Air Resources Board

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TO: All Interested Parties

SUBJECT: WORKSHOP TO DISCUSS THE CALIFORNIA EMISSIONS REGULATIONS AND TEST PROCEDURES FOR NEW SPARK-IGNITION MARINE ENGINES AND BOATS

At the time and place noted below, the California Air Resources Board (Board or ARB) will host a public workshop to discuss proposed amendments to California's emissions regulations and test procedures for new spark-ignition marine engines including outboard and personal watercraft (OB/PWC) engines, sterndrive and inboard (SD/I) engines, and the boats that use them. Specifically, the discussion will focus on alternative standards for High Performance SD/I engines (i.e., those with rated power greater than 373 kilowatts), the adoption of not-to-exceed (NTE) limits, carbon monoxide (CO) standards, evaporative control requirements, the incorporation of general relief provisions, requirements for new replacement engines, and other minor changes.

The workshop will be held at the following time and location:

Date: Tuesday, March 18, 2008

Time: 9:30 a.m. – 12:00 noon, Pacific Standard Time

Location: California Air Resources Board – Annex 4 Auditorium
9530 Telstar Avenue
El Monte, California 91731

Background:

On December 10, 1998, ARB adopted exhaust emission regulations and test procedures for new OB/PWC engines. The regulation required a phase-in of progressively more stringent exhaust standards from 2001 through 2008 for combined hydrocarbons and oxides of nitrogen (NMHC+NOx). Since methane is not ozone forming, only the non-methane component of hydrocarbon was to be considered for compliance with the standard. CO emissions were not subject to control in that

regulation. The test procedures adopted by the Board were largely aligned with United States Environmental Protection Agency (U.S. EPA) requirements for OB/PWC engines, but ARB's regulations required more stringent long term emission standards for California engines.

On July 26, 2001, the Board adopted exhaust emission standards for new SD/I engines and boats. The new standards were two-tiered with the first tier commencing in 2003 and the second tier phasing-in from 2007 to 2009. As with OB/PWC engine standards, the SD/I standards were established in the form of NMHC+NOx. However, since SD/I engines are derived from automotive engines, the second tier of standards was based on the same type of control systems applicable to automotive engines, namely three-way catalytic converters. This final NMHC+NOx standard, five grams per kilowatt-hour (5.0 g/kW-hr), was significantly more stringent than the final standards for OB/PWCs and pre-controlled SD/I engines that existed at the time of the regulation. Furthermore, it was applicable to all SD/I engines regardless of rated power, including high performance engines. A standard for CO was not established in this rulemaking; however, it was understood that CO emissions would nonetheless decrease sharply due to the use of catalytic converters. In addition to emission standards, the Board also adopted on-board diagnostics marine (OBD-M) requirements for SD/I engine and boat manufacturers. These diagnostics were based on automotive OBD-II monitoring systems already in production, but tailored to the marine environment. For example, misfire monitoring is not required under OBD-M unless deemed necessary by ARB or the manufacturer to protect the viability of the catalytic converter in use; however, OBD-II requires misfire to be monitored regardless on all passenger vehicles.

On November 17, 2005, the Board revisited its requirements for SD/I engines and boats, originally adopted in 2001, to allow manufacturers an option to delay the introduction of engines meeting the catalyst-based second tier standards by one year in exchange for 100 percent compliance in 2008 and for incorporating low-permeation evaporative control fuel lines on vessels using these engines. The low-permeation fuel lines ensured the preservation of emission benefits that would otherwise have been lost. The Board also provided temporary relief to manufacturers of high performance engines by delaying the second tier standard (5.0 g/kW-hr NMHC+NOx) for these engines until 2009, and by allowing them to meet the standard through averaging. Furthermore, the Board agreed to consider the granting of additional relief for these engines prior to 2009, if warranted, for small volume manufacturers. The Board adopted other relief provisions during this rulemaking such as revised durability periods and default certification levels for high performance engines. The Board also agreed to consider the future adoption of CO standards for spark-ignition marine engines and to the consideration of harmonizing with other requirements that were under development by U.S. EPA at that time.

On May 18, 2007, U.S. EPA published a Notice of Proposed Rulemaking (NPRM) in the Federal Register for nonroad spark-ignition engines and equipment that would generally harmonize federal and California exhaust standards for OB/PWC and SD/I engines. An

exception to complete harmonization is that the federal proposal would allow standard performance engines (i.e., less than or equal to 373 kilowatt (kW) rated power) to comply with the standards through emissions averaging. In addition to emissions averaging, the federal proposal would also permit the banking of emission credits from engines certified to more stringent exhaust levels than required and the trading (or selling) of those credits to other manufacturers. The NPRM also proposed the adoption of CO standards as well as evaporative control requirements and NTE standards for OB/PWC and SD/I engines and boats. Furthermore, the NPRM proposed to include the methane component of hydrocarbon in its certification standard for gasoline fueled engines and to incorporate general relief provisions for unforeseen technical and economic hardships that may befall engine or equipment manufacturers. U.S. EPA is expected to promulgate a final rulemaking for OB/PWC and SD/I standards in June of 2008.

Purpose of the Workshop:

Staff believes that sufficient reason exists to amend the California regulations and test procedures for new spark-ignition marine engines and boats, and it wishes to publicly discuss the amendments it is considering with members of the regulated industry and other interested parties prior to presenting them to the Board on July 24, 2008. Staff's amendments aim to enhance alignment with other ARB and U.S. EPA regulations and to address issues that have developed since the last time the Board considered the regulations (2005). ARB welcomes comments and suggestions related to the following proposed amendments:

Total Hydrocarbon plus Oxides of Nitrogen (THC+NOx) Standards

As adopted in 1998, and later amended in 2001 and 2005, Title 13 of the California Code of Regulations (CCR), Section 2442(b) (13 CCR 2442(b)), requires spark-ignition marine engines to comply with NMHC+NOx standards as a condition of certification and sale in California. Only the non-methane component of hydrocarbon was included in those standards because the intent of the regulation was to control ozone and methane does not contribute to ozone formation in the atmosphere. In recent years, however, methane has been identified as one of the greenhouse gases responsible for manmade global warming. Therefore, staff intends to propose that all future marine standards reflect the total hydrocarbon species instead of only the non-methane component. Additionally, such action would harmonize the form of California's spark-ignition marine standards with that proposed by U.S. EPA for gasoline certification (THC+NOx).

Carbon Monoxide Standards

Staff intends to propose the adoption of CO standards for new OB/PWC and SD/I engines equivalent in magnitude to the CO standards proposed by U.S. EPA in its May 18, 2007, NPRM. The proposal would incorporate the same power delineation proposed by U.S. EPA for OB/PWC engines (i.e., above and below 40 kW), but this

delineation would only apply to CO standards and not to existing NMHC+NOx standards. The existing NMHC+NOx standards are currently bifurcated in California regulations at 4.3 kW and defined by equations that differ somewhat from those used by U.S. EPA in defining its proposed federal THC+NOx standards. Staff sees no reason to modify the California NMHC+NOx standards (other than to include methane - see previous topic) since manufacturers are already certifying to them successfully and since U.S. EPA's proposed standards offer no opportunity for additional emission benefits in California. However, staff agrees with U.S. EPA's assessment that no new technology should be necessary to comply with the proposed CO standards for SD/I engines other than the three-way catalytic converters already present on California engines nor should any new technology be required for OB/PWC engines other than that necessary to comply with U.S. EPA's proposed requirements to which California is herein proposing to align. Table 1 below summarizes staff's proposed CO standards.

Table 1

PROPOSED CO STANDARDS FOR OB/PWC & SD/I ENGINES

ENGINE CATEGORY	MODEL YEAR	MAXIMUM POWER *[kilowatts]*	CO STANDARD *[grams per kilowatt-hour]*
OB/PWC[a]	2009 and later	kW ≤ 40	500 - 5 x P[b,c]
		kW > 40	300.0[c]
SD/I[d]	2009 and later	kW ≤ 373	75.0[e,f]
		kW > 373	350.0[f]

a Abbreviation for Outboard and Personal Water Craft engines
b P is defined as Maximum Engine Power in kilowatts (kW)
c Standards may be corporate averaged
d Abbreviation for Sterndrive and Inboard Engines
e The CO standard is 150 grams per kilowatt-hour (g/kW-hr) for engines meeting the 14.0 - 16.0 g/kW-hr HC+NOx standards
f Standards are fixed

High Performance (> 373 kW) Engine Standards

Staff is considering a relaxation of the 5.0 g/kW-hr NMHC+NOx exhaust standard for high performance SD/I engines (as currently required under 13 CCR 2423(b)), in exchange for the incorporation of evaporative control systems on vessels using high performance engines beginning in 2009. Such an amendment, however, would be contingent on the ability of the evaporative control systems to provide comparable emission benefits to those that would be lost from the proposed relaxation of the exhaust standard. Staff estimates that approximately 2.2 tons per day of NMHC+NOx emission benefits would be lost by relaxing the standards for high performance engines without the remedial effect of an evaporative control requirement.

Industry maintains that enormously large and expensive catalytic converters would be necessary to meet, if at all possible, California's existing catalyst-based exhaust standard for high performance engines. High performance engines are typically operated at wide-open throttle for extended periods, and as such are calibrated to run fuel-rich most of the time. This is done primarily to prevent exhaust valve failure due to the high temperatures and cylinder pressures generated within the engines. Conversely, three-way catalytic converters only achieve optimal performance at or near stoichiometric air/fuel ratios. According to industry's claims, even if a catalytic converter could be developed for high performance engines that met the current standard and that continued to operate reliably throughout the engines' useful life, such a catalyst would likely double or even triple the cost of a new high performance engine. The reasons for this being, in part, the significantly increased amount of precious metal loading and development costs for such a large catalytic converter, the lack of readily available emissions measurement equipment for running certification testing on high displacement engines, and the limited economies of scale in the high performance engine market. High performance engines are estimated to make up less than two percent of California's annual sales of new SD/I engines (≈ 250 engines).

California's existing regulation permits high performance manufacturers to comply with the 5.0 g/kW-hr NMHC+NOx standard by averaging emission levels between high performance and standard performance engines. At the time of this provision's adoption, ARB recognized the potential that some small volume manufacturers might not be able to take advantage of averaging, and staff was asked to consider additional relief, if necessary, prior to the standards becoming effective for high performance engines in 2009. Currently only one manufacturer of high performance engines in the California marketplace, Mercury Marine, has enough standard performance engine volume to benefit from this provision. Therefore, to retain such a provision could unintentionally result in an unfair competitive advantage being given to Mercury Marine.

To solve this dilemma, staff is proposing to amend the existing catalyst-based exhaust requirements for high performance engines by revising the standards to represent optimal emissions performance capability without catalytic converters. Additionally, staff is proposing to require the early introduction of evaporative standards for vessels with high performance engines to preserve the emission benefits that would otherwise be lost due to the relaxation of the existing catalyst-based exhaust standard. The proposed evaporative standards include diurnal control and permeation control for tanks and hoses and are the same standards proposed by U.S. EPA in its May 18, 2007, NPRM, but would be implemented in California at an accelerated schedule. Staff believes that the proposed evaporative standards can be met with passive-purge carbon canister systems and readily available low permeation tubing. Staff believes the number of boats in question is small enough that existing supplies of carbon canisters and components would be adequate to meet the demand of high performance vessels in California. Not only would carbon canister systems be, at a minimum, an emissions neutral solution for high performance engines, the relatively low cost of canisters (approximately $150 - $300 per boat) compared to that of a catalytic converter that

purportedly could triple the cost of a $40,000 - $90,000 dollar engine makes staff's proposal extremely cost effective.

Staff is also considering an optional certification test cycle for high performance engines. The optional cycle would be similar to the currently required E4 steady-state test cycle, but instead of measuring emissions at "no load" idle, manufacturers would test at 15 percent load. Industry has recently provided data to staff suggesting that high performance engines typically operate at loaded idle to ensure smooth engine operation, primarily for passenger comfort. Industry maintains that loaded idle operation is therefore more representative of high performance engine operation than "no load" idle operation and should be reflected in the certification test cycle. An additional effect of loaded idle is improved emissions performance.

The proposed exhaust (including CO) and evaporative standards for high performance engines and boats are listed in Table 2 below. They are based primarily on data compiled by U.S. EPA, which were made public in its May 18, 2007, NPRM, and rely heavily on the analysis presented in that NPRM and its incorporated Regulatory Impact Analysis. Concurrently, ARB staff has been investigating the feasibility of evaporative control measures for vessels with spark-ignition marine engines, but has not yet determined appropriate standards for California. A comprehensive proposal to address California's needs for evaporative control on marine vessels will be forthcoming in the near future; therefore, staff's proposed evaporative standards for high performance vessels should be considered interim for now. However, the evaporative standards proposed by U.S. EPA are at least sufficient to make up for the loss of benefit that would result should the Board adopt staff's proposal to relax the existing exhaust standards for high performance engines in California. Furthermore, the introduction of canisters on the limited number of high performance vessels expected to be sold in California could serve as a type of pilot program for the industry's boat builders, who, as proposed by U.S. EPA, would be required to incorporate similar evaporative control designs on vessels with standard performance engines beginning as early as 2010 nationwide. The proposed U.S. EPA procedures for preconditioning and for measuring evaporative emissions would also apply to staff's proposed high performance evaporative requirements.

Table 2

PROPOSED EXHAUST & INTERIM EVAPORATIVE STANDARDS
FOR HIGH PERFORMANCE ENGINES AND BOATS

MODEL YEAR	MAXIMUM ENGINE POWER *[kilowatts]*	HC+NOx STANDARD *[grams per kilowatt-hour]*	CO STANDARD *[grams per kilowatt-hour]*	PERMEATION STANDARDS *[grams per square meter per day]*		DIURNAL[a] STANDARD *[grams per gallon per day]*
				Hose[b]	Tank[c]	
2009 - 2010	373 < kW ≤ 485	16.0	350.0	15.0	1.5	0.16[d]
	kW > 485	25.0				
2011 and later	373 < kW ≤ 485	16.0				
	kW > 485	22.0				

a Diurnal testing requires fuel with 9 pounds per square inch (psi) Reid Vapor Pressure volatility and a 24 hour fuel temperature cycle of 27.6 º to 30.2 º Celsius
b Fuel line permeation testing requires gasoline fuel with 10% ethanol content and must be performed at a test temperature of 23 ± 2 º Celsius
c Fuel tank permeation testing requires gasoline fuel with 10% ethanol content and must be performed at a test temperature of 28 ± 2 º Celsius
d This is for non-trailerable boats; trailerable boats must meet a 0.4 grams per gallon per day diurnal standard over a fuel temperature cycle of 25.6 º to 32.2 º Celsius

Not-To-Exceed Limits

Staff intends to continue working with U.S. EPA and the marine industry to finalize NTE requirements that will be harmonized federally and in California.

Relief Provisions

California's spark-ignition marine regulations do not allow standard performance SD/I engines to comply with the 5.0 g/kW-hr NMHC+NOx standard through corporate averaging. U.S. EPA, however, has proposed corporate averaging for these engines in its May 18, 2007, NPRM, and the marine industry has asked ARB to harmonize with the federal proposal, maintaining that averaging provides the engine manufacturer with some flexibility in the event that unforeseen circumstances might otherwise prevent the manufacturer from being able to certify an engine family (e.g., the abrupt discontinuation of an engine model by the base engine supplier or insufficient time to design and validate catalytic converters for a newly introduced engine line).

While staff recognizes that unforeseen circumstances beyond the control of the engine marinizer can and do occur, we do not believe that corporate averaging is the most viable solution for the California market. SD/I engine manufacturers have long maintained that it is virtually impossible to guarantee the ultimate destination of the engines they sell, and as such, they cannot guarantee that California would not receive more than its fair share of higher emitting engines should ARB agree to allow corporate averaging. Corporate averaging could also complicate ARB's ability to enforce the regulations in that compliant SD/I engines would no longer be readily differentiable from

noncompliant engines in the field by ARB inspectors. Furthermore, should ARB attempt to implement corporate averaging within State boundaries rather than as a participant in the federal program, U.S. EPA has the right to deny credits for any engines certified early in California, which would serve as a disincentive for SD/I manufacturers to introduce its cleanest engines in California. Consequently, ARB would have to adopt significantly more stringent standards than currently required to ensure that its goals for air quality would still be achieved with respect to a corporate averaging approach.

Still, staff understands that some type of relief provision is warranted. Therefore in lieu of corporate averaging for SD/I engines, the overwhelming majority of which already comply with the standards without averaging, we propose to allow manufacturers to certify one engine family (or other logical grouping) per year to emission levels above the fixed 5.0 g/kW-hr THC+NOx and 75 g/kW-hr CO standards. As with corporate averaging, however, one or more of the remaining engine families in a manufacturer's product line would be required to be certified to emission levels more stringent than the existing fixed exhaust standards to make up for the deficit of the higher emitting engine family. This approach, hereafter referred to as Single Family Averaging, would be similar to the way some manufacturers in California are certifying 4.3 liter or 8.1 liter engine families in 2008 and 2009 under the supplemental measures provision of the regulation. However, the supplemental measures provision is not applicable beyond 2009; therefore, a new amendment is necessary.

In addition to the typical stipulations of an averaging program, such as calculation methodology, records keeping, and reporting requirements as documented in 13 CCR 2442(b)(2), staff intends that the following criteria also be applicable with respect to its Single Family Averaging proposal:

- Only one engine family per year per manufacturer may be certified with emission levels less stringent than the standards
- No engine family may be certified less stringent than the standards for more than three years
- Previously certified engine families may not subsequently be certified less stringent
- New engine families certified less stringent than the standards must still comply with applicable OBD-M requirements and evaporative control standards
- Family Emission Limits (FEL) and caps would apply for all averaged engines
    - FEL cap for existing engine families would be 16/150 g/kW-hr for THC+NOx/CO
    - FEL cap for new engine families would be 10/100 g/kW-hr for THC+NOx/CO

Staff is also considering the proposal of a separate provision granting the Executive Officer of ARB discretion to issue additional temporary relief for matters of extreme hardship for which the single family averaging relief provision may not be completely adequate. Such relief would not be automatically available to the manufacturer and the manufacturer would be required to show proof that the situation necessitating relief was completely beyond its control, and that the manufacturer had done everything feasible to resolve the situation under existing provisions.

On-Board Diagnostics Marine (OBD-M) Requirements

Staff intends to propose that misfire monitoring become a mandatory component of the OBD-M requirements for SD/I engines beginning in 2009. Currently misfire monitoring is only required when ARB or the certifying manufacturer determines that engine misfire would cause the catalyst to fail before the emissions durability period of the engine had elapsed (e.g., 480 hours or 10 years for standard performance engines certified with a catalyst). At the time when the OBD-M requirements were originally adopted, industry believed that catalyst construction would have to be far more robust than that of existing automotive catalysts to meet the 5.0 g/kW-hr NMHC+NOx standard and remain durable in a water environment. By virtue of that assumption, industry contended that misfire would not be an issue regarding catalyst durability and ARB agreed to make misfire monitoring a conditional OBD-M requirement. However, now that manufacturers have begun certifying SD/I engines in California, all have voluntarily included misfire monitoring as part of their OBD-M systems, presumably, at least in part, because they have found ways to incorporate conventionally designed catalytic converters that are susceptible to damage from engine misfire. As such, and because misfire monitoring has already been introduced voluntarily, staff believes that mandatory misfire monitoring should be a requirement for all future OBD-M systems. Nevertheless, audio/visual alert device suppression provisions would remain in effect per existing provisions. As a reminder, OBD-M is required for all SD/I engines large or small, and will continue to be required for all SD/I engines even if staff's proposal to relax high performance engine standards to non-catalyst-based levels is approved by the Board.

Replacement Engine Requirements

California's spark-ignition marine engine test procedures currently require new SD/I replacement engines to comply with current model year emission standards. This would unintentionally necessitate that a catalyst-equipped engine be used to replace the engine in an older model boat that may not be properly designed to accommodate or support a catalyst-equipped engine (e.g., limited engine compartment space, incompatible wiring harnesses, etc.). Staff intends to propose revised language that would require the use of the cleanest engine currently available that could be installed in a boat without unreasonable modifications. If no cleaner engine is available or compatible with the boat, a less stringent new replacement engine may be used so long as its emissions performance is at least as stringent as that of the engine being replaced.

Voluntary Standards

Staff is considering proposing voluntary requirements for spark-ignition marine engines. Engines certified to these voluntary standards would be eligible for a new 5 STAR emissions rating. The proposed requirements would include:

- A THC+NOx exhaust standard of 2.5 g/kW-hr
- A CO standard of 50 g/kW-hr
- Diurnal and permeation standards proposed by U.S. EPA in the May 18, 2007, NPRM
- OBD-M with mandatory misfire monitoring

Miscellaneous

Staff intends to revise or adopt definitions for, but not necessarily limited to, the following terms to enhance harmonization with the requirements proposed by U.S. EPA in its May 18, 2007, NPRM and RIA documents:

> "High Performance Engine" means a spark-ignition sterndrive or inboard engine with maximum engine power greater than 373 kilowatts that has design features to enhance power output such that the expected operating time until rebuild is substantially shorter than 480 hours.
>
> "Spark-ignition" means relating to a gasoline-fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark-ignition engines usually use a throttle to regulate intake air flow to control power during normal operation.
>
> "Maximum Engine Power" means the maximum brake power point on the nominal power curve for the engine configuration, as defined and further explained in Title 40 of the Code of Federal Regulations, Section 1045.140. The power value should be rounded to the nearest whole kilowatt.
>
> "Sterndrive/inboard engine" means a spark-ignition engine that is used to propel a vessel, but is not an outboard engine or a personal watercraft engine. This includes engines on propeller driven vessels, jet boats, air boats, and hovercraft.

Staff intends to propose other non-substantial modifications to the regulations and test procedures to correct grammatical and typographical errors, to correct references and citations, and to improve clarity.

Staff welcomes discussion on how to secure, within its authority, fair competition and a level playing field for California dealers faced with the potential for unfair competition from out-of-State competitors.

Workshop Materials:

Workshop presentations and handouts will be available at the workshop and on ARB's SORE website at: http://www.arb.ca.gov/msprog/offroad/sore/sore.htm . If you would like to receive notification by email of updates to the SORE website, please sign up at: http://www.arb.ca.gov/listserv/sore.htm .

Additional Information:

If you have a disability-related accommodation need, please go to http://www.arb.ca.gov/html/ada/ada.htm for assistance, or contact the ADA Coordinator at (916) 323-4916. If you are a person who needs assistance in a language other than English, please go to http://www.arb.ca.gov/as/eeo/languageaccess.htm or contact the Bilingual Coordinator at (916) 324-5049.

ARB staff is soliciting comments and questions from interested stakeholders before the workshop takes place. If you have comments or questions about the proposed workshop agenda or the topics to be discussed, please submit them to Mr. Jeff Lowry, Staff Specialist, at (626) 575-6841, jlowry@arb.ca.gov, or Mr. Scott Rowland, Manager, at (626) 575-6676, srowland@arb.ca.gov.

Sincerely,

/s/

Robert H. Cross, Chief
Mobile Source Control Division

cc: Mr. Scott Rowland, Manager
Off-Road Controls Section

Mr. Jeff Lowry, Staff Specialist
Off-Road Controls Section