STATEMENT OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION
ON THE AIR RESOURCES BOARD'S
PROPOSED AMENDMENTS TO THE REGULATION FOR MOBILE CARGO HANDLING EQUIPMENT AT PORTS AND INTERMODAL RAIL YARDS

September 19, 2011

MECA is pleased to provide testimony in support of ARB's proposed amendments to the regulation for mobile cargo handling equipment used at ports and intermodal rail yards including the relief provisions in the proposal allowing compliance extensions when verified diesel emission control systems (VDECS) are not available. We believe that the proposal presents a balanced approach that extends flexibility and relief to fleets while allowing additional time for expanding the selection of verified diesel emission control systems (VDECS) available for retrofitting non-yard truck cargo handling equipment (CHE) and vehicles. MECA members are committed to continue to develop and verify the VDECS technologies to meet the emission reduction targets of this regulation.

MECA is a non-profit association of the world's leading manufacturers of emission control technology for motor vehicles. Our members have over 35 years of experience and a proven track record in developing and manufacturing emission control technology for a wide variety of diesel and gasoline on-road and off-road vehicles and equipment. A number of our members have extensive experience in the development, manufacture, and application of PM and NOx control retrofit technologies including most of the devices on ARB's verified technology list.

Our members have invested and continue to invest significant resources in developing and verifying diesel retrofit technologies for the whole range of in-use diesel engines currently operating in California, including on-road, off-road, and stationary sources. New diesel emission control products continue to be added to ARB's list of verified technologies. The number of VDECS suitable for off-road vehicles has continued to increase to include five passively regenerated Level 3 DPF devices, including one device that achieves 85% PM and 40% NOx reduction based on HC-SCR/ Lean NOx catalysts. The list also includes four actively regenerated Level 3 DPFs designed specifically to accommodate challenging duty cycles with low exhaust temperatures. Furthermore there is one Level 2 device combining a DOC with alternate fuel to achieve a 50% PM reduction and four Level 1 VDECS that end users may use to help them comply with this regulation. Manufacturers are expected to verify even more passive and active filter technologies in the coming year for off-road applications to further expand the options available to fleet owners to comply with ARB's requirements. Several manufacturers are closely engaged in verifying combined Level 3 DPF and urea-SCR retrofit technology with ARB and these efforts should lead to additional commercial, verified NOx and PM reduction technologies.

We provide the following summary of emission control technology options available to

reduce PM and NOx emissions from existing off-road vehicles along with some additional comments regarding the technological feasibility and retrofit experience with these devices to meet diesel emission reduction goals. MECA provides additional documents on diesel retrofit technologies on our website, www.dieselretrofit.org, such as "Retrofitting Emission Controls on Diesel-Powered Vehicles" and "Case Studies of Construction Equipment Diesel Retrofit Projects."

Technologies to Reduce Diesel PM and NOx Emissions from CHE

Diesel Particulate Filters – Diesel particulate filters (DPFs) are the most effective PM reduction technology for a wide range of diesel engine applications. High-efficiency DPF technology can reduce PM emissions by up to 90 percent or more, ultra-fine carbon particles by up to 99+ percent and, depending on the system design, toxic HC emissions by up to 80 percent or more. Over 200,000 on-road heavy-duty vehicles and 50,000 off-road pieces of equipment have been retrofitted with passively or actively regenerated DPFs worldwide. The durability and performance of PM control technologies is being demonstrated on OEM on-road applications beginning with the 2007 model year. Since 2007, nearly every new diesel vehicle sold in the U.S. or Canada has been equipped with a high efficiency diesel particulate filter to comply with the U.S. EPA's 2007/2010 on highway regulations. This represents over 800,000 new trucks operating on DPFs mostly in the U.S. Beginning in 2010 the same new highway trucks have been required to reduce NOx emissions by 90% relative to pre-2007 requirements and are being equipped with NOx control technologies such as urea-SCR catalysts and high flow EGR systems. An increasing number of new off-road diesel engines are now being certified with DPFs to comply with EPA's interim Tier 4 PM emission standards. MECA's annual sales survey of retrofit technologies has shown that since 2001, approximately 25,000 Level 3 DPFs in California and nearly 60,000 across the country have been installed on vehicles from construction equipment to long-haul Class 8 tractors and many others including cargo handling equipment.

These advanced wall-flow DPFs not only capture soot particles in the $PM_{2.5}$ range, they are also very effective at capturing over 99+% of ultrafine particles. Ultrafine particles in the less than 20 nanometer size range contribute almost nothing to the overall mass of PM in the exhaust however; they may represent a huge number of particles with an extremely high surface area. Recently numerous health studies have shown that these ultrafine particles may pose the greatest adverse health effects due to their high surface area that can attract volatile toxic compounds and their ability to penetrate deep into the lungs. Although ultrafine particles are not currently regulated they are the topic of extensive research and discussion among the health community. A co-benefit of Level 3 DPF filters is that they capture or oxidize the majority of ash, carbonaceous or volatile ultrafine particles in the exhaust.

Flow-Through Filters – These "partial" filters make use of wire mesh supports or tortuous metal substrates that employ sintered metal sheets. These metal substrates can be catalyzed directly or used in combination with an upstream catalyst to facilitate regeneration of soot deposits. Several partial filter designs have been verified by ARB as Level 2 PM reduction technologies with one specifically verified for rubber tired gantry cranes. These partial filter designs are less susceptible to plugging and can offer PM reduction efficiencies in the 50-75

percent range depending on engine operating conditions and the soluble fraction of the PM. Some of these partial filter designs have also been shown to operate over longer periods of time before ash cleaning associated with engine lubricant consumption is necessary.

Development work is underway to further enhance the performance of filter system designs. For example, work continues on developing and implementing additional filter regeneration strategies that will expand the applications for retrofitting DPFs. Development work on filter materials and designs to further enhance filter system durability and to further reduce backpressure are also under development.

Selective Catalytic Reduction (SCR) – SCR technology is a proven NOx emission control strategy. To reduce NOx, these catalysts rely on either an ammonia or hydrocarbon (HC) reductant. The most commonly used approach uses a urea solution as a source of the ammonia. Ammonia SCR has been used to control NOx emissions from stationary sources for over 25 years. More recently, it has been applied to select mobile sources, including trucks, marine vessels, and locomotives. In 2005, SCR using a urea-based reductant was introduced on a large number of on-road diesel heavy-duty engines to help meet the Euro 4 or Euro 5 heavy-duty NOx emission standards. There are now more than 300,000 SCR-equipped trucks operating in Europe. SCR is being used by most engine manufacturers for complying with U.S. EPA's on-road heavy-duty diesel engine emission standards since 2010 and in Japan since 2009. Several auto manufacturers have also commercialized SCR systems for light-duty diesel vehicles that are being sold in California and across the U.S. Some new off-road diesel engines are now being equipped with SCR systems to comply with EPA's interim Tier 4 NOx standards. Most engine manufacturers have indicated that SCR will be used on a large variety of new off-road diesel engines to comply with future EPA Tier 4 final regulations.

Several MECA member companies have proven experience in the installation of SCR systems for both stationary and mobile engines, as well as the installation of integrated DPF+SCR emission control systems for combined PM and NOx reductions. A number of off-road diesel demonstrations have been done with combination SCR+DPF retrofit systems. For example, an SCR+DPF system was installed on a 170 hp John Deere compressor engine involved in the Croton Water Treatment project in New York City. In California, a 300-ton gantry crane powered by a turbocharged, after-cooled diesel engine rated at 850 kW was equipped with such a combined emission system in 2001. Applying SCR to diesel-powered engines provides simultaneous reductions of NOx, PM, and HC emissions and VDECS manufacturers are in the process of verifying DPF + SCR retrofit systems for both on-road and off-road applications. In some of these applications, SCR + DPF equipped retrofit systems have achieved over 80% NOx reduction. There are nearly 300 SCR + DPF retrofit devices operating on medium and heavy-duty on-road vehicles in Europe. Although important differences exist between on-road and off-road diesel applications, many of the same manufacturers develop similar systems for OEM on-road and off-road applications. The experience from on-road applications are typically carried over into more challenging off-road vehicles.

Lean NOx Catalyst (LNC) Technology – LNC or HC-SCR catalysts typically use a HC reductant, such as the diesel fuel on board the vehicle, to reduce the NOx in the exhaust.

Integrated HC-SCR + DPF retrofit devices have been installed on thousands of on-road vehicles and a system capable of Level 3 PM and 40% NOx reduction has been verified for off-road equipment. ARB has verified a similar technology option that combines a lean NOx catalyst with a diesel particulate filter to achieve 25 percent NOx reduction with Level 3 particulate control on a wide variety of on-road heavy-duty engines.

Experience with Retrofitting Off-Road Equipment

General remarks on the lack-of performance of retrofit devices are often made with no supporting information to back them up. There are always isolated issues with any technology but in general DPF retrofit systems have been demonstrated repeatedly to work at a high level of durability and reliability. Although off-road applications, like those in cargo handling, pose engineering challenges and special requirements, the use of exhaust emission control technology for off-road diesel engines is not new. Both PM and NOx control technologies have been demonstrated and commercialized for off-road applications in California and elsewhere. For over 30 years, off-road diesel engines used in the construction, mining, and materials handling industries have been equipped with exhaust emission control technology – initially with diesel oxidation catalysts (DOCs) and followed later by diesel particulate filters (DPFs). These systems have been installed on vehicles as original equipment or as retrofit technology on over 250,000 non-road engines worldwide. Over 50,000 active and passive DPF retrofit systems have been installed worldwide on off-road applications. More than 20,000 of these filters have been successfully employed in Europe on construction equipment used in tunneling projects. A 2003 survey (SAE Paper 2004-01-0076) of 3,848 construction retrofit installations from 2001 to 2003 in Europe found a failure rate of only 1-2 percent. The failures were most often associated with improper engine maintenance and operation rather than DPF functionality. Any product issues cited in this study were easily addressed through further product improvements.

Proper integration of emission control technology on off-road vehicles and equipment is important for three reasons: 1) to ensure the system is installed at the appropriate place in the exhaust system to optimize effectiveness, 2) to ensure the system physically fits in the available space, and 3) to ensure safety. Over 30 years of experience in integrating emission control technologies on a variety of diesel and SI off-road vehicles and equipment ranging from <25 hp to over 750 hp provides a clear indication that emission control technology can be successfully integrated on a wide range of off-road vehicles to meet ARB's proposed standards and ensure the safety of the vehicle operator and others. Safety is an essential component of the engineering and installation of retrofit emission control devices. MECA and our members have been actively engaged with ARB and California OSHSB staff to develop effective and realistic amendments to the California Code of Regulations that serve to ensure that modifying construction equipment with VDECS is done with consideration to the safe operation of the vehicle, the operators and workers at the ports and intermodal rail yards. Having a well defined safety review process in place will ensure that implementation of the proposed regulations is accomplished with minimal administrative delays or judgments.

The importance of proper engine maintenance cannot be overemphasized for the durability and long term performance of the vehicle and DPF. Regular maintenance becomes

critical once a DPF is installed because the presence of smoke in the exhaust can no longer be used as an indicator of engine operation problems. High smoke opacity could be a sign of excessive oil consumption or a bad fuel injector, both of which result in high engine out PM that may result in plugging of the filter. Once a DPF is installed in the exhaust it will capture the PM and mask any signs of high smoke. Therefore MECA fully supports the inclusion of the mandatory opacity-based monitoring program as part of the proposed amendments. An opacity test is an inexpensive, simple measurement that should be an integral part of a proactive preventative maintenance program. This measurement has been required for on-highway vehicles for some time whereas it is a new procedure for off-road fleets. The SAE standard (J1667) provides a recommended practice for performing an opacity measurement that is applicable to both on-road and off-road vehicles. In fact, EPA off-road engine certifications provide the opacity limit that the engine was certified to as well as the PM mass standard. Performing an annual opacity measurement is a way for fleets to actively monitor the condition of their engines and perform the necessary maintenance to keep their equipment functioning at the engine manufacturers recommended standards. This will have the added co-benefit of reduced emissions from all of the CHE and better performance and longer vehicle life for fleet owners.

End users have suggested alternate ways to monitor the state of maintenance of the engine such as the use of back pressure monitor (BPM) data downloads in lieu of opacity measurements. Although the two may be related, the BPM information is a direct indicator of the health of the DPF system whereas; the opacity is a direct indicator of the health of the engine. The backpressure only indirectly relates to the maintenance of the engine. For example, high backpressure may be a result of high engine out PM, or incomplete filter cleaning. To get at the root cause of a high back pressure problem an opacity measurement will be required to rule out any engine maintenance problems. Our members experience has shown that 90% of the time, an engine maintenance problem will precede a DPF problem. Performing annual opacity measurements and maintaining service records puts the maintenance professionals in charge of their fleet. Ultimately, if a problem arises, a BPM download will most likely be done to help in its diagnosis; however having the regular opacity checks will identify the need for engine maintenance before a more serious DPF problem arises that may lead to a necessary and costly filter replacement.

MECA members are engaged with ARB staff on the next round of amendments to the verification and in-use compliance regulation. This will insure that VDECS have demonstrated the durability and performance required of their final applications. The in-use compliance program insures that devices in the field continue to meet their design standards over their full useful life.

Port and intermodal rail yard equipment owners have multiple options to comply with this regulation including replacing older vehicles with new equipment, repowering older equipment with new Tier 4 interim or Tier 4 final certified engines or retrofitting older engines by installing best available control technology (BACT) such as Level 3 DPF wall-flow filters. Recently a number of OEMs have certified Tier 4 interim engines without OEM installed DPFs. At least one engine manufacturer has indicated that it intends to certify Tier 4 final engines

without wall-flow particulate filters. MECA is very concerned that a large number of future off-road engines will be deployed without DPFs that will survive many decades of use in the ports. By not using DPFs, these Tier 4 compliant engines will be able to comply with this regulation without employing BACT as required of older, in-use vehicles that are retrofit with VDECS or Tier 4 FEL certified engines that are required to install Level 3 VDECS. The Tier 4 certified engines that do not employ DPFs will be emitting billions of ultrafine PM particles for years to come. The original off-road fleet rule, adopted by the Board in May of 2007, provided a backstop that required all off-road vehicles operated in the state to be equipped with DPFs either via retrofits or original equipment by 2023. The removal of this requirement will mean that only some vehicles and equipment will operate with the best available control technology.

Conclusions

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 innovative regulatory program. MECA fully supports the amendments in this proposal and we believe that this regulation will significantly reduce PM and NOx emissions from in-use, diesel, cargo handling equipment operating at California's ports and intermodal rail yards. These important emission reduction strategies not only protect the health of all the citizens of California but also provide an important source of economic growth and green jobs for the state. We wish to thank the ARB staff for its willingness to receive input from all interested parties throughout the regulatory process. Our industry pledges its continued support and commitment to work with ARB staff and all interested stakeholders to ensure that the desired emission reductions outlined in the proposed amendments to the regulation for mobile cargo handling equipment are effectively achieved within the time frame specified in the proposal.

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