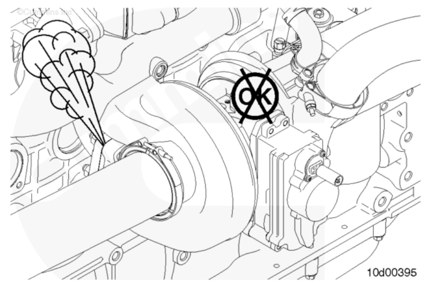
(/qs3/pubsys2/xml/en/manual/4022254/4022254-titlepage.html)

General Information



The following procedure contains troubleshooting steps and information regarding the aftertreatment system.

Note : The information in this procedure only applies to rear gear train engines.

Leaks in the exhaust system can cause exhaust odor or white smoke.

Inspect the exhaust piping for leaks, cracks, and loose connections. Refer to Procedure 010-024 in Section 10. (/qs3/pubsys2/xml/en/procedures/31/31-010-024-tr-isb10.html)

Tighten the exhaust clamps, if necessary. See equipment manufacturer service information for the correct torque value.

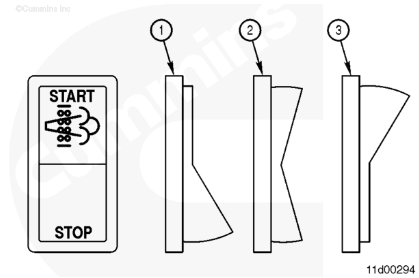
It may be necessary to perform a stationary (parked) regeneration to locate exhaust leaks. Refer to Procedure 014-013 in Section 14. (/qs3/pubsys2/xml/en/procedures/31/31-014-013-tr-isb10.html)

The ambient temperature affects the length of time it will take to perform a stationary (parked) regeneration, because the engine must work harder to increase the exhaust temperatures to the appropriate levels in cold ambient temperatures.

In cold ambient temperatures (approximately -18°C [0°F] or colder), stationary (parked) regeneration may take longer to complete. In extremely cold ambient temperatures, stationary (parked) regeneration may **not** complete.

In these cases, it may be necessary to warm the engine to operating temperature before starting the stationary (parked) regeneration, or to move the vehicle to a location with higher ambient temperatures.

The vehicle manufacturer has the option of installing two switches that control the aftertreatment function: the start switch and the permit switch.



The start switch (called the Diesel Particulate Filter Regeneration Start Switch in INSITE™ electronic service tool) is used to start a stationary (parked) regeneration. The vehicle manufacturer may also reference this switch as a "stationary regeneration switch", "start switch", or "parked regeneration switch".

The permit switch (called the Diesel Particulate Filter Permit Switch in INSITE™ electronic service tool) is used to allow the operator to disable active regeneration, if necessary. The vehicle manufacturer may also reference this switch as an "inhibit switch", "stop switch", or "disable switch".

The start switch can be hardwired to the engine control module (ECM), or it can be multiplexed over J1939 multiplexing.

If the start switch is hardwired, it shares an ECM pin with the diagnostic switch. When the switch is turned ON and the engine is OFF, the ECM interprets this signal as the diagnostic switch. When the switch is turned ON and the engine is operating, the ECM interprets this signal as the start switch.

If the start switch is J1939-multiplexed, the signal for this switch is broadcast over the J1939 data link.

A J1939-multiplexed start switch signal has priority over a hardwired start switch signal. Therefore, if the start switch is enabled over J1939, the hardwired signal is ignored by the engine ECM.

The default setting for the start switch is “enabled”. If the start switch is enabled in INSITE™ electronic service tool, but no switch is installed (either hardwired or J1939-multiplexed), the switch status will remain OFF.

The position of the start switch can be monitored with INSITE™ electronic service tool in the data monitor/logger screen.

The permit switch can be hardwired to the ECM, or it can be multiplexed over J1939 multiplexing.

A J1939-multiplexed permit switch signal has priority over a hardwired start switch signal, so if the permit switch is enabled over J1939, the hardwired signal is ignored by the engine ECM.

The position of the permit switch can be monitored with INSITE™ electronic service tool in the Data Monitor/Logger screen:

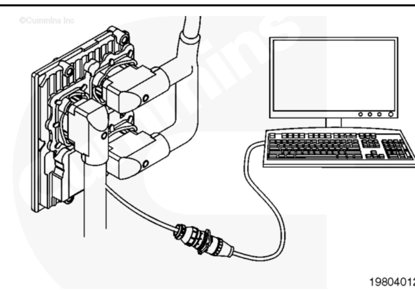
- When the permit switch is ON, active regeneration is allowed
- When the permit switch is OFF, active regeneration is **not** allowed.

The default setting for the permit switch is “enabled”. If the permit switch is enabled in INSITE™ electronic service tool, but no switch is installed (either hardwired or J1939-multiplexed), the switch status will remain OFF.

If the vehicle is operated for an extended period of time with the permit switch OFF, fault codes for the above normal levels of aftertreatment diesel particulate filter (DPF) soot load or aftertreatment DPF system timeout can result (Fault Codes 1921, 1922, 2639, and 3753).

If the aftertreatment DPF soot load reaches the least severe level (Fault Code 2639), and the permit switch is OFF, the ECM will also log a Fault Code 2777.

If the aftertreatment exhaust gas temperature sensors are **not** connected properly, or if the wiring in the harness between the engine and aftertreatment is **not** correct, the engine may experience frequent DPF lamp illuminations, or stationary (parked) regenerations that do **not** complete.



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To verify the correct sensor locations, use INSITE™ electronic service tool to monitor the following parameters with the ignition key ON, but with the engine **not** operating.

- Aftertreatment Diesel Oxidation Catalyst (DOC) Inlet Temperature Sensor Signal Voltage (V)
- Aftertreatment DPF Inlet Temperature Sensor Signal Voltage (V)
- Aftertreatment DPF Outlet Temperature Sensor Signal Voltage (V).

Unplug each of the aftertreatment exhaust gas temperature sensors, one at a time.

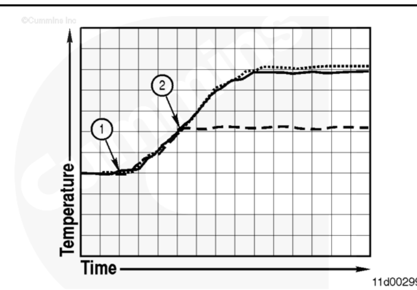
If the voltage changes when the sensor is unplugged, the wiring harness connector is connected to the correct sensor.

If the voltage does **not** change when the sensor is unplugged, switch the connector location to the other temperature sensor, unplug it, and check for a voltage change.

An incorrectly assembled aftertreatment wiring harness can **not** be checked by unplugging each of the aftertreatment exhaust gas temperature sensors.

The **only** method to check for a misassembled aftertreatment wiring harness is to check the wiring harness connectors for correct pin installation. See the engine wiring diagram for connector pin identification and location.

When performing a stationary (parked) regeneration, monitor the exhaust temperatures in the aftertreatment system to determine why a stationary (parked) regeneration will **not** complete.



Possible causes for stationary (parked) regenerations that will **not** complete include:

- Misassembled aftertreatment wiring harness
- Aftertreatment exhaust gas temperature sensors installed in the wrong locations
- A plugged aftertreatment DOC
- A malfunctioning turbocharger
- Exhaust leaks between the engine and the aftertreatment
- Very low ambient temperatures (less than -18°C [0°F]).

A normal stationary (parked) regeneration will follow the pattern shown.

- The dashed line is for the aftertreatment DOC inlet temperature sensor
- The dotted line is for the aftertreatment DPF inlet temperature sensor
- The solid line is for the aftertreatment DPF outlet temperature sensor.

When the stationary (parked) regeneration begins (1), all three temperatures should be approximately the same, and should increase at the same rate.

The wiring to the aftertreatment temperature sensors appears to be correct in this example, because they all read approximately the same temperature at the beginning of the stationary (parked) regeneration and increase at the same rate.

Aftertreatment injection begins when all three temperatures reach approximately 289°C [552°F] (2).

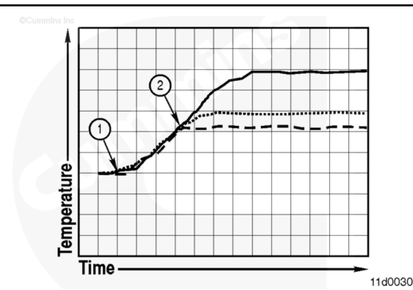
Once aftertreatment injection begins, the aftertreatment DOC inlet temperature may vary slightly, but will typically remain between 260 and 399°C [500 and 750°F].

The aftertreatment DPF inlet and outlet temperatures will increase to approximately 482 to 649°C [900 to 1200°F]. The temperatures may vary during the stationary (parked) regeneration, as the amount of fuel injected during aftertreatment injection is changed to maintain a constant temperature.

The aftertreatment DPF inlet and outlet temperatures will remain at this temperature for the duration of the stationary (parked) regeneration.

This graph illustrates a stationary (parked) regeneration where the inlet of the aftertreatment DOC is blocked.

- The dashed line is for the aftertreatment DOC inlet temperature sensor
- The dotted line is for the aftertreatment DPF inlet temperature sensor
- The solid line is for the aftertreatment DPF outlet temperature sensor.



In this condition, the engine speed will increase to the stationary (parked) regeneration speed of 1000 to 1100 rpm.

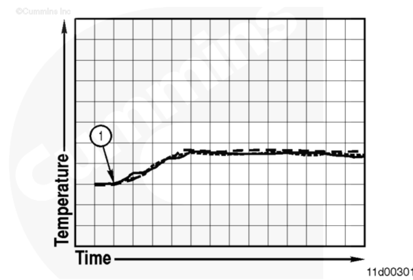
Raising the aftertreatment temperature to the aftertreatment injection temperature may take longer to complete than normal if the inlet to the aftertreatment DOC is plugged, restricting some of the exhaust flow.

Once aftertreatment injection begins (2), the aftertreatment DPF inlet and outlet temperatures will differ greatly due to the plugged aftertreatment DOC being unable to oxidize the injected fuel. The aftertreatment DPF has some capability to oxidize the injected fuel, but can **not** maintain this condition without damaging the filter material over time. It is possible that white smoke would be present from the vehicle tailpipe in this condition.

The wiring to the aftertreatment temperature sensors appears to be correct in this example, because they all read approximately the same temperature at the beginning of the stationary (parked) regeneration and they increase at the same rate.

The possible cause of this condition is a plugged aftertreatment DOC. Use the following procedure to inspect the aftertreatment DOC. Refer to Procedure 011-049 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-049-tr-isb10.html)

This graph illustrates a stationary (parked) regeneration where the engine can **not** build enough heat to start aftertreatment injection (1).



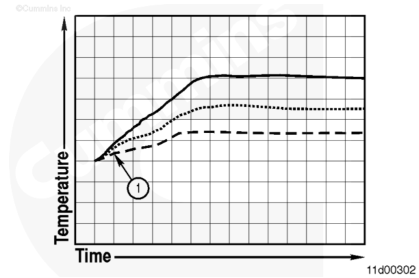
- The dashed line is for the aftertreatment DOC inlet temperature sensor
- The dotted line is for the aftertreatment DPF inlet temperature sensor
- The solid line is for the aftertreatment DPF outlet temperature sensor.

The engine speed will likely increase to the stationary (parked) regeneration speed of 1000 to 1100 rpm, but because the aftertreatment temperatures do **not** increase enough to start aftertreatment injection, the stationary (parked) regeneration will **not** complete.

The wiring to the aftertreatment temperature sensor appears to be correct in this example, because they all read approximately the same temperature for the same conditions.

Possible causes of this issue include:

- A malfunctioning turbocharger. Use the following procedure to verify the turbocharger sector gear has full travel. Refer to Procedure 010-134 in Section 10. (/qs3/pubsys2/xml/en/procedures/31/31-010-134-tr-isb10.html)
- Low ambient temperatures. Move the vehicle to a location with higher ambient temperatures.



This graph illustrates a stationary (parked) regeneration where the wiring to the aftertreatment temperature sensors is incorrect (1).

- The dashed line is for the aftertreatment DOC inlet temperature sensor
- The dotted line is for the aftertreatment DPF inlet temperature sensor
- The solid line is for the aftertreatment DPF outlet temperature sensor.

In this condition, the engine speed will increase to the stationary (parked) regeneration speed of 1000 to 1100 revolutions per minute (rpm).

Aftertreatment injection will **not** occur in this condition because the aftertreatment DOC inlet temperature does **not** reach the required temperature. Because aftertreatment injection is **not** occurring, the aftertreatment temperatures should **not** read differently.

The possible cause of this condition is an incorrectly assembled aftertreatment wiring harness. See the aftertreatment exhaust gas temperature sensor wiring information in this procedure.

A regeneration that will **not** complete can be caused by malfunctions in the exhaust gas recirculation (EGR), variable geometry turbocharger (VGT) systems, or fueling. These malfunctions do **not** allow the aftertreatment to reach the necessary temperatures for aftertreatment fuel injection. When performing a stationary (parked) regeneration, monitor the following parameters to determine why a stationary (parked) regeneration will **not** complete:

- EGR Differential Pressure
- EGR Valve Position Measured (Percent Open)
- Exhaust Gas Pressure
- Intake Manifold Pressure
- Percent Load
- Turbocharger Actuator Position Measured (Percent Closed)
- Turbocharger Speed.

During a stationary (parked) regeneration, these are the typical values for a healthy system.

- EGR Differential Pressure - Less than 12.7 mm-Hg [0.5 in-Hg]
- EGR Valve Position Measured (Percent Open) - Zero percent
- Exhaust Gas Pressure - 304 to 3400 mm-Hg [89 to 135 in-Hg]
- Intake Manifold Pressure - 15.0-127 mm-Hg [0.6 to 5.0 in-Hg]

- Percent Load - Less than twelve percent
- Turbocharger Actuator Position Measured (Percent Closed) - 90 to 100 percent
- Turbocharger Speed - 18k to 28k rpm.

During a stationary (parked) regeneration, the EGR valve should be closed to help increase the load on the engine.

A leaking EGR valve can be detected by monitoring the EGR differential pressure while the EGR valve is closed.

If the EGR differential pressure exceeds 12.7 mm-Hg [0.5 in-Hg] while the EGR Valve Position Measure (Percent Open) is zero percent during the stationary (parked) regeneration, a leaking EGR valve has been detected.

Clean and inspect the EGR valve for reuse. Refer to Procedure 011-022 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-022-tr-isb10.html)

During a stationary (parked) regeneration, the turbocharger also closes down to help increase the load on the engine.

If the Turbocharger Actuator Position Measured (Percent Closed) is **not** within 90 to 100 percent, or, the exhaust gas pressure is **not** within 304 to 3400 mm-Hg [89 to 135 in-Hg], a malfunction of the VGT is the likely cause of the stationary (parked) regeneration that will **not** complete.

Check the VGT sector gear travel. Refer to Procedure 010-134 in Section 10. (/qs3/pubsys2/xml/en/procedures/31/31-010-134-tr-isb10.html)

Check the variable geometry turbocharger shroud plate and nozzle ring for damage or wear. Refer to Procedure 010-033 (/qs3/pubsys2/xml/en/procedures/31/31-010-033-tr-isb10.html) in Section 10.

304 to 3400 mm-Hg

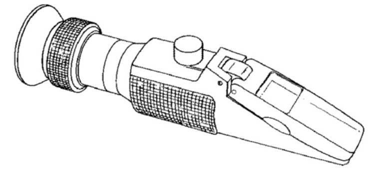
During a stationary (parked) regeneration, the percent load on the engine will fluctuate until the engine and aftertreatment reach a steady condition. Once the engine stabilizes, the percent load should remain less than 12 percent. The percent load should **not** consistently exceed 12 percent during the stationary (parked) regeneration.

Note : The percent load may fluctuate when the engine fan cycles ON and OFF.

Test

⚠ CAUTION ⚠

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use a DEF that does not meet the specifications provided or to operate the vehicle/equipment without DEF.



⚠ CAUTION ⚠

Never add water or any other fluid besides what is specified to the DEF tank. The aftertreatment system may be damaged.

⚠ CAUTION ⚠

Having the correct concentration of DEF is critical to the engine and aftertreatment system performing correctly.

⚠ CAUTION ⚠

Cummins Inc. is not responsible for malfunctions or damage resulting from what Cummins Inc. determines to be abuse or neglect, including, but not limited to: operation without correctly specified diesel exhaust fluid, lack of maintenance of the aftertreatment system, improper storage or shutdown practices, or unauthorized modifications of the engine and aftertreatment system. Cummins Inc. is also not responsible for malfunctions caused by incorrect diesel exhaust fluid, water, dirt, or other contaminants in the diesel exhaust fluid. Follow the instructions provided with the service tool.

To test the concentration of the DEF, use the Cummins® DEF refractometer, service tool, Part Number 4919554, or equivalent. Follow the instructions provided with the service tool.

Note : The concentration of the DEF must be 32.5 ± 0.7 percent by weight, however when using the Cummins® DEF refractometer service tool, the acceptable DEF measurement specification is 32.5 ± 1.5 percent. This specification takes into consideration the refractometer tool tolerances, variability, and calibration when measuring DEF concentration.

If the DEF concentration is found to be outside of this specification, drain the DEF tank, flush with distilled water, and fill with new and/or known good DEF. Check the DEF concentration.

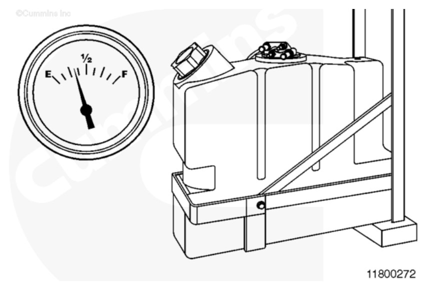
Concentration of the DEF **must** be checked when:

- The vehicle has been stored for an extended period of time
- It is suspected that water has been added to the DEF tank.

Contamination/Incorrect Fluid

DEF can become contaminated by the following situations:

- If equipped, the aftertreatment DEF tank coolant heating system malfunctions, allowing coolant to mix with the DEF.
- The aftertreatment DEF tank cap is missing/damaged, or the tank vent malfunctions.
- Filling the aftertreatment DEF tank with the incorrect fluid.

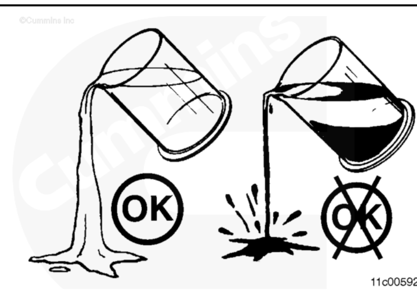


In the event that the DEF becomes contaminated, inspect the DEF to determine the most likely source.

Obtain a sample from the DEF tank and pour the sample into an appropriate container. Make sure to get a sample from the highest fluid level.

Inspect for petroleum base liquids, such as, but not limited to:

- Diesel fuel
- Hydraulic fluid
- Brake fluid.

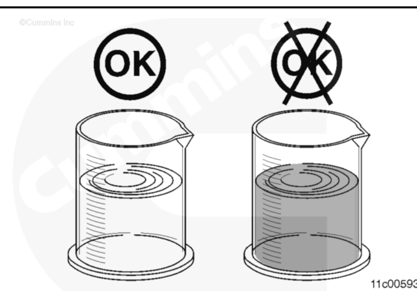


DEF is comprised largely of water. Petroleum based liquids will separate from the DEF and rise to the top. Check for separation of the fluids, as well as their characteristics.

If contaminated, reference the steps detailed later in this procedure.

Inspect for non-petroleum base liquids, such as, but not limited to:

- Water
- Coolant
- Windshield washer fluid.

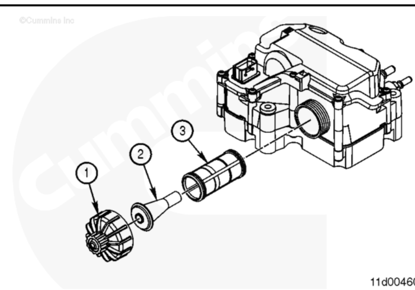


If water has been added, the DEF will remain clear. As a result, the DEF will become diluted, reducing the concentration level.

Note : If only water has been added to the DEF tank, drain the DEF tank, flush with distilled water, and fill the tank with new and/or known good DEF. Check the DEF concentration after completing the refill. Reference the Test Section of this procedure.

For other non-petroleum based liquids that may have been added to the DEF, typically those fluids have coloring and will mix with DEF. If the DEF has a color tint to it, look for other fluids used on the vehicle that may match, such as coolant or windshield washer fluid.

If contaminated, reference the steps detailed later in this procedure.



Note : Make sure to view and troubleshoot any fault codes that occur during the following steps with INSITE™ electronic service tool. Reference the Fault Code Troubleshooting Manual, ISB6.7 CM 2250, ISC8.3 and ISL9 CM 2250, and IS15 CM 2250, Bulletin 4022225 (/qs3/pubsys2/xml/en/bulletin/4022225.html).

If the DEF has been contaminated, remove the aftertreatment DEF dosing unit filter. Refer to Procedure 011-060 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-060-tr-isb10.html)

Inspect the filter for signs that the contaminated fluid went through the dosing system.

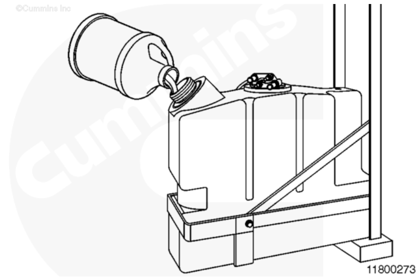
If the contaminated fluid did **not** go through the dosing system, drain the DEF tank, flush with distilled water, and replace the DEF in-tank filter. See equipment manufacturer service information for specific information on servicing the DEF tank.

After the DEF tank has been cleaned, fill the tank with new and/or known good DEF. Check the DEF concentration after completing the refill. Reference the Test section of this procedure.

Note : Any discarded contaminated fluids and/or parts must be disposed of according to local area ordinances.

If the contaminated fluid did go through the dosing system:

1. Drain the DEF tank. Flush with several fills of water until it is clean and clear of contamination. Replace the DEF in-tank filter. See the original equipment manufacturer service information for specific information on servicing the DEF tank.
2. Clean and rinse the aftertreatment DEF dosing unit filter with distilled water. Refer to Procedure 011-060 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-060-tr-isb10.html)
3. Fill the aftertreatment DEF tank with distilled water.
4. Perform INSITE™ electronic service tool DEF Dosing Unit Override Test. Repeat the test until the distilled water runs clear. Use the Cummins® DEF refractometer, Part Number 4919554, to check the concentration of the distilled water after being sprayed out of the dosing system. If the system is free of contaminants, distilled water will register zero percent concentration. Refer to Procedure 011-063 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-063.html)
5. Drain the distilled water from the DEF tank and fill with new and/or known good DEF. Check the DEF concentration after completing the refill, reference the Test section of this procedure.
6. Replace the aftertreatment DEF dosing unit filter. Refer to Procedure 011-060 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-060-tr-isb10.html)
7. Use the following procedure to test the performance and spray pattern of the aftertreatment DEF dosing valve. Perform INSITE™ electronic service tool DEF Dosing Unit Override Test. Residual water in the dosing system can possibly lower the DEF concentration being sprayed. Continue to run the DEF Dosing Unit Override Test until DEF is sprayed out of the dosing system. Use the Cummins® DEF refractometer, Part Number 4919554, to check for proper concentration of the DEF. Refer to Procedure 011-063 in Section 11. (/qs3/pubsys2/xml/en/procedures/31/31-011-063.html)
8. Perform a stationary (parked) regeneration. Refer to Procedure 014-013 in Section 14. (/qs3/pubsys2/xml/en/procedures/31/31-014-013-tr-isb10.html)



9. Road test the vehicle for 30 minutes to verify system operation.

Last Modified: 09-Nov-2020