ENVIRONMENTAL PROTECTION AGENCY40 CFR Parts 9, 85, 86, 89, 92, 94, 1033, 1039, 1042, 1065, and 1068

[EPA-HQ-OAR-2003-0190; FRL_XXXX-X]

RIN 2060-AM06

Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final Rule.

SUMMARY: EPA is adopting a comprehensive program to dramatically reduce pollution from locomotives and marine diesel engines. The controls will apply to all types of locomotives, including line-haul, switch, and passenger, and all types of marine diesel engines below 30 liters per cylinder displacement, including commercial and recreational, propulsion and auxiliary. The near-term emission standards for newly-built engines will phase in starting in 2009. The near-term program also includes new emission limits for existing locomotives and marine diesel engines that apply when they are remanufactured, and take effect as soon as certified remanufacture systems are available, as early as 2008. The long-term emissions standards for newly-built locomotives and marine diesel engines are based on the application of high-efficiency catalytic aftertreatment technology. These standards begin to take effect in 2015 for locomotives and in 2014 for marine diesel engines. We estimate particulate matter (PM) reductions of 90 percent and nitrogen oxides (NO_x) reductions of 80 percent from engines meeting these standards, compared to engines meeting the current standards.

We project that by 2030, this program will reduce annual emissions of NO_x and PM by 800,000 and 27,000 tons, respectively. EPA projects these reductions will annually prevent up to 1,100 PM-related premature deaths, 280 ozone-related premature deaths, 120,000 lost work days, 120,000 school day absences, and 1.1 million minor restricted-activity days. The annual monetized health benefits of this rule in 2030 will range from $9.2 billion to $11 billion, assuming a 3 percent discount rate, or between $8.4 billion to $10 billion, assuming a 7% discount rate. The estimated annual social cost of the program in 2030 is projected to be $740 million, significantly less than the estimated benefits.

DATES: This rule is effective on **[insert date, 60 days after publication in the FEDERAL REGISTER**]. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of **[insert date, 60 days after publication in the FEDERAL REGISTER**].

ADDRESSES: EPA has established a docket for this action under Docket ID No. **EPA-HQ-2003-0190.** All documents in the docket are listed on the www.regulations.gov web site. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through www.regulations.gov or in hard copy at the Air Docket, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air Docket is (202) 566-1742.

FOR FURTHER INFORMATION CONTACT: John Mueller, U.S. EPA, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214-4275; fax number: (734) 214-4816; email address: Mueller.John@epa.gov, or Assessment and Standards Division Hotline; telephone number: (734) 214-4636.

SUPPLEMENTARY INFORMATION:

Does This Action Apply to Me?

- *Locomotives*

Entities potentially affected by this action are those that manufacture, remanufacture or import locomotives or locomotive engines; and those that own or operate locomotives. Regulated categories and entities include:

Category	NAICS Code[1]	Examples of potentially affected entities
Industry	333618, 336510	Manufacturers, remanufacturers and importers of locomotives and locomotive engines
Industry	482110, 482111, 482112	Railroad owners and operators
Industry	488210	Engine repair and maintenance

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. This table lists the types of entities that EPA is now aware could potentially be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your

[1] North American Industry Classification System (NAICS)

company is regulated by this action, you should carefully examine the applicability criteria in 40 CFR 92.1, 1033.1, 1065.1, and 1068.1. If you have questions, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

- *Marine Engines and Vessels*

Entities potentially affected by this action are companies and persons that manufacture, sell, or import into the United States new marine compression-ignition engines, companies and persons that rebuild or maintain these engines, companies and persons that make vessels that use such engines, and the owners/operators of such vessels. Affected categories and entities include:

Category	NAICS Code[1]	Examples of potentially affected entities
Industry	333618	Manufacturers of new marine diesel engines
Industry	33661 and 346611	Ship and boat building; ship building and repairing
Industry	811310	Engine repair, remanufacture, and maintenance
Industry	483	Water transportation, freight and passenger
Industry	487210	and Sightseeing Transportation, Water
Industry	4883	Support Activities for Water Transportation
Industry	1141	Fishing
Industry	336612	Boat building (watercraft not built in shipyards and typically of the type suitable or intended for personal use)

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. This table lists the types of entities that EPA is now aware could potentially be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your company is regulated by this action, you should carefully examine the applicability criteria in 40 CFR 94.1, 1042.1, 1065.1, and 1068.1. If you have questions, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

Outline of This Preamble

I. Overview

This final rule completes an important step in EPA's ongoing National Clean Diesel Campaign (NCDC) by adding new programs for locomotives and marine diesel engines to the clean diesel initiatives we have already undertaken for highway, other nonroad, and stationary diesel engines. As detailed below, it significantly strengthens the locomotive and marine diesel programs we proposed last year (72 FR 15938, April 3, 2007), especially in controlling emissions during the critical early years through the early introduction of advanced technologies and the more complete coverage of existing engines. When fully implemented, this coordinated set of new programs will reduce harmful diesel engine emissions to a small fraction of their previous levels.

The new programs address all types of diesel locomotives-- line-haul, switch, and passenger rail, and all types of marine diesel engines below 30 liters per cylinder displacement (hereafter referred to as “marine diesel engines”).[2] These engines are used to power a wide variety of vessels, from small fishing and recreational boats to large tugs and Great Lakes freighters. They are also used to generate auxiliary vessel power, including on ocean-going ships.

Emissions of fine particulate matter ($PM_{2.5}$) and nitrogen oxides (NO_x) from these diesel engines contribute to nonattainment of the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone. Today, locomotives and marine diesel engines account

[2] Marine diesel engines at or above 30 liters per cylinder, called Category 3 engines, are typically used for propulsion power on ocean-going ships. EPA is addressing Category 3 engines through separate actions, including a planned rulemaking for a new tier of federal standards (see Advance Notice of Proposed Rulemaking published December 7, 2007 at 72 FR 69522) and participation on the U.S. delegation to the International Maritime Organization for negotiations of new international standards (see http://www.epa.gov/otaq/oceanvessels.com for information on both of those actions), as well as EPA’s Clean Ports USA Initiative (see http://www.epa.gov/cleandiesel/ports/index.htm).

for about 20 percent of mobile source NO_x emissions and 25 percent of mobile source diesel $PM_{2.5}$ emissions in the U.S. Absent this final action, by 2030 the relative contributions of NO_x and $PM_{2.5}$ from these engines would have grown to 35 and 65 percent, respectively.

We are finalizing a comprehensive three-part program to address this problem. First, we are adopting stringent emission standards for existing locomotives and for existing commercial marine diesel engines above 600 kilowatt (kW) (800 horsepower (hp)). These standards apply when the engines are remanufactured. This part of the program will take effect as soon as certified remanufacture systems are available, for some engines as early as a few months from now. Under our existing program, locomotives have been certified to one of three tiers of standards: Tier 0 for locomotives originally built between 1973 and 2001, Tier 1 for those built between 2002 and 2004, and Tier 2 for those built in or after 2005. Under this new program, certified locomotive remanufacture systems must be made available by 2010 for Tier 0 and Tier 1 locomotives, and by 2013 for Tier 2 locomotives. Remanufacture systems that are certified for use in marine engine remanufactures are likewise required to be used. We are not, however, setting a specific compliance date for certified marine diesel remanufacture systems because we expect that engine manufacturers will be well motivated by the market opportunity to certify emissions-compliant systems.

Second, we are adopting a set of near-term emission standards, referred to as Tier 3, for newly-built locomotives and marine engines. The Tier 3 standards reflect the application of technologies to reduce engine-out particulate matter (PM) and NO_x.

Third, we are adopting longer-term standards, referred to as Tier 4, for newly-built locomotives and marine engines. Tier 4 standards reflect the application of high-efficiency catalytic aftertreatment technology enabled by the availability of ultra-low sulfur diesel fuel (ULSD). These standards take effect in 2015 for locomotives, and phase in over time for marine engines, beginning in 2014. Finally, we are adopting provisions in all three parts of the program to eliminate emissions from unnecessary locomotive idling.

Locomotives and marine diesel engines designed to these Tier 4 standards will achieve PM reductions of 90 percent and NO_x reductions of 80 percent, compared to engines meeting the current Tier 2 standards. The new standards will also yield sizeable reductions in emissions of nonmethane hydrocarbons (NMHC), carbon monoxide (CO), and hazardous compounds known as air toxics. Table I-1 summarizes the PM and NO_x emission reductions for the new standards compared to today's (Tier 2) emission standards; for remanufactured engines, the comparison is to the current standards for each tier of locomotives covered, and to typical unregulated levels for marine engines.

Table I-1 Reductions from Levels of Existing Standards

Sector	Standards Tier	PM	NO_x
Locomotives	Remanufactured Tier 0	60%	15-20%
	Remanufactured Tier 1	50%	--
	Remanufactured Tier 2	50%	--
	Tier 3	50%	--
	Tier 4	90%	80%
	all tiers -- idle emissions	50%	50%
Marine Diesel Engines [a]	Remanufactured Engines	25-60%	up to 20%
	Tier 3	50%	20%
	Tier 4	90%	80%

Note:
(a) Standards vary by displacement and within power categories. Reductions indicated are typical.

On a nationwide annual basis, these reductions will amount to 800,000 tons of NO_x and 27,000 tons of PM by 2030, resulting annually in the prevention of up to 1,100 PM-related premature deaths, 280 ozone-related premature deaths, 120,000 lost work days, 120,000 school day absences, and 1.1 million minor restricted-activity days. We estimate the annual monetized health benefits of this rule in 2030 will range from \$9.2 billion to \$11 billion, assuming a 3 percent discount rate, or between \$8.4 billion to \$10 billion, assuming a 7% discount rate.[3] The estimated annual social cost of the program in 2030 is projected to be \$740 million, significantly less than the estimated benefits.

A. What Is EPA Finalizing and How Does It Differ From the Proposal?

This final rule makes a number of important changes to the program set out in our Notice of Proposed Rulemaking (NPRM). Among these are changes that will yield significantly greater overall NO_x and PM reductions, especially in the critical early years of the program: The adoption of standards for remanufactured marine engines and a 2-year pull-ahead of the Tier 4 NO_x requirements for line-haul locomotives and for 2000-3700 kW (2760-4900 hp) marine engines.

The major elements of the final program are summarized below. We are also revising existing testing, certification, and compliance provisions to better ensure emissions control in use. Detailed provisions and our justifications for them are discussed in sections III and IV. Section VII of this preamble describes a number of

[3] Low and high benefits estimates are derived from a range of ozone-related premature mortality studies (including an assumption of no causality) and $PM_{2.5}$-related premature mortality based on the ACS study (Pope et al., 2002). Benefits also include $PM_{2.5}$- and ozone-related morbidity benefits. See section VI for a complete discussion and analysis of benefits associated with the final rule.

alternatives that we considered in developing the rule. After evaluating the alternatives, we believe that our new program provides the best opportunity for achieving timely and very substantial emissions reductions from locomotive and marine diesel engines. It balances a number of key factors: (1) achieving very significant emissions reductions as early as possible, (2) providing appropriate lead time to develop and apply advanced control technologies, and (3) coordinating requirements in this final rule with existing highway and nonroad diesel engine programs. The provisions we are finalizing that are different from the proposed program are:

- The adoption of standards for remanufactured marine diesel engines to address emissions from the existing fleet (this was presented as one of the proposal alternatives),
- Inclusion of Tier 4 NO_x controls on 2015-2016 model year locomotives at initial build rather than at first remanufacture,
- A two-year pull-ahead of the Tier 4 NO_x standard for 2000-3700 kW marine engines to 2014,
- Inclusion of Class II railroads in the remanufactured locomotives program,
- No Tier 4 standards for the small fleet of large recreational vessels at this time,
- A revised approach to migratory vessels that spend part of their time overseas,
- Credit for locomotive design measures that reduce emissions as part of efforts to improve efficiency,
- A number of changes to test and compliance requirements detailed in sections III and IV.

Overall, our comprehensive three-part approach to setting standards for locomotives and marine diesel engines will provide very large reductions in PM, NO_x, and toxic compounds, both in the near-term (as early as 2008), and in the long-term. These reductions will be achieved in a manner that: (1) leverages technology developments in other diesel sectors, (2) aligns well with the clean diesel fuel requirements already being implemented, and (3) provides the lead time needed to deal with the significant engineering design workload that is involved.

(1) Locomotive Emission Standards

We are setting stringent exhaust emission standards for newly-built and remanufactured locomotives, furthering the initiative for cleaner locomotives started in 2004 with the establishment of the ULSD locomotive fuel program, and adding this important category of engines to the highway and nonroad diesel applications already covered under EPA’s National Clean Diesel Campaign.

Briefly, for newly-built line-haul locomotives we are setting a new Tier 3 PM standard of 0.10 grams per brake horsepower-hour (g/bhp-hr), based on improvements to existing engine designs. This standard will take effect in 2012. We are also setting new Tier 4 standards of 0.03 g/bhp-hr for PM and 1.3 g/bhp-hr for NO_x, based on the evolution of high-efficiency catalytic aftertreatment technologies now being developed and introduced in the highway diesel sector. The Tier 4 standards will take effect in 2015. We are requiring that remanufactured Tier 2 locomotives meet a PM standard of 0.10 g/bhp-hr, based on the same engine design improvements as Tier 3 locomotives, and that remanufactured Tier 0 and Tier 1 locomotives meet a 0.22 g/bhp-hr PM standard. We are also requiring that remanufactured Tier 0 locomotives meet a NO_x standard of 7.4 g/bhp-hr, the same level as current Tier 1 locomotives, or 8.0 g/bhp-hr if the locomotive is not equipped with a separate loop intake air cooling system. Section III provides a detailed discussion of these new standards, and section IV details improvements being made to the applicable test, certification, and compliance programs.

In setting our original locomotive emission standards in 1998, the historic pattern of transitioning older line-haul locomotives to road- and yard-switcher service resulted in our making little distinction between line-haul and switch locomotives. Because of the increase in the size of new locomotives in recent years, that pattern cannot be sustained by the railroad industry, as today's 4000+ hp (3000+ kW) locomotives are poorly suited for switcher duty. Furthermore, although there is still a fairly sizeable legacy fleet of older smaller line-haul locomotives that could find their way into the switcher fleet, essentially the only newly-built switchers put into service over the last two decades have been of radically different design, employing one to three smaller high-speed diesel engines designed for use in nonroad applications. We are establishing new standards and special certification provisions for newly-built and remanufactured switch locomotives that take these factors into account.

Locomotives spend a substantial amount of time idling, during which they emit harmful pollutants, consume fuel, create noise, and increase maintenance costs. We are requiring that idle controls, such as Automatic Engine Stop/Start Systems (AESS), be included on all newly-built Tier 3 and Tier 4 locomotives. We also are requiring that they be installed on all existing locomotives that are subject to the new remanufactured engine standards, at the point of first remanufacture under the standards, unless already equipped with idle controls. Additional idle emissions control beyond AESS is encouraged in our program by factoring it into the certification test program.

(2) Marine Engine Emission Standards

We are setting emissions standards for newly-built and remanufactured marine diesel engines with displacements up to 30 liters per cylinder (referred to as Category 1 and 2, or C1 and C2, engines). Newly-built engines subject to the new standards include those used in commercial, recreational, and auxiliary power applications, and those below 37 kW (50 hp) that were previously regulated in our nonroad diesel program.

The new marine diesel engine standards include stringent engine-based Tier 3 standards for newly-built marine diesel engines that phase in beginning in 2009. These are followed by aftertreatment-based Tier 4 standards for engines above 600 kW (800 hp) that phase in beginning in 2014. The specific levels and implementation dates for the Tier 3 and Tier 4 standards vary by engine size and power. This yields an array of emission standards levels and start dates that help ensure the most stringent standards feasible at the earliest possible time for each group of newly-built marine engines, while helping engine and vessel manufacturers implement the program in a manner that minimizes their costs for emission reductions. The new standards and implementation schedules, as well as their technological feasibility, are described in detail in section III of this preamble.

We are also adopting standards to address the considerable impact of emissions from large marine diesel engines installed in vessels in the existing fleet. These standards apply to commercial marine diesel engines above 600 kW when these engines are remanufactured, and take effect as soon as certified remanufacture systems are available. The final requirements are different from the programmatic alternative on which we sought comment in that there is no mandatory date by which marine remanufacture systems must be made available. However, systems for the larger Category 2 marine diesel engines are expected to become available at the same time as the locomotive remanufacture systems for similar engines, as early as 2008, because Category 2 marine diesel engines are often derived from locomotive engines. This new marine remanufacture program is described in more detail in section III.B(2)(b). We intend to revisit this program in the future to evaluate the extent to which remanufacture systems are being introduced into the market without a mandatory requirement, and to determine if the program should be extended to small commercial and recreational engines as well.

Taken together, the program elements described above constitute a comprehensive program that addresses the problems caused by locomotive and marine diesel emissions from both a near-term and long-term perspective. It does this while providing for an orderly and cost-effective implementation schedule for the railroads, vessel owners, manufacturers, and remanufacturers.

B. Why Is EPA Taking This Action?

(1) Locomotives and Marine Diesels Contribute to Serious Air Pollution Problems

As we discuss extensively in both the proposal and today's action, EPA strongly believes it is appropriate to take steps now to reduce future emissions from locomotive and marine diesel engines. Emissions from these engines generate significant emissions of $PM_{2.5}$ and NO_x that contribute to nonattainment of the National Ambient Air Quality Standards for $PM_{2.5}$ and ozone. NO_x is a key precursor to ozone and secondary PM formation. These engines also emit hazardous air pollutants or air toxics, which are associated with serious adverse health effects. Finally, emissions from locomotive and marine diesel engines cause harm to public welfare, including contributing to visibility impairment and other harmful environmental impacts across the U.S.

The health and environmental effects associated with these emissions are a classic example of a negative externality (an activity that imposes uncompensated costs on others). With a negative externality, an activity's social cost (the cost borne to society imposed as a result of the activity taking place) exceeds its private cost (the cost to those directly engaged in the activity). In this case, as described below and in section II, emissions from locomotives and marine diesel engines and vessels impose public health and environmental costs on society. However, these added costs are not reflected in the costs of those using these engines and equipment. The current market and regulatory scheme do not correct this externality because firms in the market are rewarded for minimizing their production costs, including the costs of pollution control, and do not benefit from reductions in emissions. In addition, firms that may take steps to use equipment that reduces air pollution may find themselves at a competitive disadvantage compared to firms that do not. The emission standards that EPA is finalizing help address this market failure and reduce the negative externality from these emissions by providing a regulatory incentive for engine and locomotive manufacturers to produce engines and locomotives that emit fewer harmful pollutants and for railroads and vessel builders and owners to use those cleaner engines.

Emissions from locomotive and marine diesel engines account for substantial portions of the country's current ambient $PM_{2.5}$ and NO_x levels. We estimate that today these engines account for about 20 percent of mobile source NO_x emissions and about 25 percent of mobile source diesel $PM_{2.5}$ emissions. Under this rulemaking, by 2030, NO_x emissions from these diesel engines will be reduced annually by 800,000 tons and $PM_{2.5}$ emissions by 27,000 tons, and these reductions will grow beyond 2030 as fleet turnover to the cleanest engines continues.

EPA has already taken steps to bring emissions levels from highway and nonroad diesel vehicles and engines to very low levels over the next decade, while the per horsepower-hour emission levels for locomotive and marine diesel engines remain at much higher levels -- comparable to the emissions for highway trucks in the early 1990s.

Both ozone and $PM_{2.5}$ contribute to serious public health problems, including premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, loss work days, and restricted activity days), changes in lung function and increased respiratory symptoms, altered respiratory defense mechanisms, and chronic bronchitis. Diesel exhaust is of special public health concern, and since 2002 EPA has classified exposure to diesel exhaust as likely to be carcinogenic to humans by inhalation from environmental exposures.[4] Recent studies are showing that populations living near large diesel emission sources such as major roadways, rail yards, and marine ports are likely to experience

[4] U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/600/8-90/057F. Office of Research and Development, Washington DC. This document is available electronically at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060.

greater diesel exhaust exposure levels than the overall U.S. population, putting them at greater health risks. [5,6]

EPA recently conducted an initial screening-level analysis[7] of selected marine port areas and rail yards to better understand the populations that are exposed to diesel particulate matter (DPM) emissions from these facilities.[8,9] This screening-level analysis focused on a representative selection of national marine ports and rail yards.[10] Of the 47 marine ports and 37 rail yards selected, the results indicate that at least 13 million people, including a disproportionate number of low-income households, African-Americans, and Hispanics, living in the vicinity of these facilities, are being exposed to ambient DPM levels that are 2.0 $\mu g/m^3$ and 0.2 $\mu g/m^3$ above levels found in areas further from these facilities. Because those populations exposed to DPM emissions from marine ports and rail yards are more likely to be low-income and minority residents, these populations will benefit from the controls being finalized in this action. The detailed findings of this study are available in the public docket for this rulemaking.

Today, millions of Americans continue to live in areas that do not meet existing air quality standards. Currently, ozone concentrations exceeding the 8-hour ozone NAAQS occur over wide geographic areas, including most of the nation's major population centers. As of October 10, 2007, approximately 88 million people live in 39 designated areas (which include all or part of 208 counties) that either do not meet the current $PM_{2.5}$ NAAQS or contribute to violations in other counties, and 144 million people live in 81 areas (which include all or part of 368 counties) designated as not in

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[5] Kinnee,E.J.; Touman, J.S.; Mason, R.; Thurman,J.; Beidler, A.; Bailey, C.; Cook, R. (2004) Allocation of onroad mobile emissions to road segments for air toxics modeling in an urban area. Transport. Res. Part D 9: 139-150.

[6] State of California Air Resources Board. Roseville Rail Yard Study. Stationary Source Division, October 14, 2004. This document is available electronically at: http://www.arb.ca.gov/diesel/documents/rrstudy.htm and State of California Air Resources Board. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, April 2006. This document is available electronically at: http://www.arb.ca.gov/regact/marine2005/portstudy0406.pdf

[7] This type of screening-level analysis is an inexact tool and not appropriate for regulatory decision-making; it is useful in beginning to understand potential impacts and for illustrative purposes. Additionally, the emissions inventories used as inputs for the analyses are not official estimates and likely underestimate overall emissions because they are not inclusive of all emission sources at the individual ports in the sample. For example, most inventories included emissions from ocean-going vessels (powered by Category 3 engines), as well as some commercial vessel categories , including harbor crafts, (powered by Category 1 and 2 engines), cargo handling equipment, locomotives, and heavy-duty vehicles. This final rule will not address emissions from ocean-going vessels, cargo handling equipment or heavy-duty vehicles.

[8] ICF International. September 28, 2007. Estimation of diesel particulate matter concentration isopleths for marine harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190

[9] ICF International. September 28, 2007. Estimation of diesel particulate matter population exposure near selected harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190

[10] The Agency selected a representative sample of the top 150 U.S. ports including coastal, inland, and Great Lake ports. In selecting a sample of rail yards the Agency identified a subset from the hundreds of rail yards operated by Class I Railroads.

attainment for the 8-hour ozone NAAQS. These numbers do not include the people living in areas where there is a significant future risk of failing to maintain or achieve either the current or future $PM_{2.5}$ or ozone NAAQS.

In addition to public health impacts, there are public welfare and environmental impacts associated with ozone and $PM_{2.5}$ emissions. Ozone causes damage to vegetation which leads to crop and forestry economic losses, as well as harm to national parks, wilderness areas, and other natural systems. NO_x and direct emissions of $PM_{2.5}$ can contribute to the impairment of visibility in many parts of the U.S., where people live, work, and recreate, including national parks, wilderness areas, and mandatory class I federal areas. The deposition of airborne particles can also reduce the aesthetic appeal of buildings and culturally important objects through soiling and can contribute directly (or in conjunction with other pollutants) to structural damage by means of corrosion or erosion. Finally, NO_x emissions from diesel engines contribute to the acidification, nitrification, and eutrophication of water bodies.

While EPA has already adopted many emission control programs that are expected to reduce ambient ozone and $PM_{2.5}$ levels, including the Clean Air Interstate Rule (CAIR) (70 FR 25162, May 12, 2005) and the Clean Air Nonroad Diesel Rule (69 FR 38957, June 29, 2004), the Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements (66 FR 5002, Jan. 18, 2001), and the Tier 2 Vehicle and Gasoline Sulfur Program (65 FR 6698, Feb. 10, 2000), the additional $PM_{2.5}$ and NO_x emission reductions resulting from this rule will assist states in attaining and maintaining the Ozone and the $PM_{2.5}$ NAAQS both near term and in the decades to come.

In September 2006, EPA finalized revised $PM_{2.5}$ NAAQS standards and over the next few years the EPA will undergo the process of designating areas that do not meet this new standard. EPA modeling, conducted as part of finalizing the revised NAAQS, projects that in 2015 up to 52 counties with 53 million people may violate either the daily or annual standards for $PM_{2.5}$ (or both), while an additional 27 million people in 54 counties may live in areas that have air quality measurements within 10 percent of the revised NAAQS. Even in 2020 up to 48 counties, with 54 million people, may still not be able to meet the revised $PM_{2.5}$ NAAQS and an additional 25 million people, living in 50 counties, are projected to have air quality measurements within 10 percent of the revised standards. The locomotive and marine diesel $PM_{2.5}$ reductions resulting from this rulemaking are needed by a number of states to both attain and maintain the revised $PM_{2.5}$ NAAQS.

State and local governments continue working to protect the health of their citizens and comply with requirements of the Clean Air Act (CAA or "the Act"). As part of this effort they recognize the need to secure additional major reductions in both diesel $PM_{2.5}$ and NO_x emissions by undertaking numerous state-level actions.[11] However, they

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[11] Two examples of state and local actions are: California Air Resources Board (2006). Emission Reduction Plan for Ports and Goods Movements, (April 2006), Available electronically at www.arb.ca.gov/gmp/docs/finalgmpplan090905.pdf ; Connecticut Department of Environmental

have also urged Agency action to finalize a strong locomotive and marine diesel engine program that will provide crucial emission reductions both in the near and long-term.

The federal program finalized today results in earlier and significantly greater NO_x and PM reductions from the locomotive and marine sector than the proposed program because of the first-ever national standards for remanufactured marine engines and the starting of Tier 4 NO_x requirements for line-haul locomotives and for 2000-3700 kW (2760-4900 hp) marine engines two years earlier than proposed. These changes reflect important cooperative efforts by the regulated industry to implement cleaner technology as early as possible. While the program finalized today will help many states and communities achieve cleaner air, for some areas, such as the South Coast of California, the reductions achieved through this rule will not alone enable them to meet their near term ozone and PM air quality goals. This was also the case for our 1998 locomotive rulemaking, where the State of California worked with Class I railroads operating in southern California to develop a Memoranda of Understanding (MOU) ensuring that the cleanest technologies enabled by federal rules were expeditiously introduced in areas of California with greatest air quality improvement needs. EPA continues to support California's efforts to reconcile likely future growth in the locomotive and marine sector with the public health protection needs of the area, and today's final rule includes provisions which are well-suited to encouraging early deployment of cleaner technologies through the development of similar programs.

In addition to these new standards, EPA has a number of voluntary programs that help enable government, industry, and local communities to address challenging air quality problems. The EPA SmartWay program has worked with railroads to encourage them to reduce unnecessary locomotive idling and will continue to promote the use of innovative idle reduction technologies that can substantially reduce locomotive emissions while reducing fuel consumption. EPA's National Clean Diesel Campaign, through its Clean Ports USA program is working with port authorities, terminal operators, and trucking and rail companies to promote cleaner diesel technologies and emission reduction strategies through education, incentives, and financial assistance. Part of these efforts involves voluntary retrofit programs that can further reduce emissions from the existing fleet of diesel engines. Finally, EPA is implementing a new Sustainable Ports Strategy which will allow EPA to partner with ports, business partners, communities and other stakeholders to become world leaders in sustainability, including achieving cleaner air. This new strategy builds on the success of collaborative work EPA has been doing in partnership with the American Association of Port Authorities (AAPA), and through port related efforts of Clean Ports USA, SmartWay, EPA's Regional Diesel Collaboratives and other programs. Together these approaches augment the regulations being finalized today, helping states and communities achieve larger reductions sooner in the areas of our country that need them the most.

Protection. (2006). Connecticut's Clean Diesel Plan, (January 2006). See http://www.dep.state.ct.us/air2/diesel/index.htm for description of initiative.

(2) Advanced Technologies Can Be Applied

Air pollution from locomotive and marine diesel exhaust is a challenging problem. However, we believe it can be addressed effectively through a combination of engine-out emission reduction technologies and high-efficiency catalytic aftertreatment technologies. As discussed in greater detail in section III.C, the development of these aftertreatment technologies for highway and nonroad diesel applications has advanced rapidly in recent years, so that new engines can achieve very large emission reductions in PM and NO_x (in excess of 90 and 80 percent, respectively).

High-efficiency PM control technologies are being broadly used in many parts of the world and are being used domestically to comply with EPA's heavy-duty truck standards that started taking effect in the 2007 model year. These technologies are highly durable and robust in use and have proved extremely effective in reducing exhaust hydrocarbon (HC) and carbon monoxide emissions.

Control of NO_x emissions from locomotive and marine diesel engines can also be achieved with high-efficiency exhaust emission control technologies. Such technologies are expected to be used to meet the stringent NO_x standards included in EPA's heavy-duty highway diesel and nonroad Tier 4 programs and have been in production for heavy-duty trucks in Europe since 2005 and in many stationary source applications throughout the world.

Section III.C discusses additional engineering challenges in applying these technologies to newly-built locomotive and marine engines, as well as the development steps that we expect to be taken to resolve the challenges. With the lead time available and the assurance of ULSD for the locomotive and marine sectors in 2012, as provided by our 2004 final rule for nonroad engines and fuel, we are confident the application of advanced technology to locomotives and marine diesel engines will proceed at a reasonable rate of progress and will result in systems capable of achieving the new standards on time.

(3) Basis for Action Under the Clean Air Act

Authority for the actions promulgated in this document is granted to the EPA by sections 114, 203, 205, 206, 207, 208, 213, 216, and 301(a) of the Clean Air Act as amended in 1990 (42 U.S.C. 7414, 7522, 7524, 7525, 7541, 7542, 7547, 7550 and 7601(a)).

Authority to Set Standards. EPA is promulgating emissions standards for new marine diesel engines pursuant to its authority under section 213(a)(3) and (4) of the CAA. EPA is promulgating emission standards for new locomotives and new engines used in locomotives pursuant to its authority under section 213(a)(5) of the CAA.

EPA has previously determined that certain existing locomotive engines, when they are remanufactured, are returned to as-new condition and are expected to have the same performance, durability, and reliability as freshly-manufactured locomotive engines. Consequently we set emission standards for these remanufactured engines that apply at the time of remanufacture (defined as "to replace, or inspect and qualify, each and every power assembly of a locomotive or locomotive engine, whether during a single maintenance event or cumulatively within a five-year period…" (see 61 FR 53102, October 4, 1996; 40 CFR 92.2). In this action we are adopting new tiers of standards for both freshly manufactured and remanufactured locomotives and locomotive engines.

In the proposal for this rulemaking we also discussed applying a similar approach to marine diesel engines. Many marine diesel engines, particularly those above 600 kW (800 hp), periodically undergo a maintenance process that returns them to as-new condition. A full rebuild that brings an engine back to as-new condition includes a complete overhaul of the engine, including piston, rings, liners, turbocharger, heads, bearings, and geartrain/camshaft removal and replacement. Engine manufacturers typically provide instructions for such a full rebuild. Marine diesel engine owners complete this process to maintain engine reliability, durability, and performance over the life of their vessel, and to avoid the need to repower (replace the engine) before their vessel wears out. A commercial marine vessel can be in operation in excess of 40 years, which means that a marine diesel engine may be remanufactured to as-new condition three or more times before the vessel is scrapped.

Because these remanufactured engines are returned to as-new condition, section 213(a)(3) and (4) give EPA the authority to set emission standards for those engines. We are adopting requirements for remanufactured marine diesel engines, described in section III.B(2)(b) of this action. For the purpose of this program, we are defining remanufacture as the replacement of all cylinder liners, either in one maintenance event or over the course of five years (for the purpose of this program, "replacement" includes the removing, inspecting and requalifying a liner). While replacement of cylinder liners is only one element of a full rebuild, it is common to all rebuilds. Marine diesel engines that do not have their cylinder liners replaced all at once or within a five-year period, or that do not perform cylinder liner replacement at all, are not considered to be returned to as-new condition and therefore are not considered to be remanufactured. Those engines will not be subject to the marine remanufacture requirements.

Pollutants That Can Be Regulated. CAA section 213(a)(3) directs the Administrator to set NO_x, volatile organic compounds (VOCs), or carbon monoxide standards for classes or categories of engines such as marine diesel engines that contribute to ozone or carbon monoxide concentrations in more than one nonattainment area. These "standards shall achieve the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the engines or vehicles, giving appropriate consideration to cost, lead time, noise, energy, and safety factors associated with the application of such technology."

CAA section 213(a)(4) authorizes the Administrator to establish standards to control emissions of pollutants which "may reasonably be anticipated to endanger public health and welfare" where the Administrator determines, as it has done for emissions of PM, that nonroad engines as a whole contribute significantly to such air pollution. The Administrator may promulgate regulations that are deemed appropriate, taking into account costs, noise, safety, and energy factors, for classes or categories of new nonroad vehicles and engines which cause or contribute to such air pollution.

Level of the Standards. CAA section 213(a)(5) directs EPA to adopt emission standards for new locomotives and new engines used in locomotives that achieve the "greatest degree of emissions reductions achievable through the use of technology that the Administrator determines will be available for such vehicles and engines, taking into account the cost of applying such technology within the available time period, the noise, energy, and safety factors associated with the applications of such technology." Section 213(a)(5) does not require any review of the contribution of locomotive emissions to pollution, though EPA does provide such information in this rulemaking. As described in section III of this preamble and in chapter 4 of the final Regulatory Impact Analysis (RIA), EPA has evaluated the available information to determine the technology that will be available for locomotives and engines subject to EPA standards.

Certification and Implementation. EPA is also acting under its authority to implement and enforce both the marine diesel emission standards and the locomotive emission standards. Section 213(d) provides that the standards EPA adopts for both new locomotive and marine diesel engines "shall be subject to sections 206, 207, 208, and 209" of the Clean Air Act, with such modifications that the Administrator deems appropriate to the regulations implementing these sections. In addition, the locomotive and marine standards "shall be enforced in the same manner as [motor vehicle] standards prescribed under section 202" of the Act. Section 213 (d) also grants EPA authority to promulgate or revise regulations as necessary to determine compliance with, and enforce, standards adopted under section 213.

Technological Feasibility and Cost of Standards. The evidence provided in section III.C of this Preamble and in chapter 4 of the RIA indicates that the stringent emission standards we are setting today for newly-built and remanufactured locomotive and marine diesel engines are feasible and reflect the greatest degree of emission reduction achievable through the use of technology that will be available in the model years to which they apply. We have given appropriate consideration to costs in setting these standards. Our review of the costs and cost-effectiveness of these standards indicate that they will be reasonable and comparable to the cost-effectiveness of other emission reduction strategies that EPA has required in prior rulemakings. We have also reviewed and given appropriate consideration to the energy factors of this rule in terms of fuel efficiency as well as any safety and noise factors associated with these standards.

Health and Environmental Need for the Standards. The information in section II of this Preamble and chapter 2 of the RIA regarding air quality and public health impacts provides strong evidence that emissions from marine diesel engines and locomotives significantly and adversely impact public health or welfare. EPA has already found in previous rules that emissions from new marine diesel engines contribute to ozone and carbon monoxide concentrations in more than one area which has failed to attain the ozone and carbon monoxide NAAQS (64 FR 73300, December 29, 1999). EPA has also previously determined that it is appropriate to establish PM standards for marine diesel engines under section 213(a)(4), and the additional information on the carcinogenicity of exposure to diesel exhaust noted above reinforces this finding. In addition, we have already found that emissions from nonroad engines as a whole significantly contribute to air pollution that may reasonably be anticipated to endanger public welfare due to regional haze and visibility impairment (67 FR 68241, Nov. 8, 2002). We find here, based on the information in the NPRM and in section II of this preamble and Chapters 2 and 3 of the final RIA, that emissions from the new marine diesel engines likewise contribute to regional haze and to visibility impairment.

The PM and NO_x emission reductions resulting from these standards are important to states' efforts in attaining and maintaining the ozone and the $PM_{2.5}$ NAAQS in the near term and in the decades to come. As noted above, the risk to human health and welfare will be significantly reduced by the standards finalized in today's action.

II. Air Quality and Health Impacts

The locomotive and marine diesel engines subject to this final rule generate significant emissions of particulate matter (PM) and nitrogen oxides (NO_x) that contribute to nonattainment of the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone. These engines also emit hazardous air pollutants or air toxics that are associated with serious adverse health effects and contribute to visibility impairment and other harmful environmental impacts across the U.S.

By 2030, these standards are expected to reduce annual locomotive and marine diesel engine $PM_{2.5}$ emissions by 27,000 tons; NO_x emissions by 800,000 tons; and volatile organic compound (VOC) emissions by 43,000 tons as well as reducing carbon monoxide (CO) and toxic compounds known as air toxics.[12]

We project that reductions of $PM_{2.5}$, NO_x, and VOC emissions from locomotive and marine diesel engines will produce nationwide air quality improvements. According to air quality modeling performed in conjunction with this rule, all 39 current $PM_{2.5}$ nonattainment areas will experience a decrease in their projected 2030 design values. Likewise the 133 mandatory class I federal areas that EPA modeled will all see improvements in their visibility. This rule will also result in nationwide ozone benefits. In 2030, 573 counties (of 579 that have monitored data) experience at least a 0.1 ppb decrease in their ozone design values.

A. Overview

From a public health perspective, we are concerned with locomotive and marine diesel engines' contributions to atmospheric levels of particulate matter in general, diesel $PM_{2.5}$ in particular, various gaseous air toxics, and ozone. Today, locomotive and marine diesel engine emissions represent a substantial portion of the U.S. mobile source diesel

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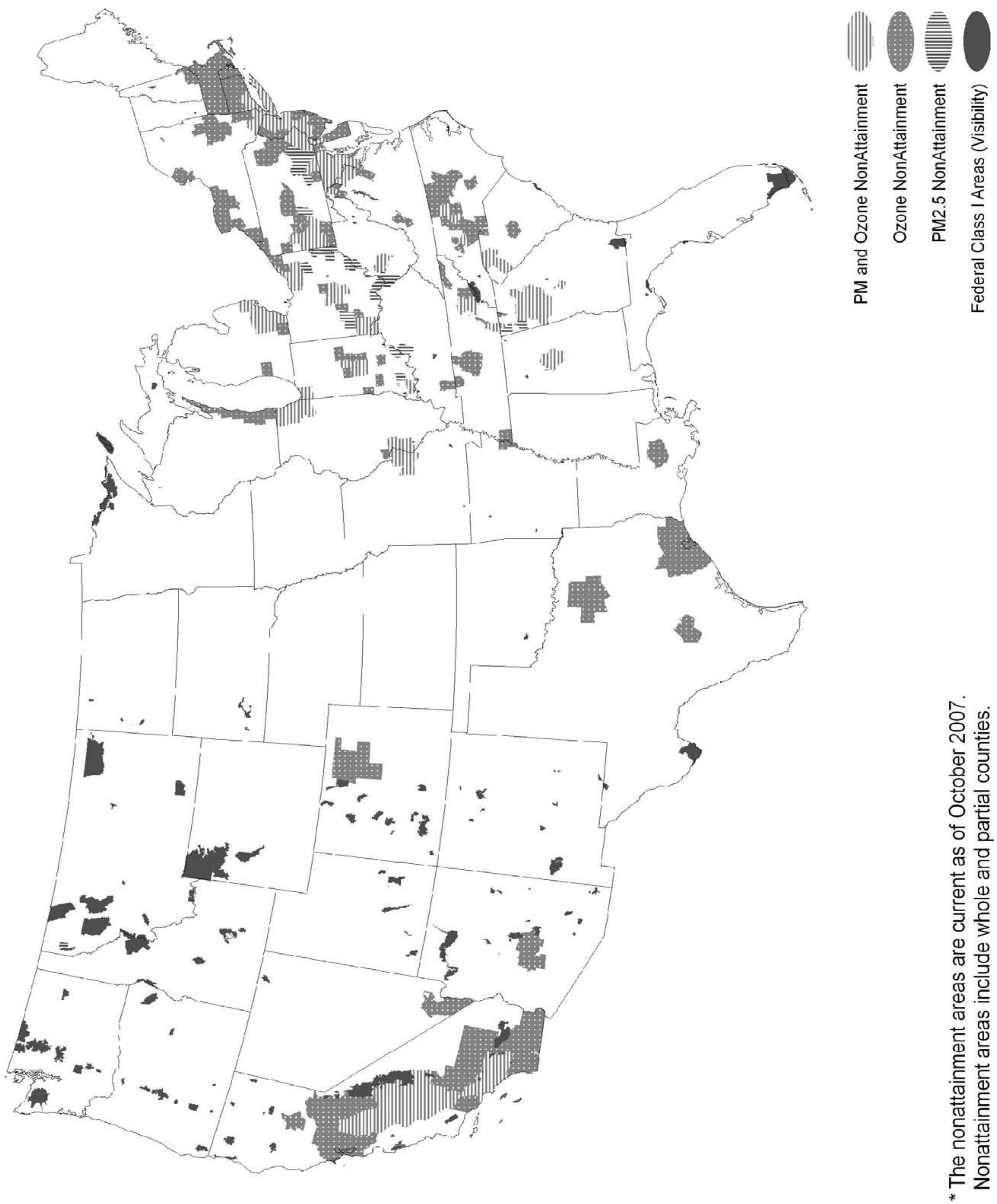
[12] Nationwide locomotive and marine diesel engines comprise approximately 3 percent of the nonroad mobile sources hydrocarbon inventory. EPA National Air Quality and Emissions Trends Report 1999. March 2001, Document Number: EPA 454/R-0-004. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at: http://www.epa.gov/air/airtrends/aqtrnd99/

$PM_{2.5}$ and NO_x inventories, approximately 20 percent of mobile source NO_x and 25 percent of mobile source diesel $PM_{2.5.}$ Over time, the relative contribution of these diesel engines to air quality problems is expected to increase as the emission contribution from other mobile sources decreases and the usage of locomotives and marine vessels increases. By 2030, without the additional emissions controls finalized in today's rule, locomotive and marine diesel engines will emit about 65 percent of the total mobile source diesel $PM_{2.5}$ emissions and 35 percent of the total mobile source NO_x emissions.

Based on the most recent data available for this rule, air quality problems continue to persist over a wide geographic area of the United States. As of October 10, 2007 there are approximately 88 million people living in 39 designated areas (which include all or part of 208 counties) that either do not meet the current $PM_{2.5}$ NAAQS or contribute to violations in other counties, and 144 million people living in 81 areas (which include all or part of 366 counties) designated as not in attainment for the 8-hour ozone NAAQS. These numbers do not include the people living in areas where there is a significant future risk of failing to maintain or achieve either the current or future $PM_{2.5}$ or ozone NAAQS. Figure II-1 illustrates the widespread nature of these problems. This figure depicts counties which are currently designated nonattainment for either or both the 8-hour ozone NAAQS and $PM_{2.5}$ NAAQS. It also shows the location of mandatory class I federal areas for visibility.

Figure II-1 Air Quality Problems are Widespread



The engine standards finalized in this rule will help reduce emissions of PM, NO_x, VOCs, CO, and air toxics and their associated health and environmental effects. Emissions from locomotives and diesel marine engines contribute to PM and ozone concentrations in many, if not all, of these nonattainment areas.[13] The engine standards being finalized today will become effective as early as 2008, making the expected $PM_{2.5}$, NO_x, and VOC inventory reductions from this rulemaking critical to a number of states as they seek to either attain or maintain the current $PM_{2.5}$ or ozone NAAQS.

Beyond the impact locomotive and marine diesel engines have on our nation's ambient air quality the diesel exhaust emissions from these engines are also of particular concern since exposure to diesel exhaust is classified as likely to be carcinogenic to humans by inhalation from environmental levels of exposure.[14] Many people spend a large portion of time in or near areas of concentrated locomotive or marine diesel emissions, near rail yards, marine ports, railways, and waterways. Recent studies show that populations living near large diesel emission sources such as major roadways[15], rail yards[16] and marine ports[17] are likely to experience greater diesel exhaust exposure levels than the overall US population, putting them at a greater health risk.

EPA recently conducted an initial screening-level analysis[18] of selected marine port areas and rail yards to better understand the populations that are exposed to diesel particulate matter (DPM) emissions from these facilities.[19,20] This screening-level

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[13] See section II.B.(1)(c) and II.B.(2)(c) for a summary of the impact emission reductions from locomotive and marine diesel engines will have on air quality in current $PM_{2.5}$ and ozone nonattainment areas.
[14] U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/600/8-90/057F. Office of Research and Development, Washington DC. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060.
[15] Kinnee, E.J.; Touma, J.S.: Mason, R.; Thurman, J.; Beidler, A.; Bailey, C.; Cook, R. (2004) Allocation of onroad mobile emissions to road segments for air toxics modeling in an urban area. Transport. Res. Part D 9:139-150; also see Cohen, J.; Cook, R; Bailey, C.R.; Carr, E. (2005) Relationship between motor vehicle emissions of hazardous pollutants, roadway proximity, and ambient concentrations in Portland, Oregon. Environ. Modeling & Software 20: 7-12.
[16] Hand, R.; Di, P; Servin, A.; Hunsaker, L.; Suer, C. (2004) Roseville Rail Yard Study. California Air Resources Board. This document is available in Docket EPA-HQ-OAR-2003-0190. [Online at http://www.arb.ca.gov/diesel/documents/rrstudy.htm]
[17] Di P.; Servin, A.; Rosenkranz, K.; Schwehr, B.; Tran, H. (April 2006); Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach. State of California Air Resources Board.
[18] This type of screening-level analysis is an inexact tool and not appropriate for regulatory decision-making; it is useful in beginning to understand potential impacts and for illustrative purposes. Additionally, the emissions inventories used as inputs for the analyses are not official estimates and likely underestimate overall emissions because they are not inclusive of all emission sources at the individual ports in the sample. For example, most inventories included emissions from ocean-going vessels (powered by Category 3 engines), as well as some commercial vessel categories , including harbor crafts (powered by Category 1 and 2 engines), cargo handling equipment, locomotives, and heavy-duty vehicles. This final rule will not address emissions from ocean-going vessels, cargo handling equipment or heavy-duty vehicles.
[19] ICF International. September 28, 2007. Estimation of diesel particulate matter concentration isopleths for marine harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190

analysis focused on a representative selection of national marine ports and rail yards.[21] Of the 47 marine ports and 37 rail yards selected, the results indicate that at least 13 million people, including a disproportionate number of low-income households, African-Americans, and Hispanics, living in the vicinity of these facilities, are being exposed to ambient DPM levels that are 2.0 $\mu g/m^3$ and 0.2 $\mu g/m^3$ above levels found in areas further from these facilities. Because those populations exposed to DPM emissions from marine ports and rail yards are more likely to be low-income and minority residents, these populations will benefit from the controls being finalized in this action. The detailed findings of this study are available in the public docket for this rulemaking.

In the following sections we review important public health effects linked to pollutants emitted from locomotive and marine diesel engines. First, the human health effects caused by the pollutants and their current and projected ambient levels are discussed. Following the discussion of health effects, the modeled air quality benefits resulting from this action and the welfare effects associated with emissions from diesel engines are presented. Finally, the locomotive and marine engine emission inventories for the primary pollutants affected by this rule are provided. In summary, the emission reductions from this rule will contribute to controlling the health and welfare problems associated with ambient PM and ozone levels and with diesel-related air toxics.

Taken together, the materials in this section and in the proposal describe the need for tightened emission standards for both locomotive and marine diesel engines and the air quality and public health benefits resulting from this program. This section is not an exhaustive treatment of these issues. For a fuller understanding of the topics treated here, you should refer to the extended presentations in Chapter 2, 3 and 5 of the Regulatory Impact Analysis (RIA) accompanying this final rule.

B. Public Health Impacts

(1) Particulate Matter

The locomotive and marine engine standards detailed in this action will result in significant reductions in primary (directly emitted) $PM_{2.5}$ emissions. In addition, the standards finalized today will reduce emissions of NO_x and VOCs which contribute to the formation of secondary $PM_{2.5}$. Locomotive and marine diesel engines emit high levels of NO_x which react in the atmosphere to form secondary $PM_{2.5}$ (namely ammonium nitrate). These engines also emit SO_2 and VOC which react in the atmosphere to form secondary $PM_{2.5}$ composed of sulfates and organic carbonaceous $PM_{2.5}$. This rule will reduce both primary and secondary PM.

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[20] ICF International. September 28, 2007. Estimation of diesel particulate matter population exposure near selected harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190

[21] The Agency selected a representative sample of the top 150 U.S. ports including coastal, inland and Great Lake ports. In selecting a sample of rail yards the Agency identified a subset from the hundreds of rail yards operated by Class I Railroads.

(a) Background

Particulate matter (PM) represents a broad class of chemically and physically diverse substances. It can be principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size. PM is further described by breaking it down into size fractions. PM_{10} refers to particles generally less than or equal to 10 micrometers (µm) in diameter. $PM_{2.5}$ refers to fine particles, generally less than or equal to 2.5 µm in diameter. Inhalable (or "thoracic") coarse particles refer to those particles generally greater than 2.5 µm but less than or equal to 10 µm in diameter. Ultrafine PM refers to particles less than 100 nanometers (0.1 µm) in diameter. Larger particles tend to be removed by the respiratory clearance mechanisms (e.g. coughing), whereas smaller particles are deposited deeper in the lungs.

Fine particles are produced primarily by combustion processes and by transformations of gaseous emissions (e.g., SOx, NO_x and VOC) in the atmosphere. The chemical and physical properties of $PM_{2.5}$ may vary greatly with time, region, meteorology, and source category. Thus, $PM_{2.5}$ may include a complex mixture of different pollutants including sulfates, nitrates, organic compounds, elemental carbon and metal compounds. These particles can remain in the atmosphere for days to weeks and travel hundreds to thousands of kilometers.

The primary $PM_{2.5}$ NAAQS includes a short-term (24-hour) and a long-term (annual) standard. The 1997 $PM_{2.5}$ NAAQS established by EPA set the 24-hour standard at a level of 65µg/m^3 based on the 98th percentile concentration averaged over three years. The annual standard specifies an expected annual arithmetic mean not to exceed 15µg/m^3 averaged over three years.

EPA has recently amended the NAAQS for $PM_{2.5}$ (71 FR 61144, October 17, 2006). The final rule, signed on September 21, 2006, addressed revisions to the primary and secondary NAAQS for PM to provide increased protection of public health and welfare, respectively. The level of the 24-hour $PM_{2.5}$ NAAQS was revised from 65µg/m^3 to 35 µg/m^3 and the level of the annual $PM_{2.5}$ NAAQS was retained at 15µg/m^3. With regard to the secondary standards for $PM_{2.5}$, EPA has revised these standards to be identical in all respects to the revised primary standards.

(b) Health Effects of $PM_{2.5}$

Scientific studies show ambient PM is associated with a series of adverse health effects. These health effects are discussed in detail in the 2004 EPA Particulate Matter Air Quality Criteria Document (PM AQCD), and the 2005 PM Staff Paper.[22,23] Further discussion of health effects associated with PM can also be found in the RIA for this rule.

Health effects associated with short-term exposures (hours to days) to ambient PM include premature mortality, increased hospital admissions, heart and lung diseases, increased cough, adverse lower-respiratory symptoms, decrements in lung function and changes in heart rate rhythm and other cardiac effects. Studies examining populations exposed to different levels of air pollution over a number of years, including the Harvard Six Cities Study and the American Cancer Society Study, show associations between long-term exposure to ambient $PM_{2.5}$ and both total and cardiovascular and respiratory mortality.[24] In addition, a reanalysis of the American Cancer Society Study shows an association between fine particle and sulfate concentrations and lung cancer mortality.[25]

The health effects of $PM_{2.5}$ have been further documented in local impact studies which have focused on health effects due to $PM_{2.5}$ exposures measured on or near roadways. These studies take into account all air pollution sources, including both spark-ignition (gasoline) and diesel powered vehicles, and indicate that exposure to $PM_{2.5}$ emissions near roadways, which are dominated by mobile sources, are associated with potentially serious health effects. For instance, a recent study found associations between concentrations of cardiac risk factors in the blood of healthy young police officers and $PM_{2.5}$ concentrations measured in vehicles.[26] Also, a number of studies have shown associations between residential or school outdoor concentrations of some fine particle constituents that are found in motor vehicle exhaust, and adverse respiratory outcomes, including asthma prevalence in children who live near major roadways.[27,28,29] Although the engines considered in this rule differ from those in these studies with respect to their applications and fuel qualities, these studies provide an indication of the types of health effects that might be expected to be associated with personal exposure to $PM_{2.5}$ emissions from large marine diesel and locomotive engines.

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[22]U.S. EPA (2004) Air Quality Criteria for Particulate Matter (Oct 2004), Volume I Document No. EPA600/P-99/002aF and Volume II Document No. EPA600/P-99/002bF. This document is available in Docket EPA-HQ-OAR-2003-0190.

[23]U.S. EPA (2005) Review of the National Ambient Air Quality Standard for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA-452/R-05-005. This document is available in Docket EPA-HQ-OAR-2003-0190.

[24] Dockery, DW; Pope, CA III: Xu, X; et al. 1993. An association between air pollution and mortality in six U.S. cities. N Engl J Med 329:1753-1759.

[25] Pope, C. A., III; Burnett, R. T.; Thun, M. J.; Calle, E. E.; Krewski, D.; Ito, K.; Thurston, G. D. (2002) Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. J. Am. Med. Assoc. 287:1132-1141.

[26] Riediker, M.; Cascio, W.E.; Griggs, T.R.; et al. (2004) Particulate matter exposure in cars is associated with cardiovascular effects in healthy young men. Am J Respir Crit Care Med 169: 934–940.

[27] Van Vliet, P.; Knape, M.; de Hartog, J.; Janssen, N.; Harssema, H.; Brunekreef, B. (1997). Motor vehicle exhaust and chronic respiratory symptoms in children living near freeways. Env. Research 74: 122-132.

[28] Brunekreef, B., Janssen, N.A.H.; de Hartog, J.; Harssema, H.; Knape, M.; van Vliet, P. (1997). Air pollution from truck traffic and lung function in children living near roadways. Epidemiology 8:298-303.

[29] Kim, J.J.; Smorodinsky, S.; Lipsett, M.; Singer, B.C.; Hodgson, A.T.; Ostro, B (2004). Traffic-related air pollution near busy roads: The East Bay children's respiratory health study. Am. J. Respir. Crit. Care Med. 170: 520-526.

Recent new studies from the State of California provide evidence that $PM_{2.5}$ emissions within marine ports and rail yards can contribute significantly to elevated ambient concentrations near these sources.[30,31] A substantial number of people experience exposure to locomotive and marine diesel engine emissions, raising potential health concerns. The controls finalized in this action will help reduce exposure to $PM_{2.5}$, specifically exposure to marine port and rail yard related diesel $PM_{2.5}$ sources. Additional information on marine port and rail yard emissions and ambient exposures can be found in Chapter 2 of the RIA.

(c) Current and Projected $PM_{2.5}$ Levels

$PM_{2.5}$ concentrations exceeding the level of the $PM_{2.5}$ NAAQS occur in many parts of the country.[32] In 2005 EPA designated 39 nonattainment areas for the 1997 $PM_{2.5}$ NAAQS (70 FR 943, January 5, 2005). These areas are comprised of 208 full or partial counties with a total population exceeding 88 million. The 1997 $PM_{2.5}$ NAAQS was recently revised and the 2006 $PM_{2.5}$ NAAQS became effective on December 18, 2006. Table II-1 presents the number of counties in areas currently designated as nonattainment for the 1997 $PM_{2.5}$ NAAQS as well as the number of additional counties that have monitored data that is violating the 2006 $PM_{2.5}$ NAAQS.

Table II-1: Fine Particle Standards: Current Nonattainment Areas and Other Violating Counties

Nonattainment Areas/Other Violating Counties	Number of Counties	Population[a]
1997 $PM_{2.5}$ Standards: 39 areas currently designated	208	88,394,000
2006 $PM_{2.5}$ Standards: Counties with violating monitors[b]	49	18,198,676
Total	257	106,595,676

Notes:
(a) Population numbers are from 2000 census data.
(b) This table provides an estimate of the counties violating the 2006 $PM_{2.5}$ NAAQS based on 2003-05 air quality data. The areas designated as nonattainment for the 2006 $PM_{2.5}$ NAAQS will be based on 3 years of air quality data from later years. Also, the county numbers in the summary table includes only the counties with monitors violating the 2006 $PM_{2.5}$ NAAQS. The monitored county violations may be an underestimate of the number of counties and populations that will eventually be included in areas with multiple counties designated nonattainment.

A number of state governments have told EPA that they need the reductions this rule will provide in order to meet and maintain the $PM_{2.5}$ NAAQS. Areas designated as not attaining the 1997 $PM_{2.5}$ NAAQS will need to attain the 1997 standards in the 2010 to

[30] State of California Air Resources Board. Roseville Rail Yard Study. Stationary Source Division, October 14, 2004. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at: http://www.arb.ca.gov/diesel/documents/rrstudy.htm.
[31] State of California Air Resources Board. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, April 2006. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at: ftp://ftp.arb.ca.gov/carbis/msprog/offroad/marinevess/documents/portstudy0406.pdf
[32] A listing of the $PM_{2.5}$ nonattainment areas is included in the RIA for this rule.

2015 time frame, and then maintain them thereafter. The attainment dates associated with the potential new 2006 $PM_{2.5}$ nonattainment areas are likely to be in the 2015 to 2020 timeframe. The emission standards finalized in this action become effective as early as 2008 making the NO_x, PM, and VOC inventory reductions from this rulemaking useful to states in attaining or maintaining the $PM_{2.5}$ NAAQS.

EPA has already adopted many emission control programs that are expected to reduce ambient $PM_{2.5}$ levels and which will assist in reducing the number of areas that fail to achieve the $PM_{2.5}$ NAAQS. Even so, our air quality modeling for this final rule projects that in 2020, with all current controls but excluding the reductions achieved through this rule, up to 11 counties with a population of 24 million may not attain the current annual $PM_{2.5}$ standard of 15 $\mu g/m^3$. These numbers do not account for additional areas that have air quality measurements within 10 percent of the annual $PM_{2.5}$ standard. These areas, although not violating the standards, will also benefit from the additional reductions from this rule ensuring long term maintenance of the $PM_{2.5}$ NAAQS.

Air quality modeling performed for this final rule shows that in 2020 and 2030 all 39 current $PM_{2.5}$ nonattainment areas will experience decreases in their $PM_{2.5}$ design values. For areas with current $PM_{2.5}$ design values greater than 15$\mu g/m^3$ the modeled future-year population weighted $PM_{2.5}$ design values are expected to decrease on average by 0.08 $\mu g/m^3$ in 2020 and by 0.16 $\mu g/m^3$ in 2030. The maximum decrease for future-year $PM_{2.5}$ design values will be 0.38 $\mu g/m^3$ in 2020 and 0.81$\mu g/m^3$ in 2030. The air quality modeling methodology and the projected reductions are discussed in more detail in Chapter 2 of the RIA.

(2) Ozone

The locomotive and marine engine standards finalized in this action are expected to result in significant reductions of NO_x and VOC emissions. NO_x and VOC contribute to the formation of ground-level ozone pollution or smog. People in many areas across the U.S. continue to be exposed to unhealthy levels of ambient ozone.

(a) Background

Ground-level ozone pollution is typically formed by the reaction of volatile organic compounds (VOC) and nitrogen oxides (NO_x) in the lower atmosphere in the presence of heat and sunlight. These pollutants, often referred to as ozone precursors, are emitted by many types of pollution sources, such as highway and nonroad motor vehicles and engines, power plants, chemical plants, refineries, makers of consumer and commercial products, industrial facilities, and smaller area sources.

The science of ozone formation, transport, and accumulation is complex.[33] Ground-level ozone is produced and destroyed in a cyclical set of chemical reactions,

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[33]U.S. EPA Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). U.S. Environmental Protection Agency, Washington, D.C., EPA 600/R-05/004aF-cF, 2006. This document is

many of which are sensitive to temperature and sunlight. When ambient temperatures and sunlight levels remain high for several days and the air is relatively stagnant, ozone and its precursors can build up and result in more ozone than typically occurs on a single high-temperature day. Ozone can also be transported into an area from pollution sources found hundreds of miles upwind, resulting in elevated ozone levels even in areas with low local VOC or NO_x emissions.

The current ozone NAAQS, established by EPA in 1997, has an 8-hour averaging time. The 8-hour ozone NAAQS is met at an ambient air quality monitoring site when the average of the annual fourth-highest daily maximum 8-hour average ozone concentration over three years is less than or equal to 0.084 ppm. On June 20, 2007, EPA proposed to strengthen the ozone NAAQS, the proposed revisions reflect new scientific evidence about ozone and its effects on people and public welfare.[34] The final ozone NAAQS rule is scheduled for March 2008.

(b) Health Effects of Ozone

The health and welfare effects of ozone are well documented and are assessed in EPA's 2006 ozone Air Quality Criteria Document (ozone AQCD) and EPA Staff Paper.[35,36] Ozone can irritate the respiratory system, causing coughing, throat irritation, and/or uncomfortable sensation in the chest. Ozone can reduce lung function and make it more difficult to breathe deeply; breathing may also become more rapid and shallow than normal, thereby limiting a person's activity. Ozone can also aggravate asthma, leading to more asthma attacks that require medical attention and/or the use of additional medication. There is evidence of an elevated risk of mortality associated with acute exposure to ozone, especially in the summer or warm season when ozone levels are typically high. Animal toxicological evidence indicates that with repeated exposure, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue and irreversible reductions in lung function. People who are more

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available in Docket EPA-HQ-OAR-2003-0190. This document may be accessed electronically at: http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_cd.html.

[34] EPA proposed to set the 8-hour primary ozone standard to a level within the range of 0.070-0.075 ppm. The agency also requested comments on alternative levels of the 8-hour primary ozone standard, within a range from 0.060 ppm up to and including retention of the current standard (0.084 ppm). EPA also proposed two options for the secondary ozone standard. One option would establish a new form of standard designed specifically to protect sensitive plants from damage caused by repeated ozone exposure throughout the growing season. This cumulative standard would add daily ozone concentrations across a three month period. EPA proposed to set the level of the cumulative standard within the range of 7 to 21 ppm-hours. The other option would follow the current practice of making the secondary standard equal to the proposed 8-hour primary standard.

[35] U.S. EPA Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). U.S. Environmental Protection Agency, Washington, D.C., EPA 600/R-05/004aF-cF, 2006. This document is available in Docket EPA-HQ-OAR-2003-0190. This document may be accessed electronically at: http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_cd.html

[36] U.S. EPA (2007) Review of the National Ambient Air Quality Standards for Ozone, Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper.EPA-452/R-07-003. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at: http:www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_sp.html.

susceptible to effects associated with exposure to ozone can include children, the elderly, and individuals with respiratory disease such as asthma. Those with greater exposures to ozone, for instance due to time spent outdoors (e.g., children and outdoor workers), are also of particular concern.

The recent ozone AQCD also examined relevant new scientific information that has emerged in the past decade, including the impact of ozone exposure on such health effects as changes in lung structure and biochemistry, inflammation of the lungs, exacerbation and causation of asthma, respiratory illness-related school absence, hospital admissions and premature mortality. Animal toxicological studies have suggested potential interactions between ozone and PM with increased responses observed to mixtures of the two pollutants compared to either ozone or PM alone. The respiratory morbidity observed in animal studies along with the evidence from epidemiologic studies supports a causal relationship between acute ambient ozone exposures and increased respiratory- related emergency room visits and hospitalizations in the warm season. In addition, there is suggestive evidence of a contribution of ozone to cardiovascular-related morbidity and non-accidental and cardiopulmonary mortality.

(c) Current and Projected Ozone Levels

Ozone concentrations exceeding the level of the 8-hour ozone NAAQS occur over wide geographic areas, including most of the nation's major population centers.[37] As of October 10, 2007, there were approximately 144 million people living in 81 areas (which include all or part of 366 counties) designated as not in attainment with the 8-hour ozone NAAQS. These numbers do not include the people living in areas where there is a future risk of failing to maintain or attain the 8-hour ozone NAAQS.

States with 8-hour ozone nonattainment areas are required to take action to bring those areas into compliance in the future. Based on the final rule designating and classifying 8-hour ozone nonattainment areas (69 FR 23951, April 30, 2004), most 8-hour ozone nonattainment areas will be required to attain the ozone NAAQS in the 2007 to 2013 time frame and then maintain the NAAQS thereafter.[38] Many of these nonattainment areas will need to adopt additional emission reduction programs and the NO_x and VOC reductions from this final action are particularly important for these states. In addition, EPA's review of the ozone NAAQS is currently underway with a final rule scheduled for March 2008. If the ozone NAAQS is revised then new nonattainment areas will be designated. While EPA is not relying on it for purposes of justifying this rule, the emission reductions from this rulemaking will also be helpful to states if EPA revises the ozone NAAQS to be more stringent.

EPA has already adopted many emission control programs that are expected to reduce ambient ozone levels. These control programs are described in section I.B.1 of this preamble. As a result of these programs, the number of areas that fail to meet the 8-

[37] A listing of the 8-hour ozone nonattainment areas is included in the RIA for this rule.
[38] The Los Angeles South Coast Air Basin 8-hour ozone nonattainment area will have to attain before June 15, 2021.

hour ozone NAAQS in the future is expected to decrease. Based on the air quality modeling performed for this rule, which does not include any additional local controls, we estimate nine counties (where 22 million people are projected to live) will exceed the 8-hour ozone NAAQS in 2020.[39] An additional 39 counties (where 29 million people are projected to live) are expected to be within 10 percent of violating the 8-hour ozone NAAQS in 2020.

This rule results in reductions in nationwide ozone levels. The air quality modeling projects that in 2030, 573 counties (of 579 that have monitored data) experience at least a 0.1 ppb decrease in their ozone design values. There are three nonattainment areas in southern California, the Los Angeles-South Coast Air Basin nonattainment area, the Riverside Co. (Coachella Valley) nonattainment area and the Los Angeles – San Bernardino (W. Mojave) nonattainment area, which will experience 8-hour ozone design value increases due to the NO_x disbenefits which occur in these VOC-limited ozone nonattainment areas. Briefly, NO_x reductions at certain times and in some areas can lead to increased ozone levels. The air quality modeling methodology (Section 2.3), the projected reductions (Section 2.2.4), and the limited NO_x disbenefits (Section 2.2.4.2.1), are discussed in more detail in Chapter 2 of the RIA.

Results from the air quality modeling conducted for this final rule indicate that the locomotive and marine diesel engine emission reductions in 2020 and 2030 will improve both the average and population-weighted average ozone concentrations for the U.S. In addition, the air quality modeling shows that on average this final rule will help bring counties closer to ozone attainment as well as assist counties whose ozone concentrations are within ten percent below the standard. For example, in projected nonattainment counties, on a population-weighted basis, the 8-hour ozone design value will on average decrease by 0.13 ppb in 2020 and 0.62 ppb in 2030.[40]

The impact of the reductions has also been analyzed with respect to those areas that have the highest design values, at or above 85 ppb, in 2020. We project there will be nine US counties with design values at or above 85 ppb in 2020. After implementation of this rule, we project that one of these nine counties will drop below 85 ppb. Further, two of the nine counties will be at least 10 percent closer to a design value of less than 85 ppb, and on average all nine counties will be about 18 percent closer to a design value of less than 85 ppb.

(3) Air Toxics

People experience elevated risk of cancer and other noncancer health effects from exposure to the class of pollutants known collectively as "air toxics". Mobile sources are

[39] We expect many of the 8-hour ozone nonattainment areas to adopt additional emission reduction programs but we are unable to quantify or rely upon future reductions from additional state and local programs that have not yet been adopted.

[40] Ozone design values are reported in parts per million (ppm) as specified in 40 CFR Part 50. Due to the scale of the design value changes in this action, results have been presented in parts per billion (ppb) format.

responsible for a significant portion of this exposure. According to the National Air Toxic Assessment (NATA) for 1999, mobile sources, including locomotive and marine diesel marine engines, were responsible for 44 percent of outdoor toxic emissions and almost 50 percent of the cancer risk among the 133 pollutants quantitatively assessed in the 1999 NATA. Benzene is the largest contributor to cancer risk of all the assessed pollutants and mobile sources were responsible for about 68 percent of all benzene emissions in 1999. Although the 1999 NATA did not quantify cancer risks associated with exposure to diesel exhaust, EPA has concluded that diesel exhaust ranks with other emissions that the national-scale assessment suggests pose the greatest relative risk.

According to the 1999 NATA, nearly the entire U.S. population was exposed to an average level of air toxics that has the potential for adverse respiratory noncancer health effects. This potential was indicated by a hazard index (HI) greater than 1.[41] Mobile sources were responsible for 74 percent of the potential noncancer hazard from outdoor air toxics in 1999. About 91 percent of this potential noncancer hazard was from acrolein;[42] however, the confidence in the RfC for acrolein is medium[43] and confidence in NATA estimates of population noncancer hazard from ambient exposure to this pollutant is low.[44] It is important to note that NATA estimates of noncancer hazard do not include the adverse health effects associated with particulate matter identified in EPA's Particulate Matter Air Quality Criteria Document. Gasoline and diesel engine emissions contribute significantly to particulate matter concentration.

The NATA modeling framework has a number of limitations which prevent its use as the sole basis for setting regulatory standards. These limitations and uncertainties are discussed on the 1999 NATA website.[45] Even so, this modeling framework is very useful in identifying air toxic pollutants and sources of greatest concern, setting regulatory priorities, and informing the decision making process.

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[41] To express chronic noncancer hazards, we used the RfC as part of a calculation called the hazard quotient (HQ), which is the ratio between the concentration to which a person is exposed and the RfC. (RfC is defined by EPA as, "an estimate of a continuous inhalation exposure to the human population, including sensitive subgroups, with uncertainty spanning perhaps an order of magnitude, which is likely to be without appreciable risks of deleterious noncancer effects during a lifetime.") A value of the HQ less than one indicates that the exposure is lower than the RfC and that no adverse health effects would be expected. Combined noncancer hazards were calculated using the hazard index (HI), defined as the sum of hazard quotients for individual air toxic compounds that affect the same target organ or system. As with the hazard quotient, a value of the HI at or below 1.0 will likely not result in adverse effects over a lifetime of exposure. However, a value of the HI greater than 1.0 does not necessarily suggest a likelihood of adverse effects. Furthermore, the HI cannot be translated into a probability that adverse effects will occur and is not likely to be proportional to risk.

[42] U.S. EPA (2006) National-Scale Air Toxics Assessment for 1999. This material is available electronically at http://www.epa.gov/ttn/atw/nata1999/risksum.html.

[43] U.S. EPA (2003) Integrated Risk Information System File of Acrolein. National Center for Environmental Assessment, Office of Research and Development, Washington, D.C. 2003. This material is available electronically at http://www.epa.gov/iris/subst/0364.htm.

[44] U.S. EPA (2006) National-Scale Air Toxics Assessment for 1999. This material is available electronically at http://www.epa.gov/ttn/atw/nata1999/risksum.html.

[45] U.S. EPA (2006) National-Scale Air Toxics Assessment for 1999. http://www.epa.gov/ttn/atw/nata1999.

The following section provides a brief overview of air toxics which are associated with nonroad engines, including locomotive and marine diesel engines, and provides a discussion of the health risks associated with each air toxic.

(a) Diesel Exhaust (DE)

Locomotive and marine diesel engines emit diesel exhaust (DE), a complex mixture comprised of carbon dioxide, oxygen, nitrogen, water vapor, carbon monoxide, nitrogen compounds, sulfur compounds and numerous low-molecular-weight hydrocarbons. A number of these gaseous hydrocarbon components are individually known to be toxic, including aldehydes, benzene and 1,3-butadiene. The diesel particulate matter (DPM) present in diesel exhaust consists of fine particles (< 2.5µm), including a subgroup with a large number of ultrafine particles (< 0.1 µm). These particles have a large surface area which makes them an excellent medium for adsorbing organics and their small size makes them highly respirable and able to reach the deep lung. Many of the organic compounds present on the particles and in the gases are individually known to have mutagenic and carcinogenic properties. Diesel exhaust varies significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, accelerate, decelerate), and fuel formulations (high/low sulfur fuel). Also, there are emissions differences between on-road and nonroad engines because the nonroad engines are generally of older technology. This is especially true for locomotive and marine diesel engines.[46]

After being emitted in the engine exhaust, diesel exhaust undergoes dilution as well as chemical and physical changes in the atmosphere. The lifetime for some of the compounds present in diesel exhaust ranges from hours to days.

(i) Diesel Exhaust: Potential Cancer Effects

In EPA's 2002 Diesel Health Assessment Document (Diesel HAD)[47], exposure to diesel exhaust was classified as likely to be carcinogenic to humans by inhalation from environmental exposures, in accordance with the revised draft 1996/1999 EPA cancer guidelines. A number of other agencies (National Institute for Occupational Safety and Health, the International Agency for Research on Cancer, the World Health Organization, California EPA, and the U.S. Department of Health and Human Services) have made similar classifications. However, EPA also concluded in the Diesel HAD that it is not possible currently to calculate a cancer unit risk for diesel exhaust due to a variety of

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[46] U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/600/8-90/057F Office of Research and Development, Washington DC. Pp1-1 1-2. This document is available electronically at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060. This document can be found in Docket EPA-HQ-OAR-2003-0190.

[47] U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/600/8-90/057F Office of Research and Development, Washington DC. This document is available electronically at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060. This document can be found in Docket EPA-HQ-OAR-2003-0190.

factors that limit the current studies, such as limited quantitative exposure histories in occupational groups investigated for lung cancer.

For the Diesel HAD, EPA reviewed 22 epidemiologic studies on the subject of the carcinogenicity of workers exposed to diesel exhaust in various occupations, finding increased lung cancer risk, although not always statistically significant, in 8 out of 10 cohort studies and 10 out of 12 case-control studies within several industries, including railroad workers. Relative risk for lung cancer associated with exposure ranged from 1.2 to 1.5, although a few studies show relative risks as high as 2.6. Additionally, the Diesel HAD also relied on two independent meta-analyses, which examined 23 and 30 occupational studies respectively, which found statistically significant increases in smoking-adjusted relative lung cancer risk associated with exposure to diesel exhaust, of 1.33 to 1.47. These meta-analyses demonstrate the effect of pooling many studies and in this case show the positive relationship between diesel exhaust exposure and lung cancer across a variety of diesel exhaust-exposed occupations.[48,49]

In the absence of a cancer unit risk, the Diesel HAD sought to provide additional insight into the significance of the diesel exhaust-cancer hazard by estimating possible ranges of risk that might be present in the population. An exploratory analysis was used to characterize a possible risk range by comparing a typical environmental exposure level for highway diesel sources to a selected range of occupational exposure levels. The occupationally observed risks were then proportionally scaled according to the exposure ratios to obtain an estimate of the possible environmental risk. A number of calculations are needed to accomplish this, and these can be seen in the EPA Diesel HAD. The outcome was that environmental risks from diesel exhaust exposure could range from a low of 10^{-4} to 10^{-5} to as high as 10^{-3}, reflecting the range of occupational exposures that could be associated with the relative and absolute risk levels observed in the occupational studies. Because of uncertainties, the analysis acknowledged that the risks could be lower than 10^{-4} or 10^{-5}, and a zero risk from diesel exhaust exposure was not ruled out.

Retrospective health studies of railroad workers have played an important part in determining that exposure to diesel exhaust is likely to be carcinogenic to humans by inhalation from environmental exposures. Key evidence of the diesel exhaust exposure linkage to lung cancer comes from two retrospective case-control studies of railroad workers which are discussed at length in the Diesel HAD and summarized in Chapter 2 of the RIA.

(ii) Diesel Exhaust: Other Health Effects

Noncancer health effects of acute and chronic exposure to diesel exhaust emissions are also of concern to the EPA. EPA derived a diesel exhaust reference concentration (RfC) from consideration of four well-conducted chronic rat inhalation

[48] Bhatia, R., Lopipero, P., Smith, A. (1998) Diesel exposure and lung cancer. Epidemiology 9(1):84-91.
[49] Lipsett, M: Campleman, S; (1999) Occupational exposure to diesel exhaust and lung cancer: a meta-analysis. Am J Public Health 80(7): 1009-1017.

studies showing adverse pulmonary effects.[50,51,52,53] The RfC is 5 µg/m^3 for diesel exhaust as measured by diesel PM. This RfC does not consider allergenic effects such as those associated with asthma or immunologic effects. There is growing evidence, discussed in the Diesel HAD, that exposure to diesel exhaust can exacerbate these effects, but the exposure-response data are presently lacking to derive an RfC. The EPA Diesel HAD states, "With DPM [diesel particulate matter] being a ubiquitous component of ambient PM, there is an uncertainty about the adequacy of the existing DE [diesel exhaust] noncancer database to identify all of the pertinent DE-caused noncancer health hazards." (p. 9-19). The Diesel HAD concludes "that acute exposure to DE [diesel exhaust] has been associated with irritation of the eye, nose, and throat, respiratory symptoms (cough and phlegm), and neurophysiological symptoms such as headache, lightheadedness, nausea, vomiting, and numbness or tingling of the extremities."[54]

Exposure to diesel exhaust has also been shown to cause serious noncancer effects in occupational exposure studies. One study of railroad workers and electricians, cited in the Diesel HAD[55], found that exposure to diesel exhaust resulted in neurobehavioral impairments in one or more areas including reaction time, balance, blink reflex latency, verbal recall, and color vision confusion indices. Pulmonary function tests also showed that 10 of the 16 workers had airway obstruction and another group of 10 of 16 workers had chronic bronchitis, chest pain, tightness, and hyperactive airways. Finally, a variety of studies have been published subsequent to the completion of the Diesel HAD. One such study, published in 2006[56], found that railroad engineers and conductors with diesel exhaust exposure from operating trains had an increased incidence of chronic obstructive pulmonary disease (COPD) mortality. The odds of COPD mortality increased with years on the job so that those who had worked more than 16 years as an engineer or conductor after 1959 had an increased risk of 1.61 (95% confidence interval, 1.12 - 2.30). EPA is assessing the significance of this study within the context of the broader literature.

(iii) Ambient $PM_{2.5}$ Levels and Exposure to Diesel Exhaust PM

The Diesel HAD also briefly summarizes health effects associated with ambient PM and discusses the EPA's annual $PM_{2.5}$ NAAQS of 15 µg/m^3. There is a much more

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[50] Ishinishi, N; Kuwabara, N; Takaki, Y; et al. (1988) Long-term inhalation experiments on diesel exhaust. In: Diesel exhaust and health risks. Results of the HERP studies. Ibaraki, Japan: Research Committee for HERP Studies; pp. 11-84.

[51] Heinrich, U; Fuhst, R; Rittinghausen, S; et al. (1995) Chronic inhalation exposure of Wistar rats and two different strains of mice to diesel engine exhaust, carbon black, and titanium dioxide. Inhal. Toxicol. 7:553-556.

[52] Mauderly, JL; Jones, RK; Griffith, WC; et al. (1987) Diesel exhaust is a pulmonary carcinogen in rats exposed chronically by inhalation. Fundam. Appl. Toxicol. 9:208-221.

[53] Nikula, KJ; Snipes, MB; Barr, EB; et al. (1995) Comparative pulmonary toxicities and carcinogenicities of chronically inhaled diesel exhaust and carbon black in F344 rats. Fundam. Appl. Toxicol. 25:80-94.

[54] "Health Assessment Document for Diesel Engine Exhaust," U.S. Environmental Protection Agency, 600/8-90/057F, http://www.epa.gov/ttn/atw/dieselfinal.pdf, May 2002, p. 9-9.

[55] Kilburn (2000) See HAD Chapter 5-7.

[56] Hart, JE, Laden F; Schenker, M.B.; and Garshick, E. Chronic Obstructive Pulmonary Disease Mortality in Diesel-Exposed Railroad Workers; Environmental Health Perspective July 2006: 1013-1016.

extensive body of human data showing a wide spectrum of adverse health effects associated with exposure to ambient PM, of which diesel exhaust is an important component. The $PM_{2.5}$ NAAQS is designed to provide protection from the noncancer and premature mortality effects of $PM_{2.5}$ as a whole.

(iv) Diesel Exhaust PM Exposures

Exposure of people to diesel exhaust depends on their various activities, the time spent in those activities, the locations where these activities occur, and the levels of diesel exhaust pollutants in those locations. The major difference between ambient levels of diesel particulate and exposure levels for diesel particulate is that exposure accounts for a person moving from location to location, proximity to the emission source, and whether the exposure occurs in an enclosed environment.

Occupational Exposures

Occupational exposures to diesel exhaust from mobile sources, including locomotive engines and marine diesel engines, can be several orders of magnitude greater than typical exposures in the non-occupationally exposed population.

Over the years, diesel particulate exposures have been measured for a number of occupational groups. A wide range of exposures have been reported, from 2 µg/m^3 to 1,280 µg/m^{3,} for a variety of occupations. Studies have shown that miners and railroad workers typically have higher diesel exposure levels than other occupational groups studied, including firefighters, truck dock workers, and truck drivers (both short and long haul).[57] As discussed in the Diesel HAD, the National Institute of Occupational Safety and Health (NIOSH) has estimated a total of 1,400,000 workers are occupationally exposed to diesel exhaust from on-road and nonroad vehicles including locomotive and marine diesel engines.

Elevated Concentrations and Ambient Exposures in Mobile Source-Impacted Areas

Regions immediately downwind of rail yards and marine ports may experience elevated ambient concentrations of directly-emitted $PM_{2.5}$ from diesel engines. Due to the unique nature of rail yards and marine ports, emissions from a large number of diesel engines are concentrated in a small area. Furthermore, emissions occur at or near ground level, allowing emissions of diesel engines to reach nearby receptors without fully mixing with background air.

A 2004 study conducted by the California Air Resources Board (CARB) examined the air quality impacts of railroad operations at the J.R. Davis Rail Yard, the

[57] Diesel HAD Page 2-110, 8-12; Woskie, SR; Smith, TJ; Hammond, SK: et al. (1988a) Estimation of the DE exposures of railroad workers: II. National and historical exposures. Am J Ind Med 12:381-394.

largest service and maintenance rail facility in the western United States.[58] The yard occupies 950 acres along a one-quarter mile wide and four-mile long section of land in Roseville, CA. The study developed an emissions inventory for the facility for the year 2000 and modeled ambient concentrations of diesel PM using a well-accepted dispersion model (ISCST3). The study estimated substantially elevated diesel PM concentrations in an area 5,000 meters from the facility, with higher concentrations closer to the rail yard. Using local meteorological data, annual average contributions from the rail yard to ambient diesel PM concentrations under prevailing wind conditions were 1.74, 1.18, 0.80, and 0.25 $\mu g/m^3$ at receptors located 200, 500, 1000, and 5000 meters from the yard, respectively. Several tens of thousands of people live within the area estimated to experience substantial increases in annual average ambient $PM_{2.5}$ as a result of these rail yard emissions.

Another study from CARB evaluated air quality impacts of diesel engine emissions within the Ports of Long Beach and Los Angeles in California, one of the largest ports in the U.S.[59] Like the earlier rail yard study, the port study employed the ISCST3 dispersion model. Using local meteorological data, annual average concentrations were substantially elevated over an area exceeding 200,000 acres. Because the ports are located near heavily-populated areas, the modeling indicated that over 700,000 people lived in areas with at least 0.3 $\mu g/m^3$ of port-related diesel PM in ambient air, about 360,000 people lived in areas with at least 0.6 $\mu g/m^3$ of diesel PM, and about 50,000 people lived in areas with at least 1.5 ug/m^3 of ambient diesel PM directly from the port. Most recently, CARB released several additional Railyard Health Risk Assessments which all show that diesel PM emissions result in significantly higher pollution risks in nearby communities.[60] Together these studies highlight the substantial contribution these facilities make to elevated ambient concentrations in populated areas.

As mentioned in section II.A of this preamble, EPA recently conducted an initial screening-level analysis of a representative selection of national marine port areas and rail yards to begin to better understand the populations that are exposed to DPM emissions from these facilities.[61,62] As part of this study, a computer geographic information system (GIS) was used to identify the locations and property boundaries of

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58 Hand, R.; Pingkuan, D.; Servin, A.; Hunsaker, L.; Suer, C. (2004) Roseville rail yard study. California Air Resources Board. [Online at http://www.arb.ca.gov/diesel/documents/rrstudy.htm] This document can be found in Docket EPA-HQ-OAR-2003-0190.

59 State of California Air Resources Board. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, April 2006. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at: ftp://ftp.arb.ca.gov/carbis/msprog/offroad/marinevess/documents/portstudy0406.pdf

60 These studies are available in Docket EPA-HQ-OAR-2003-0190. Studies are also available at http://www.arb.ca.gov/railyard/hra/hra.htm

61 ICF International. September 28, 2007. Estimation of diesel particulate matter concentration isopleths for marine harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190.

62 ICF International. September 28, 2007. Estimation of diesel particulate matter population exposure near selected harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190.

47 marine ports and 37 rail yard facilities.[63] Census information was used to estimate the size and demographic characteristics of the population living in the vicinity of the ports and rail yards. The results indicate that at least 13 million people, including a disproportionate number of low-income, African-Americans, and Hispanics, live in the vicinity of these facilities and are being exposed to ambient DPM levels that are 2.0 $\mu g/m^3$ and 0.2 $\mu g/m^3$ above levels found in areas further from these facilities. These populations will benefit from the controls being finalized in this action. This study is discussed in greater detail in chapter 2 of the RIA and detailed findings of this study are available in the public docket for this rulemaking.

(b) Other Air Toxics—benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, POM, naphthalene

Locomotive and marine diesel engine exhaust emissions also contribute to ambient levels of other air toxics known or suspected as human or animal carcinogens, or that have noncancer health effects. These other air toxics include benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, polycyclic organic matter (POM), and naphthalene. All of these compounds, except acetaldehyde, were identified as national or regional cancer risk or noncancer hazard drivers in the 1999 National-Scale Air Toxics Assessment (NATA) and have significant inventory contributions from mobile sources. That is, for a significant portion of the population, these compounds pose a significant portion of the total cancer and noncancer risk from breathing outdoor air toxics. The reductions in locomotive and marine diesel engine emissions finalized in this rulemaking will help reduce exposure to these harmful substances.

Benzene: EPA has characterized benzene as a known human carcinogen (causing leukemia) by all routes of exposure, and concludes that exposure is associated with additional health effects, including genetic changes in both humans and animals and increased proliferation of bone marrow cells in mice.[64,65,66] EPA states in its IRIS database that data indicate a causal relationship between benzene exposure and acute lymphocytic

[63] The Agency selected a representative sample of the top 150 U.S. ports including coastal, inland, and Great Lake ports. In selecting a sample of rail yards the Agency identified a subset from the hundreds of rail yards operated by Class I Railroads.
[64] U.S. EPA. 2000. Integrated Risk Information System File for Benzene. This material is available electronically at http://www.epa.gov/iris/subst/0276.htm.
[65] International Agency for Research on Cancer (IARC). 1982. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France, p. 345-389.
[66] Irons, R.D.; Stillman, W.S.; Colagiovanni, D.B.; Henry, V.A. 1992. Synergistic action of the benzene metabolite hydroquinone on myelopoietic stimulating activity of granulocyte/macrophage colony-stimulating factor in vitro, Proc. Natl. Acad. Sci. 89:3691-3695.

leukemia and suggests a relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia. The IARC has determined that benzene is a human carcinogen and the U.S. DHHS has characterized benzene as a known human carcinogen.[67,68]

A number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene.[69,70] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[71, 72] In addition, recent work, including studies sponsored by the Health Effects Institute (HEI), provides evidence that biochemical responses are occurring at lower levels of benzene exposure than previously known.[73,74,75,76] EPA's IRIS program has not yet evaluated these new data.

1,3-Butadiene: EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation.[77, 78] The IARC has determined that benzene is a human carcinogen and the

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[67] International Agency for Research on Cancer (IARC). 1987. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Supplement 7, Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France.

[68] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: http://ntp.niehs.nih.gov/go/16183.

[69] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193-197.

[70] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541-554.

[71] Rothman, N., G.L. Li, M. Dosemeci, W.E. Bechtold, G.E. Marti, Y.Z. Wang, M. Linet, L.Q. Xi, W. Lu, M.T. Smith, N. Titenko-Holland, L.P. Zhang, W. Blot, S.N. Yin, and R.B. Hayes (1996) Hematotoxicity among Chinese workers heavily exposed to benzene. Am. J. Ind. Med. 29: 236-246.

[72] U.S. EPA (2002) Toxicological Review of Benzene (Noncancer Effects). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington DC. This material is available electronically at http://www.epa.gov/iris/subst/0276.htm.

[73] Qu, O.; Shore, R.; Li, G.; Jin, X.; Chen, C.L.; Cohen, B.; Melikian, A.; Eastmond, D.; Rappaport, S.; Li, H.; Rupa, D.; Suramaya, R.; Songnian, W.; Huifant, Y.; Meng, M.; Winnik, M.; Kwok, E.; Li, Y.; Mu, R.; Xu, B.; Zhang, X.; Li, K. (2003) HEI Report 115, Validation & Evaluation of Biomarkers in Workers Exposed to Benzene in China.

[74] Qu, Q., R. Shore, G. Li, X. Jin, L.C. Chen, B. Cohen, et al. (2002) Hematological changes among Chinese workers with a broad range of benzene exposures. Am. J. Industr. Med. 42: 275-285.

[75] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., et al. (2004) Hematotoxically in Workers Exposed to Low Levels of Benzene. Science 306: 1774-1776.

[76] Turtletaub, K.W. and Mani, C. (2003) Benzene metabolism in rodents at doses relevant to human exposure from Urban Air. Research Reports Health Effect Inst. Report No.113.

[77] U.S. EPA (2002) Health Assessment of 1,3-Butadiene. Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC. Report No. EPA600-P-98-001F. This document is available electronically at http://www.epa.gov/iris/supdocs/buta-sup.pdf.

[78] U.S. EPA (2002) Full IRIS Summary for 1,3-butadiene (CASRN 106-99-0). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC http://www.epa.gov/iris/subst/0139.htm.

U.S. DHHS has characterized 1,3-butadiene as a known human carcinogen.[79,80] There are numerous studies consistently demonstrating that 1,3-butadiene is metabolized into genotoxic metabolites by experimental animals and humans. The specific mechanisms of 1,3-butadiene-induced carcinogenesis are unknown; however, the scientific evidence strongly suggests that the carcinogenic effects are mediated by genotoxic metabolites. Animal data suggest that females may be more sensitive than males for cancer effects associated with 1,3-butadiene exposure; while there are insufficient data in humans from which to draw conclusions about sensitive subpopulations.

1,3-Butadiene also causes a variety of reproductive and developmental effects in mice; no human data on these effects are available. The most sensitive effect was ovarian atrophy observed in a lifetime bioassay of female mice.[81]

Formaldehyde: Since 1987, EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[82] EPA is currently reviewing recently published epidemiological data. For instance, research conducted by the National Cancer Institute (NCI) found an increased risk of nasopharyngeal cancer and lymphohematopoietic malignancies such as leukemia among workers exposed to formaldehyde.[83, 84] NCI is currently updating these studies. A recent National Institute of Occupational Safety and Health (NIOSH) study of garment workers also found increased risk of death due to leukemia among workers exposed to formaldehyde.[85] Extended follow-up of a cohort of British chemical workers did not find evidence of an increase in nasopharyngeal or lymphohematopoietic cancers, but a continuing statistically significant excess in lung cancers was reported.[86] Recently, the IARC re-classified formaldehyde as a human carcinogen (Group 1).[87]

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[79] International Agency for Research on Cancer (IARC) (1999) Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 71, Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide and Volume 97 (in preparation), World Health Organization, Lyon, France.

[80] U.S. Department of Health and Human Services (2005) National Toxicology Program 11th Report on Carcinogens available at: ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.

[81] Bevan, C.; Stadler, J.C.; Elliot, G.S.; et al. (1996) Subchronic toxicity of 4-vinylcyclohexene in rats and mice by inhalation. Fundam. Appl. Toxicol. 32:1-10.

[82] U.S. EPA (1987) Assessment of Health Risks to Garment Workers and Certain Home Residents from Exposure to Formaldehyde, Office of Pesticides and Toxic Substances, April 1987.

[83] Hauptmann, M..; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2003. Mortality from lymphohematopoetic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95: 1615-1623.

[84] Hauptmann, M..; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2004. Mortality from solid cancers among workers in formaldehyde industries. American Journal of Epidemiology 159: 1117-1130.

[85] Pinkerton, L. E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193-200.

[86] Coggon, D, EC Harris, J Poole, KT Palmer. 2003. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. J National Cancer Inst. 95:1608-1615.

[87] International Agency for Research on Cancer (IARC). 2006. Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol. Volume 88. (in preparation), World Health Organization, Lyon, France.

Formaldehyde exposure also causes a range of noncancer health effects, including irritation of the eyes (burning and watering of the eyes), nose and throat. Decreased pulmonary function has been observed in humans. Effects from repeated exposure in humans include respiratory tract irritation, chronic bronchitis and nasal epithelial lesions.[88]

Acetaldehyde: EPA has characterized acetaldehyde as a probable human carcinogen, based on nasal tumors in rats.[89] Acetaldehyde is reasonably anticipated to be a human carcinogen by the U.S. Department of Health and Human Services (DHHS) in the 11th Report on Carcinogens and is classified as possibly carcinogenic to humans (Group 2B) by the International Agency for Research on Carcinogens (IARC).[90,91] EPA is currently conducting a reassessment of cancer and noncancer risk from inhalation exposure to acetaldehyde.

The primary noncancer effects of exposure to acetaldehyde vapors include irritation of the eyes, skin, and respiratory tract.[92] In short-term (4 week) rat studies, compound-related histopathological changes were observed only in the respiratory system at various concentration levels of exposure.[93, 94] Data from these studies were used by EPA to develop an inhalation reference concentration. Some asthmatics have been shown to be a sensitive subpopulation to decrements in functional expiratory volume (FEV1 test) and bronchoconstriction upon acetaldehyde inhalation.[95]

Acrolein: Acrolein is extremely acrid and irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation, mucus hypersecretion and congestion. Levels considerably lower than 1 ppm (2.3 mg/m^3) elicit subjective complaints of eye and nasal irritation and a decrease in the respiratory rate.[96,97] Lesions to

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[88] U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry. 1999. Toxicological Profile for formaldehyde. Available at http://www.atsdr.cdc.gov/toxprofiles/tp111.html.

[89] U.S. EPA. 1991. Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at http://www.epa.gov/iris/subst/0290.htm.

[90] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.

[91] International Agency for Research on Cancer (IARC). 1999. Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemical to Humans, Vol 71. Lyon, France.

[92] U.S. EPA. 1991. Integrated Risk Information System File of Acetaldehyde. This material is available electronically at http://www.epa.gov/iris/subst/0290.htm.

[93] Appleman, L. M., R. A. Woutersen, V. J. Feron, R. N. Hooftman, and W. R. F. Notten. 1986. Effects of the variable versus fixed exposure levels on the toxicity of acetaldehyde in rats. J. Appl. Toxicol. 6: 331-336.

[94] Appleman, L.M., R.A. Woutersen, and V.J. Feron. 1982. Inhalation toxicity of acetaldehyde in rats. I. Acute and subacute studies. Toxicology. 23: 293-297.

[95] Myou, S.; Fujimura, M.; Nishi K.; Ohka, T.; and Matsuda, T. 1993. Aerosolized acetaldehyde induces histamine-mediated bronchoconstriction in asthmatics. Am. Rev. Respir.Dis.148(4 Pt 1): 940-3.

[96] Weber-Tschopp, A; Fischer, T; Gierer, R; et al. (1977) Experimentelle reizwirkungen von Acrolein auf den Menschen. Int Arch Occup Environ Hlth 40(2):117-130. In German

the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein. Based on animal data, individuals with compromised respiratory function (e.g., emphysema, asthma) are expected to be at increased risk of developing adverse responses to strong respiratory irritants such as acrolein. This was demonstrated in mice with allergic airway-disease by comparison to non-diseased mice in a study of the acute respiratory irritant effects of acrolein.[98] EPA is currently in the process of conducting an assessment of acute exposure effects for acrolein. The intense irritancy of this carbonyl has been demonstrated during controlled tests in human subjects who suffer intolerable eye and nasal mucosal sensory reactions within minutes of exposure.[99]

EPA determined in 2003 that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was available on the carcinogenic effects of acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[100] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[101]

Polycyclic Organic Matter (POM): POM is generally defined as a large class of organic compounds which have multiple benzene rings and a boiling point greater than 100 degrees Celsius. Many of the compounds included in the class of compounds known as POM are classified by EPA as probable human carcinogens based on animal data. One of these compounds, naphthalene, is discussed separately below. Polycyclic aromatic hydrocarbons (PAHs) are a subset of POM that contain only hydrogen and carbon atoms. A number of PAHs are known or suspected carcinogens. Recent studies have found that maternal exposures to PAHs (a subclass of POM) in a population of pregnant women were associated with several adverse birth outcomes, including low birth weight and reduced length at birth, as well as impaired cognitive development at age three.[102,103] EPA has not yet evaluated these recent studies.

Naphthalene: Naphthalene is found in small quantities in gasoline and diesel fuels but is primarily a product of combustion. EPA recently released an external review

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[97] Sim, VM; Pattle, RE. (1957) Effect of possible smog irritants on human subjects. J Am Med Assoc 165(15):1908-1913.

[98] Morris JB, Symanowicz PT, Olsen JE, et al. 2003. Immediate sensory nerve-mediated respiratory responses to irritants in healthy and allergic airway-diseased mice. J Appl Physiol 94(4):1563-1571.

[99] Sim VM, Pattle RE. Effect of possible smog irritants on human subjects JAMA165: 1980-2010, 1957.

[100] U.S. EPA. 2003. Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at http://www.epa.gov/iris/subst/0364.htm

[101] International Agency for Research on Cancer (IARC). 1995. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 63, Dry cleaning, some chlorinated solvents and other industrial chemicals, World Health Organization, Lyon, France.

[102] Perera, F.P.; Rauh, V.; Tsai, W-Y.; et al. (2002) Effect of transplacental exposure to environmental pollutants on birth outcomes in a multiethnic population. Environ Health Perspect. 111: 201-205.

[103] Perera, F.P.; Rauh, V.; Whyatt, R.M.; Tsai, W.Y.; Tang, D.; Diaz, D.; Hoepner, L.; Barr, D.; Tu, Y.H.; Camann, D.; Kinney, P. (2006) Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children. Environ Health Perspect 114: 1287-1292.

draft of a reassessment of the inhalation carcinogenicity of naphthalene.[104] The draft reassessment recently completed external peer review.[105] Based on external peer review comments received to date, additional analyses are being undertaken. This external review draft does not represent official agency opinion and was released solely for the purposes of external peer review and public comment. Once EPA evaluates public and peer reviewer comments, the document will be revised. The National Toxicology Program listed naphthalene as "reasonably anticipated to be a human carcinogen" in 2004 on the basis of bioassays reporting clear evidence of carcinogenicity in rats and some evidence of carcinogenicity in mice.[106] California EPA has released a new risk assessment for naphthalene, and the IARC has reevaluated naphthalene and re-classified it as Group 2B: possibly carcinogenic to humans.[107] Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[108]

C. Environmental Impacts

There are a number of public welfare effects associated with the presence of ozone, NO_x and $PM_{2.5}$ in the ambient air. In this section we discuss visibility, the impact of deposition on ecosystems and materials, and the impact of ozone on plants, including trees, agronomic crops and urban ornamentals.

(1) Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light. Airborne particles degrade visibility by scattering and absorbing light. Visibility is important because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas such as national parks and wilderness areas and special emphasis is given to protecting

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[104] U.S. EPA (2004) Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at http://www.epa.gov/iris/subst/0436.htm.

[105] Oak Ridge Institute for Science and Education (2004) External Peer Review for the IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. August 2004. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=84403

[106] National Toxicology Program (NTP). (2004). 11th Report on Carcinogens. Public Health Service, U.S. Department of Health and Human Services, Research Triangle Park, NC. Available from: http://ntp-server.niehs.nih.gov.

[107] International Agency for Research on Cancer (IARC) (2002) Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France.

[108] U.S. EPA (1998) Toxicological Review of Naphthalene, Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at http://www.epa.gov/iris/subst/0436.htm

visibility in these areas. For more information on visibility, see the final 2004 PM AQCD as well as the 2005 PM Staff Paper.[109,110]

EPA is pursuing a two-part strategy to address visibility. First, to address the welfare effects of PM on visibility, EPA has set secondary $PM_{2.5}$ standards which act in conjunction with the establishment of a regional haze program. In setting this secondary standard, EPA has concluded that $PM_{2.5}$ causes adverse effects on visibility in various locations, depending on PM concentrations and factors such as chemical composition and average relative humidity. Second, section 169 of the Clean Air Act provides additional authority to address existing visibility impairment and prevent future visibility impairment in the 156 national parks, forests and wilderness areas categorized as mandatory class I federal areas (62 FR 38680-81, July 18, 1997).[111] In July 1999, the regional haze rule (64 FR 35714) was put in place to protect the visibility in mandatory class I federal areas. Visibility can be said to be impaired in both $PM_{2.5}$ nonattainment areas and mandatory class I federal areas.

Locomotives and marine engines contribute to visibility concerns in these areas through their primary $PM_{2.5}$ emissions and their NO_x emissions which contribute to the formation of secondary $PM_{2.5}$.

Current Visibility Impairment

As of October 10, 2007, almost 90 million people live in nonattainment areas for the 1997 $PM_{2.5}$ NAAQS. These populations, as well as large numbers of individuals who travel to these areas, are likely to experience visibility impairment. In addition, while visibility trends have improved in mandatory class I federal areas the most recent data show that these areas continue to suffer from visibility impairment.[112] In summary, visibility impairment is experienced throughout the U.S., in multi-state regions, urban areas, and remote mandatory class I federal areas.[113,114]

Future Visibility Impairment

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[109] U.S. EPA (2004) Air Quality Criteria for Particulate Matter (Oct 2004), Volume I Document No. EPA600/P-99/002aF and Volume II Document No. EPA600/P-99/002bF. This document is available in Docket EPA-HQ-OAR-2003-0190.

[110] U.S. EPA (2005) Review of the National Ambient Air Quality Standard for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA-452/R-05-005. This document is available in Docket EPA-HQ-OAR-2003-0190.

[111] These areas are defined in section 162 of the Act as those national parks exceeding 6,000 acres, wilderness areas and memorial parks exceeding 5,000 acres, and all international parks which were in existence on August 7, 1977.

[112] U.S. EPA (2002) Latest Findings on National Air Quality – 2002 Status and Trends. EPA 454/K-03-001.

[113] US EPA, Air Quality Designations and Classifications for the Fine Particles ($PM_{2.5}$) National Ambient Air Quality Standards, December 17, 2004. (70 FR 943, Jan 5. 2005) This document is also available on the web at: http://www.epa.gov/pmdesignations/

[114] US EPA. Regional Haze Regulations, July 1, 1999. (64 FR 35714, July 1, 1999)

Air quality modeling conducted for this final rule was used to project visibility conditions in 133 mandatory class I federal areas across the US in 2020 and 2030. The results indicate that improvement in visibility will occur in all mandatory class I federal areas although all areas will continue to have annual average deciview levels above background in 2020 and 2030. Chapter 2 of the RIA contains more detail on the visibility portion of the air quality modeling.

(2) Plant and Ecosystem Effects of Ozone

Elevated ozone levels contribute to environmental effects, with impacts to plants and ecosystems being of most concern. Ozone can produce both acute and chronic injury in sensitive species depending on the concentration level and the duration of the exposure. Ozone effects also tend to accumulate over the growing season of the plant, so that even low concentrations experienced for a longer duration have the potential to create chronic stress on vegetation. Ozone damage to plants includes visible injury to leaves and a reduction in food production through impaired photosynthesis, both of which can lead to reduced crop yields, forestry production, and use of sensitive ornamentals in landscaping. In addition, the reduced food production in plants and subsequent reduced root growth and storage below ground, can result in other, more subtle plant and ecosystems impacts. These include increased susceptibility of plants to insect attack, disease, harsh weather, interspecies competition and overall decreased plant vigor. The adverse effects of ozone on forest and other natural vegetation can potentially lead to species shifts and loss from the affected ecosystems, resulting in a loss or reduction in associated ecosystem goods and services. Lastly, visible ozone injury to leaves can result in a loss of aesthetic value in areas of special scenic significance like national parks and wilderness areas. The final 2006 Criteria Document presents more detailed information on ozone effects on vegetation and ecosystems.

As discussed above, locomotive and marine diesel engine emissions of NO_x contribute to ozone and therefore the NO_x standards will help reduce crop damage and stress on vegetation from ozone.

(3) Atmospheric Deposition

Wet and dry deposition of ambient particulate matter delivers a complex mixture of metals (e.g., mercury, zinc, lead, nickel, aluminum, cadmium), organic compounds (e.g., POM, dioxins, furans) and inorganic compounds (e.g., nitrate, sulfate) to terrestrial and aquatic ecosystems. The chemical form of the compounds deposited is impacted by a variety of factors including ambient conditions (e.g., temperature, humidity, oxidant levels) and the sources of the material. Chemical and physical transformations of the particulate compounds occur in the atmosphere as well as the media onto which they deposit. These transformations in turn influence the fate, bioavailability and potential toxicity of these compounds. Atmospheric deposition has been identified as a key component of the environmental and human health hazard posed by several pollutants including mercury, dioxin and PCBs.[115]

Adverse impacts on water quality can occur when atmospheric contaminants deposit to the water surface or when material deposited on the land enters a water body through runoff. Potential impacts of atmospheric deposition to water bodies include those related to both nutrient and toxic inputs. Adverse effects to human health and welfare can occur from the addition of excess particulate nitrate nutrient enrichment, which contributes to toxic algae blooms and zones of depleted oxygen, which can lead to fish kills, frequently in coastal waters. Particles contaminated with heavy metals or other toxins may lead to the ingestion of contaminated fish, ingestion of contaminated water, damage to the marine ecology, and limited recreational uses. Several studies have been conducted in U.S. coastal waters and in the Great Lakes Region in which the role of ambient PM deposition and runoff is investigated.[116,117,118,119,120]

Adverse impacts on soil chemistry and plant life have been observed for areas heavily impacted by atmospheric deposition of nutrients, metals and acid species, resulting in species shifts, loss of biodiversity, forest decline and damage to forest productivity. Potential impacts also include adverse effects to human health through ingestion of contaminated vegetation or livestock (as in the case for dioxin deposition), reduction in crop yield, and limited use of land due to contamination.

The NO_x, VOC and PM standards finalized in this action will help reduce the environmental impacts of atmospheric deposition.

(4) Materials Damage and Soiling

The deposition of airborne particles can reduce the aesthetic appeal of buildings and culturally important articles through soiling, and can contribute directly (or in conjunction with other pollutants) to structural damage by means of corrosion or erosion.[121] Particles affect materials principally by promoting and accelerating the corrosion of metals, by degrading paints, and by deteriorating building materials such as

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[115] U.S. EPA (2000) Deposition of Air Pollutants to the Great Waters: Third Report to Congress. Office of Air Quality Planning and Standards. EPA-453/R-00-0005. This document is available in Docket EPA-HQ-OAR-2003-0190.

[116] U.S. EPA (2004) National Coastal Condition Report II. Office of Research and Development/ Office of Water. EPA-620/R-03/002. This document is available in Docket EPA-HQ-OAR-2003-0190.

[117] Gao, Y., E.D. Nelson, M.P. Field, et al. 2002. Characterization of atmospheric trace elements on $PM_{2.5}$ particulate matter over the New York-New Jersey harbor estuary. Atmos. Environ. 36: 1077-1086.

[118] Kim, G., N. Hussain, J.R. Scudlark, and T.M. Church. 2000. Factors influencing the atmospheric depositional fluxes of stable Pb, 210Pb, and 7Be into Chesapeake Bay. J. Atmos. Chem. 36: 65-79.

[119] Lu, R., R.P. Turco, K. Stolzenbach, et al. 2003. Dry deposition of airborne trace metals on the Los Angeles Basin and adjacent coastal waters. J. Geophys. Res. 108(D2, 4074): AAC 11-1 to 11-24.

[120] Marvin, C.H., M.N. Charlton, E.J. Reiner, et al. 2002. Surficial sediment contamination in Lakes Erie and Ontario: A comparative analysis. J. Great Lakes Res. 28(3): 437-450.

[121] U.S EPA (2005) Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. This document is available in Docket EPA-HQ-OAR-2003-0190.

concrete and limestone. Particles contribute to these effects because of their electrolytic, hygroscopic, and acidic properties, and their ability to adsorb corrosive gases (principally sulfur dioxide). The rate of metal corrosion depends on a number of factors, including the deposition rate and nature of the pollutant; the influence of the metal protective corrosion film; the amount of moisture present; variability in the electrochemical reactions; the presence and concentration of other surface electrolytes; and the orientation of the metal surface.

The $PM_{2.5}$ standards finalized in this action will help reduce the airborne particles that contribute to materials damage and soiling.

D. Other criteria pollutants affected by this Final Rule

Locomotive and marine diesel engines account for about 1 percent of the mobile source carbon monoxide (CO) inventory. Carbon monoxide (CO) is a colorless, odorless gas produced through the incomplete combustion of carbon-based fuels. The current primary NAAQS for CO are 35ppm for the 1-hour average and 9 ppm for the 8-hour average. These values are not to be exceeded more than once per year. As of October 10, 2007, there are 854 thousand people living in 4 areas (made up of 5 counties) that are designated as nonattainment for CO.

Carbon monoxide enters the bloodstream through the lungs, forming carboxyhemoglobin and reducing the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected, but only at higher CO levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks. Carbon monoxide also contributes to ozone nonattainment since carbon monoxide reacts photochemically in the atmosphere to form ozone. Additional information on CO related health effects can be found in the Air Quality Criteria for Carbon Monoxide.[122]

E. Emissions from Locomotive and Marine Diesel Engines

(1) Overview

The engine standards in this final rule will affect emissions of $PM_{2.5}$, NO_x, VOCs, CO, and air toxics for locomotive and marine diesel engines. Based on our analysis for this rulemaking, we estimate that in 2001 locomotive and marine diesel engines contributed almost 60,000 tons (18 percent) to the national mobile source diesel $PM_{2.5}$ inventory and about 2.0 million tons (16 percent) to the mobile source NO_x inventory. In 2030, absent the standards finalized today, these engines will contribute about 50,000 tons (65 percent) to the mobile source diesel $PM_{2.5}$ inventory and almost 1.6 million tons

[122] U.S. EPA (2000) Air Quality Criteria for Carbon Monoxide, EPA/600/P-99/001F. This document is available in Docket EPA-HQ-OAR-2003-0190.

(35 percent) to the mobile source NO_x inventory. Under today's final standards, by 2030, annual NO_x emissions from these engines will be reduced by 800,000 tons, $PM_{2.5}$ emissions by 27,000 tons, and VOC emissions by 43,000 tons.

Locomotive and marine diesel engine emissions are expected to continue to be a significant part of the mobile source emissions inventory, both nationally and in ozone and $PM_{2.5}$ nonattainment areas, in the coming years. Absent the standards finalized today, we expect overall emissions from these engines to decrease modestly over the next ten to fifteen years then remain relatively flat through 2025 due to existing regulations such as lower fuel sulfur requirements, the phase-in of locomotive and marine diesel Tier 1 and Tier 2 engine standards, and the current Tier 0 locomotive remanufacturing requirements. Starting after 2025, emission inventories from these engines once again begin increasing due to growth in the locomotive and marine sectors, see Table II-2.

Each sub-section below discusses one of the affected pollutants, including expected emissions reductions associated with the final standards. Table II-2 summarizes the impacts of this rule for 2012, 2015, 2020, 2030 and 2040. Further details on our inventory estimates are available in chapter 3 of the RIA.

Table II- 2 Estimated National (50 State) Reductions in Emissions from Locomotive and Marine Diesel Engines

Pollutant [short tons]	2012	2015	2020	2030	2040
Direct $PM_{2.5}$					
$PM_{2.5}$ Emissions Without Rule	53,000	48,000	46,000	46,000	49,000
$PM_{2.5}$ Emissions with Rule	49,000	41,000	32,000	20,000	13,000
$PM_{2.5}$ Reductions Resulting from Rule	4,000	7,000	14,000	27,000	37,000
NO_x					
NO_x Emissions Without Rule	1,678,000	1,635,000	1,584,000	1,584,000	1,708,000
NO_x Emissions with Rule	1,591,000	1,474,000	1,213,000	790,000	564,000
NO_x Reductions Resulting from Rule	87,000	161,000	371,000	795,000	1,144,000
VOC					
VOC Emissions Without Rule	71,000	70,000	70,000	71,000	76,000
VOC Emissions with Rule	63,000	55,000	42,000	28,000	21,000
VOC Reductions Resulting from Rule	8,000	15,000	28,000	43,000	55,000

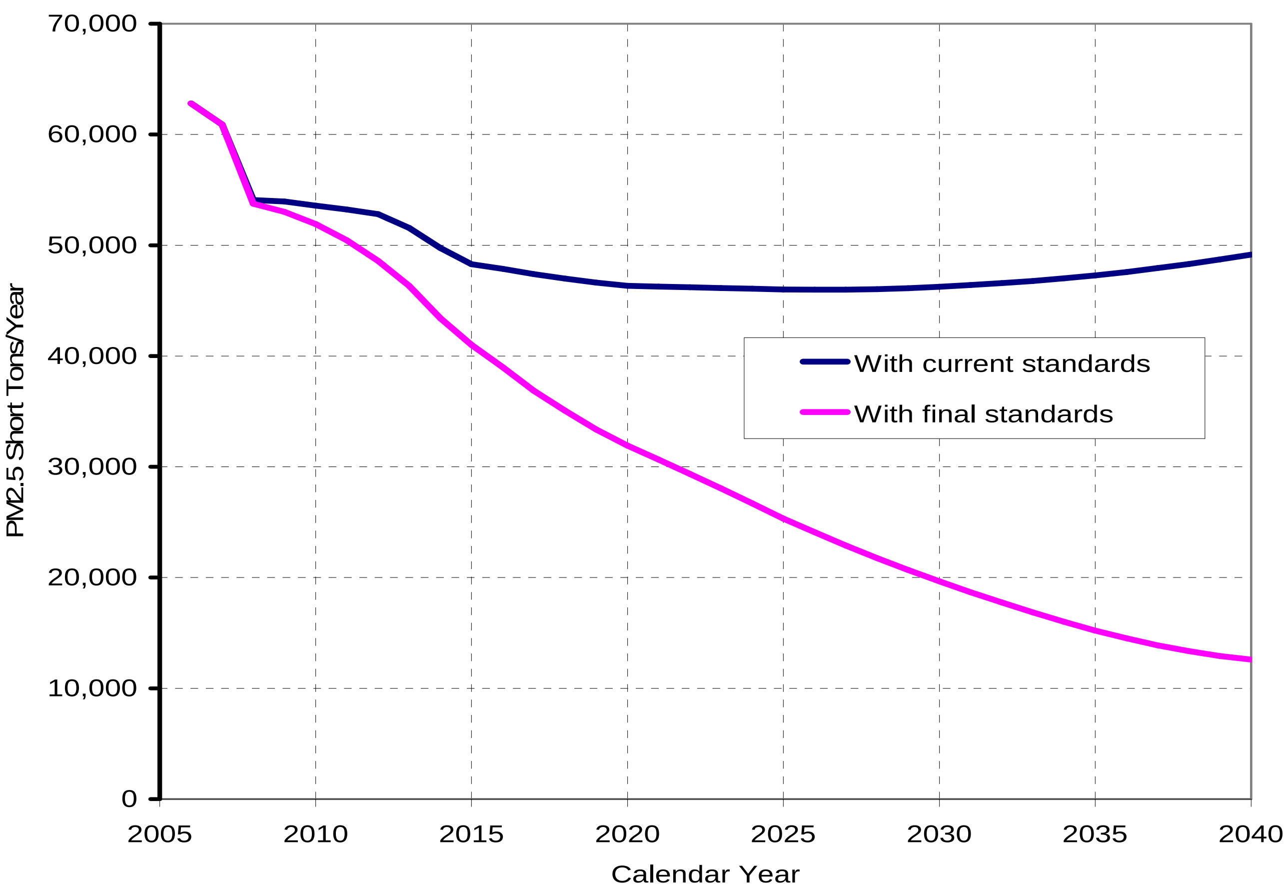
(2) $PM_{2.5}$ Emission Reductions

As described earlier, EPA believes that reductions of diesel $PM_{2.5}$ emissions are an important part of the nation's progress toward clean air. $PM_{2.5}$ reductions resulting from this final rule will reduce hazardous air pollutants or air toxics from these engines, reduce diesel exhaust exposure in communities near these emissions sources, and help areas address visibility and other environmental impacts associated with $PM_{2.5}$ emissions.

In 2001, annual emissions from locomotive and marine diesel engines totaled about 60,000 tons (18 percent) of the national mobile source diesel $PM_{2.5}$ inventory and by 2030 these engines, absent this final rule, contribute about 50,000 tons (65 percent) of the mobile source diesel $PM_{2.5}$ inventory. Both Table II-2 and Figure II-2 show that $PM_{2.5}$ emissions are relatively flat through 2030 before beginning to rise again due to growth in these sectors.

Table II-2 and Figure II-2 present $PM_{2.5}$ emission reductions from locomotive and marine diesel engines with the final standards required in this rule. Emissions of $PM_{2.5}$ drop in 2012 and 2015 by 4,200 and 7,300 tons respectively. By 2020, annual $PM_{2.5}$ reductions total 14,500 tons and by 2030 emissions are reduced further by 27,000 tons annually. Significant reductions from these engines continue through 2040 when approximately 37,000 tons of $PM_{2.5}$ are annually eliminated as a result of this rule.

Figure II-2 $PM_{2.5}$ Reductions from Final Rule



(3) NO_x Emissions Reductions

In 2001 annual emissions from locomotive and marine diesel engines totaled about 2.0 million tons. Due to earlier engine standards for these engines, annual NO_x emissions drop to approximately 1.6 million tons in 2030. Both Table II-2 and Figure II-3 show NO_x emissions remaining fairly flat through 2030 before beginning to rise again due to growth in these sectors.

As shown in Table II-2 and Figure II-3, in the near term this rule reduces annual NO_x emissions from the current national inventory baseline by 87,000 tons in 2012 and 161,000 tons in 2015. By 2020, annual NO_x emissions are cut by 371,000 tons and by 2030- 795,000 tons are eliminated. As with $PM_{2.5}$ emissions, a yearly decline in NO_x emissions continues through 2040 when more than 1.1 million tons of $NO_{x\ are}$ annually reduced from locomotive and marine diesel engines.

These numbers are comparable to emission reductions projected in 2030 for our already established Clean Air Nonroad Diesel (CAND) program. Table II-3 provides the 2030 NO_x emission reductions (and PM reductions) for this rule compared to the Heavy-Duty Highway rule and CAND rule. The 2030 NO_x reductions of about 738,000 tons for the CAND rule are slightly less than those from this rule.

Figure II-3 NO_x Reductions from Rule

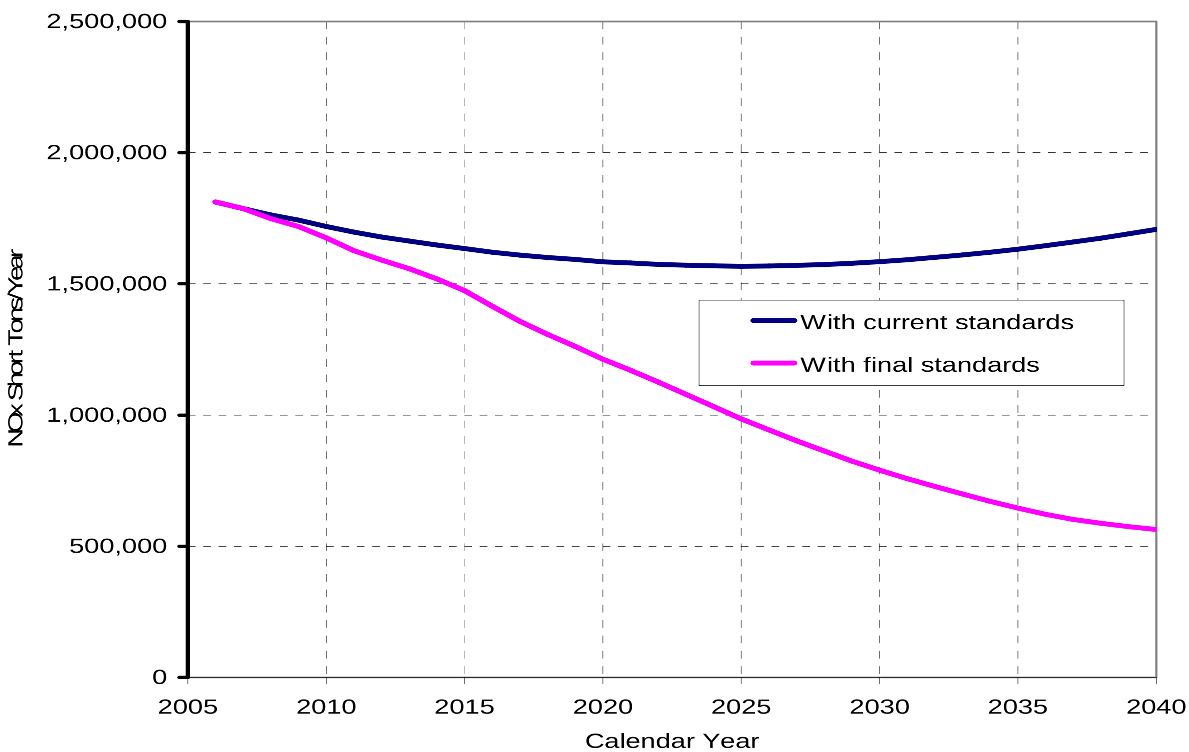


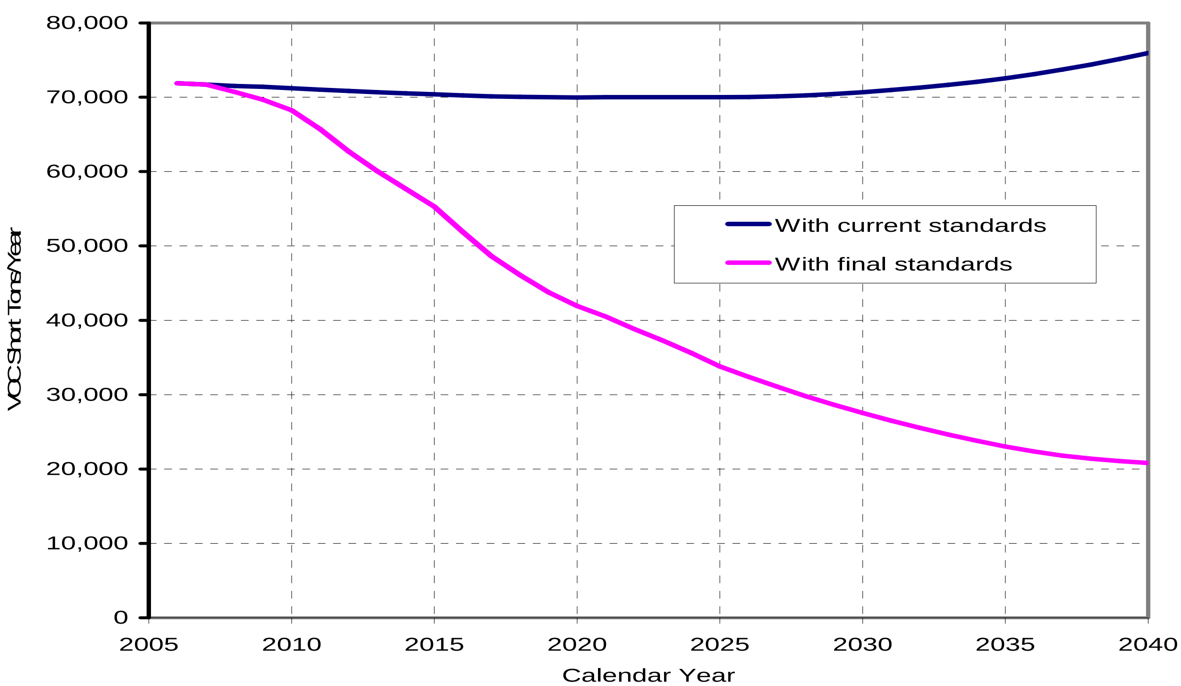
Table II- 3 Projected 2030 Emissions Reductions from Recent Mobile Source Rules (short tons)

Rule	NO_x	$PM_{2.5}$
Locomotive and Marine	795,000	27,000
Clean Air Nonroad Diesel	738,000	129,000
Heavy-Duty Highway	2,600,000	109,000

(4) Volatile Organic Compounds Emissions Reductions

Emissions of volatile organic compounds (VOCs) from locomotive and marine diesel engines are shown in Table II-2, along with the estimates of the reductions we expect from the HC standard in our rule in 2012, 2015, 2020, 2030 and 2040. In 2012, 8,000 tons of VOCs are reduced and in 2015 15,000 tons are annually eliminated from the inventory. By 2020, reductions will expand to 28,000 tons annually from these engines. Over the next ten years, annual reductions from controlled locomotive and marine diesel engines will produce annual VOC reductions of 43,000 tons in 2030 and 55,000 tons in 2040. Figure II -4 shows our estimate of VOC emissions between 2006 and 2040 both with and without this rule.

Figure II-4 VOC Reductions from Rule



III. Emission Standards

This section details the emission standards, implementation dates, and other major requirements of the new program. Following brief summaries of the types of locomotives and marine engines covered, we describe the provisions for:

- Standards for remanufactured Tier 0, 1, and 2 locomotives,
- Tier 3 and Tier 4 standards for newly-built line-haul locomotives,
- Standards and other provisions for switch locomotives,
- Requirements to reduce idling locomotive emissions,
- Tier 3 and Tier 4 standards for newly-built marine diesel engines, and
- Standards for remanufactured marine diesel engines.

An assessment of the technological feasibility of the standards follows the program description. To ensure that the benefits of the standards are realized throughout the useful life of these engines, and to incorporate lessons learned over the last few years from the existing test and compliance programs, we are also revising test procedures and related certification requirements, and adding comparable provisions for remanufactured marine diesel engines. These are described in section IV.

A. What Locomotives and Marine Engines Are Covered?

The regulations being adopted affect locomotives currently regulated under part 92 and marine diesel engines and vessels currently regulated under parts 89, 1039, and 94, as described below.[123] In addition, they apply to existing marine diesel engines above 600 kW (800 hp).

With some exceptions, the locomotive regulations apply for all locomotives originally built in or after 1973 that operate extensively within the United States. See section IV.B for a discussion of the exemption for locomotives that are used only incidentally within the U.S. The exceptions include historic steam-powered locomotives and locomotives powered solely by an external source of electricity. In addition, the regulations generally do not apply to some existing locomotives owned by small businesses. Furthermore, engines used in locomotive-type vehicles with less than 750 kW (1006 hp) total power (used primarily for railway maintenance), engines used only for hotel power (for passenger railcar equipment), and engines that are used in self-propelled passenger-carrying railcars, are excluded from these regulations. The engines

[123] All of the regulatory parts referenced in this preamble are parts in Title 40 of the Code of Federal Regulations, unless otherwise noted.

used in these smaller locomotive-type vehicles are generally subject to the nonroad engine requirements of Parts 89 and 1039.

The marine diesel engine program applies to all propulsion and auxiliary engines with per cylinder displacement up to 30 liters.[124] For purposes of these standards, these marine diesel engines are categorized both by per cylinder displacement and by maximum engine power.

According to our existing definitions, a marine engine is defined as an engine that is installed or intended to be installed on a marine vessel. Engines that are on a vessel but that are not "installed" are generally considered to be land-based nonroad engines and are regulated under 40 CFR Part 89 or Part 1039. Consistent with our current marine diesel engine program, the standards adopted in this rule apply to engines manufactured for sale in the United States or imported into the United States beginning with the effective date of the standards. The standards also apply to any engine installed for the first time in a marine vessel after it has been used in another application subject to different emission standards. In other words, an existing nonroad diesel engine would become a new marine diesel engine, and subject to the marine diesel engine standards, when it is marinized for use in a marine application.

Consistent with our current program, the marine engine standards we are finalizing will not apply to marine diesel engines installed on foreign vessels. While we received many comments requesting that we extend the new standards to engines on foreign vessels operating in the United States, we have determined that it is appropriate to postpone this decision to our rulemaking for Category 3 marine diesel engines. This will allow us to consider all engines on an ocean-going vessel as a system; this may facilitate the application of advanced emission control technologies because these engines often share a common fuel and/or exhaust system. This approach is also consistent with the United States Government's proposal to amend Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL) currently under consideration at the International Maritime Organization (IMO), which calls for

[124] Marine diesel engines at or above 30 liters per cylinder, called Category 3 engines, are typically used for propulsion power on ocean-going ships. EPA is addressing Category 3 engines through separate actions, including a planned rulemaking for a new tier of federal standards (see Advance Notice of Proposed Rulemaking published December 7, 2007 at 72 FR 69522) and participation on the U.S. delegation to the International Maritime Organization for negotiations of new international standards (see http://www.epa.gov/otaq/oceanvessels.com for information on both of those actions), as well as EPA's Clean Ports USA Initiative (see http://www.epa.gov/cleandiesel/ports/index.htm).

significant emission reductions from all engines on ocean-going vessels.[125] EPA expects to finalize new Category 3 engine emission standards in late 2009.[126]

B. What Standards Are We Adopting?

(1) Locomotive Standards

(a) Line-Haul Locomotives

We are setting new emission standards for newly-built and remanufactured line-haul locomotives. Our standards for newly-built line-haul locomotives will be implemented in two tiers: Tier 3, based on engine design improvements, and Tier 4, based on the application of the high-efficiency catalytic aftertreatment technologies now being developed and introduced in the highway diesel sector. Our standards for remanufactured line-haul locomotives apply to all Tier 0, 1, and 2 locomotives and are based on engine design improvements. Table III-1 summarizes the line-haul locomotive standards and implementation dates. The feasibility of the new standards and the technologies involved are discussed in detail in section III.C.

Table III-1 Line-Haul Locomotive Standards (g/bhp-hr)

Standards Apply to:	Take Effect in Year:	PM	NO_x	HC
Remanufactured Tier 0 without separate loop intake air cooling	2008 as Available, 2010 Required	0.22	8.0	1.00
Remanufactured Tier 0 with separate loop intake air cooling	2008 as Available, 2010 Required	0.22	7.4	0.55
Remanufactured Tier 1	2008 as Available, 2010 Required	0.22	7.4	0.55
Remanufactured Tier 2	2008 as Available, 2013 Required	0.10	5.5	0.30
New Tier 3	2012	0.10	5.5	0.30
New Tier 4	2015	0.03	1.3	0.14

125 See "Revision of the MARPOL Annex VI, the NOx Technical Code and Related Guidelines; Development of Standards for NOx, PM, and SOx," submitted by the United States, BLG 11/15, Sub-Committee on Bulk Liquids and Gases, 11th Session, Agenda Item 5, February 9, 2007, Docket ID EPA-HQ-OAR-2007-0121-0034. This document, along with the U.S. Statement concerning the same, is also available on our website: www.epa.gov/otaq/oceanvessels.com

126 See 72FR68518, December 5, 2007 for the new regulatory deadline for the final rule for an additional tier of standards for Category 3 rulemaking (final rule by December 17, 2009).

(i) Remanufactured Locomotives

As proposed, we are setting new standards for the existing fleet of Tier 0, Tier 1, and Tier 2 locomotives, to apply at the time of remanufacture. These standards will also apply at the first remanufacture of Tier 2 locomotives added to the fleet between now and the start of Tier 3.

Commenters have suggested that EPA adopt a naming convention for the standards tiers to avoid confusion over whether, for example, the terms “Tier 0 standards” and “Tier 0 locomotives” are referring to the “old” Tier 0 standards adopted in 1998 or the “new” Tier 0 standards promulgated in this rule. A similar confusion may exist for old and new Tier 1 and Tier 2 standards, including for marine engines. The confusion is compounded by the fact that many of the locomotives previously subject to the old Tier 0 standards will now be subject to the new Tier 1 standards, and so a Tier 0 locomotive that is upgraded to meet them could fairly be called a Tier 1 locomotive, and likewise for Tier 2/Tier 3 standards.

In response, we are adopting a simple approach whereby a Tier 0 locomotive remanufactured under the more stringent Tier 0 standards we are adopting in this rule will be designated a Tier 0+ locomotive. A Tier 0 locomotive originally manufactured with a separate loop intake air cooling system that is remanufactured to the Tier 1+ standards will be designated as a Tier 1+ locomotive. We are adopting the same approach for Tier 1 and Tier 2 locomotives. That is, those remanufactured under the new standards would be called Tier 1+ and Tier 2+ locomotives, respectively. We are also suggesting that in many contexts, including a number of places in this final rule, there is really no need to make distinctions of this sort, as no ambiguity arises. In these contexts it would be perfectly acceptable to drop the “+” designation and simply refer to Tier 0, 1, and 2 locomotives and standards.

As described in section IV.B(3), the new Tier 0+, 1+, and 2+ standards (and corresponding switch-cycle standards) may apply when a Tier 0, 1, or 2 locomotive is remanufactured anytime after this final rule takes effect, if a certified remanufacture system is available. However, this early certification is voluntary on the part of the manufacturers, and so if no emissions control system is certified early for a locomotive, these standards will instead apply beginning January 1, 2010 for Tier 0 and 1, and no later than January 1, 2013 for Tier 2. We are also adopting the proposed reasonable cost provision, described in section IV.B(3), to protect against the unlikely event that the only certified systems made in the early program phase are exorbitantly priced.

Although under this approach, certification of new remanufacture systems in the early phase of the program is voluntary, we believe that developers will strive to certify systems to the new standards as early as possible, even in 2008, to establish these products in the market, especially for the locomotive models anticipated to have significant numbers coming due for remanufacture in the next few years. This focus on higher volume products also maximizes the potential for large emission reductions very early in this program, greatly offsetting the effect of slow turnover to new Tier 3 and Tier 4 locomotives inherent in this sector.

These remanufactured locomotive standards represent PM reductions of about 50 percent for Tier 0 and Tier 1 locomotives, and NO_x reductions of about 20 percent for Tier 0+ locomotives with separate loop aftercooling. Significantly, these reductions will be substantial in the early years. This will be important to State Implementation Plans (SIPs) being developed to achieve attainment with the NAAQS, owing to the 2008 start date and relatively rapid remanufacture schedule (roughly every 7 years, though it varies by locomotive model and age).

Some commenters argued for delaying the remanufactured locomotive standards and some argued for accelerating them. However, little technical justification was provided on either side and, after reconsideration, we believe the proposed standards and dates are appropriate. However, based on the comments, we have identified two current Tier 0 locomotive models that are not likely to meet the new standards under the full range of required test conditions, owing to limitations in the original locomotive design. These are the General Electric (GE) Dash-8 locomotives not equipped with separate loop aftercooling, and the Electro-Motive Diesel (EMD) SD70MAC locomotives that are equipped with separate loop aftercooling. As a result, we are allowing an exception in ambient temperature and altitude conditions under which these models, when remanufactured, must meet the new standards, as detailed in the Part 1033 regulations. These exceptions are limited to the extent that it is technically feasible to meet the relevant standards under most in-use conditions.

(ii) Newly-Built Locomotives

We are adopting the proposed Tier 3 and Tier 4 line-haul locomotive standards but with an earlier start date for Tier 4 NO_x, along with an additional compliance flexibility option. We requested comment in the NPRM on whether additional NO_x emission reductions would be feasible and appropriate for Tier 3 locomotives in the 2012 timeframe, based on reoptimization of existing Tier 2 NO_x control technologies, or the addition of new engine-based technologies such as exhaust gas recirculation (EGR). Manufacturers submitted detailed technical comments indicating that achieving such reductions would result in a large fuel economy penalty, a major engine redesign that would hamper Tier 4 technology development, or both. Our own review of the technical options leads us to the same conclusion and we are therefore finalizing the Tier 3 emissions standards as proposed.

We proposed to allow manufacturers to defer meeting the Tier 4 NO_x standard on newly-built locomotives until the 2017 model year, in order to work through any implementation and technological issues that might arise with advanced NO_x control technology. Even so, we expected that manufacturers would undertake a single comprehensive redesign program for Tier 4, relying on the same basic locomotive platform and overall emission control space allocations for all Tier 4 product years. With this in mind, we proposed that locomotives certified under Tier 4 in 2015 and 2016 without Tier 4 NO_x control systems should have these systems added when they undergo their first remanufacture and be subject to the Tier 4 NO_x standard thereafter.

We received many comments from state and local air quality agencies, and from environmental organizations, arguing that earlier implementation of these advanced technologies is technologically feasible and emphatically stating that they were needed to address the nation's air quality problems. Further review of the test data available for the proposed rule and of new test data available since the proposal supports the argument for earlier implementation of Tier 4 NO_x controls. This information is discussed in detail in section III.C. Consequently, after considering this data and industry comments regarding feasibility, we have concluded that the progress made in the development of NO_x aftertreatment technology has been such that this proposed allowance to defer NO_x control is not consistent with our obligation under section 213(a)(3) of the Clean Air Act to set standards that "achieve the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the engines or vehicles, giving appropriate consideration to cost, lead time, noise, energy, and safety factors associated with the application of such technology."

We are therefore not adopting this allowance for deferred NO_x control in 2015-2016 Tier 4 locomotives, effectively advancing the Tier 4 NO_x standard for locomotives by two years. Besides meeting our obligation under the Clean Air Act, this change will simplify the certification and compliance program for all stakeholders by providing a single step for Tier 4 implementation. It will also provide substantial additional NO_x reductions during years that are important to some states for NAAQS attainment, thus helping to address what was arguably the most critical comment we received from state and local air agencies and environmental organizations.

We recognize that designing locomotives to meet the stringent Tier 4 standards in 2015 with the high levels of performance and reliability demanded by the railroad industry will be challenging. As in other recent EPA mobile source programs, we proposed and are finalizing several compliance flexibility measures to aid the transition to these very clean technologies. Specifically, we are adopting two distinct compliance flexibility options for NO_x that, while ensuring the earliest possible introduction of advanced emission control, will provide locomotive manufacturers some level of risk mitigation should the technology solutions prove to be less robust than we project. The first compliance flexibility is consistent with the flexibility program described in our NPRM providing an in-use compliance margin for NO_x of 1.3 g/bhp-hr at full useful life (i.e., a 2.6 g/bhp-hr emissions cap for in-use testing) for the first three Tier 4 model years. See section IV.A(8) for details on this program.

The second flexibility provision is an alternative NO_x compliance option that reduces the in-use NO_x add-on to 0.6 g/bhp-hr (i.e., a 1.9 g/bhp-hr emissions cap for any in-use testing) for model years 2015-2022. While significantly tightening the in-use emissions cap, the provision provides manufacturers with significantly more time to develop advanced NO_x emission control systems using real in-use experiences from the locomotive fleet. Complementing this focus on improving technology through experience with the in-use fleet, this provision also allows manufacturers to substitute additional in-use tests on locomotives in lieu of the typical production line testing requirements of our locomotive regulations. This optional in-use testing would be in addition to the current in-use testing requirements of our locomotive certification program. See section IV.A(8) for details on this program.

For reasons explained in the NPRM, Tier 4 line-haul locomotives will not be required to meet standards on the switch cycle, but we are requiring that newly-built Tier 3 locomotives and Tier 0 through Tier 2 locomotives remanufactured under this program be subject to switch cycle standards, set at levels above the line-haul cycle standards. Section III.B(1)(b) provides details.

(b) Switch Locomotives

The NPRM discussed at some length the importance and challenges of turning over today's large switch locomotive fleet to clean diesel. In response, we proposed standards and other provisions aimed at overcoming these challenges by encouraging the replacement of old high-emitting units with newly-built or refurbished locomotives powered by very clean engines developed for the nonroad equipment market.

We are adopting the new standards for switch locomotives that we proposed. As proposed, we are also continuing the existing Part 92 policy of requiring Tier 0 switch locomotives to only meet standards on the switch cycle, while requiring Tier 1 and Tier 2 locomotives to meet the applicable standards on both the line-haul and switch cycles. This policy was adopted to ensure that manufacturers design emission controls to function broadly over all notches. The switch cycle standards shown in Table III-2 will require emission reductions equivalent to those required by our new standards that apply over the line-haul cycle. Note that these switch cycle standards also apply to the Tier 3 and earlier line-haul locomotives that are subject to compliance requirements on the switch cycle, as mentioned above and in Section III.B(1)(b).

We are also adopting the proposed Tier 3 and 4 emission standards for newly-built switch locomotives, as shown in Table III-2. These standards are slightly more stringent than the Tier 3 and Tier 4 line-haul standards. Given these more stringent switch cycle standards, it is not necessary to require to Tier 3 and 4 switchers to meet the line-haul standards over the line-haul cycle.

Table III-2 Emission Standards for Switch Locomotives (g/bhp-hr)

Switch Locomotive Standards Apply to:	Take Effect in Year:	PM	NO_x	HC
Remanufactured Tier 0	2008 as available, 2010 required	0.26	11.8	2.10
Remanufactured Tier 1	2008 as available, 2010 required	0.26	11.0	1.20
Remanufactured Tier 2	2008 as available, 2013 required	0.13	8.1	0.60
Tier 3	2011	0.10	5.0	0.60
Tier 4	2015	0.03	1.3	0.14

We are also finalizing the proposed streamlined certification option to help in the early implementation of the switch locomotive program. As described in section IV.B(9), during a 10-year program start-up period aimed at encouraging the turnover of the existing switcher fleet to the new cleaner engines, switch locomotives may use nonroad-certified engines (Table III-3) without need for an additional certification under the locomotive program. In the years before the nonroad Tier 4 start dates, we are making this provision available using pre-Tier 4 nonroad engines meeting today's standards of 0.15 g/bhp-hr PM and 3.0/4.8 g/bhp-hr NO_x+NMHC (below/above 750 hp), because switchers built with these nonroad engines will still be much cleaner than those meeting the current switch locomotive Tier 2 standards of 0.24 and 8.1 g/bhp-hr PM and NO_x, respectively.

Commenters suggested that we allow the use of even earlier-tier nonroad engines under this option, as these would still be substantially cleaner than the engines being replaced. However, we feel this would defeat the purpose of the program, and would not be justifiable on a feasibility basis, as current-tier nonroad engines will be available for incorporation into new switchers in any year of the program. We are adopting other compliance and ABT provisions relevant to switch locomotives as discussed in section IV.B(1), (2), (3), and (9).

Table III-3 Relevant Large Nonroad Engine Tier 4 Standards (g/bhp-hr)

Engine Power	Model Year	PM	NO_x
At or Below 750 hp	2011	0.01	3.0 (NO_x+NMHC) [a]
	2014	0.01	0.30
750-1200 hp	2011	0.075	2.6
	2015	0.02	0.50
Over 1200 hp	2011	0.075	0.50 genset 2.6 non-genset
	2015	0.02	0.50

Note:
(a) 0.30 NO_x for 50% of sales in 2011-2013, or alternatively 1.5 g NO_x for 100% of sales.

Finally, we are revising the definition of a switch locomotive to make clear that it is the total switch locomotive power rating (including power from any auxiliary engines that can operate when a main engine is operating), and not the individual engine power rating, that must be below 2300 hp to qualify, and to drop the unnecessary requirement that it be designed or used primarily for short distance operation. This clears up the ambiguity in the Part 92 definition over multi-engine switchers.

(c) Reduction of Locomotive Idling Emissions

We are adopting the proposed requirement that an Automatic Engine Stop/Start System (AESS) be used on all new Tier 3 and Tier 4 locomotives and installed on all existing locomotives that are subject to the new remanufactured engine standards, at the point of first remanufacture under the new standards. Locomotives equipped with an AESS device under this program must shut down the locomotive engine after no more than 30 continuous minutes of idling, and be able to stop and start the engine at least six times per day without causing engine damage or other serious problems. Continued idling is allowed under the following conditions: to prevent engine damage such as damage caused by coolant freezing, to maintain air pressure for brakes or starter systems, to recharge the locomotive battery, to perform necessary maintenance, or to otherwise comply with applicable government regulations.

Commenters also pointed out that it can sometimes be appropriate to allow a locomotive to idle to heat or cool the cab, and we are adopting regulations to allow it where necessary. Our implementation of this provision will rely on the strong incentive railroads have to limit idling to realize fuel cost savings after they have invested capital by installing an AESS system on a locomotive. We expect the railroads to appropriately develop policies instructing operators when it is acceptable to idle the locomotive to provide heating or cooling to the locomotive cab. We do not believe that those individuals responsible for developing railroad policies have any incentive to encourage or allow unnecessary idling. It is our intention to stay abreast of how well this combination of idle control systems and railroad policies does in fact accomplish the intended goal of reducing unnecessary idling. In general, we may consider it to be circumvention of this provision for an individual operator to use the AESS system in a manner other than that for which the system was designed and implemented per a railroad's policy directive.

A further reduction in idling emissions can be achieved through the use of onboard auxiliary power units (APUs), either as standalone systems or in conjunction with an AESS. In contrast to AESS, which works to reduce unnecessary idling, the APU goes further by also reducing the amount of time when locomotive engine idling is necessary, especially in cold weather climates. APUs are small (less than 50 hp) diesel engines that stop and start themselves as needed to provide: heat to both the engine coolant and engine oil, power to charge the batteries, and power to run accessories such as those required for cab comfort. This allows the much larger locomotive engine to be shut down while the locomotive remains in a state of readiness, thereby reducing fuel consumption without the risk of the engine being damaged in cold weather. APUs are powered by nonroad engines compliant with EPA or State of California nonroad engine standards, and emit at much lower levels than an idling locomotive under current standards.

Some commenters suggested we require both an AESS and an APU. However, the amount of idle reduction an APU can provide is dependent on a number of variables, such as the function of the locomotive (e.g. a switcher or a line-haul), where it operates (i.e. geographical area), and its operating characteristics (e.g. number of hours per day that it operates). As we stated in the NPRM, at this time we are not requiring that APUs be installed on every locomotive because it is not clear how much additional benefit they would provide outside of regions and times of the year where low temperatures or other factors that warrant the use of an APU exist and because they do involve some inherent design and operational complexities that could not be justified without such commensurate benefits. We are, however, adopting the proposed provision to encourage the additional use of APUs by providing in our test regulations, a process by which the manufacturer can appropriately account for the proven emission benefits of a more comprehensive idle reduction system.

In response to comment, we are adopting a more flexible approach that will allow the idle reduction requirement for remanufactured Tier 0+, 1+, and 2+ locomotives to be addressed in a separate certification apart from the certification of the full remanufacture system. Under this approach, remanufacturers will be allowed to obtain a certificate for a system that meets all of the requirements of part 1033 except for those of §1033.115(g). However, since the idle controls would still need to be installed in a certified configuration before the remanufactured locomotive is returned to service, some other entity would need to obtain a certificate to cover the requirements of §1033.115(g). (This separate certification approach is somewhat analogous to allowing a motor vehicle engine manufacturer to hold the certificate for exhaust emission standards and a motor vehicle manufacturer to hold the certificate for evaporative emission standards for a single motor vehicle.) Note that manufacturers of freshly manufactured locomotives and their customers will also have the choice as to whether the AESS is installed as part of the certified engine configuration at the factory or by an aftermarket company pursuant to a separate certification before the freshly manufactured locomotive is put into service. These provisions will allow more companies to remain in the AESS manufacturing market and thus provide more choices to the railroads.

As described in Chapter 5 of the RIA, manufacturers of AESS, and demonstrations done in partnership between government and industry have shown that for most locomotives the fuel savings that result in the first few years after installation of an AESS system will offset the cost of adding the system to the locomotive. Given these short payback times for adding idle reduction technologies to a typical locomotive, normal market forces have led many railroads to retrofit a number of their locomotives with such controls. However, as is common with pollution, market prices generally do not account for the external social costs of the idling emissions, leading to an underinvestment in idling reduction systems. This rulemaking addresses those locomotives for which the railroads judge the fuel savings insufficient to justify the cost of the retrofit. We believe that applying AESS to these locomotives is appropriate when one also considers the significant emissions reductions that will result.

(2) Marine Diesel Engine Standards

(a) Newly-Built Marine Engines

We are adopting Tier 3 and Tier 4 emission standards for newly-built marine diesel engines with displacements under 30 liters per cylinder. Our analysis of the feasibility of these standards is summarized in section III.C and detailed in the RIA.

We are retaining our existing per-cylinder displacement approach to establishing cutpoints for standards, but are revising and refining it in several places to ensure that the appropriate standards apply to every group of engines in this very diverse sector and to provide for an orderly phase-in of the program to spread out the redesign workload burden:

We are moving the C1/C2 cutpoint from 5 liters/cylinder to 7 liters/cylinder, because the latter is a more accurate cutpoint between today's high- and medium-speed diesels.

We are revising the per-cylinder displacement cutpoints within Category 1 to better define the application of standards.

An additional differentiation is made between high power density engines typically used in planing vessels and standard power density engines, with a cutpoint between them set at 35 kW/liter (47 hp/liter).

We are removing the distinction for marine diesels under 37 kW (50 hp) in Category 1, originally made because these were regulated under our nonroad engine program.

Finally, we will further group engines by maximum engine power, especially in regards to setting appropriate long-term aftertreatment-based standards.

Note that we are retaining the differentiation between recreational and non-recreational marine engines within Category 1 because there are differences in their certification programs. Also, as discussed below, we are not finalizing Tier 4 standards for recreational marine engines at this time. Section IV.C(10) clarifies the definition of recreational marine diesel engine.

The new standards and implementation schedules are shown on Tables III-4 through 7. Briefly summarized, the marine diesel standards include stringent engine-based Tier 3 standards, phasing in over 2009-2014. They also include aftertreatment-based Tier 4 standards for commercial marine engines at or above 600 kW (800 hp), phasing in over 2014-2017. For engines of power levels not included in the Tier 3 and Tier 4 tables, the previous tier of standards (Tier 2 or Tier 3, respectively) continues to apply. These standards and implementation dates are the same as those proposed except: (1) recreational marine engines are not subject to Tier 4 standards; (2) The Tier 4 NO_x standard for 2000-3700 kW engines has been pulled forward by two years; (3) The proposed optional Tier 4 approach coordinated with locomotive Tier 4 has been modified; and (4) based on comments we received, the Tier 3 standards for high power density engines in the 3.5 to 7 liter/cylinder category (Table III-5) have been adjusted slightly to better align them with standards in other categories. The first three of these changes are discussed in more detail below. See section 3.2.1.1 of the Summary and Analysis of Comments document for discussion of the fourth.

Table III-4 Tier 3 Standards for Marine Diesel C1 Commercial Standard Power Density

Maximum Engine Power	L/Cylinder	PM g/bhp-hr *(g/kW-hr)*	NO_x+HC [d] g/bhp-hr *(g/kW-hr)*	Model Year
<19 kW	<0.9	0.30 *(0.40)*	5.6 *(7.5)*	2009
19 to <75 kW	<0.9 [a]	0.22 *(0.30)*	5.6 *(7.5)*	2009
		0.22 *(0.30)* [b]	3.5 *(4.7)* [b]	2014
75 to <3700 kW	<0.9	0.10 *(0.14)*	4.0 *(5.4)*	2012
	0.9- <1.2	0.09 *(0.12)*	4.0 *(5.4)*	2013
	1.2- <2.5	0.08 *(0.11)* [c]	4.2 *(5.6)*	2014
	2.5- <3.5	0.08 *(0.11)* [c]	4.2 *(5.6)*	2013
	3.5- <7.0	0.08 *(0.11)* [c]	4.3 *(5.8)*	2012

Notes:
(a) <75 kW engines at or above 0.9 L/cylinder are subject to the corresponding 75-3700 kW standards.
(b) Option: 0.15 g/bhp-hr (*0.20 g/kW-hr*) PM / 4.3 g/bhp-hr (*5.8 g/kW-hr*) NO_x+HC in 2014.
(c) This standard level drops to 0.07 g/bhp-hr (*0.10 g/kW-hr*) in 2018 for <600 kW engines.
(d) Tier 3 NO_x+HC standards do not apply to 2000-3700 kW engines.

Table III-5 Tier 3 Standards for Marine Diesel C1 Recreational and Commercial High Power Density

Maximum Engine Power	L/cylinder	PM g/bhp-hr (g/kW-hr)	NO_x+HC g/bhp-hr (g/kW-hr)	Model Year
<19 kW	<0.9	0.30 *(0.40)*	5.6 *(7.5)*	2009
19 to <75 kW	<09 [a]	0.22 *(0.30)*	5.6 *(7.5)*	2009
		0.22 *(0.30)* [b]	3.5 *(4.7)* [b]	2014
75 to <3700 kW	<0.9	0.11 *(0.15)*	4.3 *(5.8)*	2012
	0.9- <1.2	0.10 *(0.14)*	4.3 *(5.8)*	2013
	1.2- <2.5	0.09 *(0.12)*	4.3 *(5.8)*	2014
	2.5- <3.5	0.09 *(0.12)*	4.3 *(5.8)*	2013
	3.5- <7.0	0.08 *(0.11)*	4.3 *(5.8)*	2012

Notes:
(a) <75 kW engines at or above 0.9 L/cylinder are subject to the corresponding 75-3700 kW standards.
(b) Option: 0.15 g/bhp-hr (*0.20 g/kW-hr*) PM / 4.3 g/bhp-hr (*5.8 g/kW-hr*) NO_x+HC in 2014.

Table III-6 Tier 3 Standards for Marine Diesel C2 [a]

Maximum Engine Power	L/cylinder	PM g/bhp-hr (g/kW-hr)	NO_x+HC [b] g/bhp-hr (g/kW-hr)	Model Year
<3700 kW	7- <15	0.10 *(0.14)*	4.6 *(6.2)*	2013
	15- <20	0.20 *(0.27)* [c]	5.2 *(7.0)*	2014
	20- <25	0.20 *(0.27)*	7.3 *(9.8)*	2014
	25- <30	0.20 *(0.27)*	8.2 *(11.0)*	2014

Notes:
(a) See note (c) of Table III-7 for optional Tier 3/Tier 4 standards.
(b) Tier 3 NO_x+HC standards do not apply to 2000-3700 kW engines.
(c) For engines below 3300 kW in this group, the PM Tier 3 standard is 0.25g/bhp-hr *(0.34 g/kW-hr)*.

Table III-7 Tier 4 Standards for Marine Diesel C1 and C2

Maximum Engine Power	PM g/bhp-hr *(g/kW-hr)*	NO_x g/bhp-hr *(g/kW-hr)*	HC g/bhp-hr *(g/kW-hr)*	Model Year
At or above 3700 kW	0.09 *(0.12)* [a]	1.3 *(1.8)*	0.14 *(0.19)*	2014 [c]
	0.04 *(0.06)*	1.3 *(1.8)*	0.14 *(0.19)*	2016 [b,c]
2000 to <3700 kW	0.03 *(0.04)*	1.3 *(1.8)*	0.14 *(0.19)*	2014 [c,d]
1400 to <2000 kW	0.03 *(0.04)*	1.3 *(1.8)*	0.14 *(0.19)*	2016 [c]
600 to <1400 kW	0.03 *(0.04)*	1.3 *(1.8)*	0.14 *(0.19)*	2017 [b]

Notes:
(a) This standard is 0.19 g/bhp-hr *(0.25 g/kW-hr)* for engines with 15-30 liter/cylinder displacement.
(b) Optional compliance start dates can be used within these model years; see discussion below.
(c) Option for C2: Tier 3 PM / NO_x+HC at 0.10 / 5.8 g/bhp-hr *(0.14/7.8 g/kW-hr)* in 2012, and Tier 4 in 2015.
(d) The Tier 3 PM standards continue to apply for these engines in model years 2014 and 2015 only.

Engine manufacturers argued that modifying standard power density engines between 2000 and 3700 kW for Tier 3 NO_x, and again for Tier 4 NO_x shortly after would be too difficult. They argued that these engines could meet Tier 4 NO_x in 2014, two years earlier, if the Tier 3 NO_x+HC standard, proposed to apply in 2012, 2013, or 2014, depending on displacement, did not have to be met. We have analyzed this group of engines and agree that the suggested approach would be feasible and would have very little detrimental effect on NO_x reductions in 2012-2013, while providing significant additional NO_x reductions thereafter. We are therefore leaving the Tier 3/Tier 4 PM standards as proposed but revising the NO_x implementation schedule as suggested by the industry.

The Tier 3 standards for engines with maximum engine power less than 75 kW (100 hp) are based on the nonroad diesel Tier 2 and Tier 3 standards, because these smaller marine engines are largely derived from (and often nearly identical to) the nonroad engine designs. The relatively straightforward carry-over nature of this approach also allows for an early implementation schedule, in model year 2009, providing substantial early benefits to the program. However, some of the nonroad engines less than 75 kW are also subject to aftertreatment-based Tier 4 nonroad standards, and our new program does not carry these over into the marine sector, due to vessel design and operational constraints discussed in section III.C. Because of the widespread use of both direct- and indirect-injection diesel engines in the 19 to 75 kW (25-100 hp) engine market today, we are making two options available to manufacturers for meeting Tier 3 standards on any engine in this range, as indicated in Table III-4. One option focuses on lower PM and the other on lower NO_x, though both require substantial reductions in both PM and NO_x and will take effect in 2014.

With important exceptions, we are subjecting marine diesel engines at or above 75 kW (100 hp) to new emissions standards in two steps, Tier 3 and Tier 4. The Tier 3 standards are based on the engine-out emission reduction potential (apart from the addition of exhaust aftertreatment) of the nonroad Tier 4 diesel engines that will be introduced beginning in 2011. The Tier 3 standards for C1 engines will phase in over 2012-2014. We believe it is appropriate to coordinate the marine Tier 3 standards with the nonroad Tier 4 (rather than Tier 3) engine developments in this way because marine diesel engines are largely derived from land-based nonroad counterparts, and because the advanced fuel and combustion systems that we expect the Tier 4 nonroad engines to employ will allow approximately a 50 percent reduction in PM when compared to the reduction potential of the nonroad Tier 3 engines. Inserting an additional marine engine tier based on nonroad Tier 3 engines would result in overly short lead time and stability periods and/or a delay in stringent standards.

We are applying high-efficiency aftertreatment-based Tier 4 standards to all commercial and auxiliary C1 and C2 engines over 600 kW (800 hp). These standards will phase in over 2014-2017. Marine diesels over 600 kW, though fewer in number, are the workhorses of the inland waterway and intercoastal marine industry, running at high load factors, for many hours a day, over decades of heavy use. As a result they also account for the bulk of marine diesel engine emissions.

After considering the substantial number of comments received on the feasibility of extending Tier 4 standards to engines below 600 kW, we are not at this time setting Tier 4 standards for these engines. We may do so at some point in the future if further technology developments show a path to address the issues we identify in RIA chapter 4 with the application of aftertreatment technologies to smaller vessels.

We are also not extending the Tier 4 program to recreational marine diesel engines. In our proposal we indicated that at least some recreational vessels, those with engines above 2000 kW (2760 hp), have the space and design layout conducive to aftertreatment-based controls and professional crews who oversee engine operation and maintenance. This suggested that aftertreatment-based standards would be feasible for these larger recreational engines. While commenters on the proposal did not disagree with these views, they pointed out these very large recreational vessels often travel outside the United States, and, for tax reasons, flag outside the U.S. as well. Commenters argued that applying Tier 4 standards to large recreational marine diesel engines would further discourage U.S.-flagging because vessels with those engines would be limited to using only those foreign ports that make ULSD and reductant for NO_x aftertreatment available at recreational docking facilities, limiting their use and hurting the vessel's resale value. The aftertreatment devices used to meet Tier 4 are expected to be sensitive to sulfur in the exhaust and so ULSD must be used in these engines.

In general, we expect ULSD to become widely available worldwide, which would help reduce these concerns. However, there are areas such as Latin America and parts of the Caribbean that currently do not plan to require use of this fuel. Even in countries where ULSD is available for highway vehicles but not mandated for other mobile sources, recreational marinas may choose to not make ULSD and reductant available if demand is limited to a small number of vessels, especially if the storage and dispensing costs are high. To the extent the fuel requirements for Tier 4 engines encourage vessel owners to flag outside the United States, the results would be increased emissions since the international standards for these engines are equivalent to EPA's Tier 1 standards.

After considering the above, we conclude that it is preferable at this time to hold recreational engines marine diesel engines to the Tier 3 standards. We plan to revisit this decision when we consider the broader questions of the application of our national marine diesel engine standards to engines on foreign vessels that enter U.S. ports in the context of our Category 3 marine diesel engine rulemaking.

There is a group of commercial vessels that share some of the characteristics of recreational vessels in that they also operate outside the United States. However, the concerns that lead us to exclude recreational vessels from the Tier 4 standards (flagging or registering in a foreign country and thus avoiding all U.S. emission standards; resale value) do not generally apply to commercial vessels. Unlike recreational vessels, the majority of commercial vessels with C1 or C2 main propulsion engines that operate in the United States do not have the option of flagging offshore. This is because they are engaged full-time in harbor activities in U.S. ports or in transporting freight or otherwise operating only between two U.S. ports, and cabotage laws require such vessels be flagged in the United States. In addition, most of these vessels operate at or between U.S. ports, so ULSD availability is not expected to be a problem. Finally, the resale of U.S. commercial vessels on the world market is already affected by other U.S.-specific vessel design and operation requirements, and these standards are not expected to affect that situation.

Nevertheless, some commercial vessels are used in ways that could make the use of ULSD and even urea an intractable problem. These are commercial vessels that are routinely operated outside of the United States for extended periods of time, including tug/barge cargo vessels operated on circle routes between the United States and Latin America that routinely refuel in places where ULSD is not available, and lift boats, utility boats, supply boats and crewboats that are used in the offshore drilling industry and are contracted to work in waters off Latin America or Western Africa for up to several years at a time without returning to the United States. Owners of these vessels informed us that requiring them to use Tier 4 engines will adversely impact their business in significant ways since they would have to arrange for ULSD and urea outside the United States, potentially at great additional cost, and that this is turn would affect their ability to compete with foreign transportation providers who do not face the same costs. These owners flag their vessels in the U.S. to maximize the flexibility of their business operations, but they informed us that they would consider segregating their fleets and flagging some elsewhere if they are required to use Tier 4 engines. Similar to the recreational marine case, the engines on reflagged vessels would not be subject to any U.S. emission controls or compliance requirements. In addition, there could be adverse impacts on associated industries that use these services, if there are fewer vessels available for use in the Untied States. For all of these reasons, these vessel owner/operators encouraged EPA to consider a provision that would not require these vessels to use Tier 4 engines.

We do not expect ULSD availability at foreign commercial ports to be a widespread problem. Many industrial nations already have or are expected to shift to ULSD in the near future, including Japan (by 2008), Singapore (in 2007), Mexico (in 2007 for “Northern border areas”), the EU member states (by 2009), and Australia (by

2009). Other countries may also make ULSD available by 2016, as refineries in other countries modify their production to supply ULSD to the U.S. markets even if they do not require it domestically. However, ULSD may be difficult to obtain in some areas of the world, notably Latin America and Africa. Therefore, it is reasonable to include a limited compliance exemption from the Tier 4 standards for the narrow set of vessels that are described above.

Because the decision of whether a Tier 4 engine is required must be made at the design phase of a vessel, and not after it goes into service, it is preferable to define such an exemption based on vessel design characteristics instead of the owner's intentions for how the vessel may ultimately be used. After consulting with industry representatives, we concluded that the most obvious design feature that indicates the vessel is intended for extensive international use is compliance with international safety standards. We have concluded that the costs of obtaining and maintaining certification for the International Convention for the Safety of Life at Sea (SOLAS) are high enough to discourage owners of vessels that will not be used outside the United States to obtain certification to evade the Tier 4 standards. These costs can range from about $250,000 to $1 million in capital costs and from about $50,000 to $100,000 in annual operating costs. The Port State Information Exchange database maintained by the U.S. Coast Guard indicates that about 30 percent of offshore supply vessels built annually are SOLAS certified and that 3 percent or fewer passenger vessels and tugs built annually are SOLAS certified (based on new vessel construction, 1995-2006).[127] Therefore, to be eligible for the exemption, the owner will be required to obtain and maintain relevant international safety certification pursuant to the requirements of the United States Coast Guard and SOLAS for the vessel on which an exempted engine is installed.

Vessel owners will be required to petition EPA for an exemption for a particular vessel in order for an engine manufacturer to sell them an exempted engine; granting of the exemption will not be automatic. In evaluating a request for a Tier 4 exemption, we will consider the owner's projections of how and where the vessel will be used and the availability of ULSD in those areas, as well as the mix of SOLAS and non-SOLAS vessels in the owner's current fleet and the extent to which those vessels are being or have been operated outside the United States. In general, it is our expectation that fleets should first use existing pre-Tier 4 vessels for operations were ULSD may not be available. Therefore, we would not expect to grant an exemption for a vessel that will be part of a fleet that does not already have a significant percentage of Tier 4 vessels, since a fleet with a smaller percentage of Tier 4 vessels would likely have more pre-Tier 4 vessels that could be employed in the overseas application instead. For example, if 30 percent of an owner's current fleet has SOLAS certification, we would expect that up to 70 percent of the vessels in that fleet could be Tier 4 compliant without changes in the operation of the fleet. We may also ask the petitioner to demonstrate that other vessels in the petitioner's fleet remain in service outside the United States and have not been placed into service domestically. EPA does not expect to approve applications for the Tier 4

[127] Memorandum to Docket EPA-HQ-OAR-2003-0190, Marine Vessels – SOLAS Certification, from Jean MarieRevelt, dated January 11, 2007.

exemption described in this paragraph prior to 2021; we expect that the existing fleet of Tier 3 vessels can be used for overseas operations during that time. If an owner petitions EPA for an exemption prior to that year, we may request additional information on the owner's expected operation plans for that vessel and a more complete explanation as to why another vessel in the existing fleet could not be redirected to the offshore application with the Tier 4 vessel under construction taking that vessel's place. Finally, a failure to maintain SOLAS certification for the vessel on which an exempted engine is installed would result in a finding of noncompliance and the owner would be liable for applicable fines and other penalties.

To address the situation in which an owner of a vessel with Tier 4 engines wants to use that vessel in a country that does not have ULSD available, we are also including a provision that will allow the owner to petition EPA to temporarily remove or disable the Tier 4 controls on vessels that are operated solely outside the United States for a given period of time. The petitioner will need to specify where the vessel will operate, how long the vessel it will operate there, and why the owner will be unable to provide ULSD for the vessel. The petitioner will also be required to describe what actions will be taken to disable or disconnect the Tier 4 controls. Permission to disable or remove the Tier 4 controls will be allowed only for the period specified by the owner and agreed to by EPA; however, the owner may re-petition EPA at the end of that period for an extension. As part of the approval of such a petition, the petitioner will be required to agree to re-install or reconnect the Tier 4 emission control devices prior to re-entry into the United States, whether this occurs only at the end of the specified period or earlier.

These provisions for migratory vessels are intended to facilitate the use of vessels certified to the U.S. federal marine diesel emission standards while they are operated for extended periods in areas that may not have ULSD available. It should be noted that vessels that receive either limited exemptions or that petition EPA to remove or disable Tier 4 controls will still be subject to the MARPOL emission limits when they are operated outside the United States. We may review these migratory vessel provisions in the context of our upcoming Category 3 marine diesel engine rulemaking. We may also revisit this program in the future if the number of exemption requests appears to be unreasonably high or if we find that significant numbers of vessels that have obtained exemptions from Tier 4 are, in fact, in use domestically.

Note that the implementation schedule in the above marine standards tables is expressed in terms of model years, consistent with past practice and the format of our regulations. However, in two cases we believe it is appropriate to provide a manufacturer the option to delay compliance somewhat, as long as the standards are implemented within the indicated model year. Specifically, we are allowing a manufacturer to delay Tier 4 compliance within the 2017 model year for 600-1000 kW (800-1300 hp) engines by up to 9 months (but no later than October 1, 2017) and, for Tier 4 PM, within the 2016 model year for engines at or above 3700 kW (4900 hp) by up to 12 months (but no later than December 31, 2016). We consider this option to delay implementation appropriate in order to give some flexibility in spreading the implementation workload and ensure a smooth transition to the long-term Tier 4 program.

The Tier 4 standards for locomotives and for C2 diesel marine engines of comparable size are at the same numerical levels but differ somewhat in implementation schedule: Locomotive Tier 4 standards start in 2015, while diesel marine Tier 4 standards start in 2016 for engines in the 1400-2000 kW (1900-2700 hp) range, and in 2014 for engines over 2000 kW (with final PM standards starting in 2016 for these engines). We consider these locomotive and marine diesel Tier 4 implementation schedules to be close enough to warrant our adopting a marine engine option based on the Tier 4 locomotive schedule, aimed at facilitating continuance of today's frequent practice of developing a common engine platform for both markets. Commenters on the proposal supported this marine engine option, but expressed concerns about competitiveness issues and argued that we should remove the proposed restriction to engines of 7-15 liter/cylinder displacement and under 3700 kW maximum engine power.

We are adopting this locomotive-based marine engine option, but with some changes from the proposed approach to address potential competitiveness issues, as well as our own concern that this option be used only for the intended purpose of avoiding unnecessary dual design efforts. First, we are retaining some limits on its scope, specifically to engines above both a 7 liters per cylinder limit (Category 2 in the marine sector) and a 1400 kW (1900 hp) maximum engine power. Second, if the option is used, its standards must be met for all of a manufacturer's marine engines at or above 1400 kW (1900 hp) in the same displacement category (that is, 7-15, 15-20, 20-25, or 25-30 liters per cylinder) in all of the model years 2012 through 2016. This will help ensure the option is not gamed by artificially subdividing engine platforms. Because the switch locomotive program we are establishing already includes a similar streamlined option allowing the use of land-based nonroad engines, we are not extending this option to switchers.

We are adopting another provision to help ensure that this locomotive-based marine engine option is environmentally beneficial and is not used to gain a competitive advantage. We are requiring that marine engines under this option meet Tier 3 standards in 2012, the year Tier 3 starts for locomotives, with standards numerically corresponding to locomotive Tier 3 standards levels: 0.14 g/kW-hr (0.10 g/bhp-hr) PM and 7.8 g/kW-hr NO_x+HC (5.8 g/bhp-hr: that is, 5.5 + 0.30 g/bhp-hr combined NO_x and HC). Otherwise a manufacturer could take advantage of the later-starting marine Tier 3 schedule to generate credits or allow increased emissions from these engines until 2015 when the option requires Tier 4 compliance. This approach also deals fairly with the problem identified in the proposal regarding redesigning locomotive-based engine platforms to meet the numerically lower marine Tier 3 NO_x level.

Finally, we considered but are not adopting a provision that would set a total vessel power limit for the Tier 4 standards. The comments we received on this issue lead us to conclude that multiple-engine configurations are used in vessel designs for specific purposes and are not likely to be employed to evade the Tier 4 standards. We may consider this type of restriction in a future action, however, if multiple-engine vessels are built in applications that have typically used a different number of engines in the past.

(b) Remanufactured Marine Engines

In addition to the standards for newly-built engines, we are adopting for the first time emission standards for marine diesel engines on existing vessels. Many of these existing engines will remain in the fleet for 40 years or more, making them what would otherwise be a substantial source of air pollution. The marine remanufacture program will provide early PM reductions by reducing emissions from this legacy fleet sooner than would be the case from the retirement of old vessels in favor of new vessels with cleaner engines. Additional early NO_x reductions are expected to be achieved from the use of locomotive remanufacture systems recertified under this program for Category 2 engines.

The program we are finalizing is modified from what we described in the NPRM. In the NPRM we described a two-part program that would have applied to all commercial marine diesel engines above 600 kW when they are remanufactured. In the first part, which we considered beginning as early as 2008, vessel owners/operators and engine rebuilders who remanufacture engines would be required to use a certified remanufacture system when an engine is remanufactured (defined as replacement of all cylinder liners, either in one event or over a five-year period) if such a certified system is available. In the second part, which we considered beginning in 2013, a marine diesel engine identified by EPA as a high-sales volume engine model would have been required to meet specified emission requirements when it is remanufactured. Specifically, the remanufacturers or owners of such engines would have been required to use systems certified to meet the standard; if no certified system is available, they would have needed to either retrofit the engines with emission reduction technology that demonstrates at least a 25 percent reduction or replace the engines with new ones. For engines not identified as high-sales volume engines, Part 1 would have continued to apply.

Several commenters requested that EPA not finalize this program at this time but instead consider it in a separate rulemaking. They noted that this would allow additional time to consider the program and its requirements. Postponing the program, however, would also result in the loss of important emission reductions early in the program. Delay is also not necessary because the program we are adopting consists only of the first part of the program described in our proposal, requiring the owner of a marine diesel engine to use a certified marine remanufacture system when the engine is remanufactured if such a system is available. We are not adopting a requirement for the mandatory availability of remanufacture systems. (Under the option discussed in the proposal, in certain circumstances, if a remanufacture system was not made available the owner would have been required to retrofit an emission control technology, repower the vessel (replace its engines) or scrap the vessel.)

The marine remanufacture program we are adopting applies to all commercial marine diesel engines with maximum engine power greater than 600 kW and manufactured in 1973 or later, through Tier 2. The beginning date of 1973 is based on our existing locomotive program; many of the techniques used to achieve those standards are expected to be applicable to marine diesel engines over 600 kW.

As described in more detail below, the program draws on aspects of our locomotive remanufacture and diesel retrofit programs with regard to the basic requirements that apply and how remanufacture systems are certified. The remainder of this section describes the main features of the program. The technological feasibility of this program is described in section III.C, and the certification requirements are set out in section IV. Small manufacturer, engine dresser, vessel builder, and operator flexibilities are set out in section IV.A(13)(b).

Similar to the locomotive program, the marine program we are finalizing applies when a marine diesel engine is remanufactured. Covered engines are those that are remanufactured to as-new condition. Based on discussions with engine manufacturers, we have determined that replacing all cylinder liners is a simple and clear indicator that the servicing being done is extensive enough for the engine to be considered functionally equivalent to a freshly manufactured engine, both mechanically and in terms of how it is used. Therefore, we are defining remanufacture as the removal and replacement of all cylinder liners, either during a single maintenance event or over a five-year period. It should be noted that marine diesel engines are not considered to be remanufactured if the rebuilding process falls short of this definition (i.e., the cylinder liners are removed and replaced over more than a five-year period). As with locomotives, remanufactured marine diesel engines are new until they are sold or placed into service.

For the purpose of this program, “replace” includes removing, inspecting, and requalifying a liner. This addresses the situation in which an engine experiences a cylinder failure prior to a scheduled rebuild: the owner might replace the failed cylinder right away and replace the others at rebuild; then, at the time of rebuild, the installer would likely inspect the cylinder that was a few months old to make sure it qualified for continued use according to the certificate holder’s instructions. We do not think that owners will fail to requalify cylinders to avoid the remanufacture requirements because requalification is done both to ensure the continued reliability and durability of the engine and as part of surveys necessary to retain vessel certification for safety and other purposes. The five-year provision was first adopted in the locomotive program to help ensure that the standards are not avoided through phased remanufacturing (i.e., not replacing the power assemblies all at once). It is reasonable to use this approach in the marine sector as most commercial engines are rebuilt all at once, although some owners may choose a rolling rebuild approach in which a certain number of cylinders are rebuilt every year. We may revisit the five-year limit after a few years of the program to evaluate whether this is the appropriate period and whether owners are adjusting their rebuild practices, particularly with respect to rolling rebuilds, to circumvent the regulations (see discussion of rolling rebuilds, below).

When an engine is remanufactured, it must be certified as meeting the emission standards for remanufactured engines (by using a certified remanufacture system) unless there is no certified remanufacturing system available for that engine. In other words, the owner/operator or installer of a covered engine would be required to use a certified marine remanufacture system when remanufacturing that engine if one is available. If there is no certified system available at that time, there is no requirement. Availability means not only that EPA has certified a system, but also that it can be obtained and installed in a timely manner consistent with normal business practices. For example, a system would generally not be considered to be available if it required that the engine be removed from the vessel and shipped to a factory to be remanufactured unless that is the normal rebuild process for that engine. Similarly, a system would not be considered to be available if the component parts are not available for purchase in the period normally associated with a scheduled rebuild. If a certified system is not available there is no requirement to comply with this program until the next remanufacture, at which time the remanufacturer would need to check again to see if a system is available. Nonavailability due to inability to obtain parts may be demonstrated by a written record that shows a good faith effort to obtain parts.

Several states and localities have voluntary retrofit programs to reduce emissions from marine diesel engines. These programs encourage vessel owners to apply emission reduction strategies in return for a financial or operational incentive. Retrofit systems range from engine adjustments to installing different cylinders, fuel injectors, turbochargers, or other engine components. To receive the incentive, the owner must demonstrate the reduction, often through emission measurements. We received state agency comments expressing concern about the potential inconsistency between state and local retrofit programs and a potential marine remanufacture program. Specifically, a situation could be created in which a vessel owner who has already applied a retrofit device pursuant to a state or local retrofit program would be required to remove the voluntary retrofit device and install a certified marine remanufacture system. We do not want to negatively impact the positive benefits that arise from state and local retrofit programs, especially in those cases in which the retrofit achieves a greater reduction (e.g., retrofit of a SCR system) than a certified marine remanufacture system. We also do not want to discourage these programs especially in early years where states and local programs may achieve reductions before certified remanufacture systems become available.

Therefore, we are adopting a provision that will allow an owner/operator of an engine that is fit with a retrofit device prior to 2017 pursuant to a state or local retrofit program to request a qualified exemption from the marine remanufacture requirements for that engine. This qualified exemption will be available only to engines equipped with retrofit device under a state or local program before 2017. The owner/operator must request the exemption prior to a remanufacturing event that would otherwise trigger the requirement to use a certified remanufacture system. The request must include documentation that the vessel has been retrofit pursuant to a state or local retrofit program and a signed statement declaring that to be true. Except for the initial request for a specific vessel and a specific retrofit, a request would be considered to be approved unless we notify the requestor otherwise within 30 days of the date that we receive the request. Note that the exemption does not apply where the sponsoring government specifies that inclusion in the retrofit program is not intended to provide an exemption from the requirements of this subpart. EPA's granting of the exemption is conditioned upon the owner/operator's continued use and maintenance of the retrofit kit that provides the basis for the exemption.

Beginning in 2017, this exemption will no longer be available for new retrofits. Engines included in state or local retrofit programs will be required to use a certified remanufacture system if one is available when the engine is remanufactured. In this case either the certified remanufacture system would be part of the retrofit or the vessel owner would use a certified remanufacture system the next time at the next remanufacture event.

At this time, we are adopting standards for remanufacture systems only for marine diesel engines over 600 kW. This 600 kW threshold is reasonable because of the long hours of use, often at high load, of engines above 600 kW, and their long services lives. These engines are also more likely to undergo regular full overhauls, returning them to as-new condition. Commercial marine diesel engines larger than 600 kW typically undergo periodic full, like-new rebuilds. These large engines are often installed on tugs, towboats, ferries, offshore supply vessels, lakers, and coasters, which require reliable power at all times. These vessels are often used for ten or more hours a day, every day of the year. As a result, these engines are typically subject to regular maintenance to ensure their dependability. In addition, many manufacturers provide guidance for a full rebuild to as-new condition. This might include replacing piston rings, heads, bearings, and gear train/camshaft as well as piston liners.[128] Rebuilding to as-new condition helps ensure smooth operation over the full maintenance interval. Owners of these vessels are also motivated to maintain their engines because it is very complicated and expensive to repower their vessels; replacing an engine may require major hull modifications. Because these vessels operate for decades, often 40 or more years, their engines may be remanufactured to as-new condition anywhere from three to six or even more times before the vessel is scrapped.

We are not setting standards for marine remanufacture systems for engines below 600 kW because we currently do not have sufficient data to determine the extent that rebuilding of engines below 600kW qualifies as remanufacturing to an as new condition. Smaller commercial engines under 600 kW or recreational engines typically have shorter useful lives than the larger engines and do not see as much wear on an annual basis. This means it takes longer to acquire the hours between maintenance intervals. Engines on some smaller commercial or recreational marine vessels may not be rebuilt at all but, instead, are replaced or the vessel is scrapped. There may also be other technological and cost issues with applying remanufacture requirements to smaller commercial or recreational engines.

For these reasons, we are finalizing only standards for remanufactured commercial marine diesel engines above 600 kW. We may revisit this approach after implementing the program to evaluate whether other remanufactured marine diesel engines should be included in the program as well.

A certified marine remanufacture system must achieve a 25 percent reduction in PM emissions compared to the engine's measured baseline emissions level (the emission

[128] See Note from Amy Kopin, Mechanical Engineer, to Jean Marie Revelt, EPS, Re: Marine Remanufacture Program. A copy of this Note is available in Docket OAR-2003-0190.

level of the engine as rebuilt according to the manufacturer's specification but before the installation of the remanufacture system) without increasing NO_x emissions (within 5 percent). We are not finalizing a 0.22 g/kW-hr PM cap, as proposed. The percent reduction is being adopted because the large range of engine platforms on existing marine diesel engines makes the selection of an effective numeric emission limit impractical. A more stringent emission limit may prevent the development of remanufacture systems for many engines, while a less stringent limit could allow manufacturers to certify remanufacture systems for engines that already meet the limit without any additional emission benefits. A percentage reduction has the advantage of allowing more engines to participate in the program while ensuring valid emission reductions.

We are not adopting the multi-step approach discussed in the proposal. This approach, based on the Urban Bus program, would have entailed setting standards based on reductions of 60 percent, 40 percent, and 20 percent, and requiring that a rebuild use the certified kit meeting the most stringent of these three standards if available. Manufacturers expressed concern that such a requirement would discourage the development of remanufacture systems since they could rapidly become obsolete. Owners were concerned that they would be subject to a moving requirement that would complicate their engine maintenance and overhaul schedules and could result in identical engine models being required to use different remanufacture systems. They also were concerned that such an approach would mean they would have to use a different system every time they remanufacture, and the impacts on engines that are remanufactured over several maintenance events. For these reasons, instead of adopting the multi-step approach, we are adopting a single emission reduction requirement. If several certified systems are available, we will allow any of them to be used. However, states may develop incentive programs to encourage the use of the certified remanufacture system with the greatest reduction. Also, we may revisit the emission level in the future to determine if it should be modified to reflect advances in applying new PM reduction technologies to existing marine diesel engines.

We expect that this PM reduction will be met by using incrementally-improved components that are replaced when an engine is remanufactured, based on reduction technologies manufacturers are already using or will be using to achieve the Tier 3 PM standards. For example, a remanufacture system could reduce PM emissions by using different fuel injectors or different piston rings to reduce oil consumption. Remanufacturing systems may not adversely affect engine reliability, durability, or power.

Some engine manufacturers expressed concern about the potential for unintended adverse effects on engine performance, reliability, or durability that could occur if another entity develops a remanufacture system for their engines. They were particularly concerned about being held responsible for an emission failure if the remanufacture system does not perform as intended, or for an engine failure if the system causes other engine components to fail. To address this concern, the program we are finalizing requires any person who wishes to certify a remanufacture system for an engine not produced by that person to notify the original engine manufacturer and request their comments on the remanufacture system. Any comments received by the certifier are required to be included in the certification application, as well as a description of how those comments were addressed.

As we described at proposal, this final rule includes a cost cap on marine diesel remanufacture systems of $45,000 per ton of PM reduced, based on the incremental cost of the remanufacture system (the cost in excess of what a rebuild would otherwise cost). This cost cap is analogous to the reasonable cost limit in the current locomotive remanufacturing program and is intended to ensure that marine remanufacture systems do not impose excessively burdensome cost requirements on vessel owners that are not justified by the benefits of the reductions. The $45,000 per ton of PM reduced is similar to the cost of a number of mobile source retrofit programs. This cap includes all costs to the vessel owner associated with the remanufacture system beyond those associated with an engine remanufactured without a certified system, such as labor for any special installation procedures and any modifications to the vessel or its operation (e.g., fuel consumption impacts).

It may not be possible for the certifier to predict the characteristics of all vessels that can use the remanufacture system and therefore provide a comprehensive estimate of the total incremental costs of installing the remanufacture system. Therefore, in addition to an estimate of the vessel-related installation costs that would apply to most vessels, the certifier must also provide and an estimate of the amount of residual incremental costs that would be available for installation of the remanufacture system on a particular vessel without triggering the $45,000 per ton PM threshold (i.e., the maximum amount installation may cost for a particular vessel after the cost of the remanufacture system is deducted from the $45,000 maximum cost). This will guide vessel owners in determining if the cost of a certified remanufacture system will exceed the $45,000 threshold for a particular vessel.

We are including a provision that will allow a vessel owner to request an exemption from EPA if the vessel owner can demonstrate to EPA's satisfaction that actual installation cost for his or her vessel will exceed the $45,000 per ton PM threshold. This may be necessary, for example, if a vessel with external keel cooling cannot be modified to achieve required cooling levels required by the remanufacture system without extensive modifications to the vessel hull. We are also including a small business exemption as well as a financial hardship provision (see Section IV.A.13(b)(vi and vii)) that would allow postponing the requirements for owners who can show financial hardship.

Marine remanufacture systems can be certified as soon as this rule goes into effect. A remanufacture system will be considered to be available 120 days after we issue a certificate of conformity for it or 90 days after we include it on our list of certified remanufacture systems, whichever is later. Prior to the end of that period, a kit will not be considered to be "available." This period allows time for owners to arrange for remanufacturing with a certified system once one that applies to the relevant engine has been certified. Once a marine remanufacture system is certified, as evidenced by an EPA-issued certificate of conformity, it will be considered to be available until it is withdrawn or the certificate holder fails to obtain a certificate of conformity for a subsequent year. We will maintain a list of available remanufacture systems and provide access to this list by posting it on our website. Owners should consult the list prior to any particular remanufacturing event to determine whether a certified system is available and therefore whether they are affected by the program. Uncertified systems purchased before that date can be used as long as they are consistent with the normal parts inventory practices of the owner or rebuild facility. Stockpiling of uncertified remanufacture systems to evade the requirements of the program is not allowed.

For engines on a rolling rebuild schedule (i.e., cylinder liners are not replaced all at once but are replaced in sets on a schedule of 5 or fewer years, for example 5 sets of 4 liners for a 20-cylinder engine on a 5-year schedule), the requirement is triggered at the time the remanufacture system becomes available, with the engine required to be in a certified configuration when the last set of cylinder liners is replaced. The remanufacturing requirements do not apply for cylinder-liner replacements that occurred before the remanufacture system becomes available. Any remanufacturing that occurs after the system is available needs to use the certified system, including remanufacturing that occurs on a rolling schedule over less than five years following the availability of the remanufacturing system. If the components of a certified remanufacture system are not compatible with the engine's current configuration, the program allows the owner to postpone the installation of the remanufacture system until the replacement of the last set of cylinder-liners, which would occur no later than five years after the availability of the system. At that time, all engine components must be replaced according to the certified remanufacture system requirements.

Initially, we expect marine remanufacture systems to be certified for C2 engines that are derived from certified locomotive remanufacture systems. Some of these certified locomotive systems are already used on C2 marine diesel engines, or can be used with modification. The new Tier 0+, Tier 1+ and Tier 2+ certified locomotive remanufacture systems are likely to be capable of being used on marine diesel engines without much additional development when those certified locomotive systems become available, for additional reductions. To encourage this practice, we are providing a streamlined certification process for locomotive systems certified to the new Tier 0+, Tier 1+, or Tier 2+ standards for use on C2 engines. The streamlined certification will also be allowed for existing Tier 0 locomotive remanufacture systems (certified under part 92), but those systems can be used only on pre-Tier 1 (uncertified) C2 marine engines, and the use of these existing Tier 0 systems will not be permitted after systems certified to the new Tier 0+ (or Tier 1+ if applicable) locomotive standards are made available. The streamlined certification process will require only an engineering analysis demonstrating that the system would achieve emission reductions from marine engines similar to those from locomotives. The streamlined certification process will allow modifications to the previously certified locomotive system as necessary to install the system on a C2 marine engine. If the manufacturer of a locomotive remanufacture system chooses to modify that system in a substantive way, for example to remove NO_x emission controls (because the marine remanufacture program only requires PM reductions), then the system will have to be recertified as a marine remanufacture system based on measured values and subject to all of the other certification requirements of the marine remanufacture program (see section IV). We are not providing a similar streamlined certification process for C1 marine systems because there are currently no certified remanufacture systems for C1-equivalent engines through our other mobile source programs.

The program described above is engine-based in that it assumes that remanufacture systems will consist of changes to engine components or operational settings. At least one user asked EPA to consider also allowing remanufacture systems consisting of the use of specified fuels or fuel additives. The program we are adopting will allow this type of remanufacture system, subject to the following constraints.

First, the use of a remanufacture system based on a fuel or fuel additive will not be mandatory if such a system is certified. Instead, the use of a fuel or fuel additive system will be allowed as an alternative compliance mechanism in place of an engine-based remanufacture system. In other words, if an engine-based remanufacture system is certified, owners of the affected engine models can either use that engine-based system or use a fuel or fuel additive system if one has also been certified; if there is no certified engine-based system, then there is no requirement to use the fuel or fuel additive remanufacture system. This requirement is necessary because, in contrast to an engine-based system, a fuel or fuel additive-based system requires positive action on the part of the owner to achieve the emission reductions. In the case of an engine-based system, the owner installs the replacement parts at the time of rebuild; installation of the parts will achieve the required reductions and there is little impact on the owner or the vessel's operations. In the case of a fuel or fuel additive system, however, the owner will be required to use the specified fuel or fuel additive at all times; if the owner does not take the required action, the "system" will not be in use. Because a fuel or fuel additive-based system will require the owner to do something on a continuous basis and require additional recording and recordkeeping, the success of the system requires a positive commitment on behalf of the owner/operator.

Second, the certifier of a remanufacture system based on a fuel or fuel additive will be required to show that use of the fuel or fuel additive meets the 25 percent PM reduction based on measured values, without increasing NO_x emissions, for all engines to which the system will apply. This will require testing an engine with and without the use of the specified fuel or fuel additive. Different engines may be combined into one engine family for the purpose of certification, based on EPA approval.

Third, any fuel or fuel additive for which certification is sought under the marine remanufacture program must first be registered under 40 CFR Part 79, Registration of Fuels and Fuel Additives. This is to ensure that the fuel or fuel additive does not contain substances that are otherwise controlled by EPA.

Fourth, as part of the certification, the certifier will be required to provide a sampling procedure that can be used by EPA or other enforcement authorities to verify owner compliance onboard and for enforcement purpose. That procedure should explain how to detect if the appropriate level of fuel additive or if the appropriate fuel type is actually being used onboard on the basis of a fuel sample taken from a fuel tank on the vessel. In addition to being provided to EPA as part of the certification process, the certifier will be required to provide a copy of this procedure to the purchaser as part of the remanufacture system package and will be required to maintain a copy of the procedure on the internet to facilitate in-field compliance verification.

Fifth, the remanufacture system will require a notification to be placed at the appropriate fill location (either on the fuel tank inlet in the case of fuels or pre-blended fuel additives, or as specified on the engine in the case of fuel additives not blended in the fuel) that indicates the engine is outfitted with a fuel or fuel additive remanufacture system and that compliant fuel or additives must be used at all times.

Finally, when an owner agrees to use a fuel or fuel additive-based remanufacture system in lieu of an engine-based system, that owner must also agree to any recordkeeping requirements specified in the certification of that system. These may include keeping a record of the purchase of the specified fuel or fuel additive and, in the case of additives, the amounts and dates of the additive use. These requirements must be set out by the certifier as part of the kit, and the owner will be deemed to have agreed to them by affixing a label to the engine or appropriate fuel or fuel additive inlet indicating that it is certified with a fuel or fuel-additive remanufacture system.

If an owner or operator chooses a certified remanufacture system based on a particular fuel or fuel additive to meet these remanufacture requirements, the failure to use the fuel or fuel additive would be a violation of 1068.101(b)(1).

Allowing the use of fuel or fuel additive-based remanufacture systems is not intended to be a mechanism to require fuel switching for marine diesel engines, either to 15 ppm fuel earlier than required or to distillate from residual fuel for auxiliary engines on vessels with Category 3 marine diesel engines or for those smaller vessels than may currently use residual fuel in their C2 main propulsion engines. It is also not intended to prevent the use of off-spec fuel in marine diesel engines. If there is no certified engine-based remanufacture system available for an engine, a fuel or fuel additive-based kit will not be required to be used even if one is certified.

EPA is committed to the development and successful operation of a marine remanufacture program. We intend to assess the effectiveness of this program as early as 2012 to ascertain the extent to which engine manufacturers are providing certified remanufacture systems. If remanufacture system are not available or are not in the process of being developed and certified at that time for a significant number of engines, we may consider changes to the program. As part of that assessment, we may evaluate whether to include Part 2 of the program described in our proposal. Part 2 would require the owner/operator or installers of a marine diesel engine identified by EPA as a high-sales volume engine to either use a certified remanufacture system when the engine is remanufactured or, if no system is available, retrofit an emission reduction technology for the engine that meets the 25 percent PM reduction, or repower (replace the engine with a freshly manufactured engine). Part 2 was intended to create a market for marine remanufacture systems, to help ensure their development over the initial five years of the program. However, vessel owners were very concerned that a mandatory repower program would have the opposite impact, and would discourage certification of remanufacture systems in favor of mandatory repowers due to the higher value of a replacement engine compared to a remanufacture system. In evaluating the effectiveness of the remanufacture program in the future, EPA may revisit the need for Part 2, or something similar, to ensure emission reductions from the large marine legacy fleet are occurring in a timely and effective manner. We may also evaluate other aspects of the program, including the criteria that trigger a remanufacturing event (including the 5-year period for incremental remanufactures), and whether we should set remanufacture standards for engines less than 600 kW.

(3) Carbon Monoxide, Hydrocarbon, and Smoke Standards

We did not propose and are not setting new standards for CO. Emissions of CO are typically relatively low in diesel engines today compared to non-diesel pollution sources. Furthermore, among diesel application sectors, locomotives and marine diesel engines are already subject to relatively stringent CO standards in Tier 2-- essentially 1.5 and 3.7 g/bhp-hr, respectively, compared to the current heavy-duty highway diesel engine CO standard of 15.5 g/bhp-hr. Therefore, the Tier 3 and Tier 4 CO standards for all locomotives and marine diesel engines will remain at current Tier 2 levels and remanufactured Tier 0, 1 and 2 locomotives will likewise continue to be subject to the existing CO standards for each of these tiers. Although we are not setting more stringent standards for CO in Tier 4, we note that aftertreatment devices using precious metal catalysts that we project will be employed to meet Tier 4 PM, NO_x and HC standards will provide meaningful reductions in CO emissions as well.

As discussed in section II, HC emissions, often characterized as VOCs, are precursors to ozone formation, and include compounds that EPA considers to be air toxics. As with CO, emissions of HC are typically relatively low in diesel engines compared to non-diesel sources. However, in contrast to CO standards, the HC standard for Tier 2 line-haul locomotives (0.30 g/bhp-hr), though comparable to HC standards from other diesel applications in Tier 2 and Tier 3, is more than twice that of the long-term 0.14 g/bhp-hr standard set for both the heavy-duty highway 2007 and nonroad Tier 4 programs. For marine diesel engines, the Tier 2 HC standard is expressed as part of a combined NO_x+HC standard varying (by engine size) between 5.4 and 8.2 g/bhp-hr, which clearly allows for high HC levels. Our more stringent Tier 3 NO_x+HC standards for marine diesel engines will likely provide some reduction in HC emissions, but we expect that the catalyzed exhaust aftertreatment devices used to meet the Tier 4 locomotive and marine NO_x and PM standards will concurrently provide very sizeable reductions in HC emissions. Therefore, in accordance with the Clean Air Act section 213 provisions outlined in section I.B(3) of this preamble, we are applying a 0.14 g/hp-hr HC standard to locomotives and marine diesel engines in Tier 4. This level is the same as that adopted for highway and nonroad diesel engines equipped with high-efficiency aftertreatment.

We are retaining the existing form of the HC standards through Tier 3. That is, locomotive and marine HC standards will remain in the form of total hydrocarbons (THC), except for gaseous- and alcohol-fueled engines (See 40CFR §92.8 and §94.8). Likewise, the Tier 3 marine NO_x+HC standards are based on THC, except that Tier 3 standards for less than 75 kW (100 hp) engines are based on NMHC, consistent with their basis in the nonroad engine program. Tier 4 HC standards are expressed as NMHC standards, consistent with aftertreatment-based standards adopted for highway and nonroad diesel engines.

As for other diesel mobile sources, we believe that locomotive smoke standards currently in place are of diminishing usefulness as PM emissions are reduced to very low levels, as these low-PM engines emit very little or no visible smoke. We are therefore not setting smoke standards for locomotives covered under the new 40 CFR Part 1033 created by this final rule, if the locomotives are certified to a PM family emission limit (FEL) or standard of 0.05 g/bhp-hr (0.07 g/kW-hr) or lower. Locomotives certified with PM at higher levels are subject to smoke standards equal to those established previously in Part 92. This allows manufacturers of locomotives certified to Tier 4 PM (or to an FEL slightly above Tier 4) to avoid the unnecessary expense of testing for smoke. Marine diesel engines currently have no smoke standards and we are not setting any in this rule.

Commenters suggested that smoke testing is superfluous for pre-Tier 4 engines as well, because a properly maintained engine meeting any tier of EPA emissions standards will also meet the smoke standards. Based on the available information, we remain unconvinced that this argument is valid in all cases and we are therefore retaining the smoke standards for locomotives with PM FELs above 0.05 g/bhp-hr. However, we do agree that this relationship generally holds true for engines designed to emission standards being set in this rule, and are therefore waiving the smoke test requirement from certification, production line, and in-use testing, unless there is visible evidence of excessive smoke emissions. This provides the test cost savings sought by the manufacturers but retains the EPA enforcement opportunity if smoke should become a problem in engines subject to this program.

C. Are the Standards Feasible?

In this section, we describe the feasibility of the various emission control technologies we project will be used to meet the standards we are finalizing today. Because of the range of engines and applications we cover in this rulemaking and because of the diversity in technologies that will be available for them, our standards span a range of emission levels. We have identified a number of different emission control technologies we expect will be used to meet these standards. The technologies range from incremental improvement of existing engine components to highly advanced catalytic exhaust aftertreatment systems similar to those expected to be used to control emissions from heavy-duty diesel trucks and nonroad equipment.

We first describe the feasibility of emission control technologies we project will be used to meet the standards we are finalizing for existing locomotive and marine engines that are remanufactured as new (i.e., Tier 0, 1, 2 locomotives and marine diesel engines >600 kW). We next describe how these same technologies will be applied to meet the interim standards for freshly manufactured engines (i.e., Tier 3). We conclude this section with a discussion of catalytic exhaust aftertreatment technologies projected to be used to meet our Tier 4 standards. Throughout this section, we also address many of the comments submitted by stakeholders concerning the feasibility, applicability, performance, and durability of the emission control technologies we presented in the Notice of Proposed Rulemaking (NPRM). For a more detailed analysis of these technologies, issues related to their application to locomotive and marine diesel engines, and our response to public comments, we refer you to the Regulatory Impact Analysis (RIA) and Summary & Analysis of Comments documents associated with this rulemaking.

(1) Emission Control Technologies for Remanufacture of Existing Locomotives and Marine Diesel Engines >600 kW

In the locomotive sector, emissions standards already exist for engines that are remanufactured as new. Some of these engines were originally unregulated (i.e. Tier 0), and others were originally built to earlier emissions standards (Tier 1 and Tier 2). This rulemaking now requires more stringent standards for these engines whenever the locomotives are remanufactured as new. Our remanufactured engine standards apply to locomotive engines and marine engines >600 kW that were originally built as early as 1973.

We project that incremental improvements to existing engine components will make it feasible to meet both our locomotive and marine remanufactured engine standards for PM. In many cases, these improvements have already been implemented on newly built locomotives to meet our current locomotive standards. To meet the more stringent NO_x standard for the locomotive Tier 0+ and Tier 1+ remanufacturing program, we expect that improvements in fuel system design, engine calibration and optimization of existing after-cooling systems will be used to reduce NO_x from the current 9.5 g/bhp-hr Tier 0 standard to the tightened Tier 1+ standard for NO_x of 7.4 g/bhp-hr. These are the same technologies used to meet the current Tier 1 emission standard of 7.4 g/bhp-hr. In essence, locomotive manufacturers will duplicate current Tier 1 locomotive NO_x and HC emission solutions and incorporate them into the portion of the existing Tier 0 fleet able to accommodate them (i.e. locomotives manufactured with separate-circuit cooling systems for intake air and engine coolant). For older Tier 0 locomotives without separate-circuit cooling systems, reaching the Tier 1 NO_x level will not be possible, and 8.0 g/hp-hr represents the lowest achievable NO_x emission level through the application of improved fuel system design.

To meet the more stringent PM standards for the Tier 0+, 1+, and 2+ locomotive and marine remanufacturing programs (as well as the new locomotive Tier 3 interim standards), we expect that lubricating oil consumption control technologies will be implemented. A significant fraction of the PM in today's medium-speed locomotive and locomotive-based marine engines is comprised of lubricating oil.[129] Engine design changes which reduce oil consumption also reduce the volatile organic fraction of the engine-out PM. Whether oil consumption is reduced through improvements in piston

[129] Smith, B., Osborne, D., Fritz, S., "AAR Locomotive Emissions Testing 2006 Final Report," Association of American Railroads, Document # LA-023.

ring-pack design, improved closed crankcase ventilation systems, or a combination of both, lower PM emissions will result. We believe that use of existing low-oil-consumption piston ring-pack designs - in conjunction with improvements to closed crankcase ventilation systems – can provide the significant, near-term PM reductions required for these remanufacturing programs. These PM-reducing technologies can be applied to all medium-speed locomotive and locomotive-based marine engines - including those built as far back as 1973.

For the remanufacture of locomotive- and nonroad-based marine engines >600 kW, we believe that similar improvements to piston ring-pack designs, as well as turbocharger, fuel system, and closed crankcase ventilation system improvements can achieve the 25 percent PM reduction required in this program without the use of exhaust aftertreatment devices. Turbocharger designs which increase engine airflow or charge air cooling system enhancements which reduce intake air temperatures can reduce PM levels. Fuel system changes such as increased injection pressure or improved injector tip design can enhance fuel atomization, improving combustion efficiency and reducing soot PM. Any combination of these improvements – or other technologies which achieve the 25 percent PM reduction – can become part of a certified marine remanufacture kit.

We believe that some fraction of the remanufacturing systems for locomotives can be developed and certified as early as this year, so we are requiring the usage of the new Tier 0+, Tier 1+ and Tier 2+ emission control systems as soon as they are available. However, we estimate that it will take approximately 2 years to complete the development and certification process for all of the Tier 0+ and Tier 1+ emission control systems, so full implementation of the Tier 0+ and Tier 1+ remanufactured engine standards is not anticipated until it is required in 2010. We base this lead time on the types of technology that we expect to be implemented and on the amount of lead time locomotive manufacturers needed to certify similar systems for our current remanufacturing program. The lead time required to implement the design changes necessary to meet the Tier 3 and remanufactured Tier 2 locomotive PM emission standards led to an implementation date of 2012 for new Tier 3 engines and 2013 for remanufactured Tier 2 engines. These engine changes include further improvements to ring pack designs (especially for two-stroke engines) and the implementation of high efficiency crankcase ventilation systems, which are described and illustrated in detail in Chapter 4 of the RIA.

(2) Emission Control Technologies for New Tier 3 Locomotive and Marine Diesel Engines

The new Tier 3 locomotive and marine diesel engine standards require PM reductions relative to current the Tier 2 levels. Based upon our on-highway and nonroad clean diesel experience, we expect that the introduction of ULSD fuel into the locomotive and marine sectors will reduce sulfate PM formation and assist in meeting the PM standards for locomotives (both remanufactured Tier 2 and new Tier 3) and new marine diesel engines. We believe that the combination of reduced sulfate PM and incremental design changes that bring oil and crankcase emission control to near Tier 3 nonroad or

2007 heavy-duty on-highway levels can provide at least a 50 percent reduction in PM emissions.

For Tier 3 marine diesel engines (which are, in almost all instances, a derivative of land-based nonroad and locomotive engines), the technologies and design changes needed to meet the more stringent NO_x and PM standards are already being developed for nonroad Tier 4 applications. In order to meet our nonroad Tier 4 emission levels, these engines, in the years before 2012, will see significant base engine improvements designed to reduce engine-out emissions. For details on the design, calibration, and hardware changes we expect will be used to meet the Tier 3 standards for lower horsepower marine engines, we refer you to our nonroad Tier 4 rulemaking.[130] For example, we expect that marine engines will utilize high-pressure, common-rail fuel injection systems or improvements in unit injector design. When such fuel system improvements are used in conjunction with engine mapping and calibration optimization, the marine Tier 3 diesel engine standards can be met. In the case of locomotive-based marine engines, we expect that manufacturers will transfer the technologies used to meet locomotive standards to the marine engine designs.

The 2009 Tier 3 start date for marine engines <75 kW constitutes a special case. We proposed this very early start date, matched with standard levels equal to the nonroad engine Tier 4 standard levels that take effect in 2008, based on our assessment that these engines are close derivatives of the nonroad engines on which they are based - in some cases, with no substantive modifications. The 2009 start date accounts for time needed to make the necessary modifications, prepare for and conduct the certification process, and deal with the large overall workload burden for diesel engine manufacturers. Although the manufacturers commented that this is a very aggressive schedule, at the limits of feasibility, they did not refute our assessment. Their objections to implementation of the not-to-exceed (NTE) standard on the same schedule, and our response, are discussed in section IV.A(3).

Because all of the aforementioned technologies to reduce NO_x and PM emissions can be developed for production, certified, and introduced into the marine engine sector without extended lead-time, we believe these technologies can be implemented for some engines as early as 2009, and for all engines by 2014, on a schedule that very closely follows the nonroad Tier 4 engine changes.

(3) Catalytic Exhaust Aftertreatment Technologies for Tier 4 Locomotive and Marine Engines

For marine diesel engines in commercial service that are greater than 600 kW and for all locomotives, we are setting stringent Tier 4 standards based on the use of advanced catalytic exhaust aftertreatment systems to control both PM and NO_x emissions. There are four main issues to address when analyzing the application of this technology to these

[130] "Final Regulatory Impact Analysis: Control of Emissions from Nonroad Diesel Engines," EPA420-R-04-007, May 2004, Docket EPA-HQ-OAR-2003-0012. The RIA is also available online at http://epa.gov/nonroad-diesel/2004fr/420r04007.pdf

new sources: the efficacy of the fundamental catalyst technology in terms of the percent reduction in emissions given certain engine conditions such as exhaust temperature; its appropriateness in terms of packaging; its long-term durability; and whether the technology significantly impacts an industry's supply chain infrastructure - especially with respect to supplying urea reductant for NO_x aftertreatment on locomotives and marine vessels. We have carefully examined these points, and based upon our analysis (detailed in Chapter 4 of the RIA), we have identified robust PM and NO_x catalytic exhaust aftertreatment systems that are suitable for locomotives and marine engines that also pose a manageable impact on the rail and marine industries' infrastructure.

(a) Catalytic PM Emission Control Technology

The most effective exhaust aftertreatment used for diesel PM emission control is the diesel particulate filter (DPF). In Europe, more than one million light-duty diesel passenger cars are OEM-equipped with DPF systems, and worldwide, over 200,000 DPF retrofits to diesel engines have been completed.[131] Broad application of catalyzed diesel particulate filter (CDPF) systems with greater than 90 percent PM control began with the successful introduction of 2007 model year heavy-duty diesel trucks in the United States. These systems use a combination of passive and active soot regeneration strategies. CDPF systems utilizing metal substrates are a further development that balances a degree of elemental carbon soot control with reduced backpressure, improved ability of the trap to clear oil ash, greater design freedom regarding filter size/shape, and greater system robustness. Metal-CDPFs were initially introduced as passive-regeneration retrofit technologies for diesel engines designed to achieve approximately 60 percent control of PM emissions. Recent data from development of these systems for Euro-4 truck applications has shown that metal-CDPF trapping efficiency for elemental carbon PM can exceed 70 percent for engines with inherently low elemental carbon emissions.[132]

Data from locomotive testing confirms a relatively low elemental carbon fraction and relatively high organic fraction for PM emissions from medium-speed Tier 2 locomotive engines.[133] The use of an oxidizing catalyst with platinum group metals (PGM) coated directly to the CPDF combined with a diesel oxidation catalyst (DOC) mounted upstream of the CDPF will provide 95 percent or greater removal of HC, including the semi-volatile organic compounds that contribute to PM. Such systems will reduce overall PM emissions from a locomotive or marine diesel engine by approximately 90 percent from today's levels.

We believe that locomotive and marine diesel engine manufacturers will benefit from the extensive development taking place to implement DPF technologies in advance

[131] "Diesel Particulate Filter Maintenance: Current Practices and Experience", Manufacturers of Emission Controls Association, June 2005, online at http://meca.org/galleries/default-file/Filter_Maintenance_White_Paper_605_final.pdf
[132] Jacob, E., Lämmerman, R., Pappenheimer, A., Rothe, D. "Exhaust Gas Aftertreatment System for Euro 4 Heavy-duty Engines", MTZ, June, 2006
[133] Smith, B., Osborne, D., Fritz, S. "AAR Locomotive Emissions Testing 2006 Final Report" Association of American Railroads, Document # LA-023.

of the heavy-duty truck and nonroad PM standards in Europe and the United States. Given the steady-state operating characteristics of locomotive and marine engines, DPF regeneration strategies will certainly be capable of precisely controlling PM under all conditions and passively regenerating whenever the exhaust gas temperature is >250 °C. Therefore, we believe that the Tier 4 PM standards we are adopting for locomotive and marine diesel engines are technologically feasible. And given the level of activity in the on-highway and nonroad sectors to implement DPF technology, we have concluded that our implementation dates for locomotive and marine diesel engines are appropriate and achievable.

(b) Catalytic NO_x Emission Control Technology

We have analyzed a variety of technologies available for NO_x reduction to determine their applicability to diesel engines in the locomotive and marine sectors. As described in more detail in Chapter 4 of the RIA, we expect locomotive and marine diesel engine manufacturers will choose to use Selective Catalytic Reduction (SCR) to comply with our new standards. SCR is a commonly-used aftertreatment device for meeting stricter NO_x emissions standards in diesel applications worldwide. Stationary power plants fueled with coal, diesel, and natural gas have used SCR for three decades as a means of controlling NO_x emissions, and currently European heavy-duty truck manufacturers are using this technology to meet Euro 5 emissions limits. To a lesser extent, SCR has been introduced on diesel engines in the U.S. market, but the applications have been largely limited to ferry boats and stationary electrical power generation demonstration projects in California and several of the Northeast states. However, several heavy-duty truck engine manufacturers have indicated that they will use SCR technology by 2010, when 100 percent of the heavy-duty diesel trucks are required to meet the NO_x limits of the 2007 heavy-duty highway rule.[134,135] Providing comment on our NPRM, locomotive and marine diesel engine manufacturers confirm that they expect to use urea-SCR catalyst systems to comply with our Tier 4 standards. While other promising NO_x-reducing technologies such as lean NO_x catalysts, NO_x adsorbers, and advanced combustion control continue to be developed (and may be viable approaches to the standards we are setting today), our analysis assumes that SCR will be the Tier 4 NO_x technology of choice in the locomotive and marine diesel engine sectors.

An SCR catalyst supports the chemical reactions which reduce nitrogen oxides in the exhaust stream to elemental nitrogen (N_2) and water by using ammonia (NH_3) as the reducing agent. The most-common method for supplying ammonia to the SCR catalyst is to inject an aqueous urea-water solution into the exhaust stream. In the presence of high-temperature exhaust gasses (>250 °C), the urea hydrolyzes to form NH_3 and CO_2. The NH_3 is stored on the surface of the SCR catalyst where it is used to complete the NO_x-reduction reaction. In theory, it is possible to achieve 100 percent NO_x conversion if the

[134] "Review of SCR Technologies for Diesel Emission Control: European Experience and Worldwide Perspectives," presented by Dr. Emmanuel Joubert, 10th DEER Conference, July 2004.
[135] Lambert, C., "Technical Advantages of Urea SCR for Light-Duty and Heavy-Duty Diesel Vehicle Applications," SAE Technical Paper 2004-01-1292, 2004.

NH_3-to-NO_x ratio (α) is 1:1 and the space velocity within the catalyst is not excessive. However, given the space limitations in packaging exhaust aftertreatment devices in mobile applications, an α of 0.85-1.0 is often used to balance the need for high NO_x conversion rates against the potential for NH_3 slip (where NH_3 passes through the catalyst unreacted). The urea dosing strategy and the desired α are dependent on the conditions present in the exhaust gas; namely temperature and the quantity of NO_x present (which can be determined by engine mapping, temperature sensors, and NO_x sensors). Overall NO_x conversion efficiency, especially under low-temperature exhaust gas conditions, can be improved by controlling the ratio of two NO_x species within the exhaust gas; NO_2 and NO. This can be accomplished through use of an oxidation catalyst upstream of the SCR catalyst to promote the conversion of NO to NO_2. The physical size and catalyst formulation of the oxidation catalyst are the principal factors that control the NO_2-to-NO ratio, and by extension, improve the low-temperature performance of the SCR catalyst.

Recent studies have shown that SCR systems are capable of providing well in excess of 80 percent NO_x reduction efficiency in high-power, diesel applications.[136,137,138] SCR catalysts can achieve significant NO_x reduction throughout much of the exhaust gas temperature operating range observed in locomotive and marine applications. Collaborative research and development activities between diesel engine manufacturers, truck manufacturers, and SCR catalyst suppliers have also shown that SCR is a mature, cost-effective solution for NO_x reduction on diesel engines in other mobile sources. While many of the published studies have focused on highway truck applications, similar trends, operational characteristics, and NO_x reduction efficiencies have been reported for marine and stationary applications as well.[139] Given the preponderance of studies and data - and our analysis summarized here and detailed in Chapter 4 of the RIA - we have concluded that this technology is appropriate for locomotive and marine diesel applications. Furthermore, locomotive and marine diesel engine manufacturers will benefit from the extensive development taking place to implement SCR technologies in advance of the heavy-duty truck NO_x standards in Europe and the U.S. The urea dosing systems for SCR, already in widespread use across many different diesel applications, are expected to become more refined, robust, and reliable in advance of our Tier 4 locomotive and marine standards. Given the predominately steady-state operating characteristics of locomotive and marine engines, SCR NO_x control strategies will certainly be capable of precisely controlling NO_x under all conditions whenever the exhaust gas temperature is greater than 250 °C.

To ensure that we have the most up-to-date information on urea-SCR NO_x technologies and their application to locomotive and marine engines, we have met with a number of locomotive and marine engine manufacturers, as well as manufacturers of

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[136] Walker, A.P. et al., "The Development and In-Field Demonstration of Highly Durable SCR Catalyst Systems," SAE 2004-01-1289.
[137] Conway, R. et al., "Combined SCR and DPF Technology for Heavy Duty Diesel Retrofit," SAE Technical Paper 2005-01-1862, 2005.
[138] "The Development and On-Road Performance and Durability of the Four-Way Emission Control SCRTTM System," presented by Andy Walker, 9th DEER Conference, August 28, 2003.
[139] Telephone conversation with Gary Keefe, Argillon, June 6, 2006.

catalytic NO_x emission control systems. Through our discussions we have learned that some engine manufacturers perceive some risk regarding urea injection accuracy and long-term catalyst durability, both of which could result in either less efficient NO_x reduction or ammonia emissions. Comments on our NPRM, submitted by the Manufacturers of Emission Controls Association (MECA), provided additional information on the issues of urea dosing accuracy, catalyst durability, and system performance and their comments are consistent with our own analysis that urea-SCR technology can provide durable control of NO_x emissions. We have carefully investigated these issues for other diesel applications and conclude that precise urea injection systems and durable catalysts already exist and have been applied to urea-SCR NO_x emission control systems which are similar to those that we expect to be implemented in locomotive and marine applications.

Urea injection systems applied to on-highway diesel trucks and diesel electric power generators already ensure the precise injection of urea, and these applications have similar—if not more dynamic—engine operation as compared to locomotive and marine engine operation. To ensure precise urea injection across all engine operating conditions, these systems utilize NO_x sensors to maintain closed-loop feedback control of urea injection. These NO_x-sensor-based feedback control systems are similar to oxygen sensor-based systems that are used with catalytic converters on virtually every gasoline vehicle on the road today. These systems, already developed for many diesel engines, are directly applicable to locomotive and marine engines as well.

(c) Durability of Catalytic PM and NO_x Emission Control Technology

Published studies indicate that SCR systems will experience very little deterioration in NO_x conversion throughout the life-cycle of a diesel engine.[140, 141] The principal mechanism of deterioration in an SCR catalyst is thermal sintering - the loss of catalyst surface area due to the melting and growth of active catalyst sites under high-temperature conditions (as the active sites melt and combine, the total number of active sites at which catalysis can occur is reduced). This effect can be minimized by design of the SCR catalyst washcoat and substrate for the exhaust gas temperature window in which it will operate. Several commenters noted that locomotives are subject to consist operation in tunnels, which results in elevated exhaust gas temperatures. Further, they speculated that these elevated exhaust temperatures could reach 700 °C – a temperature that could lead to deterioration of catalyst performance over the useful life of a locomotive. To investigate this scenario, EPA conducted a study (in cooperation with locomotive manufacturers and the railroads) in August, 2007 on Union Pacific's Norden tunnel system (between Sparks, NV and Roseville, CA).[142] We determined that the peak,

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140 Conway, R. et al., "NOx and PM Reduction Using Combined SCR and DPF Technology in Heavy Duty Diesel Applications," SAE Technical Paper 2005-01-3548, 2005.

141 Searles, R.A., et. al., "Investigation of the Feasibility of Achieving EURO V Heavy-Duty Emission Limits with Advanced Emission Control Systems," 2007 AECC Conference - Belgium, Paper Code: F02E310.

142 "Locomotive Exhaust Temperatures During High Altitude Tunnel Operation In Donner Pass," U.S. EPA, August 29, 2007. This document is available in Docket EPA-HQ-OAR-2003-0190-0736..

post-turbine exhaust gas temperature observed in the 2 trailing units of a 4-unit lead consist was only 560 °C. In light of this new information, we are more confident that catalytic aftertreatment devices will be both effective and durable when used in locomotive service.

Another mechanism for catalyst deterioration is chemical poisoning - the plugging and/or chemical de-activation of active catalytic sites. Phosphorus from the engine oil and sulfur from diesel fuel are the primary components in the exhaust stream which can de-activate a catalytic site. The risk of catalyst deterioration due to sulfur poisoning will be all but eliminated with the 2012 implementation of ULSD fuel (<15 ppm S) for locomotive and marine applications. Locomotive and marine operators will already have several years of experience running ULSD fuel by the time NO_x aftertreatment technology is required. Catalyst deterioration due to chemical poisoning can also be reduced through the use of an engine oil with lower levels of sulfated ash, phosphorous, and sulfur (commonly referred to as "low-SAPS" oil). Such an oil formulation, designed for use in 2007 DPF- and DOC-equipped on-highway, heavy-duty engines was introduced in October 2006 and is specified by the American Petroleum Institute (API) as "CJ-4."[143] This specification has new and/or lower limits on the amount of sulfated ash, phosphorous, and sulfur an oil may contain and was developed specifically for 2007 on-highway engines equipped with exhaust aftertreatment technologies running on ULSD fuel. Previous oil formulations for heavy-duty, on-highway engines, such as API CI-4, did not specify a limit for sulfur content, and allowed higher levels of phosphorous (0.14% vs. 0.12%) and ash (1.2~1.5% vs. 1.0%) content.[144]

The migration of low-SAPS engine oil properties to future locomotive and marine oil formulations – while beneficial and directionally helpful in regards to the durability, performance, and maintenance of the exhaust aftertreatment components we reference – does not affect our feasibility analysis. European truck and marine applications have shown that SCR is a durable technology even without using a low-SAPs oil formulation. One commenter suggested that these newer, low-SAPS oil formulations, developed for use in on-highway and nonroad diesel engines, may not be appropriate for locomotive or marine applications. While we acknowledge that the exact oil formulation for locomotive and marine applications using ULSD fuel is not known today, we do believe that there is adequate time to develop an appropriate oil formulation. For example, in the State of California, all intra-state locomotives, marine vessels (in the SCAQMD), and nonroad engines have been operating with ULSD fuel since June, 2006 – so there should already be field data/experience available today to begin developing an oil formulation for ULSD in advance of the implementation date for aftertreatment-forcing standards. In addition, the nonroad sector will have transitioned to ULSD fuel nationwide by June, 2010, followed by the locomotive sector in June, 2012 - again, leaving ample time to

[143] "API CJ-4 Performance Specifications," American Petroleum Institute, online at http://apicj-4.org/performance_spec.html. This document is available in Docket EPA-HQ-OAR-2003-0190-0738.
[144] "CJ-4 Performance Specification: Frequently Asked Questions," Lubrizol, online at http://www.lubrizol.com/cj-4/faq.asp. This document is available in Docket EPA-HQ-OAR-2003-0190-0741.

develop an oil formulation which does not contain any more sulphated-ash than necessary to neutralize crankcase acids.

Thermal cycling, mechanical vibration, and shock loads are all factors which can affect the mechanical durability of exhaust system components. The stresses applied to the aftertreatment devices by these factors can be managed through the selection of proper materials and the design of support and mounting structures which are capable of withstanding the shock and vibration levels present in locomotive and marine applications. One commenter to our NPRM stated that shock loading for a locomotive catalyst is estimated to be 10-12 g. This level of shock loading is consistent with the levels that catalyst substrate manufacturers, catalyst canners, and exhaust system manufacturers are currently designing to (for OEM aftertreatment systems and components subject to the durability requirements of on-highway, marine, and nonroad applications). Nonroad applications such as logging equipment are subject to shock loads in excess of 10 g and on-highway applications can exceed 30 g (with some OEM applications specifying a 75 g shock load requirement).[145] In addition, the American Bureau of Shipping (ABS) specification for exhaust manifolds on diesel engines states that these parts may need to withstand vibration levels as high as +/-10 g at 600 °C for 90 minutes.[146] Given these examples of shock and vibration requirements for today's nonroad, on-highway, and marine environments, we believe that appropriate support structures can be designed and developed for the aftertreatment devices we expect to be used on Tier 4 locomotives.

(d) Packaging of Catalytic PM and NO_x Emission Control Technologies

Locomotive manufacturers will need to design the exhaust system components to accommodate the aftertreatment system. Our analysis, detailed in the RIA, shows that the packaging requirements for the aftertreatment system are such that they can be accommodated within the envelope defined by the Association of American Railroads (AAR) Plate "L" clearance diagram for freight locomotives.[147] The typical volume required for the SCR catalyst and post-SCR ammonia slip catalyst for Euro V and U.S. 2010 heavy-duty truck applications is approximately 2 times the engine displacement, and the upstream DOC/CDPF volume is approximately 1-1.5 times the engine displacement. Due to the longer useful life and maintenance intervals required for locomotive applications, we estimate that the SCR catalyst volume will be sized at approximately 2.5 times the engine displacement, and the combined DOC/CDPF volume will be approximately 1.7 times the engine displacement. For a typical locomotive engine with 6 ft^3 of total cylinder displacement, the volume requirement for the aftertreatment components alone would be approximately 25 ft^3 (of the 80 ft^3 estimated to

[145] Correspondence from Adam Kotrba of Tenneco. This document is available in Docket EPA-HQ-OAR-2003-0190-0742.
[146] "ABS Rules for Building and Classing – Steel Vessels Under 90 Meters (295 Feet) In Length," Part 4 - Vessel Systems and Machinery, American Bureau of Shipping, 2006.
[147] "AAR Manual of Standards and Recommended Practices," Standard S-5510, Association of American Railroads.

be available for packaging these components and their associated ducts/hardware above the engine).

EPA engineers have examined Tier 2 EMD and GE line-haul locomotives and acknowledge that packaging the necessary aftertreatment components will be a difficult task. However, this task should not be more difficult (and will quite likely less so) than the packaging challenges faced by nonroad and on-highway applications. Given the space available on today's locomotives, we feel that packaging catalytic PM and NO_x emission control technologies onboard locomotives may be less challenging than packaging similar technologies onboard other mobile sources (such as light-duty vehicles, heavy-duty trucks, and nonroad equipment). Given that similar exhaust systems are either already implemented onboard these vehicles or will be implemented on these vehicles years before similar systems would be required onboard locomotives and marine vessels, we have concluded that any packaging issues will be successfully addressed early in the locomotive and marine vessel design process. Our analysis concludes that there is adequate space to package these components, as well as their associated ducts, transitions, and urea/exhaust mixing devices. This conclusion also applies to new switcher locomotives as well, which while being shorter in length than line-haul locomotives, are also equipped with smaller, less-powerful engines – resulting in smaller volume requirements for the aftertreatment components.

For commercial vessels which use marine diesel engines greater than 600 kW, we expect these vessels will be designed to accommodate the exhaust system components engine manufacturers specify as necessary to meet the new standards. Our discussions with marine architects and engineers, along with our review of vessel characteristics, leads us to conclude that for commercial marine vessels, adequate engine room space can be made available to package aftertreatment components. Packaging of these components, and analyzing their mass/placement effect on vessel characteristics, will become part of design process undertaken by marine architecture firms.[148]

We did determine, however, that for recreational vessels and for vessels equipped with engines less than 600 kW, catalytic PM and NO_x exhaust aftertreatment systems were less practical from a packaging standpoint than for the larger, commercially operated vessels. We have identified catalytic emission control systems that would significantly reduce emissions from these smaller vessels. However, after taking into consideration costs, energy, safety, and other relevant factors, we found a number of reasons, detailed in the RIA, to not adopt any new exhaust aftertreatment-forcing standards at this time on these smaller vessels. One reason is that most of these vessels use seawater-cooled exhaust systems - and even seawater injection into their exhaust systems - to cool engine exhaust gases and prevent the overheating materials such as a fiberglass hull. This current practice of cooling and seawater injection could reduce the effectiveness of catalytic exhaust aftertreatment systems. This is significantly more challenging than for gasoline catalyst systems due to much larger relative catalyst sizes

[148] Telephone conversation between Brian King, Elliot Bay Design Group, and Brian Nelson, EPA, July 24, 2006.

and cooler exhaust temperatures typical of diesel engines. In addition, because of these vessels' small size and their typical operation by planing high on the surface of the water, catalytic exhaust aftertreatment systems pose several significant packaging and weight challenges. These challenges could be addressed by the use of lightweight hull and superstructure materials. But any solution which employs new, lightweight hull and superstructure materials would have to be developed, tested and approved by classifying organizations prior to their application on vessels using catalytic exhaust aftertreatment systems. Taken together, these factors led us to conclude that it is not prudent to set aftertreatment-forcing emission standards for marine diesel engines below 600 kW at this time.

(e) Infrastructure Impacts of Catalytic PM and NO_x Emission Control Technologies

For PM trap technology the rail and marine industries will experience minimal impacts on their infrastructures. Since PM trap technology relies on no separate reductant, any infrastructure impacts will be limited to some minor changes in maintenance practices and equipment at maintenance facilities. Such maintenance will be limited to the infrequent removal of ash buildup from within a PM trap. This type of maintenance may require that maintenance facilities periodically remove PM traps for ash cleaning and may involve the use of a crane or other lifting device. We understand that much of this kind of infrastructure already exists for other locomotive and marine engine maintenance practices. We have toured shipyards and locomotive maintenance facilities at rail switchyards, and we observed that such facilities are generally already adequate for any required PM trap removal and maintenance.

We do expect some impact on the railroad and marine sectors to accommodate the use of a separate reductant for use in a NO_x SCR system. For light-duty, heavy-duty, and nonroad applications, the commonly preferred reductant in an SCR system has been a 32.5 percent urea-water solution. The 32.5 percent solution, also known as the "eutectic" concentration, provides the lowest freezing point (-11 °C or 12 °F) and ensures that the ratio of urea-to-water will not change when the solution begins to freeze.[149] Heated urea storage tanks and insulation of the urea dosing hardware onboard the locomotive (urea storage tank, pump, and lines) may be necessary to prevent freeze-up in northern climates. Locomotives and marine vessels are commonly refueled from large, centralized fuel storage tanks, tanker trucks, or tenders with long-term purchase agreements. Urea suppliers will be able to distribute urea to the locomotive and marine markets in a similar manner, or they may choose to employ multi-compartment diesel fuel/urea tanker trucks for delivery of both products simultaneously. The frequency that urea will need to be replenished is dependent on many factors; urea storage capacity, engine duty-cycle, and expected urea dosing rate for each application. We expect that locomotive manufacturers and marine vessel designers will size the urea storage tanks appropriate to the usage factors for each application plus some margin-of-safety (to reduce the probability that an engine will be operated without urea). Discussions concerning the urea infrastructure in

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[149] Miller, W. et al., "The Development of Urea-SCR Technology for US Heavy Duty Trucks," SAE Technical Paper 2000-01-0190, 2000.

North America and specifications for an emissions-grade urea solution are now under way amongst light- and heavy-duty on-highway diesel stakeholders.

Although an infrastructure for widespread transportation, storage, and dispensing of SCR-grade urea does not currently exist in the U.S., the affected stakeholders in the light- and heavy-duty on-highway and nonroad diesel sectors are expected to follow the European model, where diesel engine/truck manufacturers and fuel refiners/distributors have formed a collaborative working group known as “AdBlue.” The goal of the AdBlue organization is to resolve potential problems with the supply, handling, and distribution of urea and to establish standards for product purity.[150] With regard to urea production capacity, the U.S. has more-than-sufficient capacity to meet the additional needs of the rail and marine industries. For example, in 2003, the total diesel fuel consumption for Class I railroads was approximately 3.8 billion gallons.[151] If 100 percent of the Class I locomotive fleet were equipped with SCR catalysts, approximately 190 million gallons-per-year of 32.5 percent urea-water solution would be required.[152] It is estimated that 190 million gallons of urea solution would require 0.28 million tons of dry urea (1 ton dry urea is needed to produce 667 gallons of 32.5 percent urea-water solution). Currently, the U.S. consumes 14.7 million tons of ammonia resources per year, and relies on imports for 41 percent of that total (of which, urea is the principal derivative). In 2005 domestic ammonia producers operated their plants at 66 percent of rated capacity, resulting in 4.5 million tons of reserve production capacity.[153] In the very long-term situation above, where 100 percent of the locomotive fleet required urea, only 6.2 percent of the reserve domestic capacity would be needed to satisfy the additional demand. A similar analysis for the marine industry, with a yearly diesel fuel consumption of 2.2 billion gallons per year, would not significantly impact the urea demand-to-reserve capacity equation. Since the rate at which urea-SCR technology is introduced to the railroad and marine markets will be gradual - and the reserve urea production capacity is more-than-adequate to meet the expected demand from all diesel markets in the 2017 timeframe – EPA does not project any urea cost or supply issues, beyond the costs estimated in the RIA, will result from implementing the Tier 4 standards.

(f) Unregulated Pollutants

There is potential for the formation of unregulated pollutants of significant concern to EPA any time engine technologies change, including when new emission control technologies are added. Some examples of these unregulated pollutants include N_2O and ammonia (NH_3). In addition, failure to dose urea in SCR system while operating under load may cause elevated NO_2 emissions. Similarly, use of a CDPF that produces NO_2 in excess of what is needed for passive regeneration - and operated without

[150] “Ensuring the Availability and Reliability of Urea Dosing for On-Road and Non-Road,” presented by Glenn Barton, Terra Corp., 9th DEER Conference, August 28, 2003.
[151] "National Transportation Statistics - 2004," Table 4-5, U.S. Bureau of Transportation Statistics.
[152] Assuming the dosing rate of 32.5 percent urea-water solution is 5 percent of the total fuel consumed; 3.8 billion gallons of diesel fuel * 0.05 = 190 million gallons of urea-water solution.
[153] "Mineral Commodity Summaries 2006," page 118, U.S. Geological Survey, online at www.minerals.usgs.gov/minerals/pubs/mcs/mcs2006.pdf

a downstream SCR system - may lead to elevated NO_2 emissions. Such increased NO_2 emissions could be a concern for operation in enclosed environments such as locomotive operation in minimally ventilated or unventilated tunnels. Similarly, use of NO_x reduction catalysts with poor selectivity could result in elevated N_2O emissions. An aggressive urea dosing strategy within an SCR system (for high levels of NO_x control) without a properly designed/calibrated feedback control system, ammonia slip catalyst, or adequate exhaust/urea mixing could also result in elevated ammonia (NH_3) emissions. These NH_3 emissions, which can be minimized through the use of closed-loop feedback and control of urea injection, can be all-but-eliminated through use of an oxidation catalyst downstream of the SCR catalyst. Such catalysts, commonly referred to a "slip catalysts," are in use today and have been shown to be highly effective at eliminating ammonia emissions.[154]

The issue of NH_3 emissions (or ammonia slip) was raised by several commenters, with claims that excessive NH_3 emissions are "inevitable", and may reach 25 ppm during steady-state operation and 100 ppm during transient operation. We have assessed this issue and concluded that a properly-designed slip catalyst, with good selectivity to nitrogen (N_2), can convert most of the excess NH_3 released from the SCR catalyst into N_2 and water. Recent studies by the Johnson Matthey and the Association for Emissions Control by Catalyst (AECC) have shown that an aged SCR system equipped with a slip catalyst can achieve tailpipe NH_3 levels of less of than 10 ppm when tested on the European Stationary Cycle (ESC) and European Transient Cycle (ETC).[154,155] The SCR system in the Johnson Matthey study was aged on a cycle which included 400 hours of high-temperature operation at 650 °C (to simulate active DPF regeneration events). Our analysis of the locomotive engine operating conditions presumes a maximum, post-turbine exhaust temperature of 560 °C. This presumption is based on implementation of a "passive" DPF regeneration approach (in which NO_2 created by the oxidation catalyst is sufficient to oxidize trapped soot) and our own testing of locomotives during consist operation in non-ventilated tunnels.[142] Under these conditions, we expect slip catalysts to be durable and effective in reducing NH_3 slip.

We expect manufacturers to be conscious of these possibilities and to take appropriate action to minimize or prevent the formation of unregulated pollutants when designing emission control systems. Manufacturers must comply with the "Prohibited Controls" section of 40 CFR 1033.115 (c), which states:

"You may not design or produce your locomotives with emission control devices, systems, or elements of design that cause or contribute to an unreasonable risk to public health, welfare, or safety while operating. For example, this would apply if the locomotive emits a noxious or toxic substance it would otherwise not emit that contributes to such an unreasonable risk."

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[154] Smedler, Gudmund, "NOx Emission Control Options", 2007 HDD Emission Control Symposium – Gothenberg, Sweden, September 11, 2007.
[155] Searles, R.A., et. al., "Investigation of Feasibility of Achieving EURO V Heavy-Duty Emission Limits with Advanced Emission Control Systems," 2007 AECC Conference – Belgium, Paper Code: F02E310.

Emission control systems designed to meet the 2007 and 2010 heavy-duty truck and Tier 2 light-duty vehicle emission standards already take these unregulated pollutants into account through compliance with Section 202 (A)(4) of the Clean Air Act. CDPF systems that minimize formation of excess NO_2 while still relying primarily on passive regeneration have entered production for OEM and retrofit applications. Compact urea-SCR systems that have been developed to meet the U.S. 2010 heavy-duty truck standards use closed-loop controls that continuously monitor NO_x reduction performance. Such systems have the capability to control stack emissions of NH_3 to below 5 ppm during transient operation even without the use of an ammonia slip catalyst. We understand that such systems may still emit some very small level of uncontrolled pollutants and we would not generally consider a system that releases de minimis amounts of NH_3 or N_2O while employing technology consistent with limiting these emissions to be in violation of §1033.115 (c) – which is the same way we currently treat passenger cars and heavy-duty trucks with regard to N_2O and H_2S emissions.

(4) The New Standards are Technologically Feasible

Our rulemaking involves a range of engines, and we have identified a range of technologically feasible emission control technologies that we project will be used to meet our new standards. Some of these technologies are incremental improvements to existing engine components, and many of these improved components have already been applied to similar engines. The other technologies we identified involve catalytic exhaust aftertreatment systems. For these technologies we carefully examined the catalyst technology, its applicability to locomotive and marine engine packaging constraints, its durability with respect to the lifetime of today's locomotive and marine engines, and its impact on the infrastructure of the rail and marine industries. From our analysis, which is presented in detail in our RIA, we conclude that incremental improvements to engine components and the implementation of catalytic PM and NO_x exhaust aftertreatment technology will be feasible to meet our new emissions standards.

IV. Certification and Compliance Program

This section describes the regulatory changes being finalized for the locomotive and marine compliance programs, beyond the standards discussed in section III. The most obvious change is that the regulations have been written in plain language. They are structured to contain the provisions that are specific to locomotives in a new part 1033 and the provisions that are specific to marine engines and vessels in a new part 1042. We also proposed to apply the general provisions of existing parts 1065 and 1068.[156] The plain language regulations, however, are not intended to significantly change the compliance program, except as specifically noted in today's notice. These plain language regulations will supersede the regulations in part 92 and 94 (for Categories 1 and 2) as early as the 2008 model year. See section III for the starting dates

[156] We proposed modifications to the existing provisions of 40 CFR part 1068 on May 18, 2007 (72 FR 28097). Readers interested in the compliance provisions that will apply to locomotives and marine diesel engines should also read the actual regulatory changes in that will be finalized in that rulemaking.

for different engines. The changes from the existing programs are described below briefly along with other notable aspects of the compliance program. See the regulatory text for the detailed requirements and see the Summary and Analysis of Comments document for a more complete rationale for the changes being adopted. Note: The term manufacturer is used in this section to include locomotive and marine manufacturers and remanufacturers.

A. Issues Common to Locomotives and Marine

For many aspects of compliance, we are adopting similar provisions for marine engines and locomotives, which are discussed in this section. Several other issues are also included in this section, where we are specifying different provisions, but where the issues are similar in nature. The remaining compliance issues are discussed in sections IV. B. (for locomotives) and IV. C. (for marine).

(1) Test Procedures

(a) Incorporation of Part 1065 Test Procedures for Locomotive and Marine Diesel Engines

As part of our initiative to update the content, organization and writing style of our regulations, we are revising our test procedures. We have grouped all of our engine dynamometer and field testing test procedures into one part entitled, "Part 1065: Test Procedures." For each engine or vehicle sector for which we have recently promulgated standards (such as land-based nonroad diesel engines or recreational vehicles), we identified an individual part as the standard-setting part for that sector. These standard-setting parts then refer to one common set of test procedures in part 1065. These programs regulate land-based on-highway heavy-duty engines, land-based nonroad diesel engines, recreational vehicles, and nonroad spark-ignition engines over 19 kW. In this rule, we are applying part 1065 to all locomotive and marine diesel engines, as part of plan to eventually have all our engine programs refer to a common set of procedures.

In the past, each engine or vehicle sector had its own set of testing procedures. There are many similarities in test procedures across the various sectors. However, as we introduced new regulations for individual sectors, the more recent regulations featured test procedure updates and improvements that the other sectors did not have. As this process continued, we recognized that a single set of test procedures allows for improvements to occur simultaneously across engine and vehicle sectors. A single set of test procedures is easier to understand than trying to understand many different sets of procedures, and it is easier to move toward international test procedure harmonization if we only have one set of test procedures. We note that procedures that are particular for different types of engines or vehicles, for example, test schedules designed to reflect the conditions expected in use for particular types of vehicles or engines, remain separate and are reflected in the standard-setting parts of the regulations.

The part 1065 test procedures are organized and written to be clearer than locomotive- and marine-specific test procedures found in parts 92 and 94. In addition, part 1065 improves the content of the respective testing specifications, including the following:

- Specifications and calculations written in the international system of units (SI)
- Procedures by which manufacturers can demonstrate that alternate test procedures are equivalent to specified procedures.
- Specifications for new measurement technology that has been shown to be equivalent or more accurate than existing technology
- Procedures that improve test repeatability
- Calculations that simplify emissions determination
- New procedures for field testing engines
- More comprehensive sets of definitions, references, and symbols
- Calibration and accuracy specifications that are scaled to the applicable standard, which allows us to adopt a single specification that applies to a wide range of engine sizes and applications.

We are adopting the lab-testing and field-testing specifications in part 1065 for all locomotive and marine diesel engines. These procedures replace those currently published in parts 92 and 94. We are making a gradual transition from the part 92 and 94 procedures. In general, we specify that manufacturers use the test procedures in 1065 when certifying under part 1033 or 1042. However, we will allow manufacturers to use a combination of the old and new test procedures through 2014, provided such use is done using good engineering judgment. Moreover, manufacturers may continue to rely on carryover test data based on part 92 or 94 procedures to recertify engine families that are not changing.

In the future, we may apply the test procedures specified in part 1065 to other types of engines, so we encourage companies involved in producing or testing other engines to stay informed of developments related to these test procedures.

(b) Revisions to Part 1065

Part 1065 was originally adopted on November 8, 2002 (67 FR 68242) and was initially applicable to standards regulating large nonroad spark-ignition engines and recreational vehicles under 40 CFR parts 1048 and 1051. The test procedures initially adopted in part 1065 were sufficient to conduct testing, but on July 13, 2005 (70 FR 11534) we promulgated a final rule that reorganized these procedures and added content to make various improvements. Today, we are finalizing additional modifications, largely as proposed. The reader is referred to the NPRM, the regulatory text, and the docket for more information about the changes being made to Part 1065 in this final rule. Note that since part 1065 applies for diesel engines subject to parts 86 and 1039, we are also making some minor revisions to those parts to reflect the changes being made to part 1065. (We are also making a technical correction to an equation in §86.117-96.)

These changes will become effective [INSERT DATE 60 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]. Section 1065.10(c)(6) of the existing regulations includes a provision that automatically allows manufacturers an additional 12 months beyond the effective date to revise their test procedures to comply with the new regulations. Since these changes will not affect the stringency of the standards, we also plan to use our authority under § 1065.10(c)(4) to allow the use of carryover data collected using the earlier procedures.

(2) Certification Fuel

It is well-established that measured emissions may be affected by the properties of the fuel used during the test. For this reason, we have historically specified allowable ranges for test fuel properties such as cetane and sulfur content. These specifications are intended to represent most typical fuels that are commercially available in use. This helps to ensure that the emissions reductions expected from the standards occur in use as well as during emissions testing.

In our previous regulation of in-use locomotive and marine diesel fuel, we established a 15 ppm sulfur standard at the refinery gate for locomotive and marine (LM) diesel fuel beginning June 1, 2012. However, since we intended to allow the sale, distribution, and use of higher sulfur LM diesel fuel (such as contaminated ULSD) to continue indefinitely, we did not set a “hard and fast” downstream requirement that only 15 ppm LM diesel may be sold and distributed in all areas of the country . Because refiners cannot intentionally produce off-specification fuel for locomotives, most in-use locomotive and marine diesel fuel will be ULSD (with a sulfur content of 15 ppm or less). Nevertheless, we expect that some fuel will be available with sulfur levels between 15 and 500 ppm, and our existing regulations require that such fuel be designated as 500 ppm sulfur diesel fuel. Note that fuel designated as 500 ppm sulfur is also known as low sulfur diesel fuel (LSD)

Because we have reduced the upper limit for locomotive and marine diesel fuel sulfur content for refiners to 15 ppm in 2012, we are establishing new ranges of allowable sulfur content for diesel test fuels. See section IV. C. (8) for information about testing marine engines designed to use residual fuel. For marine diesel engines, we are specifying the use of ULSD fuel as the test fuel for Tier 3 and later standards. We believe this will correspond to the fuels that these engines will see in use over the long term. We recognize that this approach will mean that some marine engines will use a test fuel that is lower in sulfur than in-use fuel during the first few years and that other Tier 2 marine engines allowed to be produced after 2012 will use a test fuel that is higher in sulfur than fuel already available in use when they are produced. However, we believe that it is more important to align changes in marine test fuels with changes in the PM standards than strictly with changes in the in-use fuel. Nevertheless, we are allowing Tier 2 certification with fuel meeting the 7 to 15 ppm sulfur specification to simplify testing but will require that PM emissions be corrected to be equivalent to testing conducted with the specified fuel. This will ensure that the effective stringency of the Tier 2 standards will not be affected.

For locomotives, we will require that Tier 4 engines be certified based on ULSD test fuels. We are also requiring that these locomotives use ULSD in the field. We will continue to allow the use of 500 ppm LM diesel fuel, in older locomotives in the field.[157] Thus, we are requiring that remanufacture systems for Tier 0 and Tier 1 locomotives be certified on LSD test fuel. We are allowing the use of test fuels other than those specified here. Specifically, we will allow the use of ULSD during emission testing for locomotives otherwise required to use LSD, provided they do not use sulfur-sensitive technology (such as oxidation catalysts). However, as a condition of this allowance, the manufacturer will be required to add an additional amount to the measured PM emissions to make them equivalent to what would have been measured using LSD. For example, we will allow a manufacturer to test with ULSD if they adjusted the measured PM emissions upward by 0.01 g/bhp-hr (which would be a relatively conservative adjustment and would ensure that manufacturers would not gain an inappropriate advantage by testing on ULSD).

We are adopting special fuel provisions for Tier 3 locomotives and Tier 2 locomotive remanufacture systems. The final regulations specify that the test fuel for these be ULSD without sulfur correction since these locomotives will use ULSD in use for most of their service lives. However, unlike Tier 4 locomotives, we will not require them to be labeled to require the use of ULSD, unless they included sulfur sensitive technology.

We are adopting a new flexibility for locomotives and Category 2 marine engines to reduce fuel costs for testing. Because these engines can consume 200 gallons of diesel fuel per hour at full load, fuel can represent a significant fraction of the testing cost, especially if the manufacturer must use specially blended fuel rather than commercially available fuel. To reduce this cost, we will allow manufacturers to immediately begin testing of locomotives and Category 2 marine engines with commercially available diesel fuel. We do not believe that this will change the effective stringency of the standards.

For both locomotive and marine engines, all of the specifications described above will apply to emission testing conducted for certification, production-line testing, and in-use, as well as any other testing for compliance purposes for engines in the designated model years. Any compliance testing of previous model year engines will be done with the fuels designated in our regulations for those model years.

(3) Supplemental emission standards

We are continuing the supplemental emission standards for locomotives and marine engines. For locomotives, this means we will continue to apply notch emission

[157] Under our existing fuel regulations (40 CFR 80.510(g)), 500 ppm LM diesel fuel may not be sold and/or distributed in the Northeast/Mid-Atlantic (NE/MA) area beginning October 1, 2012. Such fuel may no longer be used in the NE/MA area beginning December 1, 2012.

caps, based on the emission rates in each notch, as measured during certification testing. We recognize that for our Tier 4 standards it will not be practical to measure very low levels of PM emissions separately for each notch during testing, and thus we are changing the calculation of the PM notch cap for Tier 4 locomotives. All other notch caps will be determined and applied as they currently are under 40 CFR 92.8(c). See §1033.101(e) of the regulations for the detailed calculation.

Marine engines will continue to be subject to not-to-exceed (NTE) standards; however, we are making certain changes to these standards based upon our understanding of in-use marine engine operation and based upon the underlying Tier 3 and Tier 4 duty cycle emissions standards. As background, we determine NTE compliance by first applying a multiplier to the duty-cycle emission standard, and then we compare to that value an emissions result that is recorded when an engine runs within a certain range of engine operation. This range of operation is called an NTE zone (see 40 CFR 94.106). The first regulation of ours that included NTE standards was the commercial marine diesel regulation, finalized in 1999. After we finalized that regulation, we promulgated other NTE regulations for both heavy-duty on-highway and nonroad diesel engines. We also finalized a regulation that requires heavy-duty on-highway engine manufacturers to conduct field testing to demonstrate in-use compliance with the on-highway NTE standards. Throughout our development of these other regulations, we have learned many details about how best to specify NTE zones and multipliers that will ensure the greatest degree of in-use emissions control, while at the same time will avoid disproportionately stringent requirements for engine operation that has only a minor contribution to an engine's overall impact on the environment. Based upon the Tier 3 and Tier 4 standards—and our best information of in-use marine engine operation—we are making certain improvements to our marine NTE standards.

For marine engines we are broadening the NTE zones in order to better control emissions in regions of engine operation where an engine's emissions rates (i.e. grams/hour, tons/day) are greatest; namely at high engine speed and high engine load. This is especially important for commercial marine engines because they typically operate at steady-state at high-speed and high-load operation. This change also will make our marine NTE zones much more similar to our on-highway and nonroad NTE zones. Additionally, we analyzed different ways to define the marine NTE zones, and we determined a number of ways to improve and simplify the way we define and calculate the borders of these zones. We feel that these improvements will help clarify when an engine is operating within a marine NTE zone.

Note that we specify different duty cycles to which a marine engine may be certified, based upon the engine's specific application (e.g., fixed-pitch propeller, controllable-pitch propeller, constant speed, auxiliary, etc.). These duty cycles are described below in section IV. C. (9) . Correspondingly, we also have a unique NTE zone for each of these duty cycles. These different NTE zones are intended to best reflect an engine's real-world range of operation for that particular application. One primary change in the NTE zones, compared to the NPRM, is for controllable-pitch propeller applications. Rather than using the nonroad NTE zone, as proposed, the final NTE zone for these engines has been revised to better reflect marine engine operation. Please refer to section 1042.101(c) of the new regulations for a description of our new NTE standards. In the cases where marine auxiliary engines use the same duty cycle as their land-based nonroad counterparts, we are adopting the same NTE standards as we have already finalized for nonroad engines in 40CFR §1039.101. As the standards for marine diesel engines under 75 kW are based on the corresponding nonroad engine standards, we are aligning the NTE standard start dates for these engines with the nonroad engine NTE start dates in 2012 and 2013.

We are also implementing new NTE multipliers. We have analyzed how the Tier 3 and Tier 4 emissions standards affect the stringency of the marine NTE standards, especially in comparison to the stringency of the underlying duty cycle standards. We recognized that in certain sub-regions of our new NTE zones, slightly higher multipliers are necessary because of the way that our more stringent Tier 3 and Tier 4 emissions standards will affect the stringency of the NTE standards. For comparison, Tier 2 marine NTE standards contain multipliers that range in magnitude from 1.2 to 1.5 times the corresponding duty cycle standard. The new multipliers range from 1.2 to 1.9 times the standard. Even with these slightly higher NTE multipliers, we are confident that our changes to the marine NTE standards will ensure the greatest degree of in-use emissions control. We are also confident that our changes to the marine NTE standards will continue to ensure proportional emissions reductions, across the full range of marine engine operation.

We are also adopting other NTE provisions for marine engines that are similar to our existing heavy-duty on-highway and nonroad diesel NTE standards. We are making these particular changes to account for the implementation of catalytic exhaust treatment devices on marine engines. One such provision is to account for when a marine engine rarely operates within a limited region of the NTE zone (i.e. less than 5 percent of in-use operation). Another provision allows small deficiencies in NTE compliance for a limited period of time. We feel that these provisions have been effective in our on-highway and nonroad NTE programs; therefore, we are adopting them for our marine NTE standards as well.

(4) Emission Control Diagnostics

We requested comment on a requirement that all Tier 4 engines include a simple engine diagnostic system to alert operators to general emission-related malfunctions. As is described in the S&A document, we are not adopting such general requirements today. (See section 0of this Final Rule for related requirements involving SCR systems.) We are, however, adopting special provisions for locomotives that include emission related diagnostics. First, we will require locomotive operators to respond to malfunction indicators by performing the required maintenance or inspection. Second, locomotive manufacturers will be allowed to repair such malfunctioning locomotives during in-use compliance testing (they would still be required to include a description of the malfunction in the in-use testing report.). This approach takes advantage of the unique market structure with two major manufacturers and only a few railroads buying nearly all of the freshly manufactured locomotives. These provisions create incentives for both the manufacturers and railroads to work together to develop a diagnostic system that would effectively reveal real emission malfunctions. Our current regulations already require that locomotive operators complete all manufacturer-specified emission-related maintenance, and this new requirement treats repairs indicated by diagnostic systems as such emission-related maintenance. Thus, the railroads will have a strong incentive to make sure that they only have to perform this additional maintenance when real malfunctions are occurring. On the other hand, manufacturers will want to have all emission malfunctions revealed so that when they test an in-use locomotive they can repair identified malfunctions before testing if the railroad has not yet done it.

(5) Monitoring and Reporting of Emissions Related Defects

We are applying the defect reporting requirements of §1068.501 to replace the provisions of subparts E in parts 92 and 94. This will result in two significant changes for manufacturers. First, §1068.501 obligates manufacturers to tell us when they learn that emission control systems are defective and to conduct investigations under certain circumstances to determine if an emission-related defect is present. Second, it changes the thresholds after which they must submit defect reports. See the text 40 CFR 1068.501 for details about this requirement.

(6) Rated Power

We are specifying in parts 1033 and 1042 how to determine maximum engine power in the regulations for both locomotives and marine engines. The term "maximum engine power" will be used for marine engines instead of previously undefined terms such as "rated power" or "power rating" to specify the applicability of the standards. The addition of this definition is intended to allow for more objective applicability of the standards. More specifically, for marine engines, we define maximum engine power to mean the maximum brake power output on the nominal power curve for an engine.

For locomotives, the term "rated power" will continue to be used, but is explicitly defined to be the brakepower of the engine at notch 8. We will continue to use the term “rated power” because this definition is consistent with the commercial meaning of the term.

(7) In-use Compliance for SCR Operation

As discussed in section III.C, we are projecting that manufacturers will use urea-based SCR systems to comply with the Tier 4 emission standards.[158] These systems are very effective at controlling NO_x emissions as long as the operator continues to supply urea of acceptable quality. Thus we considered concepts put forward by manufacturers in other mobile source sectors in dealing with this issue. These include design features to prevent an engine from being operated without urea if an operator ignores repeated warnings and allows the urea level to run too low. EPA has issued a guidance document for urea SCR systems discussing the use of such features on highway diesel vehicles.

[158] The provisions described in this section will apply equally to SCR systems using reductants other than urea, except for systems using normal diesel fuel as the reductant.

We believe that the nature of the locomotive and large commercial marine sectors supports a different in-use compliance approach. This approach focuses on requirements for operators of locomotives and marine diesel engines that depend on urea SCR to meet EPA standards, aided by onboard alarm and logging mechanisms that engine manufacturers will be required to include in their engine designs. Except in the rare instance that operation without urea may be necessary, the regulatory provisions put no burden on the end-user beyond simply filling the urea tank with appropriate quality urea. Specifically, we are specifying:

- That it is illegal to operate without acceptable quality urea when the urea is needed to keep the SCR system functioning properly;

- That manufacturers must include clear and prominent instructions to the operator on the need for, and proper steps for, maintaining urea, including a statement that it is illegal to operate the engine without urea;

- That manufacturers must include visible and audible alarms at the operator's console to warn of low urea levels or inadequate urea quality;

- That engines and locomotives must be designed to track and log, in nonvolatile computer memory, all incidents of engine operation with inadequate urea injection or urea quality; and

- That operators must report to EPA in writing any incidence of operation with inadequate urea injection or urea quality within 30 days of each incident, and

- That, when requested, locomotive and vessel operators must provide EPA with access to, and assistance in obtaining information from, the electronic onboard incident logs

We understand that in extremely rare circumstances, such as during a temporary emergency involving risk of personal injury, it may be necessary to operate a vessel or locomotive without adequate urea. We would intend such extenuating circumstances to be taken into account when considering what penalties or other actions are appropriate as a result of such operation. The information from SCR compliance monitoring systems described above may also be useful for state and local air quality agencies and ports to assist them in any marine engine compliance programs they implement.

Our new regulations specify that what constitutes acceptable urea solution quality be specified by the manufacturers in their maintenance instructions and require that the certified emission control system must meet the emissions standards with any urea solution within stated specifications. This could be facilitated by an industry standard for urea quality, which we expect will be generated in the future as these systems move closer to market. We recognize that this will likely require automated sensing of some characteristic indicator such as urea concentration or exhaust NO_x concentration.

We believe these provisions can be an effective tool in ensuring urea use for locomotives and large commercial marine vessels because of the relatively small number of railroads and operators of large commercial vessels in the U.S., especially considering that the number of SCR-equipped locomotives and vessels will ramp up quite gradually over time. In-use compliance provisions of the sort we are adopting for locomotives and large commercial marine engines would be much less effective in other mobile source sectors such as highway vehicles because successful enforcement involving millions of vehicle owners would be extremely difficult. In addition, the highway and nonroad diesel sectors are characterized by a wide variety of applications and duty cycles, which further differentiate in-use compliance approaches that may make sense in the relatively uniform rail and marine sectors from those that would be effective in the highway and nonroad sectors.

(8) Temporary In-Use Compliance Margins

Consistent with the approach we took in the highway heavy-duty rule (66 FR 5113) and nonroad diesel rule (69 FR 38957), we are adopting a provision for in-use compliance flexibility in the initial years of the Tier 4 program. We proposed to allow adjusted in-use compliance standards for the first three model years of the Tier 4 locomotive standards to help assure the manufacturers that they will not face recall if they exceed standards by a small amount during this transition to advanced clean diesel technologies.

Commenters suggested that the reasons we gave for applying this provision to locomotives were valid for marine engines too. We agree and are extending this provision to Tier 4 marine diesel engines. Commenters also argued that we over-emphasized the flexibility needed for NO_x technology compared to PM technology. In response, we have concluded that it is appropriate to provide an alternative set of margins available to manufacturers willing to accept more stringent in-use compliance levels for NO_x in exchange for somewhat less stringent levels for PM.

Table IV-1 shows the in-use adjustments that we will apply. These adjustments would be added to the appropriate standards or FELs in determining the in-use compliance level for a given in-use hours accumulation. Our intent is that these add-on levels be available only for highly-effective advanced technologies such as particulate traps and SCR, and so we will apply them only to engines certified at or below the Tier 4 standards without the use of credits, through the first three model years of the new standards. As part of the certification process, manufacturers will still be required to demonstrate compliance with the unadjusted Tier 4 certification standards using deteriorated emission rates. Therefore manufacturers will not be able to use these in-use adjustments in setting design targets for the engine. They need to project that engines will meet the standards in use without adjustment. The in-use adjustments merely provide some assurance that they will not be forced to recall engines because of some small miscalculation of the expected deterioration rates.

Also, to avoid what would essentially be a doubling up of the benefits of the two alternatives, contrary to their purpose, we are requiring that a manufacturer may only use the alternative set of add-ons for an engine family if this choice is indicated in the certification application and may not reverse this choice in carry-over certifications or certifications by design.

Table IV-1 In-Use Add-Ons (g/bhp-hr)

For useful life fractions	Primary Set		Alternative Set	
	NO_x	PM	NOx	PM
<50% UL	0.7	0.01	0.2	0.03
50%-75% UL	1.0		0.3	
>75% UL	1.3		0.4	

As discussed in section III.B(1)(a)(ii), in response to industry comments, we are providing another Tier 4 NO_x compliance option for line-haul locomotives with a reduced in-use NO_x add-on of 0.6 g/bhp-hr. Under this option, for the first 8 model years of Tier 4 (2015-2022), a line-haul locomotive manufacturer may certify a locomotive to the 1.3 g/bhp-hr NO_x standard without needing to calculate or apply a deterioration factor. These locomotives, when tested in-use must comply with an in-use standard of 1.9 g/bhp-hr but do not get the additional NO_x compliance margins discussed above.

Because this option is meant to address manufacturer concerns about manufacturing variability as well as catalyst durability, we are allowing manufacturers using this option to substitute an in-use locomotive test for each required production line test. These tests must be conducted on locomotives with more than 50 hours of accumulated operation, but at less than one-half of their useful life, and are in addition to normally-required manufacturer in-use testing. Furthermore, locomotives certified under this option may not generate credits under the ABT program because of their potentially higher in-use emissions. Also, of course, they may not be purposely designed to emit regulated pollutants at higher levels in use than at certification. This option will be available through the 2022 model year. It will not be available for the 2015-2022 model year locomotives when they are remanufactured in 2023 or later.

(9) Fuel Labels and Misfueling

The advanced emission controls that will be used to comply with many of the new standards will require the use of ULSD. Therefore, we are requiring that manufacturers notify each purchaser of a Tier 4 locomotive or marine engine that it must be fueled only with the ultra low-sulfur diesel fuel meeting our regulations. We are also applying this requirement for locomotives and engines having sulfur-sensitive technology and certified using ULSD. All of these locomotives and vessels must be labeled near the refueling inlet to say: “Ultra-Low Sulfur Diesel Fuel Only”. These labels are required to be affixed or updated any time any engine on a vessel is replaced after the new program goes into effect.

We are requiring the use of ULSD in locomotives and vessels labeled as requiring such use, including all Tier 4 locomotives and marine engines. More specifically, use of the wrong fuel for locomotives or marine engines would be a violation of 40 CFR

1068.101(b)(1) because use of the wrong fuel would have the effect of disabling the emission controls.

We addressed the supply of ultra-low sulfur fuel in our previous regulation of in-use locomotive and marine diesel fuel. Specifically, we established a 15 ppm sulfur standard at the refinery gate for locomotive and marine (LM) diesel fuel beginning June 1, 2012. However, since we allow the sale, distribution, and use of 500 ppm LM diesel fuel to continue indefinitely, we did not set a "hard and fast" downstream requirement that only 15 ppm LM diesel may be sold and distributed in all areas of the country[159]. This was to allow the LM diesel fuel pool to remain an outlet for off-specification distillate product and interface/transmix material. Because refiners cannot intentionally produce off-specification fuel for locomotives—refiners will no longer be able to produce nonroad, locomotive, or marine diesel fuel above 15 ppm beginning June 1, 2012—most in-use locomotive and marine diesel fuel will be ULSD (with a sulfur content of 15 ppm or less). Nevertheless, we expect that some fuel will be available with sulfur levels between 15 and 500 ppm, and our regulations require such fuel to be designated as 500 ppm sulfur diesel fuel.

We received comments regarding the fact that we did not set a strict downstream requirement on the use of 15 ppm LM for the entire country. The commenters feared that while a port might receive deliveries of 15 ppm LM fuel, the port might keep its pump labeled as "500 ppm LM" to allow it to receive and dispense either 15 ppm or 500 ppm LM. (As part of the diesel fuel regulations, all pumps dispensing diesel fuel must be labeled with the type and maximum sulfur level of the diesel fuel being dispensed.) The commenters were concerned that if such practice were widespread, marine vessels that require ULSD could potentially have problems finding it.

We understand the commenters' concerns and have discussed a few potential solutions to this problem. One possible option is to require large ports (i.e., ports over some certain size) to make 15 ppm LM diesel fuel available. This size requirement could be by volume of single sale or above some other specified volume. Under this requirement, those ports with multiple tanks could continue to offer 500 ppm LM diesel fuel in addition to the 15 ppm LM diesel fuel. Or, if a port (regardless of size) continues to sell 500 ppm LM diesel fuel, it must also sell 15 ppm LM diesel fuel. Another potential option would be to limit the sale of 500 ppm LM diesel fuel to small ports and locomotives only. However, these potential solutions would need to be discussed thoroughly with all stakeholders (including those in the fuel distribution and marketing industry) and put out for notice and comment. Therefore, we are merely noting potential solutions in this final rule but we are committing to investigate this issue further and, if the facts warrant doing so, addressing it in a separate action.

[159] However, in the Northeast/Mid-Atlantic (NE/MA) area, as defined at 40 CFR 80.510(g), 500 ppm LM diesel fuel may no longer be sold and/or distributed beginning October 1, 2012. Such fuel may no longer be used in the NE/MA area beginning December 1, 2012.

(10) Deterioration Factor Plan Requirements

In this rulemaking, we are amending our deterioration factor (DF) provisions to include an explicit requirement that DF plans be submitted by manufacturers for our approval in advance of conducting engine durability testing, or in the case where no new durability testing is being conducted, in advance of submitting the engine certification application. We are not fundamentally changing either the locomotive or marine engine DF requirements with this provision, other than to require advance approval.

An advance submittal and approval format will allow us sufficient time to ensure consistency in DF procedures, without the need for manufacturers to repeat any durability testing or for us to deny an application for certification should we find the procedures to be inconsistent with the regulatory provisions. We expect that the DF plan would outline the amount of service accumulation to be conducted for each engine family, the design of the representative in-use duty cycle on which service will be accumulated, and the quantity of emission tests to be conducted over the service accumulation period.

(11) Production Line Testing

We proposed to continue the existing production line testing provisions that apply to manufacturers. Some manufacturers suggested that we should eliminate this requirement on the basis that very low noncompliance rates are being detected at a high expense. While we agree that compliance rates have been very good, we do not agree that they mean that the program has little or no value. As we move toward more stringent emission standards with this rulemaking, we anticipate that the margin of compliance with the standards for these engines is likely to decrease. Consequently, this places an even greater significance on the need to ensure little variation in production engines from the certification engine, which is often a prototype engine. For this reason, it is important to maintain our production line testing program.

However, the existing regulations allow manufacturers to develop alternate programs that provide equivalent assurance of compliance on the production line and to use such programs instead of the specified production line testing program. For example, given the small sales volumes associated with marine engines it may be appropriate to include a production a verification program for marine engines as part of a manufacturer’s broader production verification programs for its non-marine engines. We believe these existing provisions already address the concerns raised to us by the manufacturers.

We are adding provisions to allow manufacturers to use special procedures for production line testing of catalyst-equipped engines. Under the existing Part 92 and Part 94 programs, a manufacturer of a catalyst-equipped locomotive or Category 2 marine engine would be required to assemble and test the engine with a complete catalyst system. At the manufacturer’s choice, the engine could be broken in by operating it for up to 300 hours or it could be tested in a “green” state and its measured emissions adjusted by applying “green engine factors”. The new regulations in Parts 1033 and 1042 will continue to allow these options, but will also include additional options.

For locomotives, the new regulations will allow a locomotive to be used in service for up to 1,000 hours before it is tested. This will be sufficient time to degreen a catalyst. We believe that this approach should work well for locomotives given the very close working relationships between the manufacturers and the major railroads. (See section IV. A. (8) for additional interim provisions related to production-line testing of locomotives.)

We do not believe this locomotive approach would work for marine engines because the marine market is much more diverse and the very close working relationships cannot be assumed. Therefore, we will rely on our general authority to approve alternate PLT programs. Should a consensus develop in the future about how to appropriately verify that engines and catalysts are produced to conform to the regulations, we may adopt specific regulatory provisions to address these marine engines.

(12) Evaporative Emission Requirements

While nearly all locomotives currently subject to part 92 are fueled with diesel fuel, §92.7 includes evaporative emission provisions that would apply for locomotives fueled by a volatile liquid fuel such as gasoline or ethanol. These regulations do not specify test procedures or specific numerical limits, but rather set "good engineering" requirements. We are adopting these same requirements in part 1033.

We are also adopting similar requirements for marine engines and vessels that run on volatile fuels. We are not aware of any compression-ignition marine engines currently being produced that would be subject to these requirements but believe that it is appropriate to adopt these requirements now rather than waiting until such engines are produced. In this final rule, we are adopting requirements for controlling evaporative emissions that are identical to those for locomotives. As described in the proposal, we intend to apply to compression-ignition marine engines and vessels the same requirements we will be adopting for spark-ignition engines and vessels before the end of 2008 (as proposed at 72 FR 28098). We therefore intend to modify part 1042 in the final rule corresponding to that proposal related to spark-ignition marine engines and vessels. Specifically, if someone were to build a marine vessel with a compression-ignition engine that runs on a volatile liquid fuel, the engine would be subject to the exhaust emission standards of part 1042, but the fuel system would be subject to the evaporative emission requirements of the recently proposed part 1045.[160]

(13) Small Business Provisions

There are a number of small businesses that will be subject to this rule because they are locomotive manufacturers/remanufacturers, railroads, marine engine manufacturers, post-manufacture marinizers, vessel builders, or vessel operators. We largely continue the existing provisions that were adopted previously for these small businesses in the 1998 Locomotive and Locomotive Engines Rule (April16, 1998; 63 FR

[160] Part 1045 was proposed on May 18, 2007 (72 FR 28097).

18977); our 1999 Commercial Marine Diesel Engines Rule (December 29,1999; 64 FR 73299) and our 2002 Recreational Diesel Marine program (November 8, 2002; 67 FR 68304). These provisions, which are discussed below, are designed to minimize regulatory burdens on small businesses needing added flexibility to comply with emission standards while still ensuring the greatest emissions reductions achievable. (See section IX.C of this rule for discussion of our outreach efforts with small entities.)

(a) Locomotive Sector

(i) Production-Line and In-Use Testing Does not Apply

Production-line and in-use testing requirements do not apply to small locomotive manufacturers until January 1, 2013, which is up to five calendar years after this program becomes effective.

In the 1998 Locomotive Rule (April 16, 1998; 63 FR 18977), the in-use testing exemption was provided to small remanufacturers with locomotives or locomotive engines that became new during the 5-year delay, and this exemption was applicable to these locomotives or locomotive engines for their entire useful life (the exemption was based on model years within the delay period, but not calendar years as we are promulgating today). As an amendment to the existing in-use testing exemption, small remanufacturers with these new locomotives or locomotive engines must now begin complying with the in-use testing requirements after the five-year delay on January 1, 2013 (exemption based on calendar years). Thus, they are no longer exempt from in-use testing for the entire useful life of a locomotive or a locomotive engine. We are finalizing this provision to ensure that small remanufacturers comply with our standards in-use, and subsequently, the public is assured they are receiving the air quality benefits of today's standards. In addition, this amendment provides a date certain for small remanufacturers when in-use testing requirements begin to apply.

We received a number of comments asking us to clarify whether or not we were still planning to require production-line audits or verification for small locomotive remanufacturers during this 5-year delay (until January 1, 2013). In response, we are clarifying that we did not intend to exempt small locomotive remanufacturers from production-line audits during the 5-year delay (our intent was to exempt these entities from production-line and in-use testing requirements). We believe this requirement is of minimal regulatory burden to small locomotive remanufacturers. Moreover, we have clarified the general auditing regulations to explicitly allow audits to be conducted by the owner/operator, which further minimizes the burden.

(ii) Class III Railroads Exempt from New Standards for Existing Fleets

EPA is limiting the category of small railroads which are exempt from the Tier 0, 1 and 2 remanufacturing requirements for existing fleets to those railroads that qualify as Class III railroads and that are not owned by a large parent company. Under the current Surface Transportation Board classification system, this exemption is limited to railroads having total revenue less than $25.5 million per year. This change requires that all Class

II railroads, when remanufacturing their locomotives, meet the new standards finalized for existing fleets.

EPA had requested comment on whether the small railroads exemption from emissions standards for existing fleets had been effective and appropriate and whether they should continue under the new program finalized today. Under part 92, only railroads qualifying as "large" businesses, as defined by the Small Business Administrations (SBA) were subject to the standards for their pre-existing fleet. The SBA definition of a large railroad is based on employment. For line-haul railroads the threshold is 1,500 or more employees, and for short-haul railroads it is 500 or more employees. Additionally, any railroad owned by a parent company that is large by SBA definition is also subject to the current existing fleet requirements. Although this excludes a majority of the more than 500 U.S. freight railroads, it addresses the vast majority of the emissions because it includes all Class I railroads.

The majority of comments supported revising the criterion for exempting railroads from emissions standards for existing fleets. While some of these commenter's felt that a revenue based approach exempting Class III railroads was appropriate, others disagreed, and argued that all railroads, regardless of classification or revenues should be subject to the new emission standards for existing fleets. These commenters' felt no exemption would be legitimate because of both the extremely long operational life of these locomotive engines and the predominance of Class II and III railroads in various nonattainment areas of the country which contribute to air quality problems. Those commenters' opposing any change to the existing exemption scheme argued that the current approach of exempting all small railroads should be retained because the costs involved in meeting new standards for existing fleets would impose a heavy financial burden on small railroads currently exempt from the program. Additionally, these commenters' argued that small railroads' emissions are trivial and do not impact air quality.

In finalizing this new approach, EPA believes that continuing to exempt Class III railroads with annual revenues under $25.5 million while including all Class II railroads in the existing fleet program is a reasonable approach that addresses both industry concerns regarding costs while also recognizing that small railroads do contribute to air pollution in areas they service including nonattainment areas throughout the U.S.

We are clarifying our definition that intercity passenger or commuter railroads are not included as railroads that are small businesses because they are typically governmental or are large businesses. Due to the nature of their business, these entities are largely funded through tax transfers and other subsidies. Thus, the only passenger railroads that could qualify for the small railroad provisions will be small passenger railroads related to tourism.

(iii) Small Railroads Excluded from In-Use Testing Program

The railroad in-use testing program continues to apply to Class I freight railroads only, and thus, no small railroads are subject to this testing requirement. It is important to note many Class II and III freight railroads qualify as small businesses. This provision provides flexibility to all Class II and III railroads, which includes small railroads. All Class I freight railroads are large businesses. [161]

(iv) Hardship Provisions

Section 1068.245 of the existing regulations in title 40 contains hardship provisions for engine and equipment manufacturers, including those that are small businesses. We will apply this section for locomotives as described below.

Under the unusual circumstances hardship provision, locomotive manufacturers may apply for hardship relief if circumstances outside their control cause their failure to comply and if the failure to sell the subject locomotives will have a major impact on the company's solvency. An example of an unusual circumstance outside a manufacturer's control may be an "Act of God," a fire at the manufacturing plant, or the unforeseen shut down of a supplier with no alternative available. The terms and time frame of the relief depend on the specific circumstances of the company and the situation involved. As part of its application for hardship, a company is required to provide a compliance plan detailing when and how it will achieve compliance with the standards.

(b) Marine Sector

(i) Revised Definitions of Small-Volume Manufacturer and Small-Volume Boat Builder

As proposed, we are revising the definitions of small-volume manufacturer (SVM) and small-volume boat builder to include worldwide production. Currently, a SVM is defined as a manufacturer with annual U.S.-directed production of fewer than 1,000 engines (marine and nonmarine engines), and a small-volume boat builder is defined as a boat manufacturer with fewer than 500 employees and with annual U.S.-directed production of fewer than 100 boats. By including worldwide production in these definitions, we prevent a manufacturer or boat builder with a large worldwide production of engines or boats, or a large worldwide presence, from receiving relief from the requirements of this program. The provisions that apply to small-volume manufacturers and small-volume boat builders as described below are intended to minimize the impact of this rule for those entities that do not have the financial resources to quickly respond to requirements in the rule.

(ii) Broader Engine Families and Testing Relief

<u>Broader engine families</u>: We are finalizing as proposed the provision that post-manufacture marinizers (PMMs) and SVMs be allowed to continue to group all commercial Category 1 engines into one engine family for certification purposes, all

[161] U.S. EPA, Assessment and Standards Division, Memorandum from Chester J. France to Alexander Cristofaro of U.S. EPA's Office of Policy, Economics, and Innovation, Locomotive and Marine Diesel RFA/SBREFA Screening Analysis, September 25, 2006.

recreational engines into one engine family, and all Category 2 engines into one family. As with existing regulations, these entities are responsible for certifying based on the "worst-case" emitting engine. This approach minimizes certification testing because the marinizer and SVMs can use a single engine in the first year to certify their whole product line. In addition, marinizers and SVMs may then carry-over data from year to year until changing engine designs in a way that might significantly affect emissions.

As described in the proposal, this broad engine family provision still requires a certification test and the associated burden for small-volume manufactures. We realize that the test costs are spread over low sales volumes, and we recognize that it may be difficult to determine the worst-case emitter without additional testing but we need a reliable, test-based, technical basis to issue a certificate for these engines. However, manufacturers will be able to use carryover test data to spread costs over multiple years of production.

Production-line and deterioration testing: In addition, as proposed, SVMs producing engines less than or equal to 600 kW (800 hp) are exempted from production-line and deterioration testing for the Tier 3 standards. We will assign a deterioration factor for use in calculating end-of-useful life emission factors for certification. This approach minimizes compliance testing since production-line and deterioration testing is more extensive than a single certification test. As described in the proposal, Tier 3 standards for these engines are not expected to require the use of aftertreatment – similar to the existing Tier 1 and Tier 2 standards. The Tier 4 standards for engines greater than 600 kW are expected to require aftertreatment emission-control devices. Currently, we are not aware of any SVMs that produce engines greater than 600 kW, except for one marinizer that plans to discontinue their production in the near future.[162]

We are finalizing provisions that require SVMs to undertake production-line and deterioration testing in the future if they begin producing these larger engines due to the sophistication of manufacturers that produce engines with aftertreatment technology. We believe these manufacturers will have the resources to conduct both the design and development work for the aftertreatment emission-control technology, along with production-line and deterioration testing.

(iii) Delayed Standards

One-year delay: As described in the proposal, post-manufacture marinizers (PMMs) generally depend on engine manufacturers producing base engines for marinizing. This can delay the certification of the marinized engines. There may be situations in which, despite its best efforts, a marinizer cannot meet the implementation dates, even with the provisions described in this section. Such a situation may occur if an engine supplier without a major business interest in a marinizer were to change or drop an engine model very late in the implementation process or was not able to supply the

[162] U.S. EPA, Assessment and Standards Division, Memorandum from Chester J. France to Alexander Cristofaro of U.S. EPA's Office of Policy, Economics, and Innovation, Locomotive and Marine Diesel RFA/SBREFA Screening Analysis, September 25, 2006.

marinizer with an engine in sufficient time for the marinizer to recertify the engine. Based on this concern, we are finalizing as proposed to allow a one-year delay in the implementation dates of the Tier 3 standards for post-manufacture marinizers qualifying as small businesses (the definition of small business, not SVM, used by EPA for these provisions for manufacturers of new marine diesel engines -- or other engine equipment manufacturing -- is 1,000 or fewer employees; as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201) and producing engines less than or equal to 600 kW (800 hp).

As described above and in the proposal, the Tier 4 standards for engines greater than 600 kW (800hp) are expected to require aftertreatment emission-control devices. We will not apply this one-year delay to small PMMs that begin marinizing these larger engines in the future due to the sophistication of entities that produce engines with aftertreatment technology. We expect that the large base engine manufacturer (with the needed resources), not the small PMM, will conduct both the design and development work for the aftertreatment emission-control technology and that they will also take on the certification responsibility in the future. Thus, the small PMM marinizing large engines will not need a one-year delay.

<u>Three-year delay for not-to-exceed (NTE) requirements</u>: As described in the proposal, additional lead time is also appropriate for PMMs to demonstrate compliance with NTE requirements. Their reliance on another company's base engines affects the time needed for the development and testing work needed to comply. Thus, as proposed, PMMs qualifying as small businesses and producing engines less than or equal to 600 kW (800hp) may also delay compliance with the NTE requirements by up to three years, for the Tier 3 standards. Three years of extra lead time (compared to one year for the primary certification standards) is appropriate considering their more limited resources. As described above and in the proposal, the Tier 4 standards for engines greater than 600 kW are expected to require aftertreatment emission-control devices. We do not apply this three-year delay to small PMMs that begin marinizing these larger engines in the future due to the sophistication of entities that produce engines with aftertreatment technology. We expect that the large base engine manufacturer (with the needed resources), not the small PMM, will conduct both the design and development work for the aftertreatment emission-control technology and that they will also take on the certification responsibility in the future. Thus, the small PMM marinizing large engines does not need a three-year delay for compliance with the NTE requirements.

<u>Five-year delay for recreational engines</u>: For recreational marine diesel engines, the existing regulations (2002 Recreational Diesel Marine program; November 8, 2002, 67 FR 68304) allow small-volume manufacturers up to a five-year delay for complying with the standards. However, as proposed, we will not continue this provision. As discussed above and in the proposal, the Tier 3 standards for these engines are expected to be engine-out standards which do not require the use of aftertreatment – similar to the existing Tier 1 and Tier 2 standards. The Tier 4 standards will not apply to recreational engines. Also, Tier 3 engines are expected to require far less in terms of new hardware, and in fact, are expected to only require upgrades to existing hardware (i.e., new fuel systems). In addition, manufacturers have experience with engine-out standards from the

existing Tier 1 and Tier 2 standards, and thus, they have learned how to comply with such standards. Thus, small-volume manufacturers of recreational marine diesel engines do not need more time to meet the new standards. For small PMMs of recreational marine diesel engines, the one-year delay described earlier will provide enough time for these entities to meet today's standards.

(iv) Engine Dressing Exemption

We are finalizing as proposed that marine engine dresser will continue to be exempt from certification and compliance requirements. As described in the proposal, many marine diesel engine manufacturers take a new, land-based engine and modify it for installation on a marine vessel. Some of these companies modifying an engine make no changes that might affect emissions. Instead, the modifications may consist of adding mounting hardware and a generator or reduction gears for propulsion. It can also involve installing a new marine cooling system that meets original manufacturer specifications and duplicates the cooling characteristics of the land-based engine but with a different cooling medium (such as sea water). In many ways, these manufacturers are similar to nonroad equipment manufacturers that purchase certified land-based nonroad engines to make auxiliary engines. This simplified approach of producing an engine can more accurately be described as dressing an engine for a particular application. As indicated above, engine dressers make changes to an engine without affecting the emission characteristics of the engine, which would include modifications that do not affect aftertreatment emission-control devices or systems (as stated earlier, Tier 4 standards for engines greater than 600 kW (800hp) are expected to require aftertreatment).

Because the modified land-based engines are subsequently used on a marine vessel, however, these modified engines are considered marine diesel engines, which then fall under these requirements. As described in the proposal, while we continue to consider them to be manufacturers of a marine diesel engine, they are not be required to obtain a certificate of conformity (as long as they ensure that the original label remains on the engine and report annually to EPA that the engine models that are exempt pursuant to this provision). This extends section 94.907 of the existing regulations. For further details of engine dressers responsibilities see section 1042.605 of the regulations.

(v) Vessel Builder Provisions

Current recreational marine engines regulations (2002 Recreational Diesel Marine program; November 8, 2002, 67 FR 68304) allow manufacturers with a written request from a small-volume boat builder to produce a limited number of uncertified engines (over a five year period) -- an amount equal to 80 percent of the boat builders sales for one year. For builders with very small production volumes, this 80 percent allowance could be exceeded, as long as sales did not exceed 10 engines in any one year nor 20 total engines over five years and applied only to engines less than or equal to 2.5 liters per cylinder. We are not continuing this provision because recreational marine engines are subject only to the Tier 3 standards that are not expected to change the physical characteristics of engines (Tier 3 standards will not result in a larger engine or otherwise require any more space within a vessel). Because of the similarity to Tier 2 engine standards there will be no need for boat builders to redesign engine compartments thus eliminating the need for this 5 year delay provision.

(vi) Small Vessel Operators Exempt from New Standards for Existing Fleet

In the proposed rule, we requested comment on an alternative program option (*Alternative 5: Existing Engines*) that would for the first time set emission standards for marine diesel engines on existing vessels – the marine existing fleet or remanufacture program. As described earlier in section III.B.2.b, *Remanufactured Marine Standards,* we plan to finalize only the first part of this option requiring the owner of a marine diesel engine (vessel operator) to use a certified marine remanufacture system when the engine is remanufactured if such a system is available.

The marine existing fleet program will apply only to those commercial marine diesel engines (C1 and C2 engines) which meet the following criteria:

- Greater than 600kW (800hp);
- Tier 0 or Tier 1 engines for C1 engines;
- Tier 0, Tier 1 or Tier 2 engines for C2 engines;
- Built in model year 1973 or later; and
- Have a certified kit available at time of remanufacture.

We estimate that about 4 percent (or about 3,885 of 105,406 engines) of all C1 and C2 engines are subject to the existing fleet program and are likely to have certified kits available at the time of remanufacture. Thus, the percentage of vessels impacted by the remanufacture program is estimated to be similar.

Industry commented that a small portion of the vessel operators with engines greater than 600 kW (800hp) are small businesses that would be significantly burdened by the existing fleet program. To address these comments, the requirements of the marine existing fleet program do not apply to owners of marine diesel engines or vessel operators with less than $5 million in gross annual sales revenue. This threshold includes annual sales revenue from parent companies or affiliates of the owners/operators. (Small Business Administration's (SBA) regulations at 13 CFR 121.103 describe how SBA determines affiliation.) If at some future date gross annual sales revenues are $5 million or more, they become subject to the existing fleet program at that point. The $5 million limit was chosen because a substantial sample of data for vessel operators -- with vessels that have C1 and C2 engines greater than 600 kW -- indicates that a significant portion of the total revenue for this sample set, about 80 percent, is generated by operators with $5 million or more in annual sales revenue.[163]

[163] The Waterways Journal, Inc., 2006 Inland River Record.

We expect that the amount of emissions from this sector correlates reasonably well with the amount of revenue generated (anticipate that revenue corresponds to activity which correlates well to emissions), and thus, most of the emissions from vessel operators (with engines greater than 600 kW (800 hp)) is obtained from those operators with $5 million or greater in revenue. The $5 million threshold for annual sales revenue is estimated to include about 8 percent less of the total vessel operator revenue compared to a $10 million limit, while reflecting 15 percent more revenue than a $1 million threshold. About 90 percent of all vessel operators with C1 and C2 engines have less than $5 million in revenue. The cost to remanufacture engines is a greater burden to the vessel operators with less than $5 million in revenue (larger fraction of revenue, etc.) than those above this limit. Therefore, the $5 million revenue threshold eliminates the regulatory burden for a substantial number of small vessel operators, while capturing a significant portion of the emissions from operators in the marine remanufacture program.

(vii) Hardship Provisions

Sections 1068.245, 1068.250 and 1068.255 of the existing title 40 regulations contain hardship provisions for engine and equipment manufacturers, including those that are small businesses. As proposed, we will apply these sections for marine applications such as PMMs, SVMs, and small-volume boat builders, which will effectively continue existing hardship provisions for these entities as described below.

In addition, for the marine existing fleet or remanufacture program, we are now providing these same hardship provisions to vessel operators or marine remanufacturers that qualify as small businesses. These provisions are described below.

<u>Post-Manufacture Marinizers (PMMs), Small-Volume Manufacturers (SVMs), and Vessel Operators (or Marine Remanufacturers)</u>: As proposed, we are continuing two existing hardship provisions for PMMs and SVMs. In addition, we now extend these two provisions to small vessel operators or small marine remanufacturers for the marine existing fleet program. All of these entities may apply for this relief on an annual basis. First, under an economic hardship provision, PMMs, SVMs, and vessel operators (or marine remanufacturers) may petition us for additional lead time to comply with the standards. They must show that they have taken all possible business, technical, and economic steps to comply, but the burden of compliance costs will have a major impact on their company's solvency. As part of its application of hardship, a company is required to provide a compliance plan detailing when and how it plans to achieve compliance with the standards. Hardship relief could include requirements for interim emission reductions and/or purchase and use of emission credits. The length of the hardship relief decided during initial review is up to one year, with the potential to extend the relief as needed. We anticipate that one to two years is normally sufficient. Also, for PMMs and SVMs, if a certified base engine is available, they must generally use this engine. We believe this provision will protect PMMs and SVMs from undue hardship due to certification burden. Also, some emission reduction can be gained if a certified base engine becomes available. See the regulatory text in 40 CFR 1068.250 for additional information.

Second, under the unusual circumstances hardship provision, PMMs, SVMs, and vessel operators (or marine remanufacturers) may also apply for hardship relief if circumstances outside their control cause the failure to comply and if the failure to sell the subject engines will have a major impact on their company's solvency. An example of an unusual circumstance outside a manufacturer's control may be an "Act of God," a fire at the manufacturing plant, or the unforeseen shut down of a supplier with no alternative available (the second example is mainly for PMMs and SVMs). The terms and time frame of the relief depend on the specific circumstances of the company and the situation involved. As part of its application for hardship, a company is required to provide a compliance plan detailing when and how it will achieve compliance with the standards. We consider this relief mechanism to be an option of last resort. We believe this provision will protect PMMs, SVMs, and vessel operators (or marine remanufacturers) from circumstances outside their control. We, however, do not envision granting hardship relief if contract problems with a specific company prevent compliance for a second time. See the regulatory text in 40 CFR 1068.245 for additional information.

Small-volume boat builders: As proposed, we are continuing the unusual circumstances hardship provision for small-volume boat builders (those with less than 500 employees and worldwide production of fewer than 100 boats). Small-volume boat builders may apply for hardship relief if circumstances outside their control cause the failure to comply and if the failure to sell the subject vessels will have a major impact on the company's solvency. An example of an unusual circumstance outside a boat builder's control may be an "Act of God," a fire at the boat building facility, or the unforeseen breakdown of a supply contract with an engine supplier. This relief allows the boat builder to use an uncertified engine and is considered a mechanism of last resort. The terms and time frame of the relief depend on the specific circumstances of the company and the situation involved. As part of its application for hardship, a company is required to provide a compliance plan detailing when and how it plans to achieve compliance with the standards. See the regulatory text in 40 CFR 1068.250 for additional information.

In addition, as described in the proposal, small-volume boat builders generally depend on engine manufacturers to supply certified engines in time to produce complying vessels by the date emission standards begin to apply. We are aware of other applications where certified engines have been available too late for equipment manufacturers to adequately accommodate changing engine size (for engines meeting Tier 4 standards, which are described in section III.B.2 of today's rule)[164] or performance characteristics. To address this concern, we are allowing small-volume boat builders to request up to one extra year before using certified engines if they are not at fault and will face serious economic hardship without an extension. See the regulatory text in 40 CFR 1068.255 for additional information.

[164]Tier 3 engine-out standards are not expected to change the physical characteristics of marine engines. Tier 3 standards will not result in a larger engine or otherwise require any more space within a vessel. For Tier 4 standards, we expect that vessels will be designed to accommodate emission components that engine manufacturers specify as necessary to meet these new standards (e.g., ensure adequate space is available to package aftertreatment components.)

(14) Alternate Tier 4 NO_x+HC Standards

We proposed to continue our existing emission averaging programs for the new Tier 4 NO_x and HC standards for locomotives and marine engines. However, the existing averaging programs do not allow manufacturers to show compliance with HC standards using averaging. Because we are concerned that this could potentially limit the benefits of our averaging program as a phase-in tool for manufacturers, we are establishing an alternate NO_x+HC standard of 1.4 g/bhp-hr that could be used as part of the averaging program. Manufacturers that were unable to comply with the Tier 4 HC standard would be allowed to certify to a NO_x+HC FEL, and use emission credits to show compliance with the alternate standard instead of the otherwise applicable NO_x and HC standards. For example, a manufacturer may choose to use banked emission credits to gradually phase in its Tier 4 1200 kW marine engines by producing a mix of Tier 3 and Tier 4 engines during the early part of 2014. NO_x+HC credits and NO_x credits could be averaged together without discount.

The value of this alternate standard (1.4 g/bhp-hr) is the rounded sum of the Tier 4 NO_x and HC standards. We proposed to set this value at the level of the NO_x standard (1.3 g/bhp-hr). However, based on the comments received, we no longer believe this to be appropriate. See the Summary and Analysis of Comments for more discussion of this issue.

(15) Other Issues

We are finalizing other minor changes to the compliance program. For example, engine manufacturers will be required to provide installation instructions to vessel manufacturers and kit installers to ensure that engine cooling systems, aftertreatment exhaust emission controls, and other emission controls are properly installed. Proper installation of these systems is critical to the emission performance of the equipment. Vessel manufacturers and kit installers will be required to follow the instructions to avoid improper installation that could render emission controls inoperative. Improper installation would subject them to penalties equivalent to those for tampering with the emission controls.

We are also clarifying the general requirement that no emission controls for engines subject to this final rule may cause or contribute to an unreasonable risk to public health, welfare, or safety, especially with respect to noxious or toxic emissions that may increase as a result of emission-control technologies. The regulatory language, which addresses the same general concept as the existing §§92.205 and 94.205, implements sections 202(a)(4) and 206(a)(3) of the Act and clarifies that the purpose of this requirement is to prevent control technologies that would cause unreasonable risks, rather than to prevent trace emissions of any noxious compounds. This requirement prevents the use of emission-control technologies that produce pollutants for which we have not set emission standards but nevertheless pose a risk to the public. As is described in Section III and the Summary and Analysis of Comments document, this provision does not preclude the use of urea-based SCR emission controls.

Some marine engine manufacturers have expressed concern over the current provisions in our regulation for selection of an emission data engine. Part 94 specifies that a marine manufacturer must select for testing from each engine family the engine configuration which is expected to be worst-case for exhaust emission compliance on in-use engines. Some manufacturers have interpreted this to mean that they must test all the ratings within an engine family to determine which is the worst-case. Understandably, this interpretation could cause production problems for many manufacturers due to the lead time needed to test a large volume of engines. Our view is that the current provisions do not necessitate testing of all ratings within an engine family. Rather, manufacturers are allowed to base their selection on good engineering judgment, taking into consideration engine features and characteristics which, from experience, are known to produce the highest emissions. This methodology is consistent with the provisions for our on-highway and nonroad engine programs. Therefore, we are keeping essentially the same language in part 1042 as is in part 94. We are adopting similar language for locomotives and will apply it in the same manner as we do for marine engines.

B. Compliance Issues Specific to Locomotives

(1) Refurbished Locomotives

Section 213(a)(5) of the Clean Air Act directs EPA to establish emission standards for "new locomotives and new engines used in locomotives." In the previous rulemaking, we defined "new locomotive" to mean a freshly manufactured or remanufactured locomotive.[165] We defined "remanufacture" of a locomotive as a process in which all of the power assemblies of a locomotive engine are replaced with freshly manufactured (containing no previously used parts) or reconditioned power assemblies. In cases where all of the power assemblies are not replaced at a single time, a locomotive is considered to be "remanufactured" (and therefore "new") if all of the power assemblies from the previously new engine had been replaced within a five year period.

Our new regulations clarify the definition of "freshly manufactured locomotive" when an existing locomotive is substantially refurbished including the replacement of the old engine with a freshly manufactured engine. The existing definition in §92.12 states that freshly manufactured locomotives are locomotives that do not contain more than 25 percent (by value) previously used parts. We allowed freshly manufactured locomotives to contain up to 25 percent used parts because of the current industry practice of using various combinations of used and unused parts. This 25 percent value applies to the dollar value of the parts being used rather than the number because it more properly weights the significance of the various used and unused components. We chose 25 percent as the cutoff because setting a very low cutoff point would have allowed manufacturers to circumvent the more stringent standards for freshly manufactured locomotives by including a few used parts during the final assembly. On the other hand,

[165] As is described in this section, freshly manufactured locomotives, repowered locomotives, refurbished locomotives, and all other remanufactured locomotives are all "new locomotives" in both the previous and new regulations.

setting a very high cutoff point could have required remanufacturers to meet standards applicable to freshly manufactured locomotives, but such standards may not have been feasible given the technical limitations of the existing chassis.

We are adding to §1033.901 a definition of "refurbish" which will mean the act of modifying an existing locomotive such that the resulting locomotive contains less than 50 percent (by value) previously used parts (but more than 25 percent). We believe that where an existing locomotive is improved to this degree, it is appropriate to consider it separately from locomotives that are simply remanufactured in a conventional sense. As described below, we are specifying provisions for refurbished locomotives that vary by application (switch or line-haul) and model year (before or after 2015). See also section IV.B(2), which describes minimum credit proration factors for refurbished locomotives.

We are also clarifying that any locomotives built before 1973 become "new" and thus subject to our emission standards when refurbished. In the 1998 rulemaking, we determined that pre-1973 locomotives should not be considered "new" when remanufactured.[166] An important policy consideration in making that determination was our analysis of the feasibility of such locomotives to meet the Tier 0 emission standards. However, that analysis is not valid for refurbished locomotives. Given the degree to which such locomotives are redesigned and reconfigured, there is no reason that they should be considered differently from 1973 locomotives simply because their frames (or some other parts) were originally manufactured earlier.

We requested comment on setting more stringent standards for refurbished locomotives, considering that these locomotives are restored to a condition likely to allow for many years of continued service. Industry commenters expressed concern that our subjecting refurbished locomotives to more stringent standards could prove counterproductive, because state and local programs that currently help fund voluntary refurbishments to very clean emission levels could lose their incentive to continue doing so, given that these refurbishments would now just be meeting EPA standards. It was further argued that these refurbishments would also lose any opportunity to generate valuable ABT credits, given the challenge just in meeting the standards.

We believe that the need for financial incentives will be just as clear and just as strong under the new program as before. Refurbishing a locomotive effectively removes an old, high-emitting locomotive from the fleet and replaces it with a clean one. The substantial cost of doing so and the potential that, absent incentives, old locomotives (especially switchers) would continue in operation almost indefinitely are the true drivers for creating incentives, regardless of the standards involved. We expect that state and local government officials involved in this process are well aware of this and will act accordingly. The ABT credits that can be gained from these refurbishments have not been a major factor to date and, considering that the credits can subsequently be used to produce other, less clean locomotives, we do not believe that state and local governments

[166] "Locomotive Emission Standards: Regulatory Support Document", APPENDIX L, "Exclusion of Pre-1973 Locomotives", April 1998.

would or should be satisfied to help finance clean locomotives that result in dirtier locomotives elsewhere. As detailed below, we are therefore adopting more stringent standards for refurbished locomotives and phasing in these standards in way that we believe best facilitates continued refurbishment of existing locomotives, while recognizing differences between the switch and line-haul locomotive fleets and the emission reduction trends resulting from our tiered approach to standards-setting.

Currently, small numbers of old low-horsepower locomotives are being refurbished as significantly lower-emitting switch locomotives. The regulations in part 92 subject these locomotives to the Tier 0 standards (unless they contain less than 25 percent previously used parts) and allow them to generate emission credits if they are cleaner than required. The regulations in part 1033 will continue this approach through model year 2014. It is important to note that since most of these locomotives were originally manufactured before 1973, simply by meeting the Tier 0 standards they will achieve significant emission reductions.

For similar reasons, we are adopting an interim program for slightly larger locomotives with power between 2300 and 3000 horsepower refurbished through model year 2014. These locomotives, which are frequently used as road switchers, would also be subject to the Tier 0 standards for this period.

We do not believe, however, that it would be appropriate to allow switch locomotives to be refurbished to the Tier 0+ standards in the long-term. Once the Tier 4 standards begin to apply, we will allow these locomotives to be certified to the Tier 3 switch locomotive standards, which will still provide the opportunity to generate some emission credits as an incentive.

The story is slightly different for higher power line-haul locomotives, which are currently not being refurbished. Nearly all of these remaining in the Class I railroad fleets were originally manufactured in or after 1973 and are already subject to the Tier 0 or later standards. Therefore there will be less of an air quality incentive to fund their refurbishment, and so we are specifying that refurbished line-haul locomotives be subject to the same standards as freshly manufactured locomotives. The regulations would treat them the same except for emission credit proration factors, which are described in section IV.B.(2)

Another important consideration is the potential for refurbishment to be used as a loop hole to circumvent the freshly manufactured standards for line-haul locomotives. Railroads currently turn over their line-haul fleets much faster than their switch fleets. However, it is not hard to envision a scenario in which railroads began refurbishing their locomotives rather than buying freshly manufactured locomotives, especially as the Tier 4 standards went into effect. A long-term program that requiring that refurbished line-haul locomotives meet the same standards as freshly manufactured locomotives prevents refurbishment from being used as such a loophole.

Table IV-2 Provisions for Refurbished Switch Locomotives

	Applicable Tier of Standards	Minimum Proration Factor
Locomotives refurbished before 2015	Tier 0+	0.60
Locomotives refurbished in 2015 or later	Tier 3	0.60

Table IV-3 Provisions for Refurbished Line-Haul Locomotives

	Applicable Tier of Standards	Minimum Proration Factor
Locomotives refurbished before 2015	Tier 2+/3	0.60
Locomotives refurbished in 2015 or later	Tier 4	0.60

(2) Averaging, Banking and Trading

For the most part, our new regulations will continue the existing averaging banking and trading provisions for locomotives. This section only highlights the provisions that are most significant in the context of this Final Rule. The reader is encouraged to read subpart H of part 1033 for details of this program.

In order to ensure that the ABT program is not used to delay the implementation of the Tier 4 technology, we are applying a restriction similar to the averaging restriction that was adopted for Tier 2 locomotives in the previous locomotive rulemaking. We are restricting the number of Tier 4 locomotives that could be certified using credits to no more than 50 percent of a manufacturer's annual production. As was true for the earlier restriction, this is intended to ensure that progress is made toward compliance with the advanced technology expected to be needed to meet the Tier 4 standards. This will encourage manufacturers to make every effort toward meeting the Tier 4 standards, while allowing some use of banked credits to provide needed lead time in implementing the Tier 4 standards by 2015, allowing them to appropriately focus research and development funds.

We proposed to allow the carryover of all Part 92 credits except for PM credits generated from Tier 0 or Tier 1 locomotives. The Tier 0 and Tier 1 PM standards under part 92 were set above the average baseline level to act as caps on PM emissions rather than technology-forcing standards. While Part 92 allows credits generated only relative the estimated average baseline rather than the standards, we were still concerned that such credits might have been windfall credits. However, as is described in the Summary and Analysis of Comments document, after further analysis we now believe that allowing the carryover of all part 92 PM credits is appropriate and will allow such credits to be used under part 1033.

We are also updating the proration factors for credits generated or used by remanufactured locomotives. The updated proration factors better reflect the difference in service time for line-haul and switch locomotives. The ABT program is based on credit calculations that assume as a default that a locomotive would remain at a single FEL for its full service life (from the point it is originally manufactured until it is scrapped). However, when we established the existing standards, we recognized that technology would continue to evolve and that locomotive owners may wish to upgrade their locomotives to cleaner technology and certify the locomotive to a lower FEL at a subsequent remanufacture. We established proration factors based on the age of the locomotive to make calculated credits for remanufactured locomotives consistent with credits for freshly manufactured locomotive in terms of lifetime emissions. These proration factors are shown in §1033.705 of the new regulations. These replace the existing proration factors of §92.305. For example, using the new proration factors, a 15 year old line-haul locomotive certified to a new FEL that was 1.00 g/bhp-hr below the applicable standard would generate the same amount of credit as a freshly manufactured locomotive that was certified to an FEL that was 0.43 g/bhp-hr below the applicable standard because the proration factor would be 0.43. For comparison, under the old regulations, the proration factor would have been 0.50.

We are correcting how the proration factors apply for refurbished locomotives to more appropriately give credits to railroads for upgrading old locomotives to use clean engines, rather than to continue using the old high emission engines indefinitely. As with the rest of the program, credits will be calculated from the difference between the applicable standard and the emissions of the new refurbished locomotive, adjusted to account for the projected time the would remain in service. The correction creates a floor for the credit proration factor for refurbished locomotives of 0.60. This is equal to the proration factor for 20 year old switchers and would also be equivalent to a proration factor for a locomotive that was just over 10 years old. For example, refurbishing a 35 year old switch locomotive to an FEL 1.0 g/bhp-hr below the Tier 0 standard would generate the same amount of credit as a conventional remanufacture of a 20 year old switch locomotive to an FEL 1.0 g/bhp-hr below the Tier 0 standard. This is because we believe that such refurbished switch locomotives will almost certainly operate as long as a 20 year old locomotive that was remanufactured at the same time. Similarly, we believe that refurbished line-haul locomotives would likely operate as long as a 10 year old locomotive that was remanufactured at the same time.

Finally, we are finalizing special provisions for credits generated and used by Tier 3 and later locomotives. Under the current part 92 ABT program, credits are segregated based on the cycle over which they are generated but not by how the locomotive is intended to be used (switch, line-haul, passenger, etc.). Line-haul locomotives can generate credits for use by switch locomotives, and vice versa, because both types of locomotives are subject to the same standards. However, for the Tier 3 and Tier 4 programs, switch and line-haul locomotives are subject to different standards with emissions generally measured only for one test cycle. We will allow credits generated by

Tier 3 or later switch locomotives over the switch cycle to be used by line-haul locomotives to show compliance with line-haul cycle standards. As proposed, we are not allowing such cross-cycle use of line-haul credits (or switch credits generated by line-haul locomotives) by Tier 3 or later switch locomotives.

To make this approach work without double-counting of credits, we are also adopting a special calculation method where the credit using locomotive is subject to standards over only one duty cycle while the credit generating locomotive is subject to standards over both duty cycles (and can thus generate credits over both cycles). In such cases, we would require the use of credits under both cycles. For example, for a Tier 4 line-haul engine family needing 1.0 megagram of NO_x credits to comply with the line-haul emission standard, the manufacturer would have to use 1.0 megagram of line-haul NO_x credits and 1.0 megagram of switch NO_x credits if the line-haul credits were generated by a locomotive subject to standards over both cycles.

(3) Phase-In and Reasonable Cost Limit

The new Tier 0 and 1 emission standards become applicable on January 1, 2010. We also proposed a requirement for 2008 and 2009 when a remanufacturing system is certified to these new standards. If such a system is available before 2010 for a given locomotive model at a reasonable cost, remanufacturers of those locomotives may no longer remanufacture them to the previously applicable standards. They must instead comply with the new Tier 0 or 1 emission standards when they are remanufactured. Similarly, we are requiring them to use certified Tier 2 systems for 2008 through 2012 when a remanufacturing system is certified to the new Tier 2 standards. For the purposes of this provision, “reasonable cost” means that the total incremental cost to the operators of the locomotive (including initial hardware, increased fuel consumption, and increased maintenance costs) during the useful life of the locomotive must be less than $250,000. This cost limit is based on the upper cost we think likely to be required to meet these standards and reflects comments on our NPRM from remanufacturers.

As part of this phase-in requirement, we are requiring certifiers to notify customers that they are applying for certificate such that their locomotives will become subject to the new standards. We would then allow owners/operators a minimum 90-day grace period (after we issue the certificate) in which they could remanufacture their locomotives to the previously applicable standards once they are notified by the certificate holder that such systems are available. This allows them to use up inventory of older parts. However, where the certifiers do not immediately notify them, railroads would allowed a grace period of at least 120 days after they are notified. This combined approach allows sufficient time to find out about the availability of kits and to make appropriate plans for compliance. We are also adding a new provision for owners/operators that limits the total number of locomotives that would need to meet the new standards during 2008 and 2009 to a fraction of the total number of remanufactures they do between [INSERT DATE 150 DAYS AFTER PUBLICATION] and December 31, 2009 that are subject to either the old or new standards.

We are adding provisions that would allow Tier 0/1 remanufacturers to use during the phase-in period an assigned deterioration factor of 0.03 g/bhp-hr for PM and assume that all other deterioration factors are zero. We will also apply an in-use PM add-on of 0.03 g/bhp-hr. These two provisions are intended to address lead time concerns raised by commenters. The commenters correctly point out that the available lead time is not sufficient to allow remanufacturers to verify durability of the emission controls in a more conventional way. By addressing this lead time issue, we will make it more likely that the low emission kits will be brought to market early.

(4) Recertification without Testing

Once manufacturers have certified an engine family, we have historically allowed them to obtain certificates for subsequent model years using the same test data if the engines remain unchanged from the previous model year. We refer to this type of certification as "carryover." We are also extending this allowance to owner/operators. Specifically, we are adding the following paragraph to the end of §1033.240:

> (c) An owner/operator remanufacturing its locomotive to be identical to the previously certified configuration may certify by design without new emission test data. To do this, submit the application for certification described in §1033.205, but instead of including test data, include a description of how you will ensure that your locomotives will be identical in all material respects to their previously certified condition. You have all of the liabilities and responsibilities of the certificate holder for locomotives you certify under this paragraph.

(5) Railroad Testing

Section 92.1003 requires Class I freight railroads to annually test a small sample of their locomotives. We proposed to adopt the same requirements in §1033.810, but asked for comments on whether this program should be changed. In particular, we requested suggestions to better specify how a railroad selects which locomotives to test, which has been a source of some confusion in recent years. In this final rule, we are adopting a revised approach that should reduce this confusion. The regulations provide four options for railroads to select locomotives for testing and require EPA to notify the railroad by January 1st for any year in which we choose to specify which locomotives should be tested.

In addition, the maximum annual testing rate is being lowered to 0.075 percent, from the previously applicable rates of 0.15 to 0.10 percent. This new rate will require Class I railroads to test approximately 20 locomotives per year. We believe that this number of tests (in addition to the testing required for certificate holders) will be enough to allow us to appropriately monitor the emission performance of in-use locomotives.

(6) Test Conditions and Corrections

In our previous rule, we established test conditions that are representative of in-use conditions. Specifically, we required that locomotives comply with emission standards when tested at temperatures from 45°F to 105°F and at both sea level and altitude conditions up to about 4,000 feet above sea level. One of the reasons we established such a broad range was to allow outdoor testing of locomotives. While we only required that locomotives comply with emission standards when tested at altitudes up to 4,000 feet for purposes of certification and in-use liability, we also required manufacturers to submit evidence with their certification applications, in the form of an engineering analysis, that shows that their locomotives were designed to comply with emission standards at altitudes up to 7,000 feet. We included correction factors that are used to account for the effects of ambient temperature and humidity on NO_x emission rates.

We are now changing how the regulations deal with the test temperatures. We are specifying that testing without correction may be performed down to a lower limit of 60°F. In implementing the prior regulations, we found that the broad temperature range with correction, which was established to make testing more practical, was problematic. Given the uncertainty with the existing correction, manufacturers have generally tried to test in the narrower range being adopted today. However, we will still allow manufacturers to test at lower temperatures but will require them to develop correction factors specific to their locomotive designs.

We are also changing the altitude requirements for switch locomotives in response to a comment noting that switch locomotives will rarely operate above 5,500 feet. For switch locomotives, we will only require manufacturers to show that their locomotives comply with emission standards at altitudes up to 5,500 feet.

(7) Duty Cycles and Calculations

(a) Idle Weighting Adjustments

While we did not propose any changes to the weighting factors for the locomotive duty cycles, we did request comment on whether such changes would be appropriate in light of the proposed idle reduction requirements. The regulations specify an alternate calculation for locomotive equipped with idle shutdown features. This provision allows a manufacturer to appropriately account for the inclusion of idle reduction features as part of its emission control system. There are three primary reasons why we are not changing the calculation procedures with respect to the idle requirements. First, different shutdown systems will achieve different levels of idle reduction in use. Thus, no single adjustment to the cycle would appropriately reflect the range of reductions that will be achieved. Second, the existing calculation provides an incentive for manufacturers to design shutdown systems that achieve in the greatest degree of idle reduction that is practical. Finally, our feasibility analysis is based in part on the emission reductions achievable relative to the existing standards. Since some manufacturers already rely on the calculated emission reductions from shutdown features incorporated into many of their locomotive designs, our feasibility is based in part on allowing such calculations.

We are adopting a slight change to the way this adjustment works as compared to the previous regulations. We are specifying that idle emission rates for locomotives meeting our minimum shutdown requirements in §1033.115 be reduced by 25 percent, unless the manufacturer demonstrates that greater idle reduction will be achieved.

(b) Representative Cycles

We also recognize that the potential exists for locomotives to include additional power notches, or even continuously variable throttles, and that the standard FTP sequence for such locomotives would result in an emissions measurement that does not accurately reflect their in-use emissions performance. Moreover, some locomotives may not have all of the specified notches, making it impossible to test them over the full test. Under the previous regulations, we handled such locomotives under our discretion to allow alternate calculations (40 CFR 92.132(e)). We are now adopting more specific provisions in §1033.520. In general, for locomotives missing notches, we believe the existing duty cycle weighting factors should be reweighted without the missing notches. For locomotives without notches or more than 8 power notches, the regulations reference following information provided to us by manufacturers for the previous rulemaking that shows typical notch power levels expressed as a percentage of the rated power of the engine.

In response to comments we are also adding provisions to address locomotives that include new design features that will result in changes to the in-use duty cycle. Specifically, the regulations state that manufacturers must notify us if they are adding design features that will make the expected average in-use duty cycle of their engine family significantly different from the otherwise applicable test cycle. They must also recommend an alternate test cycle that represents the expected average in-use duty cycle. We will specify whether to use the default duty cycle, the recommended cycle, or a different cycle, depending on which cycle we believe best represents expected in-use operation. For locomotives subject to both line-haul and switch cycle standards, the regulations specify that a single set of standards would apply for the representative cycle.

(c) Energy Saving Design Features

We are adopting special provisions for locomotives equipped with energy-saving design features, such as sophisticated electronic optimization of throttle and brake settings based on route data or locomotive operation in a consist, electronically controlled pneumatic (ECP) brakes, and hybrid technology. The provisions we are adopting recognize that to whatever degree the total work done by a locomotive is reduced, the mass emissions would likely also be reduced. For example, if certain design features reduced by three percent the amount of work needed to pull a typical train, then the mass emission rate (g/hr) would generally also be reduced by three percent. Under the new provisions, manufacturers will be allowed to adjust their locomotives' emissions to reflect this, based on data gathered prior to certification.

Manufacturers choosing to adjust emissions under these provisions must present a test plan to EPA for approval prior generating the in-use data necessary to estimate their emissions reductions. The degree to which manufacturers would be allowed to take a credit at certification would be determined from a statistical analysis of their supporting data to address the uncertainty in their estimate. This would minimize the possibility that manufacturers would be given credit for emission reductions that did not actually occur. Later, additional data on the in-use fleet using the feature could be gathered to improve the statistical certainty and this could then be factored into subsequent certifications. In concept, however, if we had perfect data, we would grant the manufacturers full credit for the savings.

Since our standards are specified as brake-specific emission limits, no credit or adjustment will be allowed for features that only improve the engine's brake-specific fuel consumption. The nature of the test procedure itself already properly credits such features. Thus, allowing additional credits to be calculated would be double-counting of credits.

(8) Non-OEM Remanufacturing Parts

We are adopting measures in §1033.645 to help provide for the continued participation in remanufacturing by parts manufacturers willing to take responsibility for the long-term emissions performance of their parts but who lack the wherewithal to design and certify entire locomotive remanufacture systems that may include complex emissions control systems far beyond their expertise. Under this program, we would determine, based on an upfront engineering analysis, that the part supplier has a reasonable basis for concluding that use of their part would be equivalent to the OEM part in use. We would later verify its emission performance through in-use emission testing.

The exact nature of the engineering analysis necessary to demonstrate that the part supplier has a reasonable basis for concluding that use of their part (or parts) will not cause emissions to increase beyond the level expected from the OEM part in use, is expected to vary. We see four possible paths to accomplish this.

- The part is shown to be identical to the original part in all material respects.
- The part differs physically from the original in a small number of ways and each of these is evaluated to show that the aftermarket part will be as good as or better than the original with respect to emissions performance.
- Measurable emission-critical parameters such as fuel injection profile or engine oil consumption rate are established and an engine (or relevant engine subsystem) using the aftermarket part is shown through testing to perform as good or better than one with the original part with respect to these parameters.
- Emissions testing and durability demonstration is performed in essentially the same manner as for remanufactured system certification.

For example, cylinder liners differing only in color and part number from the OEM liners would be identical in all material respects. Those having different bore groove patterns would not be considered identical, but an analysis of the difference this makes in the oil's interaction with the cylinder wall and rings (which could have an impact on PM emissions) could suffice to make the demonstration. Chrome-plated cylinder liners in combination with a specified piston ring set used in place of original rings and non-plated liners could be expected to affect the emission-critical parameter of oil consumption, especially later in the locomotive useful life due to differences in wear rates. Bench or field testing over time demonstrating lower oil consumption trends than original equipment could provide a sufficient demonstration, provided no other emission-critical parameters are involved. We do not believe it is necessary or even possible to specify in the regulations the appropriate emission-critical parameters for all of the locomotive aftermarket components identified in this provision or to specify the test procedures and criteria by which these parameters are evaluated. Instead, we are establishing broad criteria and requiring the part suppliers to propose the appropriate emission-critical parameters and corresponding test or analytical methods appropriate to the part they produce.

We would allow railroads to use the non-OEM part during remanufacturing once we have approved the supplier's engineering analysis. Once the part has been installed in at least 250 locomotives, we would require one of them to be tested. One additional locomotive would need to be tested from the next additional 500 locomotives that use the part. If any locomotives fail to meet all standards, we generally require one additional locomotive to be tested for each locomotive that fails. We would generally allow the supplier to include testing performed by others. For example, if a railroad tests a locomotive with the part under §1033.810, the supplier could submit those test data as fulfillment of its test obligations.

We are adopting these provisions to address the specific issue of parts that are typically replaced during remanufacturing and for which there is an active aftermarket. Therefore, we are only specifying cylinder liners, cylinder heads, pistons, rings, and fuel injectors as being covered by this program. We reserve the authority to expand the program to cover other parts.

(9) Use of Nonroad Engines Certified Under 40 CFR Parts 89 and 1039

Section 92.907 currently allows the use of a limited number of nonroad engines in locomotive applications without certification under the locomotive program. We believe a similar allowance should also be included in the new regulations. However, we are making some changes to these procedures. In general, manufacturers have not taken advantage of these previously existing provisions. In some cases, this was because the manufacturer wanted to produce more locomotives than allowed under the exemption. However, in most cases, it was because the customer wanted a full locomotive certification with the longer useful life and additional compliance assurances. We are adopting new separate approaches for the long term (§1033.625) and the short term (§1033.150), each of which addresses at least one of these issues.

For the long term, we are replacing the existing allowance that relies on part 89 certificates with a design-certification program that makes the locomotives subject to the locomotive standards in use but does not require new testing to demonstrate compliance at certification. Specifically, this program allows switch locomotive manufacturers using nonroad engines to introduce up to 30 locomotives of a new model prior to completing the traditional certification requirements. While the manufacturer would be able to certify without new testing, the locomotives would have locomotive certificates. Thus, purchasers would have the compliance assurances they desire.

As is described in section III B (1)(b), the short term program is more flexible and does not require that the locomotives comply with the switch cycle standards; instead the engines would be subject to the part 1039 standards. The manufacturers would be required to use good engineering judgment to ensure that the engines' emission controls would function properly when installed in the locomotives. For example, the locomotive manufacturer would need to ensure that sufficient cooling capacity was available to cool the engine intake air. Given the relative levels of the part 1039 standards and those being proposed in 1033, we do believe there is little environmental risk with this short-term allowance and thus are not including any limits of the sales of such locomotives. Nevertheless, we are limiting this allowance to model years through 2017. This provides sufficient time to develop these new switchers. These locomotives would not be exempt from the part 1033 locomotive standards when remanufactured, unless the remanufacturing of the locomotive took place prior to 2018 and involved replacement of the engines with certified new nonroad engines. Otherwise, the remanufactured locomotive will be required to be covered by a part 1033 remanufacturing certificate.

(10) Mexican and Canadian Locomotives

Under the prior regulations, Mexican and Canadian locomotives are subject to the same requirements as U.S. locomotives if they operate extensively within the U.S. The regulations 40 CFR 92.804(e) states:

Locomotives that are operated primarily outside of the United States, and that enter the United States temporarily from Canada or Mexico are exempt from the requirements and prohibitions of this part without application, provided that the operation within the United States is not extensive and is incidental to their primary operation.

We are changing this exemption to make it subject to our prior approval, since we have found that the current language has caused some confusion. When we created this exemption, it was our understanding that Mexican and Canadian locomotives rarely operated in the U.S. and the operation that did occur was limited to within a short distance of the border. We are now aware that there are many Canadian locomotives that do operate extensively within the U.S. and relatively few that meet the conditions of the exemption. We have also learned that some Mexican locomotives may be operating more extensively in the United States. Thus, it is appropriate to make this exemption subject to our prior approval. To obtain this exemption, a railroad will be required to submit a detailed plan for our review prior to using uncertified locomotives in the U.S. We will grant an exemption for locomotives that we determine will not be used extensively in the U.S. and that such operation will be incidental to their primary operation. Mexican and Canadian locomotives that do not have such an exemption and do not otherwise meet EPA regulations may not enter the United States.

(11) Other Locomotive Issues

The regulations in part 92 allow locomotive owners to voluntarily subject their pre-1973 locomotives to the Tier 0 standards or to include in the locomotive program low-horsepower locomotives that would otherwise be excluded based on their rated power. We are also including these options in the new part 1033. We will also provide two additional options. First, we will allow Tier 0 switch locomotives, which are normally not subject to line-haul cycle standards, to be voluntarily certified to the line-haul cycle standards. Second, we will allow any locomotives to be voluntarily certified to a more stringent tier of standards. An example of where these options may be desirable would be a case in which a customer wants to purchase a refurbished switch locomotive that meets the Tier 2 standards. While it may seem obvious that it would be allowed, the old regulations are unclear. The part 1033 regulations eliminate this confusion.

The existing and proposed regulations both specified that railroads are required to perform emission-related maintenance. In response to comments, we have added to the regulations a clarification that unscheduled maintenance has to be performed in a timely manner, no later than at the next "92-day" inspection required by the Federal Railroad Administration. Railroads expressed concern that the regulations, as previously written, would have required them to immediately remove a locomotive from service to make emission-related repairs. This was not our intent. Rather, the maintenance provision was intended to merely require that the maintenance be performed in a timely manner. For many repairs, it may be appropriate to wait until the next 92-day inspection. However, for many others it would be appropriate to make the repair sooner to the extent practical.

In response to comments, we are adding an interim allowance to simplify certification testing of locomotive engines. Specifically, for model years before 2014, we will allow manufacturers to test locomotives engines for certification without replicating the transient behavior in the locomotive. This will make it easier for manufacturers to certify new cleaner remanufacturing systems for the full range of locomotive models.

C. Compliance Issues Specific to Marine Engines

(1) Remanufacturing

As discussed in Section III, above, we are adopting a marine remanufacture program for marine diesel engines over 600 kW built from 1973 through Tier 2 that requires the use of a certified remanufacture system when such an engine is remanufactured, if one is available. Certified remanufacture systems must achieve at least a 25 percent reduction in PM emissions. This section briefly describes several certification and compliance provisions for the marine remanufacture program; the full program is contained in the regulations for this rule.

In general, the normal certification requirements for new marine diesel engines would apply, with minor variations as needed to accommodate the characteristics of remanufactured engines. For example, engine families are based on the same criteria as for freshly manufactured engines, and testing, reporting, the application for certification, and warranty requirements closely follow the provisions that apply for freshly manufactured engines.

In general, remanufactured engines are considered to be "new" engines, and they remain new until sold or placed back into service after the replacement of the last cylinder liner. The standards do not apply for engines that are rebuilt without removing cylinder liners. For a new engine to be placed into service, it must be covered by a certificate of conformity.

As is the case with our other emission control programs, certification testing for conformity demonstration will be performed on the most common configuration within an engine family. An engine family is a group of engines that have the same characteristics with respect to combustion cycle and fuel, cooling system, method of air aspiration, method of exhaust aftertreatment, combustion chamber design, bore and stroke, and mechanical or electronic controls. Other configurations may be included if it can be shown based on good engineering judgment that they are likely to provide a PM reduction similar to the configuration tested. Compliance for these other configurations is based on an engineering demonstration that the remanufacturing system reduces PM emissions by 25 percent without increasing NO_x emissions. Engine families may also include remanufacturing systems corresponding to engines that were originally produced over multiple model years, as long as the configurations does not change in a way that affects the validity of certification for the remanufacturing system.

To certify a remanufacture system, a manufacturer must measure baseline emissions and emissions from an engine remanufactured using its system. A baseline emission rate would be established by remanufacturing an engine following normal procedures. That engine or a second engine of the same configuration is then tested for emissions after remanufacturing with the expected emission controls. The remanufacturing system meets the emission standards of the program by demonstrating a minimum 25 percent reduction in PM emissions and no increase in NO_x emissions (within 5 percent). The remanufacturer must also demonstrate that the remanufacturing system does not adversely affect engine reliability or power.

The remanufacturer must also demonstrate that the total marginal cost of the remanufacturing system is less than $45,000 per ton of PM reduction. For the purpose of this demonstration, marginal cost means the difference in costs between remanufacturing the engine using the remanufacture system and remanufacturing the engine conventionally. Total marginal costs over the period of one useful life are divided by the projected PM emissions over one useful life to obtain the cost of the remanufacture system per ton of PM reduced. Costs to be considered include hardware costs, labor costs, operating costs over one useful life period, and other costs (such as shipping).

The useful life provisions established for freshly manufactured engines would apply equally to remanufactured engines. In general, remanufacturers would be responsible for meeting emission standards for 10 years or 10,000 hours of operation for Category 1 engines, and 10 years or 20,000 hours of operation for Category 2 engines.

Certification will rely on a deterioration factor, similar to freshly manufactured engines. The certifying company may either use an assigned value of 0.015 g/kW-hr for PM or develop a new deterioration factor based on engine testing. For Tier 2 engines, the certifying company needs to add the deterioration factor to measured emission levels for certification. The deteriorated number must be less than the applicable PM standard. For Tier 1 and earlier engines, the deterioration factor is added to the emission level established for the certified configuration and that higher emission level serves as the emission standard for any in-use testing after certification.

The regulations allow for simplified certification requirements for remanufacture systems that are already certified under the locomotive program. This would require only an engineering analysis demonstrating that the system would achieve emission reductions from marine engines similar to those from locomotives. Because the marine remanufacture program requires only a PM reduction, locomotive remanufacture system manufacturers may modify those locomotive systems with respect to NO_x emissions. In that case, the system will have to be recertified as a marine remanufacture system based on measured values and subject to all of the other certification requirements of the marine remanufacture program

Remanufactured engines are not eligible for generating or using emission credits for averaging, banking, or trading. This is appropriate because the program we are finalizing only mandatory if a system has been certified for the relevant engine. We will reconsider allowing systems to be based on emission credits when we consider whether to adopt a mandatory marine remanufacture program (Part 2 of the proposed program) at a later date.

Not-to-exceed standards do not apply to remanufacturing. This is appropriate because the base engine in most cases is not subject to NTE requirements. In addition, NTE is most appropriately considered in the initial engine design phase; requiring remanufactured engines to meet the NTE requirements would likely require more intensive engine redesign than is anticipated by the simpler program we are finalizing.

Finally, other provisions such as those governing maintenance intervals, warranties, duty cycles, test fuel, labeling, recordkeeping, etc. are the same as or similar to those for freshly manufactured engines.

(2) Replacement engines

We are revising certain aspects of our existing provisions with regard to replacement engines, as described below. These requirements apply to all marine diesel engines, propulsion or auxiliary, regardless of marine application. Section 1042.601(c) provisions apply instead of the provision of section 1068.240(b)(3) that applies for other nonroad engines.

(a) Replacement with a freshly manufactured engine

Under the current marine diesel engine program, an engine manufacturer is generally prohibited from selling a marine engine that does not meet the standards that are in effect when that engine is produced. However, we recognize that there may be situations in which a vessel owner may require an engine certified to an earlier tier of standards. The two most likely situations are (1) when a vessel has been designed to use a particular engine such that it cannot physically accommodate a different engine due to size or weight constraints (e.g., a new engine model will not fit into the existing engine compartment); or (2) when the engine is matched to key vessel components such as the propeller, or when a vessel has a pair of engines that must be matched for the vessel to function properly.

To address these extreme situations, we amended existing regulation 40 CFR 94.1103(b)(3) to allow a manufacturer to produce a new engine which meets an earlier tier of standards if the Administrator determined that no new engine certified to the emission limits in effect at that time is produced by any manufacturer with the appropriate physical or performance characteristics needed to repower the vessel. An engine manufactured pursuant to this provision is subject to certain conditions: the replacement engine must meet standards at least as stringent as those of the original engine; the engine manufacturer must take possession of the original engine or confirm it is destroyed; and the replacement engine must be clearly labeled to show that it does not comply with the standards and that sale or installation of the engine for any purpose other than as a replacement engine is a violation of federal law and subject to civil penalty.

We subsequently revised this provision to allow the engine manufacture to make the determination of whether an engine compliant with the current standards would fit a vessel, but solely in cases of catastrophic failure (see 70 CFR 40419, July 13, 2005). This change was made to reflect industry concerns that obtaining prior EPA approval would take too long. The engine manufacturer may make the determination in catastrophic failure situations provided that the following conditions are met: the manufacturer must determine that no certified engine is available, either from its own product lineup or that of the manufacturer of the original engine (if different); and the engine manufacturer must document the reasons why an engine of a newer tier is not usable, and this report must be made available to us upon request. We also specified in §94.1103(a)(8) that no other significant modifications to the vessel can be made as part of the process of replacing the engine, or for a period of 6 months thereafter.

In response to comments on the proposal for this rulemaking, we are finalizing three additional revisions to the replacement engine provisions. First, engine manufacturers may now make the determination with respect to the feasibility of using a current tier engine in both noncatastrophic and catastrophic situations. This is a significant change to the program. Engine manufacturers and user groups were concerned about the amount of time that would be needed to obtain prior EPA approval, even in these noncatastrophic cases. Even though the noncatastrophic engine replacement is more typically planned in advance, it is still the case that the determination must be made in a timely manner to ensure the engine manufacturer has time to produce the engine before the vessel is taken out of service for the replacement. Therefore, we are revising the program to allow the engine manufacturer to make such determinations, provided certain additional conditions are met: the engine manufacturer must examine the suitability of replacement with any current tier engine, either produced by that manufacturer or any other manufacturer; the engine manufacturer must make a record of each determination, which must be kept for eight years and contain specific information; the record must be submitted to EPA within 30 days after shipping each engine along with a statement certifying that the information contained in that record is true. We may reduce the reporting and recordkeeping requirements in this section after a manufacturer has established a consistent level of compliance with the requirements of this section.

These records will be used by EPA to evaluate whether engine manufacturers are properly making the feasibility determination and applying the replacement engine provisions. We may void any exemptions we determine do not conform to the applicable requirements. When assessing penalties under this provision we would consider whether the manufacturer acted in good faith. Thus manufacturers are encouraged to keep additional records to support their good faith attempt to comply with the regulations. For example, manufacturers could keep records of requests for replacement engines that are denied.

In making the determination that a current tier engine is not a feasible replacement engine for a vessel, we expect the engine manufacturer will evaluate not just engine dimensions and weight but may also include other pertinent vessel characteristics. These pertinent characteristics would include downstream vessel components such as drive shafts, reduction gears, cooling systems, exhaust and ventilation systems, and propeller shafts; electrical systems for diesel generators (indirect drive engines); and such other ancillary systems and vessel equipment that would affect the choice of an engine. At the same time, there are differences between the new tier and original tier engines that should not affect this determination, such as the warranty period or life expectancy of a newer tier engine, or its cost or production lead time. These characteristics should not be part of the determination of whether or not a new tier engine can be used as a replacement engine. With regard to the warranty period or life expectancy for the new tier engine, an exception may be if these are significantly shorter for the new tier eng than for an older tier engine or the original engine and the shorter warranty period or life expectancy for the newer model is consistent with industry practices.

In addition, in the case of a vessel with two or more paired engines, if the engine not in need of replacement has accumulated service in excess of 75 percent of its useful life we specify that the determination must consider replacement of both engines in the pair. This requirement is necessary to prevent circumvention of the freshly manufactured engine requirements by replacing one engine at a time and relying on the need to pair the engines as the sole justification for producing an engine to an earlier tier. We are also specifying that no additional modifications may be made to a vessel for six months after installing a new replacement engine made to a previous tier. This is to avoid circumvention of the requirement to use a freshly manufactured engine when a vessel is refurbished such that it becomes a new vessel.

The second change to the replacement engine provision is necessary to accommodate the new tiers of standards we are adopting in this rulemaking. Specifically, in making the feasibility determination the engine manufacturer is now required to consider all previous tiers and use any of their own engine models from the most recent tier that meets the vessel's physical and performance requirements. If an engine manufacturer can produce an engine that meets a previous tier of standards representing better control of emissions than that of the engine being replaced, the manufacturer would need to supply the engine meeting the tier of standards with the lowest emission levels. For example, if a Tier 1 engine is being replaced after the Tier 3 standards go into effect, the engine manufacturer would have to demonstrate why a Tier 2 as well as a Tier 3 engine cannot be used before a Tier 0 engine can be produced and installed. Similarly, for an engine built prior to 2004, the engine manufacturer would have to demonstrate why a Tier 1, Tier 2, or a Tier 3 engine cannot be used. It should be noted, in the case of Tier 0 engines, that MARPOL Annex VI prohibits replacing an existing engine at or above 130 kW with a freshly manufactured engine unless it meets the Tier 1 standards.

The third change to the replacement engine provisions pertains to Tier 4 engines. We are making the advance determination that Tier 4 engines equipped with aftertreatment technology to control either NO_x or PM are not required for use as replacement engines for engines from previous tiers in accordance with this regulatory replacement engine provision. Note, however, that Tier 4 engines will be required to be used as replacement engines if the original engine being replaced is a Tier 4 engine. We are making this determination in advance because we expect that installing such a Tier 4 engine in a vessel that was originally designed and built with a previous tier engine could require extensive vessel modifications (e.g., addition of a urea tank and associated plumbing; extra room for a SCR or PM filter; additional control equipment) that may affect important vessel characteristics (e.g., vessel stability). It should be noted that by making this advance determination, EPA is not implying that Tier 4 engines are never appropriate for use as replacement engines for engines from previous tiers; this determination is intended to simplify the search across engines and is based on the presumption that Tier 4 engines may not fit in most cases. We are also not intending to prevent states or local entities from including Tier 4 engines in incentive programs that encourage vessel owners to replace previous tier existing engines with new Tier 4 engines or to retrofit control technologies on existing engines, since those incentive programs often are designed to offset some of the costs of installing and/or using advanced emission control technology solutions. This advance determination is being made solely for Tier 4 marine diesel replacement engines that comply with the Tier 4 standards through the use of catalytic aftertreatment systems. Should an engine manufacturer develop a Tier 4 compliant engine solution that does not require the use of such technology, then this automatic determination will not apply. Instead our existing provision will apply and it will be necessary to show that a non-catalytic Tier 4 engine would not meet the required physical or performance needs of the vessel.

(b) Replacement with an Existing Engine

Our current marine diesel engine program does not contain provisions that address the case in which an engine is replaced with an existing used engine. This means that if a vessel owner replaces an existing engine with a used engine, then that replacement engine is not required to be certified to our marine standards. It should be noted, however, that engines greater than 600 kW that are built after 1973 would still be subject to the remanufacture program described in Section III(C)(2)(b). This means if the existing engine that is the replacement engine has all of its cylinder liners replaced, it will be required to be remanufactured using a certified remanufacture system if one is available for that engine. It is our expectation that a vessel owner would not replace an existing engine above 600 kW with a partially-rebuilt engine, and therefore we do not expect to see replacement engines that are not remanufactured if there is a certified remanufacture system available.

These remanufacture requirements would apply whether the owner is obtaining an identical existing (used) replacement engine due to an engine failure or through an engine exchange for a periodic engine rebuild. These requirements would also apply if a vessel owner is obtaining a different model existing (used) replacement engine, for whatever reason.

It should be noted that pursuant to the definition of "new marine engine," used engines brought into the marine market from other segments (e.g., locomotive, land-based nonroad, or highway sectors) are considered to be new marine diesel engines when they are marinized or modified for use on a vessel, and must meet the standards for newly manufactured engines in effect when such an engine is marinized or modified for installation on a vessel.

(c) Swing Engines

A swing engine is an additional engine that is purchased at the time the vessel is constructed as part of a rebuild strategy. When an engine is due for rebuild, that engine is removed from the vessel and replaced with the swing engine. The removed engine is rebuilt and then becomes the swing engine. Note that a swing engine is not meant to be a replacement engine in case of engine failure. Rather, it is a maintenance practice.

It is our expectation that the swing engine would undergo a complete rebuild, including cylinder liner replacement, before it is made available as the swing engine. That would constitute remanufacturing, and the engine would be required to comply with the engine remanufacture requirements. In general, this means that all engines that are part of a swing engine rebuild practice are expected to comply with the remanufacture requirements over time, providing a certified remanufacture system is available.

(d) Vessel Refurbishing

Our current program specifies that in addition to newly manufactured vessels, a vessel is considered to be "new" if it is modified such that the value of the modifications exceeds 50 percent of the value of the modified vessel. Such a refurbished vessel would be required to have an engine that is compliant with the standards in place when the vessel is modified. We expect that most vessel modifications will not trigger this threshold, but the requirement is necessary to accommodate those cases where a major structural change is done to a vessel that make it like-new.

We are revising this provision to specify how temporary modifications will be treated under this provision. In general, temporary modifications to a vessel would not be considered to be vessel refurbishing for the purpose of the "new vessel" definition. We are defining temporary modifications as modifications to a vessel that are made pursuant to a written contract between the vessel owners and the purchaser of the vessel's services and that are made for the purpose of fulfilling the purchaser's marine service requirements. To be considered to be temporary, the modifications must be removed from the vessel upon expiration of the contract or after a period of one year, whichever is shorter. While we will allow a vessel owner to petition EPA for a longer period of time, we will generally assume that changes that are necessary for longer than one year are quasi-permanent. We do not expect there to be many petitions for longer periods of time because temporary modifications that exceed 50 percent of the vessel's value would be considerable and would likely involve the vessel's power plant.

(3) Personal Use Exemption

The current marine diesel engine emission control program contains certain exemptions from the standards, including the following: test engines; manufacturer-owned engines; display engines; competition engines; export engines; and certain military engines. We also provide an engine dresser exemption that applies to marine diesel engines that are produced by marinizing a certified highway, nonroad, or locomotive engine without changing it in any way that may affect the emissions characteristics of the engine.

In addition to these existing exemptions we are also adding a new provision that exempts an engine installed on a vessel manufactured by a person for his or her own use (see 40 CFR 1042.630). This is intended to address the hobbyists and fishermen who make their own vessel (from a personal design, for example, or to replicate a vintage vessel) and who would otherwise be considered to be a manufacturer subject to the full set of emission standards by introducing a vessel into commerce. The exemption is intended to allow such a person to install a rebuilt engine, an engine that was used in another vessel owned by the person building the new vessel, or a reconditioned vintage engine (to add greater authenticity to a vintage vessel). The exemption is not intended to allow such a person to order a new uncontrolled engine from an engine manufacturer. We expect this exemption to involve a very small number of vessels, so the environmental impact of this exemption will be negligible, while the cost would otherwise be high to install a certified compliant engine.

Because the exemption is intended for hobbyists and fishermen, we are setting additional constraints. First, the vessel may not be used for general commercial purposes. The one exception to this is that the exemption allows a fisherman to use the vessel for his or her own commercial fishing. Second, the exemption is limited to one such vessel over a ten-year period and does not allow exempt engines to be sold for at least five years. We believe these restrictions are not unreasonable for a true hobby builder or comparable fisherman. Moreover, we require that the vessel generally be built from unassembled components, rather than simply completing assembly of a vessel that is otherwise similar to one that must use a freshly manufactured engine certified to meet the applicable emission standards. The person also must be building the vessel him- or herself, and not simply ordering parts for someone else to assemble. Finally, the vessel must be a vessel that is not classed or subject to Coast Guard inspections or surveys.

(4) Lifeboat/Rescue Boat Exemption

Our current marine diesel engine program does not exempt lifeboats or rescue boats, and we did not propose to revise that approach. This approach was developed for the Tier 2 marine diesel engine standards. As we explained in our 1999 FRM, the technologies that would meet Tier 2 standards would not have inherent negative effect on the performance or power density of an engine, and we expected that manufacturers would be able to use the range of technologies available to maintain or even improve the performance capabilities and reliability of their engines. We also note that land-based emergency engines such as standby generators are not exempt from our emission control requirements in either highway or nonroad applications.

We received several comments from manufacturers of lifeboats and rescue boats requesting that we reconsider this approach and exempt engines on lifeboats and rescue boats from the Tier 3 and Tier 4 standards. They noted that engines on lifeboats and rescue boats are not regularly used as they are intended for use only during emergencies, and they are generally only operated for 3 minutes once a week and are water tested for a short period only a few times a year. Boat manufacturers were also concerned about the reliability of electronic controls and advanced technology aftertreatment systems in these situations, especially when the boats are stored on deck and exposed to the elements.

We've also learned that at least some engine manufacturers that have certified engines in the past for use on Coast Guard approved lifeboats and rescue boats pursuant to Coast Guard and international (International Convention for the Safety of Life at Sea - SOLAS) requirements have not yet done so for Tier 2 engines and may elect not to do so at all.[167] The Coast Guard and SOLAS certification requirements are meant to ensure that an engine will perform after it is inverted, will operate when submerged up to the crankshaft, and will readily start at temperatures as low as -15 degrees C. This certification is expensive and time-consuming, and those costs may be difficult to recover over the limited U.S. market for lifeboats and rescue boats (100 to 150 boats per year). Manufacturers of those lifeboats that use those engines must either find an alternative engine for their product, and recertify the boats to the Coast Guard and SOLAS requirements, or exit the market.

After considering these comments, we conclude that it is reasonable to modify our program for engines used on Coast Guard approved lifeboats and rescue boats. First, our final program exempts engines intended to be used on lifeboats and rescue boats from the Tier 4 standards. This exemption is appropriate for technological reasons. We expect the Tier 4 standards to be met through the application of aftertreatment technology. While we believe these technologies will be durable and reliable, it is also the case the

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[167] See http://www.uscg.mil/hq/g-m/mse4/boatlb.htm#LIFEBOAT_FOR_MERCHANT_VESSELS for Coast Guard requirements for lifeboats and rescue boats.

additional complexity could possibly affect engine performance in an emergency, which is the sole situation in which these engines would be used. For example, it would be necessary to ensure the engines on the lifeboat or rescue boat have onboard at all time an adequate supply of urea that meets the quality requirements of an SCR system. In addition, if the engine on the lifeboat or rescue boat is only run for very short periods of time for periodic onboard tests, the PM filter may not have time to regenerate. This could result in a small risk of plugging. Therefore, it is reasonable to exempt these engines from the Tier 4 requirements. It is worth noting that most lifeboat engines are less than 600 kW and thus would not be subject to Tier 4 standards.

Second, to avoid a situation in which an engine certified to the Coast Guard and SOLAS requirements is not available for use in a lifeboat or rescue boat application, we are providing an exemption that would have the effect of delaying the date of the emission standards for engines used on those boats until SOLAS certified engines of the respective emissions tier become available. Specifically, we will grant exemptions for engines not complying with the Tier 3 requirements for use in a Coast Guard approved lifeboat or rescue boat until such time as a comparable Tier 3 engine that meets the weight, size, and performance requirements of the boat is certified under the Coast Guard and SOLAS requirements. Once such an engine becomes available, the non Tier 3 compliant engines may not be sold for use in these applications. This provision is necessary because the Coast Guard has observed a precipitous drop in available SOLAS certified engines with the emissions tier change from the Tier 1 emissions standards to the Tier 2 emissions standards. Given the high cost of SOLAS certification and the low sales of SOLAS certified engines, engine manufacturers have delayed SOLAS certification of new emission tier engines. After considering the high cost of SOLAS certification, the need for additional lead time to complete the SOLAS certification process and the importance of lifeboats and rescue boats to safety, we have concluded it is appropriate to provide this exemption. We are not requiring engine manufacturers to certify these engines by a specified date. However, we anticipate that engine manufacturers will over time certify their Tier 3 engines to the Coast Guard and SOLAS requirements, or modify their existing Coast Guard certified engines as necessary to comply with the Tier 3 requirements. Most of the marine diesel engines used on lifeboats and rescue boats are derived from land-based highway or nonroad engines. Once the Tier 3 requirements for those engines go into effect and the Tier 2 or Tier 1 counterparts are retired from the fleet, it will become more expensive to continue to provide parts and service for these older engines, and engine manufacturers will prefer to provide newer tier engines for lifeboats and rescue boats globally. Because it is not possible to determine when that change will take place, the final program specifies that when they do become available, they must be used.

Finally, we are extending this exemption to Tier 2 engines as well. We have learned that some lifeboat and rescue boat manufacturers are having trouble obtaining engines that meet the Tier 2 standards. Note that because Tier 2 engines are not regulated under part 1042, this exemption is included in a new section in part 94 (94.914). As with the Tier 3 exemption, once a Tier 2 engine becomes available that meets the weight, size, and performance requirements of the boat and is certified under the Coast Guard and

SOLAS requirements the exemption will no longer be available for freshly manufactured engines.

Engines that are produced to an earlier tier pursuant to these provisions must be labeled to make clear that their use is limited to lifeboats or rescue boats approved by the U.S. Coast Guard under approval series 160.135 or 160.156. Using such a vessel as for a purpose other than a lifeboat or rescue boat is a violation of the regulations.

The above provisions are applicable only to engines in lifeboats and rescue boats used solely for emergency purposes. This is an important distinction because there are cases in which a lifeboat may serve dual use on a vessel, both for general transportation (e.g., tenders) and for emergencies. Engines in lifeboats and rescue boats that are not used solely for emergency purposes are not exempt. These engines are not expected to remain idle long enough for urea storage or PM trap regeneration to be a problem. For all these reasons, the Tier 2 and 3 flexibility and Tier 4 exemption will apply only to engines intended for installation on lifeboats approved by the U.S. Coast Guard under approval series 160.135 (except those which are also approved for use as launches or tenders) and rescue boats approved by the U.S Coast Guard under series 160.156.

(5) Stand-by Emergency Auxiliary Engines

We are exempting certain stand-by emergency auxiliary engines from the Tier 4 standards. This exemption is necessary due to the fact that these engines are rarely used, their operation being limited to periodic testing of several minutes duration. While the technologies that will be used to achieve the Tier 4 standards are expected to be durable, it is also the case that operation for such short periods of time may not be enough to engage the aftertreatment regeneration strategy. In addition, these auxiliary engines would need separate urea tanks, rendering them more complicated to maintain and use in an emergency situation.

This exemption is limited to dedicated stand-by emergency auxiliary engines subject to United States Coast Guard requirements set out in 46 CFR part 112. In general, these stand-by emergency auxiliary engines are supplemental to the ships' main auxiliary engines. They are located away from the main engine compartment, have separate fuel tanks, and are connected to the ships' power system in such a way as to provide for emergency power only to emergency equipment and not the ship's power grid generally. These engines must be labeled for use as marine stand-by emergency auxiliary engines only.

Marine stand-by emergency engine means any marine auxiliary engine whose operation is limited to unexpected emergency situations on a vessel; these engines are subject to testing and maintenance required by the United States Coast Guard. They are generally used to produce power for critical networks or equipment (including power supplied to portions of a vessel) when electric power from the main auxiliary engine(s) is interrupted. Marine auxiliary engines used to supply power to the vessel's general electric grid or that are operated on a constant basis are not considered to be emergency marine auxiliary engines.

Exempted engines are required to meet the applicable Tier 3 standards (in part 89 or part 94, as applicable). See 40 CFR 1068.265 for the provisions that apply for such exempt engines. The engines must also be labeled to make clear that they are exempt and their use is limited to emergency stand-by auxiliary power as specified in United States Coast Guard requirements set out in 46 CFR part 112.

(6) Gas Turbine Engines

While gas turbine engines[168] are used extensively in naval ships, they are not used very often in commercial ships. Because of this and because we do not currently have sufficient information, we are not including marine gas turbines in this rulemaking. Nevertheless, we believe that gas turbines could likely meet the new standards (or similar standards) since they generally have lower emissions than diesel engines and may reconsider gas turbines in a future rulemaking.

(7) Natural Gas Engines

The increasing deployment of tankers carrying liquefied natural gas has led to greater numbers of large marine engines running on natural gas instead of diesel fuel. Depending on the technological approach engine manufacturers take, these engines could fall under our definition for spark-ignition engines even though their design and development is more like compression-ignition engines. Without some clarifying provision, these engines would therefore be subject to the standards that we are developing for inboard spark-ignition engines, which are based on automotive technologies. Since this is clearly not appropriate, we are adopting a provision to specify that natural gas engines above 250 kW are subject to standards for marine compression-ignition engines regardless of our regulatory definitions for spark-ignition and compression-ignition engines. Since the analysis of control technology and the estimated costs and emission reductions are very similar to that for diesel-fueled engines, we have made no effort to separately analyze these engines relative to the new emission standards.

(8) Residual Fuel Engines

The vast majority of Category 1 and 2 marine diesel engines subject to EPA's emission standards operate on distillate diesel fuel. There are cases, however, in which the owner of a vessel may prefer to operate a Category 2 engine on another type of diesel fuel. This is mainly the case for auxiliary engines on ocean-going vessels, to allow them to use the same fuel that is used in the propulsion engine (typically residual fuel). There are also a few vessels operated on the Great Lakes that use residual fuel or residual fuel blends.

Our marine diesel engine program requires engine manufacturers to perform certification testing using the same type of fuel that will be used in actual engine

[168] Gas turbine engines are internal combustion engines that can operate using diesel fuel, but do not operate on a compression-ignition or other reciprocating engine cycle. Power is extracted from the combustion gas using a rotating turbine rather than reciprocating pistons.

operation. This requirement, which was also included in our 1999 Tier 2 rule, is intended to ensure that engines meet the emission limits in operation. In our proposal, we noted that engine manufacturers have not certified Category 1 or 2 engines that can be operated on residual fuel to the Tier 2 standards. Manufacturers explained that it is not profitable to do so due to the small size of the U.S. market for these engines. They also informed us that it would be difficult to meet EPA's PM standards on residual fuel.

Some owners expressed concern to EPA about the unavailability of large auxiliary engines certified to the Tier 2 standards on residual fuel. These owners expressed a preference for auxiliary engines run on the same fuel as propulsion engines to simplify ship operations. To respond to this concern, we asked for comment on a compliance consisting of an alternative PM standard and a tighter NO_x standard. The alternative standards would be available for auxiliary engines to be installed on vessels with Category 3 propulsion engines. Certification testing would still be required on residual fuel but we would allow alternative PM measurement procedures. To ensure that questions of test fuel and PM measurement are resolved before certification testing, manufacturers would have to apply to EPA to exercise this flexibility.

The alternative of exempting residual fuel engines from the test fuel requirement and allowing them to be tested on distillate fuel is not appropriate. All of our mobile source emission control programs are predicated on an engine meeting the emission standards in use. The test fuel requirement is one of several provisions that help ensure in-use compliance, including useful life periods, emission deterioration factors, durability testing, and not-to-exceed zone. Amending the test fuel provisions to allow manufacturers to certify residual fuel engines using distillate fuel would introduce considerable uncertainty into the in-use performance of these engines, would weaken the emission standards, and would be contrary to the goals of our program.

We received no comments supporting the compliance flexibility described above, and therefore we are not revising our program with respect to test fuels or the standards that apply to engines with per cylinder displacement below 30 liters that use residual fuel. We expect to revisit this issue in the context of our upcoming rulemaking for Category 3 marine diesel engines.

(9) Duty Cycles for Marine Engines

Manufacturers pointed out two inconsistencies between the proposal and existing requirements for marine engines related to the proposed duty cycles for marine propulsion engines less than 37 kW and the proposed duty cycle for propeller-law auxiliary engines. We agree that the existing 4-mode duty cycle (E3) should be used for these applications and have corrected this in the final rule.

We received comment that the 8-mode (C1) duty cycle was not designed to represent variable-speed propulsion engines intended for use with variable-pitch or electrically-coupled propellers. Caterpillar provided an example of a power curve for a variable-speed engine designed to operate with a controllable pitch propeller where the operation is limited at low and mid-range speeds. In this case, we agree that the constant speed (E2) test duty cycle, combined with the NTE requirements, is more representative of the operation of this engine than the proposed C1 cycle. For this engine, the power and torque at the C1 intermediate speed is relatively low, leading to a heavy weighting of low power operation. In addition, the power limit curve, for overload protection, is at lower power than even the E3 duty cycle.

Controllable pitch propellers are also used with variable speed engines that have power curves that are more similar to those seen for nonroad engines or marine engines used with fixed pitch propellers. We are concerned that the E2 duty cycle would not be representative of the operation of these engines. Therefore, we are finalizing the E3 duty cycle for variable-speed propulsion engines intended for use with variable-pitch or electrically-coupled propellers. In the case where the engine is not capable of operating over the E3 duty cycle in-use, the E2 duty cycle would be used. For the purposes of this requirement, we consider an engine capable of operating over the E3 duty cycle if the engine can safely achieve more than 1.15 times the power specified in the E3 duty cycle at 63, 80, and 91 percent of maximum test speed.

(10) Definition of Recreational Marine Diesel Vessel

We are adopting a revised the definition of recreational marine diesel vessel in part 1042 that will essentially return to the definition we originally adopted in 1999. This revision will effectively rescind that change we made in our 2003 recreational engine rule (68 FR 9745, February 28, 2003). As is described later, in that rulemaking we revised the definition of recreational vessel by adding a reference to the Coast Guard definition in 46 USC 2101. However, since then, it has become clear that the revision resulted in significant confusion for industry.

As described above, the Tier 3 standards that apply to recreational marine diesel engines are different than those that apply to standard power density commercial engines and recreational engines are not subject to the Tier 4 standards. Recreational engines are also subject to different compliance requirements, notably the duty cycle for certification testing and their useful life. These programmatic differences reflect the different way in which these engines are used, with recreational engines generally having a higher power/density ratio, operating at a higher load, and being used for fewer hours over their life than commercial engines.

Recreational engines are defined based on whether or not they are intended by the engine manufacturer to be installed on a recreational vessel. In our 1999 Tier 2 marine diesel engine rule, we defined recreational vessel as a vessel intended by the vessel operator to be operated primarily for pleasure or leased to another for the latter's pleasure, with the exception of (i) vessels less than 100 gross tons that carry more than six passengers; and (ii) vessels more than 100 gross tons that carry one or more passengers, where passenger means someone who pays to be on the vessel.

The goal of this definition was to exclude so-called recreational vessels that are in fact operated like commercial vessels: those that are operated many hours a year (for example, charter fishing vessels and smaller tour vessels that are rented on an individual basis, with or without a crew). A personal vessel owned by an individual for his personal use and not for hire was intended to be considered to be a recreational vessel. For smaller vessels, this is achieved by requiring that there be fewer than six paying passengers; this allows an individual to invite friends onboard his or her vessel in return for some pecuniary arrangement (e.g., paying for the gas). For larger vessels, above 100 gross tons, the presence of any paying passenger prevents the vessel from being characterized as recreational; this is intended to cover luxury yachts that recover costs by taking paying passengers onboard. The specified paying passenger thresholds are high enough to make them likely to be known at the time the vessel is purchased.

In the 2003 rule, we revised the definition of recreational vessel, by adding a reference to the Coast Guard definition. However, the Coast Guard definition and EPA's definition have different intents. Coast Guard's requirements are safety related to ensure adequate lifesaving equipment is onboard a recreational vessel. For example, the Coast Guard definitions differentiate between charter and noncharter vessels based on whether vessels are operated with or without a crew. The intent of EPA's approach is to identify those vessels that are intended for pleasure as opposed to commercial applications. Thus our definition needs to rely on features that can be known at the time of manufacture. For example, by setting a six passenger threshold for small vessels our intent was to identify those vessels clearly identified by the manufacture as being intended for charter use and not used as a charter either incidentally or unintentionally.

Since the Coast Guard definitions do not reflect the intent of EPA's program and are inconsistent with EPA's definitions, we are revising the definitions to remove the references to the Coast Guard definitions and reverting back to the original definitions adopted in 1999. While the new definition is being adopted in part 1042, §94.12(i) of part 94 will allow manufacturers to use this new definition for certification under part 94. Commercial vessels that were categorized as recreational prior to that time due to confusion about the meaning of the definitions will not be affected by the revised definitions.

(11) Engine Stockpiling by Vessel Builders

Our existing marine diesel engine program specifies in §94.1103(a)(5) that it is a prohibited act to introduce into commerce a new vessel containing an engine not covered by a certificate of conformity applicable for an engine model year the same as or later than the calendar year in which the manufacture of the new vessel is initiated.[169] However, as an exception, we allow vessel manufacturers to use up their normal inventory of engines not certified to new, more stringent emission standards if they were built before the date on which the new standards apply (subject to stockpiling prohibitions). With the adoption of the Tier 3 and 4 emission standards, the location of

[169] The manufacture of a vessel is initiated when the keel is laid, or the vessel is at a similar stage of construction. "A similar stage of construction" means: 1) the stage at which construction identifiable with a specific vessel begins, and 2) assembly of that vessel has commenced comprising at least 50 tons or one percent of the estimated mass of all structural material, whichever is less.)

this provision transfers to §1068.101(a)(1), including the exception noted above now being located in §1068.105(a).

The normal inventory approach above was developed in response to traditional business practice in automotive and other industries where vehicles and equipment are serially manufactured. Although this scheme works well for most manufacturers of small, serially-produced marine vessels, its application to manufacturers of large, commercial marine vessels may not be so straightforward. In this latter case there are typically long lead-time build schedules and low production volumes, which translate to vessel manufacturers maintaining lean inventory onsite at the shipyard. Vessel manufacturers usually order engines from dealers upon entering into a vessel construction agreement with an end customer. Due to lengthy build schedules, which for many projects can be counted in years, and the location of some shipyards in low-lying coastal areas subject to seasonal flooding, engines are often delivered and warehoused at the dealers' offsite location until such time as the vessels are ready to receive them for installation. Especially in projects where construction agreements involve multiple vessels, engines for all vessels may be ordered and delivered to the dealer during the same year in which construction of the first vessel is initiated. Due to this type of business practice, we will allow vessel manufacturers to consider as part of their normal inventory those engines that are warehoused at offsite dealerships and for which the vessel manufacturer entered into a purchase agreement prior to a change in applicable emission standards, provided this practice is consistent with the vessel manufacturers past engine ordering practices. We will allow this normal inventory of engines to be used up after new emission standards apply. It should be noted, however, that this clarification does not extend to engines that are not the subject of a prior purchase agreement, and would not allow a vessel manufacturer to search for a previous tier engine among engine dealers to evade the standards. Also, if a dealer has previous tier engines that are not the subject of a prior purchase agreement after a new tier of standards goes into effect, those engines may be used only as replacement engines, subject to §1042.615; those engines may not be sold for use in new vessels.

(12) Other Issues

Several commenters, including the United States Coast Guard, raised questions regarding the possibility that advanced aftertreatment based emission control systems for marine diesel engines may need to be by-passed or otherwise modified or disabled in order to guarantee safe operation under emergency conditions. In general terms, the commenters speculated that the catalyst systems could fail in such a manner as to restrict exhaust flow reducing engine power and potentially endangering vessel safety.

Marine vessels that lose power to a main propulsion engine or generating engine providing essential power to main propulsion engine auxiliaries could go adrift with almost no control. Unlike trucks and locomotives, marine vessels have no brakes and can literally "coast" for miles and due to their enormous tonnage have an incredible amount of momentum and can cause catastrophic damage via collisions, allisions, and groundings. In the past, main propulsion failures on marine vessels have resulted in severe loss of life, property, and damage to the marine environment. Due to this precedent, a loss of main propulsion is defined as a "marine casualty or accident" in 46 CFR 4.03-1(b)(2)(ix) and 46 CFR 4.05-1 requires the occurrence to be immediately reported to the Coast Guard. To avoid potential loss of propulsion 46 CFR 58.01-35 effectively requires that main propulsion auxiliary machinery be provided in duplicate to prevent single point of failure.

Our discussions with the engine manufacturers regarding the technologies they expect to use to comply with the rules we are finalizing today, lead us to conclude that such failure mechanisms are extremely unlikely given the robust nature of the technologies[170]. However, reflecting the high priority everyone places on safety and the reality that no one can say today with absolute certainty how emission control systems will be designed in the future, we are continuing several regulatory provisions that further ensure safe vessel operation under all circumstances. Consistent with Coast Guard's requirements for main propulsion auxiliary machinery, we feel these provisions address the single point of failure concern in the design of emission control systems.

First, we are continuing our general regulatory requirement found in §1042.115(e) stating that a manufacturer may not design engines with emission-control devices, systems, or elements of design that cause or contribute to an unreasonable risk to public health, welfare, or safety while operating. Likewise, our regulations continue to make clear that actions taken by the operators of marine vessels in order to respond to a temporary emergency will not be considered tampering under §1068.101(b)(1) provided the system is returned to its proper function as soon as possible. Lastly, in evaluating auxiliary emission control devices (AECDs) for marine diesel engines we will continue to recognize that AECDs, such as those that eliminate a single point of failure, are not defeat devices as defined under §1042.115(f) if the AECDs are necessary to prevent engine (or vessel) damage or accidents. In the case of AECD approval, we will continue our current practice of reviewing manufacturer certification applications to ensure that these provisions are only used when necessary. Further, it is our general expectation that engine manufacturers will provide diagnostic systems to alert vessel operators when such AECDs are active and if the AECD requires the operator to take an action, the diagnostic system should give the vessel operator as much advance warning as reasonably possible.

V. Costs and Economic Impacts

In this section, we present the projected cost impacts and cost effectiveness of the standards, and our analysis of the expected economic impacts on affected markets. The projected benefits and benefit-cost analysis are presented in Section VI. The benefit-cost analysis explores the net yearly economic benefits to society of the reduction in mobile source emissions expected to be achieved by this rulemaking. The economic impact analysis explores how the costs of the rule will likely be shared across the manufacturers

[170] We should note here that the standards in our rules are performance-based rather than a prescription for the application of a specific technology. Our rules do not prevent a manufacturer from developing and applying new or different technology at some future time as long as it meets the performance basis in the rules (e.g., a 0.04 g/kW-hr standard PM).

and users of the engines and equipment that will be affected by the standards. Unless noted otherwise, all costs are in 2005 dollars.

The annual monetized health benefits of this rule in 2030 will range from $9.2 and $11 billion, assuming a 3 percent discount rate, or between $8.4 billion to $10 billion, assuming a 7 percent discount rate. The social costs of the new standards are estimated to be approximately $738 million in 2030.[171] The impact of these costs on society are estimated to be small, with the prices of rail and marine transportation services estimated to increase by about 1 percent.

Further information on these and other aspects of the economic impacts of our final rule are summarized in the following sections and are presented in more detail in the Final RIA for this rulemaking.

A. Engineering Costs

The following sections briefly discuss the various engine and equipment cost elements considered for this cost analysis and present the total engineering costs we have estimated for this rulemaking; the reader is referred to Chapter 5 of the final RIA for a complete discussion of our engineering cost estimates. When referring to "equipment" costs throughout this discussion, we mean the locomotive and/or marine vessel related costs as opposed to costs associated with the diesel engine being placed into the locomotive or vessel. Estimated freshly manufactured engine and equipment engineering costs depend largely on both the size of the piece of equipment and its engine, and on the technology package being added to the engine to ensure compliance with the standards. The wide size variation of engines covered by this program (e.g., small marine engines with less than 37 kW (50 horsepower, or hp) through locomotive and marine C2 engines with over 3000 kW (4000 hp) and the broad application variation (e.g., small pleasure crafts through large line haul locomotives and cargo vessels) that exists in these industries makes it difficult to present an estimated cost for every possible engine and/or piece of equipment. Nonetheless, for illustrative purposes, we present some example per engine/equipment engineering cost impacts throughout this discussion. This engineering cost analysis is presented in detail in Chapter 5 of the final RIA.

Note that the engineering costs here do not reflect changes to the fuel used to power locomotive and marine engines. Our Nonroad Tier 4 rule (69 FR 38958) controlled the sulfur level in all nonroad fuel, including that used in locomotives and marine engines. The sulfur level in the fuel is a critical element of the locomotive and marine program. However, since the costs of controlling locomotive and marine fuel sulfur have been considered in our Nonroad Tier 4 rule, they are not considered here. This analysis considers only those costs associated with the locomotive and marine program being finalized today. Also, the engineering costs presented here do not reflect

[171] The estimated 2030 social welfare cost of $738 million is based on draft compliance costs for this final rule of $740 million for that year. The final compliance cost estimate for 2030 is somewhat higher, at $759 million; see section VI.C for an explanation. This difference is not expected to have an impact on the results of the market analysis or on the expected distribution of social costs among stakeholders.

any savings that are expected to occur because of the engine ABT program and the various flexibilities included in the program which are discussed in section IV of this preamble. As discussed there, these program features have the potential to provide savings for both engine and locomotive/vessel manufacturers.

(1) Freshly Manufactured Engine and Equipment Variable Engineering Costs

Engineering costs for exhaust emission control devices (i.e., catalyzed DPFs, SCR systems, and DOCs) were estimated using a methodology consistent with the one used in our 2007 heavy-duty highway rulemaking. In that rule, surveys were provided to nine engine manufacturers seeking information relevant to estimating the engineering costs for and types of emission-control technologies that might be enabled with ultra low-sulfur diesel fuel (15 ppm S). The survey responses were used as the first step in estimating the engineering costs of advanced emission control technologies anticipated for meeting the 2007 heavy-duty highway standards. We then built upon these engineering costs using input from members of the Manufacturers of Emission Controls Association (MECA). We also used this information in our recent nonroad Tier 4 (NRT4) rule. Because the anticipated emission control technologies expected to be used on locomotive and marine engines are the same as or similar to those expected for highway and nonroad engines, and because the expected suppliers of the technologies are the same for these engines, we have used that analysis as the starting point for estimating the engineering costs of these technologies in this rule.[172] Importantly, the analysis summarized here and detailed in the final RIA takes into account specific differences between the locomotive and marine products when compared to on-highway trucks (e.g., engine size).

Engineering costs of control include variable costs (for new hardware, its assembly, and associated markups) and fixed costs (for tooling, research, redesign efforts, and certification). We are projecting that the Tier 3 standards will be met by optimizing the engine and emission controls that will exist on locomotive and marine engines in the Tier 3 timeframe. Therefore, we have estimated no hardware costs associated with the Tier 3 standards. For the Tier 4 standards, we are projecting that SCR systems and DPFs will be the most likely technologies used to comply. Upon installation in a new locomotive or a new marine vessel, these devices would require some new equipment related hardware in the form of brackets, new sheet metal, and a reductant storage and delivery system. The annual variable costs for example years, the PM/NO_x split of those engineering costs, and the net present values that would result are presented in Table V-1.[173] As shown, we estimate the net present value for the years 2006 through 2040 of all variable costs at \$1.5 billion using a three percent discount rate, with \$1.3 billion of that

[172] "Economic Analysis of Diesel Aftertreatment System Changes Made Possible by Reduction of Diesel Fuel Sulfur Content," Engine, Fuel, and Emissions Engineering, Incorporated, December 15, 1999, Public Docket No. A-2001-28, Docket Item II-A-76.

[173] The PM/NOx+NMHC cost allocations for variable costs used in this cost analysis are as follows: SCR systems including marinization costs on marine applications are 100% NOx+NMHC; DPF systems including marinization costs on marine applications are 100% PM; and, equipment hardware costs are split evenly.

being engine-related variable costs.[174] Using a seven percent discount rate, these costs are $674 million and $575 million, respectively.

Table V-1 Freshly Manufactured Engine and Equipment Variable Engineering Costs (Millions of 2005 dollars)

Year	Engine Variable Engineering Costs	Equipment Variable Engineering Costs	Total Variable Engineering Costs	Total For PM	Total For NO_x+NMHC
2008	$0	$0	$0	$0	$0
2009	$0	$0	$0	$0	$0
2010	$0	$0	$0	$0	$0
2011	$0	$0	$0	$0	$0
2012	$0	$0	$0	$0	$0
2015	$60	$11	$71	$37	$34
2020	$82	$14	$96	$50	$46
2030	$99	$18	$117	$61	$56
2040	$98	$17	$115	$60	$55
NPV at 3%	$1,255	$220	$1,475	$772	$703
NPV at 7%	$575	$100	$674	$353	$321

We can also look at these variable engineering costs on a "per engine" and a "per piece of equipment" basis rather than an annual total basis. Doing so results in the costs summarized in Table V-2. The costs shown represent the total engine-related and equipment-related engineering hardware costs associated with all of the new emissions standards to which the given power range and market segment would need to comply. For example, a commercial marine engine below 600 kW (805 hp) would need to comply with the Tier 3 standards as its final tier and would, therefore, incur no new hardware costs. In contrast, a commercial marine engine over 600 kW is expected to comply with both Tier 3 and then Tier 4 and would, therefore, incur hardware costs associated with the Tier 4 standards. The costs also represent long term costs or those costs after expected learning effects have occurred and warranty costs have stabilized.

[174] Throughout our cost and economic impact analyses, net present value (NPV) calculations are based on the period 2006-2040, reflecting the period when the NPRM analysis was completed. This has the consequence of discounting the current year costs, effectively 2007, and all subsequent years are discounted by an additional year. The result is a slightly smaller NPV of engineering costs than by calculating the NPV over 2007-2040 (3% smaller for 3% NPV and 7% smaller for 7% NPV). The same convention applies for the emission inventories as shown in Table V-7. We have used 2006 because we intended to publish the proposal in 2006. For the final analysis, we have chosen to continue with 2006 to make comparisons between proposal and final analyses more clear.

Table V-2 Long-term Variable Engineering Cost per New Engine & Piece of Equipment to Comply with the Final Tier of Standards (2005 dollars) [a]

Power Range	Locomotive Line haul	Locomotive Switcher [b]	C1 Marine	C2 Marine
Engine Costs ($/engine)				
600≤kW<1500	NA [c]	NA	$11,540	$29,960
≥1500 kW	$54,630	$13,640	$20,050	$55,750
# of engines/piece of equipment				
600≤kW<1500	NA	NA	2	2
≥1500 kW	1	1	2	2
Equipment Costs ($/piece of equipment for Tier 4 engines)				
600≤kW<1500	NA	NA	$23,070	$59,910
≥1500 kW	$54,630	$13,640	$40,110	$111,510
Equipment Costs ($/piece of equipment to accommodate Tier 4 engines)				
600≤kW<1500	NA	NA	$5,500	$5,500
≥1500 kW	$10,400	$7,500	$10,400	$10,400
Total Variable Cost ($/piece of equipment)				
600≤kW<1500	NA	NA	$28,570	$65,420
≥1500 kW	$65,020	$21,140	$50,490	$121,890

Notes:
(a) We have estimated no variable engineering costs associated with the Tier 3 standards and none associated with the Tier 4 standards for power ranges below 600 kW (800 hp) or for the recreational marine and small commercial marine categories.
(b) Locomotive switchers generally use land-based nonroad engines (i.e., NRT4 engines); therefore, we have used NRT4 cost estimates for locomotive switchers in this rulemaking.
(c) NA (not applicable) means there are no engines in that market segment/power range.

(2) Freshly Manufactured Engine and Equipment Fixed Engineering Costs

Because these technologies are being researched for implementation in the highway and nonroad markets well before the locomotive and marine emission standards take effect, and because engine manufacturers will have had several years complying with the highway and nonroad standards, we believe that the technologies used to comply with the locomotive and marine standards will have undergone significant development before reaching locomotive and marine production, and we have considered this in estimating the costs for research and development. Chapter 5 of the final RIA details our approach which differs from our approach in the draft RIA. We anticipate that engine manufacturers would introduce a combination of primary technology upgrades to meet the new emission standards. Achieving very low NO_x emissions requires basic research on NO_x emission-control technologies and improvements in engine management. There would also have to be some level of tooling expenditures to make possible the fitting of new hardware on locomotive and marine engines. We also expect that locomotives and marine vessels being fitted with Tier 4 engines would have to undergo some level of redesign to accommodate the aftertreatment devices expected to meet the Tier 4 standards. The total of fixed engineering costs and the net present values of those costs are shown in Table V-3.[175] As shown, we have estimated the net present value for the years 2006 through 2040 of all fixed engineering costs at $549 million using a three percent discount rate, with $471 million of that being engine-related research costs. Using a seven percent discount rate, these costs are $422 million and $371 million, respectively.

Table V-3 Freshly Manufactured Engine and Equipment Fixed Engineering Costs (Millions of 2005 dollars)

Year	Engine Research	Engine Tooling	Engine Certification	Equipment Redesign	Total Fixed Engineering Costs	Total for PM	Total for NO_x +NMHC
2008	$34	$0	$0	$0	$34	$11	$23
2009	$34	$0	$0	$0	$34	$11	$23
2010	$68	$0	$0	$0	$68	$23	$46
2011	$114	$19	$5	$0	$138	$50	$88
2012	$80	$0	$0	$0	$80	$27	$54
2015	$46	$17	$1	$13	$76	$30	$46
2020	$0	$0	$0	$3	$3	$1	$1
2030	$0	$0	$0	$3	$3	$1	$1
2040	$0	$0	$0	$0	$0	$0	$0
NPV at 3%	$471	$33	$6	$39	$549	$194	$354
NPV at 7%	$371	$24	$5	$22	$422	$148	$274

Some of the estimated fixed engineering costs would occur in years prior to the Tier 3 standards taking affect in 2012. Engine manufacturers would need to invest in engine tooling and certification prior to selling engines that meet the standards. Engine research is expected to begin five years in advance of the standards for which the research is done. We have estimated some engine research for both the Tier 3 and Tier 4 standards, although the research associated with the Tier 4 standards is expected to be higher since it involves work on aftertreatment devices which only the Tier 4 standards would require. By 2016, the Tier 4 standards would be fully implemented and engine research toward the Tier 4 standards would be completed. Similarly, engine tooling and certification efforts would be completed. We have estimated that equipment redesign, driven mostly by marine vessel redesigns, would continue for many years given the nature of the marine market. Therefore, by 2017 all engine-related fixed engineering costs would be zero, and by 2033 all equipment-related fixed engineering costs would be zero.

(3) Freshly Manufactured Engine Operating Costs

We anticipate an increase in costs associated with operating locomotives and marine vessels. We anticipate three sources of increased operating costs: reductant use; DPF maintenance; and a fuel consumption impact. Increased operating costs associated

[175] The PM/NOx+NMHC cost allocations for fixed costs used in this cost analysis are as follows: Engine research expenditures are 67% NO_x+NMHC and 33% PM; engine tooling and certification costs are split evenly; and, equipment redesign costs are split evenly.

with reductant use would occur only in those locomotives/vessels equipped with a SCR engine using a reductant like urea. Maintenance costs associated with the DPF (for periodic cleaning of accumulated ash resulting from unburned material that accumulates in the DPF) would occur in those locomotives/vessels that are equipped with a DPF engine. The fuel consumption impact is anticipated to occur more broadly--we expect that a one percent fuel consumption increase would occur for all new Tier 4 engines, locomotive and marine, due to higher exhaust backpressure resulting from aftertreatment devices. These costs and how the fleet cost estimates were generated are detailed in Chapter 5 of the final RIA and are summarized in Table V-4.[176]

Table V-4 Freshly Manufactured Engine Estimated Increased Operating Costs (Millions of 2005 dollars)

Year	Reductant Use	DPF Maintenance	Fuel Consumption Impact	Total Operating Costs	Total for PM	Total for NO_x+NMHC
2008	$0	$0	$0	$0	$0	$0
2009	$0	$0	$0	$0	$0	$0
2010	$0	$0	$0	$0	$0	$0
2011	$0	$0	$0	$0	$0	$0
2012	$0	$0	$0	$0	$0	$0
2015	$23	$0	$7	$30	$4	$26
2020	$143	$3	$42	$187	$24	$164
2030	$409	$8	$118	$535	$67	$468
2040	$619	$12	$175	$806	$99	$707
NPV at 3%	$4,031	$75	$1,157	$5,264	$654	$4,610
NPV at 7%	$1,575	$29	$453	$2,057	$256	$1,801

As shown, we have estimated the net present value for the years 2006 through 2040 of the annual operating costs at $5.2 billion using a three percent discount rate and $2.1 billion using a seven percent discount rate. The operating costs are zero until Tier 4 engines start being sold since only the Tier 4 engines are expected to incur increased operating costs (note that operating costs associated with the remanufacturing programs are discussed below). Reductant use represents the largest source of increased operating costs. Because reductant use is meant for controlling NO_x emissions, most of the operating costs are associated with NO_x+NMHC control.

(4) Engineering & Operating Costs Associated with the Remanufacturing Programs

We have also estimated engineering costs associated with the locomotive and marine remanufacturing programs. The remanufacturing process is not a low cost endeavor. However, it is much less costly than purchasing a freshly manufactured engine. The engineering costs we have estimated associated with the remanufacturing program are not meant to capture the remanufacturing process but rather the incremental

[176] The PM/NOx+NMHC cost allocations for operating costs used in this cost analysis are as follows: Reductant costs are 100% NOx+NMHC; DPF maintenance costs are 100% PM; and, fuel consumption impacts are split evenly.

engineering costs to that process. Therefore, the remanufacturing costs estimated here are only those engineering and operating costs resulting from the requirement to meet a more stringent standard than the engine was designed to meet at its original sale. In addition to incremental hardware costs, we expect that some remanufactured engines will see a fuel consumption impact. We expect a one percent fuel consumption increase will occur for remanufactured Tier 0 locomotives because we believe that the tighter NO_x standard will be met using retarded timing. For the same reason, we expect a two percent fuel consumption increase for remanufactured C2 marine engines. The marine engines will have timing retarded to the same degree as locomotives, but the relative degree of timing retard will be greater for marine engines given their initial state of control. These engineering and operating costs and how they were generated are detailed in Chapter 5 of the final RIA and are summarized in Table V-5.[177] As shown, we have estimated the net present value for the years 2006 through 2040 of the annual engineering and operating costs associated with the locomotive and marine remanufacturing programs at $2.1 billion using a three percent discount rate and $1.2 billion using a seven percent discount rate.

Table V-5 Estimated Hardware and Operating Costs Associated with the Locomotive & Marine Remanufacturing Programs (Millions of 2005 dollars)

Year	Locomotive	Marine	Total	Total for PM	Total for NO_x+NMHC
2008	$59	$16	$75	$38	$38
2009	$32	$21	$54	$27	$27
2010	$58	$27	$85	$42	$42
2011	$111	$32	$143	$71	$71
2012	$91	$44	$135	$68	$68
2015	$52	$37	$89	$44	$44
2020	$37	$26	$63	$31	$31
2030	$94	$12	$106	$53	$53
2040	$158	$3	$161	$80	$80
NPV at 3%	$1,669	$450	$2,120	$1,060	$1,060
NPV at 7%	$864	$289	$1,153	$577	$577

(5) Total Engineering & Operating Costs

The total engineering and operating costs associated with today's final rule are the summation of the new engine and new equipment engineering costs, both fixed and variable, the new engine operating costs for freshly manufactured engines, and the hardware and operating costs associated with the locomotive and marine remanufacturing programs. These costs are summarized in Table V-6.

[177] Costs associated with the remanufacturing program are split evenly between NO_x+NMHC and PM. Note that the costs associated with the marine remanufacturing program are consistent with the inventory reductions discussed in section II. Our estimate of the number of remanufactured engines is presented in a memorandum from Amy Kopin to the docket for this rule (see Docket Item No. EPA-HQ-OAR-2003-0190-0847).

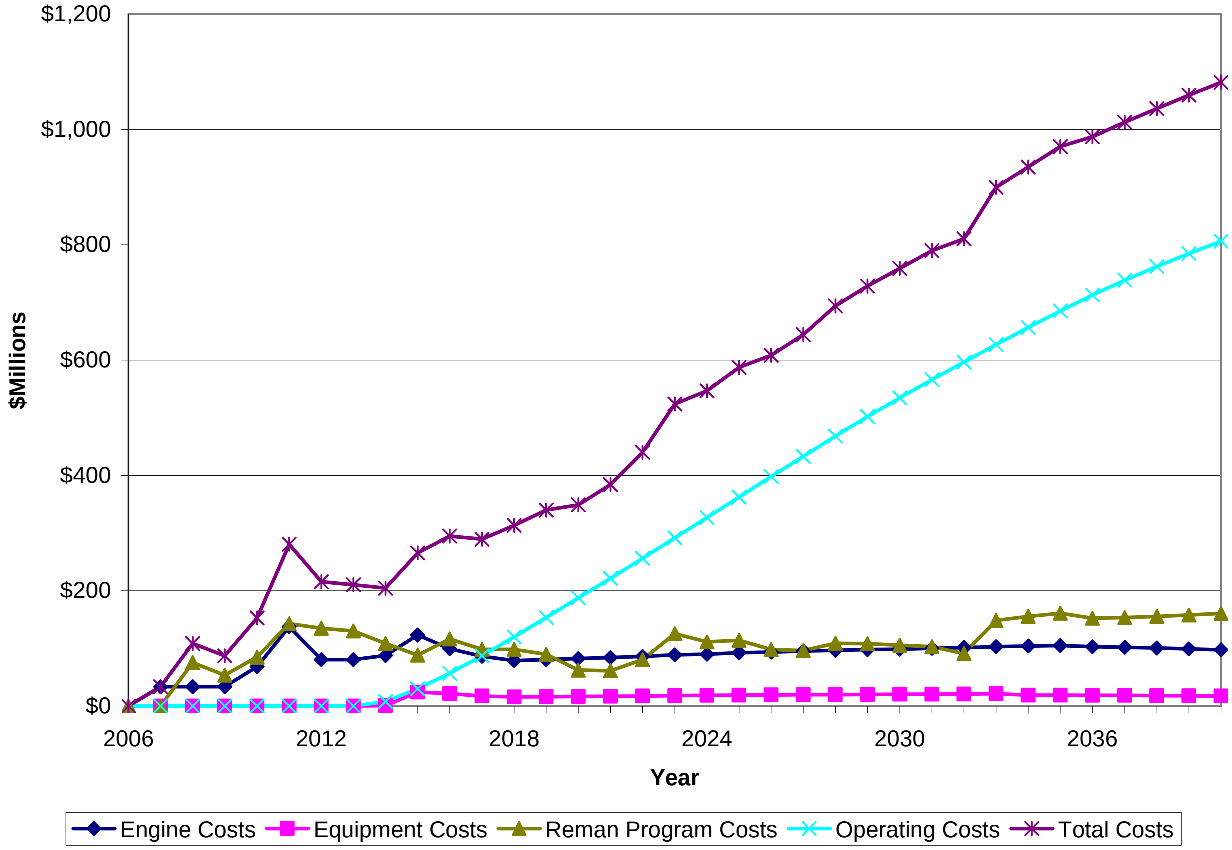
Table V-6 Total Engineering & Operating Costs of the Final Program (Millions of 2005 dollars)

Year	Freshly manufactured Engine Related Engineering Costs	Freshly manufactured Equipment Related Engineering Costs	Freshly manufactured Engine & Equipment Operating Costs	Hardware and Operating Costs Associated with the Remanufacturing Programs	Total Engineering Costs	Total PM Costs	Total NO_x+NMHC Costs
2008	$34	$0	$0	$75	$109	$49	$60
2009	$34	$0	$0	$54	$87	$38	$49
2010	$68	$0	$0	$85	$153	$65	$88
2011	$138	$0	$0	$143	$281	$121	$160
2012	$80	$0	$0	$135	$215	$94	$121
2015	$123	$24	$30	$89	$266	$116	$150
2020	$82	$17	$187	$63	$349	$106	$242
2030	$99	$20	$535	$105	$759	$181	$578
2040	$98	$17	$806	$161	$1,082	$240	$842
NPV at 3%	$1,764	$260	$5,264	$2,120	$9,407	$2,680	$6,727
NPV at 7%	$974	$122	$2,057	$1,153	$4,307	$1,333	$2,973

As shown, we have estimated the net present value of the annual engineering costs for the years 2006 through 2040 at $9.4 billion using a three percent discount rate and $4.3 billion using a seven percent discount rate. Roughly half of these costs are operating costs, with the bulk of those being reductant related costs. As explained above in the operating cost discussion, because reductant use is meant for controlling NO_x emissions, most of the operating costs and, therefore, the majority of the total engineering costs are associated with NO_x+NMHC control.

Figure V-1 graphically depicts the annual engineering costs associated with the program being finalized today. The engine costs shown represent the engineering costs associated with engine research and tooling, etc., and the incremental costs for new hardware such as DPFs and reductant SCR systems. The equipment costs shown represent the engineering costs associated with equipment redesign efforts and the incremental costs for new equipment-related hardware such as reductant storage and delivery systems, sheet metal and brackets. The remanufacturing program costs include incremental hardware and operating costs for the locomotive and marine remanufacturing programs. The operating costs include incremental increases in operating costs associated with reductant use, DPF maintenance, and a one percent fuel consumption increase for new Tier 4 engines. The total program engineering costs are shown in Table V-6 as $9.4 billion at a three percent discount rate and $4.3 billion at a seven percent discount rate.

Figure V-1 Annual Engineering Costs of the New Engine Standards and Locomotive & Marine Remanufacturing Programs



B. Cost Effectiveness

As discussed in section VI, this rule is very cost beneficial, with social benefits far outweighing social costs. However, this does not shed light on how cost effective this control program is compared to other control programs at providing the expected emission reductions. One tool that can be used to assess the value of the final program is the ratio of engineering costs incurred per ton of emissions reduced and comparing that ratio to other control programs. As we show in this section, the PM and NO_x emissions reductions from the new locomotive and marine diesel program compare favorably—in terms of cost effectiveness—to other mobile source control programs that have been or will soon be implemented. We note that today's action builds upon the efforts undertaken by the engine manufacturing industry to comply with our recent 2007/2010 heavy-duty highway and nonroad Tier 4 (NRT4) rulemakings. As such, and as discussed at length in Chapter 5 of the final RIA, much of the research and development associated with diesel emission controls builds upon the work done to comply with those earlier rules. This does not change the conclusion that the cost effectiveness of today's action compares favorably with other actions deemed appropriate for society.

We have calculated the cost per ton of our program based on the net present value of all engineering costs incurred and all emission reductions generated from the current year 2006 through the year 2040. This approach captures all of the costs and emissions reductions from our program including those costs incurred and emissions reductions generated by the locomotive and marine remanufacturing programs. The baseline case for this evaluation is the existing set of engine standards for locomotive and marine diesel engines and the existing remanufacturing requirements. The analysis timeframe is meant to capture both the early period of the program when very few new engines that meet the standards would be in the fleet, and the later period when essentially all engines would meet the new standards.

Table V-7 shows the emissions reductions associated with today's rule. These reductions are discussed in more detail in section II of this preamble and Chapter 3 of the final RIA.

Table V-7 Estimated Emissions Reductions Associated with the New Locomotive and Marine Program (Short tons)

Year	$PM_{2.5}$	PM_{10} [a]	NO_x	NMHC
2015	7,000	8,000	161,000	14,000
2020	14,000	15,000	371,000	26,000
2030	27,000	27,000	795,000	40,000
2040	37,000	38,000	1,144,000	52,000
NPV at 3%	308,000	318,000	8,757,000	492,000
NPV at 7%	134,000	139,000	3,708,000	221,000

Note:
(a) Note that, $PM_{2.5}$ is estimated to be 97 percent of the more inclusive PM_{10} emission inventory.

In Section II we generate and present $PM_{2.5}$ inventories since recent research has determined that these are of greater health concern. Similarly, NMHC is estimated to be 93 percent of the more inclusive VOC emission inventory. Traditionally, we have used PM_{10} and NMHC in our cost effectiveness calculations. Since cost effectiveness is a means of comparing control measures to one another, we use PM_{10} and NMHC in our cost effectiveness calculations for comparisons to past control measures.

Using the engineering costs shown in Table V-6 and the emission reductions shown in Table V-7, we can calculate the $/ton associated with today's rule. These are shown in Table V-8. The resultant cost per ton numbers depend on how the engineering costs presented above are allocated to each pollutant. Therefore, as described in section V.A, we have allocated costs as closely as possible to the pollutants for which they are incurred. These allocations are also discussed in detail in Chapter 5 of the final RIA.

Table V-8 Final Program Aggregate Cost per Ton and Long-Term Annual Cost per Ton

Pollutant	2006 Thru 2040 Discounted Lifetime Cost Per Ton At 3%	2006 Thru 2040 Discounted Lifetime Cost Per Ton At 7%	Cost Per Ton In 2030	Cost Per Ton in 2040
NO_x+NMHC	$730	$760	$690	$700
PM	$8,440	$9,620	$6,620	$6,360

The costs per ton shown in Table V-8 for 2006 through 2040 use the net present value of the annualized engineering costs and emissions reductions associated with the program for the years 2006 through 2040. We have also calculated the costs per ton of emissions reduced in the years 2030 and 2040 using the annual engineering costs and emissions reductions in those specific years. These numbers are also shown in Table V-8. All of the costs per ton include costs and emission reductions that will occur from the locomotive and marine remanufacturing programs.

In comparison with other emissions control programs, we believe that the new locomotive and marine program represents a cost effective strategy for generating substantial NO_x+NMHC and PM reductions. This can be seen by comparing the cost effectiveness with the cost effectiveness of a number of standards that EPA has adopted in the past. Table V-9 and Table V-10 summarize the cost per ton of several past EPA actions to reduce emissions of NO_x+NMHC and PM from mobile sources.

Table V-9 New Locomotive and Marine Program Compared to Previous Mobile Source Programs for NO_x+NMHC

Program	\$/ton NO_x+NMHC
Today's locomotive & marine standards	\$730
Tier 4 Nonroad Diesel (69 FR 39131)	\$1,140
Tier 2 Nonroad Diesel (EPA420-R-98-016, Chapter 6)	\$710
Tier 3 Nonroad Diesel (EPA420-R-98-016, Chapter 6)	\$480
Tier 2 vehicle/gasoline sulfur (65 FR 6774)	\$1,580 – 2,650
2007 Highway HD (66 FR 5101)	\$2,530
2004 Highway HD (65 FR 59936)	\$250 – 480

Note: Costs adjusted to 2005 dollars using the Producer Price Index for Total Manufacturing Industries.

Table V-10 New Locomotive and Marine Standards Compared to Previous Mobile Source Programs for PM

Program	\$/ton PM
Today's locomotive & marine standards	\$8,440
Tier 4 Nonroad Diesel (69 FR 39131)	\$12,630
Tier 1/Tier 2 Nonroad Diesel (EPA420-R-98-016, Chapter 6)	\$2,700
2007 Highway HD (66 FR 5101)	\$15,990

Note: Costs adjusted to 2005 dollars using the Producer Price Index for Total Manufacturing Industries.

C. EIA

We prepared an Economic Impact Analysis (EIA) to estimate the social costs associated with the final control program to estimate the market-level changes in prices and outputs for affected markets, the social costs of the program, and the expected distribution of those costs across stakeholders. As defined in EPA's *Guidelines for Preparing Economic Analyses*, social costs are the value of the goods and services lost by society resulting from a) the use of resources to comply with and implement a regulation and b) reductions in output. [178]

A quantitative Economic Impact Model (EIM) was developed to estimate price and quantity changes and total social costs associated with the emission control program. The EIM is a computer model comprised of a series of spreadsheet modules that simulate the supply and demand characteristics of each of the markets under consideration. The model methodology is firmly rooted in applied microeconomic theory and was developed following the methodology set out in OAQPS's *Economic Analysis Resource Document*.[179] Chapter 7 of the RIA contains a detailed description of the EIM, including the economic theory behind the model and the data used to construct it, the baseline equilibrium market conditions, and the model's behavior parameters. The EIM and the estimated compliance costs presented above are used to estimate the economic impacts of the program. The results of this analysis are summarized below.

The engineering costs we used in the EIA are an earlier version of the estimated compliance costs developed for this final rule. The net present value of the engineering costs used in the EIA is estimated to be approximately $9.17 billion (NPV over the period of analysis at 3 percent discount rate), which is about $240 million less than the net present value of the final estimated engineering costs of about $9.41 billion. This difference is the sum of various cost adjustments, the largest of which are an increase of about $222 million in operating costs for the marine markets and $42 million in the operating costs for the rail markets (NPV over the period of analysis at 3 percent discount rate). These changes are not expected to have a substantial impact on the market level results because the differences are relatively small on an annual basis. For example, operating costs for C2 marine markets increase by about 15 percent in 2030 (from $107 million to $123 million). The previous estimate of $107 million was associated with an increase of approximately 1.1 in the price of marine transportation services and a decrease of approximately 0.5 percent in the quantity of marine transportation services provided. A small increase in operating costs is not likely to change those results by very much. The market-level impacts on the other downstream markets are also likely to be very small and not economically significant. Finally, the difference in compliance costs will not affect the distribution of social costs, which is a function of the price elasticity of supply and demand.

(1) Market Analysis Results

In the market analysis, we estimate how prices and quantities of goods and services affected by the emission control program can be expected to change once the program goes into effect.

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[178] EPA Guidelines for Preparing Economic Analyses, EPA 240-R-00-003, September 2000, p 113. A copy of this document can be found at http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html

[179] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Innovative Strategies and Economics Group, OAQPS Economic Analysis Resource Document, April 1999. A copy of this document can be found at http://www.epa.gov/ttn/ecas/econdata/Rmanual2/

The compliance costs associated with the new locomotive and marine diesel engine standards are expected to lead to price and quantity changes in these markets. A summary of the market analysis results is presented in Table V-11 for 2012, which is representative of the first year of the Tier 3 standards; 2016, which is representative of the first year of the Tier 4 standards; and 2030, which represents market impacts of the program in the long-term. Results for all years can be found in Chapter 7 of the RIA.

For all markets, the market impacts for the early years of the program are driven by the transportation markets. In these years, the only direct compliance costs are associated with the remanufacture programs; there are no variable costs associated with the Tier 3 standards and therefore no direct compliance costs. The transportation markets will experience operating costs increases; these will result in small increases in transportation market prices, which will translate to small contractions in demand for locomotives and marine diesel engines and vessels. This is expected exert marginal downward pressure on prices in those markets, of less than 0.1 percent. The production decreases are also expected to be very small, at 0.1 percent or less.

The Tier 4 programs are expected to result in larger market changes due to the direct compliance costs associated with Tier 4 standards and the continuing costs of the remanufacture programs. For the locomotive markets, the price increases in 2016 are expected to be about 4 percent for line haul locomotives and about one percent for switchers in 2016. In the long term (by 2030), prices are expected to increase to about 3.2 percent for line haul locomotives and about 1.5 percent for switchers. These small price increases reflect the relative amount of the compliance costs compared to the total cost of a locomotive or switcher (the engine is only a small part of the total cost of the locomotive). In all cases, the decrease in the quantity of line haul locomotives or switchers produced is expected to be less than 0.5 percent.

In the marine markets, price increases for engines are expected to be larger in 2016, varying from about 9 percent for C1 engines above 600 kW (800 hp) to 17 percent for auxiliary engines and C2 engines above 600 kW.[180] The price increases for vessels that use these engines, however, are smaller (about 2 percent and 7 percent, respectively), reflecting the relative amount of the compliance costs compared to the price of a commercial marine vessel. Production quantities are expected to decrease by less than 4 percent for engines and vessels. The long-term price impacts are similar, with expected price increases of about 12 percent for engines C2 above 600 kW and 7 percent for C1 engines above 600 kW, and vessel price increases of less than 5 percent. Long-term production quantity decreases are expected to be less than 3 percent.

[180] Results presented in this section are by marine engine category in kW; the actual EIA analysis presented in Chapter 7 of the RIA was performed using marine engine categories by hp.

Table V-11. Estimated Market Impacts for 2012, 2016, 2030 (2005$)

Market[c]	Average Variable Engineering Cost Per Unit	Change in Price		Change in Quantity	
		Absolute	Percent	Absolute	Percent
2012					
Rail Sector					
Locomotives	$0	-$535	-0.03%	-1	-0.1%
Switcher/Passenger	$0	-$348	-0.03%	0	-0.1%
Transportation Services	NA	NA[a]	0.1%	NA[a]	-0.1%
Marine Sector					
Engines					
Auxiliary >600 kW	$0	-$47	0.00%	0	-0.1%
C1>600 kW	$0	-$8	0.00%	0	0.0%
C2>600 kW	$0	-$139	-0.03%	0	- 0.1%
Other marine	$0	$0	0.00%	0	0.0%
Vessels					
C1>600 kW	$0	-$174	-0.01%	0	0.0%
C2>600 kW	$0	-$2,419	-0.07%	0	-0.1%
Other marine	$0	-$3	0.00%	1	0.0%
Transportation Services	NA	NA[a]	0.2%	NA[a]	-0.1%
2016					
Rail Sector					
Locomotives	$84,274	$83,227	4.2%	-1	-0.1%
Switcher/Passenger	$14,175	$13,494	1.0	0	-0.1%
Transportation Services	NA	NA[a]	0.3%	NA[a]	-0.1%
Marine Sector					
Engines					
Auxiliary >600 kW	$37,097	$35,569	17.1%	-11	-3.4%
C1>600 kW	$18,483	$16,384	8.5%	-15	-3.7%
C2>600 kW	$71,806	$71,602	16.3%	0	-0.2%
Other marine	$0	$0	0.00%	0	0.0%
Vessels					
C1>600 kW	$8,277	$34,043[b]	2.1%	-14	-3.7%
C2>600 kW	$12,107	$255,143[b]	7.0%	0	-0.2%
Other marine	$0	-$4	0.00%	-1	0.0%
Transportation Services	NA	NA[a]	0.4%	NA[a]	-0.2%
2030					
Rail Sector					
Locomotives	$65,343	$63,019	3.2%	-4	-0.3%
Switcher/Passenger	$21,139	$19,628	1.5%	-1	-0.3%
Transportation Services	NA	NA[a]	0.6%	NA[a]	-0.3%
Marine Sector					
Engines					
Auxiliary >600 kW	$28,359	$27,021	13.0%	-11	-2.8%
C1>600 kW	$14,131	$12,479	6.5%	-13	-2.9%

C2>600 kW	$54,893	$54,264	12.3%	-1	-0.5%
Other marine	$0	-$1	0.0%	0	0.0%
Vessels					
C1>600 kW	$6,933	$25,768[b]	1.6%	-12	-2.9%
C2>600 kW	$10,169	$164,774[b]	5.1%	0	-0.5%
Other marine	$0	-$12	0.0%	-4	0.0%
Transportation Services	NA	NA[a]	1.1%	NA[a]	-0.5%

Notes:
(a) The prices and quantities for transportation services are normalized ($1 for 1 unit of services provided) and therefore it is not possible to estimate the absolute change price or quantity; see 7.3.1.5.
(b) The estimated vessel impacts include the impacts of direct vessel compliance costs and the indirect impacts of engine markets for both propulsion and auxiliary engines. See Chapter 7 of the RIA.
(c) Results presented in this table are by marine engine category in kW; the actual EIA analysis presented in Chapter 7 of the RIA was performed using marine engine categories by hp.

(2) Economic Welfare Analysis

In the economic welfare analysis, we look at the total social costs associated with the program and their distribution across key stakeholders.

The total estimated social costs of the program are about $221 million, $284 million, 332 million and $738 million for 2012, 2016, 2020, and 2030. These estimated social costs are nearly identical to the total compliance costs for those years. The slight reduction in social costs when compared to compliance costs occurs because the total engineering costs do not reflect the decreased sales of locomotives, engines and vessels that are incorporated in the total social costs. Results for all years are presented in Chapter 7 of the RIA.

Table V-12 shows how total social costs are expected to be shared across stakeholders for selected years.

We estimate the net social costs of the program to be approximately $738 million in 2030.[181] The rail sector is expected to bear about 62.5 percent of the social costs of the program in 2030, and the marine sector is expected to bear about 37.5 percent. In each of these two sectors, these social costs are expected to be born primarily by producers and users of locomotive and marine transportation services (about 98 percent). The remaining 2 percent is expected to be borne by locomotive, marine engine, and marine vessel manufacturers and fishing and recreational users.

[181] All estimates presented in this section are in 2005$.

Table V-12 Summary of Estimated Social Costs for 2012, 2016, 2020, 2030 (2005$, $million)

Stakeholder Group[a]	2012		2016	
	Surplus Change	Percent	Surplus Change	Percent
Locomotives				
Locomotive Producers	-$35.1	15.9%	-$8.3	2.9%
Line haul producers	-$27.8	12.6%	-$0.9	0.3%
Switcher/Passenger producers	-$7.2	3.3%	-$7.4	2.6%
Rail transportation service providers	-$21.4	9.7%	-$43.4	15.3%
Rail transportation service consumers	-$68.4	31.0%	-$138.9	48.8%
Total locomotive sector	-$124.9	56.6%	-$190.6	67.0%
Marine				
Marine engine producers	-$45.8	20.7%	-$2.1	0.7%
Auxiliary >600 kW	-$16.0	7.3%	-$0.5	0.2%
C1 > 600 kW	-$19.0	8.6%	-$1.6	0.5%
C2 > 600 kW	-$10.7	4.9%	$0.0	0.0%
Other marine	$0.0	0.0%	$0.0	0.0%
Marine vessel producers	-$0.3	0.1%	-$15.8	5.6%
C1 > 600 kW	-$0.1	0.0%	-$13.5	4.7%
C2 > 600 kW	-$0.1	0.1%	-$2.2	0.8%
Other marine	-$0.1	0.0%	-$0.1	0.0%
Recreational and fishing vessel consumers	$0.0	0.0%	$0.0	0.0%
Marine transportation service providers	-$11.9	5.4%	-$18.1	6.4%
Marine transportation service consumers	-$38.1	17.3%	-$57.9	20.3%
Auxiliary Engines <600 kW	-$0.0	0.0%	$0.0	0.0%
Total marine sector	-$96.1	43.5%	-$93.8	33.0%
TOTAL PROGRAM	-$221.0		-$284.4	
Stakeholder Group	2020		2030	
	Surplus Change	Percent	Surplus Change	Percent
Locomotives				
Locomotive Producers	-$1.1	0.3%	-$3.1	0.4%
Line haul producers	-$1.0	0.3%	-$2.7	0.4%
Switcher/Passenger producers	-$0.1	0.0%	-$0.4	0.1%
Rail transportation service providers	-$46.4	14.0%	-$109.0	14.8%
Rail transportation service consumers	-$148.6	44.8%	-$348.9	47.3%
Total locomotive sector	-$196.1	59.1%	-$461.1	62.5%
Marine				
Marine engine producers	-$1.8	0.5%	-$2.0	0.3%
Auxiliary >600 kW	-$0.4	0.1%	-$0.5	0.1%
C1 > 600 kW	-$1.3	0.4%	-$1.4	0.2%
C2 > 600 kW	$0.0	0.0%	-$0.1	0.0%
Other marine	$0.0	0.0%	$0.0	0.0%
Marine vessel producers	-$10.3	3.1%	-$9.2	1.2%
C1 > 600 kW	-$8.8	2.7%	-$8.2	1.1%
C2 > 600 kW	-$1.3	0.4%	-$0.7	0.1%
Other marine	-$0.1	0.0%	-$0.3	0.0%
Recreational and fishing vessel consumers	$0.0	0.0%	$0.0	0.0%
Marine transportation service providers	-$29.5	8.9%	-$63.3	8.6%

Marine transportation service consumers	-$94.4	28.4%	-$202.5	27.4%
Auxiliary Engines <600 kW	$0.0	0.0%	$0.0	0.0%
Total marine sector	-$135.9	40.9%	-277.0	37.5%
TOTAL PROGRAM	$332.0		$738.1	

Note:
(a) Results presented in this table are by marine engine category in kW; the actual EIA analysis presented in Chapter 7 of the RIA was performed using marine engine categories by hp.

Table V-13 shows the distribution of total surplus losses for the program from 2007 through 2040. This table shows that the rail sector is expected to bear about 62 percent of the total program social costs through 2040 (NPV 3%), and that most of the costs are expected to be borne by the rail transportation consumers. The marine sector is expected to bear about 38 percent of the total program social costs through 2040 (NPV 3%), most of which are also expected to be borne by the marine transportation consumers. This is consistent with the structure of the program, which leads to high compliance costs for the rail marine transportation sectors.

Table V-13. Estimated Net Social Costs 2007 Through 2040 by Stakeholder ($million, 2005$)

Stakeholder Groups[a]	Surplus Change	Percent of Total Surplus	Surplus Change	Percent of Total Surplus
Locomotives	NPV 3%		NPV 7%	
Locomotive producers	-$221.1	2.4%	-$160.4	3.8%
Line Haul	-$172.2		-$124.5	
Switcher/Passenger	-$48.9		-$35.9	
Rail transportation service providers	-$1,302.7	14.2%	-$568.6	13.6%
Rail transportation service consumers	-$4,168.7	45.6%	-1,819.5	43.5%
Total locomotive sector	-$5,692.6	62.6%	-$2,548.5	61.0%
Marine				
Marine engine producers	-$307.5	3.4%	-$229.4	5.5%
Auxiliary >600 kW	-$87.3		-$64.0	
C1 > 600 kW	-$106.8		-$74.6	
C2 > 600 kW	-$56.8		-$42.6	
Other marine	-$56.7		-$48.1	
Marine vessel producers	-$150.0	1.6%	-$72.5	1.7%
C1 > 600 kW	-$126.8		-$60.8	
C2 > 600 kW	-$19.7		-$10.2	
Other marine	-$3.5		-$1.5	
Recreational and fishing vessel consumers	$0.2		$0.1	
Marine transportation service providers	-$704.6	7.7%	-$308.4	7.4%
Marine transportation service consumers	-$2,254.7	24.6%	-$986.9	23.6%
Auxiliary Engines <600 kW	-$40.2	0.4%	-$34.2	-0.8%
Total marine sector	$3,456.7	37.8%	-$1,631.3	39.0%
TOTAL PROGRAM	-$9.149.2		-$4,179.8	

Note:
[a] Results presented in this table are by marine engine category in kW; the actual EIA analysis presented in Chapter 7 of the RIA was performed using marine engine categories by hp.

(3) What Are the Significant Limitations of the Economic Impact Analysis?

Every economic impact analysis examining the market and social welfare impacts of a regulatory program is limited to some extent by limitations in model capabilities, deficiencies in the economic literatures with respect to estimated values of key variables necessary to configure the model, and data gaps. In this EIA, there three potential sources of uncertainty: (1) uncertainty resulting from the way the EIM is designed, particularly from the use of a partial equilibrium model; (2) uncertainty resulting from the values for key model parameters, particularly the price elasticity of supply and demand; and (3) uncertainty resulting from the values for key model inputs, particularly baseline equilibrium price and quantities.

Uncertainty associated with the economic impact model structure arises from the use of a partial equilibrium approach, the use of the national level of analysis, and the assumption of perfect competition. These features of the model mean it does not take into account impacts on secondary markets or the general economy, and it does not consider regional impacts. The results may also be biased to the extent that firms have some control over market prices, which would result in the modeling over-estimating the impacts on producers of affected goods and services.

The values used for the price elasticities of supply and demand are critical parameters in the EIM. The values of these parameters have an impact on both the estimated change in price and quantity produced expected as a result of compliance with the new standards and on how the burden of the social costs will be shared among producer and consumer groups. In selecting the values to use in the EIM it is important that they reflect the behavioral responses of the industries under analysis.

Finally, uncertainty in measurement of data inputs can have an impact on the results of the analysis. This includes measurement of the baseline equilibrium prices and quantities and the estimation of future year sales. In addition, there may be uncertainty in how similar engines and equipment were combined into smaller groups to facilitate the analysis. There may also be uncertainty in the compliance cost estimations.

While variations in the above model parameters may affect the distribution of social costs among stakeholders and the estimated market impacts, they will not affect the total social costs of the program. This is because the total social costs are directly related to the total compliance costs. To explore the effects of key sources of uncertainty on the distribution of social costs and on estimated price and quantity impacts, we performed a sensitivity analysis in which we examine the results of using alternative values for several model parameters. The results of these analyses are contained in Appendix 7H of the RIA prepared for this rule.

Despite these uncertainties, we believe this economic impact analysis provides a reasonable estimate of the expected market impacts and social welfare costs of the new standards in future. Acknowledging benefits omissions and uncertainties, we present a best estimate of the social costs based on our interpretation of the best available scientific literature and methods supported by EPA's Guidelines for Preparing Economic Analyses and the OAQPS Economic Analysis Resource Document.

VI. Benefits

This section presents our analysis of the health and environmental benefits that are estimated to occur as a result of the final locomotive and marine engine standards throughout the period from initial implementation through 2030. Nationwide, the engines that are subject to the emission standards in this rule are a significant source of mobile source air pollution. The standards will reduce exposure to NO_x and direct PM emissions and help avoid a range of adverse health effects associated with ambient $PM_{2.5}$ and ozone levels. In addition, the standards will help reduce exposures to diesel PM exhaust, various gaseous hydrocarbons and air toxics. As described below, the reductions in PM and ozone from the standards are expected to result in significant reductions in premature deaths and other serious human health effects, as well as other important public health and welfare effects.

EPA typically quantifies and monetizes PM- and ozone-related impacts in its regulatory impact analyses (RIAs) when possible. The RIA for the proposal for this rulemaking only quantified benefits from PM; in the current RIA we quantify and monetize the ozone-related health and environmental impacts associated with the final rule. The science underlying the analysis is based on the current ozone criteria document.[182] To estimate the incidence and monetary value of the health outcomes associated with this final rule, we used health impact functions based on published epidemiological studies, and valuation functions derived from the economics literature.[183] Key health endpoints analyzed include premature mortality, hospital and emergency room visits, school absences, and minor restricted activity days. The analytic approach to characterizing uncertainty is consistent with the analysis used in the RIA for the proposed O3 NAAQS.

The benefits modeling is based on peer-reviewed studies of air quality and health and welfare effects associated with improvements in air quality and peer-reviewed studies of the dollar values of those public health and welfare effects. These methods are consistent with benefits analyses performed for the recent analysis of the proposed Ozone

[182] U.S. Environmental Protection Agency (2006) Air quality criteria for ozone and related photochemical oxidants (second external review draft) Research Triangle Park, NC: National Center for Environmental Assessment; report no. EPA/600R-05/004aB-cB, 3v.Available: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=137307[March 2006]

[183] Health impact functions measure the change in a health endpoint of interest, such as hospital admissions, for a given change in ambient ozone or PM concentration.

NAAQS and the final PM NAAQS analysis.[184,185] They are described in detail in the RIAs prepared for those rules.

The range of PM benefits associated with the final standards is estimated based on risk reductions estimated using several sources of PM-related mortality effect estimates. In order to provide an indication of the sensitivity of the benefits estimates to alternative assumptions about PM mortality risk reductions, in Chapter 6 of the RIA we present a variety of benefits estimates based on two epidemiological studies (including the ACS study and the Six Cities Study) and the recent PM mortality expert elicitation.[186] EPA intends to ask the Science Advisory Board to provide additional advice as to which scientific studies should be used in future RIAs to estimate the benefits of reductions in PM-related premature mortality.

The range of ozone benefits associated with the final standards is also estimated based on risk reductions estimated using several sources of ozone-related mortality effect estimates. There is considerable uncertainty in the magnitude of the association between ozone and premature mortality. This analysis presents four alternative estimates for the association based upon different functions reported in the scientific literature. We use the National Morbidity, Mortality and Air Pollution Study (NMMAPS),[187] which was used as the primary basis for the risk analysis in the ozone Staff Paper[188] and reviewed by the Clean Air Science Advisory Committee (CASAC).[189] We also use three studies that synthesize ozone mortality data across a large number of individual studies.[190,191,192] Note that there are uncertainties within each study that are not fully captured by this range of estimates.

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[184] U.S. Environmental Protection Agency. August 2007. Proposed Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Ozone. Prepared by: Office of Air and Radiation. Available at http://www.epa.gov/ttn/ecas/ria.html#ria2007.

[185] U.S. Environmental Protection Agency. October 2006. Final Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter. Prepared by: Office of Air and Radiation. Available at HTTP://www.epa.gov/ttn/ecas/ria.html.

[186] Industrial Economics, Incorporated (IEc). 2006. Expanded Expert Judgment Assessment of the Concentration-Response Relationship Between $PM_{2.5}$ Exposure and Mortality. Peer Review Draft. Prepared for: Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. August.

[187] Bell, M.L., et al. 2004. Ozone and short-term mortality in 95 US urban communities, 1987-2000. Jama, 2004. 292(19): p. 2372-8.

[188] U.S. EPA (2007) Review of the National Ambient Air Quality Standards for Ozone, Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper.EPA-452/R-07-003. This document is available in Docket EPA-HQ-OAR-2003-0190. This document is available electronically at: http:www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_sp.html.

[189] CASAC (2007). Clean Air Scientific Advisory Committee's (CASAC) Review of the Agency's Final Ozone Staff Paper. EPA-CASAC-07-002. March 26.

[190] Bell, M.L., F. Dominici, and J.M. Samet. A meta-analysis of time-series studies of ozone and mortality with comparison to the national morbidity, mortality, and air pollution study. Epidemiology, 2005. 16(4): p. 436-45.

[191] Ito, K., S.F. De Leon, and M. Lippmann. Associations between ozone and daily mortality: analysis and meta-analysis. Epidemiology, 2005. 16(4): p. 446-57.

[192] Levy, J.I., S.M. Chemerynski, and J.A. Sarnat. 2005. Ozone exposure and mortality: an empiric bayes metaregression analysis. Epidemiology, 2005. 16(4): p. 458-68.

Recognizing that additional research is necessary to clarify the underlying mechanisms causing these effects, we also consider the possibility that the observed associations between ozone and mortality may not be causal in nature.. EPA has requested advice from the National Academy of Sciences on how best to quantify uncertainty in the relationship between ozone exposure and premature mortality in the context of quantifying benefits associated with ozone control strategies.

The range of total ozone- and PM-related benefits associated with the final standards is presented in Table VI-1. We present total benefits based on the PM- and ozone-related premature mortality function used. The benefits ranges therefore reflect the addition of each estimate of ozone-related premature mortality (each with its own row in Table VI-1) to estimates of PM-related premature mortality, derived from either the epidemiological literature or the expert elicitation. The estimates in Table VI-1, and all monetized benefits presented in this section, are in year 2006 dollars.

Table VI-1 Estimated 2030 Monetized PM-and Ozone-Related Health Benefits of the Final Locomotive and Marine Engine Standards[a]

2030 Total Ozone and PM Benefits – PM Mortality Derived from American Cancer Society Analysis[a]			
Premature Ozone Mortality Function or Assumption	Reference	Mean Total Benefits (Billions, 2006$, 3% Discount Rate)[c,d]	Mean Total Benefits (Billions, 2006$, 7% Discount Rate)[c,d]
NMMAPS	Bell et al., 2004	$9.7	$8.9
Meta-analysis	Bell et al., 2005	$11	$9.8
	Ito et al., 2005	$11	$10
	Levy et al., 2005	$11	$10
Assumption that association is not causal		$9.2	$8.4
2030 Total Ozone and PM Benefits – PM Mortality Derived from Expert Elicitation[b]			
Premature Ozone Mortality Function or Assumption	Reference	Mean Total Benefits (Billions, 2006$, 3% Discount Rate)[c,d]	Mean Total Benefits (Billions, 2006$, 7% Discount Rate)[c,d]
NMMAPS	Bell et al., 2004	$5.2 to $37	$4.8 to $34
Meta-analysis	Bell et al., 2005	$6.2 to $38	$5.8 to $35
	Ito et al., 2005	$6.7 to $39	$6.3 to $35
	Levy et al., 2005	$6.7 to $39	$6.4 to $35
Assumption that association is not causal		$4.7 to $37	$4.4 to $33

Notes:
(a) Total includes ozone and $PM_{2.5}$ benefits. Range was developed by adding the estimate from the ozone premature mortality function to the estimate of $PM_{2.5}$-related premature mortality derived from the ACS study (Pope et al., 2002).
(b) Total includes ozone and $PM_{2.5}$ benefits. Range was developed by adding the estimate from the ozone premature mortality function to both the lower and upper ends of the range of the $PM_{2.5}$ premature mortality functions characterized in the expert elicitation.
The effect estimates of five of the twelve experts included in the elicitation panel fall within the empirically-derived range provided by the ACS and Six-Cities studies. One of the experts fall below this range and six of the experts are above this range. Although the overall range across experts is summarized in this table, the full uncertainty in the estimates is reflected by the results for the full set of 12 experts. The twelve experts' judgments as to the likely mean effect estimate are not evenly distributed across the range illustrated by arraying the highest and lowest expert means.
(c) Note that total benefits presented here do not include a number of unquantified benefits categories. A detailed listing of unquantified health and welfare effects is provided in Table VI-6.

(d) Results reflect the use of both a 3 and 7 percent discount rate, as recommended by EPA's Guidelines for Preparing Economic Analyses and OMB Circular A-4. Results are rounded to two significant digits for ease of presentation and computation.

(1) Quantified Human Health and Environmental Effects of the Final Standards

In this section we discuss the ozone and $PM_{2.5}$ health and environmental impacts of the final standards. We discuss how these impacts are monetized in the next section. It should be noted that the emission control scenarios used in the air quality and benefits modeling are slightly different than the final emission control program. The differences reflect further refinements of the regulatory program since we performed the air quality modeling for this rule. Emissions and air quality modeling decisions are made early in the analytical process. Chapter 3 of the RIA describes the changes in the inputs and resulting emission inventories between the preliminary assumptions used for the air quality modeling and the final emission control scenario.

Estimated Ozone and PM Impacts

To model the ozone and PM air quality benefits of this rule we used the Community Multiscale Air Quality (CMAQ) model. CMAQ simulates the numerous physical and chemical processes involved in the formation, transport, and deposition of particulate matter. This model is commonly used in regional applications to estimate the ozone and PM reductions expected to occur from a given set of emissions controls. The meteorological data input into CMAQ are developed by a separate model, the Penn State University / National Center for Atmospheric Research Mesoscale Model, known as MM5. The modeling domain covers the entire 48-State U.S., as modeled in proposed ozone NAAQS analysis.[193] The grid resolution for the modeling domain was 12 x 12 km.

While this rule will reduce ozone levels generally and provide national ozone-related health benefits, this is not always the case at the local level. Due to the complex photochemistry of ozone production, reductions in NO_x emissions lead to both the formation and destruction of ozone, depending on the relative quantities of NO_x, VOC, and ozone catalysts such as the OH and HO_2 radicals. In areas dominated by fresh emissions of NO_x, ozone catalysts are removed via the production of nitric acid which slows the ozone formation rate. Because NO_x is generally depleted more rapidly than VOC, this effect is usually short-lived and the emitted NO_x can lead to ozone formation later and further downwind. The terms "NO_x disbenefits" or "ozone disbenefits" refer to the ozone increases that can result from NO_x emissions reductions in these localized areas. According to the North American Research Strategy for Tropospheric Ozone (NARSTO) Ozone Assessment, these disbenefits are generally limited to small regions within specific urban cores and are surrounded by larger regions in which NO_x control is

[193] See the Regulatory Impact Analysis for the Proposed Ozone NAAQS (EPA-452/R-07-008, July 2007). This document is available at http://www.epa.gov/ttn/ecas/ria.html#ria2007.

beneficial.[194] For this analysis, we observed two urban areas that, to some degree, experience ozone disbenefits: Southern California and Chicago.

Marginal changes in ozone in these areas are much more dependent upon baseline air quality conditions than PM due to nonlinearities present in the chemistry of ozone formation. A marginal decrease in NO_x emissions modeled on its own in these areas, as was done for this analysis, may yield a very different ambient ozone concentration than if it were modeled in combination with other planned or future controls. For example, recent California SIP modeling indicates that with a combined program of national and local controls, California can reach ozone attainment by 2024 through a mixture of substantial NO_x (and VOC) reductions.[195] In areas prone to ozone disbenefits, our ability to draw conclusions based on air quality modeling conducted for the final rule is limited because the yet-to-occur emission reductions in these areas are not accounted for in our analytical approach. Within these regions, it is expected that the additional NO_x reductions from SIP-based controls would lead to fewer ozone disbenefits from the marginal changes modeled here. More detailed information about the air quality modeling conducted for this analysis is included in the air quality modeling technical support document (TSD), which is located in the docket for this rule.

The modeled ambient air quality data serves as an input to the Environmental Benefits Mapping and Analysis Program (BenMAP).[196] BenMAP is a computer program developed by EPA that integrates a number of the modeling elements used in previous Regulatory Impact Analyses (e.g., interpolation functions, population projections, health impact functions, valuation functions, analysis and pooling methods) to translate modeled air concentration estimates into health effects incidence estimates and monetized benefits estimates.

The addition of ozone mortality to our health impacts analysis has led to an increased focus on the issue of ozone disbenefits for two related reasons: (1) The monetized value of ozone-related benefits, in terms of ozone's contribution to total rule-related benefits, has increased due to the inclusion of ozone mortality; and (2) The overall ozone impacts of NO_x reductions in certain geographic regions of the U.S., when modeled on the margin, may be negative.

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[194] The NARSTO Assessment Document synthesizes the scientific understanding of ozone pollution, giving special consideration to behavior on expanded scales over the North American continent, encompassing Canada, the United States, and Mexico. Successive drafts of this Assessment Document experienced progressive stages of review by its authors and by outside peers, and transcripts were recorded containing the review comments and the corresponding actions. This included an external review by the NRC, the comments of which were addressed and incorporated in the final draft. NARSTO, 2000. An Assessment of Tropospheric Ozone Pollution – A North American Perspective. NARSTO Management Office (Envair), Pasco, Washington. http://narsto.org/

[195] SCAQMD (2007). Final 2007 Air Quality Management Plan. Available at: http://www.aqmd.gov/aqmp/07aqmp/index.html. Accessed November 8, 2007.

[196] Information on BenMAP, including downloads of the software, can be found at http://www.epa.gov/air/benmap.

Figure 1 shows the diurnal pattern of ozone concentrations in the 2030 baseline and post-control scenarios for a grid cell in Orange County, CA during July. From this figure it is clear that the disbenefits (points when the control case ozone levels are higher than the baseline) are occurring primarily during nighttime hours when ozone is generally low.

This diurnal pattern means that the extent of the disbenefits is not as large as one might have thought. Our conversion from using a 24-hour metric to using the maximum 8-hour average metric in the ozone mortality studies (see page 6-4 and the health impacts section) excludes the nighttime hours when NO_x-related disbenefits are most likely to occur.

Figure 2: July 2030 time-series of CMAQ base and control modeling for Orange County, CA

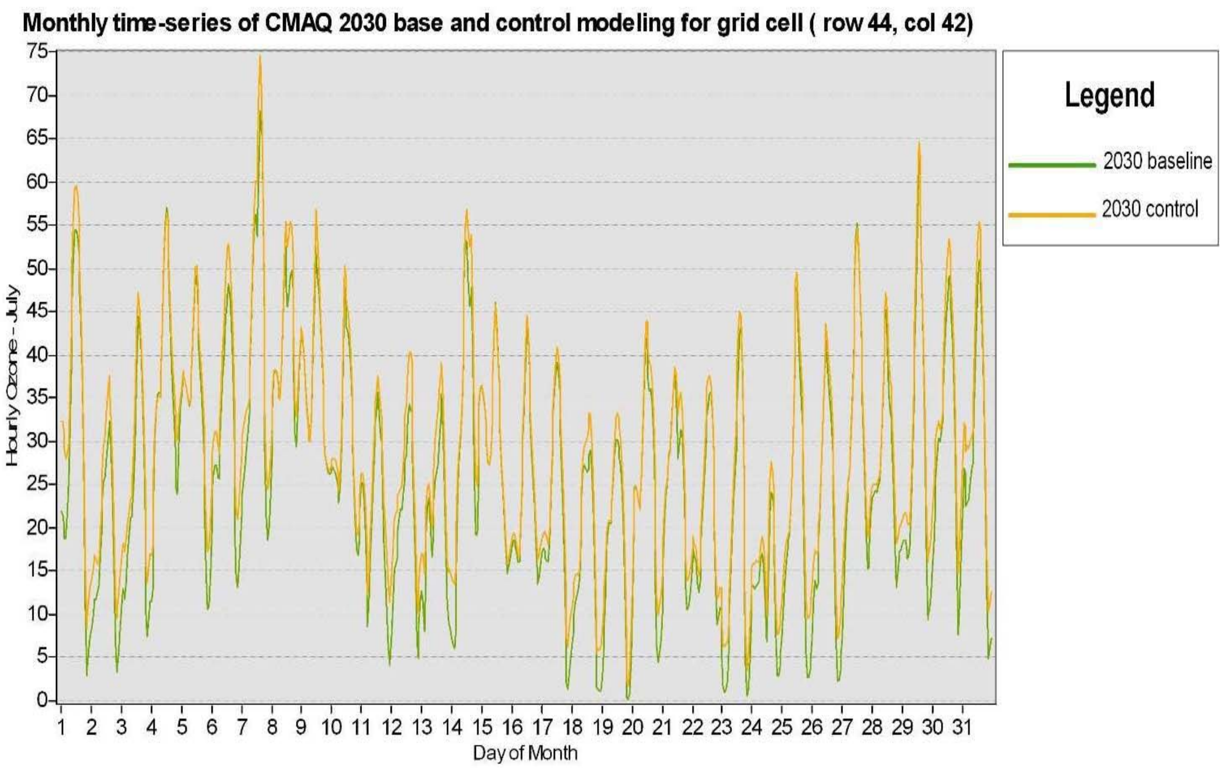

Table VI-2 resents the estimates of ozone- and PM-related health impacts for the years 2020 and 2030, which are based on the modeled air quality changes between a baseline, pre-control scenario and a post-control scenario reflecting the final emission control strategy.

The use of two sources of PM mortality reflects two different sources of information about the impact of reductions in PM on reduction in the risk of premature death, including both the published epidemiology literature and an expert elicitation study conducted by EPA in 2006. In 2030, based on the estimate provided by the ACS study, we estimate that PM-related emission reductions related to the final rule will result in 1,100 fewer premature fatalities annually. The number of premature mortalities avoided increases to 2,600 when based on the Six Cities study. When the range of expert opinion is used, we estimate between 500 and 4,900 fewer premature mortalities in 2030. We also estimate 680 fewer cases of chronic bronchitis, 2,500 fewer non-fatal heart attacks, 870 fewer hospitalizations (for respiratory and cardiovascular disease combined), 720,000 fewer days of restricted activity due to respiratory illness and approximately 120,000 fewer work-loss days. This analysis projects substantial health improvements for children from reduced upper and lower respiratory illness, acute bronchitis, and asthma attacks. These results are based on an assumed cutpoint in the long-term mortality concentration-response functions at 10 μg/m3, and an assumed cutpoint in the short-term morbidity concentration-response functions at 10 μg/m3. The impact using four alternative cutpoints (3 $\mu g/m^3$, 7.5 $\mu g/m^3$, 12 $\mu g/m^3$, and 14 $\mu g/m^3$) has on $PM_{2.5}$-related mortality incidence estimation is presented in Chapter 6 of the RIA.

For ozone, we estimate a range of between 54-250 fewer premature mortalities as a result of the final rule in 2030, assuming that there is a causal relationship between ozone exposure and mortality. We also estimate that by 2030, the final rule will result in over 500 avoided respiratory hospital admissions and emergency room visits, 290,000 fewer days of restricted activity due to respiratory illness, and 110,000 school loss days avoided.

Table VI-2 Estimated Reduction in Incidence of Adverse Health Effects Related to the Final Locomotive and Marine Engine Standards[a]

		2020	2030
Health Effect		Mean Incidence Reduction (5th – 95th %ile)	
PM-Related Endpoints			
Premature Mortality – Derived from Epidemiology Literature	Adult, age 30+ - ACS cohort study (Pope et al., 2002)	490 (190 - 790)	1,100 (440 – 1,800)
	Adult, age 25+ - Six-Cities study (Laden et al., 2006)	1,100 (610 - 1,600)	2,600 (1,400 – 3,700)
	Infant, age <1 year – Woodruff et al. 1997	1 (1 - 2)	2 (1 – 3)
Premature Mortality – Derived from Expert Elicitation[b]	Adult, age 25+ - Lower Bound (Expert K)	220 (0 - 1,100)	500 (0 – 2,400)
	Adult, age 25+ - Upper Bound (Expert E)	2,200 (1,100 - 3,300)	4,900 (2,500 – 7,500)
Chronic bronchitis (adult, age 26 and over)		310 (56 - 560)	680 (130 – 1,200)
Acute myocardial infarction (adults, age 18 and older)		1,000 (550 - 1,500)	2,500 (1,300 – 3,600)
Hospital admissions—respiratory (all ages)[c]		120 (58 - 170)	270 (130 – 400)
Hospital admissions—cardiovascular (adults, age >18)[d]		240 (150 - 330)	600 (380 – 820)
Emergency room visits for asthma (age 18 years and younger)		410 (240 - 580)	890 (520 – 1,300)
Acute bronchitis (children, age 8–12)		1,000 (-35 – 2,100)	2,300 (-77 – 4,600)
Lower respiratory symptoms (children, age 7–14)		9,200 (4,400 – 14,000)	20,000 (9,700 – 31,000)
Upper respiratory symptoms (asthmatic children, age 9–18)		6,700 (2,100 – 11,000)	15,000 (4,600 – 25,000)
Asthma exacerbation (asthmatic children, age 6–18)		8,400 (920 – 24,000)	19,000 (2,000 – 53,000)
Work loss days (adults, age 18–65)		59,000 (51,000 – 67,000)	120,000 (110,000 – 140,000)
Minor restricted-activity days (adults, age 18–65)		350,000 (290,000 – 400,000)	720,000 (610,000 – 830,000)
Ozone-Related Endpoints			
Premature Mortality, All ages – Derived from NMMAPS	Bell et al., 2004	13 (-22 - 49)	54 (-43 – 150)
Premature Mortality, All ages – Derived from Meta-analyses	Bell et al., 2005	44 (-47 - 140)	180 (-69 – 420)
	Ito et al., 2005	60 (-34 - 150)	240 (-14 – 500)
	Levy et al., 2005	62 (-14 – 140)	250 (44 - 450)
Premature Mortality – Assumption that association between ozone and mortality is not causal		0	0
Hospital admissions- respiratory causes (children, under 2; adult, 65 and older)[e]		14 (-150 - 170)	260 (-350 - 890)
Emergency room visit for asthma (all ages)		69	250

	(-89 - 270)	(-190 - 830)
Minor restricted activity days (adults, age 18-65)	84,000 (43,000 – 120,000)	290,000 (150,000 – 430,000)
School absence days	33,000 (-17,000 – 77,000)	110,000 (-15,000 – 240,000)

Notes:
(a) Incidence is rounded to two significant digits. PM and ozone estimates represent impacts from the final standards nationwide.
(b) Based on effect estimates derived from the full-scale expert elicitation assessing the uncertainty in the concentration-response function for PM-related premature mortality (IEc, 2006).[197]
The effect estimates of five of the twelve experts included in the elicitation panel fall within the empirically-derived range provided by the ACS and Six-Cities studies. One of the experts fall below this range and six of the experts are above this range. Although the overall range across experts is summarized in this table, the full uncertainty in the estimates is reflected by the results for the full set of 12 experts. The twelve experts' judgments as to the likely mean effect estimate are not evenly distributed across the range illustrated by arraying the highest and lowest expert means.
(c) Respiratory hospital admissions for PM include admissions for chronic obstructive pulmonary disease (COPD), pneumonia, and asthma.
(d) Cardiovascular hospital admissions for PM include total cardiovascular and subcategories for ischemic heart disease, dysrhythmias, and heart failure.
(e) Respiratory hospital admissions for ozone include admissions for all respiratory causes and subcategories for COPD and pneumonia.

(2) Monetized Benefits

Table VI-3 presents the estimated monetary value of reductions in the incidence of health and welfare effects. Tables VI-4 and VI-5 present the total annual PM- and ozone-related health benefits, which are estimated to be between \$9.2 and \$11 billion in 2030, assuming a 3 percent discount rate, or between \$8.4 and \$10 billion, assuming a 7 percent discount rate, using the ACS-derived estimate of PM-related premature mortality (Pope et al., 2002) and the range of ozone-related premature mortality studies derived from the epidemiological literature. The range of benefits expands to between \$4.7 and \$39 billion, assuming a 3 percent discount rate, when the estimate includes the opinions of outside experts on PM and the risk of premature death, or between \$4.4 and \$35 billion, assuming a 7 percent discount rate. All monetized estimates are stated in 2006\$. These estimates account for growth in real gross domestic product (GDP) per capita between the present and the years 2020 and 2030. As the tables indicate, total benefits are driven primarily by the reduction in premature fatalities each year.

The above estimates of monetized benefits include only one example of non-health related benefits. Changes in the ambient level of $PM_{2.5}$ are known to affect the level of visibility in much of the U.S. Individuals value visibility both in the places they live and work, in the places they travel to for recreational purposes, and at sites of unique public value, such as at National Parks. For the final standards, we present the recreational visibility benefits of improvements in visibility at 86 Class I areas located

[197] Industrial Economics, Incorporated (IEc). 2006. Expanded Expert Judgment Assessment of the Concentration-Response Relationship Between $PM_{2.5}$ Exposure and Mortality. Peer Review Draft. Prepared for: Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. August.

throughout California, the Southwest, and the Southeast. These estimated benefits are approximately $170 million in 2020 and $400 million in 2030, as shown in Table VI-3.

Table VI-3, VI-4 and VI-5 do not include those additional health and environmental benefits of the rule that we were unable to quantify or monetize. These effects are additive to the estimate of total benefits, and are related to two primary sources. First, there are many human health and welfare effects associated with PM, ozone, and toxic air pollutant reductions that remain unquantified because of current limitations in the methods or available data. A full appreciation of the overall economic consequences of the final standards requires consideration of all benefits and costs projected to result from the new standards, not just those benefits and costs which could be expressed here in dollar terms. A list of the benefit categories that could not be quantified or monetized in our benefit estimates are provided in Table VI-6.

Table VI-3 Estimated Monetary Value in Reductions in Incidence of Health and Welfare Effects (in millions of 2006$) [a,b]

		2020	2030
$PM_{2.5}$-Related Health Effect		Estimated Mean Value of Reductions (5th and 95th %ile)	
Premature Mortality – Derived from Epidemiology Studies[c,d,]	Adult, age 30+ - ACS study (Pope et al., 2002) 3% discount rate 7% discount rate	 $3,400 ($810 - $7,00) $3,100 ($730 - $6,300)	 $8,100 ($1,900 - $16,000) $7,300 ($1,700 - $15,000)
	Adult, age 25+ - Six-cities study (Laden et al., 2006) 3% discount rate 7% discount rate	 $7,800 ($2,200 - $15,000) $7,000 ($1,900 - $13,000)	 $18,000 ($5,100 - $35,000) $17,000 ($4,600 - $32,000)
	Infant Mortality, <1 year – (Woodruff et al. 1997) 3% discount rate 7% discount rate	 $7 ($2 - $14) $7 ($2 - $13)	 $13 ($3.5 - $26) $12 ($3.1 - $23)
Premature mortality – Derived from Expert Elicitation[c,d,e]	Adult, age 25+ - Lower bound (Expert K) 3% discount rate 7% discount rate	 $1,500 ($0 - $7,700) $1,400 ($0 - $7,000)	 $3,600 ($0 - $18,000) $3,200 ($0 - $16,000)
	Adult, age 25+ - Upper bound (Expert E) 3% discount rate 7% discount rate	 $15,000 ($4,100 - $30,000)	 $36,000 ($9,500 - $70,000) $32,000

		$14,000 ($3,700 - $27,000)	($8,600 - $63,000)
Chronic bronchitis (adults, 26 and over)		$150 ($12 - $500)	$340 ($28 - $1,100)
Non-fatal acute myocardial infarctions 3% discount rate 7% discount rate		 $110 ($34 - $230) $110 ($31 - $230)	 $260 ($74 - $550) $250 ($69 - $540)
Hospital admissions for respiratory causes		$2.1 ($1.0 - $3.2)	$4.9 ($2.4 - $7.3)
Hospital admissions for cardiovascular causes		$6.7 ($4.2 - $9.2)	$17 ($11 - $23)
Emergency room visits for asthma		$0.15 ($0.08 - $0.23)	$0.33 ($0.18 - $0.49)
Acute bronchitis (children, age 8–12)		$0.08 ($0 - $0.2)	$0.17 ($0 - $0.42)
Lower respiratory symptoms (children, 7–14)		$0.18 ($0.07 - $0.33)	$0.40 ($0.15 - $0.73)
Upper respiratory symptoms (asthma, 9–11)		$0.21 ($0.06 - $0.46)	$0.46 ($0.13 - $1.0)
Asthma exacerbations		$0.45 ($0.05 - $1.3)	$1.0 ($0.11 - $2.9)
Work loss days		$8.9 ($7.7 - $10)	$18 ($16 - $21)
Minor restricted-activity days (MRADs)		$22 ($13 – $32)	$46 ($27 - $66)
Recreational Visibility, 86 Class I areas		$170 (na)[f]	$400 (na)
Ozone-related Health Effect			
Premature Mortality, All ages – Derived from NMMAPS	Bell et al., 2004	$100 (-$170 - $420)	$440 (-$340 - $1,400)
Premature Mortality, All ages – Derived from Meta-analyses	Bell et al., 2005	$340 (-$360 - $1,200)	$1,400 (-$550 - $3,900)
	Ito et al., 2005	$460 (-$260 - $1,400)	$1,900 (-$120 - $4,700)
	Levy et al., 2005	$480 (-$110 - $1,300)	$2,000 ($280 - $4,400)
Premature Mortality – Assumption that association between ozone and mortality is not causal		$0	$0
Hospital admissions- respiratory causes (children, under 2; adult, 65 and older)		-$0.54 (-$4.6 - $3.3)	$2.7 (-$11 - $17)
Emergency room visit for asthma (all ages)		$0.03 (-$0.03 - $0.1)	$0.09 (-$0.07 - $0.30)
Minor restricted activity days (adults, age 18-65)		$2.5 (-$4.0 - $9.9)	$8.8 (-$7.8 - $28)
School absence days		$2.9 (-$1.5 - $6.8)	$11 (-$1.3 - $21)
Worker Productivity		$0.53 (na)[f]	$2.9 (na)[f]

Notes:

(a) Monetary benefits are rounded to two significant digits for ease of presentation and computation. PM and ozone benefits are nationwide.
(b) Monetary benefits adjusted to account for growth in real GDP per capita between 1990 and the analysis year (2020 or 2030)
(c) Valuation assumes discounting over the SAB recommended 20 year segmented lag structure. Results reflect the use of 3 percent and 7 percent discount rates consistent with EPA and OMB guidelines for preparing economic analyses (EPA, 2000; OMB, 2003).
(d) The valuation of adult premature mortality, derived either from the epidemiology literature or the expert elicitation, is not additive. Rather, the valuations represent a range of possible mortality benefits.
(e) Based on effect estimates derived from the full-scale expert elicitation assessing the uncertainty in the concentration-response function for PM-related premature mortality (IEc, 2006).[198] The effect estimates of five of the twelve experts included in the elicitation panel fall within the empirically-derived range provided by the ACS and Six-Cities studies. One of the experts fall below this range and six of the experts are above this range. Although the overall range across experts is summarized in this table, the full uncertainty in the estimates is reflected by the results for the full set of 12 experts. The twelve experts' judgments as to the likely mean effect estimate are not evenly distributed across the range illustrated by arraying the highest and lowest expert means.
(f) We are unable at this time to characterize the uncertainty in the estimate of benefits of worker productivity and improvements in visibility at Class I areas. As such, we treat these benefits as fixed and add them to all percentiles of the health benefits distribution.

Table VI-4 Total Monetized Benefits of the Final Locomotive and Marine Engine Rule –3% Discount Rate

Total Ozone and PM Benefits (billions, 2006$) – PM Mortality Derived from the ACS Study					
2020			2030		
Ozone Mortality Function	Reference	Mean Total Benefits	Ozone Mortality Function	Reference	Mean Total Benefits
NMMAPS	Bell et al., 2004	$4.0	NMMAPS	Bell et al., 2004	$9.7
Meta-analysis	Bell et al., 2005	$4.2	Meta-analysis	Bell et al., 2005	$11
	Ito et al., 2005	$4.4		Ito et al., 2005	$11
	Levy et al., 2005	$4.4		Levy et al., 2005	$11
Assumption that association is not causal		$3.9	Assumption that association is not causal		$9.2
Total Ozone and PM Benefits (billions, 2006$) – PM Mortality Derived from Expert Elicitation (Lowest and Highest Estimate)					
2020			2030		
Ozone Mortality Function	Reference	Mean Total Benefits	Ozone Mortality Function	Reference	Mean Total Benefits
NMMAPS	Bell et al., 2004	$2.1 to $16	NMMAPS	Bell et al., 2004	$5.2 to $37
Meta-analysis	Bell et al.,	$2.4 to $16	Meta-analysis	Bell et al.,	$6.2 to $38

[198] Industrial Economics, Incorporated (IEc). 2006. Expanded Expert Judgment Assessment of the Concentration-Response Relationship Between $PM_{2.5}$ Exposure and Mortality. Peer Review Draft. Prepared for: Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. August.

	2005			2005	
	Ito et al., 2005	$2.5 to $16		Ito et al., 2005	$6.7 to $39
	Levy et al., 2005	$2.5 to $16		Levy et al., 2005	$6.7 to $39
Assumption that association is not causal		$2.0 to $16	Assumption that association is not causal		$4.7 to $37

Table VI-5 Total Monetized Benefits of the Final Locomotive and Marine Engine Rule –7% Discount Rate

Total Ozone and PM Benefits (billions, 2006$) – PM Mortality Derived from Epidemiology Studies (ACS and Six Cities)					
2020			2030		
Ozone Mortality Function	Reference	Mean Total Benefits	Ozone Mortality Function	Reference	Mean Total Benefits
NMMAPS	Bell et al., 2004	$3.7	NMMAPS	Bell et al., 2004	$8.9
Meta-analysis	Bell et al., 2005	$3.9	Meta-analysis	Bell et al., 2005	9.8
	Ito et al., 2005	$4.0		Ito et al., 2005	$10
	Levy et al., 2005	$4.0		Levy et al., 2005	$10
Assumption that association is not causal		$3.6	Assumption that association is not causal		$8.4
Total Ozone and PM Benefits (billions, 2006$) – PM Mortality Derived from Expert Elicitation (Lowest and Highest Estimate)					
2020			2030		
Ozone Mortality Function	Reference	Mean Total Benefits	Ozone Mortality Function	Reference	Mean Total Benefits
NMMAPS	Bell et al., 2004	$2.0 to $14	NMMAPS	Bell et al., 2004	$4.8 to $34
Meta-analysis	Bell et al., 2005	$2.2 to $15	Meta-analysis	Bell et al., 2005	$5.8 to $35
	Ito et al., 2005	$2.3 to $15		Ito et al., 2005	$6.3 to $35
	Levy et al., 2005	$2.3 to $15		Levy et al., 2005	$6.4 to $35
Assumption that association is not causal		$1.9 to $14	Assumption that association is not causal		$4.4 to $33

Table VI-6 Unquantified and Non-Monetized Potential Effects of the Final Locomotive and Marine Engine Standards

Pollutant/Effects	Effects Not Included in Analysis - Changes in:
Ozone Health[a]	Chronic respiratory damage[b] Premature aging of the lungs[b] Non-asthma respiratory emergency room visits Exposure to UVb (+/-)[e]
Ozone Welfare	Yields for -commercial forests -some fruits and vegetables -non-commercial crops Damage to urban ornamental plants Impacts on recreational demand from damaged forest aesthetics Ecosystem functions Exposure to UVb (+/-)[e]
PM Health[c]	Premature mortality - short term exposures[d] Low birth weight Pulmonary function Chronic respiratory diseases other than chronic bronchitis Non-asthma respiratory emergency room visits Exposure to UVb (+/-)[e]
PM Welfare	Residential and recreational visibility in non-Class I areas Soiling and materials damage Damage to ecosystem functions Exposure to UVb (+/-)[e]
Nitrogen and Sulfate Deposition Welfare	Commercial forests due to acidic sulfate and nitrate deposition Commercial freshwater fishing due to acidic deposition Recreation in terrestrial ecosystems due to acidic deposition Existence values for currently healthy ecosystems Commercial fishing, agriculture, and forests due to nitrogen deposition Recreation in estuarine ecosystems due to nitrogen deposition Ecosystem functions Passive fertilization
CO Health	Behavioral effects
HC/Toxics Health[f]	Cancer (benzene, 1,3-butadiene, formaldehyde, acetaldehyde) Anemia (benzene) Disruption of production of blood components (benzene) Reduction in the number of blood platelets (benzene) Excessive bone marrow formation (benzene) Depression of lymphocyte counts (benzene) Reproductive and developmental effects (1,3-butadiene) Irritation of eyes and mucus membranes (formaldehyde) Respiratory irritation (formaldehyde) Asthma attacks in asthmatics (formaldehyde) Asthma-like symptoms in non-asthmatics (formaldehyde) Irritation of the eyes, skin, and respiratory tract (acetaldehyde) Upper respiratory tract irritation and congestion (acrolein)
HC/Toxics Welfare	Direct toxic effects to animals Bioaccumulation in the food chain Damage to ecosystem function Odor

Notes:
(a) The public health impact of biological responses such as increased airway responsiveness to stimuli, inflammation in the lung, acute inflammation and respiratory cell damage, and increased susceptibility to respiratory infection are likely partially represented by our quantified endpoints.
(b) The public health impact of effects such as chronic respiratory damage and premature aging of the lungs may be partially represented by quantified endpoints such as hospital admissions or premature mortality, but a number of other related health impacts, such as doctor visits and decreased athletic performance, remain unquantified.
(c) In addition to primary economic endpoints, there are a number of biological responses that have been associated with PM health effects including morphological changes and altered host defense mechanisms. The public health impact of these biological responses may be partly represented by our quantified endpoints.
(d) While some of the effects of short-term exposures are likely to be captured in the estimates, there may be premature mortality due to short-term exposure to PM not captured in the cohort studies used in this analysis. However, the PM mortality results derived from the expert elicitation do take into account premature mortality effects of short term exposures.
(e) May result in benefits or disbenefits.
(f) Many of the key hydrocarbons related to this rule are also hazardous air pollutants listed in the Clean Air Act.

(3) What Are the Significant Limitations of the Benefit-Cost Analysis?

Every benefit-cost analysis examining the potential effects of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Limitations of the scientific literature often result in the inability to estimate quantitative changes in health and environmental effects, such as potential increases in premature mortality associated with increased exposure to carbon monoxide. Deficiencies in the economics literature often result in the inability to assign economic values even to those health and environmental outcomes which can be quantified. These general uncertainties in the underlying scientific and economics literature, which can lead to valuations that are higher or lower, are discussed in detail in the RIA and its supporting references. Key uncertainties that have a bearing on the results of the benefit-cost analysis of the final standards include the following:

- The exclusion of potentially significant and unquantified benefit categories (such as health, odor, and ecological benefits of reduction in air toxics, ozone, and PM);
- Errors in measurement and projection for variables such as population growth;
- Uncertainties in the estimation of future year emissions inventories and air quality;
- Uncertainty in the estimated relationships of health and welfare effects to changes in pollutant concentrations including the shape of the C-R function, the size of the effect estimates, and the relative toxicity of the many components of the PM mixture;
- Uncertainties in exposure estimation; and
- Uncertainties associated with the effect of potential future actions to limit emissions.

As Table VI-3 indicates, total benefits are driven primarily by the reduction in premature mortalities each year. Some key assumptions underlying the premature mortality estimates include the following, which may also contribute to uncertainty:

- Inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis. Although biological mechanisms for this effect have not yet been completely established, the weight of the available epidemiological, toxicological, and experimental evidence supports an assumption of causality. The impacts of including a probabilistic representation of causality were explored in the expert elicitation-based results of the recently published PM NAAQS RIA. Consistent with that analysis, we discuss the implications of these results in the RIA for the final standards.

- All fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because PM produced via transported precursors emitted from locomotive and marine engines may differ significantly from PM precursors released from electric generating units and other industrial sources. However, no clear scientific grounds exist for supporting differential effects estimates by particle type.

- The C-R function for fine particles is approximately linear within the range of ambient concentrations under consideration (above the assumed threshold of 10 μg/m3). Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of PM, including both regions that may be in attainment with $PM_{2.5}$ standards and those that are at risk of not meeting the standards.

- There is considerable uncertainty in the magnitude of the association between ozone and premature mortality. The range of ozone benefits associated with the final standards is estimated based on the risk of several sources of ozone-related mortality effect estimates. Recognizing that additional research is necessary to clarify the underlying mechanisms causing these effects, we also consider the possibility that the observed associations between ozone and mortality may not be causal in nature. EPA has requested advice from the National Academy of Sciences on how best to quantify uncertainty in the relationship between ozone exposure and premature mortality in the context of quantifying benefits.

Despite these uncertainties, we believe this benefit-cost analysis provides a conservative estimate of the estimated economic benefits of the final standards in future years because of the exclusion of potentially significant benefit categories. Acknowledging benefits omissions and uncertainties, we present a best estimate of the total benefits based on our interpretation of the best available scientific literature and methods supported by EPA's technical peer review panel, the Science Advisory Board's Health Effects Subcommittee (SAB-HES). The National Academies of Science (NRC, 2002) also reviewed EPA's methodology for analyzing the health benefits of measures taken to reduce air pollution. EPA addressed many of these comments in the analysis of the final PM NAAQS.[199,200] The analysis of the final standards incorporates this most recent work to the extent possible.

(4) Benefit-Cost Analysis

In estimating the net benefits of the final standards, the appropriate cost measure is ‘social costs.’ Social costs represent the welfare costs of a rule to society. These costs do not consider transfer payments (such as taxes) that are simply redistributions of wealth. Table VI-7 contains the estimates of monetized benefits and estimated social welfare costs for the final rule and each of the final control programs. The annual social welfare costs of all provisions of this final rule are described more fully in Section VII of this preamble.

The results in Table VI-7 suggest that the 2020 monetized benefits of the final standards are greater than the expected social welfare costs. Specifically, the annual benefits of the total program will range between \$3.9 to \$8.8 billion annually in 2020 using a three percent discount rate, or between \$3.6 to \$8.0 billion assuming a 7 percent discount rate, compared to estimated social costs of approximately \$330 million in that same year. These benefits are expected to increase to between \$9.2 and \$22 billion annually in 2030 using a three percent discount rate, or between \$8.4 and \$20 billion assuming a 7 percent discount rate, while the social costs are estimated to be approximately \$740 million. Though there are a number of health and environmental effects associated with the final standards that we are unable to quantify or monetize (see Table VI-6), the benefits of the final standards far outweigh the projected costs. When we examine the benefit-to-cost comparison for the rule standards separately, we also find that the benefits of the specific engine standards far outweigh their projected costs.

[199] National Research Council (NRC). 2002. Estimating the Public Health Benefits of Proposed Air Pollution Regulations. The National Academies Press: Washington, D.C.
[200] U.S. Environmental Protection Agency. October 2006. Final Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter. Prepared by: Office of Air and Radiation. Available at HTTP://www.epa.gov/ttn/ecas/ria.html.

Table VI-7 Summary of Annual Benefits, Costs, and Net Benefits of the Final Locomotive and Marine Engine Standards (Millions, 2006$)[a]

Description	2020 (Millions of 2006 dollars)	2030 (Millions of 2006 dollars)
Estimated Social Costs[b]		
Locomotive	$200	$460
Marine	$140	$280
Total Social Costs	$330	$740
Estimated Health Benefits of the Final Standards[c,d,e,f]		
Locomotive		
3 percent discount rate	$2,000 to $4,400	$4,300 to $11,000
7 percent discount rate	$1,900 to $4,000	$4,000 to $10,000
Marine		
3 percent discount rate	$1,900 to $4,400	$4,900 to $11,000
7 percent discount rate	$1,700 to $4,000	$4,400 to $10,000
Total Benefits		
3 percent discount rate	$3,900 to $8,800	$9,200 to $22,000
7 percent discount rate	$3,600 to $8,000	$8,400 to $20,000
Annual Net Benefits (Total Benefits – Total Costs)		
3 percent discount rate	$3,600 to $8,500	$8,500 to $21,000
7 percent discount rate	$3,300 to $7,700	$7,700 to $19,000

Notes:
(a) All estimates represent annualized benefits and costs anticipated for the years 2020 and 2030. Totals may not sum due to rounding.
(b) The calculation of annual costs does not require amortization of costs over time. Therefore, the estimates of annual cost do not include a discount rate or rate of return assumption (see Chapter 7 of the RIA). In Section V, however, we do use both a 3 percent and 7 percent social discount rate to calculate the net present value of total social costs consistent with EPA and OMB guidelines for preparing economic analyses.
(c) Total includes ozone and $PM_{2.5}$ benefits. Range was developed by adding the estimate from the ozone premature mortality function, including an assumption that the association is not causal, to both estimates of $PM_{2.5}$-related premature mortality derived from the ACS (Pope et al., 2002) and Six-Cities (Laden et al., 2006) studies, respectively.
(d) Annual benefits analysis results reflect the use of a 3 percent and 7 percent discount rate in the valuation of premature mortality and nonfatal myocardial infarctions, consistent with EPA and OMB guidelines for preparing economic analyses (US EPA, 2000 and OMB, 2003).[201,202]
(e) Valuation of premature mortality based on long-term PM exposure assumes discounting over the SAB recommended 20-year segmented lag structure described in the Regulatory Impact Analysis for the Final Clean Air Interstate Rule (March, 2005).
(f) Not all possible benefits or disbenefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table VI-6.

VII. Alternative Program Options

The program we are finalizing today represents a broad and comprehensive approach to reducing emissions from locomotive and marine diesel engines. As we

[201] U.S. Environmental Protection Agency, 2000. Guidelines for Preparing Economic Analyses. www.yosemite1.epa.gov/ee/epa/eed/hsf/pages/Guideline.html.
[202] Office of Management and Budget, The Executive Office of the President, 2003. Circular A-4. http://www.whitehouse.gov/omb/circulars.

developed this final rule, we considered a number of alternatives with regard to the scope and timing of the standards. After carefully evaluating these alternatives, we believe that our new program provides the best opportunity for achieving timely and substantial emission reductions from locomotive and marine diesel engines. Our final program balances a number of key factors: (1) achieving significant emissions reductions as early as possible, (2) providing appropriate lead time to develop and apply advanced control technologies, and (3) coordinating requirements in this final rule with existing highway and nonroad diesel engine programs. The alternative scenarios described here were constructed to further evaluate each individual aspect of our program, and have enabled us to achieve the appropriate balance between these key factors. This section presents a summary of our analysis of these alternative control scenarios. For a more detailed explanation of our analysis, including a year by year breakout of expected costs and emission reductions, please refer to Chapter 8 of the Regulatory Impact Analysis (RIA) prepared for this final rulemaking.

A. Summary of Alternatives

(1) Alternative 1: Proposed Program from the Notice of Proposed Rulemaking

Alternative 1 examines the differences between the program we proposed and the program we are finalizing in this rulemaking. The proposal consisted of a three-part program. First, it proposed more stringent standards for existing locomotives that would apply when they were remanufactured. These standards would go into effect as soon as a certified remanufacture system became available. Second, we proposed a set of near-term emission standards, referred to as Tier 3, for freshly manufactured locomotives and marine engines that reflected the application of technologies to reduce engine-out PM and NO_x. Third, we proposed longer-term standards, referred to as Tier 4, that utilized high-efficiency catalytic aftertreatment technology enabled by the availability of ULSD. These standards would phase in over time, beginning in 2014. In addition, we proposed eliminating emissions from unnecessary locomotive idling.

The final rule makes a number of important changes to the program originally set out in the proposal which we believe will yield significantly greater overall NO_x and PM reductions, especially in the critical early years of the program. In particular, the adoption of standards for remanufactured marine engines and a 2-year pull-ahead of the Tier 4 NO_x requirements for line-haul locomotives and for 2000-3700 kW marine engines provide greater near-term reductions than the proposal. The final rule also expands the remanufactured locomotive program to include Class II railroads.

As a stand-alone program, through the year 2040 Alternative 1 provides $PM_{2.5}$ reductions of 286,000 tons NPV 3%, or 121,000 tons NPV 7%, and NO_x reductions of 8,140,000 tons NPV 3%, or 3,320,000 tons NPV 7%. The cost of this alternative through 2040 is estimated to be \$8,760 million NPV 3%, or \$3,900 million NPV 7%. In 2020, this alternative provides monetized health and welfare benefits of \$3.3 billion at a 3% discount rate, or \$3.0 billion at a 7% discount rate, and \$8.8 billion in 2030 at a 3% discount rate, or \$8.0 billion at a 7% discount rate. Through 2040 our final program provides additional $PM_{2.5}$ reductions of 22,000 tons NPV 3%, or 13,000 tons NPV 7%, and additional NO_x reductions of 620,000 tons NPV 3%, or 390,000 tons NPV 7%. Through 2040, the additional costs of our final program will be $650 million NPV 3%, or $410 million NPV 7%. The additional $PM_{2.5}$ monetized health and welfare benefits in 2020 of our final program are $0.6 billion at a 3% discount rate, or $0.6 billion at a 7% discount rate, while in 2030 the additional monetized health and welfare benefits total $0.4 billion at a 3% discount rate, or $0.4 billion at a 7% discount rate.

(2) Alternative 2: Exclusion of Remanufacturing Standards

Alternative 2 examines the potential impacts of the locomotive and marine remanufacturing programs by excluding them from the analysis (see sections III.B.(1)(a)(*i*), III.B.(1)(b), and III.B.(2)(b) of this Preamble for more details on the remanufacturing standards). As a stand-alone program, Alternative 2 provides $PM_{2.5}$ reductions of 240,000 tons NPV 3%, or 96,000 tons NPV 7%, and NO_x reductions of 7,640,000 tons NPV 3%, or 3,030,000 tons NPV 7%, through the year 2040. The cost of this alternative through 2040 is estimated to be $8,080 million NPV 3%, or $3,430 million NPV 7%. In 2020, this alternative provides monetized health and welfare benefits of $2.5 billion at a 3% discount rate, or $2.3 billion at a 7% discount rate, and $8.2 billion in 2030 at a 3% discount rate, or $7.5 billion at a 7% discount rate. Compared to the final program, our analysis shows that by 2040 eliminating the locomotive and marine remanufacture programs lessen $PM_{2.5}$ emission reductions by 68,000 tons NPV 3%, or 38,000 tons NPV 7%, and NO_x emission reductions by nearly 1,120,000 tons NPV 3%, or 680,000 tons NPV 7%. The cost of this alternative, as compared to our final program through 2040, is estimated to be $1,330 million less NPV 3%, or $880 million less NPV 7%. Compared to our final program, eliminating the locomotive and marine remanufacture programs reduce the monetized health and welfare benefits by $1.4 billion at a 3% discount rate, or $1.3 billion at a 7% discount rate in 2020, and $1.0 billion at a 3% discount rate, or $0.9 billion at a 7% discount rate in 2030.

(3) Alternative 3: Elimination of Tier 3

Alternative 3 eliminates the Tier 3 standards, while retaining the Tier 4 standards and the combined marine and locomotive remanufacturing requirements. As a stand-alone program, alternative 3 provides $PM_{2.5}$ reductions of 237,000 tons NPV 3%, or 100,000 tons NPV 7%, and NO_x reductions of 8,360,000 tons NPV 3%, or 3,530,000 tons NPV 7%, through the year 2040. The cost of this alternative through 2040 is estimated to be $9,240 million NPV 3%, or $4,160 million NPV 7%. In 2020, this alternative provides monetized health and welfare benefits of $2.8 billion at a 3% discount rate, or $2.6 billion at a 7% discount rate, and $7.8 billion in 2030 at a 3% discount rate, or $7.1 billion at a 7% discount rate. Comparing this alternative to our final program allows us to consider the value of the Tier 3 standards on their own merits. Specifically, this alternative would lessen $PM_{2.5}$ emissions reductions by nearly 71,000 tons NPV 3%, or 34,000 tons NPV 7%, and NO_x emissions by 400,000 tons NPV 3 %, or 180,000 tons NPV 7%. The cost of this alternative, as compared to our final program through 2040, is estimated to be $170 million less at NPV 3%, or $150 million less at NPV 7%. The monetized health and welfare benefits that would be forgone by eliminating Tier 3 are $1.1 billion at a 3% discount rate, or $1.0 billion at a 7% discount rate in 2020, and $1.4

billion at a 3% discount rate, or $1.3 billion at a 7% discount rate in 2030. Although the remanufacturing programs provide substantial benefits in the near-term, as evidenced by the analysis of Alternative 2, it is clear that Tier 3 also plays an important role in providing both near and long-term emission reductions.

(4) Alternative 4: Tier 4 Exclusively in 2013

Alternative 4 most closely reflects the program described in our Advanced Notice of Proposed Rulemaking, whereby we would set new aftertreatment based emission standards as soon as possible. In this case, we believe the earliest that such standards could logically be started is in 2013 (three months after the introduction of 15 ppm ULSD in this sector). Alternative 4 eliminates our Tier 3 standards along with the locomotive and marine remanufacturing standards, while pulling the Tier 4 standards ahead to 2013 for all portions of the Tier 4 program. We are unable to make an accurate estimate of the cost for such an approach since we do not believe it to be technically feasible at this time. However, we have reported a cost in the summary table reflecting the same cost estimation method we used for our primary case and have denoted unestimated additional costs as ‘C’. These additional unestimated costs would include costs for additional engine test cells, engineering staff, and engineering facilities necessary to introduce Tier 4 early. As a stand-alone program, alternative 4 provides $PM_{2.5}$ reductions of 249,000 tons NPV 3%, or 101,000 tons NPV 7%, and NO_x reductions of 8,320,000 tons NPV 3%, or 3,420,000 tons NPV 7% through the year 2040. In 2020, this alternative provides monetized health and welfare benefits of $3.0 billion at a 3% discount rate, or $2.8 billion at a 7% discount rate, and $8.4 billion in 2030 at a 3% discount rate, or $7.6 billion at a 7% discount rate. Through 2040, this alternative, as compared to our final program, would decrease $PM_{2.5}$ reductions by more than 59,000 NPV 3% tons, or 33,000 tons NPV 7%, and NO_x emissions by 440,000 tons NPV 3%, or 290,000 tons NPV 7%. Compared to our final program, the reduction in monetized health and welfare benefits of this alternative would be $0.9 billion at a 3% discount rate, or $0.8 billion at a 7% discount rate in 2020, while in 2030 the reductions in monetized benefits would be $0.8 billion at a 3% discount rate, or $0.8 billion at a 7% discount rate.

B. Summary of Results

A summary of the four alternatives is contained in Table VII-1 and Table VII-2 below. The PM and NO_x emissions reductions from the alternatives described here compare favorably—in terms of cost effectiveness—to other mobile source control programs that have been or will soon be implemented. These alternatives show that each element of our comprehensive program: the locomotive and marine remanufacturing programs, the near-term Tier 3 emission standards, and the long-term Tier 4 emission standards, represent valuable emission control programs on their own. The collective program results in the greatest emission reductions we believe to be possible giving consideration to all of the elements described in this final rule. Overall, our final program will provide very large reductions in PM, NO_x, and toxic compounds in both the near-term and the long-term. These reductions will be achieved in a manner that: (1) leverages technology developments in other diesel sectors, (2) aligns well with the clean diesel fuel requirements already being implemented, and (3) provides the lead time needed to deal with the significant engineering design workload that is involved.

Table VII-1 Summary of Inventory and Costs at NPV 3% and 7%

Alternatives	Standards	Estimated $PM_{2.5}$ Reductions 2006-2040		Estimated NO_x Reductions 2006-2040		Total Costs[a] Millions 2006-2040	
		NPV 3%	NPV 7%	NPV 3%	NPV 7%	NPV 3%	NPV 7%
Final Rule	• Locomotive Remanufacturing • Marine Remanufacturing, • Tier 3 Near-term program, • Tier 4 Long-term standards	308,000	134,000	8,760,000	3,710,000	$9,410	$4,310
Alternative 1: Proposed Case (NPRM)	• Proposed Locomotive Remanufacturing program, • Proposed Tier 3 Near-term program, • Proposed Tier 4 Long-term standards	286,000	121,000	8140000	3,320,000	$8,760	$3,900
Alternative 2: Exclusion of Remanufacturing Standards	• Tier 3 Near-term program, • Tier 4 Long-term standards	240,000	96,000	7640000	3,030,000	$8,080	$3,430
Alternative 3: Elimination of Tier 3	• Locomotive Remanufacturing, • Marine Remanufacturing, • Tier 4 Long-term standards	237,000	10,000	8360000	3,530,000	$9,240	$4,160
Alternative 4: Tier 4 Exclusively in 2013	• Tier 4 Long-term standards only in 2013	249,000	101,000	8,320,000	3,420,000	$9,070+C	$3950+C

Note:
(a) 'C' represents the additional costs necessary to accelerate the introduction of Tier 4 technologies that we are unable to estimate at this time.

Table VII-2 Inventory, Cost, and Benefits for 2020 and 2030

	$PM_{2.5}$ Emissions Reductions (tons)		NO_x Emissions Reductions (tons)		Total Costs[a] (Millions)		Benefits[b,c] (Billions) $PM_{2.5}$ only 3% Discount Rate		Benefits[b,c] (Billions) $PM_{2.5}$ only 7% Discount Rate	
	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Final Rule	14,000	27,000	370,000	790,000	$350	$760	$3.9	$9.2	$3.6	$8.4
Alternative 1: Proposed Case (NPRM)	13,000	26,000	310,000	780,000	$300	$750	$3.3	$8.8	$3.0	$8.0
Alternative 2: Exclusion of Remanufacturing Standards	8,800	24,000	280,000	760,000	$290	$720	$2.5	$8.2	$2.3	$7.5
Alternative 3: Elimination of Tier 3	8,800	21,000	350,000	760,000	$350	$760	$2.8	$7.8	$2.6	$7.1
Alternative 4: Tier 4 Exclusively in 2013	10,000	24,000	350,000	790,000	$360	$780	$3.0	$8.4	$2.8	$7.6

Notes:
(a) 'C' represents the additional costs necessary to accelerate the introduction of Tier 4 technologies that we are unable to estimate at this time.
(b) Note that the range of PM-related benefits reflects the use of an empirically-derived estimate of PM mortality benefits, based on the ACS cohort study (Pope et al., 2002).
(c) Annual benefits analysis results reflect the use of a 3 percent and 7 percent discount rate in the valuation of premature mortality and nonfatal myocardial infarctions, consistent with EPA and OMB guidelines for preparing economic analyses (US EPA, 2000 and OMB, 2003).U.S. Environmental Protection Agency, 2000. Guidelines for Preparing Economic Analyses. http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

VIII. Public Participation

Many interested parties participated in the rulemaking process that culminates with this final rule. This process provided opportunity for submitting written public comments following the proposal that we published on April 3, 2007 (72 FR 15938). We considered these comments in developing the final rule. In addition, we held public hearings on the proposed rulemaking on May 8 and 10, 2007, and we have considered comments presented at the hearings.

Throughout the rulemaking process, EPA met with stakeholders including representatives from industry, government, environmental organizations, and others. The program we are finalizing today was developed as a collaborative effort with these stakeholders.

We have prepared a detailed Summary and Analysis of Comments document, which describes comments we received on the proposal and our response to each of these comments. The Summary and Analysis of Comments is available in the docket for this rule at the Internet address listed under **ADDRESSES**, as well as on the Office of Transportation and Air Quality Web site (www.epa.gov/otaq/locomotv.htm and www.epa.gov/otaq/marine.htm). In addition, comments and responses for key issues are included throughout this preamble.

IX. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

Under section 3(f)(1) of Executive Order (EO) 12866 (58 FR 51735, October 4, 1993), this action is an "economically significant regulatory action" because it is likely to have an annual effect on the economy of $100 million or more. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under EO 12866, and any changes made by EPA after submission to OMB have been documented in the docket for this action.

In addition, EPA prepared an analysis of the potential costs and benefits associated with this action. This analysis is contained in the final Regulatory Impact Analysis that was prepared for this rulemaking, and is available in the docket at the docket internet address listed under **ADDRESSES** above.

B. Paperwork Reduction Act

The information collection requirements in this final rule have been submitted for approval to the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. EPA may not conduct the information collection requirements in this rule and may not penalize anyone for failing to comply with the information collection requirements in the rule unless they are currently approved by OMB.

EPA plans to be collect information to ensure that locomotives and marine diesel engines conform to the regulations throughout their useful lives. Section 208(a) of the Clean Air Act requires that manufacturers provide information the Administrator may reasonably require to determine compliance with the regulations; submission of the information is therefore mandatory. We will consider confidential all information meeting the requirements of Section 208(c) of the Clean Air Act.

The annual public reporting and recordkeeping burden for this collection of information is estimated to be 287 hours per respondent for locomotives, and 149 hours per respondent for marine. The projected number of respondents and annual reporting, recordkeeping, and cost burdens to respondents are as follows:

- Estimated total number of potential respondents: for locomotives- 7; for marine- 13.

- Estimated total annual burden hours: for locomotives- 14,040 (2,010 per respondent); for marine- 25,167 (1,940 per respondent).

- Estimated total annual costs: for locomotives- $1.65 million ($315,000 per respondent); for marine- $1.45 million ($112,000 per respondent).

Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9. When this ICR is approved by OMB, EPA will publish a technical amendment to 40 CFR part 9 in the Federal Register to display the OMB control number for the approved information collection requirements contained in this final rule.

C. Regulatory Flexibility Act

(1) Overview

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

For purposes of assessing the impacts of today's rule on small entities, small entity is defined as: (1) a small business as defined by the Small Business Administration’s (SBA) regulations at 13 CFR 121.201 (see Table IX-1, below); (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

Table IX-1 - Primary SBA Small Business Categories Potentially Affected by this Regulation

Industry	NAICS[a] Codes	Defined by SBA as a small business if less than or equal to:[b]
Locomotive:		
Manufacturers, remanufacturers and importers of locomotives and locomotive engines	333618, 336510	1,000 employees
Railroad owners and operators	482110, 482111, 482112	1,500 employees 500 employees
Engine repair and maintenance	488210	$6.5 million annual sales
Marine:		
Manufacturers of freshly manufactured marine diesel engines	333618	1,000 employees
Ship and boat building; ship building and repairing	336611, 346611	1,000 employees
Engine repair and maintenance	811310	$6.5 million annual sales
Water transportation, freight and passenger	483	500 employees
Water transportation, freight and passenger – Offshore Marine Services	483	$25.5 million annual sales
Scenic and Sightseeing Transportation, Water	487210	$6.5 million annual sales
Navigational Services to Shipping	488330	$6.5 million annual sales
Commercial Fishing	114	$4.0 million annual sales
Boat building (watercraft not built in shipyards and typically of the type suitable or intended for personal use)	336612	500 employees

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

After considering the economic impacts of today's final rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities. The small entities directly regulated by this final rule are shown in

Table IX-1 (and are not small governmental jurisdictions or small non-profit organizations). We have determined that about five small entities representing less than one percent of the total number of companies affected will have an estimated impact exceeding three percent of their annual sales revenues. The vast majority of small entities (about several thousand small companies) will have an estimated impact of less than one percent on their annual sales revenues. (An analysis of the impacts of the rule on small entities was performed for the rule, and can be found in the docket for this rulemaking.[203,204])

Although this final rule will not have a significant economic impact on a substantial number of small entities, EPA nonetheless has tried to reduce the impact of this rule on small entities, as described below.

(2) Outreach Efforts and Special Compliance Provisions for Small Entities

In addition to the inputs we sought prior to issuing the proposed rule, we also received additional comments following its publication. First we summarize the pre-proposal outreach, followed by additional comments we received after the proposal was published.

Early on, we sought the input of a number of small entities affected by the rule on potential regulatory flexibility provisions and the needs of these small businesses. For marine diesel engine manufacturers, we had separate meetings with the four small companies in this sector, which are post-manufacture marinizers (companies that purchase a complete or semi-complete engine from an engine manufacturer and modify it for use in the marine environment by changing the engine in ways that may affect emissions). We also met individually with one small commercial vessel builder and a few vessel trade associations whose members include small vessel builders. For locomotive manufacturers and remanufacturers, we met separately with the three small businesses in these sectors, which are all remanufacturers. In addition, we met with a railroad trade association whose members include small railroads. For nearly all meetings, EPA provided each small business with an outreach packet that included background information on this proposed rulemaking; and a document outlining some flexibility provisions for small businesses that we have implemented in past rulemakings. (This outreach packet and a complete summary of our discussions with small entities can be found in the docket for this rulemaking.)[205]

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[203] U.S. EPA, Assessment and Standards Division, Locomotive and Marine Diesel RFA/SBREFA Screening Analysis, Memorandum from Chester J. France to Alexander Cristofaro of U.S. EPA's Office of Policy, Economics, and Innovation, September 25, 2006.
[204] U.S. EPA, Assessment and Standards Division, Supplement to Locomotive and Marine Diesel RFA/SBREFA Screening Analysis - Marine Existing Fleet Program Impact Analysis, Memorandum from Lucie Audette and Bryan Manning to Docket EPA-HQ-OAR-2003-0190, December 12, 2007.
[205] U.S. EPA, Summary of Small Business Outreach for Locomotive and Marine Diesel NPRM, Memorandum to Docket EPA-HQ-OAR-2003-0190 from Bryan Manning, January 18, 2007.

The primary feedback we received from these small entities pre-proposal was to continue the flexibility provisions that we have provided to small entities in earlier locomotive and marine diesel rulemakings. A number of these provisions are listed below. Therefore, we will largely continue the existing flexibility provisions finalized in the 1998 Locomotive and Locomotive Engines Rule (April 16,1998; 63 FR 18977); our 1999 Commercial Marine Diesel Engines Rule (December 29,1999; 64 FR 73299) and our 2002 Recreational Diesel Marine program (November 8, 2002; 67 FR 68304).

In the proposed rule, we requested comment on an alternative program option – a marine existing fleet or remanufacture program (Alternative 5: Existing Engines) – and as described earlier in this preamble, we are finalizing a portion of this alternative. Based on oral testimony at the hearings and written comments (from trade associations, small entities, etc.), we are providing flexibilities to vessel operators and/or marine remanufacturers as described below. For a complete description of the flexibilities in this final rule, please refer to the Certification and Compliance Program, section IV.A.(13) - Small Business Provisions.

(a) Transition Flexibilities

(i) Locomotive Sector

Small locomotive remanufacturers are granted a waiver from production-line and in-use testing for up to five calendar years after this program becomes effective.

Class III railroads qualifying as small businesses are exempt from new Tier 0, 1, and 2 remanufacturing requirements for locomotives in their existing fleets. The Certification and Compliance Program section IV.A.(13) provides a discussion on the revisions being made in this program.

Railroads qualifying as small businesses continue being exempt from the in-use testing program.

(ii) Marine Sector

Post-manufacture marinizers and small-volume manufacturers (annual worldwide production of fewer than 1,000 engines) are allowed to group all engines into one engine family, based on the worst-case emitter.

Small-volume manufacturers producing engines less than or equal to 600 kW (800 hp) are exempted from production-line and deterioration testing (assigned deterioration factors) for Tier 3 standards.

Post-manufacture marinizers qualifying as small businesses and producing engines less than or equal to 600 kW (800 hp) may delay compliance with the Tier 3 standards by one model year.

Post-manufacture marinizers qualifying as small businesses and producing engines less than or equal to 600 kW (800 hp) may delay compliance with the Not-to-Exceed requirements for Tier 3 standards by up to three model years.

Marine engine dressers (modify base engine without affecting the emission characteristics of the engine) are exempted from certification and compliance requirements.

Post-manufacture marinizers, small-volume manufacturers, and small-volume boat builders (less than 500 employees and annual worldwide production of fewer than 100 boats) have hardship relief provisions – i.e., apply for additional time.

For the marine existing fleet or remanufacture program, vessel operators and marine remanufacturers qualifying as small businesses also have hardship relief provisions allowing them if necessary to apply for additional time to comply with program requirements.

Vessel operators who earn less than $5 million in gross annual sales revenue are exempted from the marine existing fleet or remanufacture program. If at some future date annual gross revenues exceed $5 million, they become subject to the existing fleet program at that point.

(b) Small Entity Compliance Information

In addition to the above flexibilities, EPA is also preparing documentation to help small entities comply with this rule. This documentation will be available on the Office of Transportation and Air Quality Web site. Small entities may also contact our office to obtain copies of this documentation.

D. Unfunded Mandates Reform Act

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

203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

This rule contains no federal mandates for state, local, or tribal governments as defined by the provisions of Title II of the UMRA. The rule imposes no enforceable duties on any of these governmental entities. Nothing in the rule would significantly or uniquely affect small governments. EPA has determined that this rule contains federal mandates that may result in expenditures of more than $100 million to the private sector in any single year. Accordingly, EPA has evaluated under section 202 of the UMRA the potential impacts to the private sector. EPA believes that this rule represents the least costly, most cost-effective approach to achieve the statutory requirements of the rule. The costs and benefits associated with this rule are included in the final Regulatory Impact Analysis (RIA), as required by the UMRA. This analysis, can be found in chapter 6 of the final RIA; a complete discussion of why the approach being finalized in this action was chosen, is located in chapter 8 of the final RIA. EPA has determined that this rule contains no regulatory requirements that might significantly or uniquely affect small governments.

Thus, this rule is not subject to the requirements of sections 202 and 205 of the UMRA.

E. Executive Order 13132 (Federalism)

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

This final rule does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. Although section 6 of Executive Order 13132 does not apply to this rule, EPA did consult with representatives of various State and local governments in developing this rule. EPA consulted with representatives from the National Association of Clean Air Agencies (NACAA, formerly STAPPA/ALAPCO), the Northeast States for Coordinated Air Use Management (NESCAUM), and the California Air Resources Board (CARB). These organizations and other state organizations submitted comments on the proposed rule. Their comments are available in the rulemaking docket, and are summarized and addressed in the Summary and Analysis of Comments document (which also available in the rulemaking docket).

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

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

Executive Order 13175, entitled "Consultation and Coordination with Indian Tribal Governments" (65 FR 67249, November 9, 2000), requires EPA to develop an accountable process to ensure "meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." This final rule does not have tribal implications, as specified in Executive Order 13175. The rule will be implemented at the Federal level and impose compliance costs only on locomotive manufacturers, locomotive engine manufacturers, locomotive operators, locomotive remanufacturers, marine engine manufacturers, and marine vessel manufacturers. Tribal governments will be affected only to the extent they purchase and use the regulated engines and vehicles. Thus, Executive Order 13175 does not apply to this rule.

Although Executive Order 13175 does not apply to this rule, EPA did solicit additional comment on this rule from tribal officials. A comment was received from one tribal government; that comment is available in the rulemaking docket, and is summarized and addressed in the Summary and Analysis of Comments document (which is also available in the rulemaking docket).

G. Executive Order 13045: Protection of Children From Environmental Health and Safety Risks

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

This final rule is subject to the Executive Order because it is an economically significant regulatory action as defined by Executive Order 12866, and we believe that the environmental health or safety risk addressed by this action may have a disproportionate effect on children. Accordingly, we have evaluated the environmental health or safety effects of these risks on children. The results of this evaluation are discussed above in section II of this preamble, and in chapter 2 of the Regulatory Impact Analysis (RIA).

EPA recently conducted an initial screening-level analysis of selected marine port areas and rail yards[206,207] to begin to understand the populations, including children, that are exposed to DPM emissions from these facilities. This screening-level analysis[208] indicates that at the 47 marine ports and 37 rail yards studied, at least 13 million people, including 3.5 million children live in neighborhoods that are exposed to higher levels of DPM from these facilities than people living further away and will benefit from the controls being finalized in this action..

With regard to children, the screening-level analysis shows that the age composition of the total affected population near both the marine ports and rail yards matches closely the age composition of the overall U.S. population. However, for some individual facilities the young appear to be over-represented in the affected population compared to the overall U.S. population. See section VI of this preamble and chapters 2 and 6 of the RIA for a discussion on the air quality and monetized health benefits of this rule, including the benefits to children's health.

This rulemaking will achieve significant reductions of various emissions from locomotive and marine diesel engines, including NO_x, PM, and air toxics. These pollutants raise concerns regarding environmental health or safety risks that EPA has reason to believe may have a disproportionate effect on children, such as impacts from ozone, PM, and certain toxic air pollutants.

EPA has evaluated several regulatory strategies for reductions in emissions from locomotive and marine diesel engines, and we believe that we have selected the most stringent and effective control reasonably feasible at this time (in light of the technology and cost requirements of the Clean Air Act), which will benefit the health of children.

H. Executive Order 13211: Actions That Significantly Affect Energy Supply, Distribution, or Use

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" (66 FR 28355 (May 22, 2001)), requires EPA to prepare and submit a Statement of Energy Effects to the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, for certain actions identified as "significant energy actions." Section 4(b) of Executive Order 13211 defines "significant energy actions" as "any action by an agency (normally

[206] ICF International. September 28, 2007. Estimation of diesel particulate matter concentration isopleths for marine harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190.
[207] ICF International. September 28, 2007. Estimation of diesel particulate matter population exposure near selected harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190.
[208] This type of screening-level analysis is an inexact tool and not appropriate for regulatory decision-making; it is useful in beginning to understand potential impacts and for illustrative purposes. Additionally, the emissions inventories used as inputs into our analysis are not official estimates and they likely underestimate overall emissions because they are not inclusive of all emissions sources at the individual ports in our sample.

published in the Federal Register) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices of inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking: (1)(i) that is a significant regulatory action under Executive Order 12866 or any successor order, and (ii) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (2) that is designated by the Administrator of the Office of Information and Regulatory Affairs as a significant energy action." We have prepared a Statement of Energy Effects for this action as follows.

This rule's potential effects on energy supply, distribution, or use have been analyzed and are discussed in detail in section 5.8 of the RIA. In summary, while we project that this rule would result in an energy effect that exceeds the 4,000 barrel per day threshold noted in E.O. 13211 in or around the year 2022 and thereafter, the program consists of performance-based standards with averaging, banking, and trading provisions that make it likely that our estimated impact is overstated. Further, the fuel consumption estimates upon which we are basing this energy effect analysis, which are discussed in full in sections 5.4 and 5.5 of the RIA, do not reflect the potential fuel savings associated with automatic engine stop/start (AESS) systems or other idle reduction technologies. Such technologies can provide significant fuel savings which could offset our projected estimates of increased fuel consumption. Nonetheless, our projections show that this rule could result in energy usage exceeding the 4,000 barrel per day threshold noted in E.O. 13211.

I. National Technology Transfer Advancement Act

As noted in the proposed rule, Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law No. 104-113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. The NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This rule references technical standards adopted by EPA through previous rulemakings. No new technical standards are established in this rule. The standards referenced in today's rule involve test procedures for measuring engine emissions. These measurement standards include those that were developed by EPA as well as the International Organization for Standardization (ISO) engine testing voluntary consensus standards, adopted in previous rulemakings. These standards have served EPA's emissions control goals well since their implementation and have been well accepted by industry. Therefore, EPA will continue to use the ISO and existing EPA-developed standards referenced in 40 CFR Parts 94 and 1065.

J. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order (EO) 12898 (59 FR 7629 (Feb. 16, 1994)) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

EPA has determined that this final rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population.

This rulemaking will achieve significant reductions of various emissions from locomotive and marine diesel engines, including NO_x, PM, and air toxics. Exposure to these pollutants raises concerns regarding environmental health for the U.S. population in general including the minority populations and low-income populations that are the focus of the environmental justice executive order.

EPA has evaluated several regulatory strategies for reductions in emissions from locomotive and marine diesel engines, and we believe that we have selected the most stringent and effective control reasonably feasible at this time (in light of the technology and cost requirements of the Clean Air Act).

The emission reductions from the stringent new standards finalized in the locomotive and marine diesel rule will have large beneficial effects on communities in proximity to port, harbor, waterway, railway, and rail yard locations, including low-income and minority communities. In addition to stringent exhaust emission standards for freshly manufactured and remanufactured engines, the final rules includes provisions targeted to further reduce emissions from regulated engines that directly impact low-income and minority communities. The idle reduction provision is one example: "Even in very efficient railroad operations, locomotive engines spend a substantial amount of time idling, during which they emit harmful pollutants, consume fuel, create noise, and increase maintenance costs. A significant portion of this idling occurs in rail yards, as railcars and locomotives are transferred to build up trains. Many of these rail yards are in urban neighborhoods, close to where people live, work, and go to school" (from section III.C(1)(c) of this preamble). The final rule includes a mandatory locomotive idle reduction requirement that will begin to take effect as early as 2008. Another example is the emission standards for freshly manufactured switch locomotives. Switch locomotives are major polluters in urban rail yards. These standards are earlier and more stringent than the line-haul locomotive standards, and include incentives for introducing cleaner switchers using Tier 4 nonroad engines. Further examples can be found in averaging, banking, and trading program provisions aimed at ensuring that emissions are not shifted from line-haul locomotives operating in rural areas to rail yards in urban communities.

EPA recently conducted an initial screening-level analysis of selected marine port areas and rail yards[209,210] to better understand the populations, including minority and low-income, that are exposed to DPM emissions from these facilities. This screening-level analysis[211] indicates that at the 47 marine ports and 37 rail yards studied at least 13 million people, including a high percentage of low-income households, African-Americans, and Hispanics, live in the vicinity of these facilities and are exposed to higher levels of DPM than urban background levels. Thus, these residents will benefit from the controls being finalized in this action. See section II.A and II.B of this preamble and chapter 2 of the RIA for a discussion on the benefits of this rule, including the benefits to minority and low-income communities. Because those living in the vicinity of marine ports and rail yards are more likely to be low-income and minority residents, these populations will receive a significant benefit from this rule.

K. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 et seq., as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of the rule in the Federal Register. A Major rule cannot take effect until 60 days after it is published in the Federal Register. This action is a "major rule" as defined by 5 U.S.C. 804(2). This rule will be effective [INSERT DATE 60 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].

X. Statutory Provisions and Legal Authority

Statutory authority for the controls in this final rule can be found in sections 213 (which specifically authorizes controls on emissions from nonroad engines and vehicles), 203-209, 216, and 301 of the Clean Air Act (CAA), 42 U.S.C. 7547, 7522, 7523, 7424, 7525, 7541, 7542, 7543, 7550, and 7601.

List of Subjects

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[209] ICF International. September 28, 2007. Estimation of diesel particulate matter concentration isopleths for marine harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190.

[210] ICF International. September 28, 2007. Estimation of diesel particulate matter population exposure near selected harbor areas and rail yards. Memorandum to EPA under Work Assignment Number 0-3, Contract Number EP-C-06-094. This memo is available in Docket EPA-HQ-OAR-2003-0190.

[211] This type of screening analysis is an inexact tool and not appropriate for regulatory decision-making; it is useful in beginning to understand potential impacts and for illustrative purposes. Additionally, the emissions inventories used as inputs into our analysis are not official estimates and they likely underestimate overall emissions because they are not inclusive of all emission sources at the individual ports in our sample.

40 CFR Part 9

Reporting and recordkeeping requirements.

40 CFR Part 85

Confidential business information, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 86

Administrative practice and procedure, Confidential business information, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 89

Environmental protection, Administrative practice and procedure, Confidential business information, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Vessels, Warranties.

40 CFR Part 92

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Incorporation by reference, Labeling, Penalties, Railroads, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 94

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Incorporation by reference, Labeling, Penalties, Vessels, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1033

Environmental protection, Administrative practice and procedure, Confidential business information, Incorporation by reference, Labeling, Penalties, Railroads, Reporting and recordkeeping requirements.

40 CFR Part 1039

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Incorporation by reference, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1042

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Incorporation by reference, Labeling, Penalties, Vessels, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1065

Environmental protection, Administrative practice and procedure, Incorporation by reference, Reporting and recordkeeping requirements, Research.

40 CFR Part 1068

Environmental protection, Administrative practice and procedure, Confidential business information, Imports, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements, Warranties.

Dated: [INSERT SIGNATURE DATE], 2008.

Stephen L. Johnson,

Administrator.