MAXXFORCE®
ADVANCED DIESEL POWER

# 2010 MaxxForce® 11 and 13L Diagnostics

**Study Guide**
**TMT-121130**

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# Introduction

Welcome to this engine training course, 2010 MaxxForce® 11 and 13 Diagnostics for Technicians. This course will introduce technicians to the diagnostic procedures used to solve starting and performance problems.

This program consists of this introduction and the following five modules: Required Tests, Special Tests for the Fuel Supply System, Special Tests for the High-Pressure Fuel System, Special Tests for the Cold Start Assist System, and Special Tests for the Air Management System.

Upon completion of this course, you will be able to identify the steps and procedures used to diagnose both starting and engine performance issues, and use ServiceMaxx™ to perform various engine tests.

**Objectives**

**Upon completion of this course, you will be able to:**

- **Identify the steps and procedures used to diagnose starting and performance issues.**
- **Use ServiceMaxx™ to perform various engine tests.**

**WARNING**

**To prevent personal injury or death, the engine must be stationary for at least 5 minutes before performing any work on the high-pressure fuel system to allow for system depressurization. Use the Electronic Service Tool to monitor fuel rail pressure and cycle the ignition switch to the OFF position. Turn the key-on with the engine off to verify that rail pressure is within a safe range before opening any high-pressure fuel line connections.**

## NOTES

# Required Tests Module 1

## Overview

The diagnostic manual on ISIS® includes both Hard-Start No-Start and Performance Diagnostic procedures. Each of these sections is divided into required tests and special tests. This module will cover the required tests used to diagnose both starting and performance issues.

***"This module will cover the required tests used to diagnose both starting and performance issues."***

Refer to the electronic control system and performance specifications sections in the diagnostic manual when performing engine tests.

## Starting Issues

### Overview

There are several tests used to identify the cause of a starting issue. These tests are divided into required tests and special system tests.

Always perform the required tests in sequence, and perform the special tests only when directed by the results of a required test.

***"Always perform the required tests in sequence."***

If the cause of the problem is found when performing a required test, repair the fault and retest. If the problem was corrected, do not complete any remaining required tests. In addition, always use the latest service literature when servicing an engine.

First, we'll explain the required tests for starting issues.

There are three required tests for starting issues. They are:

- Visual Inspection
- DTCs and Sensor Comparison
- Engine Cranking Test

## Visual Inspection

***"The first required test for starting issues is a visual inspection."***

The first required test for starting issues is a visual inspection of the engine and its subsystems.

Start by checking the engine oil and quality. Is the oil the correct weight? Is the oil diluted or its viscosity changed from fuel or coolant contamination?

Check the coolant level and quality. Is the coolant level low or are there traces of oil mixed in with the coolant? Problems in these systems may indicate a mechanical issue with the engine.

Check the fuel level in the tank and take a fuel sample from the primary filter. Check for:

- poor fuel quality
- water
- sediment
- clouding
- ice crystals in the fuel

Check the entire air management system from the air filter housing to the intake manifold. Look for loose connections that will allow dirt and dust to enter the system. The presence of either will quickly wear the liners to the point of low compression and hard starting.

***"Look for loose connections that will allow dirt and dust to enter the system."***

Check the Electrical System for chaffed wiring or broken connections.

Check the exhaust system. Leaks around the Exhaust Aftertreatment Assembly or dented pipes could be a sign of a high restriction that could prevent the engine from starting.

Any issues found during the visual inspection should be repaired before continuing.

***"Any issues found during the visual inspection should be repaired before continuing."***

### DTC's and Sensor Comparison

The second required test for starting issues is to check for DTC's and compare sensor values. Start by turning the ignition key to the ON position.

Connect the Electronic Service Tool, or EST, and record the sensor values and any active, pending, previously active, or healing Diagnostic Trouble Codes. Evaluate previously active and healing codes, which have a high number of counts.

If an active or pending code exists, refer to the Diagnostic Trouble Codes section of the diagnostic manual.

***"If any sensor values are suspect, compare the data collected with the signal values section of the manual."***

If any sensor values are suspect, compare the data collected with the signal values section of the manual.

### Engine Cranking

The last required test for starting issues is the Engine Cranking test. This test allows you to analyze the engine's systems by monitoring specific sensor values while cranking.

Start by opening the Hard-Start No-Start session in ServiceMaxx™.

Begin recording and crank the engine for 10 to 20 seconds.

***"Compare the recorded session values to the cranking specifications."***

Compare the recorded session values to the cranking specifications.

If no rpm signal is present, see CKP Sensor and CMP Sensor in Electronic Control Systems Diagnostics.

If either Engine Speed or Switched Battery was less than the specifications, check the starting and charging system.

If the Turbocharger 1 Turbine Outlet Pressure, or TC1TOP, was greater than the specification, excessive backpressure may be causing the no-start condition. Check this by opening

the exhaust before the pre-DOC and then retest.

If the Diesel Particulate Filter Differential Pressure, or DPFDP, was greater than the specification, excessive backpressure created by the filter may be causing the no-start condition. Refer to Electronic Control Systems Diagnostics for further procedures.

If the Fuel Delivery Pressure, or FDP, was less than the specification, go to the Special Tests for the Fuel Supply System.

If the FDP was within specification and Fuel Rail Pressure, or FRP, was less than specification, go to the Special Tests for the High-Pressure Fuel System.

If all values are within specification, and the engine is subjected to temperatures below 50˚F or 10˚C during normal operation, go to the Special Tests for the Cold Start Assist System.

This concludes the required tests for starting issues.

***“If the Diesel Particulate Filter Differential Pressure, or DPFDP, was greater than the specification, refer to Electronic Control Systems Diagnostics for further procedures.”***

## Performance Issues

### Overview

There is also a series of tests used to determine the cause of a performance concern. These tests are divided into required tests and special system tests.

***"There are six required tests for performance issues."***

There are six required tests for performance issues. They are:

- Visual Inspection
- DTCs and Sensor Comparison
- Engine Low Idle to High Idle
- High-Pressure Pump Test
- KOER Air Management Test
- Road Test

### Visual Inspection / DTC's and Sensor Comparison

The first two required tests for performance issues are:

- Visual Inspection
- DTC's and Sensor Comparison

Each of these has already been described in the Required Tests for Starting Issues.

### Engine Low Idle to High Idle Engine Low Idle to High Idle

***"The Engine Low Idle to High Idle Test is used to check sensor values with the engine running at high idle."***

The third required test for performance issues is the Engine Low Idle to High Idle Test. This test is used to check sensor values with the engine running at high idle.

Start by turning the ignition key to the ON position.

Then, open the Performance session in ServiceMaxx™ and begin recording.

Now check the Accelerator Pedal Position, or APP, sensor signal.

The APP signal should be 0% at rest and 99.6% when the accelerator pedal is fully depressed to the floor.

***"The APP signal should be 0% at rest and 99.6% when the accelerator pedal is fully depressed to the floor."***

Refer to the Accelerator Pedal Position section in Electronic Control Systems Diagnostics if the APP signal does not meet specifications.

If the APP signal is within specification, continue to the next step.

Start the engine and run at idle for five seconds. Push the accelerator pedal until it is fully depressed to the floor and APP reads 99.6%. Hold the pedal for ten seconds and then let the engine return to idle.

Compare the recorded sensor values to the high idle specifications.

If the Fuel Delivery Pressure is less than the minimum specification, go to the Special Tests for the Fuel Supply System.

***"If the Fuel Delivery Pressure is less than the minimum specification, go to the Special Tests for the Fuel Supply System."***

If the Fuel Delivery Pressure is within specification, but Fuel Rail Pressure is less than the specification, go to the Special Tests for the High-Pressure Fuel System.

If the Turbocharger 1 Turbine Outlet Pressure is greater than the

specification, open the exhaust before the pre-DOC and retest.

***"The Diesel Particulate Filter may be restricted if DPF Differential Pressure is greater than the specification."***

The Diesel Particulate Filter may be restricted if DPF Differential Pressure is greater than the specification. Refer to Electronic Control Systems Diagnostics for further procedures.

If the Intake Manifold Pressure, or IMP, is less than the specification, inspect the air management system for the following conditions:

- Charge-Air-Cooler and Tubing Leaks
- Intake Restriction
- Wastegate Malfunction
- Excessive Back Pressure
- Low Compression
- and Turbocharger Damage

If the Intake Manifold Pressure is within specification perform the Crankcase Pressure Test.

***"If the engine does not accelerate smoothly, check for aeration and restriction in the fuel supply system."***

If the engine does not accelerate smoothly, check for aeration and restriction in the fuel supply system.

If there is no aeration or restriction, perform the cylinder cut-out and relative compression tests to isolate the weak cylinder.

## High-Pressure Pump Test

The fourth required test for performance issues is the High-Pressure Pump Test. This test checks the condition of the high-pressure fuel system.

During this test the Fuel Pressure Control Valve will be commanded to produce several different pressures.

The ECM then determines if the high-pressure pump is able to react quickly based on the test results.

Start with the engine running and select the High-Pressure Pump Test in ServiceMaxx™. The test will begin once it is opened.

If any of the test results displayed a slow response time, go to the Special Tests for the High-Pressure Fuel System.

If the High-Pressure Pump was able to produce the commanded pressures, perform the Key-On Engine-Running Air Management Test.

***"During the High-Pressure Pump Test the Fuel Pressure Control Valve will be commanded to produce several different pressures."***

## Key-On Engine-Running Air Management Test

The fifth required test for performance issues is the Key-On Engine-Running Air Management Test. This test is used to verify that all air management actuators are working correctly.

***"Before beginning, there must be a minimum of 90 psi in the vehicle's air tanks."***

Before beginning, there must be a minimum of 90 psi in the vehicle's air tanks.

Start by selecting the KOER Air Management Test in ServiceMaxx™.

During this test the ECM cycles the air management actuators. While the test is running monitor the effect that each actuator has on Intake Manifold Pressure.

If a problem is found with the EGR Valve or the Engine Throttle Valve, go to Electronic Control Systems Diagnostics.

If a problem is found with any other air management actuator, perform the Air Control Valve Tests.

**NOTE**

**If the truck has progressive shift or gear down protection enabled, disable these features prior to performing the Road Test.**

### Road Test

The last required test for performance issues is the Road Test. This test is used to check for unacceptable engine performance at full load and rated speed.

With the engine running, open the Performance Session in ServiceMaxx™ and begin recording the session.

When conditions are safe, select a suitable gear and accelerate until rated RPM is reached at 100% load. At that point, the road test is complete.

Stop recording and review the session once the vehicle is parked.

Compare the values at 100% load and rated speed to the specifications.

If the Fuel Delivery Pressure was less than the specification, go to the Special Tests for the Fuel Supply System.

If the Fuel Delivery Pressure was within specification but Fuel Rail Pressure was less than specification, go to the Special Tests for the High-Pressure Fuel System.

If the Turbocharger 1 Turbine Outlet Pressure was greater than the specification, check for proper exhaust back pressure valve operation. Check for an exhaust system restriction if the valve operated correctly.

***"Check for an exhaust system restriction if the valve operated correctly."***

If Intake Manifold Pressure was less than the specification, check for leaks at the charge-air connections.

If all recorded values were within specifications, perform the Crankcase Pressure Test.

Finally, if the engine did not accelerate smoothly or felt like it was not running on all cylinders, perform the Aeration and Restriction, Relative Compression, and the Cylinder Cutout Tests.

## NOTES

# Special Tests for the Fuel Supply System

# Module 2

## Overview

The next four modules will explain the additional steps and procedures used for diagnosing issues with fuel supply, high-pressure fuel, cold start assist, and air management.

This module will describe the four special tests used when diagnosing the Fuel Supply System. They are:

- System Priming
- Delivery Pressure
- Low-Pressure Pump Dead Head
- Aeration and Restriction

All four of the special tests are used when diagnosing starting issues. Only three tests are used when diagnosing performance issues.

***"All four of the special tests are used when diagnosing starting issues."***

## System Priming

The first test is System Priming. This test is only used when diagnosing a starting issue. The fuel system must be primed to ensure there is no air in the low-pressure fuel lines and filters.

If fuel does not pull from the fuel tank when priming the system, either the supply line has a restriction or an air

leak; or the fuel primer pump assembly is faulty.

***"Fuel lines may be removed when performing various tests."***

Fuel lines may be removed when performing various tests. Be sure to prime the fuel system anytime a fuel line connection is broken.

## Delivery Pressure

The second test is the Delivery Pressure Test. This test is used when diagnosing both starting and performance issues.

First, make sure the fuel line connections are clean.

Now, disconnect the inlet connection from the low-pressure pump. Connect the supply line from the Clean Fuel Tank directly to the fuel pump inlet.

***"Fill the system with fuel by squeezing the primer on the tool's supply line."***

Fill the system with fuel by squeezing the primer on the tool's supply line.

Crank the engine and monitor fuel delivery pressure.

When diagnosing a performance issue, run the engine at high idle and record the fuel delivery pressure.

If the fuel delivery pressure is now within specification, perform the Aeration and Restriction Test.

If the fuel delivery pressure is below specification, perform the Low-Pressure Pump Dead Head Test.

## Low-Pressure Pump Dead Head

The third test is the Low-Pressure Pump Dead Head Test. This test is used when diagnosing both starting and performance issues.

***"The Low-Pressure Pump Dead Head Test is used when diagnosing both starting and performance issues."***

This test will help determine which component is causing the low fuel delivery pressure reading.

Start with the Clean Fuel Tank still connected and disconnect the fuel pump outlet line. Connect the fuel inlet restriction/aeration tool to the fuel pump outlet port.

Next, connect the fuel block off tool as well as a fuel pressure gauge to the compucheck fitting.

Squeeze the primer on the Clean Fuel Tank supply line to remove any air in the lines.

***"Squeeze the primer on the Clean Fuel Tank supply line to remove any air in the lines."***

Crank the engine and monitor the gauge pressure.

If the pressure is below specification, the low-pressure pump is defective and must be replaced.

If the fuel pressure meets specification, there is a component downstream

from the pump causing low delivery pressure.

Inspect the engine mounted fuel filter assembly for:

- a cracked stand pipe
- a damaged stand pipe o-ring
- a damaged filter o-ring
- a porous filter housing

***"If all of these components are in working order, there may be a leak in the high-pressure fuel system."***

If all of these components are in working order, there may be a leak in the high-pressure fuel system. Go to the Special Tests for the High-Pressure Fuel System.

## Aeration and Restriction

### Overview

The fourth test is the Aeration and Restriction Test. This test is used when diagnosing both starting and performance issues.

Aeration and Restriction consists of two separate tests; the Aeration Test and the Restriction Test. Always perform these tests in sequence beginning with the Aeration Test.

### Aeration Test

Start by disconnecting the fuel pump outlet line.

Connect the Fuel Inlet Restriction/ Aeration Tool to the fuel pump outlet

port. Use the fuel line coupler to connect the aeration tool to the fuel pump outlet line.

Prime the fuel system to remove any air in the fuel lines.

Crank or run the engine and use a flashlight to look for fuel aeration in the Restriction/Aeration Tool.

If the fuel is not aerated, go to the Restriction Test.

***"If the fuel is not aerated, go to the Restriction Test."***

If the fuel is aerated, connect the Clean Fuel Tank to the primer pump inlet and prime the system to remove air from the fuel lines.

Crank or run the engine and look for fuel aeration.

If the fuel is not aerated with the Clean Fuel Tank connected, repair the lines or components between the vehicle fuel tank and primer pump.

If the fuel is still aerated with the Clean Fuel Tank connected, the cause of the aeration is either the primer pump or the fuel pump supply line. Repair as necessary.

***"If the fuel is still aerated with the Clean Fuel Tank connected, the cause of the aeration is either the primer pump or the fuel pump supply line."***

**Restriction Test**

Start by removing the Restriction/ Aeration Tool from the previous test and re-install the original fuel line.

Use the fuel line coupler to connect the Restriction/Aeration Tool between the pump inlet port and the pump supply line.

Connect a vacuum gauge to the compucheck fitting on the Restriction / Aeration Tool.

Prime the system.

Crank or run the engine while monitoring the vacuum gauge.

***"If the supply restriction is within specification, verify the Fuel Delivery Pressure sensor reading is accurate."***

If the supply restriction is within specification, verify the Fuel Delivery Pressure sensor reading is accurate. If it is ok, go to the Special Tests for the High-Pressure Fuel System.

If the supply restriction is above specification, connect the Clean Fuel Tank to the primer pump inlet.

Prime the system.

Crank or run the engine while monitoring the vacuum gauge.

If supply restriction is above specification with the Clean Fuel Tank connected, the strainer/primer pump or pump supply line is restricted. Clean the strainer and check the fuel line.

If the supply restriction is within specification, connect the Clean Fuel Tank to the primary fuel filter inlet.

Prime the system.

Crank or run the engine while monitoring the vacuum gauge.

If the supply restriction is above specification with the Clean Fuel Tank connected to the primary fuel filter inlet, the primary filter or the fuel supply line to the primer pump is restricted.

Replace the primary filter, clean the fuel strainer and check the fuel lines.

If the supply restriction is now within specification, the fuel line from the tank is restricted.

This concludes the Special Tests for the Fuel Supply System.

***"If the supply restriction is now within specification, the fuel line from the tank is restricted."***

## NOTES

# Special Tests for the High-Pressure Fuel System

# Module 3

## Overview

This module will describe the six special tests used when diagnosing the High-Pressure Fuel System. These six tests will check the FRP sensor, pump inlet pressure, injector fuel return, pressure relief valve, injector leakage, and pump return pressure. In addition, we will explain three ServiceMaxx™ procedures related to performance diagnostics.

All six of the special tests are used when diagnosing starting issues. Only five tests are used when diagnosing performance issues.

***"All six of the special tests are used when diagnosing starting issues."***

## FRP Sensor

The first test is the FRP sensor test. This test is only used when diagnosing a starting issue. The FRP Sensor test will determine if the sensor is sending a false reading to the ECM. A biased low Fuel Rail Pressure sensor can cause a no-start condition by keeping the ECM from firing the injectors.

Start by unplugging the Fuel Rail Pressure sensor harness connector.

Attempt to start the engine.

If the engine starts, there is a fault in either the Fuel Rail Pressure sensor or circuit. Go to Electronic Control Systems Diagnostics for further test procedures.

If the engine does not start, reconnect the sensor harness and perform the High-Pressure Pump Inlet Pressure Test.

## Pump Inlet Pressure

***"The Pump Inlet Pressure Test is used when diagnosing both starting and performance issues."***

The second test is the Pump Inlet Pressure Test. This test is used when diagnosing both starting and performance issues.

The High-Pressure Pump requires sufficient fuel from the low-pressure fuel system to operate correctly. With the Fuel Delivery Pressure sensor on the non-filtered side of the system, an in-spec sensor reading does not guarantee the High-Pressure Pump is receiving fuel. A restriction in the secondary filter could prevent fuel from reaching the High-Pressure Pump.

Start by disconnecting the Down-Stream-Injection Metering Unit fuel supply hose. Now connect the Restriction/Aeration Tool to the supply hose and install the fuel block off fitting. Connect the fuel pressure gauge and crank or start the engine.

Monitor the gauge pressure to determine if the engine mounted fuel filter is restricting fuel delivery.

If the gauge pressure is below specification, the secondary fuel filter is restricted.

***"If the gauge pressure is below specification, the secondary fuel filter is restricted."***

If the gauge pressure is within specification, the fuel supply to the High-Pressure Pump is sufficient. Perform the Injector Fuel Return Test.

## Injector Fuel Return

The third test is the Injector Fuel Return Test. This test is used when diagnosing both starting and performance issues.

This test will check for high-pressure fuel system leaks caused by faulty injectors or pipe connections.

Start by removing the banjo bolt at the injector fuel return port on the cylinder head. Replace the banjo bolt with the return line test fitting. Attach the test hose and route the free end into a fuel container. Crank or run the engine and monitor fuel flowing from the test hose.

If diagnosing a starting issue there should be no fuel returned while cranking.

***"If diagnosing a starting issue there should be no fuel returned while cranking."***

If fuel is flowing from the test hose, perform the Rail Pressure Leak Isolation Test.

If fuel is not flowing, re-install the fuel return line to the cylinder head and perform the Pressure Relief Valve Test.

***"If diagnosing a performance issue there should be approximately 27ml of fuel returned in one minute."***

If diagnosing a performance issue there should be approximately 27ml of fuel returned in one minute.

If the amount of fuel returned is greater than the specification, perform the Rail Pressure Leak Isolation Test.

If the amount of fuel returned is equal to or less than the specification, perform the Pressure Relief Valve Test.

## Pressure Relief Valve

The fourth test is the Pressure Relief Valve Test. This test is used when diagnosing both starting and performance issues.

Start by removing the rail return line banjo bolt, and replace it with the return line test fitting.

Connect the test hose to the fitting and place the free end into a fuel container.

Now, crank or run the engine and monitor fuel flow from the hose.

***"If fuel flows from the hose, the Fuel Rail Pressure Relief Valve is leaking."***

If fuel flows from the hose, the Fuel Rail Pressure Relief Valve is leaking. Replace the relief valve and retest.

If fuel does not flow from the hose, the High-Pressure Pump has failed.

If you have completed all of the diagnostic steps and the Fuel Rail Pressure sensor is not biased, pump inlet pressure meets specifications, high-pressure pipe to injector connections are not leaking, and fuel does not flow from the pressure relief valve; the fuel pump needs to be replaced.

## Rail Pressure Leak Isolation

The fifth test is the Rail Pressure Leak Isolation Test. This test is used when diagnosing both starting and performance issues.

Start with the return line tester connected to the injector fuel return port. Remove the number six injector fuel line and cap off the rail with a high-pressure rail plug.

***"Remove the number six injector fuel line and cap off the rail with a high-pressure rail plug."***

Crank or run the engine while monitoring both Fuel Rail Pressure and fuel flowing from the test hose.

If you are performing this test to diagnose a starting issue, watch for an increase in fuel rail pressure and fuel flow from the test hose. If rail pressure increases to the minimum starting pressure and fuel stops flowing, replace the number six injector tube and pipe.

If the Fuel Rail Pressure does not increase to starting pressure, and fuel

is still leaking, continue capping off the fuel rail ports until the leak is isolated.

If you are performing this test to diagnose a performance issue the amount of fuel returned must be measured and compared to specifications.

***"If the amount of fuel returned is greater than the specification, continue capping off one rail port at a time, until the leak is isolated."***

If the amount of fuel returned is greater than the specification, continue capping off one rail port at a time, until the leak is isolated.

If the amount of fuel returned is equal to or less than the specification, replace the number six injector tube and pipe.

After replacing an injector tube and pipe, retest with all of the injectors connected to ensure that there are no other leaks in the system.

## Pump Return Pressure

The sixth test is the Pump Return Pressure Test. This test is required for both starting and performance issues and must be performed whenever the fuel pump has been replaced.

Start by disconnecting the pump return line.

Using the fuel line coupler, connect the Restriction/Aeration Tool between the pump return port and the pump return line.

Connect a fuel pressure gauge to the compucheck fitting on the Restriction/ Aeration Tool.

Start and run the engine at high idle while monitoring the fuel pressure gauge.

***"Start and run the engine at high idle while monitoring the fuel pressure gauge."***

If the gauge reading is above specification, inspect the fuel return line between the High-Pressure Pump and the fuel tank for a restriction.

If the gauge reading is within specification, no further action is required.

## ServiceMaxx™: Relative Compression

The Relative Compression Test is used in conjunction with the Cylinder Cutout Test to determine if the cause of an engine misfire is mechanical or fuel related. This test is used to determine if each cylinder is in good mechanical condition.

**NOTE**

**It is important to ensure that the vehicle's batteries are fully charged before beginning this test.**

During this test the ECM looks at the speed of each piston's approach to top-dead-center compression and then the speed of each piston's down-stroke after passing top-dead-center. The ECM compares the two speeds and calculates the difference.

Start by opening the Relative Compression Test in ServiceMaxx™.

A window will appear to guide you through the test procedure.

The test will begin and you'll be instructed to crank the engine. After several seconds, the on-screen instructions will tell you to stop cranking. ServiceMaxx™ will now gather the information from the test and tell you to review the results.

***"A cylinder with low compression is represented by a shorter bar on the graph."***

A graph of the results will appear once the test is complete. A cylinder with low compression is represented by a shorter bar on the graph. In this case, the speeds of the piston's approach and down-stroke have little difference. Repeat this test a total of three times and compare the results from each test.

## ServiceMaxx™: Cylinder Cutout

The Cylinder Cutout Test allows you to disable each injector. This test is used to determine each cylinder's contribution to engine performance.

**NOTE**

**Before beginning this test, verify that fuel pressures are within specification and relative compression results are satisfactory.**

Start by opening the Cylinder Cutout test session and start the engine. Run the engine at idle for 10 seconds and verify that the engine coolant temperature is at least 160° Fahrenheit, or 71° Celsius.

Now, disable an injector and monitor the engine load and fuel rate while listening for engine tone changes.

Repeat this process for each injector. Compare the results for a disabled injector to the baseline values for engine fuel rate and engine load. If the engine load and fuel rate did not increase when an injector was disabled, that cylinder is not contributing to engine performance.

***"If the engine load and fuel rate did not increase when an injector was disabled, that cylinder is not contributing to engine performance."***

If the engine load and fuel rate did increase when an injector was disabled, that cylinder is contributing to engine performance. No action is required.

If the Cylinder Cutout Test identified a low-contributing cylinder and the Relative Compression Test did not, replace the failed injector.

If the Cylinder Cutout Test and the Relative Compression Test identify the same cylinder, determine the cause of the mechanical issue and then retest.

## ServiceMaxx™: Injector Replacement

An injector replacement procedure is used to program the ECM after replacing one or more injectors. There is a ten digit Injector Quantity Adjustment, or IQA code, marked on each injector. This code and the cylinder number where the injector is being installed must be programmed into the ECM.

***"An injector replacement procedure is used to program the ECM after replacing one or more injectors."***

This procedure allows the ECM to precisely control the injection of fuel into the combustion chamber.

Start by opening the Injector Quantity Adjustment session in ServiceMaxx™.

Enter the codes of the new injectors into the appropriate fields in the session.

***"Once the code has been entered, click "Program Engine" to save the information in the ECM."***

Once the code has been entered, click "Program Engine" to save the information in the ECM.

This concludes the Special Tests for the High-Pressure Fuel System.

## NOTES

## NOTES

# Special Tests for the Cold Start Assist System

# Module 4

## Overview

This module will describe the four special tests used when diagnosing the Cold Start Assist System. These four tests will check overall operation, igniter current draw, solenoid fuel supply, and igniter fuel supply.

All four of the special tests are used when diagnosing starting issues and will not be used when diagnosing a performance issue.

## System Test

The first test is the System Test. This test will determine if the cold start assist system is operating correctly.

The Cold Start Assist System is supported by two other engine systems: the electronic control system and the fuel supply system. Any issues with either of these systems may cause ineffective cold start assist operation.

Start by turning the ignition key to the ON position.

Select the Hard-Start No-Start Session from the Sessions drop down menu.

Record the Intake Manifold Temperature, or IMT, Engine Coolant

**NOTE**

**This test can only be performed if Engine Coolant Temperature 1 is below 50° Fahrenheit or 10° Celsius. If the temperature is above that value, use ServiceMaxx™ to run the Cold Start Assist Test.**

Temperature, or ECT1, and Fuel Delivery Pressure, or FDP, values.

Cycle the ignition switch.

Crank the engine when the wait-to-start lamp begins flashing. During cranking, monitor the IMT and FDP sensor values.

***"If FDP is below specification, go to the Special Tests for the Fuel Supply System."***

If FDP is below specification, go to the Special Tests for the Fuel Supply System.

If Intake Manifold Temperature does not increase approximately 10° Fahrenheit or 3.8° Celsius during engine cranking, the Cold Start Assist System is not functioning correctly. Perform the Igniter Current Draw Test.

If Intake Manifold Temperature does increase, the Cold Start Assist System is working correctly.

## Igniter Current Draw

The second test is the Igniter Current Draw Test. This test is used to verify that the igniter is reaching the proper temperature.

Start by connecting a current clamp around the igniter power circuit and zeroing the meter.

Open the Actuator Test in ServiceMaxx™ and select Cold Start Fuel Igniter.

With the duty cycle set at 95%, click start test.

Monitor the current draw using the electronic tester. The current draw should stabilize within a few seconds.

***"Monitor the current draw using the electronic tester."***

If the current draw is less than 20 amps, there is a problem with the igniter, fusible link, wiring, or relay.

Go to Electronic Control Systems Diagnostics to diagnose low current draw.

If the current draw is at or above 20 amps, the igniter is working correctly. Perform the Solenoid Fuel Supply Test.

## Solenoid Fuel Supply

The third test is the Solenoid Fuel Supply Test. This test is used to verify fuel pressure at the Cold Start Fuel Solenoid. There should be approximately 10 psi of pressure under normal operation.

***"There should be approximately 10 psi of fuel pressure under normal operation."***

Start by disconnecting the fuel supply line from the solenoid. Connect the fuel pressure gauge to the line.

Crank the engine while monitoring fuel pressure.

If the fuel pressure is below specification, the fuel line or pressure regulator in the filter housing is faulty. Repair as necessary.

If the fuel pressure is within specification, perform the Igniter Fuel Supply Test.

## Igniter Fuel Supply

The fourth test is the Igniter Fuel Supply Test. This test is used to verify fuel pressure at the Cold Start Fuel Igniter.

**NOTE**

**This test can only be performed if Engine Coolant Temperature 1 is below 50° Fahrenheit or 10° Celsius. If the temperature is above that value, use ServiceMaxx™ to run the Cold Start Assist Test.**

Start by disconnecting the fuel supply line at the igniter. Now, connect a fuel pressure gauge to the supply line.

Turn the ignition key to the ON position. When the wait-to-start lamp begins flashing, crank the engine and monitor the gauge reading.

If the fuel pressure is below specification, fuel is not passing through the solenoid. Go to Electronic Control Systems Diagnostics, Cold Start Fuel Solenoid.

If the fuel pressure is within specification, the igniter draws the correct current, and the solenoid is functioning but the Intake Manifold Temperature does not rise; fuel flow through the igniter may be restricted. Repair or replace the igniter.

This concludes the Special Tests for the Cold Start Assist System.

## NOTES

## NOTES

# Special Tests for the Air Management System

# Module 5

## Overview

This module will describe the three special tests used when diagnosing the Air Management System. These three tests will check the Air Control Valve and actuators, Centrifugal Crankcase oil separator, and crankcase pressure. In addition, we will explain a ServiceMaxx™ procedure that is needed for proper EGR operation.

All three of the special tests are used when diagnosing performance issues and will not be used when diagnosing a starting issue.

***"All three of the special tests are used when diagnosing performance issues."***

## Air Control Valve

The first test is the Air Control Valve Test. This test is used to check two devices: the Exhaust Back Pressure Valve, and the Turbocharger 2 Wastegate actuator.

Current ECM calibrations may affect the turbocharger 2 wastegate actuator position. With the key ON, the ECM may send a 100% duty cycle to the turbocharger 2 wastegate actuator to open the wastegate. To see actuator movement during this test, it may be necessary to command the

Turbocharger 2 Wastegate Control to 5% duty cycle.

**NOTE**

**There must be a minimum of 90 psi in the vehicle's air tanks before beginning this test.**

Start by opening the Actuator Test in ServiceMaxx™.

Select one of the two Air Control Valve actuators from the drop down menu.

Set the duty cycle to 95% and start the test.

Air pressure will be supplied to the actuator for five seconds.

The actuator is operating correctly if the actuator rod moves through its full travel.

***"If the actuator rod does not move, remove the air supply line from the actuator and repeat the test."***

If the actuator rod does not move, remove the air supply line from the actuator and repeat the test.

If air cannot be heard leaving the open air supply line when running the test, go to Electronic Control Systems Diagnostics for the actuator being tested.

If air can be heard leaving the open air supply line, check for a faulty actuator or sticking valve.

## Centrifugal Crankcase Oil Separator

The second test is the Centrifugal Crankcase Oil Separator Test. This test is used to verify that the separator

is spinning. During normal operation, the separator will spin at very high speeds to remove oil contaminants from crankcase gasses.

Before beginning this test, ensure that the engine is at normal operating temperature and that the oil level and temperature are within specification.

The Crankcase Oil Separator Speed sensor is mounted on top of the breather housing and detects separator rotation.

Start by monitoring the sensor signal in ServiceMaxx™ with the engine running.

If the sensor is displaying an rpm signal, the crankcase breather is operating correctly.

If the sensor is displaying zero rpm, continue to the next step.

To diagnose a faulty speed sensor, place an ultrasonic ear next to the breather housing and verify breather element rotation.

Turn the engine OFF and listen for centrifugal noise.

If centrifugal noise is not heard, refer to the Engine Service Manual for centrifugal crankcase oil separator removal and replacement procedures.

***“Before beginning this test, ensure that the engine is at normal operating temperature and that the oil level and temperature are within specification.”***

If centrifugal noise can be heard, see Crankcase Oil Separator Speed sensor in Electronic Control Systems Diagnostics.

## Crankcase Pressure

The third test is the Crankcase Pressure Test. This test is used to determine if there is excessive crankcase pressure being caused by a faulty internal, or external engine component.

**NOTE**

**Verify that the centrifugal crankcase oil separator is functioning correctly before performing this test.**

Start by connecting the Blow-by Test tool and manometer to the breather outlet elbow. Start the engine and run at high idle until the manometer reading stabilizes.

If crankcase pressure is within specification, no repair is required.

If crankcase pressure is above specification, continue to the next step.

Bleed the air from the vehicle's air tanks and remove and cap off the air line from the remote mounted centrifugal oil filter.

***"Start the engine and run at high idle while monitoring the manometer reading."***

Start the engine and run at high idle while monitoring the manometer reading.

If pressure is within specification, repair or replace the remote mounted centrifugal oil filter.

If pressure is still above specification, continue to the next step.

If the engine has an air compressor, disconnect the air discharge line and re-run the test.

If crankcase pressure is at or below specification, compressed air was leaking into the crankcase. Repair or replace the air compressor.

If crankcase pressure is still above specification, one or more cylinders are leaking compression into the crankcase. Perform the Relative Compression Test to pinpoint the suspect cylinder.

***"If crankcase pressure is still above specification, one or more cylinders are leaking compression into the crankcase."***

## ServiceMaxx™: O2 Sensor Calibration

The O2 Sensor Calibration procedure must be performed to reprogram the ECM whenever the oxygen sensor is replaced. This sensor's signal is a critical ECM input for EGR system operation.

Start by connecting the new sensor to the engine harness connector and leave the sensor body outside of the exhaust during programming.

Open the O2 Sensor Calibration session under the Procedures tab.

ServiceMaxx™ will begin to calibrate the oxygen sensor once the session opens.

***"A window will appear indicating whether the calibration was completed successfully or if a problem occurred during calibration."***

A window will appear indicating whether the calibration was completed successfully or if a problem occurred during calibration.

This concludes the Special Tests for the Air Management System.

## NOTES

## NOTES

# Conclusion

This concludes the 2010 MaxxForce® 11 and 13 Engine Diagnostics training course for technicians.

Thanks for your participation.

You are now required to take a post-test.

## NOTES