

**WRITTEN COMMENTS
OF THE
MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION
ON THE
CONSUMER PRODUCT SAFETY COMMISSION'S ADVANCED NOTICE OF
PROPOSED RULEMAKING ON PORTABLE GENERATORS**

February 11, 2007

The Manufacturers of Emission Controls Association (MECA) is pleased to respond to the Consumer Product Safety Commission's (CPSC) request for comments and information on the Portable Generators; Advanced Notice of Proposed Rulemaking. These comments are consistent with MECA's response to CPSC's Request for Information on Techniques to Substantially Reduce CO from Gasoline Portable Generators dated April 28, 2006. MECA supports CPSC Staff's motivation to reduce portable generator related deaths due to carbon monoxide (CO) poisoning. MECA firmly believes that cost-effective catalyst technology exists to substantially reduce CO emissions from these small gasoline engines.

MECA is a non-profit association of the world's leading manufacturers of emission control technology for motor vehicles and stationary internal combustion engines. Our members have over 30 years of experience and a proven track record in developing and manufacturing emission control technology for a wide variety of on-road and non-road vehicles and engines. A number of our members have extensive experience in the development, manufacture, and commercial application of CO emission control technologies for stationary engines, as well as, expertise in applying catalyst technologies to small spark ignited engines less than 25 hp.

Catalyst technology for small gasoline engines, like those used in portable generators, draws from the more than 30 years of successful experience in the U.S. with catalytic converters applied to light-duty gasoline cars and trucks. The centerpiece of this automotive emission control technology base is the three-way catalyst used on gasoline, spark-ignited vehicles in all major world markets today. The name three-way catalyst (TWC) was applied to catalytic controls that were capable of reducing all three criteria pollutants: carbon monoxide (CO), oxides of nitrogen (NO_x), and volatile organic compounds or hydrocarbons (VOCs, HC). Today, more than 90% of the new automobiles sold around the world are equipped with catalytic converters, adding to the more than 600 million vehicles worldwide that have been equipped with catalysts since their first introduction in the U.S. in 1975. Three way catalysts typically operate within a narrow range of inlet exhaust gas compositions that corresponded to approximately the stoichiometric air/fuel ratio where they are capable of simultaneously achieving high conversion efficiencies for all three common regulated pollutants. CO conversion efficiencies greater than 95% are often observed.

The widespread use of catalysts on passenger cars has been spreading into other spark ignited engine applications in both on and off-road vehicles. An example of where TWC technology was applied by a manufacturer ahead of regulations was demonstrated and commercialized by Indmar Marine Engines. These inboard marine engines are equipped with

catalysts to reduce emissions of CO by more than 50% and smog-forming gases by more than 66% with no reported loss in performance. (epa.gov/otaq/regs/nonroad/marine/si/420f06057.htm).

There are a variety of technical publications and reports available that provide details about the application and performance of catalysts on smaller, four-stroke gasoline engines. The SAE technical publication literature contains many technical papers on the application of catalysts to both two-stroke and four-stroke gasoline engines used on motor scooters and motorcycles. Catalysts have been successfully applied to motor scooters and motorcycles in a variety of world markets (including the U.S., Europe, Taiwan, India, Thailand) to comply with regional emission regulations. Some of these applications include very small displacement engines (e.g., under 200 cc of total engine cylinder displacement). CO conversion efficiencies from applications of catalysts to motor scooters and motorcycles range from 50% to in excess of 90% depending on the system design and the air/fuel ratio at the inlet of the catalyst.

A more direct analogy to portable generator applications can be drawn from catalyst technology that has been successfully applied to a wide variety of small, two and four-stroke gasoline engines such as those on handheld equipment (e.g., chainsaws, leaf blowers, string trimmers), and non-handheld equipment (e.g., lawn mowers, motor scooters, motorcycles, marine engines, and forklift trucks). In many cases these catalyst systems have been specifically engineered to provide high reductions of CO and HC emissions as well as reductions in NOx emissions. The successful application of catalysts to these smaller gasoline engines has required the engineering of exhaust systems that effectively manage exhaust component temperatures, provide for efficient packaging of the catalyst within the exhaust system, include consideration for the safe operation of the engine in the environment, have adequate mechanical and catalytic durability, as well as, reduce exhaust emissions. All of this catalytic system experience can be directly applied to the design of safe, effective, and durable catalyst systems for four-stroke, gasoline portable generators.

MECA is aware of two manufacturers of four-stroke, gasoline generators that are already using properly designed exhaust systems with catalysts to reduce CO emissions by more than 90% compared to uncontrolled levels: Westerbeke Corporation and Kohler Power Systems. Both of these companies have targeted marine applications for these ultra-low CO emitting generators. Westerbeke's line of Safe-CO™ generators was introduced in 2004. In 2006, Kohler Power Systems became the second manufacturer to offer portable generators with catalytic converters.

Both the California Air Resources Board (CARB) and the U.S. EPA have recently evaluated the performance of catalysts on Class I (up to 225 cc cylinder displacement) and Class II (225 cc or greater cylinder displacement) gasoline four-stroke engines used in off-road applications of non-handheld equipment (e.g., lawn mowers, riding tractors, portable generators). In these test programs, catalysts were shown to perform effectively, over extended hours of operation, in reducing hydrocarbon, NOx, and CO exhaust emissions. The ARB test program was concluded in 2004 and a final report is available on the ARB website at: www.arb.ca.gov/msprog/offroad/sore/sore.htm (listed as "Durability of Low Emissions Small Off-Road Engines – Final Report"). EPA issued a report in March 2006 ("EPA Technical Study

on the Safety of Emission Controls for Nonroad Spark-Ignition Engines < 50 Horsepower”) on their small engine test program. This 2006 EPA report is available at: www.epa.gov/otaq/equipment.htm.

The ARB and EPA studies show that catalysts can be integrated into the existing muffler designs used on these small engines and provide significant reductions in exhaust emissions. The ARB test program was completed in advance of ARB approving Tier 3 emission standards for Class I and Class II engines that began in the 2007. The EPA study, in particular, addressed emission performance and safety issues with the implementation of catalysts on these small engines and concluded that the application of catalysts to these small gasoline engines would not cause any incremental increase in risk of fire or burn to consumers. The focus, in terms of emissions control, for both the ARB and EPA test programs was the reduction of hydrocarbon and NO_x exhaust emissions from these small gasoline engines. CO emission performance of the catalyst system designs were also evaluated and ranged from 50% to greater than 70% depending on system design and air/fuel ratio of the exhaust components present at the inlet of the catalyst.

The published experience of catalyst performance on four-stroke gasoline engines indicates that high efficiencies for reducing CO emissions are strongly influenced by the air/fuel stoichiometry in the exhaust upstream of the catalyst. Maximum reduction efficiencies for all three regulated pollutants (hydrocarbons, CO, NO_x) can be obtained if the air/fuel ratio of the exhaust stream is controlled to be near the stoichiometric ratio of reducing and oxidizing components in the exhaust stream. At or near this stoichiometric air/fuel ratio, catalyst efficiencies can be well in excess of 90% for all three pollutants provided that the catalyst temperature is above its activation temperature (typically 350°C or higher), and that a reasonable catalyst volume relative to the volumetric flow of exhaust gas is contained in the system. MECA believes that the ultra-low CO emission generators offered by Westerbeke and Kohler employ this type of strategy (controlled exhaust air/fuel ratio near the stoichiometric point) to achieve high CO conversion efficiencies across a catalyst. In automotive or larger four-stroke motorcycle catalyst applications, this precise air/fuel control is achieved using a closed-loop control strategy that employs an oxygen sensor present in the exhaust, upstream of the catalyst. The sensor provides a feedback loop to the engine’s intake air and fuel metering system.

The modest CO conversion efficiencies using catalysts (e.g., 30-60%) reported by ARB and EPA in their small engine test programs are generally indicative of engine operation under net fuel-rich conditions. Small gasoline engines are often designed to operate in a net fuel-rich condition to limit combustion and exhaust temperatures as a means of managing engine component durability. In net fuel-rich exhaust conditions, high CO catalyst efficiencies can also be achieved through use of some type of air introduction into the exhaust down stream of the engine. This strategy is generally termed secondary air injection. Air injection into the exhaust shifts the air/fuel ratio of the exhaust to a leaner (more oxygen rich) condition upstream of the catalyst and favors oxidation of CO and hydrocarbons over the catalyst. Lean exhaust conditions, however, are less favorable for the reduction of NO_x over a precious metal-based, three-way catalyst. Both the ARB and EPA small engine test programs include examples of the use of secondary air injection into the exhaust, typically through some type of passive, venturi-based approach.

In summary, catalyst-based exhaust emission controls are a proven, cost-effective, durable, and safe strategy for reducing CO emissions from small, four-stroke gasoline engines like those used in portable generators. The combination of precious metal-based three-way catalyst formulations and precise air/fuel control has been shown to provide CO conversion efficiencies well in excess of 90% on a variety of small four-stroke gasoline engines, including portable generators currently offered by at least two manufacturers. MECA strongly supports the CPSC's efforts in reducing CO emissions and improving the safety of portable generators.