

# SECTION 04: EXHAUST SYSTEM

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## Section 04: EXHAUST SYSTEM

### 1. EXHAUST AFTERTREATMENT SYSTEM OVERVIEW

The technology behind clean emissions is through the immediate aftertreatment of engine exhaust. The process for reducing NO<sub>x</sub> via aftertreatment is called Selective Catalytic Reduction (SCR). It requires a catalytic converter into which is injected Diesel Exhaust Fluid (DEF). The primary component of DEF is water; the active component is urea. Urea is a nitrogen compound that turns to ammonia when heated. When a urea-and-water solution is injected into the exhaust stream and passed over a catalyst, the urea reacts with the NO<sub>x</sub> to form nitrogen and water vapor – two clean and harmless components of the air we breathe. The aftertreatment system primary function is to capture and oxidize (regenerate) the particulate matter (soot) in the engine exhaust gases and to reduce NO<sub>x</sub>. To achieve this goal, the exhaust aftertreatment system is split into two main sections: the exhaust gases first enter the **Diesel Oxidation Catalyst (DOC)** and **Diesel Particulate Filter (DPF)** assembly to capture and regenerate the soot on a regular or passive basis, then the exhaust gases flow through the **catalytic converter** to reduce NO<sub>x</sub> to minimum level. Through constant monitoring of the exhaust gas temperature and the system back pressure, EMS is able to manage regeneration.

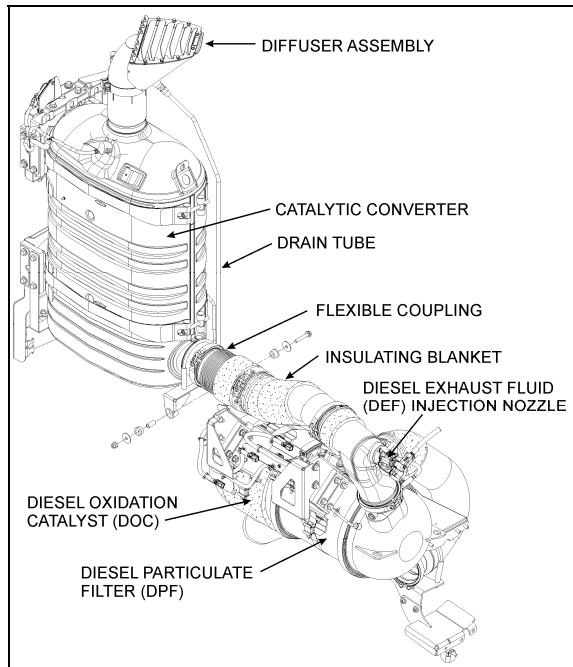


FIGURE 1: EXHAUST SYSTEM

The exhaust aftertreatment system is rubber mounted to the vehicle structure. This feature reduces the transmission of vibrations to the exhaust aftertreatment system thus resulting in extended life of the system, brackets and also noise reduction.

#### 1.1 MAINTENANCE


Inspect the exhaust system periodically for restrictions and leaks. Figure 1 presents the major components of the exhaust system. Exhaust leaks are commonly the result of loose clamp bolts, corroded or punctured pipes. In addition to excessive noise, a leaking exhaust system could allow toxic gases to enter the vehicle. Damage to surrounding components from hot gases could result as well. Replace damaged or corroded exhaust components immediately.

Inspect the exhaust system as follows:

- At vehicle inspection intervals ;
- Whenever a change is noticed in the sound of the exhaust system ;
- When components close to the exhaust system get unnaturally dirty ; and
- Whenever the exhaust system is damaged.

Replace damaged or corroded exhaust system components without delay.

When operating the engine in a service garage or in a closed area, the exhaust must be vented to the outside. Place the shop vent hose over the exhaust outlet pipe.

 **DANGER**

Avoid breathing exhaust gases since they contain carbon monoxide which is odorless and colorless but harmful. Carbon monoxide is a dangerous gas that can cause unconsciousness and can be lethal. If, at any time you suspect that exhaust fumes are entering the vehicle, locate and correct the cause(s) as soon as possible.

#### **NOTE**

*The key to successful regeneration is high exhaust temperature for an extended period of time. For this reason, insulating blankets must remain permanently on the exhaust system.*

*If insulating blankets are removed from the system, the exhaust gases temperature may not be high enough to permit efficient particulate oxidation during passive regeneration, resulting in increased fuel consumption due to overuse of active or stationary regeneration.*

1.2 FLEXIBLE COUPLING INSTALLATION

The flexible coupling contains a rigid interior pipe (Fig. 2). To allow appropriate flexibility once installed, be sure interior pipe is concentric to flexible part and that the flexible coupling is straight when installed. This piece of equipment handles vibration and thermal expansion.

**CAUTION**

Adequately support the exhaust system line. The load of the exhaust line **must not** be transferred to the turbocharger.

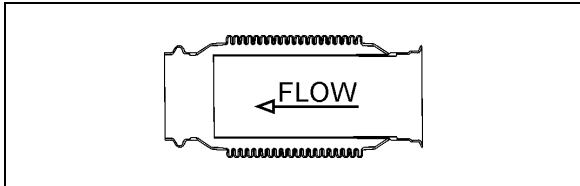


FIGURE 2: FLEXIBLE COUPLING 04022

2. DIESEL PARTICULATE FILTER (DPF)

Besides trapping soot, the **DPF (Diesel Particulate Filter)** also traps the ash that has been generated when additives in engine oil are burned. However, unlike soot, ash cannot be oxidized. The ash that accumulates in the filter will eventually cause an increase in exhaust back pressure. EMS will constantly monitor the ash accumulation and forecast the approximate time until DPF ash cleaning is required. This allows you the opportunity to plan for the DPF ash cleaning interval. If ash cleaning is not performed proactively, and the back pressure increases beyond the system limit, EMS will flag the amber warning light on the telltale panel, notifying the operator that an ash cleaning is required. Clean remanufactured DPF cartridge will be available through Prevoist on an exchange basis. For most vehicle applications and duty cycle, this will occur after approximately 200,000-400,000 miles (320,000-640,000 km) of operation.

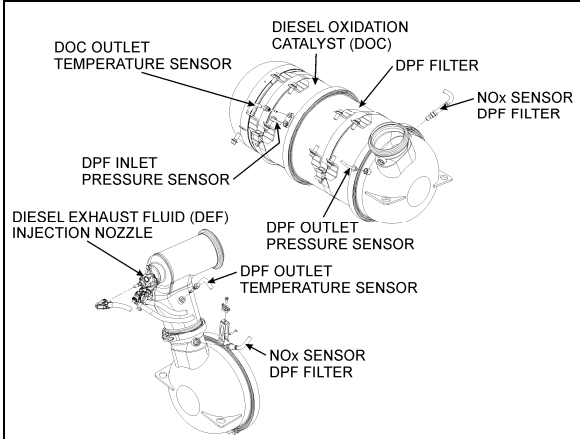


FIGURE 3: DIESEL OXIDATION CATALYST (DOC) & DIESEL PARTICULATE FILTER (DPF) ASSEMBLY 04016

**WARNING**

**HOT SURFACES**

Keep yourself clear of hot Aftertreatment System surfaces, particularly during and after active or stationary regeneration. Hot surfaces can cause serious burns.

Make sure Aftertreatment System components are cold before handling.

**WARNING**

**HOT EXHAUST**

During stationary regeneration, exhaust gases temperature may get very hot at the diffuser outlet. Do not direct diffuser at combustible materials. Before initiating stationary regeneration, make sure that the diffuser outlet is clear of objects and that no one is working near the diffuser outlet. Stationary regenerations must be undertaken outdoors only.

**Never** initiate regeneration when exhaust gas collection system is in place.

**WARNING**

**TOXICITY**

Do not initiate a stationary regeneration in a closed area like a garage. **Stationary regeneration must be undertaken outdoors only.**

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### 2.1 DIESEL PARTICULATE FILTER (DPF) REMOVAL

To remove the DPF, proceed as follows:



#### CAUTION

External and internal temperatures remain hot long after engine has been shutdown. Allow the Exhaust Aftertreatment System to cool before handling. Wear protective clothing and glove while servicing.

1. First, open the engine compartment doors;
2. Put insulating blanket aside;
3. Disconnect pressure and temperature sensors;
4. Support Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) assembly;



#### CAUTION

##### HEAVY DEVICE

A suitable lifting or holding device is required. Properly support and attach lifting equipment to prevent the DOC and DPF assembly from falling when servicing.

5. Unfasten clamps holding DOC and DPF assembly;
6. Carefully lower DOC and DPF assembly;
7. To make sure components are reinstalled in the same position, mark position of DOC, DPF and clamps in relation with one another before taking apart;



#### CAUTION

##### FRAGILE - HANDLE WITH CARE

Use extreme care when handling DPF cartridge as it could be damaged or destroyed by dropping or sudden impact.

Clean remanufactured DPF cartridge will be available on an exchange basis. For this reason, it is very important to maintain the cartridge in perfect condition. Damaged cartridge may not be refunded.

8. Also replace clamps and gaskets when replacing DPF;

#### NOTE

When replacing the DPF cartridge, refer to the specifications on the DPF attached tag for proper replacement DPF selection.

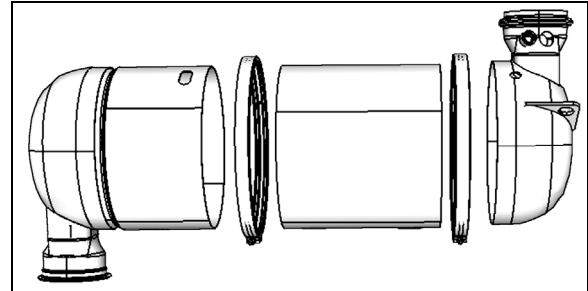


FIGURE 4: TAKING DOC AND DPF APART

9. Always put DOC and DPF back together again in a vertical position to facilitate gaskets positioning;
10. Torque clamps to 160 Lb-in (18 Nm) by hand;



#### CAUTION

Always torque clamps by hand.

11. With a rubber mallet, hit clamps forcefully around circumference to make sure gasket is fully seated;
12. Support Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) assembly during reinstallation;
13. Reconnect pressure and temperature sensors;
14. Fasten clamps holding DOC and DPF assembly;
15. Put insulating blanket back.

### 3. CATALYTIC CONVERTER

In the first instance, the catalytic converter of the Selective Catalytic Reduction (SCR) does not need any maintenance. Unless an accident or damage occurs in the vicinity of the engine compartment; the catalytic converter will not have to be replaced.


However if the catalytic converter must be replaced, use one of the two following procedures:

**3.1 REMOVAL**

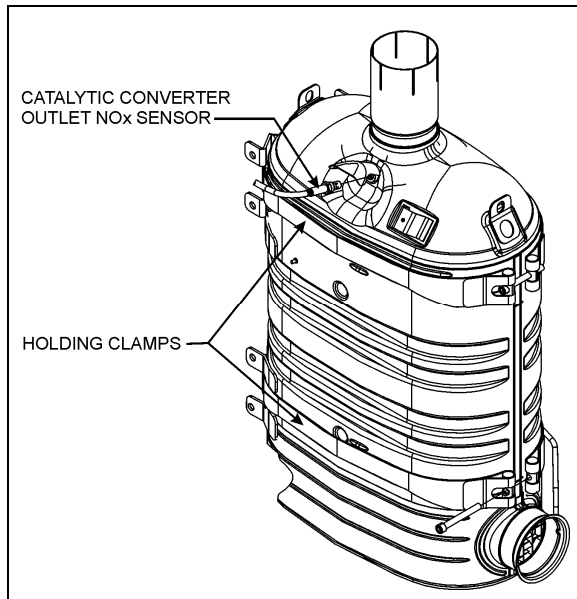
**Procedure # 1**

Radiator must be removed in order to lower the catalytic converter for replacement.

- Set the starter selector switch to the *OFF* position.
- Shut off the heater line shut-off valves.
- Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".

	<p><b>CAUTION</b></p>
<p>Tag hoses and cables for identification before disconnecting in order to facilitate re-installation. Plug all openings to prevent dirt from entering the system.</p>	


- Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.



**FIGURE 5: CATALYTIC CONVERTER**

- Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
- Disconnect the electric fan-clutch connector located near the cooling fan right angle gearbox.


- Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.
- Open radiator door. Unfasten bolts and screws fixing radiator sealing frame.
- Remove radiator and air cooler assembly.

	<p><b>WARNING</b></p>
<p>Due to the heavy load of the radiator assembly, it must be adequately supported before attempting to remove it.</p>	

- Safely support catalytic converter from the top.
- Disconnect catalytic converter outlet NOx sensor.
- Remove clamps holding catalytic converter then lower.
- Remove or disconnect any piece of equipment or component that might be in the way or that might prevent removing the catalytic converter.

**Procedure # 2**

- Set the starter selector switch to the *OFF* position.
- Shut off the heater line shut-off valves.
- Remove DOC and DPF assembly (Refer to paragraph 2.1 in this Section).
- Remove pipe connecting DOC & DPF assembly to catalytic converter.
- Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".

	<p><b>CAUTION</b></p>
<p>Tag hoses and cables for identification before disconnecting in order to facilitate re-installation. Plug all openings to prevent dirt from entering the system.</p>	

- Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.

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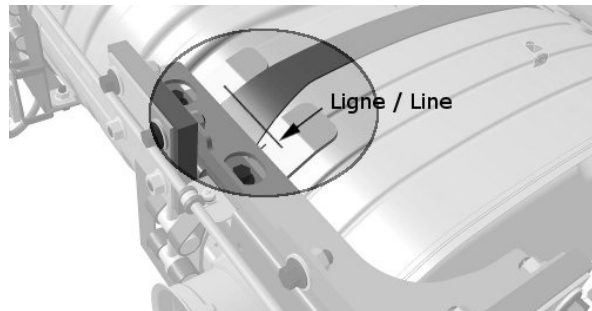
- Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
- Disconnect and remove a section of air intake duct mounted between the air cooler outlet and the engine.
- Remove coolant surge tank.
- Release tension from drive belt (Refer to paragraph 12.1 and 15.1 in Section 05: Cooling System).
- Cut cable ties and disconnect electrical connector from fan clutch. Remove fan drive shaft fasteners at the gear box.
- Remove radiator fan drive mechanism support.
- Safely support catalytic converter from the top.
- Disconnect catalytic converter outlet NOx sensor.
- Remove clamps holding catalytic converter then lower.
- Remove or disconnect any piece of equipment or component that might be in the way or that might prevent removing the catalytic converter.

### 3.2 ASSEMBLING CATALYTIC CONVERTER

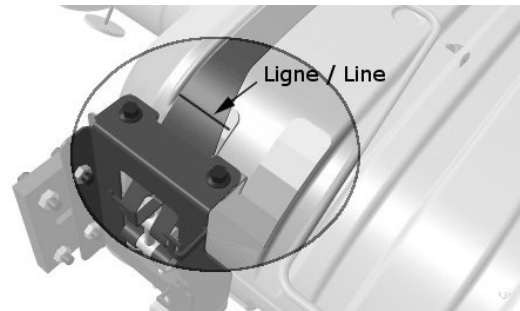
#### Before removing

- Mark, with a vertical line the angular position of the lower (both sides) and upper clamps with regard to the clamps support located on the catalytic converter.

Lower

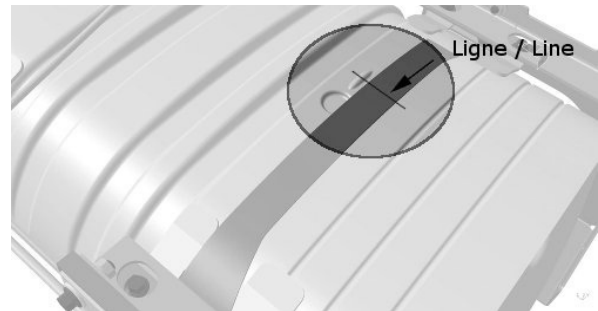


Upper

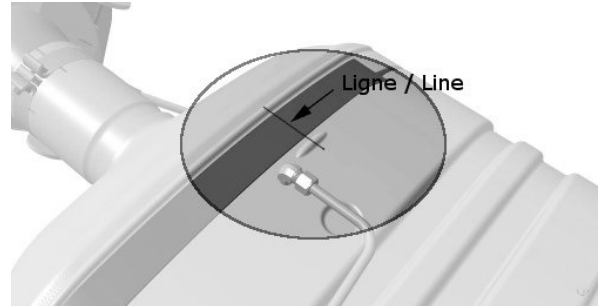


- Mark, with a vertical line the central position of the lower and upper clamps with regard to the emboss located at the bottom and at the top of the catalytic converter.

Lower



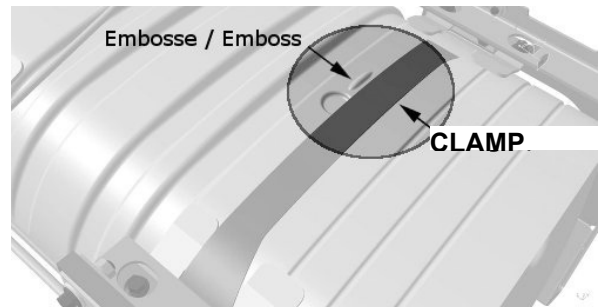
Upper



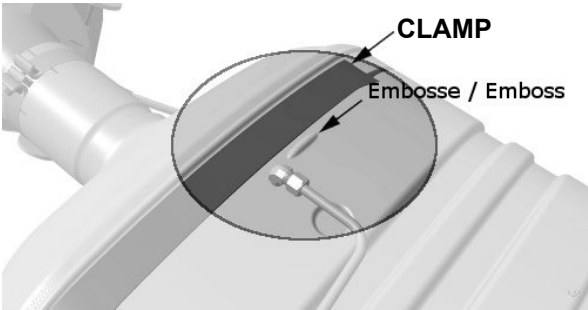
#### Assembling

- Position the upper clamps above the upper emboss and the lower clamps below the lower emboss of the catalytic converter.

Lower

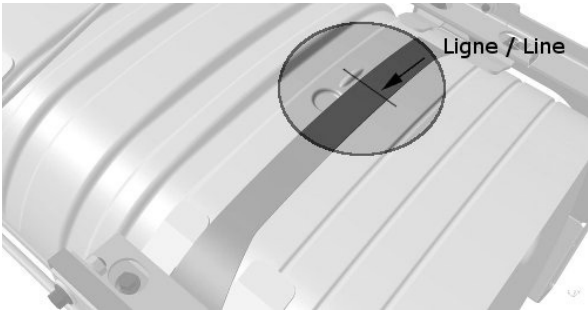


Upper

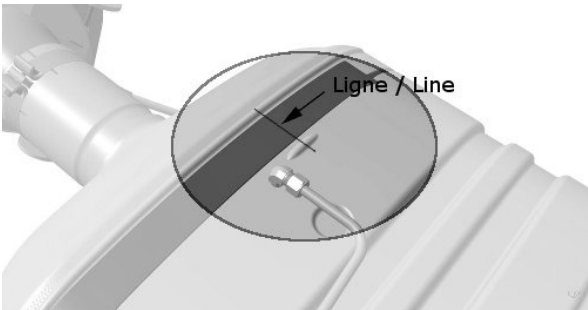


- Using the lines made earlier, line up the lower and upper clamps with regard to the emboss of the converter and afterward, line up the lines made earlier on the clamps with regard to the clamp supports on the catalytic converter.

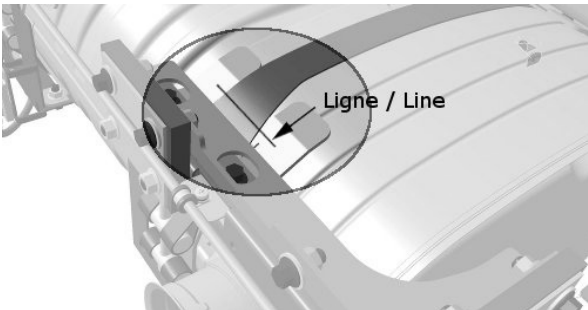
Lower



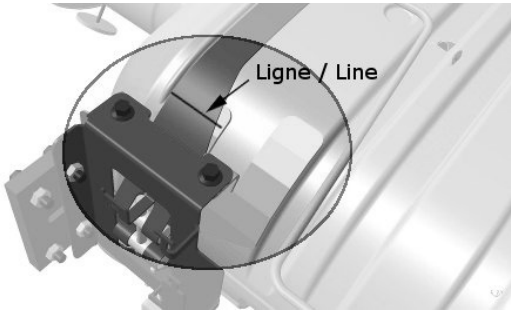
Upper



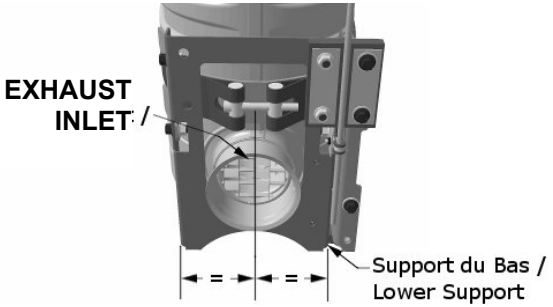
Lower



Upper



- Before tightening the parts, make sure that the catalytic converter lower support is well centered with the exhaust inlet of the catalytic converter.



- While tightening the bolts, keep in mind to respect the alignment of the parts and keep the lower support as centered as possible with the catalytic converter exhaust inlet.

4. DIFFUSER ASSEMBLY

During stationary regeneration, exhaust gases temperature may get very hot at the DPF outlet. The diffuser decreases the exhaust gasses temperature by about half approximately, at 6 inches above the diffuser. The diffuser is an important component of the exhaust system and must remain on the vehicle at all times. Operating the vehicle without the diffuser may seriously damage the vehicle.

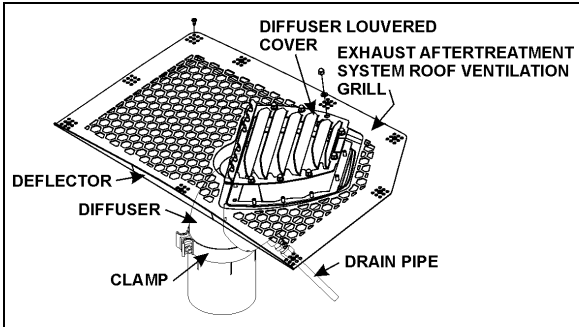


FIGURE 6: DIFFUSER ASSEMBLY

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### 4.1 DIFFUSER ADJUSTMENT

Should an adjustment of the diffuser position be necessary, first remove the exhaust aftertreatment roof ventilation grill.



#### CAUTION

To prevent paint damage and fiberglass overheating caused by hot exhaust gases, the diffuser louvered cover must be flush with the roof surface or may not exceed the roof surface more than ¼ inch (6mm).



#### CAUTION

Tighten clamps properly in order to prevent any movement of the diffuser assembly. An impact wrench is necessary.

1. Loosen the clamp securing the diffuser assembly to the catalytic converter.

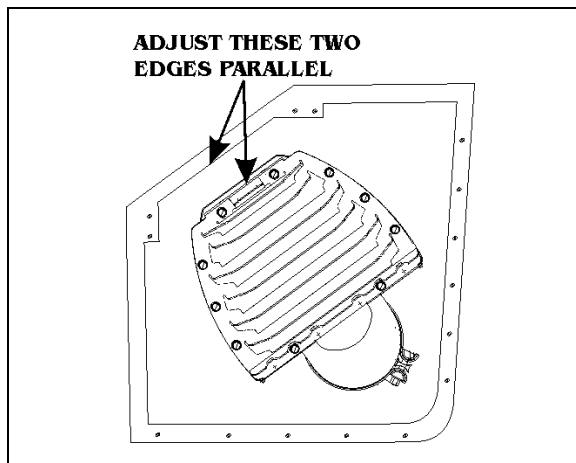


FIGURE 7: DIFFUSER POSITION ADJUSTMENT 04015\_1

2. For proper angular position, make sure that the two edges shown on figure 7 are parallel with each other.
3. Using a straightedge, adjust the diffuser assembly level. The top surface of the warning plate fixed on the diffuser louvered cover must be flush with the roof surface (fig.8). It may exceed about 1/4in (6mm). Place the straightedge as shown on figure 8.
4. Tighten the clamp securing the diffuser assembly to the catalytic converter.

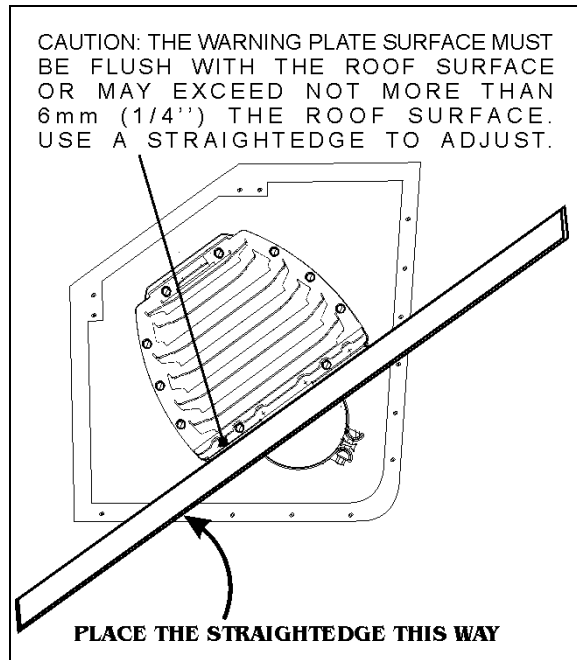


FIGURE 8: DIFFUSER POSITION ADJUSTMENT 04015\_2

5. Reinstall the exhaust aftertreatment system roof ventilation grill and deflector. Put a small quantity of Sika 221 on screws (fig.9).

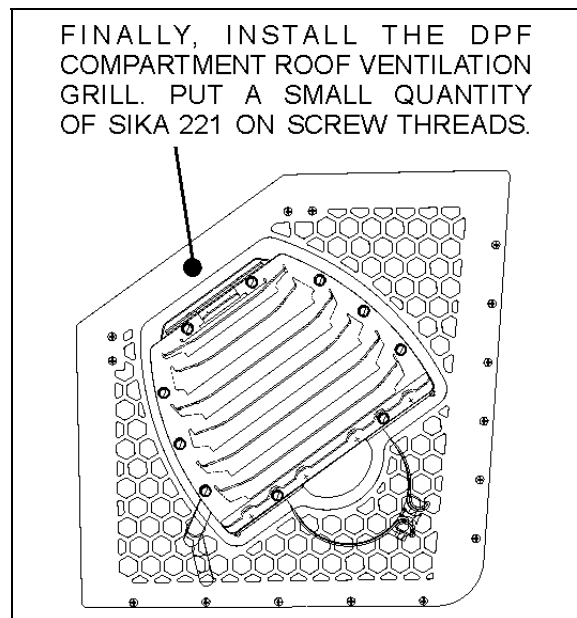


FIGURE 9: DIFFUSER POSITION ADJUSTMENT 04015\_3

### 4.2 MAINTENANCE

At vehicle inspection intervals, inspect the diffuser assembly as follows:

- Inspect diffuser grille for stress cracking;



- Check for presence of foreign matter and debris inside the diffuser housing, remove and clean if applicable;
- Check for proper functioning of the rain cap inside the diffuser housing, make sure that it moves freely;
- Make sure that the water drain tube is not clogged. Pour a cup of water into the diffuser housing and assure that all the water is drained at once at the other end of the drain tube. If tube is clogged, remove tube and blow compressed air inside, in reverse flow;
- Check that the warning plate "THIS DIFFUSER SURFACE MUST BE FLUSH WITH THE ROOF SURFACE" is still in place.

4.3 EXHAUST GAS COLLECTION ADAPTER

A diffuser adapter (Prevost #040710) is available through Prevost Parts to permit connection with current exhaust gas collecting system.

**CAUTION**

To prevent paint damage and fiberglass overheating caused by hot exhaust gas leaks or back drafts that other collection device may produce, always use Prevost adapter #040710.

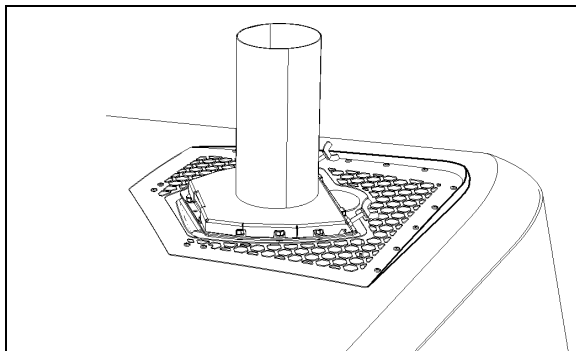


FIGURE 10: EXHAUST GAS COLLECTION ADAPTER<sup>04020</sup>

**5. DIESEL EXHAUST FLUID (DEF) TANK AND INJECTION SYSTEM**

The DEF tank and injection system control unit continuously vary the amount of DEF injected in response to the engine's current load conditions.

Diesel Exhaust Fluid (DEF) is stored in a 60 liters plastic tank located aft of the condenser compartment.

**MAINTENANCE**

Drain and clean DEF tank, also clean DEF tank filler neck filter every 175,000 miles (280 000 km) or once a year, whichever comes first.

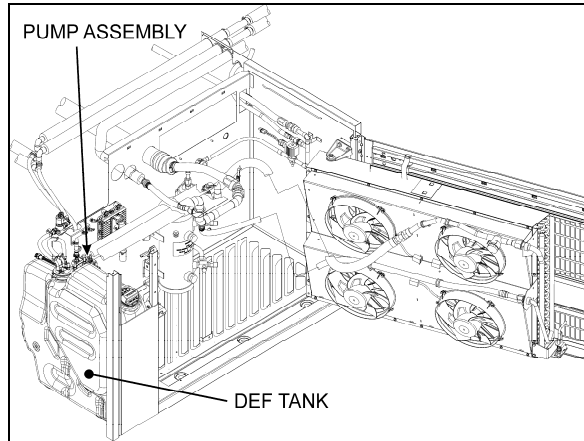


FIGURE 11: DEF TANK AND PUMP LOCATION

A pump located beside the DEF tank is used to pressurize the system and deliver the fluid.

A heating coil located inside the tank use engine coolant to keep the DEF warm during cold season.

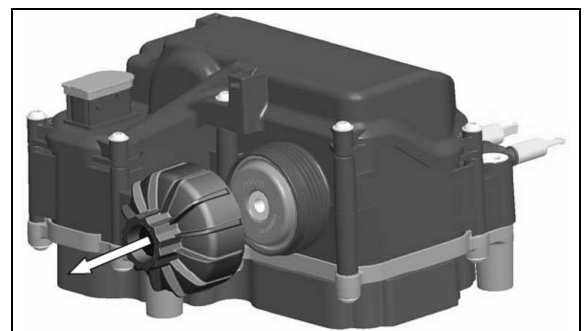
DEF is injected into the exhaust gases through an injection nozzle located between the DPF and the catalytic converter (refer to figure 1).

In the catalytic converter, nitrogen oxides are transformed into harmless nitrogen gas and water.

The system notifies the driver when it is time to top up with DEF.

**5.1 PUMP ASSEMBLY FILTER ELEMENT REPLACEMENT**

- Using a 27 mm wrench, remove filter cover.



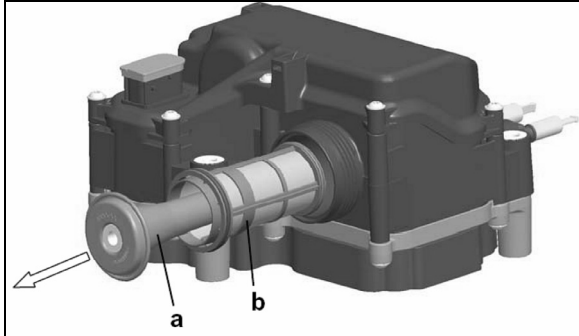
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### CAUTION

Contamination or damage of the sealing surface on the housing is not acceptable.

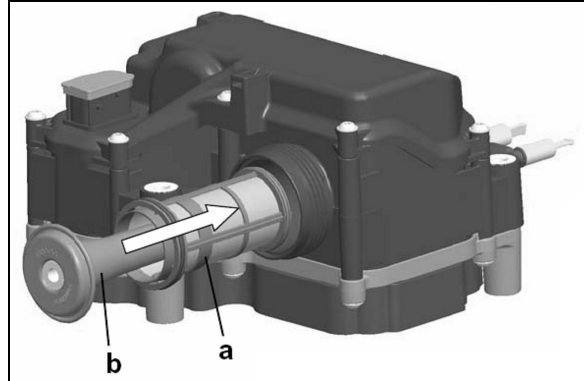
- Remove the equalizing element and the filter element.



### CAUTION

Protect filter area in the housing from contamination!

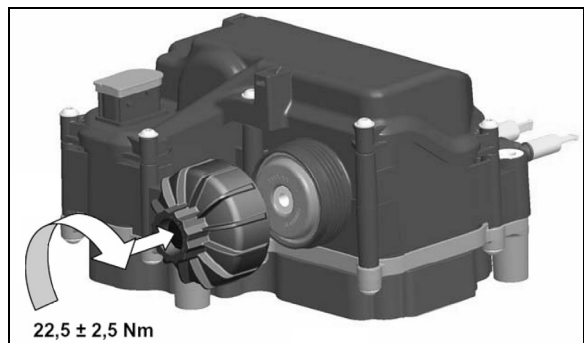
- Replace the filter element and the equalizing element.



### CAUTION

The sealing surfaces on the housing must be clean. No contamination or particles acceptable.

- Install filter cover. Torque to  $22.5 \pm 2.5$  Nm.



### CAUTION

It must be checked if there are cracks around the area of the filter cover. No cracks in the material are allowed. If there are cracks in the housing, the entire Supply Module must be replaced! If there are cracks in the filter cover, the filter cover must be replaced.



### MAINTENANCE


Replace pump assembly filter element every 150,000 miles (240 000 km) or every three years, whichever comes first.

**6. AFTERTREATMENT FUEL INJECTOR CLEANING**

Proper functioning of the aftertreatment fuel injector a.k.a. aftertreatment hydrocarbon injector (AHI) is required in order to obtain efficient regeneration process of the DPF. Clogged aftertreatment fuel injector will result in clogged DPF.


In addition to the activation of the CHECK telltale, emission of diagnostic troubleshooting codes (DTC) by the engine ECM (MID128) will indicate malfunction of the aftertreatment system and/or aftertreatment fuel injector. DTC may be accessed through the Driver Information Display. Select DIAGNOSTICS menu then FAULT DIAGNOSTICS and ENGINE ECU submenus.

In the Driver Information Display, you can check the status of the aftertreatment system. Select AFTERTREATMENT menu then ATS STATUS. Then check the DPF soot level with SOOT LEVEL GAUGE.

 <p><b>MAINTENANCE</b></p>
<p>Clean the aftertreatment fuel injector every 4500 hours or 150 000 miles (240 000 km) whichever comes first.</p> <p>HAVE THE AFTERTERTREATMENT FUEL INJECTOR CLEANED AT YOUR PREVOST SERVICE CENTER.</p>


**6.1 CLEANING**

This procedure covers cleaning of the aftertreatment fuel injector. Draining of the coolant or removal of the coolant lines to the aftertreatment injector is not required if the following procedure is followed.

 <p><b>WARNING</b></p>
<p>Turbocharger and exhaust system components can be hot. Contact with hot components can cause severe personal injury. Allow the turbo and exhaust system to cool before working with exhaust system components.</p>


<p><i>NOTE</i></p> <p><i>Replacement of the aftertreatment fuel injector requires draining of the coolant.</i></p>
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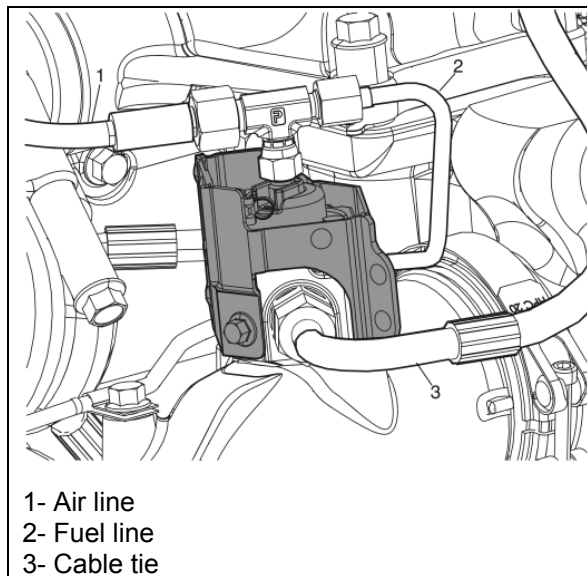
1. Apply parking brake and set the battery master switch to the OFF position.
2. Remove P-clamp bolts securing the aftertreatment fuel injector fuel, coolant and air line.

 <p><b>CAUTION</b></p>
<p>Do not kink the fuel and coolant lines. Kinking the lines may result in leakage.</p>

3. Unscrew the two-way check valve from the injector.

<p><i>NOTE</i></p> <p>The coolant line and coolant do not need to be removed for aftertreatment fuel injector cleaning.</p>
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 <p><b>WARNING</b></p>
<p>Clean up fuel spills immediately. Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.</p>

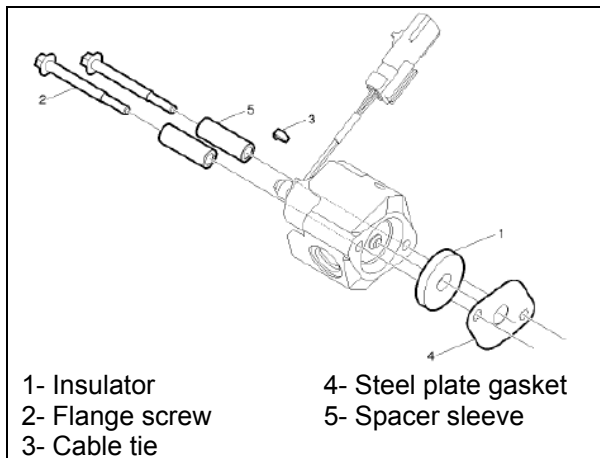


**FIGURE 12 : AFTERTREATMENT FUEL INJECTOR**

4. Remove and discard the aftertreatment injector mounting flange screws and spacer sleeves. Remove the injector mounting from the diffuser pipe (attached to the turbocharger outlet).
5. Cover the hole in the diffuser pipe to prevent dirt and cleaning solution from entering the exhaust.

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6. Remove and discard the high-temperature insulator and steel plate gasket from the bottom of the injector.



### CAUTION

Always use a fine nylon or brass brush to scrub the aftertreatment injector inlet screen. Do not use a steel bristle brush to clean the injector inlet screen. A steel bristle brush will damage the injector and could lead to leakage.

7. Inspect the inlet screen to the aftertreatment injector. If it is filled with carbon, spray carburetor cleaner on the injector screen and use a fine nylon or brass brush to scrub the screen repeatedly. Repeat as necessary to clean all carbon off of the screen.

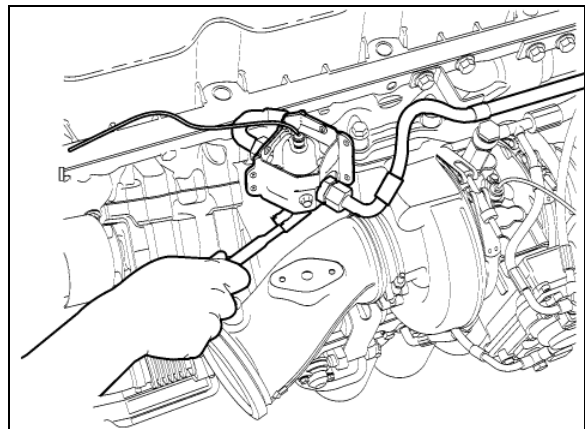


FIGURE 13 : AFTERTREATMENT FUEL INJECTOR INLET SCREEN

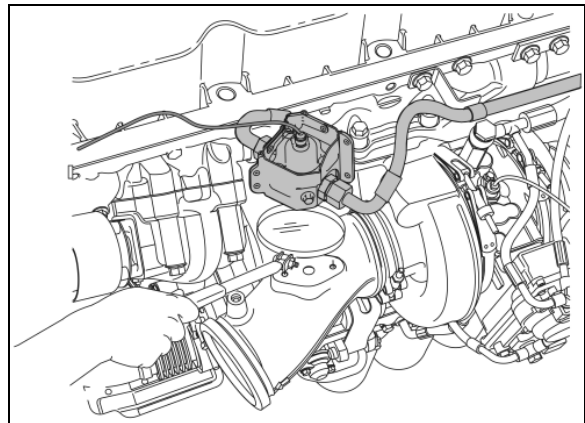
### CAUTION

Only high quality carburetor cleaner should be used to clean the injector. Other cleaners, such as brake cleaner products, do not work and may contain chlorine, which could damage the catalyst if they enter the exhaust system.

8. Turn the aftertreatment injector body to allow the injector tip to be sprayed with carburetor cleaning solution. Brush the injector tip with a stiff bristled nylon "tooth" brush. Repeat two or three times.



9. Inspect the injector tip. Use a mirror if a clear view of the tip is not possible.



10. Install a new high-temperature insulator and steel plate gasket onto the bottom of the aftertreatment injector (included in kit 85115784).
11. Apply high-temperature nickel-graphite anti-seize compound to the new injector mounting bolt threads and insert the bolts into the new spacers (included in kit 85115784).

12. Secure the injector mounting bolts. Tighten the bolts to 125±4 lbf-in (14±0.5 Nm).
13. Use carburetor cleaner and shop air to clean the aftertreatment injector and two-way check valve threads.

**CAUTION**

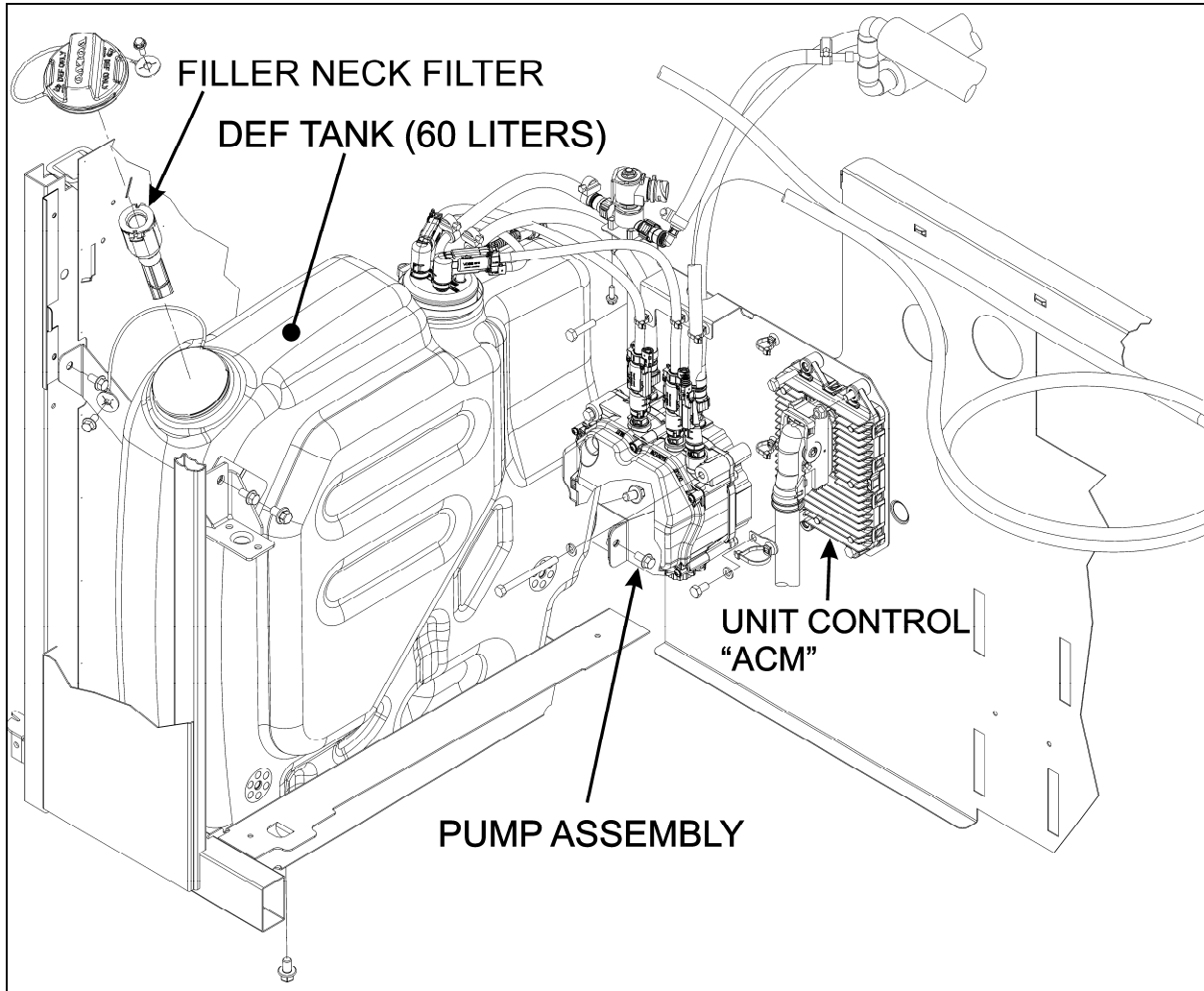
Only apply Loctite to the top threads of the aftertreatment injector. Loctite on the flare or injector tip will damage the aftertreatment injector.

14. Apply two drops of Loctite 271 180 degrees apart on the top threads of the injector. While securing the check valve with a wrench, tighten the check valve swivel nut to 133 lbf-in (15 Nm).
15. Install P-clamp bolts securing the fuel, air and coolant lines.
16. Set the battery master switch to the ON position.

## 6.2 TESTING

1. Connect Premium Tech Tool to the vehicle and perform the aftertreatment diagnostics function test in VCADS. Activate the fuel shut-off solenoid and check for leaks.
2. Use the scan tool to reset the aftertreatment injector adaptive factor. Use Guided Diagnostics to read and clear all diagnostic trouble codes (DTCs).
3. Perform a complete parked regeneration. Check for leaks and proper operation during the regeneration.
4. After shutdown, replenish fluids as necessary. Re-check the injector fuel line fitting and make sure it is tightened to specification:
  - fuel line to two-way check valve 15 Nm (133 lbf-in)
  - Air line to two-way check valve: 27Nm (239 lbf-in).

**Section 04: EXHAUST SYSTEM**



**FIGURE 14: DIESEL EXHAUST FLUID (DEF) TANK AND PUMP ASSEMBLY ARRANGEMENT**