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## DIAGNOSTIC MANUAL

### Aftertreatment Symptom-Based Diagnostic and Inspection Manual

MaxxForce® DT, 9 and 10 (EPA 10)

MaxxForce® 11, 13 and 15 (EPA 10)

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## FOREWORD

Navistar, Inc. is committed to continuous research and development to improve products and introduce technological advances. Procedures, specifications, and parts defined in published technical service literature may be altered.

Technical service literature is revised periodically. If a technical publication is ordered, the latest revision will be supplied.

**NOTE – To order technical service literature, contact your International dealer.**

## SAFETY INFORMATION

This manual provides general and specific maintenance procedures essential for reliable engine operation and your safety. Since many variations in procedures, tools, and service parts are involved, advice for all possible safety conditions and hazards cannot be stated.

Read safety instructions before doing any service and test procedures for the engine or vehicle. See related application manuals for more information.

Disregard for Safety Instructions, Warnings, Cautions, and Notes in this manual can lead to injury, death or damage to the engine or vehicle.

### Safety Terminology

Three terms are used to stress your safety and safe operation of the engine: Warning, Caution, and Note.

**Warning:** A warning describes actions necessary to prevent or eliminate conditions, hazards, and unsafe practices that can cause personal injury or death.

**Caution:** A caution describes actions necessary to prevent or eliminate conditions that can cause damage to the engine or vehicle.

**Note:** A note describes actions necessary for correct, efficient engine or vehicle operation.

### Safety Instructions

#### Work Area

- Keep work area clean, dry, and organized.
- Keep tools and parts off the floor.
- Make sure the work area is ventilated and well lit.
- Make sure a first aid kit is available.

#### Safety Equipment

- Use correct lifting devices.
- Use safety blocks and stands.

#### Protective Measures

- Wear protective safety glasses and shoes.
- Wear correct hearing protection.
- Wear cotton work clothing.
- Wear sleeved heat protective gloves.
- Do not wear rings, watches or other jewelry.
- Restrain long hair.

**Vehicle**

- Make sure the vehicle is in neutral, the parking brake is set, and the wheels are blocked before servicing engine or vehicle.
- Clear the area before starting the engine.

**Engine**

- The engine and vehicle should be operated or serviced only by qualified individuals.
- Provide necessary ventilation when operating engine in a closed area.
- Keep combustible material away from engine exhaust system and exhaust manifolds.
- Install all shields, guards, and access covers before operating engine or vehicle.
- Do not run engine with unprotected air inlets or exhaust openings. If unavoidable for service reasons, put protective screens over all openings before servicing engine.
- Shut engine off and relieve all pressure in the system before removing panels, housing covers, and caps.
- If an engine, or vehicle, is not safe to operate, tag the ignition key.

**Fire Prevention**

- Make sure charged fire extinguishers are in the work area.

**NOTE – Check the classification of each fire extinguisher to ensure that the following fire types can be extinguished.**

1. Type A - Wood, paper, textiles, and rubbish
2. Type B - Flammable liquids
3. Type C - Electrical equipment

**Batteries**

- Always disconnect the main negative battery cable first.
- Always connect the main negative battery cable last.
- Avoid leaning over batteries.
- Protect your eyes.
- Do not expose batteries to open flames or sparks.
- Do not smoke in workplace.

**Compressed Air**

- Use an OSHA approved blow gun rated at 30 psi (207 kPa).
- Limit shop air pressure to 30 psi (207 kPa).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in the work area.
- Do not direct compressed air at face or body.

### **Tools**

- Make sure all tools are in good condition.
- Make sure all standard electrical tools are grounded.
- Check for frayed power cords before using power tools.

### **Fluids Under Pressure**

- Use extreme caution when working on systems under pressure.
- Follow approved procedures only.

### **Fuel**

- Do not over fill the fuel tank. Overfill creates a fire hazard.
- Do not smoke in the work area.
- Do not refuel the tank when the engine is running.

### **Removal of Tools, Parts, and Equipment**

- Reinstall all safety guards, shields, and covers after servicing the engine or vehicle.
- Make sure all tools, parts, and service equipment are removed from the engine and vehicle after all work is done.

## MAXXFORCE® DT, 9 AND 10 AFTERTREATMENT SYSTEM DIAGNOSTICS

### 3.1. START DIAGNOSTICS HERE: ENGINE AND AFTERTREATMENT SYSTEM OPERATIONAL CHECKS

#### Overview

A properly operating aftertreatment system requires little manual intervention from the operator. Illuminated warning lamps may indicate a driving or extended idle operation that may not allow successful regeneration of the aftertreatment system. These illuminated warning lamps may also indicate an engine mechanical or performance concern.

#### Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

**NOTE – A frequent regen concern may not be repaired by only performing an Onboard Filter Cleanliness Test (OBFCT). Perform all steps in the following diagnostic procedure in order to identify root cause failure.**

**NOTE – Repair all active fault code(s) other than SPN 3719 (DPF Soot Load) before beginning Engine and Aftertreatment System Operational Checks.**

#### Operational Checks – Start Aftertreatment Diagnostics Here

Step	Action	Decision
1	<p>Verify the following engine systems are in satisfactory condition:</p> <ul style="list-style-type: none"> <li>• <b>Engine Oil:</b> Park vehicle on level ground and check oil level.</li> <li>• <b>Engine Coolant Level:</b> Check coolant level that is indicated on deaeration tank.</li> <li>• <b>Intake Air:</b> Inspect air filter gauge, located on air filter housing or dashboard.</li> <li>• <b>Electrical System:</b> Inspect batteries and electrical system (engine and vehicle) for poor or loose connections, corroded terminals, or broken and damaged wires.</li> <li>• <b>Exhaust System:</b> Check Aftertreatment and exhaust system for damage, excessive corrosion, or leaks.</li> <li>• <b>Fuel level:</b> Check instrument panel fuel gauge, look into fuel tanks to verify fuel level, and make sure fuel levels are equal in both tanks.</li> <li>• <b>Fuel quality</b> Obtain a fuel sample, and check for water, waxing, icing, sediment, gasoline, Diesel Exhaust Fluid (DEF), or kerosene.</li> <li>• <b>Fuel line routing and condition:</b> With engine OFF, visually inspect the condition and routing of fuel lines.</li> </ul> <p>Are all of the above engine systems operating as designed?</p>	<p>Yes: Go to step 2</p> <p>No: Repair appropriate engine system and go to step 2.</p>



Step	Action	Decision
4	<p>Check for an engine no start. Turn ignition switch to ON position and crank engine for a maximum of 20 seconds. If engine does not start, wait 2 to 3 minutes and crank engine again for a maximum of 20 seconds.</p> <p>Does the engine start and run?</p>	<p>Yes: Go to step 5</p> <p>No: Go to symptom 2 (Medium Duty): Engine No Start / Starts and Stalls page 17.</p>

Step	Action	Decision
5	<p>Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3719 FMI 0, 15, and 16 (DPF Soot Load).</p> <p>Is SPN 3719 or SPN 3936 with FMI 0, 15, or 16 the only fault code(s) active?</p>	<p>Yes: Go to Symptom 3 (Medium Duty): SPN 3719 or SPN 3936 Active Only or Frequent Regens page 24.</p> <p>No: Go to Symptom 4 (Medium Duty): SPN 3719 or SPN 3936 and Other Active Fault Codes page 34.</p>

**3.2. SYMPTOM 1 (MEDIUM DUTY): FREQUENT PARKED REGENS WITH NO ACTIVE FAULT CODES (MORE THAN ONE PARKED REGEN PER DAY)**

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 5.**

**NOTE – SPN 3719 FMI 15 may be inactive when a frequent regen concern is present.**

**NOTE – SPN 3936 FMI 8 can be active for this symptom.**

Step	Action	Decision
1	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Mass Air Flow (MAF) Mean Value (MMV)</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Exhaust Gas Recirculation (EGR) valve position</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 51?</p>	<p>Graph 1: Go to step 2A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing 0 to 60 MPH Test.

**NOTE** – Intake Manifold Pressure (IMP) can vary based on ECM calibration and vehicle weight. Using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor turbocharger wastegate operation to verify low boost.

Step	Action	Decision
2A	<p>Check for engine performance issues. Perform 0 to 60 MPH Test procedure below:</p> <ol style="list-style-type: none"> <li>1. Using EST, go to Sessions &gt; Performance.</li> <li>2. Find an open stretch of road, where minimum speed limit is 50 mph or higher.</li> <li>3. Pull over to the side of the road.</li> <li>4. When driving conditions are safe and vehicle has reached normal operating temperature, select the record snapshot icon from the toolbar.</li> <li>5. Press accelerator pedal fully to the floor, and accelerate from 0 mph to max allowed highway speed.</li> </ol> <p>After 0 to 60 MPH Test is complete, stop recording and save snapshot.</p>	Go to step 2B





Step	Action	Decision
3	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>2. Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5, 6, and 7 page 57.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 5: Diagnostics complete</p> <p>Graph 6: Go to step 4</p> <p>Graph 7: Go to step 7</p>

Step	Action	Decision
4	<p>Determine if DPF or DOC is contaminated. Remove the DPF and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Are the DPF or DOC contaminated?</p>	<p>Yes: Remove PDOC, and go to step 5.</p> <p>No: Install DPF and DOC, and go to step 7.</p>

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Step	Action	Decision
5	Determine if DPF, DOC, and PDOC are reusable see the DPF and DOC reuse guidelines page 159.  Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?	Yes: Install removed aftertreatment system components, and go to step 6.  No: Replace failed component(s). After repairs are complete, go to step 6.

Step	Action	Decision
6	Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)	After repairs are complete, go to step 7.



Step	Action	Decision
8	Run DSI System De-Aeration Procedure twice, to purge the Down Stream Injection (DSI) system of air. Using EST, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	Go to step 9

Step	Action	Decision
9	Using EST, check Diagnostic Trouble Code (DTC) list for any fault code(s) that may have become active during OBFCT.  Does DTC list contain any active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 10.  No: Go to step 10

Step	Action	Decision
10	Verify exhaust gas temperatures are within specification.  <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test (OBFCT).</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5 and 6 page 57.</p> <p>Which graph does snapshot most closely match?</p>	Graph 5: Go to step 11  Graph 6: Go to Performance Diagnostics section in Engine Diagnostic Manual.

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<b>Step</b>	<b>Action</b>	<b>Decision</b>
11	<p>Perform Standard Test to verify all engine systems are operating as designed. Verify engine coolant temperature is greater than 158°F (70°C). Using EST with ServiceMaxx™ software, go to Tests &gt; KOER Tests &gt; Standard Test.</p> <p>Does Standard Test run and pass?</p>	<p>Yes: Go to step 12</p> <p>No: Diagnose and repair active fault code(s) (see Electronic Control System Diagnostics section in Engine Diagnostic Manual).</p>

<b>Step</b>	<b>Action</b>	<b>Decision</b>
12	<p>Perform the following MAF Sensor Calibration procedure to accommodate for system repairs:</p> <ol style="list-style-type: none"> <li>1. Verify engine coolant temperature is greater than 180°F (82°C), and lube oil temperature is greater than 176°F (80°C).</li> <li>2. Using EST with ServiceMaxx software, go to Tests &gt; and deselect Load Test Specific Session.</li> <li>3. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>4. Go to procedures &gt; KOER Procedures &gt; MAF Sensor Calibration.</li> <li>5. After MAF Sensor Calibration is complete, stop recording.</li> <li>6. Turn the ignition switch to the OFF position for a minimum of 30 seconds.</li> <li>7. Repeat steps 3 through 5 to complete second MAF Sensor Calibration.</li> </ol> <p>Does MAF Sensor Calibration procedure run and pass?</p>	<p>Yes: Diagnostics complete</p> <p>No: Go to Performance Diagnostics section in Engine Diagnostic Manual.</p>

### 3.3. SYMPTOM 2 (MEDIUM DUTY): ENGINE NO START / STARTS AND STALLS

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 5.**

Step	Action	Decision
1	<p>Check for an exhaust system restriction by performing the following Exhaust System Restriction Test:</p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <b>CAUTION</b> </div> <p><b>To prevent damage to the starter, if engine fails to start within 20 seconds, release ignition switch, and wait 2 to 3 minutes to allow starter motor to cool.</b></p> <ol style="list-style-type: none"> <li>1. Turn ignition switch to ON position.</li> <li>2. Using EST with ServiceMaxx™ software, go to Sessions &gt; Performance and record Turbocharger 1 Turbine Outlet Pressure (TC1TOP) Key-On Engine-Off (KOEO) signal value.</li> <li>3. Select the record snapshot icon from the toolbar.</li> <li>4. Crank the engine for a maximum of 20 seconds. If engine does not start, wait 2 to 3 minutes and crank engine again for a maximum of 20 seconds.</li> <li>5. Stop recording.</li> <li>6. Use the playback feature in ServiceMaxx™ and graph TC1TOP, and Diesel Particulate Filter Differential Pressure (DPFDP) signal values.</li> </ol> <p><b>NOTE — To calculate TC1TOP (actual), subtract TC1TOP KOEO signal value recorded in step 2 from maximum TC1TOP signal value reached in step 7.</b></p> <ol style="list-style-type: none"> <li>7. Record maximum TC1TOP signal value reached from snapshot, and calculate TC1TOP actual (See Table 21, page 18).</li> <li>8. Verify DPFDP and TC1TOP (actual) are within specification. DPFDP signal value should be less than 1 psi (7 kPa), and TC1TOP (actual) should be less than 5 psi (34 kPa).</li> </ol> <p>Are DPFDP and TC1TOP signal values within specification?</p>	<p>Both DPFDP and TC1TOP signals High: Go to step 2</p> <p>TC1TOP signal High Only: Go to step 3</p> <p>Neither DPFDP or TC1TOP signal High: Go to Hard Start and No Start Diagnostics section in Engine Diagnostic Manual. After repairs are complete, go to step 8.</p>

Table 21 Example TC1TOP (Actual) Calculations

Maximum TC1TOP Signal Value During Cranking	TC1TOP KOEO Signal Value	Maximum TC1TOP Signal Value During Cranking — TC1TOP KOEO Signal Value = TC1TOP (Actual)
15.7 psi (108 kPa)	14.7 psi (101 kPa)	15.7 psi (108 kPa) – 14.7 psi (101 kPa) = 1 psi (7 kPa)
1 psi (7 kPa)	0 psi (0 kPa)	1 psi (7 kPa) – 0 psi (0 kPa) = 1 psi (7 kPa)
-13 psi (-89 kPa)	-14 psi (-96 kPa)	-13 psi (80 kPa) – (-14) psi (-96 kPa) = 1 psi (7 kPa)

Step	Action	Decision
2	<p>Determine if the Diesel Particulate Filter (DPF) is contaminated. Remove the DPF (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Is the DPF contaminated?</p>	<p>Yes: Remove Pre-Diesel Oxidation Catalyst (PDOC) &amp; Diesel Oxidation Catalyst (DOC), and then and then go to step 4.</p> <p>No: Go to step 5</p>

Step	Action	Decision
3	<p>Determine if PDOC or DOC is contaminated. Remove the PDOC and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Are the PDOC and DOC contaminated?</p>	<p>Yes: Remove DPF, and then go to step 4.</p> <p>No: Go to step 5</p>

Step	Action	Decision
4	<p>Determine if DPF, DOC, and PDOC are reusable see the DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?</p>	<p>Yes: Go to step 6</p> <p>No: Replace failed component(s). After repairs are complete, go to step 6.</p>

Step	Action	Decision
5	<p>Determine if removed aftertreatment system components need to be cleaned see the DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, do any of the removed aftertreatment system components need to be cleaned?</p>	<p>Yes: Clean components using appropriate cleaning equipment. After cleaning procedure is complete, Install components and go to step 7.</p> <p>No: Install removed aftertreatment system components, and then go to step 7.</p>

Step	Action	Decision
6	<p>Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)</p>	<p>After repairs are complete, go to step 7.</p>

Step	Action	Decision
7	<p>Check for an engine no start. Turn ignition switch to ON position and crank engine for a maximum of 20 seconds. If engine does not start, wait 2 to 3 minutes and crank engine again for a maximum of 20 seconds.</p> <p>Does the engine start and run?</p>	<p>Yes: Go to step 8</p> <p>No: Go to Hard Start and No Start Diagnostics section in Engine Diagnostic Manual.</p>

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<b>Step</b>	<b>Action</b>	<b>Decision</b>
8	<p>Do Onboard Filter Cleanliness Test (OBFCT) to clear active aftertreatment fault code(s). Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test. While OBFCT is running, check the following components for exhaust leaks, and verify all fasteners, brackets, and clamps are secure and undamaged:</p> <ul style="list-style-type: none"> <li>• Low Pressure (LP) turbocharger outlet pipe</li> <li>• Exhaust Back Pressure Valve (EBPV)</li> <li>• Flexible mesh pipe to DOC inlet</li> <li>• Inlet to DOC</li> </ul> <p>Were all components free of exhaust leaks, and all fasteners, brackets, and clamps secure and undamaged?</p>	<p>Yes: Go to step 9</p> <p>No: Repair exhaust leak or repair failed fastener, bracket, or clamp. After repairs are complete, go to step 9.</p>

<b>Step</b>	<b>Action</b>	<b>Decision</b>
9	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using EST with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Mass Air Flow (MAF) mean value</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Exhaust Gas Recirculation (EGR) valve position</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 51?</p>	<p>Graph 1: Go to step 10A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing 0 to 60 MPH Test.

**NOTE – Intake Manifold Pressure (IMP) can vary based on ECM calibration and vehicle weight. Using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor turbocharger wastegate operation to verify low boost.**

Step	Action	Decision
10A	<p>Check for engine performance issues. Perform 0 to 60 MPH Test procedure below:</p> <ol style="list-style-type: none"> <li>1. Using EST, go to Sessions &gt; Performance.</li> <li>2. Find an open stretch of road, where minimum speed limit is 50 mph or higher.</li> <li>3. Pull over to the side of the road.</li> <li>4. When driving conditions are safe and vehicle has reached normal operating temperature, select the record snapshot icon from the toolbar.</li> <li>5. Press accelerator pedal fully to the floor, and accelerate from 0 mph to max allowed highway speed.</li> </ol> <p>After 0 to 60 MPH Test is complete, stop recording and save snapshot.</p>	Go to step 10B



Step	Action	Decision
11	<p>Perform Standard Test to verify all engine systems are operating as designed. Verify engine coolant temperature is greater than 158°F (70°C). Using EST with ServiceMaxx™ software, go to Tests &gt; KOER Tests &gt; Standard Test.</p> <p>Does Standard Test run and pass?</p>	<p>Yes: Go to step 12</p> <p>No: Diagnose and repair active fault code(s). Go to Electronic Control System Diagnostics section in Engine Diagnostic Manual.</p>

Step	Action	Decision
12	<p>Perform the following MAF Sensor Calibration procedure to accommodate for system repairs:</p> <ol style="list-style-type: none"> <li>1. Verify engine coolant temperature is greater than 180°F (82°C), and lube oil temperature is greater than 176°F (80°C).</li> <li>2. Using EST with ServiceMaxx software, go to Tests &gt; and deselect Load Test Specific Session.</li> <li>3. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>4. Go to procedures &gt; KOER Procedures &gt; MAF Sensor Calibration.</li> <li>5. After MAF Sensor Calibration is complete, stop recording.</li> <li>6. Turn the ignition switch to the OFF position for a minimum of 30 seconds.</li> <li>7. Repeat steps 3 through 5 to complete second MAF Sensor Calibration.</li> </ol> <p>Does MAF Sensor Calibration procedure run and pass?</p>	<p>Yes: Diagnostics complete</p> <p>No: Go to Performance Diagnostics section in Engine Diagnostic Manual.</p>

**3.4. SYMPTOM 3 (MEDIUM DUTY): SPN 3719 OR SPN 3936 ACTIVE ONLY OR FREQUENT REGENS (MORE THAN ONE PARKED REGEN PER DAY)**

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 5.**

**NOTE – The number of regens performed in one day may vary depending on application. The following criteria should be used to determine if a regen is considered frequent:**

- **Line-haul: More than 1 parked regen per day is frequent regeneration.**
- **Severe service: More than 2 parked regens per day is frequent regeneration.**

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list to determine which of the following fault codes is active: SPN 3719/3936 FMI 0, 15, or 16.  Which fault code is active?	SPN 3719 or SPN 3936 FMI 0: Go to step 2  SPN 3719 or SPN 3936 FMI 16: Go to step 4  SPN 3719 or SPN 3936 FMI 15: Go to step 5

Step	Action	Decision
2	Do three Onboard Filter Cleanliness Tests (OBFCT) to decrease soot load of Diesel Particulate Filter (DPF). Using EST, go to Tests > KOER Aftertreatment Tests > Onboard Filter Cleanliness Test. After OBFCTs are complete, check DTC list to determine if SPN 3719 FMI 0 dropped one FMI level to SPN 3719 FMI 16.  Did SPN 3719 FMI 0 drop one FMI level to SPN 3719 FMI 16?	Yes: Go to step 3        No: Go to step 4

Step	Action	Decision
3	<p>Using Electronic Service Tool (EST) with ServiceMaxx™ software, Reset DPF soot load. Select Sessions &gt; Programming &gt; CDPF Reset Request set value to yes, then select Program Engine. When programming completes, run engine at wide open throttle (WOT) for 10 minutes. If a high soot load exists, you will see it after 10 minutes; If the high soot load is false, the DPF soot load will be recalculated to show the true soot load.</p> <p>Which fault code for soot load is active?</p>	<p>SPN 3719 FMI 16, go to Step 4</p> <p>SPN 3719 FMI 15, go to Step 5</p> <p>SPN 3719 or 3936 FMI 0, go to Step 7</p> <p>No codes, go to Step 11</p>

Step	Action	Decision
4	<p>Do three Onboard Filter Cleanliness Tests (OBFCT) to decrease soot load of Diesel Particulate Filter (DPF). Using EST, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test. After OBFCTs are complete, check DTC list to determine if SPN 3719 FMI 16 dropped one FMI level to SPN 3719 FMI 15.</p> <p>Did SPN 3719 FMI 16 drop one FMI level to SPN 3719 FMI 15?</p>	<p>Yes: Go to step 5</p> <p>No: Go to step 6</p>

Step	Action	Decision
5	<p>Do three Onboard Filter Cleanliness Tests (OBFCT) to clear SPN 3719 FMI 15. Using EST, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test. After OBFCTs are complete, check DTC list to determine if SPN 3719 FMI 15 is still active.</p> <p>Is SPN 3719 FMI 15 still active?</p>	<p>Yes: Go to step 7</p> <p>No: Go to step 6</p>

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Step	Action	Decision
6	<p>Diesel Particulate Filter ( DPF) Snap Acceleration Test (Quick Test). This procedure checks the DPF for cracks or internal damage without removing the DPF from the vehicle and is used to test basic functionality of the diesel particulate filter. This is to be done prior to removing the DPF.</p> <ol style="list-style-type: none"> <li>1. The transmission must be in neutral and the parking brake applied.</li> <li>2. Start and idle the engine.</li> <li>3. Rapidly snap the accelerator pedal from idle to full throttle. This can be performed multiple times.</li> <li>4. During the engine accelerations, visually check for a heavy black smoke exiting the exhaust pipe.</li> </ol> <p>Is black smoke visible?</p>	<p>Yes: Go to Symptom 5 (Medium Duty): Black smoke page 44.</p> <p>No: Go to step 11</p>

Step	Action	Decision
7	<p>Determine if Diesel Particulate Filter (DPF), Pre-Diesel Oxidation Catalyst (PDOC), and Diesel Oxidation Catalyst (DOC) are contaminated. Remove the DPF, PDOC, and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Are the DPF, PDOC, or DOC contaminated?</p>	<p>Yes: Go to step 8</p> <p>No: Go to step 9</p>

Step	Action	Decision
8	<p>Determine if DPF, DOC, and PDOC are reusable see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?</p>	<p>Yes: Go to step 10</p> <p>No: Replace failed component(s). After repairs are complete, go to step 10.</p>

Step	Action	Decision
9	<p>Determine if removed aftertreatment system components need to be cleaned see the DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, do any of the removed aftertreatment system components need to be cleaned?</p>	<p>Yes: Clean components using appropriate cleaning equipment. After cleaning procedure is complete, Install components and go to step 11.</p> <p>No: Install removed aftertreatment system components, and then go to step 11.</p>

Step	Action	Decision
10	Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)	After repairs are complete, go to step 11.

Step	Action	Decision
11	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using EST with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Mass Air Flow (MAF) mean value</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Exhaust Gas Recirculation (EGR) valve position</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 51?</p>	<p>Graph 1: Go to step 11A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing 0 to 60 MPH Test.

**NOTE – Intake Manifold Pressure (IMP) can vary based on ECM calibration and vehicle weight. Using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor turbocharger wastegate operation to verify low boost.**

Step	Action	Decision
11A	<p>Check for engine performance issues. Perform 0 to 60 MPH Test procedure below:</p> <ol style="list-style-type: none"> <li>1. Using EST, go to Sessions &gt; Performance.</li> <li>2. Find an open stretch of road which will safely allow full acceleration.</li> <li>3. Pull over to the side of the road.</li> <li>4. When driving conditions are safe and vehicle has reached normal operating temperature, select the record snapshot icon from the toolbar.</li> <li>5. Press accelerator pedal fully to the floor, and accelerate from 0 mph to max allowed highway speed.</li> </ol> <p>After 0 to 60 MPH Test is complete, stop recording and save snapshot.</p>	Go to step 11B



Step	Action	Decision
12	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test (OBFCT).</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5, 6, and 7 page 57.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 5: Diagnostics complete</p> <p>Graph 6: Go to step 13</p> <p>Graph 7: Go to step 15</p>



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Step	Action	Decision
14	Run DSI System De-Aeration Procedure twice, to purge the Down Stream Injection (DSI) system of air. Using EST, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	Go to step 15

Step	Action	Decision
15	Using EST, check Diagnostic Trouble Code (DTC) list for fault code(s) that may have become active during OBFCT.  Does DTC list contain active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 16.  No: Go to step 16

Step	Action	Decision
16	Verify exhaust gas temperatures are within specification.  <ol style="list-style-type: none"> <li>Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test (OBFCT).</li> <li>Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5 and 6 page 57.</p> <p>Which graph does snapshot most closely match?</p>	Graph 5: Go to step 17  Graph 6: Replace DOC. After repairs are complete, retest for original problem.

Step	Action	Decision
17	Verify root cause of frequent regens symptom.  Has root cause for frequent regens been diagnosed and repaired?	Yes: Go to step 18  No: Go back to step 1 of Engine and Aftertreatment System Operational Checks page 5 to verify engine systems are in satisfactory condition.

Step	Action	Decision
18	<p>Perform Standard Test to verify all engine systems are operating as designed. Verify engine coolant temperature is greater than 158°F (70°C). Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Tests &gt; Standard Test.</p> <p>Does Standard Test run and pass?</p>	<p>Yes: Go to step 19</p> <p>No: Diagnose and repair active fault code(s). Go to Electronic Control System Diagnostics section in Engine Diagnostic Manual.</p>

Step	Action	Decision
19	<p>Perform the following MAF Sensor Calibration procedure to accommodate for system repairs:</p> <ol style="list-style-type: none"> <li>1. Verify engine coolant temperature is greater than 180°F (82°C), and lube oil temperature is greater than 176°F (80°C).</li> <li>2. Using EST with ServiceMaxx software, go to Tests &gt; and deselect Load Test Specific Session.</li> <li>3. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>4. Go to procedures &gt; KOER Procedures &gt; MAF Sensor Calibration.</li> <li>5. After MAF Sensor Calibration is complete, stop recording.</li> <li>6. Turn the ignition switch to the OFF position for a minimum of 30 seconds.</li> <li>7. Repeat steps 3 through 5 to complete second MAF Sensor Calibration.</li> </ol> <p>Does MAF Sensor Calibration procedure run and pass?</p>	<p>Yes: Diagnostics complete</p> <p>No: Go to Performance Diagnostics section in Engine Diagnostic Manual.</p>

**3.5. SYMPTOM 4 (MEDIUM DUTY): SPN 3719 OR SPN 3936 AND OTHER ACTIVE FAULT CODES**

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 5.**

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for active fault code(s) other than SPN 3719 (DPF soot load).  Are fault code(s) other than SPN 3719 or SPN 3936 active?	Yes: Repair other active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 2.  No: Go to step 2

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list to determine which of the following fault codes is active: SPN 3719 FMI 0, 15, or 16.  Which fault code is active?	SPN 3719 or SPN 3936 FMI 0: Go to step 3  SPN 3719 or SPN 3936 FMI 16: Go to step 5  SPN 3719 or SPN 3936 FMI 15: Go to step 6

Step	Action	Decision
3	Do three Onboard Filter Cleanliness Tests (OBFCT) to decrease soot load of Diesel Particulate Filter (DPF). Using EST, go to Tests > KOER Aftertreatment Tests > Onboard Filter Cleanliness Test. After OBFCTs are complete, check DTC list to determine if SPN 3719 FMI 0 dropped one FMI level to SPN 3719 FMI 16.  Did SPN 3719 FMI 0 drop one FMI level to SPN 3719 FMI 16?	Yes: Go to step 5          No: Go to step 4

Step	Action	Decision
4	<p>Using Electronic Service Tool (EST) with ServiceMaxx™ software, Reset DPF soot load. Select Sessions &gt; Programming &gt; CDPF Reset Request set value to yes, then select Program Engine. When programming completes, run engine at wide open throttle (WOT) for 10 minutes. If a high soot load exists, you will see it after 10 minutes; If the high soot load is false, the DPF soot load will be recalculated to show the true soot load.</p> <p>Which fault code for soot load is active?</p>	<p>SPN 3719 FMI 16, go to Step 5</p> <p>SPN 3719 FMI 15, go to Step 6</p> <p>SPN 3719 or 3936 FMI 0, go to Step 8</p> <p>No code, go to Step 11</p>

Step	Action	Decision
5	<p>Do three Onboard Filter Cleanliness Tests (OBFCT) to decrease soot load of Diesel Particulate Filter (DPF). Using EST, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test. After OBFCTs are complete, check DTC list to determine if SPN 3719 FMI 16 dropped one FMI level to SPN 3719 FMI 15.</p> <p>Did SPN 3719 FMI 16 drop one FMI level to SPN 3719 FMI 15?</p>	<p>Yes: Go to step 6</p> <p>No: Go to step 7</p>

Step	Action	Decision
6	<p>Do three Onboard Filter Cleanliness Tests (OBFCT) to clear SPN 3719 FMI 15. Using EST, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test. After OBFCTs are complete, check DTC list to determine if SPN 3719 FMI 15 is still active.</p> <p>Is SPN 3719 FMI 15 still active?</p>	<p>Yes: Go to step 8</p> <p>No: Go to step 7</p>

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Step	Action	Decision
7	<p>Diesel Particulate Filter ( DPF) Snap Acceleration Test (Quick Test). This procedure checks the DPF for cracks or internal damage without removing the DPF from the vehicle and is used to test basic functionality of the diesel particulate filter. This is to be done prior to removing the DPF.</p> <ol style="list-style-type: none"> <li>1. The transmission must be in neutral and the parking brake applied.</li> <li>2. Start and idle the engine.</li> <li>3. Rapidly snap the accelerator pedal from idle to full throttle. This can be performed multiple times.</li> <li>4. During the engine accelerations, visually check for a heavy black smoke exiting the exhaust pipe.</li> </ol> <p>Is black smoke visible?</p>	<p>Yes: Go to Symptom 5 (Medium Duty): Black smoke page 44.</p> <p>No: Go to step 12</p>

Step	Action	Decision
8	<p>Determine if Diesel Particulate Filter (DPF), Pre-Diesel Oxidation Catalyst (PDOC), and Diesel Oxidation Catalyst (DOC) are contaminated. Remove the DPF, PDOC, and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Are the DPF, PDOC, or DOC contaminated?</p>	<p>Yes: Go to step 9</p> <p>No: Go to step 10</p>

Step	Action	Decision
9	<p>Determine if DPF, DOC, and PDOC are reusable see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?</p>	<p>Yes: Go to step 11</p> <p>No: Replace failed component(s). After repairs are complete, go to step 11.</p>

Step	Action	Decision
10	<p>Determine if removed aftertreatment system components need to be cleaned see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, do any of the removed aftertreatment system components need to be cleaned?</p>	<p>Yes: Clean components using appropriate cleaning equipment. After cleaning procedure is complete, Install components and go to step 11.</p> <p>No: Install removed aftertreatment system components, and then go to step 11.</p>

Step	Action	Decision
11	Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)	After repairs are complete, go to step 12.

Step	Action	Decision
12	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using EST with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Mass Air Flow (MAF) mean value</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Exhaust Gas Recirculation (EGR) valve position</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 51?</p>	<p>Graph 1: Go to step 12A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing 0 to 60 MPH Test.

**NOTE – Intake Manifold Pressure (IMP) can vary based on ECM calibration and vehicle weight. Using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor turbocharger wastegate operation to verify low boost.**

Step	Action	Decision
12A	<p>Check for engine performance issues. Perform 0 to 60 MPH Test procedure below:</p> <ol style="list-style-type: none"> <li>1. Using EST, go to Sessions &gt; Performance.</li> <li>2. Find an open stretch of road, where minimum speed limit is 50 mph or higher.</li> <li>3. Pull over to the side of the road.</li> <li>4. When driving conditions are safe and vehicle has reached normal operating temperature, select the record snapshot icon from the toolbar.</li> <li>5. Press accelerator pedal fully to the floor, and accelerate from 0 mph to max allowed highway speed.</li> </ol> <p>After 0 to 60 MPH Test is complete, stop recording and save snapshot.</p>	Go to step 12B



Step	Action	Decision
13	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>2. Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5, 6, and 7 page 57.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 5: Diagnostics complete</p> <p>Graph 6: Go to step 14</p> <p>Graph 7: Go to step 16</p>



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Step	Action	Decision
15	Run DSI System De-Aeration Procedure twice, to purge the Down Stream Injection (DSI) system of air. Using EST, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	Go to step 16

Step	Action	Decision
16	Using EST, check Diagnostic Trouble Code (DTC) list for fault code(s) that may have become active during OBFCT.  Does DTC list contain active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 17.  No: Go to step 17

Step	Action	Decision
17	Verify exhaust gas temperatures are within specification.  <ol style="list-style-type: none"> <li>Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test (OBFCT).</li> <li>Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5 and 6 page 57.</p> <p>Which graph does snapshot most closely match?</p>	Graph 5: Go to step 18  Graph 6: Replace DOC. After repairs are complete, retest for original problem.

Step	Action	Decision
18	Verify root cause of frequent regens symptom.  Has root cause for frequent regens been diagnosed and repaired?	Yes: Go to step 19  No: Go back to step 1 of Engine and Aftertreatment System Operational Checks on page 5 to verify engine systems are in satisfactory condition.

Step	Action	Decision
19	<p>Perform Standard Test to verify all engine systems are operating as designed. Verify engine coolant temperature is greater than 158°F (70°C). Using EST with ServiceMaxx software, go to Tests &gt; KOER Tests &gt; Standard Test.</p> <p>Does Standard Test run and pass?</p>	<p>Yes: Go to step 20</p> <p>No: Diagnose and repair active fault code(s) (See Electronic Control System Diagnostics section in Engine Diagnostic Manual).</p>

Step	Action	Decision
20	<p>Perform the following MAF Sensor Calibration procedure to accommodate for system repairs:</p> <ol style="list-style-type: none"> <li>1. Verify engine coolant temperature is greater than 180°F (82°C), and lube oil temperature is greater than 176°F (80°C).</li> <li>2. Using EST with ServiceMaxx software, go to Tests &gt; and deselect Load Test Specific Session.</li> <li>3. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>4. Go to procedures &gt; KOER Procedures &gt; MAF Sensor Calibration.</li> <li>5. After MAF Sensor Calibration is complete, stop recording.</li> <li>6. Turn the ignition switch to the OFF position for a minimum of 30 seconds.</li> <li>7. Repeat steps 3 through 5 to complete second MAF Sensor Calibration.</li> </ol> <p>Does MAF Sensor Calibration procedure run and pass?</p>	<p>Yes: Diagnostics complete</p> <p>No: Go to Performance Diagnostics section in Engine Diagnostic Manual.</p>



Step	Action	Decision
3	<p>Perform Onboard Filter Cleanliness Test (OBFCT) to clear active aftertreatment fault code(s). Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test. While test is running, check the following components for exhaust leaks and verify all fasteners, brackets and clamps are secure and undamaged.</p> <ol style="list-style-type: none"> <li>1. Low Pressure (LP) turbocharger outlet pipe</li> <li>2. Exhaust Back Pressure Valve (EBPV)</li> <li>3. Flexible Mesh pipe to Diesel Oxidation Catalyst (DOC) Inlet</li> <li>4. Inlet to the DOC</li> </ol> <p>Are all components free of exhaust leaks and all fasteners, brackets and clamps secure and undamaged?</p>	<p>Yes: Repair complete</p> <p>No: Repair any leaks, damage, and loose parts. End of diagnostics.</p>

Step	Action	Decision
4	<p>Check for a Failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using an Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When air management Test is complete, stop recording. Use the playback feature in ServiceMaxx™ and graph the following signal values.</p> <p>Signal Values:</p> <ul style="list-style-type: none"> <li>• Mass Air Flow (MAF) mean value</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Exhaust Gas Recirculation (EGR) Valve position</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 51?</p>	<p>Graph 1: Go to step 5A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing 0 to 60 MPH Test.

**NOTE – Intake Manifold Pressure (IMP) can vary based on ECM calibration and vehicle weight. Using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor turbocharger wastegate operation to verify low boost.**

Step	Action	Decision
5A	<p>Check for engine performance issues. Perform 0 to 60 MPH Test procedure below.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance</li> <li>2. Find an open stretch of road where minimum speed limit is 50 MPH or higher.</li> <li>3. Pull over to the side of the road.</li> <li>4. When driving conditions are safe and vehicle has reached normal operating temperature, select the record snapshot icon from the toolbar.</li> <li>5. Press accelerator pedal fully to the floor and accelerate from 0 MPH to max allowed highway speed.</li> </ol> <p>After 0 to 60 MPH Test is complete, stop recording and save snapshot.</p>	Go to step 5B



<b>Step</b>	<b>Action</b>	<b>Decision</b>
6	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>2. Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshots to Graph 5 and Graph 7 page 57.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 5: Diagnostics complete</p> <p>Graph 7: Go to step 7</p>



**DIAGNOSTIC MANUAL**

<b>Step</b>	<b>Action</b>	<b>Decision</b>
8	Run Down Stream Injection (DSI) System De-Aeration Procedure two times, to purge the DSI system of air. Using the Electronic Service Tool (EST) with ServiceMaxx™ software, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	Go to step 9

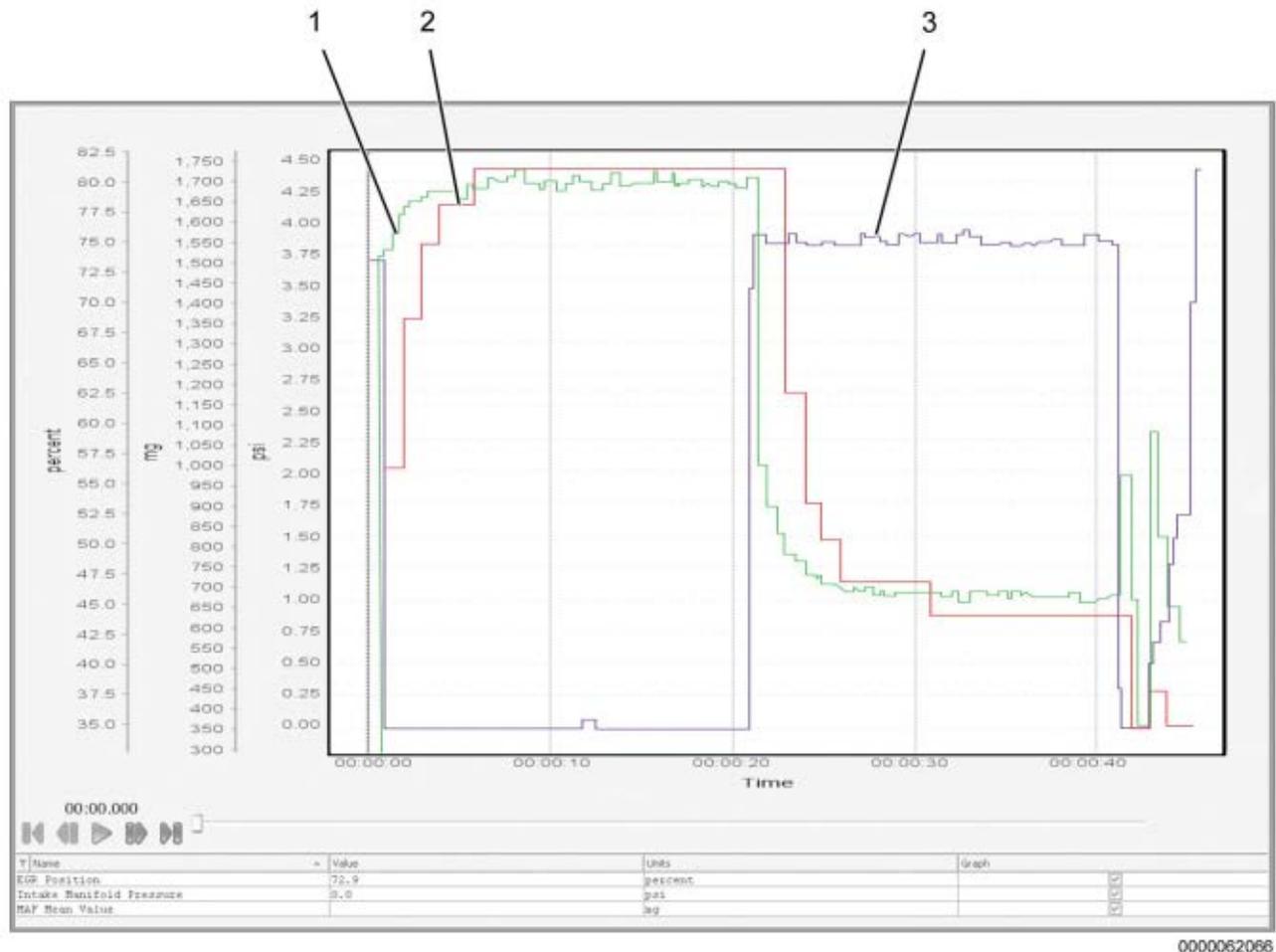
<b>Step</b>	<b>Action</b>	<b>Decision</b>
9	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for any fault code(s) that may have become active during OBFCT.  Does DTC list contain any active fault code(s)?	Yes: Diagnose and repair active fault code(s) (See Electronic Control System Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 10.  No: Go to step 10

<b>Step</b>	<b>Action</b>	<b>Decision</b>
10	Verify exhaust gas temperatures are within specification.  <ol style="list-style-type: none"> <li>Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test (OBFCT).</li> <li>Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <ul style="list-style-type: none"> <li>Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 5 and 6 page 57.</p> <p>Which graph does snapshot most closely match?</p>	Graph 5: End of diagnostics  Graph 6: Go to Performance Diagnostics section in the Engine Diagnostics Manual.

## MAXXFORCE® DT, 9 AND 10 SERVICEMAXX™ SNAPSHOTS

### 4.1. GRAPH 1: AIR MANAGEMENT SYSTEM TEST (GOOD)

NOTE – Colors in the graphs are used for clarity only and will not necessarily match the colors you will see in your ServiceMaxx™ snapshots



1. Mass Air Flow (MAF) Mean Value (MMV)(mg) [Green]
2. Intake Manifold Pressure (IMP) (psi) [Red]

3. Exhaust Gas Recirculation (EGR) valve position (percent) [Purple]

**Figure 5 Graph 1: Air Management System Test (Good)**

#### Graph Analysis:

This graph shows normal operation of the Air Management System (AMS) during the Air Management Test (AMT). The AMT gives pass or fail results based on the difference of flow in MAF Mean Value (MMV). It allows the user to validate the AMS by monitoring the effects each actuator has on Intake Manifold Pressure (IMP). IMP is normally between 2 psi (14 kPa) to 6 psi (41 kPa)

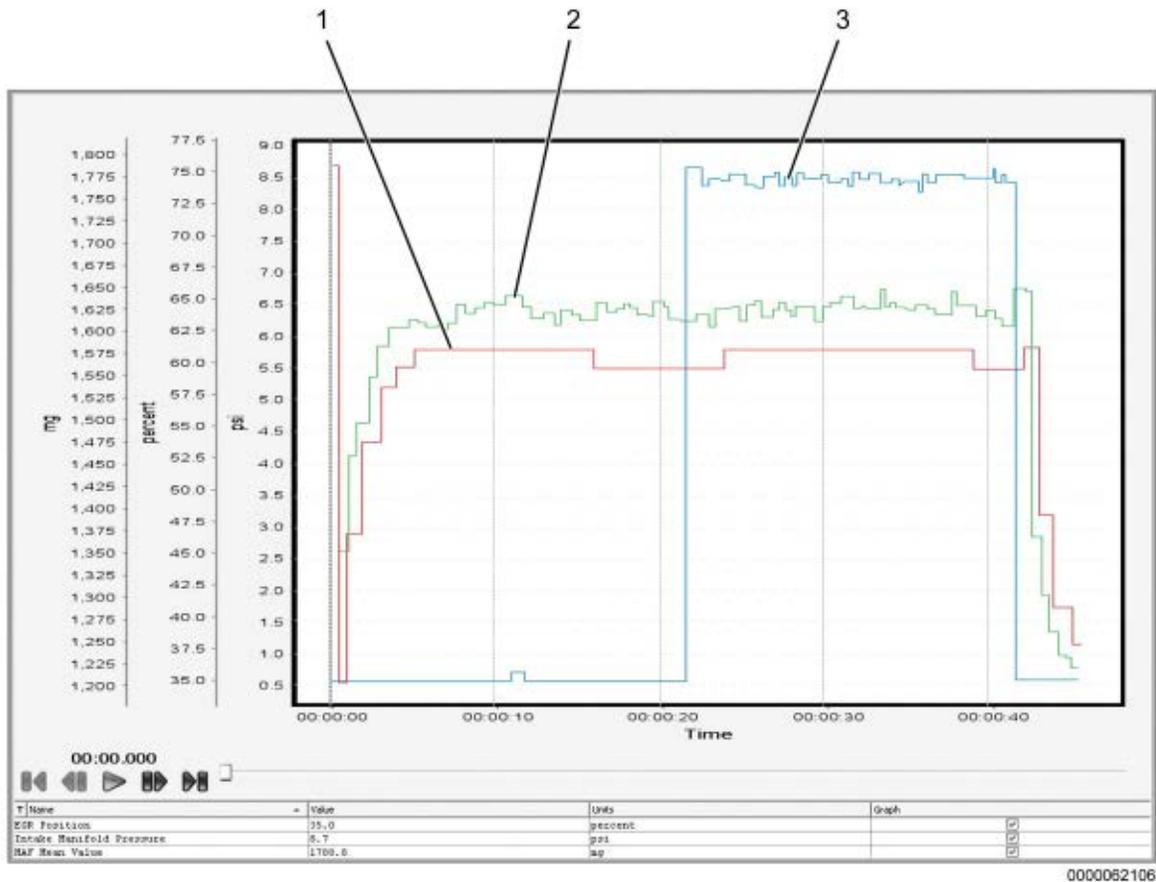
**Actions:**

1. When EGR valve is commanded ON, verify Intake Manifold Pressure (IMP) signal value drops.
2. When EGR valve is commanded ON, verify Mass Air Flow (MAF) Mean Value (MMV) drops. Calculate the difference between MMV at a stabilized high point and a stabilized low point, then compare to the table below.

<b>Engine</b>	<b>MAF Mean Value (MMV) Difference</b>	<b>Tolerance</b>
MaxxForce® DT 215 - 230 HP	690 – 1000	Less than 690 Fails AMS Test
MaxxForce® DT 245 - 300 HP	740 – 1000	Less than 740 Fails AMS Test
MaxxForce® 9 and 10 300 - 350 HP	850 – 1130	Less than 850 Fails AMS Test

**NOTE – EGR valve position will never read less than 35% and is considered closed.**

## 4.2. GRAPH 2: AIR MANAGEMENT SYSTEM TEST (BAD)



1. Intake Manifold Pressure (IMP) (psi) [Red]
2. Mass Air Flow (MAF) Mean Value (MMV)(mg) [Green]
3. Exhaust Gas Recirculation (EGR) valve position (percent) [Blue]

**Figure 6 Graph 2: Air Management System Test (Bad)**

### Graph Analysis:

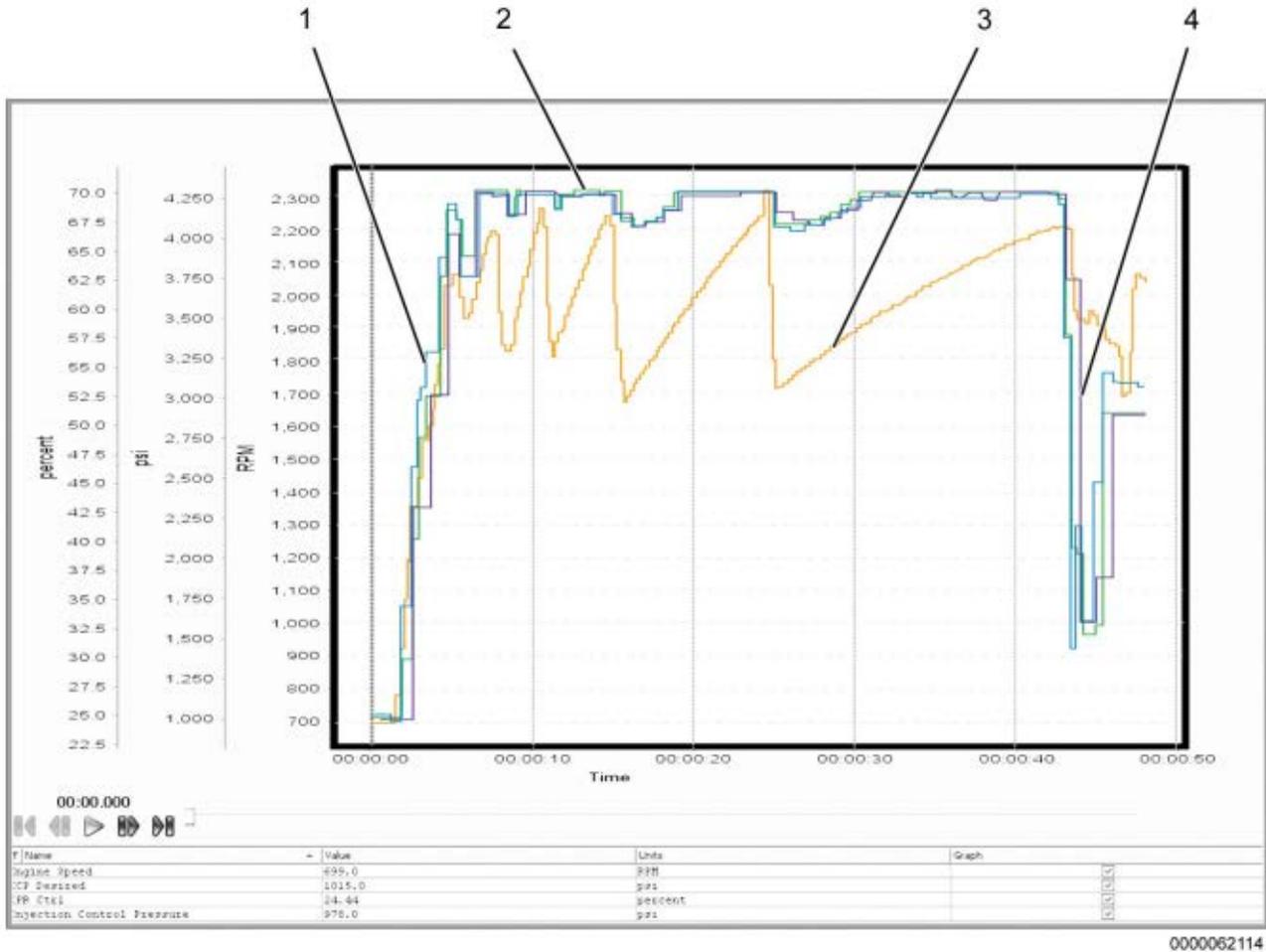
This graph shows an Air Management System (AMS) not operating as designed during the Air Management Test (AMT). The AMT gives pass or fail results. It allows the user to validate the AMS by monitoring the effects each actuator has on Intake Manifold Pressure (IMP). IMP is normally between 2 psi (14 kPa) to 6 psi (41 kPa) on engine ramp up during AMT. If the Exhaust Gas Recirculation (EGR) valve is not operating as designed, IMP will not respond to changes in EGR valve position. Excess soot will then be generated by the engine causing frequent regeneration of the aftertreatment system.

### Actions:

1. When EGR valve is commanded ON, verify Intake Manifold Pressure (IMP) signal value drops. In this graph, IMP does not drop when EGR valve is commanded ON.

**NOTE – EGR valve position will never read less than 35% and is considered closed.**

4.3. GRAPH 3: 0 TO 60 MPH TEST (ICP DESIRED AND ICP)



- 1. Injection Pressure Regulator (IPR) valve control (percent) [Blue]
- 2. Injection Control Pressure Desired (ICPD) [Green]
- 3. Engine speed (rpm) [Orange]
- 4. Injection Control Pressure (ICP) [Purple]

Figure 7 Graph 3: 0 to 60 MPH Test (ICP Desired and ICP)

Graph Analysis

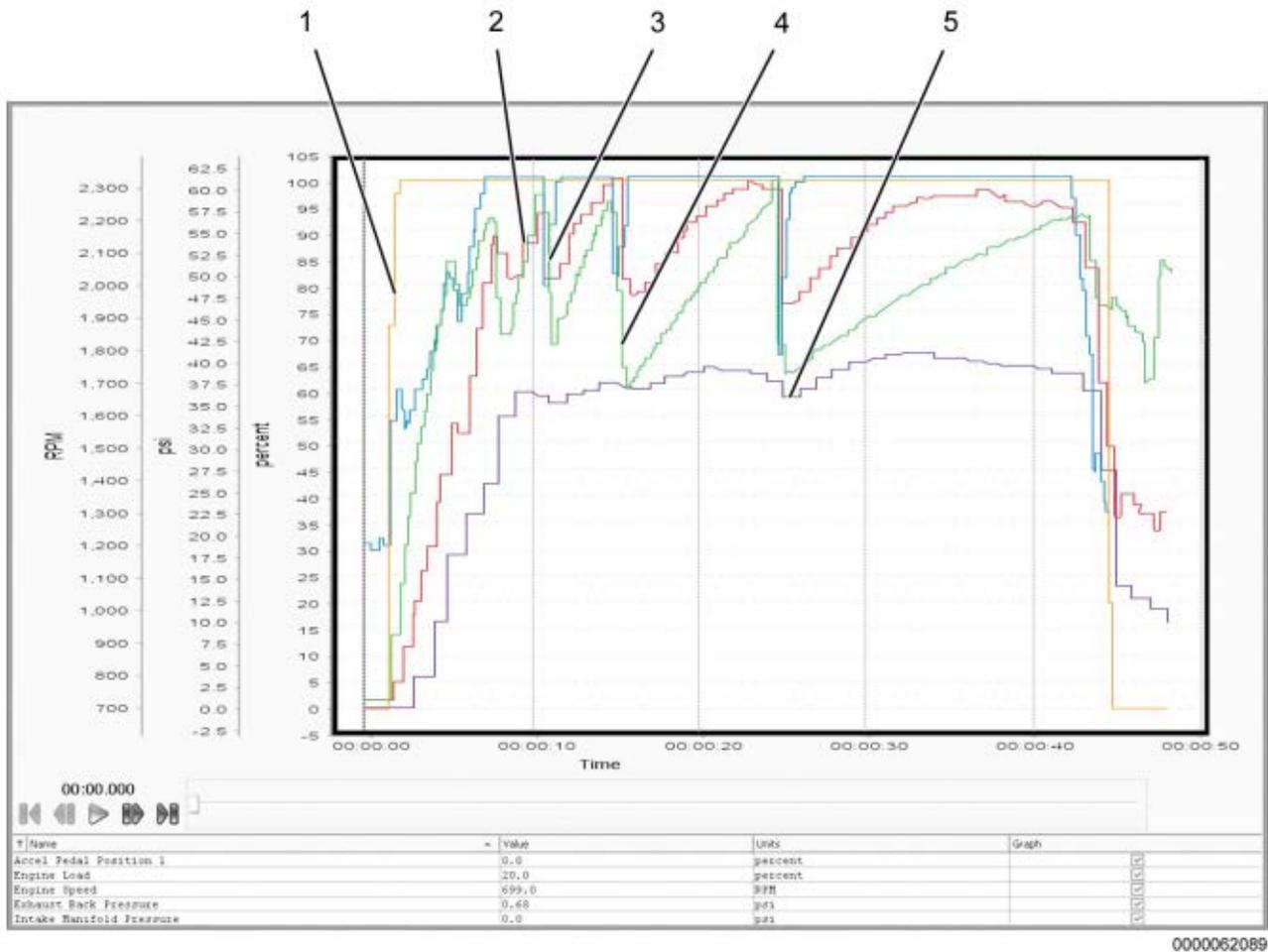
This graph shows an Injection Control Pressure (ICP) system operating as designed. This test does not give pass or fail results. It only allows the user to validate ICP and Injection Control Pressure Desired (ICPD) signal values under load. As engine rpm increases, ICP should steadily increase. Low ICP will cause low Intake Manifold Pressure (IMP). Diagnose low ICP concerns before diagnosing low IMP concerns.

Actions

- 1. Verify ICP is within 150 psi (1,034 kPa) of ICPD signal value during acceleration.
- 2. Verify Injection Pressure Regulator (IPR) valve control is less than 75%.

**NOTE – Analyze 0 to 60 MPH Test signal values only during acceleration, and not deceleration or shifting.**

**4.4. GRAPH 4: 0 TO 60 MPH TEST (ENGINE SPEED, ENGINE LOAD, IMP, EBP, AND APP1)**



- 1. Accelerator Pedal Position 1 (APP1) (percent) [Orange]
- 2. Exhaust Back Pressure (EBP) (psi) [Red]
- 3. Engine load (percent) [Blue]
- 4. Engine speed (rpm) [Green]
- 5. Intake Manifold Pressure (IMP) (psi) [Purple]

**Figure 8 Graph 4: 0 to 60 MPH Test (Engine Speed, Engine Load, IMP, EBP, and APP1)**

**Graph Analysis**

This graph shows the Intake Manifold Pressure (IMP) signal value operating as designed. This test does not give pass or fail results. It only allows the user to validate the IMP signal value under load. Accelerator Pedal Position 1 (APP1) signal value must be 99.6% to successfully reach peak boost during this test. Low IMP can be the result of low Injection Control Pressure (ICP). Diagnose low ICP concerns before diagnosing low IMP concerns.

**Actions**

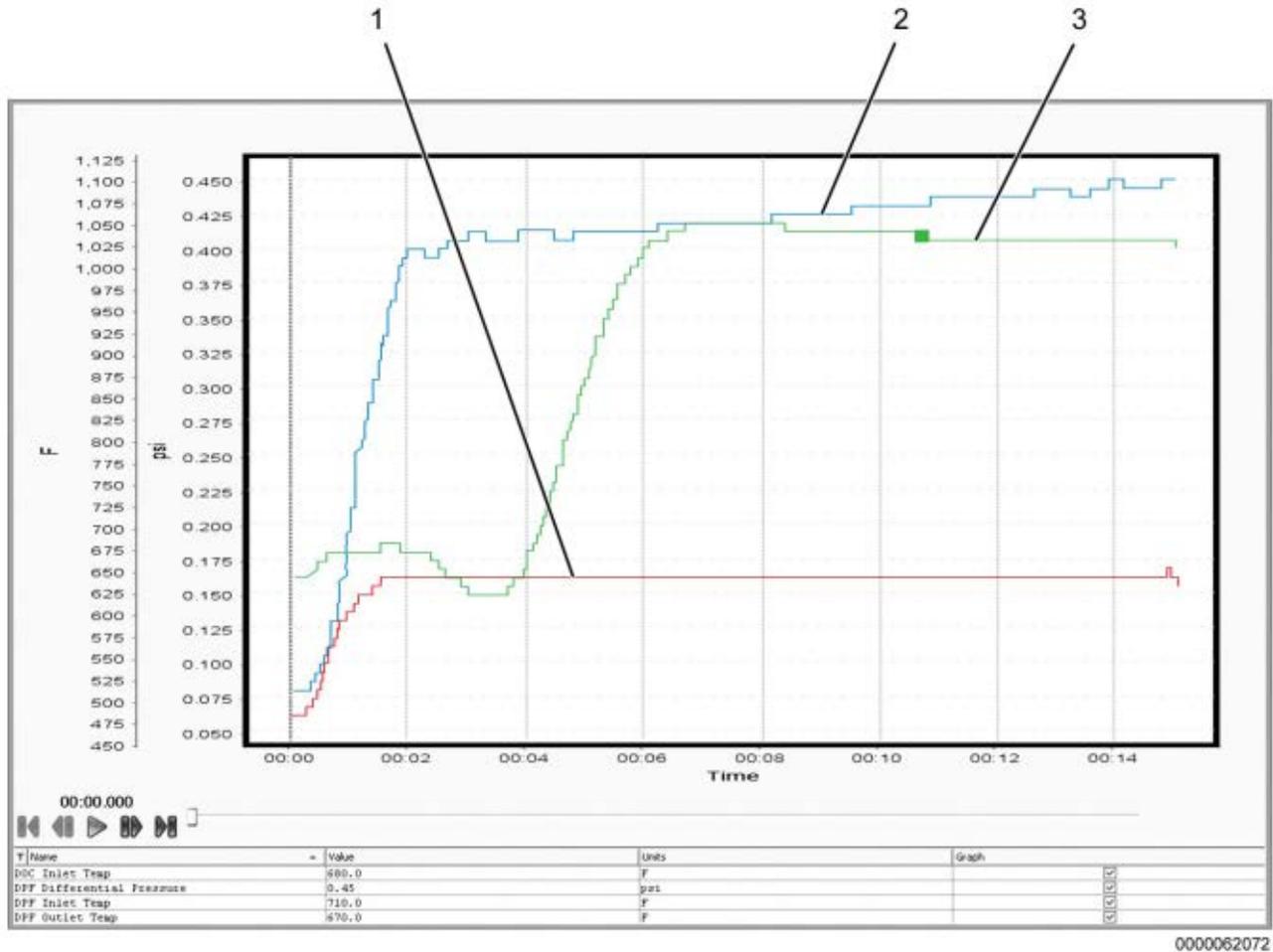
1. Verify IMP signal value is between 36 psi (248 kPa) to 42 psi\* (289 kPa), with APP1 signal value at 99.6%, and engine speed between 1800 rpm to 2200 rpm.
2. Verify Exhaust Back Pressure (EBP) is less than 70 psi (414 kPa), with APP1 signal value at 99.6%, and engine speed between 1800 rpm to 2200 rpm.

**NOTE – \* IMP signal value may be as low as 29 psi (221 kPa) on lower horsepower configurations.**

**NOTE – Analyze 0 to 60 mph test signal values only during acceleration, and not deceleration or shifting.**

#### 4.5. GRAPH 5: NORMAL EXHAUST GAS TEMPERATURES (EFFICIENT DOC AND UNRESTRICTED AFI)

NOTE – Snapshot recorded below with Diesel Particulate Filter (DPF) soot load level 5.



1. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Red]
2. Diesel Particulate Filter Inlet Temperature (DPFIT) (degrees Fahrenheit) [Blue]
3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Green]

Figure 9 Graph 5: Normal Exhaust Gas Temperatures (Efficient DOC AND Unrestricted AFI)

#### Graph Analysis:

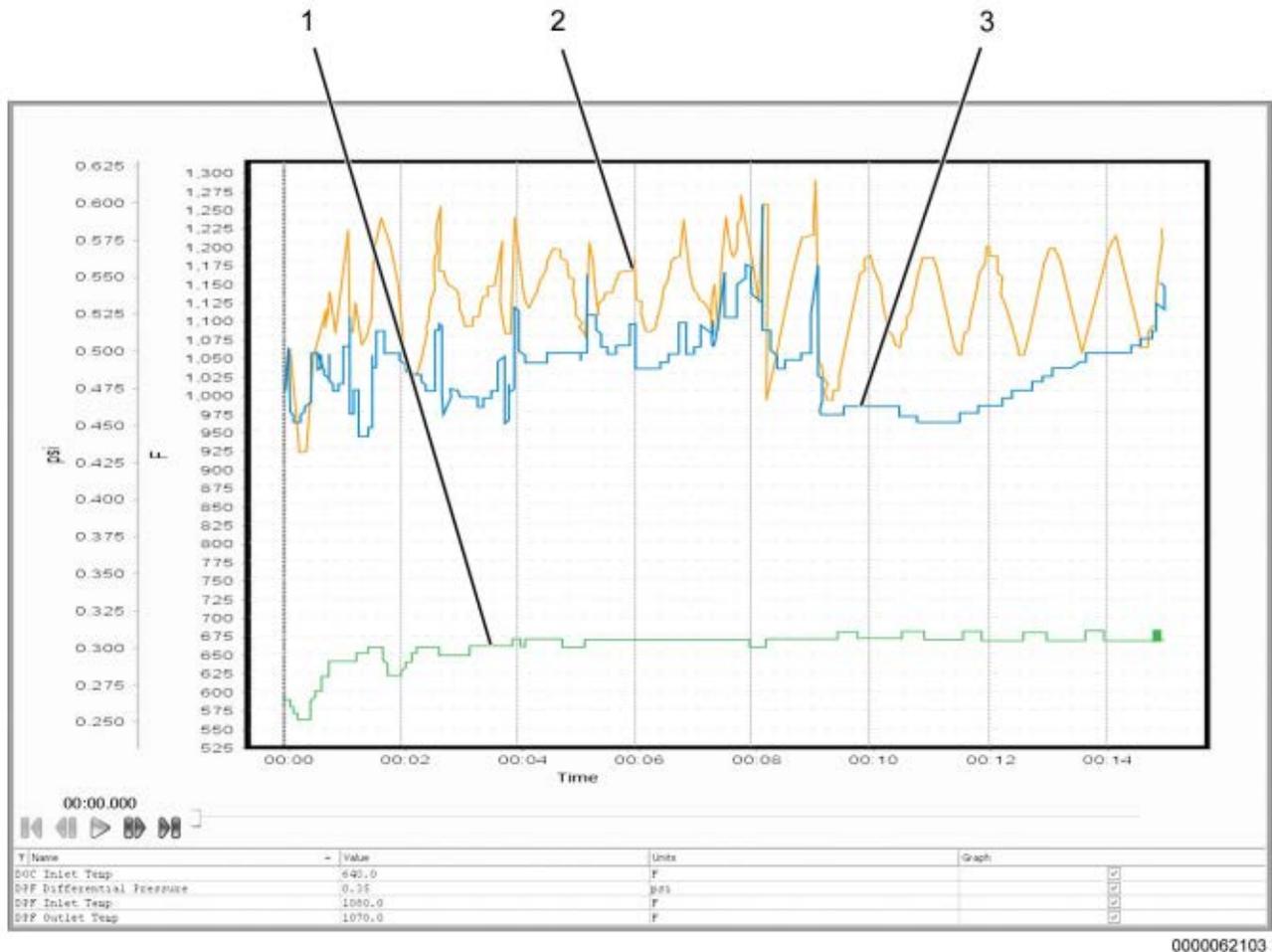
This graph shows an aftertreatment system operating as designed. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

**Actions:**

1. After Diesel Oxidation Catalyst (DOC) reaches operating temperature and stabilizes, verify Diesel Particulate Filter Inlet Temperature (DPFIT) signal value is at approximate target temperature for current soot load level (See Soot Load Level vs. Exhaust Gas Target Temperature Chart, page 62).
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C).

**NOTE – It is normal to see DOCIT, DPFIT, and DPFOT signal values to fluctuate at the beginning and end of the OBFCT.**

#### 4.6. GRAPH 6: ERRATIC EXHAUST GAS TEMPERATURES



1. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Green]
2. Diesel Particulate Filter Inlet Temperature (DPFIT) (degrees Fahrenheit) [Orange]
3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Blue]

**Figure 10 Graph 6: Erratic Exhaust Gas Temperatures**

#### Graph Analysis:

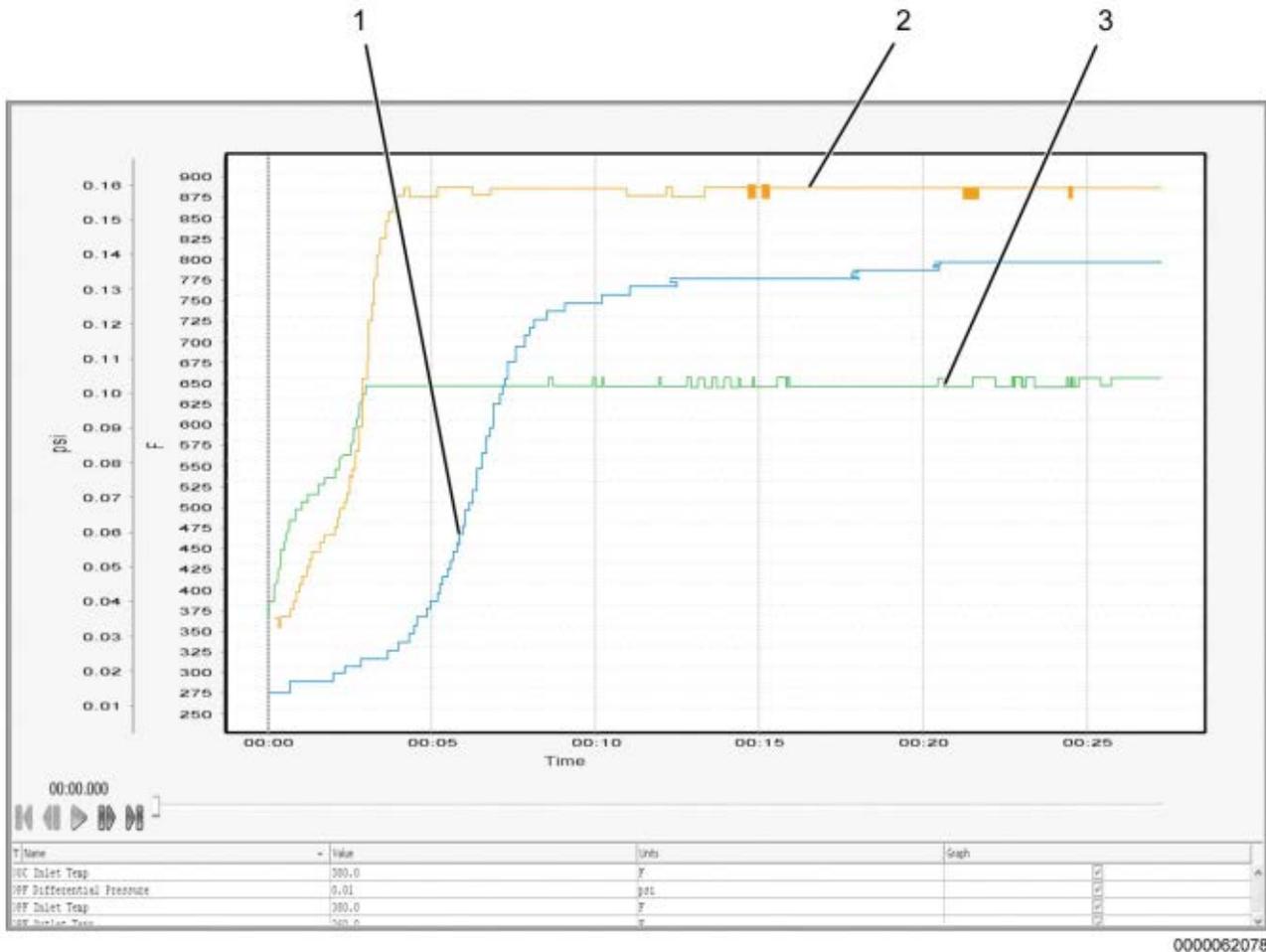
This graph shows erratic exhaust gas temperatures. Erratic temperatures in the exhaust stream occur when the Diesel Oxidation Catalyst becomes contaminated, or an issue with the Aftertreatment Fuel Injector (AFI) is present. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

#### Actions:

1. After Diesel Oxidation Catalyst (DOC) reaches operating temperature, verify Diesel Particulate Filter Inlet Temperature (DPFIT) and Diesel Particulate Filter Outlet Temperature (DPFOT) signal values do not fluctuate more than 50°F (28°C) within 2 minutes. In this graph, DPFIT and DPFOT fluctuate more than 50°F (28°C) within 2 minutes.

**4.7. GRAPH 7: LOW EXHAUST GAS TEMPERATURES (RESTRICTED AFI)**

NOTE – Snapshot recorded below with Diesel Particulate Filter (DPF) soot load level 1.



- 1. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Blue]
- 2. Diesel Particulate Filter Inlet Temperature (DPFIT) (degrees Fahrenheit) [Orange]
- 3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Green]

**Figure 11 Graph 7: Low Exhaust Gas Temperatures (Restricted AFI)**

**Graph Analysis:**

This graph shows low exhaust gas temperatures indicating a restricted Aftertreatment Fuel Injector (AFI). Low temperatures in the exhaust stream occur when fuel flow from the AFI is restricted, resulting in less fuel burning in the exhaust stream. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

**Actions:**

1. After Diesel Oxidation Catalyst (DOC) reaches operating temperature and stabilizes, verify Diesel Particulate Filter Inlet Temperature (DPFIT) signal value is at approximate target temperature for current soot load level (See Soot Load Level vs. Exhaust Gas Target Temperature Chart, page 62).
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C).

**NOTE – It is normal to see DOCIT, DPFIT, and DPFOT signal values fluctuate at the beginning and end of the OBFCT.**

**4.8. SOOT LOAD LEVEL VS. EXHAUST GAS TARGET TEMPERATURE CHART**

<b>Soot Load (%)</b>	<b>DPF Soot Load Level</b>	<b>Exhaust Gas Target Temperature (DPFIT)</b>
0 -16	0	1125°F (607°C)
17 -33	1	1110°F (599°C)
34 - 49	2	1090°F (588°C)
50 - 66	3	1075°F (579°C)
67 - 83	4	1050°F (566°C)
84 - 99	5	1025°F (552°C)
100 - 116	6	1000°F (538°C)
117 - 132	7	975°F (524°C)
133 - 149	8	900°F (482°C)
150 - 169	9	860°F (460°C)
170 - 184	10	850°F (454°C)
185 - 199	11	840°F (449°C)
200 - 216	12	835°F (446°C)
217 - 234	13	830°F (443°C)
235 - 249	14	825°F (441°C)
250 - 269	15	820°F (438°C)
270 and above	16 and above	810°F (432°C) or below

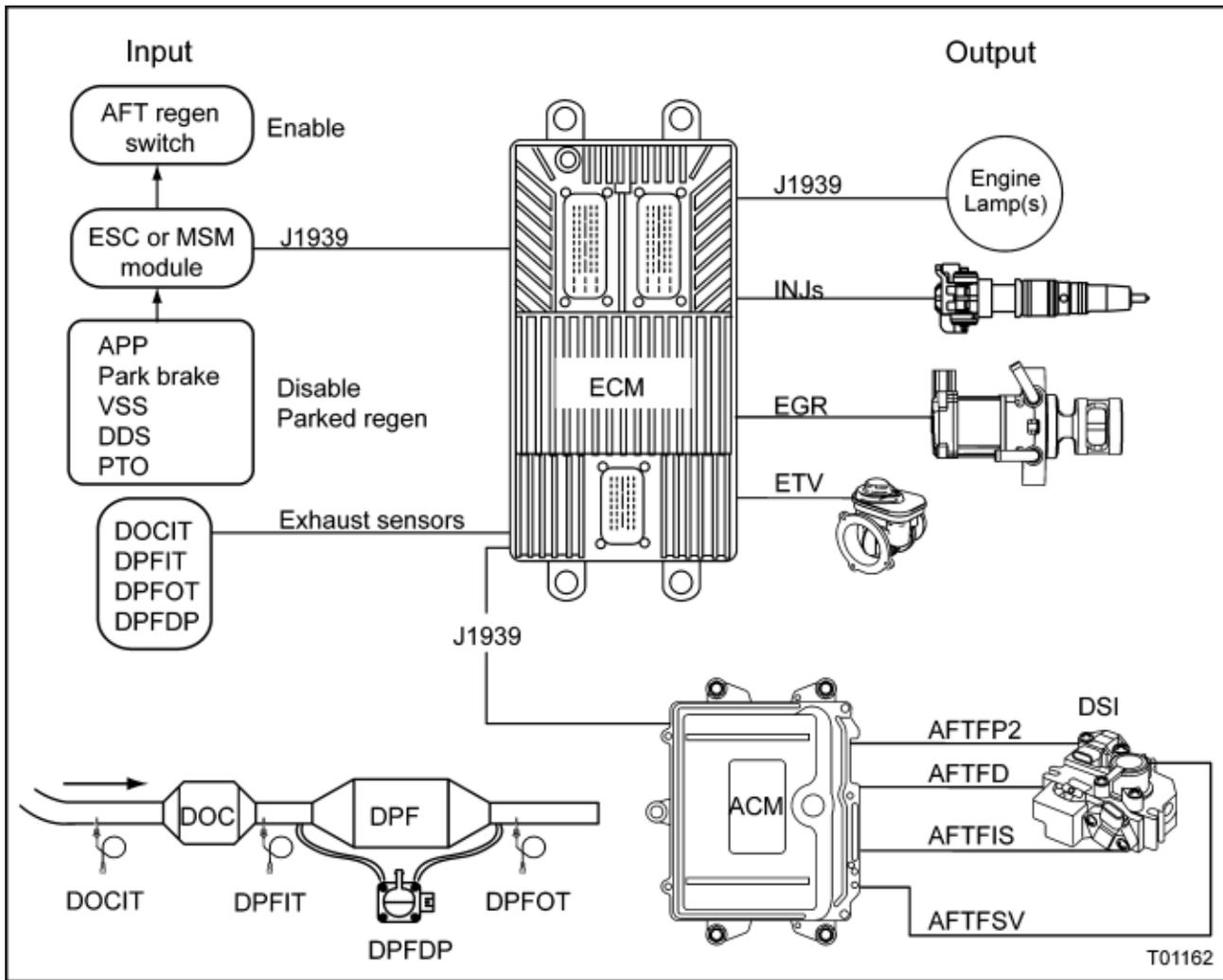
## AFTERTREATMENT SYSTEM OPERATION

### 5.1. MAXXFORCE® DT, 9 AND 10

The Aftertreatment (AFT) system, part of the larger exhaust system, processes engine exhaust to meet emission requirements. The AFT system traps particulate matter (soot) and prevents it from leaving the tailpipe.

The AFT system performs the following functions:

- Monitors exhaust gas temperatures Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Oxidation Catalyst Outlet Temperature (DOCOT), and Diesel Particulate Filter Outlet Temperature (DPFOT).
- Monitors Diesel Particulate Filter Differential Pressure (DPFDP).
- Controls engine operating parameters for emission control and failure recognition.
- Cancels regeneration of the AFT system in the event of catalyst or sensor failure.
- Calculates the level of ash accumulation in the Diesel Particulate Filter (DPF).
- Initiates regeneration of the AFT system when DPF soot load is too high by increasing exhaust gas temperatures.
- Maintains vehicle and engine performance during regeneration.

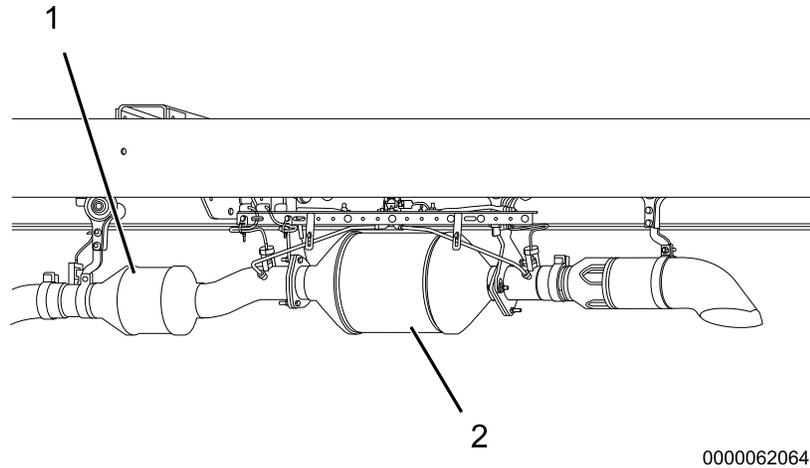


- Engine Control Module (ECM) with Barometric Absolute Pressure (BARO) internal sensor
- Multiplex System Module (MSM) body module (PayStar applications only)
- Accelerator Pedal Position (APP) sensor
- Park brake
- Vehicle Speed Sensor (VSS)
- Driveline Disconnect Switch (DDS)
- Power Take Off Switch (PTO)
- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Diesel Oxidation Catalyst Outlet Temperature (DOCOT) sensor
- Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor
- Diesel Particulate Filter Outlet Temperature (DPFOT) sensor
- Diesel Particulate Filter Differential Pressure (DPFDP) sensor

- Fuel Injectors (INJs)
- Exhaust Gas Recirculation (EGR) valve
- Engine Throttle Valve (ETV)
- Warning Indicators
- Inlet Air Heater (IAH)
- Aftertreatment Control Module (ACM)
- Aftertreatment Fuel Inlet Sensor (AFTFIS)
- Aftertreatment Fuel Pressure 2 (AFTFP2) sensor
- Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Aftertreatment Fuel Doser (AFTFD)
- Downstream Injection (DSI) unit

## COMPONENT DESCRIPTIONS (THEORY OF OPERATION)

### 6.1. MAXXFORCE® DT, 9 AND 10



1. Diesel Oxidation Catalyst (DOC)

2. Diesel Particulate Filter (DPF)

**Figure 13 DOC and DPF Assembly (MaxxForce® DT, 9 and 10 Engines)**

#### **Diesel Oxidation Catalyst (DOC)**

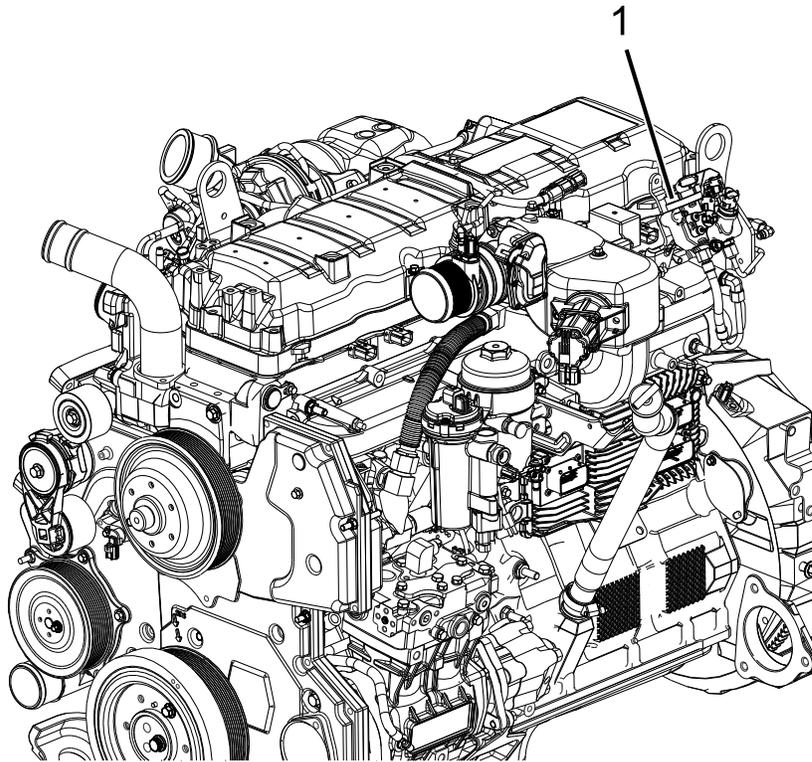
The DOC does the following:

- Oxidizes hydrocarbons and carbon monoxide (CO) in exhaust stream
- Provides heat for exhaust system warm-up

#### **Diesel Particulate Filter (DPF)**

The DPF does the following:

- Captures and temporarily stores carbon-based particulates in a filter
- Allows for oxidation (regeneration) of stored particulates once loading gets to a particular level (restriction)
- Provides the required exhaust back pressure drop for engine performance
- Stores non-combustible ash



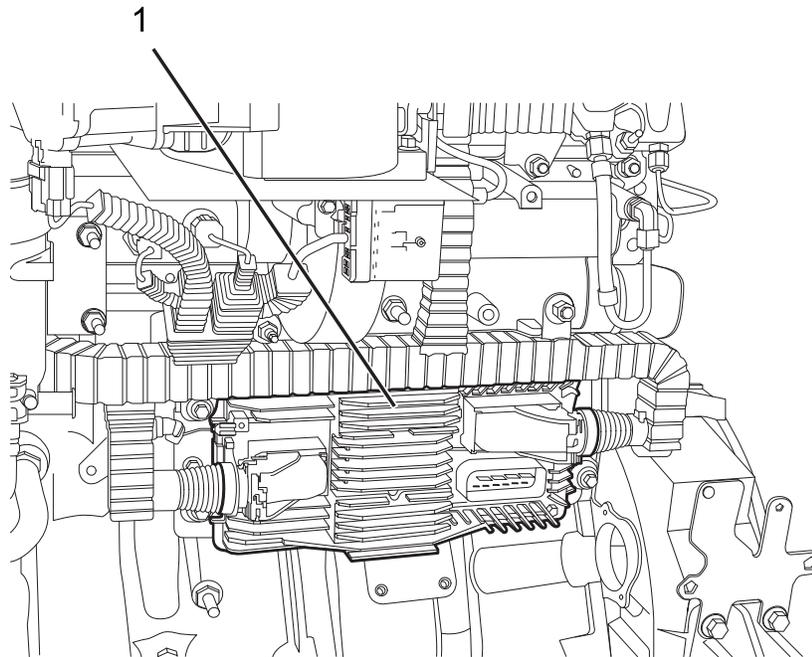
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1. Downstream Injection (DSI) unit

**Figure 14 DSI Unit (MaxxForce® DT, 9 and 10 Engines)**

### **Downstream Injection (DSI) Unit**

The DSI unit is connected to the clean side of the low-pressure fuel system, and will provide a metered amount of fuel to the Aftertreatment Fuel Injector (AFI). The DSI unit provides pressurized fuel injection pulses to the AFI. The AFI is a mechanical poppet type injector, and will only inject fuel when fuel line pressure is increased above a specific pressure.



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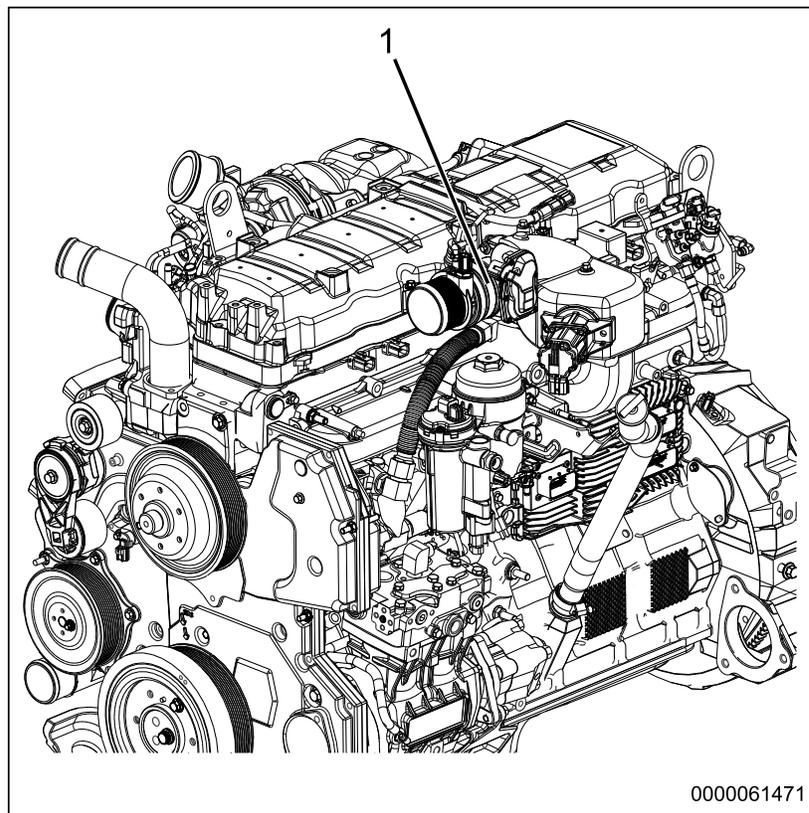
1. Engine Control Module (ECM)

**Figure 15 ECM (MaxxForce® DT, 9 and 10 Engines)**

**Engine Control Module (ECM)**

The Engine Control Module (ECM) monitors and controls engine operation to ensure maximum performance and adherence to emissions standards. The ECM performs the following functions:

- Provide reference voltage (VREF)
- Condition input signals
- Process and store control strategies
- Control actuators

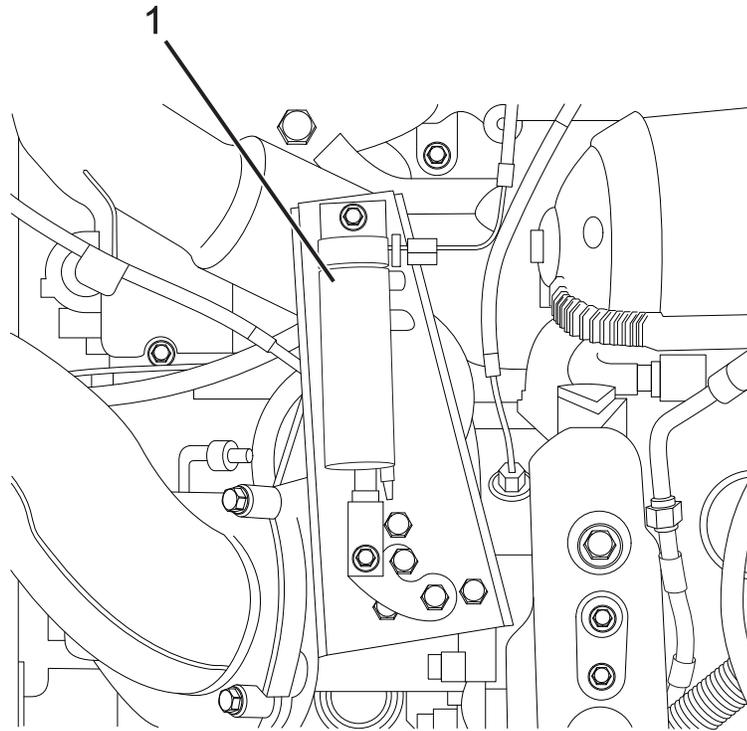


1. Engine Throttle Valve (ETV)

**Figure 16 ETV (MaxxForce® DT, 9 and 10 Engines)**

### **Engine Throttle Valve (ETV)**

The Engine Throttle Valve (ETV) controls the flow of fresh air (boosted and cooled) into the engine's air intake path through the CAC to help heat the exhaust aftertreatment during regeneration, and to assist when heavy EGR is requested. The electronic portion of the ETV contains a microprocessor that monitors valve position, electronic chamber temperature, controls the electric motor, and reports diagnostic faults to the ECM. The ETV changes position in response to ECM signals.



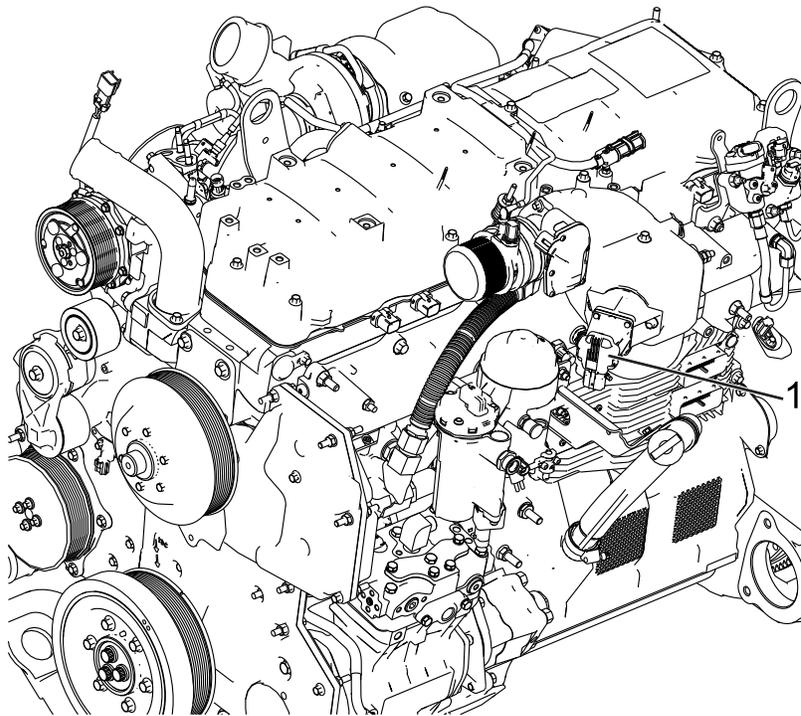
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1. Exhaust Back Pressure Valve (EBPV)

**Figure 17 EBPV (Typical)**

**Exhaust Back Pressure Valve (EBPV)**

The Exhaust Back Pressure Valve (EBPV) controls the position of the exhaust valve increasing or decreasing exhaust gas back pressure and temperature to allow the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) to function efficiently.



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1. Exhaust Gas Recirculation (EGR) valve

**Figure 18 EGR System (MaxxForce® DT, 9 and 10 Engines)**

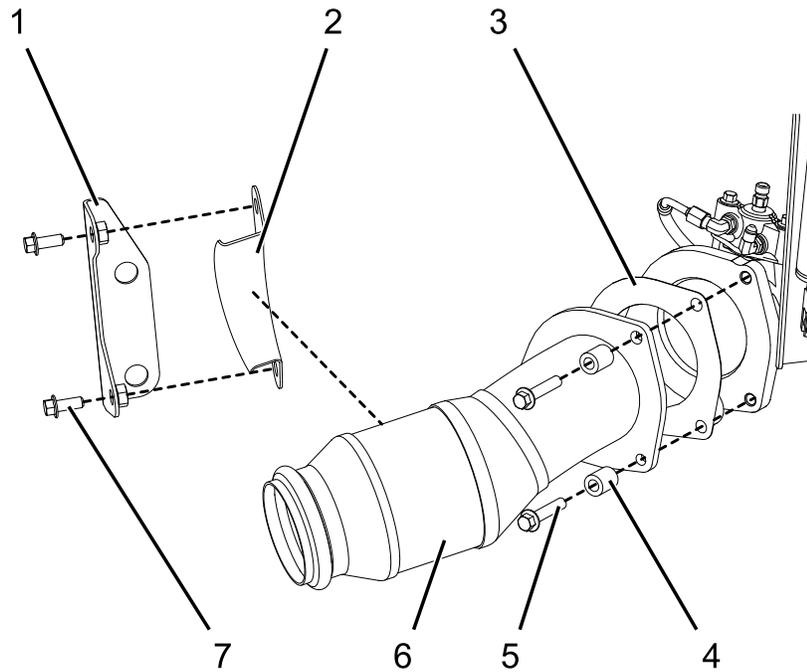
### **Exhaust Gas Recirculation (EGR) Valve**

The EGR valve receives the desired valve position from the ECM for exhaust gas recirculation. The EGR valve regulates the flow of exhaust gases through the EGR system.

### Pre-Diesel Oxidation Catalyst (PDOC)

The PDOC does the following:

- Aids in creating an exothermic reaction to improve exhaust emissions
- Allows for more efficient operation of the aftertreatment system

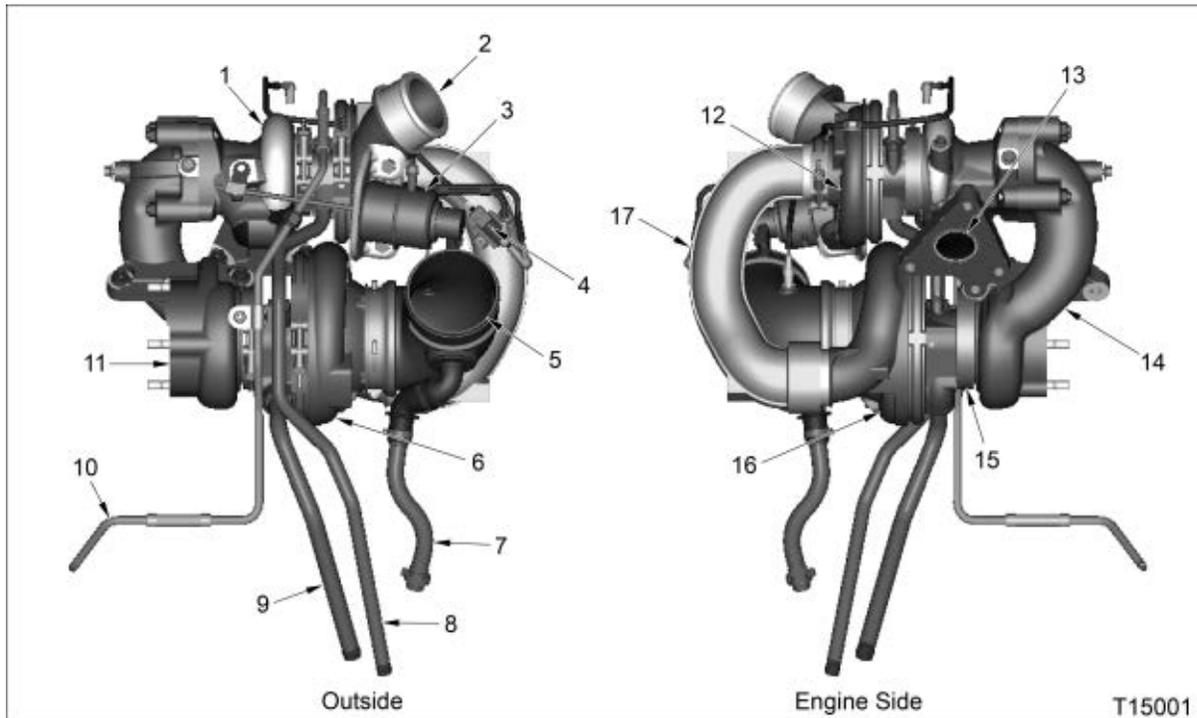


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- |   |                               |
|---|-------------------------------|
| 1. PDOC back bracket (attaches to engine) | 4. 11 x 20 x 24 mm spacer (3) |
| 2. PDOC bracket                           | 5. M10 x 50 bolt (3)          |
| 3. Exhaust Flange Gasket                  | 6. PDOC                       |
|   | 7. M10 x 25 bolt (2)          |

**Figure 19 Pre-Diesel Oxidation Catalyst (PDOC) (Typical)**

## High and Low Pressure Turbocharger Components



- |   |                                      |
|---|--------------------------------------|
| 1. High-pressure turbine housing                  | 10. Turbo oil supply tube assembly   |
| 2. High-pressure turbocharger outlet              | 11. Low-pressure turbine outlet      |
| 3. Turbo wastegate actuator                       | 12. High-pressure compressor housing |
| 4. Turbocharger 2 Wastegate Control (TC2WC) valve | 13. High-pressure turbine inlet      |
| 5. Turbo air inlet duct                           | 14. Low-pressure turbine housing     |
| 6. Low-pressure compressor housing                | 15. Low-pressure bearing housing     |
| 7. Breather outlet tube                           | 16. Low-pressure compressor housing  |
| 8. High-pressure turbo oil drain tube             | 17. Air crossover duct               |
| 9. Low-pressure turbo oil drain tube              |                                      |

**Figure 20 High and Low Pressure Turbocharger Components — MaxxForte® DT, 9 and 10 Engines (Below 245 HP Shown)**

MaxxForte® DT, 9, and 10 (EPA 10) engines are equipped with an electronically controlled two stage turbocharging system. The high and low-pressure turbochargers are installed as an assembly on the exhaust manifold, on right side of engine.

**Intake air flow:** Filtered air enters the LP compressor, where it is compressed and directed to the LPCAC (if equipped). Cooled LP air enters the HP compressor where it is further compressed and directed into the HPCAC. Compressed air then travels through the ETV and the intake throttle duct. This system provides high charge air pressure to improve engine performance and to help reduce emissions.

**Exhaust gas flow:** The HP turbocharger is connected directly to the exhaust manifold through the HP turbine inlet. Exhaust gases exit the HP turbine outlet and are directed to the LP turbine inlet. The HP turbocharger is equipped with a single wastegate, which is controlled by pneumatic actuator. When boost demand is low, the wastegate is opened, allowing part of the exhaust gas flow to bypass the turbine.

## AFTERTREATMENT SYSTEM FAULT CODES

### 7.1. MAXXFORCE® DT, 9 AND 10 (EPA 10)

SPN	FMI	Condition	Possible Causes
3242	2	DPFIT signal does not agree with other exhaust sensors	<ul style="list-style-type: none"> <li>Biased DPFIT circuit or sensor</li> </ul>
3242	3	DPFIT signal Out of Range HIGH	<ul style="list-style-type: none"> <li>DPFIT signal OPEN or short to PWR</li> <li>SIG GND circuit OPEN</li> <li>Failed DPFIT sensor</li> </ul>
3242	4	DPFIT signal Out of Range LOW	<ul style="list-style-type: none"> <li>DPFIT signal circuit short to GND</li> <li>Failed DPFIT sensor</li> </ul>
3246	2	DPFOT signal does not agree with other exhaust sensors	<ul style="list-style-type: none"> <li>Biased DPFOT sensor or circuit</li> </ul>
3246	3	DPFOT signal Out of Range HIGH	<ul style="list-style-type: none"> <li>DPFOT signal circuit OPEN or short to PWR</li> <li>SIG GND circuit OPEN</li> <li>Failed DPFOT sensor</li> </ul>
3246	4	DPFOT signal Out of Range LOW	<ul style="list-style-type: none"> <li>DPFOT signal circuit short to GND</li> <li>Failed DPFOT sensor</li> </ul>
3246	7	DPFOT not warming along with engine	<ul style="list-style-type: none"> <li>Biased DPFOT circuit or sensor</li> </ul>
3246	20	DPF over temperature - possible filter damage	<ul style="list-style-type: none"> <li>Restricted DPF</li> <li>DOC Failure</li> <li>Engine over fueling</li> <li>Downstream Injection over fueling</li> <li>Biased DPFOT sensor or circuit</li> </ul>
3251	2	DPFDP above or below desired level	<ul style="list-style-type: none"> <li>Biased DPFDP sensor or circuit</li> <li>Restricted or plugged DPF</li> <li>Reversed DPF sensor hoses</li> </ul>
3251	3	DPFDP signal Out of Range HIGH	<ul style="list-style-type: none"> <li>DPFDP signal circuit short to PWR</li> <li>SIG GND circuit OPEN</li> <li>Failed DPFDP sensor</li> </ul>
3251	4	DPFDP signal Out of Range LOW	<ul style="list-style-type: none"> <li>Reversed DPFDP sensor hoses</li> <li>DPFDP signal circuit OPEN or short to GND</li> <li>Failed DPFDP sensor</li> </ul>
3251	10	DPFDP signal abnormal rate of change	<ul style="list-style-type: none"> <li>DPFDP sensor tubes restricted or open</li> <li>Biased DPFDP circuit or sensor</li> </ul>

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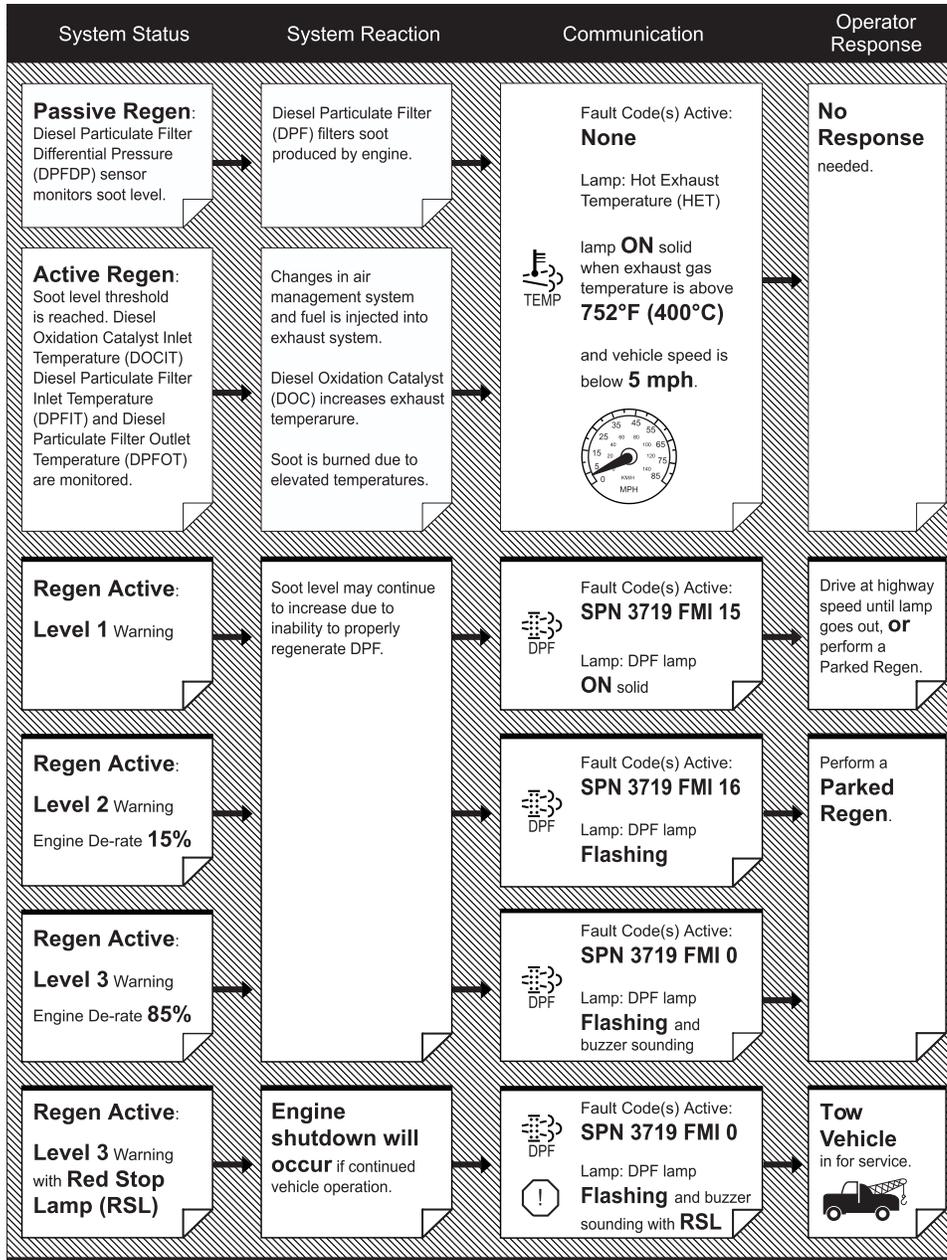
3471	1	Fuel Pressure 1 below desired (Low system pressure)	<ul style="list-style-type: none"> <li>• Lower fuel delivery pressure</li> <li>• Restricted fuel filter</li> <li>• AFT Fuel Shutoff Valve failure</li> <li>• Biased AFT Fuel Pressure 1 sensor or circuit</li> </ul>
3471	7	AFT Fuel Doser Valve not responding as expected	<ul style="list-style-type: none"> <li>• Lower fuel delivery pressure</li> <li>• Restricted fuel filter</li> <li>• AFT Fuel Shutoff Valve failure</li> <li>• Biased AFT Fuel Pressure 1 sensor or circuit</li> </ul>
3471	10	AFT Fuel Doser Valve abnormal rate of change	<ul style="list-style-type: none"> <li>• AFT Fuel Doser failure</li> </ul>
3479	3	AFT Fuel Doser Valve short to PWR	<ul style="list-style-type: none"> <li>• AFTFD circuit short to PWR</li> <li>• Failed AFTFD</li> </ul>
3479	4	AFT Fuel Doser Valve short to GND	<ul style="list-style-type: none"> <li>• AFTFD circuit OPEN or short to GND</li> <li>• Failed AFTFD</li> </ul>
3480	3	AFTFP1 signal Out of Range HIGH	<ul style="list-style-type: none"> <li>• AFTFP1 signal circuit OPEN or short to PWR</li> <li>• Failed AFTFIS</li> </ul>
3480	4	AFTFP1 signal Out of Range LOW	<ul style="list-style-type: none"> <li>• AFTFP1 signal circuit short to GND</li> <li>• Failed AFTFIS</li> </ul>
3482	3	AFT Fuel Shutoff Valve short to PWR	<ul style="list-style-type: none"> <li>• AFTFSV circuit OPEN or short to PWR</li> <li>• Failed AFTFSV</li> </ul>
3482	4	AFT Fuel Shutoff Valve short to GND	<ul style="list-style-type: none"> <li>• AFTFSV circuit short to GND</li> <li>• Failed AFTFSV</li> </ul>
3512	14	ACM VREF 1 and 2 voltage deviation	<ul style="list-style-type: none"> <li>• ACM VREF circuit short to PWR</li> <li>• ACM VREF circuit short to GND</li> <li>• Failed sensor causing short to GND on VREF circuit</li> </ul>
3556	0	AFTFP2 excessively high (Restricted injection)	<ul style="list-style-type: none"> <li>• Hydrocarbon Injector assembly failure (Plugged)</li> <li>• Biased AFT Fuel Pressure 2 sensor or circuit</li> </ul>
3556	1	AFT Fuel Pressure 2 below desired (Possible system leak)	<ul style="list-style-type: none"> <li>• Fuel leak from metering unit</li> <li>• Biased AFT Fuel Pressure 2 sensor or circuit</li> </ul>
3719	0	DPF Soot Load – Highest (level 3/3)	<ul style="list-style-type: none"> <li>• Level 3 DPF plugged</li> </ul>
3719	15	DPF Soot Load – Lowest (level 1/3)	<ul style="list-style-type: none"> <li>• Level 1 DPF Regen required</li> </ul>

3719	16	DPF Soot Load – Moderate (level 2/3)	<ul style="list-style-type: none"> <li>Level 2 DPF Regen required</li> </ul>
3936	0	DPF Soot Load – Severe De-Rate	<ul style="list-style-type: none"> <li>Level 3 DPF plugged</li> </ul>
3936	14	DPF– Regen duration above limit	<ul style="list-style-type: none"> <li>Engine unable to build enough heat to the DOC</li> <li>DOC failure</li> <li>DSI failure to inject fuel into the exhaust</li> <li>DPF failure</li> </ul>
4077	3	AFTFP2 signal Out of Range HIGH	<ul style="list-style-type: none"> <li>AFTFP2 signal circuit OPEN or short to PWR</li> <li>Failed AFTFIS</li> </ul>
4765	2	DOCIT signal does not agree with other exhaust sensors	<ul style="list-style-type: none"> <li>DOCIT biased sensor or circuit</li> </ul>
4765	3	DOCIT signal Out of Range HIGH	<ul style="list-style-type: none"> <li>DOCIT signal circuit OPEN or short to PWR</li> <li>SIG GND circuit OPEN</li> <li>Failed DPFOT sensor</li> </ul>
4765	4	DOCIT signal Out of Range LOW	<ul style="list-style-type: none"> <li>DOCIT signal circuit short to GND</li> <li>Failed DPFOT sensor</li> </ul>
4765	7	DOCIT not increasing with engine temperature	<ul style="list-style-type: none"> <li>Biased DPFOT sensor or circuit</li> </ul>
5456	3	AFTFT signal Out of Range HIGH	<ul style="list-style-type: none"> <li>AFTFT signal circuit OPEN or short to PWR</li> <li>Failed AFTFIS</li> </ul>
5456	4	AFTFT signal Out of Range LOW	<ul style="list-style-type: none"> <li>AFTFT signal circuit short to GND</li> <li>Failed AFTFIS</li> </ul>
5541	1	TC1TOP pressure below minimum	<ul style="list-style-type: none"> <li>Failed Exhaust Back Pressure valve (Stuck open)</li> </ul>
5541	3	TC1TOP signal Out of Range HIGH	<ul style="list-style-type: none"> <li>TC1TOP signal circuit OPEN or short to PWR</li> <li>SIG GND circuit OPEN</li> <li>Failed TC1TOP sensor</li> </ul>
5541	4	TC1TOP signal Out of Range LOW	<ul style="list-style-type: none"> <li>TC1TOP signal circuit short to GND</li> <li>Failed TC1TOP sensor</li> </ul>

## AFTERTREATMENT SYSTEM EVENT CHART

### 8.1. MAXXFORCE® DT, 9 AND 10

#### AFTERTREATMENT SYSTEM EVENT CHART



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## **MAXXFORCE® 11,13 AND 15 AFTERTREATMENT SYSTEM DIAGNOSTICS**

### **9.1. START DIAGNOSTICS HERE: ENGINE AND AFTERTREATMENT SYSTEM OPERATIONAL CHECKS**

#### **Overview**

A properly operating aftertreatment system requires little manual intervention from the operator. Illuminated warning lamps indicate a driving or extended idle operation that may not allow a successful regeneration of the aftertreatment system. These illuminated warning lamps may indicate an engine mechanical or performance concern.

#### **Tools Required**

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

**NOTE – A frequent regen concern may not be repaired by only performing an Onboard Filter Cleanliness Test (OBFCT). Perform all steps in the following diagnostic procedure in order to identify root cause failure.**

**NOTE – Repair all active fault code(s) other than SPN 3719 (DPF Soot Load) before beginning Engine and Aftertreatment System Operational Checks.**



Step	Action	Decision
3	<p>Diesel Particulate Filter ( DPF) Snap Acceleration Test (Quick Test). This procedure checks the DPF for cracks or internal damage without removing the DPF from the vehicle and is used to test basic functionality of the DPF. This is to be done prior to removing the DPF.</p> <ol style="list-style-type: none"> <li>1. The transmission must be in neutral and the parking brake applied.</li> <li>2. Start and idle the engine.</li> <li>3. Rapidly snap the accelerator pedal from idle to full throttle. This can be performed multiple times.</li> <li>4. During the engine accelerations, visually check for a heavy black smoke exiting the exhaust pipe.</li> </ol> <p>Is black smoke visible?</p>	<p>Yes: Go to Symptom 5 (Heavy Duty): Black smoke page 113.</p> <p>No: Go to Symptom 1 (Heavy Duty): Frequent Parked Regens with No Active Codes (More than one parked regen per day) page 83.</p>

Step	Action	Decision
4	<p>Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for engine overspeed fault code(s).</p> <p>Are engine overspeed fault code(s) active?</p>	<p>Yes: Repair engine overspeed fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 5.</p> <p>No: Go to step 5</p>

Step	Action	Decision
5	<p>Check for an engine no start. Turn ignition switch to ON position and crank engine for a maximum of 20 seconds. If engine does not start, wait 2 to 3 minutes and crank engine again for a maximum of 20 seconds.</p> <p>Does the engine start and run?</p>	<p>Yes: Go to step 6</p> <p>No: Go to Symptom 2 (Heavy Duty): Engine No Start / Starts and Stalls page 91.</p>

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<b>Step</b>	<b>Action</b>	<b>Decision</b>
6	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3719 FMI 0 or 16 (DPF Soot Load).  Is SPN 3719 FMI 0 or SPN 3719 FMI 16 the only fault code(s) active?	Yes: Go to Symptom 3 (Heavy Duty): SPN 3719 Active Only or Frequent Regens page 96.  No: Go to Symptom 4 (Heavy Duty): SPN 3719 and Other Active Fault Codes page 104.

**9.2. SYMPTOM 1 (HEAVY DUTY): FREQUENT PARKED REGENS WITH NO ACTIVE FAULT CODES (MORE THAN ONE PARKED REGEN PER DAY)**

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 80.**

**NOTE – The number of regens performed in one day may vary depending on application. The following criteria should be used to determine if a regen is considered frequent:**

- **Line-haul: More than 1 parked regen per day is frequent regeneration.**
- **Severe service: More than 2 parked regens per day is frequent regeneration.**

Step	Action	Decision
1	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Engine Speed</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Turbocharger 2 Wastegate Control (TC2WC)</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 120?</p>	<p>Graph 1: Go to step 2A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>





Step	Action	Decision
3	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>Diesel Oxidation Catalyst Outlet Temperature (DOCOT)</li> <li>Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 6, 7, and 8 page 129.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 6: Diagnostics complete</p> <p>Graph 7: Go to step 4</p> <p>Graph 8: Go to step 7</p>

Step	Action	Decision
4	<p>Determine if DPF or DOC is contaminated. Remove the DPF and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Are the DPF or DOC contaminated?</p>	<p>Yes: Remove PDOC, and then go to step 5</p> <p>No: Install DPF and DOC, and go to step 7</p>

Step	Action	Decision
5	<p>Determine if DPF, DOC, and PDOC are reusable see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?</p>	<p>Yes: Install removed aftertreatment system components, and go to step 6.</p> <p>No: Replace failed component(s). After repairs are complete, go to step 6.</p>

Step	Action	Decision
6	Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)	After repairs are complete, go to step 7

Step	Action	Decision
7	<p>Check Oxygen Sensor (O<sub>2</sub>S) operation. Start the engine and allow to reach normal operating temperature. Using EST with ServiceMaxx™ software, go to Sessions &gt; Performance. Let the engine idle for 5 minutes while monitoring O<sub>2</sub>S Temperature signal value.</p> <p>Is O<sub>2</sub>S Temperature signal value greater than 1400°F (760°C)?</p>	<p>Yes: Go to step 8</p> <p>No: Repair O<sub>2</sub>S or circuit (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>

Step	Action	Decision
8	<p>Visually inspect Aftertreatment Fuel Injector (AFI) supply line for leaks, kinks, bends, or other damage?</p> <p>Is the AFI supply line leaking or damaged?</p>	<p>Yes: Replace AFI supply line. After repairs are complete, go to step 10.</p> <p>No: Go to step 9</p>



Step	Action	Decision
10	Run DSI System De-Aeration Procedure twice, to purge the Down Stream Injection (DSI) system of air. Using EST, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	After procedure is complete, go to step 11

Step	Action	Decision
11	Using EST, check Diagnostic Trouble Code (DTC) list for fault code(s) that may have become active during OBFCT.  Does DTC list contain active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 12.  No: Go to step 12

Step	Action	Decision
12	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>2. Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Oxidation Catalyst Outlet Temperature (DOCOT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graphs 7 and 8 page 131.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 7: Go to step 13</p> <p>Graph 8: After repairs are complete, retest for original problem.</p>

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<b>Step</b>	<b>Action</b>	<b>Decision</b>
13	Verify root cause of frequent regens has been diagnosed and repaired.  Has root cause for frequent regens been diagnosed and repaired?	Yes: Diagnostics complete  No: Go back to step 1 of Engine and Aftertreatment System Operational Checks page 80 to verify engine systems are in satisfactory condition.

### 9.3. SYMPTOM 2 (HEAVY DUTY): ENGINE NO START / STARTS AND STALLS

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 80.**

Step	Action	Decision
1	<p>Check for an exhaust system restriction by performing the following Exhaust System Restriction Test:</p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"><b>CAUTION</b></div> <p><b>To prevent damage to the starter, if engine fails to start within 20 seconds, release ignition switch and wait 2 to 3 minutes to allow starter motor to cool.</b></p> <ol style="list-style-type: none"> <li>1. Turn ignition switch to ON position.</li> <li>2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Crank the engine for a maximum of 20 seconds and then stop recording.</li> <li>4. Use the playback feature in ServiceMaxx™ and graph Turbocharger 1 Turbine Outlet Pressure (TC1TOP), and Diesel Particulate Filter Differential Pressure (DPFDP) signal values.</li> <li>5. Verify DPFDP and TC1TOP are within specification. DPFDP signal value should be less than 1 psi (7 kPa), and TC1TOP signal value should be less than 5 psi (34 kPa).</li> </ol> <p>Are DPFDP and TC1TOP signal values within specification?</p>	<p>Both DPFDP and TC1TOP signals High: Go to step 2</p> <p>TC1TOP signal High Only: Go to step 3</p> <p>Neither DPFDP or TC1TOP signal High: Go to Hard Start and No Start Diagnostics section in Engine Diagnostic Manual. After repairs are complete, go to step 7.</p>

Step	Action	Decision
2	<p>Determine if Diesel Particulate Filter (DPF) is contaminated. Remove the DPF (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Is the DPF contaminated?</p>	<p>Yes: Remove Pre-Diesel Oxidation Catalyst (PDOC) and Diesel Oxidation Catalyst (DOC), and then go to step 4.</p> <p>No: Go to step 5</p>

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<b>Step</b>	<b>Action</b>	<b>Decision</b>
3	<p>Determine if PDOC or DOC is contaminated. Remove the PDOC and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.</p> <p><b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b></p> <p>Are the PDOC and DOC contaminated?</p>	<p>Yes: Remove DPF, and then go to step 4.</p> <p>No: go to step 5</p>

<b>Step</b>	<b>Action</b>	<b>Decision</b>
4	<p>Determine if DPF, DOC, and PDOC are reusable see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?</p>	<p>Yes: Go to step 6</p> <p>No: Replace failed component(s). After repairs are complete, go to step 6.</p>

<b>Step</b>	<b>Action</b>	<b>Decision</b>
5	<p>Determine if removed aftertreatment system components need to be cleaned see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, do any of the removed aftertreatment system components need to be cleaned?</p>	<p>Yes: Clean components using appropriate cleaning equipment. After cleaning procedure is complete, install components and go to step 7.</p> <p>No: Install removed aftertreatment system components, and go to step 7.</p>

<b>Step</b>	<b>Action</b>	<b>Decision</b>
6	<p>Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)</p>	<p>After repairs are complete, go to step 7.</p>









Step	Action	Decision
4	<p>Determine if removed aftertreatment system components need to be cleaned see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, do any of the removed aftertreatment system components need to be cleaned?</p>	<p>Yes: Clean components using appropriate cleaning equipment. After cleaning procedure is complete, install components and go to step 6.</p> <p>No: Install removed aftertreatment system components, and then go to step 6.</p>

Step	Action	Decision
5	<p>Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)</p>	<p>After repairs are complete, go to step 7</p>

Step	Action	Decision
6	<p>Diesel Particulate Filter (DPF) Snap Acceleration Test (Quick Test). This procedure checks the DPF for cracks or internal damage without removing the DPF from the vehicle and is used to test basic functionality of the DPF. This is to be done prior to removing the DPF.</p> <ol style="list-style-type: none"> <li>1. The transmission must be in neutral and the parking brake applied.</li> <li>2. Start and idle the engine.</li> <li>3. Rapidly snap the accelerator pedal from idle to full throttle. This can be performed multiple times.</li> <li>4. During the engine accelerations, visually check for a heavy black smoke exiting the exhaust pipe.</li> </ol> <p>Is black smoke visible?</p>	<p>Yes: Go to symptom 5 (Heavy Duty): Black smoke page 113.</p> <p>No: Go to step 7</p>

Step	Action	Decision
7	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Engine Speed</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Turbocharger 2 Wastegate Control (TC2WC)</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 120?</p>	<p>Graph 1: Go to step 8A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing Lug Down Test.

Step	Action	Decision
8A	<p>Using EST, go to Sessions &gt; Performance. Find an open stretch of road in order to perform Lug Down Test. When driving conditions are safe, select the record snapshot icon from the toolbar, and perform Lug Down procedure below:</p> <ol style="list-style-type: none"> <li>1. Select a suitable high range gear (Example: In a 10 speed gearbox, select the 8th speed).</li> <li>2. Allow engine speed to drop to 1000 rpm.</li> <li>3. Press accelerator pedal fully to the floor, and accelerate to rated engine speed.</li> </ol> <p>After Lug Down Test is complete, stop recording and save snapshot.</p>	Go to step 8B

Step	Action	Decision
8B	<p>Check for low fuel rail pressure. Using EST with ServiceMaxx™ software, use the playback feature and graph the following signal values from Lug Down Test:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Engine Speed</li> <li>• Fuel Rail Pressure (FRP)</li> <li>• Fuel Rail Pressure Desired (FRPD)</li> </ul> <p>Compare snapshot to Graph 3 and associated Graph Analysis page 124.</p> <p>Is FRP signal operating as per Graph 3 Graph Analysis?</p>	<p>Yes: Go to step 8C</p> <p>No: Diagnose and repair low fuel rail pressure (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



Step	Action	Decision
9	<p>Verify exhaust gas temperatures are within specification. Use the playback feature in ServiceMaxx™, and graph the following signal values from step 1 OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Oxidation Catalyst Outlet Temperature (DOCOT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 6, 7, and 8 page 129.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 6: Diagnostics complete</p> <p>Graph 7: Replace DOC. After repairs are complete, perform an OBFCT to verify repairs.</p> <p>Graph 8: Go to step 10</p>

Step	Action	Decision
10	<p>Check Oxygen Sensor (O<sub>2</sub>S) operation. Start the engine and allow to reach normal operating temperature. Using EST with ServiceMaxx™ software, go to Sessions &gt; Performance. Let the engine idle for 5 minutes while monitoring O<sub>2</sub>S Temperature signal value.</p> <p>Is O<sub>2</sub>S Temperature signal value greater than 1400°F (760°C)?</p>	<p>Yes: Go to step 11</p> <p>No: Repair O<sub>2</sub>S or circuit (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>

Step	Action	Decision
11	<p>Visually inspect Aftertreatment Fuel Injector (AFI) supply line for leaks, kinks, bends, or other damage?</p> <p>Is the AFI supply line leaking or damaged?</p>	<p>Yes: Replace AFI supply line. After repairs are complete, go to step 13.</p> <p>No: Go to step 12</p>



Step	Action	Decision
13	Run DSI System De-Aeration Procedure twice, to purge the Down Stream Injection (DSI) system of air. Using EST, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	Go to step 14

Step	Action	Decision
14	Using EST, check Diagnostic Trouble Code (DTC) list for fault code(s) that may have become active during OBFCT.  Does DTC list contain active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 15.  No: Go to step 15

Step	Action	Decision
15	Verify exhaust gas temperatures are within specification.  <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>2. Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Oxidation Catalyst Outlet Temperature (DOCOT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graphs 7 and 8 page 131.</p> <p>Which graph does snapshot most closely match?</p>	Graph 7: Go to step 16  Graph 8: Replace DOC. After repairs are complete, retest for original problem.

Step	Action	Decision
16	Verify root cause of frequent regens symptom.  Has root cause for frequent regens been diagnosed and repaired?	Yes: Diagnostics complete  No: Go back to step 1 of Engine and Aftertreatment System Operational Checks page 80 to verify engine systems are in satisfactory condition.

**9.5. SYMPTOM 4 (HEAVY DUTY): SPN 3719 AND OTHER ACTIVE FAULT CODES**

**NOTE – Before beginning the following step-based diagnostics, perform all vehicle operational checks page 80.**

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for active fault code(s) other than SPN 3719 (DPF soot load).  Are fault code(s) other than SPN 3719 active?	Yes: Repair other active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 2.  No: Go to step 2

Step	Action	Decision
2	Do Onboard Filter Cleanliness Test (OBFCT) to clear SPN 3719 active fault code. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions > Performance and select the record snapshot icon from the toolbar. Then go to Tests > KOER Aftertreatment Tests > Onboard Filter Cleanliness Test.  Is SPN 3719 still active after OBFCT is complete?	Yes: Go to step 3  No: Go to step 7

Step	Action	Decision
3	Determine if Diesel Particulate Filter (DPF), Pre-Diesel Oxidation Catalyst (PDOC), and Diesel Oxidation Catalyst (DOC) are contaminated. Remove the DPF, PDOC, and DOC (see Exhaust System Service Manual), and check for signs of lube oil and coolant contamination.  <b>NOTE – A black staining in the exhaust tailpipe can occur on applications that experience high idle times. This is normal and the DPF should NOT be replaced.</b>  Are the DPF, PDOC, or DOC contaminated?	Yes: Go to step 4  No: Go to step 5

Step	Action	Decision
4	Determine if DPF, DOC, and PDOC are reusable see DPF and DOC reuse guidelines page 159.  Based on DPF and DOC Re-Use Guidelines, are the DPF, DOC, and PDOC reusable?	Yes: Go to step 6  No: Replace failed component(s). After repairs are complete, go to step 6

Step	Action	Decision
5	<p>Determine if removed aftertreatment system components need to be cleaned see DPF and DOC reuse guidelines page 159.</p> <p>Based on DPF and DOC Re-Use Guidelines, do any of the removed aftertreatment system components need to be cleaned?</p>	<p>Yes: Clean components using appropriate cleaning equipment. After cleaning procedure is complete, install components and go to step 7.</p> <p>No: Install removed aftertreatment system components, and go to step 7.</p>

Step	Action	Decision
6	<p>Determine root cause of exhaust system contamination. (See Engine Symptoms Diagnostics section in Engine Diagnostic Manual.)</p>	<p>After repairs are complete, go to step 8.</p>

Step	Action	Decision
7	<p>Diesel Particulate Filter ( DPF) Snap Acceleration Test (Quick Test). This procedure checks the DPF for cracks or internal damage without removing the DPF from the vehicle and is used to test basic functionality of the DPF. This is to be done prior to removing the DPF.</p> <ol style="list-style-type: none"> <li>1. The transmission must be in neutral and the parking brake applied.</li> <li>2. Start and idle the engine.</li> <li>3. Rapidly snap the accelerator pedal from idle to full throttle. This can be performed multiple times.</li> <li>4. During the engine accelerations, visually check for a heavy black smoke exiting the exhaust pipe.</li> </ol> <p>Is black smoke visible?</p>	<p>Yes: Go to symptom 5 (Heavy Duty): Black smoke page 113.</p> <p>No: Go to step 8</p>

Step	Action	Decision
8	<p>Check for a failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test.</li> </ol> <p>When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Engine Speed</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Turbocharger 2 Wastegate Control (TC2WC)</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 120?</p>	<p>Graph 1: Go to step 9A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>





Step	Action	Decision
10	<p>Verify exhaust gas temperatures are within specification. Use the playback feature in ServiceMaxx™, and graph the following signal values from step 2 OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Oxidation Catalyst Outlet Temperature (DOCOT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graph 6, 7, and 8 page 129.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 6: Diagnostics complete</p> <p>Graph 7: Replace DOC. After repairs are complete, perform an OBFCT to verify repairs.</p> <p>Graph 8: Go to step 11</p>

Step	Action	Decision
11	<p>Check Oxygen Sensor (O<sub>2</sub>S) operation. Start the engine and allow to reach normal operating temperature. Using EST with ServiceMaxx™ software, go to Sessions &gt; Performance. Let the engine idle for 5 minutes while monitoring O<sub>2</sub>S Temperature signal value.</p> <p>Is O<sub>2</sub>S Temperature signal value greater than 1400°F (760°C)?</p>	<p>Yes: Go to step 12</p> <p>No: Repair O<sub>2</sub>S or circuit (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>

Step	Action	Decision
12	<p>Visually inspect Aftertreatment Fuel Injector (AFI) supply line for leaks, kinks, bends, or other damage?</p> <p>Is the AFI supply line leaking or damaged?</p>	<p>Yes: Replace AFI supply line. After repairs are complete, go to step 14.</p> <p>No: Go to step 13</p>



Step	Action	Decision
14	Run DSI System De-Aeration Procedure twice, to purge the Down Stream Injection (DSI) system of air. Using EST, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	After procedure is complete, go to step 15.

Step	Action	Decision
15	Using EST, check Diagnostic Trouble Code (DTC) list for fault code(s) that may have become active during OBFCT.  Does DTC list contain active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 16.  No: Go to step 16

Step	Action	Decision
16	<p>Verify exhaust gas temperatures are within specification.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>2. Go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Oxidation Catalyst Outlet Temperature (DOCOT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graphs 7 and 8 page 131.</p> <p>Which graph does snapshot most closely match?</p>	<p>Graph 7: Go to step 17</p> <p>Graph 8: Replace DOC. After repairs are complete, retest for original problem.</p>

**DIAGNOSTIC MANUAL**

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<b>Step</b>	<b>Action</b>	<b>Decision</b>
17	Verify root cause of frequent regens symptom.  Has root cause for frequent regens been diagnosed and repaired?	Yes: Diagnostics complete  No: Go back to step 1 of Engine and Aftertreatment System Operational Checks page 80 to verify engine systems are in satisfactory condition.





Step	Action	Decision
4	<p>Check for failed Air Management System (AMS) actuator.</p> <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; Load Test Specific Session and verify Load Test Specific Session is unchecked.</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> <li>3. Go to Tests &gt; KOER Tests &gt; Air Management Test. When Air Management Test is complete, stop recording. Use the playback feature in ServiceMaxx™, and graph the following signal values:</li> </ol> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Engine Speed</li> <li>• Intake Manifold Pressure (IMP)</li> <li>• Turbocharger 2 Wastegate control (TC2WC)</li> </ul> <p>Does snapshot match Graph 1 or Graph 2 page 120?</p>	<p>Graph 1: Go to step 5A</p> <p>Graph 2: Diagnose and repair failed actuator (See Performance Diagnostics section in Engine Diagnostic Manual). After repairs are complete, retest for original problem.</p>



**To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing Lug Down Test.**

Step	Action	Decision
5A	<p>Check for engine performance issues. Using EST, go to Sessions &gt; Performance. Find an open stretch of road in order to perform Lug Down Test. When driving conditions are safe, select the record snapshot icon from the toolbar, and perform Lug Down procedure below:</p> <ol style="list-style-type: none"> <li>1. Select a suitable high range gear (Example: In a 10 speed gearbox, select the 8th speed).</li> <li>2. Allow engine speed to drop to 1000 RPM</li> <li>3. Press accelerator pedal fully to the floor, and accelerate to rated engine speed.</li> </ol> <p>After Lug Down Test is complete, stop recording and save snapshot.</p>	Go to step 5B







Step	Action	Decision
8	Run Down Stream Injection (DSI) System De-Aeration Procedure twice, to purge the DSI system of air. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Procedures > KOER Aftertreatment Procedures > DSI System De-Aeration.	Go to step 9

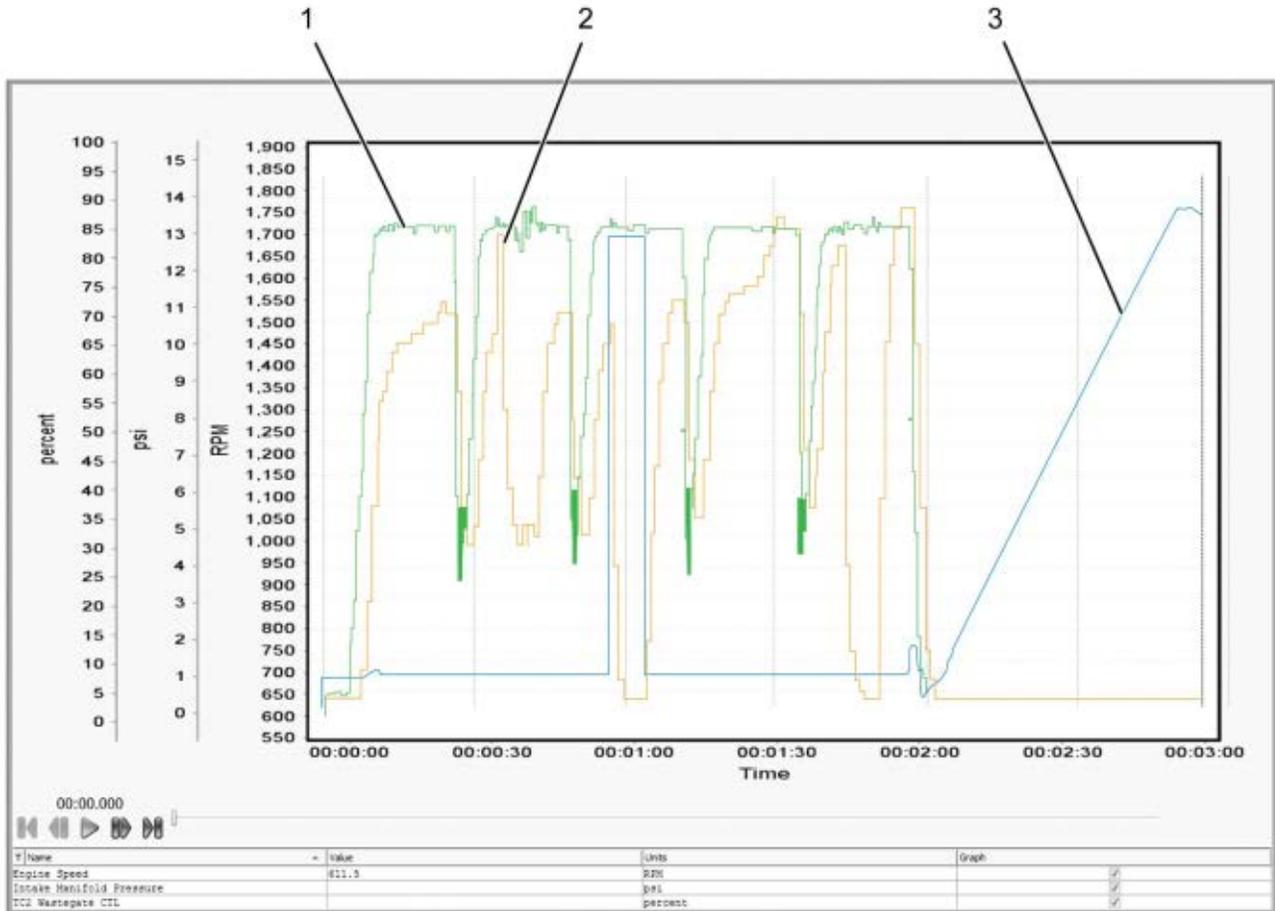
Step	Action	Decision
9	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for any fault code(s) that may have become active during OBFCT.  Does DTC list contain any active fault code(s)?	Yes: Repair active fault code(s) (See Electronic Control Systems Diagnostics in Engine Diagnostic Manual). After repairs are complete, go to step 10  No: Go to step 10

Step	Action	Decision
10	Verify exhaust gas temperatures are within specification.  <ol style="list-style-type: none"> <li>1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests &gt; KOER Aftertreatment Tests &gt; Onboard Filter Cleanliness Test (OBFCT).</li> <li>2. Go to Sessions &gt; Performance and select the record snapshot icon from the toolbar.</li> </ol> <p>When OBFCT is complete, stop recording. Use the playback feature and graph the following signal values from OBFCT:</p> <p>Signal Values</p> <p><b>Signal Values:</b></p> <ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Inlet Temperature (DOCIT)</li> <li>• Diesel Particulate Filter Inlet Temperature (DPFIT)</li> <li>• Diesel Particulate Filter Outlet Temperature (DPFOT)</li> <li>• DPF Soot Load</li> </ul> <p>Compare snapshot to Graphs 6 and 8 page 129.</p> <p>Which graph does snapshot most closely match?</p>	Graph 6: Repair complete  Graph 8: Go to Performance Diagnostics in the Engine Service Manual. After repairs are complete, retest for original problem.

## MAXXFORCE® 11, 13 AND 15 SERVICEMAXX™ SNAPSHOTS

### 10.1. GRAPH 1: AIR MANAGEMENT SYSTEM TEST (GOOD)

NOTE – Colors in the graphs are used for clarity only and will not necessarily match the colors you will see in your ServiceMaxx™ snapshots



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1. Engine speed (rpm) [Green]
2. Intake Manifold Pressure (IMP) (psi) [Orange]
3. Turbocharger 2 Wastegate Control (TC2WC) (percent) [Blue]

Figure 26 Graph 1: Air Management System Test (Good)

#### Graph Analysis:

This graph shows normal operation of the Air Management System (AMS) during the Air Management Test (AMT). The AMT does not give pass or fail results. It only allows the user to validate the AMS by monitoring the effects each actuator has on Intake Manifold Pressure (IMP). IMP is normally between 8 psi (55 kPa) to 13 psi (90 kPa) on engine ramp up during AMT. If Turbocharger 2 Wastegate Control (TC2WC) is not operating as designed, boost pressure will not respond to changes in engine load. Excess soot will then be generated by the engine causing frequent regeneration of the aftertreatment system.

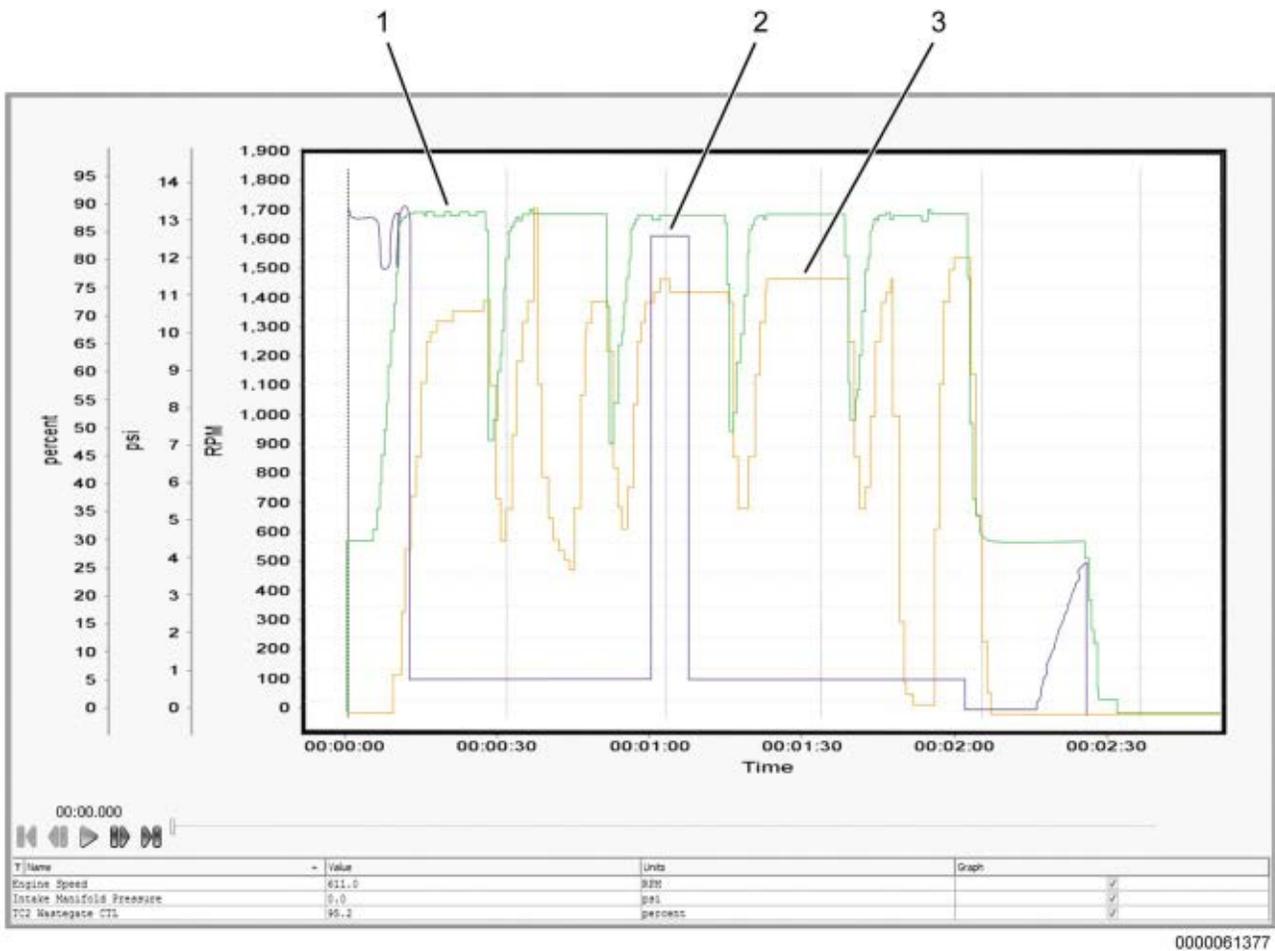
**Actions:**

1. When TC2WC is commanded ON, verify Intake Manifold Pressure (IMP) signal value drops.

**NOTE – MaxxForce® 11 ONLY: AFT regen status stays “Not Active.”**

**NOTE – Turbocharger 1 Wastegate Control (TC1WC) does not affect engine performance and is removed from post-production engines. If engine is equipped with one, it is not used by the Engine Control Module (ECM).**

10.2. GRAPH 2: AIR MANAGEMENT SYSTEM TEST (BAD)



- 1. Engine speed (rpm) [Green]
- 2. Turbocharger 2 Wastegate Control (TC2WC) (percent) [Purple]
- 3. Intake Manifold Pressure (IMP) (psi) [Orange]

Figure 27 Graph 2: Air Management System Test (Bad)

Graph Analysis:

This graph shows an Air Management System (AMS) not operating as designed during the Air management Test (AMT). The AMT does not give pass or fail results. It only allows the user to validate the AMS by monitoring the effects each actuator has on Intake Manifold Pressure (IMP) sensor. IMP is normally between 8 psi (55 kPa) to 13 psi (90 kPa) on engine ramp up during AMT. If Turbocharger 2 Wastegate Control (TC2WC) is not operating as designed, boost pressure will not respond to changes in engine load. Excess soot will then be generated by the engine causing frequent regeneration of the aftertreatment system.

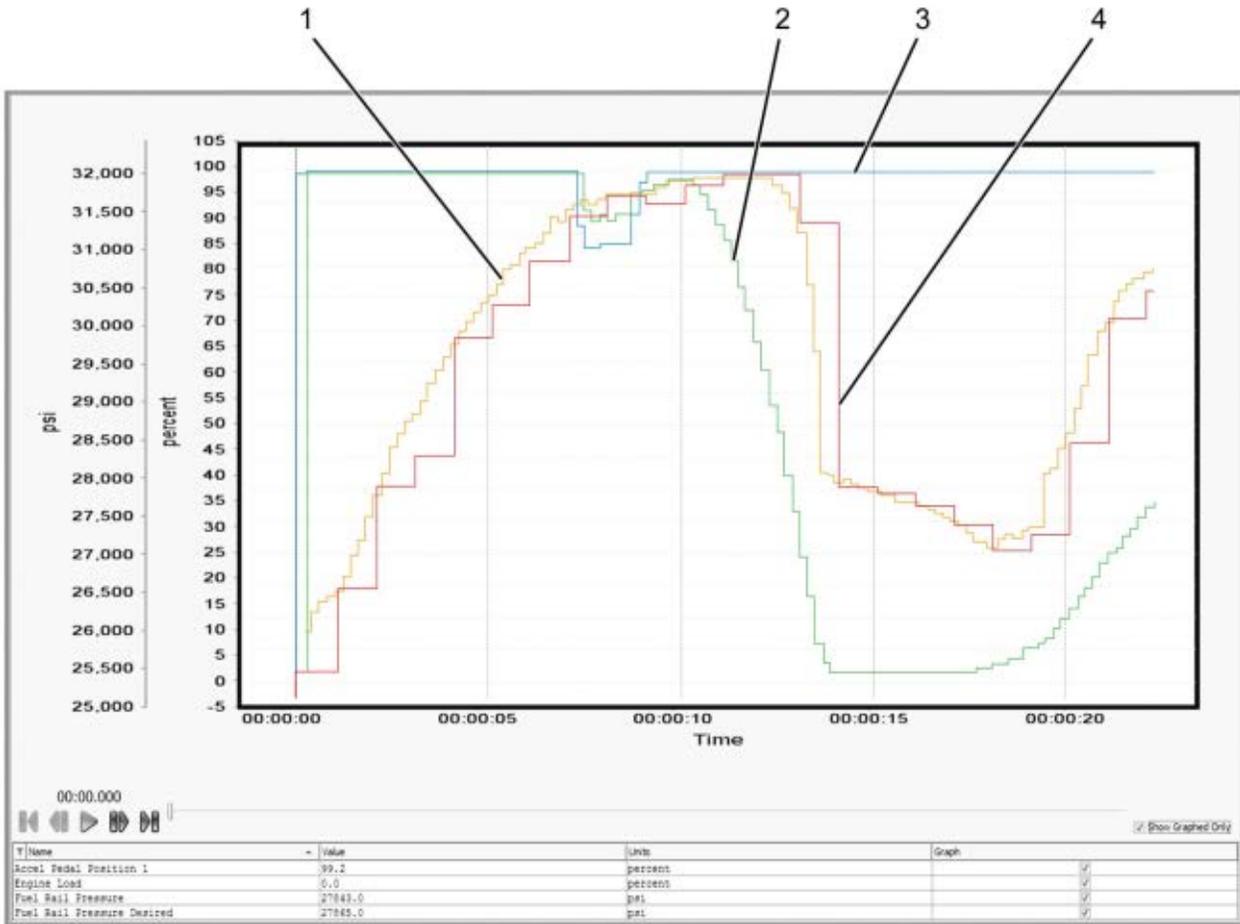
**Actions:**

1. When Turbocharger 2 Wastegate Control (TC2WC) is commanded ON, verify Intake Manifold Pressure (IMP) drops. In this graph, IMP does not drop when TC2WC is commanded ON.

**NOTE – MaxxForce® 11 ONLY: AFT regen status stays “Not Active.”**

**NOTE – Turbocharger 1 Wastegate Control (TC1WC) does not affect engine performance and is removed from post-production engines. If engine is equipped with one, it is not used by the Engine Control Module (ECM).**

10.3. GRAPH 3: LUG DOWN TEST (ENGINE SPEED, FRP, AND FRPD)



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- 1. Fuel Rail Pressure Desired (FRPD) (psi) [Orange]
- 2. Engine load (percent) [Green]
- 3. Accelerator Pedal Position 1 (APP1) (percent) [Blue]
- 4. Fuel Rail Pressure (FRP) (psi) [Red]

Figure 28 Graph 3: Lug Down Test (Engine Speed, FRP, and FRPD)

Graph Analysis:

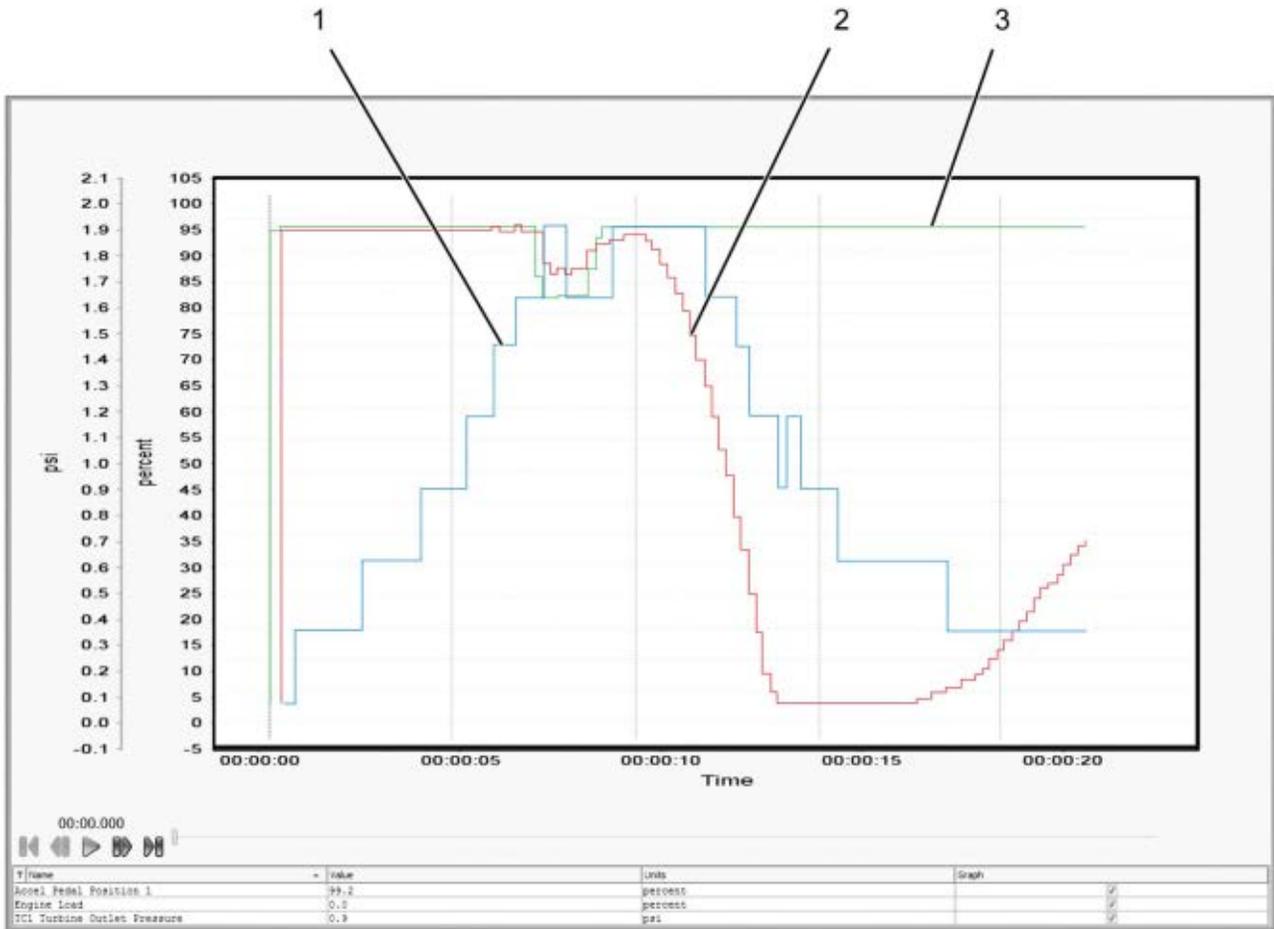
This graph shows a fuel management system operating as designed. This test does not give pass or fail results. It only allows the user to validate Fuel Rail Pressure (FRP) and Fuel Rail Pressure Desired (FRPD) signal values under load. As engine rpm increases, Fuel Rail Pressure (FRP) should steadily increase. Low FRP will cause low Intake Manifold Pressure (IMP). Diagnose low FRP concerns before diagnosing low IMP concerns.

**Actions:**

1. Verify FRP signal value reaches 31,900 psi (219,943 kPa) at full load.
2. Verify FRP signal value is within a 1000 psi (6,895 kPa) range of FRPD signal value during acceleration.

**NOTE – Analyze Lug Down Test signal values only during engine acceleration, and not deceleration or shifting.**

10.4. GRAPH 4: LUG DOWN TEST (ENGINE SPEED AND TC1TOP)



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- 1. Turbocharger 1 Turbine Outlet Pressure (TC1TOP) (psi) [Blue]
- 2. Engine Load (Percent) [Red]
- 3. Accelerator Pedal Position 1 (APP1) (Percent) [Green]

Figure 29 Graph 4: Lug Down Test (Engine Speed and TC1TOP)

**Graph Analysis:**

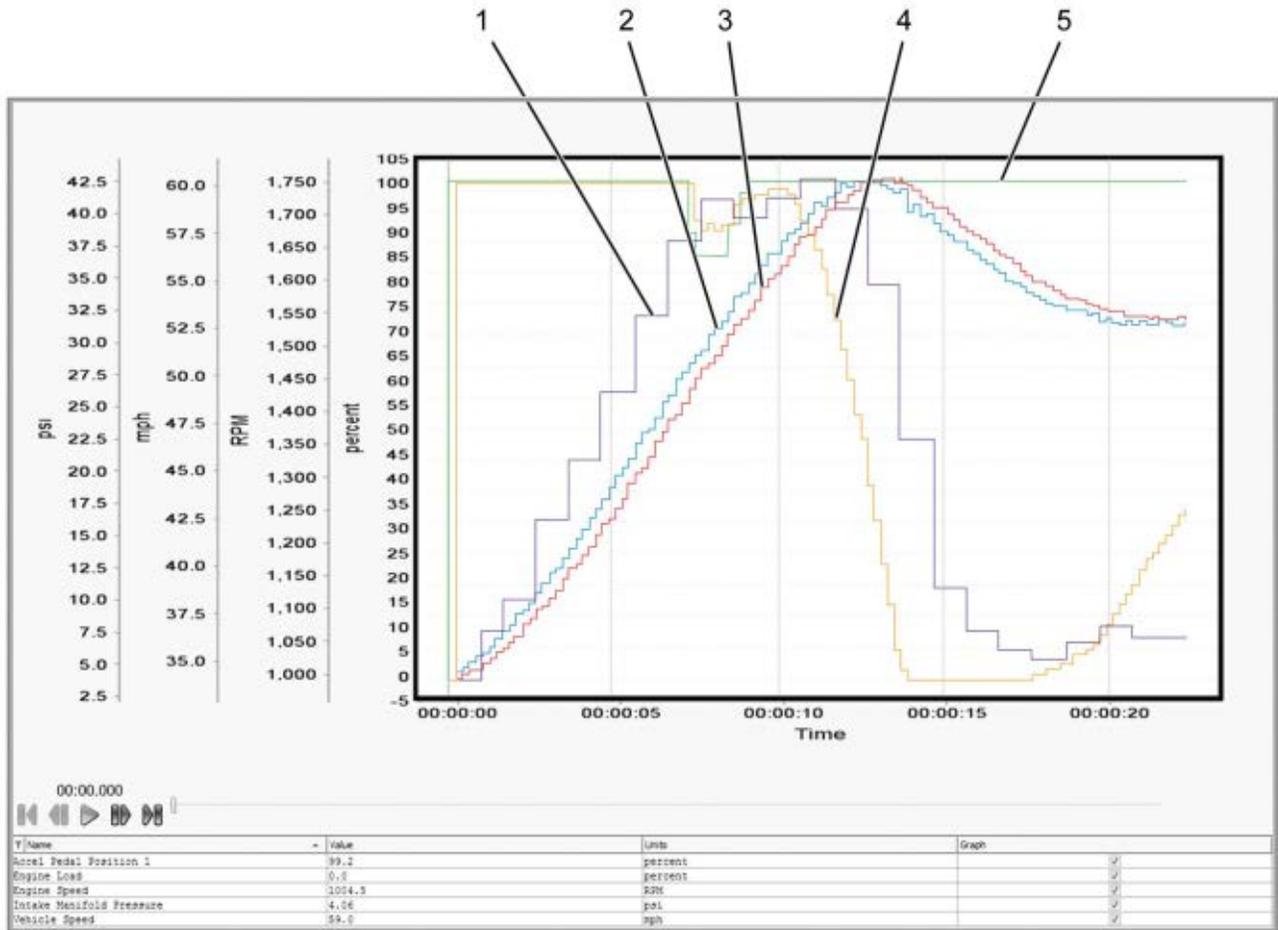
This graph shows an exhaust aftertreatment system operating as designed (unrestricted). This test does not give pass or fail results. It only allows the user to validate Turbocharger 1 Turbine Outlet Pressure (TC1TOP) signal value under load. High TC1TOP will cause low Intake Manifold Pressure (IMP). Diagnose high TC1TOP concerns before diagnosing low IMP concerns.

**Actions:**

- 1. Verify TC1TOP signal value is less than 5 psi (34 kPa) during Lug Down Test.

**NOTE – Analyze Lug Down Test signal values only during engine acceleration, and not deceleration or shifting.**

10.5. GRAPH 5: LUG DOWN TEST (ENGINE SPEED, APP1, VEHICLE SPEED, AND IMP)



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- 1. Intake Manifold Pressure (IMP) (psi) [Purple]
- 2. Engine speed (rpm) [Blue]
- 3. Vehicle speed (mph) [Red]
- 4. Engine load (percent) [Orange]
- 5. Accelerator Pedal Position 1 (APP1) (percent) [Green]

Figure 30 Graph 5: Lug Down Test (Engine Speed, APP1, Vehicle Speed, and IMP)

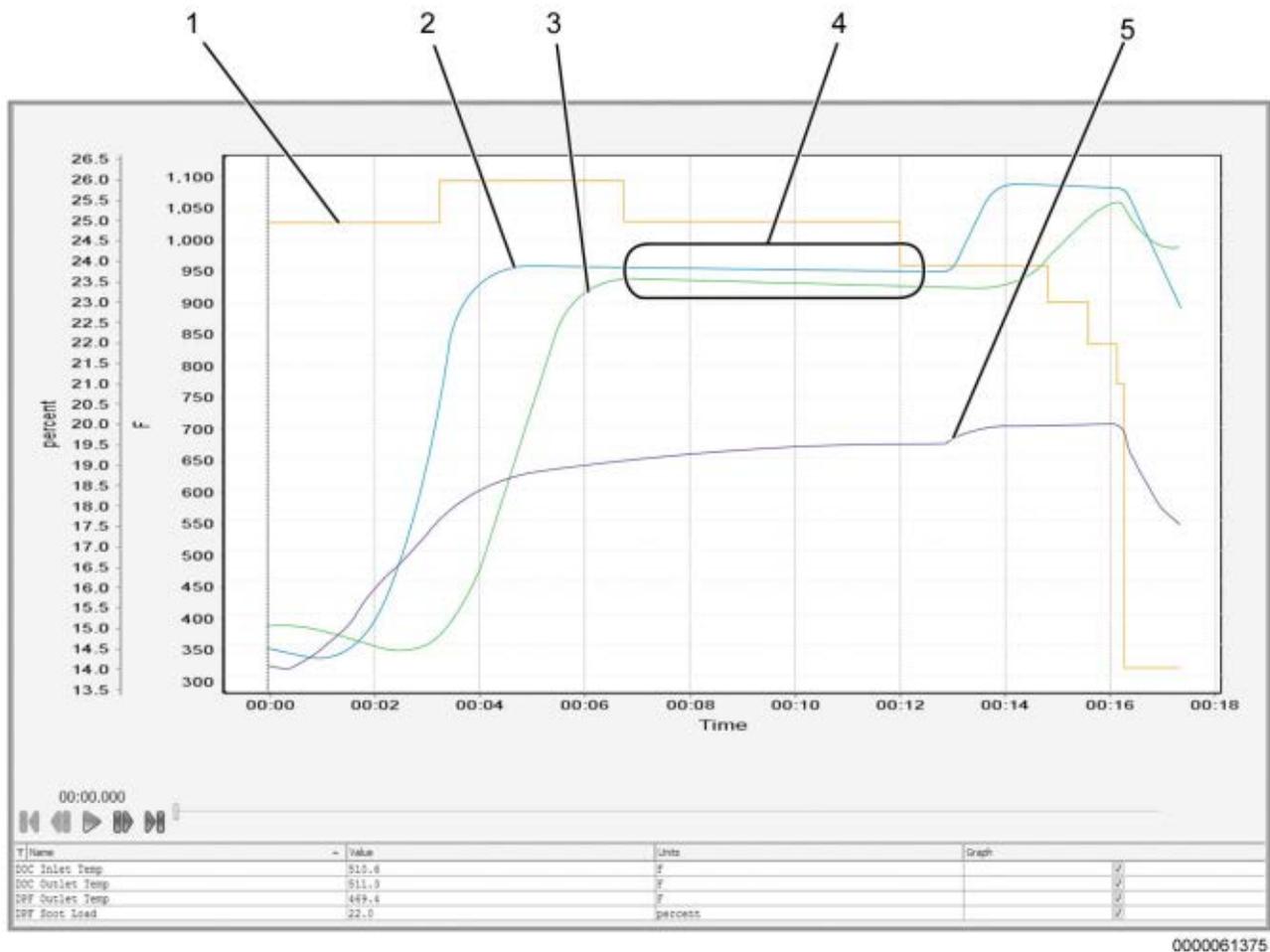
Graph Analysis:

This graph shows the Intake Manifold Pressure (IMP) signal value responding as designed. This test does not give pass or fail results. It only allows the user to validate IMP signal value under load. Engine power band is typically between 1300 to 1700 rpm with peak power occurring around 1600 rpm. Anything outside of this power band drops boost and power significantly. Accelerator Pedal Position 1 (APP1) signal value must be 99.6% to successfully reach peak boost during this test. Low IMP can be the result of low Fuel Rail Pressure (FRP), or high Turbocharger 1 Turbine Outlet Pressure (TC1TOP). Diagnose low FRP concerns first, high TC1TOP concerns second, and low IMP concerns third.

1. Verify IMP signal value is between 40 psi (276 kPa) to 43 psi (296 kPa), with Accelerator Pedal Position 1 (APP1) signal value at 99.6%, and engine speed between 1300 rpm to 1700 rpm.

**NOTE – Analyze Lug Down Test signal values only during engine acceleration, and not deceleration or shifting.**

## 10.6. GRAPH 6: NORMAL EXHAUST GAS TEMPERATURES (EFFICIENT DOC AND UNRESTRICTED AFI)



1. Diesel Particulate Filter (DPF) soot load (percent) [Orange]
2. Diesel Oxidation Catalyst Outlet Temperature (DOCOT) (degrees Fahrenheit) [Blue]
3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Green]
4. Diesel Oxidation Catalyst (DOC) at operating temperature and stabilized
5. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Purple]

**Figure 31 Graph 6: Normal Exhaust Gas Temperatures (Efficient DOC AND Unrestricted AFI)**

### Graph Analysis:

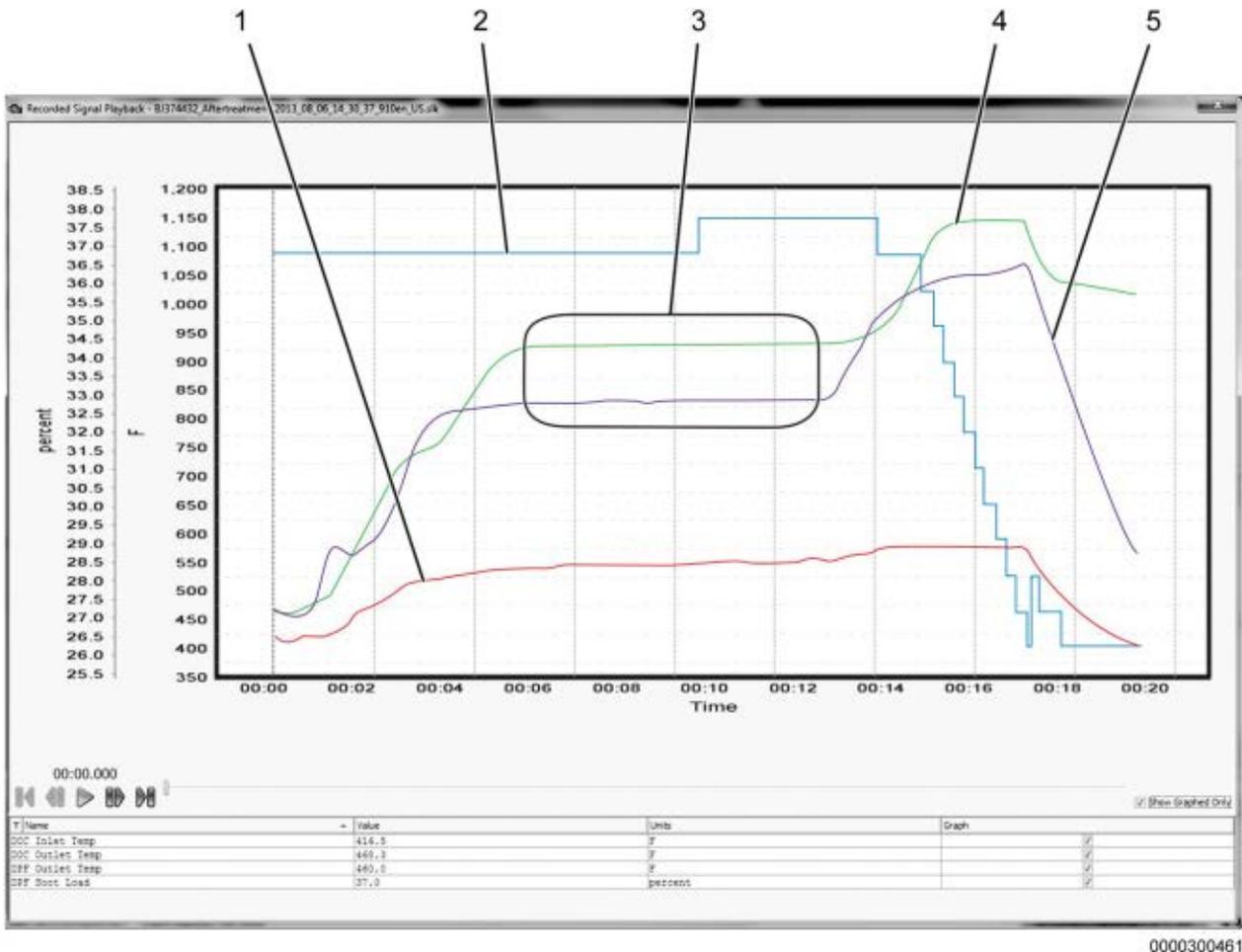
This graph shows an aftertreatment system operating as designed. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

**Actions:**

1. After Diesel Oxidation Catalyst (DOC) reaches operating temperature and stabilizes (see callout 4, graph 6), verify Diesel Oxidation Catalyst Outlet Temperature (DOCOT) and Diesel Particulate Filter Outlet Temperature (DPFOT) signal values are greater than 900°F (482°C).
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C).

**NOTE – It is normal to see Diesel Oxidation Catalyst Inlet Temperature (DOCIT), DOCOT, and DPFOT signal values to fluctuate at the beginning and end of the OBFCT.**

## 10.7. GRAPH 7: INVERTED EXHAUST GAS TEMPERATURES (INEFFICIENT DOC)



0000300461

1. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Red]
2. Diesel Particulate Filter (DPF) soot load (percent) [Blue]
3. Diesel Oxidation Catalyst (DOC) at operating temperature and stabilized.
4. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Green]
5. Diesel Oxidation Catalyst Outlet Temperature (DOCOT) (degrees Fahrenheit) [Purple]

Figure 32 Graph 7: Inverted exhaust Gas Temperatures (Inefficient DOC)

**Graph Analysis:**

This graph shows inverted exhaust gas temperatures indicating an inefficient Diesel Oxidation Catalyst (DOC). Inverted temperatures in the exhaust stream occur when the Diesel Particulate Filter Outlet Temperature (DPFOT) is higher than Diesel Oxidation Catalyst Outlet Temperature (DOCOT) after the DOC has reached operating temperature and stabilized (see callout 3, graph 7). This is caused by unburned fuel reacting with the DPF, instead of the DOC, causing an increase in DPFOT. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

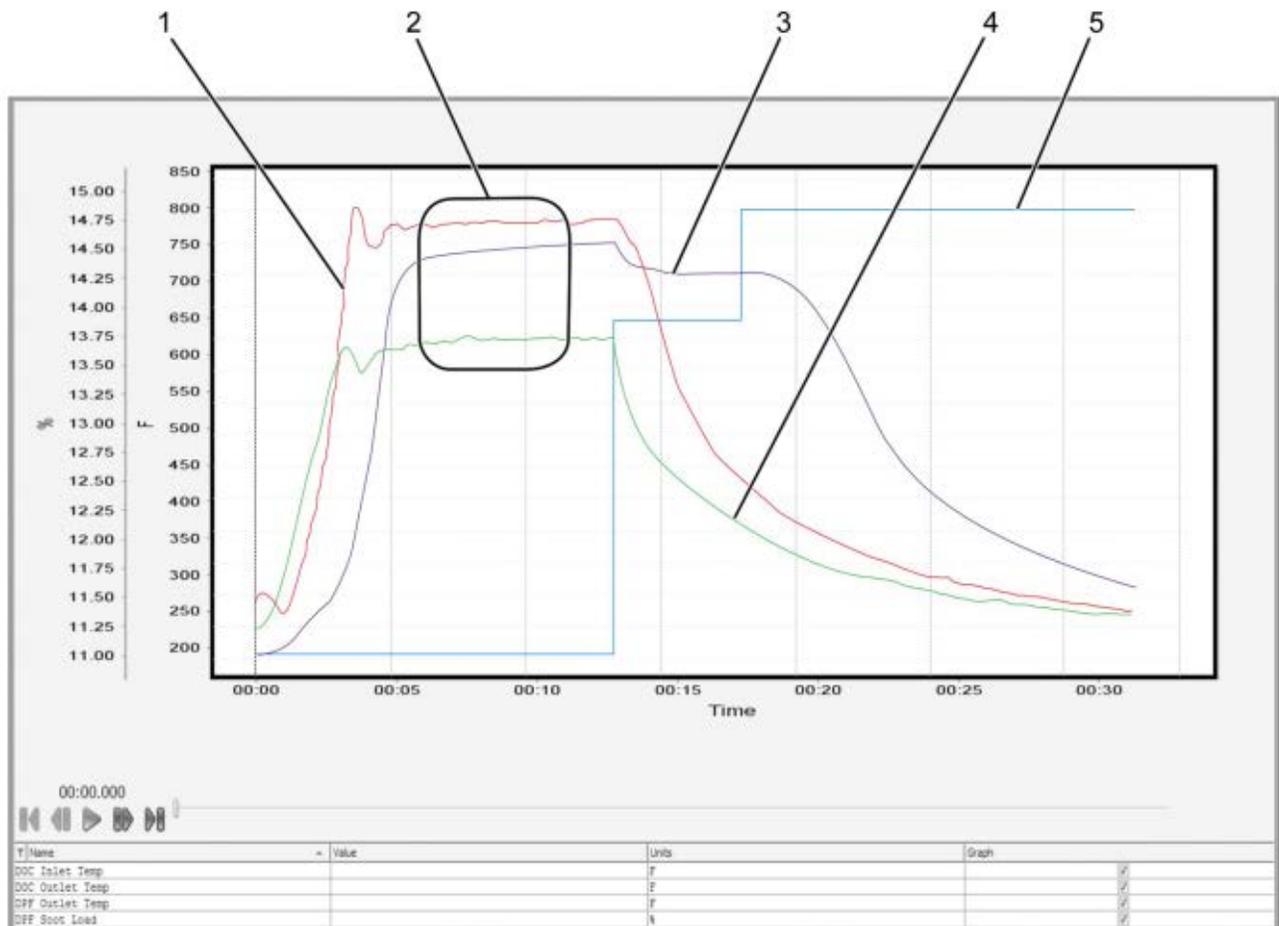
**Actions:**

1. After DOC reaches operating temperature and stabilizes (see callout 3, graph 7), verify DPFOT signal value is not 122°F (50°C) higher than DOCOT signal value. In this graph, DPFOT signal value is 122°F (50°C) higher than DOCOT indicating inverted exhaust gas temperatures.
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C).

**NOTE – It is normal to see Diesel Oxidation Catalyst Inlet Temperature DOCIT, DOCOT, and DPFOT signal values to fluctuate at the beginning and end of the OBFCT.**

**NOTE – SPN 4766 FMI 10 (DOC Efficiency) may be active when exhaust gas temperatures are inverted.**

## 10.8. GRAPH 8: LOW EXHAUST GAS TEMPERATURES (RESTRICTED AFI)



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1. Diesel Oxidation Catalyst Outlet Temperature (DOCOT) (degrees Fahrenheit) [Red]
2. Diesel Oxidation Catalyst (DOC) at operating temperature and stabilized.
3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Purple]
4. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Green]
5. Diesel Particulate Filter (DPF) soot load (percent) [Blue]

Figure 33 Graph 8: Low Exhaust Gas Temperatures (Restricted AFI)

**Graph Analysis:**

This graph shows low exhaust gas temperatures indicating a restricted Aftertreatment Fuel Injector (AFI). Low temperatures in the exhaust stream occur when Diesel Oxidation Catalyst Outlet Temperature (DOCOT) and Diesel Particulate Filter Outlet Temperature (DPFOT) are less than 900°F (482°C) after the DOC has reached operating temperature and stabilized (see callout 2, graph 8). This is caused by restricted fuel flow from the AFI, resulting in less fuel burning in the exhaust stream. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

**Actions:**

1. After DOC reaches operating temperature and stabilizes (see callout 2, graph 8), verify DOCOT and DPFOT signal values are greater than 900°F (482°C). In this graph, DOCOT and DPFOT are less than 900°F (482°C).
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C).

**NOTE – It is normal to see Diesel Oxidation Catalyst Inlet Temperature DOCIT, DOCOT, and DPFOT signal values to fluctuate at the beginning and end of the OBFCT.**

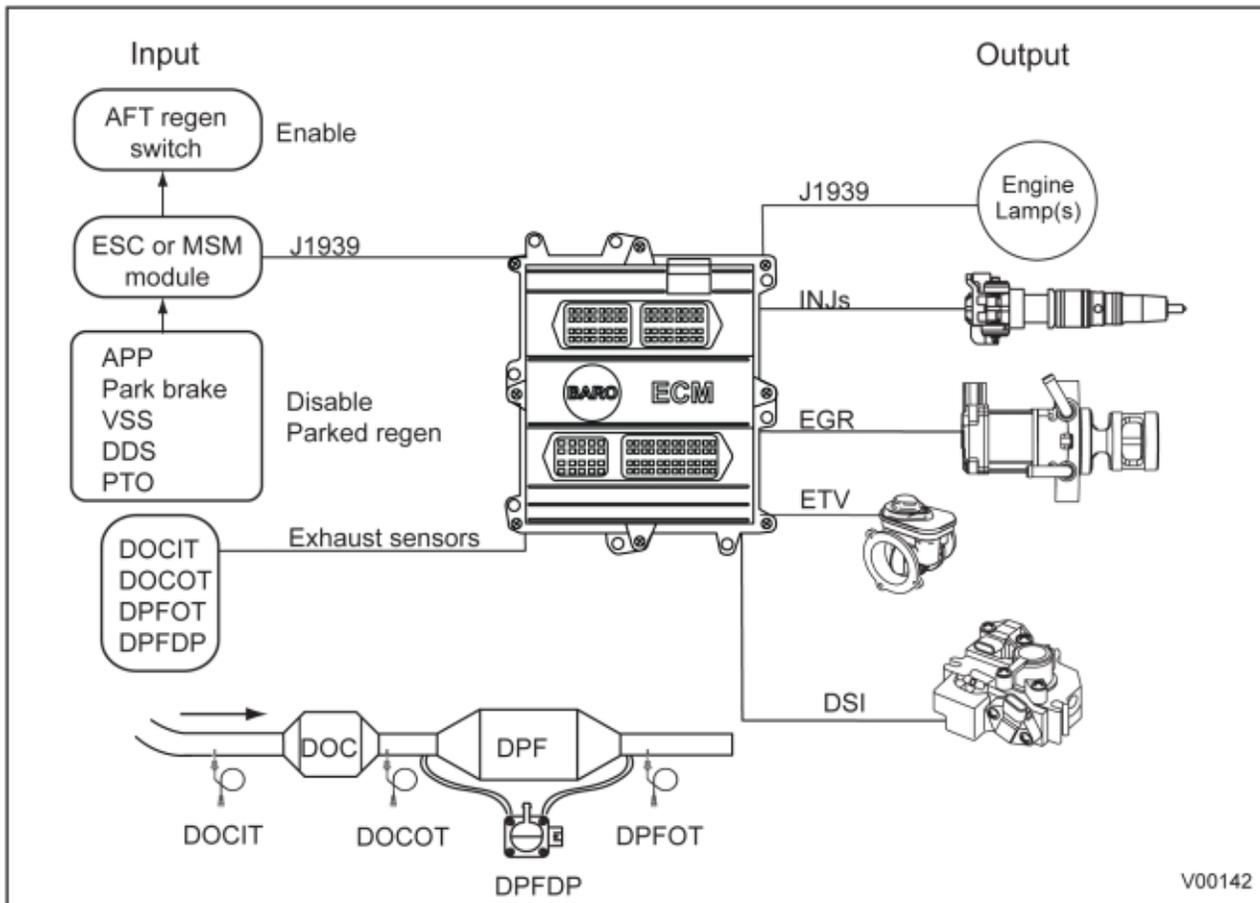
## AFTERTREATMENT SYSTEM OPERATION

### 11.1. MAXXFORCE® 11, 13 AND 15

The Aftertreatment (AFT) system, part of the larger exhaust system, processes engine exhaust to meet emission requirements. The AFT system traps particulate matter (soot) and prevents it from leaving the tailpipe.

The AFT system performs the following functions:

- Monitors exhaust gas temperatures Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Oxidation Catalyst Outlet Temperature (DOCOT), and Diesel Particulate Filter Outlet Temperature (DPFOT).
- Monitors Diesel Particulate Filter Differential Pressure (DPFDP).
- Controls engine operating parameters for emission control and failure recognition.
- Cancels regeneration of the AFT system in the event of catalyst or sensor failure.
- Calculates the level of ash accumulation in the Diesel Particulate Filter (DPF).
- Initiates regeneration of the AFT system when DPF soot load is too high by increasing exhaust gas temperatures.
- Maintains vehicle and engine performance during regeneration.



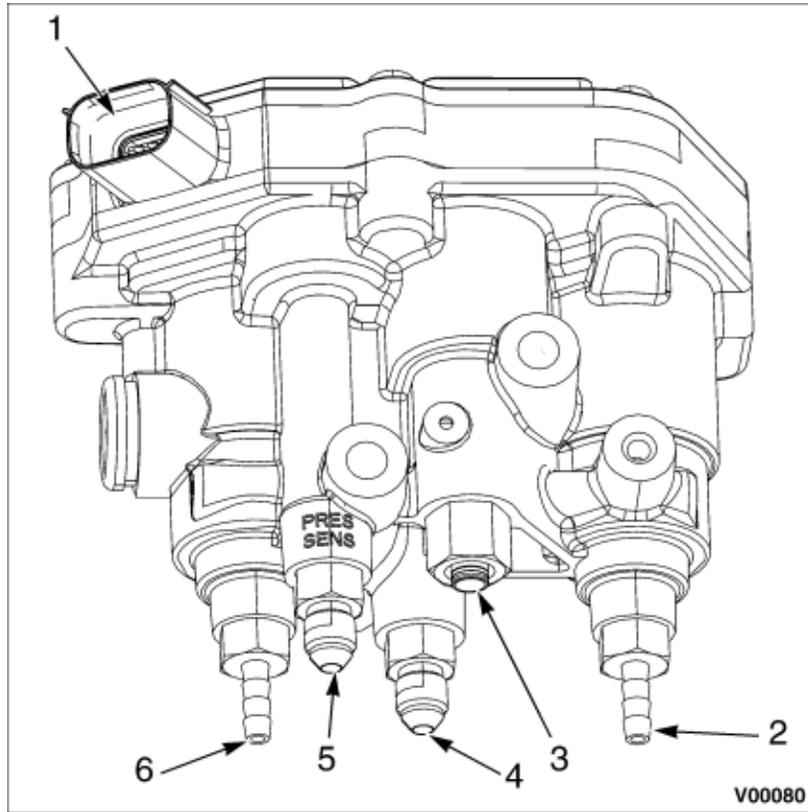
The functional diagram for the Aftertreatment (AFT) system includes the following:

- Engine Control Module (ECM) with Barometric Absolute Pressure (BARO) internal sensor
- Multiplex System Module (MSM) body module (PayStar applications only)
- Accelerator Pedal Position (APP) sensor
- Park brake
- Vehicle Speed Sensor (VSS)
- Driveline Disconnect Switch (DDS)
- Power Take Off Switch (PTO)
- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Diesel Oxidation Catalyst Outlet Temperature (DOCOT) sensor
- Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor
- Diesel Particulate Filter Outlet Temperature (DPFOT) sensor
- Diesel Particulate Filter Differential Pressure (DPFDP) sensor
- Fuel Injectors (INJs)

- Exhaust Gas Recirculation (EGR) valve
- Engine Throttle Valve (ETV)
- Warning Indicators
- Inlet Air Heater (IAH)
- Aftertreatment Fuel Inlet Sensor (AFTFIS)
- Aftertreatment Fuel Pressure 2 (AFTFP2) sensor
- Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Aftertreatment Fuel Doser (AFTFD)
- Downstream Injection (DSI) unit

## COMPONENT DESCRIPTIONS (THEORY OF OPERATION)

### 12.1. MAXXFORCE® 11 AND 13



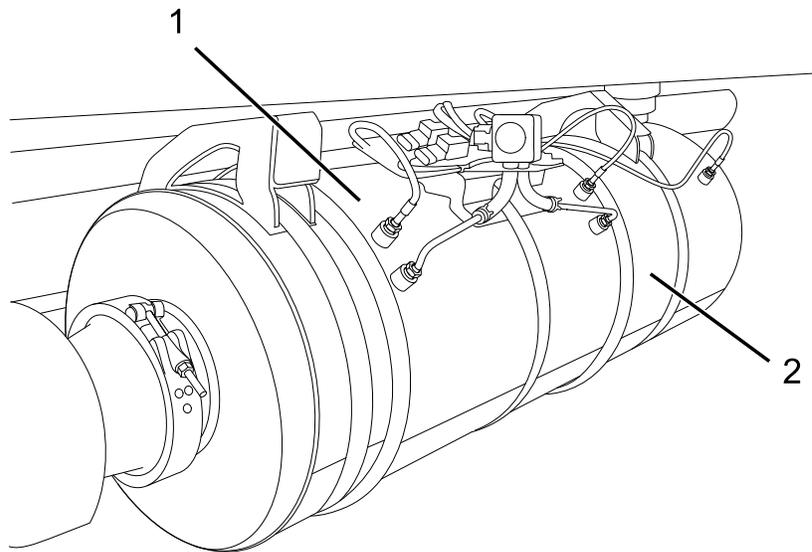
- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>1. Electrical connector</li> <li>2. Turbocharger 1 Wastegate Control (TC1WC) port</li> <li>3. Vehicle air supply port</li> <li>4. Exhaust Back Pressure Valve (EBPV) port</li> </ul> | <ul style="list-style-type: none"> <li>5. Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor port</li> <li>6. Turbocharger 2 Wastegate Control (TC2WC) port</li> </ul> |
|---|--|

**Figure 35 ACV Assembly (MaxxForce® 11 and 13 Engines)**

#### **Air Control Valve (ACV) Assembly**

The Air Control Valve (ACV) assembly contains the Low Pressure (LP) turbocharger wastegate control port, High Pressure (HP) turbocharger wastegate control port, the Exhaust Back Pressure Valve (EBPV) control port, and the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) port. Although these components are integral to the ACV, each circuit is controlled by the ECM. The ACV controls compressed air for each control valve. The air supply port is connected to the vehicle's air system.

Proper operation of the ACV is critical in preventing an aftertreatment concern. When an ACV concern is present, it will cause low engine performance and directly effect aftertreatment system operation.



0000061986

1. Diesel Particulate Filter (DPF)
2. Diesel Oxidation Catalyst (DOC)

6. Diesel Particulate Filter Outlet Temperature (DPFOT) sensor

**Figure 36 DOC and DPF Assembly (MaxxForce® 11, 13 and 15 Engines)**

#### **Diesel Oxidation Catalyst (DOC)**

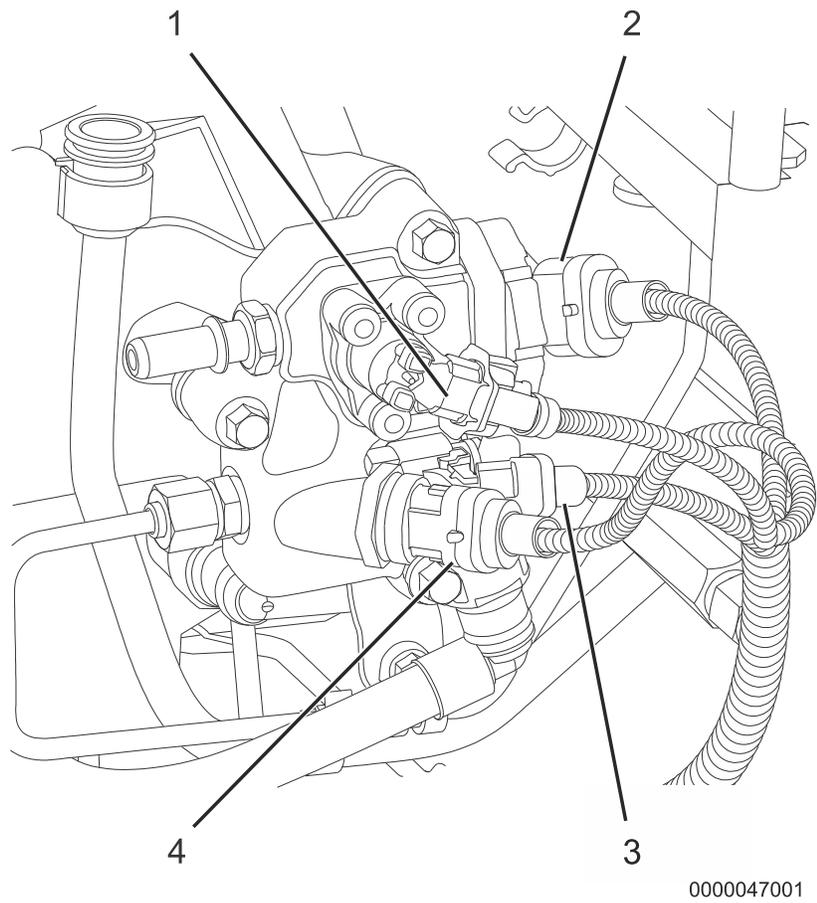
The DOC does the following:

- Oxidizes hydrocarbons and carbon monoxide (CO) in exhaust stream
- Provides heat for exhaust system warm-up

#### **Diesel Particulate Filter (DPF)**

The DPF does the following:

- Captures and temporarily stores carbon-based particulates in a filter
- Allows for oxidation (regeneration) of stored particulates once loading gets to a particular level (restriction)
- Provides the required exhaust back pressure drop for engine performance
- Stores non-combustible ash

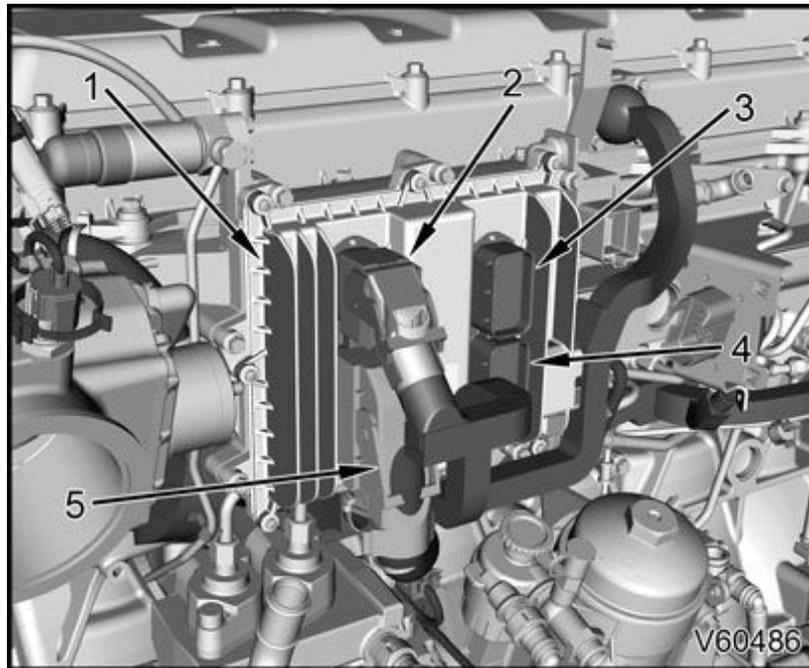


- |   |   |
|---|---|
| 1. Aftertreatment Fuel Shutoff Valve (AFTFSV) | 3. Aftertreatment Fuel Doser (AFTFD)              |
| 2. Aftertreatment Fuel Inlet Sensor (AFTFIS)  | 4. Aftertreatment Fuel Pressure 2 (AFTFP2) sensor |

**Figure 37 DSI Unit (MaxxForce® 11 and 13 Engines)**

**Downstream Injection (DSI) Unit**

The DSI unit is connected to the clean side of the low pressure fuel system, and will provide a metered amount of fuel to the AFI. The DSI unit provides pressurized fuel injection pulses to the AFI. The AFI is a mechanical poppet type injector, and will only inject fuel when fuel line pressure is increased above a specific pressure.



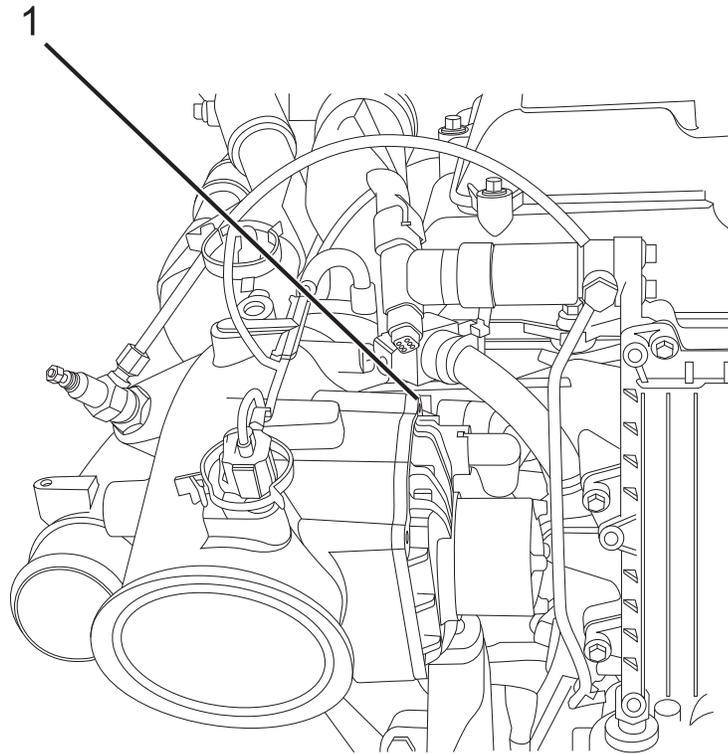
- |   |   |
|---|---|
| 1. Engine Control Module (ECM)                                      | 4. ECM 58-pin C1 chassis terminal                                 |
| 2. Engine injector harness connector<br>(to ECM 16-pin E2 terminal) | 5. Engine sensor harness connector<br>(to ECM 96-pin E1 terminal) |
| 3. ECM 58-pin C2 chassis terminal                                   |   |

**Figure 38 ECM (MaxxForce® 11 and 13 Engines)**

### **Engine Control Module (ECM)**

The Engine Control Module (ECM) monitors and controls engine operation to ensure maximum performance and adherence to emissions standards. The ECM performs the following functions:

- Provide reference voltage (VREF)
- Condition input signals
- Process and store control strategies
- Control actuators



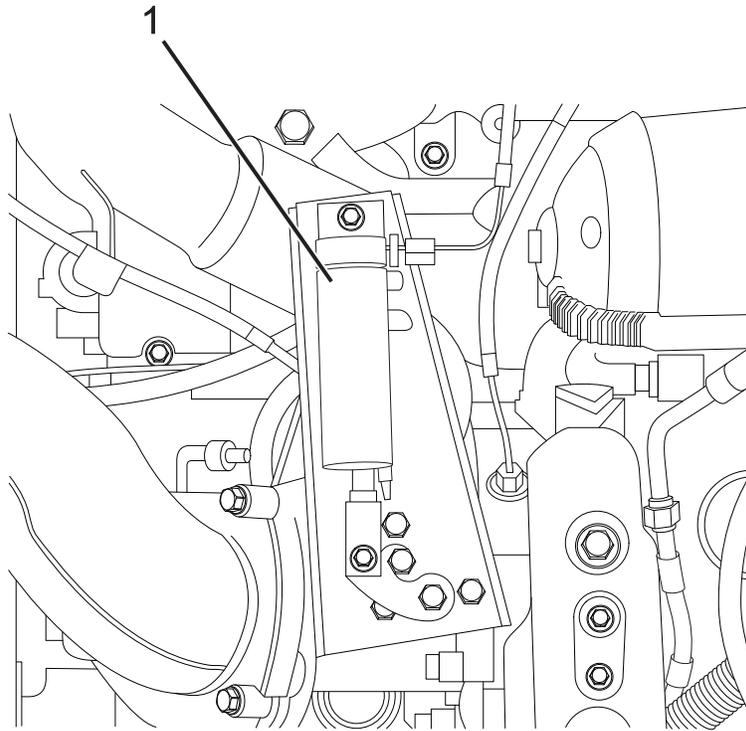
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1. Engine Throttle Valve (ETV)

**Figure 39 ETV (MaxxForce® 11 and 13 Engines)**

**Engine Throttle Valve (ETV)**

The Engine Throttle Valve (ETV) controls the flow of fresh air (boosted and cooled) into the engine's air intake path through the CAC to help heat the exhaust aftertreatment during regeneration, and to assist when heavy EGR is requested. The electronic portion of the ETV contains a microprocessor that monitors valve position, electronic chamber temperature, controls the electric motor, and reports diagnostic faults to the ECM. The ETV changes position in response to ECM signals.



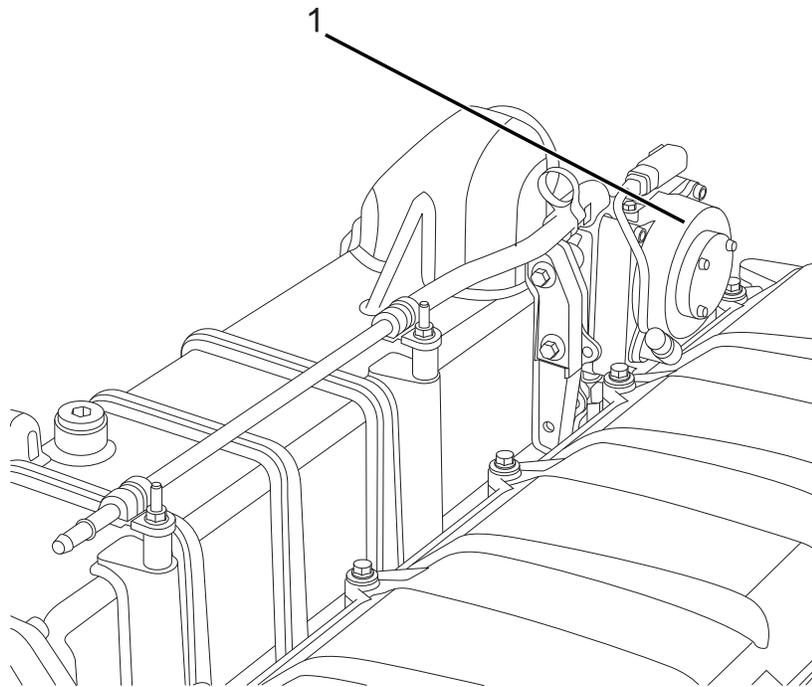
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1. Exhaust Back Pressure Valve (EBPV)

**Figure 40 EBPV (Typical)**

#### **Exhaust Back Pressure Valve (EBPV)**

The Exhaust Back Pressure Valve (EBPV) controls the position of the exhaust valve increasing or decreasing exhaust gas back pressure and temperature to allow the DOC and DPF to function efficiently.



000048951

1. Exhaust Gas Recirculation (EGR) valve

**Figure 41 EGR Valve Location MaxxForce® 11 and 13 Engines (Right Rear Engine)**

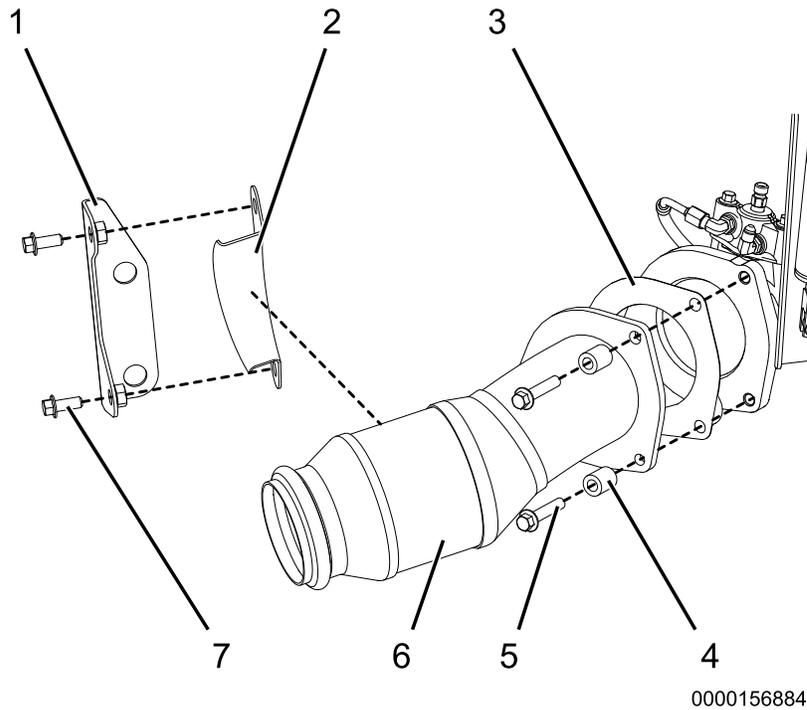
### **Exhaust Gas Recirculation (EGR) Valve**

The EGR valve receives the desired valve position from the ECM for exhaust gas recirculation. The EGR valve regulates the flow of exhaust gases through the EGR system.

**Pre-Diesel Oxidation Catalyst (PDOC)**

The PDOC does the following:

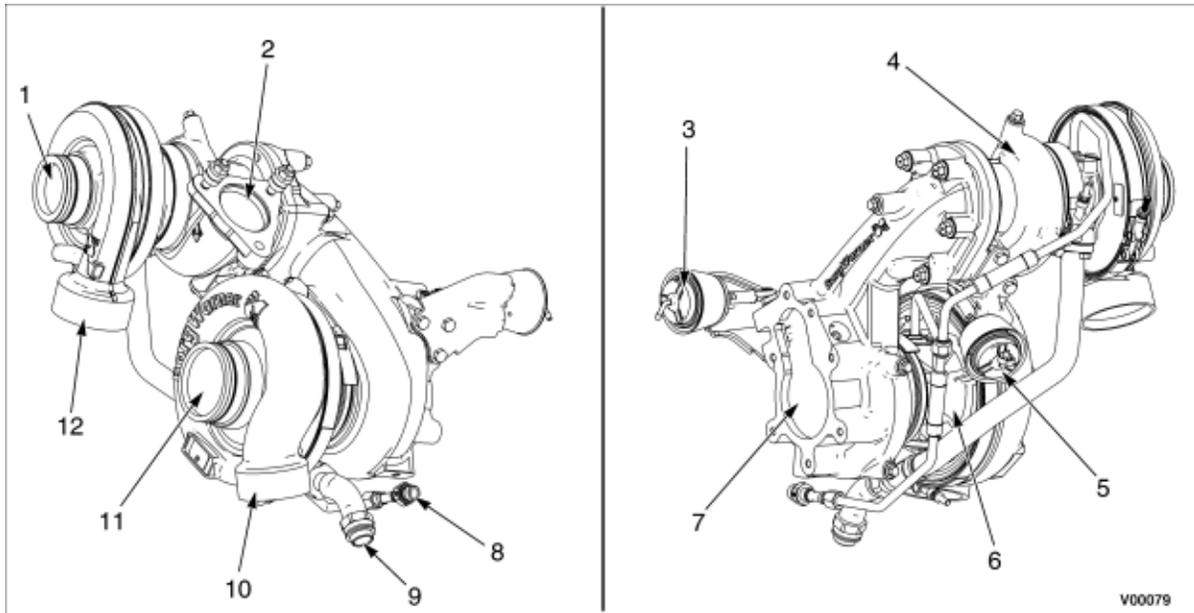
- Aids in creating an exothermic reaction to improve exhaust emissions
- Allows for more efficient operation of the aftertreatment system



1. PDOC back bracket (attaches to engine)
2. PDOC bracket
3. Exhaust Flange Gasket

4. 11 x 20 x 24 mm spacer (3)
5. M10 x 50 bolt (3)
6. PDOC
7. M10 x 25 bolt (2)

**Figure 42 Pre-Diesel Oxidation Catalyst (PDOC) (Typical)**



- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>1. HP turbocharger compressor inlet</li> <li>2. HP turbocharger turbine inlet</li> <li>3. LP turbocharger wastegate actuator</li> <li>4. HP turbocharger</li> <li>5. HP turbocharger wastegate actuator</li> <li>6. LP turbocharger</li> </ul> | <ul style="list-style-type: none"> <li>7. LP turbocharger turbine outlet</li> <li>8. Oil supply line</li> <li>9. Oil return line</li> <li>10. LP turbocharger compressor outlet</li> <li>11. LP turbocharger compressor inlet</li> <li>12. HP turbocharger compressor outlet</li> </ul> |
|---|---|

**Figure 43 High and Low Pressure Turbocharger Components — Inner and Outer Views (MaxxForce® 11 and 13 Engines)**

### Turbochargers

MaxxForce® 11 and 13 engines are equipped with a pneumatically regulated two-stage turbo charging system. The HP and LP turbochargers are installed on the right side of the engine.

**Intake air flow:** Filtered air enters the LP compressor, where it is compressed and directed to the LPCAC (if equipped). Cooled LP air enters the HP compressor where it is further compressed and directed into the HPCAC. Compressed air then travels through the ETV and the intake throttle duct. This system provides high charge air pressure to improve engine performance and to help reduce emissions.

**Exhaust gas flow:** The HP turbocharger is connected directly to the exhaust manifold through the HP turbine inlet. Exhaust gases exit the HP turbine outlet and are directed to the LP turbine inlet. The HP and LP turbochargers are equipped with wastegates, which are controlled by pneumatic actuators. When boost demand is low, the wastegate is opened, allowing part of the exhaust gas flow to bypass the turbine.

## AFTERTREATMENT SYSTEM FAULT CODES

### 13.1. MAXXFORCE® 11, 13 AND 15

SPN	FMI	Condition	Possible Causes
3251	0	DPFDP excessively HIGH (Plugged filter)	<ul style="list-style-type: none"> <li>• Restricted Diesel Particulate Filter (DPF)</li> <li>• Low Fuel Delivery Pressure</li> <li>• Restricted Aftertreatment Fuel Injector (AFI) unit</li> <li>• Parked Regen Inhibited</li> <li>• Exhaust leak(s)</li> <li>• Biased Diesel Particulate Filter Differential Pressure (DPFDP) sensor</li> <li>• Biased IMP sensor</li> <li>• Low boost pressure</li> </ul>
3251	14	DPFDP sensor pressure hoses reversed	<ul style="list-style-type: none"> <li>• DPFDP sensor pressure hoses reversed</li> <li>• DPFDP sensor hose (before filter) restricted</li> </ul>
3251	21	DPFDP excessively LOW (Sensor/circuit fault or missing DPF)	<ul style="list-style-type: none"> <li>• Biased DPFDP sensor or circuit</li> <li>• Cracked DPF</li> <li>• DPFDP sensor pressure hoses reversed</li> <li>• DPFDP sensor hose (before filter) leaking or disconnected</li> </ul>
3471	1	Fuel Pressure 1 below desired (Low system pressure)	<ul style="list-style-type: none"> <li>• Aftertreatment Fuel Doser (AFTFD) failure. Blocked, stuck open, or closed</li> <li>• Leak in AFTFD fuel supply line</li> <li>• Failed Aftertreatment Fuel Pressure 1 (AFTFP1) sensor</li> <li>• Aftertreatment Fuel Shutoff Valve (AFTFSV) stuck closed, or blocked</li> </ul>
3471	7	Fuel Doser Valve not responding as expected	<ul style="list-style-type: none"> <li>• AFTFD failure. Blocked, stuck open, or closed.</li> <li>• Stuck AFI or AFTFSV</li> <li>• Biased AFT Fuel Pressure 2 signal</li> </ul>
3480	0	AFTFP1 too high while dosing	<ul style="list-style-type: none"> <li>• Fuel Delivery Pressure (FDP) above maximum</li> <li>• Restricted fuel return line between filter housing and fuel tank</li> </ul>

## DIAGNOSTIC MANUAL

3480	1	AFTFP1 too low while dosing	<ul style="list-style-type: none"> <li>FDP below minimum</li> <li>Dirty fuel filter</li> <li>Stuck closed AFT Shutoff valve</li> <li>Fuel Leak in Down Stream Injection (DSI) System</li> </ul>
3481	7	Incorrect dosing pressure, multiple events	<ul style="list-style-type: none"> <li>FDP above maximum</li> <li>Restricted fuel return line between filter housing and fuel tank</li> </ul>
3556	0	AFT fuel pressure 2 excessively high (Restricted injection)	<ul style="list-style-type: none"> <li>Aftertreatment Fuel Injector (AFI) is plugged or sticking</li> </ul>
3556	1	AFT fuel pressure 2 below desired	<ul style="list-style-type: none"> <li>Leak in DSI system</li> <li>AFT Fuel Doser sticking Open</li> <li>AFI stuck Open</li> </ul>
3556	7	AFT Fuel Injector not responding as expected	<ul style="list-style-type: none"> <li>DSI failed system validation cycle</li> <li>Biased AFTFIS or circuit</li> <li>Biased Aftertreatment Fuel Pressure 2 (AFTFP2) sensor or circuit</li> <li>Failed AFTFD or circuit</li> <li>Failed AFTFSV or circuit</li> <li>Aftertreatment Fuel Injector (AFI) failure (plugged)</li> </ul>
3719	0	DPF Soot Load - Highest (level 3/3)	<ul style="list-style-type: none"> <li>High DPF soot level</li> <li>Low Fuel Delivery Pressure</li> <li>Restricted AFI unit</li> <li>Parked Regen Inhibited</li> <li>Exhaust leak(s)</li> <li>Biased DPFDSP sensor</li> <li>Biased IMP sensor</li> <li>Low boost pressure</li> </ul>
3719	15	DPF Soot Load - Lowest (level 1/3)	<ul style="list-style-type: none"> <li>Level 1 DPF regen required</li> </ul>
3719	16	DPF Soot Load - Moderate (level 2/3)	<ul style="list-style-type: none"> <li>Level 2 DPF regen required</li> </ul>

3720	0	DPF Ash load at maximum limit	<ul style="list-style-type: none"> <li>• High DPF ash level</li> <li>• Low Fuel Delivery Pressure</li> <li>• Restricted AFI unit</li> <li>• Parked Regen Inhibited</li> <li>• Exhaust leak(s)</li> <li>• Biased DPFD sensor</li> <li>• Biased IMP sensor</li> <li>• Low boost pressure</li> </ul>
4077	0	AFTFP2 too high while dosing	<ul style="list-style-type: none"> <li>• AFTFD stuck closed</li> <li>• AFI plugged</li> </ul>
4077	1	AFTFP2 too low while dosing	<ul style="list-style-type: none"> <li>• Fuel leak between AFTFD and AFI</li> <li>• AFTFSV stuck closed</li> </ul>
4766	10	DPF Regeneration feedback fault	<ul style="list-style-type: none"> <li>• Diesel Oxidation Catalyst Outlet Temperature (DOCOT) not heating up during exhaust injection</li> <li>• Diesel Oxidation Catalyst (DOC) failure (face plugged)</li> </ul>
4766	20	DOC Outlet Temperature above maximum desired	<ul style="list-style-type: none"> <li>• Aftertreatment Fuel Injector (AFI) plugged or sticking</li> <li>• Engine over-fueling</li> <li>• DSI leaking into exhaust</li> <li>• AFTFD stuck open</li> <li>• Fuel leak(s) to exhaust</li> <li>• DOCOT sensor or circuit failure</li> </ul>
4766	21	DOC Outlet Temperature below minimum desired	<ul style="list-style-type: none"> <li>• DOC failure</li> <li>• DSI fault, not injecting when commanded</li> <li>• DSI system fuel leak</li> <li>• DOCOT sensor or circuit failure</li> </ul>
5298	2	Reduced DOC Efficiency — De-Rate	<ul style="list-style-type: none"> <li>• Biased DOCOT sensor or circuit</li> <li>• Plugged AFI or AFI housing</li> <li>• DSI failure</li> <li>• DSI system leak</li> <li>• DOC failure</li> <li>• Restricted air filter</li> <li>• Exhaust leaks</li> </ul>

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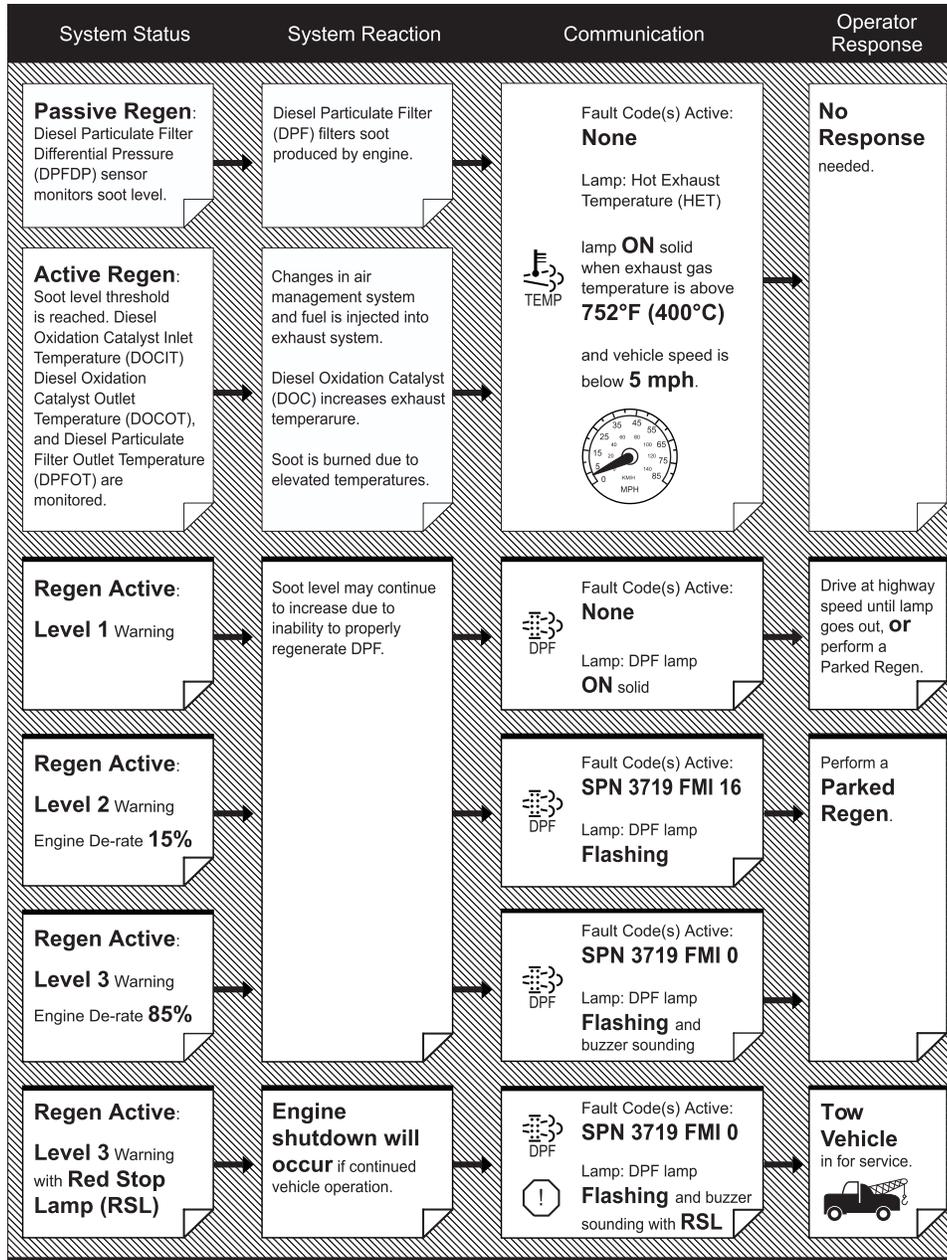
5319	31	DPF incomplete Regeneration	<ul style="list-style-type: none"><li>• Coolant leak to exhaust</li><li>• High DPFDp after DPF regen</li><li>• High ash level in DPF</li></ul>
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## AFTERTREATMENT SYSTEM EVENT CHART

### 14.1. MAXXFORCE® 11, 13 AND 15

#### AFTERTREATMENT SYSTEM EVENT CHART



0000061601

## REGEN INHIBITORS AND ENTRY CONDITIONS

### 15.1. REGEN INHIBITORS

The screenshot shows a software interface for an Aftertreatment session. On the left, there are instructions for different engine models (MacoForce 5, 7, DT, 9 & 10; MacoForce 11 & 13) and test procedures (AFS Leak Test, AFI Flow Test, AFT System Leak Test). On the right, there is a table of reggen inhibitors with columns for Name, Value, and Units. Below the table is a DTC Log section with columns for DTC, SPN, FMI, Type, Emissions-Related, Extended, Count, Message, and Module. At the bottom, there are buttons for 'Clear DTCs' and 'Refresh DTC/Vehicle Events'.

Name	Value	Units
Vehicle Speed		0.00 mph
FTO State		Off/Disabled
DPF Status		Regen not needed
Clutch Switch		Released
Brake Switch		Released
Brake Pressure Switch		Brake pedal released
AFT Regen Inhibit Status		Inhibited
AFT Regen Inhibit - System Fault Active		Not inhibited
AFT Regen Inhibit - Service Brake Active		Not inhibited
AFT Regen Inhibit - FTO Active		Not inhibited
AFT Regen Inhibit - Inhibit Switch		Not inhibited
AFT Regen Inhibit - Engine Not Warmed Up		Not inhibited
AFT Regen Inhibit - Clutch Disengaged		Not inhibited
AFT Regen Inhibit - Accelerator Off Idle		Not inhibited

Figure 45 Aftertreatment session screen shot

#### Overview

A Regen may not occur due to any of the following conditions:

- Inhibitors do not match their expected value
- Entry conditions have not been met
- Active fault code(s)

To view the status of Regen inhibitors, use an Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOER Aftertreatment Tests > Onboard Filter Cleanliness Test. Select the Inhibitors tab.

**NOTE – Any active aftertreatment system fault code(s) may inhibit a Regen. Diagnose active fault code(s), other than SPN 3719 (DPF Soot Load), before continuing (see Electronic Control Systems Diagnostics” in Engine Diagnostic Manual).**

**Table 182 Check Active Regen Inhibitors**

1. Turn ignition switch to ON position, engine OFF.
2. Using ServiceMaxx™ software, load the Aftertreatment session.
3. Start engine and run vehicle speed above 5 mph.
4. Verify all listed inhibitors are displaying Not Inhibited.

<b>Check</b>	<b>Expected Results</b>	<b>Comment</b>
AFT Regen Inhibit Status	Not Inhibited	If inhibited, correct the cause. Check switches and any DTC that may be causing the Regen inhibit.
Red Stop Alert Lamp	Off	If On, Regen can't be run. Go to appropriate aftertreatment system diagnostics section in this manual.
Regen Inhibit Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO Enable Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
If no inhibitors are active and Regen is needed, go to Parked Regen Checks (page 155).		

**Table 183 Check Parked Regen Inhibitors**

1. Turn ignition switch ON, engine OFF.
2. Using EST with ServiceMaxx™ software, load the Aftertreatment session.
3. Verify all listed Inhibitors are displaying Not Inhibited.

Checks	Expected Results	Comment
AFT Regen Inhibit status	Not Inhibited	If inhibited, correct the cause. Check switches and any DTC that may be causing the Regen inhibit.
Red Stop Alert lamp	Off	If On, Regen can't be run. Go to appropriate aftertreatment system diagnostics section in this manual.
Regen inhibit switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO enable switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
Parking brake switch	On	If Off, set parking brake, if switch does not turn On, then diagnose circuit fault.
Brake Pedal switch	Off	If On and foot is off pedal, then diagnose circuit fault.
Accelerator Pedal Position	0%	If above 0%, and foot is off pedal, then diagnose circuit fault.
Clutch Pedal Switch	Off	If On and foot is off pedal, then diagnose circuit fault.
Transmission Position	Park or Neutral	If engaged, disengage, or diagnose circuit fault.

If no inhibitors and a Regen is needed, go to the following Parked Regen Checks.

**Parked Regen Checks**

During a Parked Regen the engine speed will ramp up to 1200-1800 rpm.

**Typical readings:**

- **ETV:** 80% (closed).
- **EGR Position:** 0% (closed)
- **DOCIT:** 482 - 572°F (250-300°C)
- **DOCOT:** 1112 - 1202°F (600–650°C) (after 5-10 minutes)
- **DPFOT:** 1022 - 1112°F (550–600°C) (after 10-15 minutes)
- **DPFDP:** Decreasing steadily once DPFIT and DPFOT are steady and above 1022°F (550°C).

Using EST with ServiceMaxx™ software, open the Aftertreatment session. Start a Parked Regen and monitor signals.

**Table 184 Parked Regen Checks**

Using EST with ServiceMaxx™ software, open the Aftertreatment session. Open the inhibitors tab and check for Inhibitors.

Checks	Expected Results	Comment
Engine condition	Smooth, not stumbling	If engine does not run smoothly, diagnose engine performance problem. See "PERFORMANCE DIAGNOSTICS in appropriate Engine Diagnostic Manual.
DPF Status	Regen Needed	If signal reads "Not needed", than a Regen cannot be commanded to run.
Engine Coolant Temperature	Above 150°F (66°C)	If below 150°F (66°C), warm engine above set point.
AFT Regen Status	Active	If signal reads "Not Active", check for fault codes and Parked Regen Inhibitors.
EGR Position	Closed	If not closed, diagnose sensor or circuit (See appropriate Engine Diagnostic Manual).
ETV Position	80% ±5%	If not within specifications, see diagnose sensor or circuit (See appropriate Engine Diagnostic Manual).
DOCIT	482°F (250°C) to 572°F (300°C)	If below 482°F (250°C), using Electronic Service Tool (EST) with ServiceMaxx™ software, run the KOER Air Management Test.  If above 572°F (300°C), check for proper ETV operation, and if engine is over fueling.
DOCOT	After 5-10 minutes above 986°F (530°C)	If below 986°F (530°C), diagnose and repair active DOCOT fault code(s) (Ex. SPN 4766 FMI 10). If no active fault code(s), go to appropriate aftertreatment system diagnostics section in this manual.
DPFOT	Below 1292°F (700°C)	If above 1292°F (700°C), diagnose and repair active DPFOT fault code(s). If no active fault code(s), go to appropriate aftertreatment system diagnostics section in this manual.
DPFDP	Below 0.5 psi (3.4 kPa)	If above 0.5 psi (3.4 kPa), after the system completes a full Parked Regen, diagnose and repair active DPFDP fault code(s). If no active fault code(s), go to appropriate aftertreatment system diagnostics section in this manual.

If the DPF is face plugged, measure the distance between the filter and outlet. If not within specification, the filter cannot be cleaned and must be replaced.

## 15.2. ENTRY CONDITIONS

### Overview

A Regen may not occur due to any of the following conditions:

- Inhibitors do not match their expected value
- Entry conditions have not been met
- Active fault code(s)

To view the status of Regen inhibitors, use an Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOER Aftertreatment Tests > Onboard Filter Cleanliness Test. Select the Inhibitors tab.

**NOTE – Any active aftertreatment system fault code(s) may inhibit a Regen. Diagnose active fault code(s) before continuing (see Electronic Control Systems Diagnostics” in Engine Diagnostic Manual)**

**Table 185 Entry Conditions for an Active Regen**

---

When the ECM determines the soot level threshold is reached, the system triggers DPF Regen.

**NOTE – Short trips or stop and go driving could prevent a successful Regen.**

---

The following conditions are required for an Active Regen:

- DPF Status signal displaying: Regen Needed
- Red stop engine lamp not on
- Engine Coolant Temperature is above or at least 170°F (75°C)
- Inhibiting DTCs must not be active
- Regen Inhibit switch not active (switch must be off)
- PTO not active (switch must be off)
- Exhaust Temperature sensors below safe thresholds:
  - DOCIT below 932°F (500°C)
  - DOCOT below 120°F (650°C)
  - DPFOT below 1382°F (750°C)

---

If DPF Status displays Regen needed and vehicle is unable to perform an Active Regen, go to appropriate aftertreatment system diagnostics section in this manual.

---

**DPF Status Test**

---

This test checks the status of the DPF if the Soot level is within a Regen Needed limit. The test will automatically start a Parked Regen.

**NOTE – The KOER Standard Test must be run before performing this test.**

**This test will perform a complete Parked Regen.**

---

Engine speed is ramped up to increase exhaust flow through the DPF while the DPFDPS sensor monitors the pressure difference across the DPF. The test runs for about 15 minutes. If a Regen is needed, the engine ramps up for another 15 minutes, but this time to run DPF Regen cycle.

The following conditions are required for a Onboard Filter Cleanliness Test.

- Engine Running
  - Engine Coolant Temperature is above or at least 170°F (75°C)
  - Vehicle stationary
  - Inhibit DTCs must not be active: Go to Regen Inhibitors page 152
  - PTO not active (switch must be off)
  - Regen inhibit switch not active (switch must be off)
  - Parking brake must be applied
  - Brake pedal not depressed
  - Accelerator pedal not depressed
  - Driveline disengaged
- 
- If the Soot level is within normal range, the test completes and displays “Test Completed Successful.” This test does not give pass or fail results. The test only allows the operation of the aftertreatment system to be validated by monitoring the effects of DOCIT, DOCOT, DPFOT, and DPFDPS sensor.
  - If the test is aborted, go to Regen Inhibitors page 152. If no regen inhibitors are identified, go to appropriate aftertreatment system diagnostics section in this manual.
-

**Table 187 Entry Conditions for a Parked Regen**

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A Parked Regen can only be performed when the DPF soot level threshold is reached. The DPF lamp will flash or stay on solid, signaling the need for Regen.

---

The following conditions are required for a Parked Regen:

- Engine Running
- DPF lamp is on
- Parked Regen switch on
- DPF Status signal displaying: Regen Needed
- Red stop engine lamp not on
- Engine Coolant Temperature is above or at least 170°F (75°C)
- Vehicle speed not rolling
- Inhibiting DTCs must not be active. Go to Regen Inhibitors page 152
- Regen Inhibit switch not active (switch must be off)
- PTO not active (switch must be off)
- Exhaust Temperature sensors below safe thresholds:
  - DOCIT below 932°F (500°C)
  - DOCOT below 1202°F (650°C)
  - DPFOT below 1382°F (750°C)

---

Onboard Filter Cleanliness Test. DPF Status displays “Regen needed” and vehicle is unable to perform an Active Regen, go to appropriate aftertreatment system diagnostics section in this manual.

---

## DPF AND DOC REUSE GUIDELINES

### 16.1. MAXXFORCE® DT, 9, AND 10; MAXXFORCE® 11, 13 AND 15

**NOTE – These guidelines apply to MaxxForce® DT, 9, 10, 11, and 13 (EPA 10) non-Selective Catalyst Reduction (SCR) aftertreatment systems. When inspecting aftertreatment systems with SCR, reference the appropriate Exhaust Aftertreatment Service Manual with DPF and SCR.**

This section will provide reuse guidelines for the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF).

### 16.1.1. Diesel Particulate Filter (DPF) Inlet - Clean



0000265163

**Figure 46 Diesel Particulate Filter (DPF) Inlet - Clean.**

<b>Appearance</b>	Black soot or gray ash can be seen on the face of the DPF and within the channels.
<b>Cause</b>	The system is working properly.
<b>Action</b>	The DPF can be reused.

**16.1.2. Diesel Particulate Filter (DPF) Inlet - Dirty, but Reusable**

0000265167

**Figure 47 Diesel Particulate Filter (DPF) Inlet - Dirty, but Reusable.**

<b>Appearance</b>	Black soot or gray ash on the face of the DPF and within the channels.
<b>Cause</b>	The system is working properly.
<b>Action</b>	The DPF can be reused.

### 16.1.3. Diesel Particulate Filter (DPF) Inlet - Face Plugged



0000265174

**Figure 48 Diesel Particulate Filter (DPF) Inlet - Face Plugged.**

<b>Appearance</b>	The DPF is completely covered with black soot or gray ash.
<b>Cause</b>	Excessive soot generation.
<b>Action</b>	Determine and repair the root cause of excessive soot generation. Once the root cause is repaired, properly service and reuse the DPF.

**16.1.4. Diesel Particulate Filter (DPF) - Melted**

0000265180

**Figure 49 Diesel Particulate Filter (DPF) - Melted.**

<b>Appearance</b>	Melted or deformed DPF cells.
<b>Cause</b>	Excessive exhaust gas temperatures.
<b>Action</b>	Determine the cause of excessive exhaust gas temperatures. Refer to the appropriate Engine Diagnostic Manual for diagnostic procedures. Once the cause of the excessive exhaust gas temperature has been repaired, replace the DPF.

### 16.1.5. Diesel Particulate Filter (DPF) - Cracked but Reusable

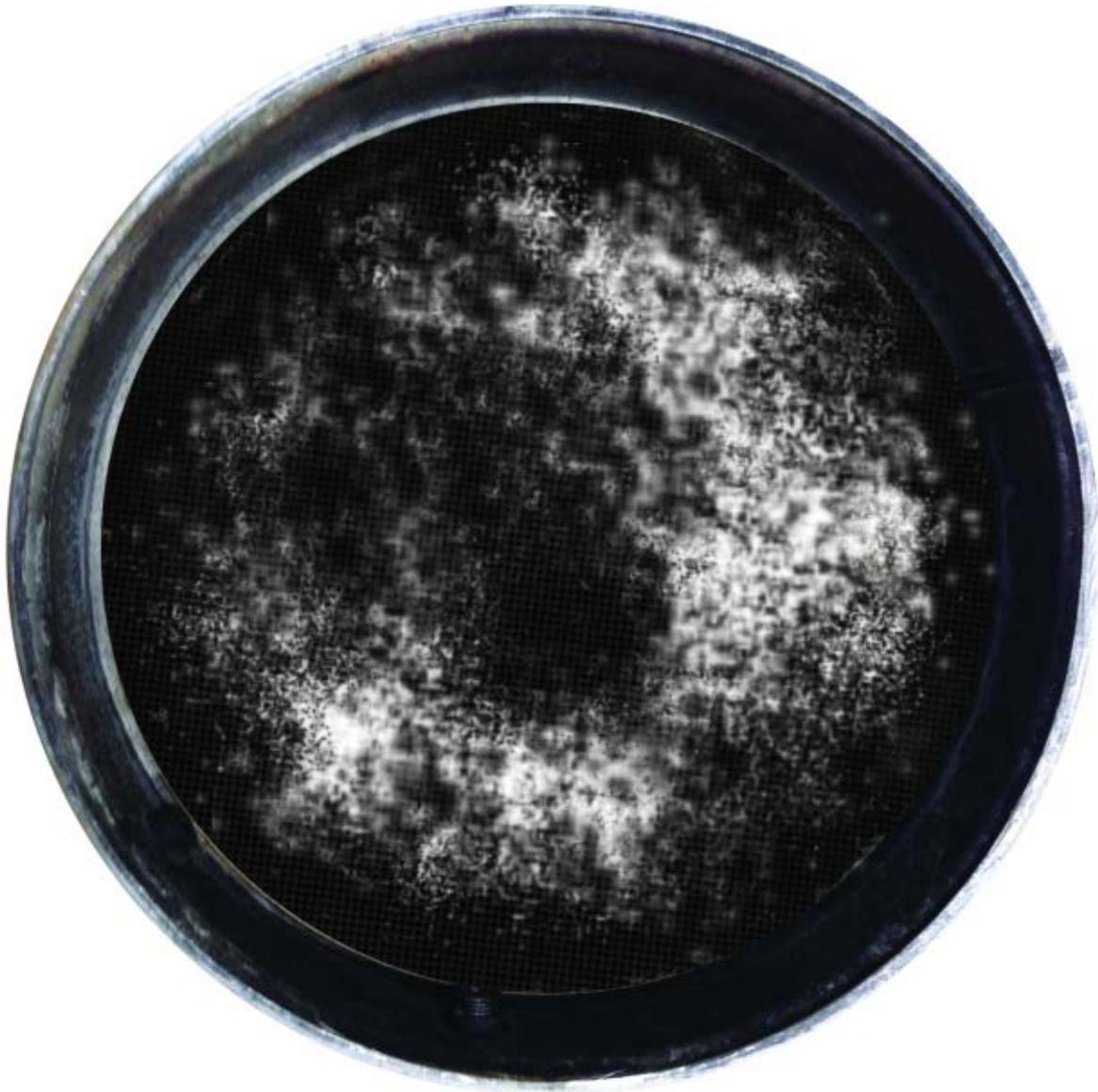


0000265185

**Figure 50 Diesel Particulate Filter (DPF) - Cracked, but Reusable.**

<b>Appearance</b>	Surface cracking on either face of the DPF.
<b>Action</b>	The DPF can be reused.

**NOTE – Surface cracking on either face of the Diesel Particulate Filter (DPF) substrate is normal and acceptable. If no black smoke is present during Snap Acceleration Test do NOT replace the DPF for surface cracks.**

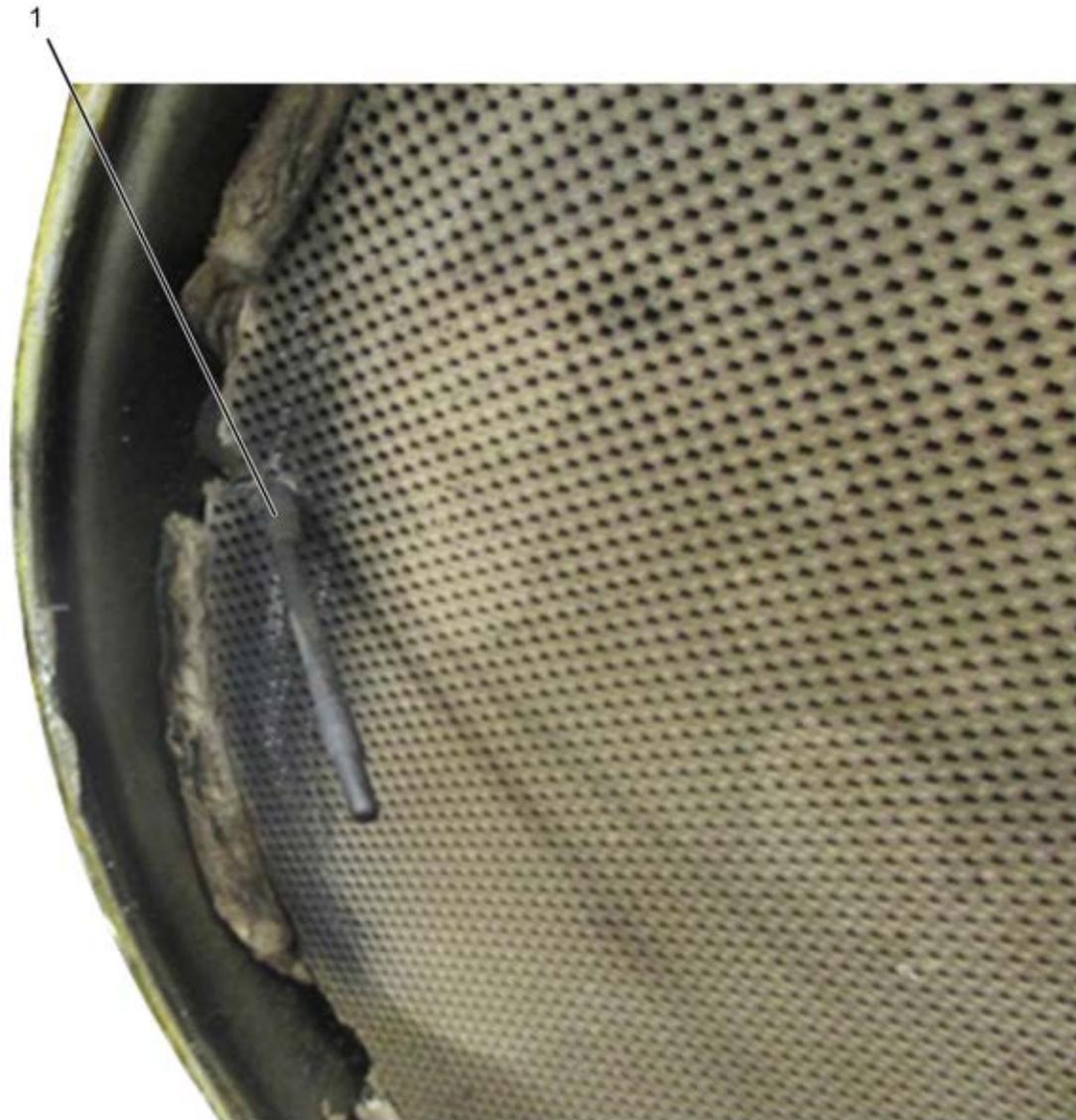
**16.1.6. Diesel Particulate Filter (DPF) Inlet- Ash on Face**

0000265191

**Figure 51 Diesel Particulate Filter (DPF) Inlet - Ash on Face.**

<b>Appearance</b>	Buildup of ash on the inlet face of the DPF.
<b>Cause</b>	Normal system operation.
<b>Action</b>	Properly service and reuse DPF.

**16.1.7. Diesel Particulate Filter (DPF) - Excessive Brick Shift**



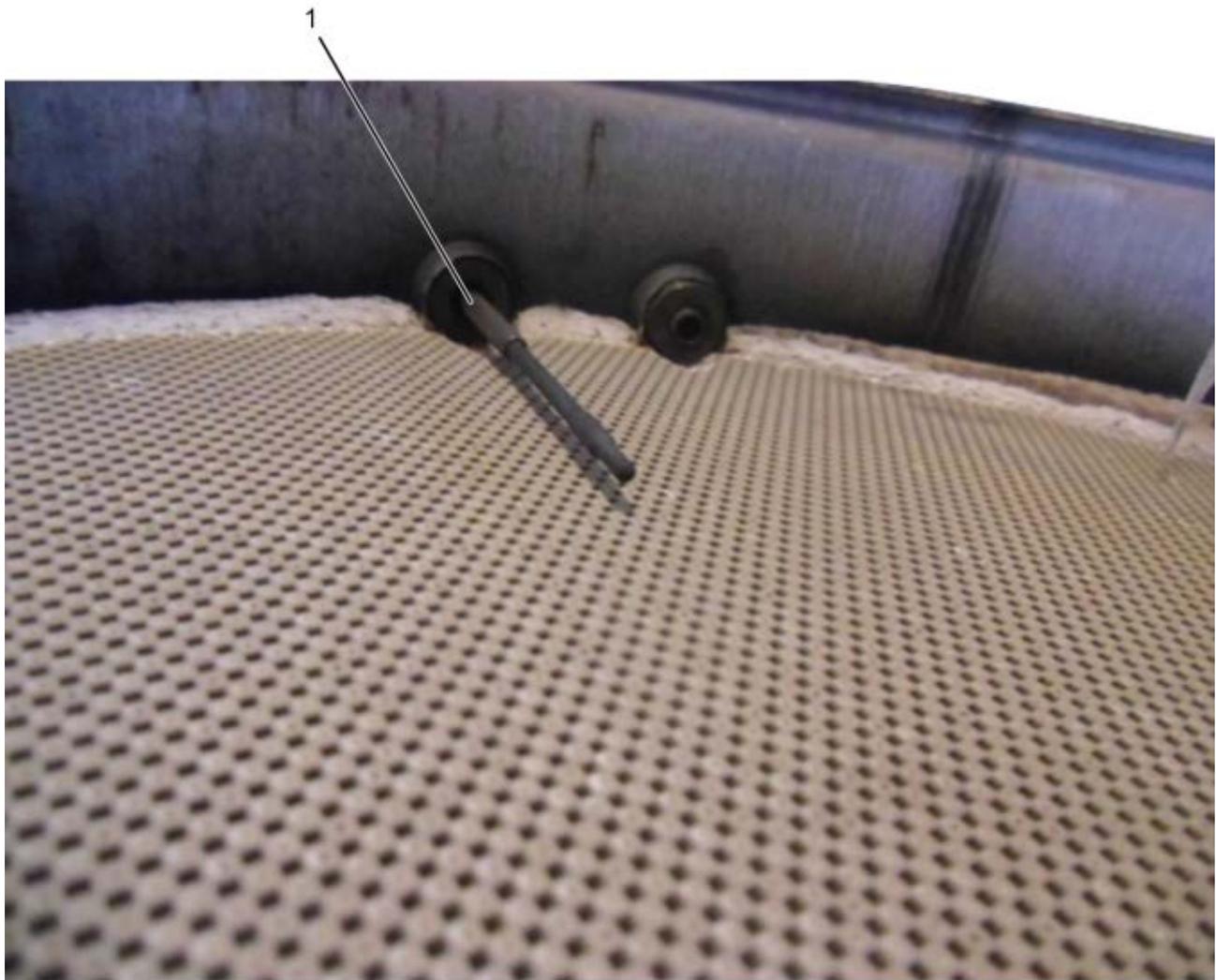
0000265140

- 1. Diesel Particulate Filter Outlet Temperature (DPFOT) sensor

**Figure 52 Diesel Particulate Filter (DPF) - Excessive Brick Shift.**

<b>Appearance</b>	The DPF brick has shifted past the DPFOT sensor causing damage to the DPF substrate.
<b>Cause</b>	Excessive soot accumulation caused by a base engine concern resulting in higher than normal exhaust back pressure.
<b>Action</b>	Determine and repair the root cause of the excessive exhaust back pressure. Once the root cause is repaired, replace the DPF.

### 16.1.8. Diesel Particulate Filter (DPF) - Moderate Brick Shift



0000265147

1. Diesel Particulate Filter Outlet Temperature (DPFOT) sensor

**Figure 53 Diesel Particulate Filter (DPF) - Moderate Brick Shift.**

<b>Appearance</b>	The DPF brick has shifted and made contact with the DPFOT sensor port bung, but has not damaged the DPF substrate.
<b>Cause</b>	Excessive soot accumulation caused by a base engine concern, resulting in higher than normal exhaust back pressure.
<b>Action</b>	Determine and repair the root cause of the excessive exhaust back pressure. Once the root cause is repaired, perform the DPF snap acceleration test. If no black smoke is seen during the snap acceleration test, the DPF can be reused.

**16.1.9. Diesel Oxidation Catalyst (DOC) Outlet - Dirty but Reusable**

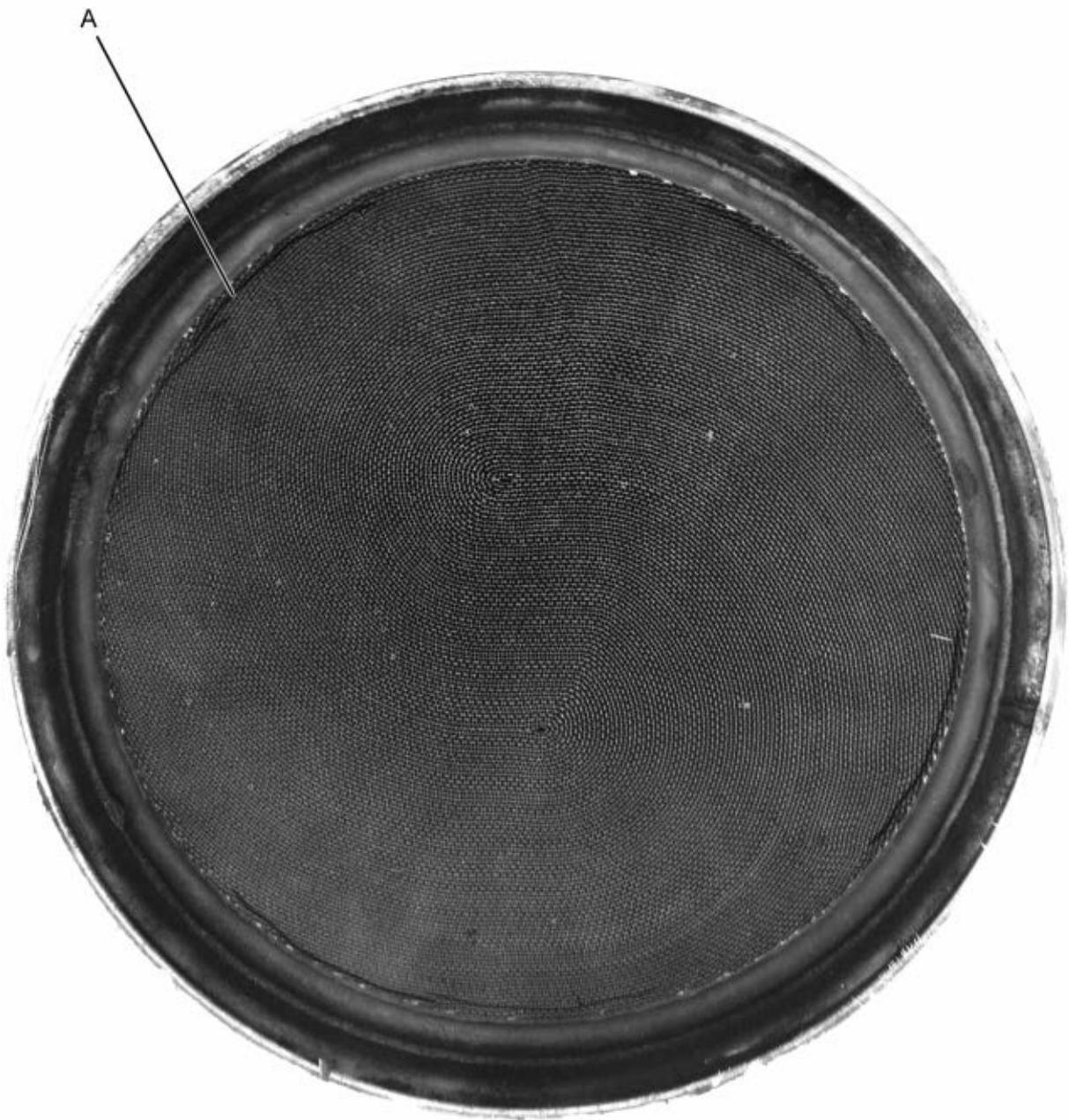


0000265121

**Figure 54 Diesel Oxidation Catalyst (DOC) Outlet - Dirty, but Reusable.**

<b>Appearance</b>	Black soot or gray ash on the face of the DOC.
<b>Cause</b>	The system is working properly.
<b>Action</b>	The DOC can be reused.

### 16.1.10. Diesel Oxidation Catalyst (DOC) - Separation



0000265131

A. DOC separation

**Figure 55 Diesel Oxidation Catalyst (DOC) - Separation.**

<b>Appearance</b>	DOC separation between the substrate and housing.
<b>Cause</b>	Occurs during the manufacturing process.
<b>Action</b>	The DOC can be reused.

16.1.11. Diesel Oxidation Catalyst (DOC) - Melted



0000265127

Figure 56 Diesel Oxidation Catalyst (DOC) - Melted.

<b>Appearance</b>	Melted or deformed DOC cells.
<b>Cause</b>	Excessive exhaust gas temperatures.
<b>Action</b>	Determine the cause of excessive exhaust gas temperatures. Refer to the appropriate Engine Diagnostic Manual for diagnostic procedures. Once the cause of the excessive exhaust gas temperature has been repaired, replace the DOC.

**16.1.12. Diesel Oxidation Catalyst (DOC) or Diesel Particulate Filter (DPF) - Damaged Sensor Port Threads**

0000265152

1. Damaged port threads

**Figure 57 Diesel Oxidation Catalyst (DOC) or Diesel Particulate Filter (DPF) Damaged Sensor Port Threads.**

<b>Appearance</b>	The DOC or DPF differential pressure or temperature sensor port threads are damaged.
<b>Cause</b>	Seized threads.
<b>Action</b>	Repair the damaged threads with DPF Repair Kit 12-235-02 (12 mm thread) and DPF Repair Kit 12-235-03 (14 mm thread).

## ABBREVIATIONS AND ACRONYMS

A or amp	Ampere
AAT	Ambient Air Temperature
ABDC	After Bottom Dead Center
ABS	Antilock Brake System
AC	Alternating Current
ACCEL	Accelerator
ACM	Aftertreatment Control Module
ACV	Air Control Valve
A/F	Air to Fuel ratio
AFI	Aftertreatment Fuel Injector
AFP	Aftertreatment Fuel Pressure
AFS	Aftertreatment Fuel Supply
AFT	Aftertreatment
AFTFD	Aftertreatment Fuel Doser
AFTFIT	Aftertreatment Fuel Inlet Temperature
AFTFIS	Aftertreatment Fuel Inlet Sensor
AFTFP	Aftertreatment Fuel Pressure
AFTFP1	Aftertreatment Fuel Pressure 1
AFTFP2	Aftertreatment Fuel Pressure 2
AFTFSV	Aftertreatment Fuel Shutoff Valve
Amb	Ambient
amp or A	Ampere
AMS	Air Management System
APP	Accelerator Pedal Position
APP1	Accelerator Pedal Position 1
APP2	Accelerator Pedal Position 2

---

APS  
Accelerator Position Sensor

APS/IVS  
Accelerator Position Sensor / Idle Validation Switch

ATA  
American Trucking Association

ATDC  
After Top Dead Center

AWL  
Amber Warning Lamp

B+ or VBAT  
Battery Voltage

BAP or BARO  
Barometric Absolute Pressure

BBDC  
Before Bottom Dead Center

BC  
Body Controller

BCS  
Boost Control Solenoid

BDC  
Bottom Dead Center

bhp  
Brake Horsepower

BOO  
Brake On / Off

BTDC  
Before Top Dead Center

C  
Celsius

CAC  
Charge Air Cooler

CACOT  
Charge Air Cooler Outlet Temperature

CAN  
Controller Area Network

CAP  
Cold Ambient Protection

CARB  
California Air Resources Board

cc  
Cubic centimeter

CCA  
Cold Cranking Ampere

CCV  
Coolant Control Valve

CCOS  
Crankcase Oil Separator (breather)

CCPS  
Crankcase Pressure Sensor

CCS  
Cruise Control Switches

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## DIAGNOSTIC MANUAL

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cfm  
Cubic feet per minute

cfs  
Cubic feet per second

CFV  
Coolant Flow Valve

CKP  
Crankshaft Position

cm  
Centimeter

CMP  
Camshaft Position

CMV  
Coolant Mixer Valve

CO  
Carbon Monoxide

Cyl  
Cylinder

DC  
Direct Current

DLC  
Data Link Connector

DMM  
Digital Multimeter

DOC  
Diesel Oxidation Catalyst

DOCIT  
Diesel Oxidation Catalyst Inlet Temperature

DOCOT  
Diesel Oxidation Catalyst Outlet Temperature

DPF  
Diesel Particulate Filter

DPFDP  
Diesel Particulate Filter Differential Pressure

DPFIT  
Diesel Particulate Filter Inlet Temperature

DPFOT  
Diesel Particulate Filter Outlet Temperature

DSI  
Down Stream Injection

DTC  
Diagnostic Trouble Code

DTCs  
Diagnostic Trouble Codes

EBP  
Exhaust Back Pressure

EBPV  
Exhaust Back Pressure Valve

ECB  
Engine Compression Brake

ECL  
Engine Coolant Level

---

ECM  
Engine Control Module

ECT  
Engine Coolant Temperature

ECT1  
Engine Coolant Temperature 1

ECT2  
Engine Coolant Temperature 2

EGR  
Exhaust Gas Recirculation

EGT  
Exhaust Gas Temperature

EGT1  
Exhaust Gas Temperature 1

EGT2  
Exhaust Gas Temperature 2

EGT3  
Exhaust Gas Temperature 3

EMI  
Electromagnetic Interference

EOP  
Engine Oil Pressure

EOT  
Engine Oil Temperature

EPA  
Environmental Protection Agency

ESN  
Engine Serial Number

EST  
Electronic Service Tool

ETC  
Engine Throttle Control

ETP  
Engine Throttle Position

ETV  
Engine Throttle Valve

EVB  
Exhaust Valve Brake

EWPS  
Engine Warning Protection System

F  
Fahrenheit

FCV  
Fuel Coolant Valve

FDP  
Fuel Delivery Pressure

fhp  
Friction horsepower

FMI  
Failure Mode Indicator

FPC  
Fuel Pump Control

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## DIAGNOSTIC MANUAL

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FPCV

Fuel Pressure Control Valve

fpm

Feet per minute

fps

Feet per second

FRP

Fuel Rail Pressure

FRPD

Fuel Rail Pressure Desired

ft

Feet

GND

Ground (electrical)

gal

Gallon

gal/h

U.S. Gallons per hour

gal/min

U.S. Gallons per minute

GCW

Gross Combined Weight

GCWR

Gross Combined Weight Rating

GVW

Gross Vehicle Weight

H<sub>2</sub>O

Water

HC

Hydrocarbons

HCI

Hydrocarbon Injection

HEST

High Exhaust System Temperature

Hg

Mercury

hp

Horsepower

HPCAC

High-Pressure Charge Air Cooler

HPCR

High-Pressure Common Rail

HPFP

High-Pressure Fuel Pump

hr

Hour

HS

Humidity Sensor

Hyd

Hydraulic

---

IAH  
Inlet Air Heater

IAHR  
Inlet Air Heater Relay

IAT  
Inlet Air Temperature

IC  
Integrated Circuit

ICP  
Injection Control Pressure

ICPR  
Injection Control Pressure Regulator

IGN  
Ignition

IMP  
Intake Manifold Pressure

IMT  
Intake Manifold Temperature

in  
Inch

inHg  
Inch of mercury

INJs  
Injectors

IPR  
Injection Pressure Regulator

ISC  
Interstage Cooler

ITV  
Intake Throttle Valve

J1939H  
J1939 Data Link High

J1939L  
J1939 Data Link Low

kg  
Kilogram

km  
Kilometer

km/h  
Kilometers per hour

KOEO  
Key-On Engine-Off

KOER  
Key-On Engine-Running

kPa  
Kilopascal

L  
Liter

lb  
Pound

lbf  
Pounds of force

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## DIAGNOSTIC MANUAL

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lb/s

Pounds per second

lbf ft

Pounds of force per foot

lb in

Pounds of force per inch

lbm

Pounds of mass

LPCAC

Low-pressure Charge Air Cooler

LSD

Low Sulfur Diesel

m

Meter

m/s

Meters per second

MAF

Mass Air Flow

MAP

Manifold Absolute Pressure

MAP/IAT

Manifold Absolute Pressure / Inlet Air Temperature

mi

Mile

MIL

Malfunction Indicator Lamp

mm

Millimeter

mpg

Miles per gallon

mph

Miles per hour

MSDS

Material Safety Data Sheet

MSM

Multiplex System Module

MY

Model Year

NC

Normally Closed (electrical)

Nm

Newton meter

NO

Normally Open (electrical)

NO<sub>x</sub>

Nitrogen Oxides

O<sub>2</sub>S

Oxygen Sensor

O<sub>2</sub>SH

Oxygen Sensor Heater

---

OSHA  
Occupational Safety and Health Administration

OWL  
Oil/Water Lamp

PID  
Parameter Identifier

P/N  
Part Number

PDOC  
Pre-Diesel Oxidation Catalyst

ppm  
Parts per million

PROM  
Programmable Read Only Memory

psi  
Pounds per square inch

psia  
Pounds per square inch absolute

psig  
Pounds per square inch gauge

pt  
Pint

PTO  
Power Takeoff

PWM  
Pulse Width Modulate

PWR  
Power (voltage)

qt  
Quart

RAM  
Random Access Memory

rpm  
Revolutions per minute

SIG GND  
Signal Ground

S/N  
Serial Number

SPEEDO  
Speedometer

SPN  
Suspect Parameter Number

SWBAT  
Switch Battery

TC2CIS  
Turbocharger 2 Compressor Inlet Sensor

TC1TOP  
Turbocharger 1 Turbine Outlet Pressure

TC2TOP  
Turbocharger 2 Turbine Outlet Pressure

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## DIAGNOSTIC MANUAL

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TC1WC

Turbocharger 1 Wastegate Control

TC2WC

Turbocharger 2 Wastegate Control

TCM

Transmission Control Module

TDC

Top Dead Center

V

Volt

VBAT or B+

Battery Voltage

VGT

Variable Geometry Turbo

VIN

Vehicle Identification Number

VREF

Reference Voltage

VSS

Vehicle Speed Sensor

WTSL

Wait to Start Lamp

WIF

Water In Fuel

WIFL

Water In Fuel Lamp

---

## TERMINOLOGY

### Accelerator Pedal Position

#### (APP) sensor

A potentiometer sensor that indicates the position of the throttle pedal.

### Actuator

A device that performs work in response to an input signal.

### Actuator Control

The ECM controls the actuators by applying a low-level signal (low-side driver) or a high-level signal (high side driver). When switched on, both drivers complete a ground or power circuit to an actuator.

### Aeration

The entrainment of air or combustion gas in coolant, lubricant, or fuel.

### Aftercooler (Charge Air Cooler)

A heat exchanger mounted in the charge air path between the turbocharger and engine intake manifold.

The aftercooler reduces the charge air temperature by transferring heat from the charge air to a cooling medium (usually air).

### Aftertreatment Fuel Doser

#### (AFTFD)

A part of the Down Stream Injection (DSI) unit that sends pressurized fuel to the Aftertreatment Fuel Injector (AFI) to inject fuel into the exhaust pipe.

### Aftertreatment Fuel Injector

#### (AFI)

Injects fuel into the exhaust system to increase temperature of the exhaust gases.

### Aftertreatment (AFT) system

A part of the exhaust system that processes engine exhaust to meet emission requirements and traps particulate matter (soot) to prevent it from leaving the tailpipe.

### Air Control Valve (ACV)

Contains the LP turbocharger wastegate control port, HP turbocharger wastegate control port, the EBPV control port, and the TC1TOP port. Although these components are integral to the ACV, each circuit is controlled by the ECM. The ACV controls compressed air for each control valve.

### Ambient temperature

The environmental air temperature in which a unit is operating. In general, the temperature is measured in the shade (no solar radiation) and represents the air temperature for other engine cooling performance measurement purposes. Air entering the radiator may or may not be the same ambient due to possible heating from other sources or recirculation. (SAE J1004 SEP81)

### Ampere (amp)

The standard unit for measuring the strength of an electrical current. The flow rate of a charge in a conductor or conducting medium of one coulomb per second. (SAE J1213 NOV82)

### Analog

A continuously variable voltage.

### American Trucking Association (ATA) Datalink

A serial datalink specified by the American Trucking Association and the SAE.

### Boost pressure

1. The pressure of the charge air leaving the turbocharger.
2. Inlet manifold pressure that is greater than atmospheric pressure. Obtained by turbocharging.

### Bottom Dead Center (BDC)

The lowest position of the piston during the stroke.

### Brake Horsepower (bhp)

The power output from an engine, not the indicated horsepower. The power output of an engine, sometimes-called flywheel horsepower, is less than the indicated horsepower by the amount of friction horsepower consumed in the engine.

### Brake Horsepower (bhp) net

Net brake horsepower is measured with all engine components. The power of an engine when configured as a fully equipped engine. (SAE J1349 JUN90)

### Calibration

ECM programming strategy to solve engine performance equations and make decisions. Calibration values are stored in ROM and put into the processor during programming to allow the engine to operate within certain parameters.

### Camshaft Position (CMP) sensor

A magnetic pickup sensor that provides the ECM with a camshaft speed and position signal.

### Carbon Monoxide (CO)

A colorless, odorless, highly poisonous gas that is formed by the incomplete combustion of carbon burning diesel engine. It is present in the exhaust gases of diesel engines.

### Catalyst

A substance that produces a chemical reaction without undergoing a chemical change itself.

### Catalytic converter

An antipollution device in the exhaust system that contains a catalyst for chemically converting some pollutants in the exhaust gases (carbon monoxide, unburned hydrocarbons, and oxides of nitrogen) into harmless compounds.

### Charge air

Dense, pressurized, heated air discharged from the turbocharger.

### Charge Air Cooler (CAC) See **Aftercooler**.

### Charge Air Outlet Temperature (CACOT) sensor

A thermistor sensor that monitors the temperature of charge air entering the intake air duct.

**Closed loop operation**

A system that uses sensors to provide feedback to the ECM. The ECM uses the sensor input to continuously monitor variables and adjust actuators to match engine requirements.

**Controller Area Network (CAN)**

A J1939 high-speed communication link.

**Coolant**

A fluid used to transport heat from one point to another.

**Coolant level switch**

A switch sensor used to monitor coolant level.

**Coolant Flow Valve (CFV)**

The CFV is ECM controlled and redirects coolant through the fuel cooler, based on EFT, when directed.

**Coolant Mixer Valve (CMV)**

Controls coolant flow through the low-temperature radiator.

**Continuous Monitor Test**

An ECM function that continuously monitors the inputs and outputs to ensure that readings are within set limits.

**Crankcase**

The housing that encloses the crankshaft, connecting rods, and allied parts.

**Crankcase breather**

A vent for the crankcase to release excess interior air pressure.

**Crankcase Oil Separator Speed (CCOSS) sensor**

The CCOSS sensor sends the ECM information about the speed of the crankcase oil separator internal components.

**Crankcase pressure**

The force of air inside the crankcase against the crankcase housing.

**Crankshaft Position (CKP) sensor**

A magnetic pickup sensor that determines crankshaft position and speed.

**Current**

The flow of electrons passing through a conductor. Measured in amperes.

**Diagnostic Trouble Code (DTC)**

2010 model year vehicles no longer utilize DTC identification by number. DTCs are now identified using the Suspect Parameter Number (SPN) and Failure Mode Indicator (FMI) identifiers only.

**Diesel Particulate Filter (DPF)**

A diesel particulate filter, sometimes called a DPF, is a device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine.

### Diesel Oxidation Catalyst (DOC)

A DOC is part of the diesel exhaust Aftertreatment system. DOCs are devices that use a chemical process to break down pollutants in the exhaust stream into less harmful components. More specifically, DOCs utilize rare metals such as palladium and platinum to reduce hydrocarbon based Soluble Organic Fraction (SOF) and carbon monoxide content of diesel exhaust by simple oxidation. The DOC can be used during an active regeneration to create higher exhaust temperatures, thereby reducing soot in the DPF.

### Digital Multimeter (DMM)

An electronic meter that uses a digital display to indicate a measured value. Preferred for use on microprocessor systems because it has a very high internal impedance and will not load down the circuit being measured.

### Displacement

The stroke of the piston multiplied by the area of the cylinder bore multiplied by the number of cylinders in the engine.

### Down Stream Injection (DSI)

The DSI system injects fuel into the exhaust system to increase temperature of the exhaust gases, and is necessary for DPF regeneration.

### Dual Stage Turbocharger

An assembly of two turbochargers (low-pressure and high-pressure) in series to provide a wide range of charge air pressures efficiently.

### Duty cycle

A control signal that has a controlled on/off time measurement from 0 to 100%. Normally used to control solenoids.

### EGR Cooler

A cooler that allows heat to dissipate from the exhaust gasses before they enter the intake manifold.

### Engine Back Pressure Valve (EBPV)

The ECM commands the EBPV to control the Exhaust Brake.

### Engine Compression Brake (ECB) valve

The ECB valve controls pressure entering the brake oil gallery from the high-pressure oil rail gallery. This activates the brake actuator pistons and opens the exhaust valves.

### Engine Compression Brake 1 (ECB1) solenoid

The ECB1 solenoid controls pressure entering the brake oil gallery from the high-pressure oil rail gallery.

### Engine Compression Brake 2 (ECB2) solenoid

The ECB2 solenoid controls pressure entering the brake oil gallery from the high-pressure oil rail gallery.

### Engine Compression Brake Pressure (ECBP) sensor

A high-pressure sensor that provides a feedback signal to the ECM indicating brake control pressure.

**Engine Control Module (ECM)**

An electronic processor that monitors and controls the engine.

**Engine Coolant Level (ECL)  
sensor**

A switch sensor that monitors coolant level.

**Engine Coolant Temperature 1  
(ECT1) sensor**

A thermistor sensor that detects engine coolant temperature.

**Engine Coolant Temperature 2  
(ECT2) sensor**

A thermistor sensor that detects engine coolant temperature.

**Engine Fuel Temperature (EFT)  
sensor**

A thermistor sensor that measures fuel temperature.

**Engine lamp**

An instrument panel lamp that comes on when DTCs are set. DTCs can be read as flash codes (red and amber instrument panel lamps).

**Engine OFF tests**

Tests that are done with the ignition switch ON and the engine OFF.

**Engine Oil Pressure (EOP)  
sensor**

A variable capacitance sensor that measures oil pressure.

**Engine Oil Temperature (EOT)  
sensor**

A thermistor sensor that measures oil temperature.

**Engine rating**

Engine rating includes **Rated hp** and **Rated rpm**.

**Engine RUNNING tests**

Tests done with the engine running.

**Engine Throttle Valve (ETV)  
and Engine Throttle Position  
Sensor**

The ETV valve is used to control airflow during a regeneration process of the aftertreatment system. The ETV valve is also used to ensure a smooth engine shut down by restricting airflow to the engine at shut down.

**Engine Warning Protection  
System (EWPS)**

Safeguards the engine from undesirable operating conditions to prevent engine damage and to prolong engine life.

**Exhaust Back Pressure (EBP)**

The pressure present in the exhaust system during the exhaust period.

### Exhaust Back Pressure Valve (EBPV)

A valve that regulates the amount of air pressure applied to the EBPV pneumatic actuator.

### Exhaust brake

A brake device using engine exhaust back pressure as a retarding medium.

### Exhaust Gas Recirculation (EGR)

A system used to recirculate a portion of the exhaust gases into the power cylinder in order to reduce oxides of nitrogen.

### Exhaust Gas Temperature (EGT)

The temperature of exhaust gases.

### Exhaust Gas Recirculation Temperature (EGRT) sensor

A thermistor sensor that detects the exhaust gas temperature entering the EGR cooler.

### Exhaust Gas Recirculation (EGR) valve

The EGRV controls the flow of exhaust gases to the intake manifold. The EGRV is integrated with an EGR Position (EGRP) sensor.

### Exhaust manifold

Exhaust gases flow through the exhaust manifold to the turbocharger exhaust inlet and are directed to the EGR cooler.

### Exhaust Manifold Pressure (EMP) sensor

A variable capacitance sensor used to indicate air pressure in the exhaust manifold.

### Exhaust Manifold Temperature (EMT) sensor

A thermistor sensor used to indicate air temperature in the exhaust manifold.

### Failure Mode Indicator (FMI)

Identifies the fault or condition effecting the individual component.

### Fuel Delivery Pressure (FDP) sensor

A variable capacitance sensor that monitors fuel pressure coming from the fuel tank and sends a signal to the ECM.

### Fuel pressure

The force fuel exerts on the fuel system as it is pumped through the fuel system.

### Fuel Pressure Control Valve (FPCV)

The FPCV controls the fuel pressure to the fuel rails and is controlled by the ECM. FPCV control depends on fuel pressure and fuel temperature.

**Fuel Rail Pressure (FRP)**

The amount of pressure in the fuel rail.

**Fuel Rail Pressure (FRP) sensor**

A variable capacitance sensor that monitors fuel pressure in the fuel rail and sends a signal to the ECM.

**Fuel strainer**

A pre-filter in the fuel system that keeps larger contaminants from entering the fuel system.

**Fuel Volume Control Valve (FVCV)**

The FVCV regulates the volume of flow sent to the HPFP. The FVCV allows a sufficient quantity of fuel to be delivered to the HPFP depending on engine load, speed, injector quantity, fuel temperature, and number of injections per cycle.

**Fully equipped engine**

A fully equipped engine is an engine equipped with only those accessories necessary to perform its intended service. A fully equipped engine does not include components that are used to power auxiliary systems. If these components are integral with the engine or, for any reason are included on the test engine, the power absorbed may be determined and added to the net brake power. (SAE J1995 JUN90)

**Fusible link (fuse link)**

A fusible link is a special section of low tension cable designed to open the circuit when subjected to an extreme current overload. (SAE J1156 APR86)

**Gross Combined Weight Rating (GCWR)**

Maximum combined weight of towing vehicle (including passengers and cargo) and the trailer. The GCWR indicates the maximum loaded weight that the vehicle is allowed to tow.

**Gross brake horsepower**

The power of a complete basic engine, with air cleaner, without fan, and alternator, and air compressor not charging.

**Hall effect**

The development of a transverse electric potential gradient in a current-carrying conductor or semiconductor when a magnetic field is applied.

**Hall effect sensor**

Transducer that varies its output voltage in response to changes in a magnetic field. Commonly used to time the speed of wheels and shafts.

**High-pressure Fuel Pump (HPFP) assembly**

The HPFP is a volumetric pump that supplies fuel at high-pressure. The HPFP is mounted in the rear valley on the top of the engine and is driven by the camshaft.

**High-pressure Piezo Common Rail (HPCR)**

The HPFP pumps fuel through separate tubes to each fuel rail. Each fuel rail has four fuel tubes, one for each injector, that maintain constant pressure from the high-pressure pump to each injector.

### Horsepower (hp)

Horsepower is the unit of work done in a given period of time, equal to 33,000 pounds multiplied by one foot per minute. 1 hp = 33,000 lb x 1 ft. /1 min.

### Humidity Sensor (HS)

A sensor that measures the moisture content of filtered air entering the intake system.

### Hydrocarbons

Organic compounds consisting of hydrogen and carbon (fuel and oil).

### Hydrocarbon slip

A normal condition that occurs in the exhaust stream in high idle time applications, where diesel fuel does not fully combust in the aftertreatment system during regeneration. The diesel fuel “slips” through the Diesel Particulate Filter (DPF), and into the clean side of the exhaust.

### Injection Pressure Regulator (IPR) valve

A valve that is used to maintain desired injection control pressure.

### Injection Control Pressure (ICP) sensor

Provides a feedback signal to the ECM indicating injection control pressure.

### Inlet Air Heater (IAH)

The IAH is primarily used to assist in starting the engine during cold weather. In addition, it helps to reduce white smoke emissions by heating the incoming air.

### Inlet Air Heater Fuel Igniter (IAHFI)

The IAHFI heats the intake air by vaporizing and igniting fuel in the air inlet duct.

### Inlet Air Heater Fuel Solenoid (IAHFS)

As the engine is cranked, the ECM energizes the IAHFS valve, introducing fuel into the IAHFI, which ignites and warms the air being drawn into the engine.

### Inlet Air Heater Relay (IAHR)

The IAHR provides voltage to the IAHFI, and is controlled by the ECM.

### Inlet Air Temperature (IAT) sensor

A thermistor sensor that monitors intake air temperature.

### Intake manifold

Engine component that evenly supplies air to each intake port in the cylinder head(s).

### Intake Manifold Pressure (IMP) sensor

A variable capacitance sensor used to indicate air pressure in the intake manifold.

### Intake Manifold Temperature (IMT) sensor

A thermistor sensor used to indicate air temperature in the intake manifold.

**Interstage Cooler (ISC)**

Uses cooled coolant to lower the charged air temperature that exits from the turbocharger low-pressure compressor and enters the turbocharger high-pressure compressor.

**Low temperature radiator  
thermostat**

Coolant flow to the low temperature radiator is regulated by the low temperature radiator thermostat.

**Lug (engine)**

When the engine is run at an overly low RPM for the load being applied.

**Manifold Absolute Pressure  
(MAP)**

Boost pressure in the manifold that is a result of the turbocharger.

**Manifold Absolute Pressure  
(MAP) sensor**

A variable capacitance sensor that measures boost pressure.

**Manometer**

A double-leg liquid-column gauge, or a single inclined gauge, used to measure the difference between two fluid pressures. Typically, a manometer records in inches of water.

**Mass Air Flow**

The intake airflow in an engine.

**Mass Air Flow (MAF) sensor**

The MAF sensor is used for closed loop control of the EGR valve and ITV. The ECM monitors the MAF signal so that the ECM can control the EGR and intake throttle systems.

**Magnehelic Gauge**

A gauge that measures pressure in inches of water.

**Magnetic Pickup Sensor**

A magnetic pickup sensor generates an alternating frequency that indicates speed. Magnetic pickups have a two-wire connection for signal and ground. This sensor has a permanent magnetic core surrounded by a wire coil. The signal frequency is generated by the rotation of the gear teeth that disturb the magnetic field.

**Metering unit valve assembly**

The Metering unit valve assembly provides a metered amount of fuel to the Aftertreatment Fuel Injector (AFI).

**Microprocessor**

An integrated circuit in a microcomputer that controls information flow.

**Nitrogen Oxides (NO<sub>x</sub>)**

Nitrogen oxides Form by a reaction between nitrogen and oxygen at high temperatures and pressures in the combustion chamber.

**Normally closed**

Refers to a switch that remains closed when no control force is acting on it.

**Normally open**

Refers to a switch that remains open when no control force is acting on it.

## DIAGNOSTIC MANUAL

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### Ohm ( $\Omega$ )

The unit of electrical resistance. One ohm is the value of resistance through which a potential of one volt will maintain a current of one ampere. (SAE J1213 NOV82)

### Oxides of Nitrogen (NO<sub>x</sub>)

Nitrogen oxides formed by a reaction between nitrogen and oxygen at high temperatures.

### Oxygen Sensor (O<sub>2</sub>S)

A sensor that monitors oxygen levels in the exhaust.

### Particulate matter

Particulate matter includes mostly burned particles of fuel and engine oil.

### Piezometer

An instrument for measuring fluid pressure.

### Power

Power is a measure of the rate at which work (force x distance) is done during a specific time. Compare with Torque.

### Power TakeOff (PTO)

Accessory output, usually from the transmission, used to power a hydraulic pump for a special auxiliary feature (garbage packing, lift equipment, etc).

### Pulse Width Modulation (PWM)

Succession of digital electrical pulses, rather than an analog signal. Efficient method of providing power between fully on and fully off.

### Random Access Memory

#### (RAM)

Computer memory that stores information. Information can be written to and read from RAM. Input information (current engine speed or temperature) can be stored in RAM to be compared to values stored in Read Only Memory (ROM). All memory in RAM is lost when the ignition switch is turned off.

### Rated gross horsepower

Engine gross horsepower at rated speed as declared by the manufacturer. (SAE J1995 JUN90)

### Rated horsepower

Maximum brake horsepower output of an engine as certified by the engine manufacturer. The power of an engine when configured as a basic engine. (SAE J1995 JUN90)

### Rated net horsepower

Engine net horsepower at rated speed as declared by the manufacturer. (SAE J1349 JUN90)

### Rated speed

The speed, as determined by the manufacturer, at which the engine is rated. (SAE J1995 JUN90)

### Rated torque

Maximum torque produced by an engine as certified by the manufacturer.

### Reference voltage ( $V_{REF}$ )

A 5 volt reference supplied by the ECM to operate the engine sensors.

**Regeneration**

Oxidation of accumulated soot (carbon-based particulates) in the Diesel Particulate Filter (DPF). The soot is reduced to ash and stored in the PDF.

**ServiceMaxx™ software**

Diagnostics software for engine components and systems.

**Signal ground**

The common ground wire to the ECM for the sensors.

**Strategy**

A plan or set of operating instructions that the microprocessor follows for a desired goal. Strategy is the computer program itself, including all equations and decision making logic. Strategy is always stored in ROM and cannot be changed during calibration.

**Stroke**

The movement of the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).

**Suspect Parameter Number (SPN)**

A 19-bit number used to identify the item for which diagnostics are being reported. The SPN is used for multiple purposes, some that are specific to diagnostics are as follows;

- Identify the least repairable subsystem that has failed.
- Identify subsystems or assemblies that may not have hard failures but may be exhibiting abnormal operating performance.
- Identify a particular event or condition that will be reported.
- Report a component and non-standard failure mode.

**Tachometer output signal**

Engine speed signal for remote tachometers.

**Thermistor**

A semiconductor device. A sensing element that changes resistance as the temperature changes.

**Thermistor Sensor**

Changes electrical resistance with changes in temperature. Resistance in the thermistor decreases as temperature increases, and increases as temperature decreases. Thermistors work with a resistor that limits current to Form a voltage signal matched with a temperature value.

**Thrust load**

A thrust load pushes or reacts through a bearing in a direction parallel to the shaft.

**Top Dead Center (TDC)**

The uppermost position of the piston during the stroke.

**Torque**

A force having a twisting or turning effect. For a single force, the cross product of a vector from some reference point to the point of application of the force within the force itself. Also known as moment of force or rotation moment. Torque is a measure of the ability of an engine to do work.

### Turbocharger

A turbine driven compressor mounted on the exhaust manifold. The turbocharger increases the pressure, temperature and density of intake air to charge air.

### Turbocharger 1 Turbine Outlet

#### Pressure (TC1TOP) sensor

A variable capacitance sensor that monitors exhaust back-pressure.

### Turbocharger 2 Compressor

#### Inlet (TC2CIS) sensor

The TC2CIS sensor includes a thermistor sensor that monitors the temperature of charge air entering the HP turbocharger. This sensor also monitors boost pressure for the LP turbocharger.

### Turbocharger Wastegate

#### Control (TCWC) solenoid

Controls the TCWC actuator by regulating the amount of charge air pressure supplied to the TCWC actuator. The TCWC solenoid is controlled by signals from the ECM in response to engine speed, required fuel quantity, boost, exhaust back-pressure, and altitude.

### Turbocharger 1 Wastegate

#### Control (TC1WC) solenoid

Controls the TC1WC actuator by regulating the amount of charge air pressure supplied to the TC1WC actuator. The TC1WC solenoid is controlled by signals from the ECM in response to engine speed, required fuel quantity, boost, exhaust back-pressure, and altitude. The TC1WC actuator is part of the turbocharger assembly.

**NOTE – TC1WC does not affect engine performance and is removed from postproduction engines.**

### Turbocharger 2 Wastegate

#### Control (TC2WC) solenoid

Controls the TC2WC actuator by regulating the amount of charge air pressure supplied to the wastegate actuator. The TC2WC solenoid is controlled by signals from the ECM in response to engine speed, required fuel quantity, boost, exhaust back-pressure, and altitude. The TC2WC actuator is part of the turbocharger assembly.

### Variable capacitance sensor

A variable capacitance sensor measures pressure. The pressure forces a ceramic material closer to a thin metal disc in the sensor, changing the capacitance of the sensor.

### Vehicle Speed Sensor (VSS)

Normally a magnetic pickup sensor mounted in the tailshaft housing of the transmission, used to indicate ground speed.

### Viscosity

The internal resistance to the flow of fluid.

### Volt (v)

A unit of electromotive force that will move a current of one ampere through a resistance of one Ohm.

### Voltage

Electrical potential expressed in volts.

Voltage drop

Reduction in applied voltage from the current flowing through a circuit or portion of the circuit current multiplied by resistance.

Voltage ignition

Voltage supplied by the ignition switch when the key is ON.

Water In Fuel (WIF) sensor

A switch sensor that measures the amount of water in the fuel.