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# Summary and Analysis of Comments: Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder

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Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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## Introduction

On May 29, 2002, we published a Notice of Proposed Rulemaking (NPRM) for proposed emission standards and test procedures for new marine compression-ignition engines at or above 30 liters/cylinder (Category 3). In that notice, we proposed Tier 1 emissions standards for new engines beginning in 2004. We also took comment on potential Tier 2 emission standards for a later date that would achieve larger emission reductions.

We held a public hearing on the NPRM in Long Beach, California on June 13, 2002. At that hearing, oral comments on the NPRM were received and recorded. A written comment period remained open until July 16, 2002. A complete list of organizations and individuals that provided comments on the NPRM is contained in the following table. Abbreviations for the organization names are also included.

This Summary and Analysis of Comments contains a detailed summary of all comments we received on the NPRM as well as our analysis of each comment and response. The reader should also refer to the final rulemaking notice in the Federal Register as well as the Final Regulatory Support Document.

## List of Commenters

| Commenter | Abbreviation |
|---|---|
| Alaska Department of Environmental Conservation (IV-D-53) | Alaska |
| American Bureau of Shipping (IV-D-10) | ABS |
| American Lung Association, et. al. (coalition of citizens groups) (IV-D-15) | ALA |
| American Maritime Congress (IV-D-12) | AMC |
| American Maritime Congress, et. al. (IV-D-39) | |
| American Petroleum Institute (IV-D-21) | API |
| American Shipbuilding Association (IV-D-47) | ASA |
| Aron (IV-D-55) | Aron |
| Bay Area Air Quality Management District (IV-D-48) | BAAQMD |
| Bluewater Network (IV-D-54) | Bluewater |
| Broward County Dept. of Planning and Environmental Protection (IV-D-40) | Broward |
| California Air Pollution Control Officers Association (IV-D-51) | CAPCOA |
| California Air Resources Board (IV-D-35) | ARB |
| Caterpillar, Inc. (IV-D-41) | Caterpillar |
| Chamber of Shipping of America (IV-D-56) | CSA |
| Coalition for Clean Air (IV-D-31) | |
| Committees for Land, Air Water and Species (IV-D-07) | CLAWS |
| Cotton Club (IV-G-02) | |
| Delaware, State of (IV-D-03) | Delaware |
| Denison, J.L. (IV-D-23) | |
| Department of Defense, Navy (IV-D-20) | DOD |
| Engine Manufacturers' Association (IV-D-30) | EMA |
| Environmental Defense (IV-D-17) | ED |
| European Association of Internal Combustion Engine Manufacturers (IV-D-04) | Euromot |
| Germanischer Lloyd (IV-D-46) | |
| Hyundai Heavy Industries, Inc. (IV-D-02) | Hyundai |
| International Association of Independent Tank Owners (IV-D-36) | Intertanko |
| International Chamber of Commerce (IV-D-29) | ICC |
| International Chamber of Shipping (IV-D-27) | ICS |
| International Council of Cruise Lines (IV-D-26) | ICCL |
| Japanese Marine Equipment Association (IV-D-05) | JMEA |
| Japanese Shipowners Association (IV-D-32) | JSA |
| Lake Carriers' Association (IV-D-33) | LCA |
| MAN B&W Diesel (IV-D-08) | |
| MSTP HELLAS LTD (IV-D-45) | |
| Natural Resources Defense Council (IV-D-43) | NRDC |
| Northeast States for Coordinated Air Use Management (IV-D-19) | NESCAUM |
| Ozone Transport Commission (IV-D-16) | OTC |
| Passenger Vessel Association (IV-D-42) | PVA |

Port of Houston Authority (IV-D-52)
Puget Sound Clean Air Agency (IV-D-34)
Residents for Less Pollution (IV-D-38)
State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (IV-D-14) STAPPA/ALAPCO
Sacramento Air Quality Management District (IV-G-01) SAQMD
San Luis Obispo County Air Pollution Control District (IV-D-37) SLOCAPCD
Santa Barbara County Air Pollution Control District (IV-D-44, IV-D-49) SBCAPCD
Seafarers International Union of North America, AFL-CIO (IV-D-13)
South Carolina Department of Health and Environmental Control (IV-D-09)
South Coast Air Quality Management District (IV-D-50) SCAQMD
Texas Natural Resource Conservation Commission (IV-D-18) TNRCC
Transportation Institute (IV-D-11)
Ventura County Air Pollution Control District (IV-D-06) VCAPCD
View from the Hill (IV-D-22)
Wartsila Corporation (IV-D-28) Wartsila

Public Hearing Testimony (IV-F-01) (June 13, 2002, Long Beach California)

- Bluewater Network
- California Air Resources Board
- California Earth Corps
- Coalition for Clean Air
- EcoLink
- MAN B&W Diesel
- Puget Sound Clean Air Agency
- Residents for Less Pollution
- San Pedro and Peninsula Homeowners Coalition
- Santa Barbara County
- South Coast Air Quality Management District
- Transportation Institute
- Wartsila Corporation

# CHAPTER 1 - Need for Emission Controls; Form of Emission Controls

## 1.1 Public Health and Welfare Need for a Domestic Emission Control Program for Category 3 Marine Diesel Engines

What We Proposed:

In our Notice of Proposed Rulemaking and Draft Regulatory Support Document, we provided information that supports the public health need for emission controls for marine diesel engines, including Category 3 marine diesel engines. As directed by the Clean Air Act (the Act), we performed a study of emissions from nonroad engines and, in 1994, determined that emissions of oxides of nitrogen (NOx), volatile organic compounds (VOCs, including hydrocarbons (HC)), and carbon monoxide (CO) from nonroad engines and equipment contribute significantly to ozone and CO concentrations in more than one nonattainment 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 determined that commercial and recreational marine diesel engines rated over 37 kW cause or contribute to such air pollution, and set standards for marine diesel engines with in-cylinder displacement of less than 30 liters (see 64 FR 73300, December 29, 1999). In this rule we are setting NOx standards for marine diesel engines with in-cylinder displacement at or above 30 liters.

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) of the Act authorizes us 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 determined that nonroad engines significantly contribute to smoke and particulate matter (PM) emissions in our 1994 rule. We also determined that commercial and recreational marine diesel engines rated over 37 kW cause or contribute to smoke and particulate matter air pollution, and we set PM standards for marine diesel engines with in-cylinder displacement of less than 30 liters (see 64 FR 73300, December 29, 1999). In this rule we considered, but are not setting, PM standards for marine diesel engines with in-cylinder displacement at or above 30 liters (see Chapter 7, below, for a discussion of PM controls for these engines).

As presented in our proposal, we estimate that Category 3 marine diesel engine 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."[1] These emissions are expected to increase to 62 percent by 2015.

We also provided information about the public health impacts of exposure to ozone, as well as particulate matter and carbon monoxide.

What Commenters Said:

**(A) Emissions from Category 3 marine diesel engines pose a serious health threat**

We received a substantial number of comments from citizens and organizations representing state and local governments expressing concern about the serious public health impact of commercial marine diesel engine emissions (see list below). Several of these commenters provided data on the impact of these engines on local air quality. NESCAUM and the Puget Sound Clean Air Agency reminded us that the emissions from these engines also contain air toxics. Puget Sound noted that 70 percent of Seattle's air toxics can be attributed to diesel exhaust.

San Luis Obispo and CAPCOA, and the Coalition for Clean Air expressed concern that emissions from Category 3 marine diesel engines may threaten the ability of states to meet and maintain health-based air quality standards. South Carolina Department of Health and Environmental Control noted that emissions from these engines "are a contributing source of ground-level ozone precursor pollutants [and] a national plan to control these sources would aid the State's efforts in meeting new and more stringent air quality standards."

National controls for these engines are necessary because, as TNRCC points out, "the federal preemption provisions of the Federal Clean Air Act give EPA essentially sole authority to set emission standards for engines for mobiles sources." Both Sacramento Metropolitan Air Quality Management District and CAPCOA noted that failure by EPA to take steps to reduce the inventory impacts of these engines "will saddle local, state and federal air agencies with the burden of additional emission reduction requirements from other sectors." This would be unfortunate because, as noted by Sacramento Metropolitan Air Quality Management District, "emission reductions from Category 3 vessels are far more cost-effective than virtually any other strategy [to reduce the relevant pollutants] including the strategy of shifting burden to onshore

[1]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. II-A-47.

industry."

While a large number of commenters were concerned about the air impacts of these emissions in California, particularly the South Coast, the American Lung association pointed out that aggressive emission reduction strategies will be critical in ensuring compliance with NAAQS in U.S. coast areas, river corridors and ports. The South Coast Air Quality Management District noted that California's South Coast is currently classified as the only "extreme" nonattainment area in the nation for ozone and is also classified as "serious" for PM10. Marine vessel emissions are of particular concern for SCAQMD because of the ozone and PM nonattainment issues. In the absence of aggressive regulation for marine diesel engines, it would be extremely difficult for this area to demonstrate compliance.

The American Lung Association also highlighted concerns that particulate matter emissions affect the global and regional climate. Other commenters, including Environmental Defense, Ozone Transport Commission, and Residents for Less Pollution, pointed to the effects of $NO_x$, PM, and sulfur oxides (SOx) emissions regional haze, acid rain, eutrophication of coastal waters and ecosystem damage in general. These concerns show that emissions from large marine diesel engines have an adverse effect on the health of the maritime environment. Coastal-zone birds and mammals, including protected species, are at greater risk due to emissions from these engines.

The Coalition for Clean Air and SCAQMD raised the issue of environmental justice, noting that the PM emissions from these engines threaten the health of vessel crews, port workers, local port businesses and coastal communities. The Coalition for Clean Air specifically called EPA's attention to the impacts on air quality in West Oakland Neighbors of emissions from Category 3 engines on vessels using the Port of Oakland but noted that the environmental justice aspects of these emissions is an issue for all Americans.

Commenters:

- Delaware
- Ventura County
- South Carolina
- STAPPA/ALAPCO
- NESCAUM
- TNRCC
- Puget Sound
- San Luis Obispo
- Sacramento
- CAPCOA
- SCAQMD
- Santa Barbara
- Natural Resources Defense Council
- American Lung Association
- Environmental Defense
- Coalition for Clean Air

Our Response:

EPA agrees with these commenters about the serious health and welfare impacts of marine diesel emissions. Consequently, we are finalizing a 2-part emission control program that will address emissions from these engines in the short- and long-term. First, we are adopting near-term Tier 1 standards that will go into effect immediately, based on readily available emission control technology. Second, we are adopting regulations that set a schedule for a future rulemaking to assess and adopt an appropriate second tier of standards.

**(B) EPA has failed to demonstrate that there is a public health need to set standards for Category 3 marine diesel engines**

The coalition of maritime interests, EMA, and the International Association of Independent Tank Owners (Intertanko) asserted that existing data are insufficient to support an EPA rulemaking to set emission standards and that EPA has overstated the absolute and relative contribution of marine diesel engines. Intertanko acknowledged that emissions from marine diesel engines can have an adverse impact on air pollution, particularly in populated port areas, which justifies the actions taken thus far by the Members of the International Maritime Organization (IMO) in Annex VI to the International Convention on the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 Relating Thereto (more commonly referred to as MARPOL or MARPOL 73/78; the standards are referred to as the Annex VI NOx standards), but that EPA overstates this impact.[2] The American Maritime Congress commented that there are very few US vessels that use Category 3 marine diesel engines, suggesting that their inventory contribution must be small.

Intertanko added that section 213(a) of the Clean Air Act requires that EPA make a determination that a risk to public health or welfare exists and find that marine diesel engine emissions are a significant contributor to air pollution before setting emission standards. Intertanko further notes that, in contrast to EPA's findings, a recent study by MAN B&W indicates that $NO_x$ emissions from shipping are relatively small, particularly compared with other modes of transportation. The coalition of maritime interests noted that the study on which EPA relies (E.H. Pechan report) makes generalized, non-vessel or engine-specific assumptions, then extrapolates them to nationwide conclusions, which may greatly overstate emission estimates. They also express doubt that EPA's attempt to derive emissions estimates from land-based diesel engine emissions and transfer them to the marine environment is appropriate.

Our Response:

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[2]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-97-50, Document II-B-01. Copies of updated versions can be obtained from the International Maritime Organization (www.imo.org)

The Clean Air Act contains the criteria that we must use to set standards for nonroad engines. Specifically, 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 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.[3] On June 17, 1994, we made an affirmative determination under section 213(a)(2) that nonroad emissions are significant contributors to ozone or CO concentrations in more than one nonattainment area. In that rule 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, pursuant to section 213(a)(4).

We made a finding that commercial and recreational marine diesel engines rated over 37 kW cause or contribute to such air pollution in our 1999 rule. We are therefore setting emission standards to reduce emissions from these engines. This finding applies to the entire category of marine diesel engines at or above 37 kW; we do not separate this category into subcategories for the purpose of evaluating their inventory contribution. However, we distinguish between types of marine diesel engines for the purpose of setting standards because, as explained in our 1999 rule and in the proposal for this rule, these engines are very diverse in terms of the physical size, engine technology, control hardware, and costs associated with reducing emissions. These differences make it difficult to design one set of emission requirements for all marine diesel engines. Instead, we developed different requirements for different marine diesel engines. New standards for Category 3 marine diesel engines take another step toward the comprehensive nonroad engine emission-control strategy envisioned in the Act.

Finally, we evaluate the contribution of a category of nonroad engines based on the emission inventory contribution of those engines, not based on the relative contribution compared with other sources. While it is true that marine diesel engines have fewer emissions per ton of merchandise transported, these engines have high emissions on a per engine basis and contribute to high ozone and PM levels in many coastal and port areas, some of which are in nonattainment areas.

## 1.2 Form of Emission Controls

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

What We Proposed:

We proposed near-term standards for marine diesel engines equivalent to the internationally negotiated NOx limits. We proposed to apply these standards to engines at or above 2.5 liters per cylinder, beginning in 2004. For Category 1 and Category 2 marine diesel engines (up to 30 liters per cylinder displacement), we proposed to apply the certification and compliance provisions contained in 40 CFR 94. For Category 3 marine diesel engines (at or above 30 liters per cylinder displacement), we proposed certification and compliance provisions similar to the internationally negotiated program but containing additional provisions that reflect the requirements of the Clean Air Act.

We also indicated we were also considering adoption of a subsequent second tier of standards for engines with per cylinder displacement greater than 30 liters (also called Category 3 marine diesel engines), which would reflect additional reductions that can be achieved through engine-based controls, and would apply to new engines built after 2006 or later. Meeting these standards would likely require the use of technologies such as selective catalytic reduction or fuel cells. The Category 3 Tier 2 standards could be finalized in this rulemaking, subject to a review prior to their effective date, or we could defer finalizing a second tier of standards until 2007. In either case, our future action on Category 3 Tier 2 standards would take into consideration continued development of new technologies, such as selective catalytic reduction and water-based emission reduction techniques, and international activity such as action at the International Maritime Organization to set more stringent international standards.

What Commenters Said:

**(A) Commenters supporting stringent Tier 2 standards**

Many of the commenters noted in 1.1(a) also expressed concern about the form of the emission control program proposed by EPA. STAPPA/ALAPCO, ARB, and Bluewater noted that the proposed Tier 1 standards equivalent to the internationally negotiated NOx limits will not result in any additional emission benefits. Environmental Defense Fund also noted that the proposed standards "do not reflect today's technology let alone viable technology in the offing." These commenters, as well as other state and environmental groups and private citizens urged EPA to finalize more stringent standards at this time, with several also recommending technology reviews before the standards go into effect. While most of these commenters did not specify standards, several supported a Tier 2/Tier 3 approach similar in stringency to EPA's standards for land-based nonroad engines or for Category 2 and 3 engines. The California ARB recommended standards reflecting a 30 percent reduction from Tier 1 by 2006 and an 80% reduction from Tier 1 by 2010. Bluewater, Environmental Defense, and Coalition for Clean Air recommended a 50 percent reduction by 2006, and 95 percent reduction by 2008, with Bluewater also including Tier 1 at an 11 percent reduction by 2004. The Ozone Transport Commission recommended Tier 2 standards at 80 percent reduction from Tier 1, beginning in 2007.

Our Response:

The emission control program we are finalizing represents a two-part strategy that will result in stringent emission controls for Category 3 marine diesel engines. Clean Air Act section 213(a)(3) requires EPA to adopt regulations that contain standards concerning certain pollutants reflecting the greatest degree of emission reductions achievable through the application of technology that will be available, taking into consideration the availability and costs of the technology, and noise, energy, safety factors and existing motor vehicle standards. EPA is also to revise these standards from time to time.

The emission-control program we are adopting in this rule meets these criteria through a two-part approach. First, we are adopting near-term Tier 1 standards that will go into effect immediately, based on readily available emission control technology. Second, we are adopting regulations that set a schedule for a future rulemaking to assess and adopt an appropriate second tier of standards. We recognize that manufacturers can achieve additional reductions with more lead time than is provided by the Tier 1 standards. They can do this by expanding the use and optimization of in-cylinder controls, combined with the significant emission reductions that may be achievable with advanced technologies such as selective catalytic reduction or water injection. We believe, however, that it is appropriate to defer a final decision on the longer-term Tier 2 standards to a future rulemaking. This is because there are several technological issues concerning the widespread commercial use of these technologies, as described in the preamble and Regulatory Support Document for this rule. By waiting a few years, we will be able to benefit from the manufacturers' experience as they continue to develop and apply these technologies on marine diesel engines. Consequently, we plan to evaluate more stringent Tier 2 standards in a future rulemaking. In the 2004-2005 time frame, engine manufacturers will have five or more years of data on a significant number of vessels. During this period, we will work with manufacturers to learn more about the advanced technologies discussed above and the steps they are taking to resolve operational and technological issues. With this information, we should be in a significantly better position to determine the emission levels that are achievable and appropriate, given appropriate lead time for the use of these advanced technologies.

This approach is consistent with the Clean Air Act. Section 213(a)(3) directs EPA to promulgate emission standards and from time to time review and revise those standards. This final rule adopts near-term standards and puts EPA on a schedule to review, and if appropriate, revise those standards in accordance with the criteria in section 213(a)(3). We believe this two-step approach is the most appropriate means to address emissions from Category 3 marine engines in the near-term in the face of incomplete information and the significant changes underway in applying emission-reduction technology to very large marine engines.

We are including a regulatory provision in 40 CFR 94.8 that establishes a schedule for a future rulemaking to promulgate additional emission standards for Category 3 marine engines that we determine are appropriate under section 213(a)(3). This rulemaking will reassess the emission standards in light of the developments in and experience with applying emission-reduction technology to Category 3 marine engines. The standards in this final rule will remain in effect until we modify them in a future rulemaking. We are committing to take final action on appropriate standards for marine diesel engines by April 27, 2007, and to issue a proposal no later than approximately one year before. This future rulemaking will allow us to exercise the

discretionary authority under Clean Air Act section 213(a)(3), which directs EPA to "from time to time revise" regulations under that provision.

Delaying adoption of the Tier 2 standards until a future rule also allows us to take steps to facilitate negotiations for appropriate consensus international standards. As many commenters noted, most of the Category 3 engines that affect U.S. air quality are installed on vessels flagged elsewhere. Adoption of international standards has the potential to maximize the level of emission reductions achieved from emission controls on U.S. and foreign vessels. For example, international standards set at an appropriate level would remove the objections to controlling emissions from engines on foreign vessels. Since engines on foreign vessels account for the large majority of emissions from Category 3 marine diesel engines impacting U.S. air quality, successful negotiation of international standards that achieve the greatest emission reduction feasible would result in the greatest improvement to air quality here in the U.S. and around the world. Addressing the long-term standards in the future rulemaking could facilitate such international action, but will also allow us to proceed expeditiously on our own if appropriate international standards are not adopted in a timely way.

The United States has already taken a leadership role for more stringent standards at the International Maritime Organization and has requested that organization to begin consideration of a second tier of international standards. If enough countries ratify the Annex by early 2003 to bring it into force, those discussions are likely to begin in 2004. Otherwise, they may occur as part of a review process which may begin as early as the summer of 2003.

### (B) Commenters supporting harmonization with Annex VI and opposing separate domestic standards for marine diesel engines

We received comments from several engine manufacturers and shipping interests urging EPA to adopt emission standards and certification and compliance provisions identical to those contained in MARPOL Annex VI and the NOx Technical Code. The American Maritime Congress, Chamber of Shipping of America, Euromot, the International Chamber of Commerce, and others reminded EPA that, due to the international nature of maritime trade, air emissions from Category 3 marine diesel engines is an international problem that requires an international solution. The American Chamber of Shipping notes that the IMO was created to provide a field of government regulation and practices for matters affecting shipping. Consequently, "the IMO is the only forum through which scientifically valid, effective and economically sound requirements can be promulgated" to control emissions from marine engines. These commenters also urged EPA to pursue more stringent standards only through the International Maritime Organization, and not unilaterally.

These commenters also recommended that EPA harmonize its certification and compliance programs with the international program as well. The Chamber of Shipping of America questioned EPA's authority to "vary certification and testing requirements were an alternate system [i.e., the NOx Technical Code] provides equally reliable results." The Japanese Marine Equipment Association recommended that EPA adopt the international certification program;

otherwise, the EPA program would be "a heavy burden for manufacturers to develop engines to comply with U.S. standards and to keep or control many documents for two different rule." The American Bureau of Shipping questioned how engines on vessels built between 2000 and 2004 would be certified. Intertanko requested information about the issue of withdrawal of U.S. engine certification: would a vessel with an engine whose certificate has been withdrawn be detained?

Several commenters, including the American Maritime Congress, the Transportation Institutes, and the Seafarers International Union of North America, expressed concern that unilateral U.S. action would have important effects on the ability of U.S. vessels to compete in international transportation. The Seafarers International Union noted that unilateral regulations will only impose additional burdens on U.S. vessels that will not be required of their foreign flag competitors. They note that this rule "will weaken [their] ability to effectively and fairly compete on a level playing field with [their] international counterparts [many of which are] heavily subsidized and oftentimes tax exempt." They also note that "American vessels are subject to a multitude of federally imposed rules, regulations and tax obligations that are largely inapplicable to their foreign counterparts." This rule will only exacerbate this difficult situation. The Lake Carriers' Association noted that the shipping industry is not the only industry that would be affected. This commenter pointed out that the U.S. steelmaking industry is currently struggling and the proposed rule would increase the cost of transporting steel and steel inputs. This rule would impose additional burdens on that industry as well.

Many of these commenters noted that EPA is pursuing these standards without having ratified Annex VI. Euromot also expressed surprise that the U.S. recommended that the parties to IMO consider a second tier of emission limits, without having ratified Annex VI. Transportation Institute, among others, urged EPA to withdraw the proposed rule and concentrate its energies on international implementation of Annex VI. The Chamber of Shipping of America strongly opposed unilateral action. "This unacceptable control strategy," they noted, "would not only result in a patchwork quilt of potentially inconsistent national requirements but also demean the credibility of the IMO process."

Our Response:

As discussed above, section 213(a) of the Act requires us to set emission standards for nonroad engines, such as Category 3 marine diesel engines. Accordingly, we are making a commitment to pursue a two-part strategy for marine diesel engines. Specifically, at the same time that we continue to assess the feasibility of more stringent emission standards for these engines, we will pursue this matter with the international community, through the International Maritime Organization.

We have an obligation under the Clean Air Act to set standards for new nonroad engines, including new marine diesel engines, that reflect the greatest degree of emission control achievable. These controls are necessary to protect human health and welfare and to reduce the impact of marine diesel engine emissions on air quality in the United States. As discussed elsewhere in this Summary and Analysis of Comments and in the preamble for this rule, these

engines contribute significantly to air quality problems in coastal and port areas, and it is important to develop long-term standards that will help mitigate these effects. We believe that Category 3 marine diesel engines can substantially reduce emissions beyond Tier 1 levels without significantly affecting the cost of buying or operating vessels.

Consequently, we will also be developing a future rule, which will be completed no later than April 27, 2007, in which we will consider the state of technology that may permit deeper emission reductions and the status of international action for more stringent standards. We will also consider the application of such a second tier of standards to engines on foreign vessels that enter U.S. ports, since engines on foreign vessels are the source of the majority of emissions from this source. At that time, we will also evaluate the costs of applying new technology.

With regard to international action, the U.S. government has prepared the appropriate documents for the President to submit Annex VI to the Senate for its advice and consent to ratification. In transmitting Annex VI to the Senate, the Administration will work with Congress on new legislation to implement the Annex. The United States government also supports a new effort to revise the Annex VI standards to include a second tier of NOx standards taking into account the emission-reduction potential of new control technologies.

The United States has also already requested the IMO's Marine Environment Protection Committee (MEPC) to begin consideration of more stringent emission limits for marine diesel engines.[4] 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. This request is consistent with Conference Resolution 3, which adopted at the same time as Annex VI and which invites the MEPC to review the NOx emission limits at a minimum of five year intervals after entry of force of the Annex. We continue to believe that it is important for MEPC to begin this review as soon as possible.

With regard to the certification and compliance provisions, many of these issues are discussed in Chapter 6 of this Summary and Analysis of Comments.

### (C) Commenters supporting EPA action as an alternative to and encouragement of international action

Sacramento Air Quality Management District and Santa Barbara County Air Pollution Control District recommended that EPA actively pursue international agreements that will result in standards beyond the Annex VI limits. They noted that this rule can set the stage for

[4]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-2001-11, Document No. II-A-16.

international efforts. This is important because Annex VI may not got into force. If that occurs, according to these commenters, the EPA standards would become the default international basis for ship emission controls if EPA standards are more stringent and apply to engines on foreign as well as U.S. vessels.

Our Response:

As explained in the preamble for our final rule and earlier in this Chapter, we are finalizing a two-tier emission control strategy. We are finalizing near-term standards equivalent to the internationally negotiated NOx limits. In the long term, we will assess the feasibility and appropriateness of a second tier of more stringent Category 3 marine diesel engine standards. Specifically, we are deferring adoption of Tier 2 standards to a future rulemaking to allow us to make the best use of information that will be available to have a sound technical basis for assessing the technological capabilities of emission-control systems that include advanced technologies. In addition, this approach will allow us to pursue further negotiations in the international arena to achieve more stringent global emission standards for marine diesel engines.

**(D) Commenters requesting more information on the interface between the domestic program and the international program**

Some commenters, including Euromot, Intertanko, and the Chamber of Shipping of America, noted that there are a number of significant differences between MARPOL Annex VI controls and those included in the proposed rule. Specifically, even though EPA claims that much of the NPRM is consistent with Annex VI, there are numerous unnecessary deviations that are likely to cause confusion, and dual certification issues. These discrepancies need to be reconciled to avoid a complete breakdown in international uniformity. Based on their belief that these deviations would complicate compliance unnecessarily, Intertanko recommended that we should accept a flag state certification that the vessel and engines are in compliance with the Annex VI standards (instead of requiring certification to EPA's Tier 1 standards as proposed) for nations that have ratified MARPOL Annex VI. Harmonization with the international program would be preferable since this approach would ensure that compliance is both feasible and cost-effective.

Euromot, among others, also noted that it is a basic requirement that certificates from non-U.S. flag states should be accepted by U.S. authorities and the only compliance check should be to verify if documentation is consistent with the IMO $NO_x$ Technical File. Otherwise, each engine would essentially need to be certified twice, by the Flag State Administration and the U.S. EPA.

Our Response:

With regard to the first comment, the United States has not yet developed legislation and corresponding regulations concerning how Annex VI will be implemented with regard to foreign vessels that enter U.S. ports. Annex VI specifies that a vessel’s International Air Pollution Prevention (IAPP) certificate and its Engine International Air Pollution Prevention (EIAPP)

certificate will be issued by the Administration that has authority over the vessel. It is anticipated that the United States will require U.S.-issued IAPPs and EIAPPs only for U.S.-flag vessels.

At the same time, however, engines installed on vessels flagged or registered in the United States will be required to be certified by EPA under the Clean Air Act even if other engines in that family or group have already been certified under Annex VI by other Administrations in other countries for installation on their vessels.[5] This approach is currently applied to all nonroad and highway engines that are used in the United States. While this may require dual certification, it is also the case that the EPA certification process can be done electronically and we do not require witness testing of engines. Also, engine manufacturers can submit the same test data used for engine certification application in other countries. As a result any additional burden associated with EPA certification will generally be very small.

The differences between the EPA compliance program and the Annex VI compliance program are discussed in Section V of the preamble for this rule and in Chapter 6 of this Summary and Analysis of Comments. In general, we have adjusted the EPA compliance program as much as possible under the Clean Air Act to avoid differences with the program contained in the NOx Technical Code.

## 1.3 Coordination with Coast Guard

What Commenters Said:

The Chamber of Shipping of America commented out that EPA should not adopt regulations without extensively consulting with the U.S. Coast Guard. Coast Guard is the recognized federal agency expert on marine vessel operations. Cooperation between Coast Guard and EPA could ensure that any requirements related to emission reductions from marine vessels are consistent with existing regulations and could also help ensure operational safety and environmental protection.

STAPPA/ALAPCO recommended that "EPA include in this rulemaking an expanded explanation of roles and responsibilities with respect to enforcement and compliance and provide a clear indication of which regulatory authority will monitor compliance and how it will do so."

Our Response:

Our final rule contains compliance and enforcement provisions consistent with the

[5]Today's rule applies to "new" marine diesel engines and to "new" marine vessels that include marine diesel engines. In general, a "new" marine diesel engine or a "new" marine vessel is one that is produced for sale in the United States or that is imported into the United States. The emission standards established in today's rule, therefore, will typically apply to marine diesel engines that are installed on vessels flagged or registered in the United States.

requirements of the Clean Air Act and our nonroad emission control programs generally. We will work with the U.S. Coast Guard with regard to the roles and responsibilities of EPA and Coast Guard for carrying out these compliance and enforcement provisions, as well as development of the implementing legislation and associated regulations for Annex VI once it is ratified by the United States.

# CHAPTER 2 - Scope and Applicability

## 2.1 "New Engines" - Foreign Flag Vessels

What We Proposed:

We proposed to apply the proposed standards to engines installed on vessels flagged or registered in the United States.[6] Noting that we have discretion in defining "new nonroad engine" as it is used in section 213 of the Act, we solicited comment on whether it would be appropriate and within our authority to exercise this discretion to define "new nonroad engine" to include marine engines on foreign vessels that enter US ports, in light of environmental and international oceans policy and any other relevant factors, including consideration of their significant emissions contribution to air quality problems in the United States. If we were to regulate engines on foreign-flagged vessels, such engines would be subject to enforcement as a condition of port entry. We also noted that even if we determined that we have the discretion to define "new nonroad engine" as outlined above, we could conclude that the most appropriate exercise of our discretion would involve retention of the 1999 definition of "new nonroad engine," for example, because of 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.

What Commenters Said:

### (A) EPA Should Include Engines on Foreign Vessels

We received comments from many individuals and organizations representing states or environmental interests in support of the idea of applying the proposed standards to engines on foreign vessels (see list below). Nearly all of these commenters noted that the vast majority of vessels transiting along U.S. coastal areas and entering U.S. ports are foreign-flagged and therefore, contribute significantly to $NO_x$, PM and other emissions. Many commenters also provided EPA with data regarding the number of foreign vessels in their area and estimated inventory contributions from the engines on these vessels.

Broward County, Florida told us that they were a nonattainment area for ozone in 1990 but are expecting to achieve attainment designation soon. Since foreign vessels account for the

[6]Today's rule applies to "new" marine diesel engines and to "new" marine vessels that include marine diesel engines. In general, a "new" marine diesel engine or a "new" marine vessel is one that is produced for sale in the United States or that is imported into the United States. The emission standards established in today's rule, therefore, will typically apply to marine diesel engines that are installed on vessels flagged or registered in the United States.

majority of vessels in U.S. ports, they urge EPA to include engines on foreign vessels in the rule to obtain significant reductions in PM and NOx emissions.

Several commenters, including the American Lung Association, Bluewater Network, and Environmental Defense, provided extensive explanations for why, as a matter of law and policy, EPA must impose stringent emission standards to marine engines on foreign-flagged ships that enter U.S. ports. These commenters cited portions of Clean Air Act section 213(a) and case law, and asserted that EPA has the right and obligation to regulate emissions from foreign-flag vessels. Environmental Defense and Santa Barbara also noted that the U.S. has not hesitated to impose environmental standards on foreign-flagged vessels that differ from standards established in international agreements when the level of protection required by Congress exceeds the protection provided by international standards. Currently, foreign vessels are regulated for safety and other issues when they enter U.S. waters and U.S. ports, and that this authority could extend to the regulation of emissions from these vessels as well, which contribute significantly to overall emissions and present serious adverse impacts to public health.

Several commenters took issue with our using tariff criteria as the basis for not regulating foreign vessels, arguing that this approach is not justified under the Clean Air Act. According to these commenters, our definition of "imported" for the sake of determining what is a new engine is inconsistent with the intent of Congress in the Clean Air Act, which was to regulate all classes of nonroad engines that "contribute to" $NO_x$ emissions. Other commenters noted that custom laws and tariff regulations are designed to manage the economic effects of imported goods throughout the national economy in the context of world trade, and that the purpose of U.S. customs law, with respect to "imports" is to impose a duty on merchandise that is brought into the country on a permanent basis, and that in the context of the Clean Air Act, the purpose of applying the term "import" is far different, that is, to reduce pollution from sources operating within U.S. territorial waters and ports.

Finally, CARB and the American Shipbuilding Association stated that by not regulating foreign-flagged ships, EPA will be placing U.S. ships at a competitive disadvantage.

Commenters:

Alaska Department of Environmental Conservation
American Lung Association, et. al.
American Shipbuilding Association
Aron
Bay Area Air Quality Management District
Bluewater Network
Broward County Department of Planning and Environmental
California Air Pollution Control Officers Association
California Air Resources Board (CARB)
Coalition for Clean Air
Committees for Land, Air Water and Species (CLAWS)
Environmental Defense
Northeast States for Coordinated Air Use Management

Ozone Transport Commission
Puget Sound Clean Air Agency
Residents for Less Pollution
Sacramento Air Quality Management District
San Luis Obispo County Air Pollution Control District
Santa Barbara County Air Pollution Control District
South Carolina Department of Health and Environmental Control
South Coast Air Quality Management District
STAPPA/ALAPCO
State of Delaware
Texas Natural Resource Conservation Commission
Ventura County Air Pollution Control District
View from the Hill

**(B) EPA Should Not Include Engines on Foreign Vessels**

We received comments from several individuals and organizations representing manufacturer or shipping interests in opposition to the idea of applying the proposed standards to engines on foreign vessels (see list below). These commenters indicated that we should retain the 1999 definition of "new nonroad engine" that excludes foreign vessels under this rulemaking, and several offered legal justifications for why this is the case. These commenters generally supported retaining the current definition of “new” marine diesel engine and “new” marine vessel that is based on whether an engine or vessel is imported within the meaning of the Harmonized Tariff Schedule of the U.S.

Euromot also noted that if the EPA standards were to apply to foreign flag vessels that enter U.S. ports it would be necessary for all engines on every vessel in the world to be certified by EPA because a ship owner cannot ensure that a particular ship will never enter a U.S. port. The American Bureau of Shipping requested that EPA clarify the right of free passage if foreign vessels are covered in this program.

Commenters:
American Maritime Congress, et. al.(coalition of maritime interests)
American Petroleum Institute
Cotton Club
Department of Defense, Navy
Engine Manufacturers Association
European Association of Internal Combustion Engine Manufacturers
Hyundai Heavy Industries Co., Inc.
International Association of Independent Tank Owners
International Chamber of Shipping
Japanese Shipowners Association
MAN B&W Diesel
Seafarers International Union of North America, AFL-CIO
Wartsila Corporation

Our Response:

This final rule does not apply to marine diesel engines used on foreign vessels that enter U.S. ports.

We will retain our current definition of "new" marine engine, which is modeled after the statutory definitions of "new motor vehicle engine" and "new motor vehicle." When we first finalized this approach, in the 1999 marine diesel engine rule, we concluded that engines installed on vessels flagged or registered in another country that come into the United States temporarily will not be subject to the emission standards.[7] Those vessels are not considered imported under the U.S. customs laws, and do not meet the definition of "new" adopted in that rule. 64 FR 73300, 73302 (Dec. 12, 1999). We continue to believe this is a reasonable exercise of the discretion provided to EPA by the Clean Air Act to interpret "new nonroad engine" or "new nonroad vehicle." See Engine Manufacturers Assoc. v. EPA, 88 F.3d 1075, 1087 (D.C. Cir. 1996).

The May 29, 2002 proposed rule solicited comment on whether to exercise our discretion and modify the definition of a "new" marine engine to find that engine emission standards apply to foreign vessels that enter U.S. ports. As discussed earlier, the standards in this rulemaking will go into effect in 2004. We will also conduct a subsequent rulemaking that will address revisions to these standards for future model years. In this subsequent rulemaking, we will consider adopting more stringent standards that require a longer lead time than the standards adopted in this final rule. The issue of applying these more stringent standards to foreign vessels will also be considered in that subsequent rulemaking.

As noted above, one of the reasons we intend to address a second phase of more stringent standards in a subsequent rulemaking is to facilitate negotiations for appropriate consensus international standards. Adoption of international standards has the potential to maximize the level of emission reductions achieved from emission controls on U.S. and foreign vessels. For example, international standards set at an appropriate level would remove the objections to controlling emissions from engines on foreign vessels. Since engines on foreign-flag vessels account for the majority of emissions from Category 3 marine diesel engines impacting U.S. air quality, successful negotiation of international standards that achieve the greatest emission reduction feasible would result in the greatest improvement to air quality here in the U.S. and around the world. Addressing the long-term standards in the future rulemaking could facilitate such international action, but will also allow us to proceed expeditiously on our own if appropriate international standards are not adopted in a timely way.

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[7]Today's rule applies to "new" marine diesel engines and to "new" marine vessels that include marine diesel engines. In general, a "new" marine diesel engine or a "new" marine vessel is one that is produced for sale in the United States or that is imported into the United States. The emission standards established in today's rule, therefore, will typically apply to marine diesel engines that are installed on vessels flagged or registered in the United States.

Our decision to defer application of the standards to engines on foreign flag vessels is not expected to lead to any significant loss in emission reductions. We fully expect that foreign vessels will comply with the MARPOL standards, whether or not they are also subject to the equivalent Clean Air Act standards being adopted in this final rule. Consequently, no significant emission reductions would be achieved by treating foreign vessels as "new" for purposes of the near-term standards in this final rule and there is no significant loss in emission reductions by not including them.

## 2.2 Other "New Engine" Issues

### 2.2.1 "Model Year" vs. "Date of Vessel Construction"

What We Proposed:

The standards we proposed are based on a "model year" approach whereby engines assembled on or after the first day of the model year must meet the emission limits. As defined in 40 CFR 94.2, model year means the manufacturer's annual new model production period which includes January 1 of the calendar year, ends no later than December 31 of the calendar year, and does not begin earlier than January 2 of the previous calendar year. That provision also specifies that if the manufacturer has no annual new model production period, model year means calendar year. We proposed 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.

What Commenters Said:

The American Bureau of Shipping commented that the difference between the definition of a "new engine" under Annex VI and the corresponding definition under the NPRM should be reconciled. They note that Annex VI applies the requirements to engines (regardless of when they were built) that are installed on ships built on or after January 1, 2000 or to engines built after January 1, 2000, that are installed on vessels built before that date. This definition differs from the NPRM definition of "new marine engine" and could be significant particularly when applied to engines on ships certified under Annex VI. They requested clarification for the scenario of an engine installed on a vessel that was built in 2002.

Our Response:

We are finalizing a definition of model year based on the date the engine is first assembled. Each of the references in the preamble to the assembly date of the engine refer to the final assembly at the manufacturer's facility (first final assembly) and not the final assembly on the vessel. This is clearly stated at 67 FR 37574. At 67 FR 37574 and 37583, the purpose of the discussion is to show that if we base the model year on engine assembly, rather than on the date of keel construction, that manufacturers will have more lead time. If we were discussing final

assembly on the vessel, then the opposite would be true. We have revised the discussion in the final rule to state consistently and clearly that the timing of emission standards is based on the first complete assembly of the engine.

With respect to the specific scenario raised in the comment, engines installed on a vessel built in 2002 would need to meet the Annex VI requirements through a statement of voluntary compliance. Such an engine would be unaffected by this final rule, since EPA certification of engines will not be required until January 1, 2004. Any Category 3 engine manufactured after this date must have a valid EPA certificate before being introduced as a marine engine.

### 2.2.2 New Ship

What We Proposed:

The definition of new vessel is set out in 40 CFR 94.2. This definition is similar to the definition of new engine: 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. 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. This determination should be based on the appraised value of the vessel before modifications compared with the value of the modified vessel. We provided an equation to clarify these requirements.

What Commenters Said:

The American Bureau of Shipping commented that this provision would be difficult to apply uniformly. They also requested that EPA clarify whether the "value before modifications" applies only to those modifications completed at a specific time, or whether this could encompass various modifications completed over a number of years, bearing in mind that the ship is a depreciating asset.

The American Lung Association commented that because EPA includes substantially modified vessels within its definition of "new vessel" it should do the same with respect to its definition of "new marine engine." This is relevant because during the turn-over time period engines are typically rebuilt several times. Requiring marine engines to meet emission standards at the time of rebuild, could lead to substantial additional emission reductions. Therefore, EPA should establish emission standards for $NO_x$ and PM emissions from remanufactured marine engines of all three categories.

Our Response:

We believe that the regulatory provisions we are adopting to clarify when a modified vessel becomes new will provide sufficiently clear guidance to shipowners. The formula we are incorporating into the regulations includes a formula with defined terms that should allow a

shipowner to calculate a percentage figure for comparing to the 50-percent threshold for triggering the requirements that apply to new vessels. This methodology takes into account the fact that a ship is a depreciating asset. Determining a ship's value before and after modifications should be done on a project basis. For example, if a ship goes into dry dock for major modifications, the value of the ship when entering and leaving dry dock would form the basis of evaluating the extent of the modifications. On the other hand, modifying the ship in two stages, each constituting a 30-percent increase in the ship's value, but separated by a token amount of operation away from dry dock, would likely be treated as a single modification for the purpose of determining whether the vessel is "new."

We agree with the American Lung Association that the long lifetime and frequent rebuilds of marine diesel engines slows the realization of emission benefits resulting from new standards. An existing marine engine is not "new" (i.e., ownership has already passed from the manufacturer to the ultimate purchaser). EPA, therefore, does not have authority to set emissions standards for an existing marine engine, beyond any standards applicable to the engine when new. However, when a marine engine that is subject to federal emissions is rebuilt it must be rebuilt to the manufacturer's original specifications. If it is not, then EPA can take enforcement action for violation of the tampering prohibition.

## 2.3 Engine Category Definitions

What We Proposed:

The engine categories for this proposal are the same as those we finalized in our 1999 rule, as follows:

Table 2.3-1
Marine Engine Category Definitions

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

What Commenters Said:

Hyundai Heavy Industries suggested that we modify these definitions. Specifically, they requested that we revised the definition for Category 2 marine engines to be "greater than or equal to" 5 liters per cylinder (as opposed to "greater than") but less than 30 liters. They also

suggested that we revised the definition of Category 3 to be "greater than or equal to" 30 liters per cylinder (as opposed to "greater than").

Our Response:

Hyundai is correct in bringing to our attention that the categories as described at 67 FR 37554 were incorrect. The correct categories are described in Table 2.3-1 and in 40 CFR 94.2.

## 2.4 Inclusion of Gas Turbine Engines and Boilers

What We Proposed:

In our proposal, we indicated that we were not considering including gas turbines in the group of engines covered by the standards. However, we requested comment on this issue and asked commenters to provide us any emissions information that is available, as well as whether it would be appropriate to regulate turbines and diesels together. We also asked commenters supporting the regulation of turbines to address whether any special provisions would be needed for testing and certification of turbines.

What Commenters Said:

The Ozone Transport Commission commented that the marine engine standards, particularly if Tier 2 standards reflecting advanced technologies such as SCR or water injection are necessary, may over time change the economics of ship engine choice, which could lead to a preference for uncontrolled gas turbines over cleaner future diesels. Delaware recommended that "EPA analyze the growth of gas turbine use and, if warranted, should adopt stringent emission limitations applicable to them" in the context of the future rule.

A number of commenters indicated that gas turbine engines should not be included in this rule. Intertanko commented that gas turbines are not in widespread commercial use. Less than 0.05% of all shipping is powered by gas turbines. While a number of older vessels still operate with steam turbines driven by steam generated in boilers fueled by bunker fuel, these sources are insignificant and should not be regulated at this time. The Department of the Navy commented that gas turbines should not be regulated since they burn clean distillate fuels and generally have much lower emissions than diesel engines of similar power. However, they did not provide data to support this point.

The American Bureau of Shipping pointed out that EPA noted that gas turbines are not included in the program, but EPA did not say whether boilers were included or not. Boilers "may use significant quantities of fuel when berthed alongside – particularly in the case of tanker steam turbine driven cargo pumping systems."

Our Response:

Consistent with our proposal, we are not including gas turbine engines in this final rule. We did not receive any additional information from commenters that clarified their baseline emissions (which we believe are lower than diesel engines), what the relevant standards should be, and how to approach testing and certification. We are also not including boilers in this final rule since we did not consider them in our proposal and they are not internal combustion engines under the Clean Air Act. We will, however, consider the applicability of standards to turbines in our future rule.

## 2.5 Geographic Boundaries

What We Proposed:

The proposed standards are intended to apply at all times. Because some emission control technologies that would be used to meet more stringent Tier 2 standards can be turned off, we also indicated we were considering 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 would demonstrate that the engine is in compliance with the relevant standards when it is operated in an area that affects U.S. air quality. It should be noted that this provision would be meaningful only if Tier 2 standards were finalized, because it is intended to be a method to ensure that the emission controls associated with more stringent standards, and so-called on/off technologies in particular, are functioning when the vessel is within a particular air shed.

What Commenters Said:

The Department of the Navy commented that imposing emission standards beyond the contiguous zone of 3 nautical miles from land, is inappropriate and not practically enforceable. In addition, emissions from marine engines 175 nautical miles offshore do not have a significant impact on air quality on-shore.

The American Bureau of Shipping requested that EPA clarify the scope of the requirement that ships operating within 320 km of the U.S. coast need to comply with the standards. The requirement for compliance with the NPRM within 320 km of the U.S. mainland and territories would appear to include ships operating within the territorial waters of adjacent countries together with those ships which transit this 320 km zone between two non-U.S. ports. This requirement needs to be clarified, both in terms of the possibility of jurisdiction over non-U.S. waters and the right of free passage.

Our Response:

At this time, we are not finalizing a requirement that ships demonstrate compliance with the

standards when they are operating within a specified distance of shore. This is because we do not have conclusive data about the distance emissions from ships are transported to land. We will reconsider this matter in our future rule. The transport issue is described in Chapter 7 of this Summary and Analysis of Comments.

For the same reasons mentioned above, and because we are eliminating the foreign-trade exemption, we do not need to clarify the issues of jurisdiction over non-U.S. waters and the right of free passage with 175 or 320 nautical miles of the U.S. coast. However, we will revisit this issue in our future rule.

## 2.6 Other Pollutants Included in MARPOL Annex VI

What We Proposed:

We proposed emission standards for NOx only, as a precursor to ground-level ozone.

What Commenters Said:

The American Bureau of Shipping noted that the proposal does not cover other substances covered by Annex VI, including ozone depleting substances, incineration, and wider aspects of fuel oil quality.

Our Response:

The standards contained in this rule are being promulgated pursuant to our authority under the Clean Air Act. We are not implementing the provisions of Annex VI. There will be separate legislation and rulemaking to incorporate the provisions of Annex VI into national law as part of our ratification efforts.

# CHAPTER 3 - Exemptions and Exclusions

## 3.1 National Security Exemption

What We Proposed:

We proposed to extend the exemptions already contained in Subpart J of 40 CFR part 94 to Category 3 marine engines, including the national security exemption. This exemption applies to engines "used in a vessel that exhibit substantial features ordinarily associated with military combat." It also allows an engine manufacturer to request a national security exemption for an engine. Such a request must be endorsed by an agency of the federal government charged with responsibility for national defense.

What Commenters Said:

The Department of Defense commented that they support a national security exemption as it is necessary to ensure that vessels of the Armed Forces are able to execute their national defense mission. They also commented that they support EPA's proposal not to extend the proposed standards to engines on warships, naval auxiliaries, or other ships owned or operated by a foreign state and used for government noncommercial services.

Our Response:

We are finalizing the national security exemption as proposed.

We are not including a specific exemption for engines used on vessels owned or operated by a foreign state and used for government noncommercial services in this rule, since we are not extending these standards to engines on foreign flag vessels. However, we will consider this issue again when we reconsider whether to include engines on foreign vessels in our future rule.

## 3.2 Emergency Engine Exemption

What We Proposed:

Consistent with our 1999 rulemaking, we did not include an exemption for emergency engines in our proposal.

What Commenters Said:

American Bureau of Shipping and the International Association of Independent Tanker

Owners commented that EPA should include an exemption for emergency engines. They noted that diesel engines used only for emergency purposes must be as simple as possible in order to ensure adequate availability at all times. These engines typically have very few service hours, since they are operated only for testing purposes and should be exempt, since the emissions resulting from testing or emergency use is negligible. They also note that emergency engines are exempt from the emission requirements in Annex VI pursuant to Regulation 13.1(b)(i).

Our Response:

We continue to believe that it is not necessary to extend an exemption to standby emergency engines. Commenters did not point out any technological reasons why engines that comply with the new Tier 1 standards we are finalizing today, equivalent to the internationally-negotiated NOx limits, would be incapable of meeting the performance needs of these engines. Consistent with our position in 1999, we continue to believe that emission-related controls that will be used to meet the standards must be equally reliable for both emergency and non-emergency engines. In addition, we do not extend an emergency exemption to similar engines not used in marine applications. Specifically, land-based emergency engines such as fire trucks and standby generators are not exempt from our emission control requirements in either highway or nonroad applications.

## 3.3 Exemption for Occasional Visits

What We Proposed:

We requested comment on whether engines on vessels that visit U.S. ports only occasionally should be exempted from the proposed emission control requirements. This exemption would apply to engines manufactured after the standards become effective and that are installed on foreign flag vessels that enter U.S. ports. This provision would be meaningful only if emission standards would apply to engines on foreign vessels.

What Commenters Said:

The American Lung Association commented that ships should be regulated regardless of the number of visits, with perhaps a "de minimis" exception for vessels visiting U.S. ports no more than once per year. The State of Delaware commented that all vessels should have to comply with the standards regardless of the number of visits, noting that “either the vessel would be able to comply with the emission standards or, the vessel should be denied the right to enter.”

Our Response:

Because we are not including engines installed on foreign vessels in this final rule, this exemption is not necessary. However, we will consider this issue again when we reconsider whether to include engines on foreign vessels in our future rule.

## 3.4 Foreign Trade Exemption

What We Proposed:

Our 1999 rulemaking included a provision that would exempt Category 1 and Category 2 marine diesel engines on U.S. vessels that spend most of their time outside the United States. This exemption was included because ship owners asserted it would be burdensome for those vessels if these engines need to be repaired or replaced. We proposed to eliminate this foreign trade exemption because the conditions that led to the need for it no longer exist.

What Commenters Said:

While several commenters supported eliminating the foreign trade exemption, there seemed to be some confusion about what this meant. For example, The American Shipbuilding Association "strongly urges" EPA to eliminate this exemption out of concern that this requirement will help "further erode the meager U.S. shipbuilding market share and U.S. shipbuilding industrial base." They are concerned about economic disadvantages for shipbuilders may that arise if U.S. vessels are held to a more stringent standard than foreign vessels. Alaska and Delaware also supported eliminating the foreign trade exemption, because they thought it concerned applying the standards to engines on foreign vessels. Bluewater noted that engines built in the U.S. for use in foreign waters should be required to meet EPA standards, since vessel routes are often changed. The removal of this exemption could also help reduce air emissions in foreign waters.

The OTC also commented that the foreign trade exemption should be eliminated and that such an exemption "could entail complications in implementation." The American Lung Association commented that if the conditions giving rise to the foreign trade exemption ever existed, they no longer hold. Such an exemption would raise administrative and enforcement issues as well as competitive equity issues, and would mean that emission reductions would not be fully realized.

The Chamber of Shipping of America commented that even though it may be true that no entity has requested application of this exemption since its inception, it is critical that the exemption be retained to provide U.S. vessels engaged in international trade, and meeting the exemption's operating criteria, with a level competitive playing field. While recent new ships have not met the requirements for the exemption, retention of the exemption is justified to provide the option for new construction where a U.S. owner contemplates trading routes that meet the criteria.

Our Response:

After considering these comments, we are eliminating the foreign trade exemption. We received no technical justifications for why it should be retained. We also received no comments refuting our justification for eliminating the exemption, as set out in the proposal: that many engine spare parts are kept onboard vessels to enable ship operators to perform maintenance and

repairs while the ship is underway; that spare parts not kept onboard can be obtained quickly via modern package delivery systems; and that, in the unlikely case that an engine fails catastrophically and must be replaced by a compliant engine, the ship operator should be able to make arrangements to obtain a certified engine, since the major manufacturers of marine diesel engines do business abroad as well as in the United States. Consequently, we continue to believe that any burden associated with having compliant engines on all U.S. vessels regardless of where they are used will be minimal or non-existent.

# CHAPTER 4 - Tier 1 Standards

## 4.1 Level of the Tier 1 Standards

What We Proposed:

We proposed a Tier 1 NOx emission standard for Category 3 marine engines which is equivalent to the MARPOL Annex VI NOx limits. As discussed in more detail in Section 4.4, we adjusted the proposed NOx standard to account for differences between the certification test fuel for the proposed standards and the test fuel in Annex VI.

What Commenters Said:

Hyundai, MAN B&W, and Intertanko commented that we should not promulgate U.S.-only Tier 1 standards with deviations from the Annex VI requirements. They commented that we should simply harmonize any rules with Annex VI and should not propose or finalize regulations that deviate from those requirements. Intertanko commented that we did not present a compelling need for the Tier 1 deviations in the proposed rule.

The Engine Manufacturers Association commented that the proposed Tier 1 standards, which they claim pull ahead the Annex VI standards in 2004, seem to be beyond EPA's jurisdiction because the U.S. Senate has not yet voted on the ratification of the Annex VI standards.

The Texas Natural Resource Conservation Commission expressed support of the Tier 1 standards as proposed. Euromot and Wartsila expressed support either applying the Annex VI NOx standard or the proposed Tier 1 standards which are similar. They also commented that all engines that have been installed on ships beginning in 2000 meet the Annex VI requirements; therefore, a 5-25% reduction in NOx has already been achieved.

We received numerous comments stating that the proposed Tier 1 standards should be more stringent. Commenters noted that the proposed Tier 1 standards mimic the Annex VI standards. They stated that these levels are already being achieved with by the majority of national and international vessels and, therefore, the proposed Tier 1 standards will not lead to any additional emission reductions. The American Lung Association et. al. commented that, based on one study,[8] "pre-control" NOx levels for Category 3 marine engines over the past 20-30 years had NOx levels within ± 2.0 g/kW-hr of the Tier 1 standard (after adjusting for the conversion to $NO_2$), and a significant fraction were already in compliance with Tier 1 levels. In addition, commenters noted that the Annex VI standards will be retroactively applied to 2000 once they are ratified, so manufacturers are designing to these standards now.

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[8] Energy & Environmental Analysis, Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data, Report to EPA, November 1999.

Commenters asserted that, because technology exists today for achieving lower emission levels, we should either tighten the proposed Tier 1 standards considerably or finalize Tier 2 standards in this rulemaking. Bluewater Network commented that we should finalize Tier 1 standards requiring an 11% NOx reduction beginning in 2004, followed by more stringent Tier 2 and Tier 3 standards (see discussion of Tier 2 standards in Section 5.1). SCAQMD commented that the proposed standard falls significantly short of achieving the minimum reductions they need from this source category to meet their air quality needs.

Several commenters noted that we are required, under Clean Air Act section 213(a)(3), to establish emission standards that achieve the greatest degree of emission reduction achievable through the application of technology. Commenters stated that the proposed standards for Category 3 marine engines do not achieve the legal requirement under Draft Reg 213(a)(3) because the standards do not reflect the technology that is available for these engines. The technologies identified by commenters are discussed in Section 5.4.

Our Response:

We are finalizing the Tier 1 standards that are the same level as the internationally-negotiated standards. As discussed in Section 6.1, although we are finalizing certain compliance provisions that differ from Annex VI to meet the requirements of the Clean Air Act, we have tried to harmonize our regulations with Annex VI as much as possible. The Tier 1 standards do not pull-ahead the international Annex VI standards because the international standards will go into effect retroactively back to 2000 once they are ratified. We are finalizing the Tier 1 standard for engines on U.S. vessels under the authority of the Clean Air Act. Our analysis of costs and benefits of the rule recognizes that engine manufacturers are meeting Annex VI levels today.

The internationally-negotiated standards represent the greatest degree of NOx emission reduction achievable by Category 3 marine diesel engines by 2004. Any emission standard required under section 213(a)(3) of the Act must be "achievable" through "technology which will be available," considering among other things "the cost of applying such technology within the period of time available to manufacturers." We believe it would be unreasonable to require more stringent standards for marine diesel engines, including Category 3 marine diesel engines, by 2004 because new marine engines that will be subject to the standards being adopted have already been designed to meet these standards. Setting more stringent standards would require more lead time for manufacturers to design and build new engines to meet such standards.

We are including a regulatory provision to establish a schedule for a future rulemaking to promulgate any additional engine controls that we determine are appropriate under section 213(a)(3) of the Act. This is discussed further in Section 5.5.

## 4.2 Lead Time

What We Proposed:

We proposed to apply the Tier 1 emission standards for new engines built on or after January 1, 2004.

What Commenters Said:

Hyundai commented that compliance to Tier 1 standards should not be required until at least 3 years following promulgation to allow manufacturers time to develop internal testing procedures at both the engine shops and on-board ships.

Our Response:

Because manufacturers are already manufacturing engines that are compliant with the internationally negotiated NOx limit, a long lead time is not necessary for manufacturers to comply with this rule. We are not finalizing any differences in the test procedures or NOx limits compared with the internationally negotiated NOx requirements that would cause manufacturers to need to develop new internal testing procedures. Therefore, we are finalizing the proposed implementation date of 2004.

## 4.3 Effect of Certification Fuel on Tier 1 NOx Standard

What We Proposed:

As discussed in detail in Section 8.1, we proposed that manufacturers must certify that they meet the applicable standards on either distillate or residual fuel. In contrast, the Annex VI standard is based on testing with distillate fuel. While distillate fuels generally have nitrogen levels of 0.0 to 0.4 weight percent, residual fuels typically have higher nitrogen concentrations (0.2 to 0.6 weight percent). To appropriately account for the emission-related effects of fuel quality, we proposed to adjust the NOx standard upward by 1.4 g/kW-hr. We based this adjustment on a difference in nitrogen concentration of 0.2 weight percent and a brake-specific fuel consumption of 220 g/kW-hr. The difference in nitrogen concentration is based on average nitrogen contents of 0.2 weight percent for distillate and 0.4 weight percent for residual.

What Commenters Said:

The Engine Manufacturers Association supports the proposed adjustment in the Tier 1 standard which is intended to account for the nitrogen content in residual fuel. For Category 1 and 2 engines, they commented that the equations in 40 CFR 94.108 (b)(2) and (e)(3) should be clarified to state that the BSFC term, noted as “measured brake specific fuel consumption,” refers to the weighted value over the certification test cycle.

We received several comments regarding the difference in average fuel nitrogen content between distillate and residual fuel used in the development of the proposed nitrogen correction factor. The American Bureau of Shipping commented that a difference of 0.38 weight percent nitrogen should be used. They commented that the data from the Lloyd’s report used by EPA to determine the nitrogen content of marine fuel includes only 22 residual fuels with an average of

0.36% nitrogen. They stated that this value increases to 0.40% if only the heavier, higher viscosity, residual fuel oils are considered. According to ABS, the use of such a limited number of samples on which to base such values is questionable. They stated that it is not uncommon to encounter residual fuel oils with nitrogen contents up to around 0.8%. ABS also commented that the Lloyd's report only gives actual nitrogen content for 13 samples (excluding a clearly erroneous value of 0.72%) that average 0.02%. They stated that this report also gave data for 9 additional gas oils for which the nitrogen content value was only described as "less than 0.3%." ABS commented that it appears that the 0.2% value was obtained by taking the values given as "less than 0.3%" as 0.3% and by including the 0.72% value.

Hyundai commented that we should assume that the difference in the average nitrogen content of marine distillate and residual fuel is 0.3 weight percent. According to their data based on fuel oil analyses between January 2000 and June 2002 (97 samples), the average nitrogen content in marine distillate fuel is 0.1% m/m. They commented that they do not have any actual analytical data regarding the nitrogen content of marine residual fuel but support the 0.4% value used in the NPRM. Euromot commented that fuels used during certification at different licensee's test beds varied between 0.01% to 0.6%; more than 70% of these cases had a nitrogen content below 0.1%. Intertanko commented that the nitrogen content of marine distillate fuel is approximately 0.02% and that the nitrogen content of residual fuel ranges from 0.2% to 0.6%.

We also received comments regarding the brake-specific fuel consumption used in the NPRM for calculating the nitrogen correction. Hyundai commented that we should assume the fuel oil consumption for Category 3 marine engines to be 220 g/kW-hr for speeds rated above 130 rpm, and 200 g/kW-hr for speeds rated at or below 130 rpm. Hyundai stated that existing fuel oil consumption rates of today's marine 2-stroke, low-speed and crosshead diesel engines (MAN B&W MC/MC-C, Wartsila RTA, and Mitsubishi UEC engines) is less than 200 g/kW-hr. The American Bureau of Shipping commented that typical crosshead/slow speed engines have fuel consumption rates around 170-180 g/kW-hr. The American Lung Association et. al. commented that we should use actual data on fuel consumption for fuel nitrogen adjustments. They commented that the proposed methodology maximizes the size of the adjustment by using a fairly conservative BSFC value and assuming all fuel nitrogen is converted to NOx. Because BSFC can be calculated from the carbon balance, they commented that it is not clear why EPA needs to assume the value.

Based on the nitrogen and fuel consumption values discussed above, Hyundai commented that the NOx standard should be $45.0 \times n^{-0.2} + 2.1$ g/kW-hr for engines rated above 130 rpm and 18.9 g/kW-hr for engines rated at or below 130 rpm. Similarly, ABS commented that the NOx standard for engines rated at or above 130 rpm, should be $45.0 \times n^{-0.2} + 2.2$ (or 2.7) g/kW-hr and the standard for engines rated "below" 130 rpm, should be 19.4 (or 19.9) g/kW-hr.

Intertanko commented that the NOx Technical Code adequately reflects the nitrogen content of fuel oil. The NOx Technical Code provides for an allowance of 10% to adjust for the nitrogen content of residual fuel oils. For a slow speed engine operating below 130 rpm, which is the majority of 2-stroke Category 3 engines, the allowance would be 10% of 17 g/kW-hr or 1.7 g/kW-hr, which differs from the proposed value of 1.4 g/kW-hr. MAN B&W commented that

the 10% allowance should be kept at least until actual documentation of the fuel-bound nitrogen influence is available and that any future changes should be introduced in cooperation with IMO. Caterpillar commented using a 1.4 g/kW-hr NOx adjustment rather than a 10% adjustment causes the proposed rule to be different than the Annex VI NOx standards and that substantial work will be needed beyond the development effort already completed for MARPOL.

Euromot, Wartsila, Caterpillar, JMEA, and JSA commented that fuel properties other than nitrogen content can influence the level of NOx emissions from diesel engines. These fuel properties include ignition quality (related to cetane in distillate fuel) and combustion performance. They commented that these and other fuel parameters are not fully investigated in this context. Euromot and Wartsila argued this supports the conclusion that distillate fuel is more reliable and accurate for use in measuring or estimating emissions. Caterpillar further commented that using nitrogen concentration to adjust NOx is questionable because fuel bound nitrogen will not affect the equilibrium concentration of nitric oxide in the hot regions of the flame zone where NOx is formed. The Santa Barbara County Air Pollution Control District questioned if there is emission-test data available showing that emissions differences from operating on distillate versus residual fuel can be calculated based on just nitrogen and sulfur contents of the fuel.

Our Response:

For the final Tier 1 standards, we will accept data for certification based on testing with either distillate or residual fuel. Because most or all manufacturers have been using distillate fuel to comply with Annex VI requirements, we expect manufacturers to meet the near-term standards generally by submitting their available emission data from testing with distillate fuels. Therefore, a fuel correction factor is not necessary for this rule.

Vessels with Category 3 marine engines primarily use residual fuel; therefore, we believe that long-term standards should be based on actual in-use fuels. In developing Tier 2 standards, we will reconsider the proposed fuel correction factor based on the comments that we received and other information that becomes available.

## 4.4 Including Category 1 and Category 2 Engines in Tier 1

What We Proposed:

We proposed to apply the Tier 1 standard to engines with specific displacement between 2.5 and 30 liters per cylinder in the near term. This would apply to these engines from 2004 to 2006, after which the already established EPA Tier 2 marine engine emission standards would apply (64 FR 73300, December 29, 1999).

What Commenters Said:

Caterpillar commented that the proposed Tier 1 standards are substantially different than the Annex VI requirements which will increase development and documentation costs.

The Engine Manufacturers Association commented that we should not finalize the provision to adopt new certification requirements for Category 1 and 2 engines (2.5 to 30 liters per cylinder). They stated that most domestic engine manufacturers have obtained IMO statements of voluntary compliance and that this proposal would require those manufacturers to recertify with EPA each year, which would lead to additional paperwork and costs for the certification applications with a minimal emissions benefit. EMA stated that, if we finalize the Tier 1 standards, we should adopt procedures to allow existing IMO statements of voluntary compliance to be converted to EPA certificates without any additional certification requirements and we should allow for simplified letter carryovers from year to year. This approach would help harmonize the proposed requirements with Annex VI and would help manufacturers meet the requirements in the proposed time frame. EMA also commented that even if Category 1 and 2 marine engines are included under the Tier 1 standards, that engines less than 130 kW should be excluded because they are not covered under the MARPOL Annex VI NOx standard.

EMA commented that the Tier 1 implementation date for Category 1 and 2 engines does not allow adequate lead time for compliance because manufacturers will have less than 12 months to comply, assuming the rule is finalized in early 2003. To allow for a more appropriate lead time and better coordination with anticipated ratification, EMA commented that the effective date for mandatory compliance should be 2005 at the earliest.

Our Response:

We are finalizing Tier 1 standards for Category 1 and 2 marine engines with specific displacements above 2.5 liters per cylinder. These standards are based on the Annex VI requirements; therefore, we do not believe that these standards will significantly increase development and documentation costs. As discussed in Section 6.1, we have tried to harmonize our regulations with Annex VI as much as possible for the Tier 1 standards being adopted here. Because of the similarities between the Annex VI and Tier 1 requirements, and because manufacturers are already meeting the Annex VI requirements, we do not believe that additional lead time is necessary. Because the Tier 1 standards apply only to engines with a specific displacement of 2.5 liters per cylinder or more, we do not believe that any engines with less than 130 kW will be affected. As discussed in Section 6.1, we do not believe that it would be consistent with the Clean Air Act to convert IMO statements of voluntary compliance to EPA certificates without any further certification requirements.

# CHAPTER 5 - Tier 2 Standards

## 5.1 Level of the Tier 2 NOx Standard

What We Proposed:

We requested comment on finalizing a Tier 2 NOx emission standard for Category 3 marine engines. In the NPRM, we considered a Tier 2 level equivalent to a 30 percent reduction beyond Tier 1, and we requested comment alternative Tier 2 levels of 50 percent and 80 percent below Tier 1.

What Commenters Said:

Several commenters stated that we should not implement Tier 2 standards at this time. They argued that we should simply harmonize any rules with Annex VI and should not propose or finalize regulations that deviate from those requirements. The Department of the Navy commented that we should seek stricter emissions standards through the International Maritime Organization and an amendment to Annex VI. EMA, Intertanko, and the Cotton Club commented that, in any efforts to establish Tier 2 standards in the future, we should work together with international regulatory bodies to develop uniform standards. They commented that this approach would ensure that unwarranted costs and competitive disadvantages are not imposed on domestic manufacturers in the international marketplace. In addition they commented that there is no basis in the underlying emissions inventory data for EPA to proceed independently with the Tier 2 standards, because they will apply only to U.S.-flag ships. EMA also commented that U.S.-flagged Category 3 vessels do not require regulation under section 213(a) of the Clean Air Act because these vessels contribute a “de minimus” amount of pollution in the U.S.

Euromot and Wartsila commented that advanced technologies can be expected to be ready from the engine manufacturer by 2007. However, given all the parties that are involved in building a new ship, the target is very challenging. They commented that if the Tier 2 standards are to be finalized in this rulemaking, EPA should consider requiring a 15-20% NOx reduction in 2007. We could then pursue a 40% NOx reduction by making use of further developments in dry cylinder combustion to achieve lower NOx values as well as wet methods for further reductions. They recommended that these further reductions be stimulated with incentive programs.

We received numerous comments that we should implement Tier 2 standards in this rulemaking, but that they should be more stringent than the 30% NOx reduction discussed in the proposal. SCAQMD commented that more stringent standards at this time are warranted and should not be delayed any further because of IMO's future actions. They argued that more stringent standards by EPA would in fact foster and expedite the development and commercialization of the control technologies for marine engines and would even facilitate

IMO's adoption of the Tier 2 standards. NESCAUM commented that Tier 2 standards should be imposed in this rulemaking because the Tier 1 standards achieve nothing beyond what is already being done and do not reflect the latest developments in technology. Several commenters stated that the Tier 2 standards discussed in the NPRM do not meet the requirement under Clean Air Act section 213 that EPA establish nonroad engine emission standards that achieve the greatest degree of emission reduction possible using available technology.

The American Lung Association et al. and CAPCOA commented that the Tier 2 standard should at least achieve a 50% reduction in NOx beyond Tier 1. Commenters stated that this is feasible through the use of technology that introduces water into the combustion process, which has been successfully tested on a number of marine vessels and would be cost effective. The American Lung Association et. al. commented that this level of reduction can be achieved with combustion chamber changes and common rail fuel injection. STAPPA/ALAPCO, OTC, and Delaware commented that the Tier 2 standards should reduce NOx by a minimum of 80% beyond the proposed Tier 1 standards. They commented that this would be feasible given SCR technology and the long lead time discussed for the Tier 2 standards in the NPRM.

Several state and environmental organizations commented that if the highest possible reductions are not achieved through a stringent Tier 2 NOx standard, we should also consider a third tier of standards that could be achieved through the use of Selective Catalytic Reduction (SCR). ARB commented that we should finalize a Tier 2 standard with a 30% NOx reduction but also add a Tier 3 standard with an 80% NOx reduction. Several other commenters stated that a 50% reduction should be required for Tier 2 and an SCR-based standard (80-95% reduction) should be required in the future. SAQMD and SBCAPCD commented that the rule should go beyond existing technology and set technology-forcing standards similar to Tier 2 and Tier 3 standards for land-based nonroad diesel engines, which range from 4 to 6.4 g/kW-hr.

Our Response:

We are not finalizing Tier 2 standards in this rulemaking. However, as discussed in Section 5.5, we are committing to a future rule in which we will pursue Tier 2 standards. In our proposal, we considered a 30-percent reduction below Annex VI levels to be the primary option for adopting long-term standards for Category 3 marine diesel engines. Comments on the proposal made two things clear. First, engine manufacturers pointed out that engine-based technologies would generally not allow them to reduce emissions by an additional 30 percent. They commented that this standard would require them to use more advanced technologies, such as water injection or selective catalytic reduction. Second, commenters representing environmental and state interests strongly objected to emission standards that rely on engine-based technologies, because these other advanced technologies are available and appear to be cost-effective. Manufacturers were generally supportive of applying advanced technologies to achieve greater reductions as long as we allow enough time to work out remaining technological issues. As a result, we are no longer considering standards based exclusively on engine-based controls. We instead plan to focus on the alternative technologies presented in the proposal, which are projected to reduce emissions significantly beyond 30 percent.

This schedule for our future rule will allow us to coordinate our actions with those of the U.S. government with respect to negotiations for a second tier of standards under MARPOL. In 2000, the United States requested the Marine Environment Protection Committee (MEPC) to consider more stringent emission controls for marine diesel engines. We anticipate that MEPC will begin these discussions in the next 12 to 18 months. At the same time, while harmonizing with future more stringent MARPOL emission limits is desirable, the standards contained in our future rule will be promulgated pursuant to the Clean Air Act and will be required to meet the requirements of section 213(a)(3) of the Act, which requires that we adopt standards based on the greatest degree of emission control achievable from available technologies.

## 5.2 Level of the Tier 2 HC and CO Standards

What We Proposed:

We also requested comment on finalizing Tier 2 HC and CO emission standards for Category 3 marine engines. In the NPRM, we considered standards of 0.4 g/kW-hr HC and 3 g/kW-hr CO. The HC standard represents the baseline level for today's engines and would achieve modest reductions or, more likely, serve to prevent emission increases in the future that might otherwise result from reducing NOx. We also asked for comment on setting a combined HC+NOx standard. For CO, the standard under consideration in the NPRM was intended to prevent large increases in CO when NOx technology is applied. Although the baseline CO level is generally below 1 g/kW-hr, we were concerned that a tighter standard would cause manufacturers to spend a disproportionate amount of effort developing emission control technologies for small changes in CO.

What Commenters Said:

Several state and environmental groups commented that we should include HC and CO standards as part of this rulemaking. Commenters stated that these standards, if stringent enough, could prevent backsliding in emissions and would ensure that HC and CO emissions do not increase in the future due to the control of other pollutants or increased vessel activity. The American Lung Association et. al. and Environmental Defense commented that in accordance with Clean Air Act section 213(a), EPA must analyze what level of CO and HC emissions is possible given current technology and set the standards accordingly. They commented that a 3 g/kW-hr standard for CO is not adequate given that uncontrolled CO levels are generally less than 1 g/kW-hr. Therefore, they commented that we must establish an emission standard for CO that is 1 g/kW-hr or lower in order to prevent backsliding.

Some engine manufacturers and shipping interest groups commented that we should not implement standards for HC and CO at this time. The Chamber of Shipping commented that more information is needed in the context of marine operations, such as the relative contributions of marine mobile sources to national inventories, and the capability of existing emissions control technology to meet future requirements in the marine operating environment. Hyundai commented that additional information should be collected on HC and CO emissions before any standards are set, such as the impact of water-based technology and data from engine testing

(prior to use) and from on-board diagnostic equipment. Wartsila commented that HC and CO emissions are generally low due to the high efficiency of Category 3 marine engines, and therefore should not be regulated.

Engine manufacturers and shipping interest groups proposed alternative HC emission standards. Hyundai commented that if HC standards are included, they would support a standard of 3.0 g/kW-hr using marine diesel oil (ISO F-DM grade). Wartsila, Euromot, and Intertanko recommended a HC standard of 1.5 g/kWh. MAN B&W recommended a HC standard of 1.4 g/kW-hr. Hyundai presented HC emissions for one of their engines which ranged from 0.2 to 1.4 g/kW-hr. Wartsila and Euromot commented that large marine diesel engines emit HC in the range of 0.6-1.1 g/kWh at full load and 1.0-1.8 g/kWh at part load. They stated that HC emissions could be reduced on 2-stroke engines using new injection nozzle designs that have a reduction potential of 50% to 60%, and are currently under development; however, this technology could not be used in all cases to meet the 0.4 g/kWh standard because practically all options for reducing HC emissions from 4-stroke engines have already been implemented. Intertanko commented that NOx reduction strategies reduce temperature in pressure in the cylinder which can prevent certain hydrocarbon species from combusting efficiently, especially for high-density fuels used in the United States. Also, they commented that changing to distillate fuel can also result in increased HC for engines that are designed to run on residual fuel because the pumps and engine parameters are intended for residual fuels. MAN B&W commented that HC is dependent on fuel quality, which is difficult to predict, and virtually impossible to monitor on board.

Engine manufacturers also commented that the proposed CO standard of 3.0 g/kWh could be met, but may be difficult and costly in some cases. Wartsila and Euromot commented that CO emissions are typically 0.5-1.2 g/kWh at full load and 0.6-3.0 g/kWh at part load so it appears that the standard can be met in most cases. However, they also commented that in some cases, CO reductions could necessitate the use of costly technical measures. They stated that an oxidation catalyst for CO reduction is not applicable due to the sulfur in the fuel and the conversion of $SO_2$ to $SO_3$ may clog the surface when in contact with water or could lead to the corrosion of systems installed after the catalyst. Hyundai presented the CO emissions range for one of their engines as 0.2-2.1 g/kW-hr. They commented that if CO standards are included, they would support a standard of 3.0 g/kW-hr using marine diesel oil (ISO F-DM grade). MAN B&W commented that they have no objections to the suggested CO limit, but feel that CO regulation is not necessary.

Bluewater, ARB, Coalition for Clean Air, and Environmental Defense commented that separate emission limits should be set for both CO and HC. They stated that HC and NOx should not be combined into a single standard so that HC does not increase as NOx emissions are reduced. Hyundai and MAN B&W commented that if a HC standard is finalized, it should not be combined with the NOx standard.

Our Response:

We are not finalizing Tier 1 emission standards for HC or CO emissions because the short

lead time does not allow manufacturers sufficient time to do the testing and design work that would be necessary to ensure compliance with such standards. However, in the future rulemaking, we will again consider the need to adopt emission standards for HC and CO emissions and the appropriate levels for those standards. Although HC and CO emissions are generally low from diesel engines, hydrocarbon emissions nevertheless combine with NOx emissions to form ozone; HC and CO can also have direct health impacts. Setting standards for HC and CO may achieve modest emission reductions, but more importantly, may be necessary to prevent HC and CO emission increases that might otherwise result from controlling NOx emissions alone.

## 5.3 Lead Time

What We Proposed:

We requested comment on an appropriate schedule for potential Tier 2 standards. In the NPRM, we discussed 2007 as an appropriate implementation date for achieving a 30% NOx reduction beyond the proposed Tier 1 standards.

What Commenters Said:

Wartsila and Euromot commented that the proposed Tier 1 or Annex VI NOx standard should be the current standard until advanced technologies are ready, validated and tested. Considering all the parties involved, and the technological and logistical challenges, the proposed time line for implementation of the Tier 2 standards would be challenging and would be feasible only if a smaller NOx reduction were targeted in 2007. Hyundai commented that if Tier 2 standards are finalized in this rulemaking, they should not be implemented until 2009 to allow time for manufacturers to develop and test adequate control technologies. They stated that there are a number of issues that need to be addressed prior to the implementation of the proposed Tier 2 standards, such as ensuring adequate control technologies and completing a sufficient number of tests for this technology at both the engine manufacturer's testing facilities as well as on board the vessel. Intertanko commented that the industry has made measurable progress in recent years and that the Tier 2 standards might be achievable given enough time; however, achieving Tier 2 levels is impractical by 2007 because there is a lack of proven technology for 2-stroke engines.

Several state and environmental organizations stated that we should finalize the Tier 2 standards in this rulemaking and should maintain a compliance deadline of 2007. Some of these commenters stated that we should establish an earlier compliance deadline of 2006. They commented that the technology already exists to meet Tier 2 levels.

Our Response:

As discussed above, we are not finalizing Tier 2 standards in this rulemaking. We intend to focus on technologies, in a future rulemaking, which we believe can be used to reduce NOx emissions significantly more than 30 percent below Tier 1 levels for Category 3 marine diesel engines. The emission-control systems expected include a combination of optimized in-cylinder

controls and advanced technologies such as selective catalytic reduction and water. These advanced technologies are discussed in Section 5.4. In the future rulemaking, we will consider the appropriate implementation schedule for potential Tier 2 standards. This schedule will consider not only what technology is available at that time, but technology that we project will be available within the given lead time.

## 5.4 Technological Feasibility/Stringency

What We Proposed:

We based the Tier 2 emission level of a 30 percent reduction beyond Tier 1 standard on potential in-cylinder control strategies. These control strategies include further optimizing engine 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 also discussed alternative Tier 2 NOx standards of 50 and 80 percent below the proposed Tier 1 standards. The 50 percent reduction was based on water introduction strategies such as water emulsion, injection, and humidification. The 80 percent reduction was based on selective catalytic reduction (SCR) or fuel cell technology.

What Commenters Said:

Vessel operator and fuel production interest groups commented that large marine diesel engines are generally designed and manufactured outside the U.S. by a small number of manufacturers; therefore, we should consult with these manufacturers and should seriously consider their views and recommendations as they evaluate the costs, capabilities and expected advances in NOx and SOx control technology. Vessel operator groups also commented that we need to distinguish between 2-stroke and 4-stroke engines in our analysis of standards and control technologies. Intertanko commented that there is no proven technology for 2-stroke engines, which make up the bulk of the power for the international ocean-going fleet, for achieving Tier 2 emission levels.

The rest of this comment summary is divided into three sections based on the primary technology types discussed by commenters: optimized engine designs, introduction of water into the combustion process, and selective catalytic reduction.

*Optimized Engine Designs*

The American Lung Association et. al. commented that there are no apparent fundamental combustion differences between medium speed Category 3 diesels and on-road diesel engines, which have achieved NOx reductions of 50% relative to 1979 levels with only combustion chamber modifications and use of advanced fuel injection and atomization systems. They stated that NOx reductions of 70 to 75% could be achieved using exhaust gas recirculation (EGR); however, they acknowledged that EGR would not be practical with the use of high sulfur fuel. They also noted that advanced common-rail fuel systems are becoming available for Category 3 engines. The American Lung Association et. al. concluded that 50% reductions beyond Tier 1

levels could be achieved through in-cylinder control strategies (without the use of EGR) which would translate to a NOx standard of 4-5 g/kW-hr. MSTP HELLAS commented that they make fuel and oil additives that will reduce NOx by 40%, HC by 75%, and soot/particulate by 75-85% while increasing fuel economy by 6%.

The Chamber of Shipping of America stated that we should not assume that all established emissions control technologies can be easily "marinized" for shipboard application. They claimed that, during promulgation of the Category 2 requirements several years ago, we made the assumption that locomotive engine emissions reduction technology would be readily transferable to marine application, when in fact, a number of design and engineering changes were necessary. They concluded that easy marinization of land based technologies should not be assumed without extensive testing to determine if the harsh operating environment in which marine engines must perform will affect the performance of the technologies in question.

Engine manufacturers commented that optimizing in-cylinder control will not achieve a 30% reduction in NOx beyond the proposed Tier 1 standard. They commented that ignition timing retard would result in lower cylinder temperatures which would increase soot formation, which leads to durability issues and smoke, and increased fuel consumption. Wartsila and Euromot commented that there are a number of engine tuning measures, but they can be used only to a limited extent. They stated that changes to injection nozzle design, injector position, injection duration, or valve timing are often limited by temperatures in the engine and may negatively affect smoke. To achieve the Annex VI limits, they commented that they have already maximized the geometric compression ratios of their engines and are further limited by piston position. They commented that they cannot use exhaust valve timing to change the effective compression ratio on 2-stroke engines because NOx would be increased by the change in the air excess ratio. In the other direction, they commented that exhaust valve timing cannot be used to decrease the air excess ratio without considering negative impacts on blowback, smoke and thermal load. Wartsila and Euromot commented that increasing fuel-air mixing through turbulence will increase NOx. They also stated that internal EGR strategies using scavenge air ports, valve timing, and turbocharging can increase the thermal load in the engine which may not be suitable without also injecting water into the cylinder. MAN B&W commented that electronically controlled engines have been recently sold into the market but the number of electronically controlled 2-stroke engines is still limited. Wartsila and Euromot commented that, for engines with common rail fuel injection, another 10-15% NOx reductions is possible through fuel injection optimization; however, this would result in increased fuel consumption. Combined, they commented that these technologies can achieve only a 15-20% NOx reduction.

Engine manufacturers concluded that a Tier 2 standard requiring a 30% NOx reduction can be achieved only through advanced technologies such as exhaust gas recirculation (EGR), water introduction into the cylinder, or selective catalytic reduction (SCR). Wartsila and Euromot commented that EGR has a high potential for NOx reduction, but can be applied only in combination with clean fuels, such as natural gas or gas oil. They stated that recirculating exhaust gas with an engine running on residual fuel would lead to corrosion and fouling problems due to the sulfur and the heavy metals in the exhaust gas, unless the exhaust gas is cleaned by costly measures. Comments on water introduction technology and SCR are discussed below.

*Water-Introduction Technology*

The State of Delaware commented that the technology involving the introduction of water into the combustion process is capable of reducing NOx levels by 50% below Tier 1 levels depending on the ratio of water to fuel and the method of introducing water into the combustion chamber.

In their comments, Wartsila and Euromot distinguished between three methods of introducing water into the combustion chamber: fuel/water emulsion, direct water injection, and humidification. They commented that fuel/water emulsion may be a solution with an emission reduction potential of 40%. However, they stated that reductions are dependent on the fuel injection system (common rail, or camshaft engines with or without optimized fuel pumps) and that on mechanical engines, where the water amount is limited by the capacity of the fuel pump, the NOx reduction potential is 15-20%. Manufacturers indicated that this method needs to be verified during onboard measurements and long term testing. They also stated that injection of water directly into the cylinder is a method under development, with a NOx reduction potential of about 50%. They commented that this technology is available today for some 4-stroke engine types and has been tested on 2-stroke engines as well. Wartsila and Euromot commented that humidification of the scavenging air in 4-stroke engines has been tested and can be used to achieve a 40% to 60% NOx reduction and should be available for commercial application in the future. However, they stated that this technology has not been tested on 2-stroke engines yet due to concerns that scavenging the cylinder with humid air could affect the oil film on the cylinder liner. For all of the water introduction technologies, Wartsila and Euromot commented that large amounts of fresh water are necessary. They commented that this fresh water might not be available at low loads where the engine does not produce enough heat for fresh water generators or in coastal regions where the sea water quality may not be sufficient for fresh water generators.

MAN B&W and Euromot commented that their experience is that water emulsion or direct water injection can achieve reductions of 40-50% with maximum water amounts equivalent to 50% of the fuel volume depending on the fuel injection system. They stated that experience with this technology is limited to certain engine types and cannot be considered to be generally applicable to all Category 3 marine engines. MAN B&W stated that current water-emulsion systems on 2-stroke engines used for power plants achieve NOx reductions in the range of 30-40%. They commented that the feasibility and reliability need to be demonstrated in the marine environment, where load changes and low load are much more frequent. They concluded that a 50% or more reduction in NOx emissions is not likely due to the combustion deterioration with more than 50% water content in the emulsion.

*Selective Catalytic Reduction (SCR)*

Several state and environmental organizations commented that NOx emission reductions in the range of 80% to 95% beyond the proposed Tier 1 standard are possible through the use of SCR. The Ozone Transport Commission commented that in 1996, SCR use was documented in

several bulk carrier and ferry applications.[9] The California Air Resources Board commented that SCR was incorporated in the design of four new oceangoing ships with slow-speed 2-stroke Category 3 engines in California about 10 years ago, and these ships continue to operate while achieving greater than 90% NOx reductions.

NESCAUM commented that SCR could be effective at reducing NOx emissions within 100 miles of ports. A recent NESCAUM study of Boston Harbor emissions found that within 100 miles of the port, full cruise pollution made up 40% of Category 3 engine emissions, which illustrates the fact that full load operation near the port does impact Boston Harbor air quality. Significant traffic operating at full load in the shipping lanes outside of Northeast ports contributes to air pollution in the Northeast and other coastal areas. They stated that Santa Barbara estimates that marine vessels contribute about 37% of total NOx in their area, which is expected to increase to 62% by 2015 and is primarily from vessels in transit at full load operation. Therefore, NESCAUM concludes that we should not be concerned that SCR would not be very effective at reducing NOx due to low load operation near ports.

Engine manufacturers agreed that an 80% reduction in NOx could be achieved through the use of SCR. However, they commented that the costs are high, so this technology should be applied only on a voluntary basis. Hyundai and Euromot commented that this technology is restricted to use with fuel with a sulfur content below 1% by weight. They commented that SCR has been demonstrated only with this lower sulfur fuel and higher sulfur fuels could affect durability. Intertanko claimed that low sulfur fuel is necessary because sulfur rapidly sours the catalytic urea.

Intertanko commented that SCR technology is not practical given the length of ocean voyages and the size of tanks required to contain the catalyst. They stated that SCR technology raises significant practical problems concerning disposal of by-products, the design of vessels to accommodate urea, and fitting large equipment in an already confined space such as the engine room. They commented that the size of the equipment (not counting the requirements for storage of catalytic material and by-products), is equivalent to 40% of the size of the main engine. They also claimed that SCR would be ineffective for 2-stroke engines due to the lower exhaust gas temperatures and the operating temperature requirements of the catalyst. The Chamber of Shipping of America commented that several issues need to be resolved before SCR can be applied to all vessel types. They commented that there are no flag state or classification society approvals that permit carriage of this substance other than as cargo and they claimed that there could be operating safety issues associated with SCR. CSA recommended coordination between the agencies responsible for overseeing safety and environmental issues regarding the operation of vessels.

Our Response:

[9] "Warship Application of Compact SCR Plant for Diesel Exhaust Emission Control." Lt. Cdr B.L. Burlingham, BSc, Ceng, MIMarE, RM, The Institute of the Marine Engineers' Third International Naval Engineering Conference and Exhibition, April 1996.

As discussed above, the future rulemaking will focus on technologies that we believe can be used to achieve significantly more than a 30 percent NOx reduction beyond Tier 1 for Category 3 marine diesel engines. In doing so, we will consider the technological approaches discussed above. Although we do not believe it is appropriate to set standards for Category 3 marine engines based on these approaches at this time, we believe that remaining technological and operational issues can be addressed in the future. These issues are discussed in detail in Section IV of the preamble and Chapter 5 of the Final Regulatory Support Document.

## 5.5 Future Rulemaking

What We Proposed:

If we were to adopt Tier 2 standards as part of this rulemaking, we proposed to revisit and reopen the Tier 2 standards in approximately 2005. At that time we would fully reassess the circumstances and re-determine the appropriate level of the standards. We also stated that if we did not adopt Tier 2 standards in this rule, we would establish a schedule for a future rulemaking to address Tier 2 standards. The schedule for this future rulemaking would also be approximately 2005.

What Commenters Said:

SBCAPCD, CAPCOA, and Bluewater Network commented that we should finalize technology forcing standards with periodic technical reviews. SBCAPD commented that such reviews would encourage technology advancement for new marine engines in contrast to the proposed rule, which would provide no regulatory encouragement for technological advancement. CAPCOA commented that we should set dates for these reviews. Bluewater Network recommended two tiers of technology forcing standards with a technology review in 2005 to make sure that these standards are appropriate. Bluewater Network commented that we must finalize Tier 2 standards in this rule because delaying the promulgation of the Tier 2 standards is inconsistent with EPA's obligations under the Clean Air Act, which requires EPA to have established standards that achieve the statutory goal by November 1992.

Engine manufacturers and shipping interests commented that it would be premature to finalize Tier 2 standards at this time and that we should not finalize Tier 2 standards until such standards can be developed along with international regulatory entities to ensure fully uniform and harmonized standards. They argued that the need for harmonized regulations justifies the deferral of Tier 2 standards. Instead they commented that we should establish a schedule for a future rulemaking to finalize Tier 2 standards. Hyundai specifically commented that the future rule should finalize Tier 2 standards in 2004. The American Shipbuilding Association commented that if these standards are finalized in the proposed rule, we run the risk of establishing unrealistic standards that cannot be met if projected advancements in technology do not occur. They argued that it is not prudent to base a standard on the premise that future advances in technology will allow orderly compliance with the standards, especially when validated technology does not exist at the time the standards are being proposed or established. As an example of their concern, they commented that this phenomenon has been experienced

after the finalization of the rule that was designed to address tributyltin antifoulant paint (TBT) in the State of Virginia, when as the deadline for compliance approached, the appropriate technology to meet the standard was not available.

Our Response:

We are including a regulatory provision that establishes a schedule for a future rulemaking to promulgate any additional engine controls that EPA determines are appropriate under section 213(a)(3) of the Act. This future rulemaking will reassess the standards in place at the time using information about the feasibility of applying advanced NOx and PM control technologies to these engines. We intend to consider an additional tier of standards for all marine diesel engines and will also consider application of these standards to engines on foreign flag vessels that enter U.S. ports. We will also include in our evaluation an assessment of the status of international action to set more stringent standards. The standards that are being promulgated in this final rule will remain in effect unless modified by a future rulemaking. EPA is committing to take final action on appropriate standards for marine diesel engines by April 27, 2007, and to issue a proposal no later than approximately one year before. The regulation adopted today establishes a rulemaking schedule for exercise of EPA's discretionary authority under section 213(a)(3), which directs EPA to "from time to time revise" regulations under that provision.

## 5.6 Form of Standard

What We Proposed:

For Category 3 marine engines, we proposed NOx emission standards as a function of engine speed. This curve was developed by IMO with a mathematical relationship based on data from uncontrolled engines. For Category 1 and 2 marine engines we base the standards on the per-cylinder displacement of the engine. The advantages of the speed-based approach is that it is consistent with Annex VI and reflects the inherent tendency of slow speed engines to have higher NOx formation rates. The disadvantages of the speed-based approach are that the standard can change by more than 0.5 g/kW-hr within the range of speed ratings offered today for a given engine. In addition, future technologies may allow more effective control of NOx for slow speed engines, allowing for a "flatter" NOx curve. In the NPRM, we requested comment on a speed versus displacement based form of the NOx standard.

What Commenters Said:

Several commenters recommended that we base NOx standards for Category 3 marine engines on engine speed. EMA, Euromot, and Wartsila commented that a speed-related NOx limit would be consistent with the Annex VI requirements and is a more appropriate form of standard for Category 3 engines, which tend to be custom built with speed characteristics tailored to the vessel in which they are used. EMA commented that Category 3 engines operate at low speed and their emission potential is far more sensitive to maximum speed. Euromot and Wartsila commented that a speed-based standard takes the different plant application and the engine's optimization point (rating) directly into consideration. Euromot, Wartsila, and MAN

B&W stated that a speed-based limit accounts for the differences in the engine sizes and reflects efficiency and thereby the lower $CO_2$ emissions that are emitted from the larger engines. Intertanko argued that the adoption of engine displacement over engine speed is not supported by the data or reasoning provided in the record or the supplemental information.

EMA commented that displacement per cylinder is an appropriate parameter for smaller (Category 1 and 2) engines because the applicable engine technology tends to be common and is easily transferred between engine designs using the same cylinder displacement. EMA commented that emissions are less sensitive to engine speed for these engines compared with low speed Category 3 engines.

Caterpillar commented that we should consider a displacement based emission standard as long as it is consistent with other international standards. Caterpillar commented that while a speed-based standard is sensible to use for standards at the Tier 1 level; however, for more stringent emission standards a displacement-based standard is more appropriate. Caterpillar stated that the use of engine speed gives an advantage to low speed engines and that the use of engine displacement is a better parameter to allow for the differences in engine emissions characteristics while not unnecessarily influencing the type of engines used in a given application. In addition, Caterpillar commented that a speed-based standard for Category 3 engines could cause a significant discontinuity for engines with engine displacements near 30 liters/cylinder because Category 2 engine standards are displacement based. Caterpillar gave the example of an engine over 30 liters/cylinder at 600 rpm having a standard of 8.8 g/kW-hr, while a Category 2 engine would have a standard of 11.0 g/kW-hr.

The American Lung Association et. al. (ALA) commented that they do not support the form of the NOx standard in the Tier 1 proposal. ALA commented that this was taken from IMO guidelines which contain a declining NOx standard with increasing rated rpm and the declining function is specified as $n^{-0.2}$, where "n" is the rpm. ALA stated that available test data does not support the use of this function, and it is unclear whether there is any engineering analysis to support a NOx standard as a function of rated rpm. ALA referred to data compiled by EEA, which they conclude shows no obvious trend in emissions as a function of rpm for the database containing emissions data on 56 engines with rated speed ranging from 100 to 1000 rpm. Six of the engines in the database were of the slow speed type. ALA argued that the NOx function should not be used because there is no justification for the use of a declining NOx standard over the 130 to 1000 rpm range. Therefore, ALA recommended that we should set a single NOx standard for Category 3 engines over 130 rpm, with the possibility of an alternative standard for the very large, 2-cycle engines with speeds below 130 rpm, in the event that there is data available that supports such an alternative standard.

Our Response:

As discussed in Section 4.1, we are finalizing Tier 1 standards that are the same level as the internationally-negotiated NOx standards. Therefore, the Tier 1 NOx emission standards are a function of engine speed. We will revisit this issue when we evaluate potential Tier 2 standards in a future rulemaking. We intend to address a new tier of standards for Category 2 engines at

that time, so we will be able to address the relative level of control for engines above and below 30 liters per cylinder. Also, we believe that emission standards requiring advanced technology will have the effect of "flattening" the emissions curve as a function of engine size. Therefore, we believe that the form of the standard will likely be less of an issue for future standards.

# CHAPTER 6 - Certification and Compliance

## 6.1 Comparison with Annex VI Requirements

What We Proposed:

We proposed a certification and compliance program similar to our existing programs for other nonroad engines.

What Commenters Said:

**(A) EPA should follow the certification procedures as defined in the Annex VI NOx Technical Code.**

Because there are significant differences between the Technical Code and EPA's proposal, dual certification will be necessary for U.S. vessels on foreign trade routes to meet the requirements of both programs. The same will be true for foreign vessels if the proposed rulemaking is extended to cover these vessels trading to the U.S. Some commenters (IV-D-36 and 39) add that this will also create a certification problem for those vessels with a voluntary MARPOL Certification when these regulations come into force in 2004, which undermines the purpose and benefits of international accords.

Letters:
American Maritime Congress, et. al.(coalition of maritime interests) (IV-D-39) **p. 8**
Chamber of Shipping of America (IV-D-56) **p. 5**
International Association of Independent Tank Owners (IV-D-36) **p. 4, 8**
Japanese Marine Equipment Association (IV-D-05) **p. 2**

To prevent unnecessary burdens on all parties involved, especially for those who already obtained Statements of Compliance with Annex VI based on a certification process fully in compliance with the requirements of the NOx Technical Code, the certification procedures should mirror Annex VI requirements.

Letters:
Germanischer Lloyd (GL) (IV-D-46) **p. 2**

EPA suggests that the differences in certification requirements between the proposed rule and Annex VI are warranted by requirements contained in the CAA and their implementing regulations that were primarily designed to address emissions from more traditional stationary and mobile sources which generally do not transcend international boundaries. EPA can use its discretion to vary certification and testing requirements where an alternate system provides

equally reliable results, as is the case with requirements contained in Annex VI. In this context, the ratification package for Annex VI should contain statutory and regulatory text which would clearly establish this discretion by Congressional mandate and therefore, make it clear that EPA is expected to promulgate regulations that would assure consistency between international and domestic requirements.

Letters:

Chamber of Shipping of America (IV-D-56) **p. 5**

The engine manufacturer should not be held responsible for the long term emissions performance of the engine (i.e., over the "useful life" of the engine). The owner/operator of the vessel is responsible for engine maintenance and therefore, should also be responsible for compliance. Even though there is no reasonable or technically reliable way the operator may be able to measure emissions on board, compliance can be determined through other parameters as contained in the Technical File. These data can ensure that the engine is in compliance. During development of the IMO NOx Technical Code, there was no disagreement that NOx emissions do not increase due to wear as long as the components and the settings are unchanged. If the installed engine is noncompliant following installation, this could only be due to a failure on the part of the ship owner/operator. However, if it can be shown that all recommended overhauls and maintenance have been performed, the ship owner/operator should be able to rely on warranties offered by the engine manufacturer to ensure compliance.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 7**
Wartsila Corporation (IV-D-28) **p. 7**

Annex VI assumes that if an engine is shown to be compliant as built then provided that it is maintained "as built" or within an approved range of components and settings, then it will be compliant over its service life and will not require any additional testing.

Letters:

American Bureau of Shipping (IV-D-10) **p. 6**

Under Annex VI, the certified emission value is determined under survey conditions as attended by the certifying organization and follows the basic principle of Annex VI that the engine builder or shipowner provides emissions testing data that is validated by the Administration. Based on the requirement included in the NPRM, it could be assumed that EPA plans to have the ability to measure exhaust emissions at all engine manufacturers' worldwide.

Letters:

American Bureau of Shipping (IV-D-10) **p. 8**
European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 2**
Wartsila Corporation (IV-D-28) **p. 4**

Our Response:

Clean Air Act section 213 directs us to establish standards for nonroad engines that "shall be enforced in the same manner as standards prescribed under section 7521 of this title." This is section 202 of the Act, which specifies the compliance requirements for motor vehicles. Section 213 also states that "(t)he regulations shall apply to the useful life of the engines or vehicles (as determined by the Administrator)." We must therefore establish regulations that specify emission warranty, useful life, emission testing, and inspections. The Chamber of Shipping of America suggests that EPA can use its discretion to vary certification and testing requirements but provides no authority for such discretion.

With respect to the ABS comment about EPA measuring emissions at manufacturers' facilities, section 208 of the Act gives EPA broad discretion to collect information from manufacturers and to enter their facilities. Also, section 206 (b) of the Act authorizes EPA to perform confirmatory testing or to require a manufacturer to perform confirmatory testing. Both foreign and domestic manufacturers are subject to this authority if they wish to obtain an EPA certificate of conformity. It is not clear why ABS understands the NPRM to imply that EPA plans to have the ability to measure emissions at all manufacturers' facilities around the world.

To meet the requirements of the Act we are finalizing compliance provisions that differ from Annex VI. However, as is discussed later in this chapter and in the preamble for this rulemaking, we have tried to harmonize our regulations with Annex VI as much as possible for the Tier 1 standards being adopted here.

**(B) The proposed rule should follow the documentation procedures as included in the Annex VI NOx Technical Code.**

With respect to documentation procedures under Annex VI, the Technical File contains test data and lists where NOx relevant components and settings are defined, which may vary between engine types. This information is important and is generally not found in maintenance manuals.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 2**
Wartsila Corporation (IV-D-28) **p. 4**
MAN B&W Diesel (IV-F-01) **p. 71**
Germanischer Lloyd (GL) (IV-D-46) **p. 2**

Our Response:

We agree that manufacturers should follow the documentation procedures included in the NOx Technical Code and have modified the regulations to maintain these records.

**(C) EPA should ensure that the criteria for engine groups or "families" are consistent with the IMO NOx Technical Code.**

If the basis for engine groupings differs significantly between the NPRM and the Annex VI requirements, it could have serious implications for certification and compliance procedures. EPA indicates in the NPRM that all similar engines would be grouped together, whereas under Annex VI, the engine builder may opt for large or small engine groups. Under Annex VI, a particular builder of slow speed engines typically declares a new engine group for each series of engines even if they are the same type, power and speed as previously built engines so that the distinction may be made between engines installed on different ship series. It is currently unclear as to whether the engine builder or EPA would define the extent of the engine groups/families under the NPRM. Differences between EPA's approach and Annex VI should be resolved.

Letters:

American Bureau of Shipping (IV-D-10) **p. 8**
European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 2**
Germanischer Lloyd (GL) (IV-D-46) **p. 2-3**
Wartsila Corporation (IV-D-28) **p. 4**

Our Response:

The regulations in 40 CFR 94.204(f) specify that "Category 3 engines shall be grouped into engine families as specified in Section 4.3 of the MARPOL Technical Code (incorporated by reference at 40 CFR 94.5)". We also allow manufacturers to ask us to group their engines differently.

**(D) EPA should clarify what the responsibility of the shipowner would be if the engine manufacturer fails in its responsibilities or ceases to exist as a manufacturer.**

The NPRM establishes the engine manufacturer as primarily responsible for compliance, whereas Annex VI places all certification responsibility on the shipowner. In the shipping industry, there is traditionally no contractual responsibility on the part of the engine builder to the shipowner once the limited warranty period has expired. In addition, the engine manufacturer is often a different entity from the engine designer and who is responsible for defining the operating parameters. EPA should clarify the provisions for compliance and the action that would be taken against the ship, in the event that the engine manufacturer fails to meet its responsibilities as defined in the proposed rule, including circumstances under which the test-bed or post-installation emission testing data is questionable or where the manufacturer fails to support the engine certification by the supply of required data. This issue could be particularly problematic for engine manufacturers that are not based in the U.S. It is unclear what direct sanction EPA would have over non-U.S. based engine manufacturers since any sanctions to be applied (such as denied entry into U.S. waters) would fall on the shipowner.

Since the NPRM places the responsibility for compliance on the engine builder, it is unclear as to the position where a shipowner decides to make certain modifications (e.g. change of the turbocharger), without the support of the engine builder. Commenter notes that Annex VI allows for such modifications but in this case, the shipowner is responsible for demonstrating

compliance.

Letters:

American Bureau of Shipping (IV-D-10) **p. 7, 9-11**

Our Response:

The Clean Air Act and the regulations adopted under the Act authorize EPA to deny, suspend, revoke, or void a certificate if the manufacturer does not meet certain requirements. If we determine the requirements are not met before approving an application for certification, we will deny the certificate. If we determine the requirements are not met after approving an application for certification, but before production is completed, we will temporarily suspend, or permanently revoke the certificate. In any of these cases, the manufacturer would be prohibited from selling, importing, or otherwise introducing the engine into U.S. commerce. If a manufacturer violates this prohibition, it would be subject to civil penalties as specified in 40 CFR part 94, subpart L. If we make a determination after the engine is introduced into U.S. commerce that the manufacturer submitted false information, we may void the certificate *ab initio*. This means that we may assess penalties as if the manufacturer had introduced the engine into commerce without a certificate. In cases where the engine fails to meet the standards during the useful life as a result of unforeseen circumstances (such as a design defect), rather than manufacturer fraud, we will require the manufacturer to repair the engine as part of a recall.

Our regulations do not limit compliance to the engine manufacturer. Ship operators are required to perform the proper emission-related maintenance. Failure to do this maintenance, or modifying the engine, without a reasonable technical basis for knowing that such action will not adversely affect emissions is considered tampering, which is prohibited under 40 CFR 94.1103.

**(E) Labeling requirements in addition to those already established as part of the IMO Technical File, are unnecessary.**

Letters:

American Bureau of Shipping (IV-D-10) **p. 9**
European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3**
MAN B&W Diesel (IV-D-08) **p. 5**

Our Response:

We believe that our labeling requirements are appropriate for marine engines. In general, it is important to have certain information permanently attached to the engine so that it is always available to EPA compliance officers. However, we recognize that C3 engines are unique in many respects. Unlike smaller engines, it may frequently be easier to access the information from the Technical File than from the engine label. Therefore, the final regulations contain the flexibility to allow manufacturers to eliminate information from the label that is available in the Technical File. Nevertheless, we will continue to require that the engine be labeled with at least the identity of the certificate holder and serial number or another unique engine identifier.

**(F) The technical file as established by the IMO NOx Technical Code should be the only valid document on board, since it already includes all necessary documentation.**

Letters:

MAN B&W Diesel (IV-D-08) **p. 2**

Our Response:

We do not agree that the Technical File will necessarily contain all documentation needed to comply with this final rule. For example, the NOx Technical Code requires that the "rated speed" and "rated power" be listed, but these will not always be the same as the maximum test speed that we require. The NOx Technical Code also does not require information about specifications for fuel quality. However, it is likely that manufacturers will include any additional information that is need for EPA compliance in the Technical File.

**(G) EPA should provide additional information with respect to the zone of compliance under Annex VI as it compares to the NPRM.**

Annex VI requires all engines which fall within its scope to be compliant at all times, whereas the NPRM provides that engines need to be in compliance when within 320 km of the U.S. The compliance status with respect to Annex VI could be unclear if engines certified in accordance with the NPRM are operating outside the 320 km zone in a condition which does not comply with the NPRM limit, particularly since that limit is based on the residual fuel oil equivalent of the Annex VI NOx limit.

Letters:

American Bureau of Shipping (IV-D-10) **p. 7**

Our Response:

We are not finalizing any provision at this time that allows the engine to be adjusted out of compliance when it is far away from the U.S.

**(H) Unlike Annex VI, the NPRM does not include a requirement for an approved Technical File and does not require compliance at all locations globally. As a result, it appears that engines certified under the NPRM would not be automatically eligible for an EIAPP as defined under Annex VI.**

Letters:

American Bureau of Shipping (IV-D-10) **p. 10**

Our Response:

As explained in the preamble for this final rule, we are setting these standards pursuant to

section 213(a)(3) of the Clean Air Act. Section 213(a)(3) requires that we set emission standards for new nonroad engines and vehicles. Our certification and compliance requirements are informed by the Clean Air Act, and are not necessarily identical to the requirements of MARPOL Annex VI or the NOx Technical Code.

However, this does not mean that engines certified under the NPRM would not automatically be eligible for an EIAPP as defined under Annex VI. The emission limits we are finalizing are equivalent to MARPOL Annex VI, and our certification requirements are very similar. Consequently, we believe that it is possible to develop a harmonized certification process whereby engine manufacturers can obtain an EPA certificate of conformity and a U.S.-issued EIAPP using the same certification application process.

**(I) The NPRM requires that engines meet emission limits under all operating conditions, whereas Annex VI requires compliance only under the appropriate test cycle and the given reference conditions. As a result, engines certified as compliant under Annex VI may not be in compliance with NPRM requirements.**

Maximum emission values at certain cycle loads may be encountered above the limit, but the modal values weighted over the whole cycle may be below the limit. Also, maximum emission values may be encountered away from the cycle mode points, but it is the values at the given mode points from which the cycle-weighted value is determined.

Letters:

American Bureau of Shipping (IV-D-10) **p. 10**

Our Response:

It is true that engines certified as compliant under Annex VI may not be compliant with EPA requirements. For example, the Annex lacks a prohibition on defeat devices. It appears that this is the requirement to which ABS is referring. However, ABS misinterprets how this prohibition would be enforced. It does not require that emissions be below the standard (i.e., the value of the cycle-weighted standard) at all operating modes, but rather that the same emission control be used (and to the same degree) at the cycle points and at points off of the cycle. Since the defeat-device provisions are generally only to prevent manufacturers from taking steps to design their engines with emission-control systems that are more effective in the laboratory than in use, we expect manufacturers to comply with the defeat-device prohibition without any particular extra effort.

## 6.2 Certification Process

**(A) EPA should not require engine manufacturers to establish deterioration factors for Category 3 engines.**

What We Proposed:

We proposed that manufacturers be required to develop deterioration factors to account for increases in emissions over time. Note: manufacturers are required to show that the engine will meet the emission standards at the end of its useful life.

What Commenters Said:

EPA should establish a certain value for deterioration factors within the context of the certification and testing process since most engine manufacturers for Category 3 engines may not have these data.

Letters:
Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 12**

Normal engine wear should make NOx emissions go down in use.

Letters:
Euromot (IV-D-04) **p. 4**

Our Response:

We do not have any basis to set deterioration factors. Given the engine manufacturers' greater familiarity with the engine and its emission controls, the manufacturer is in a better position than EPA to develop deterioration factors. It is important to note that our regulation does not require the manufacturer to perform extensive testing and allows manufacturers to base the deterioration factors on good engineering judgment.

We do not agree with Euromot that emissions will necessarily decrease in use. It is true that many forms of engine wear can reduce peak cylinder pressures, and reduce NOx emissions. However, other in-use effects can offset these impacts. For example, scaling of the aftercooler can lead to increased charge-air temperatures, which increases NOx emissions. Engines can also be adjusted in use to increase peak pressures. Thus, depending on how an engine is maintained and adjusted in use, NOx emissions may increase, decrease, or stay the same.

**(B) EPA should allow a manufacturer or owner to petition EPA to amend the emission-related maintenance instructions after the engine is in use to account for any unexpected problems.**

What We Proposed:

We proposed to require (under 40 CFR 94.211) that manufacturers provide emission-related maintenance instructions to purchasers.

What Commenters Said:

EPA should allow a manufacturer or owner to petition EPA to amend the emission-related maintenance instructions after the engine is in use to account for any unexpected problems.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 12**

Our Response:

Section 94.211 already allows manufacturers to ask to change emission-related maintenance instructions.

**(C) Given the practical difficulties of monitoring a ship's emissions while in port or elsewhere, EPA should accept an engine manufacturers' certification for compliance.**

What We Proposed:

We proposed a provision that would allow us to require operators to provide information to us that is needed to determine if they are complying with the regulations. We did not propose any specific inspection requirements.

What Commenters Said:

Aside from the expense of personnel being potentially available on a continuous basis over a wide range of coastline, it would be a burden on the ship operator and ship officers to respond to yet another inspection service in addition to those entities already making regular vessel calls. Also, vessels are required to maintain a periodic classification inspection to obtain their U.S. Coast Guard Certification of Inspection (COI), which is generally on a five year cycle. EPA could consider specific emissions criteria to be included as part of the COI process, which would allow for regular equipment monitoring and ensure that performance requirements are being met. (Note: this comment specifically responds to EPA questions posed to the Transportation Institute at the June 13, 2002 public hearing held in Long Beach, CA)

Letters:

Transportation Institute (IV-D-25) **p. 1**

Our Response:

After an engine is certified and installed on a vessel, operators must run and maintain the engine consistent with the engine manufacturers operating and maintenance instructions to avoid changing the engine in a way that increases its emissions. Consequently, we include anti-tampering provisions in our rules that specify that an operator must follow maintenance instructions and avoid modifying the engine in a way that would remove or disable elements of the emission-control system. Ensuring compliance with these provisions poses special problems for Category 3 marine diesel engines since they are often installed on vessels that do not operate

exclusively in the United States. One way to ensure compliance is to inspect the engine every time the vessel enters U.S. waters. However, this would be inconvenient both for the vessel operator and for EPA. However, relying on the Coast Guard Certification of Inspection is not appropriate, since that procedure does not currently contain an engine component, and it will not until Annex VI is ratified and goes into force for the United States. In addition, that certification process occurs only on a 5-year cycle. As a result, we are finalizing a provision requiring owners and operators of vessels with Category 3 marine diesel engines to submit an annual Certification of Compliance to verify that the engine has been operated within specified ranges for the preceding year. We believe this certification will not be burdensome for ship owners and operators and it will allow us to monitor the operation of these engines. In addition, EPA and Coast Guard will work together to develop procedures to verify onboard performance of Annex VI requirements, as Coast Guard has general authority to carry out such procedures on vessels.

We intend to cooperate with the Coast Guard in general oversight of compliance with the requirements of this final rule. To a large extent, we would expect any inspections or surveys to be done in conjunction with inspections already conducted for other purposes.

**(D) EPA should clarify the need for the conditional requirements for engine adjustments.**

What We Proposed:

We proposed to require that operators perform a short emission test after adjusting the engine.

What Commenters Said:

EPA presents two conditional requirements for engine adjustments: 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. It is unclear why the first requirement to readjust the engine's parameters within its certified range is necessary if the second requirements is fulfilled and the owner/operator is confident that the engine is not being operated in a way that might affect the manufacturer's warranty.

Letters:

Santa Barbara County Air Pollution Control District (IV-D-49) **p. Att: 2**

Our Response:

We are not at this time finalizing the provision that would require emission testing after adjustments.

**(E) Changing specified adjustable parameters**

What We Proposed:

We did not specifically address changing the allowable settings for adjustable parameters after certification.

What Commenters Said:

EPA should create a provision that would allow the original certification parameters to be revised if new parameter sets are discovered over time during actual operation that meet the emissions standards.

Letters:

Santa Barbara County Air Pollution Control District (IV-D-49) **p. Att: 2**

Our Response:

Section 94.211 allows manufacturers to ask to change emission-related maintenance instructions, including adjustable parameters.

## 6.3 Production-Line Testing

What We Proposed:

We proposed a simple testing program that was 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 did not propose a specific testing requirement, and proposed to allow manufacturers flexibility in determining how to test the engines.

What Commenters Said:

Any post-certification testing procedures should be presented by EPA and subject to public comment prior to finalization.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 12**

Our Response:

We are not finalizing post-certification testing requirements at this time. We will consider such provisions again in a later rulemaking.

## 6.4 Other Certification and Compliance Issues

### (A) EPA should not adopt special provisions to ensure appropriate control of emissions during low-power operation.

What We Proposed:

We requested comment on the need for additional control of low-power modes. (The modal weightings are based on 70 percent of engine operation occurring at 75 percent or more of the engine's maximum power.) We expressed concern that Category 3 engines operate at significantly lower power levels when they are operating within range of a port.

What Commenters Said:

An additional requirement to limit emission levels of the two low-power modes to the level of the NOx emission standard for each engine would be impractical. For Category 3 engines, it would be virtually impossible to control at two low-power modes (50% and 25% of rated power) without an Electronic Control Unit (ECU). It will be a number of years before Category 3 engines with an ECU are used on a majority of vessels.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 8**

The emissions at low power load points will be recorded within the Engine Technical file as part of the certification criteria. This is verified by the "simplified method" for continuous verification that the engine is meeting the NOx emission standards as achieved for test bed certification. There is no need to change these procedures. In the context of trying to reduce the emissions of an engine operating at low power loads, which normally occur within port areas, setting a separate standard will require engines to be developed that are more NOx efficient at low loads. EPA's assumption that this issue could be addressed with engines that are electronically controlled is overly optimistic. To date, only four ships recently built that have electronically controlled 4-stroke engines out of a worldwide fleet of approximately 56,000 vessels. Two-stroke engines are distinct for purposes of assessing the capabilities of electronic controls, but in either case, there is insufficient operational data for EPA to rely on the effects of electronic controls to drive regulatory standards.

Letters:

International Association of Independent Tank Owners (IV-D-36) **p. 12-13**

The already introduced ISO 8178 standard cycles are representative for common use of large marine engines. In the context of establishing limitations under low-load operation, the electronic engines could offer possibilities for differentiated emission characteristics. However, at this point, very few of those engines have been sold. This option should be pursued only under incentive based programs and should not be required in a common international regulation.

Letters:

MAN B&W Diesel (IV-D-08) **p. 2;** (IV-F-01) **p. 72**

Adopting special provisions to ensure emission control at low power could involve reweighting the E3 test modes or adding emission caps for the two low power modes. EPA's suggestion of making unilateral alterations to the E3 test cycle is not appropriate. The E3 cycle is an International (ISO) standard developed through a comprehensive process and has been designed to represent typical marine operations overall. EPA should not reweight certain components of the E3 test cycle. This approach would necessitate a readjustment of the applicable emission control standards, since those standards were developed with reference to the entire E3 test cycle and not just one or two modes of the 4-mode test. If EPA determines that modification of the E3 test cycle is necessary to address the issue of emission control at low power, then this issue should be brought to the ISO and resolved in the context of international standards. (Note: this issue also applies in the context of Issue 6.4 but was kept here since the commenter's discussion was raised in the context of low-load operation.)

Letters:

Engine Manufacturers Association (IV-D-30) **p. 10-11, 25**

Our Response:

While we continue to be concerned about the effectiveness of emission controls at low-power modes, there is no indication that the emission-control technologies that manufacturers are using to meet Annex VI standards are ineffective at low-power operation. Given this and our desire to harmonize our Tier 1 program with the internationally negotiated controls, we are not finalizing special provisions for low-power operation. We will reconsider this issue in a future rulemaking, especially in the context of the advanced technologies we will be evaluating at that time.

**(B) Designing engines to be automatically adjusted for changes in fuel or other parameters may have some limitations.**

What We Proposed:

We requested comment regarding designing engines to be automatically adjusted for changes in fuel.

What Commenters Said:

Designing engines to be only automatically adjusted for changes in fuel quality or other conditions is not practical because maximum combustion pressure might vary with ambient conditions, fuel quality, and the condition of the engine itself (e.g. the condition of the fuel pump plunger and the pressure drop in scavenging air cooler). Ship operators usually adjust the maximum combustion pressure manually so that it is the same as or slightly less than a certain value recommended by the engine manufacturers. This allows the operator to optimize engine performance.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 11**

Electronically controlled engines have recently been introduced in the market but the number of these engines in use (2-stroke) is still very small. Electronically controlled engines may comprise a greater portion of the marine engine market in the future but have some limitations regarding NOx control measures. Regarding the performance of these engines at low loads, part load NOx optimization measures are limited (e.g. retarded fuel injection timing, lower injection pressure, and later exhaust valve closing) and generally lead to increased smoke behavior. Introducing separate NOx limits for the two proposed low-load points for a mechanically governed engine for Tier 2 emission standards does not look feasible but differentiating between emission reductions in the high seas versus the coastal areas may be possible in the future with the electronically controlled engine.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 9**
MAN B&W Diesel (IV-D-08) **p. 5**

Given the fact that Category 3 engines often last more than 25 years, EPA should ensure that provisions regarding engine design and the adjustment of parameters do not limit the ability to install new equipment on the engine, or to incorporate design changes that could improve efficiency or emission controls.

Letters:

MAN B&W Diesel (IV-F-01) **p. 74**

Our Response:

Given the technical issues raised by the commenters, we are not finalizing any requirement for automatic adjustment in this rulemaking. We intend to further consider the need and potential for such a requirement in our future rulemaking.

**(C) EPA should specify that the engine manufacturer issue a short term warranty for the emission control components.**

What We Proposed:

We proposed that manufacturers warrant the emission controls for the useful life of the engine.

What Commenters Said:

It would not be practical for engine manufacturers to warrant emissions for the entire life of the engine. Emissions, particularly HC and CO, may increase due to the deterioration of the fuel injection systems on board the ship. EPA should only specify that manufacturers guarantee the performance of emission controls over a certain period (e.g. five years) following delivery of the

engine. In addition, the individual contracts between the shipowner and the engine manufacturer should establish a procedure for addressing defects both within the warranty period and afterward. EPA should keep in mind that some engine manufacturers may not be in business indefinitely. (See related comment in Issue 6.2(D).)

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 11**

Our Response:

We require manufacturers to warrant the emission control only for the useful life, which will generally not be longer than three years.

**(D)**

What We Proposed:

We proposed to enforce these standards in the same manner as we will for other marine engines.

What Commenters Said:

EPA should clarify enforcement and compliance procedures as well as which regulatory authority will monitor compliance and how it will do so.

Letters:

STAPPA/ALAPCO (IV-D-14) **p. 5**

Our Response:

We intend to use the same approach to enforcing compliance with the EPA standards that we have use for other highway and nonroad programs, as embodied in the regulations. It would not be appropriate in the regulations to limit our ability to enforce these standards. Enforcement of the international standards, once Annex VI goes into force, will be the subject of implementing legislation from Congress that specifically addresses this question.

**(E) EPA should clarify how provisions related to an engine recall would be applied.**

What We Proposed:

We proposed to apply the same recall provisions that apply for other marine engines.

What Commenters Said:

The NPRM provides for an engine recall if it is found that certain engines within an engine

grouping are determined to be non-compliant. This situation could be extremely burdensome to shipowners and could have serious delay and contractual implications, since such engines may not be readily removed from a ship. One commenter (IV-D-36) states that EPA should outline whether under these circumstances, the engine on board is still certified or whether the vessel will be detained. This commenter adds that EPA's suggestion that certifications may be invalidated based on individual engine performance data raises practical questions regarding costs and procedures that may be required with respect to verification testing, vessel delays and detentions, and responsibilities between engine manufacturers and vessel operators.

Letters:

American Bureau of Shipping (IV-D-10) **p. 9-10**
International Association of Independent Tank Owners (IV-D-36) **p. 4-5**

Our Response:

We recognize that recall can be burdensome, but believe that this provides a significant incentive for manufacturers to build complying engines. Moreover, the Clean Air Act is unambiguous in specifying that EPA must recall engines where there is a finding that an engine family does not meet the regulations.

**(F) EPA should ensure that the emission control requirements do not interfere with the significant and continuous maintenance work that marine engines require.**

What Commenters Said:

A marine engine is typically driven under the most effective and high-torque conditions for 20 years or more and requires the frequent replacement of parts, repair to damaged portions, as well as other engine modifications. The timing of such maintenance procedures is not always predictable and depends on the engine type and the operational conditions. Considering the demands and maintenance requirements for marine engines, EPA should ensure that emission control methods are not an obstacle for maintenance and repair.

Letters:

Japanese Shipowners Association (IV-D-32) **p. Att: 2**

Our Response:

We expect manufacturers generally to design their engines and emission-control systems in a way that allows operators to operate and maintain them appropriately. We are not aware of any reason why there should be a concern with respect to the maintenance needed for the technologies being considered to meet these standards.

**(G) EPA should not use shipyards to enforce the standards**

Letters:

American Shipbuilding Association (IV-D-47) **p. 2**

Our Response:

The proposal included a requirement to test engines after installation in a vessel before it is launched for the first time. In addition, the Clean Air Act authorizes us to test and inspect engines where we determine it is necessary to establish compliance with the regulations. We are not adopting specific testing requirements at shipyards in this final rule. However, we may choose to investigate engines at shipyards to establish compliance with the near-term standards and will consider the specific testing requirements again in our future rulemaking. While these steps may require some accommodation from shipyards, we do not believe this is an unreasonable expectation.

**(H) EPA incorrectly describes the parameter check method.**

What we proposed:

We did not propose any regulations related to the Annex VI parameter check method.

What Commenters Said:

The NPRM indicates that the Parameter Check method is limited to a check on the Engine Record Book, which is inconsistent with 2.3.12 of the NOx Technical Code. The NOx Technical Code states that it is also necessary that the engine be physically inspected by the attending Surveyor. Typically, an engine's NOx critical components and settings (i.e., markings on the fuel injection system, combustion chamber and charge air system components with the fuel pump timing) would be shown to the attending Surveyor at each survey required by Annex VI, which are then compared to the values and data as given in the approved Technical File, and used to establish whether the engine was being operated as approved.

Letters:

American Bureau of Shipping (IV-D-10) **p. 11**

Our Response:

We did not propose any regulations related to the Annex VI parameter check method. However, we expressed concern in the preamble for the proposal that, in practice, the parameter check method would likely be limited to a paperwork exercise, and thus be of limited value as an enforcement tool. ABS is incorrect in stating that a physical inspection is necessary under the Code. Annex VI leaves significant discretion by stating that "an actual inspection of the engine components and adjustable features shall be carried out in addition to the documentation inspection *as necessary* (emphasis added)." The clear implication is that a physical inspection is not always necessary.

## 6.5 Miscellaneous modifications to the proposed regulatory language

In addition to the issues described above, we made the following adjustments to the proposed regulatory language:

- We clarified the language in 40 CFR 94.7(d) to allow manufacturers to meet the requirement to allow for in-use emission sampling by giving instructions to the vessel manufacturer. This is necessary, because the engine manufacturer does not sufficiently control the assembly of the final product to meet the requirement without cooperation from vessel manufacturers.
- In 40 CFR 94.205(b), we corrected the description of how Category 2 engines must comply with requirements related to adjustable parameters. This was necessary because Category 2 engines operate with "approved adjustable' ranges, rather than "physically adjustable" ranges. This corrects an error in the December 1999 final rule.

# CHAPTER 7 - Onboard Measurement of NOx Emissions

What We Proposed:

We proposed that Category 3 diesel engines have a direct exhaust NOx monitoring system. This system would be used to verify that engines are adjusted properly in use. It could also be used for production testing. Category 3 engines typically have fuel injection timing and other adjustments that are optimized to accommodate a range of fuel qualities and environmental conditions. These engine adjustments also affect NOx emissions; therefore a shipboard means of monitoring NOx is a prudent requirement to ensure compliance with the applicable standards. Indirect methods for inferring NOx emissions based on engine operating temperatures, pressures or flows will not ensure compliance with applicable standards due to the complex relationship between these parameters and NOx emissions.

What Commenters Said:

**(A) EPA should not require any onboard measurement, post-installation verification, or other field measurements as part of this rulemaking, since this would be unreliable and burdensome.**

(1) Measurements on board will be unreliable and unreproducible due to the test cycle procedure and the measurement of power, exhaust emission and fuel consumption. Test bed measurements are more reliable and reproducible than onboard measurements. Combined with an onboard check method of the NOx relevant components and settings, test bed measurements can guarantee compliance. Some commenters (IV-D-04 and 28) note that under Annex VI, detailed procedures described in the engine Technical File prevent certain changes to the NOx relevant components and settings and using these procedures, engines can be monitored with no further emission measurements. These commenters add that tests have shown that when an engine has been in use and there is normal wear of components like injection pumps, fuel nozzles, cylinder components and the turbocharger, NOx levels will decline. The effect of this normal wear on combustion is similar to the effect of retard fuel injection and lowering the maximum firing pressure. Commenters provide additional data and graphs that show this relationship. Similarly, one commenter (IV-D-08) also generally notes that NOx does not increase with age or wear of the engine. Some commenters (IV-D-04 and 28) recommend that EPA require emission measurements to be completed by the manufacturer only during certification with distillate fuel, not on board the ship. These commenters add that to guarantee that the NOx limit is not exceeded, a parameter check can be done periodically on board to ensure that the engine settings are in compliance with the NOx Technical Code.

Letters:

Caterpillar, Inc. (IV-D-41) **p. 1**
European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 4-6**
MAN B&W Diesel (IV-D-08) **p. 3-4;** (IV-F-01) **p. 71**
Wartsila Corporation (IV-D-28) **p. 2-4;** (IV-F-01) **p. 36-37**

The only possible exception should be for add-on emission control systems that are not included within the overall engine package as certified by the engine manufacturer. In this case, post-installation verification tests may be appropriate, but any additional field tests should be required only if the engine or add-on system has emission-critical adjustable parameters.

Letters:
Engine Manufacturers Association (IV-D-30) **p. 8, 11-12, 21-24**
Japanese Marine Equipment Association (IV-D-05) **p. 2-3**

The installation of onboard emission measurement equipment that is capable of operating accurately under sea-going conditions may not be possible. Some commenters (IV-D-05, 08 and 32) note that sea conditions can adversely impact the effectiveness of onboard emissions measurements. One commenter (IV-D-08) add that well-trained and educated crew members would have to maintain, operate, and calibrate this type of equipment, which is exposed to vibrations, heat, dust, fuel oil and heavy movement in rough sea conditions. Another commenter (IV-D-05) states that there are also the adverse impacts from fuel oil properties, air properties and measuring equipment errors. Some commenters (IV-D-05 and 10) assert that considering these factors, there may be significant discrepancies between the test-bed performance of the emission tested engine and the onboard measured performance of an individual engine. One of these commenters (IV-D-10) requests that EPA clarify exactly how this onboard measurement equipment would be monitored and determine with certainty that the necessary reliable measurement and processing technology exists, together with the external indication requirement if this requirement is included in the Final Rule. This commenter adds that currently, the information given in the NPRM is insufficient regarding this matter.

Letters:
American Bureau of Shipping (IV-D-10) **p. 4-5**
Japanese Marine Equipment Association (IV-D-05) **p. 2-3**
Japanese Shipowners Association (IV-D-32) **p. Att: 1**
MAN B&W Diesel (IV-D-08) **p. 4**

EPA should not require that engine manufacturers develop emission targets that allow the ship operator to ensure that the engine is adjusted to the certified configuration. Engine emissions vary with speed, load, transient operations, ambient conditions (e.g. water and air temperature, barometric pressure, ambient humidity, fuel quality, etc.), which makes it extremely burdensome for the manufacturer to set emission targets. Instead of relying on emission measurements and established targets, the ship operator should be able to simply modify the adjustable parameters within certified limits. Commenter provides details on the limitations and

potential burden posed by onboard measurement and requirements to adjust the engine based on NOx emission levels.

Letters:

Engine Manufacturers Association (IV-D-30) **p. 8, 11-12, 21-24**

EPA should consider whether onboard emission measurement is appropriate in all cases considering the availability of the necessary measurement equipment and the expense of testing. Currently, there are no suitable devices that would ensure accurate and long term onboard NOx emission measurements. This type of equipment needs regular maintenance since filters and tubes clog quite frequently when running on residual fuel. An additional problem is that engine manufacturers do not develop measurement devices for use on board the vessel and therefore, cannot be responsible for the performance of such equipment. Commenter provides additional discussion on this issue, including details on the specific problems that might be encountered with an onboard measurement system and asserts that onboard emission measurements should not be required since it would be too difficult with laboratory equipment and too unreliable with the simpler analyzers that would typically be used on board.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 6**

EPA should not establish a new set of guidelines that differs from the already introduced guidelines in the IMO Regulation. Some commenters specifically noted that the Onboard NOx Verification Procedures under Annex VI (as included in the Technical Files of approved engines) should be sufficient for ensuring compliance. One commenter recommended that EPA simply adopt these procedures under Annex VI. Another commenter notes that MAN B&W has, in close cooperation with members of the International Association of Classification Societies, specified an on board survey based on actual performance data, which together with the established emission correlation from the test bed, is capable of ensuring compliance on board.

Letters:

American Bureau of Shipping (IV-D-10) **p. 4-5**
Chamber of Shipping of America (IV-D-56) **p. 6**
European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 6**
Germanischer Lloyd (GL) (IV-D-46) **p. 2-3**
MAN B&W Diesel (IV-D-08) **p. 2**

**(B) EPA should not require any onboard measurement, post-installation verification, or other field measurements as part of this rulemaking since it would be too costly.**

The NOx analyzer is estimated to cost approximately $85,000 (including calibration equipment and reference gas). In addition, the measuring instruments need to calibrated accurately with current state of the art techniques. The Shipbuilding Research Association of Japan has demonstrated that the costs for calibration of analytical instruments is between $5,000 and $10,000. In cases where the calibration cannot be carried out on board, a further set of

analytical instruments needs to be provided. Also, many ships are not equipped with an engine torque gauge that is necessary to calculate the amount of NOx emissions.

Letters:
Japanese Shipowners Association (IV-D-32) **p. Att: 1**

**(C) If EPA chooses to incorporate provisions for onboard measurement of emissions, any requirements should be developed in cooperation with the international community and the IMO.**

IMO has been discussing the draft guidelines for onboard NOx monitoring and recording devices, and EPA should develop measurement systems that are consistent with these guidelines. In addition, EPA should also examine data and information regarding Japanese investigations and activities relating to onboard monitoring and recording devices, which is included in the information paper DE45/IMO (DE45/INF.10).

Letters:
Japanese Marine Equipment Association (IV-D-05) **p. 3**

**(D) Onboard measurement of emissions using automatic logging equipment should be minimized and should apply only to vessels within 175 nautical miles of the U.S. coast.**

Letters:
Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 10-11, 13**

**(E) Any adjustments to automatic logging equipment should be recorded manually to be consistent with Annex VI requirements.**

Letters:
Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 11, 13**

**(F) EPA should provide additional information (including if possible, specific approval procedures) regarding any required onboard emissions data logging equipment.**

Some manufacturers do not have sufficient experience with data logging equipment. EPA should provide guidance and documentation on the equipment as well as how to verify the emission standards by using NOx concentration and exhaust temperature.

Letters:
Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 11, 13**

EPA should clarify whether adequate data logging equipment is currently available for installation and use, and should establish the vessel manufacturer/owner as the responsible party.

Commenter does not believe loggers are available that meet 40 CFR 94.110(c) (for instance, there is no automated recording of mechanical adjustments to injection timing).

Letters:

Engine Manufacturers Association (IV-D-30) **p. 22**

**(G) The use of an indicator on the outside of the vessel to show whether pollution controls are working properly would not be practical or necessary.**

Commenter notes that this approach would not be necessary since the smoke color would be lighter if the maximum combustion pressure increases.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 11**

While this concept seems simple enough, there are a number of reasons why this would not be practical or useful. It is unclear how EPA would intend to use this type of device. EPA should clarify whether this device would be used for compliance authorities to view a vessel from a distance to determine compliance or simply be used as a check during routine boarding inspections. Vessels are required to operate consistent with international standards for navigational lights. The inclusion of another light on the exterior superstructure of a vessel would be inconsistent with existing international and domestic lighting requirements and would present navigational hazards which have not been considered by EPA. In addition, this signaling device would be placed on an already extremely complicated system. Absence of the signal could mean no more than a faulty bulb, while presence of the signal would not guarantee compliance taken within the context of a complex, multi-parameter system. This simplistic approach cannot possibly take the place of boarding inspections conducted by professionals with experience and knowledge of these complex shipboard systems.

Letters:

Chamber of Shipping of America (IV-D-56) **p. 7**

**(H) Ship operators should use exhaust temperature data as guidance and should not be subject to any specific criteria in this context.**

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 13**

**(I) EPA should note that the NOx concentration and exhaust temperature might vary due to ambient conditions and fuel quality absent of any adjustments by the ship operator on engine parameters.**

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 13**

**(J) EPA should revise and clarify provisions included in 40 CFR 94.110(b).**

Requiring an engine speed gauge with an accuracy of +/- 0.1 rpm is unnecessary given the accuracy levels of other elements of the measurement system (see 40 CFR 94.110(b)(2)).

Letters:

Engine Manufacturers Association (IV-D-30) **p. 21**

In paragraph (b)(3), EPA should clarify what type of "shaft torque gauge" might be available for permanent installation on a vessel. Since engine manufacturers do not provide or equip their marine engines with torque shafts, the Final Rule should clarify that this requirement is the responsibility of the vessel manufacturer.

Letters:

Engine Manufacturers Association (IV-D-30) **p. 21-22**

Our Response:

We continue to believe that automatic onboard emission measurement and data logging systems will be a cost-effective means of ensuring that C3 marine engines meet the emission standards in use. In particular, we require engines that make automatic adjustments to emission-related parameters to use automatic logging equipment to record those changes.

Regarding onboard NOx measurement, however, we recognize that some technical issues remain. As described in the preamble to this final rule, we are not finalizing the proposed NOx monitoring requirements for Tier 1. Nevertheless, we expect to adopt such a requirement when we establish Tier 2 emission standards.

Note also that EPA and IMO are working together to draft guidelines for on-board NOx monitoring and recording devices. We are optimistic that this process will help define how to automatically measure and log emissions in a cost-effective manner.

# CHAPTER 8 - Test Procedures

## 8.1 Certification Fuel

What We Proposed:

We proposed to base the standards on testing using residual fuel, and included a correction factor to account for the emission-related effects of fuel quality, specifically fuel-bound nitrogen.

What Commenters Said:

**(A) Test facilities should be able to continue to use marine distillate fuel. To require the use of residual fuel at testing facilities could be extremely burdensome.**

In many circumstances, particularly for Korean and Japanese engine builders, it would be virtually impossible to prepare a test facility using residual fuel without relocating or redesigning the entire facility, which would be financially prohibitive. In addition, many engine builders have very limited experience testing with residual fuel.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 6**

Distillate fuel is preferable for use in certification testing since the quality and the composition of this fuel type is more clearly defined and measurements can be more accurately reproduced, particularly when comparing engines within an engine group. Generally, accounting for the nitrogen content of the fuel can provide a corrected NOx emission measurement in this context, but EPA should be mindful of other fuel properties as well. (See related point (P) below.)

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3**
Wartsila Corporation (IV-D-28) **p. 1-2**

The introduction of a residual fuel oil test basis in the NPRM would appear to introduce a number of arbitrary factors that undermine the basis of the Annex VI testing requirements. One commenter (IV-D-36) notes that distillate fuel has a more consistent specification than residual fuels and will lead to more consistent results over the full range of testing on diverse and varied engine types. This commenter adds that marine residual fuel oils have a wide range of specifications to accommodate the requirements of varied engine types, densities ranging from 950 to 1010 kg/$m^3$ and kinematic viscosities at 50° C from 30 to 700 centistokes, and that the nitrogen content varies depending on the PAH content but is generally between 0.2% and 0.6%.

This commenter concludes that because of these characteristics, residual fuel should not be used for testing purposes. Both commenters assert that EPA should not deviate from the Annex VI mandate for the use of distillate fuels for certification testing.

Letters:

American Bureau of Shipping (IV-D-10) **p. 4**
International Association of Independent Tank Owners (IV-D-36) **p. 11-12**

Most test beds cannot operate on heavy residual fuels. Testing of a typical large engine requires several tons of fuel and as a result, testing on residual fuels would not be allowed in many cases, due to local environmental regulations.

Letters:

MAN B&W Diesel (IV-D-08) **p. 2**

EPA should recognize that the NOx Technical Code adequately reflects the nitrogen content of fuel oil and should not deviate from this standard. One commenter (IV-D-36) notes that an allowance is made in the Annex VI NOx Technical Code for the nitrogen content of residual fuel oils when the vessel uses the "simplified measurement procedures" (i.e., NOx monitoring on board for periodic survey requirements), and that the primary allowance given when undertaking such a procedure is 10% for comparison purposes with the original certification levels using a distillate fuel oil meeting the ISO 8217: 1996 specification. Another commenter (IV-D-41) asserts that EPA's proposal to add in 1.4 g/kW-hr with an adjustment for fuel nitrogen is not equivalent to allowing for a 10% tolerance for field measurements as included in Annex VI. One commenter (IV-D-36) adds that to evaluate the emissions profile of a family of engines, it is important to use a fuel of uniform properties. Both commenters support harmonizing all testing procedures with Annex VI, which requires the use of a distillate grade marine fuel (per ISO 8217) as the test fuel for certification. (See Issue 6.1 for specific comments on nitrogen content.)

Letters:

Caterpillar, Inc. (IV-D-41) **p. 1**
International Association of Independent Tank Owners (IV-D-36) **p. 11-12**

**(B) EPA should consider whether more reliable and less burdensome test methods are available as an alternative to the "Standard Test Method for Total Nitrogen in Lubricating Oils and Fuel Oils by Modified Kjeldahl Method."**

Letters:

Engine Manufacturers Association (IV-D-30) **p. 12-13**

**(C) EPA should note that injection timing is not adjusted according to a specific fuel property. The timing is adjusted so that the allowed IMO-certified maximum combustion pressure is achieved but not exceeded.**

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3**
Wartsila Corporation (IV-D-28) **p. 2**

**(D) EPA should add a specification (i.e., reference to Table B-5) for distillate test fuel in 40 CFR 94.108(e)(2).**

Letters:

Engine Manufacturers Association (IV-D-30) **p. 21**

**(E) The distillate Federal Test Fuel Specification as given in 40 CFR 94.108 would not be acceptable as a marine fuel since the minimum flash point (54° C) is below 60° C as required under SOLAS and classification society rules.**

Letters:

American Bureau of Shipping (IV-D-10) **p. 13**

**(F) EPA should clarify whether there would be any relief from testing on residual fuel if a ship owner-operator committed to operating on only distillate fuel within the 175 NM zone.**

Commenter questions if data is available on if differences between the emissions created by the use of residual fuel versus the use of distillate fuel can be accurately determined by simply accounting for the nitrogen and sulfur content of the fuel. They comment that if this data is not available, ships engines should undergo post-parameter adjustment or maintenance compliance tests when operating on the fuel they typically use inside the 175 NM zone.

Letters:

Santa Barbara County Air Pollution Control District (IV-D-49) **p. Att: 3**

**(G) EPA should not add the unusable parameter of Cetane to the specification for residual oils.**

Within the ISO 8217 specification there is already an ignition property specification (CCAI).

Letters:

International Association of Independent Tank Owners (IV-D-36) **p. 12**

**(H) Fuel properties other than nitrogen could influence the level of NOx emissions.**

Other fuel properties like ignition quality and combustion performance can influence the

level of NOx emissions from diesel engines. Some commenters (IV-D-04 and 28) specifically note that EPA has not fully investigated these parameters and their impact on emissions. These commenters (IV-D-04 and 28) argue that the uncertainty associated with factors other than nitrogen when comparing residual versus distillate fuel, supports the conclusion that distillate fuel is much more reliable and accurate for use in measuring or estimating emissions.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3**
Japanese Marine Equipment Association (IV-D-05) **p. 3**
Wartsila Corporation (IV-D-28) **p. 1-2;** (IV-F-01) **p. 35**

Our Response:

We proposed to base the standards on testing using residual fuel, but are not finalizing this requirement at this time due to concerns about the lead time needed by manufacturers to develop the necessary testing capabilities for residual fuels. Most manufacturers have test facilities that can test engines using distillate fuel because it is easier to work with than residual fuel. Nevertheless, we believe that long-term standards should be based on actual in-use fuels. Thus, we will reconsider the issue of test fuel in a future rulemaking.

Similarly, we are not finalizing the nitrogen correction here. While this correction would have been needed for residual fuel testing (because of the high levels of nitrogen contained in those fuels) it is generally not needed for distillate fuel. We will reconsider the need for such corrections in a future rulemaking.

We are specifying test fuel that meets the Annex VI fuel requirements. While the distillate test fuel listed in 40 CFR 94.108 is a standard specification for diesel test fuel, it is not being applied to Category 3 engines. We believe that this fuel is generally appropriate for Category 1 and Category 2 engine tests. For those cases where it may not be appropriate, manufacturers may ask to use a different distillate fuel.

## 8.2 NTE Requirements

What We Proposed:

We did not propose not-to-exceed (NTE) requirements for Category 3 marine engines. In addition, we did not propose revisions to the NTE requirements for Category 1 and 2 marine engines. NTE requirements for Category 1 and 2 marine engines were established in prior

rulemakings.[10,11]

What Commenters Said:

The Engine Manufacturers Association commented that NTE requirements for Category 1 and 2 marine engines should be eliminated. EMA restated arguments expressed in their earlier comments during the previous rulemakings cited above.

Our Response:

We are not finalizing NTE requirements for Category 3 marine engines, nor are we revising the NTE requirements for Category 1 and 2 marine engines. We addressed all comments on the NTE zones for Category 1 and 2 marine engines in the Summary and Analysis of Comment documents for the two rules cited above.

## 8.3 Departures from Annex VI

### (A) EPA should be consistent with the IMO NOx Technical Code test cycles as given by ISO.

What We Proposed:

We proposed to use the Annex VI test procedures with a few modifications. We also asked for comment on other issues, such as whether we should consider other test cycles.

What Commenters Said:

EPA should apply the same test cycles and weighting factors as defined in the Annex VI NOx Technical Code since the test cycles are well proven and already in use by all manufacturers of marine engines. Generally, engine manufacturers try to keep low-load emissions as low as possible. In addition, vessels relying on multiple engines that provide electric-drive propulsion will generally shut down the engines that are not necessary in order to maintain the preferred loading for the engines in operation. Therefore, there is no need to re-weight the modes in order to improve emissions performance. Establishing test procedures consistent with Annex VI would avoid double testing and the possibility of confusion.

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[10] "Control of Emissions of Air Pollution from New Marine Compression-Ignition Engines at or Above 37 kW; Final Rule," 64 FR 73300, December 29, 1999. This FRM and supporting documentation are available in Air Docket A-97-50.

[11] "Control of Emissions from Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-based); Final Rule" (67 FR 68242, November 8, 2002). This FRM and supporting documentation are available in Docket A-2000-01.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3-4**
Wartsila Corporation (IV-D-28) **p. 2;** (IV-F-01) **p. 35**

Linear interpolation of emissions between test points is not possible since the operation of the engine is influenced by different performance optimization measures which are set by the manufacturer based on IMO provisions - i.e., operation of auxiliary blower at low loads (2-stroke engines) and fuel consumption, thermal load, and smoke optimization criteria (such as different means to adjust charge air pressure, variable inlet valve closing (VIC), variable injection timing (VIT), variable exhaust valve closing (VEC), and common rail (CR) technology). These are "on-off"measures and therefore, the NOx emission behavior does not follow a natural smooth curve. EPA should note that load ranges are optimized (not single points), since punctual changes could contribute to the instability of the regulating system when load changes occur within a short period of time.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 4**
Wartsila Corporation (IV-D-28) **p. 2**

The test cycles within the proposed rulemaking follow the NOx Technical Code. If EPA elects to vary these procedures, it would be adopting yet another departure from the international requirements making dual certification for test bed testing of an engine necessary.

Letters:

American Bureau of Shipping (IV-D-10) **p. 6-7**

The NPRM does not indicate the test cycle for "power station" concept machinery systems or for propulsion engines driving controllable pitch propellers (CPP). For Category 1 and 2 engines such propulsion engines are to be tested to the C1 cycle whereas in Annex VI, all CPP propulsion engines would be tested to the E2 cycle. These are quite different certification requirements.

Letters:

American Bureau of Shipping (IV-D-10) **p. 6-7**

Our Response:

In the lead time available for implementing the Tier 1 standards, we are specifying that engines be tested using the Annex VI test cycles. We are not finalizing any requirements for testing on other cycles at this time, or caps on specific load points. However, we remain concerned that Annex VI test cycles may not be sufficient to ensure full in-use compliance for engines that have electronic controls and other advanced emission-control technologies. We will therefore revisit these issues in a future rulemaking.

**(B) Any test procedures established by EPA should be consistent with the IMO NOx**

**Technical Code.**

What We Proposed:

We proposed to use the Annex VI test procedures with a few modifications.

What Commenters Said:

Deviations from Annex VI test procedures will cause an unnecessary test burden.

Letters:
Germanischer Lloyd (GL) (IV-D-46) **p. 2**

Our Response:

We are not specifying test procedures that are inconsistent with the Annex VI procedures. We are adding requirements only to ensure that test results are representative of actual in-use emissions. This will not cause any additional burden.

**(C) Agrees that the use of the Annex VI correction factor for temperature and humidity for certification should be allowed.**

Letters:
European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3**
Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 12-13**
Wartsila Corporation (IV-D-28) **p. 2;** (IV-F-01) **p. 36**

Correction factors are environmentally neutral and allow for emissions to be measured under real world conditions and compared without bias to emission standards. Without allowing for such factors, an engine's compliance with the standards must be evaluated from a worst-case scenario. Until alternative correction factors are developed, EPA should allow for the unrestricted use of the ISO 8178-1 correction factors for all emission testing.

Letters:
Engine Manufacturers Association (IV-D-30) **p. 14-15**

Category 3 engines are built and tested world-wide in all different climatic areas, and it would be practically impossible to maintain fixed "small test-bed" conditions. It is necessary to correct emissions data from test beds to certain reference values in order to obtain qualified results. The IMO Regulation allows for corrections to the emissions data based on certain reference values (other than fuel nitrogen levels). A benefit of the IMO test condition correction documentation is that the worst case scenario for the parent engine could be simulated and the engine could still be delivered at optimum performance conditions. The engine NOx value can be estimated based on the measured emissions on the test bed and the maximum NOx tolerance

performance conditions.

Letters:

MAN B&W Diesel (IV-D-08) **p. 2, 4;** (IV-F-01) **p. 73**

Our Response:

We agree that the NOx Technical Code correction factors should be used for Tier 1 testing. We may reconsider this for the future rulemaking if we have reason to believe that the correction factors would not be appropriate for advanced- technology engines.

**(D) The Annex VI provisions with respect to temperatures for testing may be more practical.**

Under the NPRM, the engine is to be compliant over the entire range of 13-30° C for ambient air temperature and 17-27° C for cooling water inlet temperature, which effectively means that the air temperature would need to be at 30° C and the coolant at 27° C, which may not be possible in all circumstances for Category 3 engines. Attaining NPRM temperatures specified in the test condition parameters when testing in certain areas during the winter months, such as Korea and Japan, would not be possible for most larger Category 3 engines. Also, fresh water coolant systems may typically be set to operate at 36° C. Annex VI corrects test results to ambient temperature 25° C and to the charge air/scavenge temperature equivalent to operation with 25° C sea water.

Letters:

American Bureau of Shipping (IV-D-10) **p. 6**

There should be no limitations on the allowable test range for ambient and scavenge air temperature, since the feasibility of testing should not depend on these factors. Ambient temperatures below 13° C or above 30° C or cooling water temperature below 17° C or above 27° C can occur, since engines are manufactured and testing in different countries all over the world with varying test conditions. Conditioning such high amounts of inlet air is not realistic and would not be economically or ecologically feasible.

Letters:

European Association of Internal Combustion Engine Manufacturers (IV-D-04) **p. 3**

Wartsila Corporation (IV-D-28) **p. 2;** (IV-F-01) **p. 36**

EPA should revise the proposed ambient air temperature to be between -10 and 40˚ C. EPA should revise the proposed charging (scavenging) air cooling water temperature to be between 3° C and 27° C.

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) p. 12

Our Response:

We limit the allowable temperature range for testing because temperature can have very significant effects on NOx emissions. While we believe correction factors can be used to correct for a limited range of temperatures, we are not convinced that current corrections are accurate for a temperature ranges as broad as those suggested by the commenters. However, 40 CFR 94.102(c) allows manufacturers to use alternate procedures if they provide equivalent results. Thus, a manufacturer could test outside of the specified range if it could show that accurate corrections factors are available.

**(E) The manufacturers' simulation of charge-air cooling should replicate the performance of in-use coolers within ± 8° C instead of ±3° C, since based on actual experience, it is practically impossible to stay within the ±4° C as included in the NOx Technical Code.**

Letters:

Hyundai Heavy Industries Co., Inc. (IV-D-02) **p. 13**

Our Response:

Temperature can have very significant effects on NOx emissions. Thus, it is important that the charge-air temperature be as representative of actual in-use operation as possible. We believe that it is possible to keep the charge-air temperature within ±3˚C, especially during a steady-state test. Also, manufacturers are allowed to deviate from this specification for short periods, as long as they are within the range when they actually measure the emissions. For example, a manufacturer that is out of the allowable range at the start of a test mode may adjust the charge-air cooling simulation enough to bring it into the allowable range, and then begin measuring emissions for that test mode.

**(F) The NPRM allows testing to be completed on single cylinder mock-ups, whereas Annex VI requires that the emission tested engine truly represents the appropriate engine group, which leads to more accurate results (since the charge air characteristics are not simulated).**

Letters:

American Bureau of Shipping (IV-D-10) **p. 8**

Our Response:

We believe this could be a useful flexibility. It is important to note, though, that manufacturers using this flexibility must also comply with 40 CFR 94.102(b), which states that manufacturers may not use any test procedures that "are not consistent with good engineering practice" or that would not produce emission measurements that are equivalent to emission

measurements that would result from emission tests performed during in-use operation using the same engine configuration installed in a vessel.

## 8.4 Other Test Procedures Issues

### (A) EPA should remove the proposed definition of "maximum test speed" both as it applies to commercial marine engines and to recreational marine engines.

What We Proposed:

We proposed to apply the current definition of "maximum test speed", which is already specified for Categories 1 and 2 in 94.107, to Category 3 engines.

What Commenters Said:

The methodology for determining maximum test speed is inappropriate in the context of marine engines and may even create a potential loophole to circumvent the standards. Instead of including this definition in the rule, EPA should follow the ISO protocol and set the maximum test speed equal to the rated engine speed and allow the manufacturer to define the rated speed as the speed at which the rated power is delivered.

Letters:

Engine Manufacturers Association (IV-D-30) **p. 12, 25**

Our Response:

The definition of maximum test speed, (the maximum engine speed in revolutions per minute, or rpm) is an important aspect of the test cycles. Under the NOx Technical Code, 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 might 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 may be certified. We are therefore applying the current definition of "maximum test speed", which is already specified for Category 1 and 2 engines in 94.107, to Category 3 engines. We recognize, however, that Category 3 engines are unique. Therefore, we will also allow manufacturers to ask us to use the maximum in-use engine speed as the maximum test speed.

### (B) EPA's statement that "...equivalent performance requires the same percent reduction in NOx emissions from the optimal calibration as is achieved under the test conditions." Section 94.205(f) is unclear and should be revised or removed.

What We Proposed:

We proposed that manufacturers must specify in the maintenance instructions how to adjust the engines to achieve emission performance equivalent to the performance demonstrated under the certification test conditions. We provided specific guidance for manufacturers must do this.

What Commenters Said:

EPA's general intent with respect to this section is unclear. Engine manufacturer's do not routinely develop "optimal engine performance calibrations" that could be used if there were no applicable emissions standards. Developing an engine to meet prescribed emission standards actually precludes a determination of what the "optimal performance" for that engine might be. In order to meet emission standards, manufacturers make alterations to engine "calibrations" as well as compression ratios, valve timing, injection timing, pressures, spray characters, and other variables. The "optimal" engine is simply unknowable in the context of regulated engine products. Commenter provides additional discussion on this issue and recommends that EPA remove this provision from the rule.

Letters:
Engine Manufacturers Association (IV-D-30) **p. 18-19, 23, 25**

Our Response:

We have revised this provision to make it more flexible. However, it will still require manufacturers to specify how to adjust the engines to achieve emission performance equivalent to the performance demonstrated under the certification test conditions. The vessel operator is required to follow the manufacturers specifications.

What We Proposed:

We proposed that exhaust flow rates must be calculated using measured fuel flow rates.

What Commenters Said:

EPA should specify the calculation procedures (in 40 CFR 94.109(a)(4)) for how exhaust flow rates are to be calculated from a measured fuel flow rate.

Letters:
Engine Manufacturers Association (IV-D-30) **p. 21**

Our Response:

Appendix 6 of the NOx Technical Code specifies how to calculate exhaust flow rates.

# CHAPTER 9 - Fuel Controls; PM Standard

## 9.1 Level of the Fuel Sulfur Standard

What We Proposed:

The majority of Category 3 engines are designed to run on residual fuel, which has high contents of sulfur, ash, metals, and nitrogen that may increase exhaust emissions. The global average sulfur concentration for residual fuel is currently about 27,000 ppm and operating on fuels with such high sulfur contents results in high SOx and direct sulfate PM emissions. 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 requested comment on whether we should set standards for the fuel that ships use. We requested comment on requiring that distillate fuel be used and on the feasibility of lower sulfur standards, such as those required for land-based nonroad and highway applications. We did not propose fuel-based regulations in this rule because setting requirements on fuel entered into commerce in the U.S. and fuel sold in the U.S. would not necessarily ensure that lower sulfur fuel is used in U.S. waters. Vessels can purchase their fuel elsewhere. However, we stated our intent to work through the MARPOL process to designate certain areas in the U.S. as SOx Emission Control Areas (SECA). Ships operating in these areas must either use fuel with a sulfur content not to exceed 15,000 ppm or an exhaust-gas cleaning system or other technology to reduce total vessel SOx emissions (including both auxiliary and main propulsion engines) to 6.0 kW-hr or less.

What Commenters Said:

### A. Commenters Supporting Fuel Sulfur Control

Many state and environmental organizations commented that we should impose a fuel sulfur content limit, which could significantly reduce SOx, PM, and NOx emissions from existing engines. Most of these commenters expressed support for working with MARPOL to designate SECAs with a sulfur limit of 1.5% as a first step. Commenters stated that we should require all U.S. and foreign-flag ships operating in U.S. waters to use fuel with a sulfur content of no higher than 15,000 ppm (1.5%) by 2007. Most of these commenters also stated that we should go further with much lower sulfur fuel requirements by working through the MARPOL process and/or implementing U.S. standards. Several commenters stated that, in addition to imposing a stringent fuel sulfur limit, we should require that ships operating within 175 nautical miles from the U.S. coast use fuel as clean as the fuel on which they were certified (i.e., distillate fuel). Commenters recommend that EPA apply a stringent standard for fuel sulfur for all ships operating within 175 nautical miles of the U.S. coastline. ARB recommended that at the very least, distillate fuel should be used in port areas.

Commenters supporting sulfur fuel control generally commented that we should set fuel

sulfur limits equivalent to that used in land based nonroad or highway applications. Recommended sulfur levels ranged from the current offroad maximum of 5000 ppm to the upcoming highway fuel sulfur limit of 15 ppm. Several phase-in schedules were also presented. Bluewater Network and Coalition for Clean Air recommended that we impose a sulfur cap of 1.5% by 2007, and lower that cap to 3,000 ppm by 2010; Bluewater Network further commented that we should lower the standard even further to 15 ppm by 2020. Broward County recommended that we impose a sulfur cap of 1.5% by 2007, 10,000 ppm by 2010 and 5,000 ppm by 2015.

State and environmental organizations generally urged us to set the most stringent fuel sulfur standard possible in the long run and note that this phased-in approach would be the most cost-effective way to stimulate further development of the fuel refinement process and ultimately would lead to better availability of top quality fuels. Environmental Defense commented that we should require ships to use distillate fuel with a rigorous and declining sulfur cap that phases in over time to meet the 15 ppm limit under the other fuel programs. They argued that, given prior EPA policy decisions on this issue and the actions of countries around the world, it is feasible and cost-effective to lower the sulfur content in fuels to this level. Because Category 3 engines are capable of running on distillate fuel without any major alterations, this approach should be pursued.

The American Lung Association et. al. commented that we should pursue an additional rulemaking within the next three years that would take a "systems" approach and establish a fuel sulfur standards along with more stringent NOx and PM standards. They recommended that the fuel sulfur standard should be as stringent as the sulfur levels established under the 2001 heavy duty engine rule (15 ppm) and should have an implementation date of 2010. They stated that if this can be achieved, the advanced technologies that require low sulfur fuel could be used to achieve the greatest degree of emission reductions possible. Delaware and STAPPA/ALAPCO also noted that a low sulfur standard would enable the installation and use of NOx control systems such as SCR where low sulfur fuel is necessary. SCAQMD commented that we should consider adopting low enough sulfur limits to allow for the use of PM traps.

**B. Commenters Opposing Fuel Sulfur Control**

Several commenters argued that we should not set unique fuel sulfur requirements in the United States. Intertanko, EMA, and API commented that we should not regulate fuel sulfur content because national regulation of fuel sulfur content will not significantly affect emissions in the U.S. from vessels that purchase fuel outside the regulatory jurisdiction. API commented that EPA's authority is likely limited to ships that are fueled in U.S. waters and to U.S. flagged ships. They argue that an in-use sulfur requirement for all ships appears to be beyond EPA's statutory authority because it would create a burden on international trade in violation of the Constitution's Foreign Commerce Clause. They also commented that the "in-use" requirement applied to U.S. vessels would place these vessels at a competitive disadvantage.

Intertanko also commented that we should not regulate fuel sulfur content because PM emissions from ships are not primarily derived from the sulfur content of fuel. They commented

that the majority of the original sulfur content is released as a sulfur dioxide gas with only a small proportion condensing within the exhaust system to produce a liquid/solid phase material that combines with carbonaceous material. They claimed that it is difficult to correlate particulate matter with sulfur once the sulfur content of fuel exceeds 0.8%, at which point fuels generally become contaminated with alternative elements that also impact PM emissions, such as aluminium, silicon, vanadium, nickel and sodium as well as lubrication oil compounds (calcium, zinc, and phosphorous). Intertanko argued that there are two other properties within the ISO 8217 specification that are of greater relevance. These properties are the CCAI of the fuel (ignition characteristics) and the micro carbon residue (PM). They concluded that it would be more effective to place a cap on the extent of polycyclic aromatic hydrocarbon (PAH) content of the fuel oils sold in the U.S. for marine use or simply a cap on density and viscosity to reduce the extent of PAH in marine fuel oils. The Japanese Shipowners Association commented that it is not clear as to which characteristic of fuel oil affects combustion because the performance of residual fuel oil quality is so varied.

Our Response:

After reviewing the comments and other information, we have decided not to set fuel-based regulations at this time. We remain concerned that 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. 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.

## 9.2 Controlling Fuel Sulfur under MARPOL Annex VI

What We Proposed:

In the proposal, we stated our intent to work through the MARPOL process to designate certain areas in the U.S. as sulfur control areas (SECA). Ships operating in these areas must either use fuel with a sulfur content not to exceed 15,000 ppm or an exhaust-gas cleaning system or other technology to reduce total vessel SOx emissions (including both auxiliary and main propulsion engines) to 6.0 kW-hr or less. We requested comment on whether all waters under U.S. jurisdiction or only specific areas should be designated as SECAs and what the impacts would be.

What Commenters Said:

Manufacturers and shipping organizations commented that if EPA implements a fuel sulfur standard, it should be consistent with Annex VI requirements (i.e., not to exceed 1.5% or 15,000 ppm in designated SOx control areas (SECA) and 4.5% or 45,000 ppm in general). The International Chamber of Shipping commented that fuel sulfur control can more easily be accommodated and enforced through a SECA. The Engine Manufacturers Association expressed a need for harmonized internationally-applicable regulations. The American Petroleum Institute commented that a 500 ppm diesel sulfur standard (current on-highway fuel) would be

inconsistent with MARPOL Annex VI and any efforts to control the sulfur level in diesel fuel should be pursued in an international forum. They argued that the SECA designation option provides for a single fuel specification for controlling emissions from marine vessels that would be uniform internationally where Annex VI requirements are in effect. They also commented that the fuel sulfur standard should be uniform in U.S. waters because if the 1.5% standard applied in some areas and not in others, or if the fuel sulfur level is controlled on a state or port basis, the result could be the creation of various fuel sulfur specifications and would create new boutique fuels, which would present complications with respect to the supply of residual fuel to marine vessels. The American Bureau of Shipping noted that for an area in the U.S. to be designated a SECA, the area would need to be shown to IMO's satisfaction that it meets the criteria of Appendix III to Annex VI.

The Japanese Shipowners Association commented that the establishment of a world standard of guaranteed marine fuel oil supply would provide a key solution in promoting the prevention of air pollution from ships. They stated that the use of residual fuel oil by ships presents numerous problems. They commented that, even though the effects of fuel oil properties on the performance of the engine and exhaust gases can be demonstrated experimentally, it is not clear which characteristics of fuel oil affects combustion since the quality of residual fuel oil is so widely varied. They stated that current fuel standards such as ISO8217 and ASTM D2069 are based primarily on viscosity and do not specify combustion characteristics. However, they commented that sulfur level relates to safety because the sulfur in the fuel can lead to excessive wear of the cylinder liner and piston rings.

State and environmental organizations commented that we should use the SOx Emission Control Area (SECA) designation under Annex VI to help control PM and $SO_2$ levels in U.S. waters. Generally these commenters advocated for a more stringent standard than the 1.5% limit, but noted that this would be an important first step toward a more stringent fuel sulfur standard. The American Lung Association et. al., Bluewater Network, and the State of Delaware commented that all U.S. territorial water should be designated as SECAs so that when Annex VI standards are adopted, all areas will be in compliance with the lower sulfur limit. The Ozone Transport Commission commented that we should consider designating areas such as the Northeast and Mid-Atlantic coast, as SECAs to address regional haze problems. The California Air Resources Board commented that the areas designated as SECAs should include California's major port areas and shipping lanes. They also commented that we should also work outside the MARPOL process if expeditious progress toward a SECA cannot be made.

Our Response:

As discussed in Section 5.5, 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). Ships operating in these designated areas must either use fuel with a sulfur content not to exceed 15,000 ppm or an exhaust-gas cleaning system or other technology to reduce total vessel SOx emissions (including both auxiliary and main propulsion engines) to 6.0 kW-hr or less. EPA plans to begin investigating designation of one or more areas in the future, and we will work with interested states to consider whether the designation of specific SOx Emission Control Areas

under the Treaty would offer significant benefits to air quality (including PM), considering associated costs. Depending upon the outcome of these consultations and the analysis of the relevant vessel traffic and emissions, the United States may propose designation of one or more areas by amendment to Regulation 14(3) of Annex VI.

## 9.3 Potential Impact of a Low Sulfur Fuel Standard

What We Proposed:

We requested comment on the impact of a low sulfur fuel standard. In the NPRM we presented estimated costs for two potential low sulfur fuel standards (1.5% and 0.3%) in which we considered all vessel operation within 175 nautical miles of the U.S. coast.

What Commenters Said:

The Chamber of Shipping of America commented that we should evaluate the issue of low sulfur fuel availability, before determining a cap for sulfur content in marine fuels. They stated that the marine fuels market has traditionally been a sulfur sink for petroleum refining operations. CSA commented that sulfur levels can vary greatly throughout the market and no particular geographic area or supplier can be identified as generally providing low or high sulfur fuel on a regular basis. They claimed that variations from 2.5% to 4.5% have been detected on samples taken in the same port and provided by the same supplier. CSA expressed concern that even though the marine fuel delivered generally meets industry specifications, it may not meet component caps proposed in the future. The American Petroleum Institute commented that establishing a diesel fuel sulfur standard in addition to those already in place or planned, will have an adverse impact on fuel supply. They commented that refiners are already concerned whether there will be sufficient supplies of diesel fuel as a result of the highway rule requirements and that if we require similar fuel sulfur levels for nonroad diesel fuel for farm and construction as well as new requirements in this notice, further increases in the demand for diesel fuel would result. API argued that a 500 ppm fuel sulfur standard may have the net effect of removing a potential market for the sale of heavier, higher sulfur residual fuel oil resulting from the refining process, which would necessitate increased processing and greater energy consumption as well as the creation of waste products that have no viable market.

The Chamber of Shipping of America commented that unilateral action in setting a fuel standard would result in logistical challenges for existing ships because they would need dual fuel capabilities due to varying national requirements. They stated that the potential for dual fuel carriage requirements presents extreme challenges with regard to existing ships and their limited capabilities to redesign fuel storage and distribution systems. The American Petroleum Institute commented that a 500 ppm sulfur standard would necessitate the use of three different types of fuel (4.5%, 1.5%, and 500 ppm) which would present both a financial and logistical burden to vessel owners/operators. They also commented that while changing over from high to low sulfur residual fuel is not a problem, changing from residual fuel to distillate fuel can be a problem. API argued that the difference in viscosity between residual and distillate fuel can affect the fuel heating needed and the change in fuels can result in thermal shock to or vapor in the fuel system.

They argued that vapor in the fuel system can lead to safety issues such as loss of engine power and vessel maneuverability in port areas, and proper care would be needed for boiler plants to make sure the furnace is purged of all gases.

Our Response:

We are not setting fuel sulfur standards at this time. In any future action in which we were to revisit marine fuel standards, we would consider the issues raised above.

## 9.4 Projected Emission Reductions from Reduced Fuel Sulfur

What We Proposed:

We requested comment on the environmental impact of a low sulfur fuel standard. In the NPRM we presented estimated PM, SOx, and NOx emissions reductions for two potential low sulfur fuel standards (1.5% and 0.3%) in which we considered all vessel operation within 175 nautical miles of the U.S. coast.

What Commenters Said:

The American Petroleum Institute commented that there are two deficiencies in our analysis of the emissions benefits of reducing sulfur in diesel fuel. First, they commented that we did not provide a basis for the finding that using distillate fuel would result in a 10% NOx reduction compared with residual fuel. Second, they commented that our estimate that 98% of the fuel sulfur is converted to SOx while the rest is converted to direct sulfate PM is based on tests performed on highway diesel engines and may not be applicable to Category 3 marine diesel engines. As a result, they concluded that we need to conduct further analysis before setting fuel standards.

Several commenters noted that the use of residual fuel capped at 15,000 ppm would lower PM and SOx emissions by 10% and 44%, respectively. Environmental Defense also noted that the use of distillate fuel would lead to an additional 10% reduction in NOx emissions. Commenters recommended that we implement more stringent fuel sulfur than 15,000 ppm standards to help reduce SOx, PM, and NOx emissions and regional haze.

Our Response:

We believe that using lower sulfur distillate fuel would result in reductions of NOx, SOx, and PM. The 10% NOx reduction is consistent with the NOx correction allowed for testing on residual fuel under the internationally negotiated NOx standards. In addition, other commenters have submitted data suggesting that this reduction could be even higher. This is discussed further in Section 4.3.

Although our sulfate conversion estimate is based on smaller land-based nonroad engines, we are not aware of any technical reason why this conversion rate would be different for larger

engines. In addition, using a 2% sulfate conversion rate (hydrated seven times), we get results consistent with data collected by one manufacturer on particulate composition. This data is presented in Chapter 4 of the Final Regulatory Support Document.

## 9.5 PM Standard

What We Proposed:

We did not propose PM standards for Category 3 marine engines. The majority of PM emissions from these engines appears to come from the sulfur and other impurities in the fuel; therefore, we considered in-use fuel sulfur control to be more capable of reducing PM emissions than engine controls. In addition, we expressed concern that current established test methods show unacceptable variability when sulfur levels exceed 0.8 weight percent which is common for both residual and distillate fuels for Category 3 engines.

What Commenters Said:

The Chamber of Shipping of America commented that we should not set a PM standard until more is known within the context of marine operations, such as the relative contributions of marine mobile sources to national PM inventories, and the capability of existing PM emissions control technology to meet future requirements in the marine operating environment. Hyundai commented that PM reductions should be achieved by reducing the fuel sulfur level instead of by setting a specific standard.

Several state and environmental organizations commented that we should adopt a specific PM standard in addition to requiring reductions in fuel sulfur. Bluewater Network and the Coalition for Clean Air commented that PM is a cancer-causing air toxic and that ocean-going ships emit large amounts of PM which affects people on ships and near ports. NESCAUM and STAPPA/ALAPCO commented that we should incorporate into the final rule a process and schedule for reviewing the feasibility of and, as appropriate, adopting more stringent PM limits for Category 3 engines. The California Air Resources Board commented that we should investigate PM control technology, considering technology from both mobile and stationary sources, and revisit this issue no later than 2005. Environmental Defense argued that relying on PM reductions through low sulfur fuel is not a permissible surrogate for an effective PM emission standard. They commented that, if no control measures are taken, PM emissions from Category 3 marine engines will nearly triple in less than 30 years. Therefore they concluded that, given the serious adverse health effects that result from elevated PM emissions, as well as the environmental justice issues in many port areas, we should set a PM standard that reflects the greatest degree of emission reduction achievable. The American Lung Association et. al. commented that Category 1, 2, and 3 marine engines are capable of meeting PM levels comparable to highway heavy-duty diesel engines (0.13 g/kW-hr), although special requirements may be necessary for slow speed diesels. They stated that PM standards for these engines would lead to enormous health and environmental benefits and expressed the concern that steps taken to reduce NOx could increase PM. The California Earth Corps commented that particulate matter is a hazardous substance under California State Proposition 65 we should promulgate a stringent

standard for particulate emissions.

Environmentalists commented that particulate matter could be reduced, cost-effectively by over 90% through the use of PM traps. The American Lung Association et. al. noted that some technology research may be necessary prior to shipboard installation of trap-oxidizers and electrostatic filters. They stated that, even though these devices are sensitive to sulfur levels, there are certain low-efficiency traps that are less sensitive to fuel sulfur. They claimed that these low-efficiency traps have retrofitted on nonroad equipment and older buses and have achieved PM reductions of 35% to 50%. They also commented that reducing sulfur would allow PM control devices to work more efficiently. California Earth Corps commented that PM reductions could also be achieved through the use of biodiesel fuels, catalytic converters, and baghouses. They stated that a baghouse is a room with a bag in it that collects particle emissions and has been used to achieve more than a 99 percent reduction in PM on stationary sources. They commented that this technology is inexpensive; the bag costs about $2400 and lasts nearly a year.

The American Lung Association et. al. commented that we did not provide a detailed explanation for why we believe that no acceptable procedure exists for measuring PM from engines using high sulfur fuel. They commented that both the U.S. DOT's Volpe Center[12] and Lloyds[13] have conducted PM measurements on marine diesel engines using high sulfur fuel and have not reported any special difficulty. They stated that the DOT study utilized the ISO 8178 method with a Sierra Model BG-1 micro-dilution continuous particulate matter sampling system and used fuel with a sulfur content of 1.49 percent. They also stated that Lloyd's used a similar system, but did not specify a defined method. They stated that both residual fuels and distillate fuels were used in the Lloyd's testing and that Lloyds showed an inter-trial variability in particulate emissions of only about 7 percent.

Our Response:

The majority of PM emissions from Category 3 marine engines comes directly from the high concentration of sulfur in the fuel. Short of changing in-use fuel quality, emission-control technologies address only the remaining portion of PM, because 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. Both distillate and residual marine fuels used in these engines

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[12] Environmental Transportation Consultants, Shipboard Marine Engine Emissions Testing for the U.S. Coast Guard, prepared for the Volpe National Transportation Systems Center, Delivery Order 31, Undated (approx. 1999).

[13] Lloyd's Register, Marine Exhaust Emissions Research Programme, Lloyd's Register Engineering Services, Undated (approx. 1991).

commonly exceed that level. No PM test method or calculation methodology has yet been developed to correct that variability. This is discussed further in Chapter 5 of the Final Regulatory Support Document. During the future rulemaking, we will revisit these issues and consider the appropriateness of adopting a PM standard for Category 3 marine diesel engines.

One commenter referred to a DOT and a Lloyd's study as evidence that PM can be accurately measured from engines operating on high sulfur fuel. They claimed that the DOT study was based on 1.49% sulfur fuel. However, the DOT study does not report fuel sulfur level. We are able to estimate the sulfur level of the fuel through a sulfur balance using the $SO_2$ and fuel consumption data in the report. Based on this data, the fuel sulfur level used by the engines that were tested for PM appears to be about 0.2-0.4%. If sulfur in the test fuel was 1.49%, then based on a sulfur balance, $SO_2$ and PM should have been measured to be considerably higher.

Although the Lloyds data reports an inter-trial variability of only 7 percent, it does not account for reproducibility of the testing between labs using different measurement systems. It is possible for a single test set up to have good inter-trial variability on an engine and fuel when another lab may have vastly different results. Correlation testing was performed with a Category 3 marine diesel engine at four engine labs. One of the conclusions of this study was that considerable PM measurements existed between the labs for fuels with a sulfur level above 0.8%.[14]

## 9.6 Alternatives to Regulating Fuel Use

What We Proposed:

As discussed above, we requested comment both on regulating fuel sold in the U.S. and on strategies for reducing the sulfur content of fuel used near the U.S. coast. For instance, we discussed the option of fuel sulfur control through the IMO process by establishing Sulfur Emission Control Areas (SECA) in the U.S. The NPRM also discussed incentive-based programs for pollution reduction from ships, such as those established in some European countries.

What Commenters Said:

The International Chamber of Shipping and the Chamber of Shipping of America commented that enforcement of any sulfur standard for marine fuels should be focused on the supplier or point of fuel delivery. They argued that it is easier to ensure compliance at the point of origin than to track vessels moving across jurisdictional boundaries. The Chamber of Shipping of America commented that compliance programs focusing at the point of sale/delivery will provide fewer compliance check points and confirm shoreside availability of compliant fuels in a particular port.

[14] Bastenhof, D., "Exhaust Gas Emission Measurements; A Contribution to a Realistic Approach," CIMAC, May 1995.

The Engine Manufacturers Association commented that rather than regulating fuel sold in the U.S., we should encourage individual ports to adopt incentive programs aimed at reducing the fuel sulfur level, similar to those adopted by Scandinavian countries and those described in the preamble.

American Petroleum Institute commented that, if we designate SECAs under Annex VI we should consider cost effective alternatives to requiring the use of low sulfur fuel. They commented that the use of new generation exhaust gas scrubbers to achieve additional reductions may be more cost-effective than a fuel sulfur-standard. They discuss a specific brand of exhaust scrubber that can replace the silencer in a vessel and achieve, SOx, NOx, and soot emissions.

Our Response:

We are not setting fuel sulfur standards at this time. In any future action in which we were to revisit marine fuel standards, we would consider the issues raised above.

# CHAPTER 10 - Estimated Costs

What We Proposed:

In the proposal we presented a detailed analysis of the projected costs associated with meeting emission standards using various technologies.

What Commenters Said:

Intertanko commented that the majority of EPA's analysis centered on four-stroke engines. They point out, however, that two-stroke diesel engines are the predominant propulsion units for the world's tanker fleets. The "Worldwide NOx Emissions from Merchant Shipping" study by MAN B&W Diesel determined that two-stroke engines are installed in 26 percent of commercial ships, but that their combined power output is almost 60 percent of the total for the world-wide fleet. Intertanko claimed that EPA's proposal failed to account for the significant challenges of applying current and projected emission-control technologies to two-stroke engines, which invalidates the published benefit and cost data.

The American Lung Association, et al (ALA) commented that the analysis of costs for upgrading a fuel-injection system appears to reflect the cost for the entire system, without subtracting the cost of components that would no longer be needed after upgrading. These subtracted costs may account for half of the estimated hardware costs. The analysis of fuel-system costs also conflict with cost data related to heavy-duty highway engines, estimating costs for injectors and pumps almost an order of magnitude greater than that for highway engines. Hardware costs generally seemed high, except for the electronic control unit (especially considering the limited sales volumes). ALA also pointed out that the net cost is sensitive to assumed sales volume and that including foreign vessels in the program would substantially reduce average costs.

Santa Barbara questioned whether EPA's cost analysis considered how emission-control requirements that apply only to U.S. vessels might affect their ability to compete with foreign vessels with unregulated engines.

Our Response:

The cost analysis included detailed itemization of technology costs for both four-stroke and two-stroke engines. There is limited data about the viability (or estimated costs) of advanced technoloigies in two-stroke engines, which is why we are unable to adopt Tier 2 standards at this time. We intend to work with manufacturers and other interested parties in developing future emission standards that would require the use of new technologies. As part of that effort, we will take steps to ensure that the emission standards are achievable, that the associated technologies are commercially viable, and that the cost analysis is accurate with respect to two-stroke engines.

We agree with ALA that our analysis of fuel-pump costs overlooked an appropriate cost credit for no longer needing the fuel pumps that are currently used on mechanically controlled engines. The ECU and wiring harness are new components that do not replace any components from the older engines. Also, our published costs for the fuel injectors already reflected the incremental cost of upgrading to the new system, rather than a total cost for the new injectors. It is true that we overlooked a cost credit for replacing the existing fuel pump with the combination of low-pressure and high-pressure pumps for the common-rail system. This cost credit would likely be slightly larger than the estimated cost for low-pressure pump, which would decrease overall costs by about 10 percent. The final rule does not contemplate common-rail injection as an emission-control technology for meeting emission standards, so we are not correcting this in the analysis.

Regarding ALA's general concern that the estimated costs are so much higher than for highway engines, we continue to believe that the published costs are appropriate for Category 3 marine diesel engines. The higher costs are caused by two main factors. First, manufacturers must amortize fixed costs over very small sales volumes, so prices are very sensitive to costs for R&D, capital, and tooling. Second, the cost of manufacturing very large precision components can lead to disproportionate cost increases for Category 3 engines.

Our assessment of the costs of meeting standards shows that the additional up-front costs for new, compliant engines is a tiny fraction of the cost of a new vessel. Similarly, operating costs for emission-control systems are generally very small compared with the overall expenses for maintaining and operating a vessel.

# CHAPTER 11 - Environmental Impact

## 11.1 General Emissions Inventory Issues

What We Proposed:

In our proposal we estimated the current and projected future emissions inventories from Category 3 marine diesel engines. Our draft inventory showed that Category 3 vessels currently account for about 1.5 percent of national mobile source NOx emissions.

What Commenters Said:

The Santa Barbara County Air Pollution Control District compared our proposed emission inventory with its own corresponding estimates of marine shipping emissions off the county's coastline. Santa Barbara commented that this comparison showed that Santa Barbara's inventory accounts for between 4% and 5% of the nationwide total depending on the inventory year. This seems improbable and should be reevaluated, particularly with respect to the following three concerns. First, our analysis that includes data from nine specific ports, does not include the Ports of Los Angeles and Long Beach as detailed ports, despite the fact that this port is one of the busiest seaports in the world. Second, our non-port inventories are erroneously low due to the assumption that most movement within 25 NM of a coastline is done by tow and push boats with Category 2 engines, when in fact, most commercial ships transiting off the Santa Barbara coastline are largely foreign-flagged container ships powered by Category 3 engines and operating under their own power. Third, our interpretation of cabotage law, which requires any vessel operating between two U.S. ports to be U.S. flagged leads to an inaccurate assessment of emissions from foreign-flagged vessels. Based on these concerns, Santa Barbara suggests that our baseline and future year emissions estimates may be too low and should be reevaluated.

Santa Barbara also notes that text relating to Santa Barbara emissions reads: "These emissions are expected to increase to 62% by 2015." The percentage increase is actually 68% and should be corrected on Page 37550 and 37563 of the NPRM.

Our Response:

It is true that Ports of Los Angeles and Long Beach were not included as one of the nine detailed ports used as the basis of much of our ports emissions work. However, for the California portion of our inventory estimate we incorporated the California inventory work done by the California Air Resources Board. This work includes not only specific analysis of the Ports of Los Angeles and Long Beach, but also includes Category 3 vessel traffic within 25 nautical miles of the Santa Barbara County coast. Thus, we believe that our proposed analysis is consistent with Santa Barbara's concerns. Issues concerning our understanding of U.S. cabotage law are covered in Section 9.3 of this chapter. Finally, we have reworded the text regarding Santa Barbara emissions to include both estimates of the percentage increase in emissions as well

as the percentage of total emissions that the future estimates represent. We believe that this clarifies the discussion of future Category 3 vessel emissions off the coast of Santa Barbara.

## 11.2 Fleet Size and Turnover

What We Proposed:

We estimated the growth of Category 3 marine diesel engine emissions by projecting increases in freight movement based on near term estimates developed by the U.S. Maritime Administration. We then used the estimated increases in freight movement to estimate the needed growth in the vessel fleet size as well as the resultant increase in port calls. Central to these projections was the assumption that new vessels would be much larger than those they replace, meaning that the projected increases in fleet size and numbers of port calls would proportionately be less than the projected increase in freight movement. Also, we assumed that all new vessels built in 2000 and later would comply with the MARPOL Annex VI NOx limits.

What Commenters Said:

The Chamber of Shipping of America stated that forecasted trade figures found in the U.S. DOT's 1999 publication, "An Assessment of the U.S. Marine Transportation System," appear to imply a potential increase in marine engine emissions. However, the estimates of U.S. foreign maritime trade doubling over 1996 tonnage levels by 2020 does not necessarily mean there will be a doubling in the number of vessel transits accommodating such trade and a corresponding increase in marine engine emissions. There is a steady trend for larger and more modern vessels to replace existing tonnage and such vessels are already being built to conform to Annex VI standards. One of the newest liner vessels being built for the domestic trade (TOTE vessels at NASSCO in San Diego) will have a capacity that is 150% of the vessel it is replacing. Also, the M/V Regine Maersk, which can carry 50% more cargo than the current generation of container ships, is one of dozens of vessels now being built for ports whose harbors and channels are currently being dredged to accommodate such growth. Therefore a growth in trade or cargo capacity does not lead to a corresponding linear increase in vessel calls or fuel emissions. In addition, recent mergers, buy-outs, and cargo slot sharing agreements have demonstrated that more cargo can be shipped with a minimal need for new vessel calls. The Transportation Institute noted only generally that the projected increases in trade will not necessarily lead to a proportional increase in port calls.

Our Response:

All of the comments received regarding the relationship between increased freight movement and increased numbers of vessels and port calls agree with and support our proposed approach of assuming that new vessels built in the future would be bigger than those they replace, and would comply with the Annex VI NOx limits. Thus, the number of vessels in the fleet and the number of port calls would increase at a lower rate than the increase in freight movement. Further, the emissions inventory in the future would grow at a slower rate than the rate of freight movement. Thus, we used out proposed approach to growth for the final rule.

## 11.3 Contribution of U.S. vs. Foreign Ships

What We Proposed:

We estimated the relative contribution of emissions from U.S. and foreign flagged vessels separately for port areas and non-port areas. For port areas we relied on port call data obtained from the U.S. Maritime Administration (MARAD). Using this data we estimated that only 6.4 percent of large vessel calls on U.S. ports were made by U.S. flagged vessels. For emissions outside of port areas we relied on U.S. Army Corp of Engineers data on freight movement to estimate that 80 percent of all emissions from large vessels outside of port areas comes from U.S. flagged vessels. Noting the apparent discrepancy between the port and non-port results, we requested comment on the issue of U.S. versus foreign flag vessel emissions, as well as additional data that would support any revisions to our analysis. Finally, we assumed that these U.S./foreign flag splits would remain constant as freight movement and thus vessel traffic increased in the future.

What Commenters Said:

In general, commenters agreed with our estimates of U.S. versus foreign flagged vessel in port areas. Several commenters provided estimates of the percentage of port calls that were from foreign flagged vessels in particular port areas, although none of these comments included the background data or analysis that went into deriving these estimates. These estimates of the percentage of port calls attributable to foreign flagged vessels varied from 85 to 97 percent. The Santa Barbara County Air Pollution Control District commented that with regards to the development of in-port inventories, it is unclear whether the activity data included 'ship registry' as one of the parameters used to associate specific and "other" ports. It appears that the use of this method could lead to biases in the data, particularly for port activity in relation to vessel registry data. If one of the nine specific ports had a majority of U.S. flagged vessels, the assumption would be that the port it is related to would also have a predominance of U.S. flagged vessels and as a result, a majority of the emissions would be from U.S. flagged ships. Santa Barbara suggested that we should develop national in-port inventories based on activity data from various marine exchanges throughout the country.

We received a number of comments questioning our estimate of U.S. versus foreign flagged vessel emissions in non-port areas. Santa Barbara noted that there was a disconnect between our estimate that port emissions were primarily from foreign flagged vessels while non-port emissions were primarily from U.S. flagged vessels. Bluewater Network, the Sacramento Metropolitan Air Quality Network, Santa Barbara and the Transportation Institute all suggested that we underestimated the emissions from foreign flagged vessels in non-port areas due to a misunderstanding of U.S. cabotage law. These commenters pointed out that foreign-flag ships often travel up the west coast or east coast to deliver goods since The Jones Act allows international ships to deposit cargo in more than one port, although the vessel cannot conduct commerce between the ports.

Bluewater Network stated that virtually all cruise ships are foreign-flagged, yet many spend much of their time in U.S. waters, traveling Alaska waters and the west coast as well as along many east coast destinations and the U.S. Virgin Islands. Thus, even though cruise ships comprise a relatively small portion of overall marine vessel emissions, they do contribute to ongoing coastal in-transit emissions.

The Transportation Institute stated that a freight tonnage data set may not be significant in determining what percentage of non-port emissions can be attributed to U.S. flagged vessels, since much heavier loads are more likely to be transported via tug/barge. The Institute also pointed out that the majority of the U.S.-flagged vessels in the Jones Act trade are involved in trades with non-contiguous U.S. locations such as Hawaii, Guam, Alaska, and Puerto Rico (and thus spend a significant portion of time outside the 175 nautical mile range).

Both the Chamber of Shipping of America and the U.S. Maritime Administration stated that U.S. flagged tonnage is not expected to increase in the next few decades and that Jones act traffic is expected to stay relatively unchanged in that time frame. Given that total freight movement and vessel traffic is expected to increase in that time frame the implication is that the U.S. flagged vessel contribution as a percentage of total Category 3 vessel emissions will likely decline in the future.

Our Response:

Regarding our estimates of the percentage of port calls attributable to U.S. versus foreign flag vessels, we find that most comments agreed with our analysis. However, we have learned that the MARAD data that we used in our proposed estimate included vessels engage only in U.S. foreign trade and did not include any port calls from vessels engaged in U.S. domestic (i.e., Jones Act) trade. Thus, we estimated the number of port calls that the Jones Act fleet makes to U.S. ports and included them in the MARAD port calls data. Taking this approach we determined that U.S. flagged vessels account for about 10 percent of calls on U.S. ports. While this new estimate is somewhat lower than that used in the proposal it is still within the range suggested by the various commenters.

We used the port matching method to determine only the total emissions at a given port, not the percentage of port calls attributable to U.S. versus foreign flagged vessels. For the U.S. foreign flag split estimate we relied on nationwide port call information and developed a single estimate for the nation as a whole. Thus, the concern that Santa Barbara expressed about the potential the port matching method has to bias the data (i.e., if one of the detailed ports is skewed on one direction toward U.S. or foreign flag vessels, any port that is matched to it would be similarly skewed) is not relevant.

We agree that there was a disconnect between our estimates of U.S. flagged vessel contribution to port and non-port emissions. It is for that reason that we discussed the issue and requested comment and additional data. We also agree that we misunderstood U.S. cabotage law with regards to how foreign flagged ships might behave near the U.S. However, we did not use this understanding of cabotage law to estimate the emissions from foreign flagged vessels, as

some commenters suggested. Rather, we discussed it as a possible explanation for the apparent disconnect between our port and non-port estimates. While we received several comments suggesting that we underestimated foreign flagged vessel emissions in non-port areas, none of those commenters provided additional data which would help us revise our estimates. However, we did receive some new information from MARAD well after the close of the comment period which showed port calls on U.S. ports not only by U.S. versus foreign flag, but also based on whether the vessel came from another U.S. port or from a foreign port. While this information was not detailed, we used it to roughly estimate that 80 percent of non-port emissions can be attributed to foreign flagged vessels. We believe that this is an area that deserves further exploration as we consider additional emission requirements for these vessels in the future.

We agree that there is unlikely to be any large increase in U.S. flagged tonnage in the future. Thus, for the final rule we have held the U.S. flagged portion of the inventory fairly steady into the future and attributed any growth to foreign flagged vessels.

## 11.4 Distance from Coast

What We Proposed:

For the purposes of developing a national inventory of emissions from Category 3 marine diesel engines we proposed to include all emissions from such engines that occur within 175 nautical miles (NM) of the U.S. coast. Additionally, we asked for comment on whether a distance other than 175 nautical miles would be more appropriate and for data that would support a different distance.

What Commenters Said:

The Santa Barbara County Air Pollution Control District stated that since California is subject to prevailing winds that will bring these pollutants onshore, measuring out to 175 NM would help accurately assess the magnitude of emissions and their impact to overall emission levels onshore. Bluewater Network stated that we should maintain the current standard of measuring shipping emissions for inventories out to 175 NM from shore.

The Chamber of Shipping of America (CSA) stated that emission inventories should include all emissions that actually impact U.S. air quality taking into account various parameters including geographic area and prevailing atmospheric conditions. CSA also pointed out that the calculation of emissions and their extrapolation to develop impacts analysis and does not relate to compliance or jurisdictional boundaries. Jurisdictional issues are thoroughly addressed in IMO Conventions and customary international law, and the compliance boundary issue would easily be resolved by adoption of international requirements.

Our Response:

The few comments we received were generally supportive of the use of 175 NM for the development of the Category 3 emissions inventory. We received no substantial new data or

information suggesting that a different distance would be more appropriate. However, as we noted in the proposal for this rule, the U.S. Department of Defense (DoD) has presented some information to us that suggests a different, shorter (offshore distance) limit be established rather than the proposed 175 nautical miles as the appropriate location where emissions from marine vessels would affect on-shore air quality. DoD's modeling work on the marine vessels issue in Southern California led them to conclude that emissions within 60 nautical miles of shore could make it back to the coast due to eddies and the nature of the sea-breeze effects. They note that this distance seems to be confirmed by satellite data showing a distinct tendency for a curved line of demarcation separating the offshore (unobstructed) or parallel ocean wind flow from a region of more turbulent, recirculated air that would impact on-shore areas. That curved line of demarcation was close to San Nicolas Island, which is about 60 nautical miles offshore. Studies and published information on other coastal areas in California indicates that they experience somewhat a narrower (perhaps 30 nautical miles) region of "coastal influence." Nevertheless, commenters from California supported a 175 nautical-mile boundary. Thus, we are including in our national emissions inventory all Category 3 marine diesel emissions that occur within 175 NM of the U.S. coast, as proposed.

Because of the continued data and modeling uncertainties surrounding this issue, we intend to investigate this issue as part of our future rule. As part of this investigation, we will consider the special characteristics of emission transport in separate parts of the country. For example, we expect that the Gulf Coast and East Coast areas of the United States would have their own unique meteorological conditions that might call for different lines of demarcation between on-shore and off-shore effects due to different prevailing winds in those parts of the country.

The emissions inventory calculated by including all emissions occurring within 175 NM of the U.S. coast is used only to determine the air quality impact of Category 3 vessels on U.S. lands for this final rule. However, the distance from the coast and the resultant air quality impact of Category 3 vessels on U.S. lands is related to issues of jurisdiction or enforcement. As previously discussed, we believe that the issue of emissions transport deserves further exploration as we consider further requirements for these engines. We expect that part of this exploration would include further study of the related issues of jurisdiction and enforcement.

# CHAPTER 12 - Miscellaneous Issues

## 12.1 Hotelling Emissions

What We Proposed:

We requested comment on any appropriate policies that would address engine emissions that occur during the time that a ship spends in port.

What Commenters Said:

Bluewater Network believes that national standards for air emissions in ports would help advance the development of technology and fuels to reduce air emissions from both ships and shore-side emission sources. EPA should finalize limits on hotelling emissions from ships. Ports such as Houston and Long Beach are currently instituting programs to control air emissions, in response to State Implementation Plans, on a site-by-site basis. However, the authority of local air districts to address air emissions from ships in port is not always clear. In most cases, a local air district's authority extends only to shore-side emission sources, preventing them from limiting air pollution from vessels. Ships should not be allowed to exceed the emission levels that are set by local air districts for shore-based projects. Bluewater provided further discussion of this issue, including specific examples that illustrate the fragmented approach at U.S. ports.

South Coast Air Quality Management District commented that emissions from hotelling comprise one third of overall emissions from marine vessels in their district. In 2010, emissions from marine vessels are expected to be at 45 tons per day, with 15 tons per day attributed to hotelling. EPA must address this issue and in doing so, should ensure emission reductions from auxiliary onboard engines, which are responsible for a substantial portion of hotelling emissions.

The Port of Houston Authority advocated incentives for port authorities to further reduce overall emissions. Federal incentives should include financial, regulatory, and credit-trading programs for port authorities to further reduce emissions beyond the current EPA standards. This would encourage operators of the equipment (which is not the port authority in most cases) to reduce emissions below the EPA standards. Federal financial incentives could come through the Federal Highway Administration's Congestion Mitigation Air Quality (CMAQ) program. A policy guidance or regulatory proposal from EPA on trading emission credits between mobile and stationary sources may help establish incentive-based reductions. Any voluntary incentive program should be administered by the state, with EPA verifying emission-reduction technologies. EPA should not impose mandatory emission reductions from sources that are already regulated. Rather, this should be achieved through amending existing regulations and standards, rather than burdening port authorities with additional requirements. Any additional emission-reduction targets beyond required levels should be set by the Port Authority, based on

their unique circumstances.

In addition, the Port of Houston Authority believes that port emissions should continue to be regulated under the existing programs within the Clean Air Act. Stationary facilities at ports are subject to the requirements of the New Source Review program. The engines and fuels that power cargo-handling equipment operating at port facilities are currently regulated by EPA's nonroad engine and fuel standards. The auxiliary engines and propulsion engines on smaller vessels are already regulated by the Category 1 and 2 marine engine standards. It appears that all the emission source categories at port facilities are currently (or soon will be) regulated, with the exception of engines and fuels on foreign vessels.

Further, the Port of Houston Authority commented that dwelling (hotelling) emissions from large marine vessels represent less than 1.5 percent of the total mobile source emissions in the Houston-Galveston Area, so the potential reductions on an area-wide basis are limited. Since a significant number of the vessels that visit the Port of Houston do so with irregular frequencies, the EPA would have to regulate a significant portion of the world's vessels to achieve even limited additional reductions in this area.

Bluewater Network, the California Earth Corps, the Ozone Transport Commission, and the South Carolina Department of Health and Environmental Control commented that EPA should explore the feasibility of requiring ports and marine vessels to be outfitted for use of shore power (or providing assistance with these efforts) as a replacement for ship-generated power for

hotelling operations. Shore power has been found to be a cost-effective means for controlling emissions from idling in other types of nonroad engines. EPA could assist states in controlling hotelling emissions by facilitating the use of shore power. The commenters note that if large marine vessels could use shore power, it could provide States with another tool to control emissions in their ports. The California Earth Corps notes that shore power is readily available and could be provided to vessels as needed. South Carolina suggested that EPA provide funds to ports to facilitate increased shore power availability. Bluewater added that EPA should consider adopting requirements for zero emissions from ships in ports where shore-based power is available; where it is not available, EPA should set limits based on the technologies and clean fuels discussed in the proposal.

The South Coast Air Quality Management District commented that EPA should aggressively pursue the regulation of auxiliary engines on ocean-going vessels in conjunction with state and local air pollution control districts. EPA should give special attention to developing NOx standards for auxiliary engines, since these engines will be emitting 15 tons per day of NOx in 2010, representing over 33 percent of total emissions from ocean-going vessels. The majority of emissions from these auxiliary engines occur at the ports during hotelling operations; a large vessel may use one to several of these engines, depending on the specific hotelling needs. These engines are much smaller in size and do not present the same technical challenges as with larger main engines, since control technologies for these smaller engines have been well developed and demonstrated for highway engines.

Euromot opposed any provision that would differentiate emission standards to address hotelling emissions. The issue of hotelling emissions is comparable to the low-load operation in-port and any engine-specific provisions regarding this issue would have a minimal benefit.

The Port of Houston Authority identified several areas of the discussion related to hotelling emissions that require further clarification.

- The proposal states: “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.” This statement is potentially misleading when read in the context of the proposed Category 3 engine rule. Auxiliary engines are generally Category 1 or Category 2 engines. In this context of, the statement could mislead readers into thinking that it is Category 3 engines that operate while a ship is dwelling at port.
- The proposal states, “These emissions are concentrated locally in the port area, which may have a disproportionate effect on neighboring communities.” This statement in the context of auxiliary engines may be exaggerated. Auxiliary engines are vented from the engine room through stacks that exit the ship at its funnel, which generally reaches more than 50 meters above the water line and well into the second vertical zone in the model used by states to predict ozone formation. Because of exit velocity and temperature, exhaust plumes may even rise into the third vertical zone of the model. EPA should evaluate the following in determining the actual effect on neighboring communities: the high elevation of exhaust stacks, the nature of the dispersion of fine PM at these elevations, the formation process of ozone, and the major stationary sources at which some of these vessels load and unload cargo. Given all these factors, the auxiliary

engines could be well below 1% of the total emissions from the entire transportation and manufacturing system associated with the vessel.

- EPA should clarify the term “in-port” when referring to dwelling (hotelling) emissions. The term “in-port” when referring to dwelling emissions may be confusing since transit emissions are also considered in-port once a vessel clears the sea-buoy. EPA could change the terminology to "dwelling emissions" for those emissions that are generated by auxiliary engines while a vessel is tied to the dock. EPA has already addressed these emissions through its Category 1 and Category 2 engine standards that cover auxiliary engines.

Our Response:

The Clean Air Act generally gives EPA the authority to set emission standards for new nonroad engines, while leaving the regulation of the use and operation of nonroad engines to state and local governments. Commenters supporting a national policy related to hotelling emissions have not addressed this fundamental obstacle to additional EPA regulations in this area. We believe that state and local governments could adopt a wide range of initiatives aimed at reducing emissions from marine auxiliary engines while ships are docked in port. We remain prepared to work with state and local governments to formulate effective policies that would reduce these emissions.

We agree with the Port of Houston Authority that Category 3 are generally not operating while a ship is docked in port. On the other hand, some Category 3 engines provide both propulsion and auxiliary power simultaneously by generating electricity that can be used either for propulsion of for onboard electrical needs. As a result, it may well be that emissions from Category 3 engines are contributing to local air pollution while ships are in port.

We intend to further evaluate the factors pointed out by the Port of Houston regarding stack height and dispersion of pollutants.

## 12.2 Economic Incentive Programs/Retrofits

What We Proposed:

We proposed to apply emission standards to new engines and require rebuilding of those engines to keep the engines operating in a way that would allow them to meet emission standards. We did not propose requirements for retrofitting emission-control technology on engines built before the emission standards take effect.

What Commenters Said:

Several of the state and environmental organizations that commented on our proposal expressed concern that it did not include provisions for the existing fleet. Many of these, including Ventura County, NESCAUM, ARB, San Luis Obispo, Sacramento, The Bay Area Air Quality Management District, CAPCOA, and SCAQMD, advocated a program that would

include incentives (like the Carl Moyer program in California) and differential port fees, and even rebuild programs like the locomotive rule or accelerated fleet retirement programs. South Carolina wanted EPA to make available funds for busy ports to promote additional reduction strategies. The Ozone Transport Commission wanted EPA to consider standards for hotelling emissions, while Bluewater suggested that EPA set national standards for air emissions in ports, including shipping and landside emissions.

Finally, the Port of Houston Authority requested EPA to expedite and complete its verification protocols for emission-reduction technologies under the Voluntary Diesel Retrofit Program. They noted that, with regard to this program, "it is critically important that the verification process is reasonable, efficient, and not overly burdensome to allow the quick implementation of effective emission-reduction technologies. Ports like Houston, Los Angeles, and Oakland would be further along in reducing their emissions if these protocols for emission-reduction technologies were developed and vendors were verified. Also, this will help state agencies who have the continued responsibility to develop feasible State Implementation Plans to achieve the NAAQS."

Our Response:

As described above, our ability to set standards for existing engines is limited by the Clean Air Act. We are also unable to create a national program based on the Carl Moyer program in California, although we encourage other states to explore this type of program for ports in their areas. A national system of differential port fees is also not feasible because, contrary to the system that exists in Europe, port fees in the United States are set by states or independent port authorities and the federal government does not have the authority to revise those fees for environmental or other purposes. In sum, many of the programs commenters suggested are better developed at the state or local government level. We encourage states and local governments to pursue these programs and share information with each other; we will provide assistance and guidance where possible.

## 12.3 Air Toxics

What Commenters Said:

The American Lung Association, et al. suggested that EPA should collect sufficient information to determine the appropriateness of setting specific standards to reduce emissions of mobile-source air toxics from marine diesel engines. There is little data available to characterize toxic emissions from marine engines, but they are likely to be substantial. EPA should establish a program to collect appropriate emission data, including an analysis of fuel content to determine the levels of certain toxic substances in marine fuels.

Our Response:

In the future we will be considering whether air toxic emissions from nonroad engines as whole cause or significantly contribute to air pollution that may endanger public health. We will

revisit this issue for marine diesel engines in that context.

## 12.4 Definition of NOx

What We Proposed:

Conventional NOx-measurement procedures convert NO emissions into $NO_2$ emissions for detection in the analyzer. Accordingly, we proposed a NOx standard on a $NO_2$-equivalent basis.

What Commenters Said:

The American Lung Association, et al noted that EPA should set a true NOx standard, not a $NO_2$-equivalent standard. Available data suggest that 92 to 95 percent of NOx emitted is in the form of NO, which is the less reactive species.

Our Response:

The form and calculation of the NOx standard is a function of the measurement procedure, which is common to all EPA programs. We believe that this procedure appropriately measures NO and $NO_2$ emissions in a way that allows manufacturers to quantify emission levels from their engines. Moreover, the Clean Air Act directs us to first consider emission standards for nonroad engines that follow from the standards already in place for heavy-duty highway engines. We therefore believe this is not the appropriate context to deviate from the established policy of measuring NO and $NO_2$ emissions, with the corresponding standard.

Also, since manufacturers are generally not able to control how much engine-out NOx is either NO or $NO_2$, any more careful differentiation of the emission standard would not necessarily result in improved prevention of ozone formation resulting from engine emissions.

## 12.5 Alternative Fuels

What We Proposed:

In the proposal, we described an approach to setting a hydrocarbon emission standard based on an engine's total hydrocarbon emission levels. In the rulemaking for Category 1 and Category 2 engines, we specified that engines running on natural gas would be subject to emission standards based on nonmethane hydrocarbon emissions (i.e., simply ignoring the methane in reporting the mass of hydrocarbon emissions).

What Commenters Said:

The Engine Manufacturers Association (EMA) argued that the proposal results in a standard for natural gas engines that is less stringent than the comparable standard applicable to engines

operating on conventional petroleum-based fuel. If methane emissions are excluded from the measurements made for engines operating on natural gas, manufacturers should be able to exclude methane or other fuels as well. Also, EMA commented that the unique standards for Category 1 and 2 engines using alternative fuels (in 40 CFR 94.8(g)) should also be applied to Category 3 engines.

Our Response:

We are not adopting emission standards to regulate hydrocarbon emissions at this time, so these issues become moot in the final rule.

## 12.6 Updates Reflecting New Recreational Marine Engine Standards

What Commenters Said:

The Engine Manufacturers Association noted a couple discrepancies in the proposed regulatory text that failed to take into account the provisions that had already been proposed for recreational marine diesel engines. They also commented in favor of EPA harmonizing its proposed standards for recreational marine diesel engines with the European standards and noted that the emission inventory for recreational marine diesel engines is several times smaller than that for Category 3 engines.

Our Response:

We have resolved these issues in the context of the final rule for recreational marine diesel engines (67 FR 68242, November 8, 2002).

## 12.7 Blue Cruise

What We Proposed:

In the proposal, we described a plan to pursue a voluntary program to encourage cruise ship operators to adopt environmentally favorable business practices, considering both water and air pollution.

What Commenters Said:

The State of Delaware commented that the Blue Cruise program could be an important component for further reducing emissions from large marine vessels. The rating system that EPA suggests in the proposed rule should work well for indicating the level of participation and achievements that each vessel has obtained. However, the stars that a vessel receives should be color coded to indicate the particular programs or standard(s) adopted by the vessel. For example, stars awarded for air emission reductions could be yellow, while stars for meeting water

discharge limitations could be blue.

Environmental Defense believes it is imperative to ensure that any voluntary program is rigorous in establishing clear, well-grounded, and ambitious environmental-performance standards. EPA should establish a program that recognizes comprehensive environmental performance and reflects the full suite of environmental impacts from this source category.

International Council of Cruise Lines supports a voluntary program overseen by EPA with input from relevant industry stakeholders and environmental groups. The program should also be coordinated with other environmental certification programs to avoid confusion and should recognize and reward both improvements in vessel performance as well as current generation vessels equipped with state-of-the-art pollution-control devices and environmentally responsible operating practices.

Hyundai Heavy Industries suggests looking to Sweden's program as an example incentive structure. They also support applying the voluntary program to cargo and commercial vessels.

Puget Sound Clean Air Agency believes that a voluntary program would not gain widespread acceptance without a financially based incentive structure. Also, the program would not address the larger reduction potential from other types of vessels. EPA should implement a broader based plan, such as the Norwegian government plan to establish an incentive-based ship environment index system. Under this system, ships that have installed certain control technologies, receive a lower index which can lead to reduced port tariffs.

The International Council of Cruise Lines wants EPA to develop nationally recognized effluent standards for advanced wastewater treatment technologies, which will give cruise lines and wastewater treatment system manufacturers a series of specific and targeted goals for improving water treatment and management. In addition, they want EPA to develop recognized standards for shipboard opacity meters, rather than rely on Method 9 for evaluating air emissions. The technology is currently in place on some ICCL member cruise lines to monitor emission loads at the source, which allows for greater accuracy in sampling and reporting emissions.

Bluewater Network argues that, because, voluntary emission reductions rarely result in significant air quality benefits, EPA instead should impose Tier 2 and Tier 3 standards beginning in 2006. EPA should hold a separate public hearing process to initiate a more aggressive Blue Cruise program. Bluewater also argues that the cruise industry has a poor history of following either mandatory or voluntary pollution programs. Therefore, if retained, the proposed Blue Cruise standards need much stronger guidelines and clear mechanisms for enforcement, monitoring, and penalties. In addition, violations of mandatory Blue Cruise standards could be made public to encourage compliance and stars should be awarded only for meaningful and significant in waste and air emissions. Commenter provides additional discussion regarding the details that should be included as part of a revised Blue Cruise program and suggests that instead of attempting to implement a voluntary award program, EPA should respond to their petition filed two years ago on behalf of more than 50 other organizations to evaluate and regulate cruise ship pollution.

Coalition for Clean Air believes that EPA should adopt meaningful standards for cruise ships in place of the proposed voluntary and unenforceable award program; the contemplated Blue Cruise program is primarily based on assumptions rather than actual testing of marine engine performance.

The Passenger Vessel Association requested that EPA identify the statutory authority under which it would act in establishing the Blue Cruise Program. In addition, they ask that EPA take into account the needs and capabilities of smaller cruise ships. Such "small ship" cruise operators offer routes within U.S. territorial waters (coastal, river, Great Lakes). Many emission-control technologies that could be used on larger ships are not appropriate for the smaller vessels. EPA should be careful to ensure that its actions and rating system of stars does not inadvertently favor the largest cruise ships.

State of Delaware suggested that vessel certification should be the responsibility of a third party to minimize the possibility that documents or logs would be altered to ensure certification.

Our Response:

We intend to take these comments into account as we work toward formulating a proposed program. Commenters will have further opportunity to provide input before and after we publish a proposal.

## 12.8 Blue Sky Series

What We Proposed:

We proposed to adopt voluntary emission standards, setting a threshold that would require manufacturers to certify their engines at NOx emission levels at least 80 percent below the internationally negotiated levels. Qualifying engines would be designated "Blue Sky Series" and would be eligible for any incentives adopted by state or local governments or by individual ports.

What Commenters Said:

The American Lung Association, et. al. advocated adopting the proposed voluntary low-emission standards and recommended adding control of PM emissions. This was seen as a way to prevent new technologies from increasing PM emissions and to facilitate state and port programs to establish the availability of low-sulfur marine diesel fuel. EPA should also include Category 1 and 2 engines under the voluntary program.

South Coast Air Quality Management District commented that credit-generation opportunities must be provided as an incentive for additional emission reductions and to protect private investments if a command-and-control approach is not feasible. These opportunities could also encourage the development and commercialization of new control technologies such as fuel cells for marine vessels. The South Coast AQMD has already adopted two pilot emission

credit rules for marine vessels, namely Rule 1631 (applicable to tug boats, and fishing and harbor vessels), and Rule 1632 (use of fuel cells during hotelling operations). In developing credit rules, EPA should provide flexibility, reasonable accountability, and positive feedback in partnership with local districts.

Bluewater Network, Coalition for Clean Air, and View from the Hill objected to the voluntary standards, believing that EPA should rather adopt mandatory Tier 2 and Tier 3 standards that would ultimately achieve 95-percent reductions by 2008. These commenters argue that voluntary emission-reduction programs rarely result in significant air quality benefits. Voluntary regulations are not enforceable and do little to change the status quo. Port communities are suffering significantly from the emissions generated from port operations that are dominated by Category 3 vessels, and port authorities and their tenant fleets have done little to reduce emissions in the harbor areas. U.S. ports are focused on expansion to accommodate even larger uncontrolled marine vessels aimed at meeting the demand of an unprecedented level of growth in trade. The belief that U.S. or foreign fleets will voluntarily focus on the emissions of marine vessels is naive at best. In addition, voluntary rules do little to advance development of emission-control technology for marine vessels.

Euromot, Wartsila, and Man B&W emphasized that the investment and operational costs of reducing NOx emissions to levels beyond Tier 1 would be quite high. Simply relying on a voluntary or "recognition" basis may not be sufficient. Incentive or voluntary programs should be adopted only in addition to a common IMO regulation. Port or state regulations should not be mandatory and the "green image" or economic incentive should be the only driving force.

Man B&W Diesel commented similarly that any incentive-based or voluntary programs should be in addition to a common IMO regulation and should not impose any additional economic or regulatory burdens.

Euromot suggested that the technologies for meeting Blue Sky standards have some limitations and will not be feasible in all cases. Specifically, direct-injection of water or water emulsion could achieve NOx reductions of up to 50% depending on the layout of the fuel-injection system., but this experience is so far limited to certain engine types and cannot be considered to be a generally applicable technology. SCR is the only technology that could reduce NOx emissions by 80 percent, but it is restricted to engines operating with low-sulfur fuel (i.e., below 1 percent). Wartsila agreed that SCR is the only technology that can achieve the objective of reducing NOx emissions by 80 percent.

Hyundai Heavy Industries Co., Inc. also pointed out that using SCR to meet the Blue Sky NOx emission limits would call for a limitation on the sulfur content of fuel (a maximum of 1 percent or 10,000 ppm). This would ensure adequate performance of the SCR control technology as long as possible.

Hyundai Heavy Industries Co., Inc. supports voluntary low-emission standards, but offers an alternative to the proposed Blue Sky NOx emission limits. For engines with speeds rated above 130 rpm, the voluntary low-emission standard should be $9.0 \times n^{-0.2} + 2.1$ g/kW-hr (80% reduction).

The nitrogen deviation (marine residual fuel - marine distillate fuel) is calculated by the commenter as 0.3 percent (3,000 ppm) (compared with EPA's value for nitrogen deviation of 0.2 percent). The 2.1 g/kW-hr fuel adjustment comes from scaling EPA's 1.4 g/kW-hr figure up by 50 percent to take into account the different nitrogen deviation. For engines with speeds rated at or below 130 rpm, the commenter recommends a voluntary low-emission standard of 5.3 g/kW-hr. This figure takes into account the same nitrogen deviation, while using a value of 200 g/kW-hr for brake-specific fuel consumption (bsfc) (a value of 220 g/kW-hr was recommended for engines with rated speed above 130 rpm). The commenter provides a breakdown of this calculation as follows: 17x0.2 + 1.4 x 200/220 x 1.5 = 5.3 g/kW-hr.

The Engine Manufacturers Association identified two typographical errors.

Our Response:

As pointed out by the engine manufacturers and summarized earlier in this document, the technologies that would achieve the targeted voluntary emission reductions are not yet available for application to all Category 3 marine engines. Given the level of the mandatory standards, the remaining question is whether and how to create a voluntary program of standards to promote the advanced technologies, which will achieve substantial emission reductions in each successful application and will further the goal of demonstrating the technology for broader application.

As a result, we are adopting voluntary Blue Sky emission standards much like we proposed. The level of the voluntary NOx standard is updated to reflect changes we made in the form of the mandatory standard—specifically by removing the adjustment factor to reflect the nitrogen content of the fuel. We will revisit this when we adopt Tier 2 standards that require reconsideration of the way we address fuel-quality issues. These changes make moot the changes to the voluntary standard suggested by Hyundai.

We continue to believe it is not appropriate to include PM limits as a qualifying criterion for earning the Blue Sky designation. The reasons for this are the same as for not adopting mandatory PM standards. We have already adopted voluntary emission standards for Category 1 and Category 2 engines.

Manufacturers do not earn emission credits for Blue Sky engines. As a result, state governments or other bodies are free to create a credit program to reward manufacturers or consumers based on their best judgment in creating incentive programs.

To the extent that manufacturers certify engines using technologies that require the use of low-sulfur fuel, we would expect manufacturers and operators to take any appropriate steps to ensure the engines burn the proper fuel.