <p><b>B.</b> Flush the DEF tank and refill the DEF tank. Refer to Operation and Maintenance Manual, “Diesel Exhaust Fluid - Flush” for the correct procedure. <b>Note:</b> Only use DEF that meets ISO 22241 standards.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to check the DEF level measurement. <b>Note:</b> Use the electronic service tool for this step and not a gauge on the application.</p>	DEF Level	<p><b>Result:</b> The DEF level indicates a value between 0 percent and 100 percent 2 minutes after the DEF tank has been filled.</p> <p>Return the engine to service.</p> <p><b>Result:</b> The DEF level indicates “Conditions Not Met” 2 minutes after the DEF tank has been filled.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Repair the DEF Tank Header</b></p> <p><b>A.</b> Repair the DEF Tank header sensor with the DEF Manifold Sensor Kit. Refer to Disassembly and Assembly, Manifold (DEF Heater) Sensor - Disassemble (Temperature, Level, Quality DEF Manifold Sensor) and Manifold (DEF Heater) Sensor - Assemble (Temperature, Level, Quality DEF Manifold Sensor).</p>	DEF Tank Header	<p><b>Result:</b> The fault is eliminated.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The fault is still present.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06556248

## Electrical Power Supply - Test

Use this procedure to troubleshoot the electrical system if a problem is suspected with the power to the engines Electronic Control Module (ECM). Use this procedure if any of the diagnostic codes in Table 176 are active or easily repeated.

Table 176

Diagnostic Trouble Codes for the Electrical Power Supply			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
168-3	168-3	Electrical System Voltage : Voltage Above Normal	The ECM detects voltage that is above the acceptable value.
168-4	168-4	Electrical System Voltage : Voltage Below Normal	The ECM detects voltage that is below the acceptable value.
3216-5	3002-5	Aftertreatment 1 Intake NOx : Current Below Normal	The ECM detects current that is below the acceptable value
3216-6	3002-6	Aftertreatment 1 Intake NOx : Current Above Normal	The ECM detects current that is above the acceptable value
3226-5	3609-5	Aftertreatment 1 Outlet NOx : Current Below Normal	The ECM detects current that is below the acceptable value

(continued)

(Table 176, contd)

<b>Diagnostic Trouble Codes for the Electrical Power Supply</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description</b> (code descriptions may vary)	<b>Comments</b>
3226-6	3609-6	Aftertreatment 1 Outlet NOx : Current Above Normal	The ECM detects current that is above the acceptable value
3360-3	3820-3	Aftertreatment #1 DEF Controller : Voltage Above Normal	The ECM detects voltage that is above the acceptable value.
3360-4	3820-4	Aftertreatment #1 DEF Controller : Voltage Below Normal	The ECM detects voltage that is below the acceptable value.
4380-2	4592-2	Aftertreatment 1 Outlet NH3 Gas Sensor Power In Range : Erratic, Intermittent, or Incorrect	The ECM detects that the power supply to the ammonia (NH3) sensor is not stable.
5758-11	3621-11	Engine Exhaust NOx Level Sensor Power Supply: Other Failure Mode	The ECM detects voltage that is outside the acceptable value.
5759-11	3619-11	Aftertreatment #1 Outlet#1 NOx Level Sensor Power Supply: Other Failure Mode	The ECM detects voltage that is outside the acceptable value.

The engine ECM requires the keyswitch to be in the ON position to maintain communications with the electronic service tool.

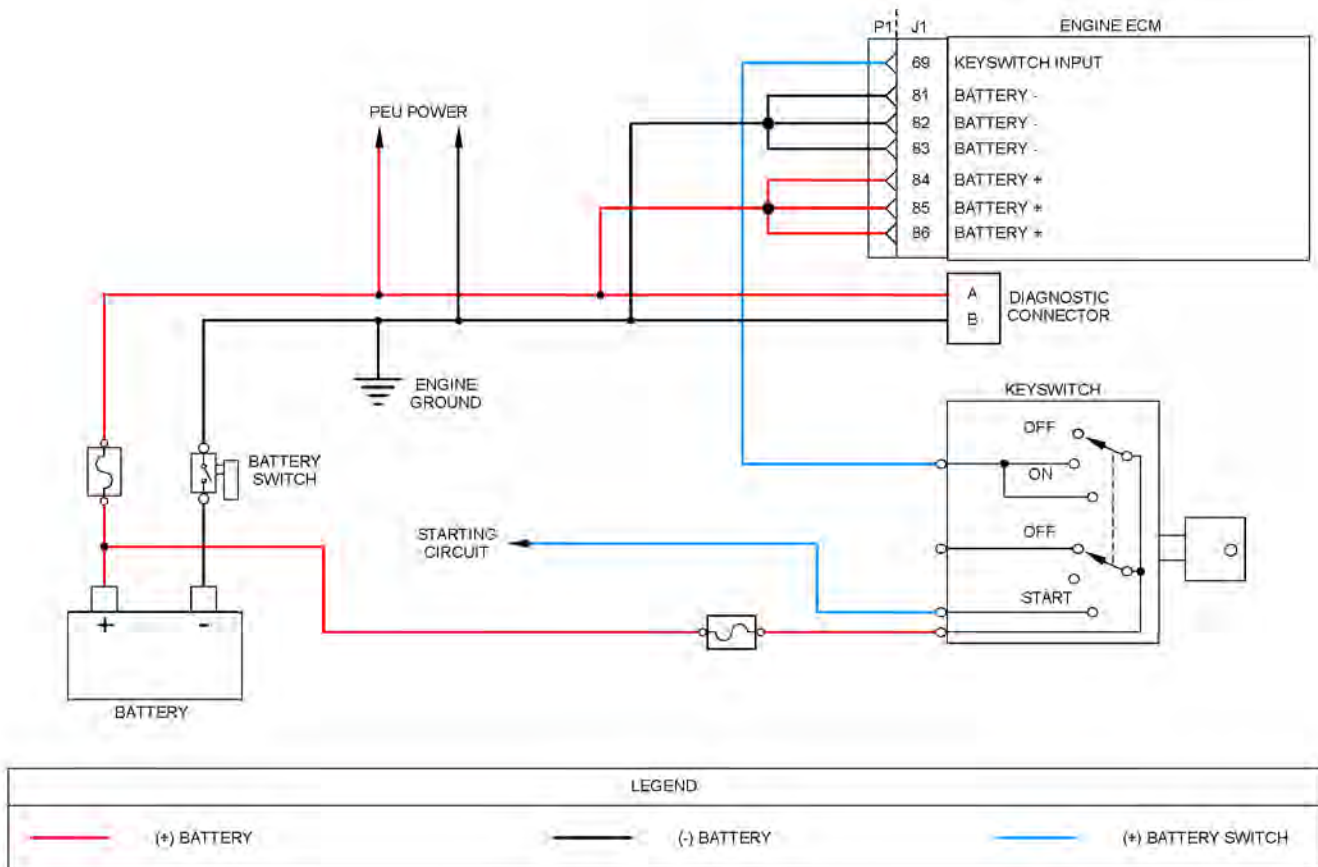


Illustration 104

g03813883

Schematic diagram for the engine electrical power supply circuit  
Not all connectors are shown. Refer to the appropriate electrical schematic

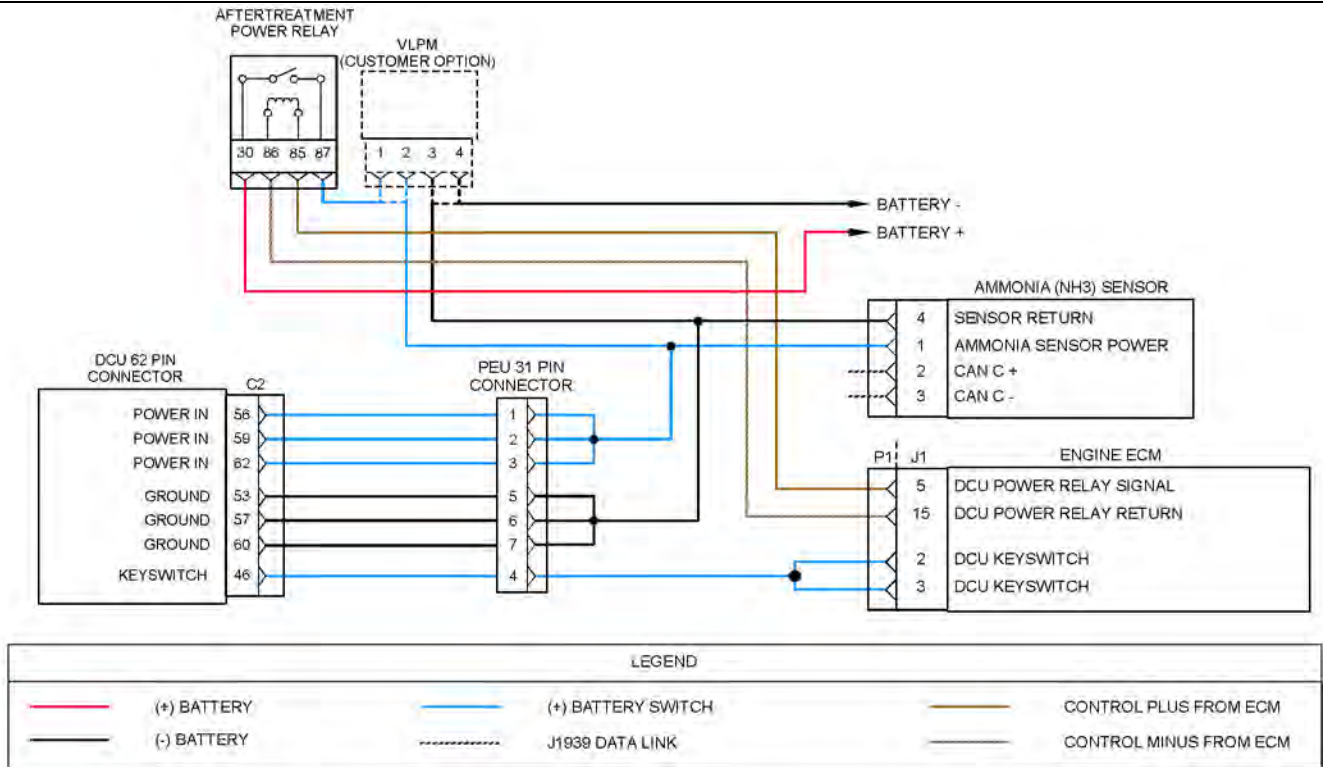


Illustration 105

g03813894

Schematic diagram for the DCU electrical power supply circuit

Not all connectors are shown. Refer to the appropriate electrical schematic

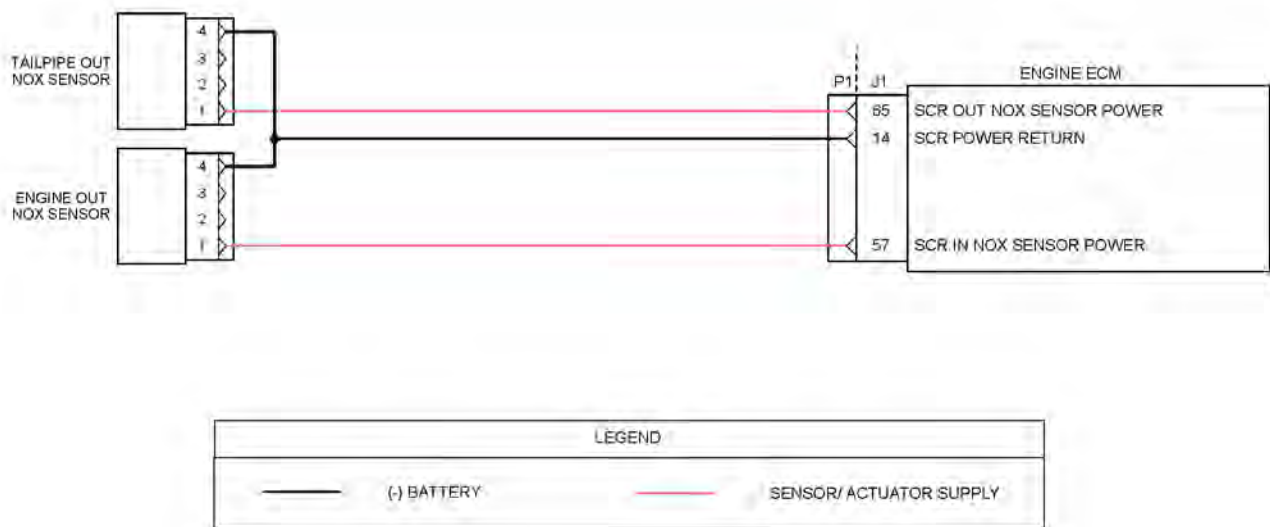


Illustration 106

g03813890

Schematic for the NOx sensor power supply circuit

Not all connectors are shown. Refer to the appropriate electrical schematic

Complete the procedure in the order in which the steps are listed.

Table 177

Troubleshooting Test Steps	Value	Results
<p><b>1. Determine the Diagnostic Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the ECM . Refer to Troubleshooting, “Electronic Service Tools”, if necessary.</p> <p><b>B.</b> Start the engine. Run the engine until the engine is at normal operating temperature.</p> <p><b>C.</b> Observe the “Active Diagnostic” screen on the electronic service tool. Wait at least 30 seconds so that any codes may become active.</p>	Diagnostic code	<p><b>Result:</b> One of the diagnostic codes listed in Table 176 is active.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The electronic service tool will not communicate with the ECM.</p> <p><b>Repair:</b> Refer to Troubleshooting, “Electronic Service Tool Does Not Communicate”.</p>
<p><b>2. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Ensure that the battery disconnect switch is in the CLOSED position.</p> <p><b>B.</b> Thoroughly inspect all connectors associated with the electrical power supplies.</p> <p><b>C.</b> Check all fuses.</p> <p><b>D.</b> Perform a 45 N (10 lb) pull test on each of the wires in the connectors associated with the electrical power supplies.</p> <p><b>E.</b> Check all the wiring associated with the electrical power supplies for abrasions and pinch points.</p> <p><b>F.</b> Verify that the “System Operating Voltage Configuration” is correctly configured in the Engine ECM configuration parameters.</p>	Damaged wire or connector. Blown fuse.	<p><b>Result:</b> A damaged wire or damaged connector was found. A blown fuse was found.</p> <p><b>Repair:</b> Repair the damaged wire or the damaged connector. Replace all blown fuses. Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault.</p> <p><b>Result:</b> The “System Operating Voltage Configuration” is configured incorrectly.</p> <p><b>Repair:</b> Program the parameter with the correct system voltage.</p> <p><b>Result:</b> A damaged wire or damaged connector was not found. The fuses are OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Load Test the Batteries</b></p> <p><b>A.</b> Use a suitable battery load tester to test the batteries. Refer to Systems Operation, Testing and Adjusting, “Battery - Test” for the correct procedure.</p>	Load test	<p><b>Result:</b> The batteries pass the load test.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The batteries do not pass the load test.</p> <p><b>Repair:</b> Recharge or replace the faulty batteries.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p>
<p><b>4. Check the Charging Circuit</b></p> <p><b>A.</b> Check the charging circuit. Refer to Systems Operation, Testing and Adjusting, “Charging System - Test”.</p>	Charging circuit	<p><b>Result:</b> The charging system is OK.</p> <p>Contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> The charging system is not OK.</p> <p><b>Repair:</b> There is a fault in the charging system. Make the necessary repairs. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p>

i07742529

## Ether Starting Aid - Test

**Before testing the ether injection system, remove the ether canister from the system.**

Use this procedure in order to troubleshoot the ether system or use this procedure if a diagnostic code in Table 178 is active or logged.

Table 178

Diagnostic Trouble Codes for Ether Injection			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
626-5	2417-5	Ether Injection Control Solenoid : Current Below Normal	The Electronic Control Module (ECM) detects a low current condition in the output from the ECM to the solenoid for ether injection.  The code is latched. The code is logged.  Ether injection is disabled.
626-6	2417-6	Ether Injection Control Solenoid : Current Above Normal	The ECM detects a high current condition in the output from the ECM to the solenoid for ether injection.  The code is latched. The code is logged.  Ether injection is disabled.

The ether injection system will improve cold weather starting of the engine. The engine Electronic Control Module (ECM) controls the ether injection system. The ether injection system is disabled if there is an active engine shutdown.

Activation of the ether starting aid is based from a map using the coolant temperature, intake manifold temperature, and atmospheric pressure. Refer to Illustration 107 .

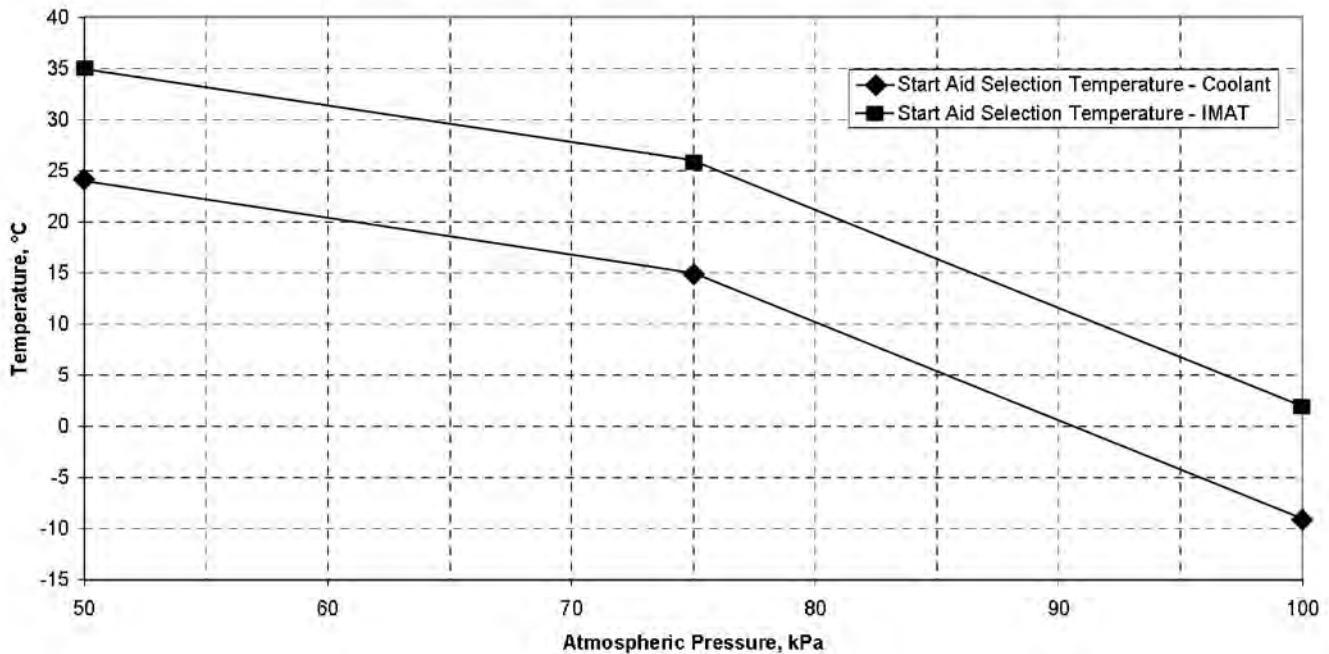


Illustration 107

g02445796

The following conditions must be met for the ether injection system to be enabled:

- Ether injection is set to enabled in the electronic service tool
- Engine coolant temperature is less than the “Start Aid Selection Temperature - Coolant” . Refer to Illustration 107 .
- Intake manifold temperature is less than the “Start Aid Selection Temperature - IMAT.”
- Coolant temperature and intake manifold air temperature are within 11° C of each other.

**Note:** Continuous cranking with Ether that does not achieve an engine start will result in the Ether being locked out if the maximum allowed volume of Ether has been exceeded (10 x 15 second cranks).

To re-enable Ether injection, a successful start must be achieved, the engine run at low idle speed for at least 5 seconds and a minimum SCR inlet temperature of 160°C achieved for at least 5 seconds.

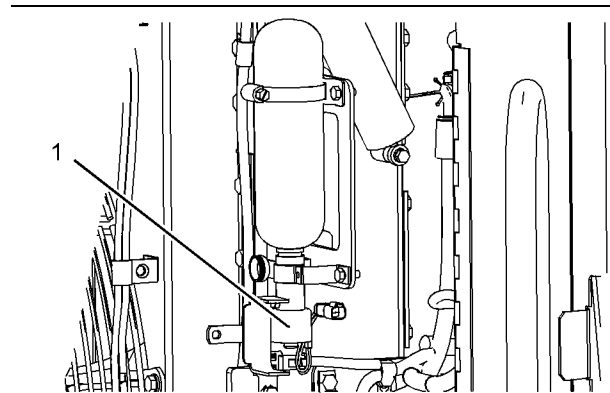


Illustration 108

g01696575

Ether starting aid group (typical example)

(1) Ether injection solenoid

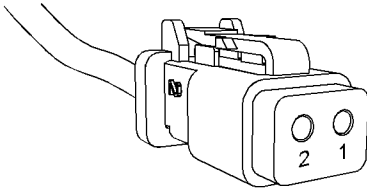


Illustration 109 g01155187

Terminal locations at the harness connector for the ether solenoid

- (1) Ether enable solenoid
- (2) Return for ether injection solenoid

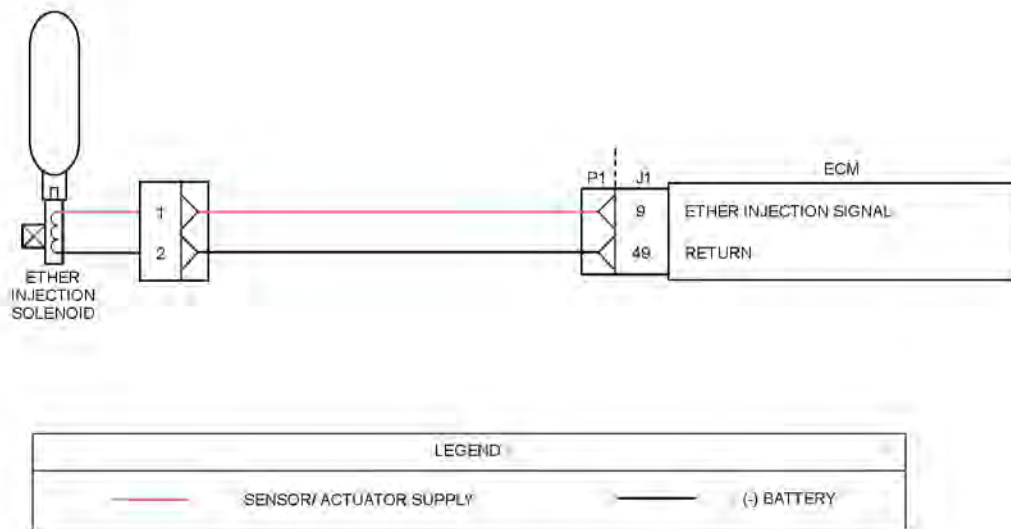


Illustration 110 g03712340

Schematic for the ether injection system

Not all connectors are shown. Refer to the appropriate electrical schematic.

Complete the procedure in the order in which the steps are listed.



Table 179

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Remove the electrical power from the ECM.</p> <p><b>B.</b> Thoroughly inspect the ECM connector J1/P1. Inspect all of the other connectors for the circuit. Refer to the diagnostic functional test Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.</p> <p><b>D.</b> Check the ECM connector (allen head screw) for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness and the wiring for abrasion and for pinch points.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> The harness and wiring are OK.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Proceed to Test Step 4.</p>
<p><b>2. Check the Wiring Between the ECM and the Ether Control</b></p> <p><b>The ether canister must be removed prior to performing this procedure.</b></p> <p><b>A.</b> Verify that the keyswitch is in the OFF position.</p> <p><b>B.</b> Remove the ether canister.</p> <p><b>C.</b> Disconnect the engine harness connector for the ether control.</p> <p><b>D.</b> Connect a digital voltmeter across the two terminals on the engine harness connector for ether control.</p> <p><b>E.</b> Turn the keyswitch to the ON position.</p> <p><b>F.</b> Measure the voltage across the terminals while the keyswitch is turned ON.</p>	<p>10 VDC</p>	<p><b>Result:</b> The voltage measured 0 VDC.</p> <p><b>Repair:</b> There is a problem in an electrical component between the ECM and the harness connector for the ether control. The problem may be inside an electrical connector. Make the necessary repairs.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The voltage measured greater than 10 VDC.</p> <p>The electrical components between the ECM and the harness connector for the ether control are OK.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Measure the Resistance of the Coil Inside the Ether Control</b></p> <p><b>A.</b> Verify that the ether control is not connected to the engine harness.</p> <p><b>B.</b> Measure the resistance of the coil inside the ether control.</p>	<p>20 Ω</p>	<p><b>Result:</b> The measured resistance was approximately 20 Ω.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The measured resistance was not approximately 20 Ω.</p> <p><b>Repair:</b> Replace the ether control.</p> <p>Proceed to Test Step 4.</p>

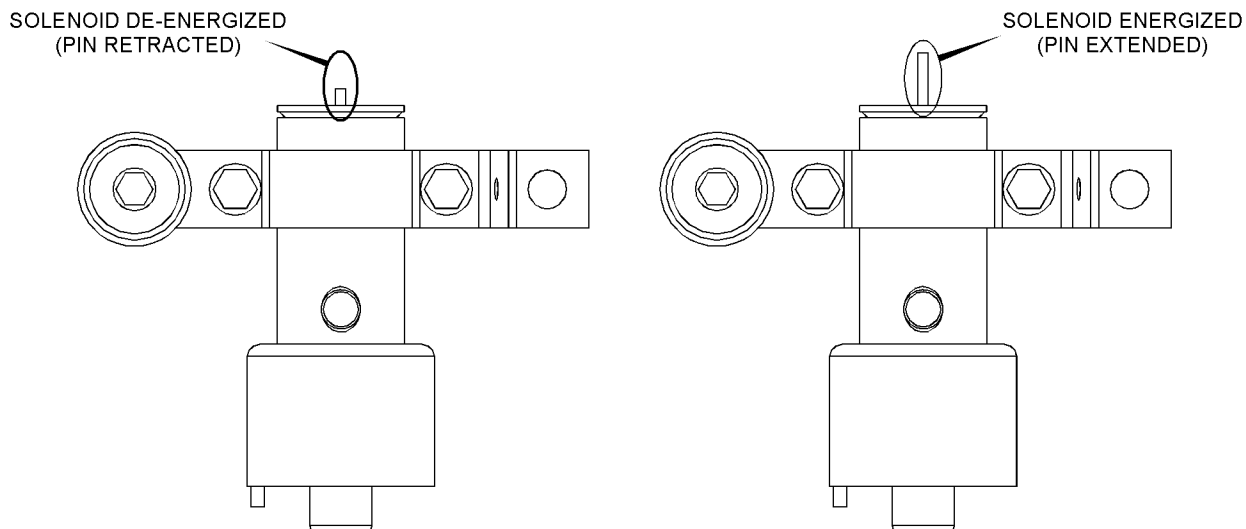


Illustration 111

g03152796

Ether solenoid activation pin

Table 180

Troubleshooting Test Steps	Values	Results
<p><b>4. Verify the Repair</b></p> <p><b>A.</b> Activate the Ether Injection Override.</p> <p><b>B.</b> Verify that the plunger moved up when the override was active.</p>	<p>Plunger movement</p>	<p><b>Result:</b> The plunger moved up when the override was active.</p> <p>Install the ether bottle and return the unit to service.</p> <p>If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).</p>

i06165010

## Fuel Transfer Pump - Test

Use this procedure to troubleshoot the relay for the Electric Fuel Lift Pump (EFLP). Use this procedure if there is a suspected electrical fault with the EFLP.

This procedure covers the following diagnostic codes:

Table 181

Diagnostic Codes for the EFLP Relay			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1075-5	3666-5	Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>There are no active 168 diagnostic codes.</p> <p>The ECM is not attempting to power the relay.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>There is a low current condition in the EFLP relay circuit for more than 2 seconds.</p> <p>The warning light will come on. The diagnostic code will be logged. The ECM is unable to activate the relay for the EFLP. The EFLP will not operate or the EFLP will operate all the time. The engine will not operate.</p>
1075-6	3666-6	Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>There are no active 168 diagnostic codes.</p> <p>The ECM is attempting to power the relay.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>There is a high current condition in the EFLP relay circuit for more than 2 seconds.</p> <p>The warning light will come on. The diagnostic code will be logged. The ECM is unable to activate the relay for the EFLP. The EFLP will not operate or the EFLP will operate all the time. The engine will not operate. The ECM will continue to attempt to activate the relay. If the current is OK for 6 seconds, then the diagnostic code will be cleared.</p>

**The following background information is related to this procedure:**

The EFLP is used in order to provide positive fuel pressure to the high-pressure fuel pump. When the keyswitch is turned to the ON position, the ECM will activate the EFLP. If the engine is not running, the ECM will deactivate the EFLP after 2 minutes.

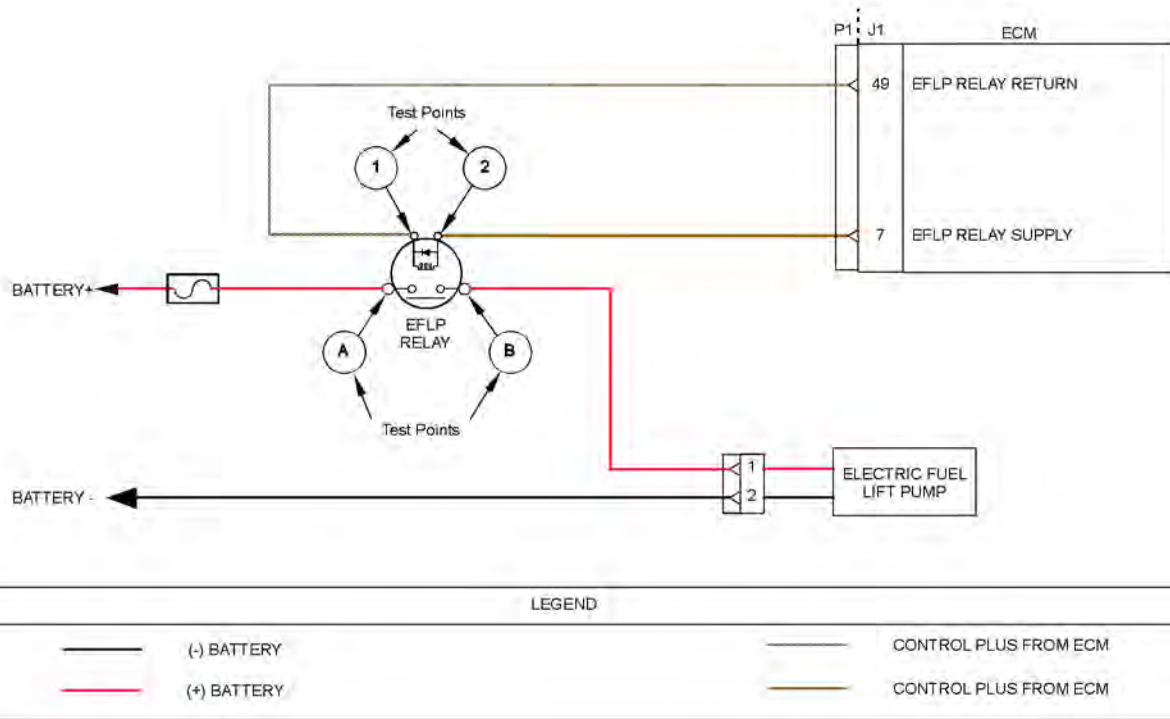


Illustration 112

g03813928

Schematic for the Electric Fuel Lift Pump (EFLP) relay

Table 182

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Thoroughly inspect the connectors between the EFLP relay and the engine ECM. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the EFLP relay.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness and wiring for abrasion and for pinch points from the injectors to the ECM.</p>	Loose connection or damaged wire	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>C.</b> Make a note of any active diagnostic codes.</p> <p><b>D.</b> Wait for at least 2 minutes for the Electric Fuel Lift Pump (EFLP) to deactivate. Make a note of any active diagnostic codes.</p>	Diagnostic codes	<p><b>Result:</b> Diagnostic code 1075-5 or 3666-5 is active when the EFLP is switched off.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> Diagnostic code 1075-6 or 3666-6 is active when the EFLP is switched on.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> An active diagnostic code or a recently logged diagnostic code was not displayed. There may be a fault with the switched power circuit for the EFLP. The ECM does not monitor the status of this condition.</p> <p>Proceed to Test Step 7.</p>

(continued)

## Circuit Tests

(Table 182, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Create a Short Circuit at the EFLP Relay</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the harness connector for the Electric Fuel Lift Pump (EFLP) relay.</p> <p><b>C.</b> Fabricate a jumper wire that is 150 mm (6 inch) long.</p> <p><b>D.</b> Use the jumper wire to connect Test Point 1 to Test Point 2 on the harness connector for the EFLP relay. Refer to Illustration 112 . Refer to the appropriate electrical schematic.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>F.</b> Use the electronic service tool to check for an active 1075-6 or 3666-6diagnostic code.</p> <p><b>G.</b> Wait for at least 2 minutes for the EFLP to deactivate. Check for an active 1075-5 or 3666-5 diagnostic code.</p> <p><b>H.</b> Turn the keyswitch to the OFF position.</p> <p><b>I.</b> Remove the jumper. Leave the connector for the EFLP disconnected.</p>	Open circuit	<p><b>Result:</b> A 1075-6 or 3666-6 diagnostic code was active with the jumper installed.</p> <p><b>Repair:</b> Install a replacement EFLP relay.</p> <p>Reconnect the connector for the EFLP relay.</p> <p>Turn the keyswitch to the ON position. Do not start the engine. Check for active diagnostic codes.</p> <p>Wait for at least 2 minutes for the EFLP to deactivate. Check for active diagnostic codes.</p> <p>Confirm that the fault has been eliminated.</p> <p><b>Result:</b> A 1075-5 or 3666-5 diagnostic code is still active with the jumper installed. There is a fault in the wiring or the ECM.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Wiring Between the ECM and the EFLP Relay for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the EFLP relay. Disconnect the J1 connector from the ECM.</p> <p><b>C.</b> Use a multimeter to measure the resistance between the following points:</p> <ul style="list-style-type: none"> <li>· J1:49 and Test Point 1 on the harness connector for the relay</li> <li>· J1:7 and Test Point 2 on the harness connector for the relay.</li> </ul>	Less than 2 Ohms	<p><b>Result:</b> At least one of the resistance measurements is greater than 2 Ohms.</p> <p><b>Repair:</b> The fault is in the wiring between the EFLP relay and the ECM.</p> <p>Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> Both resistance measurements are less than 2 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>5. Create an Open Circuit at the Relay</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the harness connector for the EFLP relay.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p>Wait for at least 2 minutes for the EFLP to deactivate.</p> <p><b>D.</b> Use the electronic service tool to check for an active 1075-6 or 3666-6 diagnostic code.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Fault moves to another injector	<p><b>Result:</b> A 1075-5 or 3666-5 diagnostic code is active.</p> <p><b>Repair:</b> Install a replacement relay.</p> <p>Turn the keyswitch to the ON position. Do not start the engine.</p> <p>Wait for at least 2 minutes for the EFLP to deactivate. Check for active diagnostic codes.</p> <p>Confirm that the fault has been eliminated.</p> <p><b>Result:</b> A 1075-6 or 3666-6 diagnostic code is still active.</p> <p>Proceed to Test Step 6.</p>

(continued)

(Table 182, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Check the Wiring Between the Relay and the ECM for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P1 connector.</p> <p><b>C.</b> Inspect the P1/J1 connector. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>D.</b> Disconnect the connector for the Electric Fuel Lift Pump (EFLP) relay.</p> <p><b>E.</b> Measure the resistance between P1:7 and all other pins on the P1 connector.</p> <p><b>F.</b> Measure the resistance between P1:49 and all other pins on the P1 connector.</p>	Greater than 1 k Ohm	<p><b>Result:</b> At least one of the resistance measurements is less than 1 k Ohm. The fault is in the wiring between the EFLP relay and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty harness.</p> <p>Turn the keyswitch to the ON position. Do not start the engine. Check for active diagnostic codes.</p> <p>Wait for at least 2 minutes for the EFLP to deactivate. Check for active diagnostic codes.</p> <p>Confirm that the fault has been eliminated.</p> <p><b>Result:</b> All resistance measurements are greater than 1 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Check the Fuse</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Wait for 5 seconds.</p> <p><b>B.</b> Turn the keyswitch to the OFF position. Check the fuse for the Electric Fuel Lift Pump (EFLP). Refer to the appropriate Electrical Schematic.</p>	Fuse blown	<p><b>Result:</b> The fuse is blown.</p> <p><b>Repair:</b> Check the wiring between the batteries and the EFLP relay for a short circuit. Refer to the appropriate Electrical Schematic. Make any necessary repairs. Replace the blown fuse.</p> <p><b>Result:</b> The fuse is not blown.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Power Supply to the Relay Connector</b></p> <p><b>A.</b> Disconnect the connector for the EFLP relay.</p> <p><b>B.</b> Measure the voltage between Test Point A on the harness connector for the relay and a suitable ground. Refer to Illustration 112 and the appropriate Electrical Schematic.</p>	Battery voltage	<p><b>Result:</b> There is no battery voltage at Test Point A on the harness connector.</p> <p><b>Repair:</b> Check all wiring between the batteries and the EFLP relay. Make any necessary repairs.</p> <p><b>Result:</b> Battery voltage is present at Test Point A on the harness connector.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Check the Power Supply to the EFLP</b></p> <p><b>A.</b> Disconnect the connector for the EFLP. Ensure that the EFLP relay is connected.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Measure the voltage between terminal 1 and terminal 2 on the harness connector for the EFLP.</p>	Battery voltage	<p><b>Result:</b> There is no battery voltage at the harness connector for the EFLP.</p> <p><b>Repair:</b> Check all wiring between the EFLP relay and the EFLP. Make any necessary repairs.</p> <p>If the wiring is OK, replace the EFLP relay.</p> <p><b>Result:</b> Battery voltage is present at the EFLP harness connector.</p> <p>If the EFLP does not activate when the keyswitch is turned to the ON position, replace the EFLP.</p>

i06895705

## Glow Plug Starting Aid - Test

This procedure covers the following diagnostic code:

Use this procedure if there is a suspected fault in the glow plug start aid circuit or the glow plugs.

Table 183

Diagnostic Trouble Codes For The Glow Plug Starting Aid			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
676-5	2246-5	Engine Glow Plug Relay : Current Below Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The engine is not cranking.</p> <p>The ECM has been powered for at least one second.</p> <p>There is a low current condition (open circuit) in the glow plug start aid relay circuit for more than 2 seconds.</p> <p>The warning light will come on. The diagnostic code will be logged. An ECM that was previously blank will require a total of 2 hours of operation before the diagnostic code will be logged.</p> <p>The ECM is unable to activate the relay for the glow plug starting aid. The glow plugs will not operate. The engine may be difficult to start in cold temperatures and the exhaust may emit white smoke.</p>
676-6	2246-6	Engine Glow Plug Relay : Current Above Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The engine is not cranking.</p> <p>The ECM has been powered for at least one second.</p> <p>There is a high current condition (short circuit) in the glow plug start aid relay circuit for more than 2 seconds.</p> <p>The warning light will come on. The diagnostic code will be logged. An ECM that was previously blank will require a total of 2 hours of operation before the diagnostic code will be logged.</p> <p>The ECM is unable to activate the relay for the glow plug starting aid. The glow plugs will not operate or the glow plugs will operate all the time. The engine may be difficult to start in cold temperatures and the exhaust may emit white smoke.</p>
Follow the troubleshooting procedure to identify the root cause of the fault.			

**The following background information is related to this procedure:**

The starting aid is used to improve the engine starting when the engine is cold. With the keyswitch in the ON position, the ECM monitors the following parameters to decide if the glow plugs need to be switched ON:

- Coolant temperature
- Intake manifold air temperature

If the glow plugs are required, then the ECM will activate the starting aid relay for a controlled period. While the glow plug start aid relay is activated, the glow plug start aid relay will supply power to the glow plugs. If a "Wait To Start" lamp is installed, then this lamp will be illuminated to indicate the "Wait To Start" period.

**"Wait to Start Lamp"**

This feature may be included as an option.



When glow plugs need to be activated prior to starting, a lamp will indicate that the operator needs to “Wait to Start” . Starting aids may be used during the cranking of the engine. Starting aids may be used if the engine has previously been started. The “Wait to Start” lamp will not be active in these conditions.

**Electronic Service Tool Test Aid**

The electronic service tool includes the test “Glow Plug Start Aid Override Test” . This test will assist the analysis of the cold starting aid.

**Overview of the Glow Plug Start Aid Override Test**

This glow plug start aid override test switches on the cold starting aid when the engine is not running. The glow plug start aid override test aids the analysis of the circuit for the glow plug start aid relay.

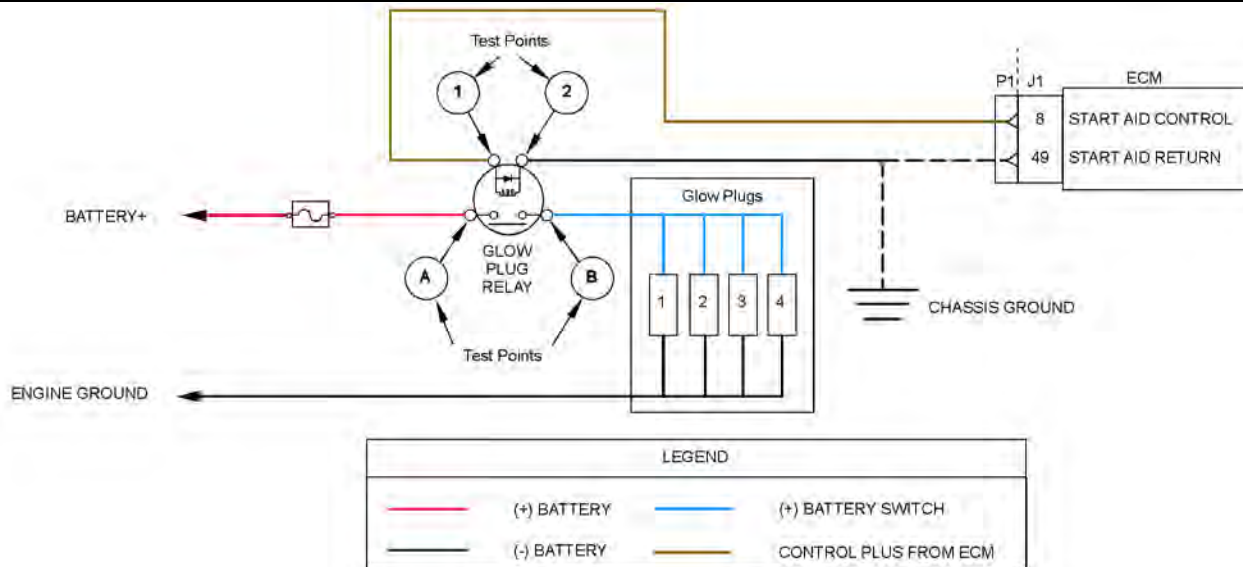


Illustration 113

g03815124

Schematic for the glow plug starting aid circuit

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Table 184

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Check that the fuses are not blown.</p> <p><b>B.</b> Inspect the terminals on the glow plug start aid relay and then inspect the connector on the flying lead from the relay. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Inspect the bus bar for the glow plugs. Ensure that the nuts that secure the bus bar to each glow plug are tightened to a torque of 2 N·m (17 lb in). Ensure that the bus bar is not shorted to the engine.</p> <p><b>D.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the glow plug starting aid.</p> <p><b>E.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>F.</b> Check the harness for abrasion and pinch points from the glow plugs back to the ECM.</p>	Loose connection or damaged wire	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. The fuses are not blown. The bus bar is secured to the glow plugs and not shorted to ground.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position. <b>Note:</b> Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool to select the "Glow Plug Start Aid Override Test" to turn on the power for the glow plugs.</p> <p><b>D.</b> Check for active diagnostic codes or recently logged diagnostic codes that are listed in Table 183 .</p>	Diagnostic codes	<p><b>Result:</b> No diagnostic codes are present.</p> <p>There may be an intermittent fault in an electrical component between the ECM and the glow plugs. The problem may be inside an electrical connector. Refer to Troubleshooting, "Electrical Connector - Inspect" to identify intermittent faults.</p> <p>There may be a fault in the glow plug switched power circuit. The ECM does not monitor the status of this condition. Proceed to Test Step 7 to test this circuit.</p> <p><b>Result:</b> Diagnostic code 676-5 or 2246-5 is active or recently logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> Diagnostic code 676-6 or 2246-6 is active or recently logged.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 184, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Create a Short Circuit at the Relay Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove the glow plug start aid relay.</p> <p><b>C.</b> Fabricate a jumper wire. Install the jumper wire between Test Point 1 and Test Point 2 on the harness connector for the glow plug relay. Refer to Illustration 113 . Refer to the appropriate Electrical Schematic.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs.</p> <p><b>F.</b> Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.</p> <p><b>G.</b> Turn the keyswitch to the OFF position and remove the jumper wire.</p>	Diagnostic code	<p><b>Result:</b> A 676-6 or 2246-6 diagnostic code is active with the jumper installed.</p> <p>Install a replacement glow plug relay.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 676-5 or 2246-5 diagnostic code is still active.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Wiring Between the ECM and the Relay for an Open Circuit</b></p> <p><b>A.</b> Verify that the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the P1 connector from the ECM.</p> <p><b>C.</b> Inspect the P1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.</p> <p><b>D.</b> Measure the resistance between Test Point 1 on the harness connector for the relay and P1:8.</p> <p><b>E.</b> Measure the resistance between Test Point 2 on the harness connector for the relay and the ground source. Refer to the appropriate Electrical Schematic.</p>	Less than 2.0 Ohms	<p><b>Result:</b> At least one of the resistance measurements is greater than 2.0 Ohms - the fault is in the wiring between the relay and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p><b>Result:</b> The resistance measurement is less than 2.0 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>5. Create an Open Circuit at the Relay</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the glow plug start aid relay.</p> <p><b>C.</b> Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs.</p> <p><b>D.</b> Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.</p>	Diagnostic codes	<p><b>Result:</b>A 676-5 or 2246-5 diagnostic code is active with the relay disconnected.</p> <p><b>Repair:</b> Install a replacement glow plug start aid relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 676-6 or 2246-6 diagnostic code is still active with the relay disconnected.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Circuit Tests

(Table 184, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Check the Wiring Between the Relay and the ECM for a Short Circuit</b></p> <p><b>A.</b> Disconnect the P1 connector.</p> <p><b>B.</b> Inspect the P1 connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Use a suitable multimeter to measure the resistance between P1:49 and all other terminals on the P1 connector.</p>	Greater than 1 k Ohm	<p><b>Result:</b> At least one of the resistance measurements is less than 1 k Ohm. There is a short in the wiring between the relay and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 1 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Check the Operation of the Glow Plugs</b></p> <p><b>A.</b> Place a suitable clamp-on ammeter on the power supply wire.</p> <p><b>B.</b> Use the electronic service tool to select the "Glow Plug Start Aid Override Test" to turn on the power for the glow plugs.</p> <p><b>C.</b> Wait for 20 seconds and then note the reading on the clamp-on ammeter.</p>	<p>Approximately 28.0 Amps for a 12 VDC system.</p> <p>Approximately 10.0 Amps for a 24 VDC system.</p>	<p><b>Result:</b> The reading on the clamp on ammeter near the expected reading.</p> <p>The glow plugs are operating correctly. Return the engine to service.</p> <p><b>Result:</b> The reading on the clamp on ammeter is between zero and the expected reading.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The reading on the clamp on ammeter is zero.</p> <p>Proceed to Test Step 9.</p>
<p><b>8. Test the Continuity of the Glow Plugs</b></p> <p><b>A.</b> Disconnect the power supply and remove the bus bar from the glow plugs.</p> <p><b>B.</b> Use a suitable digital multimeter to check continuity (resistance). Turn the audible signal on the digital multimeter ON.</p> <p><b>C.</b> Place one probe on the connection for one of the glow plugs and the other probe to a suitable ground. The digital multimeter should make an audible sound.</p> <p><b>D.</b> Repeat the continuity check on the remaining glow plugs.</p>	One or more glow plugs do not have continuity.	<p><b>Result:</b> One or more of the glow plugs do not display continuity.</p> <p><b>Repair:</b> Replace any glow plugs that do not show continuity. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All glow plugs display continuity.</p> <p>Repeat this procedure from Test Step 1.</p>
<p><b>9. Check the Fuse</b></p> <p><b>A.</b> Turn the battery disconnect switch to the OFF position.</p> <p><b>B.</b> Check the fuse for the glow plug start aid relay. Refer to the appropriate Electrical Schematic.</p>	Blown fuse	<p><b>Result:</b> The fuse is blown - there is a short in the power circuit for the glow plugs.</p> <p>Check the wiring between the batteries and the glow plug relay for a short circuit. Refer to the appropriate Electrical Schematic. Make any necessary repairs. Replace the blown fuse.</p> <p><b>Result:</b> The fuse is not blown.</p> <p>Proceed to Test Step 10.</p>

(continued)

(Table 184, contd)

Troubleshooting Test Steps	Values	Results
<p><b>10. Check the Power Supply to the Relay Connector</b></p> <p><b>A.</b> Disconnect the connector for the glow plug relay.</p> <p><b>B.</b> Measure the voltage between Test Point A on the harness connector for the relay and a suitable ground. Refer to Illustration 113 and the appropriate Electrical Schematic.</p>	Battery voltage	<p><b>Result:</b> There is no battery voltage at Test Point A on the harness connector.</p> <p><b>Repair:</b> Check all wiring between the batteries and the glow plug relay. Make any necessary repairs.</p> <p><b>Result:</b> Battery voltage is present at Test Point A on the harness connector.</p> <p>Proceed to Test Step 11.</p>
<p><b>11. Check the Power Supply to the Glow Plugs</b></p> <p><b>A.</b> Disconnect the power supply for the bus bar. Ensure that the glow plug relay is connected.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Use the electronic service tool to select the "Glow Plug Start Aid Override Test" to turn on the power for the glow plugs.</p> <p><b>D.</b> Measure the voltage between the power supply wiring for the bus bar and engine ground.</p>	Battery voltage	<p><b>Result:</b> There is no battery voltage at the power supply wiring to the bus bar.</p> <p><b>Repair:</b> Check all wiring between the bus bar and the glow plug relay. Make any necessary repairs.</p> <p>If the wiring is OK, replace the glow plug relay.</p> <p><b>Result:</b> Battery voltage is present at the power supply wiring to the bus bar.</p> <p>The glow plug circuit appears to be operating correctly.</p> <p>Return the engine to service.</p>

i06165185

## Idle Validation - Test

This procedure covers the following diagnostic codes:

Table 185

Diagnostic Trouble Codes for the Idle Validation Switches			
J1939 Code	PDL Code	Code Description	Comments
558-2	91-0	Accelerator Pedal 1 Low Idle Switch : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects the following condition: The signal from the Idle Validation Switch (IVS) is invalid.
	1634-2		
2970-2	774-0	Accelerator Pedal 2 Low Idle Switch : Erratic, Intermittent, or Incorrect	If equipped, the warning light will come on. The ECM will log the diagnostic code.
	1635-2		
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

If the application is equipped with two throttles, the engine will use the second throttle until the fault is repaired.

If a second throttle is not installed or if the second throttle has a fault, the following conditions will occur:

- The engine will default to limp home mode.

- If the engine speed is higher than the speed in limp home mode, the engine will decelerate to limp home mode.
- If the engine speed is lower than the speed in limp home mode, the engine speed will remain at the current speed.

- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

The IVS may be installed. The IVS is required for mobile applications with an analog throttle installed. The IVS is part of the throttle position sensor. The IVS is CLOSED when the low idle is set.

The configuration parameters for the throttle and for the IVS thresholds are programmed into the ECM. Use the electronic service tool in order to display the configuration parameters for the throttle and for the IVS.

If the IVS operates outside of the programmed range, then the engine speed may not respond to changes in the throttle position.

The electronic service tool may be used for the following:

- If necessary, reset the IVS threshold for an existing IVS.
- If necessary, view the IVS change point and reset the IVS thresholds when a new throttle assembly is installed.

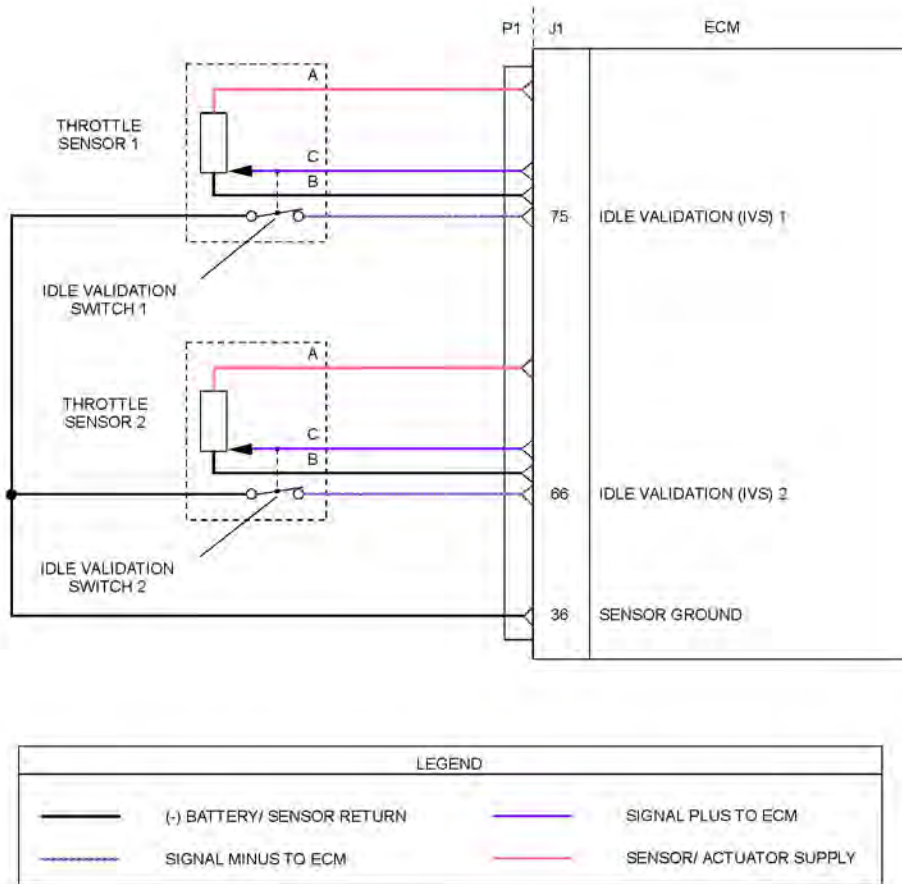


Illustration 114

g03712853

Schematic of the IVS circuit

Not all connectors are shown. Refer to the appropriate Electrical Schematic

Table 186

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Codes and/or Recently Logged Diagnostic Codes</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. <b>Note:</b> Wait at least 30 seconds in order for the diagnostic codes to become active. <b>Note:</b> A diagnostic code that is logged several times is an indication of an intermittent problem. Most intermittent problems are a poor connection in a connector.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> No diagnostic codes are active - the problem may have been intermittent.</p> <p><b>Repair:</b> Carefully inspect the connectors and wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>Result:</b> One of the diagnostic codes listed in Table 185 is active or recently logged at this time.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Operation of the IVS</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position. <b>Note:</b> Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool in order to check the current "Throttle Configuration".</p> <p><b>D.</b> Select the "SERVICE" option from the drop-down menu of the electronic service tool.</p> <p><b>E.</b> Select the "Throttle Configuration" option on the electronic service tool. Select the appropriate "Throttle Configuration" summary from the menu on the left of the screen. The IVS window for the throttle will indicate "YES" if an IVS is installed.</p> <p><b>F.</b> Select the "Throttle status" function on the electronic service tool. Select "Status" function and then select "Throttles" function.</p> <p><b>G.</b> The throttle is set in the low idle position.</p> <p><b>H.</b> Operate the throttle slowly. The IVS status should change from CLOSED (ON) to OPEN (OFF).</p>	<p>IVS status change</p>	<p><b>Result:</b> The IVS state changes from CLOSED (ON) to OPEN (OFF)</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The IVS state does not change.</p> <p>Proceed to Test Step 4.</p>

(continued)



(Table 186, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the IVS Threshold</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Use the electronic service tool in order to check the current "Throttle Configuration" .</p> <p><b>D.</b> Select the "SERVICE" option from the drop-down menu of the electronic service tool.</p> <p><b>E.</b> Select the "Throttle Configuration" option on the electronic service tool. Select the appropriate "Throttle Configuration" summary from the menu on the left of the screen. The IVS window for the throttle will indicate "YES" if an IVS is installed. Make a note of the "Idle Validation Min OFF Threshold" parameters that are displayed in the "Throttle Configuration" menu of the electronic service tool. Make a note of the "Idle Validation Max ON Threshold" parameters that are displayed in the "Throttle Configuration" menu of the electronic service tool.</p> <p><b>F.</b> To select the "Throttle status" function on the electronic service tool, select "Status" function and then select "Throttles" function.</p> <p><b>G.</b> The throttle is set in the low idle position.</p> <p><b>H.</b> Operate the throttle slowly. The IVS status should change from CLOSED (ON) to OPEN (OFF).</p>	<p>IVS operates within threshold.</p>	<p><b>Result:</b> The IVS switch operates within the "Idle Validation Min OFF Threshold" and the "Idle Validation Max ON Threshold" parameters.</p> <p>The IVS is operating correctly. Return the engine to service.</p> <p><b>Result:</b> The IVS switch cannot operate within the "Idle Validation Min OFF Threshold" and the "Idle Validation Max ON Threshold" parameters.</p> <p>Proceed to Test Step 9.</p>
<p><b>4. Inspect Electrical Connectors and the Harness</b></p> <p><b>A.</b> Inspect the P1/J1 connectors, the harness and all of the connectors for the IVS. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>B.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the suspect idle validation switch.</p> <p><b>C.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>D.</b> Check the harness for abrasion and pinch points from the throttle switch to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> Faults found in harness or connectors.</p> <p><b>Repair:</b> Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly connected.</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> No harness or connector faults found.</p> <p>Proceed to Test Step 5.</p>

(continued)

## Circuit Tests

(Table 186, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the Location of the Fault</b></p> <p><b>A.</b> Disconnect the IVS harness connector.</p> <p><b>B.</b> Fabricate a jumper wire.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Install a jumper wire between the IVS connections on the harness. Use the electronic service tool in order to check for diagnostic codes.</p> <p><b>E.</b> Remove the jumper wire that is between the IVS connections on the harness. Use the electronic service tool in order to check for diagnostic codes.</p>	<p>IVS state on with jumper installed.</p> <p>IVS state off with jumper removed.</p>	<p><b>Result:</b> With the jumper wire connected, the electronic service tool displays the IVS state in the ON position on the throttle status screen. With the jumper wire disconnected, the electronic service tool displays the IVS state in the OFF position on the throttle status screen.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The IVS status that is displayed on the electronic service tool does not change with the jumper wire either removed or installed.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Disconnect the IVS harness connector.</p> <p><b>B.</b> Disconnect the P1 connector.</p> <p><b>C.</b> If the fault is on IVS1, use a multimeter to check the resistance between the IVS1 input terminal on the IVS harness connector and P1:77.</p> <p><b>D.</b> If the fault is on IVS2, use a multimeter to check the resistance between the IVS2 input terminal on the IVS harness connector and P1:66.</p> <p><b>E.</b> Use a multimeter to check the resistance between the IVS1 output terminal on the applicable IVS harness connector and P1:36.</p>	<p>Less than 2 Ohms</p>	<p><b>Result:</b> One or more of the measured resistances is greater than 2 Ohms. There is an open circuit in the wiring.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance in all wires is less than two Ohms.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Disconnect the P1 connector.</p> <p><b>B.</b> Disconnect both IVS harness connectors.</p> <p><b>C.</b> Use a multimeter to check the resistance between P1:75 and all other terminals on the P1 connector.</p> <p><b>D.</b> Use a multimeter to check the resistance between P1:66 and all other terminals on the P1 connector.</p> <p><b>E.</b> Use a multimeter to check the resistance between P1:36 and all other terminals on the P1 connector.</p>	<p>Greater than 1 k Ohm</p>	<p><b>Result:</b> One or more of the measured resistances is less than 1 k Ohm. There is a short circuit in the wiring.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 1 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

(Table 186, contd)

Troubleshooting Test Steps	Values	Results
<p><b>8. Check the IVS Calibration</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Select the “Throttle Configuration” option on the electronic service tool. Select the appropriate “Throttle Configuration” summary from the menu on the left of the screen. The IVS window for the throttle will indicate “YES” if an IVS is installed. Make a note of the “Idle Validation Min OFF Threshold” parameters that are displayed in the “Throttle Configuration” menu of the electronic service tool. Make a note of the “Idle Validation Max ON Threshold” parameters that are displayed in the “Throttle Configuration” menu of the electronic service tool.</p> <p><b>D.</b> Select the “Throttle status” function on the electronic service tool. Select “Status” function and then select “Throttles” function.</p> <p><b>E.</b> Set the throttle to low idle.</p> <p><b>F.</b> Operate the throttle slowly toward high idle. The raw percentage values for the throttle that are shown on the electronic service tool should increase and the IVS status should change from CLOSED (ON) to OPEN (OFF) position. Make a note of the raw reading for the throttle when the IVS reading changes from the CLOSED position to the OPEN position. Repeat this step in order to obtain accurate raw percentage values for the throttle. The noted value should be within the previously noted “Idle Validation Min OFF Threshold” and “Idle Validation Max ON Threshold” limits.</p> <p><b>G.</b> The throttle is set to the full throttle position or the high idle position.</p> <p><b>H.</b> Operate the throttle slowly toward low idle. The raw percentage values for the throttle that are shown on the electronic service tool should decrease and the IVS status should change from OPEN (OFF) to CLOSED (ON) position. Make a note of the raw reading for the throttle when the IVS reading changes from the OPEN position to the CLOSED position. Repeat this step in order to obtain accurate raw percentage values for the throttle. The noted value should be within the previously noted “Idle Validation Min OFF Threshold” and “Idle Validation Max ON Threshold” limits.</p>	<p>The IVS operates within the thresholds.</p>	<p><b>Result:</b> The IVS operates within the “Idle Validation Min OFF Threshold” and the “Idle Validation Max ON Threshold” values.</p> <p>The IVS is operating correctly. Return the engine to service.</p> <p><b>Result:</b> The IVS does not operate within the “Idle Validation Min OFF Threshold” and the “Idle Validation Max ON Threshold” values.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Use the Electronic Service Tool to Reset the IVS Threshold Limits</b></p> <p>The electronic service tool can be used to change the following parameters to suit the type of throttle that is installed:</p> <ul style="list-style-type: none"> <li>· Idle Validation Min OFF Threshold</li> <li>· Idle Validation Max ON Threshold</li> </ul> <p><b>Note:</b> The limits are shown in the “Throttle Configuration” screen which is located in the “Service” menu.</p>	<p>The fault is cleared.</p>	<p><b>Result:</b> The fault is cleared after programming the new calculated values.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. Return the engine to service.</p> <p><b>Result:</b> The fault is not cleared.</p>

(continued)

(Table 186, contd)

Troubleshooting Test Steps	Values	Results
<p><b>A.</b> Refer to Test Step 9. "Check the IVS Calibration". Record the raw value of the throttle signal when the idle validation switch changes from the CLOSED position to the OPEN position.</p> <p><b>Note:</b> The default value for the "Idle Validation Min OFF Threshold" is 21%. The lowest value that should be set is 5%. The default value for the "Idle Validation Max ON Threshold" is 25%. The maximum value that is expected is 28%.</p> <p><b>B.</b> Set the "Idle Validation Min OFF Threshold" to 3% below the raw value that was previously recorded.</p> <p><b>C.</b> Set the "Idle Validation Max ON Threshold" to 3% above the raw value.</p> <p><b>D.</b> Enter the new threshold limits into the electronic service tool. Click "Submit" on the electronic service tool screen.</p> <p><b>E.</b> Turn the keyswitch to the OFF position and wait at least 5 seconds. Turn the keyswitch to the ON position.</p> <p><b>F.</b> Repeat Test Step 9. Check that the IVS operates within the newly set threshold limits.</p>		<p>Contact the Dealer Solutions Network (DSN).</p>

i06165203

## Indicator Lamp - Test

Use this procedure under the following circumstances:

- The lamps are not receiving battery voltage.
- The lamps are not operating correctly.

The following diagnostic lamps are available:

- Wait to start lamp
- Low oil pressure lamp
- Emissions system failure lamp
- Wait to disconnect lamp
- Low DEF level lamp
- Shutdown lamp
- Warning lamp

The electronic service tool can be used as a diagnostic aid in order to switch the individual lamps ON and OFF.

**Note:** The diagnostic aid that switches the lamps is contained in the "Override" section in the "diagnostics" menu of the electronic service tool.

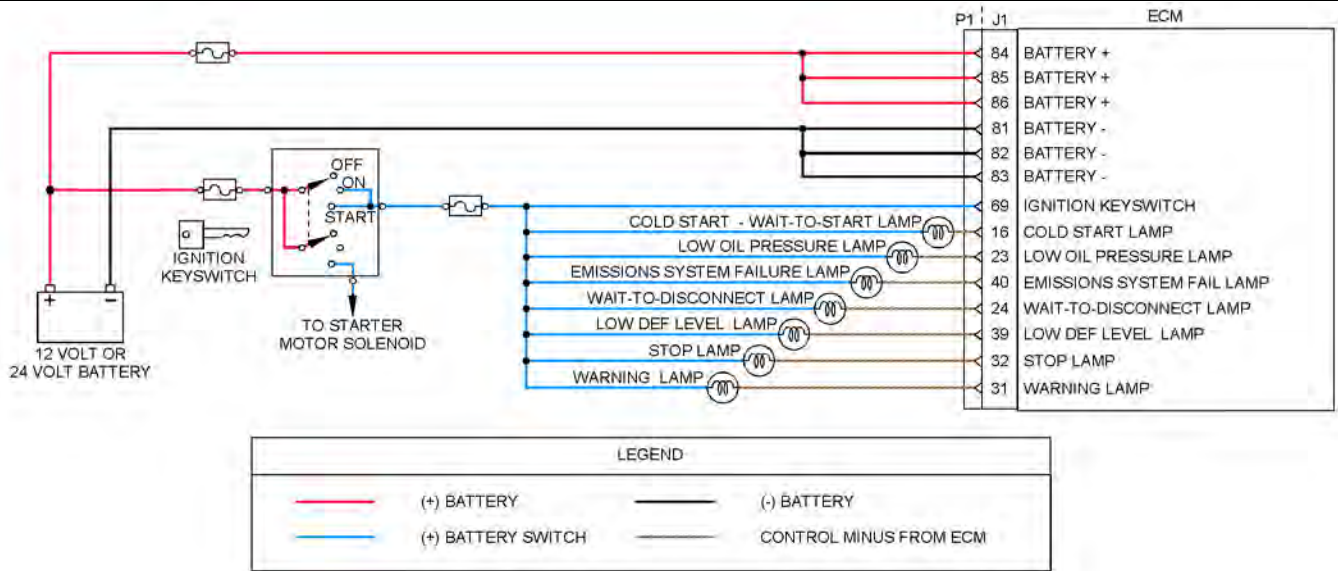


Illustration 115

g03712946

Typical schematic of the circuit for the indicator lamps  
Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Table 187

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Check that the fuses are not blown.</p> <p><b>C.</b> Thoroughly inspect the P1 connector and the lamp connections. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>D.</b> Perform a 45 N (10 lb) pull test on each of the wires in the P1 connector that are associated with the indicator lamps.</p> <p><b>E.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>F.</b> Check the harness for abrasions and for pinch points from the battery to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled. Replace any blown fuses.</p> <p>Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. The fuses are not blown.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Inspect the Lamp</b></p> <p><b>A.</b> Disconnect the lamp from the harness. Inspect the lamp in order to determine if the lamp has failed.</p> <p><b>B.</b> Measure the resistance across the two terminals of the lamp.</p>	<p>Less than 2000 Ohms</p>	<p><b>Result:</b> The lamp has greater than 2000 Ohms resistance.</p> <p><b>Repair:</b> Replace the suspect lamp.</p> <p>Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> The lamp has less than 2000 Ohms resistance.</p> <p>Proceed to Test Step 3.</p>

(continued)

(Table 187, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Measure the Input Voltage to the Lamp at the Lamp Socket</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Use the electronic service tool to select the “override” function in order to switch individual lamps ON and OFF. <b>Note:</b> The “Override” function is contained in the “Diagnostics” menu of the electronic service tool.</p> <p><b>C.</b> Measure the voltage at the lamp socket.</p>	<p>At least 10 VDC for a 12 V system. At least 22 VDC for a 24 V system.</p>	<p><b>Result:</b> The voltage is not within the expected range - the fault is in the battery supply wiring to the lamp.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> The voltage is within the expected range.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P1 connector.</p> <p><b>C.</b> Remove the bulb from the suspect lamp.</p> <p><b>D.</b> Use a multimeter to measure the resistance between the ground connection on the lamp holder and the applicable terminal on the P1 connector.</p>	<p>Less than two Ohms</p>	<p><b>Result:</b> The measured resistance is greater than two Ohms - the fault is in the wiring between the lamp holder and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is less than two Ohms.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Disconnect the P1 connector.</p> <p><b>B.</b> Use a multimeter to check the resistance between the terminal for the suspect lamp and all the other terminals on the P1 connector.</p>	<p>Greater than 100 Ohms</p>	<p><b>Result:</b> One or more of the measured resistances is less than 100 Ohms. There is a short in the wiring between the lamp holder and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 100 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06165229

## Injector Data Incorrect - Test

This procedure covers the following codes:

Table 188

Diagnostic Codes for Injector Data Incorrect			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
651-2	1-2	Engine Injector Cylinder #01 : Erratic, Intermittent or Incorrect	The Electronic Control Module (ECM) detects an injector code that is incorrect for the engine. The warning lamp will come on.

(continued)

(Table 188, contd)

652-2	2-2	Engine Injector Cylinder #02 : Erratic, Intermittent or Incorrect	
653-2	3-2	Engine Injector Cylinder #03 : Erratic, Intermittent or Incorrect	
654-2	4-2	Engine Injector Cylinder #04 : Erratic, Intermittent or Incorrect	

**The following background information is related to this procedure:**

Injector codes are 30 hexadecimal character codes that are supplied with each injector. The code is on a plate on the top of the injector and a card is also included in the packaging for the injector. The code is used by the ECM to balance the performance of the injectors.

Refer to Troubleshooting, "Injector Code - Calibrate" for further information.

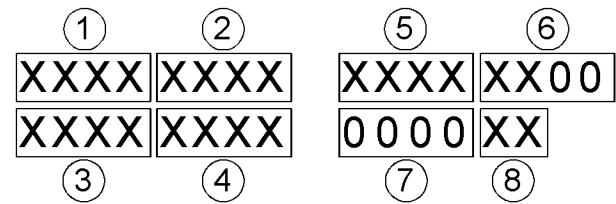


Illustration 117

g02132293

Sequence for recording the injector code

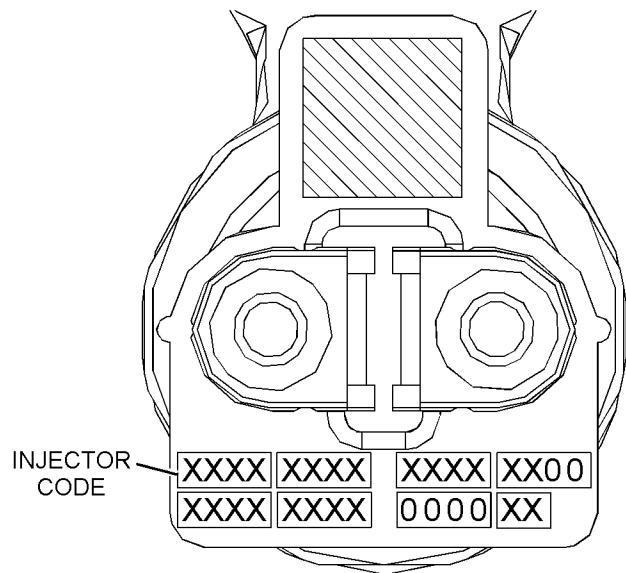


Illustration 116

g02131289

Typical code plate on an injector

Table 189

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Check for active diagnostic codes or recently logged diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> No diagnostic codes are present.</p> <p>Return the unit to service.</p> <p><b>Result:</b> One or more of the preceding diagnostic codes are active.</p> <p>Make a note of any cylinder numbers with the active diagnostic code. Proceed to Test Step 2.</p>
<p><b>2. Check the Injector Code on any Suspect Cylinders</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, "Electronic Service Tools".</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Select the following menu options on the electronic service tool in order to obtain the injector codes from the ECM:</p> <ul style="list-style-type: none"> <li>• "Service"</li> <li>• "Calibrations"</li> <li>• "Injector Trim Calibration"</li> </ul> <p><b>D.</b> Make a note of the injector codes for any suspect cylinders.</p>	<p>Diagnostic code</p>	<p><b>Result:</b> The card that was supplied with the injector is available for the suspect cylinders.</p> <p><b>Repair:</b> Compare the injector code from the card with the injector code that was recorded from the electronic service tool for each suspect cylinder.</p> <p>If the codes match, proceed to Test Step 3.</p> <p>If the codes do not match, then use the electronic service tool to input the code from the card.</p> <p><b>Result:</b> The card with the injector code is not available.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Manually Program the Injector Code</b></p> <p><b>A.</b> Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".</p> <p><b>B.</b> Make a note of the injector code that is on the injector in any suspect cylinders.</p> <p><b>Note:</b> Refer to Illustration 117 for the correct sequence for recording the injector code.</p> <p><b>C.</b> Compare the injector code from the injector with the injector code from the electronic service tool for each suspect cylinder.</p>	<p>Injector codes</p>	<p><b>Result:</b> The code on the injector is the same as the code in the ECM.</p> <p><b>Repair:</b> The injector is incorrect for the engine. Replace the injector with the correct injector for the engine. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and refer to Disassembly and Assembly, "Electronic Unit Injector - Install".</p> <p><b>Result:</b> The code on the injector is not the same as the code in the ECM.</p> <p><b>Repair:</b> Use the electronic service tool to input the correct injector code. Refer to Troubleshooting, "Injector Code - Calibrate" for the correct procedure.</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p>If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).</p>

i06165243

## Injector Solenoid - Test

This procedure covers the following diagnostic codes:



Table 190

Diagnostic Trouble Codes for Injector Solenoid			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
651-5	1-5	Engine Injector Cylinder #01 : Current Below Normal	<p>These diagnostic codes indicate an open circuit (low current) in either the solenoid or the wiring for the electronic unit injector.</p> <p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>A low current condition (open circuit) for each of five consecutive attempts to operate</p> <p>Battery voltage above 9 VDC for 2 seconds</p> <p>The warning light will come on. The ECM will log the diagnostic code. The engine will have low power and/or rough running.</p> <p>When an "Cylinder Cutout Test" is performed, a faulty electronic unit injector will indicate a low reading in comparison with the other electronic unit injectors.</p> <p>The ECM will continue to attempt to operate the electronic unit injector after the diagnostic code has been logged. An open circuit will prevent the operation of the electronic unit injector.</p>
652-5	2-5	Engine Injector Cylinder #02 : Current Below Normal	
653-5	3-5	Engine Injector Cylinder #03 : Current Below Normal	
654-5	4-5	Engine Injector Cylinder #04 : Current Below Normal	
651-6	1-6	Engine Injector Cylinder #01 : Current Above Normal	<p>These diagnostic codes indicate a short circuit (high current) in either the solenoid or the wiring for the electronic unit injector.</p> <p>The ECM detects the following conditions:</p> <p>A high current condition (short circuit) for each of five consecutive attempts to operate</p> <p>Battery voltage above 9 VDC for 2 seconds</p> <p>The warning light will come on. The ECM will log the diagnostic code. The engine will have low power and/or rough running.</p> <p>The ECM will continue to attempt to operate the electronic unit injector after the diagnostic code has been logged. A short circuit will prevent the operation of the electronic unit injector.</p>
652-6	2-6	Engine Injector Cylinder #02 : Current Above Normal	
653-6	3-6	Engine Injector Cylinder #03 : Current Above Normal	
654-6	4-6	Engine Injector Cylinder #04 : Current Above Normal	

Follow the troubleshooting procedure in order to identify the root cause of the fault.

Perform this procedure under conditions that are identical to the conditions that exist when the fault occurs. Typically, faults with the injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

These engines have Electronic Unit Injectors (EUI). The ECM sends a pulse to each injector solenoid. The pulse is sent at the correct time and at the correct duration for a given engine load and speed. The solenoid is mounted on top of the fuel injector body.

An electrical fault can prevent the electronic unit injector from operating. An open or short circuit in the ECM that is unique to one electronic unit injector will prevent that electronic unit injector from operating. An open or short circuit in common wiring within the ECM can prevent the two electronic unit injectors that share that common wiring from operating.

If an open circuit is detected in the solenoid circuit, a diagnostic code is generated. The ECM continues to try to fire the injector. If a short circuit is detected, a diagnostic code is generated. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the fault is corrected.

#### "Injector Solenoid Test"

Use the "Injector Solenoid Test" to diagnose an open or short circuit diagnostic code while the engine is not running. The "Injector Solenoid Test" will send a signal to each solenoid. The electronic service tool will indicate the status of the solenoid as "OK", "Open", or "Short".

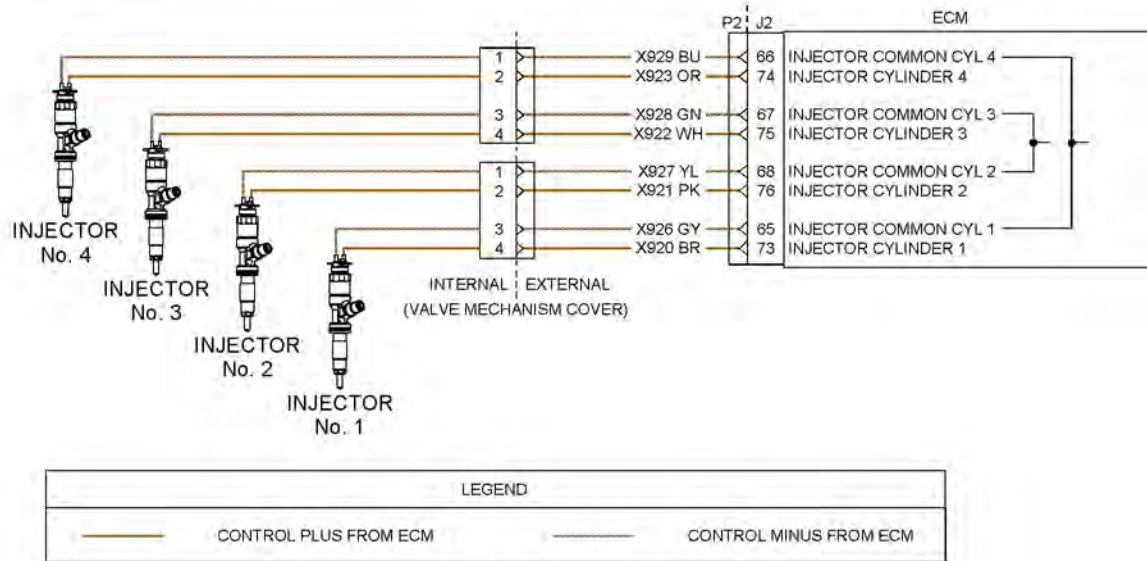


Illustration 118

g03713296

Schematic of the circuit for the injector solenoids

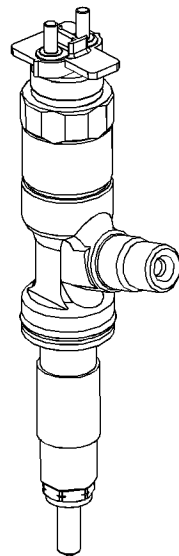


Illustration 119

g02041293

Fuel injector

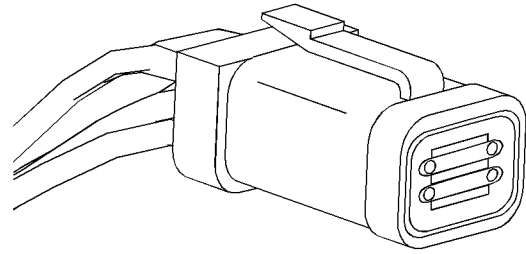
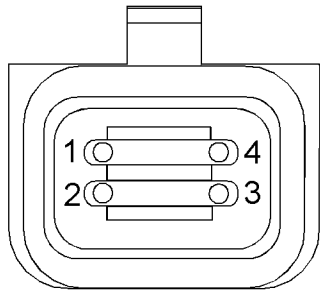


Illustration 120

Harness connector for the fuel injector solenoids

g01951833

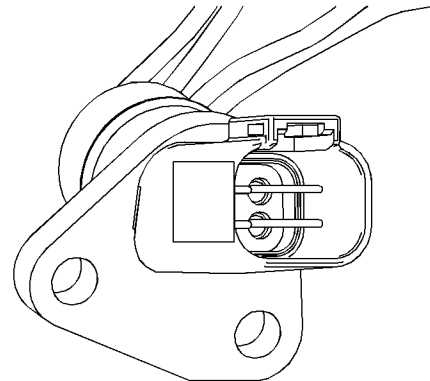
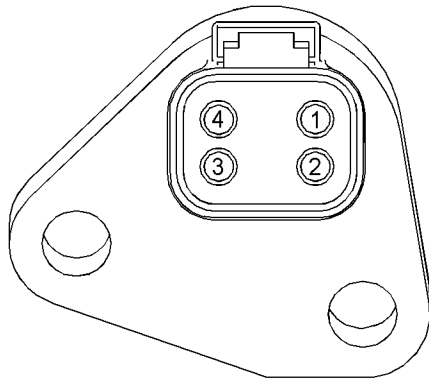


Illustration 121

Connector in the cylinder head

g01951828

**⚠ WARNING**

**Electrical Shock Hazard.** The electronic unit injectors use DC voltage. The ECM sends this voltage to the electronic unit injectors. Do not come in contact with the harness connector for the electronic unit injectors while the engine is operating. Failure to follow this instruction could result in personal injury or death.

Table 191

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF.</p> <p><b>B.</b> Thoroughly inspect the connectors at the cylinder head. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with injector solenoids.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness and wiring for abrasion and for pinch points from the injectors to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Use the "Injector Solenoid Test"</b></p> <p><b>A.</b> Start the engine.</p> <p><b>B.</b> Allow the engine to warm up to the normal operating temperature.</p> <p><b>C.</b> Stop the engine.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Access the "Injector Solenoid Test" by accessing the following display screens in order:</p> <ul style="list-style-type: none"> <li>• "Diagnostics"</li> <li>• "Diagnostic Tests"</li> <li>• "Injector Solenoid Test"</li> </ul> <p><b>F.</b> Activate the test.</p> <p><b>Note:</b> Do not confuse the "Injector Solenoid Test" with the "Cylinder Cutout Test". The "Cylinder Cutout Test" is used to shut off fuel to a specific cylinder while the engine is running. The "Injector Solenoid Test" is used to actuate the injector solenoids while the engine is not running.</p>	<p>"OK", "OPEN", or "SHORT"</p>	<p><b>Result:</b> All cylinders indicate "OK" - There is not an electronic fault with the injectors at this time.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service.</p> <p><b>Result:</b> "OPEN"</p> <p>Note the cylinders that indicate "OPEN". Proceed to Test Step 3.</p> <p><b>Result:</b> "SHORT"</p> <p>Note the cylinders that indicate "SHORT". Proceed to Test Step 4.</p>

(continued)

(Table 191, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Harness between the ECM and the Cylinder Head for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF.</p> <p><b>B.</b> Disconnect the connector for the suspect injector from the cylinder head.</p> <p><b>C.</b> Fabricate a jumper wire 100 mm (4 inch) long with terminals on both ends of the wire.</p> <p><b>D.</b> Insert one end of the jumper wire into the terminal for the supply to the suspect injector. Insert the other end of the jumper wire into the terminal for the return circuit for the suspect injector.</p> <p><b>E.</b> Turn the keyswitch to the ON position.</p> <p><b>F.</b> Perform the "Injector Solenoid Test" at least two times.</p> <p><b>G.</b> Repeat this test for each suspect injector. Stop the "Injector Solenoid Test" before handling the jumper wires.</p>	<p>Suspect injector indicates "SHORT"</p>	<p><b>Result:</b> The electronic service tool displays "SHORT" for the cylinder with the jumper wire.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The electronic service tool does not display "SHORT" for the cylinder with the jumper wire.</p> <p>Proceed to Test Step 6.</p>
<p><b>4. Check the Harness between the ECM and the Cylinder Head for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF.</p> <p><b>B.</b> Disconnect the connector for the suspect injector from the cylinder head.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Perform the "Injector Solenoid Test" at least two times.</p> <p><b>E.</b> Repeat this test for each suspect injector. Stop the "Injector Solenoid Test" before handling the jumper wires.</p>	<p>Suspect injector indicates "OPEN"</p>	<p><b>Result:</b> The electronic service tool displays "OPEN" for the suspect cylinder and the cylinder that shares the same connector.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The electronic service tool does not display "OPEN" for the suspect cylinder</p> <p>Proceed to Test Step 7.</p>

(continued)

(Table 191, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Exchange the Injector Harness Under the Valve Mechanism Cover</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF.</p> <p><b>B.</b> Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install" for the correct procedure.</p> <p><b>C.</b> Disconnect the connector for the suspect injector from the cylinder head. Disconnect the connector from the adjacent injector.</p> <p><b>D.</b> Exchange the two internal harnesses. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and refer to Disassembly and Assembly, "Electronic Unit Injector - Install" for the correct procedure.</p> <p><b>E.</b> Turn the keyswitch to the ON position.</p> <p><b>F.</b> Perform the "Injector Solenoid Test" at least two times.</p> <p><b>G.</b> Restore the wiring to the normal positions.</p>	<p>Fault moves to another injector</p>	<p><b>Result:</b> Exchanging the harnesses causes the fault to move to another injector - There is a fault with the suspect injector harness under the valve mechanism cover.</p> <p><b>Repair:</b> Repair the suspect injector harness or replace the suspect injector harness under the valve mechanism cover. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The fault remains on the same injector when the harness is exchanged - the injector may be faulty.</p> <p><b>Repair:</b> Replace the faulty injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install". Perform the "Injector Solenoid Test". Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p>
<p><b>6. Check the Wiring to the Cylinder Head for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF.</p> <p><b>B.</b> Disconnect connector P2 from the ECM.</p> <p><b>C.</b> Thoroughly inspect the P2 connector. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>D.</b> Disconnect the connector for the suspect injector from the cylinder head.</p> <p><b>E.</b> Use a multimeter to check the resistance between the terminals on the suspect cylinder head connector and the terminals on P2. Refer to Illustration 118 .</p> <p><b>F.</b> Install the removed connectors.</p>	<p>Less than 2 Ohms</p>	<p><b>Result:</b> One or more of the measured resistances is greater than 2 Ohms. The fault is in the wiring between the ECM and the cylinder head connector.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistances for the suspect injector wiring are less than 2 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Check the Wiring to the Cylinder Head for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF.</p> <p><b>B.</b> Disconnect connector P2 from the ECM.</p> <p><b>C.</b> Thoroughly inspect the P2 connector. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p>	<p>Greater than 1 k Ohm</p>	<p><b>Result:</b> At least one of the resistance measurements is less than 1 k Ohm - there is a short in the wiring between the relay and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 1 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

(Table 191, contd)

Troubleshooting Test Steps	Values	Results
<p><b>D.</b> Disconnect the connector for the suspect injector from the cylinder head.</p> <p><b>E.</b> Use a multimeter to check the resistance between the terminals for the suspect injector on P2 and all other terminals on P2. Refer to Illustration 118 .</p> <p><b>F.</b> Install the removed connectors.</p>		

i06165245

## Mode Selection - Test

This procedure covers the following diagnostic code:

This procedure is only applicable to applications equipped with a mode selection switch.

Table 192

Diagnostic Trouble Code for the Mode Selection Switch			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
2882-2	1743-2	Engine Alternate Rating Select : Erratic, Intermittent, or Incorrect	<p>The Electronic Control Module (ECM) detects a combination of switch positions for the mode switches that has not been defined.</p> <p>If equipped, the warning lamp will come on and the ECM will log the diagnostic code.</p> <p>The ECM will return the engine to the last good mode selection or setting.</p> <p>The engine will start and the engine will default to the previous mode selection.</p> <p>The engine may operate at reduced speed or reduced power depending on the mode that is selected.</p>
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

Use this procedure to check if the mode selection switch operates correctly.

The mode selection switch inputs provide the operator with the ability to select a maximum of four different modes of operation. Different modes of operation can be used giving the operator a means to select the most efficient method of completing the required work.

Each mode has a single fuel limit map, a rated speed, and a matched fuel delivery. Each mode also has a specific droop value for throttle 1 and throttle 2.

Table 193

Mode Number	Switch 2	Switch 1	Enabled
1	Open	Open	Y/N
2	Open	Closed	Y/N
3	Closed	Open	Y/N
4	Closed	Closed	Y/N

If a fault occurs in the circuit for either of the switches, the mode of operation will be different to the mode that was selected. If the mode of operation is not enabled on the application, a 2882-2 diagnostic code will become active.

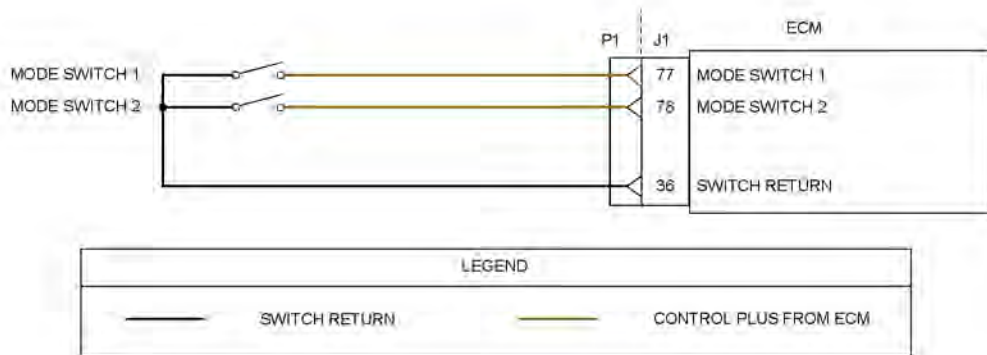


Illustration 122

g03713315

Schematic for the mode selection switch

Not all connectors are shown. Refer to the appropriate Electrical Schematic

Table 194

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch OFF.</p> <p><b>B.</b> Thoroughly inspect the P1 connector. Thoroughly inspect the mode switch connectors, plugs, and interconnections on the harness. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the P1 connector that are associated with the mode selector switches.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness for abrasions and for pinch points from the mode section switches to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Status of the Mode Selection Switch</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Monitor the status screen on the electronic service tool. Cycle the mode switch to the ON position and to the OFF position.</p>	<p>Switch status changes</p>	<p><b>Result:</b> The switch status changes on the electronic service tool as the mode switches are cycled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service.</p> <p><b>Result:</b> The switch status does not change as the mode switches are cycled.</p> <p>Proceed to Test Step 3.</p>

(continued)



(Table 194, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Insert a Jumper at the Suspect Mode Switch</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect mode selection switch.</p> <p><b>C.</b> Fabricate a jumper wire and install the jumper wire across the two contacts of the suspect switch.</p> <p><b>D.</b> Turn the keyswitch to the ON position. Monitor the status screen on the electronic service tool. Connect the jumper wire and then disconnect the jumper wire.</p> <p><b>E.</b> Turn the keyswitch to the OFF position. Remove the jumper wire.</p>	Switch status "CLOSED" with jumper installed	<p><b>Result:</b> When the jumper wire is connected, the switch is in the CLOSED position.</p> <p><b>Repair:</b> Replace the suspect mode selection switch. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> When the jumper wire is connected, the switch is in the OPEN position</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Measure the Voltage at the Switch</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the mode selection switches.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to turn both of the mode switches to the ON position.</p> <p><b>E.</b> Measure the voltage from the input of each mode switch to a suitable ground.</p>	At least 10 VDC for a 12 V system At least 22 VDC for a 24 V system	<p><b>Result:</b> One of the measured voltages is not within the expected range - The fault is in the wiring between the suspect mode switch and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured voltages are within the expected range.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the mode switches.</p> <p><b>C.</b> Use a multimeter to measure the resistance between P1:36 and the ground terminal on each of the mode switches.</p>	Less than two Ohms	<p><b>Result:</b> One of the measured resistances is greater than two Ohms - The fault is in the wiring between the suspect mode switch and P1:36.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are less than two Ohms.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the mode switches.</p> <p><b>C.</b> Disconnect the P1 connector from the ECM.</p> <p><b>D.</b> Use a multimeter to measure the resistance between P1:77 and all other terminals on the P1 connector.</p> <p><b>E.</b> Use a multimeter to measure the resistance between P1:78 and all other terminals on the P1 connector.</p>	Greater than 1 k Ohm	<p><b>Result:</b> One of the measured resistances is less than 1 k Ohm. The fault is in the wiring between the ECM and the mode switch.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are greater than 100 Ohms. There is a fault in the ECM.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06926399

## Motorized Valve - Test

This procedure covers the following

codes:

Table 195

Diagnostic Codes for the Motorized Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
649-5	3512-5	Engine Exhaust Back Pressure Regulator Control Command : Current Below Normal	<p>The ECM detects the following conditions:</p> <p>A low current condition in the output for the exhaust back pressure regulator for 2 seconds</p> <p>168 diagnostic codes are not active.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>If equipped, the warning lamp will come on. The ECM will log the diagnostic code.</p>
649-6	3512-6	Engine Exhaust Back Pressure Regulator Control Command : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>A high current condition in the output for the exhaust back pressure regulator for 2 seconds</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>If equipped, the warning lamp will come on. The ECM will log the diagnostic code.</p>
649-7	E1263 (2)	Engine Exhaust Back Pressure Regulator Control Command : Not Responding to Command	<p>The ECM detects the following conditions:</p> <p>The signal from the exhaust back pressure regulator position sensor indicates that the valve is not in the desired position.</p> <p>This diagnostic code can be caused by a loss of the 5 VDC supply to the exhaust back pressure regulator position sensor.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>If equipped, the warning lamp will come on. The ECM will log the diagnostic code.</p>
2791 -5	3405-5	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	<p>The ECM detects the following conditions:</p> <p>A low current condition in the output for the NOx Reduction System (NRS) valve (EGR valve) for 2 seconds</p> <p>168 diagnostic codes are not active.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>If equipped, the warning lamp will come on. The ECM will log the diagnostic code.</p>

(continued)

(Table 195, contd)

Diagnostic Codes for the Motorized Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
2791-6	3405-6	EGR Valve Control : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>A high current condition in the output for the NRS valve (EGR valve) for 2 seconds</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>If equipped, the warning lamp will come on. The ECM will log the diagnostic code.</p>
2791-7	E1121 (2)	EGR Valve Control Not Responding to Command	<p>The ECM detects the following conditions:</p> <p>The signal from the NRS valve position sensor indicates that the valve is not in the desired position.</p> <p>This diagnostic code can be caused by a loss of the 5 VDC supply to the NRS valve position sensor.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>If equipped, the warning lamp will come on. The ECM will log the diagnostic code.</p>

**The following background information is related to this procedure:**

#### NRS valve (EGR valve)

The NRS valve (EGR valve) is used to control the amount of exhaust gas which is recirculated into the intake manifold.

The amount of exhaust gas that is required is calculated by the software that is contained in the ECM.

The NRS valve is controlled by a PWM signal from the ECM.

#### Exhaust Back Pressure Regulator

The Exhaust Back Pressure Regulator (EBPR) is used to promote regeneration of the Diesel Particulate Filter (DPF) and provide thermal management of the Selective Catalytic Reduction (SCR) system.

When the soot level in the DPF is high, the ECM commands the EBPR to close. As the EBPR closes, the increased back pressure causes the engine to increase fuel flow. The increased fuel flow raises the exhaust gas temperature and therefore accelerates the regeneration process in the DPF.

As the soot level in the DPF reduces, the ECM commands the EBPR to open, reducing the exhaust back pressure to a normal level.

The EBPR is also used on engines with no DPF to control deposit management.

The position of the EBPR is calculated by the software that is contained in the ECM. The EBPR is controlled by a PWM signal from the ECM.

#### Air System Motor Valves Verification Test

The Air System Motor Valve Verification Test will identify whether the EGR valve, and the EBPR are working correctly. This test must be run when the engine speed is zero and the battery voltage is within an acceptable range. For a 12VDC system, the service test must only be executed if the battery voltage is between 9VDC and 16VDC. For a 24VDC system, the battery voltage must be between 18VDC and 32VDC. If the battery voltage is outside of these ranges at any time, the test must be aborted. The test will also be aborted if a position sensor diagnostic, a motor short diagnostic, or a motor open circuit diagnostic become active.

If at any point during the test the engine speed is not zero, the test will abort. The test moves the valves to various positions and then checks the position sensor within each valve to confirm that the valve has responded correctly. Each valve will be tested in turn, starting with the EGR valve. If a test threshold is exceeded or any related diagnostics become active, the test will abort and generate an error identifier.

Circuit Tests

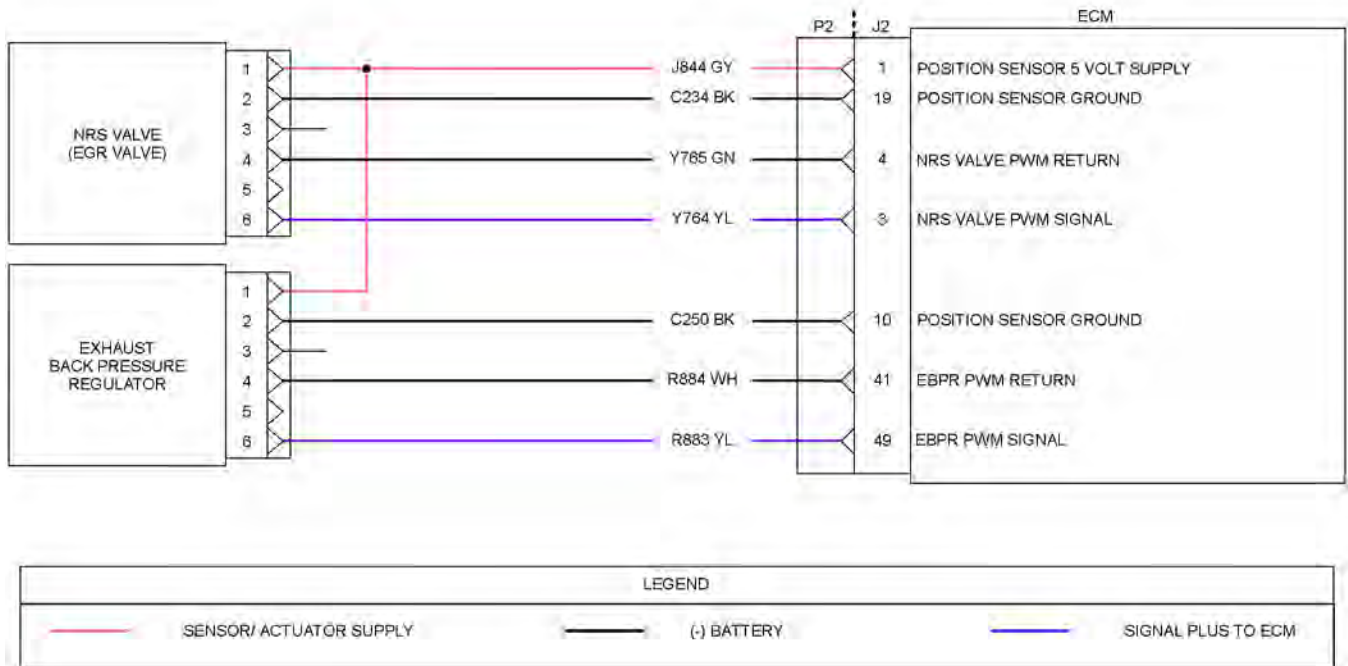


Illustration 123

g03732809

Schematic for the motorized valves

Complete the procedure in the order in which the steps are listed.

Table 196

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Thoroughly inspect the connectors for the motorized valves. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the motorized valves.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness and wiring for abrasion and for pinch points from the motorized valves to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Monitor the electronic service tool for active diagnostic codes and/or logged diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A -5 diagnostic code is active or recently logged for one or more of the motorized valves.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> A -6 diagnostic code is active or recently logged for one or more of the motorized valves.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> A -7, E1263 (2), or E1121 (2) diagnostic code is active or recently logged for one or more of the motorized valves.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> No diagnostic codes are active or logged.</p> <p><b>Repair:</b> For intermittent faults, refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p>If no intermittent faults are found, return the unit to service.</p>

(continued)

## Circuit Tests

(Table 196, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Measure the Sensor Supply Voltage at the Valve Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect valve from the engine harness.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage at the harness connector for the valve from the 5 VDC supply terminal of the position sensor to the sensor ground terminal.</p>	4.84 to 5.16 VDC	<p><b>Result:</b> The voltage from the terminal for the 5 VDC supply to the sensor common terminal measures 4.84 to 5.16 VDC.</p> <p><b>Repair:</b> Reconnect the suspect valve. Operate the engine for enough time to allow the engine to reach normal operating temperature. The suspect valve may be not responding due to frozen condensation.</p> <p>Use the electronic service tool to run the "Air System Motor Valves Verification Test".</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the -7, E1263 (2), or E1121 (2) code is still active, replace the suspect valve. Refer to Disassembly and Assembly for more information.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The sensor supply voltage is out of the nominal range. A 5 VDC supply diagnostic code is active. The fault is in the 5 VDC supply wire or the ground wire in the engine harness.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p>
<p><b>4. Create a Short Circuit at the Valve Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect valve.</p> <p><b>C.</b> Fabricate a jumper wire that is 150 mm (6 inch) long.</p> <p><b>D.</b> Install the jumper between the signal and return pins on the connector for the suspect valve to create a short circuit.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Check for active diagnostic codes on the electronic service tool.</p> <p><b>F.</b> Remove the jumper wire from the connector for the motorized valve.</p>	Open circuit	<p><b>Result:</b> A -6 diagnostic code is active when the jumper wire is installed. A -5 diagnostic code is active with the jumper removed.</p> <p><b>Repair:</b> Reconnect the valve.</p> <p>Check for active diagnostic codes on the electronic service tool. Wait at least 30 seconds in order for the codes to be displayed.</p> <p>If the -5 diagnostic code returns, then replace the valve. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> A -5 diagnostic code is still active with the jumper installed.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 196, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector and the connector for the suspect valve.</p> <p><b>C.</b> For the EBPR, use a multimeter to check the resistance between terminal 4 on the valve connector and P2:41.</p> <p><b>D.</b> For the EBPR, use a multimeter to check the resistance between terminal 6 on the valve connector and P2:49.</p> <p><b>E.</b> For the NRS valve, use a multimeter to check the resistance between terminal 4 on the valve connector and P2:4.</p> <p><b>F.</b> For the NRS valve, use a multimeter to check the resistance between terminal 6 on the valve connector and P2:3.</p> <p><b>G.</b> Reconnect the connectors.</p>	Less than 2 Ohms	<p><b>Result:</b> All measured resistances are less than 2 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> One or more of the measured resistances is greater than 2 Ohms. There is a fault in the wiring.</p> <p><b>Repair:</b> Repair the valve connector or replace the wiring harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p>
<p><b>6. Create an Open Circuit at the Valve Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect valve to create an open circuit.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Check for active diagnostic codes on the electronic service tool. Wait at least 30 seconds in order for the codes to be displayed.</p>	Diagnostic codes	<p><b>Result:</b> A -5 diagnostic code is now active. There is a short in the valve.</p> <p><b>Repair:</b> Reconnect the valve.</p> <p>Check for active diagnostic codes on the electronic service tool. Wait at least 30 seconds in order for the codes to be displayed.</p> <p>If the -6 diagnostic code returns, then replace the valve. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> There is still a -6 diagnostic code.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector and the connector for the suspect valve.</p> <p><b>C.</b> For the EBPR, use a multimeter to check the resistance between P2:41 and all other terminals on the P2 connector.</p> <p><b>D.</b> For the EBPR, use a multimeter to check the resistance between P2:49 and all other terminals on the P2 connector.</p> <p><b>E.</b> For the NRS valve, use a multimeter to check the resistance between P2:4 and all other terminals on the P2 connector.</p>	Greater than 1 k Ohm	<p><b>Result:</b> All measured resistances are greater than 1 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> One or more of the measured resistances is less than 1 k Ohm. There is a fault in the wiring.</p> <p><b>Repair:</b> Repair the valve connector or replace the wiring harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p>If the fault has not been eliminated, contact the Dealer Solutions Network (DSN).</p>

(continued)

## Circuit Tests

(Table 196, contd)

Troubleshooting Test Steps	Values	Results
F. For the NRS valve, use a multimeter to check the resistance between P2:3 and all other terminals on the P2 connector.		
G. Reconnect the connectors.		

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## NOx Sensor - Test

The ECM is monitoring the NOx level being reported by the sensor. If the NOx value is not steady when the engine speed/fueling is steady, the codes listed below will log. If the NOx value is steady when the engine speed/load is changing, the codes listed below will log.

Table 197 lists the diagnostic codes for the NOx sensors.

Table 197

Diagnostic Trouble Codes for the NOx Sensors			
J1939 Code	CDL Code	Code Description (code descriptions may vary)	Comments
3216-7	E1431 (2)	Aftertreatment #1 Intake NOx : Not Responding Properly	The engine out NOx level is not responding as expected. The code is logged.
3226-7	E1432 (2)	Aftertreatment #1 Outlet NOx : Not Responding Properly	The tailpipe out NOx level is not responding as expected. The code is logged.
4364-2	E1410 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	The Engine Out and Tailpipe Out NOx Sensors are installed in the incorrect locations
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 198

Required Tools			
Tool	Part Number	Part Description	Qty
A	T401199	Kit - Test	1
B	T402192	Adapter	1
C	N/A	Wired Borescope/5.5 mm HD Camera	1

Table 199

Associated Diagnostic Trouble Codes	
J1939 Code	CDL Code
412-15	E1092 (1)
412-16	E1092 (2)
4364-2	E1410 (2)
4360-16	E946 (2)
4360-17	E947 (1)
4360-18	E947 (2)
4765-17	E2165 (1)
5298-17	2180-1

Complete the procedure in the order in which the steps are listed.



Table 200

Troubleshooting Test Steps	Values	Results
<p><b>1. Check that the latest available software is installed and there are no applicable Technical Information Bulletins or Special Instruction documentation released</b></p> <p><b>A.</b> Ensure that the latest software is installed on the engine ECM.</p> <p><b>B.</b> Ensure that the latest software is installed on the Dosing Control Unit (DCU)</p> <p>If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p><b>C.</b> Ensure all Technical Information Bulletins and/or Special Instruction documented for the issue and/or product are reviewed and followed.</p>	Software and Publications	<p><b>Result:</b> The latest software is not installed.</p> <p><b>Repair:</b> Install the latest engine ECM software and then install the latest DCU software. If necessary, refer to Troubleshooting, "ECM Software - Install" for the correct procedure.</p> <p>Start the engine and wait for 2 minutes.</p> <p>If the fault is cleared, return the engine to service.</p> <p>If the fault is still present, proceed to Test Step 2.</p> <p><b>Result:</b> Applicable Technical Information Bulletin/Special Instruction publication is available.</p> <p><b>Repair:</b> Review and follow instructions provided in the available publication.</p> <p><b>Result:</b> The latest software is installed.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Determine the Diagnostic Code</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the engine Electronic Control Module (ECM) . Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Determine the diagnostic trouble code that is active.</p>	Diagnostic trouble code	<p><b>Result:</b> A 4364-2 (E1410 (2)) diagnostic code is active or recently logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> A 3216-7 (E1431 (2)) or 3226-7 (E1432 (2)) diagnostic code is active or recently logged.</p> <p>Proceed to Test Step 4.</p>
<p><b>3. Check that the NOx Sensors are Installed Correctly</b></p> <p><b>A.</b> Verify that the sensors are located in the correct position.</p> <ul style="list-style-type: none"> <li>• The engine out NOx sensor has black protective coating on the wires.</li> <li>• The tailpipe out NOx sensor has gray protective coating on the wires.</li> </ul> <p><b>B.</b> If the sensors are installed in the wrong positions, install the sensors in the correct positions. Refer to Disassembly and Assembly, "Nitrogen Oxide Sensor - Remove and Install" for the correct procedure.</p>	Correct installation	<p><b>Result:</b> The NOx sensors are already in the correct locations.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> The NOx sensors have been swapped.</p> <p>Proceed to Test Step 9.</p>
<p><b>4. Perform a "DEF Dosing System Accuracy Test" using the Electronic Service Tool</b></p> <p><b>A.</b> Use Tooling A and Tooling B and refer to Systems Operation, Testing and Adjusting, Aftertreatment SCR System Dosing - Test for the procedure.</p>	DEF Dosing System Accuracy Test	<p><b>Result:</b> Droplets form around the DEF injector nozzle during the prime pressurization phase of the test. Refer to Illustration 124</p> <p><b>Repair:</b> Install a replacement DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p>Proceed to Test Step 5</p> <p><b>Result:</b> Droplets do not form around the DEF injector nozzle during the prime pressurization phase of the test.</p> <p>Proceed to Test Step 5</p>



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Illustration 124  
Typical example of droplets forming on the DEF injector nozzle

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Table 201

<p><b>5. Repeat the “DEF Dosing System Accuracy Test” using the Electronic Service Tool</b></p> <p><b>A.</b> Use Tooling A and Tooling B and refer to Systems Operation, Testing and Adjusting, Aftertreatment SCR System Dosing - Test for the procedure.</p>	<p>DEF Dosing System Accuracy Test</p>	<p><b>Result:</b> The quantity of DEF collected is between 105 mL (3.6 oz) and 130 mL(4.4 oz).</p> <p>Proceed to Test Step 6</p> <p><b>Result:</b> The quantity of DEF collected is not between 105 mL(3.6 oz) and 130 mL(4.4 oz).</p> <p><b>Repair:</b> Install a replacement DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p>Proceed to Test Step 6</p>
<p><b>6. Observe the Spray Pattern from the DEF Injector During the “DEF Dosing System Accuracy Test” using the Electronic Service Tool</b></p> <p><b>Note:</b> To observe the spray pattern clearly from the DEF injector, it may be necessary to run the “DEF Dosing System Accuracy Test” again using a suitable large container to collect the DEF.</p>	<p>DEF Dosing System Accuracy Test</p>	<p><b>Result:</b> The spray is finely atomized and conical with even spray all around.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> The spray is not finely atomized and conical with even spray all around.</p> <p><b>Repair:</b> Install a replacement DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.</p> <p>Proceed to Test Step 7</p>
<p><b>7. Inspect the Inside of the Clean Emissions Module (CEM) Mixer Assembly</b></p> <p><b>A.</b> Remove the DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install</p> <p><b>B.</b> Use Tooling C to inspect the inside of the Clean Emissions Module (CEM) mixer assembly for DEF deposits.</p>	<p>CEM Mixer Assembly Inspection</p>	<p><b>Result:</b> DEF deposits are still visible in the Clean Emissions Module Mixer Assembly. Refer to Illustration 125</p> <p><b>Repair:</b> Use the electronic service tool to perform the “Aftertreatment Recovery Procedure 3 times and repeat step 7B.” .</p> <p><b>Note:</b> There are two versions of the “Aftertreatment Recovery Procedure” . One version is for engines with a DPF. The other version is for engines without a DPF. Ensure that the correct procedure is used.</p> <p><b>Note:</b> The success of the “Aftertreatment Recovery Procedure” can be improved by covering the radiator to increase the engine coolant temperature. The coolant temperature and charge air cooler outlet temperature must be monitored on the electronic service tool while the radiator is covered.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p> <p><b>Note:</b> An SCR inlet temperature greater then 370° C (698° F) will improve the success rate of the “Aftertreatment Recovery Procedure” . This can be achieved by increasing the engine load by applying electrical load. <b>Do not let the SCR inlet temperature rise above 450° C (842° F).</b></p> <p><b>Result:</b> The Clean Emissions Module (CEM) Mixer Assembly contains no DEF deposits. Refer to Illustration 126</p>

(continued)

(Table 201, contd)

		<p>Proceed to Test Step 8.</p> <p><b>Note:</b> Test steps 11 and 12 must be performed before returning the unit to service.</p>
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Illustration 125  
Typical example of DEF deposits in the CEM mixer assembly

g06304951



Illustration 126  
Typical example of a CEM mixer assembly with DEF deposits cleared

g06305355

Table 202

<p><b>8. Perform an "Aftertreatment System Functional Test"</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the engine ECM. Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Perform an "Aftertreatment System Functional Test" using the electronic service tool.</p>	Successful completion of test	<p><b>Result:</b> The test completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The test did not complete successfully.</p> <p>Proceed to Test Step 9.</p>
<p><b>9. Check for an Engine Misfire</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the engine ECM.</p> <p><b>B.</b> Perform a "Cylinder Cutout Test" using the electronic service tool.</p>	Misfire	<p><b>Result:</b> A misfire was detected.</p> <p><b>Repair:</b> Replace or repair the failed component or components.</p> <p>Proceed to Test Step 10.</p> <p><b>Result:</b> A misfire was not detected.</p> <p>Proceed to Test Step 11.</p>
<p><b>10. Check the Aftertreatment System for Oil or Fuel</b></p> <p><b>A.</b> Remove excess oil or fuel from the piping with a clean cloth.</p> <p><b>B.</b> Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p><b>C.</b> Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours.</p> <p><b>D.</b> Check the quantity of drained oil or fuel in the container.</p>	CEM	<p><b>Result</b> The volume of drained oil or fuel is greater than 1.0 L (1.05669 qt).</p> <p><b>Repair:</b> Install a replacement CEM. Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p>Return the unit to service.</p> <p><b>Result</b> The volume of drained oil or fuel is less than 1.0 L (1.05669 qt).</p> <p>Proceed to Test Step 11.</p>
<p><b>11. Check the Exhaust System for Leaks</b></p> <p><b>A.</b> Check the entire exhaust system for leaks.</p>	Exhaust leaks	<p><b>Result:</b> There were not any exhaust leaks found.</p> <p><b>Repair:</b> For a 3216-7 (E1431 (2)) diagnostic code replace the intake NOx sensor.</p> <p>For a 3226-7 (E1432 (2)) diagnostic code replace the outlet NOx sensor.</p> <p>Refer to Disassembly and Assembly, "Nitrogen Oxide Sensor - Remove and Install" for the correct procedure.</p> <p>Proceed to Test Step 12.</p> <p><b>Result:</b> There were exhaust leaks found.</p> <p><b>Repair:</b> Repair the exhaust leaks.</p> <p>Proceed to Test Step 13.</p>

(continued)

(Table 202, contd)

<p><b>12. Recover the Aftertreatment System</b></p> <p><b>A.</b> Clean any remaining oil or fuel from the piping and the CEM inlet with a clean cloth.</p> <p><b>B.</b> Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install".</p> <p><b>C.</b> Run the engine at high idle with no load for a minimum of 20 minutes.</p> <p><b>Note:</b> During the following step, there are two versions of the "Aftertreatment Recovery Procedure". One version is for engines with a DPF. The other version is for engines without a DPF. Ensure that the correct procedure is used.</p> <p><b>D.</b> Use the electronic service tool to perform the "Aftertreatment Recovery Procedure". While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.</p> <p><b>Note:</b> Engine RPM Override may be necessary to complete the Aftertreatment Recovery Procedure.</p>	<p>CEM</p>	<p><b>Result:</b> The "Aftertreatment Recovery Procedure" complete successfully.</p> <p>Proceed to Test Step 13.</p> <p><b>Result</b> The "Aftertreatment Recovery Procedure" failed. An error code is generated by the electronic service tool.</p> <p><b>Repair:</b> Troubleshoot the error code. Refer to Troubleshooting, "Service Tool Error Identifiers".</p> <p><b>Result:</b> The "Aftertreatment Recovery Procedure" failed. No error codes are generated.</p> <p>A replacement CEM may be required. Contact the Dealer Solutions Network (DSN).</p>
<p><b>13. Perform a "Aftertreatment System Functional Test"</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the ECM. Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Perform a "Aftertreatment System Functional Test" using the electronic service tool.</p>	<p>Successful completion of test</p>	<p><b>Result:</b> The test completed successfully.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The test did not complete successfully.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06133171

The engine has the following options of set speed control:

- Single speed
- No speed (no PTO control)

## Power Take-Off - Test

**Note:** This procedure only applies to engines equipped with Power Take-Off (PTO) switches.

Use this procedure under the following circumstances:

- The correct supply voltage to the PTO switches is suspect.
- Operation of the PTO switches is suspect.

**Note:** Some applications may only have one PTO switch.

The PTO switches provide the operator with the ability to select the desired engine speed. Engine speed will decrease with increasing load. The PTO switches can be used to control the engine speed.

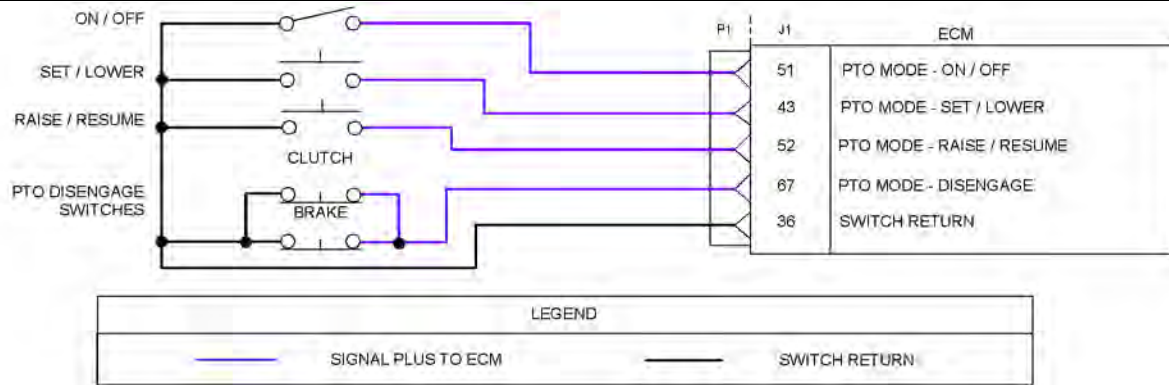


Illustration 127

g03733170

Schematic for the PTO switches

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Table 203

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Thoroughly inspect the J1/P1 connectors on the Electronic Control Module (ECM), the switch connections and battery connections. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the switch connector and the ECM connector that are associated with the active diagnostic code. Refer to Illustration 127 .</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness for corrosion, abrasion, and pinch points from the PTO mode switches to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the "PTO Mode Switches" on the Electronic Service Tool</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Observe the status of the PTO mode switch on the electronic service tool while cycling the PTO ON/OFF switch.</p> <p><b>E.</b> Use the electronic service tool in order to observe the status of the PTO mode switch while cycling the PTO Set/Lower switch.</p> <p><b>F.</b> Use the electronic service tool in order to observe the status of the PTO mode switch while cycling the PTO Raise/Resume switch.</p>	<p>Switch status changes from "OPEN" to "CLOSED"</p>	<p><b>Result:</b> The switch status changes on the electronic service tool as the PTO switches are cycled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service.</p> <p><b>Result:</b> The switch status does not change as the PTO switches are cycled.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Status of the PTO Mode Disengage Switches</b></p> <p><b>A.</b> Use the electronic service tool in order to observe the switch status while the PTO mode disengage switches are operated OFF and ON.</p> <p><b>Note:</b> The PTO mode - Disengage switches usually function by the operation of the brake, clutch, or the operator switch. These switches should be operated separately for this test.</p>	<p>Switch status changes from "ENGAGED" to "DISENGAGED"</p>	<p><b>Result:</b> The PTO mode - Disengage switch operates correctly.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service.</p> <p><b>Result:</b> The PTO mode - Disengage switch does not operate correctly.</p> <p>Proceed to Test Step 4.</p>

(continued)



(Table 203, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Suspect PTO Switch</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove the two wires from the suspect switch. Use a suitable jumper in order to join the two wires together.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Monitor the status screen on the electronic service tool while the jumper wire is being disconnected and reconnected.</p>	Switch status changes when jumper is installed	<p><b>Result:</b> When the jumper wire is connected, the status of the PTO mode switches is "CLOSED" . When the jumper wire is disconnected, the status of the PTO mode switches is "OPEN" - The fault is in the switch.</p> <p><b>Repair:</b> Replace the switch. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the problem.</p> <p><b>Result:</b> When the jumper wire is connected, the status of the PTO mode switches is "OPEN" or when the jumper wire is disconnected the status of the PTO mode switches is "CLOSED" .</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Measure the Resistance of the Cables at the ECM</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect switch.</p> <p><b>C.</b> Disconnect the P1 connector from the ECM.</p> <p><b>D.</b> Measure the resistance between P1:36 and the appropriate pin on the P1 connector for the suspect switch. Refer to Illustration 127 .</p> <p><b>E.</b> Repeat the procedure for each of the PTO mode switches.</p>	Less than 2 Ohms with switch ON. Greater than 1 k Ohm with switch off.	<p><b>Result:</b> The measured resistance is more than 2 Ohms with the switch ON or the measured resistance is less than 1 k Ohm with the switch OFF. - There is a fault with the wires between the suspect switch and the P1 connector.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is less than two Ohms with the switch ON. The measured resistance is more than 1 k Ohm with the switch OFF.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i07044050

## Relay - Test (Aftertreatment Power Relay)

This procedure covers the following diagnostic codes:

Table 204

Diagnostic Trouble Codes for the Aftertreatment Power Relay			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5965-5	3838-5	Aftertreatment #1 DEF Control Module Relay Control : Current Below Normal	The Electronic Control Module (ECM) detects a low current condition in the aftertreatment power relay circuit.
5965-6	3838-6	Aftertreatment #1 DEF Control Module Relay Control : Current Above Normal	The ECM detects a high current condition in the aftertreatment power relay circuit.
Follow the troubleshooting procedure to identify the root cause of the fault.			

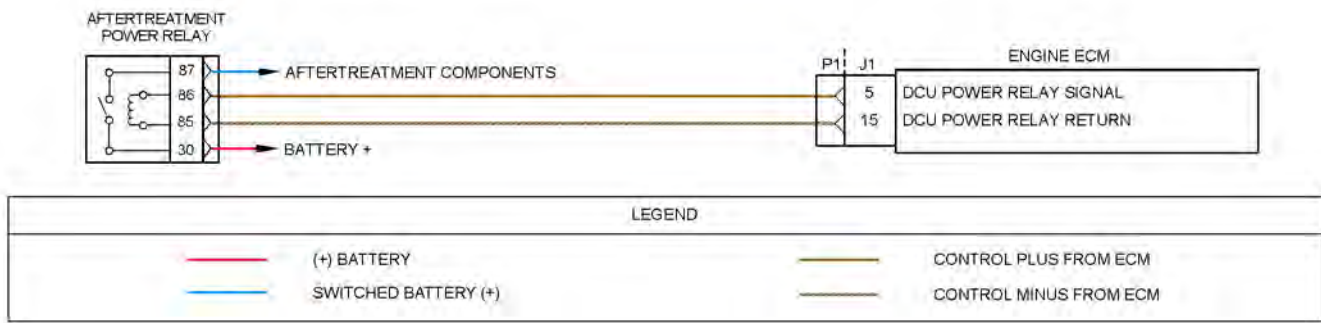


Illustration 128

g06206555

Schematic diagram for the aftertreatment power relay

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Complete the procedure in the order in which the steps are listed.

Table 205

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Check that the fuses are not blown.</p> <p><b>B.</b> Inspect the terminals on the aftertreatment power relay. Refer to Troubleshooting, “Electrical Connector - Inspect” for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the aftertreatment power relay.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness for abrasion and pinch points from the aftertreatment power relay back to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Replace any blown fuses.</p> <p>Use the electronic service tool to clear all logged diagnostic codes.</p> <p>Use the electronic service tool to perform the “Aftertreatment System Functional Test” to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. The fuses are not blown.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position. <b>Note:</b> Do not start the engine.</p> <p><b>C.</b> Use the electronic service tool to check for active diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> Diagnostic code 5965-5 or 3838-5 is active or recently logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> Diagnostic code 5965-6 or 3838-6 is active or recently logged.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 205, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Create a Short Circuit at the Relay Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Remove the aftertreatment power relay.</p> <p><b>C.</b> Fabricate a jumper wire. Install the jumper wire between terminal 85 and terminal 86 on the harness connector for the aftertreatment power relay.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.</p> <p><b>F.</b> Turn the keyswitch to the OFF position and remove the jumper wire.</p>	<p>Diagnostic code</p>	<p><b>Result:</b> A 5965-6 or 3838-6 diagnostic code is active with the jumper installed.</p> <p><b>Repair:</b> Install a replacement start relay.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 5965-5 or 3838-5 diagnostic code is still active.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Relay Control Wiring for an Open Circuit</b></p> <p><b>A.</b> Verify that the keyswitch is in the OFF position.</p> <p><b>B.</b> Disconnect the P1 connector from the ECM.</p> <p><b>C.</b> Inspect the P1 connector. Refer to Troubleshooting, "Electrical Connector - Inspect" for details.</p> <p><b>D.</b> Measure the resistance between Terminal 85 on the harness connector for the aftertreatment power relay and P1:5.</p> <p><b>E.</b> Measure the resistance between Terminal 86 on the harness connector for the start relay and P1:15.</p>	<p>Less than 5 Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is greater than 5 Ohms - the fault is in the wiring for the after-treatment power relay control circuit.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p><b>Result:</b> Both resistance measurements are less than 5 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

## Circuit Tests

(Table 205, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Create an Open Circuit at the Relay</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the aftertreatment power relay.</p> <p><b>C.</b> Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.</p>	Diagnostic codes	<p><b>Result:</b> A 5965-5 or 3838-5 diagnostic code is active with the relay disconnected.</p> <p><b>Repair:</b> Install a replacement aftertreatment power relay.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 5965-6 or 3838-6 diagnostic code is still active with the relay disconnected.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Wiring Between the Relay and the ECM for a Short Circuit</b></p> <p><b>A.</b> Disconnect the P1 connector.</p> <p><b>B.</b> Inspect the P1 connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Measure the resistance between P1:5 and all other terminals on the P1 connector.</p> <p><b>D.</b> Measure the resistance between P1:15 and all other terminals on the P1 connector.</p>	Greater than 1.0 k Ohm	<p><b>Result:</b> At least one of the resistance measurements is less than 1.0 k Ohm. There is a short in the wiring between the relay and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 1.0 k Ohm.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06165272

## Sensor Calibration Required - Test

The Electronic Control Module (ECM) performs calibrations of pressure sensors automatically. Use this procedure if the diagnostic code in Table 206 is active or easily repeated.

Table 206

Diagnostic Codes Table for Sensor Calibration			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments

(continued)

(Table 206, contd)

411-13	3387-13	Engine Exhaust Gas Recirculation Differential Pressure : Out of Calibration	The ECM detects the following conditions: The NRS differential pressure is outside the acceptable range during initialization check, or during sensor calibration when the engine is not running. The warning lamp will come on and the engine will be derated. The code is logged.
3358-13	3385-13	Engine Exhaust Gas Recirculation Inlet Pressure : Out of Calibration	The ECM detects the following conditions: The offset between the NRS inlet pressure and the barometric pressure is outside the acceptable range during initialization check. The offset between the NRS inlet pressure and the barometric pressure is outside the acceptable range during sensor calibration when the engine is not running. The warning lamp will come on and the engine will derate. The code is logged.
3563-13	1785-13	Engine Intake Manifold #1 Absolute Pressure : Out of Calibration	The ECM detects the following conditions: The offset between the intake manifold air pressure and the barometric pressure is outside the acceptable range during initialization check. The offset between the intake manifold air pressure and the barometric pressure is outside the acceptable range during sensor calibration with the engine not running. The warning lamp will come on and the engine will derate. The code is logged.

Table 207

Troubleshooting Test Steps	Values	Results
<p><b>1. Check For Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to check that coolant temperature, intake manifold air temperature, and NRS temperature are all at least 5° C (41° F).</p> <p><b>Note:</b> Wait at least 10 seconds in order for the diagnostic codes to become active.</p> <p><b>E.</b> Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes. Look for an active or logged -3 or -4 codes for the pressure sensor or the barometric pressure sensor.</p> <p><b>F.</b> Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes. Look for an active or logged -13 code for a pressure sensor or the barometric pressure sensor.</p> <p><b>G.</b> Turn the keyswitch to the OFF position.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> There are no active diagnostic codes for the pressure sensors.</p> <p><b>Repair:</b> If there are logged diagnostic codes for the intake manifold pressure sensor, the fault may be intermittent. Refer to Troubleshooting, “Electrical Connectors - Inspect” in order to identify intermittent faults.</p> <p><b>Result:</b> One or more of the temperature sensors is reading less than 5° C (41° F).</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> There is an active -3 or -4 diagnostic code for a pressure sensor or the barometric pressure sensor.</p> <p><b>Repair:</b> Troubleshoot these codes before continuing with this procedure.</p> <p><b>Result:</b> 3358-13 (3385-13) and 3563-13 (1785-13) diagnostic codes are active.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> There is an active -13 diagnostic code for only one sensor.</p> <p>Proceed to Test Step 4.</p>
<p><b>2. Ensure that the Systems are Fully Thawed</b></p> <p><b>A.</b> Move the machine into an environment where the ambient temperature is greater than 5° C (41° F) for the duration of any troubleshooting.</p> <p><b>B.</b> If engine has been operated or stored in cold ambient conditions where there is a risk of ice formation on a sensor or sensor pipes, run engine until the coolant temperature exceeds 65° C (149° F) for 20 minutes.</p> <p><b>C.</b> Turn the keyswitch to the OFF position. Wait for at least 20 seconds. The electronic service tool will disconnect.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Verify that coolant temperature, intake manifold air temperature, and NRS temperature are all now at least 5° C (41° F).</p> <p><b>F.</b> Check for active -13 diagnostic codes.</p> <p><b>G.</b> Check that the suspect sensor is installed correctly. Check that the suspect sensor is fully seated into the engine.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> There are no active -13 codes.</p> <p><b>Repair:</b> The fault was caused by ice in the system that has now been thawed. Return the unit to service</p> <p><b>Result:</b> Both 3358-13 (3385-13) and 3563-13 (1785-13) codes are active or logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> A single -13 code is active or logged.</p> <p>Proceed to Test Step 4.</p>
<p><b>3. Check the Barometric Pressure Sensor</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p>	<p>Barometric pressure sensor fault</p>	<p><b>Result:</b> There is no active -13 code. The fault was caused by a faulty barometric pressure sensor.</p>

(continued)

(Table 207, contd)

Troubleshooting Test Steps	Values	Results
<p><b>B.</b> Install a new barometric pressure sensor.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>Note:</b> Wait at least 10 seconds in order for the diagnostic codes to become active.</p> <p><b>D.</b> Monitor the status parameter for the suspect sensor on the electronic service tool.</p>		<p>Use the electronic service tool to clear all logged codes. Return the unit to service.</p> <p><b>Result:</b> Either a 3358-13 (3385-13) or 3563-13 (1785-13) code is active.</p> <p>Proceed to Test Step 4.</p>

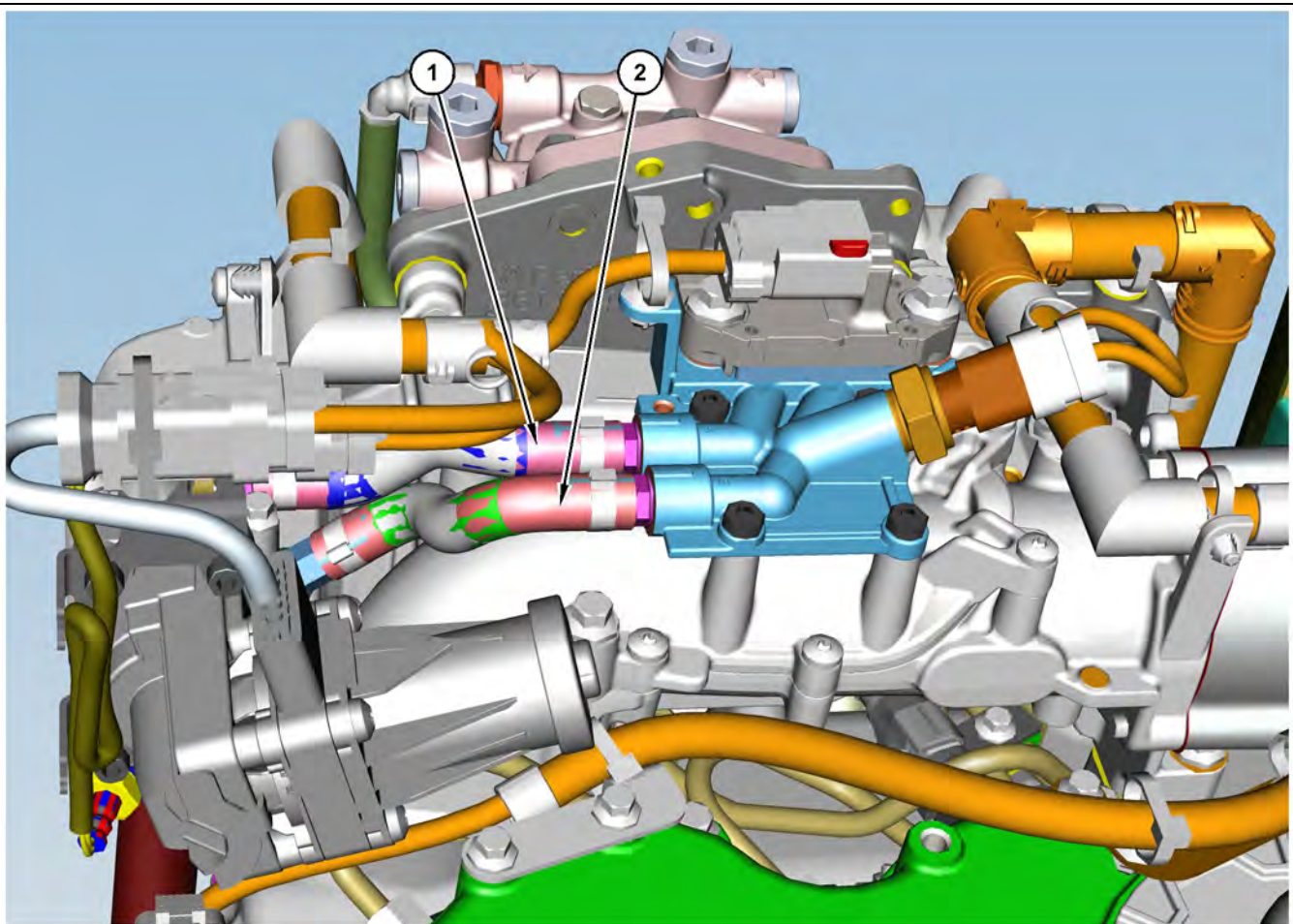


Illustration 129

g03724216

(1) Pipe for the NRS differential pressure sensor

(2) Pipe for the NRS inlet pressure sensor

Table 208

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Suspect Pressure Sensor</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect sensor and remove the sensor from the engine.</p> <p><b>C.</b> Check the sensor for a blockage.</p> <p><b>D.</b> Temporarily reconnect the sensor to the harness. Do not install the sensor on the engine.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>F.</b> Check for an active -13 diagnostic code for the suspect sensor.</p>	<p>Barometric pressure sensor fault</p>	<p><b>Result:</b> There is an active -13 code or the sensor is blocked</p> <p>Temporarily connect a new sensor to the harness. Use the electronic service tool to confirm that the repair eliminates the fault.</p> <p>If the fault is eliminated, permanently install the new sensor. Refer to Disassembly &amp; Assembly for the correct installation procedure.</p> <p>If the fault is still present, proceed to Test Step 3.</p> <p><b>Result:</b> There is no active -13 code.</p> <p>Check that the sensor pipe is free of blockages or restrictions. Refer to Illustration 129 . If necessary, remove the pipe and clear any blockage with an air line that is set at a maximum pressure of 200 kPa (29 psi). If the blockage is cleared, reinstall the pipe. If the blockage cannot be cleared or there is a restriction, replace the pipe.</p> <p>Install the sensor. Refer to Disassembly &amp; Assembly for the correct installation procedure.</p> <p>Turn the keyswitch to the ON position. Run the engine at idle speed for 5 minutes.</p> <p>Turn the keyswitch to the OFF position. Ensure ECM is fully powered-down.</p> <p>Turn the keyswitch to the ON position. Do not start the engine. Wait for 10 seconds. Confirm code is not active.</p> <p>Use the electronic service tool to clear all logged codes.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i08198239

## Sensor (Data Link Type) - Test

Use this procedure to troubleshoot the electrical system if a fault is suspected with the CAN data link sensors. Also use this procedure if a diagnostic code in Table 209 is active or easily repeated.



Table 209

<b>Diagnostic Trouble Codes for the Data Link Sensors</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description</b> (code descriptions may vary)	<b>Comments</b>
3216-11	3002-11	Aftertreatment #1 Intake NOx : Other Failure Mode	The NOx sensor cannot reach the correct operating temperature in the defined time period
3216-12	3002-12	Aftertreatment #1 Intake NOx : Failure	The data received from the NOx sensor is out of range. The code is logged. The warning lamp is illuminated.
3226-11	3609-11	Aftertreatment #1 Outlet NOx : Other Failure Mode	The NOx sensor cannot reach the correct operating temperature in the defined time period
3226-12	3609-12	Aftertreatment #1 Outlet NOx : Failure	The data received from the NOx sensor is out of range. The code is logged. The warning lamp is illuminated.
4377-12	3138-12	Aftertreatment #1 Outlet NH3 : Failure (DOC/SCR engines only)	The data received from the ammonia (NH3) sensor is out of range. The code is logged. The warning lamp is illuminated.

If the electronic service tool will not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Does Not Communicate" before starting this procedure. The procedure verifies that electrical power is being supplied to the ECM and to the diagnostic connector.

The data links are used to communicate information between the engine ECM and other control modules that are a part of the application. The electronic service tool also communicates with the ECM via the data links.

The diagnostic connector contains connections for electrical power and for the data links.

When the keyswitch is in the OFF position, the electronic service tool may communicate with the ECM. However, the communications may be disrupted and the communications may require frequent reconnection. To avoid any disruption, place the keyswitch in the ON position when the electronic service tool is being used.

The electronic service tool may display the following error message:

"The version of the ECM is not recognized and the integrity of the changed parameters and displayed data is not guaranteed."

This message indicates that one of the following conditions exists:

- The flash file in the ECM is newer than the version of the electronic service tool.
- The latest version of the electronic service tool has not been installed.

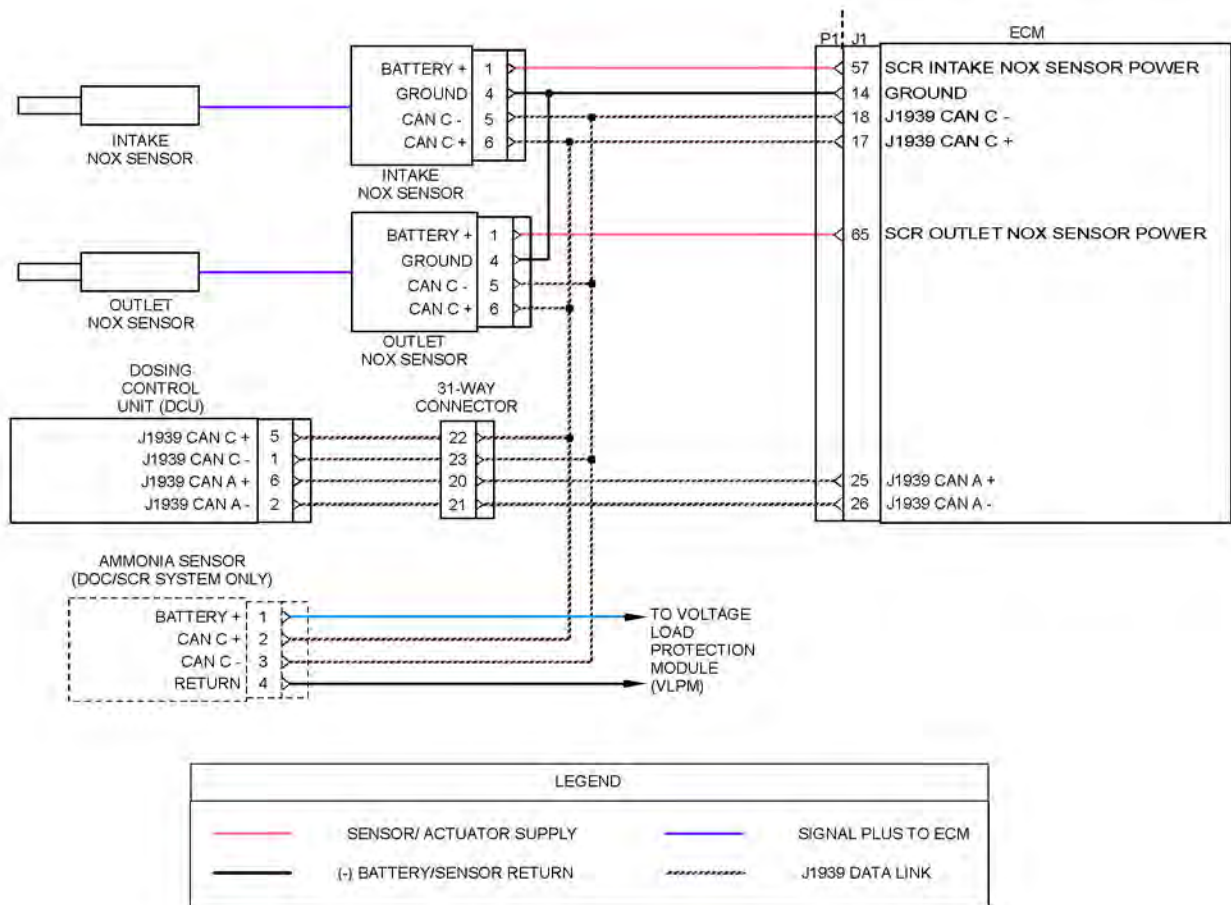


Illustration 130

g03776697

Schematic for the data-type sensors

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Complete the procedure in the order in which the steps are listed.

Table 210

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Connectors</b></p> <p><b>A.</b> Thoroughly inspect the connectors that are associated with the data link circuits. Verify that the connectors are free of debris, free of corrosion, and securely connected.</p> <p><b>B.</b> Perform a 45 N (10 lb) pull test on all the wires associated with the data link circuits.</p>	Connectors	<p><b>Result:</b> The connectors were connected correctly and did not have corrosion or moisture.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The connectors were not connected correctly or the connectors have corrosion or moisture.</p> <p><b>Repair:</b> Repair the connectors and/or the wiring. Replace parts, if necessary. <b>The DCU connector is not serviceable.</b></p> <p>Proceed to Test Step 8.</p>
<p><b>2. Check for Active or Recently Logged Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the engine Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools"</p> <p><b>B.</b> Look for active or logged codes.</p>	Diagnostic Trouble Codes	<p><b>Result:</b> There is an active or recently logged 3216-11 or 3226-11 diagnostic code.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> There is an active or recently logged 3216-12 diagnostic code.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> There is an active or recently logged 3226-12 diagnostic code.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> There is an active or recently logged 4377-12 diagnostic code.</p> <p>Proceed to Test Step 6.</p> <p><b>Result:</b> There is an active or recently logged 3360-14 diagnostic code.</p> <p>Proceed to Test Step 8.</p>
<p><b>3. Inspect the NOx Sensor</b></p> <p><b>A.</b> Remove the suspect NOx sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>B.</b> Inspect the NOx sensor for visible damage.</p>	NOx sensor OK	<p><b>Result:</b> The NOx sensor is damaged.</p> <p><b>Repair:</b> Ensure that the latest engine software is installed. Refer to Troubleshooting, ECM Software - Install for the correct procedure.</p> <p>Install a replacement NOx sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The NOx sensor is not damaged.</p> <p><b>Repair:</b> Clean the NOx sensor using only a soft brush.</p> <p><b>Note:</b> Do not use abrasive materials or fluids to clean the NOx sensor.</p> <p>Reinstall the NOx sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Proceed to Test Step 8.</p>

(continued)

(Table 210, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Override the SCR Intake NOx Sensor</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Use the electronic service tool to perform the “Aftertreatment #1 Intake NOx Level Sensor Power Supply Override” .</p> <p><b>D.</b> Check for active diagnostic codes.</p>	<p>Diagnostic trouble codes</p>	<p><b>Result:</b> The 3216-12 diagnostic code is no longer active.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The 3216-12 diagnostic code is still active.</p> <p><b>Repair:</b> Ensure that the latest engine software is installed. Refer to Troubleshooting, ECM Software - Install for the correct procedure.</p> <p>Install a replacement NOx sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Proceed to Test Step 8.</p>
<p><b>5. Override the SCR Outlet NOx Sensor</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Use the electronic service tool to perform the “Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply Override” .</p> <p><b>D.</b> Check for active diagnostic codes.</p>	<p>Diagnostic trouble codes</p>	<p><b>Result:</b> The 3226-12 diagnostic code is no longer active.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The 3226-12 diagnostic code is still active.</p> <p><b>Repair:</b> Inspect the SCR outlet NOx sensor probe. If there are soot deposits on the probe, the DPF may have failed.</p> <p>Ensure that the latest engine software is installed. Refer to Troubleshooting, ECM Software - Install for the correct procedure.</p> <p>If the SCR outlet sensor probe does not have soot deposits, install a replacement NOx sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Proceed to Test Step 8.</p>
<p><b>6. Override the Ammonia Sensor</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Use the electronic service tool to reset the active 4377–12 diagnostic code.</p> <p><b>D.</b> Use the electronic service tool to perform the “Aftertreatment #1 DEF Dosing Control Module Key Switch Line Override” .</p> <p><b>E.</b> Check for active diagnostic codes.</p>	<p>Diagnostic trouble codes</p>	<p><b>Result:</b> The 4377-12 diagnostic code is no longer active.</p> <p>Proceed to Test Step 8.</p> <p><b>Result:</b> The 4377-12 diagnostic code is still active.</p> <p><b>Repair:</b> Install a replacement ammonia sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Check that diagnostic code 4377-12 is no longer active. If the code is still active, replace the controller and then confirm that the fault has been eliminated.</p> <p>If the fault is still present, proceed to Test Step 7.</p>

(continued)

(Table 210, contd)

Troubleshooting Test Steps	Values	Results
<p><b>7. Check if a Replacement Pump and Electronics Unit (PEU) Eliminates the Fault</b></p> <p><b>A.</b> Ensure that the latest flash file for the application is installed in the DCU. Use the electronic service tool to perform the "Aftertreatment System Functional Test" .</p> <p>If the 4377-12 diagnostic code returns, continue with this procedure.</p> <p><b>B.</b> Contact the Dealer Solutions Network (DSN).</p> <p><b>C.</b> If the DSN recommends the use of a replacement Pump and Electronics Unit (PEU), install a replacement PEU.</p>	Diagnostic codes	<p><b>Result:</b> The PEU is replaced.</p> <p>Use the electronic service tool to reset all active diagnostic codes. Proceed to Test Step 8.</p>
<p><b>8. Perform the "Aftertreatment System Functional Test"</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Use the electronic service tool to reset all active diagnostic codes.</p> <p><b>C.</b> Use the electronic service tool to perform the "Aftertreatment System Functional Test" .</p>	Diagnostic Codes	<p><b>Result:</b> The test passed and no diagnostic codes became active.</p> <p>Return the engine to service.</p> <p><b>Result:</b> The test failed.</p> <p>Troubleshoot any diagnostic codes that became active during the test. Refer to Troubleshooting "Diagnostic Trouble Codes".</p> <p>If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).</p>

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## Sensor Signal (Analog, Active) - Test

This procedure covers the following diagnostic codes:

Table 211

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
100-3	100-3	Engine Oil Pressure Sensor : Voltage Above Normal	The Electronic Control Module (ECM) detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
100-4	100-4	Engine Oil Pressure Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.

(continued)

## Circuit Tests

(Table 211, contd)

<b>Diagnostic Codes for the Active Analog Sensors</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
108-3	3528-3	Barometric Pressure Sensor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
108-4	3528-4	Barometric Pressure Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
157-3	1797-3	Fuel Rail Pressure Sensor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
157-4	1797-4	Fuel Rail Pressure Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
157-12	1797-12	Fuel Rail Pressure Sensor : Failure	The ECM detects that the fuel rail pressure sensor has an in-range failure. The warning lamp will flash. The code is logged.
411-2	3387-2	EGR Differential Pressure : Er- ratic, Intermittent, or Incorrect	The ECM detects signal voltage that is not stable.  The code is logged. The warning light will come on. The ECM will log the diagnostic code.
411-3	3387-3	EGR Differential Pressure Sen- sor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
411-4	3387-4	EGR Differential Pressure Sen- sor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
3358-3	3385-3	EGR Intake Pressure Sensor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
3358-4	3385-4	EGR Intake Pressure Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
3563-3	1785-3	Intake Manifold Pressure Sen- sor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
3563-4	1785-4	Intake Manifold Pressure Sen- sor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
1176-3	2738-3	Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
1176-4	2738-4	Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
Follow the troubleshooting procedure to identify the root cause of the fault.			

The following conditions must exist before any of the above codes will become active:

- There are no active 3509 codes.

- There are no active 168 codes.

**The following background information is related to this procedure:**

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The 5 VDC sensor supply provides power to all 5 VDC sensors. The ECM supplies 5 VDC to terminal "3" of the fuel rail pressure sensor connector and to terminal "1" of all other active sensor connectors. The sensor common from the ECM connector goes to terminal "1" of the connector for the fuel rail pressure sensor. The sensor common from the ECM connector goes to terminal "2" of all other active sensor connectors. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

### **Pull-up Voltage**

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage to detect an open in the signal circuit. When the ECM detects a voltage above a threshold on the signal circuit, an open circuit diagnostic code (XXXX-3) is generated for the sensor.

If the sensor is disconnected, pull-up voltage indicates that the wires from the sensor connector to the ECM are not open or shorted to ground. If the sensor is disconnected, the absence of pull-up voltage indicates an open in the signal wire or a short to ground. If the sensor is disconnected and the voltage is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

Circuit Tests

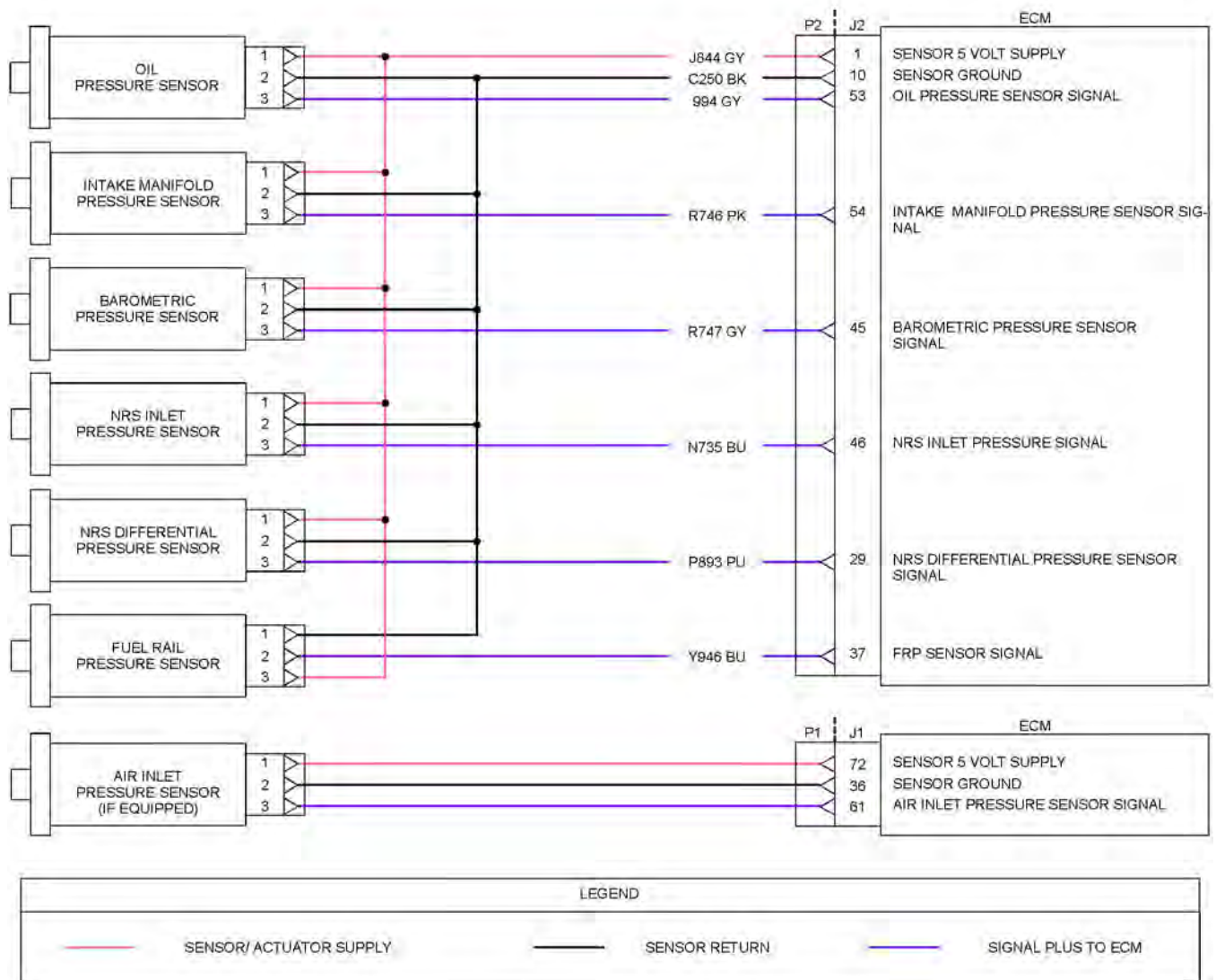


Illustration 131

g06274072

Schematic for the active sensors



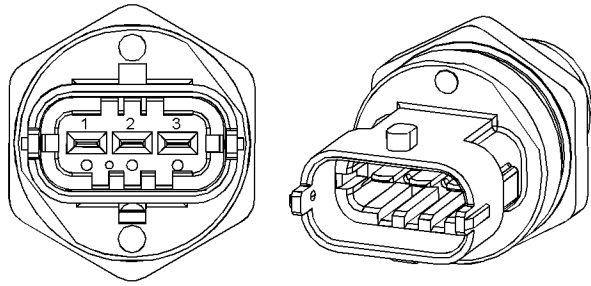


Illustration 132 g03374231

**Fuel rail pressure sensor**

- (1) Ground
- (2) Signal
- (3) 5 VDC Supply

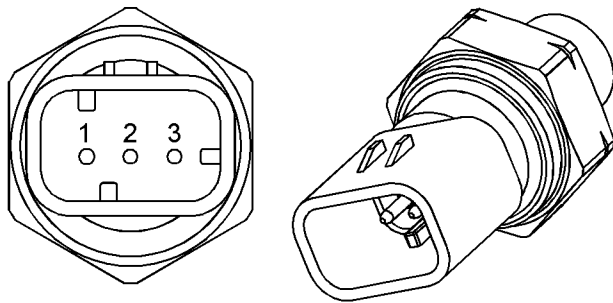


Illustration 133 g01170310

**Typical example of an engine pressure sensor**

- (1) 5 VDC Supply
- (2) Ground
- (3) Signal

Table 212

Troubleshooting Test Steps	Values	Results
<p><b>1. Check for Diagnostic Codes</b></p> <p><b>A.</b> Establish communication between the electronic service tool and the ECM . Refer to Troubleshooting, “Electronic Service Tools”, if necessary.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Look for a -3, or -4 active or logged codes:</p>	<p>Diagnostic code</p>	<p><b>Result:</b> There are no active diagnostic codes for the active sensors.</p> <p><b>Repair:</b> If there are logged diagnostic codes for the active sensors, the fault may be intermittent.</p> <p>Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults.</p> <p><b>Result:</b> A diagnostic code that is listed in Table 211 is active.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the 5 VDC Supply Voltage at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Measure the voltage between the sensor supply pin and the sensor return pin at the suspect sensor.</p>	<p>Test passed</p>	<p><b>Result:</b> The supply voltage is approximately 5.0 ± 0.2 VDC</p> <p>Connect the sensor and then proceed to Test Step 3.</p> <p><b>Result:</b> The supply voltage is not approximately 5.0 ± 0.2 VDC.</p> <p>There is a short in the harness to the battery. Repair the wiring or replace the harness</p> <p>Verify that the problem is resolved.</p>

(continued)

(Table 212, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Type of Diagnostic Code that is Active</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes.</p> <p><b>B.</b> Use the electronic service tool to check for active diagnostic codes. Record all active diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A 157–12 diagnostic code is active.  <b>Repair:</b> If this code is active when the engine is cranking but not starting, use the electronic service tool to check the speed/timing sensor status on the “Engine Starting” screen. If the status of the speed/timing sensors is “Not Detected”, refer to Troubleshooting, Speed/Timing - Test to diagnose the speed/ timing sensor fault.                      If the speed/timing sensor circuit is OK, replace the fuel rail pressure sensor. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>Result:</b> A 411-2 code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> An alternative XXXX-2 diagnostic code is active for one or more of the active sensors.</p> <p><b>Repair:</b> Replace the suspect sensor.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Return the unit to service.</p> <p><b>Result:</b> An XXXX-3 diagnostic code is active for one or more of the active sensors.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> An XXXX-4 diagnostic code is active for one or more of the active sensors.</p> <p>Proceed to Test Step 6.</p>
<p><b>4. Diagnose a 411-2 Code</b></p> <p><b>A.</b> Remove the exhaust inlet pipe and the exhaust outlet pipe from the NRS cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install.</p> <p><b>B.</b> Inspect the inlet port and the outlet port of the NRS cooler for excessive fouling with condensate and/or soot.</p> <p><b>Note:</b> A light coating of soot is normal. There must be no evidence of wet or shiny condensate fouling or excessive soot deposits that cover most of the internal tubes.</p>	<p>Diagnostic Codes</p>	<p><b>Result:</b> The NRS cooler has excessive fouling.</p> <p>Replace the NRS cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install.</p> <p>Verify that the problem is resolved.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p> <p><b>Result:</b> The NRS cooler does not have excessive fouling.</p> <p>Install a replacement NRS differential pressure sensor. Refer to Disassembly and Assembly, Pressure Sensor (Cooled Exhaust Gas) - Remove and Install.</p> <p>Verify that the problem is resolved.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

(continued)

## Circuit Tests

(Table 212, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Create a Short at the Sensor Connector</b></p> <p><b>A.</b> Use a jumper wire to create a short between the signal terminal and the ground terminal at the sensor connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor.</p> <p><b>D.</b> Turn the keyswitch to the OFF position.</p>	Short created	<p><b>Result:</b> A -4 diagnostic code became active after creating the short at the sensor connector.</p> <p>The wiring is OK. Replace the sensor. Verify that the problem is resolved.</p> <p><b>Result:</b> A -4 diagnostic code does not become active for the suspect sensor.</p> <p>Proceed to Test Step 7.</p>
<p><b>6. Create an Open at the Suspect Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the sensor connector of the suspect sensor with the active -4 diagnostic code.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Create an Open	<p><b>Result:</b> A -3 diagnostic code became active after disconnecting the sensor.</p> <p>The wiring is OK. Replace the sensor. Verify that the problem is resolved.</p> <p><b>Result:</b> A -3 diagnostic code did not become active after disconnecting the sensor.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Perform the Wiggle Test</b></p> <p>Carefully following this procedure is the best way to identify the root cause of an intermittent problem.</p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Use the electronic service tool to run the "Wiggle Test" .</p> <p><b>C.</b> Slowly wiggle the wiring and the connectors between the P2 connector and the sensor. Pay particular attention to the wiring near each connector. Be sure to wiggle all the wiring. As you wiggle the wiring look for these problems.</p> <ol style="list-style-type: none"> <li>1. Loose connectors or damaged connectors</li> <li>2. Moisture on the connectors or the wiring</li> <li>3. Damaged that is caused by excessive heat</li> <li>4. Damage that is caused by chafing</li> <li>5. Improper routing of wiring</li> <li>6. Damaged insulation</li> </ol>	Test passed	<p><b>Result:</b> The wiring failed the Wiggle Test.</p> <p>There is a problem with the wiring. Repair the wiring or replace the wiring.</p> <p>Verify that the problem is resolved.</p> <p>STOP</p> <p><b>Result:</b> The wiring passed the Wiggle Test.</p> <p>The problem may be intermittent. Inspect the wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p>If the wiring looks OK, perform the following procedure.</p> <ol style="list-style-type: none"> <li>1. Turn the keyswitch to the OFF position.</li> <li>2. Disconnect the connectors. Carefully inspect the terminals for proper installation. Make sure that each terminal is clean and dry.</li> <li>3. Insert a pin into each socket. Verify that each socket grips the pin firmly. Repair any problems.</li> <li>4. Connect all connectors.</li> <li>5. Verify that the problem is resolved.</li> <li>6. Return the unit to service.</li> </ol> <p>STOP</p>

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## Sensor Signal (Analog, Passive) - Test

This procedure covers the following diagnostic codes:

Table 213

Diagnostic Trouble Codes for Analog Passive Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
105-3	172-3	Engine Intake Manifold #1 Temperature : Voltage Above Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The signal voltage from the intake manifold air temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>Engine coolant temperature is above <math>-10^{\circ}\text{C}</math> (<math>15.0^{\circ}\text{F}</math>).</p> <p>The ECM will use the default value of <math>70^{\circ}\text{C}</math> (<math>158^{\circ}\text{F}</math>) for the intake manifold air temperature. "Voltage High" will be displayed next to the status for "Intake Manifold Air Temperature" on the electronic service tool.</p> <p>The engine may show the following symptoms:</p> <ul style="list-style-type: none"> <li>Poor stability</li> <li>Poor cold running</li> <li>Poor acceleration under load</li> <li>White smoke</li> </ul>
105-4	172-4	Engine Intake Manifold #1 Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the intake manifold air temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>The ECM will use the default value of <math>70^{\circ}\text{C}</math> (<math>158^{\circ}\text{F}</math>) for the intake manifold air temperature. "Voltage Low" will be displayed next to the status for "Intake Manifold Air Temperature" on the electronic service tool.</p> <p>The engine may show the following symptoms:</p> <ul style="list-style-type: none"> <li>Poor stability</li> <li>Poor cold running</li> <li>Poor acceleration under load</li> <li>White smoke</li> </ul>
110-3	110-3	Engine Coolant Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the engine coolant temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds.</p> <p>The ECM will default to <math>90^{\circ}\text{C}</math> (<math>194^{\circ}\text{F}</math>) for engine coolant temperature. "Voltage Above Normal" will be displayed next to the status for "Engine Coolant Temperature" on the electronic service tool.</p> <p>The engine may show the following symptoms:</p> <ul style="list-style-type: none"> <li>Poor stability</li> <li>Poor cold running</li> <li>White smoke</li> </ul>

(continued)

(Table 213, contd)

<b>Diagnostic Trouble Codes for Analog Passive Sensors</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
110-4	110-4	Engine Coolant Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the engine coolant temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. The ECM will default to 90 °C (194 °F) for engine coolant temperature. "Voltage Below Normal" will be displayed next to the status for "Engine Coolant Temperature" on the electronic service tool.</p> <p>The engine may show the following symptoms:                      Poor stability                      Poor cold running                      White smoke</p>
172-3	2526-3	Engine Air Inlet Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the air inlet temperature sensor is greater than 4.95 VDC for at least 8 seconds.</p>
172-4	2526-4	Engine Air Inlet Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the air inlet temperature sensor is less than 0.2 VDC for at least 8 seconds.</p>
174-3	174-3	Engine Fuel Temperature 1 : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the fuel temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>The ECM will default to 40° C (104° F) for fuel temperature. "Voltage Above Normal" will be displayed next to the status for "Engine Fuel Temperature" on the electronic service tool.</p>
174-4	174-4	Engine Fuel Temperature 1 : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the fuel temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>The ECM will default to 40° C (104° F) for fuel temperature. "Voltage Below Normal" will be displayed next to the status for "Engine Fuel Temperature" on the electronic service tool.</p>
412-3	3386-3	Engine Exhaust Gas Recirculation Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the Nox Reduction System (NRS) temperature sensor is greater than 4.975 VDC for more than 8 seconds.</p>
412-4	3386-4	Engine Exhaust Gas Recirculation Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the NRS temperature sensor is less than 0.2 VDC for more than 8 seconds.</p>

(continued)

(Table 213, contd)

<b>Diagnostic Trouble Codes for Analog Passive Sensors</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
2630-3	3372-3	Engine Charge Air Cooler Outlet Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the ATAAC outlet temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "ATAAC Temperature" on the electronic service tool.</p>
2630-4	3372-4	Engine Charge Air Cooler Outlet Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the ATAAC outlet temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "ATAAC Temperature" on the electronic service tool.</p>
3242-3	2452-3	Aftertreatment #1 DPF Intake Gas Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the DPF inlet temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "DPF Inlet Temperature" on the electronic service tool.</p>
3242-4	2452-4	Aftertreatment #1 DPF Intake Gas Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the DPF inlet temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "DPF Inlet Temperature" on the electronic service tool.</p>
4360-3	3105-3	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the SCR inlet temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "SCR Inlet Temperature" on the electronic service tool.</p>

(continued)

(Table 213, contd)

<b>Diagnostic Trouble Codes for Analog Passive Sensors</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
4360-4	3105-4	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the SCR inlet temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "SCR Inlet Temperature" on the electronic service tool.</p>
4360-20	3105-20	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Data Drifted High	<p>The ECM detects the following conditions:</p> <p>The SCR inlet temperature sensor has probably failed in range.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Data Drifted High" will be displayed next to the status for "SCR Inlet Temperature" on the electronic service tool.</p>
4765-3	3956-3	Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the DOC inlet temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "DOC Inlet Temperature" on the electronic service tool.</p>
4765-4	3956-4	Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the DOC inlet temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "DOC Inlet Temperature" on the electronic service tool.</p>
7441-3	4648-3	Aftertreatment Ambient Air Temperature : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the aftertreatment ambient air temperature sensor is greater than 4.95 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "Aftertreatment Ambient Air Temperature" on the electronic service tool.</p>
7441-4	4648-4	Aftertreatment Ambient Air Temperature Sensor : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the aftertreatment ambient air temperature sensor is less than 0.2 VDC for more than 8 seconds.</p> <p>An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "Aftertreatment Ambient Air Temperature" on the electronic service tool.</p>
Follow the troubleshooting procedure in order to identify the root cause of the fault.			



The Dosing Control Unit (DCU) communicates any error conditions from temperature sensors that are connected to the DCU to the engine ECM over the CAN C data link.

**Note:** The following conditions must exist before any of the above codes will become active:

- The ECM has been powered for at least 2 seconds.
- There are no active 168-X diagnostic codes.

The ECM will log the diagnostic code. If equipped, the warning light will come on.

This procedure covers open circuit diagnostic codes and short circuit diagnostic codes that are associated with the following sensors that are connected to the DCU:

- DOC inlet temperature sensor
- DPF inlet temperature sensor (if equipped)
- SCR inlet temperature sensor

This procedure covers open circuit diagnostic codes and short circuit diagnostic codes that are associated with the following sensors that are connected to the ECM:

- Coolant temperature sensor
- Intake manifold air temperature sensor
- Fuel temperature sensor
- Air inlet temperature sensor
- ATAAC outlet temperature sensor
- NRS inlet temperature sensor
- Aftertreatment ambient air temperature sensor (if equipped)

**The following background information is related to this procedure:**

The troubleshooting procedures for the diagnostic codes of each temperature sensor are identical. The temperature sensors have two terminals. The signal line is connected to each sensor connector terminal 1. Terminal 2 is the return line. The signal voltage from terminal 1 of each sensor is supplied to the appropriate terminal in the ECM or the DCU.

#### **Pull-up Voltage**

The ECM and the DCU continuously output a pull-up voltage on the circuit for the sensor signal wire. The ECM/DCU uses this pull-up voltage in order to detect an open in the signal circuit. When the ECM/DCU detects a voltage above a threshold on a signal circuit, an open circuit diagnostic code (XXX-3) is communicated to the engine ECM.

If the sensor is disconnected, pull-up voltage at the connector indicates that the wires are not open or shorted to ground. If the sensor is disconnected, the absence of pull-up voltage indicates an open in the signal wire or a short to ground. If the sensor is disconnected and the voltage is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

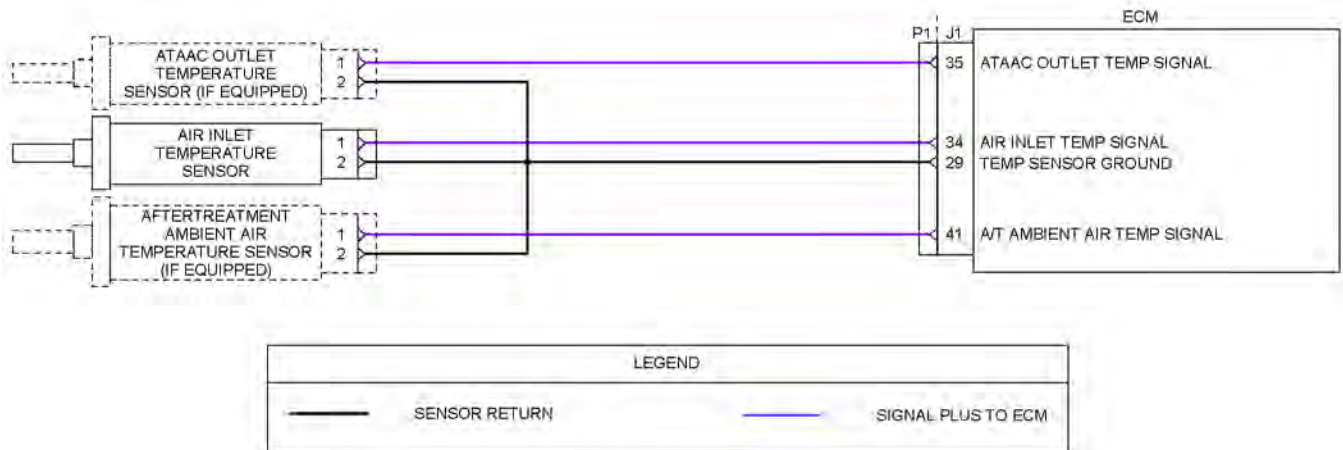


Illustration 134

g03713988

Schematic for passive engine temperature sensors on the P1 connector  
 Not all connectors are shown. Refer to the appropriate Electrical Schematic.

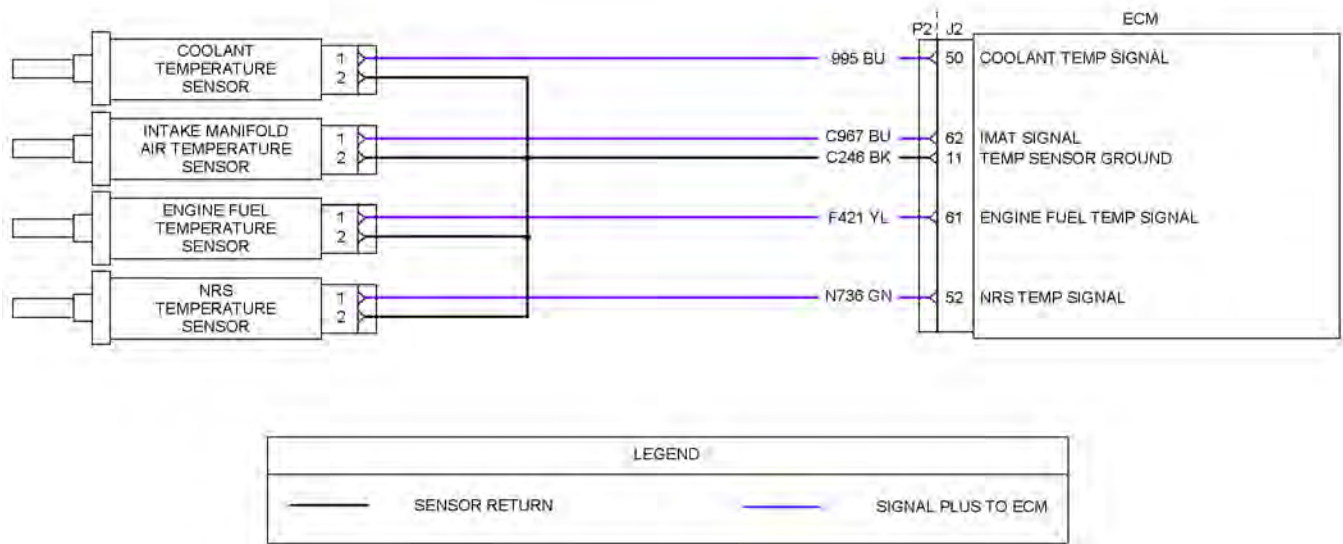


Illustration 135

g03675493

Schematic for passive engine temperature sensors on the P2 connector

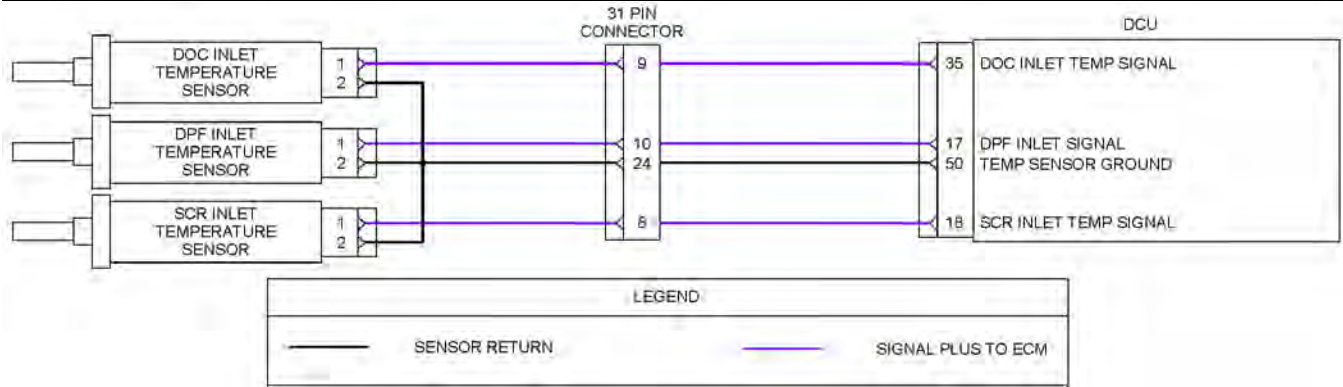


Illustration 136

g03713995

Schematic for passive engine temperature sensors on the DCU connector  
Not all connectors are shown. Refer to the appropriate Electrical Schematic.

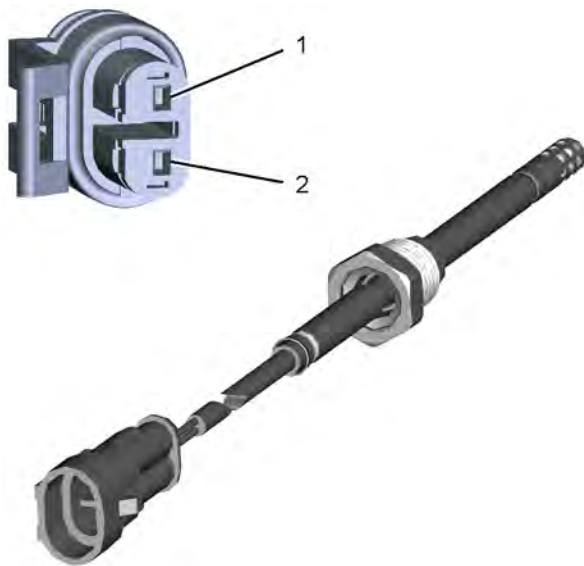


Illustration 137

g03714041

Typical view of a CEM temperature sensor and mating connector

- (1) Signal
- (2) Ground

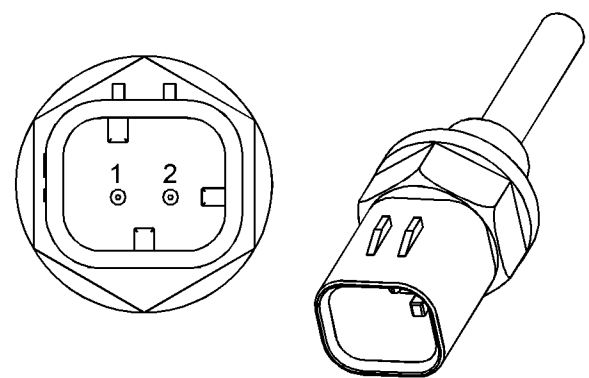


Illustration 138

g01170313

Typical view of an engine temperature sensor

- (1) Signal
- (2) Ground

Table 214

Troubleshooting Test Steps	Values	Results
<p><b>1. Perform the Wiggle Test</b></p> <p>Carefully following this procedure is the best way to identify the root cause of an intermittent problem.</p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Use the electronic service tool to run the "Wiggle Test" .</p> <p><b>C.</b> Slowly wiggle the wiring and the connectors between the P2 connector and the sensor. Slowly wiggle the wiring and the connectors between the P1 connector and the sensor. Pay particular attention to the wiring near each connector. Be sure to wiggle all of the wiring.</p> <p><b>D.</b> As you wiggle the wiring look for these problems.</p> <ol style="list-style-type: none"> <li>1. Loose connectors or damaged connectors</li> <li>2. Moisture on the connectors or the wiring</li> <li>3. Damage that is caused by excessive heat</li> <li>4. Damage that is caused by chafing</li> <li>5. Improper routing of wiring</li> <li>6. Damaged insulation</li> </ol>	<p>Wiggle test</p>	<p><b>Result:</b> The wiring failed the Wiggle Test.</p> <p><b>Repair:</b> There is a problem with the wiring. Repair the wiring or replace the wiring.</p> <p>Verify that the problem is resolved.</p> <p>Proceed to Test Step 2</p> <p><b>Result:</b> The wiring passed the Wiggle Test.</p> <p><b>Repair:</b> The problem may be intermittent. Inspect the wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p>If the wiring looks OK perform the following procedure.</p> <ol style="list-style-type: none"> <li>1. Turn the keyswitch to the OFF position.</li> <li>2. Disconnect the connectors. Carefully inspect the terminals for proper installation. Make sure that each terminal is clean and dry.</li> <li>3. Insert a pin into each socket. Verify that each socket grips the pin firmly. Repair any problems.</li> <li>4. Connect all connectors.</li> <li>5. Verify that the problem is resolved.</li> <li>6. Return the unit to service.</li> </ol> <p>Proceed to Test Step 2</p>
<p><b>2. Check for Diagnostic Trouble Codes</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Access the "Active Diagnostic Code" screen on the electronic service tool.</p> <p><b>Wait at least 30 seconds in order for the diagnostic codes to become active.</b></p> <p><b>D.</b> Look for one of the diagnostic codes that are listed in Table 213 .</p>	<p>Codes</p>	<p><b>Result:</b> A -3 diagnostic code is active.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> A -4 or 4360-20 diagnostic code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> For a diagnostic code that is <b>logged</b> but not currently active, Proceed to Test Step 4.</p>

(continued)

(Table 214, contd)

<p><b>3. Create a Short at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect sensor.</p> <p><b>C.</b> Install the jumper wire between terminal 1 (sensor signal) and terminal 2 (sensor return) at the sensor connector.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor.</p> <p><b>Wait at least 30 seconds in order for the diagnostic codes to become active.</b></p> <p><b>F.</b> Turn the keyswitch to the OFF position.</p>	<p>Short Circuit Recognized</p>	<p><b>Result:</b> The -3 diagnostic code remains active for the suspect sensor.</p> <p><b>Repair:</b> There is an open in the harness. Repair the wiring or replace the harness.</p> <p>Verify that the problem is resolved.</p> <p><b>Result:</b> A -4 diagnostic code became active after creating the short at the sensor connector:</p> <p><b>For Aftertreatment temperature sensors only:</b></p> <p>Move the sensor to a different location in the Clean Emissions Module:</p> <p><b>Result:</b> Original error code is no longer active but a new code from the new position is active.</p> <p><b>Repair:</b> Replace the faulty sensor.</p> <p><b>Result:</b> No error codes are active in the new position.</p> <p>Verify that the problem is resolved.</p> <p><b>For other passive sensors:</b></p> <p><b>Repair:</b> The wiring is OK. Replace the sensor.</p> <p>Verify that the problem is resolved.</p>
<p><b>4. Create an Open at the Suspect Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the sensor connector of the suspect sensor with the active -4 or -20 diagnostic code.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor.</p> <p><b>Wait at least 30 seconds in order for the diagnostic codes to become active.</b></p> <p><b>For a 110-3 code, start the engine and let the engine idle for 7 minutes. The engine must be running for at least 7 minutes in order for the diagnostic to run.</b></p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	<p>Open Circuit Recognized</p>	<p><b>Result:</b> The -4 or -20 diagnostic code remains active for the suspect sensor.</p> <p><b>Repair:</b> There is an open in the harness. Repair the wiring or replace the harness.</p> <p>Verify that the problem is resolved.</p> <p><b>Result:</b> A -3 diagnostic code became active after disconnecting the sensor.</p> <p><b>For Aftertreatment temperature sensors only:</b></p> <p>Move the sensor to a different location in the Clean Emissions Module:</p> <p><b>Result:</b> Original error code is no longer active but a new code from the new position is active.</p> <p><b>Repair:</b> Replace the faulty sensor.</p> <p><b>Result:</b> No error codes are active in the new position.</p> <p>Verify that the problem is resolved.</p> <p><b>For other passive sensors:</b></p> <p><b>Repair:</b> The wiring is OK. Replace the sensor.</p>

(continued)

(Table 214, contd)

		Verify that the problem is resolved.
If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).		

i06575681

## Sensor Supply - Test

This procedure covers the following diagnostic codes:

Table 215

<b>Diagnostic Trouble Codes for Sensor Supplies</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
678-3	41-3	ECU 8 Volts DC Supply : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The 8 VDC supply is more than 8.8 VDC for more than one second.</p> <p>The ECM has been powered for more than 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>The ECM will log the diagnostic code and the warning lamp will illuminate when this diagnostic code is active.</p> <p>The engine may be limited to low idle.</p>
678-4	41-4	ECU 8 Volts DC Supply : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The 8 VDC supply is less than 7.2 VDC for more than one second.</p> <p>The ECM has been powered for more than 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>The ECM will log the diagnostic code and the warning lamp will illuminate when this diagnostic code is active.</p> <p>The engine may be limited to low idle.</p> <p>An active diagnostic code may not cause any noticeable effect on engine response unless the voltage drops below 6.5 VDC.</p>

(continued)

(Table 215, contd)

Diagnostic Trouble Codes for Sensor Supplies			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3509-3	262-3	Sensor Supply Voltage 1 : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions:  The 5 VDC supply for the sensors is greater than 5.16 VDC for more than one second.  The ECM has been powered for at least 3 seconds.  Diagnostic code 168-4 is not active.  The warning lamp will come on. The ECM sets all the sensors on the 5 VDC circuit to the default values. The engine will be derated.
3510-3	2131-3	Sensor Supply Voltage 2 : Voltage Above Normal	
3509-4	262-4	Sensor Supply Voltage 1 : Voltage Below Normal	The ECM detects the following conditions:  The 5 VDC supply for the sensors is less than 4.84 VDC for more than one second.  The ECM has been powered for at least 3 seconds.  Diagnostic code 168-4 is not active.  The warning lamp will come on. The ECM sets all the sensors on the 5 VDC circuit to the default values. The engine will be derated.
3510-4	2131-4	Sensor Supply Voltage 2 : Voltage Below Normal	

**Note: A 678-XX diagnostic code indicates a fault in the 8 VDC circuit on the J1/P1 connector. A 3509-XX diagnostic code indicates a fault in the 5 VDC circuit on the J2/P2 connector. A 3510-XX diagnostic code indicates a fault in the 5 VDC circuit on the J1/P1 connector.**

**The following background information is related to this procedure:**

The ECM supplies regulated +5 VDC to the following sensors on P2:1:

- Barometric pressure sensor
- Intake manifold air pressure sensor
- Fuel pressure sensor
- Engine oil pressure sensor
- NRS intake pressure sensor
- NRS differential pressure sensor
- NRS valve position sensor
- Exhaust Back Pressure Regulator (EBPR) position sensor

A diagnostic code can be caused by the following conditions:

- A short circuit in the harness

- A faulty sensor
- An open circuit in the harness

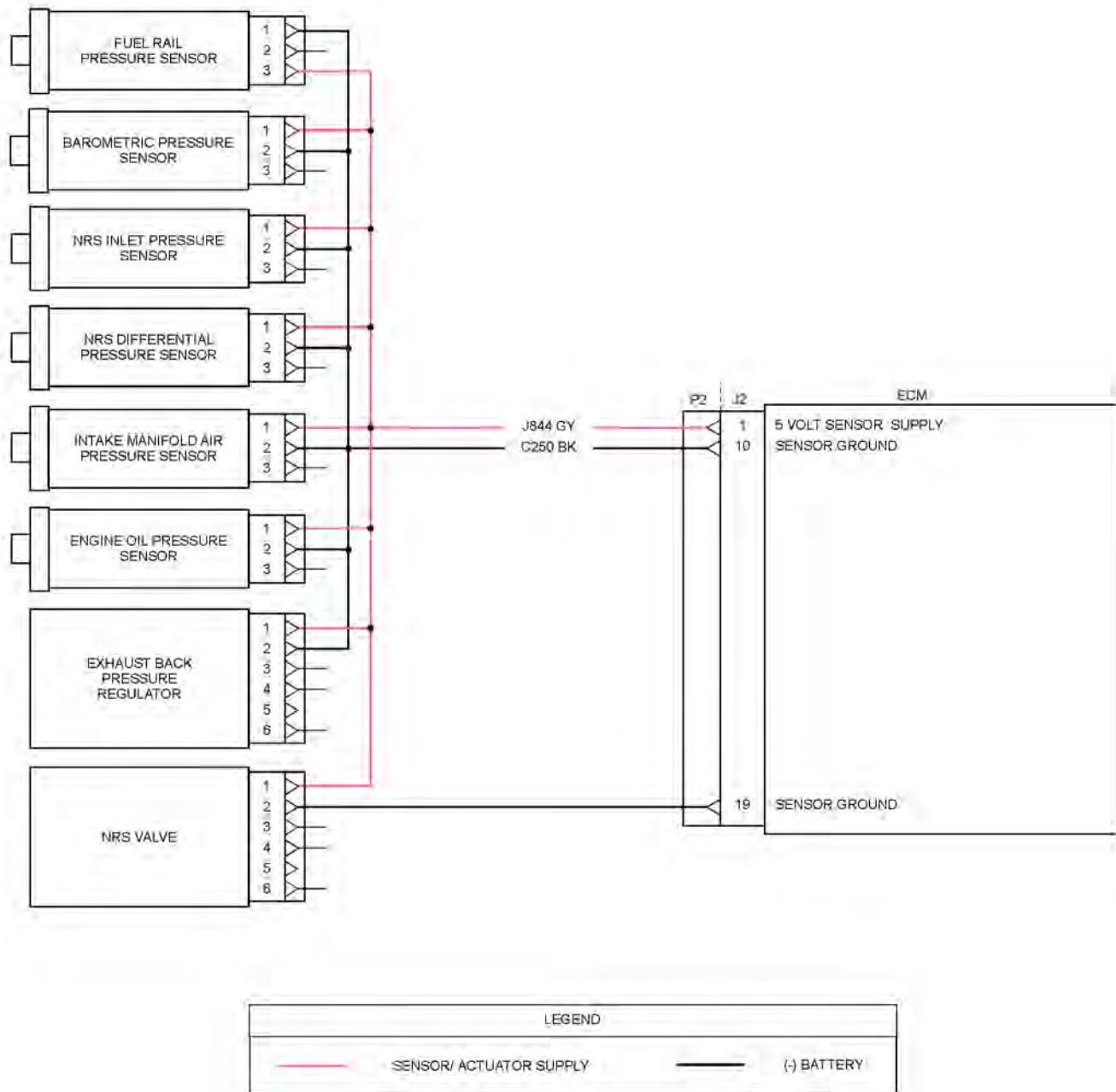


Illustration 139

g03713485

Typical example of the schematic for the 5 VDC supply on P2:1

**Note:** Refer to the Electrical Schematic for the application for information regarding components that are connected to the 5 V and 8 V supplies on the J1/ P1 connector.



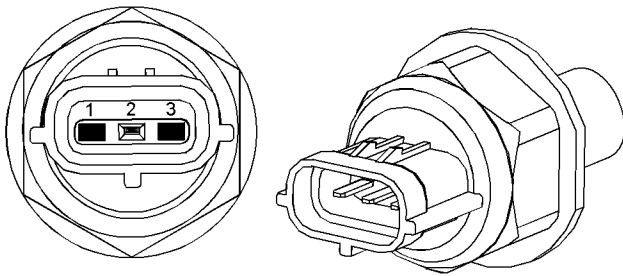


Illustration 140 g02315513

Typical example of the fuel rail pressure sensor

- (1) Sensor ground
- (3) 5 VDC supply

**Note:** The position of the terminal for the voltage supply on the fuel rail pressure sensor is different to all other engine pressure sensors.

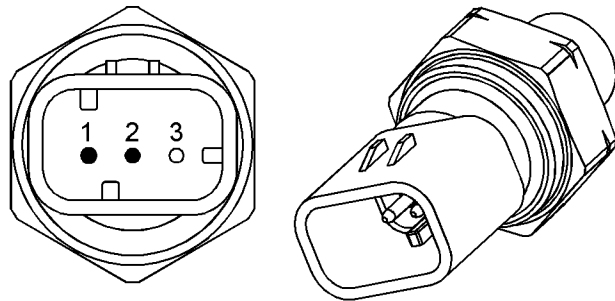


Illustration 141 g02315514

Typical example of an engine pressure sensor

- (1) 5 VDC supply
- (2) Sensor ground

Table 216

Troubleshooting Test Steps	Values	Results
<p><b>1. Determine the Code</b></p> <p><b>A.</b> Connect the electronic service tool to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Determine if a diagnostic trouble code is present.</p>	<p>Diagnostic Codes</p>	<p><b>Result:</b> A -3 or -4 code is present.</p> <p>Note which sensor supply has the active diagnostic code.</p> <p>Proceed to Test Step 2.</p>

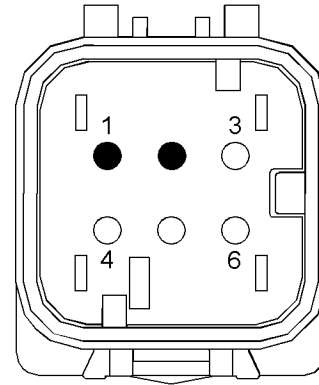


Illustration 142 g02315534

Typical example of the connector for the NRS valve

- (1) 5 VDC supply
- (2) Sensor ground

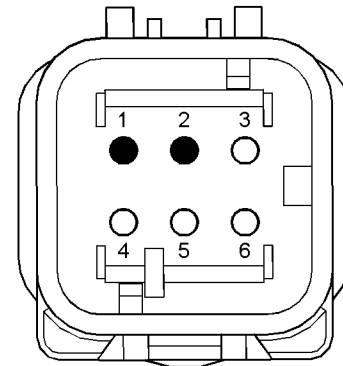


Illustration 143 g03130436

Typical example of the connector for the Exhaust Back Pressure Regulator (EBPR)

- (1) 5 VDC supply
- (2) Ground

Complete the procedure in the order in which the steps are listed.

(continued)

(Table 216, contd)

<p><b>2. Check for a Failed Sensor</b></p> <p><b>A.</b> Connect to the electronic service tool.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Disconnect a sensor on the suspect sensor supply circuit.</p> <p><b>D.</b> Monitor the electronic service tool when the sensor is disconnected to see if the active code changes to logged.</p> <p><b>E.</b> Connect the suspect sensor to the wiring harness</p> <p><b>F.</b> Repeat steps C through E for each sensor on the suspect sensor supply.</p>	<p>Failed Sensor</p>	<p><b>Result:</b> The suspect sensor supply active code changes to logged when a sensor is unplugged.</p> <p><b>Repair:</b> Replace the failed sensor.</p> <p>Verify that the repair resolved the problem.</p> <p><b>Result:</b> The suspect sensor supply active code remains active after all sensors on the sensor supply circuit have been checked.</p> <p><b>Repair:</b> A failed wiring harness has been detected. Repair or replace the wiring harness.</p> <p>Verify that the repair resolved the problem.</p>
<p>If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).</p>		

i07287344

## Solenoid Valve - Test

### (Solenoid Valves that Connect to the Dosing Control Unit (DCU))

This procedure covers the following diagnostic codes:

Table 217

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3361-5	3821-5	Aftertreatment #1 DEF Dosing Unit : Current Below Normal	<p>The ECM detects the following conditions:</p> <p>A low current condition in the output from the DCU to the solenoid in the DEF injector</p> <p>There are no active 168 diagnostic codes.</p> <p>The warning lamp will come on. The diagnostic code will be logged.</p>
3361-6	3821-6	Aftertreatment #1 DEF Dosing Unit : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>A high current condition in the output from the DCU to the solenoid in the DEF injector.</p> <p>There are no active 168 diagnostic codes.</p> <p>The warning lamp will come on. The diagnostic code will be logged.</p>

(continued)

(Table 217, contd)

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3363-5	3126-5	Aftertreatment #1 DEF Tank Heater : Current Below Normal	<p>The ECM detects the following conditions:</p> <p>A low current condition in the output from the DCU to the solenoid in the coolant diverter valve.</p> <p>There are no active 168 diagnostic codes.</p> <p>The warning lamp will come on. The diagnostic code will be logged.</p>
3363-6	3126-6	Aftertreatment #1 DEF Tank Heater : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>A high current condition in the output from the DCU to the solenoid in the coolant diverter valve.</p> <p>There are no active 168 diagnostic codes.</p> <p>The warning lamp will come on. The diagnostic code will be logged.</p>
Follow the troubleshooting procedure to identify the root cause of the fault.			

**The following background information is related to this procedure:**

#### Coolant Diverter Valve

The coolant diverter valve controls the flow of coolant to the heater in the Diesel Exhaust Fluid (DEF) tank. When required, the valve is opened to allow hot coolant to circulate through the DEF tank. This flow allows the coolant to heat the DEF to a useable temperature.

#### DEF Injector

The DEF injector controls the flow of DEF into the exhaust stream in the Clean Emissions Module (CEM). The DEF injector is controlled by the Dosing Control Unit (DCU).

#### DEF Coolant Diverter Valve Solenoid Override

The override is used to check the solenoid and diverter valve harness. This override will open the coolant diverter valve, allowing coolant to flow through the Pump and Electronics Unit (PEU). This test can be used to verify that the coolant diverter valve is working correctly.

This override will only enable with the engine running at idle prior to the DEF system priming to operating pressure.

#### DEF Dosing Injector Override

This override allows the user to test the electrical circuit for the DEF injector. The override commands the DEF injector to open. This override only operates when there is no engine speed.

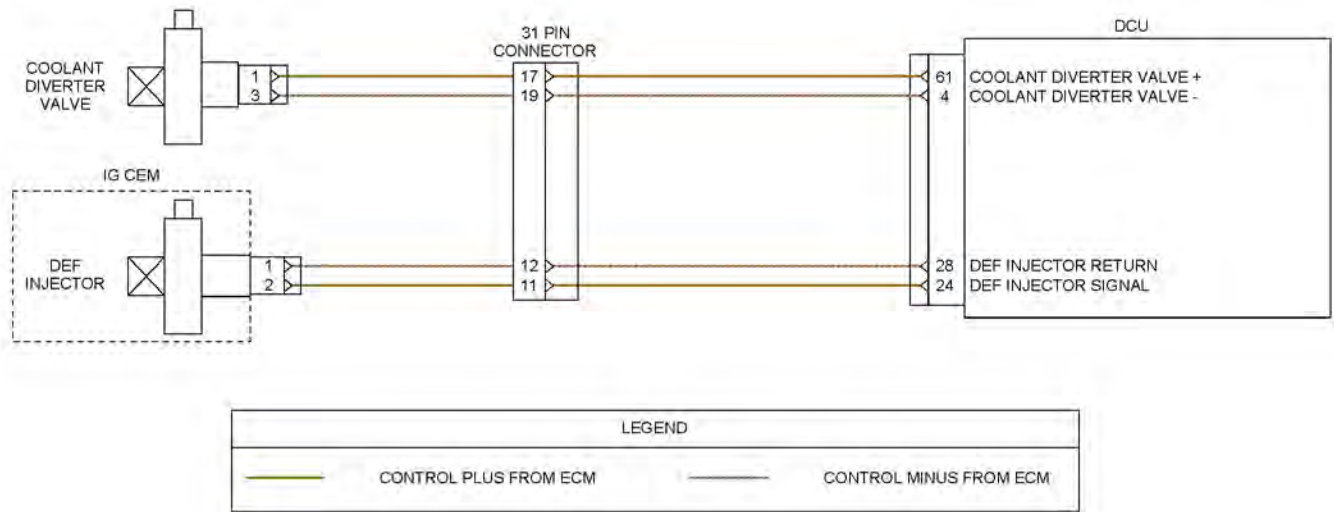


Illustration 144

g03733173

Schematic for the solenoid valves

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

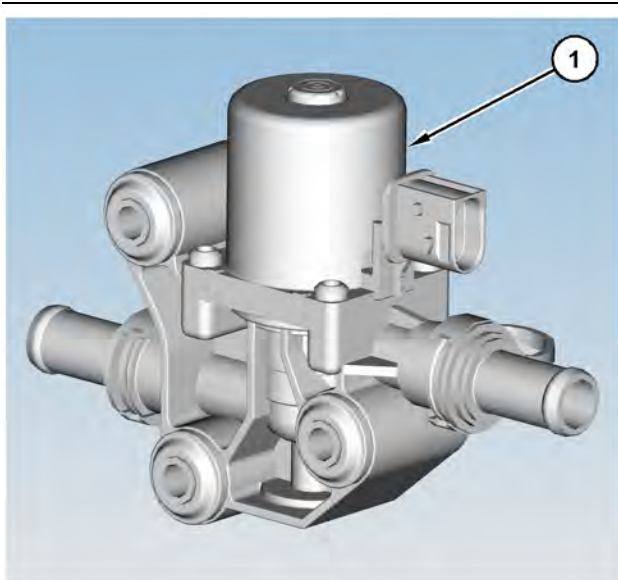


Illustration 145

g03714645

Coolant diverter valve

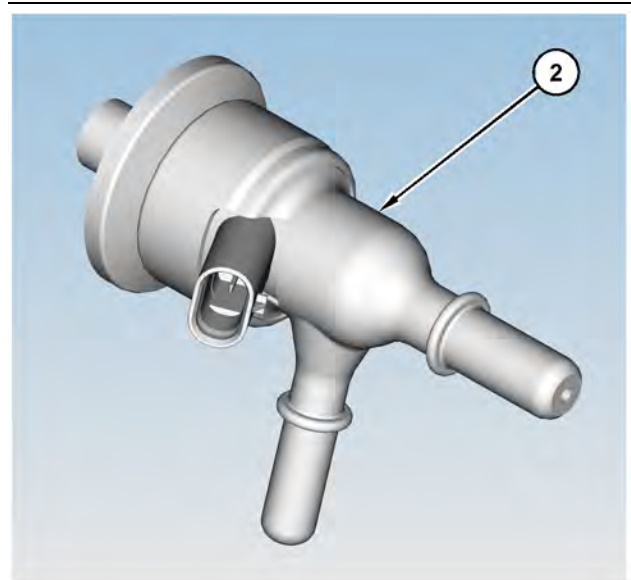


Illustration 146

g03714646

DEF injector

Table 218

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Battery Voltage</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Use a suitable multimeter to measure the battery voltage.</p>	<p>At least 12.5 V for a 12 V system At least 25V for a 24V system</p>	<p><b>Result:</b> The battery voltage is lower than the expected range.</p> <p><b>Repair:</b> Refer to Troubleshooting, Battery Problem to investigate the cause of low battery voltage.</p> <p><b>Result:</b> The battery voltage is within the expected range.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Thoroughly inspect the 31-pin connector for the PEU. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>B.</b> Thoroughly inspect the connectors for the coolant diverter valve and the DEF injector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the connectors that are associated with the active diagnostic code.</p> <p><b>D.</b> Ensure that the DCU connector is securely connected and locked in place.</p> <p><b>E.</b> Check the harness for corrosion, abrasion, and pinch points from the solenoids to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes.</p> <p>Use the electronic service tool to perform the "Aftertreatment System Functional Test" to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to perform the "DEF Dosing Injector Override" .</p> <p><b>E.</b> Verify if any of the diagnostic codes that are listed in Table 217 are active.</p> <p><b>F.</b> Start the engine.</p> <p><b>G.</b> Use the electronic service tool to perform the "DEF Coolant Diverter Valve Solenoid Override" .</p> <p><b>H.</b> Verify if any of the diagnostic codes that are listed in Table 217 are active.</p> <p><b>I.</b> Turn the keyswitch to the OFF position.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A diagnostic code is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> No diagnostic codes are active. There may be an intermittent fault.</p> <p><b>Repair:</b> Use the electronic service tool to perform a Wiggle Test.</p> <p>If no faults are found, return the unit to service.</p> <p>If the Wiggle Test identifies a fault, investigate the cause. Proceed to Test Step 5.</p>

(continued)

(Table 218, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Internal Resistance of the Suspect Component</b></p> <p>For a suspect DEF injector, complete Steps A to C. For a suspect coolant diverter valve, complete Steps D to F.</p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the DEF injector.</p> <p><b>C.</b> Measure the resistance between pins 1 and 2 on the injector.</p> <p><b>D.</b> Turn the keyswitch to the OFF position.</p> <p><b>E.</b> Disconnect the connector for the coolant diverter valve.</p> <p><b>F.</b> Measure the resistance between pins 1 and 3 on the coolant diverter valve.</p>	<p>Internal resistance</p>	<p><b>Result:</b> On a DEF injector, the measured resistance is less than 6.0 Ohms or more than 8.0 Ohms. There is a fault in the injector.</p> <p><b>Repair:</b> Install a replacement DEF injector.</p> <p><b>Result:</b> On a DEF injector, the measured resistance is between 6.0 Ohms and 8.0 Ohms.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> On a coolant diverter valve in a 12 VDC system, the measured resistance is less than 9.0 Ohms or more than 13.0 Ohms. On a coolant diverter valve in a 24 VDC system, the measured resistance is less than 25.0 Ohms or more than 37.0 Ohms. There is a fault in the valve.</p> <p><b>Repair:</b> Install a replacement coolant diverter valve.</p> <p><b>Result:</b> On a coolant diverter valve in a 12 VDC system, the measured resistance is between 9.0 Ohms and 13.0 Ohms. On a coolant diverter valve in a 24 VDC system, the measured resistance is between 25.0 Ohms and 37.0 Ohms.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Wiring Between the Suspect Component and the 31-Pin Connector for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the 31-pin connector and the solenoid connector for the suspect circuit.</p> <p><b>C.</b> Use a multimeter to check the resistance between the signal terminal on the 31-pin connector and the signal terminal on the component connector. Refer to Illustration 144 .</p> <p><b>D.</b> Use a multimeter to check the resistance between the return terminal on the 31-pin connector and the return terminal on the component connector. Refer to Illustration 144 .</p> <p><b>E.</b> Reconnect the connectors.</p>	<p>Open circuit</p>	<p><b>Result:</b> One of the measured resistances is greater than 2 Ohms - There is a fault in the wiring between the 31-pin connector and the component connector.</p> <p><b>Repair:</b> Repair or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are less than 2 Ohms.</p> <p>Proceed to Test Step 6.</p>

(continued)

(Table 218, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Check the Wiring Between the Suspect Component and the 31-Pin Connector for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the 31-pin connector and the connector for the suspect component.</p> <p><b>C.</b> Use a multimeter to check the resistance between the signal terminal on the 31-pin connector and all other terminals in the 31-pin connector. Check the resistance between the signal terminal on the 31-pin connector and a known good ground.</p> <p><b>D.</b> Use a multimeter to check the resistance between the return terminal on the 31-pin connector and all other terminals in the 31-pin connector. Check the resistance between the return terminal on the 31-pin connector and a known good ground.</p>	Short circuit	<p><b>Result:</b> One of the measured resistances is less than 1 k Ohms. There is a fault in the wiring between the 31-pin connector and the suspect component.</p> <p><b>Repair:</b> Repair or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are greater than 1 k Ohms.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the Wiring Between the 31-Pin Connector and the Dosing Control Unit (DCU) for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the 31-pin connector and the DCU connector.</p> <p><b>C.</b> Use a multimeter to check the resistance between the signal terminal on the 31-pin connector and the signal terminal on the DCU connector. Refer to Illustration 144 .</p> <p><b>D.</b> Use a multimeter to check the resistance between the return terminal on the 31-pin connector and the return terminal on the DCU connector. Refer to Illustration 144 .</p> <p><b>E.</b> Reconnect the connectors.</p>	Open circuit	<p><b>Result:</b> One of the measured resistances is greater than 2 Ohms - There is a fault in the wiring between the 31-pin connector and the DCU connector.</p> <p><b>Repair:</b> Repair or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are less than 2 Ohms.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Wiring Between the 31-Pin Connector and the Dosing Control Unit (DCU) for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the 31-pin connector and the DCU connector.</p> <p><b>C.</b> Use a multimeter to check the resistance between the signal terminal on the 31-pin connector and all other terminals in the 31-pin connector. Check the resistance between the signal terminal on the 31-pin connector and a known good ground.</p> <p><b>D.</b> Use a multimeter to check the resistance between the return terminal on the 31-pin connector and all other terminals in the 31-pin connector. Check the resistance between the return terminal on the 31-pin connector and a known good ground.</p>	Short circuit	<p><b>Result:</b> One of the measured resistances is less than 1 k Ohms. There is a fault in the wiring between the 31-pin connector and the DCU connector.</p> <p><b>Repair:</b> Repair or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are greater than 1 k Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i08232943

## Solenoid Valve - Test

(Solenoid Valves that Connect to the Engine ECM)

This procedure covers the following diagnostic codes:

Table 219

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1076-5	18-5	Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>Low current in the output from the ECM to the fuel pump solenoid for 0.6 seconds</p> <p>There are no active 168 diagnostic codes.</p> <p>The ECM has been powered for at least 0.25 seconds.</p> <p>The warning lamp will come on. The ECM will log the diagnostic code. This diagnostic code detects a fault in the circuit for the fuel pump solenoid.</p>
1076-6	18-6	Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>High current in the output from the ECM to the fuel pump solenoid for 0.6 seconds.</p> <p>There are no active 168 diagnostic codes.</p> <p>The ECM has been powered for at least 0.25 seconds.</p> <p>The warning lamp will come on. The ECM will log the diagnostic code. This diagnostic code detects a fault in the circuit for the fuel pump solenoid. This fault is most likely to be caused by a high side short to ground or a low side short to power.</p>
1188-5	526-5	Engine Turbocharger 1 Wastegate Drive : Current Below Normal	<p>The ECM detects the following conditions:</p> <p>A low current condition in the output from the ECM to the solenoid for the wastegate regulator.</p> <p>There are no active 168 diagnostic codes.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged.</p> <p>The engine will be derated while this diagnostic code is active. After the engine derate has been activated, the electronic service tool will indicate "Turbo Protection Derate Active" .</p> <p>This diagnostic code detects a fault in the wastegate regulator that is most likely to be an open circuit.</p>

(continued)



(Table 219, contd)

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1188-6	526-6	Engine Turbocharger 1 Wastegate Drive : Current Above Normal	<p>The ECM detects the following conditions:</p> <p>A high current condition in the output from the ECM to the solenoid in the wastegate regulator</p> <p>There are no active 168 diagnostic codes.</p> <p>The ECM has been powered for at least 2 seconds.</p> <p>The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged.</p> <p>The engine will be derated while this diagnostic code is active. After the engine derate has been activated, the electronic service tool will indicate "Turbo Protection Derate Active" .</p> <p>This diagnostic code detects a fault in the circuit for the wastegate regulator. This fault is most likely to be caused by a high side short to ground or a low side short to power.</p>
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

**The following background information is related to this procedure:**

#### Electronically Controlled Wastegate

The engine has a turbocharger with an electronically controlled wastegate. Typically, the wastegate is a mechanical valve that is used in the turbocharger in order to regulate the intake manifold pressure to a set value.

The control system for the electronically controlled wastegate precisely regulates the intake manifold pressure by using a wastegate regulator to control the wastegate.

The required intake manifold pressure is calculated by the software that is contained in the ECM. The ECM uses the wastegate regulator to control the wastegate in order to provide the precise value of intake manifold pressure. The solenoid in the wastegate regulator is controlled by a PWM signal from the ECM.

#### Suction Control Valve for the High-Pressure Fuel Pump

The high-pressure fuel pump is equipped with a suction control valve. The suction control valve precisely controls the amount of fuel that enters the high-pressure fuel pump.

The amount of fuel that is required is calculated by the software that is contained in the ECM. The solenoid in the suction control valve is controlled by a PWM signal from the ECM.

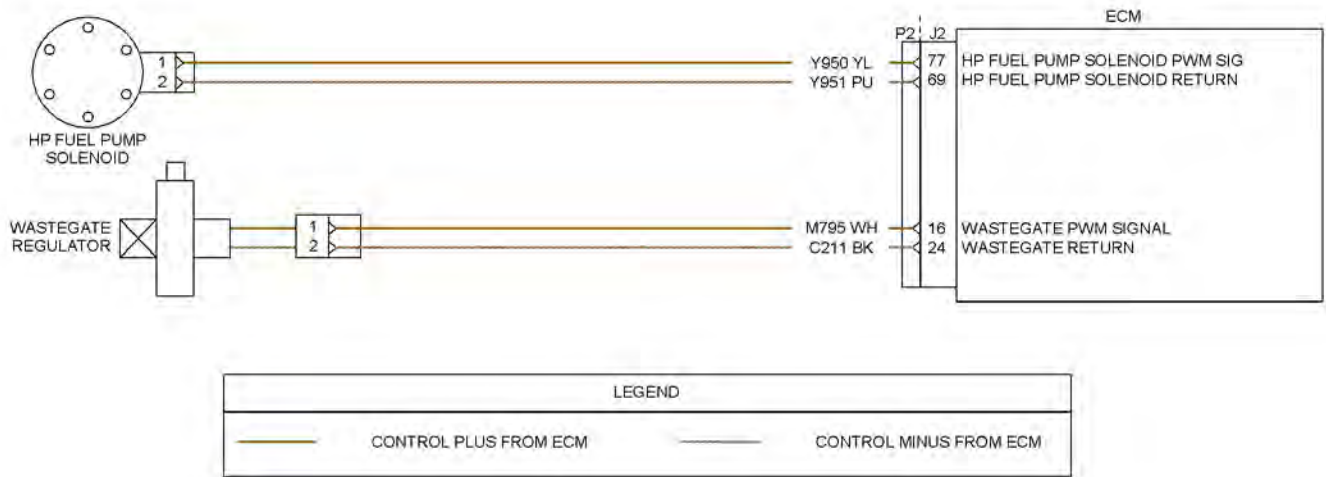


Illustration 147

g03714200

Schematic for the solenoid valves

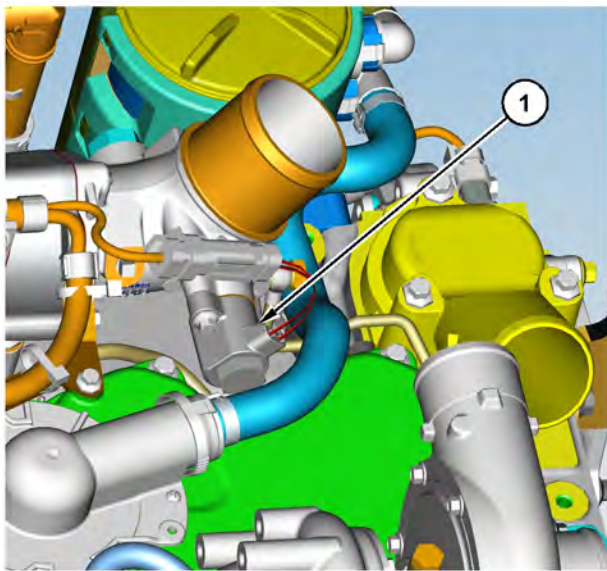


Illustration 148

g03714641

(1) Wastegate regulator

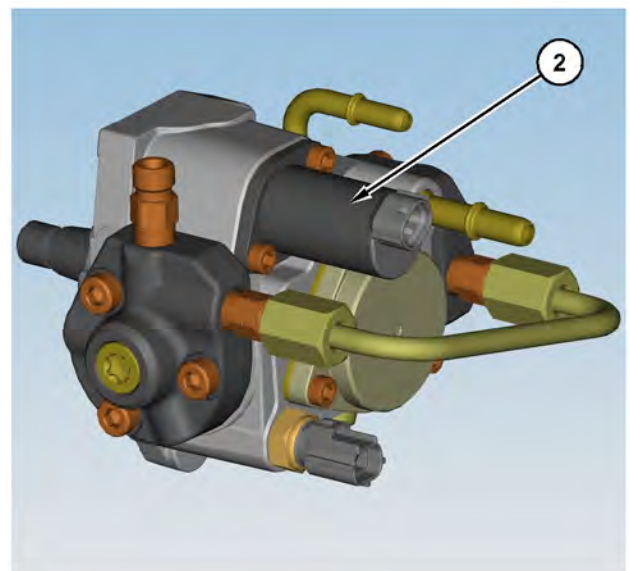


Illustration 149

g03714642

Typical example of the high-pressure fuel pump  
(2) Solenoid for the Suction Control Valve (SCV)

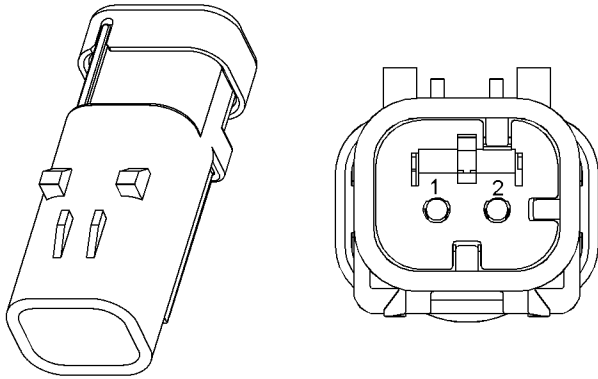


Illustration 150

g01971875

Connector for the wastegate regulator

- (1) Signal
- (2) Return

Table 220

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Thoroughly inspect the terminal connections on the P2/J2 ECM connector and the solenoids. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>B.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the solenoid connectors that are associated with the active diagnostic code.</p> <p><b>C.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>D.</b> Check the harness for corrosion, abrasion, and pinch points from the solenoids to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait at least 20 seconds for activation of the diagnostic codes.</p> <p><b>D.</b> Verify if any of the diagnostic codes that are listed in Table 219 are active.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A -5 diagnostic code is active.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> A -6 diagnostic is active.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 220, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Create a Short Circuit at the Harness Connector for the Solenoid</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect solenoid.</p> <p><b>C.</b> Fabricate a jumper wire that is 150 mm (6 inch) long.</p> <p><b>D.</b> Install the wire between the two pins on the harness connector for the suspect solenoid in order to create a short circuit.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Wait for 10 seconds. Check for active diagnostic codes on the electronic service tool.</p> <p><b>F.</b> Remove the jumper wire from the connector for the solenoid valve.</p>	<p>Open circuit</p>	<p><b>Result:</b> An -5 diagnostic code was active before installing the jumper. An -6 diagnostic code is active when the jumper is installed - There is a fault in the solenoid.</p> <p><b>Repair:</b> Temporarily connect a replacement for the suspect valve to the harness.</p> <p>Turn the keyswitch to the ON position. Use the electronic service tool in order to check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed.</p> <p>If the fault is eliminated, reconnect the suspect valve. If the fault returns, permanently install the replacement valve. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>Result:</b> A -5 diagnostic code is still active with the jumper installed.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Wiring for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector and the connector for the suspect valve.</p> <p><b>C.</b> Use a multimeter to check the resistance between the signal terminal on P2 and the signal terminal on the valve connector. Refer to Illustration 147 .</p> <p><b>D.</b> Use a multimeter to check the resistance between the return terminal on P2 and the return terminal on the valve connector. Refer to Illustration 147 .</p> <p><b>E.</b> Reconnect the connectors.</p>	<p>Less than two Ohms</p>	<p><b>Result:</b> One of the measured resistances is greater than two Ohms - There is a fault in the engine wiring harness</p> <p><b>Repair:</b> Repair the engine wiring harness or replace the engine wiring harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All measured resistances are less than two Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

(Table 220, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Create an Open Circuit at the Solenoid</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect solenoid valve.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait for 10 seconds. Check for active diagnostic codes on the electronic service tool.</p>	<p>Short circuit</p>	<p><b>Result:</b> An -6 diagnostic code was active before disconnecting the valve. An -5 diagnostic code is active with the valve disconnected.</p> <p><b>Repair:</b> Temporarily connect a replacement for the suspect valve to the harness.</p> <p>Turn the keyswitch to the ON position. Use the electronic service tool in order to check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed.</p> <p>If the fault is eliminated, reconnect the suspect valve. If the fault returns, permanently install the replacement valve. Refer to Disassembly and Assembly for the correct procedure.</p> <p><b>Result:</b> A -6 diagnostic code is still active with the valve disconnected.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Wiring for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector and the connector for the suspect valve.</p> <p><b>C.</b> Use a multimeter to check the resistance between the suspect signal terminal on P2 all other terminals on P2. Refer to Illustration 147 .</p> <p><b>D.</b> Use a multimeter to check the resistance between the suspect return terminal on P2 and all other terminals on P2. Refer to Illustration 147 .</p> <p><b>E.</b> Reconnect the connectors.</p>	<p>Greater than 100 Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is less than 100 Ohms - The fault is in the engine harness.</p> <p><b>Repair:</b> Repair the faulty harness or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 100 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06926441

## Soot Sensor - Test

**This procedure is only applicable to engines that have a Diesel Particulate Filter (DPF).**

Use this procedure to troubleshoot a fault with the soot sensor. Also, use this procedure if the diagnostic code in Table 221 is active or easily repeated.

Table 221

Diagnostic Codes Table for Soot Sensor
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(continued)

(Table 221, contd)

J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4783-3	3397-3	DPF #1 Mean Soot Signal : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage for the soot sensor is greater than 32 VDC for 60 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The EBPR may close as a precaution.
4783-4	3397-4	DPF #1 Mean Soot Signal : Voltage Below Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage for the soot sensor is less than 9 VDC for 60 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The EBPR may close as a precaution.
4783-12	3397-12	DPF #1 Mean Soot Signal : Failure	The ECM detects the following conditions: The soot sensor has failed. The warning lamp will come on and the ECM will log the diagnostic code.
4783-21	3397-21	DPF #1 Mean Soot Signal : Data Drifted Low	The ECM detects the following conditions: The soot sensor has not received a valid signal from the soot antenna for at least 60 seconds. The warning lamp will come on and the ECM will log the diagnostic code.

Table 222

Required Tools			
Tool	Part Number	Part Description	Qty
A	T40-0025	Attenuator	1

The following conditions must exist before any of the preceding codes will become active:

- The ECM has been powered for at least 60 seconds.
- There are no active 168 codes.

**The following background information is related to this procedure:**

The soot sensor is powered from the switched battery voltage. A signal is sent by the soot sensor to one soot antenna. The signal that is received by the other antenna is sent back to the soot sensor. The signal is attenuated by the soot in the Diesel Particulate Filter (DPF). The soot sensor calculates the soot load in the DPF by measuring the attenuation of the signal.

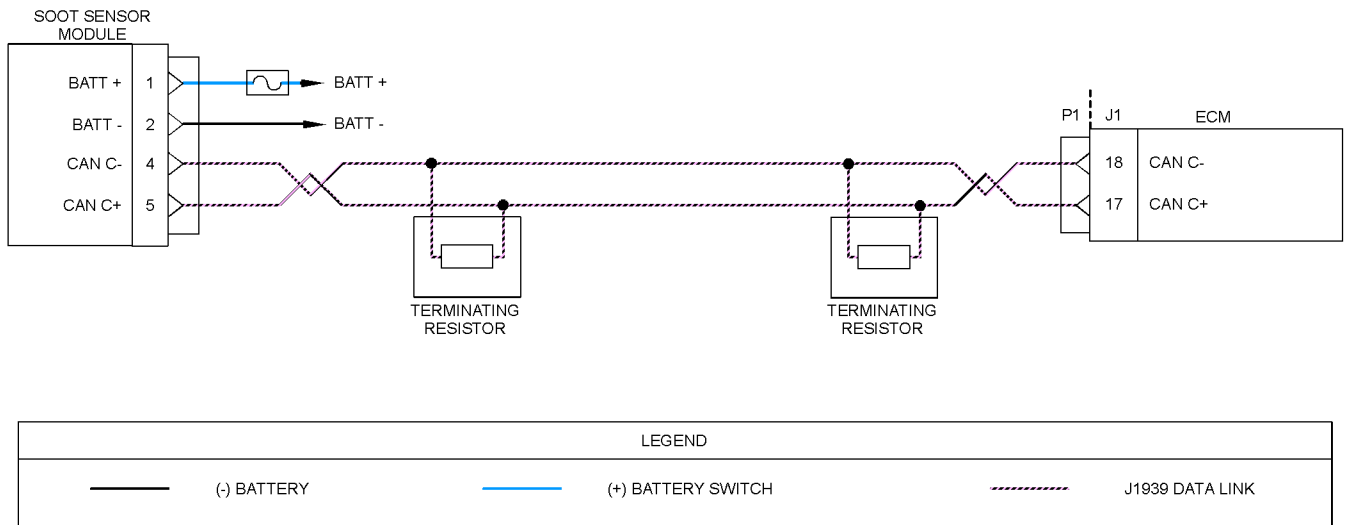


Illustration 151

g03812262

Schematic diagram for the soot sensor circuit

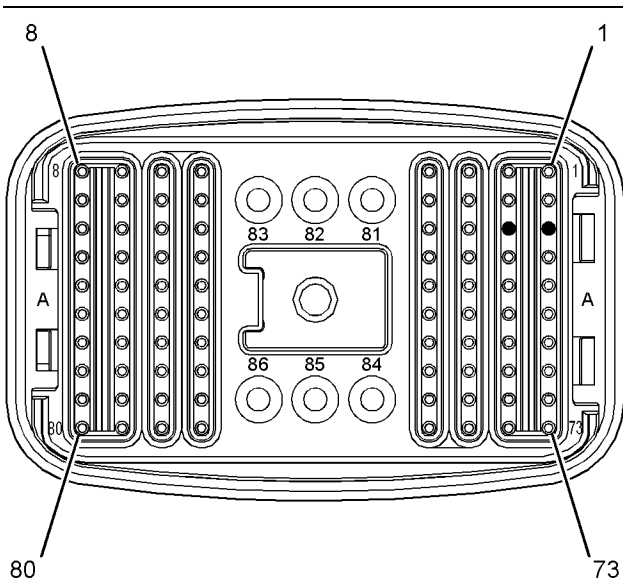


Illustration 152

g03812265

View of the pin locations on the P1 connector for the soot sensor

- (17) CAN C +
- (18) CAN C -

Complete the procedure in the order in which the steps are listed.

Table 223

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the connectors for the speed/timing sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the suspect sensor connector and the sensor connections at the ECM.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the ground connection on the ECM for abrasions and pinch points.</p> <p><b>F.</b> Check the harness for abrasion and pinch points from the suspect sensor to the ECM.</p> <p><b>G.</b> Check that the suspect sensor is installed correctly. Check that the suspect sensor is fully seated into the engine.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p><b>Repair:</b> There may be an intermittent fault. Use the electronic service tool to perform a Wiggle Test. If no fault is identified</p> <p>If no fault is identified, proceed to Test Step 2.</p>
<p><b>2. Check For Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Use the electronic service tool to monitor active diagnostic codes or recently logged diagnostic codes. Look for an active or logged code.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> Diagnostic code 4783-3 or 3397-3 is active.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> Diagnostic code 4783-4 or 3397-4 is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> Diagnostic code 4783-12 or 3397-12 is active.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> Diagnostic code 4783-21 or 3397-21 is active.</p> <p>Proceed to Test Step 6.</p>
<p><b>3. Check for a High Voltage at the Soot Sensor</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Measure the voltage across pins 1 and 2 on the soot sensor connector.</p> <p><b>C.</b> Turn the keyswitch to the OFF position.</p>	<p>Greater than 32 VDC</p>	<p><b>Result:</b> The supply voltage is within the acceptable range for the soot sensor.</p> <p>Return the unit to service</p> <p><b>Result:</b> The supply voltage is above the acceptable range for the soot sensor.</p> <p><b>Repair:</b> Investigate the cause of the high voltage. Refer to Systems Operation, Testing and Adjusting, "Charging System - Inspect".</p>

(continued)



(Table 223, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check for a Low Voltage at the Soot Sensor</b></p> <p><b>A.</b> Turn the keyswitch to the ON position.</p> <p><b>B.</b> Measure the voltage across pins 1 and 2 on the soot sensor.</p> <p><b>C.</b> Turn the keyswitch to the OFF position.</p>	Less than 9 VDC	<p><b>Result:</b> The supply voltage is within the acceptable range for the soot sensor.</p> <p>Return the unit to service.</p> <p><b>Result:</b> The supply voltage is below the acceptable range for the soot sensor.</p> <p><b>Repair:</b> Make sure that any in-line fuses are intact. Replace any blown fuses.</p> <p>Check that the supply voltage is adequate. Refer to Systems Operation, Testing and Adjusting, "Charging System - Inspect".</p> <p>If the supply voltage is satisfactory, inspect the wiring and the connectors. Refer to Troubleshooting, "Electrical Power Supply - Test".</p>
<p><b>5. Diagnostic Code 4783-12 or 3397-12 is Active</b></p> <p><b>A.</b> If diagnostic code 4783-12 or 3397-12 is active, the soot sensor has a fault.</p>	Faulty sensor	<p><b>Result:</b> Diagnostic code 4783-12 or 3397-12 is active. There is a fault in the soot sensor.</p> <p><b>Repair:</b> Replace the soot sensor.</p>
<p><b>6. Check the Soot Antennas</b></p> <p><b>Note:</b> If diagnostic code 4783-21 or 3397-21 is active, the soot sensor is not receiving a signal from the soot antennas.</p> <p><b>Note:</b> If any corrective action is performed, allow a period of 60 seconds for the diagnostic code to disappear.</p> <p><b>A.</b> Inspect the coaxial cable. Check each connection for dirt or water ingress. All connectors must be clean and dry before connections are made. Verify that all the connectors are securely connected.</p> <p><b>B.</b> Torque all coaxial connectors to 1.2 N·m (10.6 lb in).</p> <p><b>C.</b> After 60 seconds, check for diagnostic code 4783-21 or 3397-21.</p> <p><b>D.</b> If diagnostic code 4783-21 or 3397-21 is still active, continue with this procedure.</p> <p><b>E.</b> Disconnect the coaxial cables from the antennas.</p> <p><b>F.</b> Connect the ends of the coaxial cables to Tooling (A).</p> <p><b>G.</b> Perform the "DPF Soot Loading Sensor Functional Test" on the electronic service tool by selecting the following menus:</p> <ul style="list-style-type: none"> <li>· "Diagnostics"</li> <li>· "Diagnostic Tests"</li> <li>· "DPF Soot Loading Sensor Functional Test"</li> </ul> <p><b>H.</b> Disconnect the coaxial cables from the attenuator.</p>	Faulty soot antenna	<p><b>Result:</b> The "DPF Soot Loading Sensor Functional Test" is successful. The fault is in a soot antenna.</p> <p><b>Repair:</b> Remove the two soot antennas from the DPF. Refer to Disassembly and Assembly, "Soot Antenna - Remove and Install".</p> <p>Inspect the soot antennas for damaged or bent probes. Replace a damaged antenna. If no damage is found, replace both antennas.</p> <p>Install the two soot antennas. Refer to Disassembly and Assembly, "Soot Antenna - Remove and Install". Ensure that the antenna connectors are tightened to a torque of 1.2 N·m (10.6 lb in).</p> <p>After 60 seconds, confirm that diagnostic code 4783-21 or 3397-21 is no longer active.</p> <p><b>Result:</b> The "DPF Soot Loading Sensor Functional Test" is not successful. The fault is in the soot sensor or a coaxial cable.</p> <p><b>Repair:</b> Replace the soot sensor. Ensure that the antenna connectors are tightened to a torque of 1.2 N·m (10.6 lb in).</p> <p>Repeat the "DPF Soot Loading Sensor Functional Test" and confirm that the test is successful.</p> <p>If the fault has not been eliminated, contact the Dealer Solutions Network (DSN).</p>

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## Speed Control - Test (Analog)

This procedure covers the following diagnostic codes:

Table 224

Diagnostic Trouble Codes for Analog Throttles			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
91-3	91-3	Accelerator Pedal Position 1 : Voltage Above Normal	The Electronic Control Module (ECM) detects one of the following conditions:
29-3	774-3	Accelerator Pedal Position 2: Voltage Above Normal	The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. 3509 (262) codes are not active. The setting for the upper diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.
91-4	91-4	Accelerator Pedal Position 1 : Voltage Below Normal	The ECM detects one of the following conditions:
29-4	774-4	Accelerator Pedal Position 2: Voltage Below Normal	The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. 3510 (2131) codes are not active. The setting for the lower diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

If a fault occurs with the primary throttle with secondary throttle is installed, the secondary throttle will be used until the fault is repaired.

If a fault occurs with the secondary throttle, the engine will use the primary throttle until the fault is repaired.

If a functional throttle is not available, the following conditions will occur:

- The engine will default to the limp home speed.
- If the engine speed is higher than the limp home speed, the engine will decelerate to the limp home speed.

- If the engine speed is lower than the limp home speed, the engine speed will remain at the current speed.
- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

The diagnostic codes above relate to an analog sensor. Use this procedure only if the analog sensor uses an output from a variable resistor.

The sensor is most likely to be mounted on a throttle pedal. The sensor is attached directly to the throttle assembly. The sensor provides an output voltage to the ECM. The sensor output voltage will vary with the position of the throttle. Foot operated or hand operated throttle assemblies are available.

The sensor receives +5 VDC power from the ECM. The sensor will produce a raw signal voltage that will alter between low idle and high idle. The voltage is changed into a throttle position within the range 0% to 100% by the ECM.

The sensor senses the speed requirement from the throttle position. A second sensor may override this speed requirement from the first sensor. This override will be subject to an input from a secondary throttle or from the SAE J1939 (CAN) data link or from a PTO control.

Use the electronic service tool in order to check the input status.

**Note:** The identification letters for the terminals in the connectors may vary dependent on the manufacturer of the throttle pedal.

During the following procedure, refer to the electrical schematic for the application.

Complete the procedure in the order in which the steps are listed.

Table 225

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Thoroughly inspect the terminal connections on the P1/J1 ECM connector and the analog throttle position sensors. Refer to Troubleshooting, "Electrical Connector - Inspect".</p> <p><b>B.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the analog throttle position sensor connectors that are associated with the active diagnostic code.</p> <p><b>C.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>D.</b> Check the harness for corrosion, abrasion, and pinch points from the analog throttle position sensors to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes.</p> <p><b>D.</b> Verify if any of the diagnostic codes that are listed in Table 224 are active.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> There are no active diagnostic codes for the analog throttle position sensors.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> One or more of the diagnostic codes listed in Table 224 is active.</p> <p>Proceed to Test Step 5.</p>
<p><b>3. Check the Throttle Position with the Electronic Service Tool</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position. Do not start the engine.</p> <p><b>C.</b> Observe the throttle position reading on the electronic service tool.</p> <p><b>D.</b> Operate the throttle over the full range of movement.</p>	<p>20 percent to 27 percent at low idle.</p> <p>80 percent to 87 percent at high idle</p>	<p><b>Result:</b> The ECM is not receiving the correct signal from the sensor.</p> <p><b>Repair:</b> Use the electronic service tool to verify that the throttle has been configured correctly before continuing with this procedure. If the fault is still present after the throttle has been configured correctly, replace the analog throttle position sensor.</p> <p><b>Result:</b> The sensor is operating correctly.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 225, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Throttle Selection Status with the Electronic Service Tool</b></p> <p><b>A.</b> Check the status of the throttle selection switch (if equipped). Use the electronic service tool in order to check the status of the throttle selection switch.</p>	<p>Throttle 1 has control when status is "OFF"</p> <p>Throttle 2 has control when status is ON.</p>	<p><b>Result:</b> The throttle section switch is operating correctly.</p> <p>Return the engine to service.</p> <p>If an intermittent fault exists, refer to Troubleshooting, "Electrical Connector - Inspect"</p> <p><b>Result:</b> The wrong throttle is selected.</p> <p><b>Repair:</b> Switch to the other throttle. There may be a fault with the selector switch input.</p> <p>Check the connections between the throttle selection switch and the P1 connector. Refer to Troubleshooting, "Electrical Connector - Inspect".</p>
<p><b>5. Check the Sensor Supply Voltage</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the suspect throttle position sensor.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage between the 5 VDC terminal and the ground terminal on the harness connector for the sensor.</p>	<p>4.84 VDC to 5.16 VDC</p>	<p><b>Result:</b> The correct supply voltage is not reaching the sensor. The fault is in the 5 VDC supply wire or the ground wire between the suspect throttle position sensor and the P1 connector.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The supply voltage is reaching the sensor.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Verify the Type of Active Diagnostic Code</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes.</p> <p><b>B.</b> Use the electronic service tool to check for active diagnostic codes that are listed in Table 224 . Record all active diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> A -3 diagnostic code is active.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> A -4 diagnostic code is active.</p> <p>Proceed to Test Step 9.</p> <p><b>Result:</b> There are no active diagnostic codes for the throttle position sensors - The fault may be intermittent.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Electrical Connector - Inspect".</p>

(continued)

## Circuit Tests

(Table 225, contd)

Troubleshooting Test Steps	Values	Results
<p><b>7. Create a Short Circuit at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the throttle position sensor with the -3 diagnostic code.</p> <p><b>C.</b> Fabricate a jumper wire. Install the jumper wire between the sensor signal terminal and the ground terminal on the harness connector for the throttle position sensor.</p> <p><b>D.</b> Turn the keyswitch to the ON position.</p> <p><b>E.</b> Access the "Active Diagnostic Codes" screen on the electronic service tool. Look for an active -4 diagnostic code for the suspect sensor.</p> <p><b>F.</b> Turn the keyswitch to the OFF position.</p> <p><b>G.</b> Remove the jumper wire.</p>	Diagnostic codes	<p><b>Result:</b> An -3 diagnostic code was active before the jumper was installed. An -4 diagnostic code is active with the jumper installed.</p> <p><b>Repair:</b> Install a replacement analog throttle position sensor.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The -3 diagnostic code remains active with the jumper installed.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Sensor Signal Wire for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect throttle position sensor. Disconnect the P1 connector from the ECM.</p> <p><b>C.</b> Measure the resistance between the sensor signal terminal on the harness connector and the appropriate sensor signal terminal on the P1 connector.</p>	Less than two Ohms	<p><b>Result:</b> The resistance measurement is greater than two Ohms - There is an open circuit or high resistance in the sensor signal wire.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The resistance measurement is less than two Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

(continued)

(Table 225, contd)

Troubleshooting Test Steps	Values	Results
<p><b>9. Create an Open Circuit at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the throttle position sensor with the -4 diagnostic code.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait for at least 10 seconds for activation of the diagnostic codes.</p> <p><b>D.</b> Use the electronic service tool to check the "Active Diagnostic Codes" screen on the electronic service tool. Check for an -3 diagnostic code.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Diagnostic codes	<p><b>Result:</b> An -4 diagnostic code was active before disconnecting the sensor. An -3 diagnostic code is active with the sensor disconnected.</p> <p><b>Repair:</b> Install a replacement analog throttle position sensor.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The -4 diagnostic code is still active with the sensor disconnected.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Check the Sensor Signal Wire for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect throttle position sensor. Disconnect the P1 connector from the ECM.</p> <p><b>C.</b> Measure the resistance between the suspect sensor signal terminal and all other terminals on the P1 connector.</p>	Greater than 100 Ohms	<p><b>Result:</b> At least one of the resistance measurements is less than 100 Ohms - There is a short in the wiring harness.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p><b>Result:</b> All resistance measurements are greater than 100 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Speed Control - Test (PWM)

Use this procedure if the digital throttle position sensor is suspected of incorrect operation. This procedure also covers the following diagnostic codes:

Table 226

<b>Diagnostic Trouble Codes for the Digital Throttles</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
29-3	774-3	Accelerator Pedal Position 2 : Voltage Above Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The ECM has been powered for 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>There are no active 678 or 41 codes.</p> <p>The setting for the upper diagnostic limit has been exceeded for one second.</p> <p>If equipped, the warning lamp will come on. The diagnostic code will be logged.</p>
29-4	774-4	Accelerator Pedal Position 2 : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The ECM has been powered for 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>There are no active 678 or 41 codes.</p> <p>The setting for the lower diagnostic limit has been exceeded for one second.</p> <p>If equipped, the warning lamp will come on. The diagnostic code will be logged.</p>
29-8	774-8	Accelerator Pedal Position 2 : Abnormal Frequency, Pulse Width or Period	<p>The ECM detects the following conditions:</p> <p>The signal frequency from the digital throttle position sensor is equal to 0% or 100% for more than 2 seconds.</p> <p>The ECM has been powered for at least 3 seconds.</p> <p>Diagnostic codes 29-3, 774-3, 29-4, and 774-4 are not active.</p> <p>There are no active 678 or 41 codes.</p> <p>The ECM sets the Throttle Position to "0%" .</p> <p>If equipped, the warning lamp will come on. The diagnostic code will be logged if the engine is running. The diagnostic code will not be logged if the engine is cranking.</p>
91-3	91-3	Accelerator Pedal Position 1 : Voltage Above Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The ECM has been powered for 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>There are no active 678 or 41 codes.</p> <p>The setting for the upper diagnostic limit has been exceeded for one second.</p> <p>If equipped, the warning lamp will come on. The diagnostic code will be logged.</p>

(continued)



(Table 226, contd)

Diagnostic Trouble Codes for the Digital Throttles			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
91-4	91-4	Accelerator Pedal Position 1 : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The ECM has been powered for 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>There are no active 678 or 41 codes.</p> <p>The setting for the lower diagnostic limit has been exceeded for one second.</p> <p>If equipped, the warning lamp will come on. The diagnostic code will be logged.</p>
91-8	91-8	Accelerator Pedal Position 1 : Abnormal Frequency, Pulse Width or Period	<p>The ECM detects the following conditions:</p> <p>The signal frequency from the digital throttle position sensor is equal to 0% or 100% for more than 2 seconds.</p> <p>The ECM has been powered for at least 3 seconds.</p> <p>Diagnostic codes 91-3 and 91-4 are not active.</p> <p>There are no active 678 or 41 codes.</p> <p>The ECM sets the Throttle Position to "0%".</p> <p>If equipped, the warning lamp will come on. The diagnostic code will be logged if the engine is running. The diagnostic code will not be logged if the engine is cranking.</p>
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

If a fault occurs with the primary throttle, the engine will use the secondary throttle until the fault is repaired.

If a fault occurs with the secondary throttle, the engine will use the primary throttle until the fault is repaired.

If a functional throttle is not available, the following conditions will occur:

- The engine will default to the limp home speed.
- If the engine speed is higher than the limp home speed, the engine will decelerate to the limp home speed.
- If the engine speed is lower than the limp home speed, the engine speed will remain at the current speed.
- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.

- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

### Digital Throttle Position Sensor

The digital throttle position sensor is used to provide a digital throttle position signal to the ECM. The sensor output is a constant frequency signal with a pulse width that varies with the throttle position. This output signal is referred to as either a duty cycle or a pulse width modulated signal (PWM). This output signal is expressed as a percentage between 0 and 100 percent.

The digital throttle position sensor is most likely to be attached directly to the throttle assembly. The digital throttle position sensor requires no adjustment.

The duty cycle at low idle and the duty cycle at high idle can vary depending on the application. The percent of duty cycle is translated in the ECM into a throttle position of 3 to 100 percent.

The digital throttle position sensors are powered by +8 VDC from the ECM. The supply voltage is from J1: to the digital throttle position sensor connector.

If the application is using the ECM dedicated PTO functions, the digital throttle position sensor will be ignored while the engine is in PTO mode.

The ECM is in PTO mode if the PTO ON/OFF Switch is ON. This status can be checked with the electronic service tool. Refer to Troubleshooting, "Power Take-Off - Test" for testing if the PTO is being used.

**Note:** The identification letters for the terminals in the connectors may vary dependent on the manufacturer of the throttle pedal.

During the following procedure, refer to the electrical schematic for the application.

Complete the procedure in the order in which the steps are listed.

Table 227

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Thoroughly inspect the terminal connections on the P1/J1 ECM connector and the PWM throttle position sensors. Refer to Troubleshooting, “Electrical Connector - Inspect”.</p> <p><b>B.</b> Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the PWM throttle position sensor connector.</p> <p><b>C.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>D.</b> Check the harness for corrosion, abrasion, and pinch points from the PWM throttle position sensor to the ECM.</p>	Loose connection or damaged wire	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check for Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes.</p> <p><b>D.</b> Verify if any of the diagnostic codes that are listed in Table 226 are active.</p> <p><b>Note:</b> When the ECM calibrates new duty cycle values for the low and the high idle throttle position, the ECM assumes the initial lower position for the duty cycle at low idle and the initial upper position for the duty cycle at high idle. The initial lower position and the initial upper position can be obtained by accessing the following screens on the electronic service tool:</p> <ul style="list-style-type: none"> <li>· Service</li> <li>· Throttle Configuration</li> <li>· “Throttle# 1”</li> </ul> <p>As a result, the throttle position status may reach 100 percent well before the throttle pedal is fully depressed. This situation is normal. Cycle the throttle to the high idle position several times for the ECM to adjust the calibration automatically. During normal operation, more movement of the throttle can be required for the throttle position status to increase above 3 percent. The status may reach the 100 percent value prior to the limit of the high idle position. This process is done to ensure that the throttle reaches these two critical points for engine operation.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Diagnostic codes	<p><b>Result:</b> At least one of the diagnostic codes listed in Table 226 is active.</p> <p>Proceed to Test Step 4.</p> <p><b>Result:</b> None of the preceding diagnostic codes are active or recently logged - There may be an intermittent fault.</p> <p><b>Repair:</b> Refer to Troubleshooting, “Electrical Connector - Inspect” in order to identify intermittent faults. If the fault is still present, proceed to Test Step 3.</p>

(continued)

(Table 227, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Duty Cycle of the Digital Throttle Position Sensor</b></p> <p><b>A.</b> Access the following screens on the electronic service tool in order to check the upper and the lower diagnostic limit of the throttle position sensors:</p> <ul style="list-style-type: none"> <li>• “Service”</li> <li>• “Throttle Configuration”</li> <li>• “Throttle# 1”</li> </ul> <p><b>B.</b> Make a note of the lower diagnostic limit and the upper diagnostic limit.</p> <p><b>C.</b> Verify that the keyswitch is in the ON position.</p> <p><b>D.</b> Access the following screens on the electronic service tool in order to monitor the duty cycle of the throttle position:</p> <ul style="list-style-type: none"> <li>• “Status”</li> <li>• “Throttles”</li> </ul> <p><b>E.</b> Monitor the duty cycle of the throttle at the “low idle” position and the “high idle” position.</p>	<p>Duty cycle above lower diagnostic limit at low idle</p> <p>Duty cycle below upper diagnostic limit at high idle</p>	<p><b>Result:</b> OK - The digital throttle position sensor is operating correctly.</p> <p>Return the engine to service.</p> <p><b>Result:</b> Not OK - The digital throttle position sensor circuit is not operating correctly.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check the Supply Voltage at the Digital Throttle Position Sensor</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Install a breakout “T” with three terminals at the suspect digital throttle position sensor connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage between the +8 VDC terminal and the sensor return terminal.</p>	<p>7.5 VDC to 8.5 VDC</p>	<p><b>Result:</b> The sensor supply voltage is not within the expected range. The fault is in the sensor supply wiring or the ground wiring between the sensor and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The sensor supply voltage is within the expected range.</p> <p>Proceed to Test Step 5.</p>

(continued)

(Table 227, contd)

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the Duty Cycle of the Throttle Position Sensor at the Sensor</b></p> <p><b>Note:</b> Performing certain steps within this procedure requires the use of a multimeter that can measure a PWM duty cycle.</p> <p><b>A.</b> Access the following screens on the electronic service tool to check the upper and the lower diagnostic limit of the suspect throttle position sensors:</p> <ul style="list-style-type: none"> <li>• “Service”</li> <li>• “Throttle Configuration”</li> <li>• “Throttle# 1”</li> </ul> <p><b>B.</b> Make a note of the lower diagnostic limit and the upper diagnostic limit.</p> <p><b>C.</b> Turn the keyswitch to the OFF position.</p> <p><b>D.</b> Remove the signal wire for the suspect digital throttle position sensor from the connector. Refer to the Electrical Schematic for the application.</p> <p><b>E.</b> Install a breakout “T” with three terminals at the digital throttle position sensor connector.</p> <p><b>F.</b> Connect the multimeter probes to the sensor signal terminal and the sensor ground terminal of the breakout T.</p> <p><b>G.</b> Turn the keyswitch to the ON position.</p> <p><b>H.</b> While the duty cycle is being monitored on the multimeter, operate the throttle through the full range of movement.</p>	<p>Duty cycle above lower diagnostic limit at low idle</p> <p>Duty cycle below upper diagnostic limit at high idle</p>	<p><b>Result:</b> Not OK.</p> <p><b>Repair:</b> Replace the suspect digital throttle position sensor.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> OK.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Bypass the Signal Wire</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect digital throttle position sensor connector. Disconnect the P1 connector from the ECM.</p> <p><b>C.</b> Remove the sensor signal wire from the connector for the suspect digital throttle position sensor. Remove the applicable signal wire from P1.</p> <p><b>D.</b> Install the jumper wire between P1 and the signal terminal on the suspect throttle sensor connector.</p> <p><b>E.</b> Access the following screens on the electronic service tool to check the upper and the lower diagnostic limit of the throttle position sensor:</p> <ul style="list-style-type: none"> <li>• “Service”</li> <li>• “Throttle Configuration”</li> <li>• “Throttle# 1”</li> </ul> <p><b>F.</b> Make a note of the lower diagnostic limit and the upper diagnostic limit.</p>	<p>Duty cycle above lower diagnostic limit at low idle</p> <p>Duty cycle below upper diagnostic limit at high idle</p>	<p><b>Result:</b> OK - The throttle operates correctly with the bypass installed. The fault is in the sensor signal wiring.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> Not OK</p> <p><b>Repair:</b> Recheck the wiring, the ECM connectors, and the digital throttle position sensor connector. If no faults are found, contact the Dealer Solutions Network (DSN).</p>

(continued)

(Table 227, contd)

Troubleshooting Test Steps	Values	Results
<p><b>G.</b> Turn the keyswitch to the ON position.</p> <p><b>H.</b> Check the duty cycle of the position sensor on the electronic service tool while the digital throttle is being moved over the full range.</p>		

i06167060

## Speed/Timing - Test

This procedure covers the following diagnostic codes:

Table 228

Diagnostic Codes for the Speed/Timing Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
190-8	190-8	Engine Speed : Abnormal Frequency, Pulse Width, or Period	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>An intermittent loss of signal or a complete loss of signal from the primary speed/timing sensor for 2 seconds</p> <p>The engine has been running for more than 3 seconds.</p> <p>3512 or 3483 diagnostic trouble codes are not active.</p> <p>The warning light will come on and the diagnostic code will be logged.</p> <p>The ECM will use the signal from the secondary speed/timing sensor.</p> <p>The engine will be derated. If the signal from the secondary speed/timing sensor is also lost, the engine will shut down.</p>
723-8	342-8	Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width or Period	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>A loss of signal from the secondary speed/timing sensor for 2 seconds while the signal from the primary speed/timing sensor remained valid</p> <p>The engine has been running for more than 3 seconds.</p> <p>3512 or 3483 diagnostic trouble codes are not active.</p> <p>The warning lamp will come on and the diagnostic code will be logged.</p> <p>The loss of signal from the secondary speed/timing sensor will prevent the engine from starting.</p>

(continued)

(Table 228, contd)

<b>Diagnostic Codes for the Speed/Timing Sensors</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Code Description (code descriptions may vary)</b>	<b>Comments</b>
637-11	261-11	Engine Timing Sensor : Other Failure Mode	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The outputs from the primary speed/timing sensor and the secondary speed/timing sensor differ by more than 8 degrees of crankshaft rotation.</p> <p>The engine has been running for more than 5 seconds.</p> <p>Diagnostic code 190-8 is not active.</p> <p>3512 or 3483 diagnostic trouble codes are not active.</p> <p>The warning light will come on. This code will not be logged.</p>
3512-3	3483-3	Sensor Supply Voltage 4 : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The 8 VDC supply is more than 8.8 VDC for more than one second.</p> <p>The ECM has been powered for more than 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>The ECM will log the diagnostic code and the warning lamp will illuminate while this diagnostic code is active.</p> <p>The engine may be limited to low idle.</p>
3512-4	3483-4	Sensor Supply Voltage 4 : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The 8 VDC supply is less than 7.2 VDC for more than one second.</p> <p>The ECM has been powered for more than 3 seconds.</p> <p>Diagnostic code 168-4 is not active.</p> <p>The ECM will log the diagnostic code and the warning lamp will illuminate while this diagnostic code is active.</p> <p>The engine may be limited to low idle.</p> <p>An active diagnostic code may not cause any noticeable effect on engine response unless the voltage drops below 6.5 VDC.</p>
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

Use this procedure when the engine will not start and the electronic service tool indicates a faulty sensor by displaying "Not Detected" against the faulty sensor on the "No Start Parameter" screen.

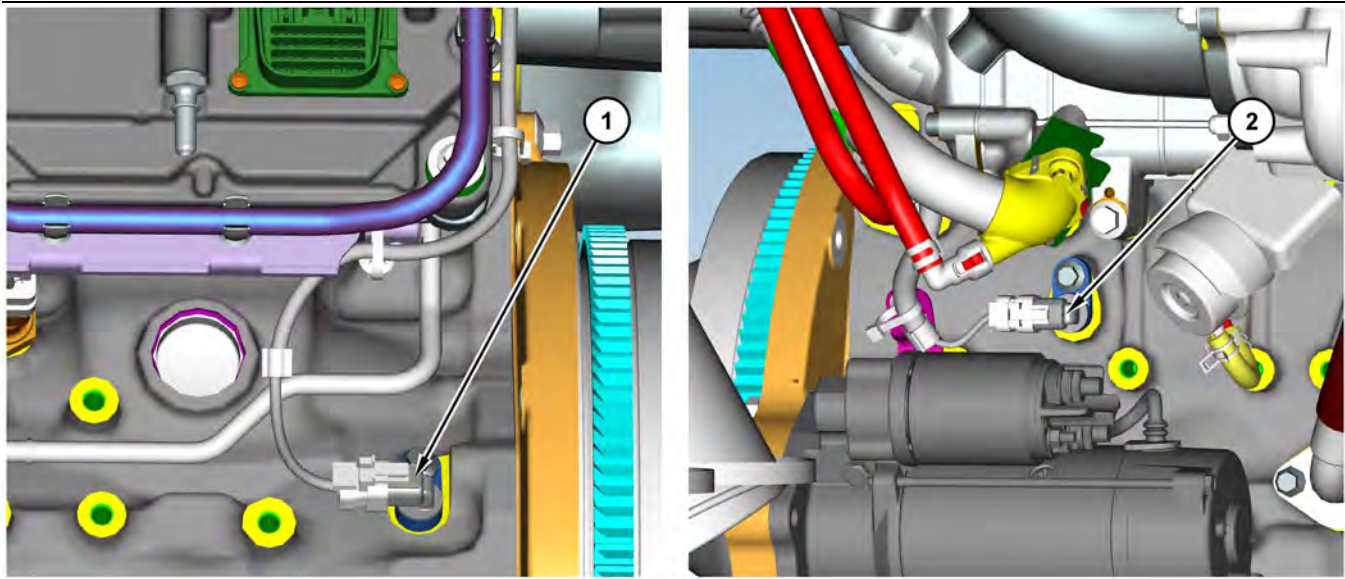


Illustration 153

g03796519

Typical examples of the sensor locations

(1) Primary speed/timing sensor

(2) Secondary speed/timing sensor

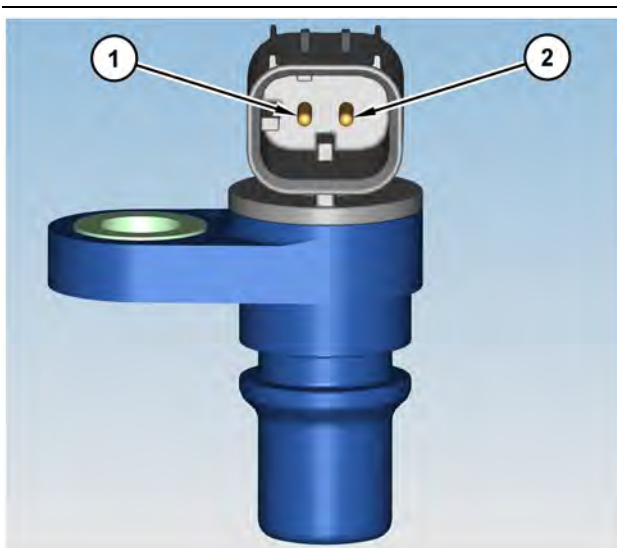


Illustration 154

g03796527

Speed/timing sensor

- (1) 8 VDC Supply
- (2) Signal

The engine uses two engine speed/timing sensors. The primary speed/timing sensor is located on the left-hand side of the cylinder block close to the flywheel housing. The primary speed/timing sensor generates a signal by detecting the movement of the teeth that are located on the crankshaft timing ring. The signal that is generated by the speed/timing sensor is transmitted to the ECM. The ECM uses the signal from the speed/timing sensor to calculate the position of the crankshaft. The signal is also used to determine the engine speed.

The secondary speed/timing sensor is located on the right-hand side of the cylinder block toward the rear of the engine. The secondary speed/timing sensor generates a signal that is related to the camshaft position. The secondary speed/timing sensor detects the movement of the teeth on the timing ring for the camshaft. The signal that is generated by the speed/timing sensor is transmitted to the ECM. The ECM calculates the speed and the rotational position of the engine by using the signal. The secondary speed/timing sensor is required for starting purposes.

During normal operation, the secondary speed/timing sensor is used to determine the cycle that the engine is on. When the timing has been established, the primary speed/timing sensor is then used to determine the engine speed and the angular position.

The loss of signal to the primary sensor and/or the secondary sensor will result in one of the following faults:

- The engine will continue to run when only one sensor signal is present from either the primary sensor or the secondary sensor.



- Loss of signal both sensors during operation of the engine will cause fuel injection to be terminated and the engine will stop.

The primary sensor and the secondary sensor are interchangeable components. If a sensor is suspect, the sensors can be exchanged in order to eliminate a fault. If a secondary sensor is suspect and a replacement secondary sensor is not available, then the primary sensor and the secondary sensor can be exchanged. This exchange will allow testing to determine if the secondary sensor is faulty.

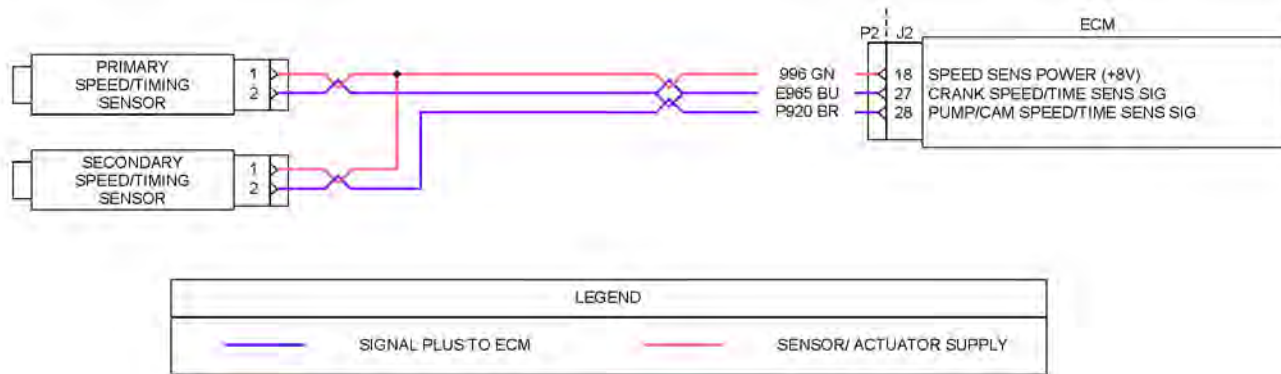


Illustration 155

g03812318

Schematic for the speed/timing sensors

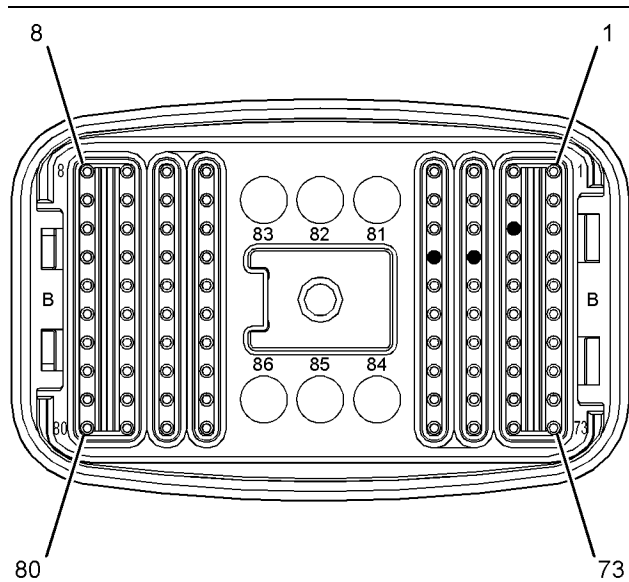


Illustration 156

g03812322

Pin locations for the speed/timing sensor on the P2 connector

- (18) Supply for the speed/timing sensor (8 VDC)
- (27) Signal for the primary speed/timing sensor
- (28) Signal for the secondary speed/timing sensor

Complete the procedure in the order in which the steps are listed.

Table 229

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the connectors for the speed/timing sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the suspect sensor connector and the sensor connections at the ECM.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the ground connection on the ECM for abrasions and pinch points.</p> <p><b>F.</b> Check the harness for abrasion and pinch points from the suspect sensor to the ECM.</p> <p><b>G.</b> Check that the suspect sensor is installed correctly. Check that the suspect sensor is fully seated into the engine.</p>	Loose connection or damaged wire	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check For Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. If the engine will start, then run the engine.</p> <p><b>D.</b> Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Diagnostic codes	<p><b>Result:</b> Diagnostic code 637-11 or 261-11 is active or recently logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> Diagnostic code 190-8, 723-8, or 342-8 is active or recently logged.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> Diagnostic code 3512-3, 3483-3, 3512-4 or 3483-4 is active or recently logged.</p> <p>Proceed to Test Step 9.</p>
<p><b>3. Inspect the Sensors</b></p> <p><b>A.</b> Ensure that the speed/timing sensors are correctly seated in the cylinder block and that the retaining bolts are tightened to a torque of 22 N·m (16 lb ft). Ensure that the speed/timing sensors are not damaged.</p> <p>Replace any damaged sensors. Refer to Disassembly and Assembly, "Crankshaft Position Sensor - Remove and Install" or refer to Disassembly and Assembly, "Camshaft Position Sensor - Remove and Install".</p> <p><b>B.</b> Turn the keyswitch to the ON position. If the engine will run, then run the engine.</p> <p><b>C.</b> Use the electronic service tool to check if the 637-11 or 261-11 diagnostic code is still active.</p>	Faulty sensor	<p><b>Result:</b> A 637-11 or 261-11 diagnostic code is no longer active.</p> <p>Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service.</p> <p><b>Result:</b> A 637-11 or 261-11 diagnostic code is still active.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 229, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Crankshaft Timing Ring and the Timing Ring on the Camshaft</b></p> <p><b>A.</b> Remove the primary speed/timing sensor and the secondary speed/timing sensor. Refer to Disassembly and Assembly, "Crankshaft Position Sensor - Remove and Install" or refer to Disassembly and Assembly, "Camshaft Position Sensor - Remove and Install".</p> <p><b>B.</b> Use a flashlight in order to check the timing ring on the camshaft through the camshaft timing hole for damage.</p> <p><b>C.</b> Use a flashlight in order to check the crankshaft timing ring for damaged teeth or missing teeth. Ensure that the crankshaft timing ring has not been displaced from the crankshaft.</p>	<p>Loose timing ring or damaged teeth</p>	<p><b>Result:</b> Fault identified with the crankshaft timing ring or the timing ring on the camshaft.</p> <p><b>Repair:</b> If necessary, replace the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove" and refer to Disassembly and Assembly, "Camshaft - Install".</p> <p>If necessary, replace the crankshaft timing ring. Refer to Disassembly and Assembly, "Crankshaft Timing Ring - Remove and Install".</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault.</p> <p><b>Result:</b> No faults found.</p> <p>Repeat this procedure from Test Step 3.</p>
<p><b>5. Measure the Supply Voltage at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the speed/timing sensor with the active diagnostic code.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage from terminal 1 on the sensor connector to engine ground.</p>	<p>7.5 VDC to 8.5 VDC</p>	<p><b>Result:</b> The sensor supply voltage is not within the expected range - The fault is in the sensor supply wiring between the sensor and the ECM.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The sensor supply voltage is correct.</p> <p>Proceed to Test Step 6.</p>

(continued)

## Circuit Tests

(Table 229, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Exchange the Sensors</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Exchange the primary speed/timing sensor with the secondary speed/timing sensor. Refer to Disassembly and Assembly, "Crankshaft Position Sensor - Remove and Install" and refer to Disassembly and Assembly, "Camshaft Position Sensor - Remove and Install".</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Start the engine.</p> <p><b>E.</b> Use the electronic service tool to check for active diagnostic codes. Wait for 30 seconds in order for diagnostic codes to become active.</p>	<p>A 190-8 diagnostic code was previously active. A 723-8, or 342-8 diagnostic code is now active.</p> <p>OR</p> <p>A 723-8, or 342-8 diagnostic code was previously active. A 190-8 diagnostic code is now active.</p>	<p><b>Result:</b> The active diagnostic code is now for the other speed/timing sensor.</p> <p><b>Repair:</b> Turn the keyswitch to the OFF position.</p> <p>Disconnect the suspect sensor and remove the suspect sensor from the engine.</p> <p>Install a replacement sensor. Refer to Disassembly and Assembly, "Crankshaft Position Sensor - Remove and Install" or refer to Disassembly and Assembly, "Camshaft Position Sensor - Remove and Install".</p> <p>Turn the keyswitch to the ON position and start the engine.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The diagnostic code that was previously active is still active.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Check the Signal Wire for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector. Disconnect the connector for the suspect speed/timing sensor.</p> <p><b>C.</b> Check the resistance between terminal 2 on the harness connector for the sensor and the appropriate terminal on the P2 connector. Refer to Illustration 155 .</p>	<p>Less than two Ohms</p>	<p><b>Result:</b> The resistance is greater than two Ohms - There is an open circuit or high resistance in the signal wire.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The resistance is less than two Ohms.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Signal Wire for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector. Disconnect the connector for the suspect speed/timing sensor.</p> <p><b>C.</b> Check the resistance between the suspect sensor signal terminal and all other terminals on the P2 connector. Refer to Illustration 156 .</p>	<p>Greater than 100 Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is less than 100 Ohms. The fault is in the sensor signal wiring.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 100 Ohms.</p> <p>Proceed to Test Step 9.</p>

(continued)

(Table 229, contd)

Troubleshooting Test Steps	Values	Results
<p><b>9. Disconnect the Sensors One at a Time</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the engine speed/timing sensors one at a time. Wait 30 seconds after each sensor is disconnected. Use the electronic service tool to monitor the diagnostic codes.</p> <p><b>Note:</b> The 3512-X or 3483-X diagnostic code will become inactive when the sensor that caused the 8 VDC diagnostic code is disconnected.</p>	Diagnostic code	<p><b>Result:</b> The 3512-X or 3483-X diagnostic code is not active when all of the sensors are disconnected.</p> <p><b>Repair:</b> Replace the suspect sensor.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 3512-X or 3483-X diagnostic code is still active.</p> <p>Proceed to Test Step 10.</p>
<p><b>10. Check the 8 VDC Supply from the ECM</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 connector from the ECM.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage from J2:18 on the ECM to a suitable ground.</p>	7.5 to 8.5 VDC	<p><b>Result:</b> The 8 VDC supply voltage from the ECM is within specification. The fault is in the harness.</p> <p><b>Repair:</b> Repair the faulty connectors or replace the harness. Reconnect all sensor and ECM connectors. Ensure that all of the seals are correctly in place. Ensure that all connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 8 VDC supply voltage from the ECM is outside the specified limits.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i06167061

## Switch Circuits - Test (Multiposition Throttle Switch)

This procedure covers the following diagnostic codes:

Table 230

Diagnostic Trouble Codes for Throttle Switch			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
29-2	774-2	Accelerator Pedal Position 2 : Erratic, Intermittent or Incorrect	The Electronic Control Module (ECM) detects the following condition:
91-2	91-2	Accelerator Pedal Position 1 : Erratic, Intermittent or Incorrect	There is an invalid combination of positions for the multi-position switch.  If equipped, the warning light will come on. The ECM will log the diagnostic code.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

If the application is equipped with two throttles, the engine will use the second throttle until the fault is repaired.

If a second throttle is not installed or if the second throttle has a fault, the following conditions will occur:

- The engine will default to the limp home speed.
- If the engine speed is higher than the limp home speed, the engine will decelerate to the limp home speed.
- If the engine speed is lower than the limp home speed, the engine speed will remain at the current speed.
- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

Check that the software configuration in the ECM is correct for a multi-position throttle.

If the engine has an analog throttle with an Idle Validation Switch (IVS), then refer to Troubleshooting, "Idle Validation - Test".

The throttle switch provides the operator with the ability to select the desired engine speed. The throttle switch configuration may be selected between 0 to 4 switches. A multi-position rotary switch may be used.

The throttle switch is typically connected to the four throttle inputs of the ECM. Each position generates a specific ON/OFF pattern on the throttle inputs. A diagnostic code is generated if a pattern that does not correspond with any of the switch positions is detected.

Once a diagnostic code is generated, the ECM ignores the throttle input signals. The desired engine speed is set to low idle if no alternative throttle is detected.

Voltage at the throttle inputs to the ECM should be  $13.8 \pm 0.5$  VDC when the throttle inputs are open. The voltage should be less than 0.5 VDC when the throttle inputs are closed.

During the following procedure, refer to the electrical schematic for the application.

Complete the procedure in the order in which the steps are listed.

Table 231

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Thoroughly inspect the P1 connector and any other connectors that are included in the application for this throttle switch. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the switch connector and the ECM connector that are associated with the active diagnostic code.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the ground connection on the ECM for abrasions and pinch points.</p> <p><b>F.</b> Check the harness for abrasion and pinch points from the suspect sensor to the ECM.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check Throttle Cab Switch Position on the Electronic Service Tool</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Turn the keyswitch to the ON position.</p> <p><b>C.</b> Observe the status of the throttle switch and the throttle inputs on the electronic service tool while moving the throttle switch to each position.</p>	<p>Throttle switch status changes on the electronic service tool</p>	<p><b>Result:</b> The throttle switch is functioning correctly. If there are logged diagnostic codes for the throttle switch, the fault may be intermittent.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Electrical Connectors - Inspect" in order to identify intermittent faults.</p> <p><b>Result:</b> Record the suspect input.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Install a Jumper at the Throttle Switch Connector</b></p> <p><b>A.</b> Disconnect the connector for the throttle switch.</p> <p><b>B.</b> Observe the status of the suspect throttle input on the electronic service tool.</p> <p><b>C.</b> Connect a suitable jumper wire between terminal 1 on the throttle switch connector and the terminal for the suspect throttle input.</p> <p><b>D.</b> Observe the status of the suspect throttle input on the electronic service tool.</p> <p><b>E.</b> Remove the jumper wire.</p>	<p>Status is ON with jumper installed</p> <p>Status is OFF with jumper removed</p>	<p><b>Result:</b> The fault is in the throttle switch.</p> <p><b>Repair:</b> Install a replacement throttle switch.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The fault is not in the throttle switch.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 231, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check the Harness for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P1 ECM connector and the connector for the throttle switch.</p> <p><b>C.</b> Measure the resistance between each of the throttle switch inputs and the appropriate terminal on the P1 connector.</p> <p><b>D.</b> Measure the resistance between the return terminal on the throttle switch and the "Switch Return" terminal on the P1 connector.</p>	<p>Less than two Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is greater than two Ohms. The fault is in the wiring between the throttle switch and the P1 connector.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault.</p> <p><b>Result:</b> All resistance measurements are less than two Ohms.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Harness for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P1 ECM connector and the connector for the throttle switch.</p> <p><b>C.</b> Measure the resistance between the suspect input terminal and all other terminals on the P1 connector.</p> <p><b>D.</b> Measure the resistance between the "Switch Return" terminal and all other terminals on the P1 connector.</p>	<p>Greater than 100 Ohms</p>	<p><b>Result:</b> At least one of the resistance measurements is less than 100 Ohms. There is a short in the harness between the throttle switch connector and the P1 connector.</p> <p><b>Repair:</b> Repair the faulty wiring or replace the faulty wiring.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All resistance measurements are greater than 100 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

i07746265

## Switch Circuits - Test (Air Filter Restriction Switch)

Use the following procedure to troubleshoot a problem with a two-wire air filter restriction switch circuit. The procedure that follows also covers the diagnostic codes that are listed in Table 232 .

Table 232

Diagnostic Trouble Codes for the Air Filter Restriction Switch			
J1939 Code	PDL Code	Code Description (Code descriptions may vary)	Comments

(continued)



(Table 232, contd)

107-3	582-3	Air Filter Differential Pressure Switch voltage above normal	<p>This code indicates a fault in the circuit for the air filter restriction switch.</p> <p>The Electronic Control Module (ECM) detects the following conditions: The air filter restriction switch circuit is open for at least 1 second. The engine is not running.</p> <p>Monitoring of air filter restriction when the engine is running will be disabled whilst this code is active.</p>
107-4	582-4	Air Filter Differential Pressure Switch voltage below normal	<p>This code indicates a fault in the circuit for the air filter restriction switch.</p> <p>The Electronic Control Module (ECM) detects the following conditions: The air filter restriction switch circuit is grounded for at least 1 second. The engine is not running.</p> <p>Monitoring of air filter restriction when the engine is running will be disabled whilst this code is active.</p>

The engine is equipped with an air filter restriction switch. The type of switch that is installed is a "Normally Closed" switch.

Table 233 contains the normal engine conditions and switch states for the air filter restrictions switch.

Table 233

Diagnostic Summary for a "Normally Closed" Air Filter Restriction Switch		
Engine Condition	Switch State	Active Diagnostic Code
Not running (key on)	Closed	Normal condition
Running	Closed	Normal Condition (no air filter restriction detected)
Not running (key on)	Open	107-3 (582-3)
Running	Open	107-15 (E583-1) or 107-16 (E583-2) (air filter restriction detected)

**Note:** A 107-15 (E583-1) or a 107-16 (E583-2) diagnostic code indicates that the air inlet is restricted. Refer to Troubleshooting, "Inlet Air Is Restricted".

During the following procedure, refer to the electrical schematic for the application.

Complete the procedure in the order in which the steps are listed.

Table 234

Troubleshooting Test Steps	Values	Results
<p><b>1. Check the Air Filter Restriction Switch</b></p> <p><b>A.</b> Turn the keyswitch to OFF.</p> <p><b>B.</b> Disconnect the air filter restriction switch from the wiring harness connector.</p> <p><b>C.</b> Install a jumper wire in the wiring harness connector between the signal and ground terminals.</p> <p><b>D.</b> Turn the keyswitch to ON.</p> <p><b>E.</b> Monitor the electronic service tool for active fault codes.</p>	Diagnostic codes	<p><b>Results :</b> There is not an active 107-3 or 582-3 diagnostic code. A failed air filter restriction switch has been detected.</p> <p><b>Repair :</b> Replace the air filter restriction switch.</p> <p>Verify that the repairs eliminated the issue. Return the machine to service.</p> <p><b>Results :</b> There is an active 107-3 or 582-3 diagnostic code. An open circuit in the wiring harness has been detected.</p> <p><b>Repair :</b> Repair or replace the wiring harness.</p> <p>Verify that the repair has eliminated the issue.</p> <p>If the fault is still present, contact the Dealer Solutions Network (DSN).</p>

i06177722

## Valve Position - Test

This procedure covers the following diagnostic codes:

Table 235

Diagnostic Codes for the Valve Position Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
27-3	3407-3	EGR #1 Valve Position : Voltage Above Normal	<p>The Electronic Control Module (ECM) detects the following conditions:</p> <p>The signal voltage from the position sensor on the NOx Reduction System (NRS) valve is greater than 4.8 VDC for 0.1 seconds.</p> <p>The warning lamp will come on. The ECM will log the diagnostic code. The NRS valve will be fully closed while the code is active.</p> <p>The engine will be derated.</p>
27-4	3407-4	EGR #1 Valve Position : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the NRS valve position sensor is less than 0.2 VDC for 0.1 seconds.</p> <p>The warning lamp will come on. The ECM will log the diagnostic code. The NRS valve will be fully closed while the code is active.</p> <p>The engine will be derated.</p>

(continued)

(Table 235, contd)

Diagnostic Codes for the Valve Position Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5625-3	3513-3	Engine Exhaust Back Pressure Regulator Position : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the position sensor on the exhaust back pressure regulator is greater than 4.8 VDC for 0.1 seconds.</p> <p>The warning lamp will come on. The ECM will log the diagnostic code. The engine exhaust back pressure regulator will be fully open while the code is active.</p> <p>The engine will be derated.</p>
5625-4	3513-4	Engine Exhaust Back Pressure Regulator Position : Voltage Below Normal	<p>The ECM detects the following conditions:</p> <p>The signal voltage from the position sensor on the exhaust back pressure regulator is less than 0.2 VDC for 0.1 seconds.</p> <p>The warning lamp will come on. The ECM will log the diagnostic code. The exhaust back pressure regulator will be fully open while the code is active.</p> <p>The engine will be derated.</p>
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

The following conditions must exist before any of the preceding codes will become active:

- The ECM has been powered for at least 2 seconds.
- There are no active 168 codes.
- There are no active 3509 or 262 codes.

Use this procedure in order to troubleshoot the position sensors for the following valves:

- NRS valve
- Exhaust back pressure regulator

Each position sensor is integral in the associated valve. If the following procedure indicates a fault with the position sensor, then the entire valve must be replaced.

**The following background information is related to this procedure:**

The troubleshooting procedures for the diagnostic codes of each position sensor are identical. The 5 VDC sensor supply provides power to all 5 VDC sensors. The ECM supplies 5.0 VDC to terminal "1" of both valve connectors. The sensor common from the ECM connector goes to terminal "2" of both valve connectors. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM. The signal voltage from terminal "3" of both valves is supplied to the appropriate terminal at the P2 ECM connector.

**Pull-up Voltage**

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage in order to detect an open in the signal circuit. When the ECM detects a voltage above a threshold, the ECM generates an open circuit diagnostic code (XXXX-3).

If the sensor is disconnected, pull-up voltage indicates that the wires are not open or shorted to ground. The absence of pull-up voltage indicates an open in the signal wire or a short to ground. If the voltage is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

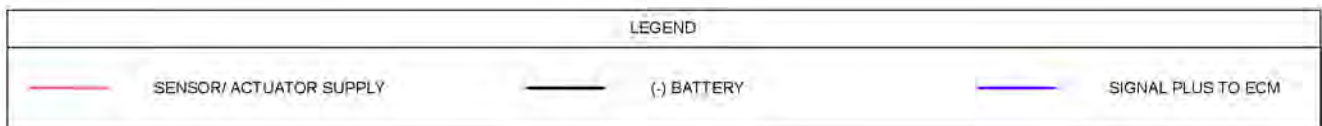
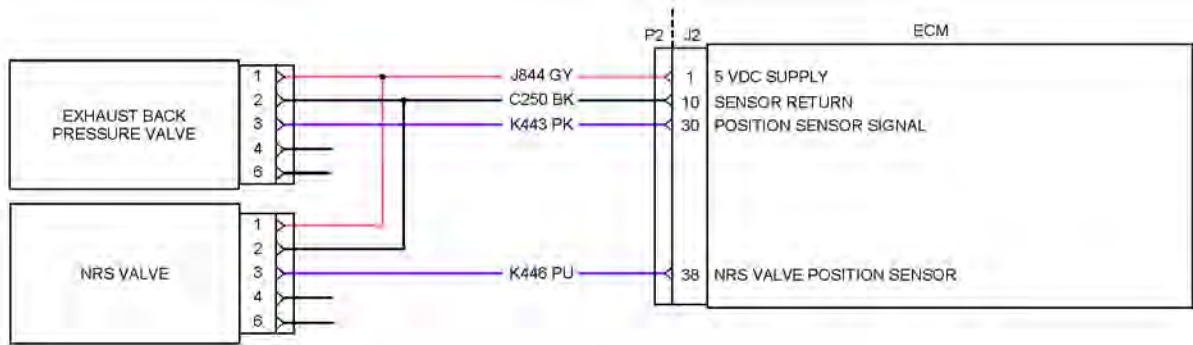


Illustration 157

g03812374

Schematic diagram for the valve position sensors

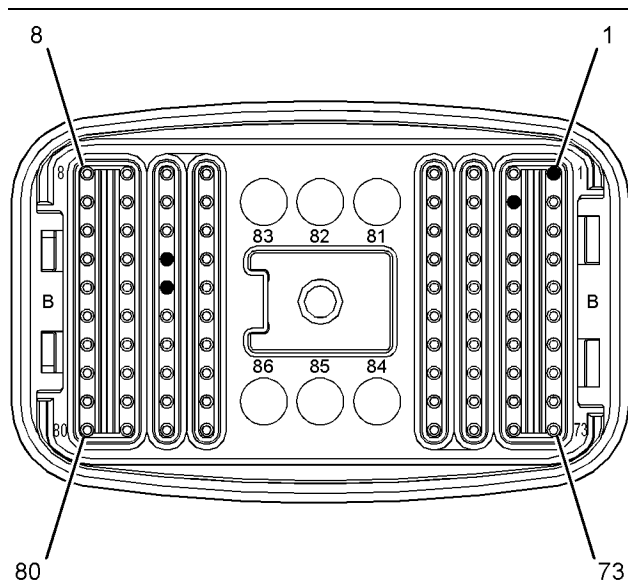


Illustration 158

g03812375

Pin locations on the P2 connector for the valve position sensors

- (1) Valve position sensor 5 VDC supply
- (10) Valve position sensors ground
- (30) Combustion air valve position sensor signal
- (38) NRS valve position sensor signal

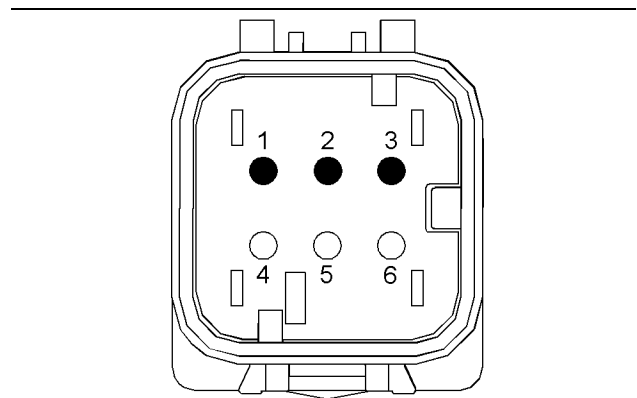


Illustration 159

g03177615

Connector for the NRS valve

- (1) 5 VDC supply
- (2) Position sensor ground
- (3) Position sensor signal

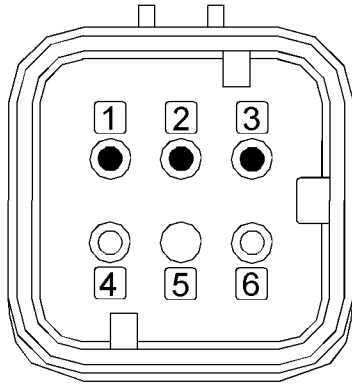


Illustration 160

g03177636

**Connector for the exhaust back pressure regulator**

- (1) 5 VDC supply
- (2) Position sensor ground
- (3) Position sensor signal

Complete the procedure in the order in which the steps are listed.

Table 236

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Inspect the connectors for the valve position sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires in the suspect sensor connector and the sensor connections at the ECM.</p> <p><b>D.</b> Check the screw for the J2 ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the ground connection on the ECM for abrasions and pinch points.</p> <p><b>F.</b> Check the harness for abrasion and pinch points from the suspect sensor to the ECM.</p>	Loose connection or damaged wire	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all of the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check For Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes.</p> <p><b>D.</b> Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	Diagnostic codes	<p><b>Result:</b> One or more of the preceding diagnostic codes are active or recently logged.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> None of the preceding diagnostic codes are active or recently logged.</p> <p><b>Repair:</b> The fault may be intermittent. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p>Perform a "Wiggle Test" by using the electronic service tool in order to identify intermittent connections.</p>
<p><b>3. Measure the Supply Voltage at the Valve Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the suspect valve from the harness.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage between terminals 1 and 2 at the connector for the valve.</p> <p><b>E.</b> Reconnect the valve to the harness.</p>	4.84 to 5.16 VDC	<p><b>Result:</b> The sensor supply voltage is out of the nominal range. The fault is in the engine harness between the valve connector and the ECM.</p> <p><b>Repair:</b> Repair the faulty valve connector or replace the faulty harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The sensor supply voltage is correct.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 236, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Verify that the Diagnostic Code is Still Active</b></p> <p><b>A.</b> Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes.</p> <p><b>B.</b> Use the electronic service tool to check for active diagnostic codes. Record all active diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> An XXXX-4 diagnostic code is active at this time.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> An XXXX-3 diagnostic code is active at this time.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> No diagnostic codes are active at this time. An intermittent fault may exist.</p> <p><b>Repair:</b> Use the electronic service tool to perform a "Wiggle Test" . If faults are indicated, then go to the appropriate procedure.</p>
<p><b>5. Create an Open Circuit at the Valve Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the valve with the XXXX-4 diagnostic code.</p> <p><b>C.</b> Remove the wire for the position sensor signal from the harness connector for the valve.</p> <p><b>D.</b> Reconnect the connector for the valve.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Wait for at least 10 seconds for activation of the diagnostic codes.</p> <p><b>F.</b> Use the electronic service tool to check the "Active Diagnostic Code" screen. Check for an XXXX-3 diagnostic code.</p> <p><b>G.</b> Turn the keyswitch to the OFF position.</p>	<p>Open circuit</p>	<p><b>Result:</b> An XXXX-4 diagnostic code was active before removing the signal wire. An XXXX-3 diagnostic code became active after removing the signal wire.</p> <p><b>Repair:</b> Disconnect the connector for the valve.</p> <p>Reconnect the signal wire for the position sensor. Reconnect the connector for the valve.</p> <p>Turn the keyswitch to the ON position. Use the electronic service tool to check for active diagnostic codes. If the XXXX-4 diagnostic code returns, there is a short in the valve.</p> <p>Install a replacement valve. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> There is still an XXXX-4 diagnostic code active with the signal wire removed. The valve position sensor is OK.</p> <p><b>Repair:</b> Return all wires to the original configuration. Proceed to Test Step 6.</p>

(continued)

## Circuit Tests

(Table 236, contd)

Troubleshooting Test Steps	Values	Results
<p><b>6. Check the Harness for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 ECM connector and the connector for the suspect valve.</p> <p><b>C.</b> For a suspect NRS valve position sensor, measure the resistance between P2:38 and all other terminals on P2.</p> <p><b>D.</b> For a suspect EBPR position sensor, measure the resistance between P2:30 and all other terminals on P2.</p> <p><b>E.</b> Install the removed connectors.</p>	Greater than 100 Ohms	<p><b>Result:</b> The measured resistance is less than 100 Ohms. There is a short circuit in the harness.</p> <p><b>Repair:</b> Repair the valve connector or replace the harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is greater than 100 Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>
<p><b>7. Create a Short Circuit at the Valve Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the valve with the XXXX-3 diagnostic code.</p> <p><b>C.</b> Fabricate a jumper wire that is 150 mm (6 inch) long.</p> <p><b>D.</b> Insert one end of the jumper wire into terminal 3 on the harness connector for the suspect valve. Insert the other end of the jumper into terminal 2.</p> <p><b>E.</b> Turn the keyswitch to the ON position.</p> <p><b>F.</b> Access the "Active Diagnostic Codes" screen on the electronic service tool and check for an active XXXX-4 diagnostic code for the suspect sensor.</p> <p><b>G.</b> Remove the jumper.</p>	Less than two Ohms	<p><b>Result:</b> An XXXX-3 diagnostic code was active before the jumper was installed. An XXXX-4 diagnostic code is active when the jumper is installed.</p> <p><b>Repair:</b> Reconnect the connector for the suspect valve.</p> <p>Turn the keyswitch to the ON position. Use the electronic service tool to check for active diagnostic codes. If the XXXX-3 diagnostic code returns, there is an open circuit in the valve. Install a replacement valve. Refer to Disassembly and Assembly for the correct procedure.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> An XXXX-3 diagnostic code remains active when the jumper is installed. The valve is OK.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Wiring Harness for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the P2 ECM connector and the connector for the suspect valve.</p> <p><b>C.</b> For a suspect NRS valve, check the resistance between terminal 3 on the valve connector and P2:38.</p> <p><b>D.</b> For a suspect exhaust back pressure regulator, check the resistance between terminal 3 on the valve connector and P2:30.</p> <p><b>E.</b> Install the removed connectors.</p>	Less than two Ohms	<p><b>Result:</b> The measured resistance is greater than two Ohms. There is an open circuit in the harness.</p> <p><b>Repair:</b> Repair the valve connector or replace the harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is less than two Ohms.</p> <p>Contact the Dealer Solutions Network (DSN).</p>



i07907488

## Water in Fuel - Test

For a 97-15 or 97-16 code, refer to Troubleshooting, "Fuel Contains Water" before returning to this procedure.

Use this procedure when the water-in-fuel sensor is suspect. This procedure also covers the following diagnostic code:

Table 237

Diagnostic Trouble Code for the Water-in-Fuel Sensor			
J1939 Code	PDL code	Code Description (code descriptions may vary)	Comments
97-3	3547-3	Water In Fuel Indicator : Voltage Above Normal	<p>The ECM detects the following conditions:</p> <p>An open circuit in the Water-In-Fuel (WIF) sensor circuit.</p> <p>The ECM has been powered for less than 5 seconds.</p> <p>The warning lamp will stay on when the "indicator lamp self check" has been completed. The ECM will disable the function to detect water in fuel while the code is active.</p>

### Water-in-Fuel Sensor Operation

The WIF sensor is a normally open sensor. During normal operation, there will be no signal sent from the WIF sensor to the ECM. If water is detected in the fuel, the sensor will send a signal to the ECM. If the signal remains constant for 45 seconds, a 97-15 (E232-1) diagnostic code will become active. If the signal remains constant for 1 hour, a 97-16 (E232-2) diagnostic code will become active. These diagnostic codes can also be caused by a short in the WIF sensor circuit.

### Water-in-Fuel Sensor Self Check

When the ignition keyswitch is turned to the ON position, the switch in the WIF sensor will close for 5 seconds. If the ECM does not detect a signal from the WIF sensor during this period, a 97-3 (3547-3) diagnostic code will become active.

Table 238

Troubleshooting Test Steps	Values	Results
<p><b>1. Inspect Electrical Connectors and Wiring</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Thoroughly inspect the connector for the WIF sensor and the P1/J1 ECM connector. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p> <p><b>C.</b> Perform a 45 N (10 lb) pull test on each of the wires that are associated with the WIF sensor.</p> <p><b>D.</b> Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in).</p> <p><b>E.</b> Check the harness for abrasions, for pinch points, and for corrosion.</p>	<p>Loose connection or damaged wire</p>	<p><b>Result:</b> There is a fault in a connector or the wiring.</p> <p><b>Repair:</b> Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check For Active Diagnostic Codes</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. If the engine will start, then run the engine.</p> <p><b>D.</b> Wait for at least 1 minute.</p> <p><b>E.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.</p>	<p>Diagnostic codes</p>	<p><b>Result:</b> There are no active diagnostic codes for the WIF sensor.</p> <p>There may be an intermittent fault.</p> <p><b>Repair:</b> Refer to Troubleshooting, "Electrical Connectors - Inspect" to identify intermittent faults.</p> <p><b>Result:</b> A 97-15 (E232 (1)) or 97-16 (E232 (2)) diagnostic code is active.</p> <p>Refer to Troubleshooting, "Fuel Contains Water" before continuing with this procedure.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> A 97-3 (3547-3) diagnostic code is active.</p> <p>Proceed to Test Step 3.</p>
<p><b>3. Check the Supply Voltage at the Sensor Connector</b></p> <p><b>Note:</b> Refer to the Electrical Schematic for the application to determine the sensor supply voltage.</p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the WIF sensor connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Measure the voltage between the sensor supply and sensor return terminals on the harness connector for the WIF sensor.</p> <p><b>E.</b> Turn the keyswitch to the OFF position.</p>	<p>Between 11 VDC and 13 VDC for a 12 VDC system.</p> <p>Between 22 VDC and 26 VDC for a 24 VDC system.</p> <p>Between 7.5 VDC and 8.5 VDC for an 8 VDC supply</p>	<p><b>Result:</b> The voltage is not within the expected range. The fault is in the sensor supply wire or the return wire.</p> <p><b>Repair:</b> Repair the faulty sensor connector or replace the faulty harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The voltage is within the expected range.</p> <p>Reconnect the WIF sensor to the harness. Proceed to Test Step 4.</p>

(continued)

(Table 238, contd)

Troubleshooting Test Steps	Values	Results
<p><b>4. Check that the Diagnostic Code is Still Active</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>C.</b> Turn the keyswitch to the ON position. Wait for at least 1 minute.</p> <p><b>D.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.</p>	Diagnostic code	<p><b>Result:</b> A 97-3 (3547-3) diagnostic code is active.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> A 97-15 (E232 (1)) diagnostic code is active.</p> <p>Proceed to Test Step 7.</p> <p><b>Result:</b> No diagnostic code is active.</p> <p>Return the unit to service.</p>
<p><b>5. Create a Short Circuit at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the WIF sensor from the harness.</p> <p><b>C.</b> Fabricate a jumper wire that is 150 mm (6 inch) long.</p> <p><b>D.</b> Use the jumper to connect the sensor signal terminal to the sensor return terminal on the harness connector for the WIF sensor.</p> <p><b>E.</b> Turn the keyswitch to the ON position. Wait for at least 1 minute.</p> <p><b>F.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.</p>	Open circuit	<p><b>Result:</b> A 97-3 (3547-3) diagnostic code was active before installing the jumper. A 97-15 (E232 (1)) code was active with the jumper installed. There is an open circuit in the WIF sensor.</p> <p><b>Repair:</b> Install a replacement sensor. Refer to Disassembly and Assembly, "Water Separator and Fuel Filter (Primary) - Remove and Install" for the correct procedure.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> There is still an active 97-3 (3547-3) diagnostic code with the jumper installed. The sensor is OK.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Harness for an Open Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the connector for the water-in-fuel sensor and P1 connector.</p> <p><b>C.</b> Use a multimeter to check the resistance of the sensor signal wiring between the sensor connector and the P1 connector.</p> <p><b>Note:</b> Refer to the Electrical Schematic for the application for the correct terminals.</p> <p><b>D.</b> Install the removed connectors.</p>	Less than 2 Ohms.	<p><b>Result:</b> The measured resistances are greater than 2 Ohms. There is an open circuit in the harness.</p> <p><b>Repair:</b> Repair the sensor connector or replace the harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is less than 2 Ohms. There may be a short circuit in the harness.</p> <p>Proceed to Test Step 7.</p>

(continued)

## Circuit Tests

(Table 238, contd)

Troubleshooting Test Steps	Values	Results
<p><b>7. Create an Open Circuit at the Sensor Connector</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the WIF sensor from the harness.</p> <p><b>C.</b> Turn the keyswitch to the ON position.</p> <p><b>D.</b> Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.</p>	Short circuit	<p><b>Result:</b> A 97-15 (E232 (1)) diagnostic code is active with the WIF sensor connected. A 97-3 (3547-3) diagnostic code was active after disconnecting the WIF sensor. There is a short in the WIF sensor.</p> <p>Install a replacement sensor. Refer to Disassembly and Assembly, "Water Separator and Fuel Filter (Primary) - Remove and Install" for the correct procedure.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The 97-15 (E232(1)) diagnostic code is still active with the WIF sensor disconnected. The WIF sensor is OK.</p> <p>Proceed to Test Step 8.</p>
<p><b>8. Check the Harness for a Short Circuit</b></p> <p><b>A.</b> Turn the keyswitch to the OFF position.</p> <p><b>B.</b> Disconnect the WIF sensor from the harness. Disconnect the P1 connector.</p> <p><b>C.</b> Use a multimeter to measure the resistance between the WIF sensor signal terminal on the P1 connector and all other terminals on P1.</p> <p><b>D.</b> Reconnect the WIF sensor to the harness. Reconnect the P1 connector.</p>	Greater than 100 Ohms	<p><b>Result:</b> The measured resistances are less than 100 Ohms. There is a short in the harness.</p> <p><b>Repair:</b> Repair the faulty sensor connector or replace the faulty harness.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.</p> <p><b>Result:</b> The measured resistance is greater than 100 Ohms. There is a fault in the ECM.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

## Service

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### Service Tool Features

**Note:** With the release of Tier 4 Final engines, more emissions control system components have been added to the engine to reduce the NOx output. The addition of these components requires two Electronic Control Modules (ECMs) for the engine and aftertreatment systems to operate. The most recent version of the electronic service tool must be used when connecting to the ECMs. Refer to Troubleshooting, “Electronic Service Tools” for instructions on correctly setting up the computer and the adapter for use on Tier 4 applications.

### Override Parameters

The override parameters screen has multiple overrides. The parameters control various functions on the engine and the aftertreatment. These functions and features allow the technician to troubleshoot different engine systems.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate for the required override.

### Override Parameters Listed in the Engine ECM Menu

#### Aftertreatment #1 Intake NOx Level Sensor Power Supply Override

This override can be used during troubleshooting to reset the SCR intake NOx sensor without having to cycle key power to the Engine ECM.

#### Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply Override

This override can be used during troubleshooting to reset the SCR Outlet NOx Sensor without having to cycle key power to the Engine ECM.

#### Aftertreatment #1 DEF Dosing Control Module Key Switch Line

This override resets the Dosing Control Unit (DCU) without having to cycle key power to the other ECM's. The reset ensures that the DCU completes a purge cycle, resets any active codes, and shuts down correctly.

This test turns off the key switch power from the engine ECM to the DCU for approximately 2 minutes. Once the DCU has successfully powered down and reset, the key switch power supply will be turned back on. The DCU will then be operational.

### Engine Fan Bypass

This override is used to turn ON the engine fan, if equipped. The override can be used to test the engine fan operation. The engine fan speed is entered as a percent of full speed, allowing the user to operate the fan at different speeds.

### Engine Fuel Supply Lift Pump Relay Override

This override is used to energize the Electric Fuel Lift Pump (EFLP) relay. The override can be used to test the EFLP relay only when engine speed is zero. The EFLP relay is switched to either ON or OFF.

### Engine Shutdown Lamp

This override provides the facility to test the electrical circuit for the Engine Shutdown Lamp. The override commands the Engine Shutdown Lamp on.

### Ether Starting Aid Override

This override is used to confirm the correct operation of the ether system. Remove the ether canister from the system before testing the ether injection system. Refer to Troubleshooting, “Ether Starting Aid - Test”. The override requires that engine speed must be zero. The override will be unavailable for a short duration if glow plugs are active.

### Glow Plug Starting Aid Override

This override is used to check that the glow plugs are functioning correctly. The override requires that engine speed must be zero. The override will be unavailable for a short duration if ether injection is active.

### Override Parameters Listed in the Diesel Exhaust Fluid Controller (DCU) Menu

#### DEF Coolant Diverter Valve Solenoid Override

This override is used to check the electrical operation of the coolant diverter valve solenoid. This override will open the coolant diverter valve. This override allows coolant to flow through the PEU assembly. This test can be used to verify that the coolant diverter valve is working correctly.

Unless the function is disabled, the override will remain enabled for 5 minutes.

## DEF Dosing Injector Override

This override is used to check the solenoid operation of the DEF Dosing Injector. The test verifies that the injector opens and closes correctly.

This test is only available when no engine speed is present.

Unless the function is disabled, the override will remain enabled for 5 minutes.

## DEF Dosing Pump Motor Override

This override is used to check the operation of the DEF Dosing Pump Motor. The override will supply current to the motor. This test verifies that the pump motor is working correctly.

This test is only available when no engine speed is present.

Unless the function is disabled, the override will remain enabled for 5 minutes.

**Note:** This override will only test the reverse (purge) function of the pump motor. Forward motion is not available.

## Line Heaters 1, 2 and 3

These overrides are used to check the electrical operation of the individual line heaters. This test can be used to verify that each line heater is working correctly.

Unless the function is disabled, the override will remain enabled for 5 minutes.

## System Troubleshooting Settings

The "System Troubleshooting Settings" screen will allow overrides to be enabled.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate for the required override.

## System Troubleshooting Settings Listed in the Engine ECM Menu

### Engine Emissions Operator Inducement Service Mode Override

The override is used by service technicians to stop the inducement counter and disable engine restrictions due to inducement to troubleshoot. Once the override is activated, the operator can navigate to other functions in the electronic service tool.

Factory passwords are required to perform this override as the engine will be operating outside of the emissions window.

## Injector Disable Override

This override will allow the user to disable the injectors from activating when performing certain troubleshooting procedures.

## SCR Thermal Management Active Override

This override will disable SCR thermal management (HC dosing) whilst performing certain troubleshooting procedures. Once the override is activated, the operator can navigate to other functions in the electronic service tool.

## Active Diagnostic Codes

The purpose of this screen is to show all the active diagnostic codes.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate.

Select the "Diagnostics" tab.

Select the "Active Diagnostic Codes" tab.

## Tab Functions At Bottom of Screen

### Reset All

This tab will reset all the active codes.

### Troubleshoot Code

This tab is not available for Tier 4 engines. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

### Troubleshoot Symptom

This tab is not available for Tier 4 engines. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

## Logged Diagnostic Codes

The purpose of this screen is to show all the logged diagnostic codes.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate.

Select the "Diagnostics" tab.

Select the "Logged Diagnostic Codes" tab.

## Tab Functions At Bottom of Screen

### Clear

This tab will clear specific codes when highlighted.

### Clear All

This tab will clear all logged diagnostic codes.

### Troubleshoot Code

This tab is not available for Tier 4 engines. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

### Troubleshoot Symptom

This tab is not available for Tier 4 engines. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

### Active Event Codes

The purpose of this screen is to show all the active event codes.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate.

Select the "Diagnostics" tab.

Select the "Events" tab.

## Tab Function At Bottom of Screen

### Reset All

This tab will reset all the active codes. Some of the event codes "latch" to active status. Repairing the system does not "unlatch" the event codes and the event codes must be reset with the electronic service tool.

### Logged Event Codes

The purpose of this screen is to show all the logged event codes.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate.

Select the "Diagnostics" tab.

Select the "Events" tab.

Select the "Logged Events" tab.

## Tab Functions At Bottom of Screen

### Clear

This tab will clear specific codes when highlighted.

### Clear All

This tab will clear all logged diagnostic codes.

### Troubleshoot Code

This tab is not available for Tier 4 engines. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

### Troubleshoot Symptom

This tab is not available for Tier 4 engines. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

### Diagnostic Tests

Electronic service tool diagnostic tests are listed below.

In the electronic service tool, select the engine ECM or the Diesel Exhaust Fluid Controller (DCU) as appropriate.

Select the "Diagnostics" tab.

Select the "Diagnostic Tests" tab.

## Diagnostic Tests Listed in the Engine ECM Menu

### Injector Solenoid Test

The purpose of the injector solenoid test is to diagnose injector wiring and injector solenoid functionality.

This test identifies an open circuit or a short circuit in the circuit for the injector solenoids. The test activates the injector solenoids one at a time when the engine is not running. A good solenoid will create an audible click when the solenoid is activated. The electronic service tool indicates the status of the solenoid as "OK", "Open", or "Short".

The injectors must be powered to enable the automatic test to be run. To start the test, select the "Start" button. The automatic test will continually cycle through the injectors until the "Stop" button is selected.

There are no test results if the "Change" button is selected to power or cutout an individual injector. When selected, the "Power All" and "Cutout All" buttons do not give test results.

## Cylinder Cutout Test

The cylinder cutout test allows one cylinder or multiple cylinders to be cut out. The cylinder cutout test is useful when troubleshooting poor engine performance or a suspected injector failure

The process involves cutting out power and restoring power to a selected cylinder. The remaining powered cylinders are then monitored for expected increases in delivered fuel volume. If the fuel volume does not increase, the cylinder that was not powered was not working prior to being cut out for the test.

A cylinder that is not working means that the power produced by that cylinder is comparatively less than the other cylinders. This fault can have numerous root causes relating to the cylinder including the injector, valves, and piston.

The cylinder cutout test can be performed on one injector or multiple injectors at once. This function provides a way to identify misfiring cylinders when the engine is running.

## Wiggle Test

The purpose of the Wiggle Test is to detect intermittent electrical faults in electronic control systems. The Wiggle Test function allows the user to determine if there is an intermittent wiring fault. The test will indicate (by changing the value reading) which parameter moved beyond a predetermined range when wiggling the wiring harness, sensor, or connector.

This test requires that the engine is OFF and the key switch is in the ON position (or ECM energized and 0 engine speed). If the engine is started with the wiggle test active, the wiggle test will abort.

The Wiggle Test will reduce all ECM requirements to trip fault codes, making the diagnostics sensitive. Under normal operation some fault codes need multiple occurrences before the code will log. But during this test the fault codes will trip the first time.

The technician must wiggle and shake the wiring to check if codes go active. If any parameter changes state electrically, an audible alarm is also activated. Once the test has ended, the ECM returns to normal diagnostic trip requirements.

## DPF Soot Loading Sensor Functional Test

**Note:** This test is only applicable to engines that have a DPF in the aftertreatment system.

This test is used to determine if the mean soot level is within range.

## Fuel Rail Pressure Relief Valve Test

The purpose of this test is check that the opening pressure for the pressure relief valve is above 220 MPa (31900 psi). The engine speed is automatically increased above a minimum threshold when this test is run. The rail pressure is then increased to 220 MPa (31900 psi). After a short time, the rail pressure is reduced to normal.

## Fuel Rail Pressure Test

The purpose of this test is to check the integrity of the high-pressure fuel system after work has been completed. The test can also help with troubleshooting general fuel system-related issues.

The engine speed is automatically increased above a minimum threshold when this test is run. The rail pressure is increased to 220 MPa (31900 psi) and held at this pressure for a time. The rail pressure is then reduced to normal. If the check is for system integrity after work, the engine must be stopped before inspecting the high-pressure fuel system for fuel leaks. If the reason for the test is troubleshooting general fuel system-related issues, check for error codes. Any error codes that occur during the test should be used to provide guidance for troubleshooting.

## Aftertreatment Regeneration System Test

**Note:** This test is only applicable to engines that have a DPF in the aftertreatment system.

### WARNING

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This test must be run with the engine running but not under load. The engine must reach a minimum coolant temperature. Once the conditions are met, engine speed and load must be reduced to the minimum level that can be achieved with the engine/equipment configuration.

The ECM software performs the necessary checks to ensure that the test runs under the required conditions. If the test aborts before completion, the electronic service tool displays any relevant error identifiers.

The following conditions must be met before the Aftertreatment Regeneration System Test can begin:

- No related active diagnostic codes
- Coolant at the minimum required temperature
- Engine speed and load in the required range



The ECM will gradually close the Exhaust Back Pressure Regulator (EBPR) to establish a desired cylinder head pressure differential. If the target pressure differential is not achieved, an error identifier will be displayed, indicating that the EGR intake pressure is not responding.

If the pressure differential is achieved, the test will wait for the DPF intake temperature to stabilize. The test will then check if the DPF intake temperature is above a minimum threshold. If the minimum temperature threshold is not met, an error identifier will be displayed to indicate that the DPF intake temperature is too low.

### Aftertreatment Regeneration System Test

**Note:** This test is only applicable to engines that do not have a DPF in the aftertreatment system.

#### **WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This test must be run with the engine running and the machine/engine out of a working mode. The engine must be warmed up to a minimum coolant temperature. Once the coolant temperature conditions are met, a pop-up screen will advise that the engine speed will be automatically increased after the warning is accepted.

Once the pre-conditions are met (no relevant active diagnostics, coolant temp condition met, elevated speed in range), the system test will begin. The EBPR valve control logic will determine the appropriate desired cylinder head pressure differential. This determination is reached with a dedicated fueling and injection timing calibration and should result in the target SCR intake temperature being met. The test will then wait for the SCR intake temperature to rise above a minimum pass threshold. If the minimum temperature threshold is not met, an error ID will be displayed indicating "SCR Intake Temperature Too Low" .

### Air System Motor Valves Verification Test

The Air System Motor Valve Verification Test will identify whether the EGR valve, and the EBPR are working correctly. This test must be run when the engine speed is zero and the battery voltage is within an acceptable range. For a 12VDC system, the service test must only be executed if the battery voltage is between 9VDC and 16VDC. For a 24VDC system, the battery voltage must be between 18VDC and 32VDC. If the battery voltage is outside of these ranges at any time, the test must be aborted. The test will also be aborted if a position sensor diagnostic, a motor short diagnostic, or a motor open circuit diagnostic become active.

If at any point during the test the engine speed is not zero, the test will abort. The test moves the valves to various positions and then checks the position sensor within each valve to confirm that the valve has responded correctly. Each valve will be tested in turn, starting with the EGR valve. If a test threshold is exceeded or any related diagnostics become active, the test will abort and generate an error identifier.

### Aftertreatment System Functional Test

This test is used to verify that the SCR System is functioning correctly. The EBPR and elevated engine speed are used to increase the exhaust gas temperature. The higher temperature allows the NOx sensors and SCR system to control active DEF dosing.

#### **WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

When the NOx sensors are ready for use, the sensors control DEF dosing and check that the NOx conversion efficiency meets the test target value.

The following conditions must be met for the test to start:

- Coolant at the minimum required temperature
- DEF at the minimum required temperature
- Exhaust gas at the minimum required temperature
- Sufficient DEF in the tank
- No related active diagnostic codes
- Engine speed and load in the required range

**Note:** On certain applications and in low ambient temperatures, a portion of the radiator may need to be blocked to increase engine temperatures to a safe level for the test to complete.

Once the target SCR inlet temperature has been achieved and the NO<sub>x</sub> conversion level has been met, the test will complete successfully.

If a related diagnostic code is generated during the test, the test will be aborted.

If the test times out with no active codes and NO<sub>x</sub> conversion test criteria is not met, a low NO<sub>x</sub> conversion error identifier is logged.

If certain DCU faults are active, the test will cycle power to the DCU in an attempt to clear these faults before continuing the test.

If an active low DEF concentration event or low NO<sub>x</sub> conversion ratio event is present, the test will be modified. This mode will request that DEF dosing be reduced to a minimum to remove all stored ammonia in the catalyst. The test will then attempt to clear the NO<sub>x</sub> conversion and DEF concentration events in an abbreviated time period. If the events are cleared, the test will complete successfully. If the events are still active, the test will fail after a timeout period.

## Manual Hydrocarbon Dosing Capability Test

### **WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This test is used to check the HC dosing process. Periodic HC dosing elevates the exhaust gas temperature to clean the SCR system so that acceptable NO<sub>x</sub> conversion is maintained. The test checks that HC dosing raises the SCR intake temperature to the correct level.

The test must be performed at low engine speed and low load. The test will only start when all the following criteria are met:

- The engine is running
- Coolant at the minimum required temperature
- No active diagnostic codes

The test will initially use the EBPR to increase the DOC intake temperature. When the target DOC inlet temperature is reached, HC dosing will begin and the initial temperature rise across the DOC is assessed. If the temperature rise is insufficient, the EBPR will be used to raise the DOC intake temperature further. If the required temperature rise is achieved, HC dosing will increase until the DPF intake temperature reaches approximately 475° C (887° F). If the target temperature is achieved, HC dosing continues until the SCR intake temperature reaches 475° C (887° F). If the target SCR intake temperature is achieved, the test will end successfully.

## Diagnostic Tests Listed in the Diesel Exhaust Fluid Controller Menu

### DEF Dosing System Purge Test

This test verifies that the DEF purging process is working correctly by purging the DEF pump and lines.

The DEF System places the pump into reverse operation. The DEF is pumped from the injector back into the tank. This process de-pressurizes the system and empties the DEF lines prior to maintenance being performed.

### DEF Dosing System Accuracy Test

This test is used to measure the amount of DEF that the dosing system is spraying into the exhaust system. The test can also be used to verify that there is an acceptable spray pattern from the DEF Injector.

**Note:** The DEF injector must be removed from the exhaust system during this test and placed in an appropriate container. Failure to do so could result in issues with the SCR system operation.

This test turns on the DEF pump and injects DEF for 6 minutes. The DEF injector atomizes the DEF and the spray pattern must be uniform in order for the SCR system to work properly. Once the test completes, the DEF pump purges the system. The amount of DEF in the container must be checked to see if the mass meets the specification.

The dosing rate is 0.33 g/s (0.012 oz/s) over a period of 6 minutes. The amount of DEF collected must be within 105 mL (3.57 fl oz) and 130 mL (4.42 fl oz).

### DEF Dosing System Verification Test

This test primes the dosing system to the required pressure for dosing. The test checks that the DEF pump is able to build adequate pressure and ensure that there are no leaks in the system.

This test will maintain dosing pressure for 10 minutes after priming. During this time, the DEF pump will pressurize the entire DEF dosing system. The DEF injector will remain closed to maintain a constant pressure within the dosing system. The DEF pump will purge the system at the end of the test.

Diesel Exhaust Fluid (DEF) temperatures can reach 65° to 70°C (149° to 158°F) during normal engine operation. Stop the engine. Wait for 15 minutes to allow the DEF system to be purged and the DEF to cool before service or repair is performed.

## Calibrations

Electronic service tool calibration procedures are listed below.

In the electronic service tool, select the engine ECM.

Select the “Service” tab.

Select the “Calibrations” tab.

## Calibrations Listed in the Engine ECM Menu

### Injector Codes Calibration

Whenever a fuel injector is replaced, the injector fuel delivery must be trimmed. Trimming the injector calibrates all the injectors to deliver the same amount of fuel. The Injector Codes Calibration allows the injector trim code information to be programmed into the ECM. After the injector is calibrated, the calibration data is checked for validity.

When new injectors are installed, the trim code for each injector must be entered using the electronic service tool. Refer to Troubleshooting, Injector Code - Calibrate for the correct procedure.

### High-Pressure Fuel Pump Calibration

High-pressure fuel pump calibration is used to perform a pump calibration manually. In normal operation, this calibration procedure will occur automatically. The calibration must be performed only as instructed during troubleshooting procedures. The pump calibration is used to optimize the dynamic characteristics of the rail pressure control. If there are issues with overshooting or undershooting the desired rail pressure, a pump calibration will improve the rail pressure control.

## Dyno Mode

In the electronic service tool, select the engine ECM.

Select the “Service” tab.

Select the “Dyno Mode” tab.

## Dyno Mode

When the engine is installed in a machine, the engine ECM receives inputs from various machine components, such as the transmission ECM or machine ECM. If the ECM does not see the inputs, the ECM assumes that something is wrong and sets a diagnostic trouble code.

Dyno Mode is used to run an engine on a dynamometer without derates or diagnostic trouble codes tripping from missing inputs. Dyno Mode does not require the CEM to be installed.

## Service Procedures

Electronic service tool service procedures are listed below.

In the electronic service tool, select the engine ECM.

Select the “Service” tab.

Select the “Service Procedures” tab.

## Service Procedures Listed in the Engine ECM Menu

### Aftertreatment Recovery Procedure (DPF Engines Only)

**Note:** This procedure is only applicable to engines that have a DPF in the aftertreatment system.

#### **WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This procedure is used specifically for engines which require periodic HC dosing to clean the SCR system. The test is performed at elevated temperatures so that acceptable NOx conversion is maintained. The purpose of the procedure is to recover performance of the complete aftertreatment system.

The ECM software will perform the necessary checks to ensure that the procedure runs under the required conditions. The checks will generate any relevant error identifiers if the procedure aborts before completion.

The following engine conditions must be met before the procedure will start:

- No related active diagnostic codes
- Coolant temperature condition met
- Engine speed and load in the required range

An EBPR check is performed by the service test before starting the regeneration process.

If an EBPR issue is present, the procedure will abort and an error identifier will be generated.

The procedure assesses the DPF soot load. If soot loading is too high to allow HC Dosing, the procedure will use elevated idle and the EBPR to reduce the soot load. The procedure will target a desulfation-specific desired cylinder head pressure differential. The procedure waits for several seconds before taking an average of the measured pressure differential. If the target is not met, an error identifier will be displayed, indicating EGR intake pressure is not responding.

If the pressure differential check passes, the procedure checks that the DPF intake temperature is above a minimum pass threshold. If the minimum temperature threshold is not met, an error identifier is displayed, indicating that the DPF intake temperature is too low. Once the system verification steps are complete, the procedure will continue to run for a set time to desulfate the DPF.

If the soot load is reduced sufficiently, the procedure assesses whether the system can generate the required SCR intake temperature. This temperature is required to remove any urea or sulfur from the aftertreatment. A higher DOC intake temperature than normal is targeted to ensure that light-off occurs the first time.

If the DOC intake temperature is reached, HC dosing will be initiated automatically. The procedure will check for adequate heat rise across the DOC during the HC dosing ignition phase. If the temperature rise is not sufficient, the procedure will perform the DPF desulfation procedure before attempting HC Dosing again. If the DOC fails to ignite again, the procedure will abort with an error identifier.

**Note:** If DPF desulfation had been previously performed due to high soot load, the test will abort immediately with an error identifier. HC dosing will not be attempted.

If the heat rise target is achieved, the procedure will continue to increase the amount of HC dosing. HC dosing increases until the DPF intake temperature stabilizes at the target value of approximately 475° C (887° F).

If this part of the procedure is successful, HC dosing will continue until the required SCR intake temperature of 475° C (887° F) is achieved. The procedure then maintains this temperature for a set time to remove sulfur and/or urea deposits from the SCR catalyst.

## Aftertreatment Recovery Procedure (Non-DPF Engines Only)

**Note:** This procedure is only applicable to engines that do not have a DPF in the aftertreatment system.

### WARNING

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This test must be run with the engine running and the machine/engine out of a working mode. The engine must be warmed up to a minimum coolant temperature. Once the coolant temperature conditions are met, a pop-up screen will advise that the engine speed will be automatically increased after the warning is accepted.

Once the pre-conditions are met (no relevant active diagnostics, coolant temp condition met, elevated speed in range), the system test will begin. The EBPR valve control logic will determine the appropriate desired cylinder head pressure differential. This determination is reached with a dedicated fueling and injection timing calibration which should result in the target SCR intake temperature being met. The test will then wait for the SCR intake temperature to rise above a minimum pass threshold. If the minimum temperature threshold is not met, an error ID will display "SCR Intake Temperature Too Low".

Once the SCR intake temperature is acceptable, a timer shows the remaining service test time for the recovery stage of the procedure. This remaining time depends on the observed SCR intake temperature. The remaining time may decrease rapidly whilst the SCR intake temperature continues to rise above the minimum acceptable temperature. The high temperature at the SCR intake will help recover the system performance. This stage may take up to 4 hours. Usually, this stage will take less than 4 hours.

After the high temperature recovery completes, the service test changes the engine operating conditions (at the elevated speed) for the SCR performance to be assessed. If the performance is found to be satisfactory, the test will be considered successful.

## Manual DPF Regeneration

**Note:** This test is only applicable to engines that have a DPF in the aftertreatment system.

**WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This test must be performed under the following conditions:

- There are no related active diagnostic codes
- The engine must be running
- The engine must be under minimum load
- Coolant must be at a minimum required temperature

If the required conditions are not maintained throughout the test, error identifiers will be displayed.

Once the pre-conditions are met, the EBPR will start to close until a target cylinder head pressure differential is achieved. If the target is not met, an error identifier will be displayed to indicate that EGR intake pressure is not responding. If the target pressure is achieved, the test will wait for the temperature to stabilize. The test will then check if the DPF intake temperature is above a minimum threshold. If the minimum temperature is not achieved, an error identifier will be displayed to indicate that DPF intake temperature is too low.

Once the system verification steps are complete, the test will monitor the soot load. If the soot has already reduced below the required level, the test will pass successfully. If the soot has not dropped below the required level, the test will monitor the soot reduction rate. If the rate is too slow, the test will send an error identifier. If the soot reduction rate is acceptable, the test will continue until the target soot level is achieved.

### Aftertreatment Sulfation Recovery Procedure

**Note:** This procedure is only applicable to engines that have a DPF in the aftertreatment system.

**WARNING**

**Avoid contact with hot surfaces. Exhaust piping and engine components become hot during engine operation and cool slowly after engine shut-down. Any contact with hot surfaces can cause severe burns.**

This test must be performed under the following conditions:

- There are no related active diagnostic codes

- The engine must be running
- Engine speed must be sufficient for desulfation to occur
- The engine must be under minimum load
- Coolant must be at a minimum required temperature

If engine speed is not within the required range during warmup, the option to continue will be offered. If the test continues, a minimum coolant temperature must be achieved. If the target parameters are not met, error identifiers will be displayed.

Once the pre-conditions are met, the EBPR will start to close until a target cylinder head pressure differential is achieved. If the target is not met, an error identifier will be displayed to indicate that EGR intake pressure is not responding. If the target pressure is achieved, the test will wait for the temperature to stabilize. The test will then check if the DPF intake temperature is above a minimum threshold. If the minimum temperature is not achieved, an error identifier will be displayed to indicate that DPF intake temperature is too low.

Once the system verification steps are complete, the test will continue to run for a set time to desulfate the DPF. This test will run for up to an hour and a percent complete signal will be displayed to indicate progress.

## Service Tool Error Identifiers

Error identifiers are displayed when an electronic service tool service test has failed. The error identifiers explain the reason for the service test failure. The service test error identifier may identify the failed component. For a list of error identifiers, refer to Troubleshooting, "Service Tool Error Identifiers". If necessary, refer to the troubleshooting guide for the appropriate troubleshooting procedure.

## Aftertreatment History

Connect to the electronic service tool.

Select the Engine ECM.

Select the Information tab.

## Aftertreatment Abnormal Shutdown History

This feature allows the user to see when the engine was stopped incorrectly. This screen shows hot shutdown events, and cold shutdown events.

A hot shutdown can damage the aftertreatment or SCR system.

A cold shutdown can damage the SCR dosing system.

---

## Low Temperature Regeneration History

**Note:** This procedure is only applicable to engines that have a DPF in the aftertreatment system.

Connect to the electronic service tool.

Select the Engine ECM.

Select the Information tab.

Select History.

Select Low Temperature Regeneration History.

The ECM logs timestamp and engine data at the start and end of a low temperature regeneration. Data can be viewed via the electronic service tool to analyze the process when low temperature regeneration occurs.

## Snapshots

Snapshots are only available for fuel system faults. Other faults will not trigger a snapshot.

Snapshots provide data in the electronic service tool for approximately 9.5 seconds before and 3.5 seconds after the time a diagnostic trouble code was recorded.

1. Select the "Information" tab. Select the "Snapshot" tab and then select the "Viewer" tab.

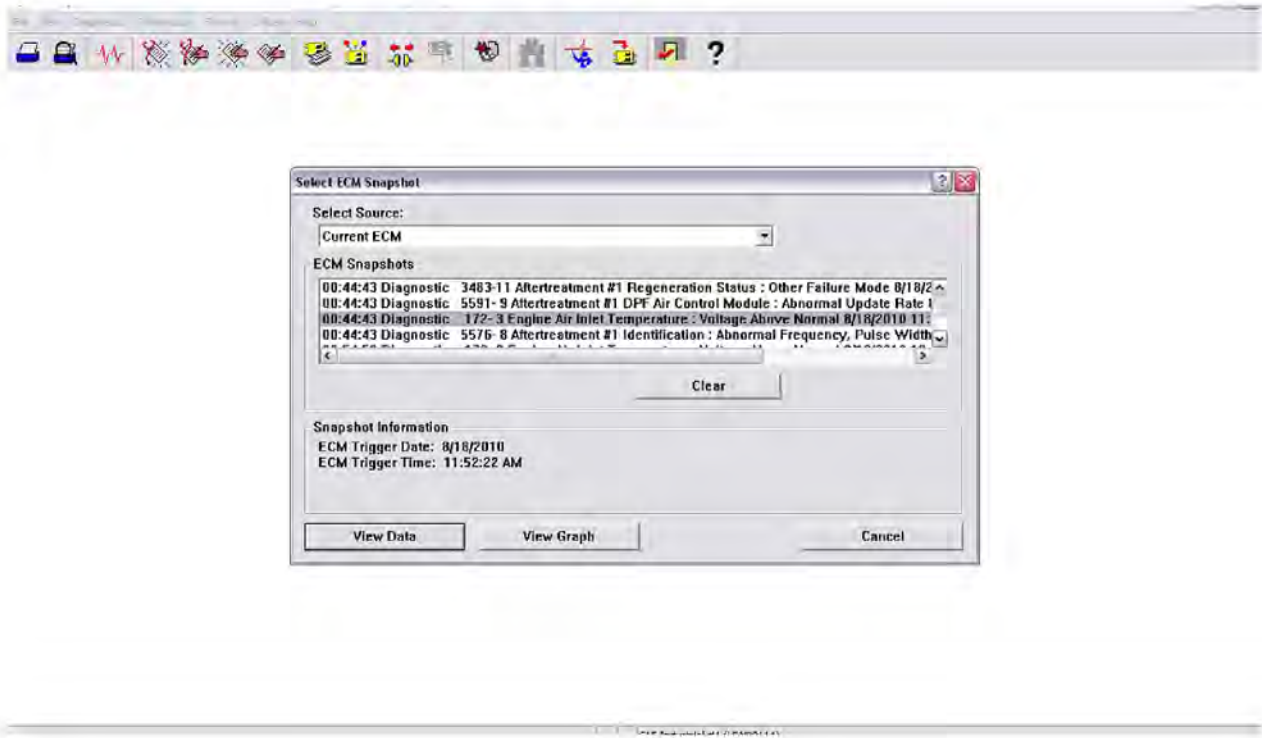


Illustration 161

g03826867

2. Select the diagnostic trouble code to be viewed.  
Select "View Data" .

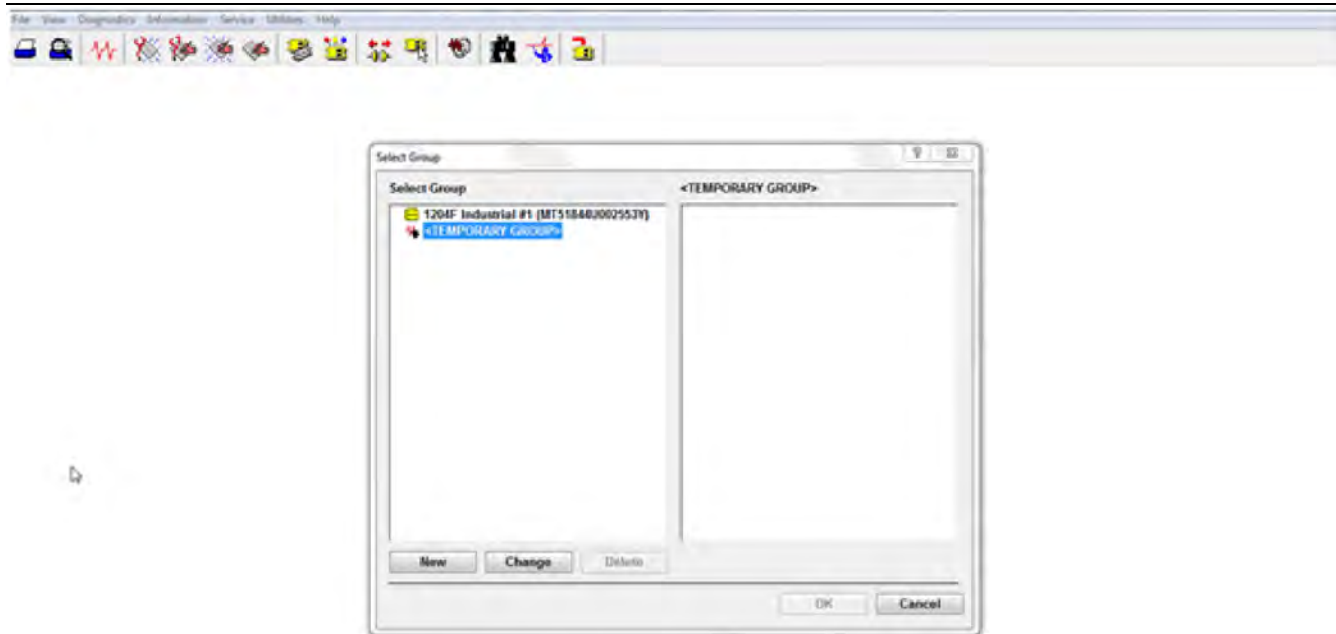


Illustration 162

g03738281

3. Select a group or select "Temporary Group"



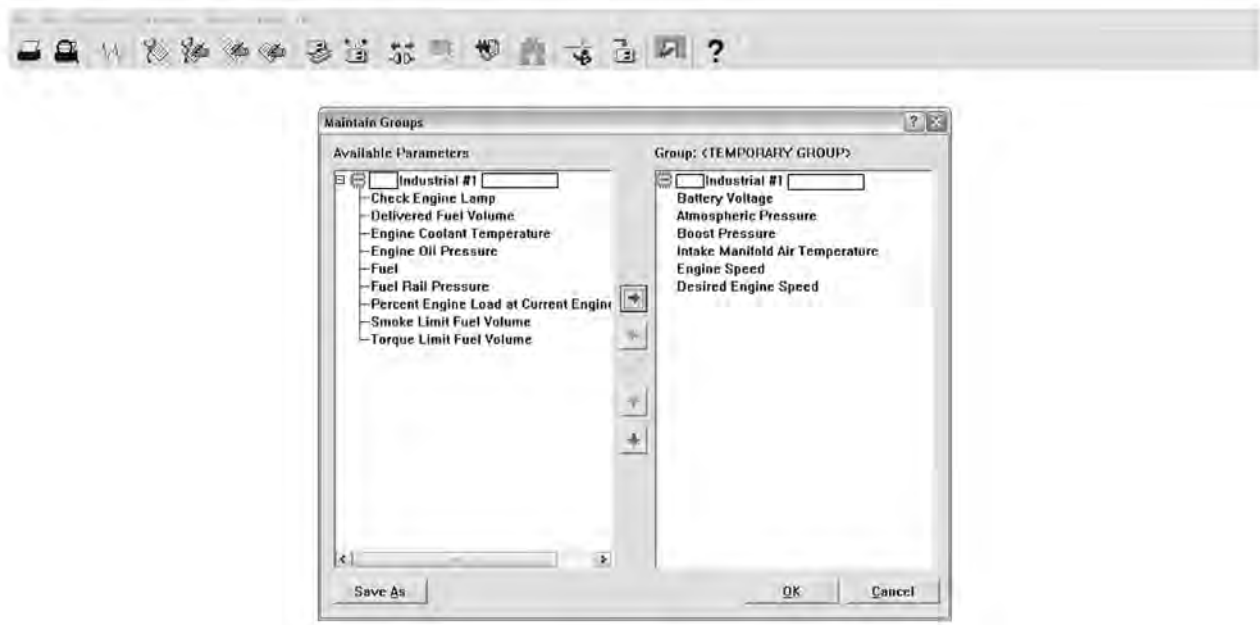


Illustration 163

g03826868

4. Select the channels to view and add the channels to the group. Select "OK" .

File View Diagnostics Information Service Utilities Help

Snapshot: 00:44:43 Diagnostic 172-3 Engine Air Inlet Temperature : Voltage Above Normal 8/18/2010 11:52:22 AM

Description	Value	Unit
Industrial #1 ( ) - <TEMPORARY GROUP>		
Battery Voltage	24.0	Volts
Atmospheric Pressure	99.94	kPa
Boost Pressure	0.00	kPa
Intake Manifold Air Temperature	49.19	Deg C
Engine Speed	0.0	rpm
Desired Engine Speed	600.0	rpm

-9.84 Sec. V +3.60 Sec.

Frame 42 of 57 << < | < || > | > >> 0.00 Sec.

View Graph Snapshots... Groups... Save to File

Illustration 164

g03826870

- The sliding time bar indicates when the diagnostic trouble code was recorded. Data can be viewed 9.5 seconds before and 3.5 seconds after the time the code was recorded.

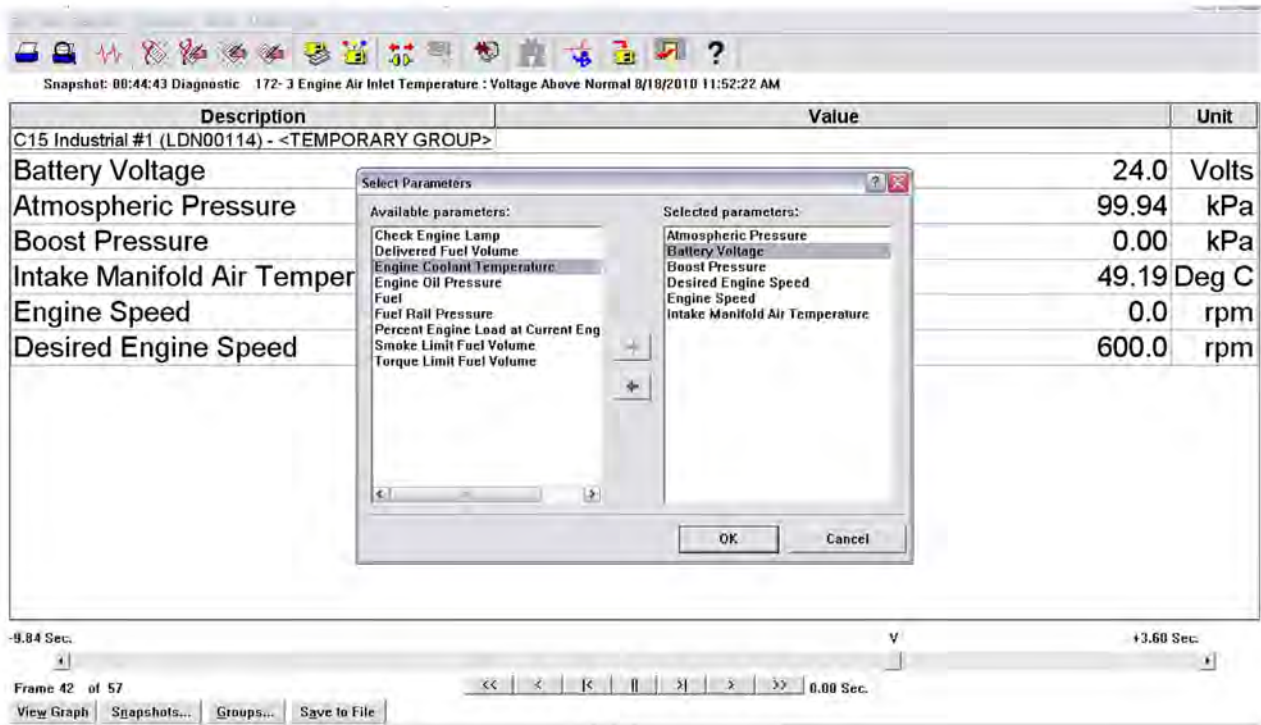


Illustration 165

g03826871

6. Select the "View Graph" tab for graphic illustrations. Select the channels to be viewed and then select "OK".

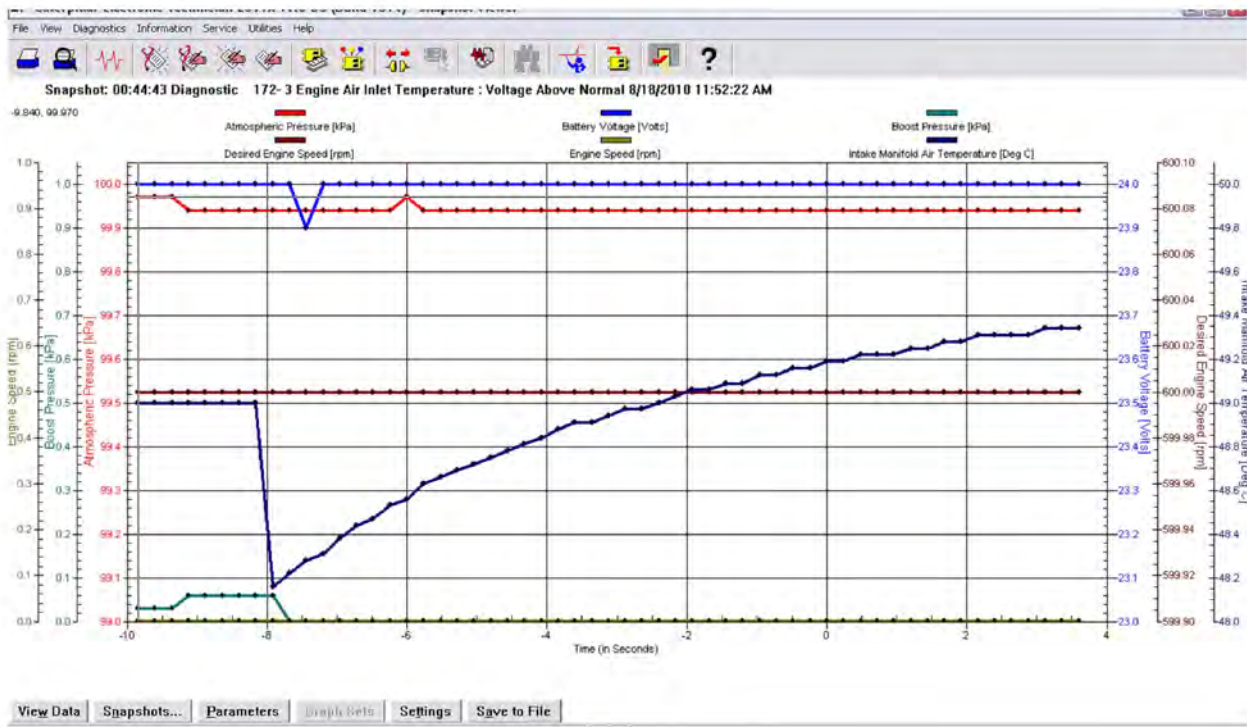


Illustration 166

g03826873

## Histogram Screens

### Tab Functions At Bottom of Screen

#### Histograms

This tab pulls up the histogram menu.

#### Clear

This tab is not available for Tier 4 engines.

#### Clear All

This tab will clear the current histogram data for this key cycle.

#### Show All Labels

This function labels all bars in the graph.

#### View Labels on Mouseover

This function labels each bar in the graph as the mouse pointer is moved over the bar.

### Screen Shots

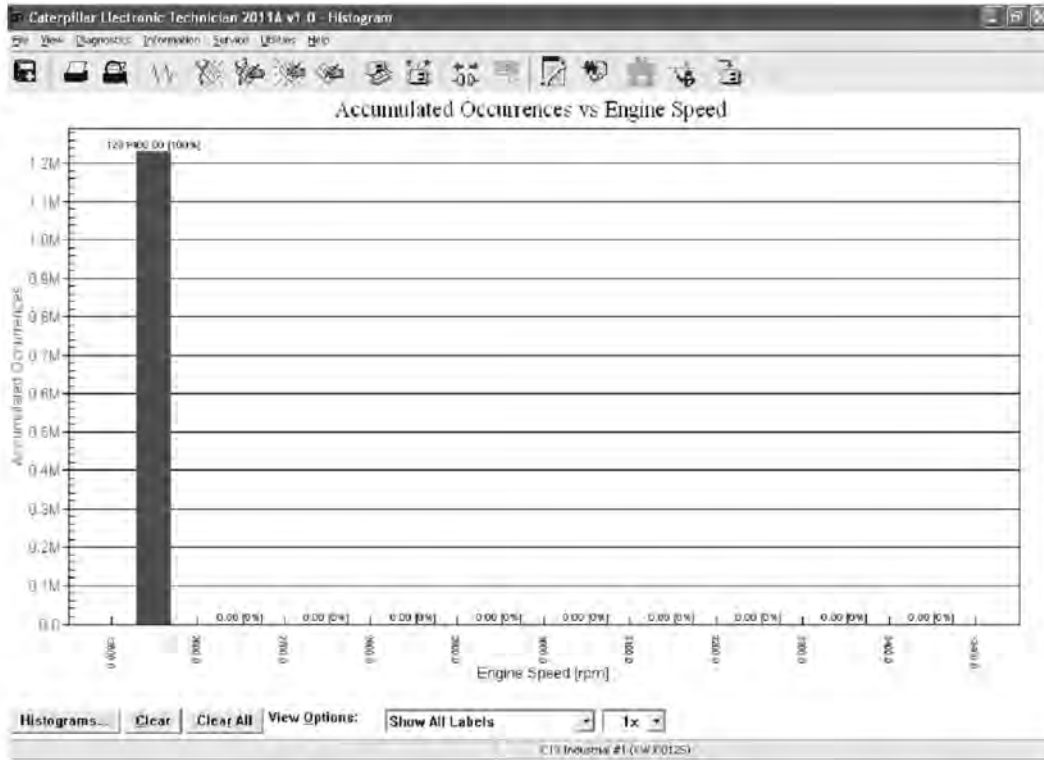


Illustration 167

g03826874

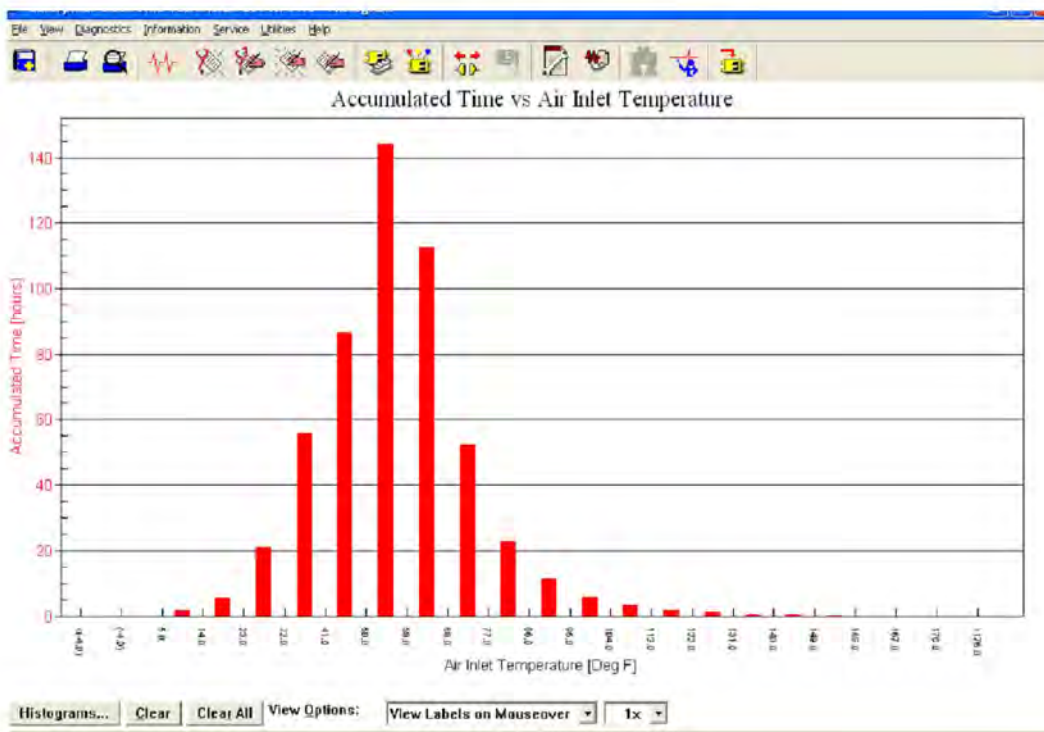


Illustration 168

g03826876

The amount of engine hours operated at indicated inlet temperature.

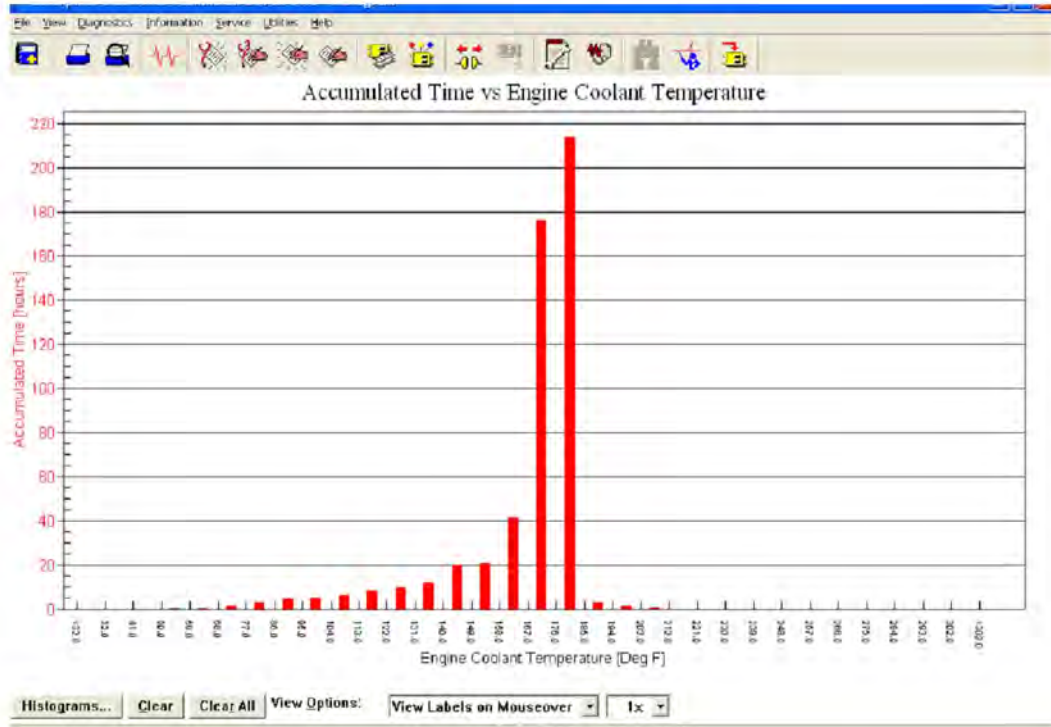


Illustration 169

g03826877

The amount of engine hours operated at indicated coolant temperature.



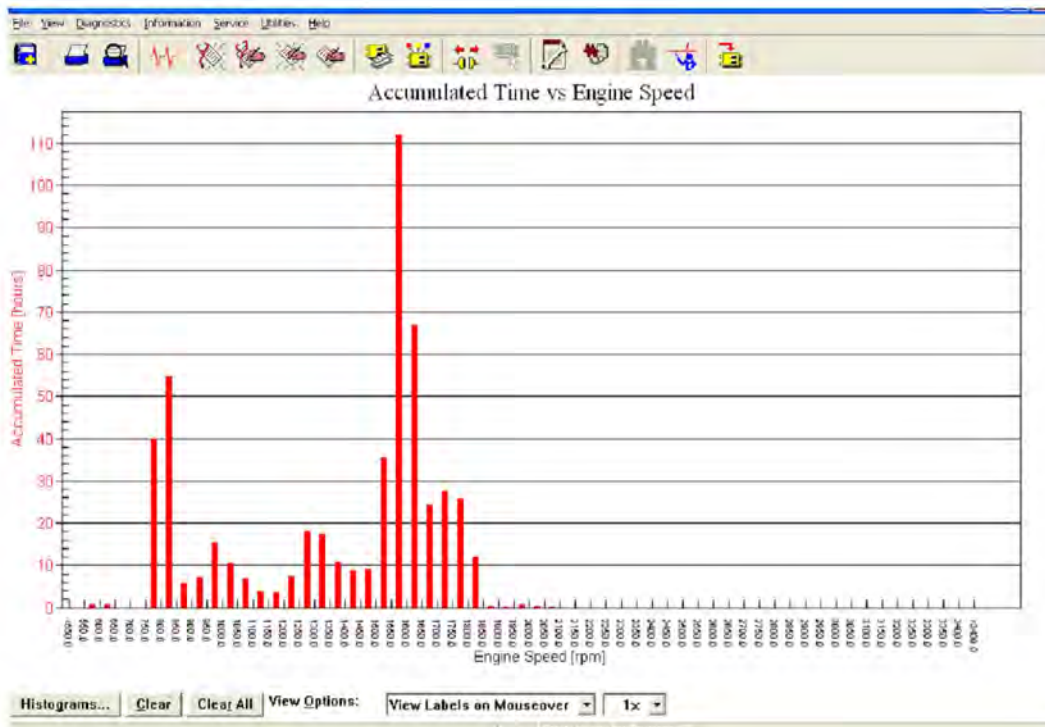


Illustration 170

g03826880

The amount of engine hours operated at indicated engine speed.

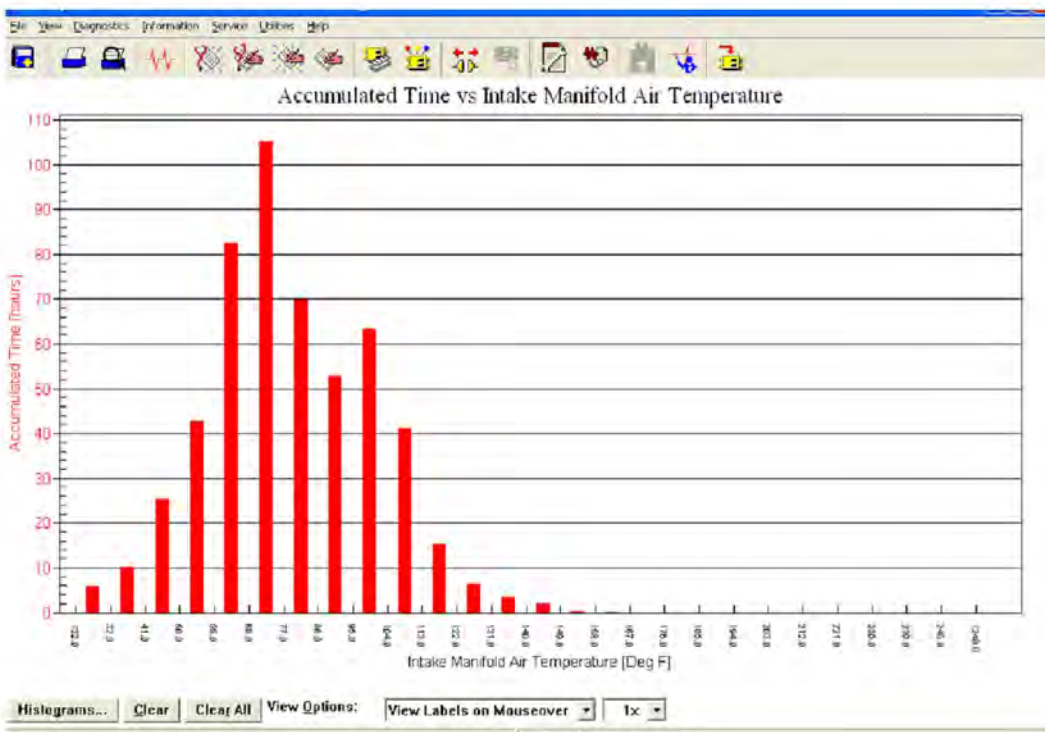


Illustration 171

g03826881

The amount of engine hours operated at indicated intake manifold air temperature.

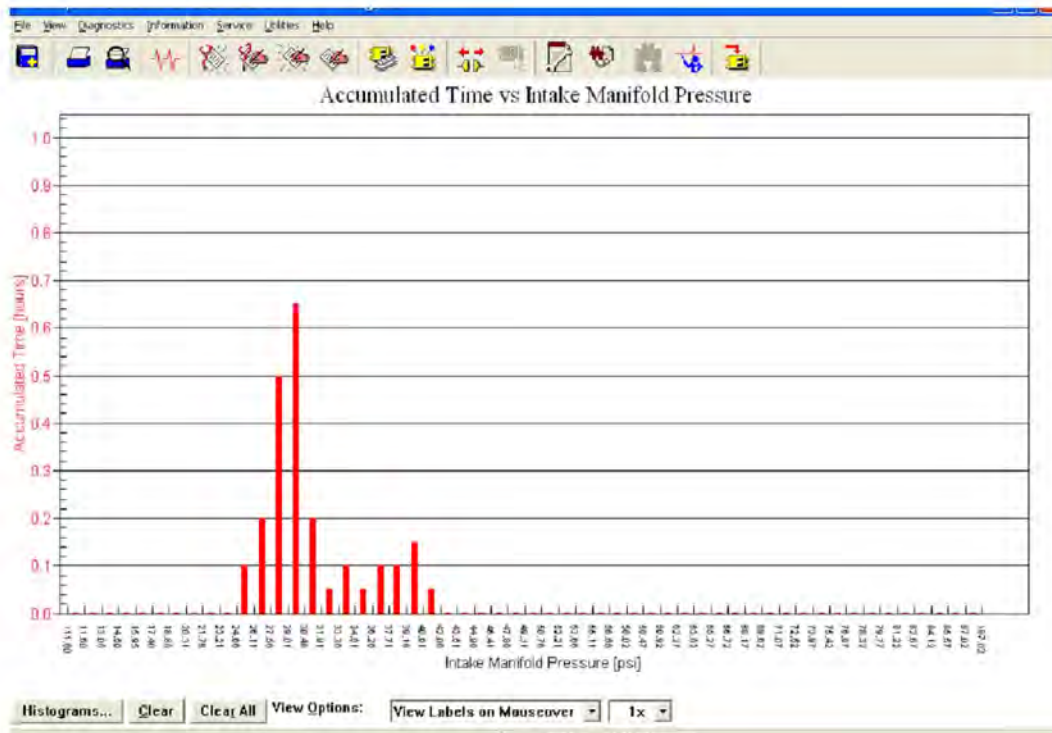


Illustration 172

g03826883

The amount of engine hours operated at indicated intake manifold pressure.



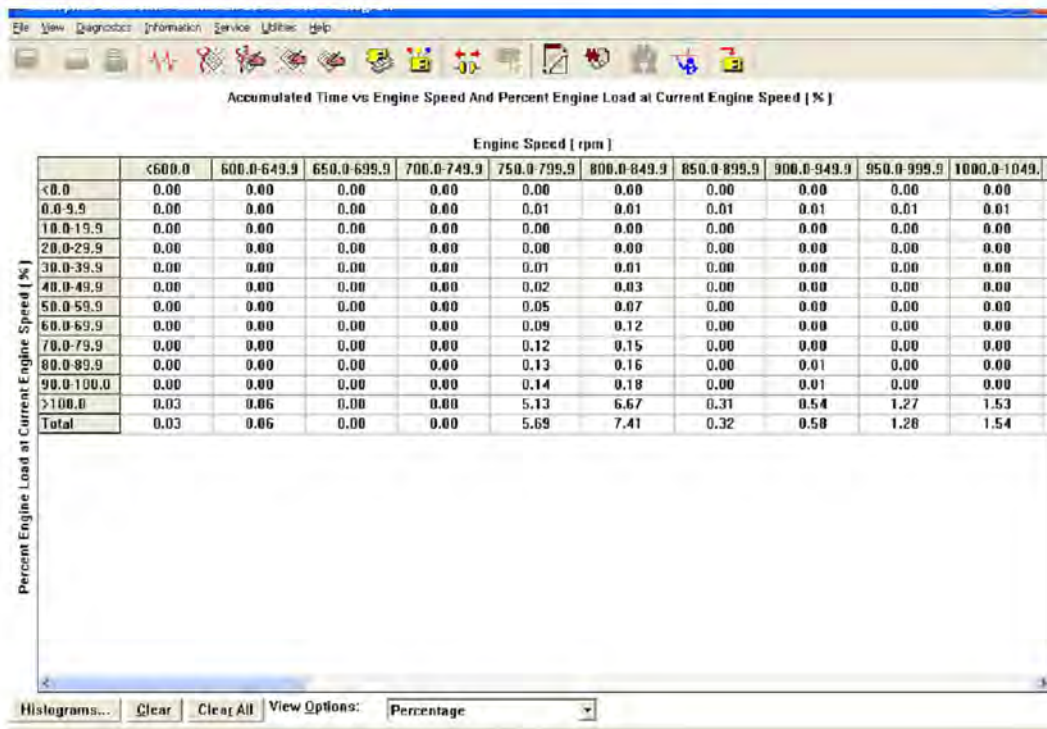


Illustration 173

g03826885

This screen is used to illustrate load percentage at the current engine speed. This screen can be helpful in understanding how the engine is being used. The screen can also be used for comparison between similar machines and/or operators.

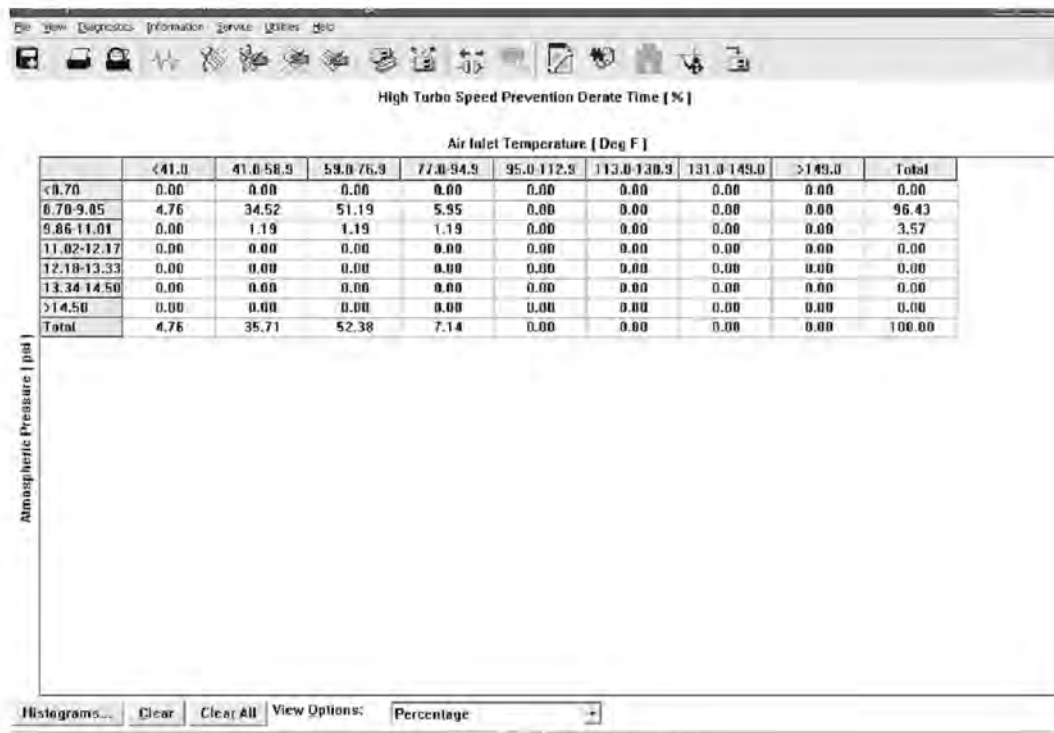


Illustration 174

g03826887

There are certain engine conditions that risk turbocharger overspeed. The engine is calibrated and certified up to a certain altitude and ambient temperature limit. If the engine is operated outside this limit, the engine is more likely to experience overspeed of the turbo. This situation occurs because the turbo has to work harder to maintain the desired boost pressure. This situation is normal under most circumstances and no additional troubleshooting is necessary.

## System Communication Status

Connect to the electronic service tool.

Select the engine ECM.

Select the "Diagnostics" tab.

This feature provides a means of troubleshooting J1939 data link issues. The feature shows which modules are not responding and which data link parameters are missing. Refer to Troubleshooting, "Data Link - Test" for further information.

## DPF Replacement Reset

**Note:** This procedure is only applicable to engines that have a DPF in the aftertreatment system.

This procedure resets the estimated DPF life remaining value when the DPF has been replaced with a known good and clean unit. This functionality is primarily intended for use at long-hour machine overhaul before the machine is put back into service again. Normally, this procedure should not be used because the DPF has been sized for the normal life of a machine. The "Aftertreatment #1 DPF Life Remaining" value is used to assess whether a new DPF is required for future usage expectations. At some stage, the back pressure associated with the original DPF may result in a performance deterioration. This deterioration is caused by the accumulation of non-combustible material (that is, ash) within the DPF.

The reported "Aftertreatment #1 DPF Life Remaining" value is an estimation based on the amount of fuel that has been burnt by the engine. The estimate is presented with appropriate caveats (for example, correct use of fuels and oils, load factor below 60%).

If the "Aftertreatment #1 DPF Life Remaining" value is reset, the "DPF#1 Soot Loading Percent" will also reset. The reset must be performed only when a new clean DPF is being fitted.

**Note:** A factory password is required to perform this reset.

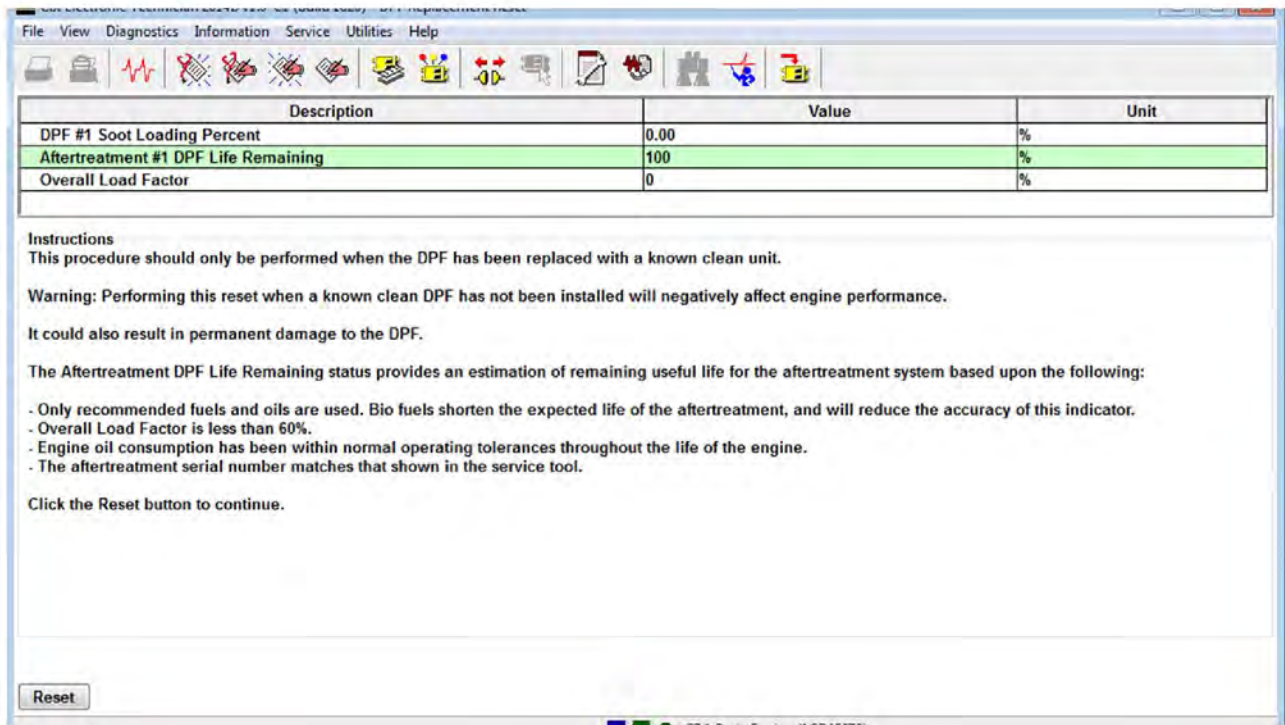


Illustration 175

g03826888

## Operator Inducement Emergency Override Timer Reset

Once the "Operator Inducement Emergency Override" allowed time has been used up, the current emergency override will show as expired. A renewal must be requested from the regulating agency. The "Operator Inducement Emergency Override Timer" can then be reset to allow reactivation if a subsequent emergency situation arises.

**Note:** A factory password is required to perform this reset.

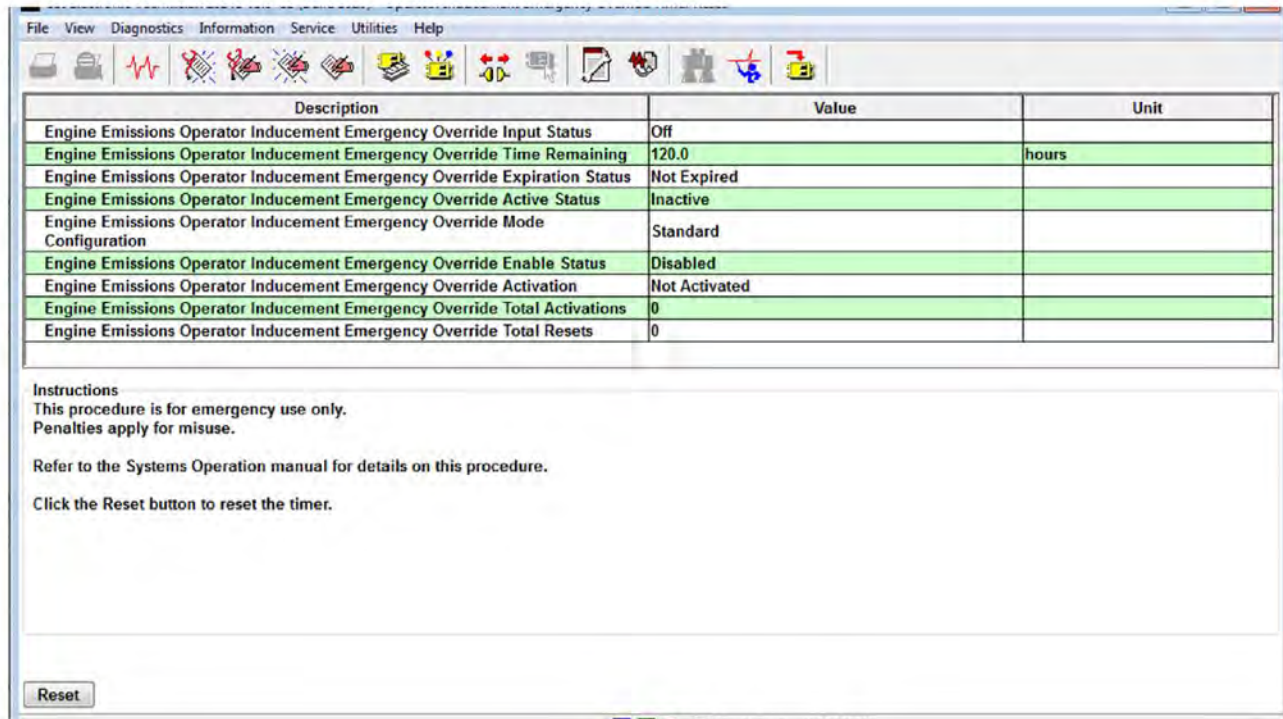


Illustration 176

g03826889

## Throttle Mode Configuration

The throttle configuration screen allows the ECM to be configured with up to two channel inputs. The inputs can be a combination of three types of speed control input. The three types of speed control input are:

- PWM throttle input providing a variable duty cycle input to control engine speed
- Analog throttle input providing a variable voltage signal to control engine speed
- Multi-Position Throttle Switch (MPTS) which uses up to four switch inputs giving a total of 16 combinations. Each switch combination can then be programmed with a desired engine speed, which can be selected by the operator.

The permitted throttle combinations are shown in the following table:

Table 239

Channel 1	Channel 2
None	None
PWM	None
None	PWM

(continued)

(Table 239, contd)

PWM	PWM
Analog	None
None	Analog
Analog	Analog
PWM	Analog
Analog	PWM
MPTS	None
MPTS	PWM
MPTS	Analog
None	MPTS
PWM	MPTS
Analog	MPTS

**Note:** The MPTS input can only be used on one channel.

There is also the option of using an Idle Validation Switch (IVS) on the analog throttle. This switch is used to confirm that the throttle pedal has been physically moved, before reacting to the analog speed demand signal. The IVS and software logic is designed to protect against signal faults which could cause unintended engine speed increases.

Programming each throttle input requires some technical knowledge of the throttle specification that is being used. Knowledge is required to program the specifications into the correct ECM parameter values.

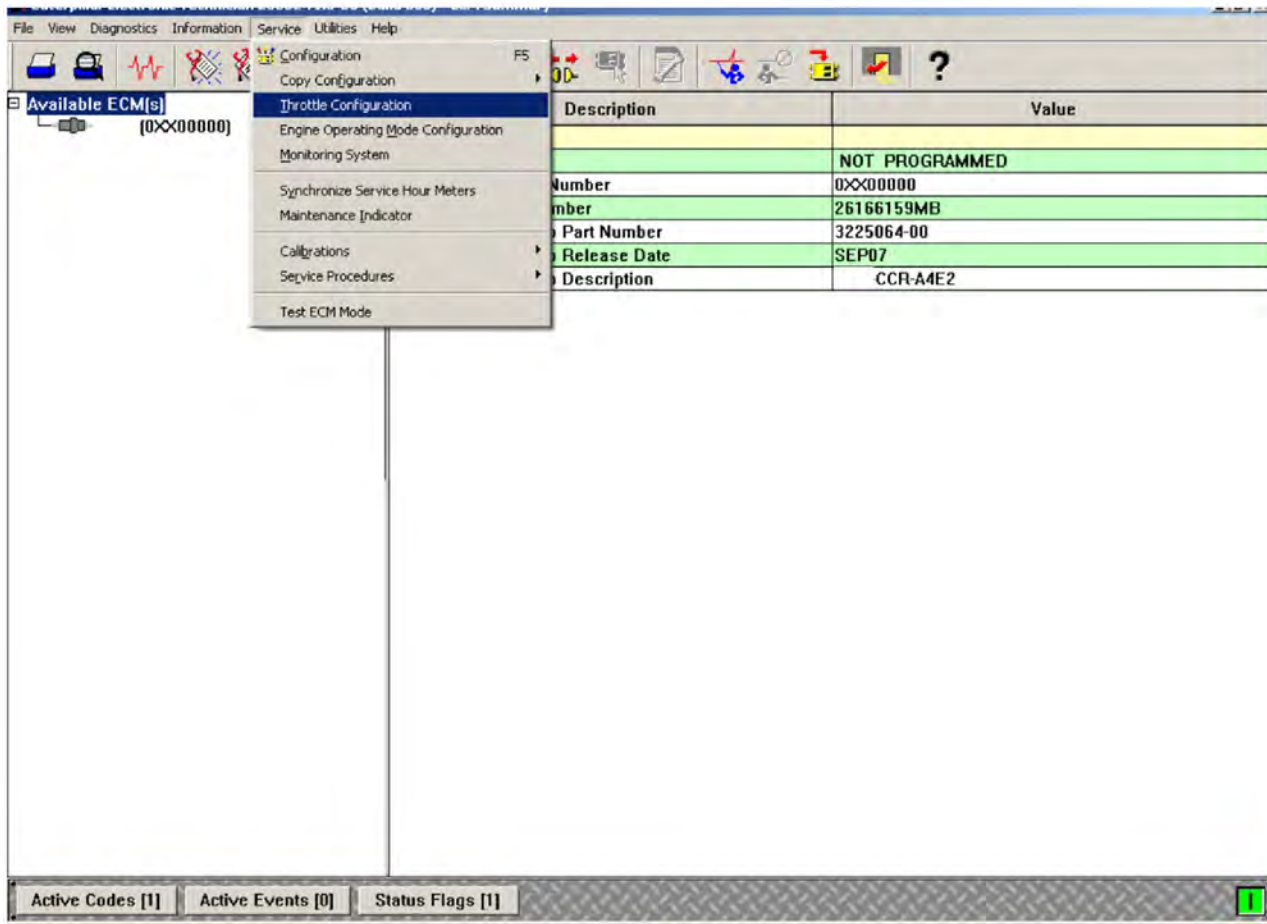


Illustration 177

g03826890

Screen 1

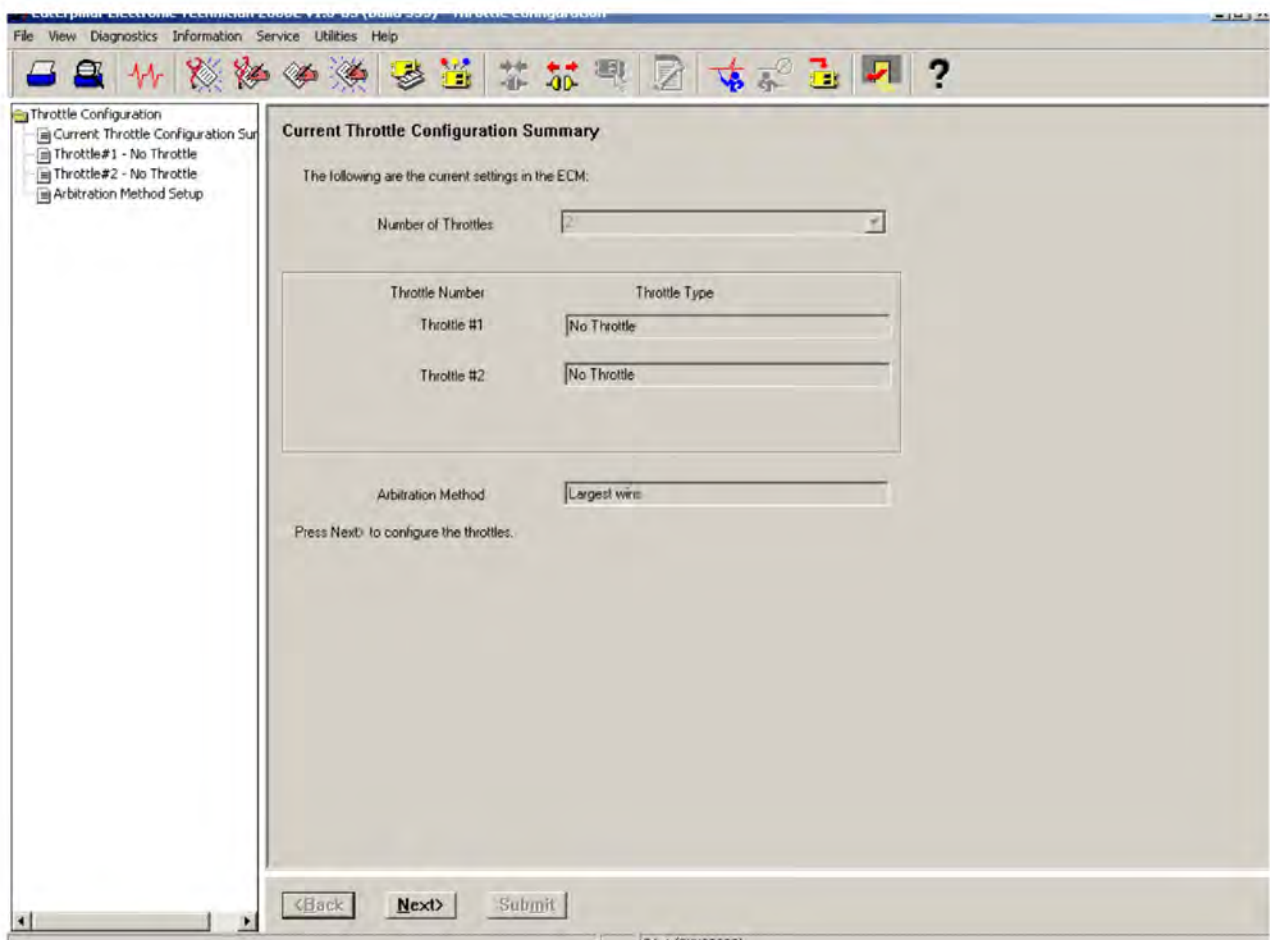


Illustration 178

Screen 2

g03826896



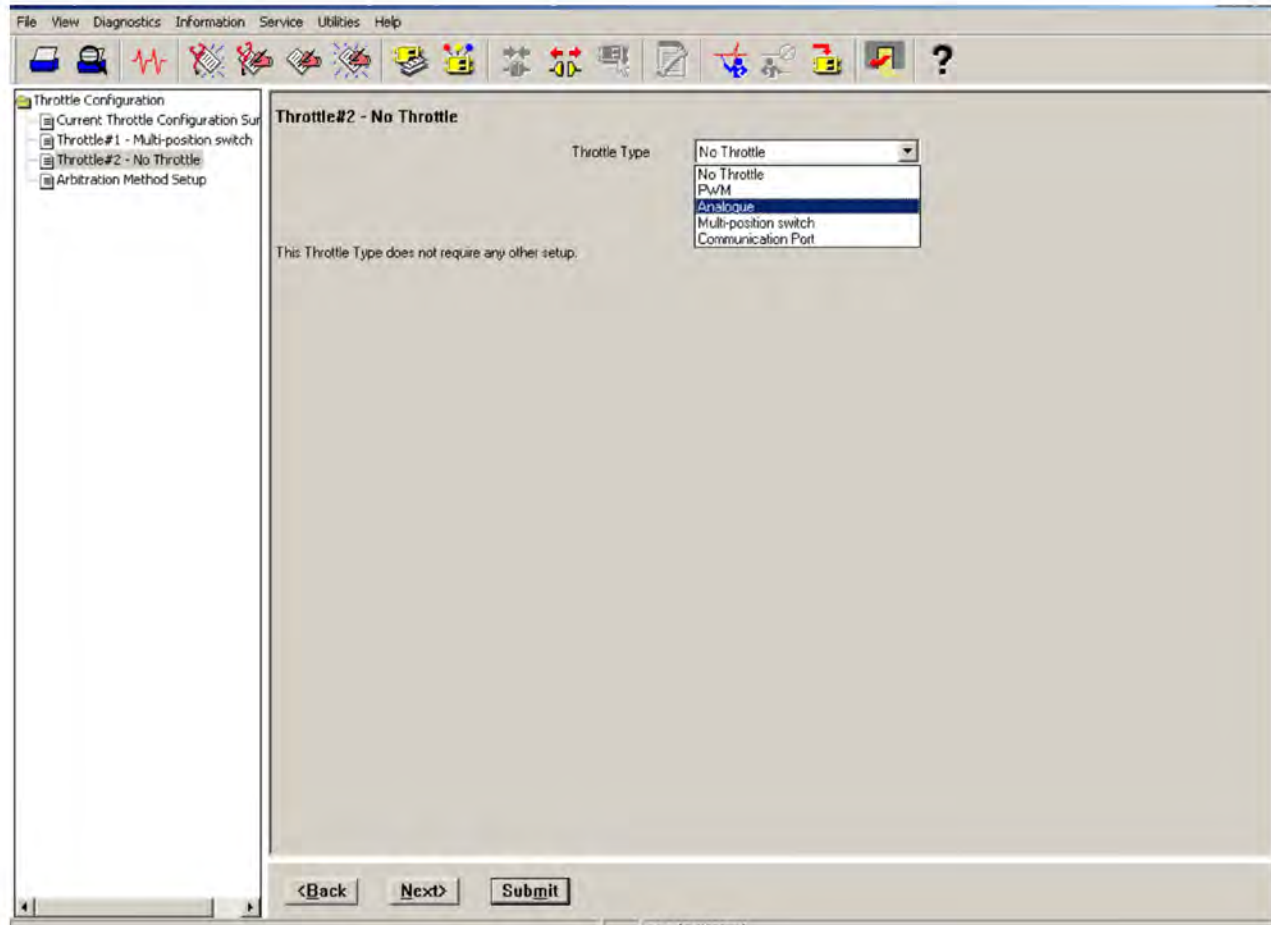


Illustration 179  
Screen 3

g03826897



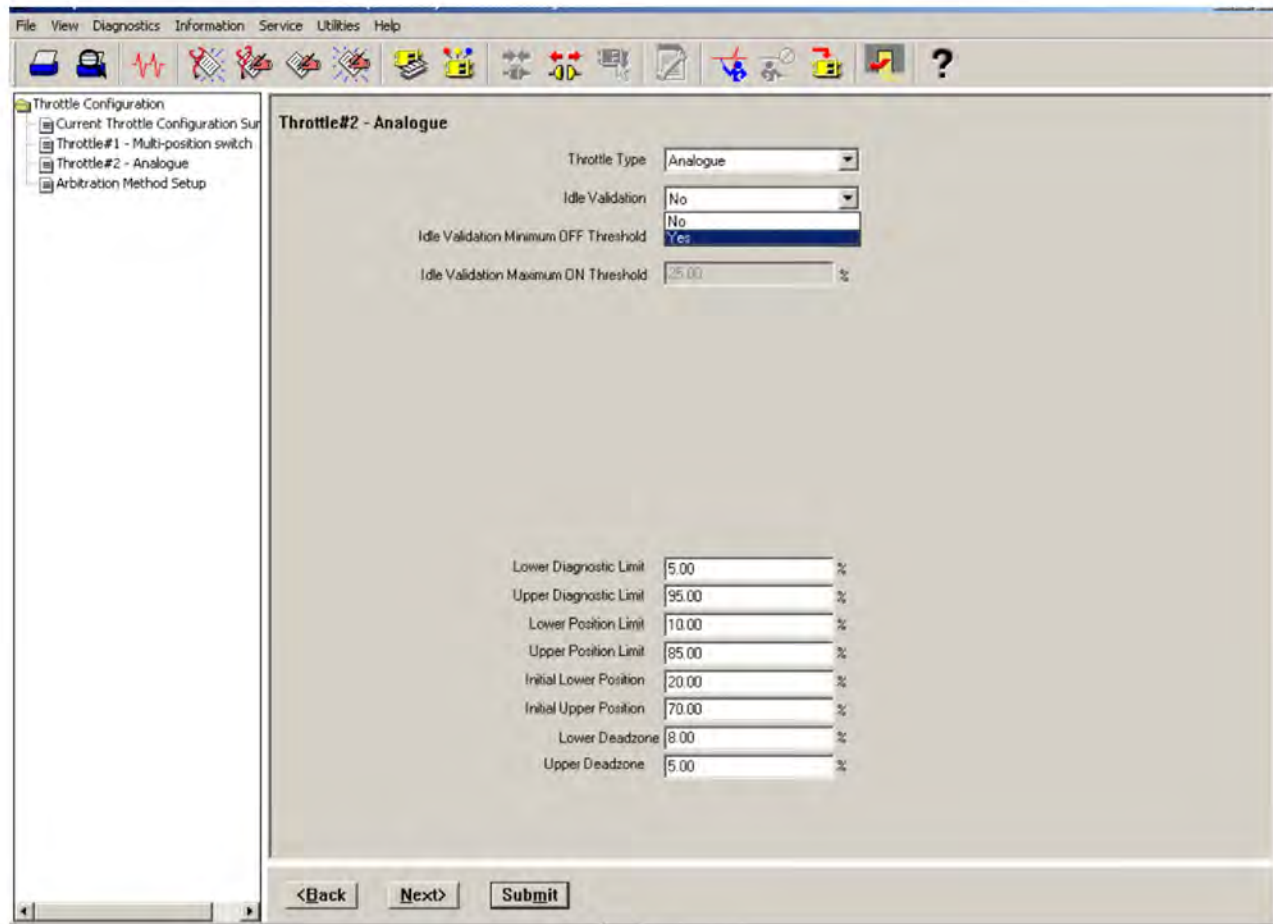


Illustration 180

g03826901

Screen 4

## Engine Operating Mode Configuration

The engine operating mode configuration feature allows the configuration of up to four separate modes that can be selected via two switch inputs.

If only one mode is required, no switch inputs are required and Mode 1 will always be used.

If two modes are required, one switch input can be selected to toggle between Mode 1 and Mode 2. If three or four modes are required, two switch inputs will be required. The numbers of switches are selected in the drop-down box at the top of the screen.

Maximum Rating Number: 1      Number of Switch Inputs: 2

Mode Selection Number	Mode Selection Switch Input 2	Mode Selection Switch Input 1	Enabled	Rating Number	Rated Speed (RPM)	High Idle	Throttle 1 Droop Percentage	Throttle 2 Droop Percentage	TSC1 Droop Percentage	Gov Type
1	Open	Open	Yes	1	2200	2200	5.00	5.00	5.00	Min/Max
2	Open	Ground	No	1	0	0.00	0.00	0.00	0.00	All Speed
3	Ground	Open	No	1	0	0.00	0.00	0.00	0.00	All Speed
4	Ground	Ground	No	1	0	0.00	0.00	0.00	0.00	Min/Max

Illustration 181

g03422567

Screen 1

Once the number of required modes and switches has been selected, each mode must be configured. Each mode is defined by the following selection:

- Mode Number - (1-4)
- Switch input 1 and 2 combinations to enable the mode
- Enabled - For example, if only three modes are required then mode 4 would be set to “NO” . If the switch combination was active for Mode 4, the ECM would display a fault code.
- Rating number – This parameter allows any available ratings in the flash file to be selected. The specific rating information can be found in the main configuration screen under “Ratings” .
- Rated Speed – This parameter is configurable between defined limits in the ECM (for example – 1800 rpm to 2200 rpm).
- High Idle – This parameter is configurable between 1800 rpm and 2800 rpm but also limited to 112% of the programmed rated speed.
- Throttle Channel 1 Droop Value – This parameter is configurable between 0-10%.
- Throttle Channel 2 Droop Value – This parameter is configurable between 0-10%.
- TSC1 Droop Value – This parameter is configurable between 0-10%.
- Governor Type – This parameter can be configured to “All Speed” governing or “Min Max” governing using the drop-down box.

Once the mode configuration has been set, the submit button must be clicked at the bottom of the page. The ECM power must be cycled from off to on.

The status of the mode switch inputs can be monitored on the status screen in the electronic service tool.

**Maintenance Indicator**

This feature is configured through the main configuration screen in the electronic service tool.

Engine Run Range Cycle Duration		Unavailable
Maintenance Parameters		
—	Maintenance Indicator Mode	Off
—	PM1 Interval	Unavailable
—	Maintenance Level 1 Cycle Interval Hours	250 hours
Configurable Inputs		

Illustration 182

g03422642

When this feature is installed, the number of maintenance cycle hours can be set. The ECM then counts down these hours and flags an Event code. A J1939 message is sent once the cycle interval reaches 0.

This parameter can then be reset via the electronic service tool or over the CAN data link after the service has been completed.

The “PM1 Interval” is not applicable to this engine.

## Operator Inducement Emergency Override Configuration

This feature is configurable through the main configuration screen in the service tool. If the request is approved by regulating agency, the “SCR Operator Inducement Emergency Override” can be triggered to remove SCR Inducements. This situation may apply where a machine is operating in a natural disaster zone where DEF fluid is not available.

The strategy will not allow SCR inducements during the standard mode timer (120 hours), or the engine run backstop timer (240 hours). The standard mode strategy can be used multiple times until the standard mode timer is expired or engine run backstop timer has been reached.

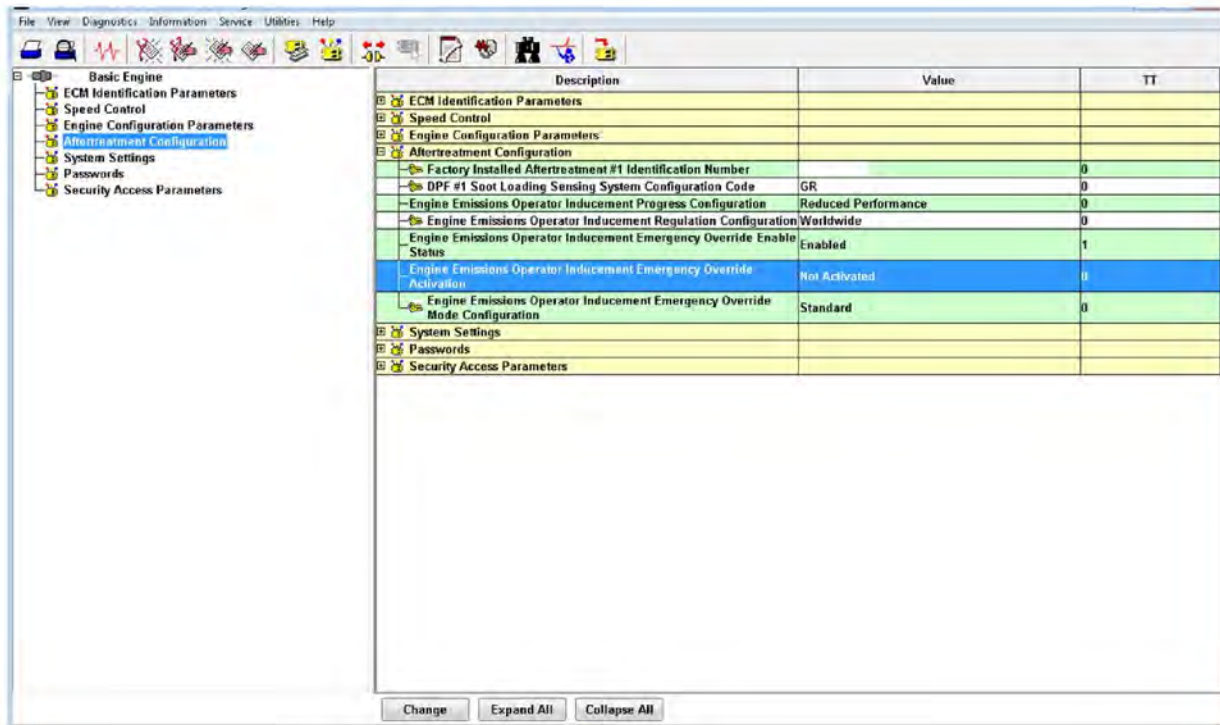


Illustration 183

g03826903

## Aftertreatment Ambient Temperature Sensor Configuration

The “Aftertreatment Ambient Temperature Selection” is available through the main configuration screen in the service tool. This feature allows the enablement of an extra ambient temperature sensor. The sensor must be installed by the customer on or near the DEF lines, with an arctic package. The purpose is to provide a more accurate temperature to be used for DEF thawing control.

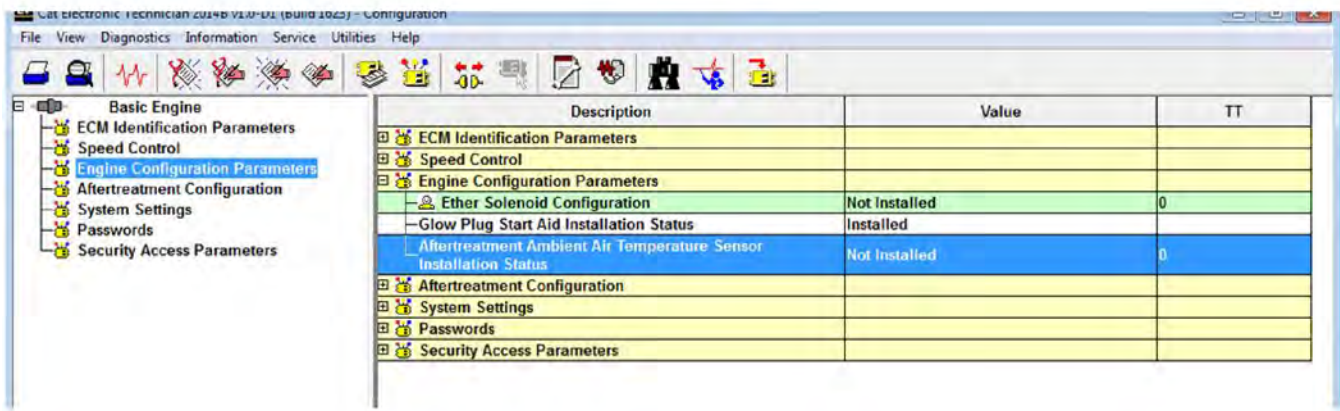


Illustration 184

g03826905

i06146201

## Service Tool Error Identifiers

Service error identifiers are displayed when an electronic service tool service test has failed. The error identifiers help to explain the reason for the service test failure. There could be cases where the error identifier isolates the failed component. If applicable, use the appropriate troubleshooting procedure.

Table 240

Service Error Identifiers	Description	Troubleshooting
\$0003	Another Service Test is Active	Only one service test may be active on a machine or engine at a time.
\$0004	Service Test Active by Another ECM	Another service test from a different ECM is active. Either wait until the test is completed or abort the test to proceed.
\$0005	Loss of Service Test Interlock	There is a communication issue between the ECM and the electronic service tool. There is too much data communicating across the data link. Disconnect any other data collecting tools.
\$0006	Service Test Aborted by Tool/Monitor	Abort by user. Restart the test if desired.
\$101A	Incorrect Throttle Position	The throttle is depressed or faulty. If the application contains a switched throttle, the switch may be faulty.
\$101B	Shift Lever Not in Neutral	Shift the transmission lever to NEUTRAL.
\$101C	Transmission Gear Incorrect	Shift the power train to NEUTRAL.

(continued)

(Table 240, contd)

<b>Service Error Identifiers</b>	<b>Description</b>	<b>Troubleshooting</b>
\$1018	Parking Brake Not Engaged	Apply the parking brake.
\$1109	Left Motor Rotation Direction Incorrect	The left drive motor velocity is greater than 0. The motor could be faulted or have a loss of communication on the datalink.
\$110A	Right Motor Rotation Direction Incorrect	The right drive motor velocity is greater than 0. The motor could be faulted or have a loss of communication on the datalink.
\$1180	Machine is Not Idle	Implements (or saws in forestry products) are actively in operation. Hydraulics are not locked out. Implement lockout solenoid is on "Hoist" and is not in float. AWD is installed and the AWD system is in "Creep" mode. Steering lockout is off. "OK To Elevate Speed" switch is OFF.
\$1126	Ground Speed Too High	The machine is moving. Stop the machine to perform the service test.
\$1012	Lever Not in Correct Position	Shift lever to neutral.
\$110C	Brake Pedal Depressed	Release the brake.
\$115C	Regeneration is Active	Wait for a DPF regeneration to complete or abort the test.
<b>Wiggle Test</b>		
\$1011	Engine running	Engine speed must be zero.
<b>DPF Soot Loading Sensor Functional Test</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$1011	Engine Running	Engine speed must be zero.
\$105F	Test Timed Out Not all conditions were met in order for the test to complete	Restart DPF Soot Loading Functional test.
\$115B	Diesel Particulate Filter soot Loading Sensor Data incorrect	Contact the Dealer Solutions Network (DSN) as a soot sensor replacement is recommended.
<b>Fuel Rail Pressure Relief Valve Test</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$1161	Fuel Temperature Too High	Fuel temperature must be above the threshold shown in the service tool and no active high fuel temperature events .
\$10FB	Engine Speed Too Low	Engine speed must be higher than or equal to low idle speed.
\$10FC	Engine Speed Too High	Engine speed must be lower than or equal to rated speed.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$10CB	Engine Load Too High	Delivered fuel volume must be less than the limit shown during the service tool test. An engine speed from the application is preventing the service test from taking control of the desired engine speed. Check that the machine is in a suitable operating mode before running the service test.
\$1162	Fuel Leakage Detected	Follow the troubleshooting procedure for the fuel leakage event.
\$1101	Fuel Rail Pressure Too Low	Refer to Troubleshooting, "Fuel Rail Pressure Problem".
\$1100	Fuel Rail Pressure Too High	The pressure relief valve may have opened due to high rail pressure and is now regulating the rail pressure to be less than 80 MPa (11600 psi). The rail pressure may be controlling incorrectly to be too high. Refer to Troubleshooting, "Fuel Rail Pressure Problem".
\$1118	Fuel Pressure Not Responding	Indicates that the rail pressure control is unstable during the service test. Contact the Dealer Solutions Network (DSN) if this fault occurs repeatedly when running the service test.
<b>Fuel Rail Pressure Test</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure. Check that there are no electrical diagnostics on the fuel system-related sensors or actuators and no injector faults relating to injector trim codes.
\$1161	Fuel Temperature Too High	Fuel temperature must be above the threshold shown in service tool and no high fuel temperature events are active.
\$10FB	Engine Speed Too Low	Engine speed must be higher than or equal to low idle speed.
\$10FC	Engine Speed Too High	Engine speed must be lower than or equal to rated speed.
\$10CB	Engine Load Too High	Delivered fuel volume must be less than the limit shown during the service tool test. An engine speed from the application is preventing the service test from taking control of the desired engine speed. Check that the machine is in a suitable operating mode before running the service test.
\$1162	Fuel Leakage Detected	Follow the troubleshooting procedure for the fuel leakage event.
\$1101	Fuel Rail Pressure Too Low	Refer to Troubleshooting, "Fuel Rail Pressure Problem".

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$1100	Fuel Rail Pressure Too High	The pressure relief valve may have opened due to high rail pressure and is now regulating the rail pressure to be less than 80 MPa (11600 psi). The rail pressure may be controlling incorrectly to be too high. Refer to Troubleshooting, "Fuel Rail Pressure Problem".
\$1118	Fuel Pressure Not Responding	Indicates that the rail pressure control is unstable during the service test. Contact the Dealer Solutions Network (DSN) if this fault occurs repeatedly when running the service test.
<b>Aftertreatment Regeneration System Test (Engine with a DPF)</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 mins and restart the Aftertreatment Regeneration System Test.
\$1164	Engine Speed / Load Incorrect	Bring engine to idle and remove load and restart the Aftertreatment Regeneration System Test. The test will try to take control of engine speed to elevate idle to required position required for duration of test.
\$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Look for associated EBPR diagnostics. Run the Air System Motor Valves Verification Test to check correct performance of the EBPR.
\$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Look for associated EBPR diagnostics. Look for exhaust system leaks. Run the Air System Motor Valves Verification Test to check correct performance of the EBPR.
\$112C	Particulate Filter Intake Temperature Too Low	The system detects the DPF inlet temperature not being high enough to allow successful DPF desulfation.  Refer to Troubleshooting, "Diesel Particulate Filter Intake Temperature Is Low". Check for exhaust leaks then restart the Aftertreatment Regeneration System Test.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. The current operating load could be too high to allow the EGR valve to close. Look for associated EGR valve diagnostics. Run the Air System Motor Valves Verification Test to check correct performance of the EGR valve.
<b>Aftertreatment Regeneration System Test (Engine without a DPF)</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$0009	Service Test Aborted by ECM	Restart the Aftertreatment Regeneration System Test.
\$1010	Engine Stopped (No Engine RPM)	Start the engine. Test will then progress.

(continued)



(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$10FB	Engine RPM Too Low	Lower the engine speed to idle. Test will try to take speed control to put engine in acceptable speed range.
\$10FC	Engine RPM Too High	Lower the engine speed to idle. Test will try to take speed control to put engine in acceptable speed range.
\$1125	Regeneration Manually Disabled	User has manually stopped the Regeneration Procedure. Restart if appropriate.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. The current operating load could be too high to allow the EGR valve to close. Look for associated EGR valve diagnostics. Run the Air System Motor Valves Verification Test to check correct performance of the EGR valve.
\$11B9	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Too Low	Service procedure has run in optimum engine conditions but has been unable to achieve the required SCR Inlet Temperature needed for Aftertreatment regeneration. Refer to Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature". If the fault persists, contact the Dealer Solutions Network (DSN) for further advice.
Various (Machine / Application specific)	Engine speed control request is being overridden by other machine speed control logic	Lower the engine speed to idle and confirm that machine is out of any working mode. Service test error identifier text may help to identify the issue.
<b>Air System Motor Valves Verification Test</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$1050	Battery Voltage Too High	For a 12 VDC system, the service test must only be executed if the battery voltage is between 9 VDC and 16 VDC. For a 24 VDC system, the service test must only be executed if the battery voltage is between 18 VDC and 32 VDC. Correct the system voltage and restart the Air System Motor Valves Verification Test.
\$1070	Battery Voltage Too Low	For a 12 VDC system, the service test must only be executed if the battery voltage is between 9 VDC and 16 VDC. For a 24 VDC system, the service test must only be executed if the battery voltage is between 18 VDC and 32 VDC. Correct the system voltage and restart the Air System Motor Valves Verification Test.
\$1164	Engine Speed/Load Incorrect	The test must be run with Key Switch on only. Stop Engine leaving ECM powered and restart the Air System Motor Valves Verification Test.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	The test has verified that the valve is electrically OK, but the actuator is not responding to the desired test profile. Contact the Dealer Solutions Network (DSN) before proceeding.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$1170	Engine Exhaust Back Pressure Regulator Not Responding to Command	Engine EGR valve is not responding to a command The test has verified that the valve is electrically OK, but the actuator is not responding to the desired test profile. Contact the Dealer Solutions Network (DSN) before proceeding
<b>Aftertreatment System Functional Test</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$105F	Service Test Timed Out	Not all conditions were met for the test to complete. Restart the Aftertreatment System Functional Test.
\$10CB	Engine Load Too High	Bring engine to idle and remove load. Current operating load is too high to allow the EGR valve to close and the EBPR to be used. Restart the Aftertreatment System Functional Test.
\$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Aftertreatment System Functional test.
\$10FB	Engine RPM Too Low	Lower the engine speed to idle. The test will attempt to take speed control to put engine in acceptable speed range. Restart the Aftertreatment System Functional Test.
\$10FC	Engine RPM Too High	Lower the engine speed to idle. The test will attempt to take speed control to put engine in acceptable speed range. Restart the Aftertreatment System Functional Test.
\$1121	Another Engine Speed Request Active	Service test request to take speed control was denied by the application.
\$112C	Particulate Filter Intake Temperature Too Low	The SCR system cannot dose due to the DPF inlet temperature not being high enough to allow DEF dosing to initiate. Check for exhaust leaks and restart the Aftertreatment System Functional Test.
\$115C	Regeneration is Active	HC dosing is currently active. Allow desulfation to complete and then restart the Aftertreatment System Functional Test.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring the engine to idle and remove load. The current operating load is too high to allow the EGR valve to close.
\$11A8	Aftertreatment SCR Catalyst Conversion Efficiency Too Low	The SCR system NOx conversion is too low to perform the test. Refer to Troubleshooting, "NOx Conversion is Low".
\$11A9	Aftertreatment Outlet NH3 Too High	There is too much NH3 in the exhaust. Perform the "Manual HC Dosing Capability Test" to raise the exhaust temperature and reduce the NH3 storage.
\$11AA	Aftertreatment Diesel Exhaust Fluid Temperature Too Low	The temperature of the DEF is too low. Operate the engine to raise the DEF Temperature.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$11B5	Aftertreatment #1 NOx Level Sensors Not Ready	The NOx sensors have not reached the correct temperature to start reading the NOx level.
\$11B9	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Too Low	The SCR system cannot dose due to the SCR inlet temperature not being high enough to allow DEF dosing to initiate. Restart the Aftertreatment System Functional Test.
\$11BB	Aftertreatment Diesel Exhaust Fluid Level Too Low	The DEF tank level is too low. Fill the DEF tank and restart the Aftertreatment System Functional Test.
\$11C0	Aftertreatment Diesel Oxidation Catalyst Intake Temperature Too Low	The SCR system cannot dose due to the DPF Inlet temperature not being high enough to allow DEF dosing to initiate. Refer to Troubleshooting, "Diesel Oxidation Catalyst Has Incorrect Inlet Temperature". Check for exhaust leaks and then restart the Aftertreatment System Functional Test.
\$11C2	Aftertreatment SCR System in Warmup Mode	The temperature of the exhaust system is not high enough to perform the test. Operate the engine to raise the exhaust temperatures. Restart the Aftertreatment System Functional Test.
\$11C3	Aftertreatment SCR System Not Able to Prime	The SCR dosing system cannot prime. Refer to Troubleshooting, "DEF Pressure is Low".
<b>Manual HC Dosing Capability Test</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$1010	Engine Stopped (No Engine RPM)	Start the engine. The test will then progress.
\$1155	Diesel Particulate Filter Soot Loading Too High	DPF soot load is above an acceptable level for safe HC dosing. If soot load events are active, refer to the appropriate troubleshooting procedure.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	The EGR valve must have closed to allow HC dosing to start and/or the EBPR to elevate exhaust back pressure to increase exhaust temperature. Check for associated EGR valve diagnostic codes. Run the "Air System Motor Valves Verification Test" to check for correct operation of the EGR valve.
\$1108	Excessive Engine RPM Change	The engine speed has changed significantly during the test which can affect the service test assessment capability. Rerun the test without changing engine speed.
\$10F5	Excessive Change in Engine Load	The engine load has been changed significantly during the test which can affect the service test assessment capability. Rerun the test without changing engine load.
\$11CA	Aftertreatment Diesel Oxidation Catalyst Conversion Efficiency Too Low	The DOC may be aged so not enough heat is being generated for the amount of HC dosing fuel being injected. The DOC may be sulfated. Run the "Aftertreatment Recovery Procedure"

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$11C0	Aftertreatment Diesel Oxidation Catalyst Intake Temperature Too Low	The DOC intake temperature is not reaching the target required by the test. Look for causes of excessive heat loss between the engine and the aftertreatment
\$11BA	Aftertreatment SCR System Not Ready to Dose	The SCR system needs to dose a small amount of DEF during HC dosing. The DEF dosing is to protect the DEF injector tip from getting damaged at high temperature. The SCR system is not working properly. Check for associated SCR system diagnostic codes and follow relevant troubleshooting procedures.
\$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Look for associated EBPR diagnostic codes. Run the "Air System Motor Valves Verification Test" to check the correct performance of the EBPR.
\$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Look for associated EBPR diagnostic codes. Check for exhaust system leaks. Run the "Air System Motor Valves Verification Test" to check the correct operation of the EBPR.
\$1130	Aftertreatment Failed to Ignite	The DOC may be aged so not enough heat is being generated for the amount of HC dosing fuel being injected. The DOC may be sulfated. Run the "Aftertreatment Recovery Procedure"
\$11B9	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Too Low	The HC dosing procedure is generating the correct heat rise. However, a significant amount of this heat is being lost before the exhaust gas reaches the SCR. Check for signs of exhaust leaks in the CEM between the DOC and the SCR.
<b>High Pressure Fuel Pump Calibration</b>		

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$0002	Active Diagnostic Present	<p>Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.</p> <p>Check that there are no electrical diagnostics on fuel system sensors or actuators, no injector faults relating to injector trim codes. One of the following sensor status is not OK:</p> <ul style="list-style-type: none"> <li>Crankshaft speed/timing.</li> <li>Camshaft speed/timing.</li> <li>Coolant temperature.</li> <li>Fuel rail pressure.</li> <li>Fuel temperature.</li> </ul> <p>There may be an electrical fault on an injector or the HP fuel pump. An injector trim may not be loaded or incorrect.</p> <p>One of the following events is active:</p> <ul style="list-style-type: none"> <li>Pressure relief valve activation.</li> <li>Fuel leakage.</li> <li>Rail pressure event.</li> <li>Battery supply diagnostic is active.</li> </ul>
\$10A7	Coolant Temperature Too Low	Coolant temperature is less than the trip point
\$1072	Coolant Temperature Too High	Coolant temperature is greater than the trip point
\$1160	Fuel Temperature Too Low	Fuel temperature must be within limits displayed during the test.
\$1161	Fuel Temperature Too High	Fuel temperature must be within limits displayed during the test.
\$1108	Excessive Engine RPM Change	Engine speed is not stable. Ensure that there is no cyclic loading from the application. Try running the test at a different engine speed or increase the load on the engine.
\$1074	Engine RPM Too Low	Engine speed must be within limits displayed during the test.
\$10FC	Engine RPM Too High	Engine speed must be within limits displayed during the test.
\$1107	Engine Load Too Low	Fuel delivery must be within the limits displayed during the test.
\$10CB	Engine Load Too High	Fuel delivery must be within the limits displayed during the test.
\$1118	Fuel Pressure Not Responding	<p>The rail pressure is unstable. Changing the engine operating condition may allow successful pump learn.</p> <p>If still unsuccessful, follow the troubleshooting guide to determine the cause is in the low-pressure system or the high-pressure system.</p>
\$115F	Engine Load Incorrect	Changing the engine operating condition may allow successful pump learn. A lower engine speed and/or a lower load condition should be used.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$000A	Calibration Failure	Likely loss of communication between the ECM and the service tool. Restart the electronic service tool and retry the calibration test.
\$0003	Another Calibration is Active	Likely loss of communication between the ECM and the service tool. Restart the electronic service tool and retry the calibration test.
\$105F	Calibration Timed Out	Retry the High Pressure Fuel Pump Calibration.
<b>Aftertreatment Recovery Procedure (Engines with a DPF)</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Aftertreatment Recovery Procedure.
\$1155	Diesel Particulate Filter Soot Loading Too High	Observed DPF soot load is above an acceptable level for safe HC dosing and too high to allow procedure to regenerate soot within the DPF. Contact the Dealer Solutions Network (DSN) for further advice.
\$11BA	Aftertreatment SCR System Not Ready to Dose	The SCR system needs to dose a small amount of DEF during HC dosing to protect the DEF injector tip from damage at high temperatures. The SCR system is not working properly. Identify associated SCR system diagnostic codes and follow relevant troubleshooting procedures.
\$112C	Particulate Filter Intake Temperature Too Low	The system cannot dose due to the DPF Inlet temperature not being high enough to allow DEF dosing to initiate. Refer to Troubleshooting, "Diesel Particulate Filter Intake temperature Is Low". Check for exhaust leaks and then restart the Aftertreatment Recovery Procedure.
\$1108	Excessive Engine RPM Change	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed and load range. Restart the Aftertreatment Recovery Procedure.
\$10F5	Excessive Change in Engine Load	Lower the engine speed to idle and remove the load. The test will try to take speed control to put engine in acceptable speed and load range. Restart the Aftertreatment Recovery Procedure.
\$10FB	Engine RPM Too Low	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Aftertreatment Recovery Procedure.
\$10FC	Engine RPM Too High	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Aftertreatment Recovery Procedure.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$1173	Diesel Particulate Filter Regeneration Rate Too Low	The procedure is running in optimum conditions for DPF soot regeneration with no issues with Soot Sensor measurement. However, observed soot load is not reducing. Contact the Dealer Solutions Network (DSN) for further advice.
\$10CB	Engine Load Too High	Bring engine to idle and remove load. The current operating load is too high to allow EGR valve to close and EBPR to operate. Restart the Aftertreatment Recovery Procedure.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. The current operating load may be too high to allow the EGR valve to close. Identify associated EGR valve diagnostics. Run the "Air System Motor Valves Verification Test" to check correct operation of the EGR valve.
\$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Identify associated EBPR diagnostics. Run the "Air System Motor Valves Verification Test" to check correct operation of the EBPR.
\$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Identify associated EBPR diagnostics. Check for exhaust system leaks. Run the "Air System Motor Valves Verification Test" to check correct operation of the EBPR.
\$11C0	Aftertreatment Diesel Oxidation Catalyst Intake Temperature Too Low	The DOC intake temperature is lower than required for the test. Identify causes of excessive heat loss between the engine and the aftertreatment.
\$11C1	Aftertreatment Recovery Unsuccessful	The procedure has run in optimum engine conditions but has been unable to recover the Aftertreatment system. Contact the Dealer Solutions Network (DSN) for further advice.
\$11B9	Aftertreatment SCR Catalyst Intake Gas Temperature Too Low	Although the procedure is generating the correct heat rise, some of this heat is being lost before the exhaust gas reaches the SCR. Check for evidence of exhaust leaks in the CEM between the DOC and the SCR.
<b>Aftertreatment Recovery Procedure (Engines without a DPF)</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$0009	Service Test Aborted by ECM	Restart the Aftertreatment Recovery Procedure.
\$1010	Engine Stopped (No Engine RPM)	Start the engine. Test will then progress.
\$10FB	Engine RPM Too Low	Lower the engine speed to idle. Test will try to take speed control to put engine in acceptable speed range.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$10FC	Engine RPM Too High	Lower the engine speed to idle. Test will try to take speed control to put engine in acceptable speed range.
\$1125	Regeneration Manually Disabled	User has manually stopped the Recovery Procedure. Restart if appropriate.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. Current operating load could be too high to allow EGR valve to close. Look for associated EGR valve diagnostics. Run Motor Valves Service test to check correct performance of the EGR valve.
\$11B9	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Too Low	Service procedure has run in optimum engine conditions but has been unable to achieve the required SCR inlet temperature needed for Aftertreatment regeneration. Refer to Troubleshooting, "SCR Catalyst Has Incorrect Inlet Temperature". If the fault persists, contact the Dealer Solutions Network (DSN) for further advice.
\$11C1	Aftertreatment Recovery Unsuccessful	Service procedure has run in optimum engine conditions but has been unable to recover the Aftertreatment system. Contact the Dealer Solutions Network (DSN) for further advice.
Various (Machine / Application specific)	Engine speed control request is being overridden by other machine speed control logic	Lower the engine speed to idle and confirm that machine is out of any working mode. Service test error identifier text may help to identify the issue.
<b>Manual DPF Regeneration</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Manual DPF Regeneration Procedure.
\$10FB	Engine RPM Too Low	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Manual DPF Regeneration Procedure.
\$10FC	Engine RPM Too High	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Manual DPF Regeneration Procedure.
\$112C	Particulate Filter Intake Temperature Too Low	The system detects the DPF inlet temperature is too low to allow successful DPF desulfation. Refer to Troubleshooting, "Diesel Particulate Filter Intake Temperature Is Low". Check for exhaust leaks and then restart the Manual DPF Regeneration Procedure.
\$1164	Engine Speed / Load Incorrect	Bring engine to idle and remove load and then restart the Manual DPF Regeneration Procedure. The test will try to take control of engine speed to elevate idle to required position for duration of test.

(continued)



(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Look for associated EBPR diagnostics. Run the "Air System Motor Valves Verification Test" to check correct operation of the EBPR.
\$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Look for associated EBPR diagnostics. Check for exhaust system leaks. Run the "Air System Motor Valves Verification Test" to check correct operation of the EBPR.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. The current operating load may be too high to allow the EGR valve to close. Check for associated EGR valve diagnostics. Run the "Air System Motor Valves Verification Test" to check correct operation of the EGR valve.
\$1172	Diesel Particulate Filter Soot Loading Too Low	The soot level in the DPF is not high enough to warrant running a regeneration. At low soot levels, the rate of regeneration is extremely slow negating the value of the test.
\$1173	Diesel Particulate Filter Regeneration Rate Too Low	The procedure is running in optimum conditions for DPF soot regeneration with no issues with soot sensor measurement. However, observed soot load is not reducing. Contact the Dealer Solutions Network (DSN) for further advice.
<b>Aftertreatment Sulfation Recovery Procedure</b>		
\$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
\$10CB	Engine Load Too High	Bring the engine to idle and remove load. Current operating load is too high to allow EGR Valve to close and EBPR to operate. Restart the Aftertreatment Sulfation Recovery Procedure.
\$10D0	Engine Has Not Been Running Long Enough	Allow the engine to idle for 2 minutes and then restart the Aftertreatment Sulfation Recovery Procedure.
\$10FB	Engine RPM Too Low	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Aftertreatment Sulfation Recovery Procedure.
\$10FC	Engine RPM Too High	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Aftertreatment Sulfation Recovery Procedure.
\$112C	Particulate Filter Intake Temperature Too Low	The DPF inlet temperature is too low to allow successful DPF desulfation. Refer to Troubleshooting, "Diesel Particulate Filter Intake Temperature Is Low" and check for exhaust leaks. Restart the Aftertreatment Sulfation Recovery Procedure.

(continued)

(Table 240, contd)

Service Error Identifiers	Description	Troubleshooting
\$1164	Engine Speed / Load Incorrect	Bring the engine to idle and remove load and then restart the Aftertreatment Sulfation Recovery Procedure. The test will try to take control of engine speed to elevate idle to required position for duration of test.
\$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Identify any associated EBPR diagnostics. Run the "Air System Motor Valves Verification Test" to check correct operation of the EBPR.
\$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Identify any associated EBPR diagnostics. Check for exhaust system leaks. Run the "Air System Motor Valves Verification Test" to check correct operation of the EBPR.
\$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring the engine to idle and remove load. The current operating load may be too high to allow the EGR valve to close. Check for associated EGR valve diagnostics. Run the "Air System Motor Valves Verification Test" to check correct operation of the EGR valve.

i06071165

## Customer Passwords

Customer passwords may be used to protect customer parameters from being changed. The electronic service tool can be used to change certain parameters. There are some parameters that cannot be changed and there are some applications that do not allow any changes to the programmable monitoring system. The passwords are programmed into the Electronic Control Module (ECM) with the electronic service tool. One password may be programmed or both passwords may be programmed. If customer passwords are not programmed, customer parameters may be changed by anyone.

To obtain customer passwords, contact the owner of the machine. If the owner has forgotten the customer passwords, factory passwords are used to create temporary customer passwords. Temporary customer passwords can be used to change the original customer passwords or any parameter that is protected by a customer password. When the electronic service tool is disconnected, a prompt will request the restoration of the original customer passwords. If the original passwords are not restored, the passwords will be changed to the temporary passwords.

i06177728

## Factory Passwords

**Note:** Factory passwords are provided only to Perkins authorized distributors.

Factory passwords are necessary to authorize access to certain screens on the electronic service tool. Factory passwords are also used to access specific configuration parameters in the Electronic Control Module (ECM). If changes are made that require factory passwords, the "Enter Factory Passwords" dialog box will automatically be displayed. A factory password must be obtained before the change can be made.

Factory passwords may be required to perform each of the following functions in the electronic service tool:

**ECM Replacement** – When an ECM is replaced, the system configuration parameters must be programmed into the new ECM. The new ECM will allow specific parameters to be programmed once without the use of factory passwords. There may be parameters that require factory passwords on the ECM that is being replaced. Factory passwords may be required in order to configure these parameters on the new ECM.

**Rerate Engine Power** – Changing the interlock code may be necessary. The interlock code is protected by factory passwords.

**Software Enabled Attachments** – The application may have special features that can be enabled with the electronic service tool. This customized software is available to provide enhanced operation for the application. These features may also require the installation of additional hardware on the application. A cost may be associated with these software enabled attachments. Factory passwords are necessary to enable this software.

**Customer passwords** – Factory passwords are required in order to restore customer passwords. Factory passwords are also required in order to reset customer passwords.

**Set Configuration parameters** – Factory passwords are required in order to modify specific configuration parameters. Refer to Troubleshooting, “Configuration Parameters” for details that are related to the parameters for your application.

If factory passwords are needed in order to change a parameter, the electronic service tool will request the password when the change is attempted. Newer versions of the electronic service tool display a padlock icon to indicate that a parameter requires a factory password for modification.

**Clear engine events and certain diagnostic codes** – Some engine events require factory passwords in order to clear the code from ECM memory. For example, factory passwords must be obtained in order to clear a code that is related to an engine overspeed condition. Clear these codes only when you are certain that the fault has been corrected.

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## ECM Will Not Accept Factory Passwords

### Probable Causes

- Incorrect information for the password request

- Incorrect passwords

## Recommended Actions

### Check the Information for the Password Request

The information for the password request must be obtained from the Electronic Control Module (ECM) that is being programmed. Do not use information from an old ECM in order to program factory passwords on a replacement ECM.

Verify that the information used for the password request is identical to the information that is displayed on the electronic service tool.

**Engine Serial Number** – The engine serial number must be from the electronic service tool screen rather than the engine information plate.

**Reason Code** – Use the reason code from the factory password screen. Reason codes are assigned for specific purposes and reason codes are not interchangeable.

Cycle the keyswitch. Try to enter the passwords again.

### Incorrect Passwords

Verify that the correct passwords were entered. Check each character in each password.

If rechecking the passwords does not correct the problem, change a customer parameter. Change the parameter from the current value to another value and then change the customer parameter back to the original value. The sequence of events will change the total tattletale. The new total tattletale will require obtaining new factory passwords. Obtain and enter new factory passwords.

i06177736

## Electronic Service Tool Does Not Communicate

Use this procedure to solve communication problems between the electronic service tool and the Electronic Control Module (ECM). The electronic service tool must communicate with the ECM on the Perkins data link and the J1939 data link.

Indicators on the communication adapter indicate that communication is occurring on a particular data link. The “J1939 / DeviceNet” indicator indicates that the communication adapter is communicating on the J1939 data link. The “J1708” indicator indicates that the communication adapter is communicating on the Perkins data link. The electronic service tool displays a message during the connection if the electronic service tool cannot communicate on both data links.

The following conditions can cause a communication problem:

- Incorrect communication adapter
- Incorrect version of the electronic service tool
- Incorrect firmware in the communication adapter
- Incorrect configuration of the electronic service tool
- A fault in the electrical power to the communication adapter
- A fault in the electrical power to the engine ECM
- A fault in the wiring for a data link
- A fault in the electrical cables between the PC and the machine

Table 241

Troubleshooting Test Steps	Values	Results
<p><b>1. Determine the Fault</b></p> <p><b>A.</b> If an indicator other than the "POWER" indicator is illuminated when the electronic service tool is not communicating with an ECM, disconnect and reconnect the communication adapter.</p>	<p>Communication problem</p>	<p><b>Result:</b> Both indicators on the communication adapter are not flashing.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The electronic service tool indicates that the engine is serviced on both links.</p> <p>Proceed to Test Step 2.</p> <p><b>Result:</b> The electronic service tool displays a message that indicates the firmware in the communication adapter does not support communication on both data links.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The electronic service tool displays an Error "#142 The interface hardware is not responding" message.</p> <p>Proceed to Test Step 3.</p> <p><b>Result:</b> The electronic service tool indicates that the electronic service tool cannot find an exact match for the software version in the ECM.</p> <p><b>Repair:</b> Update the electronic service tool to the latest available version.</p> <p><b>Result:</b> The power indicator is not illuminated.</p> <p>Proceed to Test Step 5.</p>
<p><b>2. Verify that the Correct Communication Adapter is Being Used</b></p> <p><b>A.</b> A 27610164 TIPSS Adaptor Kit must be used to communicate.</p> <p><b>B.</b> Determine the communication adapter that is being used.</p>	<p>Communication Adapter</p>	<p><b>Result:</b> An incorrect communication adapter is being used.</p> <p><b>Repair:</b> Connect a correct communication adapter. Refer to Troubleshooting, "Electronic Service Tools", if necessary.</p> <p>Attempt to establish communication. Continue with this procedure if the communication adapter does not communicate on both data links.</p> <p><b>Result:</b> A correct communication adapter is being used. However, the "Power" indicator is not illuminated.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> A correct communication adapter is being used. The "Power" indicator is illuminated.</p> <p>Proceed to Test Step 4.</p>

(continued)

(Table 241, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Check the Version of the Firmware for the Communication Adapter</b></p> <p>The version of the firmware for the communication adapter must be "1.18.47" or higher.</p> <p><b>A.</b> Electronically disconnect the electronic service tool. Verify that the "power" indicator on the communication adapter is illuminated.</p> <p><b>B.</b> Click on the "Utilities" menu.</p> <p><b>C.</b> Click on the "Comm Adapter III Toolkit" menu.</p> <p><b>D.</b> Wait for the tool kit to open. Then, click the "Utilities" menu.</p> <p><b>E.</b> Click "Reprogram CA3" .</p> <p><b>F.</b> Select the latest ".apf" file from the list.</p> <p><b>G.</b> Click "OK" . Then, click "Begin Flash" .</p> <p><b>H.</b> Wait for the "Flashes Completed Successfully" message to appear.</p> <p><b>I.</b> Click "Toolkit" . Verify that the "Software Release Version" is "1.18.47" or higher.</p> <p><b>J.</b> Attempt to connect the electronic service tool.</p>	<p>Firmware</p>	<p><b>Result:</b> The electronic service tool communicates on both data links.</p> <p>The problem is resolved.</p> <p><b>Result:</b> The electronic service tool does not communicate on both data links.</p> <p>Proceed to Test Step 4.</p>
<p><b>4. Check that the Electronic Service Tool is Configured Correctly</b></p> <p>The electronic service tool must be configured correctly in order to communicate on both data links.</p> <p><b>A.</b> Click on the "Utilities" menu.</p> <p><b>B.</b> Click on the "Preferences" menu.</p> <p><b>C.</b> Select the "Communications" tab.</p> <p><b>D.</b> Verify that "Comm Adapter III (RP120)" is selected.</p> <p>If "Comm Adapter III (RP120)" is not an option for selection, the version of the electronic service tool is incorrect. Version "2013B" or higher must be used.</p> <p>Update the version of the electronic service tool and then perform this Test Step again.</p> <p><b>E.</b> Verify that the port is correct.</p> <p><b>F.</b> Verify that the "Enable Dual Data Link Service" option is checked.</p> <p><b>G.</b> Click "OK" . The electronic service tool must reconnect in order for any changes to be used.</p> <p><b>H.</b> If changes are made to any of the settings for communications, electronically disconnect the electronic service tool . Electronically connect the electronic service tool. Attempt to establish communication. Observe the indicators on the communication adapter.</p> <p>A "limited support" warning should not be displayed. The "J1939 / Device-Net" and "PDL" indicators should be flashing. The indicator indicates that the electronic service tool is communicating on both data links.</p>	<p>Configured Correctly</p>	<p><b>Result:</b> The electronic service tool communicates on both data links.</p> <p>The problem is resolved.</p> <p><b>Result:</b> The electronic service tool does not communicate on both data links. The "POWER" indicator is not illuminated.</p> <p>Proceed to Test Step 5.</p> <p><b>Result:</b> The electronic service tool does not communicate on both data links. The "POWER" indicator is illuminated.</p> <p>Proceed to Test Step 6.</p>

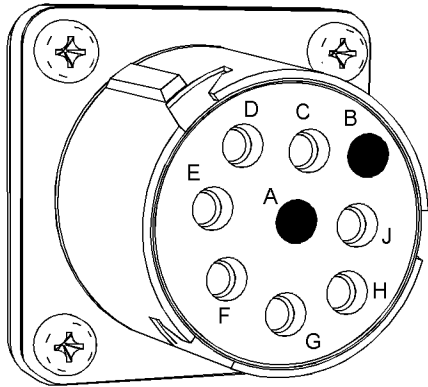


Illustration 185 g02061279

**Power terminals at the service tool connector**

(Terminal A) +Battery  
(Terminal B) -Battery

Table 242

Troubleshooting Test Steps	Values	Results
<p><b>5. Check the Electrical Power to the Communication Adapter</b></p> <p><b>A.</b> Check for battery voltage at the diagnostic connector.</p>	<p>Electrical Power</p>	<p><b>Result:</b> Battery voltage is not present at the diagnostic connector.</p> <p><b>Repair:</b> Inspect the vehicles wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs.</p> <p>Attempt to establish communication after the electrical power is at the service tool connector.</p> <p>If the service tool does not communicate on both data links, proceed to Test Step 6.</p> <p><b>Result:</b> The electronic service tool indicates that the engine is serviced on both links.</p> <p><b>Repair:</b> Verify that the cable between the diagnostic connector and the communication adapter is OK. If necessary, replace the cable.</p> <p><b>Repair:</b> Replace the communication adapter if the following conditions are true:</p> <ol style="list-style-type: none"> <li>1. There is power at the cables "DATA LINK" connector.</li> <li>2. The communication adapters "POWER" indicator is not illuminated.</li> </ol>
<p><b>6. Check the Electrical Power to the ECM</b></p> <p><b>A.</b> Verify that the keyswitch is ON.</p> <p><b>B.</b> Check the voltage between the "Battery+" terminals and the "Battery-" terminals on the P1 ECM connector.</p> <p><b>C.</b> Check the voltage between the "Keyswitch" terminal and a "Battery-" terminal on the P1 ECM connector.</p>	<p>Electrical Power</p>	<p><b>Result:</b> Battery voltage is missing from a P1 terminal.</p> <p><b>Repair:</b> Inspect the vehicles wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs.</p> <p>Attempt to establish communication after the electrical power is at all of the appropriate P1 terminals. Continue with this procedure, if necessary.</p> <p><b>Result:</b> Battery voltage is present at all of the appropriate P1 terminals.</p> <p>Contact the Dealer Solutions Network (DSN).</p>

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## Codes that Inhibit Operation of Aftertreatment System

### Diagnostic Trouble Codes that Affect the Aftertreatment System and the Conditions for Clearing the Code

The following tables list the codes that inhibit the aftertreatment system either during the current key cycle or through successive key cycles.

Table 243

<b>Codes That Clear With Each Key Cycle</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Customer Action</b>	<b>Clearing Conditions</b>
102-16	E1044 (2)	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Engine Speed >1400/1500 RPM
102-18	E1045 (2)	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Engine Speed >1400/1500 RPM
105-3	172-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
105-4	172-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-0	E361 (3)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-3	110-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-4	110-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-15	E361 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-16	E361 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-3	1797-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-4	1797-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-16	E396 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-18	E398 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
168-3	168-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
168-4	168-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
174-16	E363 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
649-5	3512-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
649-6	3512-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
649-7	E1263 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
651-2	1-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
651-5	1-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

(continued)



(Table 243, contd)

<b>Codes That Clear With Each Key Cycle</b>			
<b>J1939 Code</b>	<b>PDL Code</b>	<b>Customer Action</b>	<b>Clearing Conditions</b>
651-6	1-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-2	2-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-5	2-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-6	2-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-2	3-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-5	3-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-6	3-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-2	4-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-5	4-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-6	4-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
655-2	5-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
655-5	5-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
655-6	5-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
656-2	6-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
656-5	6-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
656-6	6-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1188-5	526-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1188-6	526-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1239-0	E499 (3)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
2791-6	3405-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
2791-7	E1121 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3242-3	2452-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3242-4	2452-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3358-3	3385-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3358-4	3385-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3358-13	3385-13	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-3	1785-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-4	1785-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-13	1785-13	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
4360-17	E947 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
4765-3	3956-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
4765-4	3956-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
4765-17	E2165 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

(continued)

(Table 243, contd)

Codes That Clear With Each Key Cycle			
J1939 Code	PDL Code	Customer Action	Clearing Conditions
5571-0	E1264 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
5625-3	3513-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
5625-4	3513-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
7440-31	E1645 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

Table 244

Codes That Stay Active Through Key Cycles			
J1939 Codes	PDL Codes	Customer Action	Clearing Conditions
27-3	3407-3	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Rectification completed and NRS system operating OK.
27-4	3407-4	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Rectification completed and NRS system operating OK.
2791-5	3405-5	Code must be cleared with the electronic service tool	The electronic service tool is required.
5298-17	E2180 (1)	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Rectification completed and "Aftertreatment Recovery Procedure" completed successfully.

i06071355

## Test ECM Mode

"Test ECM Mode" is a feature in the software that can be used to help troubleshoot an engine that may have a fault in the Electronic Control Module (ECM). This feature allows a standard ECM to be used as a test ECM. This feature eliminates the need to stock a test ECM.

1. Search for the latest flash file for the engine.

**Note:** If a newer software version is available for the engine, install the newest software on the suspect ECM. If the new software does not eliminate the fault, continue with this procedure.

2. Use the "Copy Configuration" feature on the electronic service tool to copy the parameters from the suspect ECM.

**Note:** If the "ECM Replacement" feature cannot be used, record the programmed values into the "Parameters Worksheet". Also record the system configuration parameters.

3. Disconnect the suspect ECM. Temporarily connect the test ECM to the engine. Do not mount the test ECM on the engine.

4. Flash program the test ECM with the newest software that is available.
5. Start the "Test ECM Mode" on the electronic service tool. Access the feature through the "Service" menu. The electronic service tool will display the status of the test ECM and the hours that are remaining for the "Test ECM Mode".

**Note:** "Test ECM Mode" can only be activated if the engine serial number has not already been programmed during normal operation of the ECM. If the engine serial number is programmed with the ECM not in "Test ECM Mode", the ECM can never be used as a test ECM.

6. Use the "Copy Configuration" feature on the electronic service tool to program the test ECM.

**Note:** If the "ECM Replacement" feature cannot be used, program the test ECM with the values from the following worksheets:

- Parameters Worksheet
- Configuration Parameters

7. Program the engine serial number into the test ECM.

**Note:** The "Test ECM Mode" must be activated before the engine serial number is programmed into the ECM.

**8. Verify that the test ECM eliminates the fault.**

When the “Test ECM Mode” is activated, an internal timer sets a 24 hour clock. This clock will count down only while the ECM is powered and the keyswitch is in the ON position. After the ECM has counted down the 24 hour period, the ECM will exit the “Test ECM Mode”. The parameters and the engine serial number will be set.

If the test ECM eliminates the fault, the engine can be released while the “Test ECM Mode” is still active.

Once an ECM has been activated in the “Test ECM Mode”, the ECM will stay in the “Test ECM Mode” until the timer times out. Anytime prior to the “Test ECM Mode” timing out, the “Test ECM Mode” can be reset to 24 hours.

If the ECM is used as a test ECM for more than one engine, reactivate the “Test ECM Mode”. The reactivation will reset the parameters to default values. Then use the “Copy Configuration” feature to program the parameters into the test ECM or manually program the parameters to the correct values.

i06177741

## ECM Software - Install

Use this procedure to troubleshoot the electrical system if the diagnostic code in Table 245 is active.

Table 245

Diagnostic Trouble Code for ECM Software			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
631-2	253-2	Calibration Module : Erratic, Intermittent, or Incorrect	The flash file is for a different engine family or for a different engine application. The engine will not start. Clearing this diagnostic code requires factory passwords. The personality module code must be reset to zero.

**Flash Programming** – A method of loading a flash file into the Electronic Control Module (ECM)

The electronic service tool is used to install a flash file into the ECM. The flash programming transfers the flash file from the PC to the ECM.

### Flash Programming a Flash File

1. Obtain the part number for the new flash file.

**Note:** If the part number for the flash file is not available, use “PTMI” on the Perkins secured web site.

**Note:** The engine serial number must be available in order to search for the part number of the flash file.

2. Connect the electronic service tool to the diagnostic connector.
3. Turn the keyswitch to the ON position. Do not start the engine.
4. Select “WinFlash” from the “Utilities” menu on the electronic service tool.

**Note:** If “WinFlash” will not communicate with the ECM, refer to Troubleshooting, “Electronic Service Tool Does Not Communicate”.

5. Flash program the flash file into the ECM.
  - a. Select the engine ECM under the “Detected ECMs”.

- b. Press the “Browse” button in order to select the part number of the flash file that will be programmed into the ECM.
  - c. When the correct flash file is selected, press the “Open” button.
  - d. Verify that the “File Values” match the application. If the “File Values” do not match the application, search for the correct flash file.
  - e. When the correct flash file is selected, press the “Begin Flash” button.
  - f. The electronic service tool will indicate when flash programming has been successfully completed.
6. If the engine rating is being changed, factory passwords must be obtained before the flash file will be accepted.
  7. Access the “Configuration” screen under the “Service” menu in order to determine the parameters that require programming. Look under the “Tattletale” column. All of the parameters should have a tattletale of 1 or more. If a parameter has a tattletale of 0, program that parameter.
  8. Start the engine and check for proper operation. Check that there are no active diagnostic codes.

### “WinFlash” Error Messages

If any error messages are displayed during flash programming, click on the “Cancel” button in order to stop the process. Access the information about the “ECM Summary” under the “Information” menu. Ensure that you are programming the correct flash file for your engine.

If a 630-2 or 268-2 diagnostic trouble code is displayed after flash programming, a required parameter is missing. Program the missing parameter.

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## ECM - Replace

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### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

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### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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## Engine ECM

The engine is equipped with an Electronic Control Module (ECM). The ECM contains no moving parts. Follow the troubleshooting procedures in this manual in order to be sure that replacing the ECM will correct a fault. Verify that the suspect ECM is the cause of the fault.

**Note:** Ensure that the ECM is receiving power and that the ECM is properly grounded before replacement of the ECM is attempted. Refer to the schematic diagram.

A test ECM can be used in order to determine if the ECM on the engine is faulty. Install a test ECM in place of the suspect ECM. Install the flash file with the correct part number into the test ECM. Program the parameters for the test ECM. The parameters must match the parameters in the suspect ECM. Refer to the following test steps for details. If the test ECM resolves the fault, reconnect the suspect ECM. Verify that the fault returns. If the fault returns, replace the ECM.

**Note:** If an ECM is used as a test ECM, select “Test ECM Mode” on the electronic service tool before the engine serial number is entered.

Use the electronic service tool to read the parameters in the suspect ECM. Record the parameters in the suspect ECM. Install the flash file into the new ECM. After the ECM is installed on the engine, the parameters must be programmed into the new ECM.

**Note:** When a new ECM is not available, an ECM can be used from an engine that is not in service. The ECM must have the same serial number suffix. Ensure that the replacement ECM and the part number for the flash file match the suspect ECM. Be sure to record the parameters from the replacement ECM. Use the “Copy Configuration ECM Replacement” function in the electronic service tool.

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**NOTICE**

If the flash file and engine application are not matched, engine damage may result.

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Perform the following procedure in order to replace the ECM.

1. Connect the electronic service tool to the diagnostic connector.
2. Use the “Copy Configuration ECM Replacement” function from the electronic service tool. If the “Copy Configuration” is successful, proceed to Step 4. If the “Copy Configuration” failed, proceed to Step 10b.

**Note:** Record any Logged Faults and Events for your records.

3. Record the following parameters:
  - Record all of the parameters on the “Configuration” screen.
  - Record all of the parameters on the “Throttle Configuration” screen.
  - Record all of the parameters on the “Mode Configuration” screen.
  - Record the serial numbers of the electronic unit injectors. The injector serial numbers are shown on the “Injector Trim Calibration” screen.

**Note:** If the parameters cannot be read, the parameters must be obtained elsewhere. Some parameters are stamped on the engine information plate, but most parameters must be obtained from PTMI data.

4. Remove power from the ECM.
5. Remove the ECM. Refer to Disassembly and Assembly, “Electronic Control Module - Remove and Install”.
6. Install the replacement ECM. Refer to Disassembly and Assembly, “Electronic Control Module - Remove and Install”.
7. If the replacement ECM is used as a test ECM, select “Test ECM Mode” on the electronic service tool.

8. Download the flash file.
  - a. Connect the electronic service tool to the diagnostic connector.
  - b. Select “WinFlash” from the “Utilities” menu of the electronic service tool.
  - c. Select the downloaded flash file.
9. If necessary, use the electronic service tool to clear the rating interlock. To clear the rating interlock, enter the factory password when the electronic service tool is first connected. Activating the Test ECM mode will also clear the rating interlock.
10. Use the electronic service tool to program the parameters. Perform the following procedure.
  - a. If the “Copy Configuration” procedure was successful, use the “Copy Configuration, ECM Replacement” function to load the configuration file into the ECM.
 

**Note:** During the following procedure, factory passwords may be required.

    - b. If the “Copy Configuration” procedure failed, configure the parameters individually. The parameters should match the parameters from step 3.
11. Perform the “High Pressure Fuel Pump Calibration” .
12. Check for logged diagnostic codes. Factory passwords are required to clear logged events.

i06574499

## Electrical Connectors - Inspect

Most electrical faults are caused by poor connections. The following procedure will help in detecting faults with connectors and with wiring. If a fault is found, correct the condition and verify that the fault is resolved.

Intermittent electrical faults are sometimes resolved by disconnecting and reconnecting connectors. Check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 2900A033 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires.
- Always use a 28170079 Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Always use a 2900A033 Crimp Tool to service AMP seal connectors.
- Refer to Troubleshooting, “ECM Harness Connector Terminals” to service the connectors for the Electronic Control Module (ECM).
- Always use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire to access a circuit for measurements.
- If a wire is cut, always install a new terminal for the repair.

**⚠ WARNING**

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

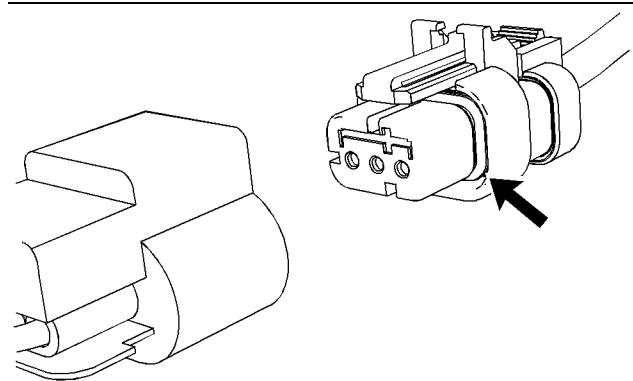


Illustration 187 g01131019  
Seal for a three-pin connector (typical example)

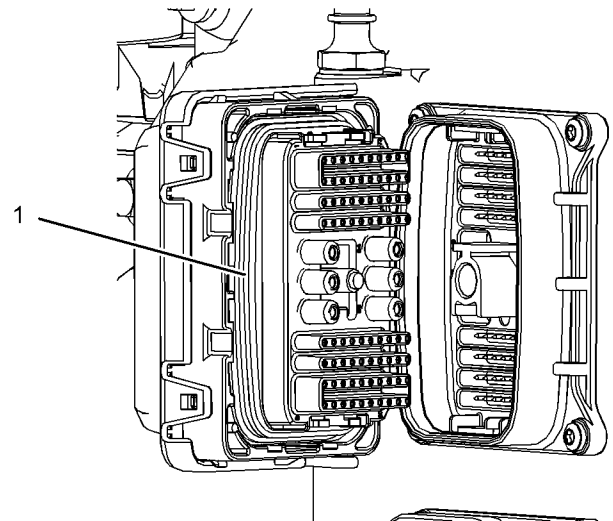


Illustration 188 g03137420  
(1) Seal for ECM connector

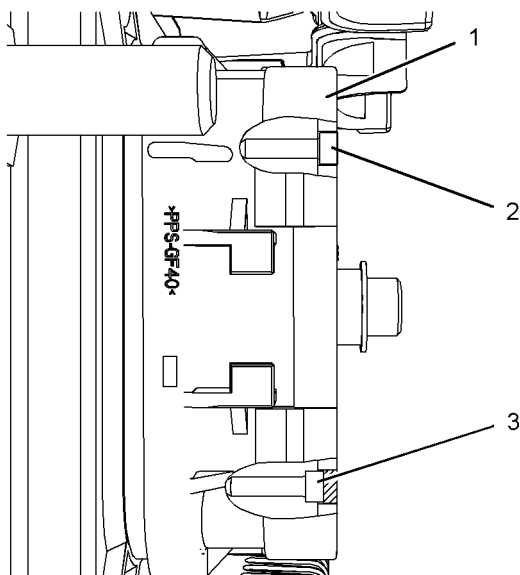


Illustration 186 g01131276

Diagram for the installation of a connector plug (typical example)

- (1) ECM connector
- (2) Correctly inserted plug
- (3) Incorrectly inserted plug

Table 246

Troubleshooting Test Steps	Values	Results
<p><b>1. Check Connectors for Moisture and Corrosion</b></p> <p><b>A.</b> Inspect all the harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. This situation can create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.</p> <p><b>B.</b> Ensure that the sealing plugs are in place. If any of the plugs are missing, replace the plug. Ensure that the plugs are inserted correctly into the connector. Refer to Illustration 186 .</p> <p><b>C.</b> Disconnect the suspect connector and inspect the connector seal. Ensure that the seal is in good condition. If necessary, replace the connector.</p> <p><b>D.</b> Thoroughly inspect the connectors for evidence of moisture entry.  <b>Note:</b> Some minor seal abrasion on connector seals is normal. Minor seal abrasion will not allow the entry of moisture. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and repaired. If the source of the moisture entry is not repaired, the fault will recur. Simply drying the connector will not rectify the fault. Check the following items for the possible moisture entry path:</p> <ul style="list-style-type: none"> <li>• Missing seals</li> <li>• Incorrectly installed seals</li> <li>• Nicks in exposed insulation</li> <li>• Improperly mated connectors</li> </ul> <p>Moisture can also travel to a connector inside a wire. If moisture is found in a connector, thoroughly check the connector harness for damage. Also check other connectors that share the harness for moisture.  <b>Note:</b> The ECM is a sealed unit. If moisture is found in an ECM connector, the ECM is not the source of the moisture. Do not replace the ECM.</p> <p><b>E.</b> Check the connectors for white deposits. White deposits may indicate that the connector has been contaminated with Diesel Exhaust Fluid (DEF). DEF may corrode the copper wire in the wiring harness.</p>	<p>Harness, connectors, and seals are OK.</p>	<p><b>Result:</b> A fault has been found with the harness or the connectors.</p> <p><b>Repair:</b> Repair the connectors or the wiring, as required. Ensure that all the seals are correctly installed. Ensure that the connectors have been reattached.</p> <p>If corrosion is evident on the pins, sockets or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion.</p> <p>If moisture was found in the connectors, run the engine for several minutes and check again for moisture. If moisture reappears, the moisture is wicking into the connector. Even if the moisture entry path is repaired, replacement of the wires may be necessary.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The harness, connectors, and seals are in good condition.</p> <p>Proceed to Test Step 2.</p>
<p><b>2. Check the Wires for Damage to the Insulation</b></p> <p><b>A.</b> Carefully inspect each wire for signs of abrasion, nicks, and cuts.                      Inspect the wires for the following conditions:</p> <ul style="list-style-type: none"> <li>• Exposed insulation</li> <li>• Rubbing of a wire against the engine</li> <li>• Rubbing of a wire against a sharp edge</li> </ul> <p><b>B.</b> Check all the fasteners for the harness and the strain relief components on the ECM to verify that the harness is correctly secured. Also check all the fasteners to verify that the harness is not compressed. Pull back the harness sleeves to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This condition damages the wires that are inside the harness.</p>	<p>The wiring is OK</p>	<p><b>Result:</b> There is damage to the harness.</p> <p><b>Repair:</b> Replace the harness.                      Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The wires are free of abrasion, nicks, and cuts and the harness is correctly clamped.</p> <p>Proceed to Test Step 3.</p>

(continued)

(Table 246, contd)

Troubleshooting Test Steps	Values	Results
<p><b>3. Inspect the Connector Terminals</b></p> <p><b>Note:</b> The ECM connectors cannot be repaired. If damage is found on an ECM connector, the harness must be replaced.</p> <p><b>A.</b> Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are correctly aligned in the connector and verify that the terminals are correctly located in the connector.</p>	<p>Terminals are aligned and undamaged</p>	<p><b>Result:</b> The terminals of the connector are damaged.</p> <p><b>Repair:</b> Repair the terminals and/or replace the terminals, as required.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The terminals are OK.</p> <p>Proceed to Test Step 4.</p>

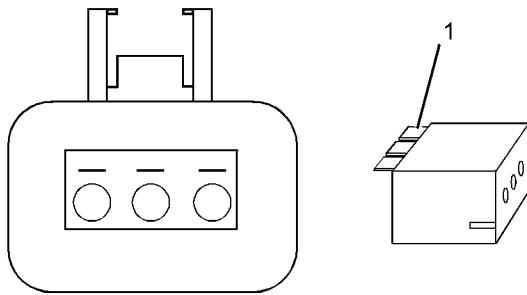


Illustration 189

g01802454

A typical example of the lock wedge.

(1) Lock wedge



Table 247

Troubleshooting Test Steps	Values	Results
<p><b>4. Perform a Pull Test on Each Wire Terminal Connection</b></p> <p><b>A.</b> Ensure that the locking wedge for the connector is installed correctly. Terminals cannot be retained inside the connector if the locking wedge is not installed correctly.</p> <p><b>B.</b> Perform the 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was correctly crimped in the terminal and whether the terminal was correctly inserted into the connector.</p>	Pull test OK	<p><b>Result:</b> A wire has been pulled from a terminal or a terminal has been pulled from the connector in the 45 N (10 lb) pull test.</p> <p><b>Repair:</b> Use the 2900A033 Crimp Tool to replace the terminal. Replace damaged connectors, as required. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> All terminals pass the pull test.</p> <p>Proceed to Test Step 5.</p>
<p><b>5. Check the Locking Mechanism of the Connectors</b></p> <p><b>A.</b> Ensure that the connectors lock correctly. After locking the connectors, ensure that the two halves cannot be pulled apart.</p> <p><b>B.</b> Verify that the latch tab of the connector is correctly latched. Also verify that the latch tab of the connector returns to the locked position.</p>	The connectors are locked and are not damaged	<p><b>Result:</b> The locking mechanism for the connector is damaged or missing.</p> <p><b>Repair:</b> Repair the connector or replace the connector, as required. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The connectors are in good condition.</p> <p>Proceed to Test Step 6.</p>
<p><b>6. Check the Screws on the ECM Connectors</b></p> <p><b>A.</b> Visually inspect the screws for the ECM connectors. Ensure that the threads on each screw are not damaged.</p> <p><b>B.</b> Connect the ECM connectors.</p> <p><b>C.</b> Use a 7 mm screw to retain each of the ECM connectors.</p> <p><b>D.</b> Tighten the two screws for the ECM connector to the correct torque of 6.0 N·m (53 lb in).</p>	The ECM connectors are secure.	<p><b>Result:</b> The screws for the ECM connectors are damaged or a threaded hole in the ECM is damaged.</p> <p><b>Repair:</b> Repair the connectors or replace the connectors or screws, as required. If a threaded hole in the ECM is damaged, replace the ECM. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p> <p><b>Result:</b> The ECM connectors are secured.</p> <p>Proceed to Test Step 7.</p>
<p><b>7. Perform the “Wiggle Test” on the Electronic Service Tool</b></p> <p><b>A.</b> Select the “Wiggle Test” from the diagnostic tests on the electronic service tool.</p> <p><b>B.</b> Choose the appropriate group of parameters to monitor.</p> <p><b>C.</b> Press the “Start” button. Wiggle the wiring harness to reproduce intermittent faults. If an intermittent fault exists, the status will be highlighted and an audible beep will be heard.</p>	Intermittent faults were indicated.	<p><b>Result:</b> No intermittent faults were found.</p> <p>If directed here from another procedure, return to the procedure and continue testing. If this test confirms that the fault has been eliminated, return the engine to service.</p> <p><b>Result:</b> At least one intermittent fault was indicated.</p> <p><b>Repair:</b> Repair the harness or the connector.</p> <p>Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.</p>

i07693101

## Injector Code - Calibrate

Injector codes are codes that are 30 hexadecimal characters in length that are supplied with each injector. The code is on a plate on the top of the injector and a card is also included in the packaging for the injector. The code is used by the Electronic Control Module (ECM) to balance the performance of the injectors.

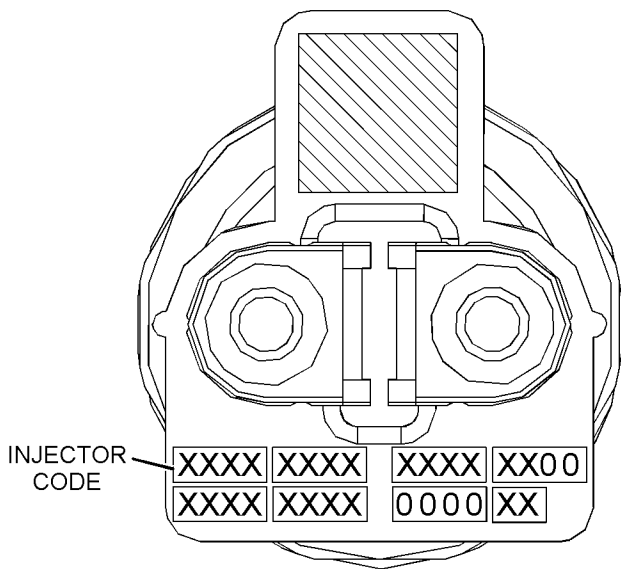


Illustration 190

g02854936

Label with the injector code

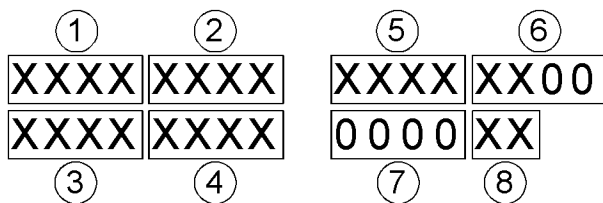


Illustration 191

g02132457

Sequence for recording the injector code

The electronic service tool is used to load the injector codes into the ECM.

The injector codes must be loaded into the ECM if any of the following conditions occur:

- An electronic unit injector is replaced.
- The ECM is replaced.
- A -2 diagnostic code is active for one or more of the injectors
- Electronic unit injectors are exchanged between cylinders.

If the ECM is replaced, the injector codes are normally transferred to the new ECM as part of the “Copy Configuration” procedure. If the “Copy Configuration” procedure fails, the injector codes must be loaded manually.

### Installing Injector Codes

**Note:** The injector code is on the electronic unit injector.

1. Record the injector code for each electronic unit injector.
2. Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, “Electronic Service Tools”.
3. Turn the keyswitch to the ON position.
4. Select the following menu options on the electronic service tool:
  - Service
  - Calibrations
  - Injector Codes Calibration
5. Select the appropriate cylinder.
6. Click the “Change” button.
7. Input the applicable injector code that was recorded in Test Step 1.
8. Click the “OK” button.
 

The injector code is loaded into the ECM.
9. Repeat the procedure for each cylinder, as required.

### Exchanging Electronic Unit Injectors

Exchanging electronic unit injectors can help determine if a combustion problem is in the electronic unit injector or in the cylinder. If two electronic unit injectors that are currently installed in the engine are exchanged between cylinders, the injector codes

must also be exchanged. Press the “Exchange” button at the bottom of the “Injector Trim Calibration” screen on the electronic service tool. Select the two electronic unit injectors that will be exchanged and press the “OK” button.

i07433030

## SCR Inducement Emergency Override

Table 248

Diagnostic Trouble Codes for SCR Inducement Emergency Override			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
7343–31	E1598 (2)	SCR Inducement Override Re- newal Required	This code indicates that the Inducement Override has been activated. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the fault.			

When an emergency situation occurs, initial activation of the override is allowed without input from Caterpillar™. Prior to activation, the operator will be notified of the following on display :  
**“EMERGENCY USE ONLY. SEE OWNERS MANUAL. PENALTIES APPLY FOR MISUSE”** .

Upon activation, the check engine, and action lamps will also illuminate to alert the operator that the override is active. A code will also become active indicating that the engine emission operator inducement emergency override is active. The code will remain active until the override is reset. The override must be paused by the operator if the emergency ends before the 120 hours of override operation has expired. While paused, the equipment will be subject to inducements (derates). The override may be reactivated if an emergency situation returns. After 120 hours of override use the override will expire, and the equipment will be subject to inducements. Upon activation, the check engine and action lamps will continue to be illuminated until the override is reset. If the override has expired, the dealer will need to reset the override to use the override again. The code indicating that the engine emission operator inducement emergency override is active, will be cleared when the override is reset. Resetting the override is the only way to clear the code.

The override needs to be reset by an authorized dealer or distributor through the electronic service tool whenever the override has expired. The override cannot be used again until the override is reset. The warning lamp will continue to be illuminated until the override is reset. The override may be reset at any point after the initial activation.

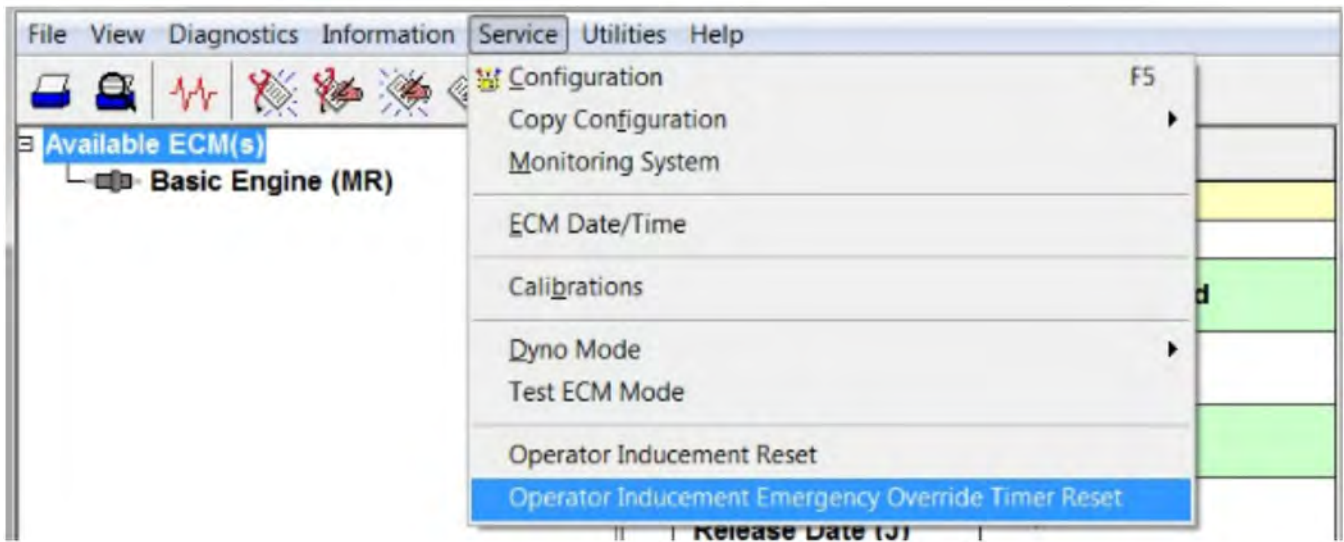


Illustration 192

g06241919

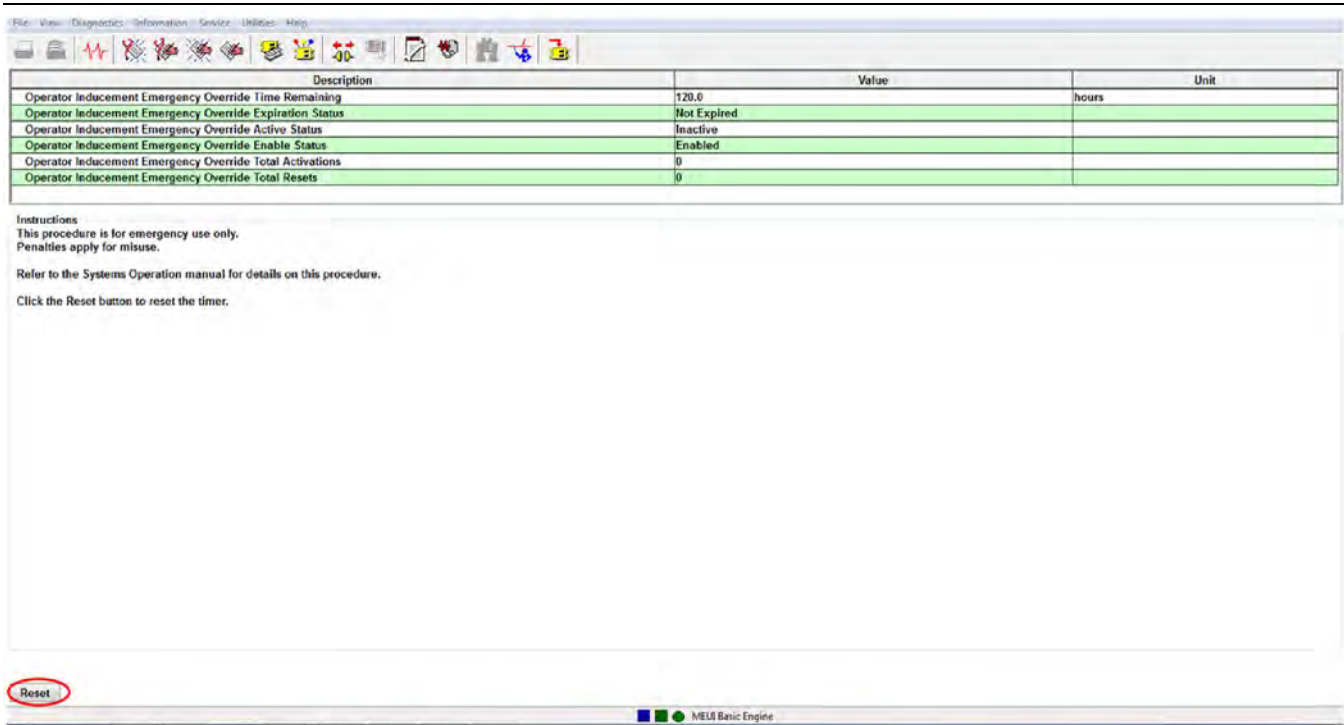


Illustration 193

g06241920

Table 249

Troubleshooting Test Steps	Values	Results
<p><b>1. Reset the Operator Inducement Emergency Override</b></p> <p><b>A.</b> Connect the electronic service tool to the diagnostic connector.</p> <p><b>B.</b> Under the "Service Tab" , navigate to "Operator Inducement Emergency Override Timer Reset" .</p> <p><b>C.</b> Click the "Reset" button at the bottom of the screen.</p>	Reset	<p><b>Result:</b> The Emergency Inducement Operator Override Reset was performed.</p> <p>Return the unit to service.</p>

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