Commercial Vehicle Safety Alliance

North American Standard Inspection Program

INSPECTION BULLETIN

2010-02 **Revised: May 19, 2010**

Inspection of Vehicles Equipped with 2007 & 2010 EPA Certified Engines

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, therefore, use standard precautions when inspecting any exhaust component with hot surfaces, but 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. All of these considerations are explained in further detail below.

New Safety Considerations & New Components to Inspect on EPA07 Vehicles

- EPA07 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 published a final rule requiring medium- and heavy-duty highway vehicles equipped with diesel engines manufactured January 1, 2007, or later (hereafter EPA07 engines) to meet new, lower oxides of nitrogen (NOx) and particulate matter (for short, PM or soot) emission levels. The regulation has 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 of this new or retro fitted 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 they require 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, or DPFs, are the essential component in trapping smoke particles from the exhaust. They must remain in working order to meet emissions regulations as well as 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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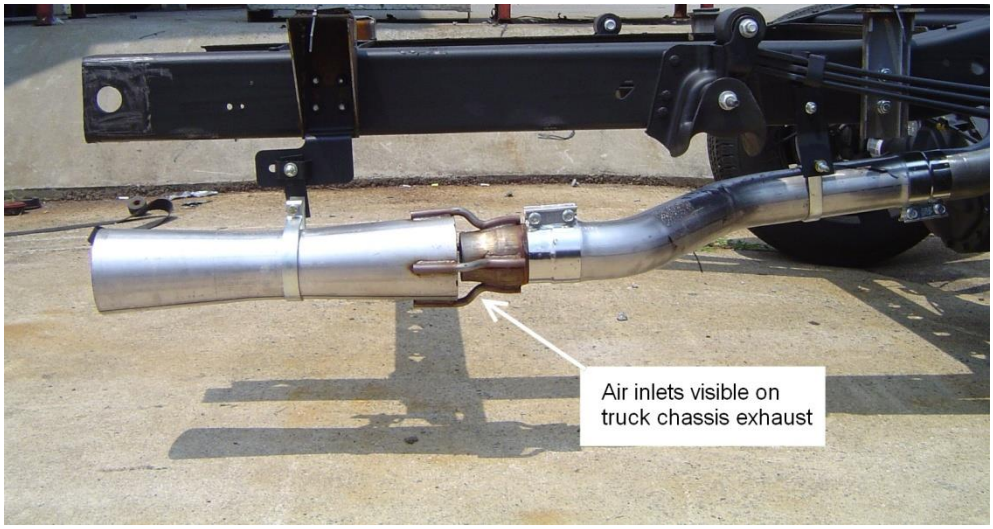

Figure 3 – Heat diffuser design with air inlets at right.

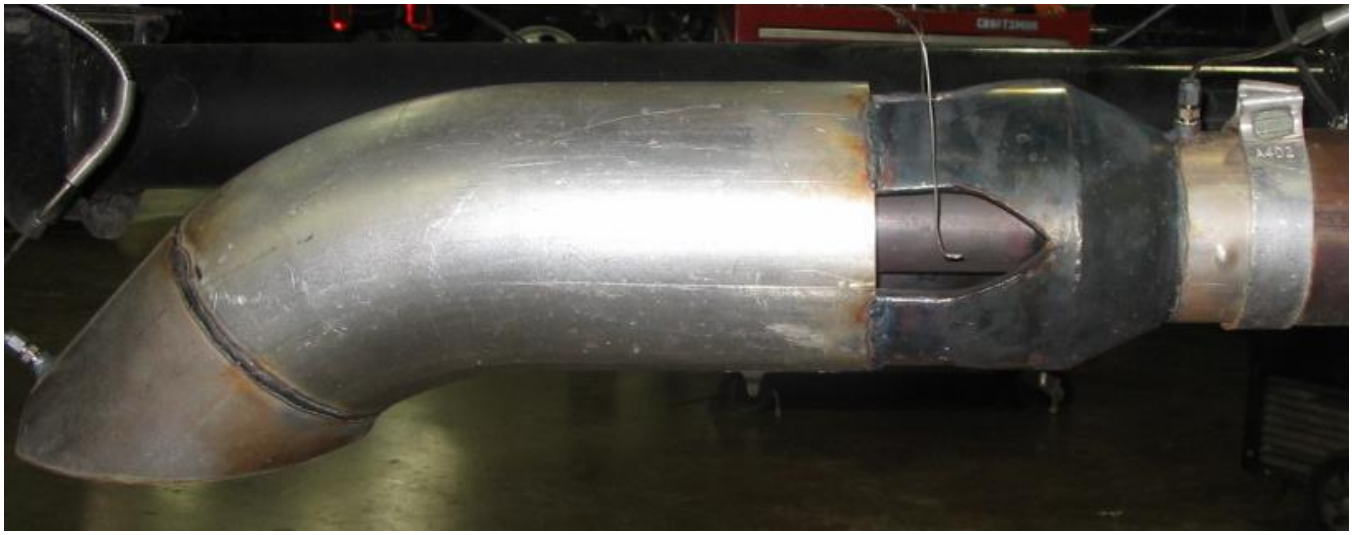

Figure 4 – Exhaust exit shown with heat diffuser and forward air inlets visible.

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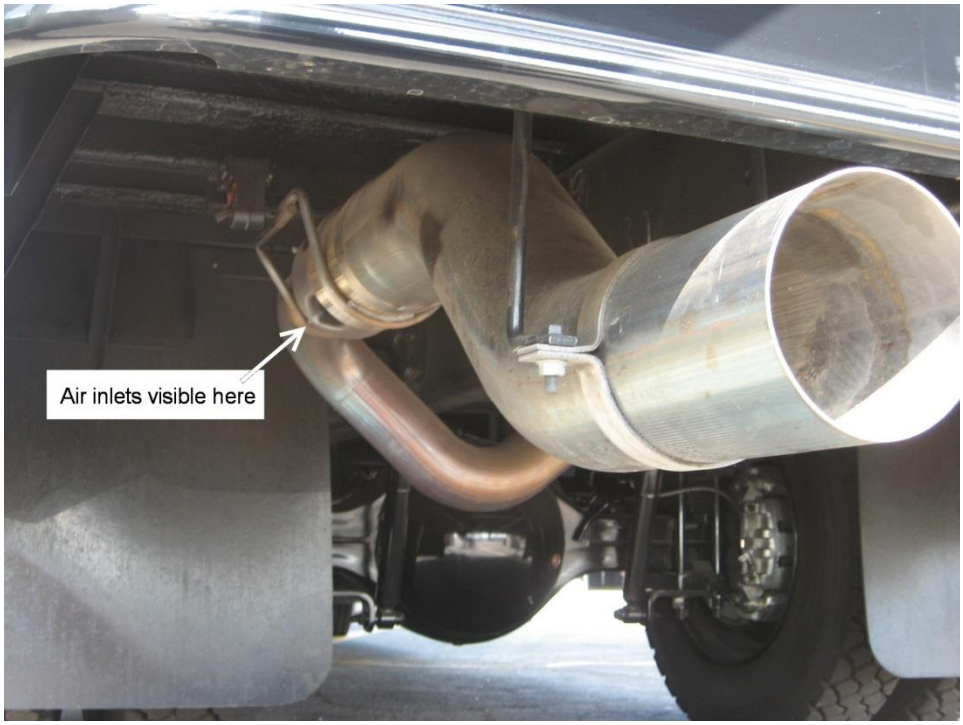

Disabling a Regeneration

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 due to their high heat retention. Appropriate care should be taken when working near hot surfaces. As a general rule, EPA07 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 altogether a regeneration event. 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, again, regeneration of a DPF cannot occur if the engine is turned off.

Figure 5 – Example of sun visor driver information placard.

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EMISSION SYSTEM INSTRUCTIONS

(Solid) LEVEL 1	(Flashing) LEVEL 2	(Flashing) (Solid) LEVEL 3	(Solid) 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.

Water Drain Holes

New exhaust systems may include rain or condensation drain holes. These are necessary to prevent internal corrosion and can easily be identified where they appear as holes in stainless steel exhaust systems that should not exhibit rust-caused perforations. They should also not be considered exhaust leaks. Other holes caused by obvious physical trauma (collision or road debris damage) such as cracks or tears could be considered leaks.

Figure 6 – Diesel particulate filter (DPF) with water drain hole.

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Sensor Wiring and Fuel Injector Supply

As was mentioned in the New Equipment section above, 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.
Figure 7 – Example of exhaust system emissions sensors and wiring.

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2010 EPA Emissions Requirements

In 2010, the EPA is requiring new vehicles to achieve a new diesel exhaust emissions regulation limit, which is .2 NOx (g/hp-hr) down from 1.2 in 2007. The industry has come up with two different methods on reducing the level of NOx.

One way is through a Selective Catalytic Reduction (SCR) used in combination with Exhaust Gas Recirculation (EGR). The SCR catalyst is located downstream from the Diesel Particulate Filter (DPF). The other method is through EGR alone, which cycles the exhaust back through the engine to reduce NOx levels.

SCR system is being used by the following manufacturers:

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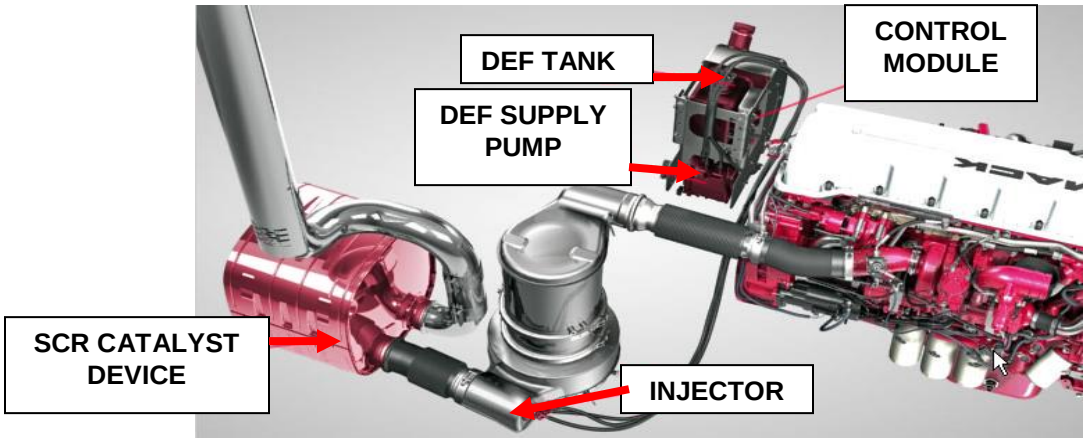
- Mack Trucks
- Volvo
- Cummins (all engines)
- Paccar MX (DAF)
- Detroit Diesel (M-B)

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 passed through the DPF to reduce NOx emissions through exhaust after treatment.



"Sample of a Mack Truck, not all makes exactly the same."

How It Works

The urea 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 urea (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 can last up to 2 minutes when the engine is shut off.

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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 will be available at pumping stations as well as in refill jugs. These will become more common on commercial motor vehicles and will begin to 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 as there is washer fluid.

Warning Lights

Warning lights are on the dash of the truck to indicate to the driver what the level of urea in the DEF tank is. If the engine is in the Level 2 warning, engine power is reduced until the DEF is filled. In the event that the DEF tank goes empty and is not refilled, the ECM will set the speed limit to 5 mph until the DEF tank is refilled.

DIESEL EXHAUST FLUID (DEF) SYSTEM INFORMATION

Instrument Cluster Indicators	(Solid)	(Flashing)	(Flashing)
	LEVEL 1	LEVEL 2	LEVEL 3
DEF Level	DEF Level reads less than 1/8 of a tank	DEF Level gage reads empty	DEF Tank is empty
Action To Be Taken/System Status	Fill DEF tank	Critical to fill DEF tank Engine torque derate active	Critical to fill DEF tank 5 mph speed limit active

* See Operator's Manual for Further Details

Diesel Exhaust Fluid Tanks

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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 of these vehicles:

- Engine cooling systems are larger, including hoses, radiators, brackets, etc.;
- Mufflers are either replaced or supplemented by 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; and,
- Fuel injectors, fuel lines, heater lines, sensors and wiring are integrated into the exhaust systems.

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