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Control of Emissions of Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder; Proposed Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 92, 94, 1033, 1039, 1042, 1065 and 1068

[EPA–HQ–OAR–2003–0190; FRL–8285–5]

RIN 2006–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: Proposed rule.

SUMMARY: Locomotives and marine diesel engines are important contributors to our nation's air pollution today. These sources are projected to continue to generate large amounts of particulate matter (PM) and nitrogen oxides (NO_X) emissions that contribute to nonattainment of the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone across the United States. The emissions of PM and ozone precursors from these engines are associated with serious public health problems including premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. In addition, emissions from locomotives and marine diesel engines are of particular concern, as diesel exhaust has been classified by EPA as a likely human carcinogen.

EPA is proposing a comprehensive program to dramatically reduce emissions from locomotives and marine diesel engines. It would apply new exhaust emission standards and idle reduction requirements to diesel locomotives of all types—line-haul, switch, and passenger. It would also set new exhaust emission standards for all types of marine diesel engines below 30 liters per cylinder displacement. These include marine propulsion engines used on vessels from recreational and small fishing boats to super-yachts, tugs and Great Lakes freighters, and marine auxiliary engines ranging from small gensets to large generators on ocean-going vessels. The proposed program includes a set of near-term emission standards for newly-built engines. These would phase in starting in 2009. The near-term program also contains more stringent emissions standards for existing locomotives. These would apply when the locomotive is remanufactured and would take effect as soon as certified remanufacture systems are available (as early as 2008), but no later than 2010 (2013 for Tier 2 locomotives). We are requesting comment on an alternative under consideration that would apply a similar requirement to existing marine diesel engines when they are remanufactured. We are also proposing long-term emissions standards for newly-built locomotives and marine diesel engines based on the application of high-efficiency catalytic aftertreatment technology. These standards would phase in beginning in 2015 for locomotives and 2014 for marine diesel engines. We estimate PM reductions of 90 percent and 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 would reduce annual emissions of NO_X and PM by 765,000 and 28,000 tons, respectively. These reductions are estimated to annually prevent 1,500 premature deaths, 170,000 work days lost, and 1,000,000 minor restricted-activity days. The estimated annual monetized health benefits of this rule in 2030 would be approximately $12 billion, assuming a 3 percent discount rate (or $11 billion assuming a 7 percent discount rate). These estimates would be increased substantially if we were to adopt the remanufactured marine engine program concept. The annual cost of the proposed program in 2030 would be significantly less, at approximately $600 million.

DATES: Comments must be received on or before July 2, 2007. Under the Paperwork Reduction Act, comments on the information collection provisions must be received by OMB on or before May 3, 2007.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA–HQ–OAR–2003–0190, by one of the following methods:

- *www.regulations.gov*: Follow the on-line instructions for submitting comments.
- *Fax:* (202) 566–1741
- *Mail:* Air Docket, Environmental Protection Agency, *Mailcode:* 6102T, 1200 Pennsylvania Ave., NW., Washington, DC 20460. In addition, please mail a copy of your comments on the information collection provisions to the Office of Information and Regulatory Affairs, Office of Management and Budget (OMB), *Attn:* Desk Officer for EPA, 725 17th St., NW., Washington, DC 20503.
- *Hand Delivery:* EPA Docket Center, (EPA/DC) EPA West, Room 3334, 1301 Constitution Ave., NW, Washington DC, 20004. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.

Instructions: Direct your comments to Docket ID No. EPA–HQ–OAR–2003–0190. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at *http://www.regulations.gov*, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through *http://www.regulations.gov* or e-mail. The *http://www.regulations.gov* Web site is an ''anonymous access'' system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an e-mail comment directly to EPA without going through *http://www.regulations.gov* your e-mail address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD–ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at *http://www.epa.gov/epahome/dockets.htm*. For additional instructions on submitting comments, go to section I.A. of the **SUPPLEMENTARY INFORMATION** section of this document, and also go to section VIII.A. of the Public Participation section of this document.

Docket: All documents in the docket are listed in the *http://www.regulations.gov* index. 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, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in *http://www.regulations.gov* or in hard copy at the EPA–EQ–OAR–2003–0190 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 EPA–EQ–OAR–2003–0190 is (202) 566–1742.

Hearing: Two hearings will be held, at 10 a.m. on Tuesday, May 8, 2007 in Seattle, WA, and at 10 a.m. on Thursday, May 10, 2007 in Chicago, IL. For more information on these hearings or to request to speak, see section VIII.C. ''WILL THERE BE A PUBLIC HEARING.''

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; *e-mail address: Mueller.John@epa.gov*, or Assessment and Standards Division Hotline; telephone number: (734) 214–4636.

SUPPLEMENTARY INFORMATION:

General Information

♦ *Does This Action Apply to Me?*

♦ Locomotive

Entities potentially regulated by this action are those which manufacture, remanufacture and/or import locomotives and/or locomotive engines; and those which own and 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.

[1] North American Industry Classification System (NAICS).

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 sections 92.1, 92.801, 92.901, 92.1001, 1065.1, 1068.1, 85.1601, 89.1, and the proposed regulations. If you have questions, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

♦ Marine

This proposed action would affect 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	336612	Boat building (watercraft not built in shipyards and typically of the type suitable or intended for personal use).

[1] North American Industry Classification System (NAICS).

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, 1065.1, 1068.1, and the proposed regulations. If you have questions, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

♦ *Additional Information About This Rulemaking*

♦ Locomotive

The current emission standards for locomotive engines were adopted by EPA in 1998 (see 63 FR 18978, April 16, 1998). This notice of proposed rulemaking relies in part on information that was obtained for that rule, which can be found in Public Docket A–94–31. That docket is incorporated by reference into the docket for this action, OAR–2003–0190.

♦ Marine

The current emission standards for new commercial marine diesel engines were adopted in 1999 and 2003 (see 64 FR 73300, December 29, 1999 and 66 FR 9746, February 28, 2003). The current emission standards for new recreational marine diesel engines were adopted in 2002 (see 67 FR 68241, November 8, 2002). The current emission standards for marine diesel engines below 37 kW (50 hp) were adopted in 1998 (see 63 FR 56967, October 23, 1998). This notice of proposed rulemaking relies in part on information that was obtained for those rules, which can be found in Public Dockets A–96–40, A–97–50, A–98–01, A–2000–01, and A–2001–11. Those dockets are incorporated by reference into the docket for this action, OAR–2003–0190.

♦ Other Dockets

This notice of proposed rulemaking relies in part on information that was obtained for our recent highway diesel and nonroad diesel rulemakings, which can be found in Public Dockets A–99–06 and A–2001–28 (see also OAR 2003–

0012).[1][2] Those dockets are incorporated by reference into the docket for this action, OAR–2003–0190.

Outline of This Preamble

I. Overview

This proposal is an important step in EPA's ongoing National Clean Diesel Campaign (NCDC). In recent years, we have adopted major new programs designed to reduce emissions from highway and nonroad diesel engines.[3] When fully implemented, these new programs would largely eliminate emissions of harmful pollutants from these sources. This Notice of Proposed Rulemaking (NPRM) sets out the next step in this ambitious effort by addressing two additional diesel sectors that are major sources of air pollution nationwide: locomotive engines and marine diesel engines below 30 liters per cylinder displacement.[4] This addresses 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 collectively called ''marine diesel engines.''). These include marine propulsion engines used on vessels from recreational and small fishing boats to super-yachts, tugs and Great Lakes freighters, and marine auxiliary engines ranging from small gensets to large generators on ocean-going vessels.[5]

Emission levels for locomotive and marine diesel engines remain at high levels—comparable to the emissions standards for highway trucks in the early 1990s—and emit high level of pollutants that contribute to unhealthy air in many areas of the U.S. Nationally, in 2007 these engines account for about 20 percent of mobile source NO_X emissions and 25 percent of mobile source diesel $PM_{2.5}$ emissions. Absent new emissions standards, we expect overall emissions from these engines to remain relatively flat over the next 10 to 15 years due to existing regulations such as lower fuel sulfur requirements and the phase-in of locomotive and marine diesel Tier 1 and Tier 2 engine standards but starting in about 2025 emissions from these engines would begin to grow. Under today's proposed program, by 2030, annual NO_X emissions from locomotive and marine diesel engines would be reduced by 765,000 tons and $PM_{2.5}$ and 28,000 tons. Without new controls, by 2030, these engines would become a large portion of the total mobile source emissions inventory constituting 35 percent of mobile source NO_X emissions and 65 percent of diesel PM emissions.

We followed certain principles when developing the elements of this proposal. First, the program must achieve sizeable reductions in PM and NO_X emissions as early as possible. Second, as we did in the 2007 highway diesel and clean nonroad diesel programs, we are considering engines and fuels together as a system to maximize emissions reductions in a highly cost-effective manner. The groundwork for this systems approach was laid in the 2004 nonroad diesel final rule which mandated that locomotive and marine diesel fuel comply with the 15 parts per million sulfur cap for ultra-low sulfur diesel fuel (ULSD) by 2012, in anticipation of this rulemaking (69 FR 38958, June 29, 2004). The costs, benefits, and other impacts of the locomotive and marine diesel fuel regulation are covered in the 2004 rulemaking and are not duplicated here. Lastly, we are proposing standards and implementation schedules that take full advantage of the efforts now being expended to develop advanced emissions control technologies for the highway and nonroad sectors. As discussed throughout this proposal, the proposed standards represent a feasible progression in the application of advanced technologies, providing a cost-effective program with very large public health and welfare benefits.

The proposal consists of a three-part program. First, we are proposing more stringent standards for existing locomotives that would apply when they are remanufactured. The proposed remanufactured locomotive program would take effect as soon as certified remanufacture systems are available (as early as 2008), but no later than 2010 (2013 for Tier 2 locomotives). We are also requesting comment on an alternative under consideration that would apply a similar requirement to existing marine diesel engines when

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[1][2] Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, 66 FR 5002 (January 18, 2001); Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel, 69 FR 38958 (June 29, 2004).

[3] See 65 FR 6698 (February 10, 2000), 66 FR 5001 (January 18, 2001), and 69 FR 38958 (June 29, 2004) for the final rules regarding the light-duty Tier 2, clean highway diesel (2007 highway diesel) and clean nonroad diesel (nonroad Tier 4) programs, respectively. EPA has also recently promulgated a clean stationary diesel engine rule containing standards similar to those in the nonroad Tier 4 rule. See 71 FR 39153. See also *http://www.epa.gov/diesel/* for information on all EPA programs that are part of the NCDC.

[4] In this NPRM, ''marine diesel engine'' refers to compression-ignition marine engines below 30 liters per cylinder displacement unless otherwise indicated. Engines at or above 30 liters per cylinder are being addressed in separate EPA actions, including a planned rulemaking, participation on the U.S. delegation to the International Maritime Organization's standard-setting work, and EPA's new Clean Ports USA Initiative (*http://www.epa.gov/cleandiesel/ports/index.htm*).

[5] Marine diesel engines at or above 30 l/cyl displacement are not included in this program. See Section III.E, below.

they are remanufactured. Second, we are proposing a set of near-term emission standards, referred to as Tier 3, for newly-built locomotives and marine engines, that reflect the application of technologies to reduce engine-out PM and NO_X. Third, we are proposing longer-term standards, referred to as Tier 4, that reflect the application of high-efficiency catalytic aftertreatment technology enabled by the availability of ULSD. These standards phase in over time, beginning in 2014. We are also proposing provisions to eliminate emissions from unnecessary locomotive idling.

Locomotives and marine diesel engines designed to these proposed standards would achieve PM reductions of 90 percent and NO_X reductions of 80 percent, compared to engines meeting the current Tier 2 standards. The proposed standards would 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 proposed standards compared to today's (Tier 2) emission standards or, in the case of remanufactured locomotives, compared to the current standards for each tier of locomotives covered.

TABLE I.–1.—REDUCTIONS FROM LEVELS OF EXISTING STANDARDS

Sector	Proposed 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
Marine Diesel Engines [a]	Remanufactured Engines [b]	25–60	up to 20
	Tier 3	50	20
	Tier 4	90	80

[a] Existing and proposed standards vary by displacement and within power categories. Reductions indicated are typical.

[b] This proposal asks for comment on an alternative under consideration that would reduce emissions from existing marine diesel engines. See section VII.A(2).

Combined, these reductions would result in substantial benefits to public health and welfare and to the environment. We project that by 2030 this program would reduce annual emissions of NO_X and PM by 765,000 and 28,000 tons, respectively, and the magnitude of these reductions would continue to grow well beyond 2030. We estimate that these annual emission reductions would prevent 1,500 premature mortalities in 2030. These annual emission reductions are also estimated to prevent 1,000,000 minor restricted-activity days, 170,000 work days lost, and other quantifiable benefits. All told, the estimated monetized health benefits of this rule in 2030 would be approximately $12 billion, assuming a 3 percent discount rate (or $11 billion assuming a 7 percent discount rate). The annual cost of the program in 2030 would be significantly less, at approximately $600 million.

A. What Is EPA Proposing?

This proposal is a further step in EPA's ongoing program to control emissions from diesel engines, including those used in marine vessels and locomotives. EPA's current standards for newly-built and remanufactured locomotives were adopted in 1998 and were implemented in three tiers (Tiers 0, 1, and 2) over 2000 through 2005. The current program includes Tier 0 emission limits for existing locomotives originally manufactured in 1973 or later, that apply when they are remanufactured. The standards for marine diesel engines were adopted in 1998 for engines under 37 kilowatts (kW), in 1999 for commercial marine engines, and in 2002 for recreational marine engines. These various Tier 1 and Tier 2 standards phase in from 1999 through 2009, depending on engine size and application. The most stringent of these existing locomotive and marine diesel engine standards are similar in stringency to EPA's nonroad Tier 2 standards that are now in the process of being replaced by Tier 3 and 4 standards.

The major elements of the proposal are summarized below. We are also proposing revised 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 and in the draft Regulatory Impact Analysis (RIA). Section VII of this preamble describes a number of alternatives that we considered in developing this proposal, including a more simplistic approach that would introduce aftertreatment-based standards earlier. Our analysis shows that such an approach would result in higher emissions and fewer health and welfare benefits than we project will be realized from the program we are proposing today. After evaluating the alternatives, we believe that our proposed program provides the best opportunity for achieving timely and very substantial emissions reductions from locomotive and marine diesel engines. It best takes into account the need for appropriate lead time to develop and apply the technologies necessary to meet these emission standards, the goal of achieving very significant emissions reductions as early as possible, the interaction of requirements in this proposal with existing highway and nonroad diesel engine programs, and other legal and policy considerations.

Overall, this comprehensive three-part approach to setting standards for locomotives and marine diesel engines would 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 would be achieved in a manner that: (1) Is very cost-effective, (2) leverages technology developments in other diesel sectors, (3) aligns well with the clean diesel fuel requirements already being implemented, and (4) provides the lead time needed to deal with the significant engineering design workload that is involved. We are asking for comments on all aspects of the proposal, including standards levels and implementation dates, and on the alternatives discussed in this proposal.

(1) Locomotive Emission Standards

We are proposing stringent exhaust emissions 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.[6]

In the Advance Notice of Proposed Rulemaking (ANPRM) for this proposal (69 FR 39276, June 29, 2004), we suggested a program for comment that would bring about the introduction of high-efficiency exhaust aftertreatment to this sector in a single step. Although it has taken longer than expected to develop, the proposal we are issuing today is far more comprehensive than we envisioned in 2004. Informed by extensive analyses documented in the draft RIA and numerous discussions with stakeholders since then, this proposal goes significantly beyond that vision. It sets out standards for locomotives in three steps to more fully leverage the opportunities provided by both the already-established clean fuel programs, and the migration of clean diesel technology from the highway and nonroad sectors. It also addresses the large and long-lived existing locomotive fleet with stringent new emissions requirements at remanufacture starting in 2008. Finally, it sets new requirements for idle emissions control on newly-built and remanufactured locomotives.

Briefly, for newly-built line-haul locomotives we are proposing 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 would take effect in 2012. We are also proposing 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 would take effect in 2015 and 2017 for PM and NO_X, respectively. We are proposing 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 also propose 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 proposed new standards, and section IV details improvements being proposed 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. In light of these trends, we are establishing new standards and special certification provisions for newly-built and remanufactured switch locomotives that take these trends into account.

Locomotives spend a substantial amount of time idling, during which they emit harmful pollutants and consume fuel. Two ways that idling time can be reduced are through the use of automated systems to stop idling locomotive engines (restarting them on an as-needed basis), and through the use of small low-emitting auxiliary engines to provide essential accessory power. Both types of systems are installed in a number of U.S. locomotives today for various reasons, including to save fuel, to help meet current Tier 0 emissions standards, and to address complaints from railyard neighbors about noise and pollution from idling locomotives.

We are proposing that idle control systems be required on all newly-built Tier 3 and Tier 4 locomotives. We also propose that they be installed on all existing locomotives that are subject to the proposed remanufactured engine standards, at the point of first remanufacture under the proposed standards, unless already equipped with idle controls. We are proposing that automated stop/start systems be required, but encourage the use of auxiliary power units by allowing their emission reduction to be factored into the certification test program as appropriate.

Taken together, the proposed elements described above constitute a comprehensive program that would address the problems caused by locomotive emissions from both a near-term and long-term perspective, and do so more completely than would have occurred under the concept described in the ANPRM. It would do this while providing for an orderly and cost-effective implementation schedule for the railroads, builders, and remanufacturers.

(2) Marine Engine Emission Standards

We are also proposing emissions standards for newly-built marine diesel engines with displacements under 30 liters per cylinder (referred to as Category 1 and 2, or C1 and C2, engines). This would include engines used in commercial, recreational, and auxiliary power applications, and those below 37 kW (50 hp) that were previously regulated separately in our nonroad diesel program. As with locomotives, our ANPRM described a one-step marine diesel program that would bring about the introduction of high-efficiency exhaust aftertreatment in this sector. Just as for locomotives, our subsequent extensive analyses (documented in the draft RIA) and numerous discussions with stakeholders since then have resulted in this proposal for standards in multiple steps, with the longer-term implementation of advanced technologies focused especially on the engines with the greatest potential for large PM and NO_X emission reductions.

The proposed 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 proposed Tier 3 and Tier 4 standards vary by engine sub-groupings. Although this results in a somewhat complicated array of emissions standards, it will ensure the most stringent standards feasible for each group of newly-built marine engines, and will help engine and vessel manufacturers to implement the program in a cost effective manner that also emphasizes early emission reductions. The proposed standards and implementation schedules, as well as their technological feasibility, are described in detail in section III of this preamble.

We are also requesting comment on an alternative we are considering to address the considerable impact of emissions from large marine diesel

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[6] We are not proposing any change to the current definition of a "new locomotive" in 40 CFR § 92.2. The terms "new locomotive", "new locomotive engine", "freshly manufactured locomotive", "freshly manufactured locomotive engine", "repower", "remanufacture", "remanufactured locomotive", and "remanufactured locomotive engine" all have formal definitions in 40 CFR 92.2. In this notice, the term "newly-built locomotive" is synonymous with "freshly manufactured locomotive".

engines installed in vessels currently in the fleet. We have in the past considered but not finalized a program to regulate such engines as ''new'' engines at the time of remanufacture, similar to the approach taken in the locomotive program. We are again considering such a program in the context of this rulemaking and are soliciting comments on this alternative.

Briefly summarized, it would consist of two parts. In the first part, which could begin as early as 2008, vessel owners and rebuilders would be required to install a certified emissions control system when the engine is remanufactured, if such a system were available. Initially, we would expect the systems installed on remanufactured marine engines to be those certified for the remanufactured locomotive program, although this alternative would not limit the program to only those engines. Eventually manufacturers would be expected to provide systems for other large engines as well. In the second part, to take effect in 2013, marine diesel engines identified by EPA as high-sales volume engine models would have to meet specified emissions standards when remanufactured. The rebuilder or owner would be required to either use a system certified to meet the standards or, if no certified systems were available, to either retrofit an emission reduction technology for the engine that demonstrates at least a 25 percent reduction or to repower (replace the engine with a new one). The alternative under consideration is described in more detail in section VII.A(2). We request comment on the elements of this alternative as well as other possible approaches to achieve this goal, with the view that EPA may adopt a remanufacture program in the final rule if appropriate.

B. Why Is EPA Making This Proposal?

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

Locomotive and marine diesel engines subject to today's proposal generate significant emissions of fine particulate matter ($PM_{2.5}$) and nitrogen oxides (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. Emissions from locomotive and marine diesel engines also cause harm to public welfare, including contributing to visibility impairment and other harmful environmental impacts across the US.

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 to society are not reflected in the costs of those using these engines and equipment. The market system itself cannot correct this externality because firms in the market are rewarded for minimizing their production costs, including the costs of pollution control. 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. To correct this market failure and reduce the negative externality from these emissions, it is necessary to give producers the signals for the social costs generated from the emissions. The standards EPA is proposing will accomplish this by mandating that locomotives and marine diesel engines reduce their emissions to a technologically feasible limit. In other words, with this proposed rule the costs of the transportation services produced by these engines and equipment will account for social costs more fully.

Emissions from locomotive and marine diesel engines account for substantial portions of the country's ambient $PM_{2.5}$ and NO_X levels. We estimate that today hese 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 today's proposed standards, by 2030, annual NO_X emissions from these diesel engines would be reduced by 765,000 tons and $PM_{2.5}$ emissions by 28,000 tons, and those reductions would continue to grow beyond 2030 as fleet turnover to the clean engines is completed.

EPA has already taken steps to bring emissions levels from light-duty and heavy-duty highway, and nonroad diesel vehicles and engines to very low levels over the next decade, as well as certain stationary diesel engines also subject to these standards, while the 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, lost 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 it as likely to be carcinogenic to humans by inhalation at environmental exposures.[7] Recent studies are showing that populations living near large diesel emission sources such as major roadways,[8] rail yards, and marine ports [9] are likely to experience greater diesel exhaust exposure levels than the overall U.S. population, putting them at greater health risks. We are currently studying the size of the U.S. population living near a sample of approximately 60 marine ports and rail yards, and will place the information in the docket upon completion prior to the final rule.

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 2006 there are approximately 157 million people living in 116 areas (461 full or partial counties) designated as not in attainment with the 8-hour ozone NAAQS. These numbers do not include people living in areas where there is a potential that the area may fail to maintain or achieve the 8-hour ozone NAAQS. With regard to $PM_{2.5}$ nonattainment, EPA has recently finalized nonattainment designations

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[7] 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.*

[8] 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.

[9] 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.*

(70 FR 943, Jan 5, 2005), and as of October 2006 there are 88 million people living in 39 areas (which include all or part of 208 counties) that either do not meet the $PM_{2.5}$ NAAQS or contribute to violations in other counties. These numbers do not include individuals living in areas that may fail to maintain or achieve the $PM_{2.5}$ NAAQS in the future.

In addition to public health impacts, there are public welfare and environmental impacts associated with ozone and $PM_{2.5}$ emissions which are also serious. Specifically, 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 substantial impairment of visibility in many part 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 articles 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 the standards proposed in this action would assist states in attaining and maintaining the Ozone and the $PM_{2.5}$ NAAQS 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 Agency will undergo the process of designating areas that are not able to 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, annual, or both standards for $PM_{2.5}$ 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 proposal will be needed by states to both attain and maintain the revised $PM_{2.5}$ NAAQS.

State and local governments are 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,[10] while also seeking Agency action, including the setting of stringent new locomotive and marine diesel engine standards being proposed today.[11] The emission reductions in this proposal will play a critical part in state efforts to attain and maintain the NAAQS through the next two decades.

While the program we are proposing today will help many states and communities achieve cleaner air, for some areas, the reductions will not be large enough or early enough to assist them in meeting near term ozone and PM air quality goals. More can be done, beyond what we are proposing today, to address the emissions from locomotive and marine diesel engines. For example, as part of this proposal we are requesting comment on a concept to set emission standards for existing large marine diesel engines when they are remanufactured. Were we to finalize such a concept, it could provide substantial emission reductions, beginning in the next few years, from some of the large legacy fleets of dirtier diesel engines.

At the time of our previous locomotive rulemaking, the State of California worked with the railroads operating in southern California to develop and implement a corollary program, ensuring that the cleanest technologies are expeditiously introduced in these areas with greatest air quality improvement needs. Today's proposal includes provisions, such as streamlined switcher locomotive certification using clean nonroad engines, that are well-suited to encouraging early deployment of cleaner technologies through the development of similar programs.

In addition to regulatory programs, the Agency has a number of voluntary programs that partner government, industry, and local communities together to help address challenging air quality problems. The EPA SmartWay program has initiatives to reduce unnecessary locomotive idling and to encourage the use of 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 strategies today through education, incentives, and financial assistance for diesel emissions reductions at ports. Part of these efforts involves voluntary retrofit programs that can further reduce emissions from the existing fleet of diesel engines. Finally, many of the companies operating in states and communities suffering from poor air quality have voluntarily entered into Memoranda of Understanding (MOUs) designed to ensure that the cleanest technologies are used first in regions with the most challenging air quality issues.

Together, these approaches can augment the regulations being proposed today helping states and communities achieve larger reductions sooner in the areas of our country that need them the most. The Agency remains committed to furthering these programs and others so that all of our citizens can breathe clean healthy air.

(2) Advanced Technology Solutions

Air pollution from locomotive and marine diesel exhaust is a challenging problem. However, we believe it can be addressed effectively through the use of existing technology to reduce engine-out emissions combined with high-efficiency catalytic aftertreatment technologies. As discussed in greater detail in section III.D, the development of these aftertreatment technologies for

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

[11] For example, see letter dated September 23, 2006 from Northeast States for Coordinated Air Use Management to Administrator Stephen L. Johnson; September 7, 2006 letter from Executive Officer of the California Air Resources Board to Acting Assistant Administrator William L. Wehrum; August 9, 2006 letter from State and Territorial Air Pollution Program Administrators and Association of Local Air Pollution Control Officials (and other organizations) to Administrator Stephen L. Johnson; January 20, 2006 letter from Executive Director, Puget Sound Clean Air Agency to Administrator Stephen L. Johnson; June 30, 2005 letter from Western Regional Air Partnership to Administrator Stephen L. Johnson.

highway and nonroad diesel applications has advanced rapidly in recent years, so that very large emission reductions in PM and NO_X (in excess of 90 and 80 percent, respectively) can be achieved.

High-efficiency PM control technologies are being broadly used in many parts of the world, and in particular to comply with EPA's heavy-duty truck standards now taking effect with the 2007 model year. These technologies are highly durable and robust in use, and have also proved extremely effective in reducing exhaust hydrocarbon (HC) emissions. However, as discussed in detail in section III.D, these emission control technologies are very sensitive to sulfur in the fuel. For the technology to be viable and capable of controlling an engine's emissions over the long term, we believe it will require diesel fuel with sulfur content capped at the 15 ppm level.

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, as well as in many stationary source applications throughout the world. These technologies are also sensitive to sulfur.

Section III.D 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 proposed application of advanced technology to locomotives and marine diesels will proceed at a reasonable rate of progress and will result in systems capable of achieving the proposed standards on the proposed schedule.

(3) Basis for Action Under the Clean Air Act

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

EPA is promulgating emissions standards for new marine diesel engines pursuant to its authority under section 213(a)(3) and (4) of the Clean Air Act (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.

CAA section 213(a)(3) directs the Administrator to set NO_X, VOCs, or carbon monoxide, standards for classes or categories of engines that contribute to ozone or carbon monoxide concentrations in more than one nonattainment area, like marine diesel engines. 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, like diesel marine engines.

Finally, 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 proposal. As described in section III of this Preamble and in Chapter 4 of the draft RIA, EPA has evaluated the available information to determine the technology the will be available for locomotives and engines proposed to be subject to EPA standards.

EPA is also acting under its authority to implement and enforce both the marine diesel emission standards and the locomotive emissions 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.

As required under section 213(a)(3), (4), and (5) we believe the evidence provided in section III.D of this Preamble and in Chapter 4 of draft RIA indicates that the stringent emission standards proposed today for newly-built and remanufactured locomotive engines and newly-built 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 also believe this may be the case for the alternative identified for existing marine engines in section VII.A(2) of this preamble. We have given appropriate consideration to costs in proposing 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 have been required. 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 proposed standards.

The information in section II of this Preamble and Chapter 2 of the draft 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 (CO) 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 standards for PM from marine diesel engines under section 213(a)(4), and the additional information on diesel exhaust carcinogenicity 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 propose to find here, based on the information in section II of this preamble and Chapters 2 and 3 of the draft 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 the standards proposed in this action would be 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 would be significantly reduced by the standards proposed today.

II. Air Quality and Health Impacts

The locomotive and marine diesel engines subject to today's proposal 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 which are associated with serious adverse health effects. Finally, emissions from locomotive and marine diesel engines cause harm to the public welfare, contribute to visibility impairment, and contribute to other harmful environmental impacts across the U.S.

By 2030, the proposed standards are expected to reduce annual locomotive and marine diesel engine $PM_{2.5}$ emissions by 28,000 tons; NO_X emissions by 765,000 tons; and volatile organic compound (VOC) emissions by 42,000 tons as well as reductions in carbon monoxide (CO) and toxic compounds known as air toxics.[12]

We estimate that reductions of $PM_{2.5}$, NO_X, and VOC emissions from locomotive and marine diesel engines would produce nationwide air quality improvements. According to air quality modeling performed in conjunction with this proposed rule, if finalized, all 39 current $PM_{2.5}$ nonattainment areas would experience a decrease in their 2020 and 2030 design values. Likewise all 116 mandatory class I federal areas would see improvements in their visibility. This rule would also result in substantial nationwide ozone benefits. The air quality modeling conducted for ozone estimates that in 2020 and 2030, 114 of the current 116 ozone nonattainment areas would see improvements in ozone air quality as a result of this proposed rule.

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, and various gaseous air toxics, and ozone. Today, locomotive and marine diesel engine emissions represent a substantial portion of the U.S. mobile source diesel $PM_{2.5}$ and NO_X emissions accounting for approximately 20 percent of mobile source NO_X and 25 percent of mobile source diesel $PM_{2.5}$. These proportions are even higher in some urban areas. 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 further emissions controls beyond those already adopted for these engines, locomotive and marine diesel engines nationally will emit more than 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 2006 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 157 million people living in 116 areas (which include all or part of 461 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 $PM_{2.5}$ 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.

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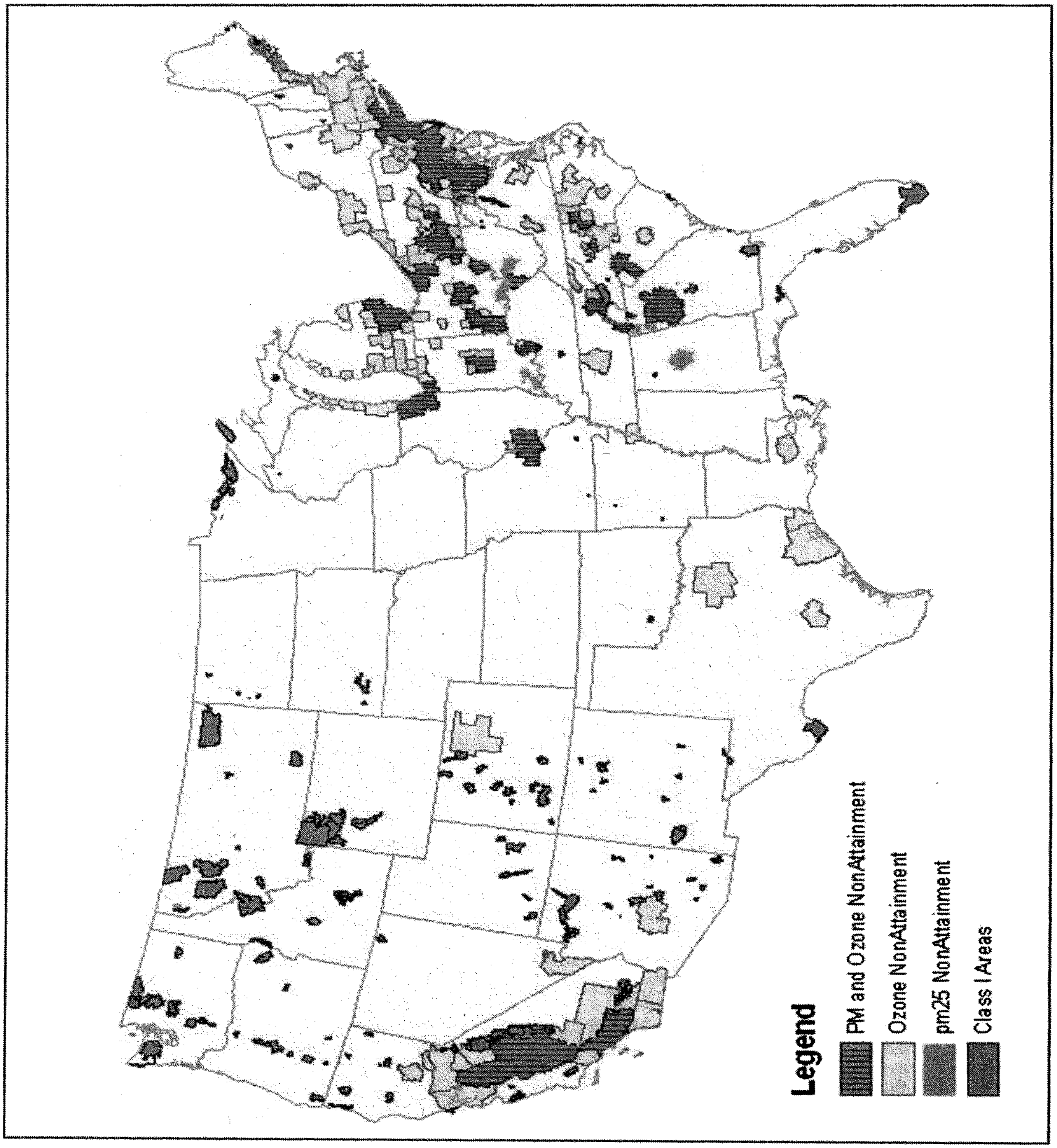
[12] Nationwide locomotive and marine diesel engines comprise approximately 3 percent of the nonroad mobile sources hydrocarbon inventory. EPA National Air Quality and Emissions Trends Report 1999. March 2001, Document Number: EPA 454/R–0–004. This document is available electronically at:*http://www.epa.gov/air/airtrends/aqtrnd99/.*

Figure II-1 Air Quality Problems are Widespread



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The engine standards proposed in this rule would 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 proposed today would become effective as early as 2008 making the expected $PM_{2.5}$, NO_X, and VOC inventory reductions from this rulemaking critical to 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 emanating from these engines are also of particular concern since diesel exhaust is classified as a likely human carcinogen.[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 U.S. population, putting them at a greater health risk. We are currently studying the size of the U.S. population living near a sample of approximately 60 marine ports and rail yards, and will place that information in the docket upon completion prior to the final rule. The diesel $PM_{2.5}$ reductions which occur as a result of this proposed rule would benefit the population near these sources and also assist state and local governments as they work to meet the NAAQS.

In the following three sections we review important public health effects linked to pollutants emitted from locomotive and marine diesel engines first describing the human health effects and the current and expected future ambient levels of direct or indirectly caused pollution. Following the discussion of health effects, we will discuss the modeled air quality benefits which are estimated to result from regulating these engines. We also discuss a number of other welfare effects associated with emissions from diesel engines. These effects include visibility impairment, ecological and property damage caused by acid deposition, eutrophication and nitrification of surface waters, environmental threats posed by polycyclic organic matter (POM) deposition, and plant and crop damage from ozone.

Finally, in section E we describe the locomotive and marine engine emission inventories for the primary pollutants affected by the proposal. We present current and projected future levels of emissions for the base case, including anticipated reductions from control programs already adopted by EPA and the States, but without the controls proposed today. Then we identify expected emission reductions from nonroad locomotive and marine diesel engines. These reductions would make important contributions 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 describe the need for tightening emission standards from both locomotive and marine diesel engines and the air quality and public health benefits we expect as a result of this proposed rule. 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 of the Draft Regulatory Impact Analysis (RIA) accompanying this proposal.

B. Public Health Impacts

(1) Particulate Matter

The proposed locomotive and marine engine standards would result in significant reductions of primary $PM_{2.5}$ emissions from these sources. In addition, locomotive and marine diesel engines emit high levels of NO_X which react in the atmosphere to form secondary $PM_{2.5}$, ammonium nitrate. Locomotive and marine diesel engines also emit SO_2 and HC which react in the atmosphere to form secondary $PM_{2.5}$ composed of sulfates and organic carbonaceous $PM_{2.5}$. This proposed rule would reduce both the directly emitted diesel PM and secondary PM emissions.

(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). $PM_{2.5}$ refers to fine particles, those 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). 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., SO_X, NO_X and VOCs) 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 through the atmosphere 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 65 μg/m^3 based on the 98th percentile concentration averaged over three years. (This air quality statistic compared to the standard is referred to as the ''design value.'') The annual standard specifies an expected annual arithmetic mean not to exceed 15 μg/m^3 averaged over three years. EPA has recently finalized $PM_{2.5}$ nonattainment designations for the 1997 standard (70 FR 943, Jan 5, 2005).[18] All areas currently in nonattainment for

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[13] See section II.B.(1)(d) and II.B.(2)(d) 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 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. [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. This document is available electronically at:*http://www.arb.ca.gov/regact/marine2005/portstudy0406.pdf.*

[18] 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/.*

$PM_{2.5}$ will be required to meet these 1997 standards between 2009 and 2014.

As can be seen in Figure II–1 ambient $PM_{2.5}$ levels exceeding the 1997 $PM_{2.5}$ NAAQS are widespread throughout the country. As of October 2006 there were approximately 88 million people living in 39 areas (which include all or part of 208 counties) that either do not meet the 1997 $PM_{2.5}$ NAAQS or contribute to violations in other counties. These numbers do not include the people living in areas where there is a significant future risk of failing to maintain or achieve the $PM_{2.5}$ NAAQS.

EPA has recently amended the NAAQS for $PM_{2.5}$ (71 FR 61144, October 17, 2006). The final rule, signed on September 21, 2006 and published in the **Federal Register** on October 17, 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 65 μg/m^3 to 35 μg/m^3 to provide increased protection against health effects associated with short-term exposures to fine particles. The current form of the 24-hour $PM_{2.5}$ standard was retained (e.g., based on the 98th percentile concentration averaged over three years). The level of the annual $PM_{2.5}$ NAAQS was retained at 15 μg/m^3, continuing protection against health effects associated with long-term exposures. The current form of the annual $PM_{2.5}$ standard was retained as an annual arithmetic mean averaged over three years, however, the following two aspects of the spatial averaging criteria were narrowed: (1) The annual mean concentration at each site shall be within 10 percent of the spatially averaged annual mean, and (2) the daily values for each monitoring site pair shall yield a correlation coefficient of at least 0.9 for each calendar quarter.

With regard to the secondary $PM_{2.5}$ standards, EPA has revised these standards to be identical in all respects to the revised primary standards. Specifically, EPA has revised the current 24-hour $PM_{2.5}$ secondary standard by making it identical to the revised 24-hour $PM_{2.5}$ primary standard and retained the annual $PM_{2.5}$ secondary standard. This suite of secondary $PM_{2.5}$ standards is intended to provide protection against PM-related public welfare effects, including visibility impairment, effects on vegetation and ecosystems, and material damage and soiling.

The 2006 standards became effective on December 18, 2006. As a result of the 2006 $PM_{2.5}$ standard, EPA will designate new nonattainment areas in early 2010. The timeframe for areas attaining the 2006 PM NAAQS will likely extend from 2015 to 2020.

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 which have monitored data that is violating the 2006 $PM_{2.5}$ NAAQS. In total more than 106 million U.S. residents, in 257 counties are living in areas which either violate either the 1997 $PM_{2.5}$ standard or the 2006 $PM_{2.5}$ standard.

TABLE II–1.—FINE PARTICLE STANDARDS: CURRENT NONATTAINMENT AREAS AND 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

[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.

EPA has already adopted many emission control programs that are expected to reduce ambient $PM_{2.5}$ levels and as a result of these programs, the number of areas that fail to achieve the 1997 $PM_{2.5}$ NAAQS is expected to decrease. Even so, EPA modeling projects that in 2015, with all current controls, up to 52 counties with 53 million population may not attain some combination of the current annual standard of 15 μg/m^3 and the revised daily standard of 35 μg/m^3, and that even in 2020 up to 48 counties with 54 million population will still not be able to attain either the annual, daily, or both the annual and daily $PM_{2.5}$ standards.[19] This does not account for additional areas that have air quality measurements within 10 percent of the 2006 $PM_{2.5}$ standard. These areas, although not violating the standards, would also benefit from the additional reductions from this rule ensuring long term maintenance of the PM NAAQS.

States have told EPA that they need the reductions this proposed rule would provide in order to meet and maintain both the current 1997 $PM_{2.5}$ NAAQS and the 2006 $PM_{2.5}$ NAAQS. Based on the final rule designating and classifying $PM_{2.5}$ nonattainment areas, most $PM_{2.5}$ nonattainment areas will be required to attain the 1997 $PM_{2.5}$ NAAQS in the 2009 to 2015 time frame, and then be required to maintain the NAAQS thereafter. The emissions standards for engine remanufacturing being proposed in this action would become effective as early as 2008, but no later than 2010, and states would rely on these expected $PM_{2.5}$ reductions to help them to either attain or maintain the 1997 $PM_{2.5}$ NAAQS. In the long term, the emission reductions resulting from the proposed locomotive and marine diesel engine standards would be important to states efforts to attain and maintain the 2006 $PM_{2.5}$ NAAQS.

(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) for PM, and the 2005 PM Staff Paper.[20] [21] [22] Further discussion of health effects associated

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[19] Final RIA PM NAAQS, Chapter 2: Defining the $PM_{2.5}$ Air Quality Problem. October 17, 2006.

[20] U.S. EPA (1996) Air Quality Criteria for Particulate Matter, EPA 600–P–95–001aF, EPA 600–P–95–001bF. This document is available in Docket EPA–HQ–OAR.

[21] 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.

[22] 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.

with PM can also be found in the draft RIA for this proposal.

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 cardio respiratory mortality.[23] In addition, a reanalysis of the American Cancer Society Study shows an association between fine particle and sulfate concentrations and lung cancer mortality.[24] The locomotive and marine diesel engines, covered in this proposal contribute to both acute and chronic $PM_{2.5}$ exposures. Additional information on acute exposures is available in Chapter 2 of the draft RIA for this proposal.

These 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.[25] Taking account of all air pollution sources, including both spark-ignition (gasoline) and diesel powered vehicles, these latter studies indicate that exposure to $PM_{2.5}$ emissions near roadways, 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 constituents of fine particles 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 proposal differ with 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. The proposed controls would help to reduce exposure, and specifically exposure near marine ports and rail yard related $PM_{2.5}$ sources.

Recently, new studies [30] from the State of California provide evidence that $PM_{2.5}$ emissions within marine ports and rail yards contribute significantly to elevated ambient concentrations near these sources. A substantial number of people experience exposure to locomotive and marine diesel engine emissions, raising potential health concerns. Additional information on marine port and rail yard emissions and ambient exposures can be found in section.B.3 of this preamble.

(c) $PM_{2.5}$ Air Quality Modeling Results

Air quality modeling performed for this proposal shows that in 2020 and 2030 all 39 current $PM_{2.5}$ nonattainment areas would experience decreases in their $PM_{2.5}$ design values. For areas with $PM_{2.5}$ design values greater than 15 $\mu g/m^3$ the modeled future-year $PM_{2.5}$ design values are expected to decrease on average by 0.06 $\mu g/m^3$ in 2020 and 0.14 $\mu g/m^3$ in 2030. The maximum decrease for future-year $PM_{2.5}$ design values in 2020 would be 0.35 $\mu g/m^3$ and 0.90 $\mu g/m^3$ in 2030. The reductions are discussed in more detail in Chapter 2 of the draft RIA.

The geographic impact of the proposed locomotive and marine diesel engine controls in 2030 on $PM_{2.5}$ design values (DV) in counties across the US, can be seen in Figure II–2.

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[23] 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.

[24] Pope Ca, III; Thun, MJ; Namboodiri, MM; Docery, DW; Evans, JS; Speizer, FE; Heath, CW. 1995. Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. Am J Respir Crit Care Med 151:669–674.

[25] Riekider, M.; Cascio, W.E.; Griggs, T.R..; Herbst, M.C.; Bromberg, P.A.; Neas, L.; Williams, R.W.; Devlin, R.B. (2003) Particulate Matter Exposures in Cars is Associated with Cardiovascular Effects in Healthy Young Men. Am. J. Respir. Crit. Care Med. 169: 934–940.

[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.

[30] 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 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: *ftp://ftp.arb.ca.gov/carbis/msprog/offroad/marinevess/documents/portstudy0406.pdf.*

Figure II-2 Impact of Proposed Locomotive/Marine controls on annual $PM_{2.5}$ Design Values (DV) in 2030

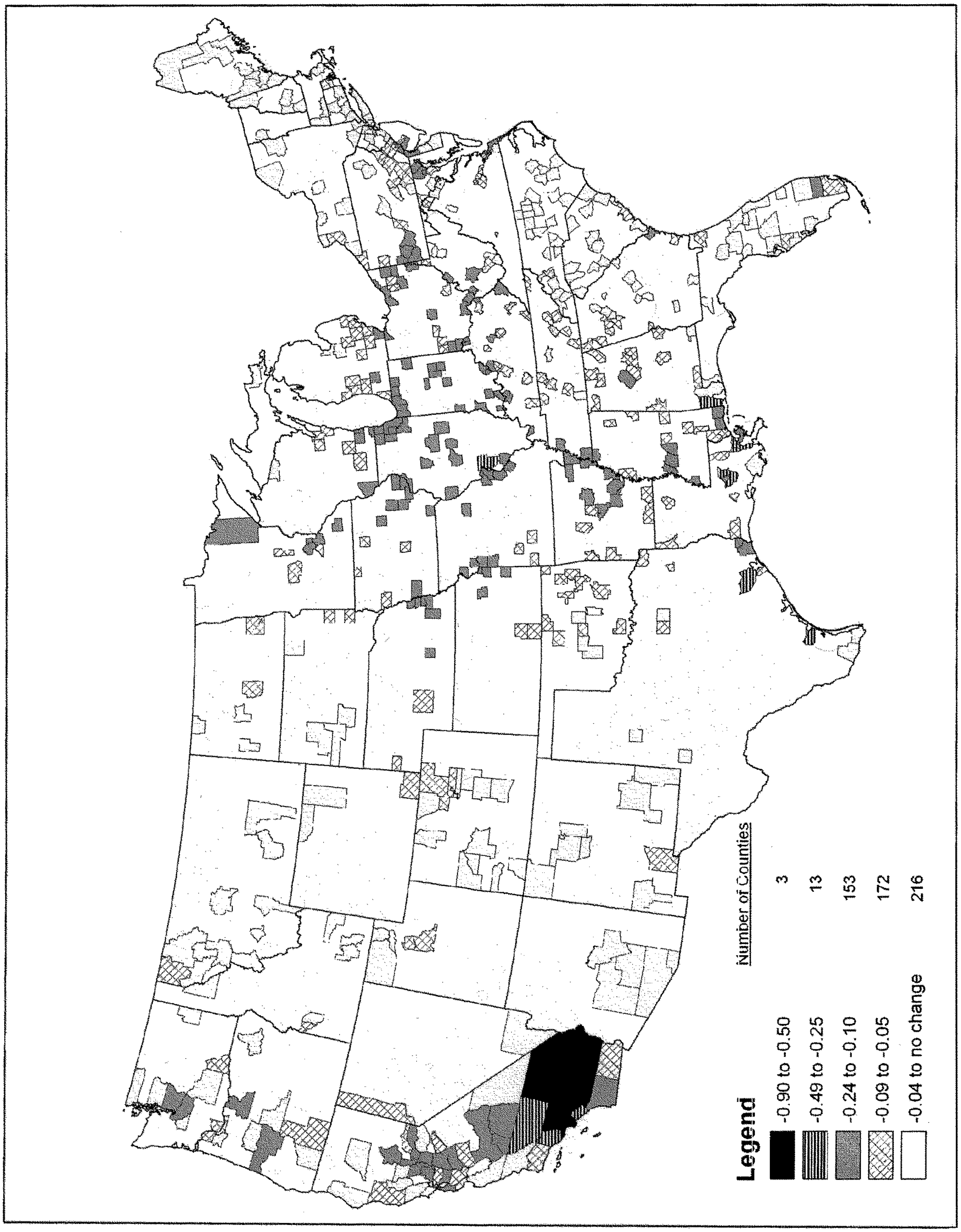

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Figure II–2 illustrates that the greatest emission reductions in 2030 are projected to occur in Southern California where 3 counties would experience reductions in their $PM_{2.5}$ design values of −0.50 to −0.90 $\mu g/m^3$. The next level of emission reductions would occur among 13 counties geographically dispersed in the southeastern U.S., southern Illinois, and southern California. An additional 325 counties spread across the U.S. would see a decrease in their $PM_{2.5}$ DV ranging from −0.05 to −0.24 $\mu g/m^3$.

(d) PM Air Quality Modeling Methodology

A national scale air quality modeling analysis was performed to estimate future year annual and daily $PM_{2.5}$ concentrations and visibility for this proposed rule. To model the air quality benefits of this rule we used the Community-Scale Air Quality (CMAQ) model. CMAQ simulates the numerous physical and chemical processes involved in the formation, transport, and destruction of ozone and particulate matter. In addition to the CMAQ model, the modeling platform includes the emissions, meteorology, and initial and boundary condition data which are inputs to this model. Consideration of the different processes that affect primary directly emitted and secondary PM at the regional scale in different locations is fundamental to understanding and assessing the effects of pollution control measures that affect PM, ozone and deposition of pollutants to the surface. A complete description of the CAMQ model and methodology employed to develop the future year impacts of this proposed rule are found in Chapter 2.1 of the draft RIA.

It should be noted that the emission control scenarios used in the air quality and benefits modeling are slightly different than the emission control program being proposed. 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 draft RIA describes the changes in the inputs and resulting emission inventories between the preliminary assumptions used for the air quality modeling and the final proposed regulatory scenario. These refinements to the proposed program would not significantly change the results summarized here or our conclusions drawn from this analysis.

(2) Ozone

The proposed locomotive and marine engine standards 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 formed by the reaction of volatile organic compounds (VOCs) and nitrogen oxides (NO_X) in the atmosphere in the presence of heat and sunlight. These two 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.[31] Ground-level ozone is produced and destroyed in a cyclical set of chemical reactions, 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 would occur on a single high-temperature day. Ozone also can be transported from pollution sources into areas hundreds of miles upwind, resulting in elevated ozone levels even in areas with low local VOC or NO_X emissions.

The highest levels of ozone are produced when both VOC and NO_X emissions are present in significant quantities on clear summer days. Relatively small amounts of NO_X enable ozone to form rapidly when VOC levels are relatively high, but ozone production is quickly limited by removal of the NO_X. Under these conditions NO_X reductions are highly effective in reducing ozone while VOC reductions have little effect. Such conditions are called ‘‘NO_X-limited.’’ Because the contribution of VOC emissions from biogenic (natural) sources to local ambient ozone concentrations can be significant, even some areas where man-made VOC emissions are relatively low can be NO_X-limited.

When NO_X levels are relatively high and VOC levels relatively low, NO_X forms inorganic nitrates (i.e., particles) but relatively little ozone. Such conditions are called ‘‘VOC-limited.’’ Under these conditions, VOC reductions are effective in reducing ozone, but NO_X reductions can actually increase local ozone under certain circumstances. Even in VOC-limited urban areas, NO_X reductions are not expected to increase ozone levels if the NO_X reductions are sufficiently large.

Rural areas are usually NO_X-limited, due to the relatively large amounts of biogenic VOC emissions in many rural areas. Urban areas can be either VOC- or NO_X-limited, or a mixture of both, in which ozone levels exhibit moderate sensitivity to changes in either pollutant.

Ozone concentrations in an area also can be lowered by the reaction of nitric oxide with ozone, forming nitrogen dioxide (NO_2); as the air moves downwind and the cycle continues, the NO_2 forms additional ozone. The importance of this reaction depends, in part, on the relative concentrations of NO_X, VOC, and ozone, all of which change with time and location.

The current ozone National Ambient Air Quality Standards (NAAQS) has an 8-hour averaging time.[32] The 8-hour ozone NAAQS, established by EPA in 1997, is based on well-documented science demonstrating that more people were experiencing adverse health effects at lower levels of exertion, over longer periods, and at lower ozone concentrations than addressed by the previous one-hour ozone NAAQS. The current ozone NAAQS addresses ozone exposures of concern for the general population and populations most at risk, including children active outdoors, outdoor workers, and individuals with pre-existing respiratory disease, such as asthma. 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.

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.[33] As of October 2006 there are approximately 157 million people living in 116 areas (which include all or part

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[31] 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 may be accessed electronically at: *http://www.epa.gov/ ttn/naaqs/standards/ ozone/s_o3_cr_cd.html.*

[32] EPA's review of the ozone NAAQS is underway and a proposal is scheduled for May 2007 with a final rule scheduled for February 2008.

[33] A listing of the 8-hour ozone nonattainment areas is included in the draft RIA for this proposed rule.

of 461 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 achieve the 8-hour ozone NAAQS.

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-hour ozone NAAQS in the future is expected to decrease.

Based on recent ozone modeling performed for the CAIR analysis,[34] which does not include any additional local ozone precursor controls, we estimate that in 2010, 24 million people are projected to live in 37 Eastern counties exceeding the 8-hour ozone NAAQS. An additional 61 million people are projected to live in 148 Eastern counties expected to be within 10 percent of violating the 8-hour ozone NAAQS in 2010.

States with 8-hour ozone nonattainment areas will be 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 8-hour ozone NAAQS in the 2007 to 2013 time frame and then be required to maintain the 8-hour ozone NAAQS thereafter.[35] We expect many of the 8-hour ozone nonattainment areas will need to adopt additional emission reduction programs. The expected NO_X and VOC reductions from the standards proposed in this action would be important to states as they seek to either attain or maintain the 8-hour ozone NAAQS.

(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 papers. [36] [37] [38] 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, and breathing may 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 a doctor's attention and/or the use of additional medication. 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 susceptible to effects associated with exposure to ozone include children, the elderly, and individuals with respiratory disease such as asthma. There is also suggestive evidence that certain people may have greater genetic susceptibility. People can also have heightened vulnerability to ozone due to greater exposures (e.g., children and outdoor workers).

The recent ozone AQCD also examined relevant new scientific information which has emerged in the past decade, including the impact of ozone exposure on such health effect indicators 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. In addition to supporting and building further on conclusions from the 1996 AQCD, the 2006 AQCD included new information on the health effects of ozone. 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.

EPA typically quantifies ozone-related health impacts in its regulatory impact analyses (RIAs) when possible. In the analysis of past air quality regulations, ozone-related benefits have included morbidity endpoints and welfare effects such as damage to commercial crops. EPA has not recently included a separate and additive mortality effect for ozone, independent of the effect associated with fine particulate matter. For a number of reasons, including (1) advice from the Science Advisory Board (SAB) Health and Ecological Effects Subcommittee (HEES) that EPA consider the plausibility and viability of including an estimate of premature mortality associated with short-term ozone exposure in its benefits analyses and (2) conclusions regarding the scientific support for such relationships in EPA's 2006 Air Quality Criteria for Ozone and Related Photochemical Oxidants (the CD), EPA is in the process of determining how to appropriately characterize ozone-related mortality benefits within the context of benefits analyses for air quality regulations. As part of this process, we are seeking advice from the National Academy of Sciences (NAS) regarding how the ozone-mortality literature should be used to quantify the reduction in premature mortality due to diminished exposure to ozone, the amount of life expectancy to be added and the monetary value of this increased life expectancy in the context of health benefits analyses associated with regulatory assessments. In addition, the Agency has sought advice on characterizing and communicating the uncertainty associated with each of these aspects in health benefit analyses.

Since the NAS effort is not expected to conclude until 2008, the agency is currently deliberating how best to characterize ozone-related mortality benefits in its rulemaking analyses in the interim. For the analysis of the proposed locomotive and marine standards, we do not quantify an ozone mortality benefit. So that we do not provide an incomplete picture of all of the benefits associated with reductions in emissions of ozone precursors, we have chosen not to include an estimate of total ozone benefits in the proposed RIA. By omitting ozone benefits in this proposal, we acknowledge that this analysis underestimates the benefits associated with the proposed standards. For more information regarding the quantified benefits included in this analysis, please refer to Chapter 6 of this RIA.

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[34] Technical Support Document for the Final Clean Air Interstate Rule Air Quality Modeling. This document is available in Docket EPA–HQ–OAR–2003–0190.

[35] The Los Angeles South Coast Air Basin 8-hour ozone nonattainment area will have to attain before June 15, 2021.

[36] 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 may be accessed electronically at:*http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_cd.html.*

[37] U.S. EPA (1996) Review of National Ambient Air Quality Standards for Ozone, Assessment of Scientific and Technical Information. OAQPS Staff Paper First Draft. EPA–452/R–96–007. This document is available electronically at: *http:www.epa.gov/ ttn/naaqs/ standards/ ozone/ s_o3_ cr_sp. html.*

[38] U.S. EPA (2006) Review of the National Ambient Air Quality Standards for Ozone, Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper Second Draft. EPA–452/D–05–002. This document is available electronically at: *http:www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_sp.html.*

(c) Air Quality Modeling Results for Ozone

This proposed rule would result in substantial nationwide ozone benefits. The air quality modeling conducted for ozone as part of this proposed rulemaking projects that in 2020 and 2030, 114 of the current 116 ozone nonattainment areas would see improvements in ozone air quality as a result of this proposed rule.

Results from the air quality modeling conducted for this rulemaking indicates that the average and population-weighted average concentrations over all U.S. counties would experience broad improvement in ozone air quality. The decrease in average ozone concentration in current nonattainment counties shows that the proposed rule would help bring these counties into attainment. The decrease in average ozone concentration for counties below the standard, but within ten percent, shows that the proposed rule would also help those counties to maintain the standard. All of these metrics show a decrease in 2020 and a larger decrease in 2030, indicating in four different ways the overall improvement in ozone air quality. For example, in nonattainment counties, on a population-weighted basis, the 8-hour ozone design value would decrease by 0.29 ppb in 2020 and 0.87 ppb in 2030.

The impact of the proposed reductions has also been analyzed with respect to those areas that have the highest design values at or above 85 ppb in 2030. We project there would be 27 U.S. counties with design values at or above 85 ppb in 2030. After implementation of this proposed action, we project that 3 of these 27 counties would drop below 85 ppb. Further, 17 of the 27 counties would be at least 10 percent closer to a design value of less than 85 ppb, and on average all 27 counties would be about 30 percent closer to a design value of less than 85 ppb.

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Figure II-3 Impact of Proposed Locomotive/Marine controls on annual Ozone Design Values (DV) on U.S. Counties in 2030

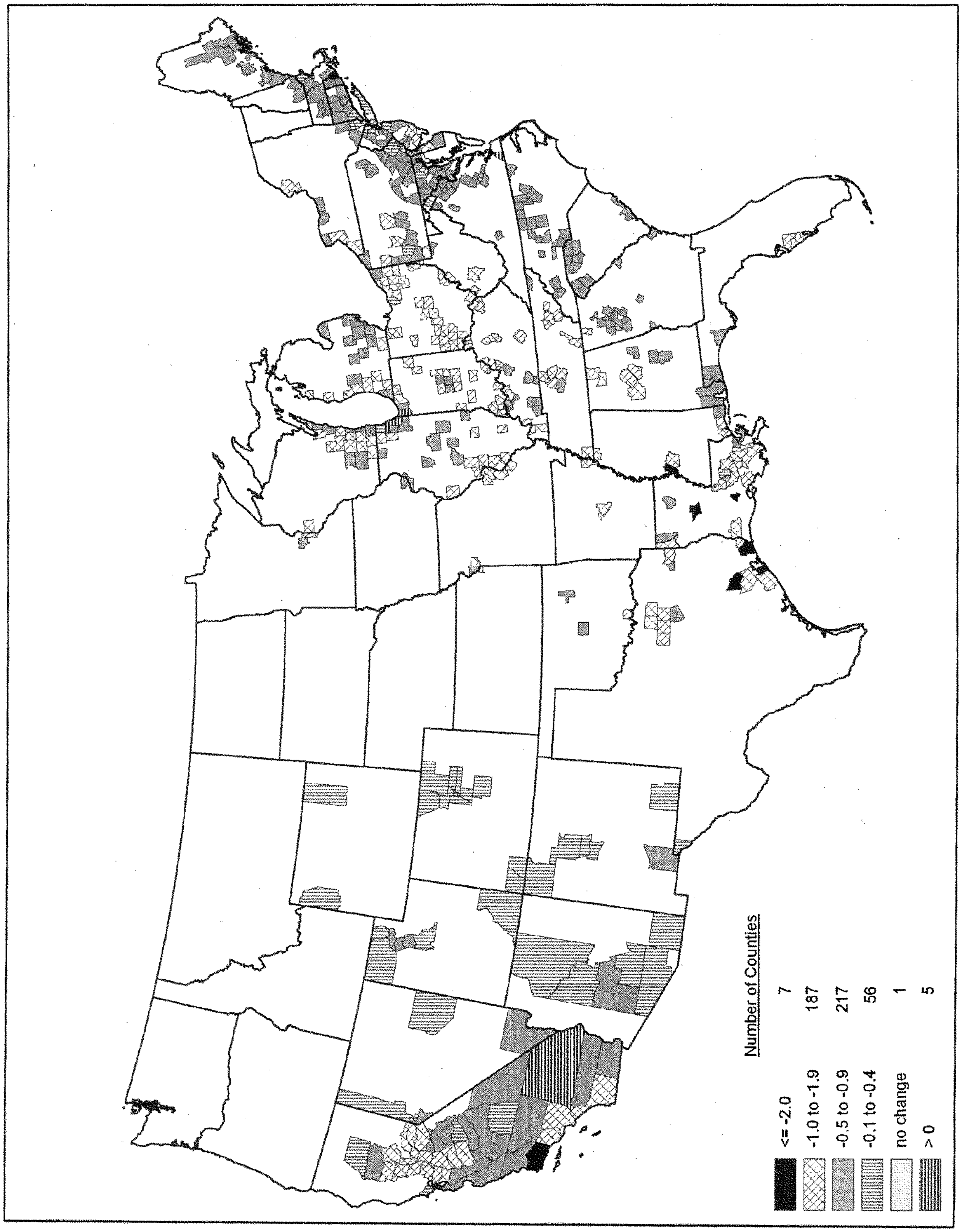

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Figure II–3 shows those U.S. counties in 2030 which are projected to experience a change in their ozone design values as a result of this proposed rule. The most significant decreases, equal or greater than −2.0 ppb, would occur in 7 counties across the U.S. including: Grant (−2.1 ppb) and Lafayette (−2.0 ppb) Counties in Louisiana; Montgomery (−2.0 ppb), Galveston (−2.0 ppb), and Jefferson (−2.0 ppb) Counties in Texas; Warren County (−2.9 ppb) in Mississippi; and Santa Barbara County (−2.7 ppb) in California. One hundred eighty-seven (187) counties would see annual ozone design value reductions from −1.0 to −1.9 ppb while an estimated 217 additional counties would see annual design value reductions from −0.5 to −0.9 ppb. Note that 5 counties including: Suffolk (+1.5 ppb) and Hampton (+0.8 ppb) Counties in Virginia; Cook County (+0.7 ppb) in Illinois; Lake County (+0.2 ppb) in Indiana; and San Bernardino County (+0.1 ppb) in California are projected to experience an increase in ozone design values because of the NO_X disbenefit that occurs under certain conditions.[39] It is expected that future local and national controls that decrease VOC, CO, and regional ozone will mitigate any localized disbenefits.

EPA's review of the ozone NAAQS is currently underway and a proposed decision in this review is scheduled for May 2007 with a final rule scheduled for February 2008. If the ozone NAAQS is revised then new nonattainment areas could be designated. While EPA is not relying on it for purposes of justifying this proposal, the emission reductions from this rulemaking would also be helpful to states if there is an ozone NAAQS revision.

(d) Ozone Air Quality Modeling Methodology

A national scale air quality modeling analysis was performed to estimate future year ozone concentrations for this proposed rule. To model the air quality benefits of this rule we used the Community-Scale Air Quality (CMAQ) model. CMAQ simulates the numerous physical and chemical processes involved in the formation, transport, and destruction of ozone and particulate matter. In addition to the CMAQ model, the modeling platform includes the emissions, meteorology, and initial and boundary condition data which are inputs to this model. Consideration of the different processes that affect primary directly emitted and secondary PM at the regional scale in different locations is fundamental to understanding and assessing the effects of pollution control measures that affect PM, ozone and deposition of pollutants to the surface. A complete description of the CAMQ model and methodology employed to develop the future year impacts of this proposed rule are found in Chapter 2.1 of the draft RIA.

It should be noted that the emission control scenarios used in the air quality and benefits modeling are slightly different than the emission control program being proposed. 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 draft RIA describes the changes in the inputs and resulting emission inventories between the preliminary assumptions used for the air quality modeling and the final proposed regulatory scenario. These refinements to the proposed program would not significantly change the results summarized here or our conclusions drawn from this analysis.

(3) Air Toxics

People experience elevated risk of cancer and other noncancer health effects from exposure to air toxics. Mobile sources are responsible for a significant portion of this risk. According to the National Air Toxic Assessment (NATA) for 1999, mobile sources were responsible for 44 percent of outdoor toxic emissions and almost 50 percent of the cancer risk. Benzene is the largest contributor to cancer risk of all 133 pollutants quantitatively assessed in the 1999 NATA. Mobile sources were responsible for 68 percent of benzene emissions in 1999. Although the 1999 NATA did not quantify cancer risks associated with exposure to this diesel exhaust, EPA has concluded that diesel exhaust ranks with the other air toxic substances that the national-scale assessment suggests pose the greatest relative risk.

According to 1999 NATA, nearly the entire U.S. population was exposed to an average level of air toxics that has the potential for adverse respiratory health effects (noncancer). Mobile sources were responsible for 74 percent of the noncancer (respiratory) risk from outdoor air toxics in 1999. The majority of this risk was from acrolein, and formaldehyde also contributed to the risk of respiratory health effects. Although not included in NATA's estimates of noncancer risk, PM from gasoline and diesel mobile sources contribute significantly to the health effects associated with ambient PM.

It should be noted that 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 Web site.[40] 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.

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 engine emissions include 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 (<2.5 µm), including a subgroup with a large number of ultrafine particles (<0.1 µm). These particles have 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.[41]

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[39] NO_X reductions can at certain times and in some areas cause ozone levels to increase. Such ''disbenefits'' are predicted in our modeling for this proposed rule. For a discussion of the phenomenon see the draft RIA Chapter 2.2. In spite of this disbenefit, the air quality modeling we conducted makes clear that the overall effect of this proposed rule is positive with 456 counties experiencing a decrease in both their 2020 and 2030 ozone design value.

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

[41] U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/600/8–90/057F Office of Research and Development, Washington, DC. Pp 1–1, 1–2. This document is available

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 Effect of Diesel Exhaust

In EPA's 2002 Diesel Health Assessment Document (Diesel HAD),[42] diesel exhaust was classified as likely to be carcinogenic to humans by inhalation at 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 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 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.[43] [44] [45]

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 diesel exhaust is a likely human carcinogen. 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.

(ii) Diesel Exhaust: Other Health Effects

Noncancer health effects of acute and chronic exposure to diesel exhaust emissions are also of concern to the Agency. EPA derived an RfC from consideration of four well-conducted chronic rat inhalation studies showing adverse pulmonary effects. [46] [47] [48] [49] The RfC is $5 \mu g/m^3$ 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 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).

Diesel exhaust has been shown to cause serious noncancer effects in occupational exposure studies. One study of railroad workers and electricians, cited in the Diesel HAD,[50] 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 [51] 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.

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electronically at *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060*.

[42] 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*.

[43] U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/6008–90/057F Office of Research and Development, Washington, DC. 9–11.

[44] Bhatia, R., Lopipero, P., Smith, A. (1998) Diesel exposure and lung cancer. Epidemiology 9(1):84–91.

[45] Lipsett, M: Campleman, S; (1999) Occupational exposure to diesel exhaust and lung cancer: a meta-analysis. Am J Public Health 80(7): 1009–1017.

[46] 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.

[47] 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.

[48] 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.

[49] 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.

[50] Kilburn (2000). See HAD Chapter 5–7.

[51] 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.

(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 National Ambient Air Quality Standard (NAAQS) of 15 μg/m^3. There is a much more 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, of which diesel PM is a constituent.

(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.

1. 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 resulting in a wide range of exposures from 2 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).[52] 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.

2. 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 recent 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 largest rail facility in the western United States.[53] 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 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 μg/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 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.[54] Like the earlier rail yard study, the port study employed the ISCST3 dispersion model. Also 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 μg/m^3 of port-related diesel PM in ambient air, about 360,000 people lived in areas with at least 0.6 μg/m^3 of diesel PM, and about 50,000 people lived in areas with at least 1.5 μg/m^3 of ambient diesel PM directly from the port.

Overall, while these studies focus on only two large marine port and railroad facilities, they highlight the substantial contribution these facilities make to elevated ambient concentrations in populated areas.

We have recently initiated a study to better understand the populations that are living near rail yards and marine ports nationally. As part of the study, a computer geographic information system (GIS) is being used to identify the locations and property boundaries of these facilities nationally, and to determine the size and demographic characteristics of the population living near these facilities. We anticipate that the results of this study will be complete in 2007 and we intend to add this report to the public docket.

(a) Gaseous Air Toxics—Benzene, 1,3-butadiene, Formaldehyde, Acetaldehyde, Acrolein, POM, Naphthalene

Locomotive and marine diesel engine exhaust emissions contribute to ambient levels of other air toxics known or suspected as human or animal carcinogens, or that have non-cancer health effects. These other compounds 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 risk 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 proposed in this rulemaking would help reduce exposure to these harmful substances.

Air toxics can cause a variety of cancer and noncancer health effects. A number of the mobile source air toxic pollutants described in this section are known or likely to pose a cancer hazard in humans. Many of these compounds also cause adverse noncancer health effects resulting from chronic,[55]

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[52] 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.

[53] 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*].

[54] Di, P.; Servin, A.; Rosenkranz, K.; Schwehr, B.; Tran, H. (2006) Diesel particulate matter exposure assessment study for the Ports of Los Angeles and Long Beach. California Air Resources Board. [Online at *http://www.arb.ca.gov/msprog/offroad/marineess/marineess.htm*].

[55] Chronic exposure is defined in the glossary of the Integrated Risk Information (IRIS) database (*http://www.epa.gov/iris*) as repeated exposure by

subchronic,[56] or acute [57] inhalation exposures. These include neurological, cardiovascular, liver, kidney, and respiratory effects as well as effects on the immune and reproductive systems.

Benzene: The EPA's Integrated Risk Information (IRIS) database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure, and 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.[58] [59] [60] EPA states in its IRIS database that data indicate a causal relationship between benzene exposure and acute lymphocytic leukemia and suggests a relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia. 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.[61] [62] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[63] [64] 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.[65] [66] [67] [68] 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.[69] [70] The specific mechanisms of 1,3-butadiene-induced carcinogenesis are unknown. However, it is virtually certain that the carcinogenic effects are mediated by genotoxic metabolites of 1,3-butadiene. Animal data suggest that females may be more sensitive than males for cancer effects; 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.[71]

Formaldehyde: Since 1987, EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[72] EPA is currently reviewing recently published epidemiological data. For instance, recently released 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.[73] [74] NCI is currently performing an update of 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.[75] Based on the developments of the last decade, in 2004, the working group of the International Agency for Research on Cancer (IARC) concluded that formaldehyde is carcinogenic to humans (Group 1), on the basis of sufficient evidence in humans and sufficient evidence in experimental animals—a higher classification than previous IARC evaluations.

Formaldehyde exposure also causes a range of noncancer health effects, including irritation of the eyes (tearing of the eyes and increased blinking) and mucous membranes.

Acetaldehyde: Acetaldehyde is classified in EPA's IRIS database as a probable human carcinogen, based on nasal tumors in rats, and is considered toxic by the inhalation, oral, and intravenous routes.[76] The primary acute effect of exposure to acetaldehyde vapors is irritation of the eyes, skin, and respiratory tract.[77] The agency is currently conducting a reassessment of the health hazards from inhalation exposure to acetaldehyde.

Acrolein: Acrolein is intensely irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation and congestion. EPA determined in 2003 using the 1999 draft cancer guidelines that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was

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the oral, dermal, or inhalation route for more than approximately 10 percent of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

[56] Defined in the IRIS database as exposure to a substance spanning approximately 10 percent of the lifetime of an organism.

[57] Defined in the IRIS database as exposure by the oral, dermal, or inhalation route for 24 hours or less.

[58] 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.*

[59] International Agency for Research on Cancer, IARC monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Some industrial chemicals and dyestuffs, International Agency for Research on Cancer, World Health Organization, Lyon, France, p. 345–389, 1982.

[60] 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.

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

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

[63] 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.

[64] 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.*

[65] 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.

[66] 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.

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

[68] 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.

[69] 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.*

[70] 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.*

[71] 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.

[72] 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.

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

[74] 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.

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

[76] U.S. EPA. 1988. 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.*

[77] U.S. EPA. 1988. 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.*

available on the carcinogenic effects of acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[78]

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.

Recent studies have found that maternal exposures to PAHs 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.[79] [80] 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 draft of a reassessment of the inhalation carcinogenicity of naphthalene.[81] The draft reassessment recently completed external peer review.[82] Based on external peer review comments, additional analyses are being considered. 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.[83] Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[84]

In addition to reducing substantial amounts of NO_X and $PM_{2.5}$ emissions from locomotive and marine diesel engines, the standards being proposed today would also reduce air toxics emitted from these engines. This will help mitigate some of the adverse health effects associated with operation of these engines.

C. Other Environmental Effects

There is a number of public welfare effects associated with the presence of ozone and $PM_{2.5}$ in the ambient air. In this section we discuss the impact of $PM_{2.5}$ on visibility 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.[85] Visibility impairment manifests in two principal ways: as local visibility impairment and as regional haze.[86] Local visibility impairment may take the form of a localized plume, a band or layer of discoloration appearing well above the terrain as a result of complex local meteorological conditions. Alternatively, local visibility impairment may manifest as an urban haze, sometimes referred to as a ''brown cloud''. This urban haze is largely caused by emissions from multiple sources in the urban areas and is not typically attributable to only one nearby source or to long-range transport. The second type of visibility impairment, regional haze, usually results from multiple pollution sources spread over a large geographic region. Regional haze can impair visibility in large regions and across states.

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 visibility in these areas. For more information on visibility see the final 2004 PM AQCD as well as the 2005 PM Staff Paper.[87] [88]

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[78] 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 electronically at *http://www.epa.gov/iris/subst/0364.htm.*

[79] 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.

[80] 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.

[81] 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.*

[82] Oak Ridge Institute for Science and Education. (2004). External Peer Review for the IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. August 2004. *http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=86019.*

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

[84] 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.*

[85] National Research Council, 1993. Protecting Visibility in National Parks and Wilderness Areas. National Academy of Sciences Committee on Haze in National Parks and Wilderness Areas. National Academy Press, Washington, DC. This document is available in Docket EPA-HQ-OAR–2005–0036. This book can be viewed on the National Academy Press Web site at *http://www.nap.edu/books/0309048443/html/.*

[86] See discussion in U.S. EPA, National Ambient Air Quality Standards for Particulate Matter; Proposed Rule; January 17, 2006, Vol 71 p 2676. This information is available electronically at *http://epa.gov/fedrgstr/EPA-AIR/2006/January/Day-17/a177.pdf.*

[87] 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–2005–0036.

[88] 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–2005–0036.

Fine particles are the major cause of reduced visibility in parts of the United States. EPA is pursuing a two-part strategy to address visibility. First, to address the welfare effects of PM on visibility, EPA set secondary $PM_{2.5}$ standards which would act in conjunction with the establishment of a regional haze program. In setting this secondary standard EPA 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).[89] 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.[90]

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

Recently designated $PM_{2.5}$ nonattainment areas indicate that, as of March 2, 2006, almost 90 million people live in nonattainment areas for the 1997 $PM_{2.5}$ NAAQS. Thus, at least these populations would likely be experiencing visibility impairment, as well as many thousands of individuals who travel to these areas. 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. In summary, visibility impairment is experienced throughout the U.S., in multi-state regions, urban areas, and remote mandatory class I federal areas.[91] [92] The mandatory federal class I areas are listed in Chapter 2 of the draft RIA for this action. The areas that have design values above the 1997 $PM_{2.5}$ NAAQS are also listed in Chapter 2 of the draft RIA for this action.

Future Visibility Impairment

Recent modeling for this proposed rule was used to project visibility conditions in the 116 mandatory class I federal areas across the U.S. in 2020 and 2030 resulting from the proposed locomotive and marine diesel engine standards. The results suggest that improvement in visibility would occur in all class I federal areas although areas would continue to have annual average deciview levels above background in 2020 and 2030. Table II–2 groups class I federal areas by regions and illustrates that regardless of geographic area, reductions in $PM_{2.5}$ emissions from this rule would benefit visibility in each region of the U.S. in mandatory class I federal areas.

TABLE II–2.—SUMMARY OF MODELED 2030 VISIBILITY CONDITIONS IN MANDATORY CLASS I FEDERAL AREAS

[Annual average deciview]

Region	Predicted 2030 visibility baseline w/o rule rule	Predicted 2030 visibility with rule control	Change in annual average deciview
Eastern			
Southeast	17.52	17.45	.07
Northeast/Midwest	14.85	14.80	.05
Western			
Southwest	9.36	9.32	.04
West (CA–NV–UT)	9.99	9.92	.07
Rocky Mountain	8.37	8.33	.04
Northwest	9.11	9.05	.06
National Class I Area Average	10.97	10.91	.06

Notes:

(a) Background visibility conditions differ by regions: Eastern natural background is 9.5 deciview (or visual range of 150 kilometers) and the West natural background is 5.3 deciview (or visual range of 230 kilometers).

(b) The results average visibility conditions for mandatory Class I Federal areas in the regions.

(c) The results illustrate the type of visibility improvements for the primary control options. The proposal differs based on updated information; however, we believe that the net results would approximate future PM emissions.

(2) Plant and Ecosystem Effects of Ozone

Ozone contributes to many 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 lower 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

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[89] 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.

[90] As mentioned above, the EPA has recently proposed to amend the PM NAAQS (71 FR 2620, Jan. 17, 2006). The proposal would set the secondary NAAQS equal to the primary standards for both $PM_{2.5}$ and $PM_{10-2.5}$. EPA also is taking comment on whether to set a separate $PM_{2.5}$ standard, designed to address visibility (principally in urban areas), on potential levels for that standard within a range of 20 to 30 $\mu g/m^3$, and on averaging times for the standard within a range of four to eight daylight hours.

[91] 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/*.

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

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 proposed NO_X standards will help reduce crop damage and stress on vegetation from ozone.

(3) Acid Deposition

Acid deposition, or acid rain as it is commonly known, occurs when NO_X and SO_2 react in the atmosphere with water, oxygen and oxidants to form various acidic compounds that later fall to earth in the form of precipitation or dry deposition of acidic particles. It contributes to damage of trees at high elevations and in extreme cases may cause lakes and streams to become so acidic that they cannot support aquatic life. In addition, acid deposition accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage.

The proposed NO_X standards would help reduce acid deposition, thereby helping to reduce acidity levels in lakes and streams throughout the country and helping accelerate the recovery of acidified lakes and streams and the revival of ecosystems adversely affected by acid deposition. Reduced acid deposition levels will also help reduce stress on forests, thereby accelerating reforestation efforts and improving timber production. Deterioration of historic buildings and monuments, vehicles, and other structures exposed to acid rain and dry acid deposition also will be reduced, and the costs borne to prevent acid-related damage may also decline. While the reduction in nitrogen acid deposition will be roughly proportional to the reduction in NO_X emissions, the precise impact of this rule will differ across different areas.

(4) Eutrophication and Nitrification

The NO_X standards proposed in this action will help reduce the airborne nitrogen deposition that contributes to eutrophication of watersheds, particularly in aquatic systems where atmospheric deposition of nitrogen represents a significant portion of total nitrogen loadings.

Eutrophication is the accelerated production of organic matter, particularly algae, in a water body. This increased growth can cause numerous adverse ecological effects and economic impacts, including nuisance algal blooms, dieback of underwater plants due to reduced light penetration, and toxic plankton blooms. Algal and plankton blooms can also reduce the level of dissolved oxygen, which can adversely affect fish and shellfish populations. In recent decades, human activities have greatly accelerated nutrient impacts, such as nitrogen and phosphorus, causing excessive growth of algae and leading to degraded water quality and associated impairment of fresh water and estuarine resources for human uses.[93]

Severe and persistent eutrophication often directly impacts human activities. For example, losses in the nation's fishery resources may be directly caused by fish kills associated with low dissolved oxygen and toxic blooms. Declines in tourism occur when low dissolved oxygen causes noxious smells and floating mats of algal blooms create unfavorable aesthetic conditions. Risks to human health increase when the toxins from algal blooms accumulate in edible fish and shellfish, and when toxins become airborne, causing respiratory problems due to inhalation. According to the NOAA report, more than half of the nation's estuaries have moderate to high expressions of at least one of these symptoms ‘‘ an indication that eutrophication is well developed in more than half of U.S. estuaries.[94]

(5) 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.[95] Particles affect materials principally by promoting and accelerating the corrosion of metals, by degrading paints, and by deteriorating building materials such as 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 proposed in this action will help reduce the airborne particles that contribute to materials damage and soiling.

D. Other Criteria Pollutants Affected by This NPRM

Locomotive and marine diesel engines account for about 1 percent of the mobile sources 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 35 ppm 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 2006, there are 15.5 million people living in 6 areas (10 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

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[93] Deposition of Air Pollutants to the Great Waters, Third Report to Congress, June 2000, EPA–453/R–00–005. This document can be found in Docket No. OAR–2002–0030, Document No. OAR–2002–0030–0025. It is also available at *www.epa.gov/oar/oaqps/gr8water/3rdrpt/obtain.html.*

[94] Bricker, Suzanne B., et al. National Estuarine Eutrophication Assessment, Effects of Nutrient Enrichment in the Nation's Estuaries, National Ocean Service, National Oceanic and Atmospheric Administration, September, 1999.

[95] 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–2005–0036.

can be found in the Air Quality Criteria for Carbon Monoxide.[96]

E. Emissions From Locomotive and Marine Diesel Engines

(1) Overview

The engine standards being proposed in this rule would affect emissions of particulate matter ($PM_{2.5}$), oxides of nitrogen (NO_X), volatile organic compounds (VOCs), and air toxics. Carbon monoxide is not specifically targeted in this proposal although the technologies applied to control these other pollutants are expected to also reduce CO emissions.

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. In the absence of new emissions standards, we expect overall emissions from these engines to decrease modestly over the next ten to fifteen years than 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 Tier 0 locomotive remanufacturing requirements. Beginning thereafter, emission inventories from these engines would once again begin increasing due to growth in the locomotive and marine sectors. Under today's proposed standards, by 2030, annual NO_X emissions from these engines would be reduced by 765,000 tons, $PM_{2.5}$ emissions by 28,000 tons, and VOC emissions by 42,000 tons.

In this section we first present base case emissions inventory contributions for locomotive and marine diesel engines and other mobile sources assuming no further emission controls beyond those already in place. The 2001 inventory numbers were developed and used as an input into our air quality modeling. Individual sub-sections which follow discuss $PM_{2.5}$, NO_X, and VOC pollutants, in terms of expected emission reductions associated with the proposed standards. The tables and figures illustrate the Agency's analysis of current and future emissions contributions from locomotive and marine diesel engines.

(2) Estimated Inventory Contribution

Locomotive and marine diesel engine emissions contribute to nationwide PM, NO_X, VOC, CO, and air toxics inventories. Our current baseline and future year estimates for NO_X and $PM_{2.5}$ inventories (50-state) are set out in Tables II–3 and II–4. Based on our analysis undertaken for this rulemaking, we estimate that in 2001 locomotives 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 proposed today, these engines would contribute about 50,000 tons (65 percent) to the mobile source diesel $PM_{2.5}$ inventory and almost 1.6 million tons (35 percent) to the mobile source NO_X inventory.

The national locomotives and marine diesel engine $PM_{2.5}$ and NO_X inventories in 2030 would be roughly twice as large as the combined $PM_{2.5}$ and NO_X inventories from on-highway diesel and land-based nonroad diesel engines. In absolute terms—locomotives and marine diesel engines, in 2030, would annually emit 22,000 more tons of $PM_{2.5}$ and 890,000 more tons of NO_X than all highway and nonroad diesels combined. This occurs because EPA has already taken steps to bring engine emissions from both on-highway and nonroad diesels to near-zero levels, while locomotives and marine diesel engines continue to meet relatively modest emission requirements. Table II–4 shows that in 2001 the land-based nonroad diesel category contributed about 160,000 tons of $PM_{2.5}$ emissions and by 2030 they drop to under 18,000 tons. Likewise, in 2001, annual $PM_{2.5}$ emissions from highway diesel engines totaled about 110,000 tons falling in 2030 to about 10,000 tons. Table II–3 shows a similar downward trend occurring for annual NO_X emissions. In 2001, NO_X emissions from highway diesel engines' amounted to over 3.7 million tons but by 2030 they fall to about 260,000 tons. Finally, land-based nonroad diesels in 2001 emitted over 1.5 million tons of NO_X but by 2030 these emissions drop to approximately 430,000 tons.

Marine diesel engine and locomotive inventories were developed using multiple methodologies. Chapter 3 of the draft RIA provides a detailed explanation of our approach. In summary, the quality of data available for locomotive inventories made it possible to develop more detailed estimates of fleet composition and emission rates than we have previously done. Locomotive emissions were calculated based on estimated current and projected fuel consumption rates. Emissions were calculated separately for the following locomotive categories: line-haul locomotives in large railroads, switching locomotives in large railroads (including Class II/III switch railroads owned by Class I railroads), other line-haul locomotives (i.e., local and regional railroads), other switch/terminal locomotives, and passenger locomotives. Our inventories for marine diesel engines were created using the inventory for marine diesel engines up to 30 liters per cylinder displacement including recreational, commercial, and auxiliary applications was developed by using a methodology based on engine population, hours of use, average engine loads, and in-use emissions factors.

TABLE II–3.—NATIONWIDE ANNUAL NO_X BASELINE EMISSION LEVELS

Category	2001			2030		
	NO_X short tons	Percent of mobile source	Percent of total	NO_X	Percent of mobile source	Percent of total short tons
Locomotive	1,118,786	9.0	5.1	854,226	19.0	8.1
Recreational Marine Diesel	40,437	0.3	0.2	48,155	1.1	0.5
Commercial Marine (C1 & C2)	833,963	6.7	3.8	679,973	15.1	6.4
Land-Based Nonroad Diesel	1,548,236	12.5	7.1	434,466	9.7	4.1
Commercial Marine (C3)*	224,100	1.8	1.0	531,641	11.8	5.0
Small Nonroad SI	100,319	0.8	0.5	114,287	2.5	1.1
Recreational Marine SI	42,252	0.3	0.2	92,188	2.1	0.9
SI Recreational Vehicles	5,488	0.0	0.0	20,136	0.4	0.2
Large Nonroad SI (>25hp)	321,098	2.6	1.5	46,253	1.0	0.4

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[96] U.S. EPA (2000). Air Quality Criteria for Carbon Monoxide, EPA/600/P–99/001F. This document is available in Docket EPA–HQ–OAR–2004–0008.

TABLE II–3.—NATIONWIDE ANNUAL NO_X BASELINE EMISSION LEVELS—Continued

Category	2001			2030		
	NO_X short tons	Percent of mobile source	Percent of total	NO_X	Percent of mobile source	Percent of total short tons
Aircraft	83,764	0.7	0.4	118,740	2.6	1.1
Total Off Highway	4,318,443	34.8	19.8	2,940,066	65.5	27.7
Highway Diesel	3,750,886	30.2	17.2	260,915	5.8	2.5
Highway non-diesel	4,354,430	35.0	20.0	1,289,780	28.7	12.2
Total Highway	8,105,316	65.2	37.2	1,550,695	34.5	14.6
Total Diesel (distillate) Mobile	7,292,308	58.7	33.5	2,277,735	50.7	21.5
Total Mobile Sources	12,423,758	100	57.0	4,490,761	100	42.4
Stationary Point and Area Sources	9,355,659	-	43.0	6,111,866	-	57.6
Total Man-Made Sources	21,779,418	-	100	10,602,627	-	100

* This category includes emissions from Category 3 (C3) propulsion engines and C2/3 auxiliary engines used on ocean-going vessels.

TABLE II–4.—NATIONWIDE ANNUAL $PM_{2.5}$ BASELINE EMISSION LEVELS

Category	2001			2030		
	$PM_{2.5}$ short tons	Percent of diesel mobile	Percent of mobile source	$PM_{2.5}$ short tons	Percent of diesel mobile	Percent of mobile source
Locomotive	29,660	8.9	6.36	25,109	32.2	10.01
Recreational Marine Diesel	1,096	0.3	0.24	1,141	1.5	0.45
Commercial Marine (C1 & C2)	28,728	8.6	6.16	23,758	30.5	9.47
Land-Based Nonroad Diesel	164,180	49.2	35.2	17,934	23.0	7.1
Commercial Marine (C3)	20,023		4.30	52,682		20.99
Small Nonroad SI	25,575		5.5	35,761		14.3
Recreational Marine SI	17,101		3.7	6,378		2.5
SI Recreational Vehicles	12,301		2.6	9,953		4.0
Large Non road SI (>25hp)	1,610		0.3	2,844		1.1
Aircraft	5,664		1.22	8,569		3.41
Total Off Highway	305,939		65.6	184,129		73.4
Highway Diesel	109,952	33.0	23.6	10,072	12.9	4.0
Highway non-diesel	50,277		10.8	56,734		22.6
Total Highway	160,229		34.4	66,806		26.6
Total Diesel (distillate) Mobile	333,618	100	71.6	78,014	100	31.1
Total Mobile Sources	466,168		100	250,934		100
Stationary Point and Area Sources Diesel	3,189			2,865		
Stationary Point and Areas Sources non-diesel	1,963,264			1,817,722		
Total Stationary Point and Area Sources	1,966,453			1,820,587		
Total Man-Made Sources	2,432,621			2,071,521		

(3) $PM_{2.5}$ Emission Reductions

In 2001 annual emissions from locomotive and marine diesel engines totaled about 60,000 tons. Table II–4 shows the distribution of these $PM_{2.5}$ emissions: locomotives contributed about 30,000 tons, recreational marine diesel roughly 1,000 tons, and commercial marine diesel (C1 and C2) 29,000 tons. Due to current standards, annual $PM_{2.5}$ emissions from these engines drop to 50,000 tons in 2030 with roughly proportional emission reductions occurring in both the locomotive and commercial marine diesel categories while the recreational marine diesel category experiences a slight increase in $PM_{2.5}$ emissions. Both Tables II–5 and Figure II–4 show $PM_{2.5}$ emissions nearly flat through 2030 before beginning to rise again due to growth in these sectors.

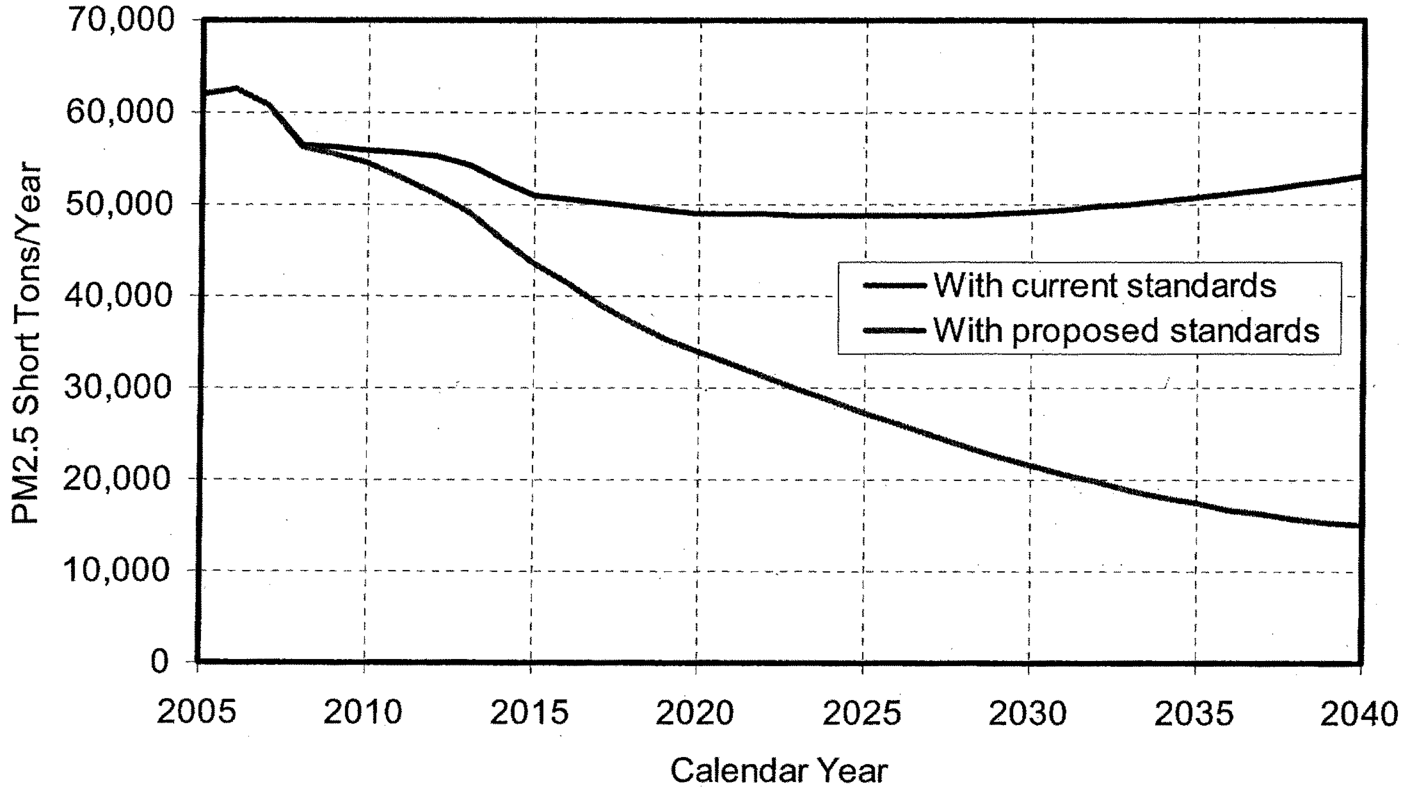
Table II–5 shows how the proposed rule would begin reducing $PM_{2.5}$ emissions from the current national inventory baseline starting in 2015 when annual reductions of 7,000 tons would occur. By 2020 that number would grow to 15,000 tons of $PM_{2.5}$, by 2030 to 28,000 annual tons, and reductions would continue to grow through 2040 to about 39,000 tons of $PM_{2.5}$ annually.

TABLE II–5.—LOCOMOTIVE AND MARINE DIESEL $PM_{2.5}$ EMISSIONS

[Short tons/year]

	2015	2020	2030	2040
Without Proposed Rule	51,000	50,000	50,000	54,000
With Proposed Rule	44,000	35,000	22,000	15,000
Reductions From Proposed Rule	7,000	15,000	28,000	39,000

Figure II-4 $PM_{2.5}$ Reductions from Proposal



Although this proposed rule results in large nationwide $PM_{2.5}$ inventory reductions, it would also help urban areas that have significant locomotive and marine diesel engine emissions in their inventories. Table II–6 shows the percent these engines contribute to the mobile source diesel $PM_{2.5}$ inventory in a variety of urban areas in 2001 and 2030. In 2001, a number of metropolitan areas saw locomotives and marine diesel engines contribute a much larger share to their local inventories than the national average including Houston (42 percent), Los Angeles (32 percent), and Baltimore (23 percent). In 2030, each of these metropolitan areas would continue to see locomotive and marine diesel engines comprise a larger portion of their mobile source diesel $PM_{2.5}$ inventory than the national average as would other communities including Cleveland (72 percent), Chicago (70 percent) and Chattanooga (70 percent).

TABLE II–6.—LOCOMOTIVE AND MARINE DIESEL CONTRIBUTION TO MOBILE SOURCE DIESEL $PM_{2.5}$ INVENTORIES IN SELECTED METROPOLITAN AREAS IN 2001 AND 2030

Metropolitan area (MSA)	2001 Percent	2030 Percent
National Average	18	65
Los Angeles, CA	32	73
Houston, TX	42	85
Chicago, IL	25	70
Philadelphia, PA	20	64
Cleveland-Akron-Lorain, OH	26	72
St. Louis, MO	22	68
Seattle, WA	17	61
Kansas City, MO	21	68
Baltimore, MD	23	68
Cincinnati, OH	24	70
Boston, MA	8	41
Huntington-Ashland WV-KY-OH	53	91
New York, NY	4	21
San Joaquin Valley, CA	9	39
Minneapolis-St. Paul, MN	11	48
Atlanta, GA	6	30
Phoenix-Mesa, AZ	5	27
Birmingham, AL	17	58
Detroit, MI	5	26
Chattanooga, TN	22	70
Indianapolis, IN	5	30

(4) NO_X Emissions Reductions

In 2001 annual emissions from locomotive and marine diesel engines totaled about 2.0 million tons. Table II–3 shows the distribution of these NO_X emissions: locomotives contributed about 1.1 million tons, recreational marine diesel roughly 40,000 tons, and commercial marine diesel (C1 and C2) 834,000 tons. Due to current standards, annual NO_X emission from these engines drop to 1.6 million tons in 2030 with roughly proportional emission reductions occurring in both the locomotive and commercial marine diesel categories while the recreational marine diesel category experiences an increase in $PM_{2.5}$ emissions. Both Table II–7 and Figure II–5 show NO_X

emissions remaining nearly flat through 2030 before beginning to rise again due to growth in these sectors.

Table II–7 shows how the proposed rule would begin reducing NO_X emissions from the current national inventory baseline starting in 2015 when annual reductions of 84,000 tons would occur. By 2020 that number would grow to 293,000 tons of NO_X, by 2030 to 765,000 annual tons, and reductions would continue to grow through 2040 to about 1.1 million tons of NO_X annually.

These numbers are comparable to emission reductions projected in 2030 for our already established nonroad Tier 4 program. Table II–8 provides the 2030 NO_X emission reductions (and PM reductions) for this proposed rule compared to the Heavy-Duty Highway rule and Nonroad Tier 4 rule. The 2030 NO_X reductions of about 740,000 tons for the Nonroad Tier 4 are similar to those from this proposed rule.

TABLE II–7.—LOCOMOTIVE AND MARINE DIESEL NO_X EMISSIONS

[Short tons/year]

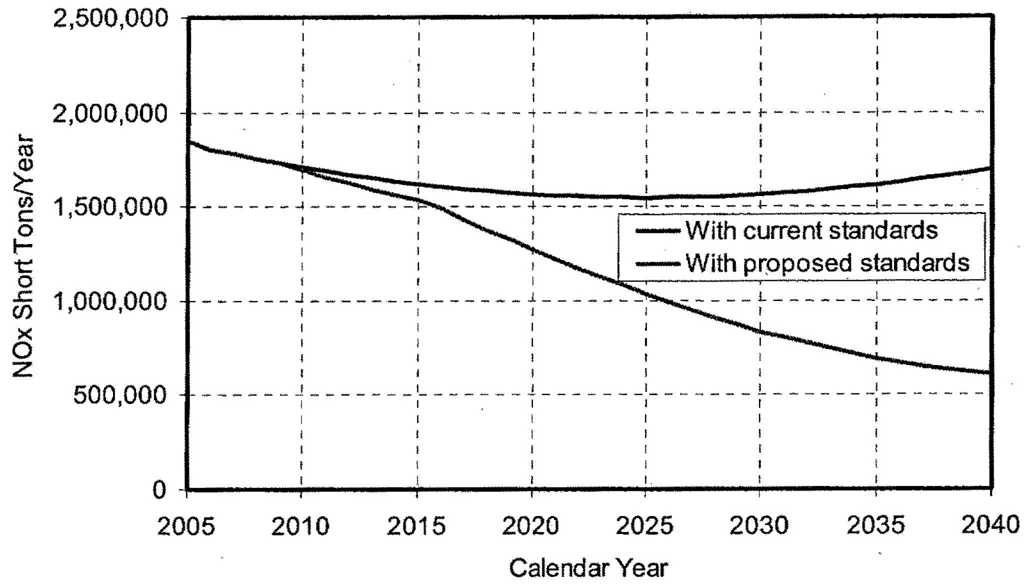
	2015	2020	2030	2040
Without Proposed Rule	1,633,000	1,582,000	1,582,000	1,703,000
With Proposed Rule	1,549,000	1,289,000	817,000	579,000
Reductions From Proposed Rule	84,000	293,000	765,000	1,124,000

TABLE II–8.—PROJECTED 2030 EMISSIONS REDUCTIONS FROM RECENT MOBILE SOURCE RULES

[Short tons]

Rule	NO_X	$PM_{2.5}$
Proposed Locomotive and Marine	765,000	28,000
Nonroad Tier 4	738,000	129,000
Heavy-Duty Highway	2,600,000	109,000

Figure II-5 NO_x Reductions from Proposal



Although this proposed rule results in large nationwide NO_X inventory reductions, it would also help urban areas that have significant concentrations of locomotive and marine diesel engines in their inventories. Table II–9 shows the percent these engines contribute to the mobile source diesel NO_X inventory in a variety of urban areas in 2001 and 2030. In 2001, a number of metropolitan areas saw locomotives and marine diesel engines contribute a much larger share to their local inventories than the national average including Houston (32 percent), Kansas City (20 percent), and Los Angeles (19 percent). In 2030, each of these metropolitan areas would continue to see locomotive and marine diesel engines comprise a larger portion of their mobile source diesel $PM_{2.5}$ inventory than the national average as would other communities including Birmingham (43 percent), Chicago (42 percent) and Chattanooga (40 percent).

TABLE II–9.—LOCOMOTIVE AND MARINE DIESEL ENGINE CONTRIBUTION TO MOBILE SOURCE NO_X INVENTORIES IN SELECTED METROPOLITAN AREAS IN 2001 AND 2030

Metropolitan areas (MSA)	2001 Percent	2030 Percent
National Average	16	35
Los Angeles, CA	19	38
Houston, TX	32	45
Chicago, IL	20	42
Philadelphia, PA	14	19
Cleveland-Akron-Lorain, OH	19	40
New York, NY	5	8
St. Louis, MO	16	37
Seattle, WA	14	31
Kansas City, MO	20	44
Cincinnati, OH	18	39
Huntington-Ashland, WV-KY-OH	39	37
Boston, MA	7	11
San Joaquin Valley, CA	9	26
Minneapolis-St. Paul, MN	9	20
Atlanta, GA	5	13
Birmingham, AL	17	43
Baltimore, MD	8	10
Phoenix-Mesa, AZ	6	15
Detroit, MI	3	9
Chattanooga, TN	16	40
Indianapolis, IN	5	13

(5) Volatile Organic Compounds Emissions Reductions

Emissions of volatile organic compounds (VOCs) from locomotive and marine diesel engines based on a 50-state inventory are shown in Table II–10, along with the estimates of the reductions in 2015, 2020, 2030 and 2040 we expect would result from the VOC exhaust emission standard in our proposed rule. In 2015 15,000 tons of VOCs would be reduced and by 2020 reductions would almost double to 27,000 tons annually from these engines. Over the next ten years annual reductions from controlled locomotive and marine diesel engines would produce annual VOC reductions of 42,000 tons in 2030 and 54,000 tons in 2040.

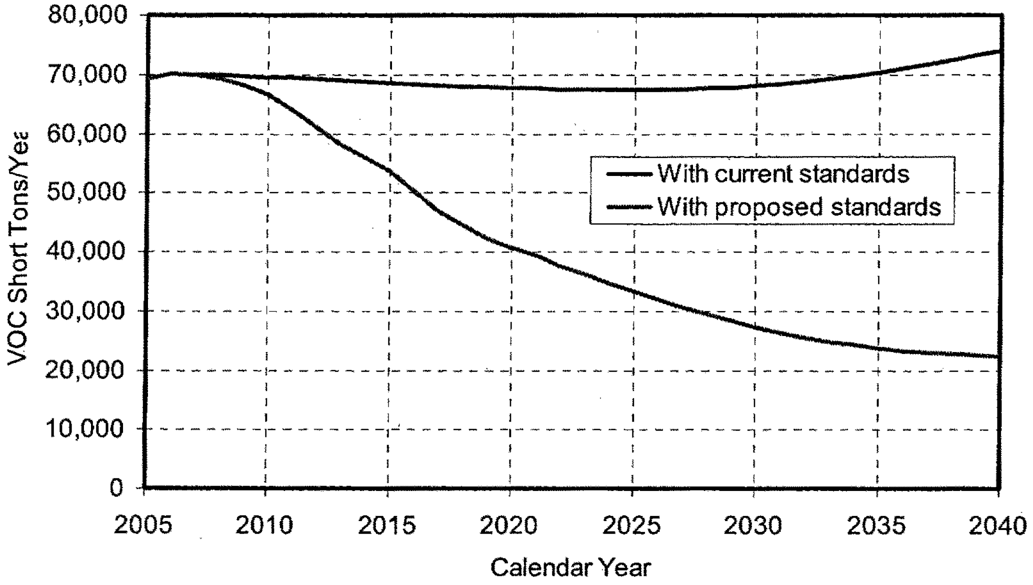
Figure II–6 shows our estimate of VOC emissions between 2005 and 2040 both with and without the proposed standards of this rule. We estimate that VOC emissions from locomotive and marine diesel engines would be reduced by 60 percent by 2030 and by 70 percent in 2040.

TABLE II–10.—LOCOMOTIVE AND MARINE DIESEL VOC EMISSIONS

[short tons/year]

	2015	2020	2030	2040
Without Proposed Rule	72,000	71,000	72,000	78,000
With Proposed Rule	57,000	44,000	30,000	24,000
Reductions From Proposed Rule	15,000	27,000	42,000	54,000

Figure II-6 VOC Reductions from Proposal



III. Emission Standards

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

- Tier 3 and Tier 4 standards for newly-built locomotives,
- Standards for remanufactured Tier 0, 1, and 2 locomotives,

- Standards and other provisions for diesel switch locomotives,
- Requirements to reduce idling locomotive emissions, as well as possible ways to encourage emission reductions through the optimization of multi-locomotive teams (consists), and
- Tier 3 and Tier 4 standards for newly-built marine diesel engines.

As discussed in sections I.A(2) and VII.A(2), we are also soliciting comment on setting standards for remanufactured marine diesel engines.

A detailed discussion of the technological feasibility of the proposed standards follows the description of the proposed program. The section concludes with a discussion of considerations and activities surrounding emissions from large Category 3 engines used on ocean-going vessels, although we are not proposing provisions for these engines in this rulemaking.

To ensure that the benefits of the standards are realized in-use and throughout the useful life of these engines, and to incorporate lessons learned over the last few years from the existing test and compliance program, we are also proposing revised test procedures and related certification requirements. In addition, we are proposing to continue the averaging, banking, and trading (ABT) emissions credits provisions to demonstrate compliance with the standards. These provisions are described further in section IV.

A. What Locomotives and Marine Engines Are Covered?

The regulations being proposed would affect locomotives currently regulated under part 92 and marine diesel engines and vessels currently regulated under parts 89 and 94, as described below.[97]

With some exceptions, the regulations apply for all locomotives 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 existing locomotives owned by railroads that are classified as small businesses.[98] 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 used in these smaller locomotive-type vehicles are generally subject to the nonroad engine requirements of Parts 89 and 1039.

There are currently three tiers of locomotive emission standards. The Tier 0 standards apply only to locomotives originally manufactured before 2002, the Tier 1 standards apply to new locomotives manufactured in 2002–2004, and the Tier 2 standards apply to new locomotives manufactured in 2005 and later. Under the existing regulations, the applicability of the Tier 1 and Tier 2 standards is based on the date of manufacture of the locomotive, rather than the engine. Thus, a newly manufactured engine in 2005 that is used to repower a 1990 model year locomotive would be subject to the Tier 0 emission standards, which are also applicable to all other 1990 model year locomotives. As described in section IV.B, we are proposing some changes to this approach.

The marine diesel engines covered by this rule would include propulsion engines used on vessels from recreational and small fishing boats to super-yachts, tugs and Great Lakes freighters, and auxiliary engines ranging from small gensets to large generators on ocean-going vessels.[99] Marine diesel engines are categorized both by per cylinder displacement and by rated power. Consistent with our existing marine diesel emission control program, the proposed standards would apply to any marine diesel engine with per cylinder displacement below 30 liters installed on a vessel flagged or registered in the United States. 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.

While marine diesel engines up to 37 kW (50 hp) are currently covered by our nonroad Tier 1 and Tier 2 standards, they were not included in the nonroad Tier 3 and Tier 4 programs. Instead, they are covered in this rule, making this a comprehensive control strategy for all marine diesel engines below 30 liters per cylinder displacement. This is a very broad range of engines and they are grouped into several categories for the existing standards, as described in detail in Chapter 1 of the draft RIA.

Consistent with our current marine diesel engine program, the standards described in this proposal would apply to engines manufactured for sale in the United States or imported into the United States beginning with the effective date of the standards. Any engine installed on a new vessel flagged or registered in the U.S. would be required to meet the appropriate emission limits. Also consistent with our current marine diesel engine program, the standards would also apply to any engine installed for the first time in a marine vessel flagged or registered in the U.S. after having 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.

Our current marine diesel engine emission controls do not apply to marine diesel engines on foreign vessels entering U.S. ports. At this time we believe it is appropriate to postpone consideration of the application of our national standards to engines on foreign vessels to a future rulemaking that would consider controls for Category 3 engines on ocean-going vessels. This will allow us consider the engines on foreign vessels as an integrated system, to better evaluate the regulatory options available for controlling their overall emission contribution to U.S. ambient air quality.

Nevertheless, we are soliciting comment on whether the emission standards we are proposing in this action should apply to engines below 30 liters per cylinder displacement installed on foreign vessels entering U.S. ports, and to no longer exclude these engines from the emission standards under 40 CFR 94.1(b)(3). Commenters are also invited to suggest when the standards should apply to foreign vessels. For example, the standards could apply based on the date the engine is built or, consistent with MARPOL Annex VI, the date the vessel is built.

B. Existing EPA Standards

NO_X emission levels from newly-built locomotives have been reduced over the past several years from unregulated levels of over 13 g/bhp-hr (17 g/kW-hr) to the current Tier 2 standard level for newly-built locomotives of 5.5 g/bhp-hr

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

[98] This small business provision is limited to railroads that are classified as small businesses by the Small Business Administration (SBA). Many but not all Class II and III railroads qualify as small businesses for this provision. See the 1998 locomotive rule (63 FR 18978, April 16, 1998) for a complete discussion of the basis and application of this provision.

[99] Marine diesel engines at or above 30 l/cyl displacement are not included in this program. See Section 3E, below.

(7.3 g/kW-hr)—a 60 percent reduction.[100] PM reductions on the order of 50 percent have also been achieved under a Tier 2 standard level of 0.20 g/bhp-hr (0.27 g/kW-hr). EPA emission standards for marine diesel engines vary somewhat due to the ranges in size and application of engines included; however Tier 2 levels for recreational and commercial marine engines are generally comparable in stringency to those adopted for locomotives, and are now in the process of phasing in over 2004–2009. See Chapter 1 of the draft RIA for a complete listing of the existing standards, including standards for remanufactured locomotives.

The Tier 2 emissions reductions have been achieved largely through engine calibration optimization and engine hardware design changes (such as improved fuel injectors and turbochargers, increased injection pressure, intake air after-cooling, combustion chamber design, reduced oil consumption and injection timing) Although these reductions in locomotive and marine emissions are important, they only bring today's cleanest locomotives and marine diesels to roughly the emissions levels of new trucks in the early 1990's, on the basis of grams per unit of work done.

C. What Standards Are We Proposing?

(1) Locomotive Standards

(a) Line-Haul Locomotives

We are proposing new emission standards for newly-built and remanufactured line-haul locomotives. Our proposed standards for newly-built line-haul locomotives would be implemented in two tiers: First, a new Tier 3 PM standard of 0.10 g/bhp-hr (0.13 g/kW-hr) taking effect in 2012, based on engine design improvements; second, new Tier 4 standards of 0.03 g/bhp-hr (0.04 g/kW-hr) for PM, 0.14 g/bhp-hr (0.19 g/kW-hr) for HC (both taking effect in 2015), and 1.3 g/bhp-hr (1.8 g/kW-hr) for NO_X (taking effect in 2017), based on the application of the high-efficiency catalytic aftertreatment technologies now being developed and introduced in the highway diesel sector. Our proposed standards for remanufactured line-haul locomotives would apply to all Tier 0, 1, and 2 locomotives and are based on engine design improvements. The feasibility of the proposed standards and the technologies involved are discussed in detail in section III.D. Table III–1 summarizes the proposed line-haul locomotive standards and implementation dates. See section III.C(3) for a discussion of the HC standards.

TABLE III–1.—PROPOSED LINE-HAUL LOCOMOTIVE STANDARDS

[g/bhp-hr]

Standards apply to:	Date	PM	NO_X	HC
Remanufactured Tier 0 & 1	2008 as Available, 2010 Required	0.22	[a] 7.4	[a] 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	PM and HC 2015 NO_X 2017	0.03	1.3	0.14

[a] For Tier 0 locomotives originally manufactured without a separate loop intake air cooling system, these standards are 8.0 and 1.00 for NO_X and HC, respectively.

(i) Remanufactured Locomotive Standards

We have previously regulated remanufactured locomotive engines under section 213(a)(5) of the Clean Air Act as new locomotive engines and we propose to continue to do so in this rule. Under our proposed standards, the existing fleet of locomotives that are currently subject to Tier 0 standards (our current remanufactured engine standards) would need to comply with a new Tier 0 PM standard of 0.22 g/bhp-hr (0.30 g/kW-hr). They would also need to comply with a new Tier 0 NO_X line-haul standard of 7.4 g/bhp-hr (9.9 g/kW-hr), except that Tier 0 locomotives that were built without a separate coolant loop for intake air (that is, using engine coolant for this purpose) would be subject to a less stringent Tier 0 NO_X standard of 8.0 g/bhp-hr (10.7 g/kW-hr) on the line-haul cycle.

These non-separate loop locomotives were generally built before 1993, though some are of more recent model years. Because of their age, many of them are likely to be retired and not remanufactured again, and many are entering lower use applications within the railroad industry. Correspondingly, their contribution to the locomotive emissions inventory is diminishing. Our analysis indicates that it is feasible to obtain a NO_X reduction for them on the order of 15 percent, from the current Tier 0 line-haul NO_X standard of 9.5 g/bhp-hr to the proposed 8.0 g/bhp-hr standard. However, we expect that any further reduction would require the addition of a separate intake air coolant loop, which provides more efficient cooling and therefore lower NO_X. This would be a fairly expensive hardware change and could have sizeable impacts on the locomotive platform layout and weight constraints. We are aware that this group of older, non-separate loop Tier 0 locomotives is fairly diverse, and that achieving even a 8.0 g/bhp-hr NO_X standard along with a stringent Tier 0 PM standard will be more difficult on some of these models than on others. We request comment on whether there are any locomotive families within this group for which meeting the proposed 8.0 g/bhp-hr standard may not be feasible, especially considering the cost of doing so and the age of the locomotives involved. Commenters should discuss feasibility and projected costs, and should also discuss the extent to which this concern is mitigated by the prospect that these locomotives will be retired rather than remanufactured anyway, or will be moved to lower usage switcher or small railroad applications, and therefore will be less likely to be remanufactured under the new Tier 0 standards.

We propose to apply the new Tier 0 standards (and corresponding switch-cycle standards) when the locomotive is remanufactured on or after January 1, 2008. However, if no certified emissions

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[100] Consistent with past EPA rulemakings, our regulations generally express standards, power ratings, and other quantities in international SI (metric) units—kW, g/kW-hr, etc. One exception to this is Part 92 (locomotives), which for historical reasons expresses standards in g/bhp-hr. This proposal retains these established norms for locomotive and marine engine regulations. However, in this preamble we have chosen to express standards in units of g/bhp-hr, to provide a common frame of reference. Where helpful for clarity, we have also included g/kW-hr standards in parentheses. In any compliance questions that might arise from differences in these due to, for example, rounding conventions, the regulations themselves establish the applicable requirements.

control system exists for the locomotive before October 31, 2007, these standards will instead apply 3 months after such a system is certified, but no later than January 1, 2010. This would provide an incentive to develop and certify systems complying with these standards as early as possible, but allow the railroad to avoid having to delay planned rebuilds if a certified system is not available when the program is expected to begin in 2008. We also propose to include a reasonable cost provision, described in section IV.B, to protect against the unlikely event that the only certified systems made available when this program starts in 2008 will be exorbitantly priced.

Although under this approach, certification of new remanufacture systems before 2010 is voluntary, we believe that developers would 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 higher volume 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.

We are also proposing to set new more stringent standards for locomotives currently subject to Tier 1 and Tier 2 standards, to apply at the point of next remanufacture after the proposed implementation dates. Tier 1 locomotives would need to comply with the same new PM standard of 0.22 g/bhp-hr (0.30 g/kW-hr) required of Tier 0 locomotives (they are already subject to the 7.4 g/bhp-hr (9.9 g/kW-hr) NO_X standard). This in essence expands the model years covered by the Tier 1 standards from 2002–2004 to roughly 1993–2004, greatly increasing the size of the Tier 1 fleet while at the same time reducing emissions from this broadened fleet. Under the proposal, Tier 2 locomotives on the rails today or built prior to the start of Tier 3 would need to comply with a new Tier 2 PM line-haul standard of 0.10 g/bhp-hr (0.13 g/kW-hr). Because this is equal to the Tier 3 standard, it essentially adds the entire fleet of Tier 2 locomotives to the clean Tier 3 category over a period of just a few years, as they go through a remanufacture cycle.

The implementation schedule for the new Tier 1 standard would be the same as the 2008/2010 schedule discussed above for Tier 0 locomotives. Meeting the new Tier 2 standard would be required somewhat later, in 2013, reflecting the additional redesign challenge involved in meeting this more stringent standard, and the need to spread the redesign and certification workload faced by the manufacturers overall. However, as for Tier 0 and Tier 1 locomotives, we are proposing that if a certified Tier 2 remanufacture system meeting the new standard is available early, anytime after January 1, 2008, this system would be required to be used, starting 3 months after it is certified, subject to a reasonable cost provision as with early Tier 0 and Tier 1 remanufactures. We request comment on whether use of certified Tier 2 remanufacture systems should be required on the same schedule as Tier 3, that is, starting in 2012, given that we expect the upgraded Tier 2 designs to be very similar to newly-built Tier 3 designs, and the likelihood that substantial numbers of Tier 2 locomotives may be approaching their first scheduled remanufacture by 2012.

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

(ii) Newly-Built Locomotive Standards

We are requesting comment on whether additional NO_X emission reductions would be feasible and appropriate for Tier 3 locomotives in the 2012 timeframe. There are proven diesel technologies not currently employed in Tier 2 locomotives that can significantly reduce NO_X emissions, most notably cooled exhaust gas recirculation (EGR). Although employed successfully in the heavy-duty highway diesel sector since 2003, a considerable development and redesign program would need to be undertaken by locomotive manufacturers to apply cooled EGR to Tier 3 locomotives. This development work would not be limited to the engine but would include substantial changes to the locomotive chassis to handle the higher levels of heat rejection (engine cooling demand) required for cooled EGR. We project that it would require a similar degree of engineering time and effort to develop a cooled EGR solution for locomotive diesel engines as it will to develop the urea SCR based solution upon which we are basing our proposed Tier 4 NO_X standard. Therefore, we have not considered the application of cooled EGR in setting our proposed Tier 3 standard.

It may be possible to reoptimize existing Tier 2 NO_X control technologies, most notably injection timing retard (used to some degree on all diesel locomotives), to achieve a more modest NO_X reduction of 10 to 20 percent from the current Tier 2 levels. In fact, a version of General Electric's Tier 2 locomotive is available today that achieves such NO_X reductions for special applications such as the California South Coast Locomotive Fleet Average Emissions Program. In general, the use of injection timing retard to control NO_X emissions comes with a tradeoff against fuel economy, durability and increased maintenance depending upon the degree to which injection timing retard is applied. Experience with on-highway trucks suggests that a 20 percent NO_X reduction based solely on injection timing retard could result in an increase of fuel consumption as much as 5 percent. We request comment on the feasibility and other impacts of applying technologies such as these in the Tier 3 timeframe. We also request comment on the extent to which any workload-based impediments to applying such technologies in Tier 3 could be addressed via balancing it by obtaining less than the proposed NO_X reductions from remanufactured locomotives. We believe that a Tier 3 NO_X standard below 5 g/bhp-hr might be achievable with a limited impact if additional engineering resources were invested to optimize such a system for general line-haul application. We encourage commenters supporting lower NO_X levels for Tier 3 locomotives to address whether some tradeoff in engineering development (or emissions averaging) between new Tier 3 locomotives and remanufactured Tier 0 locomotives might be appropriate. For example, would it be appropriate to set a Tier 3 NO_X standard at 4.5 g/bhp-hr, but relax the NO_X standard for later model Tier 0 locomotives to 8.0 g/bhp-hr instead of 7.4 g/bhp-hr?

We are proposing that a manufacturer may defer meeting the Tier 4 NO_X standard until 2017. However, we expect that each manufacturer will undertake a single comprehensive redesign program for Tier 4, using this allowed deferral to work through any implementation and technology prove-out issues that might arise with advanced NO_X control technology, but relying on the same basic locomotive platform and overall emission control space allocations for all Tier 4 product years. For this reason we are proposing that locomotives certified under Tier 4 in 2015 and 2016 without Tier 4 NO_X control systems have this system added when they undergo their first remanufacture, and be subject to the Tier 4 NO_X standard thereafter.

We are proposing that, starting in Tier 4, line-haul locomotives will not be required to meet standards on the switch cycle. Line-haul locomotives were originally made subject to switch cycle standards to help ensure robust control in use and in recognition of the fact that many line haul locomotives have in the past been used for switcher service later in life. As explained in section III.C(1)(b), the latter is of less concern today. Also, we expect that the aftertreatment technologies used in Tier 4 will provide effective control over a broad range of operation, thus lessening the need for a switch cycle to ensure robust control. We propose 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 (Table III–1) in the same proportion that the original Tier 0 through Tier 2 switch cycle standards are above their corresponding line-haul cycle standards. See section III.C(1)(b) for details.

(b) Switch Locomotives

Our 1998 locomotive rule included some provisions aimed at addressing emissions from switch locomotives. We adopted a set of switcher standards and a switcher test cycle. This cycle made use of the same notch-by-notch test data as the line haul cycle, but reweighted these notch-specific emission results to correspond to typical switcher duty. In addition to controlling emissions from dedicated switchers, we viewed this cycle as adding robustness to the line-haul emissions control program. For this reason, and because aging line-haul locomotives have often in the past found utility as switchers, we subjected all regulated locomotives to the switch cycle. We also allowed for dedicated switch locomotives, defined as locomotives designed or used primarily for short distance operation and using an engine with rated power at 2300 hp (1700 kW) or less, to be optionally exempted from the line-haul cycle standards.

There have been a number of changes in the rail industry since our 1998 rulemaking that are relevant to switchers. First, locomotives marketed for line-haul service have continued to increase in size, to a point where today's 4000+hp (3000+kW) line-haul locomotives are too large for practical use in switching service. Second, there have been practically no U.S. sales of newly-built switchers by the primary locomotive builders, EMD and GE, for many years. Third, smaller builders have entered this market, selling new or refurbished locomotives with one to three newly-built diesel engines originally designed for the nonroad equipment market, but recertified under Part 92, or sold under the 40 CFR 92.907 provisions that allow limited sales of locomotives using nonroad-certified engines. Fourth, although this new generation of switchers has shown great promise, their purchase prices on the order of a million dollars or more, compared to the relatively low cost of maintaining old switchers, have limited sales primarily for use in California and Texas where state government subsidies are available.

All of these factors together have produced a situation in which the current fleet of old switchers, including many pre-1973 locomotives not subject to any emissions standards, is maintained and kept in service. Because they have relatively light duty cycles and generally operate very close to repair facilities, they can be maintained almost indefinitely. Though many have poor fuel economy, this alone is not of great enough concern to the railroads to warrant replacing them because even very busy switchers consume a fraction of the fuel used by long-distance line-haul locomotives.

At the same time, these older switch locomotives have come under increasing public scrutiny. When operated in railyards located in urban neighborhoods, they have often become the focus of complaints from citizens groups about noise, smoke, and other emissions, and state and local governments have begun to place a higher priority on reducing their emissions.[101]

We note that switchers (or any other locomotives) that have not been remanufactured to EPA standards are not considered covered by the full preemption of state and local emission standards in section 209(e)(1) of the Clean Air Act, which applies to standards relating to the control of emissions from new locomotive engines. Similarly, the preemption that does apply for locomotives that are certified to EPA standards does not generally apply for any locomotive that has significantly exceeded its useful life. The provisions of section 209(e)(2) pertaining to other nonroad engines would apply for such engines, as well as other engines used in locomotives excluded from the definition of ''new.'' Such engines may be subject to regulation by California and other states.

As discussed in section II.B, we too are concerned that emissions from locomotives in urban railyards, many of which are switch locomotives, are causing substantial adverse health effects. Some railroads have been attempting to address these concerns, adopting voluntary idling restrictions and, where government subsidies are available, replacing older switchers with cleaner, quieter new-generation switchers. In light of these trends and market realities, we believe it is appropriate to propose standards and other provisions specific to switch locomotives, aimed at obtaining substantial overall emission reductions from this important fleet of locomotives.

We are proposing Tier 3 and 4 emission standards for newly-built switch locomotives, shown in Table III–2, based on the capability of the Tier 3 and 4 nonroad engines that will be available to power switch locomotives in the future under our clean nonroad diesel program. We propose to retain the existing switch locomotive test cycle upon which compliance with these standards would be measured, but not to apply the line-haul standards and cycle to Tier 3 and 4 switchers, in light of the divergence that has occurred in the design of newly-built switch and line-haul locomotives. We also propose that Tier 0, 1, and 2 switch locomotives certified only on the switch cycle (as allowed in our Part 92 regulations), be subject to a set of remanufactured locomotive standards equivalent to our proposed program for remanufactured line-haul locomotives, with proportional levels of emission reductions. These standards are also the switch cycle standards for the Tier 3 and earlier line-haul locomotives that are subject to compliance requirements on the switch cycle. In the case of the Tier 3 line-haul locomotives, we are proposing that the Tier 2 switch cycle standards be applied rather than the Tier 3 standards for dedicated switchers because the latter are based on nonroad engines.

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[101] See, for example, letter from Catherine Witherspoon, Executive Director of the California Air Resources Board, to EPA Administrator Stephen Johnson, September 7, 2006.

TABLE III–2.—PROPOSED EMISSION STANDARDS FOR SWITCH LOCOMOTIVES

[g/bhp-hr]

Switch locomotive standards apply to:	PM	NO$_X$	HC	Date
Remanufactured Tier 0	0.26	11.8	2.10	2008 as available, 2010 required.
Remanufactured Tier 1	0.26	11.0	1.20	2008 as available, 2010 required.
Remanufactured Tier 2	0.13	8.1	0.60	2008 as available, 2013 required.
Tier 3	0.10	5.0	0.60	2011.
Tier 4	0.03	1.3	0.14	2015.

Standards and implementation dates for large nonroad engines vary by horsepower and by whether or not the engine is designed for portable electric power generation (gensets), as shown in Table III–3. This is significant for the switch locomotive program because it has been the practice for switch locomotive builders to use a variety of nonroad engine configurations. For example, a manufacturer building a 2100 hp switcher using nonroad engines in 2011 could team three 700 hp engines designed to the nonroad Tier 4 standards of 0.01 g/bhp-hr PM and 0.30 g/bhp-hr NO$_X$, or two 1050 hp engines at 0.075/2.6 g/bhp-hr PM/NO$_X$, or a single 2100 hp engine at 0.075/0.50 or 0.075/2.6 g/bhp-hr PM/NO$_X$, depending on if the engine is a genset engine or not.

As discussed in the nonroad Tier 4 rulemaking in which we set these standards, we believe that the standards set for all of these nonroad engines achieve the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available, with appropriate consideration to factors listed in the Clean Air Act. There are reasons for a switcher manufacturer to choose one configuration of engines over another related to function, packaging, reliability and other factors. We believe that limiting a manufacturer's choice to only the cleanest configuration in any given year would hinder optimum designs and thereby would tend to work against our goal of encouraging the turnover of the current fleet of old switchers. Furthermore, we note that there is no single large engine category that consistently has the most stringent nonroad Tier 4 PM and NO$_X$ standards from year to year. We also note that, because State subsidies for the purchase of new switch locomotives have been clearly tied to their lower emissions, and also because the use of lower-emitting engines can generate valuable ABT credits, there is likely to be continuing pressure driving the industry toward the cleanest nonroad engines available in whatever new switcher market does develop.

TABLE III–3.—LARGE NONROAD ENGINE TIER 4 STANDARDS

[g/bhp-hr]

Rated power	PM	NO$_X$	Model year
≦750 hp	0.01	[a] 3.0 (NO$_X$+NMHC)	2011
	0.01	0.30	2014
750–1200 hp	0.075	2.6	2011
	0.02	[b] 0.50	2015
>1200 hp	0.075	[b] 0.50	2011
	0.02	[b] 0.50	2015

[a] 0.30 NO$_X$ for 50% of sales in 2011–2013, or alternatively 1.5 g NO$_X$ for 100% of sales.

[b] 2.6 for non-genset engines—setting the long-term Tier 4 standard for these engines was deferred in the Nonroad Tier 4 Rule.

There is one exception to this approach that we consider necessary. In the Tier 4 nonroad engine rule, we deferred setting a final Tier 4 NO$_X$ standard for non-genset engines over 750 hp. These are typically used in large bulldozers and mine haul trucks. This was done in order to allow additional time to evaluate the technical issues involved in adapting NO$_X$ control technology to these applications and engines (69 FR 38979, June 29, 2004). We believe it is appropriate to propose a Tier 4 NO$_X$ standard for switch locomotives in 2015 based on SCR technology, as we are proposing for line-haul locomotives in 2017. We believe this to be feasible because the switch locomotive designer will have a variety of nonroad engine choices equipped with SCR available in 2015, such as multiple <750 hp engines or larger genset engines, an opportunity that is not available to large nonroad machine designers due to functional and packaging constraints. To set a non-SCR based standard for switch locomotives indefinitely, or to wait to do so after we set the final Tier 4 NO$_X$ standard for mobile machine engines above 750 hp, would create significant uncertainty for the manufacturers and railroads, and would be contrary to our intent to reduce locomotive emissions in switchyards. We note too that SCR introduction in the fairly limited fleet of newly-built switchers likely to exist in 2015 and 2016 provides an opportunity for railroads to become familiar with urea handling and SCR operation in accessible switchyards, before large scale introduction in the far-ranging line-haul fleet.

Although we are factoring the current practice of building new switchers powered by nonroad-certified engines into the design of the program, it is not our intent to discourage the development and sale of traditional medium-speed engine switch locomotives. We have evaluated the proposed Tier 3 and 4 standards in this context and have concluded that they will be feasible for switchers using medium-speed engines as well as higher-speed nonroad engines.

Because in today's market the certifying switch locomotive manufacturer is typically a purchaser of nonroad engines and not involved in their design, we see the value in providing a streamlined option to help in the early implementation of this program. As described in Section IV, we are proposing that, for a program startup period sufficient to encourage the turnover of the existing switcher fleet to the new cleaner engines, switch locomotives may use nonroad-certified engines without need for certification under the locomotive program. Because of large differences in how the locomotive and nonroad programs operate in such areas as useful life and in-use testing, we do not believe it appropriate to allow locomotive ABT credits to be generated or used by locomotives sold under this option, though of course this would not preclude nonroad engine ABT credits under that program. For the same reasons, we also think it makes sense to eventually sunset this option after it has served its purpose of encouraging the early introduction of new low-emitting switch locomotives. We propose that the streamlined path be available for 10 years, through 2017, and ask for comment on whether a shorter or longer interval is appropriate, taking into account the turnover incentive provisions described below. We are proposing other compliance and ABT provisions relevant to switch locomotives as discussed in section IV.B(1), (2), (3), and (9).

Finally, we are proposing a rewording of the definition of a switch locomotive to make clear that it is the total switch locomotive power rating that must be below 2300 hp to qualify, not the engine power rating, and to drop the unnecessary stipulation that it be designed or used primarily for short distance operation. This clears up the ambiguity in the current definition over multi-engine switchers.

(c) Reduction of Locomotive Idling Emissions

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 railyards, as railcars and locomotives are transferred to build up trains. Many of these railyards are in urban neighborhoods, close to where people live, work, and go to school.

Short periods of idling are sometimes unavoidable, such as while waiting on a siding for another train to pass. Longer periods of idling operation may be necessary to run accessories such as cab heaters/air conditioners or to keep engine coolant (generally water without anti-freeze to maximize cooling efficiency) from freezing and damaging the engine if an auxiliary source of heat or power is not installed on the locomotive. Locomotive idling may also occur due to engineer habits of not shutting down the engine, and the associated difficulty in determining just when the engine can be safely shut down and for how long.

Automatic engine stop/start (AESS) systems have been developed to start or stop a locomotive engine based on parameters such as: ambient temperature, battery charge, water and oil temperature, and brake system pressure. AESS systems have been proven to reliably and safely reduce unnecessary idling. Typically they will shutdown the locomotive after a specified period of idling (typically 15–30 minutes) as long as the parameters are all within their required specifications. If one of the aforementioned parameters goes out of its specified range, the AESS will restart the locomotive and allow it to idle until the parameters have returned to their required limits. Although developed primarily to save fuel, AESS systems also reduce idling emissions and noise by reducing idling time. Any emissions spike from engine startup has been found to be minor, and thus idle emissions are reduced in proportion to idling time eliminated. It is expected that overall PM and NO_X idling emission reductions of up to 50 percent can be achieved through the use of AESS.

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. There are two main manufacturers of APUs, EcoTrans which manufacturers the K9 APU, and Kim Hotstart which manufactures the Diesel Driven Heating System (DDHS). 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 to run necessary 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. If an APU does not have the capability of an AESS built in, it may need to be installed in conjunction with one in order to receive the full complement of idle reductions that the combination of technologies can provide. The APUs are nonroad engines compliant with EPA or State of California nonroad engine standards, and emit at much lower levels than an idling locomotive.

Installation of an APU today costs approximately $25,000 to $35,000; while an AESS can cost anywhere from $7,500 to $15,000.[102] The costs vary depending on the model and configuration of the locomotive on which the equipment is being installed, and would likely be substantially lower if incorporated into the design of a newly-built locomotive. The amount of idle reduction each system can provide is also dependent on a number of variables, such as what the function of the locomotive is (e.g. a switcher or a line-haul), where it operates (i.e. geographical area), and what its operating characteristics are (e.g. number of hours per day it operates). The duty cycles in 40 CFR 92.132, based on real world data available at the time they were adopted in 1998, indicate a line haul locomotive idles nearly 40% of its operating time, and a switcher locomotive idles nearly 60% of its operating time. This idling time can be further divided into low idle (when there is no load on the engine) and normal idle (when there is a load on the engine). Only low idle can be reduced by an AESS, while an APU can reduce normal idle (or idle in a higher notch such as notch 3 which can burn up to 11 gallons per hour). Another difference between the two types of idle is the fuel consumption rate which is less at low idle than normal idle (2.4–3.6 gallons per hour vs. 2.9–5.4 gallons per hour, based on Tier 2 certification data).

Although there is a gradual trend in the railroad industry toward wider use of these types of idle control devices, we believe it is important for ensuring air quality benefits to propose that idle controls be required as part of a certified emission control system. We are proposing that at least an AESS system be required on all new Tier 3 and Tier 4 locomotives, and also installed on all existing locomotives that are subject to the new remanufactured engine standards, at the point of first remanufacture under the new standards, unless the locomotive is already equipped with idle controls. Specifically, we are requiring that 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

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[102] Jessica Montañez and Matthew Mahler, ‘‘Reducing Idling Locomotives Emissions’’, NC Department of Environment and Natural Resources, DAQ *http://daq.state.nc.us/planning/locoindex.shtml.*

causing engine damage or other serious problems. The system must prevent the locomotive engine from being restarted to resume extended idling unless one of the following conditions necessitates such idling: to prevent engine damage such as damage caused by coolant freezing, to maintain air brake pressure, to perform necessary maintenance, or to otherwise comply with applicable government regulations. EPA approval of alternative criteria could be requested provided comparable idle emissions reduction is achieved.

As described in the RIA, it is widely accepted that for most locomotives, the fuel savings that result in the first several years after installation of an AESS system will more than 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 the major railroads to retrofit many of their locomotives with such controls. However, as is common with pollution, market forces generally do not account for the external social costs of the idling emissions. This proposal addresses those locomotives for which the railroads determine that the fuel savings are insufficient to justify the cost of the retrofit. We believe that applying AESS to these locomotives is appropriate when one also considers the very significant emissions reductions that would result, as well as the longer term fuel savings. We request comment on the need for this requirement. We also request comment regarding the reasons why a railroad might choose not to apply AESS absent this provision. Are there costs for AESS and retrofits that are higher than our analysis would suggest? Are there other reasons that would lead a railroad to not adopt AESS universally?

Even though we are proposing to require only AESS systems, we encourage the additional use of APUs by providing in our proposed test regulations a way for the manufacturer to appropriately account for the emission benefits of greater idle reduction. See Section IV.B(8) for further discussion. We are not proposing that APUs must 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 they do involve some inherent design and operational complexities that could not be justified without commensurate benefits. We are however asking for comment on requiring that some subset of new locomotives be equipped with APUs where feasible and beneficial. We are also asking for comments on whether to adopt a regulatory provision that would exempt a railroad from AESS and/or APU requirements if it demonstrated that it was achieving an equal or greater degree of idle reduction using some other method.

(d) Load Control in a Locomotive Consist

A locomotive consist is the linking of two or more locomotives in a train, typically where the lead locomotive has control over the power and dynamic brake settings on the trailing locomotives. For situations where locomotives are operated in a consist, EPA is requesting comment on how the engine loads could be managed in a way which reduces the combined emissions of the consist, and in what way our program can be set up to encourage such reductions. Consists are commonly used in long trains to achieve the power and traction levels necessary to move, stop, and control the train. The trailing locomotives can be directly-coupled to the lead locomotive, or, they may be placed anywhere along the train and controlled remotely by the lead. The load settings of the individual locomotives that make up a consist are not always equal—for example, if the train has crested a hill, the leading locomotive(s) could be operating under dynamic brake (to control the speed of the train) while the trailing locomotives could be producing propulsion power (to reduce strain on the couplers). Depending on the load, track, terrain, and weather conditions, it is conceivable that the engine loads of a consist could be managed to provide the lowest fuel consumption for the power/traction needed. For example, the train power can be distributed so that the lead engine is operating at its optimum brake-specific fuel consumption point while trailing engines are operated at reduced power settings and/or shut down. The capability to manage and distribute engine power in a locomotive consist is available on the market today.

We have been made aware that it may be possible to optimize the configuration of locomotives in a consist for emissions performance without compromising other key goals such as fuel economy and safety. Our proposed regulations do not explicitly take such possible optimization into account. However, if commenters believe that significant emission reductions can be attained by controlling the engine loads in a consist (beyond those attained by the current practice of operating the consist to achieve the lowest fuel consumption rate), we would solicit their views on how to calculate the emissions reduction and on how the in-use operation of the consist could be logged and reported. For example, it may be appropriate to allow a manufacturer to use alternative notch weightings tailored to operation in an emissions-optimized consist in demonstrating compliance with the emissions standards, thus providing added flexibility in designing such locomotives to meet the standards.

(2) Marine Standards

We are also proposing new emissions standards for newly-built marine diesel engines with displacements under 30 liters per cylinder, including those used in commercial, recreational, and auxiliary power applications. As for locomotives, our ANPRM described a one-step marine diesel program that would bring about the introduction of high-efficiency exhaust aftertreatment in this sector. Just as for locomotives, our analyses of the technical issues related to the application of aftertreatment technologies to marine engines, informed by our many discussions with stakeholders, have resulted in a proposal for new standards in multiple steps, focused especially on the engines with the greatest potential for large PM and NO_X emission reductions. Our technical analyses are summarized in section III.D and are detailed in the draft RIA.

In contrast to the locomotive sector, the marine diesel sector covered by this rule is quite diverse. Commercial propulsion applications range from small fishing boats to Great Lakes freighters. Recreational propulsion applications range from sailboats to super-yachts. Similarly, auxiliary power applications range from small gensets, to generators used on barges, to large power-generating units used on ocean-going vessels. Many of the propulsion engines are used to propel high-speed planing boats, both commercial and recreational, where low weight and high power density are critically important. Some engines are situated in crowded engine compartments accessed through a hatch in the deck, while others occupy relatively spacious engine rooms. All of them share a high premium on reliability, considering the potentially serious ramifications of engine failure while underway.

The resulting diversity in engine design characteristics is correspondingly large. Sizes range from a few horsepower to thousands of horsepower. Historically, we have categorized marine engines for standards-setting purposes based on cylinder displacements: C1 engines of less than 5 liters/cylinder, C2 from 5 to 30 liters/cylinder, and Category 3 (C3) at greater than 30 liters/cylinder. (These C3 engines typically power ocean-crossing ships and burn residual fuel; we are not including such engines in this proposal). Our past standard-setting efforts have found it helpful to make further distinctions as well, considering small (less than 37 kW (50 hp)) engines and C1 recreational engines as separate categories.

Recreational engines typically power recreational vessels designed primarily for speed, and this imposes certain constraints on the type of engine they can use. For a marine vessel to reach high speeds, it is necessary to reduce the surface contact between the vessel and the water, and consequently these vessels typically operate in a planing mode. Planing imposes important design requirements, calling for low vessel weight and short periods of very high power— and thus prompting a need for high power density engines. The tradeoff is less durability, and recreational engines are correspondingly warranted for fewer hours of operation than commercial marine engines. These special characteristics are represented in EPA duty-cycle and useful life provisions for recreational marine engines.

Unlike the locomotive sector, the vast majority of marine diesel engines are derivatives of land-based nonroad diesel engines. Marine diesel engine sales are significantly lower (by 10 or even 100 fold) than the sales of the land-based nonroad engines from which they are derived. For this reason, changes to marine engine technology typically follow the changes made to the parent nonroad engine. For example, it may be economically infeasible to develop and introduce a new fuel system for a marine diesel engine with sales of 100 units annually, while being desirable to do so for a land-based nonroad diesel engine with sales of 10,000 or more units annually. Further, having developed a new technology for land-based diesel engines, it is often cheaper to simply apply the new technology to the marine diesel engine rather than continuing to carry a second set of engine parts within a manufacturing system for a marginal number of additional sales. Recognizing this reality, our proposed marine standards are phased in to follow the introduction of similar engine technology standards from our Nonroad Tier 4 emissions program. In most cases, the corresponding marine diesel standards will follow the Nonroad Tier 4 standards by one to two years.

We are proposing to retain the 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:

(1) We are proposing to move 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 (in terms of revolutions per minute (rpm)), with their correspondingly different emissions characteristics.

(2) We also propose to revise the per-cylinder displacement cutpoints within Category 1 to better refine the application of standards.

(3) An additional differentiation is proposed 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). In addition to recreational vessels, the high power-density engines are used in some commercial vessels, including certain kinds of crew boats, research vessels, and fishing vessels. Unlike most commercial vessels, these vessels are built for higher speed, which allows them to reach research fields, oil platforms, or fishing beds more quickly. This proposal addresses the technical challenges related to reducing emissions from engines with high power density.

(4) In the past, we did not formally include marine diesels under 37 kW (50 hp) in Category 1, but regulated them separately as part of the nonroad engine program, referring to them elsewhere as ''small marine engines''. They are typically marinized land-based nonroad diesel engines. Because we are now proposing to include these engines in the current marine diesel rulemaking, this distinction is no longer needed and so we are including these engines in Category 1 for Tier 3 and Tier 4 standards.

(5) Finally, we would further group engines by total rated power, especially in regard 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 the proposed standards for them.

Although this carefully targeted approach to standards-setting results in a somewhat complicated array of emissions standards, we believe it is justified because it maximizes overall emission reductions by ensuring the most stringent standards feasible for a given group of marine engines, and it also helps engine and vessel designers to implement the program in the most cost effective manner. The proposed standards and implementation schedules are shown on Tables III–4–7.

Briefly summarized, the proposed marine diesel standards include stringent engine-based Tier 3 standards, phasing in over 2009–2014. In addition, the proposed standards include aftertreatment-based Tier 4 standards for engines at or above 600 kW (800 hp), phasing in over 2014–2017, except that Tier 4 would not apply to recreational engines under 2000 kW (2670 hp). For engines of power ratings not included in the Tier 3 and Tier 4 tables, the previous tier of standards (Tier 2 or Tier 3, respectively) continues to apply.

TABLE III–4.—PROPOSED TIER 3 STANDARDS FOR MARINE DIESEL C1 COMMERCIAL STANDARD POWER DENSITY

Rated kW	L/cylinder	PM g/bhp-hr	NO_X+HC g/bhp-hr	Model year
<19 kW	<0.9	0.30	5.6	2009
19–<75 kW	[a] <0.9	0.22	5.6	2009
		[b] 0.22	[b] 3.5	2014
75–3700 kW	<0.9	0.10	4.0	2012
	0.9–<1.2	0.09	4.0	2013
	1.2–<2.5	[c] 0.08	4.2	2014
	2.5–<3.5	[c] 0.08	4.2	2013
	3.5–<7.0	[c] 0.08	4.3	2012

[a] <75 kW engines at or above 0.9 L/cylinder are subject to the corresponding 75–3700 kW standards.
[b] Option: 0.15 PM/4.3 NO_X in 2014.

[c] This standard level drops to 0.07 in 2018 for <600 kW engines.

TABLE III–5.—PROPOSED TIER 3 STANDARDS FOR MARINE DIESEL C1 RECREATIONAL AND COMMERCIAL HIGH POWER DENSITY

Rated kW	L/cylinder	PM g/bhp-hr	NO_X+HC g/bhp-hr	Model year
<19 kW	<0.9	0.30	5.6	2009
19–<75 kW	[a]<0.9	0.22	5.6	2009
		[b]0.22	[b]3.5	2014
75—3700 kW	<0.9	0.11	4.3	2012
	0.9–<1.2	0.10	4.3	2013
	1.2–<2.5	0.09	4.3	2014
	2.5–<3.5	0.09	4.3	2013
	3.5–<7.0	0.09	4.0	2012

[a] <75 kW engines at or above 0.9 L/cylinder are subject to the corresponding 75–3700 kW standards.
[b] Option: 0.15 PM/4.3 NO_X+HC in 2014.

TABLE III–6.—PROPOSED TIER 3 STANDARDS FOR MARINE DIESEL C2

Rated kW	L/cylinder	PM g/bhp-hr	NO_X+HC g/bhp-hr	Model year
=<3700 kW	7–<15	0.10	4.6	2013
	15–<20	[a]0.20	[a]6.5	2014
	20–<25	0.20	7.3	2014
	25–<30	0.20	8.2	2014

[a] For engines at or below 3300 kW in this group, the PM/NO_X+HC Tier 3 standards are 0.25/5.2.

TABLE III–7.—PROPOSED TIER 4 STANDARDS FOR MARINE DIESEL C1 AND C2

Rated kW	PM g/bhp-hr	NO_X g/bhp-hr	HC g/bhp-hr	Model year
>3700 kW	[a]0.09	1.3	0.14	2014
	0.04	1.3	0.14	[b]2016
1400–3700 kW	0.03	1.3	0.14	[c]2016
600–<1400 kW	0.03	1.3	0.14	[b]2017

[a] This standard is 0.19 for engines with 15–30 liter/cylinder displacement.
[b] Optional compliance start dates are proposed within these model years; see discussion below.
[c] Option for engines with 7–15 liter/cylinder displacement: Tier 4 PM and HC in 2015 and Tier 4 NO_X in 2017.

The proposed Tier 3 standards for engines with rated 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, model year 2009, providing substantial early benefits to the program. However, some of the less than 75 kW nonroad engines are also subject to aftertreatment-based Tier 4 nonroad standards, and our proposal would not carry these over into the marine sector, due to vessel design and operational constraints discussed in Section III.D. Because of the preponderance of both direct- and indirect-injection diesel engines in the 19 to 75 kW (25–100 hp) engine market today, we are proposing 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 would take effect in 2014.

With important exceptions, we propose that marine diesel engines at or above 75 kW (100 hp) be subject to new emissions standards in two steps, Tier 3 and Tier 4. The proposed Tier 3 standards are based on the engine-out emission reduction potential of the nonroad Tier 4 diesel engines which will be introduced beginning in 2011. Tier 3 standards for C1 engines would generally take effect in 2012, though for some engines, they would start in 2013 or 2014. We are not basing our proposed marine Tier 3 emission standards on the existing nonroad Tier 3 emission standards for two reasons. First, the nonroad Tier 3 engines will be replaced beginning in 2011 with nonroad Tier 4 engines, and given the derivative nature of marine diesel manufacturing, we believe it is more appropriate to use those Tier 4 engine capabilities as the basis for the proposed marine standards. Second, the advanced fuel and combustion systems that we expect these Tier 4 nonroad engines to apply will allow approximately a 50 percent reduction in PM when compared to the reduction potential of the nonroad Tier 3 engines. The proposed Tier 3 standards levels would vary slightly, from 0.08 to 0.11 g/bhp-hr (0.11 to 0.15 g/kW-hr) for PM and from 4.0 to 4.3 g/bhp-hr (5.4 to 5.8 g/kW-hr) for NO_X+HC. Tier 3 standards for C2 engines would take effect in 2013 or 2014, depending on engine displacement, and standards levels would also vary, from 0.10 to 0.25 g/bhp-hr (0.14 to 0.34 g/kW-hr) for PM and 4.6 to 8.2 g/bhp-hr (6.2 to 11.0 g/kW-hr) for NO_X+HC. For the largest C2 engines, those above 3700 kW (4900 hp), the NO_X+HC standard would remain at the Tier 2 levels until Tier 4 begins for these engines in 2014.

We are proposing that high-efficiency aftertreatment-based Tier 4 standards be applied to all commercial and auxiliary C1 and C2 engines over 600 kW (800 hp). These standards would 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 very large majority of marine diesel engine emissions. However, for engines at or below 600 kW, our technical analysis indicates that applying aftertreatment to them appears at this time not to be feasible. There are many reasons for this preliminary conclusion, varying in relative importance with engine size and application, but generally including insufficient space in below-deck engine compartments, catalyst packaging limitations for water-injected exhaust systems, poor catalyst performance in water-jacketed exhaust systems, and weight constraints in planing hull vessels.

Although with time and investment these issues may be resolvable for some under 600 kW (800 hp) applications, we are not, at this time, proposing Tier 4 standards for these engines. We may do so at some point in the future, such as after the successful prove-out of aftertreatment in the larger marine engines and in nonroad diesel engines have established a clearer technology path for extension to these engines. The approach taken in this proposal concentrates Tier 4 design and development efforts into the engine and vessel applications where they can do the most good.

We are confident that there is a subset of recreational vessels that are large enough to accommodate the added size of engines equipped with aftertreatment and that have appropriate maintenance procedures to ensure that the aftertreatment systems are appropriately maintained, for example, because they have a professional crew as opposed to being maintained by the owner. Based on a review of publicly available sales literature, we believe that at least the subset of recreational vessels with engines at rated power above 2000 kW (2760 hp) have the space and design layout conducive to aftertreatment and professional crews such that aftertreatment-based standards are feasible. Therefore, we are proposing to apply the Tier 4 standards to recreational marine diesel engines at rated power above 2000 kW, but we request comment on whether this is the appropriate threshold, along with any available information supporting the commenter's view. We also request comment on the issue of ULSD availability for these vessels in places that they may visit outside the United States. The rapid pace at which the industrial nations are shifting to ULSD has surpassed expectations. By no means does this ensure its availability in every port that might be frequented by large U.S. yachts, but it does give confidence that ULSD will be a global product, and certainly not confined to the coastal U.S. when Tier 4 yachts begin to appear in 2016. These large yachts are operated by professional crews who plan their itineraries ahead of time and are unlikely to put in for fuel without checking out the facility ahead of time, though quite possibly this may require somewhat more diligence in the early years of the program while the ULSD-needing fleet is ramping up in size. We also expect that, from the marinas' perspective, those frequented by these affluent visitors typically covet this business today, and will likely be reticent to leave ULSD off the list of offerings and amenities aimed at attracting them.

We are setting the Tier 4 standards for most engines above 600 kW (800 hp) at 0.03 g/bhp-hr (0.04 g/kW-hr) for PM, based on the use of PM filters, and 1.3 g/bhp-hr (1.8 g/kW-hr) for NO_X based on the use of urea SCR systems. The largest marine diesel engines, those above 3700 kW (4900 hp), would be subject to this SCR-based NO_X standard in 2014, along with a new engine-based PM standard. The Tier 4 PM standard for these engines would then start in 2016, with the addition of a filter-based 0.04 g/bhp-hr (0.06 g/kW-hr) standard. See section III.C(3) for a discussion of the Tier 4 HC standard.

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 proposing to allow 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 over 3700 kW (4900 hp) engines 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 proposed Tier 4 standards for locomotives and C2 diesel marine engines of comparable size are at the same numerical levels but differ somewhat in implementation schedule, with locomotive Tier 4 starting in 2015 for PM and 2017 for NO_X, and diesel marine Tier 4 for both PM and NO_X starting in 2016 (for engines in the 1400–3700 kW (1900–4900 hp) range). We consider these implementation schedules to be close enough to warrant our providing an option to meet either schedule for these marine engines, aimed at facilitating the development of engines for both markets, a common practice today. Because the locomotive Tier 4 phase-in is offset by only one year on either side of the marine Tier 4 2016 date, we do not expect this option to introduce major competitiveness issues between manufacturers who will be designing engines for both markets and those who will be designing for only the marine market. Furthermore, we see no reason to make this option available only those who make locomotive products, and are therefore proposing its availability to any manufacturer. Comment is requested on the need for the option, and on whether it should be limited to a particular subset of engines.

We note too that the Tier 3 marine standards for locomotive-like marine engines (that is, in the 7–15 liters/cylinder group) although having the same implementation date and numerical PM standard level as locomotive Tier 3, includes a 4.6 g/bhp-hr (6.1 g/kW-hr) NO_X+HC standard, compared to the 5.5 g/bhp-hr (7.3 g/kW-hr) NO_X standard for locomotive Tier 3. We request comment on whether some provision is needed to avoid the need for designing an engine primarily used in locomotives to meet the marine standard in order to have both ready for Tier 3, on whether sufficient ABT credits are likely to be available to deal with this, and on how to ensure we do not lose environmental benefits or inadvertently create competitiveness problems.

Some marine engine families include engines of the same basic design and emissions performance but achieving widely varying power ratings in engine models marketed through varying the number of cylinders, for example 8 to 20. These families can and do straddle power cutpoints, most notably at the 3700 kW (4900 hp) cutpoint, above which NO_X aftertreatment is expected to be needed in 2014 under our proposed standards, and at the 600 kW (800 hp) cutpoint for application of the proposed Tier 4 standards. We understand that manufacturers have concerns about additional design and certification work needed for an engine family falling into two categories, especially with regard to the 600 and 3700 kW cutpoints which involve very different standards or start dates on either side of the cutpoint. We request comment on whether this concern is a serious one for the manufacturers, on suggestions for how to address it fairly without a loss of environmental benefit, and on whether our not addressing it would cause undesirable shifts in ratings offered in the market in order to stay on one side or the other of the cutpoints. One particular idea on which we request comment is allowing engines above 3700 kW an option to meet the Tier 4 PM requirement in 2014 and the Tier 4 NO_X requirement December 31, 2016, similar to the less than 3700 kW option discussed above.

We are concerned that applying the Tier 4 standards to engines above 600 kW (800 hp) may create an incentive for vessel builders who would normally use engines greater than 600 kW to instead use a larger number of smaller engines in a vessel to get the equivalent power output. Generally, the choice of engines for a vessel is directly a function of the work that vessel is intended to do. There may be cases, however, in which a vessel designer that might have used, for example, two 630 kW engines, chooses instead to use three 420 kW engines to avoid the Tier 4 standards. We have concerns about the environmental impacts of such a result. There also may be competitiveness concerns. Therefore, we are seeking comment on whether substitution of several smaller engines for one or two larger engines is likely to occur as a result of differential standards, and on what can be done to avoid it. For example, the Tier 4 standards could be applied to engines in multi-engine vessels with a total power above a certain threshold, such as 1100 kW (1500 hp). We recognize that this would result in a need to equip engines somewhat below 600 kW with aftertreatment devices, but we believe the feasibility concerns such as space constraints discussed above for engines below this cutpoint are diminished in multi-engine vessel designs. Alternatively, we could require vessel manufacturers seeking to use more than two engines to make a demonstration to us that they are not attempting to circumvent the aftertreatment-based requirements, for example by showing that the vessel design they are using traditionally incorporates three or more engines or that there is a specific design requirement that leads to the use of several smaller engines. A third option would be to base the Tier 4 standards on the size (or other characteristics) of the vessel, for vessels that have two or more propulsion engines. Commenters on this issue should address the feasibility and potential market impacts of these potential solutions and are asked to offer their own suggestions as well.

(3) Carbon Monoxide, Hydrocarbon, and Smoke Standards

We are not proposing 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, under our proposal, the Tier 3 and Tier 4 CO standards for all locomotives and marine diesel engines would remain at current Tier 2 levels and remanufactured Tier 0, 1 and 2 locomotives would 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 would 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 for CO, emissions of HC are typically relatively low in diesel engines today compared to non-diesel sources. However, in contrast to CO standards, the line-haul locomotive Tier 2 HC standard of 0.30 g/bhp-hr, though comparable to emissions 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 proposed more stringent Tier 3 NO_X+HC standards for marine diesel engines would likely provide some reduction in HC emissions, but we expect that the catalyzed exhaust aftertreatment devices used to meet the proposed Tier 4 locomotive and marine NO_X and PM standards would 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 proposing that the 0.14 g/hp-hr HC standard apply for locomotives and marine diesel engines in Tier 4 as well.

We are proposing that the existing form of the HC standards be retained through Tier 3. That is, locomotive and marine HC standards would remain in the form of total hydrocarbons (THC), except for gaseous- and alcohol-fueled engines (See 40 CFR § 92.8 and § 94.8). Consistent with this, the Tier 3 marine NO_X+HC standards are proposed to be based on THC, except that Tier 3 standards for less than 75 kW (100 hp) engines would be based on NMHC, consistent with their basis in the nonroad engine program. However, we propose that the Tier 4 HC standards be expressed as NMHC standards, consistent with aftertreatment-based standards adopted for highway and nonroad diesel engines.

As in the case of other diesel mobile sources, we believe that existing smoke standards are of diminishing usefulness as PM levels drop to very low levels, as engines with PM at these levels emit very little or no visible smoke. We are therefore proposing to drop the smoke standards for locomotives and marine engines for any engines certified to a PM family emission limit (FEL) or standard of 0.05 g/bhp-hr (0.07 g/kW-hr) or lower. This allows engines certified to Tier 4 PM or to an FEL slightly above Tier 4 to avoid unnecessary testing for smoke.

D. Are the Proposed Standards Feasible?

In this section we describe the feasibility of the various emissions control technologies we project would be used to meet the standards proposed today. Because of the range of engines and applications we cover in this proposal, and because of the technology that will be available to them for emissions control, our proposed standards span a range of emissions levels. We have identified a number of different emissions control technologies we would expect to be used to meet the proposed standards. These technologies range from incremental improvements to existing engine components for the proposed remanufacturing program to highly advanced catalytic exhaust treatment systems similar to those expected to be used to control emissions from heavy-duty diesel trucks and nonroad equipment.

In this section we first describe the feasibility of emissions control technologies we project would be used to meet the standards we are proposing for existing engines that are remanufactured as new (i.e., Tier 0, Tier 1, Tier 2). We also describe how these same technologies would be applied to meet our proposed interim standards for new engines (i.e., Tier 3). We conclude this section with a discussion of catalytic exhaust treatment technologies projected to be used to meet our proposed Tier 4 standards. A more detailed analysis of these technologies and the issues related to their application to locomotive and marine diesel engines can be found in the draft Regulatory Impact Analysis (RIA).

(1) Emissions Control Technologies for Remanufactured Engine Standards and for New Tier 3 Engine Standards

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). We are proposing more stringent standards for these engines that apply whenever the locomotives are remanufactured as new. Our proposed remanufactured standards apply to locomotive engines that were originally built as early as 1973.

We project that incremental improvements to existing engine components would be feasible to meet our proposed locomotive remanufactured engine standards. In many cases, similar improvements to these have already been implemented on newly built locomotives to meet our current new locomotive standards. To meet the lower NO_X standard proposed for the Tier 0 locomotive remanufacturing program, we expect that improvements in fuel system design, engine calibration and optimization of existing after-cooling systems may be used to reduce NO_X from the current 9.5 g/bhp-hr Tier 0 standard to 7.4 g/bhp-hr. These are the same technologies used to meet the current Tier 1 NO_X emission standard of 7.4 g/bhp-hr. In essence, locomotive manufacturers will duplicate current Tier 1 locomotive NO_X emission solutions and adapt those same solutions to the portion of the existing Tier 0 fleet that can accommodate them. For older Tier 0 locomotives manufactured without separate-circuit cooling systems for intake air charge air cooling, reaching the Tier 1 NO_X level will not be possible. For these engines 8.0 g/hp-hr NO_X emissions represents the lowest achievable level.

To meet all of our proposed PM standards for the remanufacturing program and for the new locomotive Tier 3 interim standard, we expect that lubricating oil consumption controls will be implemented, along with the ultra low sulfur diesel fuel requirement for locomotive engines (which was previously finalized in our nonroad clean diesel rulemaking). Because of the significant fraction of lubricating oil present in PM from today's locomotives, we believe that existing low-oil-consumption piston ring-pack designs, when used in conjunction with improvements to closed crankcase ventilation systems, will provide significant, near-term PM reductions. These technologies can be applied to all locomotive engines, including those built as far back as 1973. And based upon our on-highway and nonroad clean diesel experience, we also believe that the use of ultra low sulfur diesel fuel in the locomotive sector will assist in meeting the Tier 2 remanufacturing and Tier 3 PM standards. We believe that the combination of reduced sulfate PM and improvement of oil and crankcase emission control to near Tier 3 nonroad or 2007 heavy-duty on-highway levels will provide an approximately 50% reduction in PM emissions.

We believe that some fraction of the remanufacturing systems can be developed and certified as early as 2008, so we are proposing the required usage of Tier 0, Tier 1 and Tier 2 emission control systems as soon as they are available starting in 2008. However, we estimate that it will take approximately 3 years to complete the development and certification process for all of the Tier 0 and Tier 1 emission control systems, so we have proposed full implementation of the Tier 0 and Tier 1 remanufactured engine standards 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 new engine changes necessary to meet the Tier 3 and remanufactured Tier 2 PM emission standards will require additional engine changes leading us to propose an implementation date for those engines of 2012 for Tier 3 engines and 2013 for remanufactured Tier 2 engines. These changes include further improvements to ring pack designs—especially for two-stroke engines, and the implementation of high efficiency crankcase ventilation systems. These technologies are described and illustrated in detail in our draft Regulatory Impact Analysis.

In the marine sector, emissions standards do not currently exist for engines that are remanufactured as new. In today's proposal, we are requesting comment on a marine diesel engine remanufacturing program that would apply to some of these marine engines whenever they are remanufactured as new (see section VII.A(2)). Because we are requesting comment on a marine engine remanufacturing program that essentially parallels our locomotive remanufacturing program, we expect that the same emissions control technologies described above would be implemented for remanufactured marine diesel engines just as for remanufactured locomotive engines.

We are proposing more stringent emissions standards for all newly built marine diesel engines that have a displacement of less than thirty liters per cylinder. For marine diesel engines that are either used in recreational vessels or are rated to produce less than 600 kW of power, we are proposing emissions standards that likely would not require the use of catalytic exhaust treatment technology. We are also proposing similar standards, as interim standards, for marine diesel engines that are used in commercial vessels and are rated to produce 600 kW of power or more (except if greater than 3700 kW). Collectively, we refer to these standards as our Tier 3 marine diesel engine standards.

To meet our proposed Tier 3 marine diesel engine standards, we believe that engine manufacturers will utilize incremental improvements to existing engine components. To meet the lower NO_X standards we expect that improvements in fuel system design and engine calibration will be implemented. For Category 1 engines from 75 kW through 560 kW, these technologies would be similar to designs and calibrations that likely will be used to meet our nonroad Tier 4 standards for engines. For Category 1 engines below 75 kW and greater than 560kW, and for Category 2 engines that have cylinder displacements less than 15 L/cylinder, these technologies are similar to designs that will be used to meet our nonroad Tier 3 standards, and our proposed locomotive Tier 3 standards.

In almost all instances, marine diesel engines are derivative of land based nonroad engines or locomotive engines. In order to meet our nonroad Tier 4 emission levels (phased in from 2011–2015), nonroad engines will see significant base engine improvements designed to reduce engine-out emissions. Refer to our nonroad Tier 4 rulemaking for details on the designs and calibrations we expect to be used to meet the Tier 3 standards we are proposing for the lower horsepower marine engines. For example, we expect marine engines to 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 Tier 3 marine diesel engine standards can be met. Since this technology and these components already have been implemented on on-highway, nonroad, and some locomotive engines, they can be applied to marine engines beginning as early as 2009.

Because some marine engines are not as similar to on-highway, nonroad or locomotive engines as others, we believe that full implementation of these technologies for marine engines cannot be accomplished until 2012. We expect that the PM emissions control technologies that will be used to meet our proposed Tier 3 marine diesel engine standards will be similar to the technology used to meet our nonroad Tier 3 PM standards and our proposed locomotive Tier 3 PM standards. That is, we believe that a combination of fuel injection improvements, plus the use of existing low-oil-consumption piston ring-pack designs and improved closed crankcase ventilation systems will provide significant PM reductions. And based upon our on-highway and non-road clean diesel experience, we also believe that the use of ultra low sulfur diesel fuel in the marine sector will assist in meeting the Tier 3 PM standards.

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 that these technologies can be implemented for some engines as early as 2009, and for all engines by 2014. We believe that this later date is needed only for those marine engines that are not similar to other on-highway, nonroad, or locomotive engines.

(2) Catalytic Exhaust Treatment Technologies for New Engines

For marine diesel engines in commercial service that are greater than 600 kW, for all marine engines greater than 2000 kW, and for all locomotives, we are proposing stringent Tier 4 standards based on the use of advanced catalytic exhaust treatment 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 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 applicability in terms of packaging; its long-term durability; and whether or not the technology significantly impacts an industry's supply chain infrastructure—especially with respect to supplying urea reductant for SCR to locomotives and vessels. We have carefully examined these points, and based upon our analysis (detailed in our draft Regulatory Impact Analysis), we believe that we have identified robust PM and NO_X catalytic exhaust treatment systems that are applicable to locomotives and marine engines that also pose a manageable impact on the rail and marine industries' infrastructure.

(a) Catalytic PM Emissions Control Technology

The most effective exhaust aftertreatment used for diesel PM emissions control is the diesel particulate filter (DPF). More than a million light diesel vehicles that are OEM-equipped with DPF systems have been sold in Europe, and over 200,000 DPF retrofits to diesel engines have been conducted worldwide.[103] Broad application of catalyzed diesel particulate filter (CDPF) systems with greater than 90 percent PM control is beginning with the introduction of 2007 model year heavy-duty diesel trucks in the United States. These systems use a combination of both passive and active soot regeneration. CDPF systems utilizing metal substrates are a further development that trades off a degree of elemental carbon soot control for reduced backpressure, improvements in the ability of the trap to clear oil ash, greater design freedom regarding filter size/shape, and greater 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 further 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.[104] 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.[105] 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 would provide 95 percent or greater removal of HC, including the semi-volatile organic compounds that contribute to PM. Such systems would reduce overall PM emissions from a locomotive or marine diesel engine by upwards of 90 percent.

We believe that locomotive and marine diesel engine manufacturers will benefit from the extensive development taking place to implement DPF technologies in advance of the heavy-duty truck and nonroad PM standards in Europe and the U.S. 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 proposing 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 believe that our proposed implementation dates for locomotive and marine diesel engines are appropriate and achievable.

(b) Catalytic NO_X Emissions 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 our draft RIA, we are assuming locomotive and marine diesel engine manufacturers will choose to use—Selective Catalytic Reduction, or SCR to comply with our proposed 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 limited to marine ferryboat and stationary electrical power generation demonstration projects in California and

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[103] "Diesel Particulate Filter Maintenance: Current Practices and Experience", Manufacturers of Emission Controls Association, June 2005, *http://meca.org/galleries/default-file/Filter_Maintenance_White_Paper_605_final.pdf.*

[104] Jacob, E., Lämmerman, R., Pappenheimer, A., Rothe, D. "Exhaust Gas Aftertreatment System for Euro 4 Heavy-duty Engines", MTZ, June, 2006.

[105] Smith, B., Sneed, W., Fritz, S. "AAR Locomotive Emissions Testing 2005 Final Report".

several of the Northeast states. However, 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, several heavy-duty truck engine manufacturers have indicated that they will use SCR technology.[106] [107] 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 proposing today), our analysis assumes that SCR will be the technology of choice in the locomotive and marine diesel engine sectors.

An SCR catalyst reduces nitrogen oxides 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 (>200 °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 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 an SCR system is capable of providing well in excess of 80 percent NO_X reduction efficiency in high-power, diesel applications.[108] thnsp[109] thnsp;[110] 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.[111] Given the preponderance of studies and data—and our analysis summarized here and detailed in the draft RIA—we believe that this technology is appropriate for locomotive and marine diesel applications. Furthermore, we believe that 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 proposed Tier 4 locomotive and marine standards. Given the 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 150 °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 catalytic NO_X emissions control systems. Through our discussions we have learned that some engine manufacturers currently 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. We have carefully investigated these issues, and we have concluded that accurate urea injection systems and durable catalysts already exist and have been applied to urea SCR NO_X emissions control systems that 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 accurate injection of urea, and these applications have similar—if not more dynamic—engine operation as compared to locomotive and marine engine operation. To ensure accurate 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. We believe these NO_X sensor based control systems are directly applicable to locomotive and marine engines.

Ammonia emissions, which are already minimized through the use of closed-loop feedback urea injection, can be all-but-eliminated with an oxidation catalyst downstream of the SCR catalyst. Such catalysts are in use today and have been shown to be 95% effective at reducing ammonia emissions.

Catalyst durability is affected by sulfur and other chemicals that can be present in some diesel fuel and lubricating oil. These chemicals have been eliminated in other applications by the use of ultra-low sulfur diesel fuel and low-SAPS (sulfated ash, phosphorous, and sulfur) lubricating oil. Locomotive and marine operators already will be using ultra low sulfur diesel by the time urea NO_X SCR systems would be needed, and low SAPS oil can be used in locomotive and marine engines. Thermal and mechanical vibration durability of catalysts has been addressed through the selection of proper materials and the design of support and mounting structures that are capable of withstanding the shock and vibration levels present in locomotive and marine applications. More details on catalyst durability and urea injection accuracy are available in the remainder of this section and also in our draft RIA.

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[106] "Review of SCR Technologies for Diesel Emission Control: European Experience and Worldwide Perspectives," presented by Dr. Emmanuel Joubert, 10th DEER Conference, July 2004.

[107] Lambert, C., "Technical Advantages of Urea SCR for Light-Duty and Heavy-Duty Diesel Vehicle Applications," SAE Technical Paper 2004–01–1292, 2004.

[108] Walker, A.P. *et al.*, "The Development and In-Field Demonstration of Highly Durable SCR Catalyst Systems," SAE 2004–01–1289.

[109] Conway, R. *et al.*, "Combined SCR and DPF Technology for Heavy Duty Diesel Retrofit," SAE Technical Paper 2005–01–1862, 2005.

[110] "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.

[111] Telephone conversation with Gary Keefe, Argillon, June 6, 2006.

Even though we believe that the issues of catalyst durability and urea injection accuracy have been addressed in existing NO_X SCR emissions control systems, we invite comments and the submission of additional information and data regarding catalyst durability and urea injection accuracy.

(c) Durability of Catalytic PM and NO_X Emissions Control Technology

Published studies indicate that SCR systems should experience very little deterioration in NO_X conversion throughout the life-cycle of a diesel engine.[112] 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. Another mechanism for catalyst deterioration is catalyst 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. Catalyst deterioration due to phosphorous poisoning can be reduced through the use of engine oil with low sulfated-ash, phosphorus, and sulfur content (low-SAPS oil) and through reduced engine oil consumption. The high ash content in current locomotive and marine engine oils is related to the need for a high total base number (TBN) in the oil formulation. Because today's diesel fuel has relatively high sulfur levels, a high TBN in the engine oil is necessary today to neutralize the acids created when fuel-borne sulfur migrates to the crankcase. With the use of ULSD fuel, acid formation in the crankcase will not be a significant concern. The low-SAPS oil will be available for on-highway use by October 2006 and is specified by the American Petroleum Institute as ''CJ–4.'' We also expect that Tier 3 locomotive and marine engine designs will have reduced oil consumption in order to meet the Tier 3 PM standards, and that the Tier 4 designs will be an evolutionary development that will apply catalytic exhaust controls to the Tier 3 engine designs. The durability of other exhaust aftertreatment devices, namely the DOC and CDPF, will also benefit from the use of ULSD fuel, reduced oil consumption and low-SAPS engine oil because the reduction in exposure of these devices to sulfur and phosphorous will improve their effectiveness and the reduction in ash loading will increase the CDPF ash-cleaning intervals.

(d) Packaging of Catalytic PM and NO_X Emissions Control Technology

We project that locomotive manufacturers will need to re-package/re-design the exhaust system components to accommodate the aftertreatment system. Our analysis shows 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.[113] 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 an engine with 6 ft^3 of total displacement, the volume requirement for the aftertreatment components would be approximately 25 ft^3. EPA engineers have examined Tier 2 EMD and GE line-haul locomotives and conclude that there is adequate space to package these components. This conclusion also applies to new switcher locomotives, which, while being shorter in length than line-haul locomotives, will also be equipped with smaller, less-powerful engines—resulting in smaller volume requirements for the aftertreatment components. Given the space available on today's locomotives, we feel that packaging catalytic PM and NO_X emissions control technology on-board locomotives is actually less challenging than packaging similar technology on-board other mobile sources such as light-duty vehicles, heavy-duty trucks, and nonroad equipment. Given that similar exhaust systems are either already implemented on-board these vehicles or will be implemented on these vehicles years before similar systems would be required on-board locomotives, we believe that any packaging issues would be successfully addressed early in the locomotive redesign process.

For commercial vessels that use marine diesel engines greater than 600 kW, we expect that marine vessel builders will need to re-package and re-design the exhaust system components to accommodate the aftertreatment components expected to be necessary to meet the proposed standards. Our discussions with marine architects and engineers, along with our review of vessel characteristics, leads us to conclude 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 the design process undertaken by marine architecture firms.[114]

We did determine, however, that for recreational vessels and for vessels equipped with engines less than 600 kW, catalytic PM and NO_X exhaust treatment systems were less practical from a packaging standpoint than for the larger, commercially operated vessels. We did identify catalytic emissions control systems that would significantly reduce emissions from these smaller vessels. However, after taking into consideration costs, energy, safety, and other relevant factors, we identified a number of reasons why we are not proposing at this time any standards that would likely require catalytic exhaust treatment systems on these smaller vessels. One reason is that most of these vessels use seawater (fresh or saltwater) cooled exhaust systems, and even seawater injection into their exhaust systems, to cool engine exhaust to prevent overheating materials such as a fiberglass hull. This current practice of cooling and seawater injection could reduce the effectiveness of catalytic exhaust treatment systems. This is significantly more challenging than for gasoline catalyst systems due to much larger relative catalyst sizes and cooler exhaust temperatures typical of diesel engines. In addition, because of these

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[112] Conway, R. *et al.*, ''NO_X and PM Reduction Using Combined SCR and DPF Technology in Heavy Duty Diesel Applications,'' SAE Technical Paper 2005–01–3548, 2005.

[113] ''AAR Manual of Standards and Recommended Practices,'' Standard S–5510, Association of American Railroads.

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

vessels' small size and their typical design to operate by planing high on the surface of the water, catalytic exhaust treatment systems pose several significant packaging and weight challenges. Normally, such packaging and weight challenges would be addressed by the use of lightweight hull and superstructure materials. However, the currently accepted lightweight vessel materials are incompatible with the temperatures required to sustain catalyst effectiveness. One solution could be new lightweight hull and superstructure materials which would have to be developed, tested and approved prior to their application on vessels using catalytic exhaust treatment systems. Given these issues, we believe it is prudent to not propose catalytic exhaust treatment-based emission standards for marine diesel engines below 600 kW at this time.

(e) Infrastructure Impacts of Catalytic PM and NO_X Emissions Control Technology

For PM trap technology the locomotive and marine industries will have minimal impact imposed upon their industries' infrastructures. Since PM trap technology relies on no separate reductant, any infrastructure impacts would be limited to some minor changes in maintenance practices or maintenance facilities. Such maintenance would be limited to the infrequent process of removing lubricating oil ash buildup from within a PM trap. This type of maintenance might require facilities to remove PM traps for cleaning. This might 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 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 preferred reductant in an SCR system is 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 assures that the ratio of urea-to-water will not change when the solution begins to freeze.[115] Heated storage tanks and insulated dispensing equipment may be necessary to prevent freeze-up in Northern climates. In addition, the urea dosing apparatus (urea storage tank, pump, and lines) onboard the locomotive or marine vessel may require similar protections. 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 needs to be added will be dependent on the urea storage capacity, duty-cycle, and urea dosing rate for each application. Discussions concerning the urea infrastructure in 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, in which diesel engine/truck manufacturers and fuel refiners/distributors 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.[116] Concerning 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.[117] 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.[118] 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.[119] In the hypothetical 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 in the 2017 timeframe—EPA does not project any urea cost or supply issues will result from implementing the proposed Tier 4 standards.

(3) The Proposed Standards Are Technologically Feasible

Our proposal covers a wide range of engines and the implementation of a range of emissions controls technologies, and we have identified a range of technologically feasible emissions control technologies that likely would be used to meet our proposed 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 treatment 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 draft RIA, we conclude that incremental improvements to engine components and the implementation of catalytic PM and NO_X exhaust treatment technology would be feasible to meet our proposed emissions standards.

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[115] Miller, W. *et al.*, ''The Development of Urea-SCR Technology for U.S. Heavy Duty Trucks,'' SAE Technical Paper 2000–01–0190, 2000.

[116] ''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.

[117] ''National Transportation Statistics—2004,'' Table 4–5, U.S. Bureau of Transportation Statistics.

[118] 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.

[119] ''Mineral Commodity Summaries 2006,'' page 118, U.S. Geological Survey, *www.minerals.usgs.gov/minerals/pubs/mcs/mcs2006.pdf.*

(4) A Request for Detailed Technical Comments

We have carried out an extensive outreach program with the regulated industry to understand the potential impacts and technical challenges to the application of aftertreatment technology to diesel locomotives and marine engines. We are requesting comments on all parts of our resulting analyses summarized in the preceding sections and presented in greater detail in the Draft RIA.

Further, we request comment on the following list of detailed questions provided to the Agency by a stakeholder regarding particular challenges in applying aftertreatment technologies to diesel locomotives. Some of these questions raise concerns about the feasibility of the proposed Tier 4 standards under specific environmental conditions. We present theses questions without endorsing the appropriateness of applying these conditions to locomotive catalyst designs. The reader should refer to the preceding sections and the draft RIA for our analyses of the relevant issues.

(1) How do the following attributes of the locomotive exhaust environment impact the ability of a Zeolite SCR type catalyst to operate within 10% of its ''as new'' conversion efficiency (~94%) after 34,000 MW-hours of operation?

- ○ 150 hours per year operation at 600 Celsius exhaust temperature at the inlet to the SCR, due to DPF regeneration.'' (20-minute regeneration every 20 hours of operation).
- ○ 120 minutes per year operation at 700 Celsius.
- ○ Soot exposure equal to 0.03 g/bhp-hr.
- ○ Shock loading averaging 1,000 mechanical shock pulses per year due to hard coupling.
- ○ Extended periods of vibration where the vibration load on the catalysts can reach 6G and 1000 Hz.
- ○ Water exposure due to rains, icing, water spray and condensed frozen or liquid water during 20% of its life.
- ○ Salt fog consisting of 5 ± 1% salt concentration by weight with fallout rate between 0.00625 and 0.0375 ml/cm^2/hr.
- ○ The catalysts will be subject to sands composed of 95% of SiO_2 with particle size between 1 to 650 microns in diameter with sand concentration of 1.1 ± 0.25 g/m^3 and air velocity of 29 m/s (104 km/h).
- ○ Exposure to dusts comprised of red china clay and silicon flour of particle sizes that are between 1 to 650 microns in diameter with dust concentration of 10.6 ± 7 g/m^3 with a velocity equal to locomotive motion velocity on catalyst surfaces.

(2) Is it feasible for a Zeolite SCR catalyst (as compared to the Vanadium-based catalysts) to operate within 10% of its as new conversion efficiency (~94%) after sustained exposure to real exhaust? If it is, why is it feasible? If it is not feasible, please explain why it is not.

(3) Is it feasible to maintain the conversion efficiency of a diesel oxidation catalyst at least at 45% in the same catalyst environment described in (1) above? In your comments, please explain why or why not.

(4) The feasibility of achieving low ammonia slip, i.e., less than 5 ppm, from urea-based SCR systems that dose at or above 1:1 ratios when applied to an exhaust stream with 500–600 ppm NO_X under both steady state and transient load conditions.

(5) The feasibility of a reliable NO_X sensor with 5% accuracy to control urea dosing sufficiently to achieve a 95% NO_X conversion efficiency using a Zeolite-based SCR when not kinetically limited.

(6) The expected level of ammonia slip catalyst selectivity back to NO_X when a Zeolite-based SCR is dosed at 1:1 ratios and applied to diesel engines above 3.0 MW with an exhaust stream of 500–600 ppm NO_X.

(7) The effect on overall locomotive weight and balance when applying DPF and SCR devices with a weight in excess of 8000 lbs and volume in excess of 40 cubic feet mounted above the engine.

(8) The expected effect on locomotive operating range when adding urea storage equal to 5% of locomotive fuel capacity and a 2% decrease in locomotive fuel efficiency.

(9) Incidental emissions generation resulting from the production and distribution of urea for railroad usage (200,000,000 gallons/year).

(10) The comparative performance of a given engine on the marine v. locomotive duty cycle to include an assessment of SCR technologies (i.e., *Zeolilte* v. *Vanadium*), expected effectiveness for each application, and any considerations that may be unique for one application versus the other that could impact overall NO_X conversion effectiveness.

(11) The impact of the proposed Tier 4 NO_X limit of 1.3 g/hp-hr versus incrementally higher limits on fuel burn and greenhouse gas emissions.

EPA notes that many of these issues are addressed elsewhere in the preamble and in the draft RIA. We invite comment on these questions in the context of the information provided elsewhere on these issues. In providing comments to these eleven questions, we ask that commenters provide information both directly responsive to the individual question and further to the relevance of the question in determining the appropriate emission standard for diesel locomotives. For example, question 1 lists a wide range of conditions for catalyst systems on a diesel locomotive. In that context, EPA also invites comment on the following questions.

- How do the shock loading, vibration loading, soot exposure, and temperature exposure conditions listed in Question 1 compare to conditions faced by other applications of Zeolite-type urea SCR systems that are either under development or that have been developed for on-highway diesel, nonroad diesel, marine and stationary gas turbine applications?
- Question 1 asserts that a locomotive catalyst design would directly expose catalyst substrates to rain water, icing, water spray and condensed frozen or liquid water during 20% of its life. Are there catalyst packaging and installation issues that would necessitate any direct exposure of catalyst substrates to weather?
- Question 1 implies that a locomotive catalyst design would directly expose catalyst substrates to salt fogs consisting of 5 ± 1% salt concentration by weight with fallout rate between 0.00625 and 0.0375 ml/cm^2/hr. What salt concentrations in salt fogs and what fallout rates have SCR systems applied to ocean-going vessels been exposed to? How would the systems designs, exposures and impacts be similar to or different from locomotive applications? Are there unique characteristics of locomotive catalyst installations that would increase their exposure to salt fog relative to other applications operated near or in ocean environments? What direct experiences have ocean-going vessels had regarding the durability of their catalytic emission control systems?
- Question 1 implies that locomotive catalyst systems must withstand exposure to sand ingested by the engine at a rate of up to 50 pounds per hour at notch 8. The question also implies that locomotive catalyst substrates must withstand exposure to a combination of red china clay and silicon flour at a rate of up to one-quarter ton per hour at notch 8. Are these appropriate metrics that reasonably take into consideration the design of the locomotive air-intake and filtration system and the ability of the engine and turbocharger systems to withstand such extreme exposure to ingestion of abrasive materials? Are tests replicating this condition routinely

conducted to demonstrate the durability of the engine and turbocharger systems and emissions compliance following such high rates of engine ingestion of abrasive materials?

- Questions 2 and 3 imply that greater than 45% DOC oxidation efficiency is required to maintain Zeolite SCR catalyst efficiency at greater than 94% NO_X efficiency, and that 94% NO_X efficiency is required to meet the proposed Tier 4 NO_X standard. Is greater than 45% oxidation efficiency for an upstream DOC necessary for locomotives to meet the 1.3 g/bhp-hr NO_X standard over the range of exhaust temperature encountered by locomotives over the line-haul duty cycle when using a Zeolite-based SCR system? Is 94% NO_X efficiency from the current Tier 2 locomotive baseline even necessary to achieve 1.3 g/bhp-hr NO_X emissions when using a Zeolite SCR catalyst system over the line-haul duty-cycle?
- What level of ammonia slip is achievable from modern urea-SCR systems using closed-loop feedback control? Is 5 ppm an appropriate level to set for maximum ammonia slip under any conditions?
- Is 5% of point the limit of zirconia-NO_X sensor accuracy? Does NO_X sensor accuracy currently limit NO_X conversion efficiency of feedback controlled SCR systems, and if so by how much? What level of NO_X conversion efficiency using a Zeolite-based SCR when not kinetically limited is achievable using current feedback control systems using of zirconia-NO_X sensors? What level of NO_X conversion efficiency can be expected taking into consideration projected NO_X sensor and feedback control system development over the next ten to fifteen years?

Comments submitted should provide detailed technical information and data to the extent possible. The EPA solicits comment on the extent to which any factor may impact the ability to achieve the proposed standard and if the proposed standard cannot be achieved in the commenter's view, what standard can be achieved.

E. What Are EPA's Plans for Diesel Marine Engines on Large Ocean-Going Vessels?

Today's proposal covers marine diesel engines up to 30 l/cyl displacement installed on vessels flagged or registered in the U.S. There are two additional significant sources of air pollution from diesel marine engines which are not covered by today's proposal: first, marine diesel engines of any size (Category 1, 2 or 3) installed on foreign-flagged vessels; and second, marine diesel engines at or above 30 l/cyl displacement (Category 3) installed on U.S. flagged vessels. The largest environmental concern for these types of engines are the large, ocean-going marine vessels (OGV), which are typically larger than 2,000 gross tons and involved primarily in international commerce. Ocean-going marine vessels typically are powered by one or more Category 3 diesel engines for propulsion of the vessel, and they typically also have several Category 2 engines to provide auxiliary power. Engines on OGV are predominately fueled by residual fuel (often called ''heavy fuel oil''), which is a by-product of distilling crude oil to produce lighter petroleum products such as gasoline, distillate diesel fuel, and kerosene and has a high sulfur content, up to 45,000 ppm.[120] Ocean-going vessels are a significant contributor to air pollution in the United States, in particular in coastal areas and ports. Current projections indicate that on a national level, OGVs flagged in the U.S. and other countries will contribute about 21 percent of mobile source PM, 12 percent NO_X and 76 percent of SO_X in the year 2030. These contributions can be much higher in some coastal and port areas. However, recent inventory estimates performed for the California Air Resources Board and the Commission for Environmental Cooperation in North America suggest that we are significantly underestimating the emissions for C3 engines, by as much as a factor of 2 or 3.[121]

EPA has a number of activities underway which hold promise for reducing air pollution from OGVs. These include: a future rulemaking action on C3 engine standards; negotiations underway at the International Maritime Organization to establish a new set of environmentally protective international emission standards for OGVs; studies to assess the feasibility of establishing one or more SO_X Emission Control Areas adjacent to North America to reduce SO_X and particulate matter from OGVs; and voluntary actions through our Clean Ports USA program.

(1) Future C3 Marine Rule

In 2003 we issued a final rule for new C3 engines installed on U.S. flagged vessels. That final action established NO_X limits for new C3 engines which are equal to the current international NO_X standards for C3 engines established through Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). The MARPOL standards are based on the capabilities of emission control technologies from the early 1990s, and are significantly higher then emission standards for any other mobile source in the United States. In the 2003 final rule, we identified the technical challenges associated with the application of after-treatment technologies to these engines and vessels, but committed to revisiting the issue of the appropriate long-term emission standards for C3 marine engines, both those which are on vessels flagged in the U.S. and those which are installed on foreign flagged vessels. In revisiting the standards we indicated that we would consider the state of technology that may permit deeper emission reductions and the status of international action for more stringent standards. We committed to a final Agency action by April 27, 2007.

In 2003, we believed the next round of emission standard discussions at the IMO would be well underway, if not concluded, by April of 2006. In 2003, we also believed the IMO deliberations would be one of the avenues to explore improvements in emission control technology for C3 engines and ocean-going vessels, and would provide valuable technical input for EPA's C3 rulemaking.

Despite efforts by the United States Government at IMO, deliberations regarding future emission standards for OGV did not begin until April 2006. The current round of negotiations at IMO is expected to continue through 2007. The discussions thus far at IMO have yielded new technical information which EPA will be able to make use of in our future C3 rulemaking. We expect to issue a revised schedule for the C3 rule in the next few months as well as solicit comments on the appropriate technologies, standards, and lead time EPA should consider for C3 standards.

(2) International Standards Deliberation at IMO

With respect to the discussions currently underway at the IMO, the United States Government is actively

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[120] Residual fuel also possesses a high viscosity and density, which makes it harder to handle and use of this fuel requires special equipment such as heaters, centrifuges, and purifiers. It typically also has a high ash, and nitrogen content compared to distillate diesel fuels. It is not produced to a set of narrow specifications, and so fuel parameters can be highly variable.

[121] Corbett, J.J., et al. Estimation, Validation, and Forecasts of Regional Commercial Marine Vessel Inventories, Tasks 1 and 2: Baseline Inventory and Ports Comparison, Final Report, dated 3 May 2006. Prepared for the California Air Resources Board, the Californian Environmental Protection Agency and the Commission for Environmental Cooperation in North America. ARB contract 04–346, CEC Contract 113.11. A copy of this document can be found at*www.arb.ca.gov/research/seca/jctask12.pdf.*

engaged in the negotiation of a new set of international standards for Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL Annex VI). Since the current Annex VI NO_X limits have entered into effect, and in the time frame since EPA issued our 2003 rule, improvements in both in-cylinder and external emission control technologies have been demonstrated, both in the laboratory and on-board OGVs. These technologies offer the potential to substantially reduce NO_X emissions from OGVs. In addition, the use of lower sulfur residual or distillate fuels and/or the use of SO_X scrubbing technologies offer the potential to substantially reduce PM and SO_X emissions from OGVs. We believe the member states of the IMO, including the United States, have a unique opportunity to establish appropriate long-term standards to address air pollution from OGVs.

The current discussions for the next tier of engine emission standards at IMO also provide an opportunity to apply emission reduction technologies to existing vessels. EPA is a strong supporter of reducing pollution of existing vessels through mandatory rebuild/retrofit requirements and we will continue to pursue this objective at the IMO.

(3) SO_X Emission Control Areas

The existing international agreements adopted by the IMO provide the opportunity for signatories to Annex VI of the International Convention for the Prevention of Pollution from Ships to propose the designation of one or more SO_X Emission Control Areas (SECA). When operating in a SECA, all OGVs must either use fuel with a maximum sulfur content of 15,000 ppm or use emission control technology such that the vessel meets a SO_X limit of 6 g/kW-hr (a value deemed equivalent to 15,000 ppm sulfur). This represents only approximately a 45 percent reduction in SO_X emissions compared to the world-wide fuel sulfur average for heavy-fuel oil of about 27,000 ppm. EPA is currently performing environmental impact and economic analyses that will assist the federal government in making a determination whether the U.S. Government should consider a proposal designating a SECA to one or more areas adjacent to North America. We are working closely with the Canadian Government Canada) on these efforts, and we also intend to coordinate our actions with Mexico. This could allow for the inclusion of additional coastal areas within SECAs for North American. It must be noted that the United States has not yet ratified Annex VI and any decision regarding whether the United States will pursue the designation of a SECA will be influenced by where the United States stands with respect to ratification of MARPOL Annex VI.

(4) Clean Ports USA

As part of EPA's National Clean Diesel Campaign, Clean Ports USA is an incentive-based, public-private partnership designed to reduce emissions from existing diesel engines and vessels at ports. The Clean Ports USA team works to bring together partners and build coalitions to identify and develop cost-effective diesel emission reduction projects that address the key issues affecting ports today. EPA provides technical support in verifying the effectiveness of retrofit technology, to ensure through rigorous testing that the emissions reductions promised by vendors are in fact achieved in the field.

Clean Ports USA is providing incentives to port authorities, terminal operators, cargo interests, trucking fleets, and maritime fleet owners to:

- Retrofit and replace older diesel engines with verified technologies such as diesel oxidation catalysts (DOCs), diesel particulate filters (DPFs).
- Use cleaner fuels (ultra-low sulfur diesel fuel, emulsions).
- Increase operational efficiency, including environmental management systems, logistics, and appointment systems.
- Reduce engine idling.
- Replace older engines with new, cleaner engines.

Additional information is available on the Clean Ports USA Web site at *www.epa.gov/cleandiesel/ports*.

IV. Certification and Compliance Program

This section describes the regulatory changes proposed for the locomotive and marine compliance programs. The most obvious change is that the proposed regulations have been written in plain language. They are structured to contain the provisions that are specific to locomotives in a new proposed part 1033 and contain the provisions that are specific to marine engines and vessels in a new proposed part 1042. We also propose to apply the general provisions of existing parts 1065 and 1068.[122] The proposed plain language regulations, however, are not intended to significantly change the compliance program, except as specifically noted in today's notice (and we are not reopening for comment the substance of any part of the program that remains unchanged substantively). As proposed, these plain language regulations would 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 for different engines. The changes from the existing programs are described below along with other notable aspects of the compliance program. **Note:** The term manufacturer is used in this section to include locomotive and marine manufacturers and locomotive remanufacturers. It would also include marine remanufacturers if we finalize remanufacture standards.

A. Issues Common to Locomotives and Marine

For many aspects of compliance, we are proposing similar provisions for marine engines and locomotives, which are discussed in this section. Also included in this section are issues which are similar, but where we are proposing different provisions. The other compliance issues are discussed in sections IV. B. (for locomotives) and IV. C. (for marine).

(1) Modified 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. We intend in this proposal to continue this process of having all our engine programs refer to a common set of procedures by applying part 1065 to all locomotive and marine diesel engines.

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

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[122] In a separate rulemaking, which has been submitted to the Office of Management and Budget (OMB) for review, we will be proposing modifications to the existing provisions of 40 CFR part 1068. We have placed into the docket for this current proposal, a copy of the draft part 1068 regulatory language that was submitted to OMB. Readers interested in the compliance provisions that would apply to locomotives and marine diesel engines should also read the actual regulatory changes that will be proposed in that upcoming rulemaking.