Diesel Retrofit

Frequently Asked Questions About the Installation of Emission Controls on Existing Diesel Engines

Today, emission control systems are commercially available that greatly reduce the air pollutants emitted from diesel engines. These systems can be retrofitted on trucks and buses, off-highway vehicles, and stationary diesel engines. Modern diesel emission controls can reduce carbon monoxide, hydrocarbons, particulate matter, oxides of nitrogen and toxic air pollutants. Widespread use of these control systems can significantly improve air quality. This fact sheet answers some of the frequently asked questions about diesel retrofit – the installation of emission control systems on existing diesel engines.

For additional information on diesel retrofit, including technical information on diesel retrofit technology, funding opportunities, and current news, please visit Manufacturers of Emission Controls Association's (MECA) diesel retrofit web site at: www.dieselretrofit.org.

What kind of emission control systems exist for diesel engines?

Diesel emission control systems are installed on vehicles or equipment to reduce unwanted emissions. The system may involve a device or component such as a catalyst or particulate filter. The device may or may not be used in conjunction with a fuel-borne catalyst or special fuel. Diesel emission control devices can be installed on a wide variety of vehicles including on-highway trucks and buses, off-road construction equipment, mining and material handling equipment, stationary engines, and many other applications. Using catalytic processes or filters, control devices reduce carbon monoxide (CO), hydrocarbons (HC) and particulate matter (PM) in diesel exhaust. Filter systems may also be added to an engines crankcase system to reduce PM emissions associated with them. Devices that use a process called selective catalytic reduction (SCR) use a catalyst and a liquid reagent to reduce the oxides of nitrogen (NOx) produced by the engine. Exhaust gas recirculation (EGR) recycles a portion of the engine exhaust to reduce NOx emissions. Lean NOx catalysts use catalytic processes and a reductant to lower NOx emissions.

Am I required to retrofit my diesel engine with an emission control system?

In most states, there is no requirement to install emission controls on an existing diesel engine. In California, where the state is implementing a Diesel Risk Reduction Plan,

many diesel vehicle fleets will be required to reduce diesel PM over the next several years. One option for complying with these California regulations will be to install particulate matter controls on existing diesel engines. Many school buses, transit buses, solid waste collection vehicles, on-road vehicles, stationary engines and off-road vehicles will install controls to comply with the California requirements. New York City passed Local Law 77 in 2003 to require the use of ultra-low sulfur diesel (ULSD) fuel and control technologies to reduce emissions from non-road equipment used on City construction projects. This legislation initially applied only to projects in lower Manhattan, but starting in 2004, these requirements were phased in to all City construction projects. New Jersey adopted regulations in 2005 that will require publicly owned fleets to apply the best available retrofit emission controls to existing heavy-duty diesel vehicles. Other states may consider mandatory diesel retrofit requirements as they develop plans for complying with new federal ambient air quality standards for fine particulate emissions. While the installation of emission controls is not required in most states at this time, it is important to note that many cities and businesses have retrofitted their vehicles and stationary diesel engines to reduce air pollution and protect human health. The U.S. EPA has also implemented a voluntary diesel retrofit program and introduced the Clean School Bus U.S.A and National Clean Diesel Campaign, all of which encourage diesel retrofits for diesel engines.

The U.S. EPA has adopted regulations that will require that new heavy-duty highway diesel engines meet much lower emission standards. The new standards will take effect in 2007. Today, engine manufacturers are working to integrate existing and developing emission control systems with new engine designs to achieve the new standards. Between now and 2007, however, retrofit systems offer a cost effective means of removing harmful emissions from diesel exhaust.

Why should I install a diesel emission control system?

Emission controls offer an effective means of reducing the air pollution emitted from a diesel engine. The primary reason for installing diesel emission controls is human health. Controlling harmful emissions is especially important when diesel engines are operated in confined or restricted space where workers may be exposed to high exhaust concentrations. Controlling emissions in urban environments is also important where inhabitants may be exposed to elevated concentrations over long periods. For some, reducing diesel smoke and odor is a “quality of life” issue. Installing controls can make the workplace, the highway, or the neighborhood a more pleasant place to be. While installing emission controls is primarily done to reduce human exposure to harmful air pollution, control systems are also installed to reduce building soiling and improve visibility.

How effective are diesel particulate matter controls?

Diesel particulate matter controls are very effective. Diesel oxidation catalysts, a type of control device, can reduce particulate matter emissions by 20 to 50 percent, toxic hydrocarbon emissions by greater than 70 percent, and carbon monoxide and hydrocarbon emissions by greater than 90 percent. High efficiency diesel particulate filters, another type of control device, can reduce particulate matter, carbon monoxide,

hydrocarbon and toxic hydrocarbon emissions by up to 90 percent or more. Both of these devices can significantly reduce or eliminate the smoke, soot and odors associated with diesel engine operation.

How do diesel emission controls work?

Diesel emission controls treat (or in some cases recycle) engine exhaust to remove pollutants. As part of the exhaust system, control devices convert or capture pollutants before they leave the tailpipe. In some cases, this is accomplished with the help of a special fuel or fuel-borne catalyst. The two most common types of retrofit devices are the diesel oxidation catalyst and the diesel particulate filter.

Diesel Oxidation Catalysts – A typical diesel oxidation catalyst, sometimes referred to as a purifier, is a stainless steel canister installed in the exhaust system much like a muffler. The canister contains a honeycomb-shaped substrate that is coated with catalytic metals such as platinum or palladium. There are no moving parts in the canister, just a large amount of surface area coated with a catalyst. As exhaust gases pass through the honeycomb structure, pollutants and particulate matter are chemically oxidized to harmless gases. Diesel oxidation catalysts can also be used in conjunction crankcase emission controls, emulsified fuels, and ULSD to increase the control of PM emissions and in the case of emulsified fuels, to reduce NOx emissions.

Diesel Particulate Filters – Diesel particulate filters are filters that physically trap particles in the engine exhaust before they leave the tailpipe. Typically, filters are muffler-like devices installed in the engine exhaust system. They are made of cordierite, silicon carbide, aluminum titanate, metal foils and meshes, or other material. As exhaust gases pass through the filter, particulate matter is trapped. Removing particulate matter deposited in the filter is accomplished by several means. Today, in many on-road applications, filters are regenerated through catalyst-assisted means. In catalyst-assisted filter regeneration, particles trapped on the filter are oxidized to carbon dioxide and water when exhaust gases reach manufacturer recommended temperatures. The catalysts, installed upstream of the filter or coated on the filter substrate, form chemical species that oxidize accumulated particulate matter. Fuel-borne catalysts can also be employed to reduce the regeneration temperature of the filter. In applications where exhaust temperatures are not high enough to allow catalyst-assisted regeneration, thermal management strategies or an auxiliary heat source such as an electric heating element or fuel burner can be used to regenerate the filter. In some applications, a filter may be removed from the vehicle and actively regenerated while the vehicle is out of service.

Exhaust Gas Recirculation (EGR*) –* As the name implies, EGR involves recirculating a portion of an engine's exhaust back to the charger inlet (or intake manifold in the case of a naturally aspirated engines). In most systems, an intercooler lowers the temperature of the recirculated gases. The cooled recirculated gases, which have a higher heat capacity than air and contain less oxygen than air, lower combustion temperature in the engine and reduce NOx formation. Low-pressure EGR systems are used in retrofit applications. Diesel particulate filters are always used on a low-pressure

EGR system, ensuring that large amounts of particulate matter are not recirculated to the engine. Retrofit EGR systems are capable of achieving NOx reductions of more than 40 percent. When combined with a high efficiency particulate filter, low pressure EGR systems can achieve greater than 40 percent NOx reduction and more than 85 percent reduction in PM.

Selective Catalytic Reduction (SCR) – SCR uses a catalyst and a liquid reagent to convert the nitrogen oxides in the exhaust to molecular nitrogen and water. The SCR catalyst is packaged in a canister in the exhaust system. A liquid reagent, often a solution of urea and water, is sprayed into the exhaust just upstream of the SCR catalyst. Selective catalytic reduction can reduce NOx emissions up to 70 percent or more. SCR is currently being used on both on-road and off-road vehicles. Applications include trucks, marine vessels and locomotives.

In some applications, several emission control technologies are used together to achieve reduction of several pollutants. For example, SCR and a diesel particulate filter might be installed on the same vehicle to reduce both NOx and PM emissions.

Lean NOx Catalysts – Lean NOx catalysts have similarities with diesel oxidation catalysts in that the converter canister contains a substrate coated with catalytic materials. A liquid reagent or reductant introduced upstream of the converter allows the catalyst to reduce NOx emissions. Typically, the diesel fuel itself is used for this purpose. The fuel is sprayed into the exhaust stream using a specially mounted fuel injector. The amount of fuel injected is controlled by an electronic control module. NOx reductions of up to 25 percent have been demonstrated. Lean NOx catalysts can also be combined with diesel particulate filters to simultaneously reduce both NOx and PM emissions.

How do I know if a control system will work as advertised?

EPA verifies the performance of diesel retrofit devices through a verification process. The goal of the verification process is to ensure that emission control systems perform as a manufacturer claims. EPA maintains a list of verified technologies at the web site: http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm. The California Air Resources Board (ARB) has also developed a retrofit verification procedure to verify the capabilities of retrofit devices. The California ARB maintains a list of verified technologies at the web site: http://www.arb.ca.gov/diesel/verdev/verdev.htm. The EPA's Voluntary Diesel Retrofit Program signed a Memorandum of Agreement (MOA) with the California ARB for the Coordination and Reciprocity in Diesel Retrofit Device Verification. The MOA establishes reciprocity in verifications of hardware or device-based retrofits. This agreement commits EPA and ARB to work toward accepting PM and NOx verification levels assigned by the other's verification program.

Do diesel emission controls require a special fuel?

All retrofit devices work better and achieve lower emission reductions when used with ultra low-sulfur diesel fuel (diesel fuel containing 15 parts per million of sulfur or less). Some retrofit devices are less affected by fuel sulfur than others, however. Diesel

oxidation catalysts and some diesel particulate filters can be used with fuels with sulfur levels higher than 15 ppm and still reduce carbon monoxide, hydrocarbon and particulate matter emissions. Catalyst-based diesel particulate filters are more sensitive to fuel sulfur. These devices are most effective with ultra low-sulfur fuel. Vehicle owners or operators should determine the fuel quality requirements of their emission controls by contacting the emission control manufacturer.

Will using a control device affect my engine warranty?

No. In most cases, engine manufacturers will continue to honor engine warranties if emission control systems are sized, installed and maintained properly. Control systems themselves have their own new product warranties.

Will using a control device affect my engine performance?

Emission control manufacturers work closely with engine manufacturers and vehicle owners/operators to ensure control systems do not affect vehicle performance.

How much do control devices cost?

According to the emissions control device manufacturers, the average diesel oxidation catalyst cost ranges from $500 to $2,000 per vehicle. High efficiency diesel particulate filters are currently being sold for about $5,000 to $10,000 per filter. The cost of selective catalytic reduction devices range from $12,000 to $15,000 with an oxidation catalyst, and $15,000 to $20,000 with a diesel particulate filter. A low pressure exhaust gas recirculation system including a diesel particulate filter costs in the range of $18,000 to $20,000. A system combining a lean NOx catalyst with a diesel particulate filter costs from $15,000 to $20,000.

What emission control systems are available?

A wide variety of emission control systems are available. To obtain a list of technologies verified by the U.S. EPA and the California Air Resources Board, visit the web sites given in the section titled, “How do I know if a control system will work as advertised?”

How do I install and maintain an emission control system?

Companies that make diesel emission controls, their service providers and exhaust system specialists, and other vehicle maintenance providers install emission control systems. Large fleets with in-house maintenance capability may also install emission controls. To ensure an appropriate system is installed, emission control manufacturers work with vehicle owners and fleet managers to determine the system and fuel that will work best with the vehicles being retrofitted. Control system manufacturers need accurate information on how vehicles are operated to select and size a retrofit device. They may want to install sensors and data logging equipment on candidate vehicles for several weeks to gather accurate and complete exhaust temperature data for the vehicles. This data logging process requires minimal installation time and does not interfere with normal vehicle operations. After fleet assessment, the emission control

manufacturer will work with the fleet or vehicle owner and the system installer to recommend the best retrofit solution for the customer.

Maintenance requirements depend on the type of retrofit technology used, the age and performance of the engine, the engine oil used, the vehicle's duty cycle, and time between engine service events. In some instances, diesel particulate filters should be inspected and cleaned annually or every 60,000 miles, whichever comes first. As part of any sale, control system manufacturers provide recommendations on the care and maintenance of their products. More information on filter maintenance practices can be found in MECA's technical document, Diesel Particulate Filter Maintenance: Current Practices and Experience (http://www.meca.org/galleries/default-file/Filter_Maintenance_White_Paper_605_final.pdf). Additionally, on-board monitor systems are typically provided with retrofit technologies. These monitors typically provide the end-users with diagnostic, data logging, and retrofit maintenance-related information, such as engine back pressure and exhaust temperature.

Is funding available for the purchase of emission control systems?

Many state air quality agencies and some city environmental agencies fund or help fund diesel retrofit programs. State and local air quality officials may assist in identifying funding sources for retrofit programs even if they cannot offer funding themselves. The EPA web site http://www.epa.gov/otaq/retrofit/retrofunding.htm summarizes federal and other funding sources. MECA's diesel retrofit web site http://www.dieselretrofit.org also provides information on diesel retrofit funding.

How do I get more information on diesel emission control systems and diesel retrofit programs?

For more information, please contact MECA's Antonio Santos at (202) 296-4797 x108 or asantos@meca.org. The contact person at the California Air Resources Board for diesel retrofit programs is Annette Hebert. Ms. Hebert's telephone number and e-mail address are: (626) 575-6973 and ahebert@arb.ca.gov. Contacts for EPA's Voluntary Diesel Retrofit Program are listed at: http://www.epa.gov/otaq/retrofit/contacts.htm. General information about diesel retrofit programs and technologies is available on EPA's web site: http://www.epa.gov/otaq/retrofit/overview.htm. More detailed information on diesel retrofits is also available on MECA's diesel retrofit web site at: http://www.dieselretrofit.org.

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