STATEMENT
OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION
ON THE AIR RESOURCES BOARD'S
PROPOSED REGULATION FOR COMMERCIAL HARBOR CRAFT

October 25, 2007

MECA is pleased to provide testimony in support of ARB's proposed Commercial Harbor Craft regulation. We believe an important opportunity exists to significantly reduce emissions from commercial harbor crafts. Staff has correctly emphasized the use of engine replacements and repowers as the primary compliance route for achieving the PM and NOx reductions proposed by these regulations. MECA agrees with ARB staff that the development of retrofit strategies for marine applications will likely occur in the future but this retrofit market is not currently mature enough to require retrofits as a part of the proposed regulations covering harbor craft. Leaving the option for the use of appropriate retrofit technology to comply with these proposed regulations provides some incentive for manufacturers to devote resources in the future to the verification of retrofit technology for marine applications. The verification of retrofit strategies for marine engines will likely result from the extension of verified retrofit technologies for on-road and off-road diesel engines. MECA also supports the staff proposal to require new ferries built after January 1, 2009 to be equipped with best available control technology (BACT). MECA believes that BACT for these new ferries should be DOC+SCR systems that already have significant marine engine experience.

MECA is a non-profit association made up of the world's leading manufacturers of mobile source emission controls. MECA member companies have over 30 years of experience and a proven track record in developing and commercializing exhaust emission control technologies. A number of our members have extensive experience in the development, manufacture, and commercial application of emission control technologies for diesel engines, including diesel engines used in nonroad applications. Our members are partnering with vehicle and engine manufacturers to make "clean diesel" cars and trucks a reality here in North America. A recent survey of MECA's members revealed that our industry has invested more than $2 billion in R & D and capital expenditures to develop, optimize, and commercialize advanced emission control technology to substantially reduce emissions from on-road and off-road diesel engines.

Technologies to reduce diesel emissions from marine engines, such as diesel particulate filters (DPFs), diesel oxidation catalysts (DOCs), and selective catalytic reduction (SCR) systems, are commercially available today. These emission control technologies have already been installed on millions of new light-duty and heavy-duty vehicles and equipment and as retrofit technology on hundreds of thousands of existing on-road and off-road diesel engines worldwide to provide significant reductions in diesel particulate matter (PM) and oxides of nitrogen (NOx) emissions, as well as reductions in hydrocarbon (including toxic hydrocarbons like poly-aromatic hydrocarbons) and carbon monoxide (CO) emissions. There is growing experience with these "clean diesel" emission control technologies on marine diesel engines. These marine diesel engine applications pose unique operating environments and challenging packaging envelopes for emission control technologies, but proper application engineering has resulted in the successful application of DOCs, DPFs, and SCR catalysts on a variety of marine engines.

Emission Control Technologies for Marine Diesel Engines

MECA would like to provide specific comments on the experience base with diesel particulate filters, diesel oxidation catalysts, and SCR catalysts for their potential in achieving the proposed commercial harbor craft standards. While MECA agrees with ARB staff report's assessment that retrofit with diesel emission control strategies present multiple challenges, we believe that these challenges can be overcome as demonstrated by the successful installation and operation of these technologies on several marine applications.

Diesel Particulate Filters (DPFs) – Diesel particulate filters are commercially available today, with over 200,000 on-road heavy-duty vehicles worldwide retrofitted with high-efficiency DPFs and over four million new diesel passenger cars in Europe equipped with this technology since 2000. Starting this year here in the U.S., all new heavy-duty diesel highway engines are equipped with diesel particulate filters to achieve EPA's 2007, 0.01 g/bhp-hr PM highway diesel standard. New "clean diesel" light-duty vehicles that are entering the U.S. market will also be equipped with DPFs to achieve compliance with EPA's light-duty Tier 2 PM emission regulations.

To date, the real-world experience with DPFs in these many light-duty and heavy-duty on-road vehicle applications has been very good. Through millions of miles of operation, DPFs continue to provide high reductions in PM emissions in these applications with very few operational problems. Most recently, the launch of catalyst-based filters in the U.S. and Canada on 2007 model year heavy-duty highway engines has received favorable feedback from owners and operators.

These successful on-road DPF applications are generally employing durable ceramic wall-flow filters to achieve in excess of 90% reduction in engine-out PM levels over years of operation. Light-duty and heavy-duty new vehicle applications of DPFs rely on combinations of both passive and active regeneration strategies for periodic combustion of soot that accumulates on the filter. In many cases, catalysts displayed directly on the filter substrate and/or located upstream of the filter element have been used to facilitate soot oxidation under normal exhaust temperatures. MECA supports the staff proposal that will require harbor craft diesel engines to be fueled with CARB diesel (or an approved alternative diesel fuel), since the use of ultra-low sulfur diesel fuel is an important enabler for the use of catalyst-based PM control technologies such as DPFs and DOCs. Wall-flow ceramic filter elements are now available in a number of material types including cordierite, silicon carbide, aluminum titanate, and mullite. Substrate manufacturers continue to refine the designs and production processes for these filter elements in order to improve durability characteristics, minimize exhaust backpressure, and make these filter substrates more compatible with catalyst coatings.

Wall-flow filters, in addition to trapping soot, also trap inorganic ash constituents present in the exhaust stream that are chiefly associated with lubricant additive packages. Regular maintenance of wall-flow filters to remove accumulated ash is necessary to keep engine backpressures at acceptable levels. However, through the use of low-ash containing lubricants, improved engine designs that minimize lubricant consumption, proper filter substrate sizing, and novel filter substrate cell designs (e.g., asymmetric inlet and outlet cell sizes), ash cleaning intervals can be extended to many thousands of hours of operation. Some engine manufacturers expect maintenance intervals for filters equipped on new 2007 heavy-duty trucks to reach 300,000 miles or more in Class 8 long haul trucks. Filter maintenance intervals for retrofit filters will depend strongly on duty cycles and engine lubricant consumption characteristics. MECA published a report on filter maintenance practices and experience in 2005. This report is available on the MECA website at: www.meca.org/galleries/default-file/Filter_Maintenance_White_Paper_605_final.pdf.

More recently, metal substrate filter designs have been developed and introduced for PM control of diesel engines. These designs combine more tortuous flow paths with sintered metal filter elements to achieve intermediate PM filtering efficiencies that can range from 30 to 70% depending on engine operating conditions and the soluble content of the diesel particulate matter emitted by the engine. Like ceramic wall-flow filters, these metal filter designs can be catalyzed directly or used with an upstream catalyst to facilitate regeneration of soot captured by the substrate. These metal substrate filter designs have been verified by the California Air Resources Board as a Level 2 retrofit device (50-85% PM reduction) on a range of highway diesel engines, have been used by one engine manufacturer (MAN) in Europe for complying with Euro 4 heavy-duty diesel PM limits, and are available in Europe as a retrofit PM technology for light-duty diesel vehicles. Most recently, this metal substrate filter design has been introduced by Daimler on their new Smart diesel passenger car in Europe to reduce PM emissions and comply with Euro 4 light-duty emission standards. Due to their more open designs, these metal substrate filter designs can operate over very long timeframes without the need for cleaning the substrate of trapped lubricant oil ash.

Several demonstration projects have been, or are being conducted in the U.S., to evaluate the feasibility of equipping marine engines with DPFs. In 2006, a U.S. Navy work boat/barge was retrofitted with an active DPF system. Emissions testing results show that the DPF, along with engine modifications, achieved an 85 percent reduction in PM and a 74 percent reduction in NOx emissions relative to the original engine configuration. Active filters employing diesel fuel burners for filter regeneration have been successfully installed in a limited number of marine engine applications in Europe. Additional details of the marine applications of DPFs are summarized in MECA's Locomotive and Marine case study report available at: www.meca.org/galleries/default-file/MECA%20locomotive%20and%20marine%20case%20study%20report%201006.pdf.

Diesel Oxidation Catalysts (DOCs) – DOCs are a well proven technology for oxidizing gaseous pollutants and toxic hydrocarbon species present in the exhaust of diesel engines. DOCs are also effective at reducing diesel PM emissions through the catalytic oxidation of soluble hydrocarbon species that are adsorbed on soot particles formed during the combustion process. DOCs can also oxidize NO present in the engine exhaust to NO_2. This NO_2 can then be used to oxidize soot captured on a DPF at relatively low exhaust temperatures (so-called passive filter regeneration) or to improve the low temperature performance of SCR catalysts by providing a more kinetically variable mixture of NO and NO_2 to the SCR catalyst. Both the oxidation of soluble PM species and NO oxidation pathways could be useful in meeting the proposed commercial harbor craft regulation.

Over two million oxidation catalysts have been installed on new heavy-duty highway trucks since 1994 in the U.S. These systems have operated trouble free for hundreds of thousands of miles. Many new 2007-compliant heavy-duty trucks offered for sale in the U.S. and Canada include an oxidation catalyst upstream of a catalyzed diesel particulate filter in order to reduce PM emissions to levels below 0.01 g/bhp-hr. Oxidation catalysts have been used on millions of diesel passenger cars in Europe since the early 1990s and oxidation catalysts have been installed on over 250,000 off-road vehicles around the world for over 30 years. DOCs include Pt or Pt/Pd catalyst formulations supported on ceramic or metallic substrates.

There have been limited demonstration projects evaluating the feasibility of equipping marine engines with DOCs. In 2003, the New York State Energy Research and Development Authority initiated a program to collaborate with private ferry operators to demonstrate emission reduction technologies, including DOCs. Two ferries were retrofitted with DOCs: one ferry with a DOC using a fuel-borne catalyst was estimated to achieve NOx reductions of 5 percent with ultra-low sulfur diesel and PM reductions of 50 percent; the other ferry equipped with a DOC was estimated to achieve PM reductions of 40 percent. Additional details of the marine applications of DOCs are summarized in MECA's Locomotive and Marine case study report available at: www.meca.org/galleries/default-file/MECA%20locomotive%20and%20marine%20case%20study%20report%201006.pdf.

Selective Catalytic Reduction (SCR) Technology – SCR technology is a proven NOx control strategy. SCR has been used to control NOx emissions from stationary sources for over 20 years. The experience from stationary applications of SCR technology can be applied to marine installations due to the similar, non-transient modal operating conditions employed in both applications. Stationary demonstrations range from diesel back-up generators, gensets and stationary engines used on large construction cranes. The exhaust controls that have been implemented to achieve both PM and NOx reductions include wall-flow DPFs in combination with SCR to achieve greater than 85% reduction in PM and greater than 90% reduction in NOx. MECA has summarized this experience in a case study report available at: http://www.meca.org/galleries/default-file/Stationary%20Engine%20Diesel%20Retrofit%20Case%20Studies%200807.pdf.

More recently, SCR systems have been applied to mobile sources, including trucks, off-road equipment, and marine vessels. Applying SCR to diesel-powered engines provides simultaneous reductions of NOx, PM, and HC emissions. Open loop SCR systems can reduce NOx emissions from 75 to 90 percent. Closed loop systems on stationary engines have achieved NOx reductions of greater than 95 percent. Modern SCR system designs have been detailed for mobile source applications that combine highly controlled reductant injection hardware, flow mixing devices for effective distribution of the reductant across the available catalyst cross-section, durable SCR catalyst formulations, and ammonia slip clean-up catalysts that are capable of achieving and maintaining high NOx conversion efficiencies with extremely low levels of exhaust outlet ammonia concentrations over thousands of hours of operation.

The majority of heavy-duty engine manufacturers are offering urea-SCR systems in highway truck applications to comply with Euro IV and V emission regulations in Europe, with more than 100,000 of these European SCR-equipped trucks already in service. Engine manufacturers here in North America are also seriously considering combined DPF+SCR system designs for complying with EPA's 2010 heavy-duty highway emission standards. A number of combined DPF+SCR system demonstration projections have been completed or are in progress on highway trucks both here in the U.S. and Europe. DOC+SCR systems are also being used commercially in Japan for new diesel trucks by several engine manufacturers to comply with Japan's 2005 standards for new diesel trucks. Several technology providers are developing and demonstrating retrofit SCR systems for both on-road trucks and off-road equipment that combine SCR catalysts with either DOCs or DPFs. The growing experience base and advanced technologies that are being developed to meet EPA's 2007/2010 on highway emission standards can be directly applied to marine applications and help ferry owners and operators comply with the BACT requirements for new ferries under this proposal.

Since the mid-1990s, SCR technology using a urea-based reductant has been safely installed on a variety of marine applications in Europe, including auto ferries, cargo vessels, military ships, and tugboats, with over 200 systems installed on engines ranging from approximately 450 to over 10,000 kW. The Port Authority of New York and New Jersey has recently conducted an innovative pilot project to demonstrate diesel emission reduction technologies on a Staten Island ferry. The ferry was retrofitted with DOC+SCR systems on its two main, four-stroke propulsion engines. Emissions testing observed on the ferry showed NOx reductions that typically exceeded 94% during ferry cruise modes. Additional details on this Staten Island ferry project are available at: www.mjbradley.com/documents/Austen_Alice_Report_Final_31aug06.pdf. This ferry project along with other operational, marine SCR installations provides firm evidence that SCR systems can be engineered to meet rigorous marine industry conditions and safety standards. Some of these marine SCR systems have been operating since the 1990s with high NOx conversion efficiencies and no reported safety-related issues. Because of this SCR experience with marine engines, MECA believes that DOC+SCR systems should be BACT for the propulsion engines on new ferries built and brought into service in California after January 1, 2009.

Conclusion

In closing, we commend the Air Resources Board for its continuing efforts to provide the people of California with healthy air quality and for demonstrating true leadership in this regulatory program that will significantly reduce PM and NOx emissions from commercial harbor crafts. MECA believes that technologies to reduce diesel emissions, such as DPFs, DOCs, and SCR, are available today to reduce NOx and PM emissions from off-road vehicles and engines and these same technologies can have a role in reducing emissions from both new and in-use harbor craft. Including retrofit technologies as a potential compliance option for harbor craft provides manufacturers with a clearly defined market opportunity that should allow for the extension of verified on-road and off-road retrofit technologies for reducing PM and/or NOx emissions into the marine sector. Our industry is committed to continue to invest in the development and verification of cost-effective, retrofit emission control technologies for all existing diesel engine applications, including marine harbor craft.

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