14.9 EXCESSIVE EXHAUST SMOKE (BLACK OR GRAY)

There are several causes for excessive black or gray exhaust smoke. These probable causes are:

- ☐ Restricted Air Cleaner Element
- ☐ Restricted or Cracked Charge Air Cooler
- ☐ Faulty Exhaust System
- ☐ Faulty Fuel Injector
- ☐ Defective Turbocharger
- ☐ Improper Grade of Fuel

14.9.1 Troubleshooting Procedure for Restricted Air Cleaner Element

To determine if a restrictive air cleaner element is causing excessive black or gray smoke, perform the following:

1. Remove the air filter element from the air cleaner container; refer to OEM guidelines.
2. Visually inspect the air cleaner element for damage or clogging.
   [a] If no damage or clogging is found, check the charge air cooler; refer to section 14.9.3.
   [b] If damage or clogging is found, refer to section 14.9.2.

14.9.2 Air Filter Element Replacement

Perform the following to replace the air filter element:

1. Remove and replace the damaged or clogged air filter element; refer to OEM guidelines.
2. Verify air filter element replacement; refer to section 14.9.2.1.

14.9.2.1 Test the Engine with Replaced Air Filter Element

Perform the following to determine if the new filter element resolved excessive exhaust smoke:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

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

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

1. Start and run the engine.
2. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range, approximately 88-96°C (190-205°F).
3. Visually inspect exhaust for excessive smoke.
   [a] If the engine exhaust emission appears normal, no further troubleshooting is required. Shut down the engine.
   [b] If the engine exhaust emission is excessively black or gray, shut down the engine. Check the charge air cooler; refer to section 14.9.3.

14.9.3 Troubleshooting Procedure for a Restricted or Cracked Charge Air Cooler

To determine if a charge air cooler is causing excessive exhaust smoke, perform the following:

NOTICE:

To avoid engine damage, follow the installation instructions provided with the air-to-air charge air cooler test kit.

1. Attach a WK93 air-to-air charge air cooler test kit; refer to OEM guidelines.
2. Disconnect the air inlet hose from the outlet side of the turbocharger compressor housing; refer to section 7.4.1.
3. Attach the air-to-air cooler test kit adaptor plug to fit into the hose at the compressor connector.

4. Attach an air pressure hose to the air chuck at the regulator and gradually pressurize the air inlet system to a pressure of 177 kPa (26 lb·in.^{2}).
5. Apply a water and soap solution to each hose connection, across the face of the charge air cooler.
6. Apply a water and soap solution to the air intake manifold and cylinder head mating surface area.
7. Visually inspect all joints for air leaks and all charge air cooler welded surfaces for stress leaks.
   [a] If air leaks are present around the joints, replace the charge air cooler; refer to section 14.9.4.
   [b] If any leaks are present around the air intake manifold and gaskets, repair the air intake manifold and/or replace gaskets; refer to section 14.9.5.
   [c] If no leaks are present, check for faulty exhaust system; refer to section 14.9.6.

14.9.4 Charge Air Cooler Replacement

Perform the following steps to replace the charge air cooler:

1. Replace the charge air cooler; refer to OEM guidelines.
2. Verify replacement of the charge air cooler; refer to section 14.9.5.1.

14.9.5 Air Intake Manifold Repair

Perform the following steps to repair the air intake manifold:

1. Remove the air intake manifold; refer to section 7.2.1.
2. Inspect the air intake manifold and gaskets.
3. Install the air intake manifold with new gaskets; refer to section 7.2.2.
4. Verify repair of the air intake manifold; refer to section 14.9.5.1.

14.9.5.1 Test the Engine with a Replaced Charge Air Cooler and Air Intake Manifold

To determine if the replaced charge air cooler and air intake manifold resolved the excessive exhaust smoke condition, perform the following:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

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

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

1. Start and run the engine.
2. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range, approximately 88-96°C (190-205°F).
3. Visually inspect exhaust for excessive black or gray smoke.
   [a] If the engine exhaust emission appears normal, no further troubleshooting is required. Shut down the engine.
   [b] If the engine exhaust emission is excessively black or gray, shut down the engine. Check the faulty exhaust system; refer to section 14.9.6.

14.9.6 Troubleshooting Procedure for a Faulty Exhaust System

To determine if a faulty exhaust system is causing excessive black or gray exhaust smoke, perform the following:

1. Drill an 11/32 in. hole in the exhaust pipe, 125 - 305 mm (5 - 12 in.) from the turbocharger exhaust outlet.

NOTE:
The tapped hole must be in a comparatively straight section of the turbocharger exhaust outlet.

2. Tap the hole to accommodate a 1/8 in. pipe plug.
3. Connect a manometer to the tapped hole.

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

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

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

4. Start and run the engine.
5. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range, approximately 88-96°C (190-205°F).
6. Run the engine speed to full load.
   [a] If the exhaust back pressure at full load is less than 12 kPa (3.5 in. Hg), check the fuel injectors and nozzles; refer to section 14.9.8. Shut down the engine.
   [b] If the exhaust back pressure at full load is 12 kPa (3.5 in. Hg) or greater, refer to section 14.9.7. Shut down the engine.

14.9.7 Engine Exhaust System Resolution

Perform the following steps to resolve the engine exhaust system concern:

1. Visually inspect the engine exhaust system: refer to OEM guidelines.
2. Repair and replace defective exhaust system components; refer to OEM guidelines.
3. Verify exhaust system resolution: refer to section 14.9.7.1.

14.9.7.1 Test the Engine with Replaced Exhaust System

Perform the following steps to determine if replaced engine exhaust system components have resolved the excessive black or gray exhaust smoke condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

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

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

1. Start and run the engine.
2. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range, approximately 88-96°C (190-205°F).
3. Visually inspect exhaust for excessive smoke.
   [a] If the engine exhaust emission appears normal, no further troubleshooting is required. Shut down the engine.
   [b] If the engine exhaust emission is excessively black or gray, shut down the engine. Check the fuel injector nozzles; refer to section 14.9.8.

14.9.8 Troubleshooting Procedure for a Faulty Fuel Nozzle

This Troubleshooting Guide section is under development. Refer to section 14.3 on Fuel Injection Troubleshooting.

14.9.9 Troubleshooting Procedure for a Defective Turbocharger

To determine if a defective turbocharge is causing excessive exhaust smoke, perform the following:

1. Remove the turbocharger oil drain outlet line connected to the crankcase and place the drain line into a suitable container; refer to section 7.4.2.
2. Perform a crankcase pressure test.
   [a] If the engine crankcase pressure is greater than 1.50 kPa (6 in. H_20), replace the turbocharger; refer to section 14.9.10.

[b] If the engine crankcase pressure is less than 1.50 kPa (6 in. H_20), call the Detroit Diesel Technical Service Group.

14.9.10 Turbocharger Replacement

Perform the following steps to replace a defective turbocharger:

1. Remove the defective turbocharger from the engine; refer to section 7.4.2.
2. Tag the removed turbocharger for remanufacture.
3. Install a new turbocharger on the engine; refer to section 7.4.3.
4. Verify replacement of the new turbocharger; refer to section 14.9.10.1.

14.9.10.1 Test Engine with a Replaced Turbocharger

Perform the following steps to determine if a replaced turbocharger has resolved the excessive exhaust smoke condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

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

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

1. Start the engine.
2. Run the engine speed to full load.
3. Visually inspect the exhaust for excessive black or gray smoke.
   [a] If the engine exhaust emission appears normal, no further troubleshooting is required. Shut down the engine.
   [b] If the engine exhaust emission is excessive, shut down the engine. Call Detroit Diesel Technical Service Group.

14.9.11 Troubleshooting Procedure for Improper Grade of Fuel

To determine if an improper grade of fuel is causing excessive black or gray smoke, perform the following:

1. Acquire a fuel sample from the vehicle fuel tank(s).
2. Submit fuel sample for an ASTM test analysis.
   [a] If the fuel meets specifications, check for a restrictive air cleaner; refer to OEM guidelines; refer to section 14.9.1.
   [b] If the fuel did not meet specifications, resolve improper grade of fuel; refer to section 14.9.12 and Publication 7SE270 (Lubricating Oil, Fuel, and Filters)

14.9.12 Improper Grade of Fuel Resolution

Perform the following steps to resolve the improper grade of fuel:

1. Drain the fuel tanks, refer to OEM guidelines, and dispose of properly.
2. Refill the fuel tanks with new fuel having a cetane number greater than 40.
3. Verify fuel resolution; refer to section 14.9.12.1.

14.9.12.1 Test the Engine with New Fuel

Perform the following steps to determine if the fuel refill resolved the excessive exhaust smoke condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

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

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

1. Start and run the engine.
2. Run the engine at idle under no-load conditions for approximately five minutes, allowing the engine coolant to reach normal operating range, approximately 88-96°C (190-205°F).
3. Visually inspect exhaust for excessive smoke.

   [a] If the engine smoke emission appears normal, no further troubleshooting is required. Shut down the engine.

   [b] If the engine exhaust smoke is excessively black or gray, shut down the engine. Check the air filter; refer to section 14.9.1.

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