Tips for a Successful Diesel Retrofit Project

United States Environmental Protection Agency

Tips for a Successful Diesel Retrofit Project

Transportation and Climate Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

EPA United States Environmental Protection Agency

EPA-420-B-13-025
April 2013

Tips for a Successful Diesel Retrofit Project

Here are some tips for starting your diesel retrofit project and avoiding common mistakes.

1. Create a Fleet Inventory

Verified Diesel Particulate Filters (DPFs) and Diesel Oxidation Catalysts (DOCs) are available for nonroad and highway heavy-duty diesel engines for a wide range of model years. Each retrofit device is verified for use with specific engines and/or with specific configurations. A fleet inventory is an important tool for understanding and defining your fleet, and is the first step in any retrofit project.

You will need to identify the following for each vehicle in the fleet:

- Vehicle Type: highway or nonroad
- Vehicle Class: school bus, class 8A tractor, ferry, locomotive, forklift, etc.
- Vehicle Specifications: manufacturer, model, year
- Engine Specifications: manufacturer, model, year, displacement, horsepower, location, turbo-charge, exhaust gas recirculation
- EPA Engine Family Name: found on the engine's emission label, contains 11 or 12 characters such as TCP7.2RZBDBRB or 3NVXHO466ANA
- Annual Miles Traveled (highway) or Annual Hours of Operation (nonroad)
- Maintenance History: include documented lubrication oil and fuel consumption
- Engine-out Particulate Matter (PM) Emission Levels

Based on the vehicle and engine information, you can sort your fleet into likely candidate vehicles for various emission reduction strategies: DPF, DOC, engine rebuild/replacement, or vehicle replacement.

2. Log Exhaust Temperature Data

The exhaust temperature is a significant factor in determining whether a DOC or a DPF is applicable for a specific vehicle or piece of equipment. Data logging must be performed on each vehicle to document exhaust temperatures. If different vehicle routes or sporadic work loads are used or significant changes in ambient temperatures are expected, data logging may be necessary. Exhaust pipe insulation may be used to retain heat. If insulation is used, data logging should be performed with insulation installed.

To achieve verified emissions reductions, DOCs typically require a minimum exhaust gas temperature of 150° C, which is easily achieved on a wide range of engine models, years, and duty cycles. The required minimum exhaust temperatures for passive DPF systems range from approximately 240° C for 50 percent of the operating cycle to 400° C for 30 minutes. Active DPF systems rely on an additional heat source and are, therefore, not dependant on the engine duty cycle and the resultant exhaust temperatures.

Documenting exhaust temperatures early in the process will help you identify your retrofit technology options. Fleets should maintain data logging records for all vehicles for later reference.

3. Understand DPF Regeneration Requirements

DPF regeneration occurs when the filter element reaches the temperature required for combustion of the carbon in the PM to occur, converting it to gaseous carbon dioxide (CO_2) and carbon monoxide (CO). How regeneration occurs depends on the exhaust temperature.

"Passive" regeneration occurs when the exhaust temperatures are hot enough to sufficiently raise the temperature of the filter element during the normal duty cycle. Metal-based catalysts applied to the filter alter the combustion chemistry and reduce the exhaust temperature needed for passive regeneration.

"Active" regeneration must be used when the engine exhaust temperature is not hot enough to initiate combustion of the collected PM, and requires an additional heat source to sufficiently raise the temperature of the filter element. The minimum frequency of regeneration is determined by the rate of PM build-up and is generally once per day or shift.

4. Understand DPF Cleaning Requirements

In addition to PM, the filter also traps noncombustible materials (ash), resulting primarily from lubrication oil and fuel additives. The removal of the ash from the DPF is called “cleaning” and is done much less frequently than regeneration. Intervals for DPF cleaning generally vary from bi-annually to annually, or longer, depending on engine-out PM emissions. Monitoring engine exhaust backpressure is the best way to determine if and when DPF cleaning is necessary. The need for very frequent filter cleanings may indicate incomplete filter regeneration or the need for engine maintenance. Periodic filter cleaning for ash removal is necessary for both active and passive DPF systems.

In general, cleaning requires heating the filter and using compressed air, combined with a vacuum system to blow the ash from the filter and capture it in a sealed container. Professional filter cleaning services are available. Highly automated cleaning stations are also becoming available, allowing fleet service technicians to perform cleaning on-site. Costs for cleaning stations or professional cleaning services should be considered when purchasing DPFs.

Cleaning requires the manual removal of the DPF from the vehicle. If equipment down time during cleaning is a concern, fleets may consider buying extra filters, so that each vehicle will always be equipped with a filter. The filter must be reinstalled on the original vehicle and in the correct flow direction to maintain proper operation. Track the serial numbers for each retrofit device and the vehicle on which it is originally installed. Removal of the DPF for filter cleaning and reinstallation is typically performed by fleet service technicians.

It is important that all vehicle/equipment operators and fleet service technicians are properly trained on filter cleaning procedures.

5. Select a Retrofit Technology

Several factors will determine which retrofit technology you install on each of your fleet vehicles, including your program's emissions reduction goals, the number of vehicles and available project funding, and the technical feasibility of installing various retrofit devices on your specific fleet.

EPA and California Air Resources Board's (CARB) lists of verified diesel retrofit technologies quantify the emission reductions achieved by each device and define the specific engine operating criteria that must be met in order to successfully apply that device. EPA's Verified Technology List can be found at: www.epa.gov/cleandiesel/verification/verif-list.htm. CARB has also developed a search tool EXIT Disclaimer that will identify potentially compatible CARB verified retrofit technologies, based on the fleet inventory information.

In addition, maintenance requirements and your maintenance capabilities should be considered for each type of retrofit. A centralized garage and maintenance facility may expand your retrofit options.

6. Select a Technology Supplier

To purchase goods or services under an EPA National Clean Diesel Campaign grant, you must compete the contracts for those goods and services and conduct cost and price analyses to the extent required by the procurement provisions of 40 CFR Part 30 or 31. The regulations require that efforts are made to provide small and disadvantaged businesses with opportunities to compete. In your bid proposal, be sure to specify that the technology must be verified by either EPA or CARB.

Once selected, retrofit suppliers will review actual vehicle operating conditions and perform temperature data logging prior to retrofitting a vehicle to ensure retrofit compatibility. Fleets should obtain and store data logging records for all vehicles for later reference.

7. Install the Retrofit Device

Prior to installing any retrofit device, engine inspection and maintenance should be performed to ensure proper engine operation conditions, including a check of the vehicle exhaust system integrity and lubrication oil consumption.

Installation may be performed by the retrofit supplier, or the retrofit supplier may provide training to fleet personal to perform the installation.

Since a retrofit device typically weighs more and may be larger than the muffler, stronger clamps and brackets may be required in place of those used with the original muffler. Failure to

utilize appropriate hardware can result in a mechanical failure of support brackets and damage to the retrofit components. To facilitate removal of the device for cleaning, quick-release clamps are often used.

In some applications, the retrofit device matches the dimensions of the conventional muffler and can be installed as a muffler replacement. In other cases, the space available for retrofit installation on the vehicle or equipment is very restricted, and the retrofit configuration needs to be custom designed. Safety, visibility, and vibration may also need to be addressed by a custom installation.

Retrofit devices must be mounted within a set distance from the exhaust manifold, as specified by the manufacturer. Exhaust pipe insulation may be used to retain heat. The time required for retrofit installation will vary and can range from approximately two to twelve hours.

8. Monitor Backpressure

As a DPF collects PM, the passage of exhaust gas through the pores of the filter element may be progressively blocked, causing an increase in exhaust backpressure. Since engine manufacturers place limits on the exhaust backpressures for their engine, an exhaust backpressure monitoring and operator notification system must be installed with every DPF.

If exhaust backpressure exceeds certain thresholds, the operator is notified that maintenance is needed. It is important that all vehicle/equipment operators and fleet service technicians are properly trained to recognize and respond to high backpressure alert signals. Backpressure monitoring systems should be periodically inspected for proper operation.

In most DOC retrofit applications, there is no need for backpressure monitoring. However, if the vehicle emits extremely high levels of PM and/or idles for long periods of time, an exhaust backpressure monitoring and operator notification system may be installed so that the operator is notified if maintenance is needed.

9. Maintain the Engine

It is important to properly maintain vehicles and monitor fuel and lubrication oil consumption. A bad fuel injector or increase in oil consumption may be masked by a retrofit device. A retrofit device may be damaged by a poorly maintained engine.

10. Keep Special Requirements for Closed Crankcase Ventilation Systems in Mind

Closed Crankcase Ventilation (CCV) systems are verified by EPA and CARB only when installed in conjunction with a DOC. EPA generally allows for grants to also fund the installation of a CCV in conjunction with a DPF, but grant funds can not be used to install a CCV by itself.

CCV systems may have special mounting requirements to enable oil flow back to the crankcase.

The CCV system filter cartridges must be replaced periodically. Depending on the specific manufacturer, this frequency can vary from every 500 to 1000 engine hours, or once a year, or at every lubrication oil change recommended by the engine manufacturer. Some CCV models will have a service indicator to direct you to change the filter cartridge. You should consult with your technology provider on the correct maintenance schedule for your particular CCV.

Periodic inspection is necessary to confirm proper operation. Consult the manufacturer's instructions and check return lines for kinks and tight connections. Additionally, there should not be any oil or residue in the engine intake where the CCV connects.

11. Understand Fuel Standards and Requirements

Ultra Low Sulfur Diesel fuel (ULSD), which contains up to 15 ppm sulfur, is required for highway vehicles and will begin to be phased in to the nonroad sector beginning in 2010.

ULSD is required for all DPF installations, and is highly recommended for use with all DOCs. Fuel additives should not be used, unless explicitly approved by the retrofit manufacturer.

CARB has verified many diesel emission control systems for use with biodiesel blends, subject to the following conditions:

- The biodiesel portion of the blend shall be 20 percent or less of the fuel.
- The biodiesel portion of the blend shall comply with the American Society for Testing and Materials (ASTM) specification D6751 applicable for 15 parts per million sulfur content.
- The diesel fuel portion of the blend shall comply with Title 13 California Code of Regulations, § 2281 and 2282.
- The use of biodiesel applies only to devices verified to reduce diesel particulate matter.
- Other alternative diesel fuels such as, but not limited to, ethanol diesel blends and water emulsified diesel fuel, are excluded.

You should consult with your retrofit provider regarding the use of biodiesel and negotiate the warranty accordingly. Engine manufactures have varying policies regarding the use of biodiesel and biodiesel blends and should be consulted before fueling with biodiesel.

More so than regular diesel fuels, biodiesel will gel in cold weather. Cold weather strategies include blending biodiesel with kerosene, blending biodiesel with diesel that has been treated with cold weather additives, using block and filter heaters, storing the vehicles indoors, and using a B20 blend or below. You should consult with your fuel distributor to make sure your fuel is properly treated for cold weather performance.

The EPA hopes that the information provided in this document will help you get started on your diesel retrofit initiatives and avoid common mistakes as your retrofit program evolves. If you have questions after reading this document, please send an e-mail message to Clean Diesel (cleandiesel@epa.gov).