WRITTEN COMMENTS OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION
ON THE CHINA MINISTRY OF ENVIRONMENTAL PROTECTION'S PROPOSED STAGE VI EMISSIONS STANDARDS FOR HEAVY-DUTY VEHICLES

November 13, 2016

The Manufacturers of Emission Controls Association (MECA) is pleased to provide comments in support of the China Ministry of Environmental Protection's Stage VI proposed standards for exhaust emissions from heavy-duty vehicles. MECA thanks MEP for their leadership in developing a holistic set of requirements that go beyond Euro VI and incorporate additional compliance and enforcement provisions that have evolved over the past 40 years in North America. MECA has compared the essential provisions of the European and U.S. light-duty vehicle regulatory framework in a table that can be found on our website at: http://www.meca.org/regulation/mobile-source-regulatory-comparison.

MECA is a non-profit association of the world's leading manufacturers of emission control technology for mobile sources. Our members have over 40 years of experience and a proven track record in developing and manufacturing emission control technology for a wide variety of on-road and off-road vehicles and equipment, including extensive experience in developing exhaust and evaporative emission controls for gasoline and diesel vehicles and engines in all world markets. Our industry has played an important role in the emissions success story associated with light and heavy-duty vehicles in North America, and has continually supported efforts to develop innovative, technology-forcing, emissions programs to deal with unique air quality problems such as those in China.

Finalizing these standards for new heavy-duty diesel vehicles will provide significant economic, climate change and health benefits for the citizens of China. These proposed emission standards build on the extensive experience and success with advanced diesel particulate filters (DPFs), and selective catalytic reduction (SCR) technology that spans more than 15 years in the major vehicle markets of the United States, Canada, Europe, and Japan. DPFs and SCR technologies have been used on millions of diesel vehicles to deliver cost-effective, durable reductions of diesel PM and NOx emissions consistent with China MEP's proposed standards and implementation date in the 2020-2021 timeframe.

MECA commends the MEP for putting policies in place to make 10 ppm sulfur fuel available in 2018 well in advance of the proposed implementation of this rule to facilitate and streamline the adoption of the best available emission control technologies into new vehicles that will need to comply with these proposed standards. Our industry supports the emphasis on fuel neutral standards for gasoline and diesel vehicles to create a fair and balanced market for all technologies to compete. MECA believes that this proposal represents a solid framework for a balanced, enforceable and comprehensive set of emission standards to achieve significant emission reductions from heavy-duty diesel engines and vehicles in China. Several areas warrant some additional scrutiny and consideration as MEP finalizes these heavy-duty standards. An unintended consequence of not having fuel neutral standards is that emissions may increase

over time, as the application of engines on vehicles transition to types with the least stringent emission standards requiring the least expensive emission controls. We are concerned that a stringent set of diesel emission standards may cause some applications to shift to gasoline engines and therefore we urge the MEP to finalize the emission standards for heavy-duty gasoline engines to equal emission levels as diesel engines including US style evaporative and On-Board Refueling Vapor Recovery (ORVR). Future amendments to strengthen heavy-duty OBD requirements, similar to those in the U.S. will further benefit the overall air quality in China.

For heavy-duty engines and vehicles regulated under the proposed China VI standards, advanced diesel emission control technologies including diesel oxidation catalysts, diesel particulate filters, and selective catalytic reduction catalysts will be combined with future, advanced diesel engines to comply with these emission requirements. The experience base with DPFs and SCR technology on engines and vehicles is extensive. Since 2007 every new heavy-duty diesel vehicle sold in the U.S. or Canada has been equipped with a high efficiency diesel particulate filter to comply with U.S. EPA's 2007/2010 heavy-duty highway engine emission regulation. This represents over 4 million new trucks operating on DPFs, mostly in the U.S. In 2010, new U.S. and Canadian highway trucks were required to reduce NOx emissions by 90 percent relative to pre-2007 levels and have been equipped with NOx control technologies, in addition to DPFs. SCR technology has become the NOx control technology of choice for diesel engines with successful applications on light-duty vehicles, heavy-duty vehicles, off-road equipment, marine engines, stationary engines and locomotive engines in all major markets of the world. Detailed information about the types of diesel emission control technologies being deployed on heavy-duty diesel engines can be found in MECA's diesel technology report here: http://www.meca.org/galleries/files/MECA_Diesel_White_Paper_12-07-07_final.pdf .

SCR applications on new highway, heavy-duty trucks in U.S., Europe and Japan have already been shown to allow engine manufacturers the possibilities of calibrating engines for lower fuel consumption (and lower greenhouse gas emissions), while still meeting applicable NOx emission standards. Engine manufacturers that employed SCR technologies on 2010-compliant heavy-duty, highway engines in the U.S. claimed up to 5% improvements in fuel efficiency versus engines that did not employ SCR technology. These fuel efficiency improvements are most evident at highway speeds; however, in the future, employing thermal management strategies can shorten the warm-up portion of the cold start and facilitate urea injection earlier in the test cycle and thus expand the calibration optimization window to further reduce CO_2 emissions. The high NOx conversion efficiencies associated with SCR catalysts enable engines to be operated at conditions that yield lower fuel consumption. Engine manufacturers continue to optimize engine fuel consumption characteristics and SCR system designs to assist in achieving the reductions proposed by MEP under this regulation while also achieving future GHG reductions simultaneously. The California Air Resources Board (ARB), recognizing the opportunities to further reduce NOx emissions from heavy-duty diesel engines as a way to achieve national ozone standards, are initiating work on the next round of heavy-duty engine standards setting NOx limits as low as 0.02 g/bhp-hr, which is equivalent to a 90% reduction from U.S. EPA's 2010 highway, heavy-duty engine standards. To demonstrate the feasibility of achieving these low NOx levels from heavy-duty engines, ARB and MECA are funding a test program at Southwest Research Institute on a state-of-the-art 13 L Euro VI

certified engine as well as a 12 L stoichiometric natural gas engine. The program focuses on reducing NOx emissions from the low temperature portions of the test cycle including cold-start and low speed operation. Preliminary results are achieving NOx emission levels well below 0.02 g/bhp-hr NOx on full useful life aged (435,000 miles/700,000 km) exhaust emission control components.

Beyond SCR catalyst and substrate advances, the next generation NOx reduction strategies will require careful attention to both active and passive thermal management strategies to retain the exhaust heat provided by the engine for activating catalytic controls, as well as, offering innovative approaches to actively heat the exhaust during low speed and low load operation of the engine when exhaust temperature is at a premium. An example of the types of thermal management strategies being considered under this program include dual wall and insulated exhaust pipes and exhaust manifolds, active exhaust heating systems and thermally insulating substrate mounting materials along with other low thermal mass exhaust components. Careful attention to engine calibration at low and high temperatures and urea dosing strategies are also critical to achieving these ultra-low NOx levels. Specifically, to address NOx emitted at low exhaust temperatures, manufacturers are developing passive NOx adsorber (PNA) catalyst technology, which is used in combination with the DOC to trap and store NOx at temperatures below 200^{o}C, before the SCR catalyst becomes active. Once the exhaust temperature is sufficient for SCR catalyst activity, the urea dosing system is activated as the NOx stored on the PNA begins to desorb, causing it to be converted by the ammonia reductant over the SCR catalyst. This new technology is already being evaluated on light-duty vehicles for achieving lower tailpipe NOx levels. Another technology, already in several commercial light-duty diesel applications, takes advantage of higher porosity DPF substrates to allow SCR catalyst to be deposited directly onto the DPF and thereby effectively moving the SCR closer to the turbocharger outlet in a more close-coupled position. Faster heat-up of the SCR catalyst has allowed earlier ammonia injection and NOx reduction at low temperatures. Combining this with start-stop technology on the vehicle allows the heat to be retained in the catalyst during idle and low speed operation allowing it to function over a greater part of the duty-cycle.

With engines equipped with DPF+SCR systems, the importance of proper engine maintenance cannot be overemphasized for the durability and long term performance of the vehicle and the DPF+SCR emissions system. Regular maintenance becomes critical once a DPF+SCR system 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 lead to plugging of the filter. Once a DPF is installed in the exhaust system, it will capture the PM and mask any signs of high smoke. The California Air Resources Board has recently initiated an effort to identify best maintenance practices for heavy-duty engines and MEP should utilize information under development in California to inform truck and bus owners of the importance of utilizing effective, preventive maintenance practices. Similarly, CARB is exploring alternate measurement methods for inspection and maintenance of emission controls on heavy-duty trucks. We urge MEP to follow these developments and consider including inspection and maintenance provisions as part of future in-use testing requirements.

MECA applauds MEP for including OBD requirements as part of the proposed China VI heavy-duty diesel engine and vehicle standards. We commend the agency for their vision and leadership in requiring wireless transmission under OBD protocols to comply with China VI. China will be the first demonstration in the world of wireless transmission of OBD data for the purposes of inspection and maintenance of vehicle emission control systems. This will establish important experience for the use of such innovative approaches for real-time OBD inspection of vehicles and equipment in other parts of the globe, such as the U.S., where off-road equipment does not require registration and therefore is difficult to locate and inspect. OBD provides another important check on the performance of key emissions-related components and ensures that the emissions benefit of clean emission control technology are delivered over the full regulated, useful life of the engine. We recommend that as part of future amendments, MEP considers strengthening the OBD requirements along the lines of those established by California ARB for heavy-duty engines.

MECA provides the following general comments on specific provisions within the proposal for consideration by MEP staff.

- We urge the agency to set fuel neutral and stringent standards for heavy-duty gasoline engines to prevent technology and emissions backsliding in certain segments, such as mid-size buses, where heavy-duty gasoline engines are available and could be switched by vehicle manufacturers as a way to avoid the newly proposed heavy-duty diesel requirements.
- We encourage MEP to include stringent evaporative emission requirements on propane engines based on US experience for over 15 years, including ORVR technology, and setting tighter OBD requirements like those developed in the U.S. in their future proposal of standards for gasoline heavy-duty engines.
- Consistent with the U.S. 2007/2010 heavy-duty highway standards, MEP should force closed crankcase ventilation technology to be installed on all engines covered by this proposal. Emissions from an open crankcase are an important portion of the total vehicle PM emissions that would not be detected by a tailpipe standard or PEMS but impacts air and water quality. Monitoring the closed crankcase function should be included in OBD as is being done in U.S.
- The agency should consider requiring the measurement and reporting of unregulated pollutants, such as CO_2, CH_4, NH_3 and N_2O, to establish a database for potential future regulation of vehicle GHG emissions.
- MECA supports the agencies inclusion of PEMS measurement of gaseous emissions and fuel economy for in-use compliance testing, on a chassis dynamometer, of heavy-duty vehicles to confirm that emission control technologies are working as the vehicles age.

In conclusion, MECA thanks the China MEP for bringing forward this proposal to reduce emissions from heavy-duty vehicles. Once finalized, these regulations will provide the citizens of China with significant economic, air quality and climate change benefits. MECA encourages the MEP to finalize these regulations as soon as possible in 2017 and to ensure that urea reductant is made available across the country for these new, more stringent emission regulations. MECA members stand ready to work with their customers to deliver the needed emission control technologies that will allow future new heavy-duty engines and vehicles to comply with the proposed China VI emission standards. We ask for the agency's help in ensuring that the

emission reductions expected under this proposal are realized by implementing a robust inspection, in-use compliance and enforcement program as authorized to MEP and the provincial EPBs by the 2015 version of the China Clean Air Act.

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