WRITTEN STATEMENT OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION ON THE OZONE TRANSPORT COMMISSIONS MODEL RULE TO CONTROL NOX FROM NATURAL GAS COMPRESSOR FUEL-FIRED PRIME MOVERS

September 26, 2011

The Manufacturers of Emission Controls Association (MECA) is pleased to provide comments to the Ozone Transport Commission's proposed 2014 Model Rule for Control of NOx Emissions from Natural Gas Pipeline Compressor Fuel-Fired Prime Movers. MECA believes that the emission limits outlined in the model rule are a good first step to reducing NOx from this category of engines; however we believe that the emission limits do not go far enough because significant additional reductions are achievable with the use of exhaust control technologies.

MECA is a non-profit association made up of the world's leading manufacturers of emission control technology for mobile and stationary internal combustion engines. MECA member companies have over 35 years of experience and a proven track record in developing and commercializing exhaust emission control technologies for a wide range of on-road and off-road vehicles and engines of all sizes including both rich and lean-burn, stationary, spark ignited natural gas engines. MECA member companies have commercialized the necessary emission control technologies to achieve greater than 90% NOx reduction from spark-ignited natural gas compressor engines covered by this model rule.

Two-Stroke Lean Burn Engines

MECA agrees with OTC's recommendation for NOx limits and percent reductions from these large, two-stroke, lean-burn prime mover engines. Although we believe that exhaust controls could be used to achieve further reductions in NOx emissions, however, there are limited examples of SCR technologies being retrofitted on these types of engines. There have been several demonstrations conducted by independent laboratories where SCR was retrofitted on such two-stroke, lean-burn natural gas prime mover engines that achieved **>90%** reduction in NOx, unfortunately the results of these demonstrations were never published. There are challenges in retrofitting SCR to these engines because of the relatively low exhaust temperatures. Some of our members have formulated catalysts specifically for these large two-stroke engines and demonstrated their effectiveness down to exhaust temperatures as low as 250 ^{o}C.

The limits proposed in the model rule are easily achievable with combustion controls, however when combustion controls are applied to reduce NOx from these lean-burn engines, in certain instances, there is a trade-off with carbon emissions such as CO, hydrocarbons and other hazardous air pollutants (HAPs) such as formaldehyde. There have been several published reports from studies conducted at Colorado State University and elsewhere that have measured significant increases in CO and hydrocarbon emissions as NOx emissions were lowered by incorporating combustion controls. This is a result of a commonly known NOx-CO trade-off for some engine and fuel injection technologies. Because the CO and THC emissions may possibly increase above desirable levels we recommend that the OTC include a provision that limits the allowable emissions increase of other criteria and hazardous pollutants as a result of meeting the NOx emissions under this model rule. These CO, THC and HAP emissions can be easily and cost effectively controlled by installing simple oxidation catalysts in the exhaust. This has been commercially achieved on thousands of stationary engines worldwide. At least one of our members has achieved formaldehyde, CO and VOC (non-methane and non-ethane) emissions as low as 30 ppm at 15% O_2 at exhaust temperatures as low as 270 ^oC on a large two-stroke lean-burn natural gas fired engine.

Four-Stroke Lean Burn Internal Combustion Engines

For this category of engines, MECA believes that the OTC is missing a significant opportunity to achieve further NOx reductions. SCR has long been the technology of choice for NOx emission reduction in industrial processes and stationary power generation applications. The commercial use of SCR systems for the control of NOx from lean-burn stationary engines has been around since the mid-1980s in Europe and since the early 1990s in the U.S. Since 1995, one MECA member company specifically has installed over 400 SCR systems worldwide for stationary engines with varying fuel combinations including dozens of natural gas powered compressor engines at sites in the U.S. These four-stroke, lean-burn, gas compressor engines, equipped with urea-SCR achieve in excess of 90% reduction in NOx with as little as 2-3 ppm ammonia emissions. Similar units have been deployed in power generation applications.

More recently, cost-effective urea-SCR systems based on the same catalyst technology have been developed for mobile source applications, including heavy-duty trucks, light-duty vehicles, off-road equipment, marine engines, 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 heavy-duty NOx emission standards. 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 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. Since the mid-1990s, SCR technology using a urea-based reductant has been installed on a variety of marine applications in Europe including ferries, cargo vessels, and tugboats with over 200 systems installed on engines ranging from approximately 450 to 10,400 kW. These marine SCR applications include the design and integration of systems on a vessel's main propulsion engines and auxiliary engines which have similar operating characteristics as stationary two-stroke and four-stroke lean-burn engines. SCR technology is capable of achieving in excess of 80% to 90% NOx conversion efficiency.

Our members have experience with retrofitting systems both inside and outside of existing structures that house the engines. In the case where limited interior space may be available, systems have been installed in place of the existing exhaust muffler on the roof of buildings. Some systems have also been appropriately designed to operate in cold temperature climates like those in the gas fields of Wyoming or the Sierra Mountains of California.

The emission limits being proposed to control NOx from this category of engines are easily achieved by retrofitting combustion controls. As we noted above for two-stroke, lean-burn engines, some four-stroke, natural gas engines have demonstrate a similar NOx-CO trade-off when combustion controls are applied to reduce NOx. The same types of inexpensive oxidation controls, as described above, would effectively protect from inadvertent increases of CO and

THC emissions from four-stroke lean-burn engines at the expense of achieving the desired NOx reductions under this rule.

Four-Stroke Rich-Burn engines

MECA supports the NOx emission limits being proposed for this category of gas compressor engines. For these larger displacement four-stroke, rich-burn engines, the NOx emission limits can be easily achieved by applying, closed loop, non-selective catalytic reduction technologies. The use of NSCR technology is a cost-effective way to reduce NOx emissions from existing stationary rich-burn engines. Our members have installed tens of thousands of these catalysts on rich-burn stationary natural gas fueled, reciprocating engines and have repeatedly demonstrated NOx emissions of 5 ppm at 15% O_2 representing a greater than 99% reduction relative to the untreated exhaust. These types of engines are used in power production, pumping or gas compression applications. NSCR for stationary engines is a proven technology based on automotive three-way catalyst that has been installed on over 300,000,000 automobiles with outstanding results. In addition, several MECA member companies have verified retrofit NSCR systems with ARB for use on large, spark-ignited off-road engines (engines 25 hp or greater) to reduce NOx, HCs, and CO. These verified systems can be used on existing stationary rich-burn engines as well. (A complete list of ARB-verified retrofit technologies for large, spark-ignited off-road engines is available at: www.arb.ca.gov/msprog/offroad/orspark/verdev.htm.)

Further General Comments and Suggestions

MECA believes that the OTC is missing a significant opportunity to reduce CO and VOC emissions from lean burn natural gas engines by not setting standards that would require inexpensive, passive, oxidation catalyst controls that are in use today. Oxidation catalysts have been applied to over 250,000 off-road diesel mobile source applications and hundreds of stationary lean burn SI engines. Over 50,000,000 diesel passenger cars and millions of trucks and buses have been equipped with oxidation catalysts. Oxidation catalysts are extremely effective in achieving greater than 90% reduction of hazardous air pollutants such as THC and CO from lean burn engines. These catalysts also provide significant reductions in toxic emissions by eliminating benzene, formaldehyde, acetaldehyde, methanol and other VOCs from the exhaust. Oxidation catalysts have been installed on a limited number of marine diesel applications, a duty cycle that closely mimics stationary operation. Even a relatively inexpensive oxidation catalyst can provide significant multi-pollutant co-benefits in reducing CO, HC, VOC, and SOF emissions. The OTC should consider setting CO and VOC standards that would require emissions controls on all stationary natural gas combustion engines to prevent inadvertent emissions from those engines that are susceptible to such trade-off characteristics when combustion controls are retrofitted to achieve NOx reductions.

Because some categories of engines covered by the rule are more amenable to the use of exhaust controls, we believe that aggregating engines to meet an average area NOx limit is an effective way to achieve significant emissions from these older engines while providing regulated parties with the flexibility to select the most cost effective means to achieve these limits. There is a large build up of natural gas pipeline infrastructure within the Marcellus shale formation with the potential of thousands of new engines being installed to move natural gas within and from the region. These new engines, although significantly cleaner than pre 2007 engines, would remain in the region for decades without the benefit of best available control technology. These newer engines are very compatible with retrofit SCR technology to achieve 90% or better NOx reduction. The provisions put in place by the state of Pennsylvania allowing engine aggregating is an excellent example of how such an approach can work to achieve the desired reduction in emissions from the overall engine population. Some of our members are successfully installing SCR technology on four-stroke lean-burn engines certified to 0.5-1.5 g/bhp-hr to achieve 90% reduction in tailpipe NOx emissions.

A good example of what NOx limits are achievable from in-use, spark-ignited engines, including natural gas compressor engines, has been recently adopted by the Governing Board of the San Joaquin Valley Unified Air Pollution Control District in California under Rule 4702. For some categories and applications of natural gas fueled lean and rich-burn engines the SJVAPCD has set NOx limits as low as 11 ppmvd corrected to 15% oxygen. This level of NOx emissions is achievable through the use of commercially available SCR and NSCR exhaust control technologies.

MECA requests further clarification in the rule regarding certain definitions and applicability of the rule to the various engines used in the natural gas industry infrastructure. Although the title of this model rule implies that it only applies to large, slow speed, prime mover engines powering compressors for pipeline transportation of natural gas, the definition (2.8) for a prime mover suggests a much broader classification of engines and applications. This is further supported by the diversity of engines for which NOx limits are proposed in the rule, as well as the "Purpose" in section 1.0 which appears to cover many of the types of engines used in the natural gas pipeline infrastructure. These include engines powering compressors used for injection or storage of natural gas which may not be generally thought of as prime mover engines. MECA supports a broader coverage of natural gas compressor engines by this model rule due to the increased growth in engine inventory around the Marcellus shale formation as discussed previously. Limiting this model rule to the relatively small number of existing prime mover compressor engines leaves significant NOx emissions uncontrolled from other categories of natural gas compressor engines that make up the infrastructure of this source category. The inventory of these other natural gas engine applications, such as gas gathering and production engines which feed the pipeline, is undergoing a significant increase and may represent a major source of NOx emissions in the Ozone Transport Region (OTR) in the future.

In closing, MECA recognizes the important step being taken by the OTC in addressing NOx emissions from stationary natural gas compressor engines in the OTR. As we point out in our comments, we believe that significant NOx reductions are left uncontrolled by the limited scope and high emission limits being proposed in this draft rule. Exhaust control technology such as SCR has been demonstrated and applied to new and existing lean-burn stationary engines by our members for many years. MECA and our member companies look forward to working with the OTC, the engine and equipment manufacturers, end-users, and others in ultimately achieving the goals of the final proposed model rule.

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