

**WRITTEN COMMENTS OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION
ON CALIFORNIA AIR RESOURCES BOARD'S
MOBILE SOURCE STRATEGY
DISCUSSION DRAFT**

October 19, 2015

The Manufacturers of Emission Controls Association (MECA) is pleased to respond to the California Air Resources Board's request for public comments on its Draft Mobile Source Strategy.

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 emission controls for gasoline and diesel engines and vehicles in all world markets. Our industry has played an important role in the emissions success story associated with mobile sources in the United States, and has continually supported efforts to develop innovative, technology-forcing, emissions programs to deal with air quality problems.

MECA commends ARB on its efforts to develop a comprehensive strategy to reduce criteria and GHG emissions from the mobile sector. As pointed out in the draft strategy document, cutting emissions of NOx, VOCs, PM and other pollutants from mobile on and off-road engines and vehicles provides a significant pathway for California to meet the state's future ozone and PM NAAQS attainment and GHG objectives while achieve the important health-related co-benefits of reducing pollution. The draft strategy document rightly points out California's impressive track record in reducing emissions from mobile sources over the past fifty years through the adoption of stringent emission standards for new vehicles and engines, and the implementation of emission reduction policies for existing diesel engines as part of ARB's Diesel Risk Reduction Plan. Mobile sources continue to contribute approximately 80 percent of smog-forming nitrogen oxide (NOx) emissions, 95 percent of diesel particulate matter emissions, and 50 percent of GHG emissions. We agree that more can be done to reduce emissions from the transportation sector and MECA is supporting several important demonstration programs to quantify these potential emission reduction opportunities. MECA's comments will focus on additional opportunities to reduce emissions from off-road mobile sources.

Combustion technology will continue to dominate heavy-duty powertrains in both on-road and off-road vehicles and equipment over the next 15 years. ARB's strategy calls for on-road engine technology that is effectively 90 percent cleaner than today's current standards, with clean, renewable fuels comprising half the fuels burned. To demonstrate the feasibility of achieving these low NOx levels from heavy-duty engines, ARB and MECA are partnering on a test program at Southwest Research Institute to demonstrate the achievable NOx reductions from 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. MECA is providing several exhaust

system solutions for both engines that will deploy the most advanced substrate and catalyst combinations into novel system architectures focused on low temperature NOx reduction. Beyond catalyst 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, dual wall stamped exhaust manifolds, active exhaust heating systems and thermally insulating substrate mounting materials along with other low thermal mass exhaust components. To achieve these very low NOx levels will require advanced reductant delivery systems and close attention to reductant dosing control strategies. To complete the system approach, SwRI engineers will optimize the engine calibration strategies to deliver the lowest possible engine-out emission levels in the exhaust. The goal of the program is to demonstrate the capabilities of next generation advanced NOx reduction technologies with no impact on the fuel efficiency of the diesel and natural gas engines. MECA is extremely confident that this program will deliver a successful result. Furthermore, we believe that similar low-NOx technologies could be deployed on off-road equipment to achieve a 60-70% reduction of NOx emissions beyond the Tier 4 final standards.

ARB staff has identified a Low NOx Engine Standard as one of the on-road, heavy-duty control measures in the draft mobile source strategy document. The mobile strategy includes an off-road control measure to deploy cleaner technologies by accelerating the penetration of zero and near-zero equipment and promoting in-use efficiency gains through use of connected and autonomous vehicles, and worksite efficiencies. The measure stops short of supporting the demonstration of low NOx technologies on off-road equipment and petitioning EPA to initiate a rulemaking effort to tighten emission standards from off-road equipment beyond Tier 4. In ARB's 2012 Vision Document, ARB discussed the need to develop reduced emission off-road engines that are 60% cleaner than Tier 4 final engines by meeting a 0.12 g/bhp-hr NOx emission limit. MECA believes that this component in the Vision Document should be carried over into the mobile strategy. It would be a lost opportunity not to build on the success of ARB's on-road low-NOx test program and fund a similar off-road low NOx demonstration test program. MECA would be interested in partnering with ARB on an off-road low NOx and low PM demonstration program.

To estimate the achievable level of NOx inventory reduction from off-road engines through the deployment of technologies similar to those being demonstrated in the on-road low NOx test program, MECA funded an independent emission inventory forecast study at ENVIRON, to better understand the full benefit of future national NOx tightening for off-road heavy-duty diesel engines beyond Tier 4. This analysis relied on EPA's NONROAD2008 emissions inventory model. The model was run to generate emissions inventories of NOx, VOC, CO and PM for off-road sources for calendar years 2025, 2030, 2040, and 2050. For the heavy-duty sector controls scenario, we selected NOx reduction and implementation timeline inputs for these sectors based on California ARB's June 28, 2012 Vision Document. For the heavy-duty off-road fleet, we assumed a nominal 70% NOx reduction from Tier 4 final levels for engine power ranges from 75-750 hp and an 80% NOx reduction from the small diesel off-road power

category from 25-75 hp. The NOx reductions from the off-road engines were phased in from 2025-2027 and staggered by power ranges analogous to those used to phase-in Tier 4 final off-road engine standards.

We estimated the NOx reduction potential of the fully implemented and phased-in regulations out to 2050. For the 47 contiguous states including the District of Columbia, but excluding California. The modeling results show that the off-road heavy-duty mobile sector has the potential of delivering over 215,000 tons/year of NOx reductions across the 47 lower United States plus D.C. in 2050 or nearly 600 tons per day. We believe that the heavy-duty mobile measures represent the largest opportunity for achieving NOx reductions from the mobile sector and especially for off-road equipment. These reductions would be best achieved through tighter national standards for both heavy-duty highway and off-road diesel engine applications.

To derive a cost effectiveness value, we estimated the incremental cost of the types of additional emission controls, discussed above, that would be necessary to achieve the target reductions from off-road equipment. The incremental cost of control varies widely for construction equipment due to the broad power range and equipment configurations that make up this sector. An average incremental cost of exhaust controls, beyond Tier 4 final, over the 25-750 hp power range is approximately \$350 per engine. Because there are greater opportunities to reduce NOx from the off-road sector, we estimate that these reductions can be achieved within a range of costs from \$1,000 - \$1,500 per ton of NOx.

MECA believes that further reductions in NOx emissions from new off-road diesel engines beyond the Tier 4 off-road requirements will be possible through the combinations of more advanced diesel engines with advanced diesel exhaust emission control technologies. The types of future evolutionary technologies deployed, to achieve a future lower off-road NOx standard, will likely be similar to those being demonstrated in the SwRI on-road low NOx program discussed above. Future off-road emission standards could also take the opportunity to achieve further reductions of PM emissions from this sector. We believe that an indirect benefit from tighter-off-road NOx standards may be to force DPFs on unfiltered engines in order to meet these future standards while still achieving the currently established PM limits. There is further opportunity of reducing PM beyond Tier 4 final levels for the smallest power range of 25-75 hp engines by setting a tighter PM limit that would require the use of filters. ARB is funding a feasibility demonstration of installing emission control technologies on this small diesel engine sector that is being supported by MECA members.

Recent EPA certification information for off-road diesel engines certified in model year 2015 indicates that more than half of the engine families, for engines rated from 37-560 kW, were certified without DPFs. In some cases, OEMs are choosing to remove DPFs that were certified with engines for Tier 4 interim compliance in certifying their Tier 4 final configurations. MECA encourages ARB to characterize the regulated and unregulated exhaust emissions of similar Tier 4 final off-road diesel engines certified with and without DPFs to more completely understand the impacts of these alternative compliance pathways on public health and climate change. A Tier 5 off-road diesel engine regulation that forces the use of best available PM controls and state of the art NOx controls would provide additional public health, ozone and climate change benefits associated with further emission reductions of multiple pollutants from this sector. The European Union is due to finalize soon a Stage 5 off-road diesel

engine regulation that will likely include a particle number-based emission limit to force the use of filters on a large segment of off-road diesel engines. California (and the U.S.) needs to continue its leadership role on reducing emissions from diesel engines by putting policies in place that ensure that off-road diesel engines (including applications in agriculture, construction, locomotive, and marine) utilize both high efficiency filters and SCR controls. The advent of SCR catalyst-coated filters (now commercialized for light-duty diesel applications) allows for the design of compact diesel emission control systems that can simultaneously provide high reductions in PM/black carbon and NOx, pollutants important to both California's ambient air quality and climate change policy goals.

MECA is concerned about the PM emissions durability of off-road Tier 4 engines certified without DPFs. There is ample evidence that engine-based PM control strategies are prone to higher in-use emissions than DPF-equipped engines, due to factors such as cold starts, poor maintenance, and the large variety of duty cycles encountered in the off-road sector. Given the expected, relatively small compliance margins of off-road Tier 4 final engine designs that do not utilize DPFs, MECA believes that ARB should closely scrutinize Tier 4 final certification packages of non-DPF diesel engines and allocate extra compliance and enforcement resources to follow up with in-use emissions testing of any Tier 4 off-road engines certified without a DPF. MECA also believes that ARB and EPA should also strongly consider adoption of a manufacturer run, in-use emissions testing program in the off-road sector that utilizes the latest portable emissions measurement technology to ensure that Tier 4 final off-road engines are delivering the emission reductions associated with the Tier 4 off-road standards. The off-road sector could also benefit from the adoption of on-board diagnostic requirements that are similar in scope to the heavy-duty highway diesel on-board diagnostic requirements required by ARB. In-use testing and OBD ensure that the emissions performance of the engine/equipment is maintained over the regulated full useful life.

MECA encourages ARB to continue its leadership on reducing mobile source emissions by specifying NOx and PM reduction strategies in its upcoming, finalized Mobile Source Strategy report that include demonstrating further emission reductions from off-road engines and petitioning U.S. EPA to initiate a rulemaking to tighten off-road emission standards beyond Tier 4 final levels for both PM and NOx.

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