



Inspection Bulletin

North American Standard Inspection Program

2010-02 – Inspection of Vehicles Equipped with 2007 or Later EPA-Certified Engines

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Summary

This Inspection Bulletin explains how to safely inspect motorcoaches, buses, trucks and truck tractors equipped with 2007 or later EPA-certified diesel engines and related emissions after-treatment equipment. Inspectors should note that in these vehicles, exhaust temperatures are higher, exhaust components will retain heat longer, and some exhaust components, such as mufflers, will be larger and heavier than previous versions of these same components. Inspectors should use standard precautions when inspecting any exhaust component with hot surfaces and also should be aware that, due to the added weight of the components, mounting brackets should be inspected for damage. Finally, heat diffusers may be included on these vehicles. These devices draw cool air into exhaust pipes upstream of the exhaust outlet – a configuration that is not considered an exhaust leak. These considerations are explained in further detail below.

New Safety Considerations and New Components to Inspect on EPA07/EPA10 Vehicles

- ◆ EPA07/EPA10 engine exhaust systems are hotter and retain heat longer.
- ◆ New components, including added fuel lines, injectors, sensors and heat diffusers with cooling air inlets, replace the standard muffler.
- ◆ Brackets and mounting hardware are upsized accordingly.

Background

In 2001, the U.S. Environmental Protection Agency (EPA) published a final rule requiring medium-duty and heavy-duty highway vehicles equipped with diesel engines manufactured Jan. 1, 2007, or later (hereafter referred to as EPA07 engines) to meet new lower oxides of nitrogen (NOx) and particulate matter (for short, PM or soot) emission levels. The regulation resulted in a broad inter-industry effort to accomplish the lower emission levels. The oil refining industry was required to produce and distribute ultra-low sulfur diesel (or ULSD) fuel with sulfur levels below 15 parts per million by mid-October 2006. In parallel, engine and truck manufacturers were required to reduce tailpipe emissions. This was accomplished by increasing combustion pressures, reducing combustion temperatures, increasing exhaust gas recirculation, and adding new catalysts and particulate matter (smoke) filters to the exhaust system. Those improvements necessitated larger cooling systems and all new exhaust configurations.

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New Equipment

As a result of these regulations, motorcoaches, buses, trucks and truck tractors equipped with EPA07 engines include new equipment of which inspectors should be aware. Specifically, there are new exhaust filters and catalyst systems; new mounting brackets and exhaust routing; new high-temperature stainless steel exhaust pipes/hoses; new sensors and wiring; larger coolant hoses and radiators; new fuel line routing; and new exhaust heat management systems, including heat shields, insulation and exhaust gas cooling devices.

All this new or retrofitted equipment should be well secured to the vehicle, just as any component must be well secured in older generation vehicles. The new exhaust filters and catalyst systems can weigh in excess of 200 pounds and are designed to withstand the high temperatures under which they are required to operate. The mounting brackets similarly are reinforced to withstand the weight, vibration and high temperatures of the particulate filters. Brackets should not be cracked, broken or loose.

Figure 1 – Photographs of a truck, school bus and motorcoach chassis with new exhaust systems.



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High Temperature Exhaust

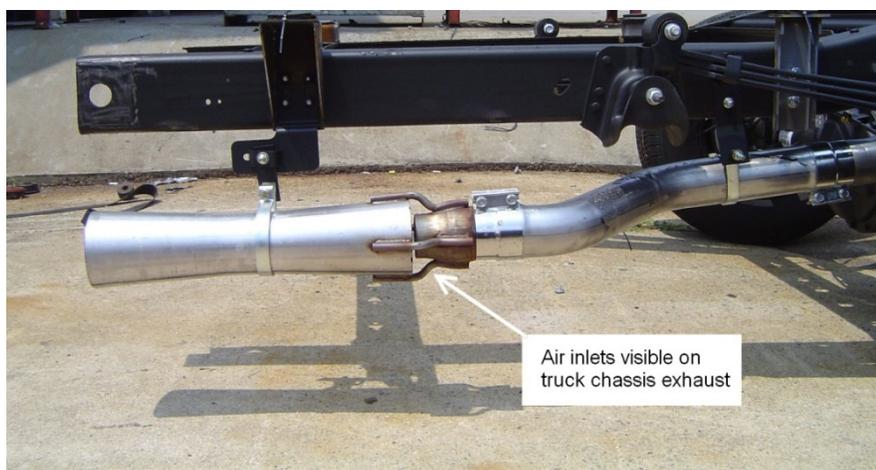
Diesel particulate filters (DPFs) are the essential component in trapping smoke particles from the exhaust. They must remain in working order to meet emissions regulations and to operate the vehicle with full power. If engine sensors indicate a DPF has failed or is missing, the engine generally will de-power, permitting the vehicle only a limited ability to “limp” to a service location. DPFs should not be altered.

One of the functions of a DPF is that it must self-clean periodically through a process called regeneration. Regeneration is achieved when the temperature of the exhaust passing through the DPF is raised to a level sufficient to cleanly burn off captured smoke particles. It can occur routinely during operation while at highway speeds or while climbing hills, for example. Or, if the vehicle is being operated such that it stops frequently or otherwise does not achieve a sustained high engine output, it may require a *forced regeneration*, in which the exhaust gases are artificially raised by the engine controls to clean the filter. Regeneration can occur while the vehicle is not moving; however, it can only occur while the engine is running.

Heat Diffusers

Many vehicles equipped with DPFs will be equipped with heat diffusers. There are multiple designs for these systems but the function of each is the same – to reduce the temperature of exit gases and diffuse the heat. Most diffusers are designed to draw cool air from the atmosphere into the exhaust flow through air inlets upstream from the exhaust exit. These air inlets should not be considered exhaust leaks. The designs are permissible, even when installed forward of 15 inches from the rear of passenger-carrying vehicles. Some examples of heat diffusers are shown in the following Figures 2-4.

Figure 2 – Chassis with a sample heat diffuser design.

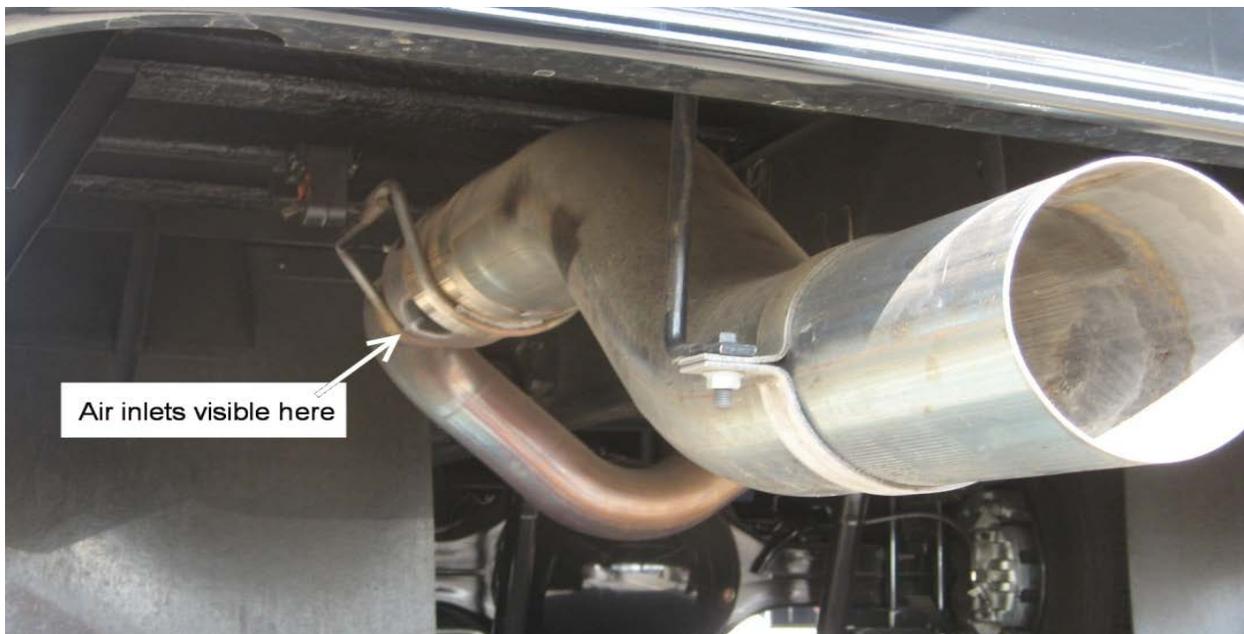


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Figure 3 – Heat diffuser design with air inlets at right.



Figure 4 – Exhaust exit shown with heat diffuser and forward air inlets visible.



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Disabling a Regeneration

In all vehicles, the driver can stop regeneration by turning off the engine. However, components of the exhaust system after a regeneration event will remain hot for long periods of time due to their high heat retention. Appropriate care should be taken when working near hot surfaces. As a general rule, EPA07/EPA10 exhaust components will have higher surface temperatures and will retain heat for longer periods compared to vehicles equipped with pre-2007 engines.

Driver Information

Inspectors should be aware that in some vehicles, exhaust system controls are included in the cab giving the driver the ability to delay the start or prevent a regeneration event altogether. However, the regeneration event will still need to be completed as required for necessary system maintenance. If not completed, the vehicle will operate at reduced performance and at some point the vehicle will stop. These controls are offered in the event that the vehicle is stopped in a location that is not compatible with a high-temperature exhaust regeneration event. In many vehicles, there is a driver information placard, such as the one below, offering information on the exhaust filter status. However, as previously stated, regeneration of a DPF cannot occur if the engine is turned off.

Example of sun visor driver information placard.

EMISSION SYSTEM INSTRUCTIONS				
 (Solid)	 (Flashing)	  	 	
LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	Exhaust System Temperature is HOT
Exhaust filter regeneration required.	Exhaust filter is full.	Exhaust filter is full. Engine performance LIMITED .	A serious engine problem has occurred. Exhaust filter may be overfull. Engine may SHUTDOWN soon.	 WARNING: Exhaust components and exhaust gas are at extremely high temperatures. When parking vehicle, keep away from people, or any flammable materials, vapors, or structures.
Drive on highway at highway speeds OR start *Parked Regeneration to prevent loss of engine power.	Pull vehicle safely off roadway and start *Parked Regeneration to prevent loss of engine power.	 WARNING: Pull vehicle safely off roadway and start *Parked Regeneration to prevent engine stopping.	 WARNING: Pull vehicle safely off roadway, turn on flashers, place warning devices, and STOP ENGINE . Seek service immediately.	
* See Operator's Manual for Further Details				
 WARNING: When performing *Parked Regeneration, make certain vehicle is safely off roadway and exhaust system is away from people, or any flammable materials, vapors, or structures. Parked Regeneration may increase engine speed.		 WARNING: Failure to follow these instructions may result in a loss of engine power, vehicle speed, increased exhaust temperatures, and may cause an accident or fire resulting in property damage, personal injury, or death.		

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Water Drain Holes

New exhaust systems may include rain or condensation drain holes. These are necessary to prevent internal corrosion or damage to after-treatment components due to water ingress on trucks with vertical outlets. They should be easy to distinguish from perforations caused by rust and may be found on low areas of piping where water accumulation may happen. These holes are also not considered exhaust leaks. Other holes such as cracks or tears caused by obvious physical trauma (collision or road debris damage) could be considered leaks.



Sensor Wiring and Fuel Injector Supply

As mentioned in the New Equipment section on page 2 of this Inspection Bulletin, these new exhaust systems are equipped with sensors, which are used to detect how well the filters are working and whether they need regeneration or maintenance. These sensors are clearly identifiable by their connection to electrical wiring that is designed and installed for service in this high-temperature environment. In addition, some exhaust systems inject fuel directly into the exhaust system to raise the temperature in order to complete the regeneration process.



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2010 EPA Emissions Requirements

In 2010, the EPA required new vehicles to achieve a new diesel exhaust emissions regulation limit, which is 0.2 NO_x (g/hp-hr) down from 1.2 in 2007. The industry came up with two different methods on reducing the level of NO_x.

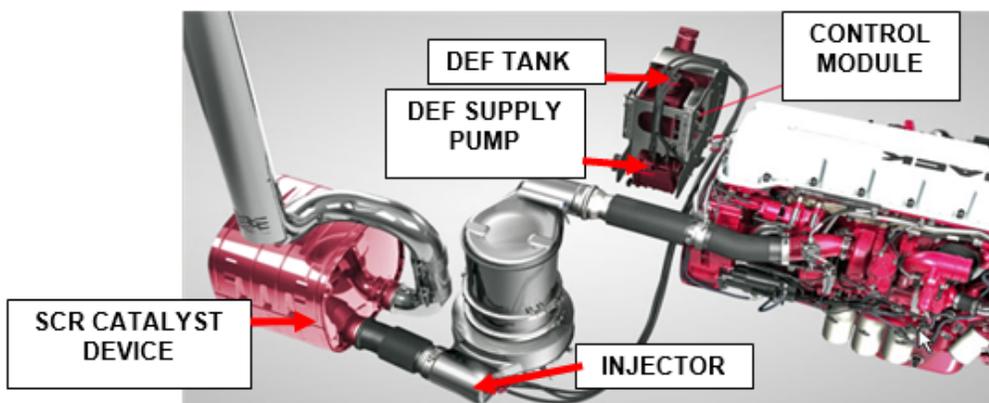
One way is through selective catalytic reduction (SCR) used in combination with exhaust gas recirculation (EGR). The SCR catalyst is located downstream from the DPF. The other method is through EGR alone, which cycles the exhaust back through the engine to reduce NO_x levels.

SCR system is being used by the following manufacturers:

- Mack Trucks
- Paccar MX (DAF)
- Volvo
- Detroit Diesel (M-B)
- Cummins (all engines)

With the EGR system, there will be no additional equipment added to the vehicle that is evident to a roadside inspector. The only engine manufacturer that is currently using EGR alone is International/Navistar.

With SCR, diesel exhaust fluid (DEF) (a urea-based fluid specifically engineered for diesel engines) is injected into the exhaust after it passes through the DPF to reduce NO_x emissions through exhaust after treatment.



Sample of a Mack truck. Not all makes are exactly the same.

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How It Works

The urea (DEF) is a non-hazardous clear fluid that freezes at -11 degrees C; therefore, the temperature is monitored and there is a heater coil inside the tank that keeps the temperature regulated. When required, a stream of DEF is injected into the exhaust. When the exhaust is mixed with the DEF droplets, it turns into ammonia and carbon dioxide. When this passes through the SCR catalyst, it is then turned into nitrogen and water vapor.

DEF Tanks

There are different sizes of DEF tanks (6, 13 and 23 g sizes). The size of the tank depends on the amount of diesel fuel that can be carried on the truck. (100g of fuel – 6g DEF tank, 200 g of fuel – 13g DEF tank, 300g – 23g DEF tank).

DEF fluid dries out and will crystallize if left in the lines; therefore, some systems use air to purge DEF out of the lines back to the tank. Inspectors may hear a spitting sound for 10 to 20 seconds, but it can last up to 2 minutes when the engine is shut off.

Diesel Exhaust Fluid

DEF is safe to handle and store; it is non-toxic, non-polluting and non-flammable. When stored at extreme temperatures, it does not become toxic. It poses no serious risk to humans, animals, equipment or the environment when handled properly. The product is slightly alkaline with a pH of approximately 9.

DEF is available at pumping stations as well as in refill jugs. These will become more common on commercial motor vehicles and could be carried, similar to extra jugs of washer fluid.

As this is a not a dangerous commodity, there are no additional requirements for a driver to carry these jugs.



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Diesel Exhaust Fluid Tanks



The white residue on the filler neck is spilled DEF. It rinses off with water. There is no reason to be concerned with minor stains such as this.

Inspection Guidance

Inspectors should conduct inspections of vehicles with EPA07 and EPA10 engines as they would any other vehicle for a North American Standard Inspection, but precautions should be taken around hot exhaust system surfaces. Mounting brackets and fixtures should be secure. The following is a quick reference list of what to expect on these vehicles:

- Engine cooling systems are larger, including hoses, radiators, brackets, etc.
- Mufflers are either replaced or supplemented by a diesel particulate filter and diesel oxidation catalyst system components.
- Exhaust temperatures during operation are significantly higher.
- Exhaust components will stay hot longer after the engine is off.
- Exhaust pipe or stack may feature heat diffusers with air inlets.
- Fuel injectors, fuel lines, heater lines, sensors and wiring are integrated into the exhaust systems.