WRITTEN COMMENTS OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION
ON CALIFORNIA AIR RESOURCES BOARD'S REQUEST FOR PUBLIC COMMENTS ON THE DRAFT CALIFORNIA CLIMATE CHANGE RESEARH PLAN

September 4, 2014

The Manufacturers of Emission Controls Association (MECA) is pleased to respond to the California Air Resources Board's request for public comments on its Discussion Draft of the California Climate Change Research Plan.

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 and the Climate Action Team for developing a Climate Change Research Plan that outlines statewide research priorities to combat climate change. The Research plan demonstrates California state agency coordination and presents research gaps that should be addressed over the next three to five years to help identify, evaluate, refine and implement successful mitigation and preparedness climate measures in California.

In the draft Climate Change Research Plan, the Climate Action Team notes that one of the major research areas will include investigating the multiple pathways that could achieve climate goals related to emissions reductions from transportation, among other sectors, as well as to give priority to research that would concurrently reduce greenhouse gas emissions, while providing other co-benefits by identifying situations where these two climate strategies might work at cross-purposes. The draft Research Plan also states that the transportation sector is the largest contributor to GHG emissions in the State. As such, the research agenda for the next five years is to evaluate the effectiveness of strategies and technological innovations to significantly reduce GHG emissions in the transportation sector.

MECA is partnering with ARB on an important heavy-duty engine technology test program that is targeting 0.02 g/bhp-hr NOx emission levels on both a diesel and stoichiometric natural gas engine. This program is just underway and is being run at the Southwest Research Institute in San Antonio, TX. Work on this test program will utilize a Volvo 13 liter diesel engine and an 11 liter Doosan stoichiometric, natural gas engine. A variety of advanced diesel and stoichiometric natural gas NOx emission control technologies, such as SCR-coated filter systems, passive NOx adsorbers, and advanced three-way catalyst systems, will be evaluated in this test program over the coming three years. The program is targeting 0.02 g/bhp-hr NOx emissions from both engines and exhaust systems over the FTP and RMC-SET test cycles. The WHTC and several vocational cycles will be included for demonstration purposes only.

Emissions measurements will include the full suite of regulated emissions including PM and CO_2. This will allow for a complete evaluation of any trade-offs between reducing NOx emissions and maintaining or reducing the CO_2 emission performance of these engines. The low NOx technologies that are being tested in this program can also be utilized in future off-road diesel engines to further reduce NOx emissions from these off-road engines far below current Tier 4 final emission limits. MECA believes that the results from this important test program will provide ARB (and EPA) the technical justification to move forward with another round of NOx tightening on highway heavy-duty and off-road engines.

The draft Research Plan cites short-lived climate pollutants, such as black carbon, as an important area where research is still needed. Black carbon emissions from diesel vehicles can be significantly reduced through emission control technology that is already commercially available. High efficiency diesel particulate filters on new and existing diesel engines provide nearly 99.9% reductions of carbon emissions. As has been shown in the heavy-duty highway sector, DPFs are extremely efficient at reducing particulate emissions over a wide range of particle sizes, including reducing emissions of the smallest, ultrafine particles emitted by a diesel engine. MECA commends ARB for its efforts in reducing diesel particulate matter through its various in-use diesel regulations that include retrofit compliance options of these in-use diesel engines with advanced technologies, such as DPFs.

In the highway, heavy-duty sector, DPF-equipped engines are routinely being certified at PM emissions levels that are 90% or more below the 0.01 g/bhp-hr 2010 EPA PM heavy-duty highway diesel engine standard. The "bonus" PM reductions provided by DPFs in the highway sector provide significantly more public health benefits than estimated by EPA in their final 2007-2010 heavy-duty highway regulation. In addition to "bonus" public health benefits afforded by DPFs, DPFs have also provided important co-benefits on climate change due to the large reductions in black carbon emissions that result from the use of high efficiency DPFs (an ARB funded study highlighting the significant impact of reducing black carbon emissions from diesel engines on climate change was released in June 2013). The addition of a more effective heavy-duty inspection and maintenance program in California is needed to ensure that DPF-equipped trucks and buses continue to deliver significant reductions in black carbon emissions over the long operating lives of these vehicles.

It is also worth noting that stoichiometric, heavy-duty natural gas engines have been shown to emit large numbers of ultrafine particulates that are largely the result of the consumption of lubricant oil during the engine combustion process (see ARB's funded work published by West Virginia University on particle emissions from stoichiometric natural gas bus engines published this summer in *Environmental Science & Technology*). These stoichiometric heavy-duty engines are currently certified without filters due to their low particulate mass emissions. Filters on these stoichiometric natural gas engines would significantly reduce the ultrafine particle emissions from these engines and provide additional public health benefits. MECA encourages ARB to investigate the benefits of applying filters to these engines and enact appropriate policies that force the use of filters on these engines.

These same opportunities for increased protection of public health and reduced climate change impacts are lost on EPA Tier 4 final off-road diesel engines that are not certified with

DPFs. In some cases, OEMs may choose to remove DPFs that were certified with engines for Tier 4 interim compliance in certifying the Tier 4 final configuration. MECA encourages ARB to characterize the regulated and unregulated exhaust emissions of similar Tier 4 final nonroad 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 would provide additional public health and climate change benefits associated with further reductions in black carbon emissions from this sector. The European Union is currently considering a Stage 5 off-road engine regulation that may include a particle number-based emission limit to force the use of filters on all off-road diesel engines.

MECA is concerned about the PM emissions durability of nonroad 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 nonroad sector. Given the expected, relatively small compliance margins of nonroad Tier 4 final engine designs that do not utilize DPFs, MECA believes that ARB (and EPA) 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 nonroad 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 nonroad sector that utilizes the latest portable emissions measurement technology to ensure that Tier 4 final nonroad engines are delivering the emission reductions associated with the Tier 4 nonroad standards. The nonroad 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.

Additional reductions in black carbon emissions will result from the light-duty sector through ARB's lower LEV III PM limits. MECA strongly supported and agreed with ARB's decision to include a 1 mg/mile particle matter standard for light-duty vehicles over the FTP test cycle in their LEV III requirements. In their Tier 3 final regulation, EPA has only harmonized with the LEV III 3 mg/mile FTP PM standard and not included a 1 mg/mile FTP PM standard. The 2012 decision by the European Commission to establish a particle number emission standard for light-duty vehicles powered by gasoline direct injection (GDI) engines as a part of their upcoming Euro 6 light-duty emission standards provides a more stringent particle emission limit for these GDI vehicles in the same time frame as the Tier 3/LEV III 3 mg/mile PM standard (phase-in for the LEV III/Tier 3, 3 mg/mile PM standard starts in 2017; implementation of the Euro 6 GDI particle number limit of 6 X 10^{11} particles/km [equivalent to the Euro 5 light-duty diesel particle number limit], measured using the European PMP particle measurement protocol, begins in September 2017; see: ec.europa.eu/enterprise/sectors/automotive/documents/directives/motor-vehicles/index_en.htm).

This European light-duty GDI particle number limit will cause auto manufacturers to introduce cleaner technologies such as advanced fuel injection systems and/or gasoline particulate filters to comply with the European Euro 6 GDI particle number limit. Auto

manufacturers are already working to bring forward early introductions of these ultra-low PM, Euro 6-compliant gasoline engines to the European market in the coming 12 to 18 months (European member states are permitted to introduce tax incentives for early introductions of Euro 6 vehicles prior to the first implementation dates of September 2014 for new models and September 2015 for all passenger car models). Nearly all auto manufacturers that sell into the European market are working with MECA members on potential applications of particulate filters on gasoline direct injection vehicles. In August 2014, the German Traffic Club (VCD, see www.vcd.org) reported that the Mercedes S500 GDI European passenger car is now equipped with a gasoline particle filter, the first public announcement on a filter equipped GDI vehicle.

Gasoline particulate filters (GPFs) are based on the same, wall-flow ceramic filters that have been successfully applied on millions of light-duty and heavy-duty diesel vehicles in Europe and the U.S. for more than 10 years. The performance and application of these gasoline particulate filters has been highlighted in a number of recent technical publications in both the U.S. and Europe (e.g., SAE paper nos. 2010-01-0365, 2011-01-0814, and 2013-01-0836; SAE paper no. 2013-01-0527 authored by Environment Canada and MECA). Like diesel particulate filters, gasoline particulate filters are capable of reducing particle/black carbon emissions by more than 85% over a wide range of particle sizes, including high capture efficiencies for ultra-fine particulates. The application of a GPF on a four-cylinder gasoline direct injection vehicle is expected to cost approximately $100-120 (see ICCT's GPF cost estimate available here: www.theicct.org/estimated-cost-gasoline-particulate-filters), making this emission control technology a cost-effective solution for reducing particulate emissions from future gasoline vehicles (even lower GPF cost estimates have been recently discussed in Europe). When these filters are properly designed, the impact of a GPF installation on the backpressure and fuel-efficiency of the vehicle is expected to be minimal.

ARB and EPA need to make sure that these same ultra-low PM, Euro 6 GDI engine/emission technologies are also utilized in the U.S. ARB will be reviewing the stringency and timing of its 1 mg/mile FTP PM LEV III limit in the coming year or two, and MECA believes that ARB should consider adoption of the European Union's Euro 5 diesel and the Euro 6 diesel/GDI particle number limits (or some other similarly stringent standard of particle emissions) to ensure that future light-duty vehicles employ the best available technology for controlling particle and black carbon emissions. A particle number standard could also be implemented as an optional compliance path along with ARB's 1 mg/mile, mass-based standard. Given the readiness of GPFs to reduce particle emissions from GDI engines, MECA believes that ARB should give strong consideration to earlier implementation of their 1 mg/mile standard (currently set to begin phase-in with the 2025 model year) and/or a particle number standard. EPA and ARB also need to continue to work together and reach agreement on measurement protocols that are acceptable for use with a 1 mg/mile FTP PM standard or a stringent particle number limit for light-duty vehicles.

As part of their short-lived climate pollutants strategy, ARB should give some consideration to additional light-duty vehicle policies that force the use of high efficiency filters on future gasoline vehicles. The application of best available filtering technology on future gasoline vehicles will provide additional black carbon reductions from this sector and further health benefits for the citizens of California. The particle/black carbon emission issues cited in

these comments for diesel and gasoline engines and vehicles are discussed in more detail in MECA's recently released report: "Ultrafine Particulate Matter and the Benefits of Reducing Particle Numbers in the United States," available on MECA's website at: http://www.meca.org/resources/reports.

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