WRITTEN COMMENTS OF THE MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION ON THE BEIJING ENVIRONMENTAL PROTECTION BUREAU'S PROPOSED PHASE 6 EMISSIONS STANDARDS FOR LIGHT-DUTY AND HEAVY-DUTY ENGINES AND VEHICLES

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The Manufacturers of Emission Controls Association (MECA) is pleased to provide comments in support of the City of Beijing's Phase VI/6 proposed standards for evaporative and exhaust emissions from light-duty and heavy-duty engines and vehicles, including OBD requirements. MECA applauds Beijing EPB for their vision and strong leadership in developing a holistic set of requirements that incorporate all of the essential elements of an effective and enforceable regulatory policy that is based on standards that have evolved over the past 40 years in North America. Furthermore, by not combining elements of different EU and U.S. regulatory frameworks, Beijing EPB has opened a path for engine and vehicle manufacturers to utilize existing technology and expertise within their organizations to quickly develop vehicles for the Beijing regional market. 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.

Finalizing these standards for new light and heavy-duty diesel engines and vehicles will provide significant economic, climate change and health benefits for the citizens of Beijing. These proposed emission standards build on the extensive experience and success with advanced three-way catalysts, 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 heavy-duty engines and vehicles to provide cost-effective, durable reductions of diesel PM and NOx emissions, consistent with Beijing EPB's proposed December 1, 2017 compliance date.

The proposed standards are based on a unified set of tailpipe performance limits, evaporative emission requirements, in-use compliance requirements and OBD thresholds based on extensive experience from the North American programs that have been implemented since 2004. MECA further applauds Beijing EPB for putting policies in place to make 10 ppm sulfur fuel available in advance of this proposal 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. MECA believes that this proposal represents a balanced, enforceable and comprehensive set of emission standards to achieve significant emission reductions from light and heavy-duty vehicles and should serve as a model for a national set of standards for China under a future China 6/VI proposal.

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 light-duty vehicles as well as heavy-duty 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 Beijing.

The majority of MECA's comments address the exhaust and evaporative emission provisions detailed in the Beijing EPB's draft proposal that was released on November 26, 2015. MECA believes that achieving the proposed Beijing 6/VI exhaust and evaporative emission standards and expected emission reductions are both technically feasible and cost effective. This fact is clearly demonstrated by the more than two million SULEV and PZEV compliant light-duty vehicles that have been sold in North America since these near-zero emission, gasoline vehicles were first introduced more than ten years ago. The technology base of advanced three-way catalysts, high cell density substrates, thermal management strategies, secondary air injection systems, advanced carbon canisters and advanced low fuel permeation materials that have already been commercialized for gasoline vehicle applications in North America can be readily applied to vehicles in Beijing and the surrounding provinces to comply with the proposed Beijing 6/VI standards. MECA has provided an overview of the types of emission control technologies that are being deployed in North America and Europe to meet the tightest emission standards for light-duty vehicles in our whitepaper that can be found here: http://www.meca.org/resources/LEV_III-Tier_3_white_paper_0215_rev.pdf from our website www.meca.org >> Resources>>Reports. A recent SAE paper (SAE paper no. 2011-01-0301) demonstrates how advanced three-way catalysts utilizing high cell density substrates can be combined to achieve Tier 3, Bin 20 or Bin 30, exhaust emission levels on a four-cylinder, light-duty gasoline vehicle.

MECA agrees with Beijing EPB's decision to propose tighter particle matter standards for light-duty vehicles. Although a tighter PM standard may require filters on some GDI engines in Beijing today, we are concerned that the proposed PM standard of 1.86 mg/km may not be strict enough to insure the use of the best available emission control technology such as gasoline particulate filters in the future. Due to the tendency of GDI engines to emit large amounts of PM, in 2011, the European Commission established a particle number emission standard for light-duty vehicles powered by gasoline direct injection (GDI) engines as a part of their upcoming Euro 6c light-duty emission standards. This PN standard was set at $6 \text{ X } 10^{11}$ particles/km, starting in 2017, measured using the European PMP particle measurement protocol; see:http://circa.europa.eu/Public/irc/enterprise/automotive/library?l=/technical_committee/december_confirmed/text-02122011pdf/_EN_1.0_&a=d.). This level of particle number emissions has been estimated to be approximately equivalent to 0.3 mg/km on a mass basis in MECA's ultrafine particle report (http://www.meca.org/resources/MECA_UFP_Executive_Summary_-Mandarin-.pdf) a portion of which has been translated to Mandarin. This European 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 6c GDI particle number limit.

Auto manufacturers are already working to bring forward early introductions of these cleaner Euro 6c-compliant gasoline engines to the European market in the coming 12 to 18 months. One manufacturer has already commercialized a vehicle that has both advanced injectors and an uncatalyzed GPF. 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. Gasoline particulate filters (GPFs) are based on the same, wall-flow ceramic filters that have been successfully applied on millions of diesel vehicles and engines in Europe and North America for more than 10 years. The performance and application of these GPFs has been highlighted in a number of recent technical publications (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 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. When these filters are properly designed, the impact of a GPF installation on the backpressure and fuel-efficiency of the vehicle has been shown to be minimal. California has adopted a tighter 0.6 mg/km PM standard beginning in 2025. We encourage Beijing EPB to require manufacturers to report both a PM and PN values as part of their certification documentation. This information would provide an important database of technology capability and justification for Beijing to potentially consider tightening future PM limits for GDI engines to insure that the best available emission control technologies used in other regions of the world are also being deployed on vehicles in Beijing.

MECA supports Beijing EPB's inclusion of tighter evaporative emission requirements for light-duty vehicles in their proposal. These tighter standards will require the use of advanced evaporative emission technologies such as; advanced carbon canisters, onboard refueling vapor recovery (ORVR) and low permeation materials that are being used to meet U.S. Tier 2 and future Tier 3 evaporative emission requirements for light-duty and medium-duty gasoline or flex-fuel vehicles. These technologies are discussed in the MECA report: "Evaporative Emission Control Technologies for Light-Duty Gasoline Vehicles" (available on MECA's website, www.meca.org, under Resources >> Reports). A detailed discussion in support of tighter evaporative standards, including ORVR, for the Chinese/Beijing light-duty vehicle fleet can be found on MECA's website here: http://www.meca.org/resources/November_2014_ORVR_Report_-_2-17-15_FINALv4_for_MECA.pdf . MECA has provided detailed comments specifically addressing the proposed evaporative requirements in the Beijing Phase 6 proposal and attached these as Appendix 1 at the end of our comments.

For heavy-duty engines and vehicles regulated under the proposed Beijing VI standards, advanced diesel emission control technologies including diesel particulate filters, and selective catalytic reduction catalysts will be combined with future, advanced diesel engines to comply with these proposed standards. 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 mobile source 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 .

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 Beijing 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 DPF filters on heavy-duty trucks. We urge Beijing to follow these developments and consider including PM or PN measurements as part of future in-use testing amendments to this regulation.

MECA applauds Beijing EPB for including full OBD requirements as part of the proposed Beijing 6 light-duty and Beijing VI heavy-duty diesel engine and vehicle standards. In particular, MECA believes that this proposal has struck the right balance with the introduction of criteria pollutant and PM efficiency diagnostic thresholds. For heavy-duty vehicles, we commend the agency for their vision and leadership by requiring wireless transmission under OBD III protocols to comply with Beijing VI. Beijing 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 difficult to locate and inspect. OBD provides another important check on the performance of key emissions-related components and ensures that the emissions benefits of clean emission control technology are delivered over the full regulated, useful life of the engine.

MECA provides the following general comments on specific provisions within the proposal for consideration by Beijing EPB 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.
- Light-duty diesel should be capable of complying with fuel neutral Beijing 6 standards. Beijing should consider including light-duty diesels in their program at a future

date.

- Consistent with the U.S. 2007/2010 heavy-duty highway standards, Beijing EPB should force closed crankcase ventilation technology to be installed on all engines covered by this proposal. This is an important element of the total vehicle PM emissions that is not 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 for in-use compliance testing, on a chassis dynamometer, of light and heavy-duty vehicles to confirm that emission control technologies are working as the vehicles age.
- LEV 2/LEV 3 standards include credits for the use of direct ozone reduction catalysts. There is considerable OEM experience with these catalysts applied to radiators that goes back more than 15 years. These catalysts destroy ground level ozone while the car is operating and are monitored by the OBD system. Beijing should consider a similar credit scheme in their light-duty standards to incentivize the use of these catalysts.

In Conclusion, MECA applauds Beijing EPB for bringing forward this visionary proposal for reducing emissions from light and heavy-duty diesel engines and vehicles. Once finalized, these regulations will provide the citizens of Beijing with significant economic, air quality and climate change benefits. MECA encourages Beijing EPB to finalize these regulations as soon as possible in 2016 and to insure that urea reductant is made available across the region 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 passenger cars and trucks in Beijing to comply with the proposed Beijing 6/VI emission standards. We ask for the agencies help in insuring that the emission reductions expected under this proposal are realized by implementing a robust inspection and enforcement program as authorized to provincial EPBs by the 2015 version of the China Clean Air Act.

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Appendix 1: MECA COMMENTS TO THE PROPOSED BEIJING PHASE IV EVAPORATIVE EMISSION REQUIREMENTS

SECTION 3.14: The text should be revised to include spilled gasoline as measured emissions. The text can read, "The hydrocarbons emitted or spilled during refueling, expressed with a $C_1H_{2.33}$ equivalent."

SECTION 3.24: Given recent events, the language defining defeat devices should be clarified to specifically include software and any other means. Text should be revised to say "A device, software, or other means which activates, adjusts, delays, or stops the operation of a part …"

SECTION 5.1.2: We suggest the addition of a Tier 2 evaporative provision that is not currently found in the proposed Beijing VI regulations. This provision is designed to prohibit fuel system venting to the atmosphere instead of capturing by the engine or canister. The suggested language is: "5.1.2.4 All fuel vapor generated from the fuel tank in a gasoline powered vehicle during in-use operations shall be routed exclusively to the evaporative control system (e.g., either canister or engine purge). The only exception to this requirement shall be for emergencies."

SECTION 5.3.4.2: Ensuring that the in-use carbon canister volume and capacity is no lower than the certified value is of primary importance to ensuring in-use emissions are controlled at the same level as the certified vehicle. It should be of more importance to specify a minimum limit than the specified maximum limit documented. We recommend that the section be revised to read " …according to the test methods in 7.7.1; the measurement results shall not be less than 0.9 times or more than 1.1 times the manufacturer declared value."

SECTION 5.3.4.3: The limit for the Type IV evaporative test is the sum of the hot soak and the higher of the two diurnal measurements. The text is unclear and could be read to suggest that the limit is based on the sum of the hot soak and both days of diurnal. The text should be rewritten to "The sum of the highest of the two diurnal losses and the hot soak test results shall meet the limits in Table 7…"

SECTION 5.3.5: The full useful life is defined at 200,000 km, yet there is no deterioration factor (DF) determination or assignment given for Type IV evaporative or Type VII refueling emissions. The DF for evaporative emissions can be developed in the same fashion as exhaust through on-track evaluation at the same kilometer points as exhaust. EPA Tier 2 regulations have assigned DFs for small-volume manufacturers that could be incorporated (see CCD-05-10, May 26, 2005 from the EPA website). Likewise, in section O.2.5.11, the reporting of Type IV evaporative and Type VII refueling emissions through in-use compliance checks should be added.

SECTION 6.2.1: In addition to the items listed in 6.2.1, the inclusion of a canister scrubber and/or AIS adsorption element should be included in the criteria. In addition, the same canister configuration should be a requirement (e.g. integrated and non-integrated vehicles cannot be grouped together). In addition, vehicles using mechanical and liquid-seals for ORVR cannot be grouped together.

SECTION 6.2.1: The next to last bullet could be improved by specifically mentioning total purge volume, purge rate profiles, and purge calibration over the drive cycle.
SECTION 7.4.2: In our opinion, no new vehicle that is tested should exceed the emissions limit for Type VII refueling or Type IV evaporative emissions. The allowance for a vehicle to exceed the limit by 10% should be removed, and no vehicle tested should be permitted to exceed the limit. This measurement should also include consideration of the deterioration factor. The same comment applies to Section 7.6.2.

SECTION F.2: The limit for the Type IV evaporative test is the sum of the hot soak and the higher of the two diurnal measurements. The text is unclear and could be read to suggest that the limit is based on the sum of the hot soak and both days of diurnal. The text immediately preceding Figure F.1 should be rewritten to "The sum of the emission masses of hydrocarbons determined at the phases of hot soak loss and the highest of the two diurnal losses is used as the overall test result."

SECTION F.6.2: The calculation of emissions should include the highest of the two days of DBL testing. More detail should be given to the definition of M_{DBL}. The definition should be revised to: "M_{DBL} – The mass of hydrocarbons emitted in the highest of the two days of diurnal breathing test, g." Sections F.5.9 and F.6 should be looked at to ensure the proper nomenclature is in place for a 48-hour DBL test.

SECTION J.B.2: We recommend that the specifications be allowed to align with SAE J285, ISO 9158, and the Chinese equivalent specification. An alternative is to choose a representative nozzle and require that specific for testing.

SECTION O.2.5.11 (in Annex O): The list of results of in-use compliance reported by the manufacturer should be added to and include "(j) Test information of evaporative emissions" and "(k) Test information of refueling emissions" plus all related test information and reported data.
Figure F.1: The test flow chart for evaporative emissions testing needs revision. The average temperature in the SHED during the hot soak is written as 305K±273.9K. It should be revised to "305K±0.7K". Also, the second soak shows an ambient temperatures of 295K±274K (22.2°C± 0.9°C). This should be revised to "295±0.9K".

Figure J.1 The flow chart for integrated system refueling shows an ambient temperature of 300K ± 275K (27°C±2°C) and a refueling temperature of 292.6K ± 273.9K (19.4°C±0.8°C). It should be revised to: "Ambient temperature: 300K ± 2K (27°C±2°C)" and "Refueling temperature: 292.4K ± 0.8K (19.4°C±0.8°C)". The same revisions are needed in the Annex Figure J.2 Test flow chart for non-integrated system refueling.

Annex P: Since the tests depend upon application of the US FTP and other drive cycles, we recommend the regulatory text be clear that the test procedures that apply include the specifications included in 40CFR86 subpart B. These specifications include shift points, road load horsepower determination, fan speeds, and many other fine points.