ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 94

[AMS-FRL-xxxx-x]

RIN 2060-xxxx

Control of Emissions of Air Pollution from New Marine Compression-Ignition Engines At or Above 30 Liters/Cylinder

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of Proposed Rulemaking.

SUMMARY: In this action, we are proposing emission standards for new marine diesel engines at or above 30 liters per cylinder on U.S. vessels. Marine diesel engines at or above 30 liters per cylinder are very large marine engines used primarily for propulsion power on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships. The vessels that use these engines are flagged in the United States and in other countries. Nationwide, these engines contribute to ozone and carbon monoxide nonattainment and to ambient particulate matter levels, particularly in commercial ports and along coastal areas.

We are proposing two tiers of emission controls for these engines on U.S. vessels. The first tier is equivalent to the internationally negotiated oxides of nitrogen standards and would be enforceable under U.S. law for new engines built in 2004 and later. The second tier of standards, which reflect additional reductions that can be achieved through engine-based controls, would apply to new engines built in 2007 and later. In addition, we are proposing voluntary low-emission engine standards that reflect advanced oxides of nitrogen emission-control technologies. Meeting these standards would likely require the use of technologies, such as selective catalyst reduction or fuel cells. We are proposing to review the second tier standards prior to their effective date to take into consideration continued development of new

technologies, such as selective catalyst reduction and water-based emission reduction techniques, and international activity such as action at the International Maritime Organization to set more stringent international standards.

Emissions from all marine diesel engines at or above 30 liters per cylinder, regardless of flag of registry, currently account for about 1.5 percent of national mobile source oxides of nitrogen emissions. This contribution can be significantly higher on a port-specific basis. The proposed standards, which would apply only to engines on U.S. flag vessels, are expected to reduce these national emissions by about 11 percent by 2030.

The contribution of these engines to national mobile source hydrocarbon and carbon monoxide inventories is small, less than 0.1 percent, and we are proposing to set standards to ensure that these emissions do not increase on a engine-specific basis. The contribution of these engines to the national mobile source particulate matter inventory is about 2.6 percent. Reductions in particulate emissions could be obtained from setting a sulfur content standard for the fuels that are used by these engines, and we request comment on whether we should adopt such standards and, if so, the level of sulfur that should be allowed.

We are also proposing new requirements for engines at or above 2.5 liters per cylinder but less than 30 liters per cylinder. The Tier 2 standards finalized for these engines in our 1999 commercial marine diesel engine rule apply beginning in 2007. Until then, engine manufacturers are encouraged to voluntarily comply with the Tier 1 standards, which are equivalent to the internationally negotiated NOx standards. The international NOx standards are not yet enforceable. Due to the continued uncertainty regarding their entry into force, we believe it is appropriate to begin to require engine manufacturers to certify these engines to the Tier 1 standards, starting in 2004. We are also proposing to eliminate the foreign trade exemption for all marine diesel engines, which was available for engines installed on vessels that spend less than 25 percent of total operating time with 320 nautical kilometers of U.S. territory. To date, this exemption has not been requested by engine manufacturers.

The proposed standards would apply to engines installed on vessels flagged in the United States. Recognizing that foreign-flag vessels constitute a significant portion of emissions from these engines, we are seeking comment on whether the standards should also apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such foreign vessels from the emission standards under 40 CFR §94.1(b)(3). If the proposed standards were applied to engines at or above 30 liters per cylinder on foreign flagged vessels, there would be an additional 15 percent reduction in the national inventory oxides of nitrogen inventory from these engines by 2030. In addition, if we were to determine that the standards should apply to engines on foreign vessels that enter U.S. ports, then all emission standards for marine diesel engines would apply, including those we finalized for marine diesel engines less than 30 liters per cylinder in our 1999 rule. In other words, any marine engine that is manufactured after the standards become effective and that is installed on a foreign vessel that enters U.S. ports, and any marine engine that is installed on such a foreign vessel that is manufactured (or that otherwise become new) after the standards become effective would need to meet our national standards. This would result in additional emission reductions from engines less than 30 liters per cylinder on these vessels.

DATES: *Comments:* Send written comments on this proposed rule by **[DATE]**. See Section XIII.A for more information about written comments

Hearing: We will hold a public hearing on **[DATE]** at **[PLACE]**. See Section XIII.B for more information about the public hearing.

ADDRESSES: *Comments:* You may send written comments in paper form or by e-mail. We must receive them by the date indicated under DATES above. Send paper copies of written comments (in duplicate, if possible) to the contact person listed below. You may also submit comments via e-mail to *"c3marine@epa.gov."* In your correspondence, refer to Docket A-2000-11. See Section XIII.A for more information on comment procedures.

Docket: EPA's Air Docket makes materials related to this rulemaking available for review in Public Docket A-2000-11 at the following address: U.S. Environmental Protection Agency (EPA), Air Docket (6102), Room M-1500 (on the ground floor in Waterside Mall), 401 M Street, S.W., Washington, DC 20460 between 8 a.m. to 5:30 p.m., Monday through Friday, except on government holidays. You can reach the Air Docket by telephone at (202)260-7548, and by facsimile at (202)260-4400. We may charge a reasonable fee for copying docket materials, as provided in 40 CFR part 2.

Hearing: We will hold a public hearing on **[DATE]** at **[PLACE]**. If you want to testify at the hearing, notify the contact person listed below at least ten days before the date of the hearing. See Section XIII.B for more information on the public hearing procedures.

FOR FURTHER INFORMATION CONTACT: Margaret Borushko, U.S. EPA, National Vehicle and Fuels Emission Laboratory, 2000 Traverwood, Ann Arbor, MI 48105; Telephone (734)214-4334; Fax: (734)214-4816, E-mail: borushko.margaret@epa.gov.

SUPPLEMENTARY INFORMATION:

Regulated Entities

This proposed action would affect companies and persons that manufacture, sell, or import into the United States new marine compression-ignition engines for use on vessels flagged or registered in the United States; companies and persons that make vessels that will be flagged or registered in the United States and that use such engines; and the owners/operators of such U.S.-flag vessels. Further requirements apply to companies and persons that rebuild or maintain these engines. Regulated categories and entities include:

Category	NAICS Code[a]	Examples of potentially regulated entities

Industry	333618	Manufacturers of new marine diesel engines
Industry	336611	Manufacturers of marine vessels
Industry	811310	Engine repair and maintenance
Industry	483	Water transportation, freight and passenger
Industry	324110	Petroleum refineries
Industry	422710, 422720	Petroleum Bulk Stations and Terminals; Petroleum and Petroleum Products Wholesalers

[a]North American Industry Classification System (NAICS)

This list is not intended to be exhaustive, but rather provides a guide regarding entities likely to be regulated by this action. To determine whether particular activities may be regulated by this action, you should carefully examine the proposed regulations. You may direct questions regarding the applicability of this action to the person listed in **FOR FURTHER INFORMATION CONTACT.**

Additional Information about this Rulemaking

Emission standards for new marine diesel engines at or above 30 liters per cylinder were considered by EPA in two previous rulemakings, in 1996 and in 1999. The notice of proposed rulemaking for the first rule (for the control of air pollution from new gasoline spark-ignition and diesel compression-ignition marine engines) can be found at 59 FR 55930 (November 1994); a supplemental notice of proposed rulemaking can be found at 61 FR 4600 (February 7, 1996); and the final rule can be found at 61 FR 52088 (October 4, 1996). The notice of proposed rulemaking for the second rule (for the control of air pollution from new compression-ignition marine engines at or above 37 kW) can be found at 63 FR 68508 (December 11, 1998); the final rule can be found at 64 FR 73300 (December 29, 1999). These documents are available on our websites, http://www.epa.gov/otaq/marine.htm and http://www.epa.gov/otaq.marinesi.htm This proposal relies in part on information that was obtained for those rulemakings, which can be found in Public Dockets A-92-28 and A-97-50. Those dockets are incorporated by reference into the docket for this proposal, A-2000-11.

Obtaining Electronic Copies of the Regulatory Documents

The preamble, regulatory language, Draft Regulatory Support Document, and other rule documents are also available electronically from the EPA Internet Web site. This service is free of charge, except for any cost incurred for internet connectivity. The electronic version of this proposed rule is made available on the date of publication on the primary web site listed below. The EPA Office of Transportation and Air Quality also publishes **Federal Register** notices and related documents on the secondary web site listed below.

1. *http://www.epa.gov/docs/fedrgstr/EPA-AIR* (either select desired date or use Search features).
2. http://www.epa.gov/otaq (look in What's New or under the specific rulemaking topic)

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Table of Contents

List of Subjects

I. Introduction

A. Overview

Marine diesel engines can be significant contributors to local ozone, CO, and PM levels, particularly in commercial ports and along coastal areas. In recognition of their inventory impact, we recently set emission standards for new marine diesel engines above 37 kW but less than 30 liters per cylinder (64 FR 73300, December 29, 1999). The standards contained in that rule cover emissions of oxides of nitrogen (NOx), particulate matter (PM), hydrocarbons (HC), and carbon monoxide (CO), and go into effect in 2004-2007, depending on engine size. Those standards are more stringent than the international standards contained in Annex VI to the International Convention on the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 Relating Thereto (this convention is also known as MARPOL; the standards are referred to as the Annex VI NOx limits).[1] They also cover more pollutants, as the MARPOL limits are for NOx emissions only. As described in Section D, below, the Annex has not yet gone into force because the requisite number of countries have not ratified it. Prior to the effective date of the national standards, engine manufacturers are encouraged to voluntarily comply with the Annex VI NOx limits pending entry into force of Annex VI. We developed a voluntary certification program to enable engine manufacturers to certify to the Annex VI NOx limits prior to the Annex VI requirements entering into force. The national emission requirements apply only to engines on vessels flagged in the United States. Marine engines on

[1]Annex VI was adopted by a Conference of the Parties to MARPOL on September 26, 1997, but has not yet entered into force. Copies of the conference versions of the Annex and the NOx Technical Code can be found in Docket A-95-50, Document II.B.01. Copies of updated versions can be obtained from the International Maritime Organization (www.imo.org)

foreign vessels were not covered by the rule.

We did not set standards for new marine diesel engines at or above 30 liters per cylinder in our 1999 rule. Our analysis at the time indicated that the Annex VI NOx limits were appropriate given the operating characteristics and fuel used by these engines. Rather than duplicate the Annex VI emission control program in our federal regulations, we encouraged engine manufacturers to comply with the Annex VI limits using our voluntary certification program. We also indicated that we would revisit the need to adopt emission limits for these engines under the Clean Air Act if the Annex does not go into effect internationally.

Although more than four years have gone by since Annex VI was adopted by the Parties to the Convention, it has not yet entered into force. There is growing concern in the United States that there are no enforceable standards for these large marine engines. Also, recently developed inventories suggest that the inventory contribution of these engines can be very high in individual port areas. We estimate that these engines account for about 1.5 percent of national mobile source NOx emissions. This contribution can be significantly higher on a port-specific basis. For example, we estimate that these engines contribute about 7 percent of mobile source NOx in the Metropolitan Statistical Areas (MSA) of Baton Rouge/New Orleans and Wilmington NC, about 5 percent of mobile source NOx in the Miami/ Fort Lauderdale and Corpus Christi MSAs, and about 4 percent in the Seattle/Tacoma/Bremerton/Bellingham MSA. In addition, these ships can have a significant impact on inventories in areas without large commercial ports. For example, Santa Barbara estimates that engine on ocean-going marine vessels contribute about 37 percent of total NOx in their area. These emissions are from ships that transit the area, and "are comparable to (even slightly larger than) the amount of NOx produced onshore by cars and truck.[2] These emissions are expected to increase to 62 percent by 2015.

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[2]Memorandum to Docket A-2001-11 from Jean Marie Revelt, "*Santa Barbara County Air Quality News*, Issue 62, July-August 2001 and other materials provided to EPA by Santa Barbara

We estimate the contribution of these engines to national PM levels is about 2.6 percent, but can also be higher on a port-specific area (see Table 2.6-1 in the draft Regulatory Support Document (RSD) for this rule and associated text). The estimated contribution of these engines to national HC and CO emissions is negligible. The inventory contribution of these engines to national NOx, PM, HC, and CO levels is expected to increase as emissions from other mobile sources decrease due to our recently finalized emission control programs for highway vehicles and heavy-duty trucks. Reductions in the inventories of these pollutants will lead to health benefits, as described in Section II.

In addition, manufacturers of diesel engines, including marine diesel engines, have gained greater experience with the emission control technologies that can be applied to these engines. Our analysis indicates that greater emission reductions can be achieved by optimizing currently available control technologies that are being used to achieve the Annex VI NOx limits.

We are proposing two tiers of NOx emission controls for these engines. The first tier is equivalent to the internationally negotiated NOx standards and would be enforceable under U.S. law for new engines built in 2004 and later. The second tier of NOx standards, which reflect additional reductions that can be achieved through engine-based emission controls, would apply to new engines built in 2007 and later. We are also proposing to set standards for HC and CO emissions to ensure that these emissions do not increase on an engine-specific basis. Particulate matter emissions from these engines are primarily due to the characteristics of the fuel they use (residual fuel), and we are requesting comment on whether we should consider a sulfur content limit for that fuel. We are proposing to review the Tier 2 standards prior to their effective date to take into consideration continued development of new technologies, such as selective catalyst reduction and water-based emission reduction techniques, and international activity such as action at International Maritime Organization (IMO) to set more stringent international

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County," March 14, 2002. Air Docket A-2001-11, Document No. XXXXX.

standards.

Consistent with our 1999 commercial marine diesel engine standards, this proposal also contains voluntary low emission standards for marine diesel engines at or above 30 liters per cylinder. As emissions from most mobile source categories continue to decline, emissions from marine vessels and associated port equipment are becoming an increasingly significant source or local, regional, and global emissions. Because of the slow turnover of vessels and associated equipment, there is an opportunity and need for the ports, shipping companies, engine manufacturers, and fuel suppliers to work on a collaborative effort to expedite and further reduce emissions beyond the Annex VI NOx limits and U.S. national standards. Two components of this proposal can help encourage these actions. The first is voluntary low emission standards set at 80 percent below the Annex VI NOx limits. These standards can be used in state-based initiatives and are expected to require the use of advanced technologies such as fuel cells or selective catalyst reduction. The second is the voluntary Blue Cruise program, in which participant vessel owners can receive special recognition from EPA for installing and using technologies that reduce waste and air emissions.

We are also proposing new requirements for engines at or above 2.5 liters per cylinder but less than 30 liters per cylinder. The Tier 2 standards we finalized for these engines in our 1999 commercial marine diesel rule are effective in 2007. Until then, and pending entry into force of Annex VI, we encouraged engine manufacturers to voluntarily comply with Tier 1 standards, which are equivalent to the internationally negotiated NOx standards. Because Annex VI has not gone into force, they remain unenforceable. Due to the continued uncertainty regarding entry into force of Annex VI, we believe it is appropriate to begin to require engine manufacturers to certify these engines to the Tier 1 standards, starting in 2004. We are also proposing to eliminate the foreign trade exemption for all marine diesel engines, which was available for engines installed on vessels that spend less than 25 percent of total operating time with 320 nautical kilometers of U.S. territory. To date, this exemption has not been requested by engine manufacturers.

The proposed standards, which would apply to engines installed on vessels flagged in the United States, are intended to help reduce ozone inventories and avoid a range of adverse health effects associated with that pollutant. They are expected to reduce national inventories of NOx emissions by about 11 percent by 2030. The estimated cost to industry of complying with the proposed Tier 2 standards is about $176,000 per engine. This represents a 9 percent increase in the total engine cost and about 0.1 percent increase in the total vessel cost. We estimate the aggregate costs (annualized over 20 years) of the rule to engine manufacturers to be about $1.6 million annually. The estimated cost-per-ton for this rule is about $140 per ton of NOx emissions.

The impact of the proposed standards on air quality in specific areas will depend in part on the characteristics of the fleet of vessels that operate in that area, particularly on the proportion of foreign-flag ships to U.S.-flag ships. Recognizing that foreign-flag vessels constitute a significant portion of emissions from these engines, we are seeking comment on whether the standards should also apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such foreign vessels from the emission standards under 40 CFR §94.1(b)(3). If we were to apply our emission standards to foreign vessels that enter U.S. ports, then the standards would apply to any marine engine that is manufactured after the standards become effective and that is installed on such a foreign vessel. The standards would also apply to any marine engine installed on such a foreign vessel that is manufactured (or that otherwise become new) after the standards become effective. Applying the proposed standards to engines on these foreign flag vessels would provide an additional 15 percent reduction in the 2030 national NOx inventory from this source.

B. How Is This Document Organized?

This document contains ten parts. After this introductory section, Section II describes the air quality need for this rulemaking and projected benefits. That sections contains a description of the human health and welfare effects of exposure to ozone, PM, and CO and reports our inventory estimates for this source for current and future years. In Section III, we describe the set of engines that would be required to comply with the proposed standards and our reasoning behind this scope of application. Section IV contains our proposed emission standards, effective dates, and testing requirements. We also explain why we believe the proposed standards are technologically feasible. Section V describes various compliance provisions. Section VI summarizes the projected impacts of the standards and discusses the benefits of this proposal. Section VII discusses the alternative approaches we considered when we developed this proposal. Section VIII describes a voluntary incentive program in which participant vessel owners can receive special recognition from EPA for installing and using technologies that reduce waste and air emissions. Finally, Sections IX and X contain information about public participation, how we satisfied our administrative requirements, and the statutory provisions and legal authority for this proposal. Additional information on many of these topics can be found in the Draft Regulatory Support Document for this proposal.

C. What Requirements Are We Proposing?

The proposed NOx emission standards for marine diesel engines at or above 30 liters per cylinder (Category 3 marine diesel engines) consist of two tiers. Tier 1 would apply to new engines built in 2004 and later and would be equivalent to the Annex VI NOx limits adopted by the Parties to MARPOL in 1997. The Tier 2 NOx standards would apply to new engines built in 2007 and later and consist of a NOx limit 30 percent below the Tier 1/Annex VI limit. For both tiers of standards, we are proposing to define NOx standards as a function of maximum engine speed, consistent with Annex VI, but are requesting comment on the merits of defining Tier 2 NOx standards instead as a function of engine displacement. Both tiers of standards can be met through engine-based emission-control technologies. The Annex VI NOx limits are based on certification on distillate fuel, which has a lower nitrogen content than the residual fuel that these engines are most likely to use in operation. Consistent with Annex VI, we are proposing that engines can be certified to the Tier 1 limits on distillate fuel, although in-use testing may be performed on residual fuel. For Tier 2, we are proposing that manufacturers certify their engines on both distillate and residual fuel. The proposed standards are adjusted for variations in fuel quality as described in Section VI, below.

In addition to the Tier 2 NOx limits, we are proposing to set hydrocarbon and carbon monoxide emission limits at 0.4 g/kW-hr and 3.0 g/kW-hr, respectively. These standards will ensure that these emissions do not increase on an engine-specific basis. We are also proposing to review the proposed standards prior to their effective date to take into consideration continued development of new technologies, such as selective catalyst reduction and water-based emission reduction techniques, and international activity such as action at IMO to adopt more stringent standards internationally.

We are not proposing a Tier 2 standard for particulate emissions from these engines. Most of the particulate emissions are a result of the high sulfur and ash content of the fuel used by these engines, and there is no acceptable measurement procedure for fuels with these characteristics. We are requesting comment, however, on whether we should consider a fuel sulfur content limit for the fuels used by these engines. One option, for example, would be to set a sulfur content cap equivalent to the limit for fuel used in SOx Emission Control Areas provided in Regulation 14 of MARPOL Annex VI. Pursuant to that regulation, the sulfur content of fuel used by vessels operating in those areas cannot exceed 15,000 ppm. The United States could also pursue this option through procedures contained in Regulation 14 of MARPOL Annex VI. That regulation provides for the designation of SOx emission control areas. We estimate that reducing the sulfur content of residual fuel to 15,000 ppm may decrease the PM inventory of these engines 18 percent and the SOx inventory by 44 percent (See Section VI.E, below). In connection with this option, we are seeking comment as to which areas of the United States should be considered for designation as SOx emission control areas under MARPOL Annex VI, and whether and how we should seek the cooperation of Canada, Mexico, and the Carribean in designating these areas. As an alternative option, we could set a national fuel sulfur cap for these fuels at a lower sulfur level. For comparison, the sulfur content of highway diesel fuel is 500 ppm, to be reduced to 15 ppm in 2007. The sulfur content of nonroad diesel fuel is between 2,000 and 3,000 ppm. Our analysis of setting fuel requirements equivalent to nonroad distillate fuel indicates that the PM inventory from this source could be reduced by 63 percent, the SOX inventory could be reduced by 89 percent, and an additional NOx benefit of 10% could be achieved (see Section VI.E, below).

We are also proposing voluntary low emission NOx standards for Category 3 marine diesel engines. These standards, which represent an 80 percent reduction from the Annex VI NOx limits, are intended to encourage the introduction and more widespread use of low-emission technologies. Manufacturers could be motivated to exceed emission requirements either to gain early experience with certain technologies or as a response to market demand or local government programs. Ship owners could take advantage of these and other emission reduction technologies to receive special recognition from EPA for installing and using technologies that reduce waste and air emissions under our proposed voluntary Blue Cruise program.

To implement these standards for marine diesel engines at or above 30 liters per cylinder in an effective way, we are proposing several compliance requirements. In general, the proposed compliance program reflects our traditional manufacturer-based approach. This is in contrast to the international approach reflected in Annex VI, which holds the vessel owner responsible for compliance once the engine is delivered onboard. Many of the proposed compliance provisions, including certification application, engine labeling, and warranty requirements, are similar or identical to the compliance provisions that we finalized in our 1999 rulemaking. In addition, we are including a post-installation verification provision which would require an emission test after an engine is installed on a vessel. We are also proposing a field measurement provision that would apply to engines with adjustable parameters or add-on emission control devices. Manufacturers of these engines would be required to equip the engine with a field measurement device. The owner of a vessel with such an engine would have to perform a field measurement when the vessel approaches within 175 nautical miles (200 statutory miles) of the U.S. coastline from the open sea or when it adjusts an engine parameter within that distance. The results of this field measurement will demonstrate that the engine is in compliance with the relevant standards when it is operated in an area that affects U.S. air quality.

We are also proposing new requirements for engines at or above 2.5 liters per cylinder but less than 30 liters per cylinder. The Tier 2 standards we finalized for these engines in our 1999 commercial marine diesel rule are effective in 2007. Until then, and pending entry into force of Annex VI, we encouraged engine manufacturers to voluntarily comply with Tier 1 standards, which are equivalent to the internationally negotiated NOx standards. Because Annex VI has not gone into force, they remain unenforceable. Due to the continued uncertainty regarding entry into force of Annex VI, we believe it is appropriate to begin to require engine manufacturers to certify these engines to the Tier 1 standards, starting in 2004. We are also proposing to eliminate the foreign trade exemption for all marine diesel engines, which was available for engines installed on vessels that spend less than 25 percent of total operating time with 320 nautical kilometers of U.S. territory. To date, this exemption has not been requested by engine manufacturers.

The proposed standards would apply to engines installed on vessels flagged in the United States. Recognizing that foreign-flag vessels constitute a significant portion of emissions from these engines, we are seeking comment on whether the standards should apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such foreign vessels from the emission standards under 40 CFR §94.1(b)(3). If we were to apply our emission standards to foreign vessels that enter U.S. ports, then the standards would apply to any marine engine that is manufactured after the standards become effective and that is installed on such a foreign vessel. The standards would also apply to any marine engine installed on such a foreign vessel that is manufactured (or that otherwise become new) after the standards become effective.

D. Why Is EPA Taking This Action?

We developed this proposed emission control program to fulfill our obligations under Section 213 of the Clean Air Act. That section, described in more detail in Section E, below, requires us to set standards for new nonroad engines. In addition, there are important public health and welfare reasons supporting the standards proposed in this document. As described in Section II.B, Category 3 marine diesel engines contribute to air pollution which causes public health and welfare problems. Emissions from these engines contribute to ground level ozone and ambient PM and CO levels, especially in and near commercial ports and waterways.[3] Exposure to ground level ozone, PM, and CO can cause serious respiratory problems. These emissions also contribute to other environmental problems, including acid deposition, eutrophication, and nitrification.

This action is a departure from the emission control strategy we finalized in 1999 (64 FR 73300, December 29, 1999) in that we are considering no longer relying solely on MARPOL Annex VI for controlling emissions from Category 3 marine diesel engines. While the Annex VI NOx limits apply to engines installed on vessels constructed on or after January 1, 2000, those standards are not enforceable until the Annex goes into effect. As specified in Article 6 of the Annex, it will go into force twelve months after the date on which not less than fifteen member states, the combined merchant fleets of which constitute not less than 50 percent of the gross tonnage of the world's merchant tonnage, have ratified the agreement. To date, more than four years after it was adopted, the Annex has been ratified by only 5 countries representing 14.6 percent of the world's merchant tonnage.[4] In addition, the Annex VI NOx limits no longer reflect the greatest degree of emission control achievable using available technology. Since we finalized our commercial marine diesel engine standards in 1999 (64 FR 73300, December 29, 1999), engine manufacturers continue to make progress in applying land-based emission control

[3] Ground-level ozone, the main ingredient in smog, is formed by complex chemical reactions of volatile organic compounds (VOCs) and NOx in the presence of heat and sunlight. Hydrocarbons (HC) are a large subset of VOC, and to reduce mobile-source VOC levels we set maximum emissions limits for hydrocarbon and particulate matter emissions.

[4] The countries that have ratified Annex VI are Sweden, Norway, Bahamas, Singapore, and Malawi. Information about Annex VI ratification can be found at www.imo.org (look under Conventions, Status of Conventions - Complete List).

technologies to marine diesel engines. Improvements in fuel systems and engine cooling can reduce Category 3 engine emissions even more than the Annex VI NOx limits would require. Some engine manufacturers are also experimenting with water emulsification and injection and aftertreatment, including selective catalyst reduction, for even greater reductions. These emission control technologies are described in greater detail in Section IV.

E. Putting This Proposal Into Perspective

This proposal should be considered in the broader context of EPA's nonroad emission-control programs, our previous marine emission control program, international activities, including MARPOL Annex VI and European Union (EU) initiatives, and activities at the state level.

1. EPA's nonroad emission-control programs

Clean Air Act section 213(a)(1) directs us to study emissions from nonroad engines and vehicles to determine, among other things, whether these emissions "cause, or significantly contribute to, air pollution that may reasonably be anticipated to endanger public health or welfare." Section 213(a)(2) further requires us to determine whether emissions of CO, VOCs, and NOx from all nonroad engines significantly contribute to ozone or CO emissions in more than one nonattainment area. If we determine that emissions from all nonroad engines are significant contributors, section 213(a)(3) then requires us to establish emission standards for classes or categories of new nonroad engines and vehicles that in our judgment cause or contribute to such pollution. We may also set emission standards under section 213(a)(4) regulating any other emissions from nonroad engines that we find contribute significantly to air pollution.

We completed the Nonroad Engine and Vehicle Emission Study, required by Clean Air Act section 213(a)(1), in November 1991.[5] On June 17, 1994, we made an affirmative determination under section 213(a)(2) that nonroad emissions are significant contributors to ozone or CO in more than one nonattainment area. We also determined that these engines make a significant contribution to PM and smoke emissions that may reasonably be anticipated to endanger public health or welfare. In the same document, we set a first phase of emission standards (now referred to as Tier 1 standards) for land-based nonroad diesel engines rated at or above 37 kW. In 1998, we set more stringent Tier 2 and Tier 3 emission levels for new land-based nonroad diesel engines at or above 37 kW and adopted Tier 1 standards for nonroad diesel engines, including marine diesel engines, less than 37 kW. Our other emission-control programs for nonroad engines are listed in Table I.E-1. This proposal takes another step toward the comprehensive nonroad engine emission-control strategy envisioned in the Act by proposing enforceable emission limits for marine diesel engines at or above 30 liters per cylinder.

Table I.E-1
EPA's Nonroad Emission-Control Programs

Engine Category	Final Rulemaking	Date
Land-based diesel engines ≥ 37 kW —Tier 1	56 FR 31306	June 17, 1994
Spark-ignition engines ≤19 kW —Phase 1	60 FR 34581	July 3, 1995
Spark-ignition marine	61 FR 52088	October 4, 1996
Locomotives	63 FR 18978	April 16, 1998
Land-based diesel engines - Tier 1 and Tier 2 for engines < 37 kW (these standards also apply to marine diesel engines < 37	63 FR 56968	October 23, 1998

[5]This study, the Nonroad Engine and Vehicle Emission Study (NEVES) is available in docket A-92-28.

Engine Category	Final Rulemaking	Date
kW) - Tier 2 and Tier 3 for engines ≥ 37 kW		
Commercial marine diesel engines above 37 kW (Standards apply to engines less than 30 liters per cylinder only)	64 FR 73300	December 29, 1999
Spark-ignition engines ≤19 kW (Non-handheld) —Phase 2	64 FR 15208	March 30, 1999
Spark-ignition engines ≤19 kW (Handheld) —Phase 2	65 FR 24268	April 25, 2000
Nonroad large spark-ignition engines, recreational vehicles, and recreational marine diesel engines	66 FR 51098 (proposal)	October 5, 2001
Highway motorcycles and marine evap.	Expected 2002	

2. MARPOL Annex VI

In response to growing international concern about air pollution and in recognition of the highly international nature of maritime transportation, the IMO developed a program to reduce NOx and SOx emissions from marine vessels.[6, 7] The development of Annex VI took place between 1992 and 1997. The Annex VI engine emission limits cover only NOx emissions; there are no restrictions on PM, HC, or CO emissions. They are based on engine speed and apply to

[6]The Annex covers a several air emissions from marine vessels: ozone depleting substances, NOx, SOx, VOCs from tanker operations, incineration, fuel oil quality. There are also requirements for reception facilities and platforms and drilling rigs.

[7]To obtain copies of this document, see Footnote 1, above.

engines above 130 kW. These standards are set out in Table I.E-2. Originally, these standards were expected to reduce NOx emissions by 30 percent when fully phased in. EPA inventory analysis, based on newly estimated emission factors for these engines, indicates that the expected reductions is on the order of about 20 percent. The EPA inventory analysis is described in more detail in the Draft Regulatory Support Document for this proposal.

With regard to implementation, the Annex VI NOx limits apply to each diesel engine with a power output of more than 130 kW installed on a ship constructed on or after January 1, 2000, or that undergoes a major conversion on or after January 1, 2000. The Annex does not distinguish between marine diesel engines installed on recreational or commercial vessels; all marine diesel engines above 130 kW would be subject to the standards regardless of their use. The test procedures to be used to demonstrate compliance are set out in the Annex VI NOx Technical Code[8]. They are based on ISO 8178 and are performed using distillate fuel. Engines can be pre-certified or certified after they are installed onboard. After demonstrating compliance, pre-certified engines would receive an Engine International Air Pollution Prevention (EIAPP) certificate. This document, to be issued by the Administration of the flag country, is needed by the ship owner as part of the process of demonstrating compliance with all of the provisions of Annex VI and obtaining an International Air Pollution Prevention (IAPP) certificate for the vessel once the Annex goes into force. The Annex also contains engine compliance provisions based on a survey approach. These survey requirements would apply after the Annex goes into force. An engine is surveyed after it is installed, every five years after installation, and at least once between 5-year surveys. Engines are not required to be tested as part of a survey, however. The surveys can be done by a parameter check, which can be as simple as reviewing the Record Book of Engine Parameters that must be maintained for each engine and verifying that current engine settings are within allowable limits.

After several years of negotiation, the Parties to MARPOL adopted a final version of Annex VI at a Diplomatic Conference on September 26, 1997. However, as noted in Section I.C,

[8]To obtain copies of this document, see Footenote 1, above.

above, the Annex has not yet gone into force. Pending entry into force, ship owners and vessel manufacturers are anticipated to install compliant engines on relevant ships beginning with the date specified in Regulation 13: January 1, 2000. In addition, ship owners are anticipated to bring existing engines into compliance if the engines undergo a major conversion on or after that date.[9] As defined in Regulation 13 of Annex VI, a major conversion is when the engine is replaced by a new engine, it is substantially modified, or its maximum continuous rating is increased by more than 10 percent. To facilitate implementation while the Annex is not yet in force and to allow engine manufacturers to certify their engines before the Annex goes into force, we set up a process for manufacturers to obtain a Statement of Voluntary Compliance.[10] An EPA-issued Statement of Voluntary Compliance should be exchangeable for an EIAPP certificate once the Annex goes into effect in the United States.

3. EPA's Commercial Marine Diesel Engine Rules

Although we included marine diesel engines in the development of our 1996 marine rule, we did not finalize standards for these engines at that time. At the time, we were considering standards based on Tier 1 land-based nonroad diesel emission controls. Emerging emission control technologies for diesel engines, particularly the Tier 2 land-based nonroad emission

[9]As defined in Regulation 13 of Annex VI, a major conversion means the engine is replaced by a new engine, it is substantially modified, or its maximum continuous rating is increased by more than 10 percent.

[10]For more information about our voluntary certification program, see "guidance for Certifying to MARPOL Annex VI," VPCD-99-02. This letter is available on our website: http://www.epa.gov/otaq/regs/nonroad/marine/ci/imolettr.pdf and in Docket A-2000-11, Document No. XXXXX.

control technologies, led us to reconsider our approach and to defer standards for these engines to a later rulemaking.

In our 1999 commercial marine diesel engine rule, we distinguished between different types of marine diesel engines. The three categories of marine diesel engines, contained in Table I.E-3, were intended to reflect differences in the land-based counterparts of these engines.

Table I.E-3

Marine Engine Category Definitions

Category	Displacement per cylinder	Land-Based Equivalent
1	disp. < 5 liters (and power ≥ 37 kW)	Agricultural equipment; construction equipment
2	5 liters ≤ disp. < 30 liters	Locomotives
3	disp ≥ 30 liters	No mobile source equivalent Power plant generators

The final standards for Category 1 and Category 2 marine diesel standards were more stringent than the Annex VI NOx limits, reflecting the greater degree of emission control that would be achievable through the application of technologies that would be used on the land-based equivalents of these engines to meet the nonroad Tier 2 and locomotive Tier 1 standards. The standards also cover more pollutants than Annex VI, including standards for HC, CO, and PM as well as NOx. The emission standards we finalized for Category 1 and Category 2 marine diesel engines are similar to the nonroad Tier 2 and locomotive Tier 1 standards, respectively.

We did not finalize standards for Category 3 marine diesel engines in 1999. Instead, we deferred to the Annex VI NOx emission control program. This decision was based on our technological analysis of control strategies for these engines which indicated that the appropriate standards should reflect reductions that can be obtained from injection rate shaping and some timing retard. These control technologies were consistent with the Annex VI NOx limits. While some Category 3 engines were already using Tier 2 engine technologies including turbocharging, injection improvements, electronics, and more efficient cooling, these technologies were being used to increase fuel efficiency and obtain optimal operation. Next-generation technologies such as exhaust gas recirculation (EGR), selective catalyst reduction (SCR), and water injection were still under development for marine diesel engines of that size. Because the Annex VI NOx limits would likely be implemented independently of any Clean Air Act requirement, EPA believed that it would be unnecessary and redundant to adopt the same program under the Clean Air Act. Vessel owners were anticipated to begin complying with the Annex VI NOx limits beginning in 2000, as indicated in the Annex.

Since 1999, Category 3 marine diesel engine manufacturers have continued to research emission control technologies and explore ways to transfer land-based diesel engine technologies to marine diesel engines. Due to these advances, and due to the contribution of these engines to ozone and PM levels, we believe it is now appropriate to consider a second tier of emission limits for Category 3 marine diesel engines that will achieve greater reductions than those expected from the Annex VI NOx limits.

4. Continuing Action at the IMO

At the time the Annex VI NOx limits were adopted, several Member States expressed concern that the NOx limits would not result in the emissions reductions they were intended to achieve. Due to the efforts of these Member States, the Conference of the Parties adopted a resolution that provides for review of the emission limits with the aim of proscribing more stringent limits taking into account the adverse effects of such emissions on the environment and any technological developments in marine engines. This review is to occur at a minimum of five-year intervals after entry into force of the Annex and, if appropriate, amend the NOx limits to reflect more stringent controls.

In March of 2000, the United States requested MEPC to begin consideration of more stringent emission limits for marine diesel engines.[11] EPA's analysis of emission control technology for our 1999 rulemaking indicated that more stringent standards are feasible for all Category 1 and Category 2 marine diesel engines. Engine manufacturers were also beginning to apply these emission control strategies to Category 3 marine diesel engines, as well as more advanced strategies such as water emulsification and selective catalyst reduction. Reflecting the potential emission reductions that could be obtained from applying these strategies to all marine diesel engines, the U.S. recommended Annex VI Tier 2 NOx limits be set at 25 to 30 percent below the existing Annex VI NOx limits, to go into effect in 2007. This would allow a 7-year period of stability for the Annex VI NOx limits, permit engine manufacturers to adjust their engine designs to include new emission control technologies, and allow manufacturers of marine diesel engines at or above 30 liters per cylinder to develop emission control strategies for those large engines. This recommendation was briefly discussed at the 44th session of the MEPC (London, March 3-16, 2000), but was not acted on.

5. European Union Actions

[11] MEPC 44/11/7, Prevention of Pollution from Ships, Revision of the NOx Technical Code, Tier 2 emission limits for marine diesel engines at or above 130 kW, submitted by the United States. This document is available at Docket A-2000-11, Document No. XXX.

In February, 1999, the European Commission D-GXI commissioned a report to "consider, analyse and recommend policy options to further the objective of reducing the harmful environmental impact of SOx and NOx from ships operating in European waters."[12] The final report was completed in August 2000. The report explores two types of regulatory options, regulatory standards and incentive plans, for both fuel and engine emission controls. The report is currently under consideration by the Commission.

In January 2001, the Directorate-General for the Environment issued a discussion paper entitled "A Community Strategy on Air Pollution from Seagoing Ships."[13] This paper contains a description of issues and solicits comments that will be used to develop a European emission control strategy for marine vessels. The discussion paper envisions two products: a Commission Communication and a proposal to amend EU Directive 1999/32 on the Sulphur Content of Liquid Fuels.

The discussion paper notes that current inventory analysis indicates that ships will account for 75% and 60% of EU land SOx and NOx emissions, respectively. A new inventory study currently being commissioned will shed more light on these contributions, particularly in-port contributions. The discussion paper also describes current EU and international regulatory regimes and the potential for further reductions. Regarding SOx emissions, EU Directive 1999/32 currently prohibits the use of marine distillate fuels having more than 2,000 ppm sulfur in Community territorial waters. While there is an exemption for ships coming from third countries, those ships must use low sulfur distillate after they make their first stop at a

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[12] Davies, M. E., et al., Study on the Economic, Legal, Environmental and Practical Implications of a European Union System to Reduce Ship Emissions of SO2 and NOx, Final Report for European Commission Contract B4-3040/98/000839/MAR/B1, August 2000. This report is available at http://www.europa.eu.int/comm/environment/air/transport.htm#3. A copy can also be found in Docket A-2000-11, Document No. XXXXX.

[13] This discussion paper can be found at http://www.europa.eu.int/comm/environment/air/future_transport.htm (Under "pollutant emissions from ships" then "new developments"). A copy of this paper can also be found in Docket A-2000-11, Document No. XXXXX.

Community port. There is some concern that this approach encourages ships to burn heavy fuel while in Community waters. Regarding NOx emissions, the paper describes the MARPOL Annex VI requirements, the EPA standards established in 1999, and the U.S. action to encourage IMO to consider more stringent NOx limits. The paper does not suggest potential emission control programs for the EU, but it requests comment support for more stringent standards.

6. Action By Individual European Countries

In 1996 the Swedish Maritime Administration, the Swedish Shipowners' Association and the Swedish Ports' and Stevedores' Association arrived at a Tripartite Agreement to decrease ship nitrogen oxides and sulphur emissions by 75% within five years. The parties agreed to establish an environmental program on differentiated fairway and port dues for NOx levels and fuel sulphur content. The program was constructed by first raising the ship related dues (from Swedish Kroner (SEK) 3.90 per gross tonne (GT) for oil tankers and SEK 3.60 per GT for ferries and other ships to SEK 5.30 and SEK 5.00 respectively) from which the discounts would be subtracted[14]. For use of low sulphur fuels a credit of SEK 0.90 per GT was given for ships operating on bunker oils of a sulphur content of less than 0.5 per cent by weight for ferries and less than 1.0 per cent for other ships. For low NOx emissions, if the emission at 75 per cent engine load is above 12 g/kWh, no NOx discount is given. Below this level the discount increases continuously down to a level of 2 g/kWh where the discount is SEK 1.60 per GT. A maximum discount of SEK 2.50 per GT is possible. The program entered into force January 1, 1998 and as of 1999, twenty of Sweden's fifty two ports have introduced environmentally differentiated harbour dues for reduced sulphur fuels, reduced NOx emissions or both. Ferries are using new technologies, including water emulsion systems (20-50% Nox reduction) and SCR systems (up to 95% NOx reduction), to achieve the low emission levels. To overcome initial problems and encourage the installation of catalytic converters, the Swedish Maritime Administration agreed to reimburse shipowners for the fairway dues paid during the first five years of the program (thru 2002). "Based on known planned installations, the National Maritime Administration expects that by 1 January 2001 the scheme will have reduced NOx emissions

[14]One Swedish Kroner (SEK) is about $0.09

from ships calling at Swedish ports by 40-45 per cent compared to the situation in 1995."[15]

[15] A further detailed discussion of this topic can be found at http://www.sjofartsverket.se/navigering/htm/frameset.htm, Docket item xxxxxxx.

Over the past three years several other localities worldwide have also incorporated adjustments in port dues based on compliance with emission levels. The Port of Mariehamn, on the Finish Island of Aland differentiates its harbor dues with regard to ships' emissions of NOx and sulphur. The proposal in 1999 was to "give ships emitting less than 10 g/kWh NOx a rebate on a linear scale where the reduction of the port due is 8 per cent for ships emitting less than 1 gramme, and 1 per cent for ships emitting 9 g/kWh. Ships using bunker oils with less than 0.5 per cent sulphur (by weight) will receive an additional reduction of 4 per cent. For vessels meeting the latter criteria and having NOx emissions of less than 1 g/kWh the proposal is to offer an extra rebate of 8 per cent. Such ships will, if the scheme is adopted, get a total reduction of 20 per cent."[16] The Norwegian government has a program for environmental differentiation of the tonnage tax (Proposition NO 1 1999/2000). The differentiation is based on a Ship Environment Index System (SEIS). The SEIS is based on up to seven different environmental parameters, including sulphur and NOx emissions with a maximum of 10 points of which 6 points are from the abatement of NOx and sulphur emissions. The program will raise the tonnage tax by 50 per cent and ships registered according to the environmental index system will receive rebates in proportion to their environmental score. Ships that earn 10 points will not pay more than they did before the new scheme began operating and ships that do not register or do not earn any points will have to pay the full tax."[17] The Green Award Foundation, with the Port of Rotterdam and some ports in Portugal and South Africa offers reduced harbor dues for tankers of more than 20,000 DWT. To earn the award, the shipowner and the vessel must comply with national and international laws and regulations as well as demonstrate environmental and safety awareness in a number of areas affecting management and crew competence as well as technical

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[16] A further detailed discussion of this topic can be found at http://www.sjofartsverket.se/navigering/htm/frameset.htm, Docket item xxxxxxx.

[17] A further detailed discussion of this topic can be found at http://www.sjofartsverket.se/navigering/htm/frameset.htm, Docket item xxxxxxx.

provisions which includes exhaust emissions.

7. State Actions: SCAQMD, Alaska and Texas Smoke Requirements

Several states have programs that address smoke emissions from marine engines. This section summarizes the programs in SCAQMD, Alaska and Texas.

SCAQMD: California's South Coast Air Quality Management District's Rule 401 states "(b)(1)A person shall not discharge into the atmosphere from any single source of emission whatsoever any air contaminant for a period or periods aggregating more than three minutes in any one hour which is: (A) As dark or darker in shade as that designated No. 1 on the Ringelmann Chart as published by the United States Bureau of Mines; or (B) Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subparagraph (b)(1)(A) of this rule."[18] The Port of Long Beach has issued literature requiring compliance with the SCAQMD rules through their Smoke Stack Emissions Program.[19]

The Port of Long Beach and the Port of los Angeles also require, as of May 1, 2001, a Voluntary Commercial Cargo Ship Speed Reduction Program. The "Air Quality Compliance Zone" is with a 12 knot speed restriction beginning 20-nautical miles from Point Fermin to the boundaries of the existing mandatory Precautionary Area. The purpose is to reduce air pollution

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[18] A further detailed discussion of this topic can be found at http://www.aqmd.gov/rules/html/r401.html. Docket item XXXX

[19] A further detailed discussion of this topic can be found at www.polb.com. Docket item XXXX.

from ships in the South Coast Air Basin.[20]

[20] A further detailed discussion of this topic can be found at http://www.polb.com/NavAlert.htm. Docket item XXXX

ALASKA: Under Alaska's present state law, with some exceptions, "ships must keep emissions from reducing visibility through the exhaust plume by more than 20% while in Alaska waters. Diesel exhausts and other smoky discharges from ships can create a haze that hangs over coastal communities. DEC receives regular complaints from coastal community residents about these emissions. The state has certified readers who observe the emissions coming from a cruise ship's smokestack to determine if the standards are being exceeded."[21]

TEXAS: The Texas Natural Resource Conservation Commission Chapter 111 of the document on Control of Air Pollution From Visible Emissions and Particulate Matter contains requirements of visible emissions from ships. The document, section 111.111(a)(6)(A) and (B), state that "(A)Visible emissions shall not be permitted from any railroad locomotive, ship or any other vessel to exceed an opacity of 30% for any five-minute period, except during reasonable periods of engine start-up. (B)Compliance with subparagraph(A) of this paragraph shall be determined by applying the following test methods, as appropriate:(i) Test Method 9,(40 CFR 60, Appendix A), or (ii) equivalent test method approved by the executive director and EPA." This document was effective June 11, 2000.[22]

II. The Air Quality Need

A. Overview

[21] A further detailed discussion of this topic can be found at http://www.state.ak.us/local/akpages/ENV.CONSERV/press/2001/rel_1115.htm. Docket item XXXX

[22] A further detailed discussion of this topic can be found at http://www.tnrcc.state.tx.us/oprd/rules/pdflib/111a.pdf

This proposal contains a regulatory strategy for Category 3 marine diesel engines on U.S. vessels. Marine diesel engines at or above 30 liters per cylinder are very large marine engines used primarily for propulsion power on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships. The vessels that use these engines are flagged in the United States and in other countries. Category 3 engines have not been regulated under our nonroad engine programs. Nationwide, these engines are a significant source of mobile source air pollution. As described in Section II.C, below, emissions from all Category 3 marine diesel engines, regardless of flag of registry, currently account for about 1.5 percent of national mobile source NOx, and 2.6 percent of national mobile source PM inventories.

We conducted a study of emissions from nonroad engines, vehicles, and equipment in 1991, as directed by the Clean Air Act, section 213(a) (42 U.S.C. 7547(a)). Based on the results of that study, we determined that emissions of NOx, VOCs (including HC), and CO from nonroad engines and equipment contribute significantly to ozone and CO concentrations in more than one noattainment area (see 59 FR 31306, June 17, 1994). Given this determination, section 213(a)(3) of the Act requires us to establish (and from time to time revise) emission standards for those classes or categories of new nonroad engines, vehicles, and equipment that in our judgment cause or contribute to such air pollution. We have determined that commercial marine diesel engines cause or contribute to such air pollution (see also the proposed commercial marine diesel engine preamble at 63 FR 68508, December 11, 1998 and the final rule at 64 FR 73300, December 29, 1999).

Where we determine that other emissions from new nonroad engines, vehicles, or equipment significantly contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, section 213(a)(4) authorizes EPA to establish (and from time to time revise) emission standards from those classes or categories of new nonroad engines, vehicles, and equipment that cause or contribute to such air pollution. We have determined that commercial marine diesel engines cause or contribute to such air pollution (see also the proposed commercial marine diesel engine preamble at 63 FR 68508, December 11, 1998 and the final rule at 64 FR

73300, December 29, 1999).

B. What are the Public Health and Welfare Concerns Associated with Emissions from Category 3 Diesel Marine Engines Subject to the Proposed Standards?

The engines that would be subject to the proposed standards generate emissions of NOx, HC, PM and CO that contribute to ozone and CO nonattainment as well as adverse health effects associated with ambient concentrations of PM. This section contains a summary of the general health effects of these substances. Further information can be found in Chapter 2 of the Draft Regulatory Support Document. National and selected port city inventories are set out in Section II.C, and estimates of the expected impact of the proposed control program are described in Section VI.

1. Ozone and its precursors

Volatile organic compounds (VOC) and NOx are precursors in the photochemical reaction which forms tropospheric ozone. Ground-level ozone, the main ingredient in smog, is formed by complex chemical reactions of VOCs and NOx in the presence of heat and sunlight. Hydrocarbons (HC) are a large subset of VOC, and to reduce mobile-source VOC levels we set maximum emissions limits for hydrocarbon and particulate matter emissions.

A large body of evidence shows that ozone can cause harmful respiratory effects including chest pain, coughing, and shortness of breath, which affect people with compromised respiratory systems most severely. When inhaled, ozone can cause acute respiratory problems; aggravate asthma; cause significant temporary decreases in lung function of 15 to over 20 percent in some healthy adults; cause inflammation of lung tissue; produce changes in lung tissue and structure; may increase hospital admissions and emergency room visits; and impair the body's immune system defenses, making people more susceptible to respiratory illnesses. Children and outdoor workers are likely to be exposed to elevated ambient levels of ozone during exercise and, therefore, are at a greater risk of experiencing adverse health effects. Beyond its human health effects, ozone has been shown to injure plants, which has the effect of reducing crop yields and reducing productivity in forest ecosystems.

There is strong and convincing evidence that exposure to ozone is associated with exacerbation of asthma-related symptoms. Increases in ozone concentrations in the air have been associated with increases in hospitalization for respiratory causes for individuals with asthma, worsening of symptoms, decrements in lung function, and increased medication use, and chronic exposure may cause permanent lung damage. The risk of suffering these effects is particularly high for children and for people with compromised respiratory systems.

Ground level ozone today remains a pervasive pollution problem in the United States. In 1999, 90.8 million people (1990 census) lived in 31 areas designated nonattainment under the 1-hour ozone NAAQS.[23] This sharp decline from the 101 nonattainment areas originally identified under the Clean Air Act Amendments of 1990 demonstrates the effectiveness of the last decade's worth of emission-control programs. However, elevated ozone concentrations remain a serious public health concern throughout the nation.

Over the last decade, declines in ozone levels were found mostly in urban areas, where emissions are heavily influenced by controls on mobile sources and their fuels. Twenty-three metropolitan areas have realized a decline in ozone levels since 1989, but at the same time ozone levels in 11 metropolitan areas with 7 million people have increased.[24] Regionally, California and the Northeast have recorded significant reductions in peak ozone levels, while four other

[23]National Air Quality and Emissions Trends Report, 1999, EPA, 2001, at Table A-19. This document is available at http://www.epa.gov/oar/aqtrnd99/. The data from the Trends report are the most recent EPA air quality data that have been quality assured. A copy of this table can also be found in Docket No. A-2001-11, Document No. II-A-XX.

[24]National Air Quality and Emissions Trends Report, 1998, March, 2000, at 28. This document is available at http://www.epa.gov/oar/aqtrnd98/. Relevant pages of this report can be found in Memorandum to Air Docket A-2000-01 from Jean Marie Revelt, September 5, 2001. This memorandum is available in Air Docket A-2001-11, Document No. II-A-XX.

regions (the Mid-Atlantic, the Southeast, the Central and Pacific Northwest) have seen ozone levels increase. The highest ambient concentrations are currently found in suburban areas, consistent with downwind transport of emissions from urban centers. Concentrations in rural areas have risen to the levels previously found only in cities.

To estimate future ozone levels, we refer to the modeling performed in conjunction with the final rule for our most recent heavy-duty highway engine and fuel standards.[25] We performed ozone air quality modeling for the entire Eastern U.S. covering metropolitan areas from Texas to the Northeast.[26] This ozone air quality model was based upon the same modeling system as was used in the Tier 2 air quality analysis, with the addition of updated inventory estimates for 2007 and 2030. The results of this modeling were examined for those 37 areas in the East for which

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[25]Additional information about this modeling can be found in our Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, document EPA420-R-00-026, December 2000. Docket No. A-2001-11, Document No. II-A-XX. This document is also available at http://www.epa.gov/otaq/diesel.htm#documents.

[26]We also performed ozone air quality modeling for the western United States but, as described further in the air quality technical support document, model predictions were well below corresponding ambient concentrations for our heavy-duty engine standards and fuel sulfur control rulemaking. Because of poor model performance for this region of the country, the results of the Western ozone modeling were not relied on for that rule.

EPA's modeling predicted exceedences in 2007, 2020, and/or 2030 and the current 1-hour design values are above the standard or within 10 percent of the standard. This photochemical ozone modeling for 2020 predicts exceedences of the 1-hour ozone standard in 32 areas with a total of 89 million people (1999 census) after accounting for light- and heavy-duty on-highway control programs.[27] We expect the NOx control strategy contained in this proposal for Category 3 marine engines will further assist state efforts already underway to attain and maintain the 1-hour ozone standard.

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[27] Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, US EPA, EPA420-R-00-026, December 2000, at II-14, Table II.A-2. Docket No. A-2001-11, Document Number II-A-XX. This document is also available at http://www.epa.gov/otaq/diesel.htm#documents.

In addition to the health effects described above, there exists a large body of scientific literature that shows that harmful effects can occur from sustained levels of ozone exposure much lower than 0.125 ppm.[28] Studies of prolonged exposures, those lasting about 7 hours, show health effects from prolonged and repeated exposures at moderate levels of exertion to ozone concentrations as low as 0.08 ppm. The health effects at these levels of exposure include transient pulmonary function responses, transient respiratory symptoms, effects on exercise performance, increased airway responsiveness, increased susceptibility to respiratory infection, increased hospital and emergency room visits, and transient pulmonary respiratory inflammation.

Prolonged and repeated ozone concentrations at these levels are common in areas throughout the country, and are found both in areas that are exceeding, and areas that are not exceeding, the 1-hour ozone standard. Areas with these high concentrations are more widespread than those in nonattainment for that 1-hour ozone standard. Monitoring data indicate that 333 counties in 33 states exceed these levels in 1997-99.[29] The Agency's recent photochemical ozone modeling forecast that 111 million people are predicted to live in areas that

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[28] Additional information about these studies can be found in Chapter 2 of "Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements," December 2000, EPA420-R-00-026. Docket No. A-2001-11, Document Number II-A-XX. This document is also available at http://www.epa.gov/otaq/diesel.htm#documents.

[29] A copy of these data can be found in Air Docket A-2001-11, Document No. II-A-XX.

are at risk of exceeding these moderate ozone levels for prolonged periods of time in 2020 after accounting for expected inventory reductions due to controls on light- and heavy-duty on-highway vehicles.[30]

2. Particulate Matter

Category 3 marine engines that would be subject to the proposed standards contribute to ambient particulate matter (PM) levels in two ways. First, they contribute through direct emissions of particulate matter. Second, they contribute to indirect formation of PM through their emissions of organic carbon, especially HC. Organic carbon accounts for between 27 and 36 percent of fine particle mass depending on the area of the country.

Particulate matter represents a broad class of chemically and physically diverse substances. It can be principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size. All particles equal to and less than 10 microns are called PM_{10}. Fine particles can be generally defined as those particles with an aerodynamic diameter of 2.5 microns or less (also known as $PM_{2.5}$), and coarse fraction particles are those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns.

[30] Memorandum to Docket A-99-06 from Eric Ginsburg, EPA, "Summary of Model-Adjusted Ambient Concentrations for Certain Levels of Ground-Level Ozone over Prolonged Periods," November 22, 2000, at Table C, Control Scenario – 2020 Populations in Eastern Metropolitan Counties with Predicted Daily 8-Hour Ozone greater than or equal to 0.080 ppm. Docket A-2001-11, Document Number II-B-XX.

Particulate matter, like ozone, has been linked to a range of serious respiratory health problems. Scientific studies suggest a likely causal role of ambient particulate matter (which is attributable to several sources including mobile sources) in contributing to a series of health effects.[31] The key health effects categories associated with ambient particulate matter include premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days), aggravated asthma, acute respiratory symptoms, including aggravated coughing and difficult or painful breathing, chronic bronchitis, and decreased lung function that can be experienced as shortness of breath. Observable human noncancer health effects associated with exposure to diesel PM include some of the same health effects reported for ambient PM such as respiratory symptoms (cough, labored breathing, chest tightness, wheezing), and chronic respiratory disease (cough, phlegm, chronic bronchitis and suggestive evidence for decreases in pulmonary function). Symptoms of immunological effects such as wheezing and increased allergenicity are also seen. Exposure to fine particles is closely associated with such health effects as premature mortality or hospital admissions for cardiopulmonary disease.

PM also causes adverse impacts to the environment. Fine PM is the major cause of reduced visibility in parts of the United States. Other environmental impacts occur when particles deposit onto soils, plants, water or materials. For example, particles containing nitrogen and sulphur that deposit on to land or water bodies may change the nutrient balance and acidity of those environments. Finally, PM causes soiling and erosion damage to materials, including culturally important objects such as carved monuments and statues. It promotes and accelerates the corrosion of metals, degrades paints, and deteriorates building materials such as concrete and limestone.

[31]EPA (1996) Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper. EPA-452/R-96-013. Docket Number A-99-06, Documents Nos. II-A-18, 19, 20, and 23. The particulate matter air quality criteria documents are also available at http://www.epa.gov/ncea/partmatt.htm.

The NAAQS for PM_{10} were established in 1987. According to these standards, the short term (24-hour) standard of 150 $\mu g/m^3$ is not to be exceeded more than once per year on average over three years. The long-term standard specifies an expected annual arithmetic mean not to exceed 50 $\mu g/m^3$ over three years. Recent PM_{10} monitoring data indicate that 14 designated PM_{10} nonattainment areas with a projected population of 23 million violated the PM_{10} NAAQS in the period 1997-99. In addition, there are 25 unclassifiable areas that have recently recorded ambient concentrations of PM_{10} above the PM_{10} NAAQS.[32]

[32]EPA adopted a policy in 1996 that allows areas with PM_{10} exceedances that are attributable to natural events to retain their designation as unclassifiable if the State is taking all reasonable measures to safeguard public health regardless of the sources of PM_{10} emissions.

Current 1999 $PM_{2.5}$ monitored values, which cover about a third of the nation's counties, indicate that at least 40 million people live in areas where long-term ambient fine particulate matter levels are at or above 16 $\mu g/m^3$ (37 percent of the population in the areas with monitors).[33] This 16 $\mu g/m^3$ threshold is the low end of the range of long term average $PM_{2.5}$ concentrations in cities where statistically significant associations were found with serious health effects, including premature mortality.[34] To estimate the number of people who live in areas where long-term ambient fine particulate matter levels are at or above 16 $\mu g/m^3$ but for which there are no monitors, we can use modeling. According to our national modeled predictions, there were a total of 76 million people (1996 population) living in areas with modeled annual average $PM_{2.5}$ concentrations at or above 16 $\mu g/m^3$ (29 percent of the population).[35]

To estimate future $PM_{2.5}$ levels, we refer to the modeling performed in conjunction with the final rule for our most recent heavy-duty highway engine and fuel standards, using EPA's Regulatory Model System for Aerosols and Deposition (REMSAD).[36] The most appropriate method of making these projections relies on the model to predict changes between current and

[33]Memorandum to Docket A-99-06 from Eric O. Ginsburg, Senior Program Advisor, "Summary of 1999 Ambient Concentrations of Fine Particulate Matter," November 15, 2000. Air Docket A-2001-11, Document No. II-B-XX.

[34]EPA (1996) Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper. EPA-452/R-96-013. Docket Number A-99-06, Documents Nos. II-A-18, 19, 20, and 23. The particulate matter air quality criteria documents are also available at http://www.epa.gov/ncea/partmatt.htm. .

[35]Memorandum to Docket A-99-06 from Eric O. Ginsburg, Senior Program Advisor, "Summary of Absolute Modeled and Model-Adjusted Estimates of Fine Particulate Matter for Selected Years," December 6, 2000. Air Docket A-2001-11, Document No. II-B-XX.

[36]Additional information about the Regulatory Model System for Aerosols and Deposition (REMSAD) and our modeling protocols can be found in our Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, document EPA420-R-00-026, December 2000. Docket No. A-2001-11, Document No. A-II-XX. This document is also available at http://www.epa.gov/otaq/disel.htm#documents.

future states. Thus, we have estimated future conditions only for the areas with current $PM_{2.5}$ monitored data (which cover about a third of the nation's counties). For these counties, REMSAD predicts the current level of 37 percent of the population living in areas where fine PM levels are at or above 16 μg/m3 to increase to 49 percent in 2030.[37]

We expect the PM control strategies contained in this proposal would further assist state efforts already underway to attain and maintain the PM NAAQS.

3. Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas produced through the incomplete combustion of carbon-based fuels. Carbon monoxide enters the bloodstream through the lungs and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected, but only at higher CO levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.

High concentrations of CO generally occur in areas with elevated mobile-source emissions. Peak concentrations typically occur during the colder months of the year when mobile-source CO emissions are greater and nighttime inversion conditions are more frequent. This is due to the enhanced stability in the atmospheric boundary layer, which inhibits vertical mixing of emissions from the surface.

[37] Technical Memorandum, EPA Air Docket A-99-06, Eric O. Ginsburg, Senior Program Advisor, Emissions Monitoring and Analysis Division, OAQPS, Summary of Absolute Modeled and Model-Adjusted Estimates of Fine Particulate Matter for Selected Years, December 6, 2000, Table P-2. Docket Number 2001-11, Document Number II-B-XX.

The current primary NAAQS for CO are 35 parts per million for the one-hour average and 9 parts per million for the eight-hour average. These values are not to be exceeded more than once per year. Air quality carbon monoxide value is estimated using EPA guidance for calculating design values. In 1999, 30.5 million people (1990 census) lived in 17 areas designated nonattainment under the CO NAAQS.[38]

[38]National Air Quality and Emissions Trends Report, 1999, EPA, 2001, at Table A-19. This document is available at http://www.epa.gov/oar/aqtrnd99/. The data from the Trends report are the most recent EPA air quality data that have been quality assured. A copy of this table can also be found in Docket No. A-200111, Document No. II-A-XX.

Nationally, significant progress has been made over the last decade to reduce CO emissions and ambient CO concentrations. Total CO emissions from all sources have decreased 16 percent from 1989 to 1998, and ambient CO concentrations decreased by 39 percent. During that time, while the mobile source CO contribution of the inventory remained steady at about 77 percent, the highway portion decreased from 62 percent of total CO emissions to 56 percent while the nonroad portion increased from 17 percent to 22 percent.[39] Over the next decade, we would expect there to be a minor decreasing trend from the highway segment due primarily to the more stringent standards for certain light-duty trucks (LDT2s).[40] CO standards for passenger cars and other light-duty trucks and heavy-duty vehicles did not change as a result of other recent rulemakings.

4. Other Welfare and Environmental Effects

In addition to the health and welfare concerns just described, Category 3 marine diesel engines can contribute to regional haze, acid deposition, and eutrophication and nitrophication. Further information on these effects can be found in Chapter 2 of the Draft Regulatory Support

[39] National Air Quality and Emissions Trends Report, 1998, March, 2000; this document is available at http://www.epa.gov/oar/aqtrnd98/. National Air Pollutant Emission Trends, 1900-1998 (EPA-454/R-00-002), March, 2000. These documents are available at Docket No. A-2000-01, Document No. II-A-72. See also Air Quality Criteria for Carbon Monoxide, US EPA, EPA 600/P-99/001F, June 2000, at 3-10. Air Docket A-2001-11, Document Number II-A-XX. This document is also available at http://www.epa.gov/ncea/coabstract.htm.

[40] LDT2s are light light-duty trucks greater than 3750 lbs. loaded vehicle weight, up through 6000 gross vehicle weight rating.

Document.

C. Contribution from Category 3 Marine Diesel Engines

1. National Inventories

We developed baseline Category 3 vessel emissions inventories under contract with E. H. Pechan & Associates, Inc.[41] Inventory estimates were developed separately for vessel traffic within 25 nautical miles of port areas and vessel traffic outside of port areas but within 175 nautical miles of the coastline. The inventories include all Category 3 traffic, including that on the Great Lakes. Different techniques were used to develop the port and non-port inventories. For port areas we developed detailed emissions estimates for nine specific ports using port activity data including port calls, vessel types and typical times in different operating modes. Emissions estimates for all other ports were developed by matching each of those ports to one of the nine specific ports already analyzed based on characteristics of port activity, such as predominant vessel types, harbor draft and region of the country. The detailed port emissions were then scaled to the other ports based on relative port activity. We developed non-port emissions inventories using cargo movements and waterways data, vessel speeds, average dead weight tonnage per ship, and assumed cargo capacity factors. More detailed information regarding the development of the baseline emissions inventories can be found in Chapter 6 of the Draft Regulatory Support Document.

There has been little study of the transport of marine vessel NOx emissions and the distance they may travel to impact air quality on land. Pollutant transport is a very complicated subject, and the transport distance can vary dramatically depending on a variety of factors, including the pollutant under consideration, as prevailing wind speed and direction, and other atmospheric conditions. When we consider how far off the coast to include emissions in our baseline the

[41] Cite Pechan report(s) when completed.

correct answer may well vary depending on geographic area and prevailing atmospheric conditions. Thus, in developing baseline emissions inventories we looked at two scenarios that we believe reasonably bracket the distances from shore that vessel emissions my be emitted and expected in impact air quality on land. First, we looked only at the pollutants emitted within 25 nautical miles of a port area as a reasonable lower bound to estimate the national inventory of Category 3 marine diesel engines. As an upper bound we considered all Category 3 emissions within 175 nautical miles of shore.

Not surprisingly, these two different distances yield different inventory results. The 1996 NOx and PM emissions inventories are shown in Table II.C-1. We used 1996 as the starting point for this analysis because that is the most recent year that we have detailed information available for the nine specific port areas. As will be discussed later in this section, this initial analysis shows that the contribution from U.S. and foreign flagged vessels differs between these two areas.

Table II.C-1
Category 3 Marine Diesel Engine 1996 Baseline Emissions Inventories (thousand short tons)

Scenario	NOx	PM
Within 25 nautical miles of ports	101	9.3
Within 175 nautical miles of coast	190	17

For the remainder of the analysis associated with the proposed emissions standards we will consider all emissions tat occur within 175 nautical miles from the coast as our primary scenario. We request comment on all aspects of our emissions inventories. In particular, we request comment on whether we should consider a range different than 175 nautical miles from the coast as our primary scenario, and why. We also request comment on whether we should consider different distances from the coast for different areas of the country. For example, should we consider a smaller distance on the East coast than the west coast to account for prevailing wind patterns?

To estimate inventories for years after 1996, we developed inventory projections based on expected increases in vessel freight movement and expected changes in vessel characteristics, as well as feet turnover based on 25 years as the average age of the world fleet at time of scrappage. We also take the MARPOL Annex VI NOx limits into account because, although these international NOx standards are not yet effective, most, if not all shipbuilders and shipping companies around the world are currently complying with them, and this is a trend we expect to continue. Our estimated emissions inventories are based on the assumption that all vessels built after 1999, both U.S. and foreign flagged, will comply with the MARPOL NOx limits. Table II.C-2 shows the future year NOx and PM inventories for selected years out to 2030. More detailed information regarding the development of the future year emissions inventories can be found in Chapter 6 of the Draft Regulatory Support Document. We request comment on these inventory projections. In particular, we request comment on whether freight growth will continue at the exponential rate that is has seen in the past, and for how long such exponential growth can be expected to continue.

One very important consideration in projecting future year inventories is the make up and size of the future vessel fleet. The size and make up of the future U.S. flagged fleet is dependent on vessel construction at U.S. shipyards, the nature of vessel replacement practices, and any growth in the number of ships in the fleet. Projecting future vessel production at U.S. shipyards is difficult for two reasons. First, vessel construction totals for U.S. shipyards have varied quite a bit from year to year, with no clear trends. Second, the U.S. government discontinued subsidies to U.S. shipyards in 1983, creating a dramatic downward shift in production at U.S. shipyards. We request comment on likely future production at U.S. shipyards, including production estimates and the rationale behind the estimates. Vessel replacement practices also play a role in future year emissions inventory projections. For example, the current U.S. flagged fleet contains a large number of older steamships. We request comment on whether these steamships are likely to be replaced with diesels when they are scrapped. We also request comment on whether there are any other vessel replacement practices or trends that we should consider when projecting future year emissions inventories. As shown in Chapter 6 of the Draft Regulatory Support Document, a substantial portion of the U.S. flagged fleet is over 30 years old. We request comment on the size and nature of any increase in U.S. shipbuilding activity that may occur in the near future in an effort to replace the aging fleet. Finally, we request comment on whether the total number of U.S. flagged vessels is expected to grow substantially in the future and why.

Table II.C-2
Future Year NOx and PM Inventories for Category 3 Marine Diesel Engines
(thousand short tons)

Year	NOx			PM		
	Ports	Non-ports	All areas	Ports	Non-ports	All areas
1996	101	89	190	9	8	17
2010	146	128	274	14	12	26
2020	196	172	367	20	16	37
2030	288	243	531	30	24	54

Baseline emission inventory estimates for the year 2000 for Category 3 marine diesel engines are summarized in Table II.C-3 in the context of other emissions sources. This table shows the relative contributions of the different mobile-source categories to the overall national mobile-source inventory. Of the total emissions from mobile sources, all Category 3 marine diesel engines contributed about 1.5 percent of NOx and 2.6 percent of PM emissions in the year 2000.

Our draft emission projections for 2020 for Category 3 marine diesel engines show how emissions from these engines are expected to increase over time if left uncontrolled beyond the MARPOL Annex VI NOx limits. The projections for 2020 are summarized in Table II.C-4 and indicate that Category 3 marine diesel engines are expected to contribute 5.7 percent NOx and 5.8 percent of PM emissions in the year 2020. Population growth and the effects of other regulatory control programs are factored into these projections. The relative importance of uncontrolled nonroad engines is higher than the projections for 2000 because there are already emission control programs in place for the other categories of mobile sources which are expected to reduce their emission levels. The effectiveness of all control programs is offset by the anticipated growth in engine populations.

Table II.C-3
Modeled Annual Emission Levels for
Mobile-Source Categories in 2000 (thousand short tons)

Category	NOx		HC		CO		PM	
	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source
Total for engines subject to proposed standards (U.S. flagged commercial marine - Category 3)	**79**	**0.6%**	**2**	**0.0%**	**4**	**0.0%**	**7.0**	**1.0%**
Commercial Marine CI - Category 3	195	1.5%	8	0.1%	16	0.0%	18.0	2.6%
Commercial Marine CI - Categories 1 and 2	700	5.2%	22	0.3%	103	0.1%	20	2.9%
Highway Motorcycles	8	0.1%	84	1.1%	329	0.4%	0.4	0.1%
Nonroad Industrial SI >	306	2.3%	247	3.2%	2,294	2.9%	1.6	0.2%

Category	NOx		HC		CO		PM	
	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source
19 kW								
Recreational SI	13	0.1%	737	9.6%	2,572	3.3%	5.7	0.8%
Recreation Marine CI	24	0.2%	1	0.0%	4	0.0%	1	0.1%
Marine SI Evap	0	0.0%	89	1.2%	0	0.0%	0	0.0%
Marine SI Exhaust	32	0.2%	708	9.2%	2,144	2.7%	38	5.4%
Nonroad SI < 19 kW	106	0.8%	1,460	18.9%	18,359	23.5%	50	7.2%
Nonroad CI	2,625	19.6%	316	4.1%	1,217	1.6%	253	36.3%
Locomotive	1,192	8.9%	47	0.6%	119	0.2%	30	4.3%
Total Nonroad	5,201	39%	3,719	48%	27,157	35%	418	60%
Total Highway	7,981	60%	3,811	50%	49,811	64%	240	34%
Aircraft	178	1%	183	2%	1,017	1%	39	6%
Total Mobile Sources	13,360	100%	7,713	100%	77,985	100%	697	100%
Total Man-Made Sources	24,444	--	18,659	--	100,064	--	3,093	--
Mobile Source percent of Total Man-Made Sources	55%	--	41%	--	78%	--	23%	-

Table II.C-4

Modeled Annual Emission Levels for

Mobile-Source Categories in 2020 (thousand short tons)

Category	NOx		HC		CO		PM	
	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source
Total for engines subject to proposed standards (U.S. flagged commercial marine - Category 3)	**150**	**2.3%**	**5**	**0.1%**	**9**	**0.0%**	**14.0**	**2.2%**
Commercial Marine CI - Category 3	367	5.7%	17	0.3%	37	0.0%	37.0	5.8%
Commercial Marine CI - Categories 1 and 2	617	9.6%	24	0.4%	125	0.1%	19.0	3.0%
Highway Motorcycles	14	0.2%	144	2.3%	569	0.6%	0.8	0.1%
Nonroad Industrial SI > 19 kW	486	7.6%	348	5.5%	2,991	3.3%	2.4	0.4%
Recreational SI	27	0.4%	1,706	27.1%	5,407	6.0%	7.5	1.2%
Recreation Marine CI	39	0.6%	1	0.0%	6	0.0%	1.5	0.2%
Marine SI Evap	0	0.0%	102	1.6%	0	0.0%	0	0.0%
Marine SI Exhaust	58	0.9%	284	4.5%	1,985	2.2%	28	4.4%
Nonroad SI < 19 kW	106	1.7%	986	15.6%	27,352	30.3%	77	12.0%
Nonroad CI	1,791	28.0%	142	2.3%	1,462	1.6%	261	40.6%
Locomotive	611	9.5%	35	0.6%	119	0.1%	21	3.3%

Category	NOx		HC		CO		PM	
	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source
Total Nonroad	4,116	63%	3,789	60%	40,053	44%	455	70%
Total Highway	2,050	33%	2,278	36%	48,903	54%	145	23%
Aircraft	232	4%	238	4%	1,387	2%	43	7%
Total Mobile Sources	6,398	100%	6,305	100%	90,343	100%	643	100%
Total Man-Made Sources	16,374	--	16,405	--	114,011	--	3,027	--
Mobile Source percent of Total Man-Made Sources	39%	--	38%	--	79%	--	21%	-

2. Inventories for Specific Ports

In the previous section we presented estimates of Category 3 marine diesel engine emissions as percentages of the national mobile source inventory. However, marine vessel activity tends to be concentrated in port areas, and thus we would expect that Category 3 marine diesel engines would have a proportionately bigger impact on the mobile source pollution inventories of port areas. Using the port-specific Category 3 inventories developed for use in our national inventory in conjunction with total port area inventories developed in support of the heavy-duty on-highway 2007 rule, we developed estimates of the contribution of Category 3 marine diesel engines to the mobile source NOx and PM inventories of several selected port areas, including several ozone nonattainment areas. The NOx results are shown in Table II.C-5, and the PM results are shown in Table II.C-6. As can be seen from these tables, the relative contribution of

Category 3 marine diesel engine pollution to mobile source pollution is expected to increase in the future. This is due both to the expected growth of shipping traffic in the future and the effect of emissions control programs already in place for other mobile sources.

Table II.C-5
Modeled NOx Inventories as a Percentage of Mobile Source NOx
in Selected Port Areas

		% of Mobile Source NOx from C3	
Ozone Nonattainment Area?	Port Area	1996	2020
Y	Baton Rouge and New Orleans, LA	7.4	15.8
Y	Los Angeles/Long Beach, CA	2.0	8.6
Y	Beaumont/Port Arthur, TX	1.4	3.1
Y	Houston/Galveston/Brazoria, TX	1.5	4.9
Y	Baltimore/Washington DC	2.1	11.4
Y	Philadelphia/Wilmington/Atlantic City	1.8	6.9
Y	New York/New Jersey	1.0	6.2
N	Seattle/Tacoma/Bremerton/ Bellingham, WA	4.3	26.3
N	Miami/Ft. Lauderdale, FL	5.4	28.1
N	Portland/Salem, OR	1.9	11.9
N	Wilmington, NC	6.9	26.8
N	Corpus Christi, TX	4.8	12.2
N	Brownsville/Harlington/San Benito, TX	1.8	6.6

Table II.C-6

Modeled PM Inventories as a Percentage of Mobile Source PM in Selected Port Areas

	% of Mobile Source PM from C3	
Port Area	1996	2020
Baton Rouge and New Orleans, LA	12.1	22.6
Los Angeles/Long Beach, CA[1]	3.9	10.8
Beaumont/Port Arthur, TX	7.4	18.3
Houston/Galveston/Brazoria, TX	3.3	8.5
Baltimore/Washington DC	3.2	9.6
Philadelphia/Wilmington/Atlantic City	2.8	6.3
New York/New Jersey	1.6	5.7
Seattle/Tacoma/Bremerton/ Bellingham, WA	8.5	25.5
Miami/Ft. Lauderdale, FL	10.6	28.7
Portland/Salem, OR	3.9	12.1
Wilmington, NC	8.1	22.4
Corpus Christi, TX	6.0	9.6
Brownsville/Harlington/San Benito, TX	3.1	14.9

1. PM nonattainment area.

3. Emissions in Nonport Areas

These ships can also have a significant impact on inventories in areas without large commercial ports. For example, Santa Barbara estimates that engine on ocean-going marine vessels contribute about 37 percent of total NOx in their area. These emissions are from ships that transit the area, and "are comparable to (even slightly larger than) the amount of NOx produced onshore by cars and truck.[42] These emissions are expected to increase to 62 percent by 2015. While Santa Barbara's exact conditions may be unique due to the relative close proximity of heavily used shipping channels to shore and the meteorological conditions in their area, other coastal areas may also have relatively high inventory impacts from ocean-going vessels.

– Contribution by flag

It is important to determine how much of the Category 3 marine diesel engine pollution inventory is contributed by U.S. flagged vessels given that we are considering whether to restrict application of the proposed standards to U.S. flag vessels only or to apply the standards to all vessels (U.S. and foreign-flag entering U.S. ports). We estimated the relative contribution of U.S. and foreign flagged vessels separately for the ports areas and the non-ports areas due to the fact the we had different data sets available to us for the two areas.

We estimated the contribution of U.S. flagged vessels for the ports areas using port call data obtained from the U.S. Maritime Administration (MARAD). These data contained all port calls in 1999 to U.S. ports by vessels of greater than 1000 gross registered tons, including the country in which they are flagged and the number of port calls each vessel made. An analysis of the port call data shows that U.S. flagged vessels only account for 6.4 percent of port calls to U.S. ports. For the lack of more detailed information regarding the breakout of U.S. and foreign flagged

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[42]Memorandum to Docket A-2001-11 from Jean Marie Revelt, "*Santa Barbara County Air Quality News*, Issue 62, July-August 2001 and other materials provided to EPA by Santa Barbara County," March 14, 2002. Air Docket A-2001-11, Document No. XXXXX.

vessel emissions we applied the percentage of port calls from U.S. and foreign flagged vessels to the national ports inventories to determine the relative contributions of each to the national ports inventories.

We used freight tonnage data from the U.S. Army Corp of Engineers (USACE) to develop relative U.S. and foreign flagged emissions contributions in non-ports areas within 175 nautical miles of the coast. In contrast to the data for the ports areas, the USACE data suggests that more than 80 percent of the non-ports emissions come from U.S. flagged vessels.

The relative contributions from U.S. and foreign flagged vessels are quite different between the ports areas and the non-ports areas. Some of this difference can be explained through U.S. cabotage law, which requires that any vessel operating between two U.S. ports be U.S. flagged. Thus, while most port traffic is foreign flagged, the foreign flagged vessels would tend to come into a single U.S. port and then leave U.S. waters. In contrast, U.S. flagged vessels would typically travel from one U.S. port to another, thus accounting for a higher percentage of the non-ports emissions. We request comment on this assessment of U.S. and foreign flagged vessel contributions, as well as additional data that would help us further understand the relative contributions of U.S. and foreign flagged vessels to the national pollution inventories.

III. What Engines Are Covered?

The scope of application of this proposal is broadly set by Clean Air Act section 213(a)(3), which instructs us to set standards for new nonroad engines and new nonroad vehicles. In this case, the proposed rule is intended to cover all new marine diesel engines installed on vessels flagged or registered in the United States that have a specific engine displacement greater than or equal to 30 liters per cylinder. Under the requirements of the Clean Air Act, once emission standards apply to a group of engines, a manufacturer must get a certificate of conformity from us before selling an engine, importing an engine, or otherwise introducing an engine into commerce in the United States.[43,44] We also require vessel manufacturers to install only certified engines on new vessels that will be flagged or registered in the United States once emission standards apply. The certificate of conformity (and corresponding engine label) provide assurance that engine manufacturers have met their obligation to make engines that meet the emission standards over the useful life we specify in the regulations.

The scope of application for emission standards for commercial marine diesel engines up to 30 liters per cylinder was established in our 1999 rulemaking (64 FR 73300, December 29, 1999). In that rule, we adopted a set of clarifying definitions that apply to those commercial marine diesel engines and the vessels that use them. We are proposing to apply those definitions to Category 3 marine diesel engines for the purpose of identifying the engines and vessels that must comply with the proposed standards. According to those definitions, which can be found in 40 CFR part 94.2, a Category 3 marine diesel engine would be subject to the proposed standards if it is:

- Manufactured after the emission standards become effective, whether domestic or imported;
- Installed for the first time in a marine vessel flagged in the U.S. after having been used in another application subject to different emission standards; or
- Installed on a new vessel flagged in the U.S.

At the same time we are soliciting comment on whether the emission standards should also apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such

[43]The term “manufacturer” means any person engaged in the manufacturing or assembling of new engines or importing such engines for resale, or who acts for and is under the control of any such person in connection with the distribution of such engines. 40 CFR 94.2.

[44]For this proposal, we consider the United States to include the States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and the Virgin Islands. See CAA section 302(d) definition of “State.”

foreign vessels from the emission standards under 40 CFR §94.1(b)(3). We are considering modifying the definition of a "new marine engine" to clarify that engine emission standards would apply to Category 1, 2 and 3 marine diesel engines that are manufactured after the standards become effective and that are installed on a foreign vessel that enters a U.S. port. The standards would also apply to any marine engine that is installed on a foreign vessel if the vessel is manufactured (or that otherwise become new) after the standards become effective.

We are also proposing to eliminate the foreign trade exemption. Under this exemption, contained in 40 CFR section 94.906(d), engines on vessels flagged or registered in the United States that spend less than 25 percent of total operating time within 320 nautical miles of U.S. territory are not required to comply with the proposed limits. This would generally affect auxiliary engines, which are usually less than 30 liters per cylinder.

We are requesting comment regarding whether we should include gas turbine engines in this rulemaking. The Clean Air Act definition of "nonroad engine" covers internal combustion engines. Since marine gas turbines are internal combustion engines, we need to consider them as nonroad engines. While we believe that gas turbine engines are capable of meeting the emission standards proposed for diesel engines, it is not clear that it would be appropriate to regulate turbines and diesels together. This is especially true given the limited amount of information that we currently have about emissions from turbines. Therefore, we are requesting that commenters provide to us any emissions information that is available. Commenters supporting the inclusion of turbines in this rulemaking should also address whether any special provisions would be needed for the testing and certification of turbines.

In the remainder of this section we discuss the proposed scope of application of the rule in greater detail.

A. What is a Marine Vessel?

For the purpose of our marine diesel engine standards, "marine vessel" has the meaning specified in the General Provisions of the United States Code, 1 U.S.C. 3 (see 40 CFR part 94.2). According to that definition, the word "vessel" includes "every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water."

B. What is a Category 3 Marine Diesel Engine?

In our 1999 commercial marine diesel engine rule, we defined marine engine as an engine that is installed or intended to be installed on a marine vessel. We also differentiated between three types of marine diesel engines. As explained in that rule, this approach is necessary because marine diesel engines are typically derivatives of land-based diesel engines and the land-based engines are not all subject to the same numerical standards and effective dates.

The definitions for the different categories of marine diesel engines are contained in 40 CFR part 94.2. Category 1 marine diesel engines, those having a rated power greater than or equal to 37 kilowatts and a specific engine displacement less than 5.0 liters per cylinder, are similar to land-based nonroad engines used in construction and farm equipment. Category 2 marine diesel engines, those having a specific engine displacement greater than or equal to 5.0 liters per cylinder but less than 30 liters per cylinder, are most often similar to locomotive engines. Category 1 and Category 2 marine diesel engines are used as propulsion engines (i.e., an engine that moves a vessel through the water or directs the movement of a vessel (40 CFR part 94.2)) on tugs, fishing vessels, supply vessels, and smaller cargo vessels. They are also used as auxiliary engines (i.e., a marine engine that is not a propulsion engine (40 CFR part 94.2)) to provide electricity for navigation equipment and crew service or other services such as pumping or powering winches or anchors.

Category 3 marine diesel engines, which are the primary focus of this proposal, are defined as having a specific engine displacement greater than or equal to 30 liters per cylinder. These are very large engines used for propulsion on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships, although a few are found on ships in the Great Lakes. Category 3 marine diesel engines have no land-based mobile source counterpart, although they are similar to engines used to generate electricity in municipal power plants. In marine applications they are either mechanical drive or indirect drive. Mechanical drive engines can be direct drive (engine speed is the same as propeller speed; this is common on very large ships) or have a gearbox (i.e., they have reduction gears; this is common on ships using medium speed Category 3 marine diesel engines). Indirect drive engines are used to generate electricity that is then used to turn the propeller shaft. These are common in cruise ships since they have heavy electricity demands. Category 3 marine diesel engines typically operate at a lower speed and higher power than Category 1 and Category 2 engines, with the slowest speed being 130-200 rpm.

Table III.A-1

Marine Engine Category Definitions

Category	Displacement per cylinder	hp range (kW)	rpm range
1	disp. < 5 liters (and power ≥ 37 kW)	37 - 2,300	1,800 - 3,000
2	5 ≤ disp. < 30 liters	1,500 - 8,000	750 - 1,500
3	disp ≥ 30 liters	2,500 - 80,000	80 - 900

C. What is a New Marine Diesel Engine?

1. The Current Regulatory Definition

As set out in 40 CFR part 94.2, a new marine engine is (i) a marine engine, the equitable or legal title to which has never been transferred to an ultimate purchaser; (ii) a marine engine installed on a vessel, the equitable or legal title to such vessel has never been transferred to an ultimate purchaser; or (iii) a marine engine that has not been placed into service on a vessel. In cases where the equitable or legal title to an engine or vessel is not transferred to an ultimate purchaser prior to its being placed into service, an engine ceases to be new after it is placed into service.

What this means is that a marine engine is new and is subject to the proposed standards before its initial sale is completed or it is placed into service. Practically, it means that any engine must meet the proposed emission standards that are in effect the first time it is sold or placed into service or the first time the vessel on which it is installed is sold or placed into service. This is true for any engine that is sold for the first time as a marine engine (placed into service on a marine vessel), regardless of whether it has previously been used in other nonroad or on-highway purposes. This clarification is necessary because some marine engines are made by "marinizing" existing land-based nonroad or highway engines. Without this clarification a marinized used highway or land-based engine would not be subject to the standards since its title was already transferred to the initial highway or land-based nonroad user.

With respect to imported marine diesel engines, 40 CFR part 94.2 defines "new" as an engine that is not covered by a certificate of conformity at the time of importation and that was manufactured after the starting date of the emissions standards which are applicable to such engine (or which would be applicable to such engine had it been manufactured for importation into the United States). According to this definition, the proposed standards would apply to engines that are imported by any person, whether newly manufactured or used, and whether they are imported as uninstalled engines or if they are already installed on a marine vessel that is imported into the U.S. In one example, a person may want to import a vessel after the effective date of the standards but the engine does not have a certificate of conformity from EPA because the engines and vessel were manufactured elsewhere. We would still consider it to be a new engine or vessel, and it would need to comply with the applicable emission standards. This provision is important to prevent manufacturers from trying to avoid the emission standards by building vessels abroad, transferring their title, and then importing them as used vessels.

2. Should New Engines on Foreign Flag Vessels Be Covered?

Today's proposal solicits comment on whether to modify the definition of a "new" marine engine to clarify that engine emission standards apply to Category 1, 2, and 3 marine diesel engines that are built after the standards become effective and that are installed on foreign flag vessels that enter U.S. ports. Such vessels and their engines would be subject to U.S. engine emission standards as a condition of port state entry.

The 1999 marine engine rule did not apply to marine engines on foreign vessels. 40 CFR §94.1(b)(3). At that time we concluded that engines installed on vessels flagged in another country that come into the United States temporarily will not be subject to the emission standards. Those vessels are not considered imported under the U.S. customs laws, and under the interpretation adopted in that rule we did not consider their engines "new" for purposes of Clear Air Act section 213, 42 U.S.C. §7547. 64 FR 73300, 73302. We are reconsidering our prior definition of a "new marine engine" and believe that it may be appropriate and within EPA's authority to treat engines on foreign vessels that enter U.S. ports as new engines and subject to regulation under section 213 based on their significant emissions contribution to air quality problems in the United States.

EPA has discretion in interpreting section 213 as it applies to new marine engines and vessels, and is considering which interpretation is most appropriate from a policy perspective.

Section 213 authorizes regulating a "new nonroad engine" and a "new nonroad vehicle." Title II of the Clean Air Act does not define either "new nonroad engine" or "new nonroad vehicle." Section 216, 42 U.S.C. §7550, defines a "new motor vehicle engine" to include an engine that has been "imported." EPA modeled the regulatory definitions of "new nonroad engine"and "new marine engine" at 40 CFR §89.2 and 40 CFR §94.2, respectively, after the statutory definitions of "new motor vehicle engine" and "new motor vehicle." These regulatory definitions may be changed consistent with the intent and purpose of Section 213 and Title II. The Clean Air Act's use of "new nonroad engine" is ambiguous and we believe that it would be reasonable to interpret it as including marine engines on foreign vessels that enter U.S. ports and that are manufactured after the standards go into effect. Title II of the Clean Air Act does not require that a nonroad engine, such as a marine engine on a foreign vessel that enters U.S. ports, must be "imported" into the United States under the customs laws, before such an engine can be regulated as a "new nonroad engine."

Title II of the Clean Air Act provides a broad statutory scheme to control harmful emissions from new mobile sources that affect air quality in the United States. For example, the motor vehicle provisions under Title II were designed to cast a broad net. They authorize the regulation of all new motor vehicles and/or engines that are built or sold in the United States, as well as the regulation of all new or used motor vehicles and/or engines that are imported into the United States. The scope of EPA's authority with respect to motor vehicles extends broadly, covering virtually any, if not all, motor vehicles that cross the border into the United States.

EPA believes it is reasonable to attribute a similar breadth of regulatory scope to a "new nonroad engine" and a "new nonroad road vehicle" as the effective scope of authority for a new motor vehicle and/or engine. Indeed, that was the general goal of the current regulatory definition of a "new marine engine" at 40 CFR §94.2. Unlike with respect to motor vehicles, however, the use of "import" in 40 CFR §94.2 results in the exclusion of an important category of engine emissions from the regulatory scheme, emissions from marine engines on foreign vessels that enter U.S. ports, if given the narrow interpretation that applies to marine vessels under the customs laws of the United States. The size of the contribution from such vessels to nationwide nonroad engine emissions, and in particular the significance of those emissions in coastal areas and port cities, warrants interpreting "new nonroad engine" under section 213 to include marine engines on foreign vessels that enter U.S. ports. Regulating marine engines on foreign vessels that enter U.S. ports would be consistent with the broad scope of "new" for motor vehicles. Furthermore, even if "new" is broader for nonroad vehicles and their engines than for motor vehicles and their engines, this would be consistent with the goal of section 213, which seeks to control emissions from nonroad categories whenever they "cause, or contribute to significant air pollution problems.

Regulating marine engines on foreign vessels that enter U.S. ports is also reasonable because it is consistent with Title II's statutory scheme. This scheme contemplates controlling emissions from motor vehicles and nonroad vehicles that are not specifically excepted from regulation. Congress did not expressly except engines on foreign vessels that enter U.S. ports from regulation. Significantly, Congress did except certain categories of mobile sources from regulation under Title II. New nonroad vehicles and engines used solely for competition are expressly excluded from regulation. 42 U.S.C. §7552(10) & (11). Congress also provided that certain new motor vehicles and new motor vehicle engines could be eligible for an exemption from regulation for the purpose of "research, investigations, studies, demonstrations, or training or for reasons of national security." 42 U.S.C. §7522(b)(1). Congress, however, did not provide, nor does the legislative history suggest, the exclusion or the exemption of engines on foreign vessels that enter U.S. ports and whose emissions affect air quality in the United States.

Even if we were to conclude that an engine on a foreign vessel that enters U.S. ports is only subject to regulation if it is "imported" into the United States as that term is used in section 216, it would be reasonable to interpret it to cover such engines. The meaning of "import" as it is used in Title II is ambiguous. Title II does not define "import." Further, the legislative history does not suggest that Title II's use of "import" can only be given its meaning under the customs laws of the United States.

A broad reading of the term "import" can fulfill section 213's purpose of controlling harmful emissions from nonroad sources that cause or contribute to adverse air quality in the United States. The meaning of "import" may reasonably differ under the customs laws and under the CAA in light of their very different purposes. The customs laws relate to the imposition of tariffs on foreign products and restricting the entry such products into the United States. Whereas it may make sense under the customs laws to not treat foreign vessels that enter U.S. ports as imports for the purpose of avoiding customs duties, it may frustrate section 213's goals to not treat marine engines on foreign vessels that enter U.S. ports as imports and, thereby, avoid engine emission standards.

If we regulate foreign-flagged vessels, such vessels would be subject to enforcement as a condition of port entry.

In deciding whether to adopt a new interpretation of a "new marine engine" EPA will consider the factors discussed above as well as the potential implications that setting engine emission standards for foreign vessels might have on international commerce and future international negotiations under MARPOL and in other fora. EPA will consider, for example, whether setting a national standard in this situation could undermine the U.S.' position with respect to the variety of other international issues that are addressed under MARPOL and in other fora. EPA will also consider [discuss potential effects on international trade]. EPA, therefore, might retain its current interpretation as discussed in the preamble to the 1999 marine engine rule that foreign vessels are not subject to section 213 because they are not "imported" into the U.S. Even in that event, EPA would be free to adopt a broader interpretation of section 213 in the future. This could occur, if, for example, negotiations with other nations do not lead to international emission standards that adequately protect air quality in the U.S. when foreign vessels enter U.S. ports.

3. Would Engines on Foreign Flag Vessels Be Covered Regardless of the Number of Their Annual Visits?

One of the things to consider, if we were to apply the standards to engines that are manufactured after the standards become effective and that are installed on foreign flag vessels that enter U.S. ports, is whether this provision should be limited by the number of times a vessel visits U.S. ports annually.

Using a strict approach, any engines on a vessel manufactured (or that otherwise becomes new) after the effective date of the standards, or manufactured before the effective date but has engines that are manufactured after the effective date, that comes to the United States, whether once a year, twenty times a year, or even more, would have to have compliant engines.

An alternative approach would apply the standards only to those vessels that are frequent visitors to the United States. A review of 1999 data on vessel entrances from the United States

Maritime Administration for 1999 indicates that there is considerable variation in the number of vessel entrances per ship. According to that data, which is described in more detail in Chapter 2 of the draft Regulatory Support Document for this rulemaking, there were about 2,500 foreign flag vessels that made only one or two entrances into the United States in 1999. These vessels accounted for 33 percent of all foreign flag vessels that entered this country, but they accounted for only about 5 percent of all vessel entrances. There were about 3,900 foreign flag vessels that entered the United States four or fewer times in that year, accounting for about 52 percent of all vessels, but they accounted for only about 12.5 percent of all vessel entrances. In other words, there is a large set of vessels that come to the United States only a few times a year. The vast majority of entrances by foreign flag vessels, 87.5 percent, are made by about 3,700 vessels that come here 5 or more times a year. We estimate that average emissions from engines on foreign flag vessels were about 1.7 tons NOx in 2000. This means that foreign vessels that enter U.S. ports only once or twice a year contributed about 6,100 tons of NOx in 2000 (about 3 percent of total Category 3 NOx emissions of 195,000 tons), and foreign flag vessels that entered U.S. ports four or fewer times a year contributed about 14,500 tons of NOx in 2000 (about 7.4 percent of Category 3 NOx emissions).

It may be appropriate to exempt vessels that come to the United States only a few times a year, because the relatively smaller effects on U.S. air quality from such vessels may not warrant imposing on such vessels the additional burden of complying with U.S. engine emission standards. This would be a temporary exemption because it would apply only as long as a vessel remains below the threshold number of vessel entrances. To qualify for this exemption, the shipowner would have to show that the ship does not frequently enter U.S. ports. This demonstration could be made based on the average number of times the vessel entered the United States in the previous two years, for existing vessels, or on the expected usage of the vessel for new vessels (e.g., a regular container or tanker route), for new vessels. In any case, a shipowner that does not obtain the exemption will have to demonstrate that the vessel's engines are compliant. In other words, the provision is applicable from the first, trip instead of being activated only after the threshold is passed.

This alternative relies on the assumption that a vessel that enters the United States only periodically does not have dramatically different number of vessel entrances from year to year. We request comment on whether this is, in fact, the case. Another important aspect of such an exemption for foreign flag vessels, if we were to include them in this rule, is what would happen if the vessel wished to make a third, or fifth, entry into a U.S. port. This is important because of the certification burden associated with making that extra annual trip. The owner of a ship with such an exemption would have to be confident that the vessel would not seek entry more than the allowable number of time. Alternatively, it may be possible to petition EPA for permission to enter an extra time. This may require entering into a settlement agreement in advance of a violation of the terms of the exemption. The settlement could include a fine, a restriction on the number of entries in the future, or some other requirement.

We request comment on all aspects of this potential alternative. Specifically, we request comment on the number of times a ship should be allowed to enter U.S. ports in a twelve-month period before being required to have compliant engines. We also request comment on whether there is much variability in port entries from year to year for vessels that come to U.S. ports only periodically.

D. What is a New Marine Vessel?

The definition of new vessel is similar to the definition of new engine. As set out in 40 CFR part 94.2, a new marine vessel is a vessel the equitable or legal title of which has never been transferred to an ultimate purchaser. In the case where the equitable or legal title to a vessel is not transferred to an ultimate purchaser prior to its being placed into service, a vessel ceases to be new when it is placed into service. Thus, a vessel is new and must have a certified engine and meet any other requirements for new vessels until its initial sale is completed or it is placed into service.

In addition, a vessel is considered to be new when it has been modified such that the value of the modifications exceeds 50 percent of the value of the modified vessel. As noted in our

1999 rulemaking, this provision is intended to prevent someone from re-using the hull or other parts from a used vessel to avoid emission standards. When applying this provision, the modifications must be completed prior to the effective date of the standards that would otherwise apply. For example, if the engine standards go into effect in 2007, modifications that are completed by December 31, 2006 will not trigger the engine requirements and the engines on that vessel would not have to meet the standards. However, if the vessel modifications are completed on or after January 1, 2007, and they exceed 50 percent of the value of the modified vessel, then the engines on the vessel must meet the standards regardless of whether they have been changed as part of the vessel modification.

The definition in 40 CFR part 94.2 refers to the "value" of the modifications, rather than the costs. This should therefore be based on the appraised value of the vessel before modifications compared with the value of the modified vessel. The following equation demonstrates the calculation, showing that a vessel is new if:

$$\frac{\text{[assessed value after modifications]} - \text{[assessed value before modifications]}}{\text{[assessed value after modifications]}} \geq 0.5$$

If the value of the modifications exceeds 50 per cent of the final value of the modified vessel, we would treat the vessel as new under 40 CFR part 94. To evaluate whether the modified vessel will be considered new, you would need to project the fair market value of the modified vessel based on an objective assessment, such as an appraisal for insurance or financing purposes, or some other third-party analysis. While the preliminary decision can be based on the projected value of the modified vessel, the decision must also be valid when basing the calculations on an assessed value of the vessel after modifications are complete.

E. Will the Foreign Trade Exemption Be Retained?

In addition to their main propulsion engines, which are generally Category 3 marine diesel engines, ocean-going commercial vessels typically have several Category 1 and Category 2 engines that are used in auxiliary power applications. They provide electricity for important navigational and maneuvering equipment, and crew services.

Several commenters to our earlier marine diesel engine rulemaking expressed concern that requiring ship owners to obtain and use compliant Category 1 and Category 2 engines for vessels that spend most of their time outside the U.S. could be burdensome for those vessels if they need to be repaired or replaced when they are away from U.S. ports. Consequently, we provided a foreign trade exemption for these engines. A vessel owner can obtain this exemption for Category 1 and Category 2 marine diesel engines if it can be demonstrated to the Administrator's satisfaction that the vessel: (a) will spend less than 25 percent of its total engine operation time within 320 nautical kilometers of U.S. territory; or (b) will not operate between two U.S. ports (40 CFR 94.906(d)). Engines that are exempt under this provision must be labeled to indicate that they have been certified only to the MARPOL Annex VI NOx curve limits and that they are for use solely on vessels that meet the above criteria.

Today, we are proposing to eliminate this foreign trade exemption. We have learned that many engine spare parts are kept onboard vessels to enable ship operators to perform maintenance and repairs while the ship is underway. In addition, obtaining parts that are not kept onboard is not expected to be a problem. Modern package delivery systems should allow ship owners to obtain parts quickly, even overnight, and necessary parts can be shipped to the next convenient port on a ship's route. If an engine fails catastrophically and must be replaced by a compliant engine, we are confident that the ship operator will be able to make arrangements to obtain a certified engine since the major manufacturers of marine diesel engines operate abroad as well as in the United States. Because the burden associated with repairing or replacing engines away from the United States is not significant, we believe it is appropriate to eliminate the exemption. We do not expect this change to have any impact on shipowners and operators because to date no engine manufacturer has applied for this exemption.

IV. Standards and Technological Feasibility

A. What are the proposed engine emission standards?

Manufacturers of Category 3 marine engines have available a wide range of technologies to control emissions. Many of these technologies are similar to those that have been developed for smaller nonroad and highway diesel engines. While Category 3 marine engines are much larger than other regulated diesel engines, many of the same engineering principles of emission formation and control apply. In fact, manufacturers have applied significant effort to reduce emissions from these engines, both to meet Annex VI NOx standards and to develop technologies to address concerns in specific areas. At the same time, it is clear that a substantial opportunity remains to adapt technologies to Category 3 marine engines

The following discussion of emission standards and the associated control technologies applies without respect to whether the standards ultimately apply only to U.S.-flag vessels or to all vessels calling on U.S. ports. Engine technology has become a very global field, with emission-control technology and compliant engines coming from all parts of the world. Manufacturers and owners of foreign-flag vessels would not face any unique constraints in using engines certified to EPA emission standards compared with U.S.-flag vessels. Nevertheless, we are proposing emission standards only for engines installed on U.S.-flag vessels, so references in this section to Category 3 marine engines apply specifically to those engines that would be subject to the proposed emission standards, unless otherwise noted.

Clean Air Act section 213 directs EPA to adopt standards requiring:

> ...the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the engines or vehicles to which such standards apply, giving appropriate consideration to the cost of applying such technology within the period of time available to manufacturers and to noise, energy, and safety factors associated with the application of such technology.

To implement this Clean Air Act directive, we are proposing two separate tiers of emission standards for new Category 3 marine engines, as described below.

1. Tier 1 Emission Standards

We propose to adopt a first tier of standards starting in the 2004 model year[45] equivalent to the Annex VI NOx limits. Manufacturers have introduced basic emission-control technologies for all types of marine diesel engines in response to the Annex VI standards. This effort has demonstrated the feasibility of in-cylinder technologies including optimized turbocharging, higher compression ratio, and optimized fuel injection, which generally includes timing retard and changes to the number and size of injector holes to increase injection pressure.

As described in Section V, we are proposing to accept emission data for Tier 1 certification based on testing with either distillate or residual fuel. Since most or all manufacturers have been using distillate fuel to comply with Annex VI requirements, we expect manufacturers to meet Tier 1 standards generally by submitting their available emission data from testing with distillate fuels. However, since Annex VI does not include detailed specifications for test fuels, we believe that we will need to correct emission data for the effect of fuel nitrogen content. This correction is described later in this section. We would require that certified engines continue to meet Tier 1 emission standards throughout their useful life when tested with either distillate or residual fuel, after correction for the effect of fuel nitrogen.

[45] We are proposing to base model years on the date on which the engine is first assembled. In other rules, we have defined the date of manufacture to be the date of the final assembly of the engine. However, we recognize that Category 3 engines are often disassembled for shipment to the site at which it is installed in the ship.

We are also proposing to apply the Tier 1 standards to all Category engines with specific displacement between 2.5 and 30 liters per cylinder. This would apply to these engines from 2004 to 2006, after which the EPA Tier 2 marine engine emission standards established in December 1999 would apply (64 FR 73300, December 29, 1999). All testing to show compliance for these engines would be based on testing with distillate fuels meeting the specifications in 40 CFR 94.108.[46] As with the Category 3 engines, this would merely formalize the Annex VI standards, which these engines should already meet. Including these engines in this proposal would remove any ambiguity regarding the applicability of emission standards. We are not proposing to include engines under 2.5 liters per cylinder, because the December 1999 emission standards generally start already in 2004. Marine diesel engines below 0.9 liters per cylinder need not meet EPA emission standards until 2005. Most of those engines are under 130 kW and are therefore not subject to Annex VI standards.

2. Effect of Fuel Variables on Emission Standards

Another objective of the Clean Air Act is to adopt test procedures that represent in-use operating conditions as much as possible, including specification of test fuels consistent with the fuels that compliant engines will use over their lifetimes. This raises the question of testing Category 3 marine engines with distillate and residual fuel. Distillate fuel has a higher quality than residual fuel, but costs significantly more, so vessels with Category 3 marine engines primarily use residual fuel. The Annex VI emission standard is based on allowing manufacturers to test with marine distillate fuels, which generally have nitrogen levels of 0.0 to 0.4 weight percent. As discussed in the Draft Regulatory Support Document, NOx emission levels increase with greater amounts of nitrogen that are bound up in the fuel. Residual fuels generally have

[46]Without the fuel-based corrections described below, the proposed Tier 1 standards for these engines default to NOx = $45.0 \times n^{-0.2}$, with emissions capped at 9.8 g/kW-hr for engine speeds over 2000 rpm.

higher nitrogen concentrations (typically 0.2 to 0.6 weight percent).

We are proposing that manufacturers of Category 3 engines may certify that they meet the Tier 1 and Tier 2 emission standards using either distillate or residual fuel. The proposed regulations include a range of fuel specifications for each fuel type. However, for testing engines after installation in the vessel, we would expect manufacturers to use residual fuel. This would add assurance that emission-control technologies reduce emissions under real operation in vessels. Without this assurance, manufacturers could implement and optimize technologies to achieve substantial emission control with distillate fuel without necessarily reducing emissions when engines operate with residual fuel.

To appropriately account for the emission-related effects of fuel quality, we analyzed the effect of nitrogen in contributing to NOx emissions. The first step is to assign a default nitrogen content for distillate fuels as a benchmark to properly characterize the Annex VI NOx standards. Fuel sampling shows an average concentration of 0.2 percent nitrogen in distillate fuel by weight (i.e., weight percent).[47] The comparable average value for residual fuels is 0.4 weight percent. To adjust the standard for testing with high-nitrogen residual fuel, we calculated the amount of additional NOx that would form if all the additional fuel-bound nitrogen would react to form NOx. This calculation depends on assigning a value for brake-specific fuel consumption, for which we use 220 g/kW-hr.[48] The resulting correction of 1.4 g/kW-hr shows up as an additive term in the equation in Table IV.A-1, since it is a constant value (independent of speed), assuming a consistent brake-specific fuel consumption rate.[49] For all testing with Category 3 engines, we would require measuring fuel-bound nitrogen and correcting measured

[47]Lloyds report.

[48]Lindhjem report.

[49]In contrast, Annex VI and the proposed Tier 1 standards allow for a 10-percent increase in emissions when testing with residual fuel, which makes the fuel correction a function of engine speed. For most Category 3 engines, 1.4 g/kW-hr is roughly 10 percent of the Annex VI NOx emission standard.

values to what would occur with a nitrogen concentration of 0.4 weight percent (see Section V). This correction methodology would apply equally to testing with distillate or residual fuels. We believe that corection is consistent with the intent of the Annex VI 10-percent allowance for higher emissions when testing engines with residual fuel. However, we believe that the nitrogen-based correction would better ensure that the targeted emission reduction are achieved in use.

This proposed approach to account for fuel nitrogen would help us ensure that engines meet the targeted level of emission control for the whole range of in-use fuels. At the same time, it allows substantial testing flexibility without compromising our ability to set an emission standard requiring the greatest degree of emission reductions for any given fuel. We request comment on this approach to testing with distillate and residual fuels. In particular, we request comment on the appropriate adjustment in the emission standard to account for the effects of testing with residual and distillate fuels in general and fuel-bound nitrogen in particular. We also request comment on how this approach to test fuels affects the cost of emission testing.

3. Tier 2 Emission Standards

Control of diesel engine emissions typically focuses on NOx and PM emissions. HC and CO limits for diesel engines generally receive less attention because the diesel combustion process inherently prevents high rates of HC and CO emissions. We estimate that HC emissions are currently at 0.4 g/kW-hr, which is significantly lower than NOx emissions from Category 3 engines, even after manufacturers substantially reduce NOx emissions. Hydrocarbon emissions nevertheless combine with NOx emissions to form ozone. We have generally adopted emission standards for other types of diesel engines in the form of a single standard for combined NOx and HC emissions. We are proposing in this program to prevent increases in HC emissions with a standard at the baseline level of 0.4 g/kW-hr. This may achieve modest reductions in HC emissions, but more importantly would prevent HC emission increases that might otherwise result from controlling NOx emissions alone. We request comment on the need for an emission standard for HC emissions and on how best to set the appropriate standard. We further request comment on setting a combined NOx+HC standard for Category 3 engines. Commenters supporting a NOx+HC standard should also address how to use NOx-only onboard emission measurements in the context of a NOx+HC standard, since it may not be possible to measure HC emissions.

We do not expect manufacturers to apply control technologies to reduce CO emissions. In fact, for current technologies, CO emissions generally decrease as manufacturers improve fuel consumption rates, so there is no incentive that would lead manufacturers to increase CO emissions. In other EPA programs for diesel engines, we generally set CO emission standards to prevent emission increases over time. We are proposing this same approach with Tier 2 standards for Category 3 marine engines. Uncontrolled CO levels are generally less than 1 g/kW-hr. We are therefore proposing an emission standard of 3 g/kW-hr for these engines, which would ensure that manufacturers don't cause significant increases in CO emissions when applying technologies designed to address NOx emissions. A tighter standard may cause a manufacturer to spend a disproportionate amount of effort developing emission-control technologies for small changes in CO emissions. We request comment on regulating CO emission levels this way and specifically whether this is an appropriate level for a CO emission standard.

Regarding PM from Category 3 marine engines, the majority of emissions comes directly from the high concentration of sulfur in the fuel. Short of changing in-use fuel quality, emission-control technologies only address the remaining portion of PM, since engine technologies are ineffective at reducing sulfur-related PM emissions. Furthermore, no acceptable procedure exists for measuring PM from Category 3 marine engines, because current established PM test methods show unacceptable variability when sulfur levels exceed 0.8 weight percent, which is common for both residual and distillate marine fuels for Category 3 engines. No PM test method or calculation methodology has been developed to correct that variability for these engines. For these reasons, we are not proposing a PM standard for Category 3 engines. We request comment on this approach; commenters supporting PM emission standards should address these issues and suggest an appropriate standard reflecting an achievable level of control. See the section below for discussion of regulating in-use fuels to achieve PM, SOx, and possibly additional NOx reductions.

Testing has shown that optimizing engine systems and developing additional control technologies will allow manufacturers of Category 3 marine engines to meet emission standards more stringent than Annex VI levels. Such improvements will require additional time. Starting with the 2007 model year, we propose to apply a second tier of standards for Category 3 engines, based on reducing the NOx standard 30 percent below the Tier 1 standard (excluding the nitrogen-adjustment; see Table IV.A-1). We believe manufacturers can achieve these proposed emission standards by further optimizing their designs and developing additional technologies for better control of fuel injection, charge air induction and mixing, and the overall design of combustion chambers and the timing of combustion events. We request comment on the timing and level of the Tier 2 standards.

Table IV.A-1

EPA Proposed Category 3 NOx Emission Limits (g/kW-hr)*

Engine Speed (n)	n ≥ 130 rpm**	n < 130 rpm
Tier 1	$45.0 \times n^{-0.2} + 1.4$	18.4
Tier 2	$31.5 \times n^{-0.2} + 1.4$	13.3
Blue Sky	$9.0 \times n^{-0.2} + 1.4$	4.8

*The proposed regulations specify emission standards based on testing with measured emission values corrected to take into account the nitrogen content of the fuel. Emission values are corrected to values consistent with testing engines with fuel containing 0.4 weight percent nitrogen. Testing with fuel containing 0.2 weight-percent nitrogen (typical for in-use distillate marine fuels) would have a correction of 1.4 g/kW-hr, so the proposed Tier 1 NOx standards would match the Annex VI NOx standards at this test point.

**No cap applies to Tier 2 standards over 2000 rpm, because Category 3 engines all have engine speeds well below that speed.

4. Emission Effects of Test Conditions and Engine Operating Modes

Section V describes how we propose to address varying test conditions for emission measurements to show that engines meet emission standards when operated over the ISO E3 duty cycle. In general, we define a range of conditions for barometric pressure, humidity, ambient air temperature and ambient water temperature for testing according to the proposed duty cycle. Weighted engine emissions may not exceed the emission standards within the specified ranges of ambient conditions. For humidity and ambient water temperature, we specify a proposed method for correcting emission levels to a reference condition. We don't propose to allow any correction or adjustment based on varying ambient air temperatures or barometric pressures within the specified ranges. The specified ranges of test conditions apply to both laboratory testing and testing onboard a vessel. We are also proposing other provisions that would require equivalent emission control under other ambient conditions.

An additional concern relates to the way emissions vary under different engine operating conditions. For Category 1 and Category 2 engines, we adopted "not-to-exceed" provisions to define an objective measure to ensure that engines would be reasonably controlling emissions under the whole range of expected normal operation, as well as the defeat-device prohibition. Since these smaller engines are mass produced for a wide range of vessels used in many different applications, we expected "normal operation" for these engines to vary considerably around the ideal propeller curve. We are not proposing this approach for Category 3 engines, since each engine intended to operate on a propeller curve is matched with a propeller for custom installation on a specific vessel. Also, the very large mass of ocean-going vessels make them relatively insensitive to perturbations caused by varying vessel loads, water currents, or weather conditions. As a result, engine operation should invariably be limited to a very narrow range around the propeller curve. Propulsion engines that operate at constant speed (whether coupled to a variable-pitch propeller or generator for electric-drive units) will similarly operate over a very narrow range. Moreover, we are proposing to require manufacturers to test their production engines after installation on the vessel to show compliance with Tier 2 emission standards, which further removes the possibility of engines departing significantly from areas of engine operation over for which they are demonstrated to control emissions.

The proposed ISO E3 duty cycle includes four test modes weighted to reflect the operation of commercial marine vessels. The modal weightings are based on 70 percent of engine operation occurring at 75 percent or more of the engine's maximum power. For Category 1 and Category 2 engines, we have applied this same duty cycle, which reflects the way such engines are expected to operate. We are concerned, however, that Category 3 engines operate at significantly lower power levels when they are operating within range of a port. Ship pilots generally operate engines at reduced power for several miles to approach a port, with even lower power levels very close to shore. Because of the relatively low weighting of the low-power test modes, it is very possible that manufacturers could meet emission standards without significantly reducing emissions at the low-power modes that are more prevalent for these engines as they operate close to commercial ports. This issue would generally not apply to vessels that rely on multiple engines providing electric-drive propulsion, since these engines can be shut down as needed to maintain the desired engine loading.

We are considering a variety of options to address this concern. We could re-weight the modes of the duty cycle to emphasize low-power operation. This has several disadvantages. For example, we have no information to provide a basis for applying different weighting factors. Also, changing the duty cycle would depart from the historic norm for marine engine testing. This would make it more difficult to make use of past emission data, which is all based on the established modal weighting. An alternative approach would be to cap emission rates at the two low-power modes. We could set the cap at the same level as the emission standard, or allow for a small variation above the emission standard. For mechanically controlled engines, such an approach could dictate the overall design of the engine. On the other hand, we expect most or all new engines to have electronic controls, which would enable the manufacturer to target emission controls specifically for low-power operation without affecting the effectiveness of emission controls at higher power. We request comment on the need to adopt special provisions to ensure appropriate control of emissions during low-power operation. We specifically request comment on an additional requirement to limit emission levels of the two low-power modes to the level of the NOx emission standard for each engine.

An additional concern relates to variation in emission levels between test modes. The proposed defeat device provisions (which already apply to Category 1 and Category 2 engines) would prevent manufacturers from producing their engines to control emissions more effectively at established test points than at other points not included in the test. This is especially important for Category 3 engines that leave the U.S., because we are expecting ship operators to measure emissions to show that the engines still meet emission standards within a certain range of a U.S. port. As described in Section V.B.10, outside the U.S., ship operators may make adjustments outside the range of adjustable parameters to which the engine is certified. Engine manufacturers would be required to develop emission targets to allow the operator to ensure that the engine has been readjusted to the certified configuration. These emission targets would vary with operating conditions and would include targets for engine speeds other than the test points speeds. We are proposing that Category 3 engine manufacturers design their engines to achieve equivalent control for varying engine speeds after any changes are made to compensate for changes such as switching fuels. In identifying the NOx emission targets, manufacturers would have the choice of either applying the same injection timing map for the tested and nontested engine speeds, or ensuring that NOx emissions for nontest speeds follow a linear interpolation between test points. Ship operators would be required to adjust their engines to have NOx levels below the target level.

5. Voluntary Low-Emission Standards

We are also proposing voluntary emission standards, consistent with the approach we have taken in several other programs, to encourage the introduction and more widespread use of low-emission technologies. Manufacturers would need to reduce emissions 80 percent below Annex VI levels (excluding the nitrogen adjustment), as shown in Table IV.A-1, to qualify their engines for designation as voluntary low-emission engines. These reduced emission levels would apply to testing with both residual and distillate fuels, with the appropriate adjustments for nitrogen content of the fuel. Data show that engines utilizing selective catalytic reduction are capable of meeting these emission levels. If we establish an objective qualifying level for voluntary low-emission engines, this would make it easier for state and local governments or individual port authorities to develop meaningful incentive-based programs to encourage preferential use of these very low-emitting engines.

Engines certified to the voluntary low-emission standards would also need to meet the proposed Tier 2 standards for HC and CO emissions.

6. Hotelling Emissions

In addition to emissions from engines while the ship is moving in port, many ships run one or more engines to produce electricity for ship operations while in port for loading and unloading. These emissions are concentrated locally in the port area, which may have a disproportionate effect on neighboring communities. Several options are available specifically to address this concern for "hotelling" emissions. Many of these go beyond our usual approach of setting emission standards for new engines, but we request comment on these and other possible approaches, given the potential to achieve substantial additional reductions in this area.

Focusing on port emissions raises several questions. (1) Would it be appropriate for regulatory provisions to focus on reducing emissions specifically from port facilities, including hotelling emissions from ships? (2) Should EPA provide targets or incentives to encourage port authorities to reduce overall port emissions, including land-based equipment and vehicles? (3) What form might such a policy take—regulatory, voluntary, administered by EPA or local governments, including financial or logistical incentives? (4) Is it appropriate to adopt national policies to ensure emission reductions in all port areas or should such policy development be tailored to port-specific concerns? (5) Should EPA emission standards differentiate between in-port and transit emission levels? If so, what form or emission levels would be appropriate for in-port operations?

While we are not proposing to take action to address hotelling or other in-port emissions separately, we request comment on these issues and on any other possible approaches to encourage or ensure that emission controls are applied appropriately in port areas.

B. When would the engine emission standards apply?

Proposing emission standards for new Category 3 marine engines starting in 2004 allows less than the usual lead time for meeting EPA requirements. We note, however, that manufacturers are already meeting the Annex VI standards, which apply to engines installed on vessels built after January 1, 2000. The Tier 1 standards proposed in this document require no additional development, design, or testing beyond what manufacturers are already doing to meet Annex VI standards.

As described in the Draft Regulatory Support Document, manufacturers are well underway in pursuing emission-control technologies that would reduce emissions from Category 3 marine engines beyond Annex VI levels. With a final rule anticipated early in 2003, manufacturers would have four years to implement technologies needed to meet the Tier 2 standards by 2007. This would include time in the early years for selecting specific approaches and developing those technologies. Manufacturers would also need that time to integrate the various technologies into an overall engine design that performs well and is durable. Given that engine manufacturers already have limited experience in applying these technologies to Category 3 marine engines, we believe the Tier 2 standards will be achievable in the proposed time frame.

C. What information supports the technological feasibility of the proposed engine emission standards?

Annex VI calls for marine diesel engines over 130 kW to meet emission standards if they are installed on vessels built on or after January 1, 2000. Engine manufacturers are meeting the Annex VI standards today with a variety of emission-control technologies. Chapter 4 of the Draft Regulatory Support Document identifies several technologies that individual manufacturers have already incorporated to reduce emissions. The most common approach has been to focus on increased compression ratio, adapted fuel injection, valve timing and different fuel nozzles to trim NOx emissions. Manufacturers have generally been able to do this with little or no increase in fuel consumption. By building engines that can meet the Annex VI standards, manufacturers have shown that they can meet the identical Tier 1 standards proposed here for Category 3 marine engines.

As described in the Draft Regulatory Support Document, we have relied on existing data to account for fuel effects in selecting the proposed Tier 1 and Tier 2 NOx emission standards for testing Category 3 marine engines with residual fuel. The Annex VI NOx standards use a different methodology, but also take into account the emission effects of testing with residual fuel, so manufacturers should not need to adopt any new technologies to comply with Tier 1 emission standards when using residual fuel.

While manufacturers have used a wide variety of technologies to meet Annex VI standards for Category 3 marine engines, engines have so far generally incorporated only a few of the available emission-control technologies. To meet Tier 2 standards, manufacturers can integrate Tier 1 technologies more broadly into the fleet and pursue several additional approaches. These include:

- Improved fuel injection. This includes injection timing, injection pressure, rate shaping (or split injection), and common rail injection systems. Electronic controls would also allow for more precise metering and timing of individual injections.
- Intake air management. Manufacturers can use more effective turbocharging and aftercooling to reduce NOx emissions. Also, valve timing can be manipulated to vary expansion and compression ratios or to recirculate exhaust gases.
- Combustion chamber modifications. Several design variables affect the compression and mixing of the fuel-air mixture before and during combustion, including higher compression ratios, piston geometry, and injector location.

Test data show that these technologies can reduce emissions up to 40 percent below Annex

VI NOx standards.[50] We believe manufacturers can incorporate emission-control technologies to achieve a 30-percent reduction below Annex VI standards for all their Category 3 marine engines. Some industry representatives have indicated that this level of control is achievable.[51] Specifying 30 percent instead of 40 percent allows for a compliance margin for manufacturers to ensure that they meet emission standards consistently with all the engines they produce in an engine family. This also allows for manufacturers to show that they meet emission standards under the range of prescribed testing and operating conditions, as described above, including measures to cap emission levels at low-power modes to the level of the proposed emission standards. These technologies, and accompanying emission data, are described in more detail in Chapter 4 of the Draft Regulatory Support Document, while Chapter 5 adds specific detail regarding our estimated deployment of each of the targeted control technologies in the analysis to develop costs estimates related to the emission standards.

The analysis of emission-control technologies in most cases applies equally to two-stroke and four-stroke engines. While there are many fundamental differences between these types of engines, most emission-control strategies could be applied effectively to both types. Perhaps the most significant difference between these engines is the tendency for significantly larger displacements and slower operating speeds with two-stroke engines. The proposed emission standards for Category 3 marine engines incorporate the same shape of the NOx curve specified by Annex VI (and shown in Table IV.A-1), which reflects the generally increasing NOx emission levels for larger engines with slower operating speeds. The proposed emission standards therefore implicitly take into account higher emission levels for two-stroke engines.

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[50] Ingalls, M., Fritz S., "Assessment of Emission Control Technology for EPA Category 3 Commercial Marine Diesel Engines," Southwest Research Institute, September 2001.

[51] Mayer, Hartmut, Euromot, e-mail response to EPA questions, January 31, 2002.

Section VII discusses a range of alternative approaches we considered in developing this proposal and explains our reasons to defer their adoption at this time.

In addition to the proposed emission standards described in this document, we are proposing to review the Tier 2 standards before they take effect. This would allow us to verify that the proposed Tier 2 standards continue to represent an achievable level of control consistent with the understanding that those standards would result in the greatest achievable degree of emission reductions. We would expect to complete the technology review, separate from this rulemaking, by the end of 2005. In particular, we are aware that there may be a substantial benefit from learning over the coming years if our projected development of emission-control technologies is appropriate. A technology review would allow us to consider the progress manufacturers have made in controlling emissions with fuel-injection and the other projected engine-based technologies. It would also allow us to evaluate the appropriateness of more stringent controls based on continued development of advanced technologies. We will also be able to consider any potential action at IMO and in the EU to adopt more stringent standards internationally. It may also be the case that additional development time would allow lead us to conclude that one or more of the advanced technologies are ready for deployment on Category 3 marine engines and could then form the basis for new or revised emission standards. We may also then be in a better position to evaluate requirements limiting the sulfur content of in-use marine fuels, as described below. We request comment on the need for and the scope of a technology review.

D. Is EPA considering any fuel standards?

The majority of Category 3 engines are designed to run on residual fuel. This fuel is made from the very end products of the oil refining process, formulated from residues remaining after the primary distilling stages of the refining process. It has higher contents of ash, metals, and nitrogen that may increase exhaust emissions. It also has a high sulfur content, which can reach 45,000 ppm, although the global average is currently about 27,000 ppm.[52] Operating on fuels

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[52] Sulphur Monitoring 2002. Report to Marine Environmental Protection Committee, 47th

with such high sulfur contents results in high SOx and direct sulfate PM emissions.

Using a residual fuel with a lower sulfur content would reduce the fraction of PM emissions from ash and metals. Using distillate fuel instead of residual fuel could result in even lower emissions. The simpler molecular structure of distillate fuel may result in more complete combustion with reduced levels of carbonaceous PM. Operation on distillate fuel would also reduce NOx emissions because distillate fuel generally contains less nitrogen and has better ignition qualities. Because of these benefits, we request comment on fuel controls to reduce exhaust emissions from Category 3 marine engines.

Annex VI contains requirements for fuels used onboard marine vessels. These requirements, which will be effective when the Annex goes into force, consist of two parts. First, Annex VI specifies that the sulfur content of fuel used onboard ships cannot exceed 45,000 ppm (4.5 percent). Information gathered in an international monitoring program indicates refiners are currently complying with this requirement. Second, the Annex provides a mechanism to designate SOx emission control areas, within which ships must either use fuel with a sulfur content not to exceed 15,000 ppm or an exhaust gas cleaning system to reduce SOx emissions. To date, two SOx emission control areas have been designated: the North Sea and English Channel, and the Baltic Sea. The Annex VI fuel provisions do not go into effect, however, until the Annex enters into force (see Section I.C. above).

Operators can meet the Annex VI fuel requirement by using low-sulfur residual fuel or by switching to distillate fuel while they operate in SOx Emission Control Areas. Due to the nature of distillate fuel, this would also reduce NOx emissions. In general, engines that are designed to operate on residual fuel oil are capable of operating on distillate fuel. For example, if the engine is to be shut down for maintenance, distillate fuel is often used to flush out the fuel system.

Session. MEPC 47/INF.2, August 28, 2001. A copy of this document can be found in Docket A-2000-11, Document No. XXXX.

However, there are several complications associated with this option. Switching to distillate fuel requires 20 to 60 minutes, depending on how slowly the operator wants to cool the fuel temperatures. According to engine manufacturers, switching from a heated residual fuel to an unheated distillate fuel too quickly could cause damage to fuel pumps. There could also be fuel pump durability problems if the engine is operated on distillate fuel for more than a few days. For continued operation on distillate fuel, ships would need to have separate (or modified) pumps and lines. In addition, modification to the fuel tanks may be necessary to ensure sufficient capacity for low-sulfur fuel.

Alternatively, ships can use residual fuels produced to meet the 15,000 ppm (1.5 percent) sulfur requirement. Refiners can produce low-sulfur residual fuel from a low-sulfur crude oil or they can put the fuel through a de-sulfonation step in the refinery process. They can also produce it by blending marine distillate fuel, which typically has fuel sulfur levels between 2,000 and 3,000 ppm.

Given the PM, and SOx benefits of using low-sulfur residual fuels and the added NOx benefit of using distillate or distillate-blend fuels, we are requesting comment on whether we should set standards for the fuel that ships use. We are also seeking comment on what form such fuel standards should take. For example, we could adopt the Annex VI limits, either through the Annex VI process or through regulation under the Act. This would set a maximum sulfur limit of 15,000 ppm. However, lower sulfur contents are feasible and would yield greater PM and SOx benefits. As a comparison, the sulfur content of highway diesel fuel is under 500 ppm today, with a 15-ppm cap applying starting in 2007. The sulfur content of nonroad diesel is not regulated, but generally ranges from 2,000 to 3,000 ppm. Reducing the sulfur content of the fuel would reduce PM and SOx emissions by 10 and 44 percent, respectively (see Chapter 4 of the Draft Regulatory Support Document). An alternative approach would be to require that ships use distillate fuels, which would achieve the same or greater reduction of PM and SOx emissions, with an additional 10-percent reduction in NOx emissions resulting from the decreased nitrogen content of the fuel. We request comment on these possible approaches to addressing the in-use fuel quality. We also request comment on an appropriate way to ensure that ships use cleaner fuels when they would need reduced emissions to protect U.S. air quality.

We also seek information on the costs and expected benefits of further reductions in allowable fuel-sulfur levels, for both ship owners and fuel suppliers. Finally, we seek comment on how to apply the standard. Historically, we have regulated in-use fuels by establishing minimum specifications that apply to those who sell the fuel. This approach may not be effective for this sector because ship owners could choose to purchase their fuel outside the U.S. If we don't adopt any requirements related to in-use fuels in this rulemaking, we could revisit these questions in the context of a technology review, as described above

We are not proposing this approach in this rule because regulating fuel sold in the U.S. would not necessarily ensure that distillate fuel was used in U.S. waters. The Clean Air Act limits us to setting requirements on fuel entered into commerce in the U.S. It is not clear if fuel on ships entering U.S. ports is "entered into commerce." If we can regulate only the fuel sold in the U.S., then a fuel sulfur standard would be unlikely to have a significant impact on emissions because ships may choose to bunker before entering or after leaving the U.S. However, Regulation 14 of MARPOL Annex VI allows areas in need of SOx emission reductions to petition to be designated as SOx Emission Control Areas (SECA). Within such waters, the maximum sulfur content of the fuel will be limited to 15,000 ppm.[53] We intend to work through the MARPOL process to designate certain areas in the U.S. as sulfur control areas which would require the use of distillate fuel. We request comment on whether all waters under U.S. jurisdiction or only specific areas should be designated as SECAs, and whether such designation(s) could be expected to have an adverse impact on port traffic within SECAs..

V. Demonstrating Compliance

A. Overview of Certification

[53] Unless SOx emission controlled by secondary means which at present is not clear.

1. How would I certify my engines?

We are proposing to base certification data and administration requirements for new Category 3 marine engines on the existing program for Category 1 and Category 2 marine engines. These provisions are contained in 40 CFR part 94, and were described in detail in the preamble to the FRM that promulgated those regulations (64 FR 73300, December 29, 1999). In general, these provisions require that a manufacturer do the following things to certify engines:

- Divide engines into groups of engines with similar emission characteristics. These groups are called "engine families".
- Test the highest emitting engine configuration within the family.
- Determine deterioration rate for emissions and apply it to the "zero-hour" emission rate. The deterioration rate is essentially the difference between the emissions of the engine when produced and the point at which it would need to be rebuilt.
- Determine the emission-related maintenance that will be necessary to keep the engines in compliance with the standards.
- Submit the test data to EPA along with other information describing the engines within the engine family. This submission is called the "application for certification".

The certification provisions proposed for new Category 3 engines are discussed more fully in later sections. You should also read the proposed regulatory text, and the existing Category 2 regulations in 40 CFR part 94. These later section highlight the differences that we are proposing to apply to Category 3.

2. How is the proposed certification method different from that used under Annex VI?

In general, the two methods are similar. Our certification process is similar to the Annex VI pre-certification process, while our production-line testing program (described later) is similar to the Annex VI initial certification survey. The most fundamental differences between the proposed approach and the method used under Annex VI are related to witness testing, durability requirements, and test procedures. We allow, but do not require witness testing. Our proposed durability requirements and testing requirements are discussed in other sections. Overall, we believe that our proposed regulations are sufficiently consistent with Annex VI that manufacturers will be able to use a single harmonized compliance strategy to certify under both systems.

3. How does a certificate of conformity relate to a Statement of Voluntary Compliance or an EIAPP?

The Clean Air Act requires that manufacturers obtain a certificate of conformity before they introduce a new engine into commerce. Once it goes into force, MARPOL ANNEX VI will require manufacturers to obtain an "Engine International Air Pollution Prevention Certificate" (EIAPP). We anticipate that engines that receive an EPA certificate of conformity will also be eligible for an Engine International Air Pollution Prevention Certificate, since the proposed Tier 1 emission limits are the same as the Annex VI NOx limits and the proposed Tier 2 limits are more stringent.

It should be noted that EIAPPs will not be issued until the Annex goes into force and can be issued only by the flag state Administration. Prior to entry into force of the Annex, and to encourage vessel owners to purchase MARPOL Annex VI compliant engines, we have developed a voluntary certification program. Under this program, the engine manufacturer can apply for and obtain a Statement of Voluntary Compliance to the MARPOL Annex VI NOx limits.[54] It is anticipated that ship owners will be able to exchange this Statement of Voluntary Compliance for an EIAPP after the Annex goes into effect. If a shipowner does not have a valid Statement of Voluntary Compliance for an engine, it may be necessary to recertify the engine to

[54]Information on how to obtain a Statement of Voluntary Compliance can be found on our website, www.epa.gov/otaq/marine.htm

obtain an EIAPP after the Annex goes into effect. Finally, it should be noted that to obtain an EIAPP in this way, the Statement of Voluntary Compliance must be issued by EPA. A shipowner with a Statement of Voluntary Compliance issued by another Administration will have to apply for certification to obtain an EIAPP.

4. Can I use a continuous emission monitoring system to demonstrate compliance for certification?

You would generally not be able to use a continuous emission monitoring system to generate emission data that would be sufficient for our certification purposes. However, as we describe later, such a system could probably be used for production line testing or for in-use verification.

5. What are the roles of the engine manufacturer and ship owner after the engine is installed?

Unlike the provisions of MARPOL Annex VI, under our proposed regulations, the engine manufacturer would have some responsibilities for in-use compliance. The manufacturer would be required to demonstrate that its engine would be capable of complying with the standards through the "useful life" of the engine (as described below, the useful life would generally be the first rebuild cycle). The manufacturer would be responsible for remedying failures that occur during that period. The ship owner would be responsible for ensuring that all proper maintenance is performed during the entire service life of the engine. After Annex VI goes into force internationally, the ship owner would also be responsible for compliance with the provisions contained in the NOx Technical Code, including the recordkeeping requirements for the Record Book of Engine Parameters and the various survey requirements.

6. How would engines on foreign-flagged vessels be certified?

We are asking for comment regarding whether EPA should regulate all engines installed in foreign-flagged vessels that will call at a U.S. Port (Categories 1, 2, and 3). In general, we would apply the same compliance provisions to foreign-flagged vessels as we would to U.S.-flagged vessels. We do not believe that manufacturers or owners of foreign-flag vessels would face unique constraints compared with manufacturers and owners of U.S.-flag vessels. Thus, the compliance discussions in the section V would apply without regard to whether the standards ultimately apply only to U.S.-flag vessels or to all vessels calling on U.S. ports.

It is worth discussing, however, how engines on foreign-flagged vessels would be certified. If we extended our regulations to these engines, compliance could be demonstrated for certification in one of two ways. Both would require that an application be submitted to EPA. It would not be sufficient to have obtained a certificate from a country other than the U.S. The simplest way to obtain an EPA certificate would be for the ship manufacturer to install a certified engine during the construction of the ship. In this case, we would treat this engine in the same manner as engines installed on U.S.-flagged vessels. Our proposed regulations would already allow this. This approach would also work for replacement auxiliary engines. The ship owner would only be required to purchase a certified marine engine.

The second approach would be for the engine to be certified after it has been installed in a vessel that will call at a U.S. port, but before the vessel is within 175 nautical miles of the U.S. As with our requirements for newly manufactured engines, we would require that emission test data be submitted in an application for certification to demonstrate that the engine complies with our requirements. This could be done by either the engine manufacturer or the ship owner. We recognize that we may need to allow different certification procedures to be used in these special cases. In fact, our existing regulations for smaller marine engines include an allowance for EPA to establish special certification procedures for engines on imported vessels (§94.222). We could modify this provision to allow these special certification procedures for foreign-flagged vessels subject to our standards irrespective of whether such vessels are considered to be imported.

It is also worth noting that any vessel subject to our standards that has one or more uncertified engines installed could be denied the right to enter a U.S. port, because the vessel would not be in compliance with U.S. law. Similarly, a vessel with an engine that has within 175 nautical miles of the U.S. coastline operated outside the range of operating parameters within which the engine is certified to comply with the applicable emission standard could be denied the right to enter a U.S. port. In addition, EPA could bring an enforcement action against the vessel and its operator under the Clean Air Act for injunctive relief and for penalties of up to $27,500 for each day that a violation occurs. As is described in section III.C.3, we are considering exemption provisions to allow vessels with uncertified engines to make occasional, but not frequent visits to U.S. ports.

B. Other Certification and Compliance Issues

1. How are engine families defined?

We are proposing that engine grouping for the purpose of certification be accomplished through the application of an "engine family" definition. Engines expected to have similar emission characteristics throughout their useful life are proposed to be classified in the same engine family. We are proposing to define engine families consistent with MARPOL. To provide for administrative flexibility in the proposal, we would have the authority to separate engines normally grouped together or to combine engines normally grouped separately based upon a manufacturer's request substantiated with an evaluation of emission characteristics over the engine's useful life. We are requesting comment on the proposed requirements for selecting engine families. Do the proposed criteria provide sufficient certainty that NOx emissions will be similar for all of the engines within a particular family?

2. Which engines must be tested?

We are proposing that manufacturers select the highest emitting-engine (i.e., "worst-case" engine) in a family for certification testing. This is consistent the Annex VI requirements. In making that determination, the manufacturer shall use good engineering judgement (considering, for example, all engine configurations and power ratings within the engine family and the range of installation options allowed). By requiring the worst-case engine to be tested, we are assured that all engines within the engine family are complying with emission standards for the smallest number of test engines. If manufacturers believe that the engine family is grouped too broadly, they may request separating engines with dissimilar calibrations (based on an evaluation of emission characteristics over the engine's useful life) into separate engine families.

For these large marine engines, conventional emission testing on a dynamometer becomes more difficult. Often the engine mock-ups that are used for the development of these engines use a single block for many years, while the power assemblies are changed out. We propose that for Category 3 engines, certification tests may be performed on these engine mock-ups, provided that their configuration is the same as that of the production engines. In addition, we are proposing to allow single-cylinder tests, since a single-cylinder test should give the same brake-specific emission results as a full engine test, as long as each cylinder in an engine is equivalent in all material respects.

We are also proposing that manufacturers be required to allow EPA to perform confirmatory testing using their certification engines. In other rules, we have required manufacturers to provide us with actual engines for our confirmatory testing program. However, this would not be practical for Category 3 engines because of their size and cost.

3. How does EPA treat adjustable parameters during certification?

Marine diesel engines are often designed with adjustable components, to allow the engine to be adjusted for maximum efficiency when used in a particular application. This practice simplifies marine diesel engine production, since the same basic engine can be used in many applications. While we recognize the need for this practice, we are also concerned that the engine meet the proposed emission limits throughout the range of adjustment. Therefore, the Agency has established provisions for Category 2 engines to allow manufacturers to specify in their applications for certification the range of adjustment for these components across which the engine is certified to comply with the applicable emission standards, and demonstrate compliance only across that range. We are proposing to also allow such adjustments for Category 3 engines. Practically, this requirement means that a manufacturer would specify different fuel injection timing calibrations for different conditions. These different calibrations would be designed to account for differences in fuel quality. Operators would then be prohibited by the anti-tampering provisions from adjusting engines to a calibration different from the calibration specified by the manufacturer. (See section V.B.10 for a discussion of adjustments away from the U.S.)

Given the broad range of ignition properties for in-use residual fuels, we expect that this allowance for Category 3 engines would result in a broader range of adjustment than is expected for Category 2 engines. Because of this broader allowance, we are also proposing that operators be required to perform a simple field measurement test to confirm emissions after a parameter adjustment or maintenance operation. This would not be required for adjustments or maintenance that would not affect emissions. In addition, given the degree to which Category 3 engines regularly undergo major maintenance (e.g., replacement of an entire power assembly), we believe that all Category 3 engines as a class should be considered to be inherently adjustable. We do not believe that a manufacturer could make an engine that would be unadjustable in practice. Therefore, we are proposing that all new Category 3 engines be equipped with emission measurement systems and with electronic-logging equipment that automatically records all adjustments to the engine and the results of the required verification tests. It is important to emphasize that we believe that it is essential that the logging equipment automatically record all adjustments without requiring the operator to turn on the data logger. (As is described in section V.B.10, this requirement would apply to all adjustments without regard to whether they occur within 175 nautical miles of the U.S. coast.) This would allow us to rely on the data log to ensure that the vessel is consistently being adjusted properly. We would also require that such adjustments be manually recorded as well, consistent with MARPOL requirements.

We request comments on these and other approaches to ensure that engines with adjustable parameters meet the proposed emission requirements. Should we require that engine manufacturers design their engines to be automatically adjusted for changes in fuel quality of other conditions and prohibit all other adjustments? Would such a prohibition be practicable? We are also requesting comment on the need for and the feasibility of indicators on the outside of the vessel (e.g. a light) to indicate whether the pollution controls are working properly. Obviously, such a feature would need to be hard-wired into the vessel controls to be reliable.

4. How would engines be labeled?

We are proposing that each new engine have a permanent emission label on the engine block, or on some other part of the engine that would not be replaced in service. This label would have to include specific emission-related information such as engine family name, model year, and basic maintenance specifications. This inclusion of this information on the label would be in addition to the recordkeeping requirements specified in the NOx technical code.

5. How does EPA ensure durable emission controls?

To achieve the full benefit of the emissions standards, we need to ensure that manufacturers design and build their engines with durable emission controls. It is also necessary to encourage the proper maintenance and repair of engines throughout their lifetime. The goal is for engines to maintain good emission performance throughout their in-use operation. Therefore, we believe it is necessary to adopt measures to address concerns about possible in-use emission performance degradation. The proposed durability provisions, described in the following sections, are intended to help ensure that engines are still meeting applicable standards in use. Most of these provisions are carried over from our program for smaller marine compression-ignition engines. We request comment on all aspects of this durability program.

The most fundamental issue related to durability is the concept of useful life. Under our regulations, useful life is the period during which an engine is required to meet the emission standards. For Category 3 marine engines subject to our standards, we are proposing that the useful life be the period during which an engine is expected to be properly functioning with respect to reliability and fuel consumption without being rebuilt. For engines that are rebuilt completely at one time, the useful life would be the expected period between original manufacture and the first engine rebuild. For engines that are maintained by replacing individual power assemblies, the useful life would be the expected period between original manufacture and the point at which the last power assembly is replaced. We expect that this period will vary to some degree among engine models. Therefore, we are proposing that manufacturers specify the useful life for their engines at the time of certification. Their specification would be subject to EPA approval, and could not be less than a minimum period of 3 years or 10,000 hours of operation (based on all engine operation, not just operation in or near U.S. waters). This specification would not limit in-use operation. Rather it would determine how the manufacturer would address emission deterioration (i.e., the manufacturer would be required to demonstrate to EPA that the engine would meet the standards for the full useful life). We are also proposing that the useful life period may not be less than any mechanical warranty that the manufacturer offers for the engine.

These minimum useful life values are lower than the minimum values for Category 2 engines due to the effect of using residual fuel, which generally has much higher sulfur levels than distillate fuels. The high sulfur levels create a more corrosive environment within the combustion chamber, which decreases durability. The period of years (three years) is also affected by the higher usage rate in terms of hours per year.

6. What are the manufacturer's responsibilities for warranty and defect reporting?

Tied to the useful life is the minimum period for the warranty required under the Clean Air Act. We believe it is important to ensure that the engine manufacturer has designed and built the engine to ensure that it will comply with the emission standards throughout its useful life, as long as it is properly maintained. Therefore, we are proposing that the warranty period be equal to the useful life period (e.g., 10,000 hours or 3 years). Under the performance warranty, the engine manufacturer would be responsible to repair any properly maintained and used engine that fails to meets the standard in use during the warranty period. (Engine operators would be responsible to repair any engines that failed to meet the standards because of improper maintenance.) We request comment on this approach.

We are also proposing defect-reporting requirements. These provisions require Category 3 engine manufacturers to report to EPA whenever a manufacturer identifies a specific emission-related defect in 2 or more engines (or 2 or more cylinders within the same engine). In most cases, we would expect the defects to be identified as part of a manufacturer's warranty process. However, the manufacturer would be required to report all defects, without regard to how they were identified. It is important to clarify that the defect reporting requirements would not require the manufacturer to collect new information. The manufacturer would be required to track and report to EPA information that they obtain through normal business practice.

7. What are deterioration factors?

To further ensure that the proposed emission limits are met in use, we are proposing to require the application of a deterioration factor (DF) to engines in evaluating emission control performance during the certification and production-line testing process. The emissions from new engines are adjusted using the DF to account for potential deterioration in emissions over the life of the engine due to aging of emission control technologies or devices. The resulting emission level is intended to represent the expected emissions at the end of the useful life period for a properly maintained engine. We believe that the effectiveness of some emission control technologies, such as aftertreatment, sophisticated fuel-delivery controls, and some cooling systems, can decline as these systems age. The DF is applied to the certification emission test data to represent emissions at the end of the useful life of the engine. We are proposing that marine diesel engine DFs be determined by engine manufacturers in accordance with good engineering practices. The DFs, however, would be subject to EPA approval, and must be consistent with in-use test data. For example, if we had in-use test data from earlier model year engines from the same basic engine family that showed that NOx emissions generally deteriorate by 0.5 g/kW-hr over the useful life, then we would approve a DF that assumed no deterioration in NOx emissions. Additionally, the DF should be calculated for the worst-case engine configuration offered within the engine family.

It is not our intent to require a great deal of data gathering on engines that use established technology for which the manufacturers have the experience to develop appropriate DFs. New DF testing may not be needed where sufficient data already exists. However, we are proposing to apply the DF requirement to all engines so that we can be sure that reasonable methods are being used to ascertain the capability of engines to meet standards throughout their useful lives. Consistent with other programs, we propose to allow manufacturers the flexibility of using durability emission data from a single engine that has been certified to the same or more stringent standard for which all of the data applicable for certification has been submitted. In addition, we request comment on whether this flexibility should be extended to allow deterioration data from highway, nonroad, or stationary engines to be used for similar marine diesel engines.

Finally, we are proposing that DFs be calculated as an additive value (i.e., the arithmetic difference between the emission level at full useful life and the emission level at the test point) for engines without exhaust aftertreatment devices. In contrast, DFs should be calculated as a multiplicative value (i.e., the ratio of the emission level at full useful life to the emission level at the test point) for engines using exhaust aftertreatment devices. This is consistent with the DF requirements applicable to other diesel engines, based on observed patterns of emission deterioration. Given the type of emission controls projected to be used to meet the proposed standards (calibration changes and combustion chamber redesign, but not aftertreatment), it is possible that NOx emissions may actually decrease with time as the piston rings and cylinder liners wear (thereby reducing peak pressures). In such cases, we would require that the manufacturer use an additive DF of zero.

It is important to note that one of the reasons we are proposing a very flexible DF program for this rulemaking because we do not expect deterioration to be a major problem for these engines. Our history with in-cylinder NOx control suggests that engine-out NOx emissions are relatively stable over time. If we were to adopt an aftertreatment-forcing standard or a standard for PM, we would likely consider more specific requirements for calculating DFs. For example, it might be appropriate to apply to these engines the more specific DF provisions that have been developed for on-highway heavy-duty engines (40 CFR §86.004-26) Commenters that favor the adoption of an aftertreatment-forcing standard or a standard for PM should address whether they believe that the proposed DF program would be sufficient to ensure that manufacturers design their aftertreatment devices to be durable.

8. What requirements are proposed for in-use maintenance?

In previous rules, we have required manufacturers to furnish the ultimate purchaser of each new nonroad engine with written instructions for the maintenance needed to ensure proper functioning of the emission control system. (Generally, manufacturers require the owners to perform this maintenance as a condition of their emission warranties.) If such required maintenance is not performed by the engine operator, then in-use emissions deterioration can result. We are proposing to require that Category 3 engine operators be required to perform this maintenance, or equivalent maintenance. This provision is comparable to our requirement for railroads to perform emission-related maintenance for locomotives (40 CFR 92.1004). In that approach, locomotive owners who fail to properly maintain a locomotive are subject to civil penalties for tampering. For marine engines, properly rebuilding engines and power assemblies would be considered to be a part of emission related maintenance.

An important part of this proposal is the allowance for operators to perform the maintenance differently than specified by the manufacturer, provided that maintenance is performed in such a way to keep the engines performing properly with respect to emissions. With the proposed emission verification requirements, it will be straightforward for ship operators to determine if their maintenance practices are sufficient. As long as their engines pass the verification tests, EPA would consider the maintenance to be equivalent. For ships that travel far from U.S. waters, this requirement would mean that maintenance would need to be performed in such a way that the engines would pass the verification tests before they come within 175 nautical miles of the U.S. coastline. (See section V.B.10 for more information about special provisions that apply for ships that travel more than 175 nautical miles from the U.S.)

Unlike our regulation for smaller marine engines, we are not proposing minimum allowable maintenance intervals for Category 3 marine diesel engines. This is also consistent with our approach for locomotives. In both cases, we believe that maintenance will be jointly agreed to by the engine manufacturer and the engine owner prior to purchase.

We are requesting comment on whether we should allow a manufacturer or owner to petition EPA to amend the emission-related maintenance instructions after the engine is in use, either within or after the useful life. This may be necessary because of the very long service lives of these engines. It may not be reasonable for us to require an owner of a 20-year old engine to be bound to maintenance practices that were set 20 years earlier. We are requesting comment on how such amendments would be made.

9. Do the proposed regulations affect engine rebuilding?

We are proposing in-use maintenance provisions that would require operators to perform emission related maintenance properly. We are proposing that this would also apply whenever an engine or engine subsystem is rebuilt. These provisions would require that all rebuilds return the engine to its original certified condition. (Failure to rebuild an engine to its original certified condition would be considered tampering with the emission controls.) We believe that the proposed provisions would address the vast majority of in-use maintenance and rebuilding practices. However, we are concerned about special circumstances in which an owner wants to upgrade the engine to be comparable to a newer configuration rather than simply returning it to its original configuration. Under Annex VI, such "substantial modifications" are allowed, but the owner is required to recertify the engine. Should we adopt a similar provision? We are also requesting comment on a voluntary rebuild standard for older ships with engines that are not subject to our standards or the Annex VI requirements. For example, should we create a program for owners of ships built before 2004 to voluntarily certify that they comply with the EPA standards for model year 2004 ships?

As described in the previous section, for ships that travel far from the U.S., the proposed in-use maintenance provisions that would require operators to perform emission related maintenance so that an engine meets the manufacturer's maintenance requirements when it is within 175 nautical miles of the United States. For rebuilds performed away from the U.S., this would require that all rebuilds be performed so that the engine could be returned to its original certified condition before the ship returns to within 175 nautical miles of the United States. (See section V.B.10 for more information about special provisions that apply for ships that travel more than 175 nautical miles from the U.S.)

10. Compliance with a certificate of conformity beyond 175 nautical miles of the U.S. coast

As described in section V.B.3, we are proposing to allow engines to be adjusted in use in accordance with the certificate of conformity. We are also proposing different compliance requirements than those adopted in prior rulemakings for new nonroad vehicles and new nonroad engines for Category 3 marine engines installed in vessels that operate outside the U.S. Under this approach a vessel operator would be conditionally allowed to adjust an engine's operating parameters different from the manufacturer's specification. This would be allowed when a vessel that is proceeding toward or out of a U.S. port is more than 175 nautical miles about (200 statutory miles) from the U.S. coastline. More precisely, we would allow this for vessels that are more than 175 nautical miles from the baseline from which the territorial sea is measured, including U.S. states or territories outside of the U.S. mainland**.**

Engine adjustments different from engine manufacturer's specifications, however, would be conditional on readjusting the engine's parameters within its certified range and confirming that emissions are within the range of emissions to which the engine is certified to comply before a vessel seeking to enter a U.S. port is 175 nautical miles from the U.S. coastline. Failure to take these actions would constitute tampering with the engine in violation of section 203(a)(3)(A) of the CAA and 40 CFR §94.1103(a)(3)(i). To confirm that emissions are within the range of emissions at which the engine is certified to comply, operators would have to perform a simple field measurement test after each parameter adjustment or maintenance operation that could reasonably be expected to affect emissions. (All adjustments and maintenance would be presumed to affect emissions unless there was a reasonable technical basis for believing that they did not affect emissions.) Furthermore, we would require that all new Category 3 engines be equipped with electronic-logging equipment that automatically records all adjustments to the engine and the results of the required verification tests. The logging equipment would be required automatically record all adjustments without requiring the operator to turn on the data logger, without regard to whether they occur within 175 nautical miles of the U.S. coast. It would not be possible to rely on the data log to ensure that the vessel is consistently being adjusted properly if the operator could turn the logger on and off. Since the logging would occur automatically, we do not believe there would be a significant burden to the operator. Such adjustments would also have to be manually recorded as well. Obviously, we would not allow adjustments that damaged the engine or its emissions controls or otherwise prevented the engine from being able to comply with our regulations after the readjustment.

Prior rulemakings that establish emission standards for new nonroad engines and vehicles prohibit anyone from disabling or otherwise tampering with an engine or vehicle that is covered by a certificate of conformity. See for example 40 CFR §94.1103(a)(3)(i). Our normal practice has been to require an engine to meet the emission standards at all specifications within an adjustable range. In addition, we normally require an engine manufacturer to make an engine's parameters unadjustable outside the range at which an engine is certified. We have adopted these practices to minimize the possibility that a certified engine can be intentionally or unintentionally adjusted to exceed the emission levels at which it is certified. If we take a different approach and allow Category 3 marine engines to conditionally allow a vessel operator to adjust an engine's operating parameters outside the range of specifications within which the engine is certified to comply with the applicable emission standards, we would be increasing the possibility that a certified engine will exceed the emission levels at which it is certified when it is in or near the United States. We are, nonetheless, proposing such an approach because of the unique issues associated with Category 3 marine engines that are installed in a vessel. These engines spend much of their time in international waters far away from U.S. coastal regions, where their emissions would have little or no effect on U.S. air quality. Tailoring the scope of the prohibition against tampering with a certified engine would allow vessel operators to readjust their engines for different performance characteristics in international waters when their emissions do not affect the U.S.

Although section 203(a)(3)(A) of the CAA prohibits the disabling of or tampering with emission control technology on a compliant motor vehicle or motor vehicle engine, there is no express statutory prohibition on such conduct with respect to new nonroad engines or vehicles. Although section 213(d) does provide that emission standards for new nonroad engines and vehicles "shall be enforced in the same manner" as standards prescribed for new motor vehicles and new motor vehicle engines, it is unclear whether this means "exactly equivalent" enforcement requirements or "analogous, comparable or consistent" enforcement requirements. The CAA, therefore, is ambiguous as to how emission standards for new nonroad engines and vehicles should be enforced.

We believe that it would be reasonable to interpret section 213(d) to allow the Agency to fashion enforcement provisions for new nonroad engines and vehicles that are consistent with, but not necessarily equivalent to, those applicable to new motor vehicles and new motor vehicle engines. Such an interpretation is consistent with the rest of section 213(d), which recognizes the need for different solutions to implement emission standards for new nonroad engines and vehicles. Specifically, section 213(d) provides that emission standards for nonroad engines and vehicles like emissions standards for new motor vehicles and new motor vehicle engines are subject to sections 206, 207, 208 and 209 "with such modifications of the applicable regulations implementing such sections as the Administrator deems appropriate."

In this case, the need for a different solution than the one that we have traditionally adopted is warranted by the fact that the engines we propose to regulate operate primarily outside of the

United States. As discussed above, marine Category 3 engines installed in vessels spend much of their time in waters far away from U.S. coastal regions, where their emissions would have little or no effect on U.S. air quality. Enforcing emission standards for these kinds of engines, therefore, is different than enforcing standards for motor vehicles and motor vehicle engines that operate primarily, if not exclusively, inside the United States. However, vessel operators that adjust an engine's operating parameters outside the range within which the engine is certified to comply with the applicable emission standards, would have to readjust the engine's parameters to its certified calibration and confirm that emissions are within the range of emissions to which the engine is certified to comply before a vessel seeking to enter a U.S. port is 175 nautical miles from the U.S. coastline.

As described in previous sections, we are proposing to apply this same approach for engine maintenance and rebuilding. Within 175 nautical miles of the U.S., improper maintenance or rebuilding of an engine would be considered to be tampering to the extent that it compromised the emission performance of the engine. On the other hand, engine maintenance and rebuilding that occurs more than 175 nautical miles away from the U.S. would be treated as any other type of emission-related adjustment. Ship operators could maintain or rebuild the engine however they would choose, provided that the engine is returned to a certified configuration and passes an emission verification test before it comes within 175 nautical miles of the U.S.

We are proposing this limit of 175 nautical miles to control Category 3 emissions that affect U.S. air quality, especially emissions from coastwise traffic. As described in the draft RSD, we believe that the emissions that occur within 175 nautical miles (200 statutory miles) of the U.S. coastline represent a significant fraction of the total inventory and that these emissions can significantly affect U.S. air quality. Assuming a 10 mile per hour wind blowing toward the coast, these emissions would reach the coast in less than one day. Setting this threshold at some shorter distance would not adequately account for these emissions. We considered proposing a larger distance. The Ozone Transport Assessment Group[55] has estimated that within the

[55] Final Report of the Ozone Transport Assessment Group, Chapter 4.

continental U.S., emissions can affect air quality as far away as 500 statutory miles from the emission source. Other analyses have suggested that NOx and SOx emissions could be transported even farther than that. However, there is uncertainty associated with the transport of ship emissions. Most transport studies have focused on transport that occurs over land, and emissions over the ocean do not have the same effect as land-based emissions due to different meteorological conditions. While we recognize that some emissions that occur beyond 175 nautical miles could potentially affect U.S. air quality, these effects are hard to quantify. At this time, we cannot determine that emissions beyond 175 nautical miles would have a significant effect in most cases. We believe that the proposed distance would protect U.S. air quality without placing an undue burden on ship operators. Nevertheless, we request comment on the proposed distance. We encourage commenters to address both the long-distance effect of marine engine emissions on U.S. air quality and the potential impact of this proposed approach on ship operations. We are requesting comment regarding the appropriateness of applying a single distance to all coastal regions, without considering prevailing wind patterns. For example, would it be more appropriate to set a larger distance for the Pacific coast and a smaller distance for the Atlantic coast? Would such an approach be practical? We are also requesting comment on whether we should treat the waters around U.S. island territories such as Guam in the same way that we treat the coastal waters around the continental U.S. Would emissions around these islands affect their air quality to the same extent as coastal emissions around the U.S. mainland? Alternatively, we could exempt the island territories from these requirements, pursuant to section 324(a) of the Act, if petitioned by the governors of the territories.

11. Are there proposed post-certification testing requirements?

To ensure compliance of production engines, we are proposing a simple testing program that is modeled loosely on our production line testing (PLT) requirements for other marine engines. The general object of any PLT program is to enable manufacturers and EPA to determine, with reasonable certainty, whether certification designs have been translated into production engines that meet applicable standards. We are not proposing a specific testing requirement, and will allow manufacturers flexibility in determining how to test the engines.

However, we are proposing some minimum requirements. First, we would require that each certified engine that a manufacturer produces be tested. We would also require that either the test directly measure brake-specific emissions, or measure other parameters that provide equal assurance that each engine meets the standards. The testing would need to occur after final installation, but before final delivery to the ultimate purchaser. We would suspend the certificate of conformity for any failing engine, or if the engine manufacturer's submittal reveals that the tests were not performed in accordance with the applicable testing procedure. The manufacturer must then bring the engine into compliance before we could reinstate the certificate of conformity subsequent to a suspension. We would also suspend the certificate of conformity for an engine family whenever an engine fails. The manufacturer would need to identify and remedy the cause of the failure before we could reinstate the certificate of conformity for future production within that family.

12. What are the prohibited acts and related requirements?

We are proposing to regulate Category 3 engines under 40 CFR part 94. This means that we are proposing to extend the general compliance provisions for smaller marine engines to Category 3 marine engines. These include the general prohibition introducing an uncertified engine into commerce, as well as the tampering and defeat-device prohibitions. However, as described in Section V(B)(10), we are proposing to modify the tampering provision for Category 3 engines to allow operation outside of the otherwise allowable range of adjustment when the vessel is far away from the U.S. All other aspects of the existing tampering prohibition would apply. These prohibitions are listed in §94.1103. EPA seeks comment on extending these provisions to Category 3 engines, and on any additional modifications that should be made to these provisions to accommodate special features of these engines.

13. Are there general exemptions for engines?

We are proposing to extend the exemptions provisions for smaller marine engines to Category 3 marine engines. These include, for example, exemptions for the purpose of national security and exemptions for engines built in the U.S. for export to other countries. These exemptions, which are described in Subpart J of 40 CFR Part 94, would exempt the engines from the proposed requirements, but would require that the manufacturer keep records or label the engines in some cases. Both the exemption and the related requirements are allowed under our general standard-setting authority.

14. What regulations would apply for imported engines?

We are proposing to extend the importation provisions for smaller marine engines to Category 3 marine engines. This means that we are proposing that engines that are imported would generally be subject to the proposed requirements based on their date of original manufacture. The existing provisions for smaller engines include permanent and temporary exemptions from this requirement. The most significant of these import exemptions for ocean-going vessels is the allowance to temporarily import an engine for repair.

15. What would be a manufacturer's recall responsibilities?

Section 207(c)(1) of the Act specifies that manufacturers must recall and repair in-use engines if we determine that a substantial number of them do not comply with the regulations in use. We are proposing to apply the existing provisions for smaller marine engines to Category 3 marine engines. These provisions are described in Subpart H of 40 CFR Part 94.

C. Test Procedures for Category 3 Marine Engines

Engine manufacturers are currently testing according to the test procedures outlined in The Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines in the "Annex VI of MARPOL 73/78 Regulations for the Prevention of Air Pollution from Ships and NOx Technical Code" from the International Maritime Organization. We are proposing to certify Category 3 marine engines using these MARPOL test procedures for diesel marine engines with modification. The modifications are described in the following sections.

1. What duty cycle do I use to test my engines?

The duty cycle used to measure emissions is intended to simulate operation in the field. Testing an engine for emissions consists of exercising it over a prescribed duty cycle of speeds and loads, typically using an engine dynamometer. The nature of the duty cycle used for determining compliance with emission standards during the certification process is critical in evaluating the likely emissions performance of engines designed to those standards.

To address operational differences between engines, we are proposing two different duty cycles for different types of C3 marine engines. Engines that operate on a fixed-pitch propeller curve would be certified using the International Standards Organization (ISO) E3 duty cycle. This is a four-mode steady-state cycle developed to represent in-use operation of marine diesel engines. The four modes lie on an average propeller curve based on the vessels surveyed in the development of this duty cycle. We are proposing ISO E2 for propulsion engines that operate at a constant speed. These are the cycles used by MARPOL.

2. What kind of fuel is required for emission testing?

To facilitate the testing process, we generally specify a test fuel that is intended to be representative of in-use fuels. Engines would have to meet the standard on any fuel that meets the proposed test fuel specifications, with one modification as described later. This test fuel is to be used for all testing associated with the regulations proposed in this document, to include certification, production line and in-use testing.

We are proposing that the official test fuel specification for C3 engines be a residual fuel. We are proposing to allow a range of fuels based on the ASTM D 2069-91 specifications for residual fuel. We will allow testing using any residual fuel meeting the specifications for RMH-55 grade of fuel including fuels meeting the specifications for RMA-10 grade of fuel. We request comment on this specification. An alternative to this approach might be to narrowly define a worst-case test fuel. Your comments should address whether the grade of the test fuel would affect the feasibility or the stringency of the proposed standard. We also are requesting comment on whether there needs to be a specification for ignition properties of the test fuels, such as cetane.

This ASTM specification does not include any specification for the nitrogen content of the fuel. Organically-bound nitrogen is a normal component of residual fuels that has a very significant effect on NOx emissions. However, the effect on NOx can be calculated from the nitrogen content of the fuel. Therefore, we are proposing to include a broad specification for the nitrogen content of the fuel (between zero and 1.0 weight percent), and to require correction of the NOx emissions based on the nitrogen content of the fuel.

We are also proposing to allow certification testing on marine distillate fuel to be consistent with MARPOL testing (see section IV.A.2). However, distillate fuels tend to have lower nitrogen content than residual fuels. To account for this, we would correct the NOx emissions, based on fuel nitrogen content, to be equivalent to testing with residual fuels. We request comment on this approach. Your comments should address whether we should account for factors other than nitrogen content of the fuel in our correction.

3. How would EPA account for variable test conditions?

We are not proposing to limit certification testing based on barometric pressure or ambient humidity. We are proposing to limit the allowable ambient air temperature to 13°C to 30°C and charge air cooling water to 17°C to 27°C. However, since a manufacturer would not always be able to stay within these ranges for tests conducted after the engine is installed in the ship, we are proposing to allow production testing and in-use testing under broader conditions. Engine manufacturers would need to provide information about how emissions are affected at other temperatures to allow production testing and in-use testing conducted under the broader conditions to be used to verify compliance with the emission standard.

We are proposing to use the MARPOL Annex VI correction factors for temperature and humidity for certification testing. We would allow the use of the corrections for a broader range of test conditions, provided the manufacturer verifies the accuracy of the correction factors outside of the range of test conditions for certification.

4. How does laboratory testing relate to actual in-use operation?

If done properly, laboratory testing can provide emission measurements that are the same as measurements taken from in-use operation. However, improper measurements may be unrepresentative of in-use operation. Therefore, we are proposing regulatory provisions to ensure that laboratory measurements accurately reflect in-use operation. In the proposed regulations, there is a general requirement that manufacturers must use good engineering judgment in applying the MARPOL Annex VI test procedures to ensure that the emission measurements accurately represent emissions performance from in-use engines. We are proposing specific requirements that the manufacturers ensure that intake air and exhaust restrictions and coolant and oil temperatures are consistent with in-use operation. Most importantly, we are proposing that manufacturers' simulation of charge-air cooling replicate the performance of in-use coolers within ±3°C.

The definition of maximum test speed, (the maximum engine speed in revolutions per minute, or rpm) is an important aspect of the test cycles proposed in this document. Under Annex VI, engine manufacturers are allowed to declare the rated speeds for their engines, and to use those speeds as the maximum test speeds for emission testing. However, we are concerned that a manufacturer could declare a rated speed that is not representative of the in-use operating characteristics of its engine in order to influence the parameters under which their engines could be certified. Therefore, we are proposing to apply the current definition of "maximum test speed" in §94.107 to Category 3 engines that are subject to our standards.

5. What is required to perform a simplified onboard measurement?

We are proposing that simplified onboard measurements be used to confirm proper adjustment of in-use engines as described in sections V.B.3 and V.B.10. These systems must be capable of measuring NOx concentration, exhaust temperature, engine speed, and engine torque. Operators would compare the NOx concentration and exhaust temperature to limits provided by the manufacturer. Tests that showed emissions higher than allowed under the manufacturer's specifications would mean that the engine was not properly adjusted. If the engine was within 175 nautical miles of the U.S. coast, then this would require that the engine be readjusted and retested. Such exceedances 175 nautical miles of the U.S. coast would not be considered to be violations of the regulations, provided they were corrected immediately.

VI. Projected Impacts

A. What are the anticipated economic impacts?

In assessing the economic impact of setting emission standards, we have made a best estimate of the combination of technologies that an engine manufacturer would most likely use to meet the new standards. The analysis presents estimated cost increases for new engines. These estimates include consideration of variable costs (for hardware and assembly time), fixed costs (for research and development, and retooling), and compliance costs (for certification testing and onboard emission measurements). The analysis also considers total operating costs, including maintenance and fuel consumption. Cost estimates based on these projected technology packages represent an expected change in the cost of engines as manufacturers begin to comply with new emission standards. All costs are presented in 2002 dollars. Full details of our cost analysis can be found in Chapter 5 of the Draft Regulatory Support Document.

Table VI.A-1 summarizes the projected costs for meeting the new emission limits. No costs are attributed to the Tier 1 standards, because we expect that all manufacturers are meeting the Annex VI standards and applying for statements of voluntary compliance from EPA. Anticipated incremental new engine cost impacts of the Tier 2 emission limits for the first years of production range from $90,000 to $146,000 per engine with an calculated composite cost of

$110,000. Long-term impacts on engine costs are expected to be lower, ranging from $23,000 to $59,000 per engine with a composite cost of $15,000. Most of this cost reduction is accounted for by the fact that research, testing, and other fixed costs dominate the cost analysis, but disappear after the projected ten-year amortization period. Some additional cost reduction is expected to result from learning in production. We believe that manufacturers will be able to combine emission-control technologies to meet the proposed Tier 2 emission standards without increasing fuel consumption or other operating costs. The cost analysis, however, includes an estimated $5,000 of annual expenses to maintain equipment for onboard emission measurement. Including this annual operating cost gives a total composite cost of $176,000 for an average engine. See Chapter 5 of the Draft Regulatory Support Document for a more detailed discussion of the analysis to estimate the costs of emission-control technology for meeting the proposed emission standards.

Table VI.A-1
Summary of Projected Costs to Meet Proposed Tier 2 Emission Standards—U.S.-flag only

Time Frame	Medium-speed Engines			Slow-speed Engines		
	6 cyl.	9 cyl.	12 cyl.	4 cyl.	8 cyl.	12 cyl.
Total cost per engine (yr. 1)	$90,431	$93,974	$97,514	$104,519	$125,087	$145,655
Total cost per engine (yr. 6 and later)	$23,627	$25,894	$28,160	$32,643	$45,807	$58,970
Annual operating costs	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000

Table VI.A-2 shows the same cost estimates for the scenario of requiring engines on foreign-flag vessels to meet emission standards. Near-term costs are generally lower because fixed costs can be amortized over substantially larger numbers of engines.

Table VI.A-2
Summary of Projected Costs to Meet Proposed
Tier 2 Emission Standards—Including Foreign-flag

Medium-speed Engines	Slow-speed Engines

	Medium-speed Engines			Slow-speed Engines		
	8 cyl.	12 cyl.	16 cyl.	4 cyl.	8 cyl.	12 cyl.
Total cost per engine (yr. 1)	$31,371	$34,205	$37,037	$42,641	$59,095	$75,550
Total cost per engine (yr. 6 and later)	$23,627	$25,894	$28,160	$32,643	$45,807	$58,970
Annual operating costs	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000

The above analysis presents unit cost estimates for each power category. With current data for engine and vessel sales for each category and projections for the future, these costs can be translated into projected direct costs to the nation for the new emission standards in any year. Aggregate annualized costs (based on a 20 year stream) are estimated to be about $1.6 million per year. Aggregate annualized costs not including the NOx monitoring costs are estimated to be about $1.5 million. Applying the proposed emission standards also to engines on foreign-flag vessels would increase aggregate annualized costs to about $51 million. In both cases, estimated aggregate costs per year fall substantially after five years as manufacturers would no longer need to recover their amortized costs.

The annualized aggregate cost (no operating costs) of $1.5 million represents 0.3 percent of total annual industry revenues based on the 1997 value of shipments. The annualized costs drop substantially in the sixth year, as noted above, and the associated percentage of total annual industry would be less. Because the total annualized costs associated with complying the proposed rule are a small percentage of total market revenues, it is unlikely that market prices or production will change as a result of these proposed rules. Furthermore, the total annualized costs associated with applying the reductions to all vessels (as shown in comparing Table VI.A-1 and VI.A-2) is smaller; thus, we would still not anticipate appreciable changes in market prices or quantities to be associated with the proposed rule.

B. What are the anticipated emission reductions of this proposal?

The following discussion gives a brief overview of the methodology we used to determine the emissions reductions from Category 3 marine diesel engines associated with this proposed rule. Chapter 6 of the Draft Regulatory Support Document provides a detailed explanation of the methodology and results. Section II of this preamble and Chapter 2 of the Draft Regulatory Support Document contain information about the health and welfare concerns associated with Category 3 marine diesel engine pollution.

To model the benefits of the proposed standards we applied an engine replacement schedule and the proposed emissions standards to the baseline inventory. We also accounted for the MARPOL Annex VI NOx limits. Although these standards are not yet effective, they are being largely complied with around the world, and we expect this trend to continue. Thus, we are using the Annex VI limits as the baseline for purposes of showing the expected emissions reductions from the proposed Tier 2 standards. Thus, we are assuming that all U.S. and foreign flagged vessels built after 1999 will comply with the Annex VI limits, and show the benefits of the proposed Tier 2 standards relative to this baseline. We are only proposing that the Tier 2 standards apply to U.S. flagged vessels. Thus, we only applied the expected emissions reductions from the proposed Tier 2 standards to the portion of the national inventory attributable to U.S. flagged vessels. Also, because we are only proposing NOx standards, we are claiming no emissions reductions in HC, CO or PM. Table VI.B-1 shows our estimates of Category 3 vessel NOx emissions with and without the proposed Tier 2 standards, as well as the impact of the MARPOL Annex VI NOx limits.

Table VI.B-1
Category 3 Marine Vessel NOx National Emissions Inventories

		1996	2010	2020	2030
No control baseline (thousand short tons)		190	303	439	659
MARPOL Annex VI	(thousand short tons)	190	274	367	531

		1996	2010	2020	2030
	Percent reduction (relative to no control)	—	9.6%	16.2%	19.5%
Tier 2	Control (thousand short tons)	190	269	343	475
	Percent reduction (relative to MARPOL Annex VI)	—	2.0%	6.8%	10.5%

As discussed in Section III, we are only proposing to apply the emissions standards to U.S. flagged vessels. The effect of applying the proposed Tier 2 standards to both U.S. and foreign flagged vessels is shown in Table VI.B-2. As can be seen from this table, the projected emissions reductions would almost triple by 2030 if the application of the proposed standards is extended to foreign flagged vessels.

Table VI.B-2
Effect of Application of Proposed Tier 2 Emissions Standards Based on Vessel Flag
(U.S. Flagged Vessels vs. All Vessels)

	2020		2030	
Scenario	NOx (1000 tons)	% reduction	NOx (1000 tons)	% reduction
Baseline (Annex VI)	367	--	531	--
U.S. Flagged Only	343	6.8%	475	10.5%
All Vessels	306	16.7%	392	26.1%

C. What is the estimated cost per ton of pollutant reduced for this proposal?

We estimated the cost per ton of NOx reduction of the proposed NOx emission standards. Chapter 7 of the Draft Regulatory Support Document contains a more detailed discussion of the cost per ton analysis. The calculated cost per ton of the proposed emission standard presented here includes all of the anticipated effects on costs and emission reductions.

1. Tier 1 cost per ton

The proposed Tier 1 standards are equivalent to the MARPOL Annex VI standards. Because engines already comply with the MARPOL Annex VI standards, we not claiming any benefits or costs to meet the EPA proposed Tier 1 standards.

2. Tier 2 cost per ton

To determine the cost per ton of NOx reduction of the proposed Tier 2 emission standards, we only considered benefits beyond those achieved by the MARPOL Annex VI standards. Table VI.C-1 presents the cost per ton of the proposed Tier 2 standards for U.S. flagged Category 3 marine engines. By weighting the projected cost and emission benefit numbers presented above by the populations, we also calculated the aggregate cost per ton of NOx reduced for Category 3. The net present value (NPV) of the costs and emissions reductions shown here are discounted at a rate of 7 percent per year. For comparison, estimates are also presented here for applying these standards to foreign flagged vessels as well. These cost per ton estimates are higher because only emission reductions within 175 nautical miles of the U.S. coast are considered and foreign flagged vessels have less operation near the U.S. than U.S. flagged vessels.

Table VI.C-1
Cost Per Ton of the Proposed Marine Tier 2 Standards for NOx.

Model Year Grouping	NPV Benefits per Ship (short tons)	NPV Operating Costs Per Ship	Engine & Vessel Costs Per Ship	Discounted Cost Per Ton
U.S. Flagged Vessels Only (proposed)				
1 to 5	1,150	$66,000	$110,000	$141
6 +			$36,000	$85
All Vessels (for comparison)				
1 to 5	73	$66,000	$47,000	$1,468
6 +			$36,000	$1,337

The costs and reductions presented in the above table are based on an 11,000 kW engine which, as discussed in Chapter 7 of the draft RSD, we believe represents the average sized engine visiting U.S. ports. An engine of this size would cost about 2.5 to 3.0 million dollars. It would be used in a vessel which would cost about $100-200 million dollars to construct. Therefore, the $176,000 cost estimate of engine improvements represents about 0.1 percent of the total vessel cost.

3. Comparison to other programs

In an effort to evaluate the cost per ton of the NOx controls discussed above for Category 3 marine engines, we looked at the cost per ton for other recent EPA mobile source rulemakings that required reductions in NOx (or NMHC+NOx) emissions. Our final standards for Category 1 and 2 marine engines yielded a cost per ton of $24-$180 per ton of HC+NOx reduced. In contrast, the 2007 standards for highway heavy-duty engines yielded a cost per ton of approximately $1600-$2100 per ton of NMHC+NOx. The rulemaking proposed in this document has a low cost-per-ton value compared other mobile source programs. Chapter 7 presents additional cost-per-ton estimates for comparison with the Draft Regulatory Support Document.

D. What are the estimated health and environmental benefits for this proposal?

In addition to the benefits of reducing ozone within and transported into urban ozone nonattainment areas, the NOx reductions from the new standards are expected to have beneficial impacts with respect to crop damage from ozone reductions, secondary particulate formation, acid deposition, eutrophication, visibility, and the viability and diversity of species in forests. These effects are described in more detail in Section II-B and in Chapter 2 of the Draft Regulatory Support Document.

We are not able to quantify or monetize the benefits at this time due to a lack of emissions inventories that would locate the emissions in specific ports, lack of appropriate national air quality modeling systems that can be used in marine settings, and lack of time to develop such techniques. Nevertheless, in certain ports with high traffic in U.S. flagged Category 3 marine vessels could experience significant benefits.

E. What would be the impacts of a low sulfur fuel requirement?

As discussed above in section IV, we are requesting comment on low sulfur fuel requirements. This analysis looks at two approaches to meeting a cap of 15,000 ppm S beginning in 2007. The first approach is to use a low sulfur marine distillate oil which would likely be a blend of residual fuel and distillate fuel. The second approach would be to used number 2 diesel fuel (3000 ppm S) such as used in land-based applications today. These two approaches provide a range of costs and benefits that could be achieved by requiring the use of low sulfur fuel. For the purpose of this analysis, we only include the operation of ships within 175 nautical miles of the U.S. coast which is where we believe emissions will have the most significant impact on U.S. air quality.

1. Cost and economic impacts

Many ships are already equipped to operate on either distillate or residual fuel. Using any sort of distillate fuel for all operation near the U.S. coast could result in additional hardware costs. These costs would for modifications to the fuel plumbing and storage associate with longer periods of operation on distillate fuel. The cost of the using marine diesel oil would be about 60 percent higher than for the higher sulfur residual fuel. The cost of the number 2 diesel would be about twice the cost of operating on residual fuel. Table VI.E-1 presents the discounted lifetime costs for either using 15,000 ppm S or 3,000 ppm S fuel on all ships operating within 175 nautical miles of the U.S. coast.

Table VI.E-1

Estimated Average Per Engine Cost Increases for Alternative Approaches

Fuel Used	Increased Hardware Costs	Increased Operating Costs
15,000 ppm S residual fuel	$50,000	$139,000
3,000 ppm S distillate fuel	$50,000	$273,000

2. Environmental impacts

For the 1.5 percent sulfur residual fuel scenario, our estimates of SOx and PM reductions are based strictly on the reduction of sulfur in the fuel from 27,000 to 15,000 ppm. In this case by itself, no NOx reductions are anticipated. Table VI.E-2 presents the emission reductions due to using this low sulfur fuel for all operation of U.S. and foreign vessels within 175 nautical miles of the U.S. coast. However, as discussed in section IV.D, there are some issues regarding how we might enforce such a fuel requirement for all operation within 175 nautical miles of the U.S. coast.

Table VI.E-2
Projected Category 3 Emissions Inventories for Switching to 15,000 ppm S Fuel

		1996	2010	2020	2030
PM	Baseline case (thousand short tons)	17.1	26.0	36.7	54.2
	Control case (thousand short tons)	17.1	21.3	30.1	44.5
	Percent reduction from baseline	--	18	18	18
SOx	Baseline case (thousand short tons)	156.2	192.8	271.2	399.7
	Control case (thousand short tons)	156.2	108.0	151.9	223.9
	Percent reduction from baseline	--	44	44	44

For the distillate fuel case, our estimates of SOx reductions are based on a reduction of sulfur in the fuel from 2.7 to 0.3 percent. Our estimates of PM reductions are based on changes in several fuel components. We estimate that PM from a marine engine operating on residual fuel is made up of 45 percent sulfate, 25 percent carbon soot, 20 percent ash, and 10 percent soluble organic hydrocarbons. Reducing sulfur in the fuel would reduce direct sulfate PM by about 90 percent. In addition, if distillate fuel is used, the ash content and the density of the fuel would be reduced. This analysis results in a total per vessel PM reduction of 63 percent. Using residual fuel can lead to NOx increases due to nitrogen in the fuel. For this analysis we use a per vessel NOx reduction of ten percent based on a reduction of nitrogen in the fuel. Table VI.E-3 presents the potential SOx, PM, and NOx reductions from using distillate fuel for all Category 3 vessel operations.

Table VI.E-3
Projected Category 3 Emissions Inventories for Switching to 3,000 ppm S Fuel

		1996	2010	2020	2030
NOx	Baseline case (Annex VI - thousand short tons)	190.0	274.1	367.5	530.8
	Control case (thousand short tons)	190.0	246.7	330.7	477.7
	Percent reduction from Annex VI baseline	--	10	10	10
PM	Baseline case (thousand short tons)	17.1	26.0	36.7	54.2
	Control case (thousand short tons)	17.1	9.6	13.6	20.1
	Percent reduction from baseline	--	63	63	63
SOx	Baseline case (thousand short tons)	156.2	192.8	271.2	399.7
	Control case (thousand short tons)	156.2	21.2	29.8	44.0
	Percent reduction from baseline	--	89	89	89

The reductions of SOx and fine PM emissions from this alternative both within port and transported into urban areas are expected to have beneficial impacts with respect to PM-related cancer and non-cancer health effects, acid deposition, eutrophication, visibility. These effects are described in more detail in Section II-B and in Chapter 2 of the Draft Regulatory Support Document.

We are not able to quantify or monetize the benefits at this time due to a lack of emissions inventories that would locate the emissions in specific ports, lack of appropriate national air quality modeling systems that can be used in marine settings, and lack of time to develop such techniques. Nevertheless, in certain ports with high traffic in U.S. flagged Category 3 marine vessels could experience significant benefits from SOx and PM reductions.

3. Cost per ton

We estimated the cost per ton of both 15,000 ppm sulfur residual fuel and 3,000 ppm sulfur distillate fuel. For this analysis, we consider operation of all ships within 175 nautical miles of the U.S. coast. In determining the cost per ton, we apportion the costs between reductions in PM and SOx emissions. One approach would be to apply all of the costs to PM and consider the SOx reductions to come at no additional cost; however, we recognize that there is benefit to reducing both PM and SOx. Therefore, we apply 10 percent of the cost to SOx reductions. No costs are applied to NOx control, so a cost per ton value is not presented.

Table VI.E-4
Cost Per Ton of a Low Sulfur Fuel Requirement

Pollutant	NPV of total lifetime costs per ship	NPV of tons reduced per ship	Discounted cost per ton
Residual fuel with 15,000 ppm sulfur			
PM	$170,000	4.3	$38,000
SOx	$19,000	61	$302
Distillate fuel with 3000 ppm sulfur			
PM	$291,000	8.7	$33,000
SOx	$32,000	121	$262

VII. Other Approaches We Considered

A. Standards Considered

Earlier in this preamble we discuss two tiers of proposed standards for new Category 3 marine engines. The first tier is equivalent to the MARPOL Annex VI NOx limits to which manufacturers have recently begun designing their engines. The second tier is 30 percent below this Tier 1 limit; we anticipate that this standard can be met relatively soon using in-cylinder controls. This section discusses two other approaches we considered when developing this proposal and presents our analysis of the feasibility and impacts of setting such standards. We considered alternative NOx emission standards 50 and 80 percent below Annex VI levels. Under either of these scenarios, additional lead time beyond 2007 may be necessary; however, in this discussion, we consider a 2007 implementation date for our analysis of the alternative approaches so that a direct comparison can be made to the proposed Tier 2 standard. Our analysis of alternative approaches applies equally to U.S. and foreign vessels. Also, if we were to adopt either of these alternative standards, all the provisions for certifying engines described in Section V would apply. However, as described below, we believe it is not appropriate to set standards for Category 3 marine engines based on these approaches at this time, due to remaining technological and operational issues. However, we may consider these approaches as the basis of new standards in the future.

1. NOx level 50 percent below Tier 1

One alternative to the proposed Tier 2 standard that we considered was an emission level one-half of the MARPOL limits. We believe reductions of this order could be achieved by introducing water into the combustion process. Water can be used in the combustion process to lower maximum combustion temperature, and therefore lower NOx formation, with an insignificant increase in fuel consumption. Water has a high heat capacity, which allows it to absorb enough of the energy in the cylinder to reduce peak combustion temperatures. Data presented below and in Chapter 8 of the Draft Regulatory Support Document suggest that a 30 to 80 percent NOx reduction can be achieved depending on ratio of water to fuel and on the method of introducing water into the combustion chamber. This data is primarily based on developmental engines; however, given enough lead time, we believe that introducing water into the combustion process may become an effective emission control strategy.

Water may be introduced into the combustion process through emulsification with the fuel, direct injection into the combustion chamber, or saturating the intake air. Water emulsification refers to mixing the fuel and water prior to injection. This strategy is limited due to instability of suspending water in fuel. To increase the effective stability, a system can be used that emulsifies the water into the fuel just before injection. Another option is to stratify the fuel and water through a single injector. The Draft Regulatory Support Document presents data on these approaches showing a 30-40 percent reduction in NOx with water fuel ratios ranging from 0.3 to 0.4.

More effective control of the water injection process can be achieved through the use of an independent nozzle for water. Using a separate injector nozzle for the water allows larger amounts of water to be added to the combustion process because the water is injected simultaneously with the fuel, and larger injection pumps and nozzles can be used for the water injection. In addition, the fuel injection timing and the amount of water injected can be better optimized. Data presented in the Draft Regulatory Support Document show NOx reductions of 40 to 70 percent with water-to-fuel ratios ranging from 0.5 to 0.9 if a separate nozzle is used for injecting water.

Other strategies for introducing water into the combustion process are being developed that will allow much higher water to fuel ratios. These strategies include combustion air humidification and steam injection. With combustion air humidification, a water nozzle is placed in the engine intake and an air heater is used to offset condensation. With steam injection, waste heat is used to vaporize water which is then injected into the combustion chamber during the compression stroke. Data on initial testing, presented in the Draft Regulatory Support Document, show NOx reductions of more than 80 percent with water to fuel ratios as high as 3.5.

Fresh water is necessary for any of these water-based NOx-reduction strategies. Introducing salt water into the engine could result in serious deterioration due to corrosion and fouling. For this reason, a ship using water strategies would need to either produce fresh water through the use of a desalination or distillation system or store fresh water on board. Cruise ships may already have a source of fresh water that could be used to enable this technology. This water source is the "gray" water, such as drainage from showers, which could be filtered for use in the engine. However, the use of gray water would have to be tested on these engines, and systems would have to be devised to ensure proper filtering. For example, it would be necessary to ensure that no toxic wastes are introduced into the gray waste-water stream. One manufacturer stated that today's ships operating with direct water injection carry the amount needed to operate the system between ports (two to four days).

Depending on the amount of water necessary, other vessels that use Category 3 marine engines may not be able to generate sufficient amounts of gray water for this technology. These ships would have to carry the water or be outfitted with new or larger distillation systems. Both of these options would displace cargo space. Finally, it should be noted that vessels that are currently equipped with water-based NOx reduction technologies are four-stroke engines and include fast ferries, cruise ships and cargo ships. The specific vessels travel relatively short distances between stops and need a much smaller volume of fresh water for a trip than would be required for crossing an ocean. More information is needed regarding operation on ocean-going vessels before this technology could be used as the basis for a NOx emission standard. If the ships were only to use this technology traveling from 175 nautical miles of the U.S. coast to port, less water storage capacity would be needed than if the ship used this NOx reduction strategy at all times. However, ships operating primarily within 175 nautical miles of the U.S. coast would need to be able to carry a volume of water of about one-half the volume of fuel they carry if they wish to keep the same refueling schedule. Ships making long runs, such as from California to

Alaska, would have to be able to store enough water for that trip even if they make it infrequently. Lastly, if this technology were applied to two-stroke engines there may be lubricity concerns with the cylinder liner. One manufacturer is developing a strategy to use DWI with EGR to minimize water requirements on such engines.

Durability issues may be a concern with water emulsification or injection systems. For onboard water emulsifying units, cavitation is used to atomize the water and mix it into the fuel. Although this works well at emulsifying the fuel, the water can cause significant wear of the injection pump. For water injection systems, high pressure water is injected similar to in a fuel injector. However, water does not have the inherent lubrication properties found in fuel. Therefore, more research may be necessary on more durable materials.

Another concern with the use of water in the combustion process is the effect on PM emissions. The water in the cylinder reduces NOx, which is formed at high temperatures, by reducing the temperature in the cylinder during combustion. However, PM oxidation is most efficient at high temperatures. At this time, we do not have sufficient information on the effect of water emulsification and injection strategies on PM emissions to quantify this effect. We request information on the effect of using water in the combustion process on PM emissions.

For these reasons we believe it is premature to set a standard based on water-based technologies at this time. We request comment on this approach.

2. NOx level 80 percent below Tier 1

The other alternative we considered to the proposed Tier 2 standard was an emission level 80 percent below the MARPOL limits. We believe reductions of this order could be achieved through the use of selective catalytic reduction. Selective catalytic reduction (SCR) is one of the most effective means of reducing NOx from large diesel engines. In SCR systems, a reducing agent, such as ammonia, is injected into the exhaust and both are channeled through a catalyst where NOx emissions are reduced. As discussed in the draft RSD, SCR can be used to reduce

NOx emissions by more than 90 percent at exhaust temperatures above 300°C. These systems are being successfully used for stationary source applications, which operate under constant, high load conditions. These systems are also being used in Category 3 engines used on ferries and cruise ships where they operate largely at high loads and over short distances so exhaust temperature and urea storage are not primary issues.

Several issues exist before application of this technology to all Category 3 engines can be deemed feasible. Issues include temperature at low load for SCR effectiveness, use of low sulfur fuel for system durability, space required for the SCR unit and urea storage, availability of regular down time for repair, availability of urea at ports, and application to slow-speed engines.

SCR systems available today are effective only over a narrow range of exhaust temperatures (above 300°C). To date, these systems have primarily been applied to four-stroke medium speed engines which have exhaust temperatures above 300°C at least at high load. Two-stroke slow speed engines have lower exhaust temperatures and are discussed later. The effectiveness of the SCR system is decreased at reduced temperatures exhibited during engine operation at partial loads. Most of the engine operation in and near commercial ports and waterways close to shore is likely to be at these partial loads. In fact, reduced speed zones can be as large as 100 miles for some ports. Because of the cubic relationship between ship speed and engine power required, engines may operate at less than 25 percent power in a reduced speed zone. During this low load operation, no NOx reduction would be expected, therefore SCR would be less effective than the proposed Tier 2 standards during low load operation near ports. Some additional heat to the SCR unit can be gained by placing the reactor upstream of the turbocharger; however, this temperature increase would not be large at low loads and the volume of the reactor would diminish turbocharger response when the engine changes load. The engine could be calibrated to have higher exhaust temperatures; however this could affect durability (depending on the fuel used) if this calibration also increased temperatures at high loads. For an engine operating on residual fuel, vanadium in the fuel can react with the valves at higher temperatures and damage the valves.

SCR systems traditionally have required a significant amount of space on a vessel; in some cases the SCR was as large as the engine itself. However, at least one manufacturer is developing a compact system which uses an oxidation catalyst upstream of the reactor to convert some NO to NO_2 thus reducing the reactor size necessary. The reactor size is reduced because the NO_2 can be reduced without slowing the reduction of NO. Therefore, the catalytic reaction is faster because NOx is being reduced through two mechanisms. This compact SCR unit is designed to fit into the space already used by the silencer in the exhaust system. If designed correctly, this could also be used to allow the SCR unit to operate effectively at somewhat lower exhaust temperatures. The oxidation catalyst and engine calibration would need to be optimized to convert NO to NO_2 without significant conversion of S to direct sulfate PM. NOx reductions of 85 to 95 percent have been demonstrated with an extraordinary sound attenuation of 25 to 35 dB(A).[56]

Information from one manufacturer who has 40 installations of SCR reveals that the engines using the technology are either using low sulfur residual fuel (0.5%-1% S) or distillate fuel. Low sulfur residual fuel is available in areas which provide incentives for using such fuel, including the Baltic Sea, however such fuel is not yet available at ports throughout the United States. However, distillate fuel is available. Low sulfur fuel is necessary to assure the durability of the SCR system because sulfur can become trapped in the active catalyst sites and reduce the effectiveness of the catalyst. This is known as sulfur poisoning which can require additional maintenance of the system. The operation characteristics of ocean going vessels may interfere with correct maintenance of the SCR system. Ferries which have incorporated this technology to date do not run continuously and therefore any maintenance necessary can be performed during regular down times. The availability of time for repair can be an issue for ocean going vessels for they do not have regular down times.

Sulfur in fuel is also a concern with an oxidation catalyst because, under the right

[56] Paro, D., "Effective, Evolving, and Envisaged Emission Control Technologies for Marine Propulsion Engines," presentation from Wartsila to EPA on September 6, 2001.

conditions, sulfur can also be oxidized to form direct sulfate PM. At higher temperatures, up to 20 percent of the sulfur could be converted to direct sulfate PM in an oxidation catalyst compared to about a 2 percent conversion rate for a typical diesel engine without aftertreatment. Depending on the precious metals used in the SCR unit, it could be possible to convert some sulfur to direct sulfate PM in the reactor as well. Manufacturers would have to design their exhaust system (and engine calibration) such that temperatures would be high enough to have good conversion of NO, but low enough to minimize conversion of S to direct sulfate PM. Direct sulfate PM emissions could be reduced by using lower sulfur fuel such as distillate.

A vessel using a SCR system would also require an additional tank to store ammonia (or urea to form ammonia). This storage tank would be sized based on the vessel use, but could be large for a vessel that travels long distances in U.S. waters between refueling such as between California and Alaska. The urea consumption results in increased operating costs. Also, if lower sulfur diesel fuel were required to ensure the durability of the SCR system or to minimize direct sulfate PM emissions, this lower sulfur fuel would increase operating costs. For SCR to be effective, an infrastructure would be necessary to ensure that ships could refuel at ports they visit. We believe that it would take some time to set up a system for getting fuel to ships that fill up using barges, especially if the standard were only to apply to U.S. flagged ships due to the low production volume. In addition, a ship that operates outside the U.S. for several months (or years) would have to ensure that it has urea available for any visits to U.S. ports.

Because SCR units are so easily adjustable, ship operators may chose to turn off the SCR unit when not operating near the U.S. coast. If they were to use this approach, they would need to construct a bypass in the exhaust to prevent deterioration of the SCR unit when not in use. To ensure that the SCR system is operating properly within 175 nautical miles of the U.S. coast, we would need to consider continuous monitoring of NOx emissions for engines using SCR. Discussions of equipment and procedures for continuous monitoring are currently under discussion by IMO in the context of Annex VI.

If the combustion is not carefully controlled, some of the ammonia can pass through the combustion process and be emitted as a pollutant. This is less of an issue for Category 3 marine engines, which generally operate under steady-state conditions, than for other mobile-source applications. In addition, in ships where banks of engines are used to drive power generators, such as cruise ships, the engines generally operate under steady-state conditions near full load. If ammonia slip still occurred, an oxidation could be used downstream of the reactor to burn off the excess ammonia.

Slow-speed marine engines generally have even lower exhaust temperatures than medium speed engines due to their two-stroke design. However, we are aware of four slow-speed Category 3 marine engines that have been successfully equipped with SCR units. Because of the low exhaust temperatures, the SCR unit is placed upstream of the turbocharger to expose the catalyst to the maximum exhaust heat. Also, the catalyst design required to operate at low temperatures is very sensitive to sulfur. Especially at the lower loads, the catalyst is easily poisoned by ammonium sulfate that forms due to the sulfur in the fuel. To minimize this poisoning on these four in-service engines, highway diesel fuel (0.05% S) is required. In addition, these ships only operate with the exhaust routed through the SCR unit when they enter port in the U.S. which is about 12 hours of operation every 2 months. Therefore, the sulfur loading on the catalyst is much lower than it would be for a vessel that continuously used the SCR system. To prevent damage to the catalyst due to water condensation, this system needs to be warmed up and cooled down gradually using external heating. Another issue associated with the larger slow-speed engines and lower exhaust temperatures is that a much larger SCR system would be necessary than for a vessel using a smaller medium-speed engine. Size is an issue because of the limited space on most ships.

We believe that more time is necessary to resolve the issues discussed above for the application of SCR to Category 3 marine engines. Therefore, we are not proposing to set a standard at this time that would require the use of a SCR system. However, given enough lead time, we believe that manufacturers will be able to refine their designs for efficiency, compactness, and cost. Therefore, we believe that SCR may be available for widespread application with Category 3 marine engines in the future, and we will consider this technology as the basis of future standards. We are also including this technology in our Blue Cruise program because of the potential large NOx reductions and because this technology may be an attractive NOx control strategy for cruise ship which use banks of engines generally operating at high load. Because cruise ships make frequent stops on regular routes, they should be able to coordinate a workable urea supply strategy. We request comment on using SCR technology on ocean-going vessels and on setting voluntary standards based on SCR technology.

A second approach for meeting an 80 percent reduction in NOx emissions would be to use fuel cells to power the vessel in place of an internal combustion engine. A fuel cell is like a battery except where batteries store electricity, a fuel cell generates electricity. The electro-chemical reaction taking place between two gases, hydrogen and oxygen generate the electricity from the fuel cell. The key to the energy generated in a fuel cell is that the hydrogen-oxygen reaction can be intercepted to capture small amounts of electricity. The byproduct of this reaction is the formation of water. Current challenges include the storage or formation of hydrogen for use in the fuel cell and cost of the catalyst used within the fuel cell.

Over the past 5 years several efforts to apply fuel cells to marine applications have been conducted. These include grants from the Office of Naval Research and the U.S. Navy. The Office of Naval Research initiated a three-phase advanced development program to evaluate fuel cell technology for ship service power requirements for surface combatants in 1997. The U.S. Navy which in early 2000 sponsored an effort to continue the development of the molten carbonate fuel cell for marine use. The Society of Naval Architects and Marine Engineers released the technical report "An Evaluation of Fuel Cells for Commercial Ship Applications." The report examines fuel cells for application in commercial ships of all types for electricity generation for ship services and for propulsion.

Fuel cell research is currently supported by several sources. including the U.S. Maritime Administration (MARAD) and the state of California's Fuel Cell Partnership. MARAD's Division of Advanced Technology has also included the topic of fuel cells as a low air emission technology that should be demonstrated. California's Fuel Cell Partnership seeks to achieve four main goals which include 1) Demonstrate vehicle technology by operating and testing the vehicles under real-world conditions in California; 2) Demonstrate the viability of alternative fuel infrastructure technology, including hydrogen and methanol stations; 3) Explore the path to commercialization, from identifying potential problems to developing solutions; and 4) Increase public awareness and enhance opinion about fuel cell electric vehicles, preparing the market for commercialization.

At this time, we consider fuel cell technology is still be in the early stages of development. We recognize that a mature fuel cell system could have significant environmental benefits and we will consider this technology in the future. We request comment on the feasibility of using fuel cells for power on marine vessels.

B. Potential Impacts of the Regulatory Alternatives

1. Costs

The following analysis presents estimated cost increases for Category 3 marine engines and vessels that would be associated with the alternative standards (see Table VII.B-1). This cost analysis follows the same methodology outlined above (VI.A) and described in more detail in the Draft Regulatory Support Document. For the 50 percent below Tier 1 case, hardware costs include water injectors, plumbing, and water storage. Operating costs include water and a small fuel oil consumption penalty. For the 80 percent below Tier 1 case, hardware costs include the cost of the SCR unit and operating costs include the cost of the urea. In the analysis of these two scenarios, we only include the operation of ships where we believe emissions will have the most significant impact on U.S. air quality. The entire increased production cost is therefore included, but the increased operating costs are only considered for operation within 175 nautical miles of the U.S. coast. These costs are based on year 1 (no learning curve adjustment) and are discounted at a rate of seven percent to present the net present value.

Table VII.B-1 presents our cost estimates for applying the standards to U.S. flagged vessels only and for applying the standards to all vessels operating within 175 nautical miles of the U.S. coast. When applying the costs to all vessels, the production costs decrease because the development costs are spread among more engines; operating costs decrease because the average vessel spends less time operating near the U.S. coast than the average U.S. flagged vessel. For water injection, the operating costs include the effective cost of the water. For SCR, the operating costs include urea consumption as well as ship operation on 0.05 percent sulfur fuel. These costs are for an average sized Category 3 marine engine which would cost about 2.5 to 3.0 million dollars. For the 50 percent below Tier 1 case, the increased production costs range from 3 to 6 percent of the cost of the engine. For the 80 percent below Tier 1 case, the increased production costs range from 20 to 25 percent of the cost of the engine.

Table VII.B-1
Estimated Average Cost Increase Per Ship for Alternative NOx Standards

Alternative Standard	Increased Production Costs per Ship (thousand $)	Increased Operating Costs per Ship (thousand $)
US Flagged Vessels Only		
50% below Tier 1	$167	$527
80% below Tier 1	$1,127	$9,671
All Vessels		
50% below Tier 1	$83	$95
80% below Tier 1	$935	$675

2. Reductions

We use the same methodology to model emissions inventories for the alternative approaches as we used for the proposed Tier 2 standards. This is outlined earlier in the preamble (VI.B) and described in more detail in the Draft Regulatory Support Document. Table VII.B-2 presents our estimates of Category 3 vessel emission reductions possible through the alternative standards applied only to U.S. flagged vessels. Table VII.B-3 presents our estimates of Category 3 vessel emission reductions possible through the alternative standards applied to all Category 3 vessels. As with for the cost analysis, we only include operation within 175 nautical miles of the U.S. coast, so only the emission reductions in that area are presented below.

Table VII.B-2
Projected Category 3 NOx Reductions for Alternative Approaches
Applied to U.S. Flagged Vessels

		1996	2010	2020	2030
Tier 1	Control case (thousand short tons)	190.0	274.1	367.5	530.8
50% below Tier 1	Control case (thousand short tons)	190.0	265.6	326.8	439.1
	Percent reduction from Tier 1	--	3.1	11.1	17.3
80% below Tier 1	Control case (thousand short tons)	190.0	260.4	301.9	382.9
	Percent reduction from Tier 1	--	5.0	17.8	27.9

Table VII.B-3
Projected Category 3 NOx Reductions for Alternative Approaches
Applied to All Vessels

		1996	2010	2020	2030
Tier 1	Control case (thousand short tons)	190.0	274.1	367.5	530.8
50% below Tier 1	Control case (thousand short tons)	190.0	260.7	276.9	311.2
	Percent reduction from Tier 1	--	4.9	24.7	41.4
80% below Tier 1	Control case (thousand short tons)	190.0	252.5	221.4	176.7
	Percent reduction from Tier 1	--	7.9	39.8	66.7

3. Cost per ton

To determine the cost per ton of NOx reduction of the proposed Tier 2 emission standards, we considered only benefits beyond those achieved by the Tier 1 standards (equivalent to the Annex VI standards). Although the Annex VI standards are not yet effective, manufacturers around the world are generally producing compliant engines and we expect this to continue. Thus, we are using the proposed Tier 1 standards as the baseline, and showing the benefits of the proposed Tier 2 standards relative to this baseline. Table VII.B-4 presents the cost per ton of the alternative standards using the same methodology discussed for the proposed Tier 2 standards above. For this analysis, we considered all costs incurred and emission reductions achieved within 175 nautical miles of the U.S. coast. The cost estimates presented here do not include future reductions in cost due to the learning curve. Both costs and benefits are discounted at a rate of seven percent.

In addition, this analysis presents estimates both for applying the alternative standards just to U.S. flagged and for applying the alternative NOx standards to all vessels operating in U.S. waters. By including foreign flagged vessels under these alternative approaches, the cost per engine decreases because the development costs can be distributed across more engines. However, the cost per ton actually increases because U.S. flagged vessels spend about 16 times more of their operating time within 175 nautical miles of the U.S. coast than foreign flagged vessels. Therefore, the tons of NOx reduced per year in U.S. waters for an average foreign flagged vessel (which make up about 97 percent of the vessels) are lower. Operating costs included in this analysis would still be proportional to the amount of time the ship operates within 175 nautical miles of the U.S. coast.

Table VII.B-4
Cost Per Ton of the Alternative NOx Control Approaches

Approach	NPV of total lifetime costs (thousand $) per ship	NPV of NOx tons reduced per ship	Discounted cost per ton
US Flagged Vessels Only			
50% below Tier 1	$694	1,915	$352
80% below Tier 1	$10,798	3,064	$3,480

All Vessels			
50% below Tier 1	$178	122	$1,382
80% below Tier 1	$1,611	195	$7,692

C. Conclusions

We considered two alternative approaches to the proposed Tier 2 NOx standard of 50 and 80 percent below Tier 1.

For a 50-percent reduction, we considered water injection with 0.5 water to fuel ratio. At the present time, the cost per ton for the water injection system ranges from $352 to $1,382 depending on if it applies to U.S. flagged vessels only or all vessels operating within 175 nautical miles of the U.S. coast. This analysis does not consider the lost space on a vessel due to water storage, nor does it consider the alternative of using a water distillation or desalination system. Water storage would either displace fuel storage and reduce the range of the vessel or reduce cargo space which would affect the money generated per cruise. In addition, more information is necessary on the effects of this technology on PM emissions. Although this technology may be more attractive in the future, we have decided not to propose standards at this level at this time due to the water storage issues as well as the development time of advances in this technology to address lubricity concerns in the cylinder liners of two-stroke engines.

For the 80 percent NOx reduction case, we considered the use of selective catalytic reduction with a urea consumption rate of about 8 percent of the fuel consumption rate. Our estimated cost per ton for this approach ranges from $3,480 to $7,692 depending on if it applies to U.S. flagged vessels only or all vessels operating within 175 nautical miles of the U.S. coast. This is considerably higher than the cost per ton figures for the recent mobile source programs presented in Chapter 7 of the Draft RSD. The cost per ton estimate for the use of SCR includes the cost of using lower sulfur fuel which we believe would be necessary for the durability of the system and to prevent increases in direct sulfate PM. In the future, however, technological advances increase the effectiveness of these units at lower temperatures and may reduce the cost of this system.

For SCR to be effective, an infrastructure would be necessary to ensure that ships could refuel at ports they visit. We believe that it would take some time to set up a system for getting fuel to ships that fill up using barges, especially if the standard were only to apply to U.S. flagged ships due to the low production volume. SCR would require space for urea storage, but it would likely be much less than that for water storage in the above approach because the volume of urea needed is only 5-10 percent of the volume of water needed for the water injection case considered above. In addition, at least one manufacturer is developing a compact SCR unit that will minimize the space needed for this system. As with water injection, we believe SCR may be appropriate for certain applications, but also believe that the remaining technology development and system cost prevent us from expecting manufacturers to apply SCR to all Category 3 marine engines at this time. We are therefore proposing to designate 80-percent reductions as a target for recognition as voluntary low-emission engines, rather than adopting mandatory standards based on this technology.

D. Speed-based vs. Displacement-based Emission Standards

Annex VI specifies the NOx emission standard as a function of engine speed. The shape of this curve was established with a mathematical relationship based on available emission data showing uncontrolled NOx emission rates as a function of maximum engine speed. The numerical level of the standard was set based on a fixed percentage reduction relative to uncontrolled emission levels. The shape of the curve generally allows for higher emissions from larger engines, which tend to operate at slower speeds. On the other hand, a given percentage reduction for all engine sizes yields greater brake-specific emission reductions from larger engines, with greater percentage reductions flattening the curve.

This speed-based approach to setting standards has several advantages. It reflects the inherent tendency of larger (and slower-speed) engines to have higher NOx-formation rates. It correspondingly reflects the challenges facing the design engineer to apply technology to reduce emissions. While maximum engine speeds can vary somewhat for a given engine, this parameter provides an effective correlation to an engine's emissions behavior. This is borne out by the emission data showing the trend of emissions as a function of engine speed on which the Annex VI NOx curve is based. Also, defining the emission standard as a formula instead of setting different standards for discrete ranges prevents any complications related to step changes in the standard at any particular engine speed.

While we believe it is appropriate for the proposed emission standards to be consistent with the Annex VI formula, this approach raises two issues that may become significant in the future. First, maximum engine speed is a design variable that can be set by the manufacturer based on an engine's particular application or a shipowner's preference. Under the speed-based formula, a manufacturer selling two otherwise identical engines may install them in different vessels that call for differing engine-speed ratings, which would allow the manufacturer to produce the engines to operate at different emission levels. For a given engine, it's not clear that emission standards should allow a higher emission level for engine installations that call for a lower speed rating. Table VII.D-1 shows the effect of speed rating on the applicable emission standard for selected engine models that are currently available. For some engines, varying engine speed causes a difference in the NOx standard of over 0.5 g/kW-hr.

Table VII.D-1
Effect of Engine Speed on Emission Standards for Selected Engines

Engine	Speed 1 (rpm)	Standard 1 (g/kW-hr)	Speed 2 (rpm)	Standard 2 (g/kW-hr)	difference (g/kW-hr)	Percent increase

Engine	Speed 1 (rpm)	Standard 1 (g/kW-hr)	Speed 2 (rpm)	Standard 2 (g/kW-hr)	difference (g/kW-hr)	Percent increase
1	111	17.0*	148	16.6	0.4	2.6%
2	132	16.9	176	16.0	0.9	5.9%
3	212	15.4	250	14.9	0.5	3.4%
4	330	14.1	360	13.9	0.2	1.8%
5	720	12.1	1000	11.3	0.8	6.8%

*The NOx formula would allow for emissions up to 17.5 g/kW-hr for an engine speed of 111 rpm, but Annex VI caps the NOx standard at 17 g/kW-hr for engines with rated speed below 130 rpm.

The second concern with a speed-based emission standard is that future emission-control technologies may allow for more effective control of NOx emissions at slow engine speeds. This would allow for a "flatter" NOx curve, or even a single NOx standard that would apply for all Category 3 engines, regardless of speed rating. It would not be appropriate to allow for higher emissions on low-speed engines if an emission-control technology enables a flatter relationship between NOx emissions and engine speed. This will become especially important if or when there is a need to adopt PM emission standards, since PM emissions are unlikely to follow the same relationship to engine speed as for NOx emissions.

The alternative approach to defining emission standards would be to follow the approach in EPA's December 1999 rulemaking for Category 1 and Category 2 marine engines. Defining emission standards based on an engine's specific displacement (in liters per cylinder) would provide a clear and discrete emission standard for each engine. Table IV.D-2 shows a variety of typical engine sizes and engine-speed values correlated with the proposed Tier 2 NOx standards that would apply to each engine. A straightforward regression of specific displacement values and the Tier 2 NOx levels shows a good correlation using the following simple formula:

$$\text{NOx} = 0.0047 \times (\text{L/cyl}) + 9.9$$

The calculated value using this formula is within 0.1 g/kW-hr across the range of engines shown in Table IV.D-2. Most two-stroke engines operate at less than 130 rpm and are therefore subject to the capped standard that doesn't vary with engine speed. The table therefore includes no two-stroke engines. Many of these slow-speed engines, however, have specific displacements between 100 and 300 L/cyl. To implement a displacement-based standard that parallels the Annex VI approach, we would need to apply a Tier 2 emission standard of 13.3 g/kW-hr to all two-stroke (or slow-speed) engine, while using the above equation to define the emission standard for four-stroke engines. On the other hand, it may be more appropriate to adopt standards reflecting the relative power output of the slow-speed engines. Slow-speed engines generally produce about half as much power as medium-speed engines for a given displacement, so we could set comparable standards by using the displacement-based formula above, but dividing the displacement term by two for slow-speed engines. This would take into account the lower specific power from slow-speed engines, resulting in comparable standards for competing engines with similar total power output.

Table IV.D-2
Values Related to Displacement-based Standards*

Engine Model	Engine speed (rpm)	Per-Cylinder displacement (L)	Proposed Tier 2 Standard	Tier 2 standard using displacement formula
Niigata 34HX	600	41	10.2	10.1
MAN B&W L48/60	514	109	10.4	10.4
MAN B&W PC4.2B	430	168	10.8	10.7
Wärtsilä 64	400	225	10.9	11.0
Wärtsilä 64 (longer stroke)	330	290	11.3	11.3
–	130	700**	13.3	13.2**

*Source: Diesel and Gas Turbine Worldwide Catalog, 2001.
**extrapolation.

The near-term adoption of emission standards equivalent to the Annex VI standards would not allow for restructuring emission standards based on displacement. It is also not clear that the advantages of displacement-based standards would warrant departing from the approach established internationally in the near term. We request comment on the appropriateness of adopting a displacement-based NOx standard. We also request comment regarding the above formula and table of values and their use in establishing Tier 2 NOx standards. We specifically request comment on whether the projected Tier 2 emission-control technologies would be expected to follow the trends implicit in the Annex VI formula. Finally, we request comment on the appropriateness of basing emission standards for four-stroke engines on engine speed (with standards set at the maximum value) or whether two-stroke engines should be expected to achieve the same degree of emission control as counterpart four-stroke engines with comparable power ratings.

VIII. The Blue Cruise Program

A. What Is the Blue Cruise Program?

As noted in previous sections, fleet turnover for marine vessels that use Category 3 marine diesel engines is very slow. The average life of these vessels is as high as 29 years, and many are scrapped only when their hulls can no longer be repaired. One consequence of the long lives of these vessels is that the full impact of an engine emission control program may not occur until well into the future.

To address this issue, and to create a mechanism to encourage purchasers of new ships to use advanced technology emission controls, we are proposing to develop a Blue Cruise program. This would be a voluntary program to encourage ship owners and operators to reduce their air and waste emissions and in so doing reduce the adverse impacts of their vessels on the environment. Basically, participant ship owners would be awarded a number of stars based on the types of air and waste emission control programs they adopt. These technologies and/or systems would be different depending on whether it is a new or existing vessel. The stars can be used by the participants on advertising materials, and even on the ship itself, to educate consumers and encourage them to choose their vessel for their transportation needs. Although the program is perhaps best suited to cruise ships, owners of other types of ships could participate and incentives could be developed to encourage them to do so. These stars would be issued to an individual ship, not an entire fleet.

The Blue Cruise program would be a cross-media program. This means that it would include the air and waste emissions of a vessel, including both solid and liquid waste. By choosing one option from each of the three categories, air, liquid waste, and solid waste, participants would reduce their overall impact on the marine environment.

The program described below is focused on cruise ships. This is because their emissions on a per vessel basis can be very high, both in terms of engines used to generate power for passenger comfort and entertainment and in terms of waste streams, including gray and black water and solid waste. In a petition to EPA Administrator Browner requesting EPA to investigate and regulate cruise ship waste emissions, Bluewater Network noted that a typical cruise ships generates as much as 210,000 gallons of sewage and 1,000,000 gallons of graywater, 130 gallons of hazardous wastes, and 8 tons of garbage during a one-week voyage..[57] Disposal of these wastes is controversial, and a report issued by the General Accounting Office in 2000 indicates that in the six-year period between 1993 and 1998, "cruise ships were responsible for 87 confirmed illegal discharge cases in U.S. waters."[58] In August 2000, the Bluewater Network sent an addendum to that petition, requesting EPA to also examine air pollution from cruise ships.

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[57]A copy of this petition can be found in Docket A-2000-11, Document No. XXXX.

[58]Marine Pollution: Progress Made to Reduce Marine Pollution by Cruise Ships, but Important Issues Remain. February 2000, GAO/RCED-00-48. A copy of this report can be found in Docket A-2000-11, Document No. XXXXX.

At the same time, cruise ship owners have taken steps to manage their waste streams more carefully. In June, 2001, the members of the International Council of Cruise Lines (ICCL), whose members include the major cruise lines that visit U.S. ports, adopted mandatory environmental standards that are to be integrated into each members's internationally mandated Safety Management Systems.[59] These standards address the waste streams noted in the Bluewater Network petition. In addition, ICCL has entered into a Memorandum of Understanding with State of Florida regarding waste management.

The Blue Cruise Program would expand on these recent pollution reduction activities by encouraging and rewarding cruise ship owners who take addition steps to reduce emissions and/or ensure that pollution reduction practices and measures are adhered to. While the focus in this discussion is on cruise ships, we request comment on whether this program should also apply to cargo and other commercial vessels and, if so, if the point system should be different for those vessels.

B. How Would the Program Work?

The Blue Cruise Program would have two components. The first component consists of making a commitment to reduce emissions through the application of technologies and/or systems that would reduce air pollution, water discharges, and waste streams. The second step involves ensuring that the equipment and/or systems that a ship owner agreed to apply are operating and being maintained correctly.

It should be noted that, due to the complexity of the program associated with its cross-

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[59]ICCL Industry Standard E-01-01 (Revision 1), Cruise Industry Waste Management Practices and Procedures (see http://www.iccl.org/policies/environmentalstandards.pdf) A copy of this document can be found in Docket A-2000-11, Document No. XXXX.

media nature, the discussion of the Blue Cruise program in this section is not meant to be a comprehensive. Instead, it is a brief description of the overall concept that is meant to stimulate discussion of the value of such a program and the provisions it should include. We will continue to develop this program, soliciting comments from interested parties, as we prepare our final rule.

1. A Commitment To Reduce Emissions

To participate in the Blue Cruise program, a ship owner would need to take steps to reduce air emissions, water discharges, and waste streams from the vessel. For air pollution, this could involve installing new emission control devices on the ship's engine. For liquid waste pollution, this could involve applying new water treatment technology. For solid waste, this could involve developing systems to reduce, reuse, and recycle solid waste, as evidenced by joining EPA's WasteWise Program.[60] The exact choice of technologies and systems, of course, would depend on the technologies that are already in use on the vessel and the level of investment the ship owner desires to make. They key requirement is that the ship owner take steps to reduce three kinds of emissions: air, water, and solid waste.

The first step toward obtaining Blue Cruise status would be to sign up to the program. Similarly to the WasteWise program, a participant would assess the ship's air and waste streams and current state of pollution reduction technology; identify and submit goals, including obtaining and using new technologies and/or procedures; and measure and report progress. Successful participants would be awarded a number of stars, with five stars being the maximum number of stars awarded, which could be used to inform consumers and the world at large that

[60] WasteWise is a free, voluntary partnership program that helps organizations reduce their solid waste streams. The program provides technical assistance, networking, and recognition for successful waste reduction. Members are required to assess their waste streams, identify and submit waste reduction goals, and measure and report progress annually. More information about the WasteWise program can be found at the Office of Solid Waste website www.epa.gov/wastewise

they are taking steps to reduce emission beyond what is legally required. Once a participant signs up for the program, the actions agreed to become mandatory. In other words, while opting into the program is voluntary, compliance with the provisions once they are opted into is not.

We are proposing to develop a matrix of options that can be used by ship owners to make their emission control decisions. An example of a matrix is shown in Table VIII.B-1. In general, each option would be assigned a number of points, and stars would be given out depending on the number of points across all categories. A ship owner will be required to take action in each category, however.

Table VIII.B-1
Draft Blue Cruise Program Options Matrix

Category	Action	Pts
Air	Use low sulfur fuel while within 200 miles of U.S. coast (out 320 nautical miles)	
	Use shore-side power for hotelling	
	Retrofit emission control devices when existing ships go in for refurbishing – Tier 1 technologies	
	Retrofit emission control devices when existing ships go in for refurbishing – Tier 2 technologies	
	Retrofit emission control devices when existing ships go in for refurbishing – Tier 1 and 2 technologies	
	Use engines that meet Voluntary Low Emission Standards for new builds	
	Other	
Water	Implement education programs for passengers on waste minimization	
	Use biodegradable and bio-enzymatic cleaning supplies, non-phosphate soaps, and materials (e.g., toiletries supplied to passengers, salon chemicals, photo processing chemicals, etc.)	

Category	Action	Pts
	Ensure that all sinks, showers, toilets, hoses, etc. are low flow	
	Ensure that only shower, galley, and stateroom sink wastes enter the gray water system	
	Install gray water treatment systems that allow gray water to be used aboard the vessel for nonhuman consumption purposes	
	At a minimum meet the Alaska Standards for Gray and Black Water Discharges and incorporate this program into the ship Environmental Management System plan	
	Other	
Solid Waste	Recycle materials shore side (possibly set up a closed loop, where vessel waste is recycled and sold to the vessel as new products)	
	Sign on to MOU with the States new approach to tracking RCRA waste and implement	
	Participate in WasteWise	
	Other	

We request comment on all aspects of this program, and especially on this approach to awarding stars under the program and the contents of the options table and point system. We also request comment on whether points should be weighted and, if so, how. For example, more weight could be assigned to air emissions for cruise ships since they are currently taking steps to reduce their waste emissions pursuant to the Cruise Industry Waste Management Practices and Procedures. Finally, we request comment on whether EPA should manage this program or whether it can be run by an independent organization.

2. Verification

For the Blue Cruise program to be meaningful, it will be necessary to ensure that not only ship owners install emission control technologies and equipment, but also that they are operated and maintained correctly. There are at least two ways to do this: self certification and third party verification.

With a self-certification system, a ship owner would certify to EPA annually that the emission control technologies and systems described in the application are functional and are being operated and maintained correctly. If a ship owner is unable to make this certification, then that ship's stars would be taken away and the ship would be disqualified from the program until ship can be brought back into compliance.

With a third party verification program, an outside entity would ensure that the emission control technologies and systems are functional and are being operated and maintained correctly. This approach may be necessary, at least at the beginning of the program, until the industry gains experience with the program. A model for third party verification could be the Coast Guard procedures put in place to conduct waste management inspections on board cruise vessels.

We request comment on these verification approaches, particularly on how a third party verification program can work.

IX. Public Participation

We request comment on all aspects of this proposal. This section describes how you can participate in this process.

A. How do I submit comments?

We are opening a formal comment period by publishing this document. We will accept comments during the period indicated under "DATES" above. If you have an interest in the proposed emission control program described in this document, we encourage you to comment on any aspect of this rulemaking. We also request comment on specific topics identified throughout this proposal.

Your comments will be most useful if you include appropriate and detailed supporting rationale, data, and analysis. If you disagree with parts of the proposed program, we encourage you to suggest and analyze alternate approaches that meet the air quality goals described in this proposal. You should send all comments, except those containing proprietary information, to our Air Docket (see “Addresses”) before the end of the comment period.

If you submit proprietary information for our consideration, you should clearly separate it from other comments by labeling it "Confidential Business Information." You should also send it directly to the contact person listed under "FOR FURTHER INFORMATION CONTACT" instead of to the public docket. This will help ensure that no one inadvertently places proprietary information in the docket. If you want us to use your confidential information as part of the basis for the final rule, you should send a nonconfidential version of the document summarizing the key data or information. We will disclose information covered by a claim of confidentiality only through the application of procedures described in 40 CFR part 2. If you don’t identify information as confidential when we receive it, we may make it available to the public without notifying you.

B. Will there be a public hearing?

We will hold a public hearing on **[DATE]** at **[PLACE]** . The hearing will start at 9:30 am and continue until everyone has had a chance to speak.

If you would like to present testimony at the public hearing, we ask that you notify the contact person listed above at least ten days before the hearing. You should estimate the time you will need for your presentation and identify any needed audio/visual equipment. We suggest that you bring copies of your statement or other material for the EPA panel and the audience. It would also be helpful if you send us a copy of your statement or other materials before the hearing.

We will make a tentative schedule for the order of testimony based on the notifications we receive. This schedule will be available on the morning of the hearing. In addition, we will reserve a block of time for anyone else in the audience who wants to give testimony.

We will conduct the hearing informally, and technical rules of evidence won't apply. We will arrange for a written transcript of the hearing and keep the official record of the hearing open for 30 days to allow you to submit supplementary information. You may make arrangements for copies of the transcript directly with the court reporter.

X. Administrative requirements

A. Administrative Designation and Regulatory Analysis (Executive Order 12866)

Under Executive Order 12866 (58 FR 51735, October 4, 1993), the Agency must determine whether the regulatory action is "significant" and therefore subject to review by the Office of Management and Budget (OMB) and the requirements of this Executive Order. The Executive Order defines a "significant regulatory action" as any regulatory action that is likely to result in a rule that may:

- Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, Local, or Tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs, or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

EPA has determined that this rule is a "significant regulatory action" under the terms of Executive Order 12866 because it raises novel legal or policy issues due to the international nature of the use of Category 3 marine diesel engines and is therefore subject to OMB review. The Agency believes that this regulation would result in none of the economic effects set forth in Section 1 of the Order. A Draft Regulatory Support Document has been prepared and is available in the docket for this rulemaking and at the internet address listed under "ADDRESSES' above. Written comments from OMB and responses from EPA to OMB are in the public docket for this rulemaking.

B. Regulatory Flexibility Act (RFA), as Amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), 5 USC 601 et. seq.

The RFA generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's rule on small entities, small entity is defined as: (1) a small business that meet the definition for business based on SBA size standards; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; or (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field. The following table X.B-1 provides an overview of the primary SBA small business categories potentially affected by this regulation.

Table X.B-1: Primary SBA Small Business Categories
Potentially Affected by this Proposed Regulation

Industry	NAICS[a] Codes	Defined by SBA as a Small Business If:[b]
Internal Combustion Engines	333618	< 1000 employees
Ship Building and Repairing	336611	< 1000 employees
Engine Repair and Maintenance	811310	< $5 Million
Water transportation, freight and passenger	483	<500 employees

NOTES:
a. North American Industry Classification System
b. According to SBA's regulations (13 CFR 121), businesses with no more than the listed number of employees or dollars in annual receipts are considered "small entities" for purposes of a regulatory flexibility analysis.

After considering the economic impacts of today's proposed rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities. Our review of the list of manufacturers of Category 3 marine diesel engines (marine diesel engines at or above 30 l/cyl) indicates that there are no U.S. manufacturers of these engines that qualify as small businesses. Our review of the U.S. shipyards that build, or have built, ships that use Category 3 marine diesel engines indicates that there are no U.S. manufacturers of these ships that qualify as small businesses. The proposed rule is not expected to significantly affect engine repair and maintenance companies since they will be required only to rebuild affected engines to their original configurations and not to certify rebuilt engines. The proposed rule is also not expected to significantly affect ship owners. With regard to testing requirements, the provisions will not impose any capital costs because the testing devices are expected to be incorporated in the engine system as delivered by the manufacturer. Operation of these systems is not expected to require significant crew resources and can be done by crew responsible for testing other engine parameters. Ship owners would also be required to maintain the engine as specified by the engine manufacturer during the useful life of the engine. These costs are not expected to be greater than the costs of maintaining unregulated engines except to the extent that ship owners do not currently maintain engines as specified by the engine manufacturer. Maintenance costs are expected to be minimal given the overall costs of maintaining all of the vessel's systems and structures.

C. Paperwork Reduction Act

The information collection requirements (ICR) in this proposed rule will be submitted for approval to the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. We will announce in a separate Federal Register Notice that the ICR has been submitted to OMB and will take comments on the proposed ICR at that time.

The Agency may not conduct or sponsor an information collection, and a person is not required to respond to a request for information, unless the information collection request displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9 and 48 CFR Chapter 15.

D. Intergovernmental Relations

1. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 104-4, establishes requirements for federal agencies to assess the effects of their regulatory actions on state, local, and tribal governments and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "federal mandates" that may result in expenditures to state, local, and tribal governments, in the aggregate, or to the private sector, of $100 million or more in any one year. Before promulgating an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if the Administrator publishes with the final rule an explanation of why that alternative was not adopted.

Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

This rule contains no federal mandates for state, local, or tribal governments as defined by the provisions of Title II of the UMRA. The rule imposes no enforceable duties on any of these governmental entities. Nothing in the rule would significantly or uniquely affect small governments.

2. Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments)

Executive Order 13175, entitled "Consultation and Coordination with Indian Tribal Governments" (65 FR 67249, November 6, 2000), requires EPA to develop an accountable process to ensure "meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." "Policies that have tribal implications" is defined in the Executive Order to include regulations that have "substantial direct effects on one or more Indian tribes, on the relationship between the Federal government and the Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes."

This proposed rule does not have tribal implications. It will not have substantial direct effects on tribal governments, on the relationship between the Federal government and Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes, as specified in Executive Order 13175. This rule contains no federal mandates for tribal governments. Thus, Executive Order 13175 does not apply to this rule. However, in the spirit of Executive Order 13175, and consistent with EPA policy to promote communications between EPA and tribal governments, EPA specifically solicits additional comment on this proposed rule from tribal officials.

E. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law 104-113, § 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless doing so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rule involves technical standards for testing. We are proposing to rely on the test procedures contained in the MARPOL NOx Technical Code.[61] These procedures are being used by virtually all Category 3 engine manufacturers. However, it is not clear whether this Technical Code is a voluntary consensus standard in the strictest sense, given that it was developed as part of an international treaty process to develop mandatory emission requirements. Nevertheless, we believe that our proposed use of these test procedures is consistent with the intent of the NTTAA.

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[61] The Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines in the Annex VI of MARPOL 73/78 Regulations for the Prevention of Air Pollution from Ships and NOx Technical Code, International Maritime Organization. See footnote 1 regarding how to obtain copies of these documents.

EPA welcomes comments on this aspect of the proposed rulemaking and, specifically, invites the public to identify potentially-applicable voluntary consensus standards and to explain why such standards should be used in this regulation.

F. Protection of Children (Executive Order 13045)

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks" (62 F.R. 19885, April 23, 1997) applies to any rule that (1) is determined to be "economically significant" as defined under Executive Order 12866, and (2) concerns an environmental health or safety risk that EPA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, Section 5-501 of the Order directs the Agency to evaluate the environmental health or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposed rule is not subject to the Executive Order because it does not involve decisions on environmental health or safety risks that may disproportionately affect children.

The effects of ozone and PM on children's health were addressed in detail in EPA's rulemaking to establish the NAAQS for these pollutants, and EPA is not revisiting those issues here. EPA also believes that the emission reductions from the strategies proposed in this rulemaking will further reduce air toxics and the related adverse impacts on children's health.

G. Federalism (Executive Order 13132)

Executive Order 13132, entitled "Federalism" (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure "meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications." "Policies that have federalism implications" is defined in the Executive Order to include regulations that have "substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government."

Under Section 6 of Executive Order 13132, EPA may not issue a regulation that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by State and local governments, or EPA consults with State and local officials early in the process of developing the proposed regulation. EPA also may not issue a regulation that has federalism implications and that preempts State law, unless the Agency consults with State and local officials early in the process of developing the proposed regulation.

Section 4 of the Executive Order contains additional requirements for rules that preempt State or local law, even if those rules do not have federalism implications (i.e., the rules will not have substantial direct effects on the States, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government). Those requirements include providing all affected State and local officials notice and an opportunity for appropriate participation in the development of the regulation. If the preemption is not based on express or implied statutory authority, EPA also must consult, to the extent practicable, with appropriate State and local officials regarding the conflict between State law and Federally protected interests within the agency's area of regulatory responsibility.

This proposed rule does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. The proposed emission standards and other related requirements for private businesses in this proposal would have national applicability, and thus would not uniquely affect State and local governments. Further, no circumstances specific to such governments exist that would cause an impact on these governments beyond those discussed in other sections of this proposal. EPA's conclusions regarding the impacts from the implementation of this proposed rule discussed in other sections are equally applicable to State and local governments. Thus, Executive Order 13175 does not apply to this rule.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed rule from State and local officials.

H. Energy Effects (Executive Order 13211)

This rule is not a "significant energy action" as defined in Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" (66 Fed. Reg. 28355 (May 22, 2001)) because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. The proposed standards have for their aim the reduction of emission from certain marine diesel engines, and have no effect on fuel formulation, distribution, or use.

I. Plain Language

This document follows the guidelines of the June 1, 1998 Executive Memorandum on Plain Language in Government Writing.

Dated_____________

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Christine Todd Whitman

Administrator.