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Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 9, 69, 80, 86, 89, 94, 1039, 1048, 1051, 1065, and 1068

[OAR–2003–0012; FRL–7662–4]

RIN 2060–AK27

Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: Nonroad diesel engines contribute considerably to our nation's air pollution. These engines, used primarily in construction, agricultural, and industrial applications, are projected to continue to contribute large amounts of particulate matter, nitrogen oxides, and sulfur oxides, all of which contribute to serious public health problems in the United States. These problems include premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. We believe that diesel exhaust is likely to be carcinogenic to humans by inhalation.

Today, EPA is adopting new emission standards for nonroad diesel engines and sulfur reductions in nonroad diesel fuel that will dramatically reduce harmful emissions and will directly help States and local areas recently designated as 8-hour ozone nonattainment areas to improve their air quality. This comprehensive national program regulates nonroad diesel engines and diesel fuel as a system. New engine standards will begin to take effect in the 2008 model year, phasing in over a number of years. These standards are based on the use of advanced exhaust emission control devices. We estimate particulate matter reductions of 95 percent, nitrogen oxides reductions of 90 percent, and the virtual elimination of sulfur oxides from nonroad engines meeting the new standards. Nonroad diesel fuel sulfur reductions of more than 99 percent from existing levels will provide significant health benefits as well as facilitate the introduction of high-efficiency catalytic exhaust emission control devices as these devices are damaged by sulfur. These fuel controls will be phased-in starting in mid-2007. Today's nonroad final rule is largely based on the Environmental Protection Agency's 2007 highway diesel program.

To better ensure the benefits of the standards are realized in-use and throughout the useful life of these engines, we are also adopting new test procedures, including not-to-exceed requirements, and related certification requirements. The rule also includes provisions to facilitate the transition to the new engine and fuel standards and to encourage the early introduction of clean technologies and clean nonroad diesel fuel. We have also developed provisions for both the engine and fuel programs designed to address small business considerations.

The requirements in this rule will result in substantial benefits to public health and welfare through significant reductions in emissions of nitrogen oxides and particulate matter, as well as nonmethane hydrocarbons, carbon monoxide, sulfur oxides, and air toxics. We are now projecting that by 2030, this program will reduce annual emissions of nitrogen oxides and particulate matter by 738,000 and 129,000 tons, respectively. These emission reductions will prevent 12,000 premature deaths, over 8,900 hospitalizations, and almost a million work days lost, and will achieve other quantifiable benefits every year. The total benefits of this rule will be approximately $80 billion annually by 2030. The substantial health and welfare benefits we are projecting for this final action exceed those we anticipated at the time of this proposal. Costs for both the engine and fuel requirements will be many times less, at approximately $2 billion annually.

DATES: This final rule is effective on August 30, 2004.

The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of August 30, 2004.

ADDRESSES: EPA has established a docket for this action under Docket ID Nos. OAR–2003–0012 and A–2001–28. All documents in the docket are listed in the EDOCKET index at *http://www.epa.gov/edocket.* Although listed in the index, some information is not publicly available, *i.e.,* CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically in EDOCKET or in hard copy at the Air Docket in the EPA Docket Center, EPA/DC, EPA West, Room B102, 1301 Constitution Ave., NW, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742.

FOR FURTHER INFORMATION CONTACT: Carol Connell, Assessment and Standards Division, Office of Transportation and Air Quality, Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214–4349; fax number: (734) 214–4050; e-mail address: *connell.carol@epa.gov,* or Assessment and Standards Division Hotline; telephone number: (734) 214–4636; e-mail address: *asdinfo@epa.gov.*

SUPPLEMENTARY INFORMATION:

Does This Action Apply To Me?

This action may affect you if you produce or import new diesel engines which are intended for use in nonroad vehicles or equipment, such as agricultural and construction equipment, or if you produce or import such nonroad vehicles or equipment. It may also affect you if you convert nonroad vehicles or equipment, or the engines used in them, to use alternative fuels. It may also affect you if you produce, import, distribute, or sell nonroad diesel fuel.

The following table gives some examples of entities that may have to follow the regulations. But because these are only examples, you should carefully examine the regulations in 40 CFR parts 80, 89, 1039, 1065, and 1068. If you have questions, call the person listed in the **FOR FURTHER INFORMATION CONTACT** section of this preamble:

Category	NAICS codes[a]	SIC codes[b]	Examples of potentially regulated entities
Industry	333618	3519	Manufacturers of new nonroad diesel engines.
Industry	333111	3523	Manufacturers of farm machinery and equipment.
Industry	333112	3524	Manufacturers of lawn and garden tractors (home).
Industry	333924	3537	Manufacturers of industrial trucks.
Industry	333120	3531	Manufacturers of construction machinery.

Category	NAICS codes[a]	SIC codes[b]	Examples of potentially regulated entities
Industry	333131	3532	Manufacturers of mining machinery and equipment.
Industry	333132	3533	Manufacturers of oil and gas field machinery and equipment.
Industry	811112	7533	Commercial importers of vehicles and vehicle components.
	811198	7549	
Industry	324110	2911	Petroleum refiners.
Industry	422710	5171	Diesel fuel marketers and distributors.
	422720	5172	
Industry	484220	4212	Diesel fuel carriers.
	484230	4213	

Notes:
[a] North American Industry Classification System (NAICS).
[b] Standard Industrial Classification (SIC) system code.

How Can I Get Copies of This Document and Other Related Information?

Docket. EPA has established an official public docket for this action under Docket ID No. OAR–2003–0012 at *http://www.epa.gov/edocket.* The official public docket consists of the documents specifically referenced in this action, any public comments received, and other information related to this action. Although a part of the official docket, the public docket does not include Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. The official public docket is the collection of materials that is available for public viewing at the Air Docket in the EPA Docket Center, (EPA/DC) EPA West, Room B102, 1301 Constitution Ave., NW, Washington, DC. The EPA Docket Center 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 Reading Room is (202) 566–1742, and the telephone number for the Air Docket is (202) 566–1742.

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An electronic version of the public docket is available through EPA's electronic public docket and comment system, EPA Dockets. You may use EPA Dockets at *http://www.epa.gov/edocket/* to view public comments, access the index listing of the contents of the official public docket, and to access those documents in the public docket that are available electronically. Although not all docket materials may be available electronically, you may still access any of the publicly available docket materials through the docket facility identified above. Once in the system, select ''search,'' then key in the appropriate docket identification number.

Outline of This Preamble

I. Overview

EPA today is completing the third recent major program to reduce emissions from the nation's mobile sources. Today's final rule establishes standards for nonroad diesel engines and fuel and builds on the recently adopted Tier 2 program for cars and light trucks and the 2007 highway diesel program for on-highway diesel engines. These three programs have in common large reductions in sulfur levels in fuel that will not only achieve public health benefits but also facilitate the introduction of advanced emissions control technologies. In 1996, emissions from land-based nonroad, marine, and locomotive diesel engines were estimated to be about 40 percent of the total mobile source inventory of $PM_{2.5}$ (particulate matter less than 2.5 microns in diameter) and 25 percent of the NO_X (nitrogen oxides) inventory. Without today's final rule, these contributions would be expected to grow to 44 percent and 47 percent by 2030 for $PM_{2.5}$ and NO_X, respectively. By themselves, land-based nonroad diesel engines are a very large part of the diesel mobile source $PM_{2.5}$ inventory, contributing about 47 percent in 1996, and growing to 70 percent of this inventory by 2020 without today's final rule. In order to meet the Clean Air Act's goal of cleaning up the nation's air, emissions reductions from the nonroad sector are necessary.

This program begins to get important emission reductions in 2008, and by 2030 we estimate that this program will reduce over 129,000 tons $PM_{2.5}$ and 738,000 tons of NO_X annually. These emission reductions will be directly helpful to the 474 counties nationwide that have been recently designated as nonattainment areas for the 8-hour ozone standard and for counties that will be designated as nonattainment for $PM_{2.5}$ later this year. The resulting ambient $PM_{2.5}$ and NO_X reductions correspond to public health improvements in 2030 including approximately 12,000 fewer premature mortalities, 15,000 fewer heart attacks, 1 million fewer lost days of work due to adults with respiratory symptoms, 5.9 million fewer days when adults have to restrict their activities due to respiratory symptoms, and almost 6,000 emergency room visits for asthma attacks in children. Our projections in this final rule for public health and welfare improvements are greater than estimated at proposal.

This final rule sets out emission standards for nonroad diesel engines—engines used mainly in construction, agricultural, industrial and mining operations—that will achieve reductions in PM and NO_X emissions levels in excess of 95 percent and 90 percent respectively. This action also regulates nonroad diesel fuel for the first time by reducing sulfur levels in this fuel more than 99 percent to 15 parts per million (ppm). These provisions mirror those already in place for highway diesel engines, which will lead to the introduction of 15 ppm sulfur diesel fuel, followed by stringent engine standards in that sector beginning in 2007 based on advanced aftertreatment technologies. We believe it is highly appropriate to bring the same types of expected advanced aftertreatment technologies to the nonroad market as soon as possible and we believe today's nonroad fuel and engine program represents the next step in a feasible progression in the application of clean technologies to nonroad diesel engines and the associated diesel fuel.

As we did with the proposed nonroad rulemaking, we followed specific principles when developing this final rule. First, the program achieves reductions in NO_X, sulfur oxides (SO_X), and PM emissions as early as possible. Second, it does so by implementing the fuel program as soon as possible while at the same time not interfering with the implementation and expected benefits of introducing ultra low sulfur fuel (diesel fuel containing no greater than 15 ppm sulfur) in the highway market as required by the 2007 highway diesel rule. Next, we are generally treating vehicles and fuels as a system, that is promulgating engine and fuel standards in tandem in order to cost-effectively achieve the greatest emission reductions. Lastly, the program provides sufficient lead time to allow the migration of advanced emissions control technologies from the highway sector to nonroad diesel engines as well as the expansion of ultra low sulfur diesel fuel production to the nonroad market.

The May 2003 proposed rulemaking culminated a multi-year effort to develop control strategies for nonroad engines. EPA worked collaboratively with stakeholders from industry, state and local government, and public health organizations in putting together its comprehensive (and widely praised) new engine standards and sulfur fuel controls. We received about 150,000 comments on the proposal, almost all of them in support. We held three public hearings on the proposal and have participated in scores of meetings with commenters in developing the provisions of today's final rule. An important aspect of this collaborative development effort has been EPA's coordination with other governments in helping to further world harmonization of nonroad engine controls and fuel sulfur levels. Information gathered in these comments and discussions, taken in context with the principles described above, has been the basis for our action today.

In summary, this rule sets out engine standards and emission test procedures (including not-to-exceed requirements) for new nonroad diesel engines, and sulfur control requirements for diesel fuel used in land-based nonroad, locomotive, and marine engines (NRLM fuel). Beginning in 2008, the new Tier 4 engine standards for five power categories for engines from under 25 horsepower (hp) to above 750 horsepower will be phased in. New engine emissions test procedures will be phased in along with these new standards to better ensure emissions control over real-world engine operation and to help provide for effective compliance determination. The sulfur reductions to land-based nonroad diesel fuel will be accomplished in two steps, with an interim step from currently uncontrolled levels to a 500 ppm cap starting in June, 2007 and the final step to 15 ppm in June, 2010. This change in fuel quality will directly lead to important health and welfare benefits associated with the reduced generation of sulfate PM and SO_X. Even more important, introduction of 15 ppm sulfur nonroad diesel fuel facilitates the introduction of advanced aftertreatment devices for nonroad engines.

Although we did not propose to control locomotive and marine diesel fuel sulfur levels to 15 ppm in the NPRM, recognizing the important environmental and public welfare benefits that such a program could enable, we have decided to finalize this second step to 15 ppm sulfur fuel control program for locomotive and marine diesel fuel beginning in 2012. Locomotive and marine diesel fuel will first be reduced from current uncontrolled levels to a 500 ppm cap starting in June 2007 and the second step down to a 15 ppm cap will take place in June, 2012. While we have chosen to reduce sulfur levels in locomotive and marine diesel fuel to 15 ppm in this rulemaking without adopting corresponding engine controls, we note that the Agency has already begun work to promulgate appropriate new standards for these engines.[1] The monetized health and welfare benefits associated with further sulfur reduction to 15 ppm outweigh the costs of the sulfur reductions. Also, doing so now allows for the promulgation of a single integrated fuel program and provides the refining industry with long term predictability for sulfur control.

The requirements in this rule will result in substantial benefits to public health and welfare and the environment through significant reductions in NO_X and PM as well as nonmethane hydrocarbons (NMHC), carbon monoxide (CO), SO_X, and air toxics. As noted, by 2030 this program will reduce annual emissions of NO_X and PM by 738,000 and 129,000 tons, respectively. We estimate these annual emission reductions will prevent 12,000 premature deaths, over 8,900 hospitalizations, 15,000 nonfatal heart attacks, and approximately 1 million days that people miss work because of respiratory symptoms, among quantifiable benefits. The overall quantifiable benefits will total $83 billion annually by 2030 using a 3 percent discount rate and $78 billion using a 7 percent discount rate at a cost of approximately $2 billion, with a 30-year net present value for the benefits of $805 billion at 3 percent discounting and $352 billion at 7 percent discounting at a net present value cost of $27 billion at 3 percent discounting and $14 billion at 7 percent discounting. Clearly the benefits of this program dramatically outweigh its cost at a ratio of approximately 40:1 in 2030.

A. What Is EPA Finalizing?

As part of the proposed rulemaking, we set out very detailed provisions for new engine exhaust emission controls, sulfur limitations in nonroad and locomotive/marine diesel fuels, test procedures, compliance requirements, and other information. We also looked at a number of alternative program options, such as requiring refiners to reduce sulfur from uncontrolled levels to 15 ppm in one step in 2008. We continue to believe that the main program options set out in the proposal are feasible and the most cost-effective requirements, taking into account other factors such as lead time and interaction with the highway diesel program, so we are generally adopting the engine and fuel provisions which we proposed.

[1] EPA is issuing an Advanced Notice of Proposed Rulemaking for locomotive and marine engine standards as part of this effort.

1. Nonroad Diesel Engine Emission Standards

Today's action adopts Tier 4 standards for nonroad diesel engines of all horsepower ratings. These standards are technology-neutral in the sense that manufacturers are the responsible party in determining which emission control technologies will be needed to meet the requirements. Applicable emissions standards are determined by model year for each of five engine power band categories. For engines less than 25 hp, we are adopting a new engine standard for PM of 0.30 g/bhp-hr (grams per brake-horsepower-hour) beginning in 2008, and leaving the previously-set 5.6 g/bhp-hr combined standard for NMHC+NO_X in place. For engines of 25 to 75 hp, we are adopting standards reflecting approximately 50 percent reductions in PM control from today's engines, again applicable beginning in 2008. Then, starting in 2013, standards of 0.02 g/bhp-hr for PM and 3.5 g/bhp-hr for NMHC+NO_X will apply for this power category. For engines of 75 to 175 hp, the standards will be 0.01 g/bhp-hr for PM, 0.30 g/bhp-hr for NO_X and 0.14 g/bhp-hr for NMHC starting in 2012, with the NO_X and NMHC standards phased in over a period of three to four years in order to address lead time, workload, and feasibility considerations. These same standards will apply to engines of 175 to 750 hp as well starting in 2011, with a similar phase-in. These PM, NO_X, and NMHC standards and phase-in schedules are similar in stringency to the 2007 highway diesel standards and are expected to require the use of high-efficiency aftertreatment systems to ensure compliance.

For engines above 750 hp, we are requiring PM and NMHC control to 0.075 g/bhp-hr and 0.30 g/bhp-hr, respectively, starting in 2011. More stringent standards take effect in 2015 with PM standards of 0.02 g/bhp-hr (for engines used in generator sets) and 0.03 g/bhp-hr (for non-generator set engines), and an NMHC standard of 0.14 g/bhp-hr. The NO_X standard in 2011 will be 0.50 g/bhp-hr for generator set engines above 1200 hp, and 2.6 g/bhp-hr for all other engines in the above 750 hp category. This application of advanced NO_X emission control technologies to generator set engines above 1200 hp will provide substantial NO_X reductions and will occur earlier than we had proposed in the NPRM. In 2015, the 750–1200 hp generator set engines will be added to the stringent 0.50 g/bhp-hr NO_X requirement as well. The long-term NO_X standard for engines not used in generator sets (mobile machinery) will be addressed in a future action (we are currently considering such an action in the 2007 time frame).

We are also continuing the averaging, banking, and trading provisions engine manufacturers can use to demonstrate compliance with the standards. We also are continuing provisions providing flexibilities which equipment manufacturers may use to facilitate transition to compliance with the new standards. In addition, we are including turbocharged diesels in the existing regulation of crankcase emissions, effective in the same year that the new standards first apply in each power category.

As discussed at length in the proposal, new test procedures and compliance provisions, especially the not-to-exceed and transient tests, are necessary to ensure the benefits of the standards being adopted today are achieved when the aftertreatment-based standards go into place. We are therefore adopting the proposed test procedures and compliance provisions, with slight modifications designed to better implement the provisions, in today's rule. We continue to believe the new transient test, cold start transient test, and not-to-exceed test procedures and standards will all help achieve our goal of emissions reductions being achieved in actual engine operation.

As noted, the final rule also continues, and in some cases modifies, existing provisions that will facilitate the transition to the new engine and fuel standards. Many of these provisions will help small business engine and equipment manufacturers meet the requirements. They will also aid manufacturers in managing their development of engines and equipment that will meet our new standards.

2. Nonroad, Locomotive, and Marine Diesel Fuel Quality Standards

The fuel program requirements are very similar to those included in the proposal, with two notable exceptions. The first involves the standards themselves with the inclusion of locomotive and marine diesel fuel in the 15 ppm standard. The second addresses the compliance provisions designed to ensure the effectiveness of the program.

We are adopting the two-step approach to sulfur control, with all land-based nonroad, locomotive, and marine diesel fuel going from uncontrolled sulfur levels of approximately 3,000 ppm sulfur to 500 ppm in June, 2007. The interim step will by itself achieve significant PM and SO_X emission reductions with associated important health benefits as early as is practicable. Then, in June

2010, the sulfur cap for land-based nonroad engine diesel fuel will be reduced to the final standard of 15 ppm. Two years later, in 2012, the 15 ppm cap for locomotive and marine engine diesel fuel will go into effect. The reduction to 15 ppm sulfur provides additional direct control of PM and SO_X emissions and is an enabling technology for the application of advanced catalyst-based emission control technologies.

Although we did not propose to control locomotive and marine diesel fuel to 15 ppm in the NPRM, after careful consideration and reviewing substantial comments from stakeholders, we have decided to include fuel used in locomotive and marine applications in the final step to 15 ppm beginning in 2012. The incremental PM health and welfare benefits associated with this standard outweigh the costs. The locomotive and marine diesel fuel program provides a near-term positive impact on public health and welfare. Also, the 15 ppm sulfur diesel fuel provides an opportunity that may enable the application of advanced catalyst-based emission control technologies to locomotive and marine diesel engines. We are issuing an Advance Notice of Proposed Rulemaking for locomotive and marine diesel engines that investigates this potential. Recognizing the value that a locomotive and marine fuel program could have for public health and welfare, State and local authorities and public health advocacy organizations provided a large number of comments encouraging us to take action in this rulemaking to address emissions from this category.

Including locomotive and marine fuel in the 15 ppm sulfur diesel fuel pool also simplifies the overall design of the fuel program and will simplify the distribution of diesel fuel. At the same time, we have finalized this standard with flexibilities designed specifically to address fuel program implementation issues raised in the comments.

Noting that sulfur levels in highway diesel fuel will generally be at or below 15 ppm starting in 2006 and not wanting to reduce the benefits of introducing this clean fuel, we spent considerable time developing a compliance assurance scheme for introducing our nonroad diesel sulfur program to mesh with the highway program requirements. We initially thought that a ''baseline'' approach essentially requiring refiners to maintain a constraint on sulfur levels of various distillate fuels, based on historical production volumes, was the most appropriate mechanism. Subsequently we learned that the other mechanism we discussed in the proposal, a ''designate and track'' type approach, is better suited to address our priorities and commitments for the nonroad diesel sulfur control program. This approach allows refiners to designate volumes of nonroad fuel into various categories and these designations would follow the fuel throughout the distribution system. We have successfully worked through our enforceability and other concerns with this approach and are now including it as our compliance mechanism for the fuel standards of today's program.

B. Why Is EPA Taking This Action?

As we have discussed extensively in both the proposal and today's action, EPA strongly believes it is appropriate to take steps now to reduce future emissions from nonroad, locomotive, and marine diesel engines. Emissions from these engines contribute greatly to a number of serious air pollution problems and would continue to do so in the future absent further reduction measures. Such emissions lead to adverse health and welfare effects associated with ozone, PM, NO_X, SO_X, and volatile organic compounds, including toxic compounds. In addition, diesel exhaust is of specific concern because it is likely to be carcinogenic to humans by inhalation as well as posing a hazard from noncancer respiratory effects. Ozone, NO_X, and PM also cause significant public welfare harm such as damage to crops, eutrophication, regional haze, and soiling of building materials.

Millions of Americans continue to live in areas with unhealthy air quality that may endanger public health and welfare. As discussed in more detail below, there are approximately 159 million people living in areas that either do not meet the 8-hour ozone National Ambient Air Quality Standards (NAAQS) or contribute to violations in other counties as noted in EPA's recent nonattainment designations for part or all of 474 counties. In addition, approximately 65 million people live in counties where air quality measurements violate the $PM_{2.5}$ NAAQS. These numbers do not include the tens of millions of people living in areas where there is a significant future risk of failing to maintain or achieve the ozone or $PM_{2.5}$ NAAQS. Federal, state, and local governments are working to bring ozone and PM levels into compliance with the NAAQS attainment and maintenance plans and the reductions included in today's rule will play a critical part in these actions. Reducing regional emissions of SO_X is critical to this strategy for attaining the PM NAAQS and meeting regional haze goals in our treasured national parks. SO_X levels can themselves pose a respiratory hazard.

Although controlling air pollution from nonroad diesel exhaust is challenging, we strongly believe it can be accomplished through the application of high-efficiency emissions control technologies. As discussed in much greater detail in section II, very large emission reductions (in excess of 90 percent) are possible, especially through the use of catalytic emission control devices installed in the nonroad equipment's exhaust system and integrated with the engine controls. To meet the standards being adopted today, application of such technologies for both PM and NO_X control will be needed for most engines. High-efficiency PM exhaust emission control technology has been available for several years, and it is the same technology we expect to be applied to meet the PM standards for highway diesel engines in 2007. For NO_X, we expect the same high-efficiency technologies being developed for the 2007 highway diesel engine program will be used to meet our new nonroad requirements. All of these technologies are dependent on the 15 ppm maximum sulfur levels for nonroad diesel fuel being adopted today. The fuel control program being adopted today also yields significant and important reductions in SO_X from these sources.

1. Basis for Action Under the Clean Air Act

Section 213 of the Clean Air Act (''the Act'' or CAA) gives us the authority to establish emissions standards for nonroad engines and vehicles. Section 213(a)(3) authorizes the Administrator to set standards for NO_X, volatile organic compounds (VOCs), and CO which ''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.'' As part of this determination, the Administrator must give appropriate consideration to cost, lead time, noise, energy, and safety factors associated with the application of such technology. The standards adopted today for NO_X implement this provision. Section 213(a)(4) authorizes the Administrator to establish standards to control emissions of pollutants (other than those covered by section 213(a)(3)) which ''may reasonably be anticipated to endanger public health and welfare.'' Here, the Administrator may promulgate regulations that are deemed appropriate for new nonroad vehicles and engines which cause or contribute to such air pollution, taking into account costs, noise, safety, and energy factors. EPA believes the new controls for PM in today's rule are an appropriate exercise of EPA's discretion under the authority of section 213(a)(4).

We believe the evidence provided in section II of this preamble and in the Regulatory Impact Analysis (RIA) indicates that the stringent emission standards adopted today are feasible and reflect the greatest degree of emission reduction achievable in the model years to which they apply. We have given appropriate consideration to costs in promulgating 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 for the same pollutants that have been required or could be required in the future. We have also reviewed and given appropriate consideration to the energy factors of this rule in terms of fuel efficiency and effects on diesel fuel supply, production, and distribution, as discussed below, as well as any safety factors associated with these new standards.

The information in this section and chapters 2 and 3 of the RIA regarding air quality and the contribution of nonroad, locomotive, and marine diesel engines to air pollution provides strong evidence that emissions from such engines significantly and adversely impact public health or welfare. First, as noted earlier, there is a significant risk that several areas will fail to attain or maintain compliance with the NAAQS for 8-hour ozone concentrations or the NAAQS for $PM_{2.5}$ during the period that these new vehicle and engine standards will be phased into the vehicle population, and that nonroad, locomotive, and marine diesel engines contribute to such concentrations, as well as to concentrations of other criteria pollutants. This risk will be significantly reduced by the standards adopted today, as also noted above. However, the evidence indicates that some risk remains even after the reductions achieved by these new controls on nonroad diesel engines and nonroad, locomotive, and marine diesel fuel. Second, EPA believes that diesel exhaust is likely to be carcinogenic to humans. The risk associated with exposure to diesel exhaust includes the particulate and gaseous components among which are benzene, formaldehyde, acetaldehyde, acrolein, and 1,3–butadiene, all of which are known or suspected human or animal carcinogens, or have noncancer health effects. Moreover, these compounds have the potential to cause health effects at environmental levels of exposure. Third, emissions from nonroad diesel engines (including locomotive and marine diesel engines) contribute to regional haze and impaired visibility across the nation, as well as to odor, acid deposition, polycyclic organic matter (POM) deposition, eutrophication and nitrification, all of which are serious environmental welfare problems.

EPA has already found in previous rules that emissions from new nonroad diesel engines contribute to ozone and CO concentrations in more than one area which has failed to attain the ozone and CO NAAQS (59 FR 31306, June 17, 1994). EPA has also previously determined that it is appropriate to establish standards for PM from new nonroad 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 significantly contribute to air pollution that may reasonably be anticipated to endanger public welfare due to regional haze and visibility impairment (67 FR 68242–68243, Nov. 8, 2002). We find here, based on the information in this section of the preamble and chapters 2 and 3 of the RIA, that emissions from the new nonroad diesel engines covered by this final action likewise contribute to regional haze and to visibility impairment that may reasonably be anticipated to endanger public welfare. Taken together, these findings indicate the appropriateness of the nonroad diesel engine standards adopted today for purposes of section 213(a)(3) and (4) of the Act. These findings were unchallenged by commenters.

These standards must take effect at ''the earliest possible date considering the lead time necessary to permit development and application of the requisite technology,'' giving ''appropriate consideration'' to cost, energy, and safety.[2] The compliance dates we are adopting reflect careful consideration of these factors. The averaging, banking, and trading (ABT), equipment manufacturer flexibilities, and phase-in provisions for NO_X are elements in our determination that we have selected appropriate lead times for the standards.

Section 211(c) of the CAA allows us to regulate fuels where emission products of the fuel either: (1) Cause or contribute to air pollution that reasonably may be anticipated to endanger public health or welfare, or (2) will impair to a significant degree the performance of any emission control device or system which is in general use, or which the Administrator finds has been developed to a point where in a reasonable time it will be in general use were such a regulation to be promulgated. This rule meets both of these criteria. Sulfur dioxide (SO_2)and sulfate PM emissions from nonroad, locomotive, marine and diesel vehicles are due to sulfur in diesel fuel. As discussed above, emissions of these pollutants cause or contribute to ambient levels of air pollution that endanger public health and welfare. Control of sulfur to 15 ppm for this fuel through a two-step program would lead to significant, cost-effective reductions in emissions of these pollutants. Control of sulfur to 15 ppm in nonroad diesel fuel will also enable emissions control technology that will achieve significant, cost-effective reduction in emissions of these pollutants, as discussed in section I.B.2 below. The substantial adverse effect of high sulfur levels on the performance of diesel emission control devices or systems that would be expected to be used to meet the nonroad standards is discussed in detail in section II. Control of sulfur to 15 ppm for locomotive and marine diesel fuel, as with nonroad diesel fuel, will provide meaningful additional benefits that outweigh the costs. In addition, our authority under section 211(c) is discussed in more detail in Appendix A to chapter 5 of the RIA.

2. What Is the Air Quality Impact of This Final Rule?

a. Public Health and Environmental Impacts

With this rulemaking, we are acting to extend advanced emission controls to another major source of diesel engine emissions: Nonroad land-based diesel engines. This final rule sets out emission standards for nonroad land-based diesel engines—engines used mainly in construction, agricultural, industrial and mining operations—that will achieve reductions in PM and NO_X standards in excess of 95 percent and 90 percent, respectively for this class of vehicles. This action also regulates nonroad diesel fuel for the first time by reducing sulfur levels in this fuel more than 99 percent to 15 ppm. The diesel fuel sulfur requirements will decrease PM and SO_2 emissions for land-based diesel engines, as well as for three other nonroad source categories: Commercial marine diesel vessels, locomotives, and recreational marine diesel engines.

[2] See Clean Air Act section 213(b).

These sources are significant contributors to atmospheric pollution of (among other pollutants) PM, ozone and a variety of toxic air pollutants. In 1996, emissions from these four source categories were estimated to be 40 percent of the mobile source inventory for $PM_{2.5}$ and 25 percent for NO_X, and 10 percent and 13 percent of overall emissions for these potential health hazards, respectively. Without further controls beyond those we have already adopted, these sources will emit 44 percent of $PM_{2.5}$ from mobile sources and 47 percent of NO_X emissions from mobile sources by the year 2030.

Nonroad engines, and most importantly nonroad diesel engines, contribute significantly to ambient $PM_{2.5}$ levels, largely through direct emissions of carbonaceous and sulfate particles in the fine (and even ultrafine) size range. Nonroad diesels also currently emit high levels of NO_X which react in the atmosphere to form secondary $PM_{2.5}$ (namely ammonium nitrate) as well as ozone. Nonroad diesels also emit SO_2 and hydrocarbons which react in the atmosphere to form secondary $PM_{2.5}$ (namely sulfates and organic carbonaceous $PM_{2.5}$). This section summarizes key points regarding the nonroad diesel engine contribution to these pollutants and their impacts on human health and the environment. EPA notes that we are relying not only on the information presented in this preamble, but also on the more detailed information in chapters 2 and 3 of the RIA and technical support documents, as well as information in the preamble, RIA, and support documents for the proposed rule.

When fully implemented, this final rule will reduce nonroad (equipment such as construction, agricultural, and industrial), diesel $PM_{2.5}$ and NO_X emissions by 95 percent and 90 percent, respectively. It will also virtually eliminate nonroad diesel SO_2 emissions, which amounted to approximately 234,000 tons in 1996, and would otherwise grow to approximately 326,000 tons by 2020. These dramatic reductions in nonroad emissions are a critical part of the effort by federal, state and local governments to reduce the health related impacts of air pollution and to reach attainment of the NAAQS for PM and ozone, as well as to improve other environmental effects such as atmospheric visibility. Based on the most recent data available for this rule, such problems are widespread in the United States. There are almost 65 million people living in 120 counties with monitored $PM_{2.5}$ levels (2000–2002) exceeding the $PM_{2.5}$ NAAQS, and 159 million people living in areas recently designated as exceeding 8-hour ozone NAAQS. Figure I–1 illustrates the widespread nature of these problems. Shown in this figure are counties exceeding the $PM_{2.5}$ NAAQS or designated for nonattainment with the 8-hour ozone NAAQS plus mandatory Federal Class I areas, which have particular needs for reductions in atmospheric haze.

Our air quality modeling also indicates that similar conditions are likely to continue to persist in the future in the absence of additional controls and that the emission reductions would assist areas with attainment and future maintenance of the PM and ozone NAAQS.[3] For example, in 2020, based on emission controls currently adopted, we project that 66 million people will live in 79 counties with average $PM_{2.5}$ levels above 15 micrograms per cubic meter (ug/m^3). In 2030, the number of people projected to live in areas exceeding the $PM_{2.5}$ standard is expected to increase to 85 million in 107 counties. An additional 24 million people are projected to live in counties within 10 percent of the standard in 2020, which will increase to 64 million people in 2030. Furthermore, for ozone, in 2020, based on emission controls currently adopted, the number of counties violating the 8-hour ozone standard is expected to decrease to 30 counties where 43 million people are projected to live. Thereafter, exposure to unhealthy levels of ozone is expected to begin to increase again. In 2030 the number of counties violating the 8-hour ozone NAAQS is projected to increase to 32 counties where 47 million people are projected to live. In addition, in 2030, 82 counties where 44 million people are projected to live will be within 10 percent of violating the ozone 8-hour NAAQS.

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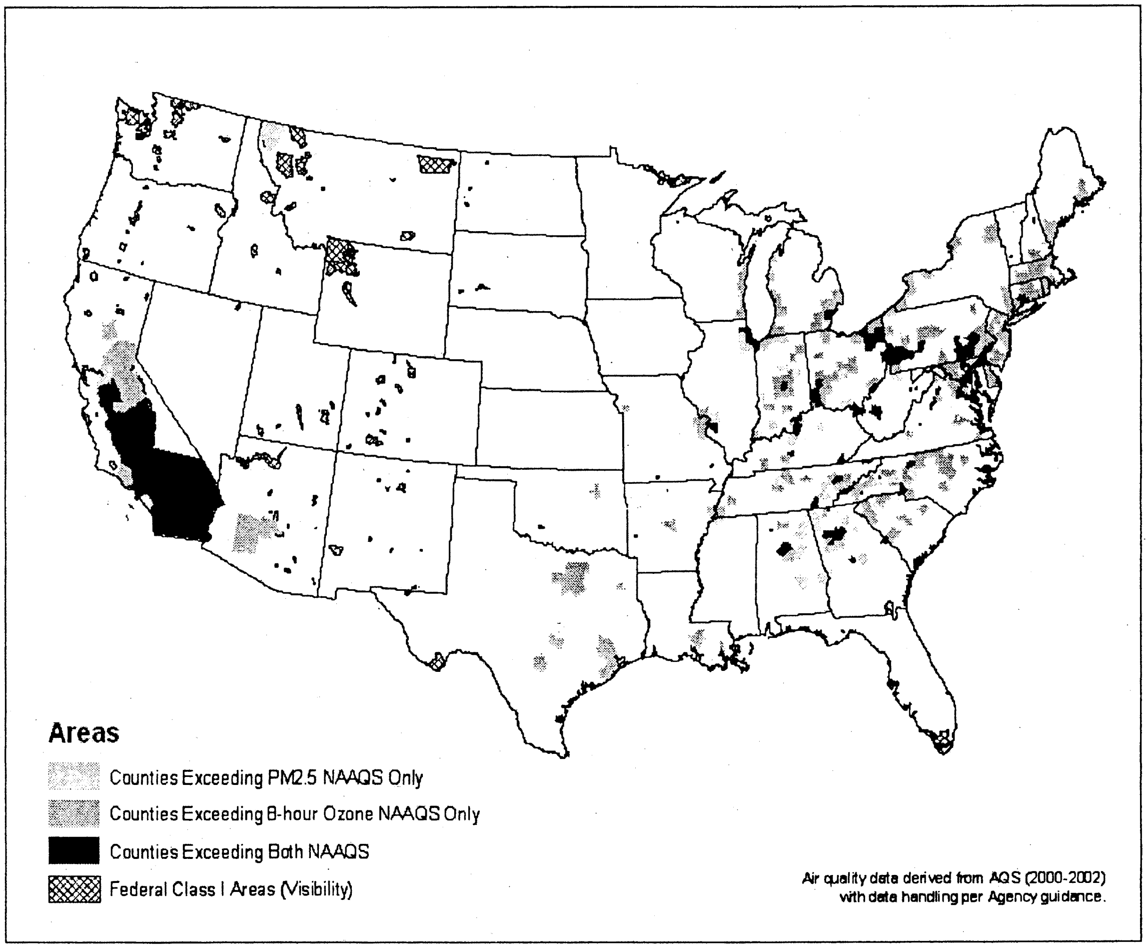
[3] Note this analysis does not include the effects of the proposed Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Interstate Air Quality Rule). 69 FR 4566 (January 30, 2004). *See http://www.epa.gov/interstateairquality/rule.html.*

Figure I-1. Air Quality Problems are Widespread



EPA is still developing the implementation process for bringing the nation's air into attainment with the $PM_{2.5}$ and 8-hour ozone NAAQS. Based on section 172(a) provisions in the Act, designated areas will need to attain the $PM_{2.5}$ NAAQS in the 2010 (based on 2007–2009 air quality data) to 2015 (based on 2012 to 2014 air quality data) time frame, and then be required to maintain the NAAQS thereafter. Similarly, we expect that most areas covered under subpart 1 and 2 will attain the ozone standard in the 2007 to 2014 time frame, depending on an area's classification and other factors, and then be required to maintain the NAAQS thereafter.

Since the emission reductions expected from this final rule would begin in this same time frame, the projected reductions in nonroad emissions would be used by states in meeting the $PM_{2.5}$ and ozone NAAQS. In their comments on the proposal, states told EPA that they need nonroad diesel engine reductions in order to be able to meet and maintain the $PM_{2.5}$ and ozone NAAQS as well as to make progress toward visibility requirements.[4] Furthermore, this action would ensure that nonroad diesel emissions will continue to decrease as the fleet turns over in the years beyond 2014; these reductions will be important for maintenance of the NAAQS following attainment.

Scientific studies show ambient PM is associated with a series of adverse health effects. These health effects are discussed in detail in the EPA Criteria Document for PM as well as the draft updates of this document released in the

[4] The following are sample comments from states and state associations on the proposed rule, which corroborate that this rule is a critical element in States' NAAQS attainment efforts. Fuller information can be found in the Summary and Analysis of Comments.

—"Unless emissions from nonroad diesels are sharply reduced, it is very likely that many areas of the country will be unable to attain and maintain health-based NAAQS for ozone and PM." (STAPPA/ALAPCO)

—"Adoption of the proposed regulation * * * is necessary for the protection of public health in California and to comply with air quality standards * * * The need for 15 ppm sulfur diesel fuel cannot be overstated." (California Air Resources Board)

—"The EPA's proposed regulation is necessary if the West is to make reasonable progress towards improving visibility in our nation's Class I areas." (Western Regional Air Partnership (WRAP))

—"Attainment of the NAAQS for ozone and $PM_{2.5}$ is of immediate concern to the states in the northeast region.* * * Thus, programs * * * such as the proposed rule for nonroad diesel engines are essential." (NESCAUM) past year.[5,6] EPA's ''Health Assessment Document for Diesel Engine Exhaust,'' (the ''Diesel HAD'') also reviews health effects information related to diesel exhaust as a whole including diesel PM, which is one component of ambient PM.[7] In the Diesel HAD, we note that the particulate characteristics in the zone around nonroad diesel engines are likely to be substantially the same as published air quality measurements made along busy roadways. This conclusion supports the relevance of health effects associated with highway diesel engine-generated PM to nonroad applications.

As described in these documents, health effects associated with short-term variation in ambient PM have been indicated by epidemiologic studies showing associations between exposure and increased hospital admissions for ischemic heart disease, heart failure, respiratory disease, including chronic obstructive pulmonary disease (COPD) and pneumonia. Short-term elevations in ambient PM have also been associated with increased cough, lower respiratory symptoms, and decrements in lung function. Additional studies have associated changes in heart rate and/or heart rhythm in addition to changes in blood characteristics with exposure to ambient PM. Short-term variations in ambient PM have also been associated with increases in total and cardiorespiratory mortality. 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, suggest an association between long-term exposure to ambient $PM_{2.5}$ and premature mortality, including deaths attributed to lung cancer.[8,9] Two studies further analyzing the Harvard Six Cities Study's air quality data have also established a specific influence of mobile source-related $PM_{2.5}$ on daily mortality and a concentration-response function for mobile source-associated $PM_{2.5}$ and daily mortality. Another recent study in 14 U.S. cities examining the effect of PM_{10} (particulate matter less than 10 microns in diameter) on daily hospital admissions for cardiovascular disease found that the effect of PM_{10} was significantly greater in areas with a larger proportion of PM_{10} coming from motor vehicles, indicating that PM_{10} from these sources may have a greater effect on the toxicity of ambient PM_{10} when compared with other sources.[10]

Of particular relevance to this rule is a recent cohort study which examined the association between mortality and residential proximity to major roads in the Netherlands. Examining a cohort of 55 to 69 year-olds from 1986 to 1994, the study indicated that long-term residence near major roads, an index of exposure to primary mobile source emissions (including diesel exhaust), was significantly associated with increased cardiopulmonary mortality.[11] Other studies have shown children living near roads with high truck traffic density have decreased lung function and greater prevalence of lower respiratory symptoms compared to children living on other roads.[12] A recent review of epidemiologic studies examining associations between asthma and roadway proximity concluded that some coherence was evident in the literature, indicating that asthma, lung function decrement, respiratory symptoms, and other respiratory problems appear to occur more frequently in people living near busy roads.[13] As discussed later, nonroad diesel engine emissions, especially particulate, are similar in composition to those from highway diesel vehicles. Although difficult to associate directly with $PM_{2.5}$, these studies indicate that direct emissions from mobile sources, and diesel engines specifically, may explain a portion of respiratory health effects observed in larger-scale epidemiologic studies. Recent studies conducted in Los Angeles have illustrated that a substantial increase in the concentration of ultrafine particles is evident in locations near roadways, indicating substantial differences in the nature of PM immediately near mobile source emissions.[14] For additional information on health effects, see the RIA.

In addition to its contribution to ambient PM concentrations, diesel exhaust is of specific concern because it has been judged to pose a lung cancer hazard for humans as well as a hazard from noncancer respiratory effects. In this context, diesel exhaust PM is generally used as a surrogate measure for diesel exhaust. Further, nonroad diesel engine emissions also contain several substances known or suspected as human or animal carcinogens, or that have noncancer health effects as described in the Diesel HAD. Moreover, these compounds have the potential to cause health effects at environmental levels of exposure. These other compounds include benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, dioxin, and POM. For some of these pollutants, nonroad diesel engine emissions are believed to account for a significant proportion of total nation-wide emissions. All of these compounds were identified as national or regional ''risk drivers'' in the 1996 NATA.[15] That is, these compounds pose a significant portion of the total inhalation cancer risk to a significant portion of the population. Mobile sources contribute significantly to total emissions of these air toxics. As discussed in more detail in the RIA, this final rulemaking will result in significant reductions of these emissions.

In EPA's Diesel HAD.[16] 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,

[5] U.S. EPA (1996.) Air Quality Criteria for Particulate Matter—Volumes I, II, and III, EPA, Office of Research and Development. Report No. EPA/600/P–95/001a–cF. This material is available electronically at *http://www.epa.gov/ttn/oarpg/ticd.html*.

[6] U.S. EPA (2003). Air Quality Criteria for Particulate Matter—Volumes I and II (Fourth External Review Draft) This material is available electronically at *http://cfpub.epa.gov/ncea/cfm/partmatt.cfm*.

[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] 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.

[9] Pope, CA, III; Burnett, RT; Calle, EE; *et al.* (2002) Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 287: 1132–1141.

[10] Janssen, NA; Schwartz J; Zanobetti A; *et al.* (2002) Air conditioning and source-specific particles as modifiers of the effect of PM_{10} on hospital admissions for heart and lung disease. Environ Health Perspect 110(1):43–49.

[11] Hoek, G; Brunekreef, B; Goldbohm, S; *et al.* (2002) Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. Lancet 360(9341):1203–1209.

[12] Brunekreef, B; Janssen NA; de Hartog, J; *et al.* (1997) Air pollution from traffic and lung function in children living near motor ways. Epidemiology (8): 298–303.

[13] Delfino RJ. (2002) Epidemiologic evidence for asthma and exposure to air toxics: linkages between occupational, indoor, and community air pollution research. Env Health Perspect Suppl 110(4): 573–589.

[14] Yifang Zhu, William C. Hinds, Seongheon Kim, Si Shen and Constantinos Sioutas Zhu Y; Hinds WC; Kim S; *et al.* (2002) Study of ultrafine particles near a major highway with heavy-duty diesel traffic. Atmos Environ 36(27): 4323–4335.

[15] U.S. EPA (2002). National-Scale Air Toxics Assessment. This material is available electronically at *http://www.epa.gov/ttn/atw/nata/*.

[16] 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*.

California EPA, and the U.S. Department of Health and Human Services) have made similar classifications.

EPA generally derives cancer unit risk estimates to calculate population risk more precisely from exposure to carcinogens. In the simplest terms, the cancer unit risk is the increased risk associated with average lifetime exposure of 1 ug/m^3. EPA 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 lack of an adequate dose-response relationship between exposure and cancer incidence.

However, in the absence of a cancer unit risk, the EPA Diesel HAD sought to provide additional insight into the significance of the cancer hazard by estimating possible ranges of risk that might be present in the population. The possible risk range analysis was developed by comparing a typical environmental exposure level for highway diesel sources to a selected range of occupational exposure levels and then proportionally scaling the occupationally observed risks 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} or be as high as 10^{-3} this being a reflection of 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. Although the above risk range is based on environmental exposure levels for highway mobile sources only, the 1996 NATA estimated exposure for nonroad diesel sources as well. Thus, the exposure estimates were somewhat higher than those used in the risk range analysis described above. The EPA Diesel HAD, therefore, stated that the NATA exposure estimates result in a similar risk perspective.

The ozone precursor reductions expected as a result of this rule are also important because of health and welfare effects associated with ozone, as described in the Air Quality Criteria Document for Ozone and Other Photochemical Oxidants. Ozone can irritate the respiratory system, causing coughing, throat irritation, and/or uncomfortable sensation in the chest.[17, 18] 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 normal activity. Ozone also can aggravate asthma, leading to more asthma attacks that require a doctor's attention and/or the use of additional medication. In addition, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue, irreversible reductions in lung function, and a lower quality of life if the inflammation occurs repeatedly over a long time period (months, years, a lifetime). People who are of particular concern with respect to ozone exposures include children and adults who are active outdoors. Those people particularly susceptible to ozone effects are people with respiratory disease, such as asthma, and people with unusual sensitivity to ozone, and children. Beyond its human health effects, ozone has been shown to injure plants, which has the effect of reducing crop yields and reducing productivity in forest ecosystems.[19, 20]

New research suggests additional serious health effects beyond those that were known when the 8-hour ozone health standard was set. Since 1997, over 1,700 new health and welfare studies relating to ozone have been published in peer-reviewed journals.[21] Many of these studies investigate the impact of ozone exposure on such health effects as changes in lung structure and biochemistry, inflammation of the lungs, exacerbation and causation of asthma, respiratory illness-related school absence, hospital and emergency room visits for asthma and other respiratory causes, and premature mortality. EPA is currently evaluating these and other studies as part of the ongoing review of the air quality criteria and NAAQS for ozone. A revised Air Quality Criteria Document for Ozone and Other Photochemical Oxidants will be prepared in consultation with EPA's Clean Air Science Advisory Committee (CASAC). Key new health information falls into four general areas: Development of new-onset asthma, hospital admissions for young children, school absence rate, and premature mortality. In all, the new studies that have become available since the 8-hour ozone standard was adopted in 1997 continue to demonstrate the harmful effects of ozone on public health and the need for areas with high ozone levels to attain and maintain the NAAQS.

Finally, nonroad diesel emissions contribute to nine categories of non-health impacts: visibility impairment, soiling and material damage, acid deposition, eutrophication of water bodies, plant and ecosystem damage from ozone, water pollution resulting from deposition of toxic air pollutants with resulting effects on fish and wildlife, and odor. In particular, EPA determined that nonroad engines contribute significantly to unacceptable visibility conditions where people live, work and recreate, including contributing to visibility impairment in Federally mandated Class I areas that are given special emphasis in the Clean Air Act (67 FR 68242, November 8, 2002). Visibility is impaired by fine PM and precursor emissions from nonroad diesel engines subject to this final rule. Reductions in emissions from this final rule will improve visibility as well as other environmental outcomes as described in the RIA.

As supplementary information, we have made estimates using air quality modeling to illustrate the types of change in future $PM_{2.5}$ and ozone levels that we would expect to result from a final rule like this as described in chapter 2 of the RIA. That modeling shows that control of nonroad emissions would produce nationwide air quality improvements in $PM_{2.5}$ and ozone levels as well as visibility improvements. On a population-weighted basis, the average modeled change in future-year $PM_{2.5}$ annual averages is projected to decrease by 0.42 μg/m^3 (3.3%) in 2020, and 0.59 μg/m3 (0.6%) in 2030. In addition, the population-weighted average modeled change in future year design values for ozone would decrease by 1.8 parts per billion (ppb) in 2020, and 2.5 ppb in 2030. Within areas predicted to violate the ozone NAAQS in the projected base case, the average decrease would be somewhat higher: 1.9 ppb in 2020 and 3.0 ppb in 2030.

[17] U.S. EPA (1996). Air Quality Criteria for Ozone and Related Photochemical Oxidants, EPA/600/P–93/004aF. Docket No. A–99–06. Document Nos. II–A–15 to 17.

[18] U.S. EPA (1996). Review of National Ambient Air Quality Standards for Ozone, Assessment of Scientific and Technical Information, OAQPS Staff Paper, EPA–452/R–96–007. Docket No. A–99–06. Document No. II–A–22.

[19] U.S. EPA (1996). Air Quality Criteria for Ozone and Related Photochemical Oxidants, EPA/600/P–93/004aF. Docket No. A–99–06. Document Nos. II–A–15 to 17.

[20] U.S. EPA (1996). Review of National Ambient Air Quality Standards for Ozone, Assessment of Scientific and Technical Information, OAQPS Staff Paper, EPA–452/R–96–007. Docket No. A–99–06. Document No. II–A–22.

[21] New Ozone Health and Environmental Effects References, Published Since Completion of the Previous Ozone AQCD, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711 (7/2002) Docket No. A–2001–28, Document II–A–79.

The PM air quality improvements expected from this final rule are anticipated to produce major benefits to human health and welfare, with a combined value in excess of half a trillion dollars between 2007 and 2030. For example, in 2030, we estimate that this program will reduce approximately 129,000 tons $PM_{2.5}$ and 738,000 tons of NO_X. The resulting ambient PM reductions correspond to public health improvements in 2030, including 12,000 fewer premature mortalities, 15,000 fewer heart attacks, 200,000 fewer asthma exacerbations in children, and 1 million fewer days when adults miss work due to their respiratory symptoms, and 5.9 million fewer days when adults have to restrict their activities due to respiratory symptoms. The reductions will also improve visibility and reduce diesel odor. For further details on the economic benefits of this rule, please refer to the benefit-cost discussion in section VI of this preamble and chapter 9 of the RIA.

b. Emissions From Nonroad Diesel Engines

The engine and fuel standards in this final rule will affect emissions of direct $PM_{2.5}$, SO_2, NO_X, VOCs, and air toxics for land-based nonroad diesel engines.[22] For locomotive, commercial marine vessel (CMV), and recreational marine vessel (RMV) engines, the final fuel standards will affect direct $PM_{2.5}$ and SO_2 emissions. Each sub-section below discusses one of these pollutants,[23] including expected emission reductions associated with the final standards.[24] Table I.B–1 summarizes the impacts of this rule for 2020 and 2030. Further details on our inventory estimates, including results for other years, are available in chapter 3 of the RIA.

TABLE I.B–1.—ESTIMATED NATIONAL (50 STATE) REDUCTIONS IN EMISSIONS FROM NONROAD LAND-BASED, LOCOMOTIVE, COMMERCIAL MARINE, AND RECREATIONAL MARINE DIESEL ENGINES

Pollutant [short tons]	2020	2030
Direct $PM_{2.5}$:		
$PM_{2.5}$ Emissions Without Rule	167,000	181,000
$PM_{2.5}$ Emissions With 500 ppm Sulfur in 2007 and No Other Controls	144,000	155,000
$PM_{2.5}$ Emissions With 15 ppm Sulfur in 2012 and No Other Controls	141,000	152,000
$PM_{2.5}$ Emissions With Entire Rule	81,000	52,000
$PM_{2.5}$ Reductions Resulting from this Rule	86,000	129,000
SO_2:		
SO_2 Emissions Without Rule	326,000	379,000
SO_2 Emisions With 500 ppm Sulfur in 2007	37,000	43,000
SO_2 Emissions With Entire Rule (15 ppm Sulfur in 2012)	3,000	3,000
SO_2 Reductions Resulting from this Rule	323,000	376,000
NO_X—Land-Based Nonroad Engines Only[a]:		
NO_X Emissions Without Rule	1,125,000	1,199,000
NO_X Emissions With Rule	681,000	461,000
NO_X Reductions Resulting from this Rule	444,000	738,000
VOC—Land-Based Nonroad Engines Only[a]:		
VOC Emissions Without Rule	98,000	97,000
VOC Emissions With Rule	75,000	63,000
VOC Reductions Resulting from this Rule	23,000	34,000

Notes:
[a] NO_X and VOC numbers only include emissions for land-based nonroad diesel engines because the Tier 4 controls will not be applied to locomotive, commercial marine, and recreational marine engines; and no NO_X and VOC emission reductions are generated through the lowering of fuel sulfur levels.

i. Direct $PM_{2.5}$

As described earlier, the Agency believes that reductions of diesel $PM_{2.5}$ emissions are needed as part of the nation's progress toward clean air. Direct $PM_{2.5}$ emissions from land-based nonroad diesel engines amount to increasingly large percentages of total man-made diesel $PM_{2.5}$. Between 1996 and 2030, we estimate that the percentage of total man-made diesel $PM_{2.5}$ emissions coming from land-based nonroad diesel engines will increase from about 46 percent to 72 percent (based on a 48 state inventory).

Emissions of direct $PM_{2.5}$ from land-based nonroad diesel engines based on a 50 state inventory are shown in table I.B–1, along with our estimates of the reductions in 2020 and 2030 we expect would result from our final rule for a $PM_{2.5}$ exhaust emission standard and from changes in the sulfur level in land-based nonroad, locomotive, and marine diesel fuel. Land-based nonroad, locomotive, and marine diesel fuel sulfur levels will be lowered to about 340 ppm in-use (500 ppm maximum) in 2007. Land-based nonroad diesel fuel sulfur will be lowered further to about 11 ppm in-use (15 ppm maximum) in 2010 and locomotive and marine diesel fuel sulfur will be lowered to the same level in 2012. In addition to $PM_{2.5}$ emissions estimates with the final rule, emissions estimates based on lowering diesel fuel sulfur without any other controls are shown in table I.B–1 for 2020 and 2030.

Figure I.B–1a shows our estimate of $PM_{2.5}$ emissions between 2000 and 2030 both without and with the final standards and fuel sulfur requirements of this rule. We estimate that $PM_{2.5}$ emissions from this source would be reduced by 71 percent in 2030.

ii. SO_2

We estimate that land-based nonroad, CMV, RMV, and locomotive diesel engines emitted about 234,000 tons of

[22] We are also adopting a few minor adjustments of a technical nature to current CO standards. Emissions effects from these standards are discussed in the RIA.

[23] The estimates of baseline emissions and emissions reductions from the final rule reported here for nonroad land-based, recreational marine, locomotive, and commercial marine vessel diesel engines are based on 50 state emissions inventory estimates. A 48 state inventory was used for air quality modeling that EPA conducted for this rule, of which Alaska and Hawaii are not a part. In cases where land-based nonroad diesel engine emissions are compared with non-mobile source portions of the inventory, we use a 48 state emissions inventory, to match the 48 state nature of those other inventories.

[24] Please see the Summary and Analyses of Comments document for discussions of issues raised about the emission inventory estimates during the comment period for the NPRM.

SO_2 in 1996, accounting for about 33 percent of the SO_2 from mobile sources (based on a 48 state inventory). With no reduction in diesel fuel sulfur levels, we estimate that these emissions will continue to increase, accounting for about 44 percent of mobile source SO_2 emissions by 2030.

As part of this final rule, sulfur levels in fuel will be significantly reduced, leading to large reductions in nonroad, locomotive, and marine diesel SO_2 emissions. By 2007, the sulfur in diesel fuel used by all land-based nonroad, locomotive, and marine diesel engines will be reduced from the current average in-use level of between 2,300 to 2,400 ppm [25] to an average in-use level of about 340 ppm, with a maximum level of 500 ppm. By 2010, the sulfur in diesel fuel used by land-based nonroad engines will be reduced to an average in-use level of 11 ppm with a maximum level of 15 ppm. Sulfur in diesel fuel used by locomotive and marine engines will be reduced to the same level by 2012. Table II.B–1 and figure II.B–1b show the estimated reductions from these sulfur changes.

[25] Highway fuel is currently used in a significant fraction of land based nonroad equipment, locomotives, and marine vessels, reducing the in-use average sulfur level from about 3,000 ppm for uncontrolled high-sulfur fuel to 2,300 or 2,400 ppm.

iii. NO_X

Table I.B–1 shows the 50 state estimated tonnage of NO_X emissions for 2020 and 2030 without the final rule and the estimated tonnage of emissions eliminated with the final rule in place. These results are shown graphically in Figure I.E–1c at the end of this section. We estimate that NO_X emissions from these engines will be reduced by 62 percent in 2030.

We note that the magnitude of NO_X reductions determined in the final rule analysis is somewhat less than what was reported in the proposal's preamble and RIA, especially in the later years when the fleet has mostly turned over to Tier 4 designs. The greater part of this is due to the fact that we have deferred setting a long-term NO_X standard for mobile machinery over 750 horsepower to a later action. When this future action is completed, we would expect roughly equivalent reductions between the proposal and the overall final program, though there are some other effects reflected in the differing NO_X reductions as well, due to updated modeling assumptions and the adjusted NO_X standards levels for engines over 750 horsepower. Section II.A.4 of this preamble contains a detailed discussion of the NO_X standards we are adopting for engines over 750 horsepower as well as the basis for those standards.

iv. VOCs and Air Toxics

Based on a 48 state emissions inventory, we estimate that land-based nonroad diesel engines emitted over 221 thousand tons of VOC in 1996. Between 1996 and 2030, we estimate that land-based nonroad diesel engines will contribute about 2 to 3 percent of mobile source VOC emissions. Without further controls, land-based nonroad diesel engines will emit about 97 thousand tons/year of VOC in 2020 and 2030 nationally.

Table I.B–1 shows our projection of the reductions in 2020 and 2030 for VOC emissions that we expect from implementing the final NMHC standards. This estimate is based on a 50 state emissions inventory. By 2030, VOC emissions from this category would be reduced by 35 percent from baseline levels.

While we are not adopting any specific gaseous air toxics standards in today's rule, air toxics emissions would nonetheless be significantly reduced through the NMHC standards included in the final rule. By 2030, we estimate that emissions of air toxics pollutants, such as benzene, formaldehyde, acetaldehyde, 1,3-butadiene, and acrolein, would be reduced by 35 percent from land-based nonroad diesel engines. Diesel PM reductions were discussed above. For specific air toxics reduction estimates, see chapter 3 of the RIA.

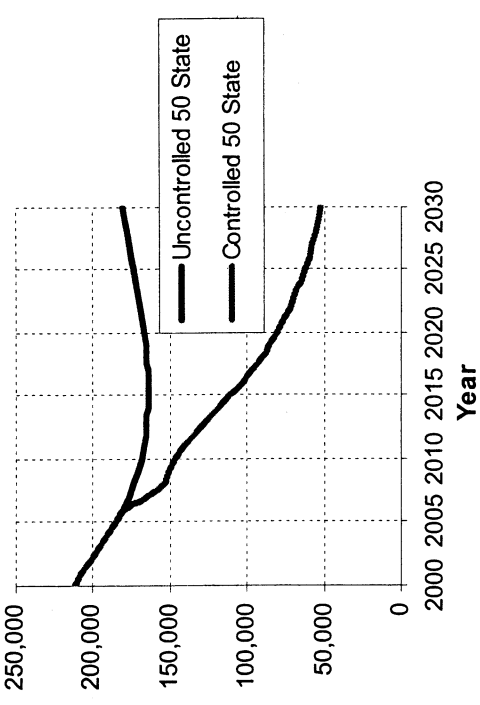


Figure I.B-1a: Estimated $PM_{2.5}$ Reductions From Nonroad Land-Based Diesel Engine Standard and Diesel Fuel Sulfur Reductions

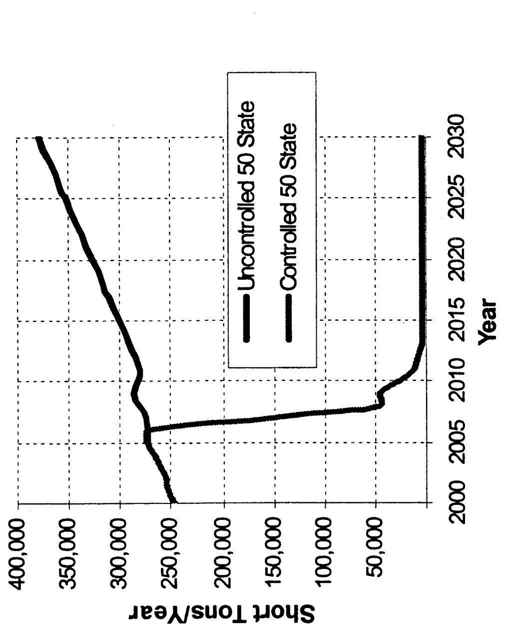


Figure I.B-1b: Estimated SO_2 Reductions From Lowering Diesel Fuel Sulfur For Land-Based Nonroad Engines, CMVs, RMVs, and Locomotives

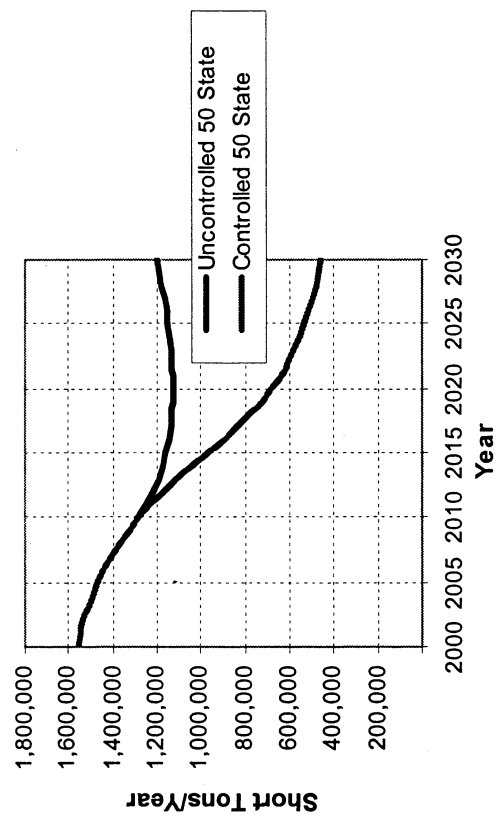


Figure I.B-1c: Estimated NOx Reductions From Land-Based Nonroad Diesel Engine Standard

II. Nonroad Engine Standards

In this section we describe the emission standards for nonroad diesel engines that we are setting to address the serious air quality problems discussed in section I. These Tier 4 standards, which take effect starting in 2008, are very similar to those proposed, and obtain very similar emissions reductions. The long-term PM filter-based standards that apply to all engines over 25 hp, combined with the fuel change and new requirements to ensure robust control in the field, will yield PM reductions of over 95% from the in-use levels of today's cleanest Tier 2 engines. Likewise, the long-term NO_X standards we are adopting for nearly all engines above 75 hp will yield NO_X reductions of about 90% from the NO_X levels expected from even the low-emitting Tier 3 engines due to first reach the market in 2006 or later. The Tier 4 standards will bring about large reductions in toxic hydrocarbon emissions as well.

In this final rule we are largely adopting the standards and timing we proposed, with the exception of those that apply to engines over 750 hp. We restructured and modified the standards and timing for these engines to address technical concerns and to focus on achieving comparable emission reductions through the introduction of advanced technology as early as feasible from specific applications within this power category. See section II.A.4 for a detailed discussion. We also are not adopting the proposed minor adjustments to the CO standard levels for some engines under 75 hp, as explained in section II.A.6. In addition, there are minor changes from the proposal in the phase-in approach we are adopting for NO_X and NMHC standards, as detailed in this section.

In this section we discuss:

- The Tier 4 engine standards, and the schedule for implementing them;
- The feasibility of the Tier 4 standards (in conjunction with the low-sulfur nonroad diesel fuel requirement discussed in section IV); and
- How diesel fuel sulfur affects an engine's ability to meet the new standards.

Additional provisions for engine and equipment manufacturers are discussed in detail in section III. These include:

- The averaging, banking, and trading (ABT) program.
- The transition program for equipment manufacturers.
- The addition of a ''not-to-exceed'' program to ensure in-use emissions control. This program includes new emission standards and related test procedures to supplement the standards discussed in this section.
- The test procedures and other compliance requirements associated with the emission standards.
- Special provisions to aid small businesses in implementing our requirements.
- An incentive program to encourage innovative technologies and the early introduction of new technologies.

A. What Are the New Engine Standards?

The Tier 4 exhaust emissions standards for PM, NO_X, and NMHC are summarized in tables II.A–1, 2, and 4.[26] Crankcase emissions control requirements are discussed in section II.A.7. Previously adopted CO emission standards continue to apply as well. All of these standards apply to covered nonroad engines over the useful life periods specified in our regulations, except where temporary in-use compliance margins apply as discussed in section III.E. To help ensure that these emission reductions will be achieved in use, we have adopted test procedures for measuring compliance with these standards tailored to both steady-state and transient nonroad engine operating characteristics. These test procedures are discussed in several subsections of section III. Another component of our program to ensure control of emissions in-use is the new ''not-to-exceed'' (NTE) emission standards and associated test procedures, discussed in section III.J.

TABLE II.A–1.—TIER 4 PM STANDARDS (G/BHP-HR) AND SCHEDULE

Engine power	Model year					
	2008	2009	2010	2011	2012	2013
hp < 25 (kW < 19)	[a] 0.30					
25 ≤ hp < 75 (19 ≤ kW < 56)	[b] 0.22					0.02
75 ≤ hp < 175 (56 ≤ kW < 130)					0.01	
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)				0.01		
hp 750 (kW > 560)	See table II.A–4					

Notes:
[a] For air-cooled, hand-startable, direct injection engines under 11 hp, a manufacturer may instead delay implementation until 2010 and demonstrate compliance with a less stringent PM standard of 0.45 g/bhp-hr, subject also to additional provisions discussed in section II.A.3.a.
[b] A manufacturer has the option of skipping the 0.22 g/bhp-hr PM standard for all 50–75 hp engines. The 0.02 g/bhp-hr PM standard would then take effect one year earlier for all 50–75 hp engines, in 2012.

TABLE II.A–2.—TIER 4 NO_X AND NMHC STANDARDS AND SCHEDULE

Engine power	Standard (g/bhp-hr)		Phase-in schedule (model year) (percent)			
	NO_X	NMHC	2011	2012	2013	2014
25 ≤ hp < 75 (19 ≤ kW < 56)	3.5 NMHC+NO_X [a]				100%	
75 ≤ hp < 175 (56 ≤ kW < 130)	0.30	0.14	[b] 50	[b] 50	[b] 100	
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)	0.30	0.14	50	50	50	100
hp > 750 (kW > 560)	See table II.A–4					

Notes: Percentages indicate production required to comply with the Tier 4 standards in the indicated model year.
[a] This is the existing Tier 3 combined NMHC+NO_X standard level for the 50–75 hp engines in this category. In 2013 it applies to the 25–50 hp engines as well.
[b] Manufacturers may use banked Tier 2 NMHC+NO_X credits from engines at or above 50 hp to demonstrate compliance with the 75–175 hp engine NO_X standard in this model year. Alternatively, manufacturers may forego this special banked credit option and instead meet an alternative phase-in requirement of 25/25/25% in 2012, 2013, and 2014 through December 30, with 100% compliance required beginning December 31, 2014. See sections III.A and II.A.2.b.

[26] Consistent with past EPA rulemakings for nonroad diesel engines, our regulations express standards, power ratings, and other quantities in international SI (metric) units—kilowatts, gram per kilowatt-hour, etc. This aids in achieving harmonization with standards-setting bodies outside the U.S., and in laboratory operations in which these units are the norm. However, in this preamble and in other rulemaking documents for the general reader, we have chosen to use terms more common in general usage in the U.S. Hence standards are expressed in units of grams per brake horsepower-hour, power ratings in horsepower, etc. In any compliance questions that might arise from differences in these due to, for example, rounding conventions, the regulations themselves establish the applicable requirements.

The long-term 0.01 and 0.02 g/bhp-hr Tier 4 PM standards for 75–750 hp and 25–75 hp engines, respectively, combined with the fuel change and new requirements to ensure robust control in the field, represent a reduction of over 95% from in-use levels expected with Tier 2/Tier 3 engines.[27] The 0.30 g/bhp-hr Tier 4 NO_X standard for 75–750 hp engines represents a NO_X reduction of about 90% from in-use levels expected with Tier 3 engines. Emissions reductions from engines over 750 hp are discussed in section II.A.4.

In general, there was widespread support in the comments for the proposed Tier 4 engine standards and for the timing we proposed for them. Some commenters raised category-specific concerns, especially for the smaller and the very large engine categories. These comments are discussed below.

1. Standards Timing

a. 2008 Standards

The timing of the Tier 4 engine standards is closely tied to the timing of fuel quality changes discussed in section IV, in keeping with the systems approach we are taking for this program. The earliest Tier 4 engine standards take effect in model year 2008, in conjunction with the introduction of 500 ppm maximum sulfur nonroad diesel fuel in mid-2007. This fuel change serves a dual environmental purpose. First, it provides a large immediate reduction in PM and SO_X emissions for the existing fleet of engines in the field. Second, its widespread availability by the end of 2007 aids engine designers in employing emissions controls capable of achieving the Tier 4 standards for model year 2008 and later engines; this is because the performance and durability of such technologies as exhaust gas recirculation (EGR) and diesel oxidation catalysts is improved by lower sulfur fuel.[28] The reduction of sulfur in nonroad diesel fuel will also provide sizeable economic benefits to machine operators as it will reduce wear and corrosion and will allow them to extend oil change intervals (see section VI.B). These economic benefits will occur for all diesel engines using the new fuel, not just for those built in 2008 or later.

As we proposed, these 2008 Tier 4 engine standards apply only to engines below 75 hp. We are not setting Tier 4 standards taking effect in 2008 for larger engines. The reasons for this differ depending on the engines' hp rating. Setting Tier 4 2008 standards for engines at or above 100 hp would provide an insufficient period of stability (an element of lead time) between Tier 2/3 and Tier 4, and so would not be appropriate. This is because these engines become subject to existing Tier 2 or 3 NMHC+NO_X standards in 2006 or 2007. Setting new 2008 standards for them thus would provide only one or two years of Tier 2/Tier 3 stability before another round of design changes would have to be made in 2008 for Tier 4.

It is also inappropriate to establish 2008 Tier 4 standards for engines of 75–100 hp. The stability issue just noted for larger engines is not present for these engines, because these engines are subject to Tier 3 NMHC+NO_X standards starting in 2008, so that our setting a Tier 4 PM standard for them in the same year would not create the situation in which engines have to be redesigned twice to comply with new standards within a space of one or two years. However, EPA believes the more significant concern for these engines is meeting the stringent aftertreatment-based standards for PM and NO_X in 2012. We are concerned that adopting interim 2008 standards for these engines would divert resources needed to achieve these 2012 standards and indeed jeopardize attaining them. Thus, although early emission reductions from these engines in 2008 would of course be desirable, we felt that the focus we are putting on obtaining much larger reductions from them in 2012, together with the fact that we already have a Tier 3 NMHC+NO_X standard taking effect for 75–100 hp engines in 2008, warrants our not adding additional control requirements for these engines during this interim period.

We note that the 50–75 hp engines also have a Tier 3 NMHC+NO_X standard taking effect in 2008 and, as noted above, we are setting a new Tier 4 2008 PM standard for them. Unlike the larger 75–100 hp engines, however, the 50–75 hp engines have one additional year, until 2013, before filter-based PM standards take effect, and also have no additional NO_X control requirement being set beyond the 2008 Tier 3 standard. These differences justify including the interim Tier 4 PM standard for these engines. We note too that achieving the 2008 PM standard is enabled in part by the large reduction in certification fuel sulfur that applies in 2008 (see section III.D). Fuel sulfur has a known correlation to PM generation, even for engines without aftertreatment. Moreover, for any manufacturers who believe that accomplishing this PM pull-ahead will hamper their Tier 3 compliance efforts for these engines, there is an alternative Tier 4 compliance option. Instead of meeting new Tier 4 PM standards in both 2008 and 2013, manufacturers may skip the Tier 4 2008 PM standard, and instead focus design efforts on introducing PM filters for these engines one year earlier, by complying with the aftertreatment-based standard for PM in 2012. These options are discussed in more detail in section II.A.3.b.

We view the 2008 portion of the Tier 4 program as highly important because it provides substantial PM and SO_X emissions reductions during the several years prior to 2011. Initiating Tier 4 in 2008 also fits well with the lead time (including stability), cost, and technology availability considerations of the overall program. Initiating the Tier 4 engine standards in 2008 provides three to four years of stability after the start of Tier 2 for engines under 50 hp. As mentioned above, it also coincides with the start date of Tier 3 NMHC+NO_X standards for 50–75 hp engines and so introduces no stability issues for these engines (as redesign for both PM and NO_X occurs at the same time). The 2008 start date provides almost 4 years of lead time to accomplish redesign and testing. The evolutionary character of the 2008 standards, based as they are on proven technologies, and the fact that some certified engines already meet these standards as discussed in section II.B, leads us to conclude that the standards are appropriate within the meaning of section 213(a)(4) of the Clean Air Act and that we are providing adequate lead time to achieve those standards.

Engine and equipment manufacturers argued in their comments that the PM pull-ahead option for 50–75 hp engines is inappropriate because it constitutes a re-opening of the Tier 3 rule, involving as it does a Tier 4 PM standard in 2008, the same year that the Tier 3 NMHC+NO_X takes effect. They further argued that the non-pull-ahead option is not a real option because PM aftertreatment cannot be implemented for these engines in 2012.

We disagree with both contentions. We determined, as part of our feasibility analysis for Tier 4, that it is feasible to design engines to meet the 2008 PM standard in the same year that a Tier 3 NMHC+NO_X standard takes effect. See section II.B and RIA sections 4.1.4 and 4.1.5. One reason is that a substantial

[27] Note that we are grouping all standards in this rule, including those that take effect in 2008, under the general designation of "Tier 4 standards." As a result, there are no "Tier 3" standards in the multi-tier nonroad program for engines below 50 hp or above 750 hp.

[28] "Nonroad Diesel Emissions Standards Staff Technical Paper," EPA420–R–01–052, October 2001.

part of the 2008 PM emission reductions do not result from engine redesign, but rather are due to the reduction in certification test fuel maximum sulfur levels from 2000 to 500 ppm that results from the fuel change in the field. This reduction in sulfur levels also aids engine designers in employing emission control technologies that are detrimentally affected by sulfur, not only for PM control, but also for NMHC and NO_X control. Examples of these sulfur-sensitive technologies are oxidation catalysts, which can substantially reduce PM and NMHC, and EGR, which is effective at reducing NO_X. We note further that designing engines to meet the 2008 PM standard is also made less difficult by our not requiring engine designers to consider the transient test, cold start, and not-to-exceed requirements that are otherwise part of the Tier 4 program. These requirements do not take effect for these engines until the 0.02 g/bhp-hr standard is implemented in 2012 or 2013. See section III.F for details.

We also believe that the second option (compliance with the aftertreatment-based PM standard in 2012, with no interim 2008 standard) is viable, and may be an attractive choice especially for engine families on the higher side of the 50–75 hp range that share a design platform with larger engines being equipped with PM filters to meet the Tier 4 standard for 75–175 hp engines in 2012. We believe 75 hp is the appropriate cutpoint for setting and timing emissions standards (see section II.A.5), but it obviously is not a hard-and-fast separator between engine platforms for all manufacturers in all product lines. Even for many 50–75 hp engines that do not share a design platform with larger engines, we believe that a 2012 implementation date for PM filter technology may be practical, considering the 4-year lead time it affords after Tier 3 begins for these engines (in 2008), 8-year lead time after the last PM standard change (in 2004), and 5-year lead time after full-scale PM filter technology implementation on highway engines (in 2007).

Engine manufacturers also commented that the two-options approach would cause their customers to switch engine suppliers in 2012 to get the least expensive engines possible in every year, thus compromising the environmental objectives and creating market disruptions. We have addressed these concerns as discussed in section II.A.3.b.

b. 2011 and Later Standards

The second fuel change for nonroad diesel fuel, to 15 ppm maximum sulfur in mid-2010, and the related engine standards for PM, NO_X, and NMHC that begin to phase-in in the 2011 model year, provide most of the environmental benefits of the program. Like the 2008 standards, these standards are timed to provide adequate lead time for engine and equipment manufacturers. They also are phased in over time to allow for the orderly transfer of technology from the highway sector, and to spread the overall workload for engine and equipment manufacturers engaged in redesigning a large number and variety of products for Tier 4.

As we explained at proposal, we believe that the high-efficiency exhaust emission control technologies being developed to meet our 2007 emission standards for heavy-duty highway diesel engines can be adapted to most nonroad diesel applications. The engines for which we believe this adaptation from highway applications will be most straightforward are those in the 175–750 hp power range, and thus these engines are subject to new standards requiring high-efficiency exhaust emission controls as soon as the 15 ppm sulfur diesel fuel is widely available, that is, in the 2011 model year. Engines of 75–175 hp are subject to the new standards in the following model year, 2012, reflecting the need to spread the redesign workload and, to some extent, the greater effort that may be involved in adapting highway technologies to these engines. Engines between 25 and 75 hp are subject to new standards for PM based on high-efficiency exhaust emission controls in 2013, reflecting again the need to spread the workload and the challenge of adapting this technology to these engines which typically do not have highway counterparts. Engines over 750 hp involve a number of special considerations, necessitating an implementation approach unique to these engines as explained in section II.A.4. Lastly , there are additional provisions discussed in sections III.B.2 and III.M to encourage early technology introduction and to further draw from the highway technology experience.

This approach of implementing Tier 4 standards by power category over 2011–2013 provides for the orderly migration of technology and distribution of redesign workload over three model years, as EPA provided in Tier 3. Overall, this approach provides 4 to 6 years of real world experience with the new technology in the highway sector, involving millions of engines (in addition to the several additional years provided by demonstration fleets on the road in earlier years), before the new standards take effect. We consider the implementation of Tier 4 standard start dates over 2011–2013 as described above to be responsive to the technology migration and workload distribution concerns.

2. Phase-In of NO_X and NMHC Standards for 75–750 hp Engines

a. Percent-of-Production Phase-In for NO_X and NMHC

We are finalizing the percent-of-production phase-in for NO_X and NMHC that we proposed for 75–750 hp engines. Because Tier 4 NO_X emissions control technology is expected to be derived from technology first introduced in highway heavy-duty diesels, we proposed to adopt the implementation pattern for the Tier 4 NO_X standard which we adopted for the heavy-duty highway diesel program. This will help to ensure a focused, orderly development of robust high-efficiency NO_X control in the nonroad sector and will also help to ensure that manufacturers are able to take maximum advantage of the highway engine development program, with resulting cost savings.

The heavy-duty highway rule allows for a gradual phase-in of the NO_X and NMHC requirements over multiple model years: 50% of each manufacturer's U.S.-directed production volume must meet the new standard in 2007–2009, and 100% must do so by 2010. Through the use of emissions averaging, this phase-in approach also provides the flexibility for highway engine manufacturers to meet that program's environmental goals by allowing somewhat less-efficient NO_X controls on more than 50% of their production during the 2007–2009 phase-in years.

We follow the same pattern in this rule. As proposed, we are phasing in the NO_X standards for nonroad diesels over 2011–2013 as indicated in table II.A–2, based on compliance with the Tier 4 standards for 50% of a manufacturer's U.S.-directed production in each power category between 75 and 750 hp in each phase-in model year. The phase-in of standards for engines over 750 hp is discussed in section II.A.4. With a NO_X phase-in, all manufacturers are able to introduce their new technologies on a limited number of engines, thereby gaining valuable experience with the technology prior to implementing it on their entire product line. In tandem with the equipment manufacturer transition program discussed in section III.B, the phase-in ensures timely progress to the Tier 4 standard levels while providing a great degree of implementation flexibility for the industry.

This ''percent of production phase-in'' is intended to take maximum advantage of the highway program technology development. It adds a new dimension of implementation flexibility to the staggered ''phase-in by power category'' used in the nonroad program for Tiers 1–3 (and also in this Tier 4) which, though structured to facilitate technology development and transfer, is more aimed at spreading the redesign workload. Because the Tier 4 program involves challenges in addressing both technology development and redesign workload, we believe that incorporating both of these phase-in mechanisms into the program is warranted, resulting in the coordinated phase-in plan shown in table II.A–2, which we are finalizing essentially as proposed. Note that this results in the new NO_X requirements for 75–175 hp engines taking effect starting in the second year of the 2011–2013 general phase-in, in effect creating a 50–50% phase-in in 2012–2013 for this category. This then staggers the Tier 4 start years by power category as in past tiers: 2011 for engines at or above 175 hp, 2012 for 75–175 hp engines, and 2013 for 25–75 hp engines (for which no NO_X adsorber-based standard and thus no percentage phase-in is being adopted), while still providing a production-based phase-in for advanced NO_X control technologies.

Comments from the States and environmental organizations argued for the completion of the phase-in by the end of 2012, contending that technology progress for NO_X control in the highway sector has been good to date and would support an accelerated phase-in in the nonroad sector. However, our assessment continues to show unique (though surmountable) challenges in adapting advanced technologies to nonroad engines, especially for engines least like highway diesels, and it is these engines that would be most affected by a truncated phase-in schedule. Furthermore, even if we were to conclude that advanced technologies will be ready earlier than expected, we would not be able to move up the start of phase-in dates because these dates also depend on low-sulfur fuel availability. Thus an end-of-2012 phase-in completion date would result in phase-ins as short as one year, thus degrading the industry's opportunity to distribute the redesign workload and departing from the pattern set by the highway program. Both of these are critical factors in our assessment that the proposed engine standards are feasible, and so a change to shorter phase-ins would jeopardize achievement of our environmental objectives for nonroad diesels. Therefore we are not adopting the suggested earlier completion of the phase-in.

As proposed, we are phasing in the Tier 4 NMHC standard for 75–750 hp engines with the NO_X standard, as is being done in the highway program. Engines certified to the new NO_X requirement would be expected to certify to the NMHC standard as well. The ''phase-out'' engines (those not certified to the new Tier 4 NO_X and NMHC standards) would continue to be certified to the applicable Tier 3 NMHC+NO_X standard. As discussed in section II.B, we believe that the NMHC standard is readily achievable through the application of PM traps to meet the PM standard, which does not involve such a phase-in. However, in the highway program we chose to phase in the NMHC standard with the NO_X standard to simplify the phase-in under the percent-of-production approach taken there, thus avoiding subjecting the ''phase-out'' engines to separate standards for NMHC and NMHC+NO_X (which could lead to increased administrative costs with essentially no different environmental result). The same reasoning applies here because, as in the highway program, the previous-tier standards are combined NMHC+NO_X standards. No commenters objected to this approach.

Because of the tremendous variety of engine sizes represented in the nonroad diesel sector, we are finalizing our proposed requirement that the phase-in requirement be met separately in both of the power categories with a phase-in (75–175 hp and 175–750 hp).[29] For example, a manufacturer that produces 1000 engines for the 2011 U.S. market in the 175 to 750 hp range would have to demonstrate compliance with the NO_X and NMHC standards on at least 500 of these engines, regardless of how many complying engines the manufacturer produces in the 75–175 hp category. (Note however that we are allowing averaging of emissions between these engine categories through the use of power-weighted ABT program credits.) We believe that this restriction reflects the availability of emissions control technology, and is needed to avoid erosion of environmental benefits that might occur if a manufacturer with a diverse product offering were to meet the phase-in with relatively low cost smaller engines, thereby delaying compliance on larger engines with much higher lifetime emissions potential. Even so, the horsepower ranges for these power categories are fairly broad, so this restriction allows ample freedom to manufacturers to structure compliance plans in the most cost-effective manner. There were no adverse comments on this approach.

[29] Note exceptions to the percent phase-in requirements during the phase-in model years discussed in sections III.L and III.M. These deal with differences between a manufacturer's actual and projected production levels, and with incentives for early or very low emission engine introductions.

b. Special Considerations for the 75–175 hp Category

As discussed in the proposal, the 75–175 hp category of engines and equipment may involve added workload challenges for the industry to develop and transfer technology. Though spanning only 100 hp, this category represents a great diversity of applications, and comprises a disproportionate number of the total nonroad engine and machine models. Some of these engines, though having characteristics comparable to many highway engines such as turbocharging and electronic fuel control, are not directly derived from highway engine platforms and so are likely to require more development work than larger engines to transfer emission control technology from the highway sector. Furthermore, the engine and equipment manufacturers have greatly varying market profiles in this category, from focused one- or two-product offerings to very diverse product lines with a great many models.

Therefore, in addition to the flexibility provided through the phase-in mechanism, we proposed two optional measures to provide added flexibility in implementing the Tier 4 NO_X standards, while keeping a priority on bringing PM emissions control into this diverse power category as quickly as possible. First, we proposed to allow manufacturers to use NMHC+NO_X credits generated by any Tier 2 engines over 50 hp (in addition to any other allowable credits) to demonstrate compliance with the Tier 4 requirement for 75–175 hp engines in 2012, 2013, and 2014 only. Second, we proposed allowing a manufacturer to instead demonstrate compliance with a reduced phase-in requirement of 25% for NO_X and NMHC in each of 2012, 2013, and the first 9 months of 2014. Full compliance (100% phase-in) with the Tier 4 standards would have needed to be demonstrated beginning October 1, 2014.

Engine manufacturers reinforced the points we made in the proposal regarding added workload challenges for this diverse category of engines and machines. However, they suggested that the first of the proposed options to address these challenges (allowing use of Tier 2 credits) is not likely to be used due to a lack of available Tier 2 credits, and therefore should be dropped, and that the second option (allowing a slower phase-in) provided too short a stability period, and should be modified to delay final compliance by an additional 3 months, to December 31, 2014 or January 1, 2015. In addition to describing the very large redesign workload, they pointed out that engines and machines in this category typically do not have a model year that differs from the calendar year, and so the substantial changes required for Tier 4 compliance in October 2014 could force the need to change the product for all of 2014, effectively shortening the phase-in to two years. One manufacturer argued that the compliance date for the 75–100 hp engines in this category should be delayed an additional year, to 2016, and that the start of the phase-in for these engines should be likewise delayed from 2012 to 2013.

We do not feel that the first option (allowing use of Tier 2 credits) should be dropped, as it provides an alternative flexibility mechanism for a power category in which flexibility is clearly important, and is environmentally helpful as it provides an option for manufacturers to achieve NO_X emission reductions earlier than under the second option. By providing an opportunity to use Tier 2 credits in the 75–175 hp category, it coordinates well with the Tier 2 credit use opportunity we are providing for the 50–75 hp engines meeting the 2008 PM standard (see section III.A), and allows for coordinated redesign and credit use planning by a manufacturer over this wide power range over many years. Nonetheless, recognizing that the second option may be more attractive to manufacturers, and considering the comments they provided on it, we have concluded that a three month phase-in extension until the end of 2014 is warranted to address the workload burden and to align product cycle dates. Thus we are adopting the December 31, 2014 implementation date suggested in comments for completion of the 75–175 hp engine phase-in.

We do not agree that an additional year of delay is appropriate for the 75–100 hp engines in this category. The comment expressing interest in our doing so did not provide any basis for it in technological feasibility or in workload burden, and we do not see any basis for it ourselves.

Therefore, we are adopting both of the proposed optional measures for the 75–175 hp engine phase-in, except that in the second option, full compliance (100% phase-in) with the Tier 4 standards will need to be demonstrated beginning December 31, 2014. As proposed, manufacturers using this reduced phase-in option will not be allowed to generate NO_X credits from engines in this power category in 2012, 2013, and 2014, except for use in averaging within the 75–175 hp category (that is, no banking or trading, or averaging with engines in other power categories). We believe that this restriction on credit use is appropriate, considering that larger engine categories will be required to demonstrate a substantially greater degree of compliance with the 0.30 g/bhp-hr NO_X standard several years earlier than engines built under this option. As the purpose of this option is to aid manufacturers in implementing Tier 4 NO_X standards for this challenging power category, we do not want any manufacturers who might be capable of building substantially greater numbers of cleaner engines to use this option as an easy and copious source of credits (owing to its slower phase-in of stringent standards) that in turn can be used to delay building clean engines in other categories or model years.

c. Alternative Phase-In Standards

To ensure that Tier 4 engine development is able to take maximum advantage of highway diesel technology advances, we proposed to adopt nonroad diesel provisions in the averaging, banking, and trading program that would parallel the heavy-duty highway engine program's ''split family provisions'' (see 68 FR 28470, May 23, 2003). In essence, these allow a manufacturer to declare an engine family during the phase-in years that is certified at NO_X levels roughly midway between the phase-out standard and phase-in standard, without the complication of tracking credit generation and use. Because they constitute a calculational simplification of the emissions averaging provisions, these split family provisions do not result in a loss in environmental benefits compared to what the phase-in can achieve.

The nonroad proposal also included specific emission levels for these split families, rather than just describing how they are calculated. Commenters suggested that we go one step further still and express these levels as alternative standards. They argued that this would facilitate attempts at harmonizing standards globally, especially for standards-setting bodies such as the European Commission that do not have emissions averaging programs. We are also aware that most manufacturers of highway diesel engines are now planning to comply with our 2007 standards using this emissions averaging approach, increasing the significance of comments on the topic from nonroad engine manufacturers, many of whom also make highway engines.[30]

After carefully considering the issues involved, we agree that the proposed approach lends itself to expression in terms outside of the averaging, banking, and trading program and that it makes sense to do so. We are creating such an alternative in the final regulations accordingly. These alternative standards do not substantively change our Tier 4 program from what we proposed, but rather respond to manufacturers' suggestions for administrative simplifications to what is essentially an averaging-based flexibility option in demonstrating compliance with the percent-of-production NO_X phase-in. The alternative NO_X phase-in standards are shown in table II.A–3. They apply only during the NO_X phase-in years. Manufacturers may use both approaches within a power category if desired, certifying some engines to the alternative standards, with the rest subject to the phase-in percentage requirement. Note that engines under 75 hp subject to Tier 4 NO_X standards do not have an alternative standard because they do not have a NO_X phase-in, and engines over 750 hp do not have an alternative standard because of the separate standards we are adopting for these engines (explained in section II.A.4).

TABLE II.A–3.—TIER 4 ALTERNATIVE NO_X PHASE-IN STANDARDS (G/BHP-HR)

Engine power	NO_X standard (g/bhp-hr)
75 ≤ hp < 175 (56 ≤ kW < 130)	[a] 1.7
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)	1.5

Notes: [a] Under the option identified in footnote b of table II.A–2, by which manufacturers may meet an alternative phase-in requirement of 25/25/25% in 2012, 2013, and 2014 through December 30, the corresponding alternative NO_X standard is 2.5 g/bhp-hr.

The engines certified under these standards will of course also need to meet the Tier 4 PM and crankcase control requirements that take effect for all engines in the first phase-in year. They will also need to comply with all Tier 4 provisions that would apply to

[30] See the recently published ''Highway Diesel Progress Review Report 2,'' EPA420–R–04–004, available at *http://www.epa.gov/otaq/diesel.htm#progreport2.*

phase-in engines, including the 0.14 g/bhp-hr NMHC standard and the NTE and transient test requirements for all pollutants. We recognize that this differs from what is required under the phase-in approach, in which these requirements would not apply to the 50% of engines categorized as ''phase-out'' engines. However, under the alternative standards approach, what would have been two different engine families (one meeting phase-in requirements and one meeting phase-out requirements, with NO_X and PM emissions averaging allowed between them under the ABT provisions) are replaced by a single engine family meeting the one set of alternative standards. Therefore all of the engines in this family must by default meet the phase-in requirements for provisions that lack any sort of averaging mechanism (NMHC standard, NTE, etc). As a result, any manufacturer choosing to design to the alternative standards rather than using the phase-in approach provides some additional environmental benefit as an indirect result of choosing this approach.

We also believe that this alternative standards provision makes appropriate a further adjustment to the NO_X phase-in scheme to better preserve both the advanced technology phase-in approach, for those manufacturers choosing that compliance path, and the alternative standards approach, for those choosing that path. Under the proposal, the provision for certifying a split engine family at a pre-designated NO_X level would not allow credit generation by or credit use on engines in the split family (other than for averaging within the family). This was consistent with our goal of providing a simple, single average NO_X standard level for the family, equivalent to arbitrarily designating a portion of the engines in the family as ''phase-out'' engines (credit generators) and the rest as ''phase-in'' engines (credit users) with a net credit balance of zero, while avoiding the burden of actually calculating and tracking credits. This was also consistent with our approach under the 2007 highway engine program from which this concept is derived.

However, because this split family provision has evolved into a set of alternative standards, there is no longer a need to prohibit the generation and use of ABT credits for these engines to preserve a de facto net zero credit balance, and so, considering that it is also not environmentally detrimental, we believe it is appropriate to allow credit use and generation for these engines as for other engines. A consequence of doing so, consistent with all of our ABT programs, is the adoption of NO_X FEL caps for these engines. To maintain the character of this compliance path as producing engines during the phase-in years that emit at NO_X levels which are roughly averaged between Tier 3 and final Tier 4 levels, we are setting NO_X FEL caps for these engines at levels reasonably close to the alternative standards. (See section III.A for details.) Because we are also maintaining the original phase-in/phase-out compliance path, a manufacturer wishing to build engines with NO_X levels higher than these FEL caps, at or approaching the Tier 3 levels, could still do so; in fact these would in actuality fit the description of a phase-out engine. This manufacturer would also, of course, have to produce a corresponding number of phase-in engines meeting the aftertreatment-based Tier 4 NO_X standards.

We also observe that the creation of alternative standards provides the opportunity to adjust the phase-in/phase-out provisions so as to reinforce their focus on introducing high-efficiency NO_X aftertreatment technology during the phase-in years, which is, of course, their aim. We are doing this by setting NO_X family emission limit (FEL) caps for phase-in engines at the same low levels as for Tier 4 engines produced in the post-phase-in years. (Again, see section III.A for details.) Although the engine manufacturers indicated in their comments that they did not believe it likely that anyone would choose this phase-in/phase-out compliance path, we believe that preserving it and focusing it on encouraging very low-NO_X engines as early as possible provides a potentially useful and environmentally desirable alternative path. Thus these two concepts have been developed to provide complementary compliance paths obtaining equivalent overall NO_X reductions, one focused on phasing in high-efficiency NO_X aftertreatment and the other on achieving NO_X control for all subject engines during the phase-in years at an average level between the Tier 3 and final Tier 4 standards levels.

3. Standards for Smaller Engines

a. Engines Under 25 hp

We are finalizing the Tier 4 program we proposed for engines under 25 hp. In the proposal we presented our view that standards based on the use of PM filters should not be set at this time for the very small diesel engines below 25 hp. We also discussed our plan to reassess the appropriate long-term standards in a technology review. However, for the nearer-term, we concluded that other proven PM-reducing technologies such as diesel oxidation catalysts and engine optimization could be applied to engines under 25 hp. Accordingly, we proposed Tier 4 PM standards to take effect beginning in 2008 for these engines based on use of these technologies.

In contrast to our proposals for other engine categories, the proposed Tier 4 standards for this category elicited very little comment from the engine manufacturers other than an expression of support for deferring consideration of any more stringent standards pending results of a future technology review. The States and environmental organizations expressed disappointment that EPA had not proposed more stringent standards for these engines, given the very large number of these engines in the field and the significant risk they pose due to individuals' exposure to diesel PM and air toxics. They urged more stringent 2008 PM standards and the adoption of standards obtaining emission reductions of 90% or more by the end of 2012. Emissions control manufacturers argued that more stringent 2008 standards based on the use of more efficient oxidation catalysts are feasible.

As discussed in section II.B.4, we continue to believe that the standards we proposed for engines under 25 hp are feasible, and commenters in the nonroad diesel industry provided no comments to the contrary. Our reasons for not proposing more stringent Tier 4 standards for these engines based on the use of PM filters and NO_X aftertreatment were mainly focused on the cost of equipping these relatively low cost engines with such devices, especially considering the prerequisite need for electronic fuel control systems to facilitate regeneration. The comments supporting more stringent standards were not convincing, as they did not address these cost issues. However, we do agree that these small engines likely have a large impact on human health, and, as discussed in section VIII.A, we are reaffirming the plan we described in the proposal to reassess the appropriate long-term standards for these engines in a technology review to take place in 2007. We will set more stringent standards for these engines at that time, if appropriate.

We also disagree with comments supporting more stringent 2008 standards that would require the use of diesel oxidation catalysts on all small engines. Although we agree that these catalysts can be applied so as to achieve emission reductions on some small engines, the emissions performance data we have analyzed do not support our setting a more stringent standard. Section 4.1.5 of the RIA summarizes such data showing a very wide range of engine-out PM emissions in this power category. Applying oxidation catalyst technology to these engines, though capable of some PM reduction if properly designed and matched to the application, is limited by sulfur in the diesel fuel. Specifically, precious-metal oxidation catalysts (which have the greatest potential for reducing PM) can oxidize the sulfur in the fuel and form particulate sulfates. Even with the 500 ppm maximum sulfur fuel available after 2007, the sulfate production potential is large enough to limit what can be done to set more stringent 2008 PM standards through the use of these catalysts. The 15 ppm maximum sulfur fuel available after 2010 will greatly improve the potential for use of oxidation catalysts, but as we discussed above, we believe that the much larger potential reduction afforded by PM filter technology warrants our waiting until the technology review in 2007 to evaluate the appropriate long-term standards for these engines. See section II.B.5 and RIA section 4.1.5 for further discussion.

When implemented, the Tier 4 PM standard and related provisions we are adopting today for engines under 25 hp will yield an in-use PM reduction of over 50% for these engines, and large reductions in toxic hydrocarbons as well. Achieving these emission reductions is very important, considering the fact that many of these smaller engines operate in populated areas and in equipment without closed cabs—in mowers, portable electric power generators, small skid steer loaders, and the like.

We are also adopting the alternative compliance option that we proposed for air-cooled, direct injection engines under 11 hp that are startable by hand, such as with a crank or recoil starter. As we explained in the proposal, the alternative is justified due (among other things) to these engines' need for loose design fit tolerances, their small cylinder displacement and bore sizes, and the difficulty in obtaining components for them with tight enough tolerances (68 FR 28363, May 23, 2003). This alternative allows manufacturers of these engines to delay Tier 4 compliance until 2010, and in that year to certify them to a PM standard of 0.45 g/bhp-hr, rather than to the 0.30 g/bhp-hr PM standard applicable beginning in 2008 to the other engines in this power category. As proposed, engines certified under this alternative compliance requirement will not be allowed to generate credits as part of the ABT program, although credit use by these engines will still be allowed.

We received no adverse comments on this proposed alternative for qualifying engines under 11 hp. Euromot commented that there are hand-startable engines in the 11–25 hp range, and that we should extend the alternative compliance option to these engines as well. However, hand-startability is not the sole defining feature of engines for which we established this alternative. Rather, the alternative is for a class of engines typified by a combination of characteristics (very small, air-cooled, direct injection, hand-startable), which give rise to the potential technical difficulties noted above. To extend the alternative to other engines simply because they have a hand-start is not justified, because they do not share these technical difficulties (or do not share them to the same degree). Such an extension could also potentially encourage manufacturers of the many models of these larger engines to market a hand-start option simply to avoid more stringent standards.

b. Standards for 25–75 hp Engines

We proposed a 0.22 g/bhp-hr PM standard for 25–75 hp engines, to take effect in 2008. We also proposed a filter-based 0.02 g/bhp-hr PM standard for these engines, to take effect in 2013, the year in which filter-based technology for these engines is expected to be applicable on a widespread basis (see section II.A.1). Also in 2013, the 25–50 hp engines would be subject to the 3.5 g/bhp-hr $NMHC+NO_X$ standard already adopted for 50–75 hp engines (taking effect in 2008 as part of Tier 3). We are adopting all of these proposed standards in this final rule.

The 2008 PM standard for these engines should maximize reduction of PM emissions using technology available in that year. We believe that the 2008 PM standard is feasible for these engines, based on the same engine or oxidation catalyst technologies feasible for engines under 25 hp in 2008, following the introduction of nonroad diesel fuel with sulfur levels reduced below 500 ppm. We expect in-use PM reductions for these engines of over 50% (and large reductions in toxic hydrocarbons as well) over the five model years this standard would be in effect (2008–2012). These engines will constitute a large portion of the in-use population of nonroad diesel engines for many years after 2008. Although we are finalizing the 2013 standards for 25–75 hp engines today, we are also reaffirming our commitment to conducting a technology review for these standards in 2007. This planned review is discussed in section VIII.A. Additional discussion of our feasibility assessment for the 2008 and 2013 standards can be found in section II.B.4 and RIA section 4.1.4.

In comments, emissions controls manufacturers argued that more stringent 2008 standards for PM and NMHC based on the use of more efficient oxidation catalysts are feasible and should be adopted. Environmental organizations argued that PM and NO_X standards for 2008 should be set at more stringent levels, based on the use of oxidation catalysts and improved engine optimization. The California Air Resources Board argued for more stringent 2008 standards for $HC+NO_X$, PM and toxics, based on the use of oxidation catalysts.

We disagree with the comments calling for more stringent 2008 standards than proposed for 25–75 hp engines, based on the use of diesel oxidation catalysts. The standards we proposed and are adopting for these engines pull ahead sizeable PM reductions starting three years ahead of the earliest PM filter-based standards for any engine size. The pull-ahead standard level balances early reductions with the need to ensure that the PM filter-based standards and Tier 3 $NMHC+NO_X$ standards are not jeopardized by an overemphasis on early reductions. Although we agree that oxidation catalysts can be applied to these engines, the emissions performance data we have analyzed do not support our setting a more stringent standard, for the same reasons described above in section II.A.3.a for engines under 25 hp. Refer to section II.B.4 and to section 4.1.4 of the RIA for additional discussion. For a discussion of comments opposed to new standards in 2008, see sections II.A.1 and II.B of this preamble.

We also do not agree that more stringent NO_X requirements based on improved engine optimization are appropriate for these engines in 2008. In 2001 we reviewed and confirmed the previously set $NMHC+NO_X$ emission standards that will be in effect for these engines during the time frame in question.[31] Because of the focus we are putting on achieving large PM reductions from these engines as early as possible, we felt that it was important to strike a balance between PM and NO_X control. As a result, we did not propose more stringent NO_X standards for 50–75 hp engines, and we proposed to apply

[31] ''Nonroad Diesel Emissions Standards Staff Technical Paper,'' EPA420–R–01–052, October 2001.

the 3.5 g/bhp-hr NMHC+NO_X standard to 25–50 hp engines in 2013 because this is the year in which the PM filter-based standard is being implemented. Requiring new NO_X controls for these engines earlier than 2013 would add a third redesign step to those already called for in 2008 and 2013. This would add a potentially unacceptable amount of redesign workload, to a point that it could jeopardize our objective of bringing stringent PM control to these engines as early as possible.

Consistent with the proposal, we are not setting more stringent NO_X standards for engines below 75 hp at this time based on the use of NO_X aftertreatment. As discussed in section 4.1.2.3 of the RIA, a high degree of complexity and engine/aftertreatment integration will be involved in applying NO_X adsorber technology to nonroad diesel engines. The similarity of larger nonroad engines (above 75 hp) to highway diesel engines, which will provide the initial experience base for this integration process, is key to our assessment that NO_X adsorbers are feasible for these engines. On the other hand, although engines under 75 hp are gradually increasing in sophistication over time, the accumulation of experience with designing and operating these engines with more advanced technology clearly lags significantly behind the sizeable experience base already developed for larger engines. At this point, we are unable to forecast how quickly adequate experience may accrue. Because this experience is crucial to ensuring the successful integration of the engines with NO_X adsorber technology, we are not adopting NO_X adsorber-based standards for engines under 75 hp in this final rule. Rather, as discussed in section VIII.A, we plan to undertake a technology assessment in the 2007 time frame which would evaluate the status of engine and emission control technologies, including NO_X controls, for engines less than 75 hp.

As described in section II.A.1.a, we are providing two PM standard compliance options to engine manufacturers for 50–75 hp engines. As part of this, we also proposed a measure to ensure that it would not be abused by equipment manufacturers who use engines that do not meet the PM pull-ahead standard in 2008–2011, but who then switch engine suppliers to avoid PM filter-equipped engines in 2012 as well (68 FR 28360, May 23, 2003). We proposed that an equipment manufacturer making a product with engines not meeting the pull-ahead standard in any of the years 2008–2011 must use engines in that product in 2012 meeting the 0.02 g/bhp-hr PM standard; that is, the equipment manufacturer would have to use an engine from the same engine manufacturer or from another engine manufacturer choosing the same compliance option. We also solicited comment on possible alternative solutions using a numerical basis, describing an example that would require the percentage of 50–75 hp machines equipped with PM filters in 2012 to be no less than the same percentage of 50–75 hp machines produced with non-pull-ahead engines in 2008–2011.

The Engine Manufacturers Association (EMA) and Deere commented on the unenforceability of the proposed ‘‘no switch’’ measure as part of a broader objection to our proposal for 50–75 hp engines. They pointed out that changing equipment model designations could easily allow an equipment manufacturer seeking to avoid PM filter-equipped engines in 2012 to declare a product in this model year a ‘‘new product,’’ not the same as the 2008–2011 product. We have concluded that there is indeed potential for this abuse to occur and, although no one commented specifically on the alternative approach, we believe it clearly addresses this problem because it does not depend on product designations.

Therefore, we are adopting a provision to discourage engine switching based on this alternative approach. An equipment manufacturer who uses 50–75 hp engines will have three options:

(1) The manufacturer may exclusively use engines certified to the 0.22 g/bhp-hr PM standard (including through use of ABT credits) over the 2008–2011 period. This manufacturer is then free to use any number of 50–75 hp engines not certified to the 0.02 g/bhp-hr standards in 2012.

(2) The manufacturer may exclusively use engines not certified to the 0.22 g/bhp-hr PM standard over the 2008–2011 period. This manufacturer must then use only 50–75 hp engines that are certified to the 0.02 g/bhp-hr standards in 2012 (including through use of ABT credits).

(3) The manufacturer may use a mix of engines in 2008–2011. In this case, the manufacturer must calculate the percentage of 50–75 hp engines used (in U.S.-directed equipment) over the 2008–2010 period that are not certified to the 0.22 g/bhp-hr PM pull-ahead standard. Then the percentage of 50–75 hp engines this manufacturer uses in 2012 that are certified to the 0.02 g/bhp-hr PM standard must be no less than this 2008–2010 non-pull-ahead percentage figure minus a 5% margin.[32]

As an example of this third option, consider an equipment manufacturer who does not use the transition flexibility provisions (described in section III.B), and over the 2008–2010 period makes 1000 50–75 hp machines for use in the U.S., 200 (20%) of which use engines not certified to the 0.22 g/bhp-hr standard. In 2012, that manufacturer must make at least 15% of his 50–75 hp machines for use in the U.S. using engines certified to the 0.02 g/bhp-hr standard. We feel that the 5% margin is needed to allow for some reasonable sales shifts within the manufacturer's product offering over time, but is small enough to ensure that any possible advantage gained from selling higher-emissions products remains minimal. Equipment manufacturers must keep production records sufficient to prove compliance. This restriction and the percentage calculation will not apply to any 2008–2012 engines at issue that are being produced under the equipment manufacturer transition flexibility provisions discussed in section III.B. For example, if in addition to the 200 engines in 2008–2010 not certified to the 0.22 g/bhp-hr standard in the above example, this manufacturer also used 500 previous-tier engines in 2008–2010 under the flexibility allowance program, his percentage target for PM filter-equipped engines in 2012 would be 35% of all the engines used in 2012 that are not previous-tier engines under the flexibility allowance program.[33]

4. Standards for Engines Above 750 hp

We are adopting different Tier 4 standards for over 750 hp engines from those we proposed, and we are also adopting different implementation dates for these engine standards, though both the proposed and final programs have as their primary focus the implementation of high-efficiency exhaust emission controls as quickly as possible. The approach being adopted reflects our careful review of the technical issues presented by these engines. For some of these engines, we are accelerating standards based on the use of aftertreatment controls. For others, we are deferring a decision on such aftertreatment-based standards. This approach represents a feasible and efficient approach to redesigning

[32] The 2011 production is not included in the percentage calculation to avoid the need for post-2011 confirmation of production volumes which, as it would occur in 2012, would be too late to easily re-focus 2012 production if the confirmed volumes differ from projections. It is not likely that manufacturers would abuse the program by switching engine suppliers for this one year of production.

[33] That is: [200/(1000–500)] = 40%; subtracting the 5% margin then yields 35%.

engines and installing aftertreatment in a coordinated, orderly manner over a decade or more, and will achieve major reductions in PM and NO_X from these large diesel engines.

Under the proposal, all engines above 750 hp were treated the same, with a phase-in of PM and NO_X aftertreatment technology that started in 2011 and finished in 2014. The final standards are based on our evaluation of the differing technical issues presented by the two primary kinds of equipment in this category, mobile power generation equipment (generator sets) and mobile machinery. For both generator sets and mobile machinery, PM aftertreatment-based standards will start in 2015, with no prior phase-in. EPA is replacing the proposed phase-in with a PM standard starting in 2011 that is comparable to the overall level of control that the proposed phase-in would achieve. Differences within these applications, however, call for different approaches to the implementation of NO_X aftertreatment technology. For generator sets above 1200 hp, an aftertreatment-based NO_X standard will start in 2011, three years earlier than the date we proposed for full implementation of such standards. For generator sets below 1200 hp, the same aftertreatment-based NO_X standard will start in 2015. As with the PM standard, there is no phase-in. For engines used in mobile machinery, which is assumed to include all equipment that is not a generator set, EPA is deferring a decision on setting aftertreatment-based NO_X standards to allow additional time to evaluate the technical issues involved in adapting NO_X adsorber technology to these applications and engines. However, EPA is adopting a NO_X standard for these engines starting in 2011 that will achieve large NO_X reductions by relying on engine-based emissions control technology. Consistent with the different approaches we are taking to setting standards for engines above and below 750 hp, we are also adopting restrictions on ABT credit use between these power categories, as described in section III.A.

Consistent with the approach we took in previous standard-setting for these engines, we proposed that nonroad diesels above 750 hp be given more lead time than engines in other power categories to fully implement Tier 4 standards, due primarily to the relatively long product design cycles typical of these high-cost, low-sales volume engines and machines. Specifically, we proposed that this category of engines move directly from Tier 2 to Tier 4, and that the Tier 4 PM standard be phased in for these engines on the same 50–50–50–100% schedule as the NO_X and NMHC phase-in schedule, over the 2011–2014 model years. This would provide engine manufacturers with up to 8 years of design stability to address concerns specific to this category. Although we expressed our belief that these proposed provisions would enable the manufacturers to meet proposed Tier 4 engine standards, we also acknowledged concerns the manufacturers had expressed to us, and asked for comment on whether this category, or some subset of it defined by hp or application, should have a later phase-in start date, a later phase-in end date, adjusted standards, additional equipment manufacturer transition flexibility provisions, or some combination of these (68 FR 28364, May 23, 2003).

Comments from manufacturers of engines and equipment in this power category expressed their widespread view that the proposed standards were inappropriate in critical respects. In addition to reiterating the need for extra lead time due to long product design cycles, they pointed to difficulties with aftertreatment placement, with fabrication of the large filters that would be needed for these engines, with potential failures caused by uneven soot loading and regeneration in large filters, with stresses due to thermal gradients across large filters, and with mechanical stresses in mining applications with high shock loads. The manufacturers noted that aftertreatment-based standards for NO_X and PM were feasible for engines used in large mobile power generators. However, manufacturers did not believe aftertreatment-based NO_X standards could be implemented in the time frame proposed for engines used in large mobile machinery such as bulldozers and mine haul trucks. States, environmental organizations, and manufacturers of emissions controls, on the other hand, expressed support for the standards we proposed for these engines.

After evaluating these issues, EPA is adopting an approach that tailors the standards to the circumstances presented by the different kinds of engines in this power category. The NO_X standards we are adopting will achieve effective NO_X control by accelerating the proposed schedule for final NO_X standards based on high-efficiency NO_X aftertreatment for the largest generator sets, and by requiring engines in other generator sets to also meet aftertreatment-based NO_X standards, although we are delaying the implementation date for these standards compared to the implementation schedule we proposed. We believe that NO_X adsorber technology will be feasible for these generator set engines. We also believe that they may be an especially attractive application for Selective Catalytic Reduction (SCR) technology, which relies on the injection of urea into the exhaust stream. There are many stationary diesel generator sets using SCR today. Large mobile generator sets, though moved from location to location, operate much like stationary units once in place, with fuel (and potentially urea) delivered and replenished periodically. See section II.B.3 for further discussion.

For equipment other than generator sets, we are deferring a decision on setting aftertreatment-based NO_X standards to allow additional time to evaluate the technical issues involved in adapting NO_X control technology to these applications and engines. We are still evaluating the issues involved for these engines to achieve a more stringent NO_X standard, and believe that these issues are resolvable. We intend to continue evaluating the appropriate long-term NO_X standard for mobile machinery over 750 hp and expect to announce further plans regarding these issues (we are currently considering such an action in the 2007 time frame). The basis for the 0.50 g/bhp-hr NO_X standard we are adopting for generator sets over 750 hp is discussed in section II.B.3. We are also modifying the PM and NMHC standards we proposed (as well as certain implementation dates for these provisions), and modifying our proposed approach to ensuring transient emissions control for these engines (discussed in section III.F). The Tier 4 standards for engines over 750 hp are shown in table II.A–4.

TABLE II.A–4.—TIER 4 STANDARDS FOR ENGINES OVER 750 HP (G/BHP-HR)

	2011			2015		
	PM	NO_X	NMHC	PM	NO_X	NMHC
Engines used in:						
generator sets ≤1200 hp	0.075	2.6	0.30	0.02	0.50	0.14
generator sets >1200 hp	0.075	0.50	0.30	0.02	No new standard	0.14
all other equipment	0.075	2.6	0.30	0.03	No new standard	0.14

Unlike NO_X control technology, we believe that the more advanced state of PM filter technology development today makes their availability for these engines by 2015, with over ten years of development lead time, more certain, and so we are setting PM standards for both mobile machinery and generator sets based on use of this technology. We note in section II.B.3 that achieving durable PM filter designs for these large applications will likely require the use of wire mesh filter technology rather than the somewhat more efficient wall flow ceramic-based technology applicable to smaller engines, justifying the somewhat higher level for the 2015 PM standards shown in table II.A–4 (0.03 or 0.02 g/bhp-hr compared to 0.01 g/bhp-hr). Section II.B.3 also contains discussion of our bases for the other Tier 4 standard levels in this category. We believe that the 2015 implementation year (versus the proposed 2014 date for the fully phased-in standard) is necessary to allow development of the requisite technologies for these large engines, and to deal with the redesign workload Tier 4 will create for the many engine and equipment models in this category which, as noted, typically have very low production volumes and long product cycles.

For the purpose of determining which nonroad engines are subject to the generator set standards, we are defining a generator set engine as: ''An engine used primarily to operate an electrical generator or alternator to produce electric power for other applications.'' This definition makes it clear that generator set engines do not include engines used in machines such as mine trucks that do mechanical work but that employ engine-powered electric motors to propel the machine, but they do include engines in nonroad equipment for which the primary purpose is to generate electric power, even if the machine is also self-propelled.

Similar to other power categories, we proposed a 50% phase-in to the final Tier 4 PM, NO_X and NMHC standards, with opportunity to average PM and NO_X between phase-in and phase-out engines in the 2011–2013 phase-in years via the ABT program. Because in this rule we are no longer phasing in to a final NO_X standard for some engines over 750 hp, it no longer makes sense to express the 2011 standards for these engines in this manner. Instead we are setting brake-specific emission standards effective in 2011. Furthermore, to avoid further complicating an already complex standards structure, we are adopting this pattern for the entire category, even with engines such as those used in generator sets for which the standards could still be expressed as a percent phase-in to final standards. Except for the pull-ahead of the long-term NO_X standard for large generator sets (which will increase the environmental benefit compared to the proposal), these 2011 PM and NO_X standards essentially correspond to averaged standards under a 50% phase-in to aftertreatment-based standards, hence our conclusion that the Tier 4 program will provide a level of control in 2011 that is substantially equivalent to that of the proposal. In addition, PM and NO_X emissions averaging through the ABT program will allow a manufacturer to comply by phasing in aftertreatment technologies as in the proposed program, should they desire to do so. Although there is no such averaging program for NMHC, the 2011 NMHC standard can be achieved without the use of advanced aftertreatment (as explained in section II.B.3), thus helping to enable a manufacturer to pursue this compliance strategy if desired.

This approach involving separate 2011 and 2015 standards is comparable to the proposed percent phase-in approach with emissions averaging. We believe that it enables manufacturers to redesign engines and equipment in a coordinated, orderly manner over a decade or more, and effectively gives targeted additional flexibility to the industry. Given the continuing availability of emissions averaging, we do not view this change as the creation of an additional, separate tier of standards compared to the proposal's phase-in of the Tier 4 standards.

5. Establishment of New Power Categories

We are finalizing our proposal to regroup the nine power categories established for previous tiers into the five Tier 4 power categories shown in table II.A–1. As we explained in the proposal, this regrouping will more closely match the degree of challenge involved in transferring advanced emissions control technology from highway engines to nonroad engines. The proposed choice of 75 hp as the appropriate cutpoint for applying aftertreatment-based NO_X control drew particular attention. In the proposal, we recognized that there is not an abrupt power cutpoint above and below which the highway-derived nonroad engine families do and do not exist, but noted further that 75 hp is a more appropriate cutpoint to generally identify nonroad engines in Tier 4 that will most likely be using highway-like engine technology than either of the closest previously-adopted power category cutpoints of 50 or 100 hp. Nonroad diesels produced today with rated power above 75 hp (up to several hundred hp) are mostly variants of nonroad engine platforms with four or more cylinders and per-cylinder displacements of one liter or more. These in turn are largely derived from or are similar to heavy-duty highway engine platforms. Even where nonroad engine models above 75 hp are not so directly derived from highway models, they typically share many common characteristics such as displacements of one liter per cylinder or more, direct injection fueling, turbocharging, and, increasingly, electronic fuel injection. These common features provide key building blocks in transferring high-efficiency exhaust emission control technology from highway to similar nonroad diesel engines. We therefore proposed to regroup power ratings using the 75 hp cutpoint.

The Engine Manufacturers Association and Euromot, which together represent the companies that make all but a tiny fraction of nonroad diesel engines sold in the U.S., expressed their support for the 75 hp cutpoint, as did every individual engine manufacturer who commented on this subject. These companies generally endorsed EPA's reasoning that the 75 hp level is appropriate to ''delineate those engines (and applications) for which the application of on-highway like NO_X aftertreatment technologies is not likely to be feasible or practical'' (EMA Comments p.10).

However, the Association of Equipment Manufacturers (AEM) and the equipment manufacturer Ingersoll-Rand commented that 100 hp is the more appropriate cutpoint for application of advanced NO_X control technology. They based this view on their observations that 75–100 hp engines do not share many of the characteristics of highway diesels, thus making technology transfer from the highway sector very costly, and customers will be negatively affected due to the relatively large cost impacts of NO_X aftertreatment on these smaller engines. They also argued that the 75 hp cutpoint would create significant misalignment in the global marketplace because European regulations do not use this cutpoint.

We agree with the equipment manufacturers' observation that there are engines above 75 hp without turbocharging or electronic controls. However, EPA did not choose the 75 hp cutpoint with the expectation that all engines above it had the same technology characteristics. There is a continuum in the degree to which key technology characteristics exist on engines throughout the power spectrum, and the 75 hp cutpoint was based on information from the current fleet of engines and on manufacturers' and EPA's expectations for future design trends, showing there is a marked difference in the prevalence of these and other key engine design characteristics for engines above and below 75 hp, and that, over time, 75–100 hp engines increasingly share advanced technology characteristics common in larger engines. Clear evidence of this trend over recent model years is documented in the RIA, section 4.1.4. As discussed in section II.B.2, the kind of engine technology generally employed by engines in the 75–100 hp range, combined with the lead time and phase-in provided for the Tier 4 NO_X standards, leads us to conclude that highway-like NO_X aftertreatment can be transferred to these engines. In addition, since our proposal, the Council of the European Union (EU) has issued a revised final version of new nonroad diesel emission standards that essentially aligns their power cutpoints with our own, including adoption of the 75 hp cutpoint for advanced technology NO_X control. EPA does not believe that the costs of meeting the NO_X standard for engines in the 75–100 hp range are unreasonable, and we refer the reader to section VI for a detailed discussion of our cost analysis for engines and equipment meeting Tier 4 standards in this power range. Moreover, EPA firmly believes such standards are technologically feasible for 75–100 hp engines. (See section II.B.2.)

Ingersoll-Rand also expressed concern that the proposed consolidation of 3 previous power categories into a single 175–750 hp category creates significant hardship by requiring the introduction of aftertreatment technologies in a single year, contrasting this with the Tier 2 standards, which phased in over 2001–2003 for these engines. In response, we note that the Tier 3 standards, which were set in the same rule that established the Tier 2 standards, will be introduced in a single year for these engines (2006), and that the Tier 2 phase-in over 3 years was established in response to particular issues and opportunities that were identified, specific to that time frame (see 62 FR 50181, September 24, 1997). In addition to the gradual phase-in of Tier 4 standards over several years, we are adopting significant flexibility provisions specifically to provide adequate lead time for equipment manufacturers to make the transition to the new standards, including some provisions that provide additional flexibility from what we proposed, as explained in section III.B.

6. CO Standards

We proposed minor changes in CO standards for some engines solely for the purpose of helping to consolidate power categories. We stated in the proposal that we were not exercising our authority to revise the CO standard for the purpose of improving air quality, but rather for purposes of administrative efficiency. However, manufacturers objected to these proposed changes, citing technological feasibility concerns, and a lack of parity with highway diesel and nonroad spark-ignition engines, given that existing CO standards levels for nonroad engines are already five times lower than the standard level for highway engines.

Because we proposed the CO standard changes for the sake of simplifying and consolidating power categories and not because of any technical considerations relating to emission reductions, we do not believe it productive to take issue with the views expressed that these proposed changes raise serious feasibility concerns. We instead are withdrawing this aspect of the proposal, the result being that the existing CO standards remain in place. In doing so, we are not considering or reexamining (and at proposal did not consider or reexamine) the substantive basis for those standards. Having multiple CO standards within a power category will, at worst, create minor inconveniences in certification and compliance efforts. As a result, in the less than 25 hp category, Tier 4 engines below 11 hp will continue to be subject to a different CO standard than 11–25 hp engines, identical to Tier 2. Likewise, different CO standards will continue to apply in Tier 4 to engines above and below 50 hp in the 25–75 hp category.

We do note, however, that we are applying new certification tests to all pollutants covered by the rule, the result being that Tier 4 engines will have to certify to CO standards measured by the transient test (NRTC) (which includes a cold start test), and the NTE. Our intent in adopting these new certification requirements is not to alter the level of stringency of the standard but rather to ensure robust control of emissions to this standard in use. The CO standards remain readily achievable using these tests, and we anticipate that no additional engine adjustments are necessary for the standards to be achievable (so there are no significant associated costs). We also explain there that the CO standards can be achieved without jeopardizing the ability to achieve all of the other engine standards.

7. Crankcase Emissions Control

We currently require the control of crankcase emissions from naturally-aspiriated nonroad diesel engines. We proposed to extend this requirement to turbocharged nonroad diesel engines as well, starting in the same model year that Tier 4 exhaust emission standards first apply in each power category.

EMA opposed the proposed extension, reiterating concerns expressed in comments on a similar proposed provision in the 2007 heavy-duty highway rule, including concerns over the impact that recirculating crankcase emissions may have on the feasibility of engine standards over the full useful life. These concerns are addressed in the Summary and Analysis of Comments document for that rule, which is included in the docket for today's rule. Besides the feasibility issues raised by EMA for nonroad diesels that are addressed in the highway rule, two nonroad-specific issues were raised as well: (1) The need to design crankcase emission control systems that operate at the high angularity experienced by some nonroad machines on uneven ground, and (2) the concern that this requirement adds to the large number of ''first time'' requirements being adopted for Tier 4. We agree that high angularity operation may add new design considerations for these controls, but do not see how it would pose a serious barrier that could not be overcome in time. The grouping of new EPA requirements in a specific model year is an important objective of our program aimed at providing stability to the design process, a goal much supported by the engine manufacturers. We have accounted for this in assessing feasibility, costs, and flexibility needs for the program. One flexibility we are providing is the three-path opportunity to satisfy our crankcase control requirement, as described below. In fact, in its written comments EMA recommended that, if EPA were to proceed with crankcase emission control requirements for Tier 4, it adopt all three options for demonstrating compliance. This is indeed what we are doing.

Thus, as proposed, in addition to allowing for compliance through the routing of crankcase emissions to the engine air intake system, we are also allowing manufacturers to instead meet the requirement by routing the crankcase gases into the exhaust stream, provided they keep the combined total of the crankcase emissions and the exhaust emissions below the applicable exhaust emission standards. Also as proposed, we are allowing manufacturers to instead meet the requirement by measuring crankcase emissions instead of completely eliminating them, provided manufacturers add these measured emissions to exhaust emissions in assessing compliance with exhaust emissions standards. Manufacturers using this option must also modify their exhaust deterioration factors or develop separate deterioration factors to account for increases in crankcase emissions as the engine ages, and must ensure that crankcase emissions can be readily measured in use. We see no reason to treat naturally-aspirated engines differently than turbocharged engines, and so are allowing these options for all Tier 4 engines subject to the crankcase control requirement, both turbocharged and naturally-aspirated. The wording of the proposed regulations limiting the options to turbocharged engines was inadvertent.

8. Prospects for International Harmonization

We received numerous comments, especially from engine and equipment manufacturers, stressing the need for EPA to work with other governmental standards-setting bodies to harmonize standards. We recognize the importance of harmonization of international standards and have worked diligently with our colleagues in Europe and Japan to achieve that objective. Harmonization of these standards will allow manufacturers continued access to world markets and lower the required research and development and tooling costs needed to meet different standards. We will continue to work with standards-setting governmental entities and with foreign and domestic manufacturers.

In October 2003, the Council and Parliament of the European Union reached agreement on revisions to a proposal developed by the European Commission that would amend Directive 97/68/EC to include nonroad diesel emissions standards similar to those in our Tier 4 program, and, as in the U.S., coordinated with low sulfur diesel fuel requirements in Europe. This revised proposal has since been finalized.[34] This revised Directive aligns well with our program in the Tier 4 time frame, even more so than did the original Commission proposal. It also closely aligns with our Tier 3 standards in the Tier 3 time frame.

For engines of 50–750 hp, the Directive's standards are very closely aligned with our own Tier 4 standards, including emissions levels, implementation dates, the defined power categories, and the lower hp limit of NO_X control based on high-efficiency exhaust emission controls (75 hp). Exceptions are noted below:

- The 2008 PM standard level for 50–75 hp engines (the equivalent of 0.3 g/bhp-hr vs our 0.22 g/bhp-hr level). Note, however, that we do allow certification to the 0.3 g/bhp-hr level as an option, provided the manufacturer must then meet our 0.02 g/bhp-hr standard in 2012, one year earlier than otherwise.
- The 2013 PM standard level for 50–75 hp engines (the equivalent of 0.01 g/bhp-hr vs our 0.02 g/bhp-hr level).
- An October 1, 2014 start for the final 75–175 hp NO_X standard (the same as our proposed date), compared to the December 31, 2014 date we are adopting in this final rule.
- For constant speed engines: no Tier 4-equivalent standards. Also, the EU's Tier 3-equivalent standards are not implemented on these engines until 2011–2012.

[34] Council of the European Union, ''Directive of the European Parliament and of the Council amending Directive 97/68/EC'', March 15, 2004.

As the EU program does not provide for emissions averaging, the alternative NO_X standards we are setting for 75–750 hp engines are the NO_X levels at which the EU standards are generally aligned during our NO_X phase-in years. The EU Directive also includes transition flexibility provisions for equipment manufacturers similar to those in our program, discussed in section III.B.

The EU program for nonroad diesels has not adopted or proposed any current or future standards for engines above 750 hp or below 25 hp, and its revised Directive for 25–50 hp engines does not subject them to any future standards beyond those entering into force in 2007 (equivalent to 0.45 g/bhp-hr PM and 5.6 g/bhp-hr hydrocarbon+NO_X), in contrast to our 2013 standards based the use of PM filters and more advanced engine-based control technologies (0.02 g/bhp-hr PM and 3.5 g/bhp-hr NMHC+NO_X). However, as discussed further in section VIII.A, the EU Directive includes plans to conduct a future technology review of appropriate standards for engines below 50 hp and above 750 hp. The year that this is planned for is 2007, the same year in which we are planning a technology review for engines below 75 hp. Considering progress to date, and announced plans for reviews in 2007, we believe that prospects for harmonized standards are excellent.

9. Exclusion of Marine Engines

For reasons outlined in the proposal, we are not applying Tier 4 standards to the marine diesel engines under 50 hp that are covered under our Tier 1 and 2 standards. We believe it is more appropriate to consider more stringent standards for a range of marine diesel engines, including these, in a future action. It should be noted that the existing Tier 2 standards will continue to apply to marine diesel engines under 50 hp until that future action is completed. We did not receive any adverse comments on this proposed approach.

B. Are the New Standards Feasible?

Today we are finalizing a program of stringent new standards for a broad category of nonroad diesel engines coupled with a new nonroad diesel fuel standard that dramatically lowers the sulfur level in nonroad diesel fuel ultimately to 15 ppm. We believe these standards are technically feasible in the leadtime provided given the availability of 15 ppm sulfur fuel and the rapid progress to develop the needed emission control technologies. We acknowledge, as pointed out by a number of commenters, that these standards will be challenging for industry to meet, in part due to differences in operating conditions and duty cycles for nonroad equipment and the diesel engines used in that equipment. Also, we recognize that transferring and effectively applying these technologies, which have largely been developed for highway engines, will require additional time after the application of the technology to on-highway engines. Diesel engine industry commenters and environmental stakeholder commenters on our proposal consistently agreed with our position that for most engine horsepower categories the technologies to meet the standards exist and that the transfer of these technologies to nonroad is possible. The biggest difference of opinions in the range of comments received by the Agency concerns the timing of the emission standards and the flexibility provisions (*i.e.*, the leadtime necessary to transfer the technology). One of the most important tasks for a feasibility analysis is to determine the appropriate amount of development time needed to successfully bring new technologies to market. We have carefully weighed the desire to have clean engines sooner, with the challenges yet to be overcome in applying the technologies to nonroad engines and equipment, in determining the appropriate timing and emission levels for the standards finalized today.

The RIA associated with today's action contains a detailed description and analysis of diesel emission control technologies, issues specific to applying these technologies to nonroad engines, and why we believe the new emission standards are feasible. Additional in-depth discussion of these technologies can be found in the final RIA for the HD2007 emission standards, the final RIA for the HD2004 emission standards, the 2002 Highway Diesel Progress Review and the recently released Highway Diesel Progress Review Report 2.[35] [36] [37] [38] The following sections summarize the challenges to applying these technologies to nonroad engines and why we believe the emission standards finalized today are technically feasible in the leadtime provided.

1. Can Advanced Diesel Emission Control Technologies Be Applied to Nonroad Engines and Equipment?

The emission standards and the introduction dates for those standards, as described earlier in this section, are premised on the transfer of diesel engine technologies being or already developed to meet light-duty and heavy-duty vehicle standards that begin in 2007. The advanced technology standards that we are finalizing today for engines over 25 horsepower will begin to go into effect four years later. This time lag between equivalent highway and nonroad diesel engine standards is necessary in order to allow time for engine and equipment manufacturers to further develop these highway technologies for nonroad engines and to align this program with nonroad Tier 3 emission standards that begin to go into effect in 2006.

This section summarizes the engineering challenges to applying advanced emission control technologies to nonroad engines and equipment, and why we believe that technologies developed for highway diesel engines can be further refined to address these issues in a timely manner for nonroad engines consistent with the emission standards finalized today.

a. Nonroad Operating Conditions and Exhaust Temperatures

Nonroad equipment is highly diverse in design, application, and typical operating conditions. This variety of operating conditions affects emission control systems through the resulting variety in the torque and speed demands (*i.e.*, power demands). In our proposal, we highlighted the challenge for design and implementation of advanced emission control technologies posed by this wide range in what constitutes typical nonroad operation. Some commenters emphasized their concerns regarding this issue as well, and their belief that these issues make the application of the technology to nonroad infeasible. While we recognize and agree with the commenters regarding the nature of the challenges, we disagree with their conclusion regarding feasibility because, as described in the following section, we see a clear path to overcome the challenges.

The primary concern for catalyst-based emission control technologies is exhaust temperature. In general, exhaust temperature increases with engine power and can vary dramatically as engine power demands vary. For catalyzed diesel particulate filters (CDPFs), exhaust temperature determines the rate of filter regeneration, and if too low, causes a need for supplemental means to ensure proper filter regeneration. In the case of the CDPF, it is the aggregate soot regeneration rate that is important, not the regeneration rate at any particular moment in time. A CDPF controls PM emissions under all conditions and can function properly (*i.e.*, not plug) even when exhaust temperatures are low for an extended time and the regeneration rate is lower than the soot accumulation rate, provided that occasionally exhaust temperatures and thus the soot regeneration rate are increased enough to regenerate the CDPF. Similarly, there is a minimum temperature (*e.g.*, 200 °C) for NO_X adsorbers below which NO_X regeneration is not readily possible and a maximum temperature (*e.g.*, 500 °C) above which NO_X adsorbers are unable to effectively store NO_X. Therefore, there is a need to match diesel exhaust temperatures to conditions for effective catalyst operation under the various operating conditions of nonroad engines.

Although the range of products for highway vehicles is not as diverse as for nonroad equipment, the need to match exhaust temperatures to catalyst characteristics is still present. This is an important concern for highway engine manufacturers and has been a focus of our ongoing 2007 diesel engine progress review. There we have learned that substantial progress is being made to broaden the operating temperature window of catalyst technologies while at the same time to design engine systems to better control average exhaust temperatures (for ongoing catalyst performance) and to attain periodically higher temperatures (to control PM filter regeneration and NO_X adsorber desulfation). Highway diesel engine manufacturers are working to address this need through modifications to engine design, modifications to engine control strategies, and modifications to exhaust system designs. New engine control strategies designed to take advantage of engine and exhaust system modifications can be used to manage exhaust temperatures across a broad range of engine operation. The technology solutions being developed for highway engines to better manage exhaust temperature are built upon the same emission control technologies (*i.e.*, advanced air handling systems and electronic fuel injection systems) that we expect nonroad engine

[35] Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, United States Environmental Protection Agency, December 2000, EPA420–R–00–026. Copy Available in EPA Air Docket A–2001–28 Item II–A–01.

[36] Regulatory Impact Analysis: Control of Emissions of Air Pollution from Highway Heavy-Duty Engines, United States Environmental Protection Agency, June 2000, EPA420–R–00–010. Copy available in EPA Air Docket A–2001–28 Item II–A–02.

[37] Highway Diesel Progress Review, United States Environmental Protection Agency, June 2002, EPA 420–R–02–016. Copy available in EPA Air Docket A–2001–28 Item II–A–52.

[38] Highway Diesel Progress Review Report 2, United States Environmental Protection Agency, March 2004, EPA420–R–04–004. Copy available in Docket OAR–2003–0012–0918.

manufacturers to use in order to comply with the existing Tier 3 emission standards.

Matching the emission control technology and the operating temperature window of the broad range of nonroad equipment may be somewhat more challenging for nonroad engines than for many highway diesel engines simply because of the diversity in equipment design and equipment use. Nonetheless, the problem has been successfully solved in highway applications facing low exhaust temperature performance situations as difficult to address as any encountered by nonroad applications. The most challenging temperature regime for highway engines are encountered at very light-loads as typified by congested urban driving with periods of extended idle operation. Under congested urban driving conditions, exhaust temperatures may be too low for effective NO_X reduction with a NO_X adsorber catalyst. Similarly, exhaust temperatures may be too low to ensure passive CDPF regeneration. To address these concerns, light-duty diesel engine manufacturers have developed active temperature management strategies that provide effective emissions control even under these difficult light-load conditions. Toyota has shown with their prototype diesel particulate NO_X reduction (DPNR) vehicles that changes to EGR and fuel injection strategies can realize an increase in exhaust temperatures of more than 100 °F under even very light-load conditions allowing the NO_X adsorber catalyst to function under these normally cold exhaust conditions.[39] Similarly, PSA Peugeot Citroen (PSA) has demonstrated effective CDPF regeneration under demanding light-load taxi cab conditions with current production technologies. [40] Both of these are examples of technology paths available to nonroad engine manufacturers to increase temperatures under light-load conditions.

While a number of commenters expressed concerns about low temperature operation for nonroad equipment, no commenters provided data showing that nonroad equipment in-use operating cycles would be more demanding of low temperature performance than passenger car urban driving. Both the Toyota and PSA systems are designed to function even with extended idle operation as would be typified by a taxi waiting to pick up a fare.

It is our conclusion that by actively managing exhaust temperatures, for example through engine management to increase exhaust temperatures, engine manufacturers can ensure highly effective catalyst-based emission control performance (*i.e.*, compliance with the emission standards across the applicable tests) and reliable filter regeneration across a wide range of engine operation as would be typified by the broad range of in-use nonroad duty cycles. Active methods of regenerating PM filters have been shown to be reliable under all operating conditions and can be applied to nonroad diesel engines in the time frame required by these regulations. The additional cost for active regeneration, beyond the cost for the PM filter alone, has been accounted for in the cost analysis summarized in section VI of this preamble.

We have conducted an analysis of various nonroad equipment operating cycles and various nonroad engine power density levels to better understand the matching of nonroad engine exhaust temperatures, catalyst installation locations and catalyst technologies. This analysis, documented in the RIA, shows that for many engine power density levels and equipment operating cycles, exhaust temperatures are quite well matched to catalyst temperature window characteristics. In particular, the nonroad transient cycle (NRTC), the cycle we are finalizing to use for certification for most engines with rated power less than 750 hp, was shown to be well matched to the NO_X adsorber characteristics with estimated performance in excess of 90 percent for a turbocharged diesel engine tested under a range of power density levels. The analysis also indicated that the exhaust temperatures experienced over the NRTC are better matched to the NO_X adsorber catalyst temperature window than the temperatures that would be expected over the highway FTP test cycle. This suggests (when coupled with the fact that PM filters function with equal effectiveness at essentially all conditions) that compliance based on testing with the nonroad Tier 4 standards on the NRTC will be somewhat easier, using similar technology, than complying with the highway 2007 emission standards on the highway transient test cycle.

In sum, we believe based on our analysis of nonroad engines and equipment operating characteristics, that, in use, some nonroad engines will experience conditions that require the use of temperature management strategies (*e.g.*, active regeneration) in order to effectively use the NO_X adsorber and CDPF systems. We have assumed in our cost analysis that all nonroad engines complying with a PM standard of 0.03 g/bhp-hr or lower will have an active means to control temperature (*i.e.* we have costed a backup regeneration system, although some applications likely may not need one). We have made this assumption believing, as indicated by a number of commenters, that manufacturers will not be able to accurately predict in-use conditions for every piece of equipment and will thus choose to provide the technologies on a back-up basis. As explained earlier, the technologies necessary to accomplish this temperature management are enhancements of both the Tier 3 emission control technologies that will form the starting point for Tier 4 engines larger than 50 hp, and the control strategies being developed for highway diesel engines.[41] Based on our analyses, we believe that there are no nonroad engine applications above 25 horsepower for which these highway engine approaches for temperature management will not work. However, we agree with commenters that given the diversity in nonroad equipment design and application, additional time will be needed in order to match the engine performance characteristics to the full range of nonroad equipment.

We have concluded that, given the timing of the emissions standards finalized today, and the availability and continuing development of technologies to address temperature management for highway engines which technologies are transferrable to all nonroad engines with greater than 25 hp power rating, nonroad engines can be designed to meet the new standards in the lead time provided, and can be provided to equipment makers in a timely manner within that lead time.

b. Nonroad Operating Conditions and Durability

Nonroad equipment is designed to be used in a wide range of tasks, from mining equipment to crop cultivation and harvesting to excavation and

[39] Sasaki, S., Ito, T., and Iguchi, S., ''Smoke-less Rich Combustion by Low Temperature Oxidation in Diesel Engines,'' 9th Aachener Kolloquim Fahrzeug—und Motorentechnik 2000. Copy available in EPA Air Docket A–2001–28 Item II–A–56.

[40] Jeuland, N., *et al.,* ''Performances and Durability of DPF (Diesel Particulate Filter) Tested on a Fleet of Peugeot 607 Taxis First and Second Test Phases Results,'' October 2002, SAE 2002–01–2790.

[41] We do not have Tier 3 emission standards for engines in the horsepower category from 25–50 hp. However, we expect that similar Tier 3 emission control technologies will form part of the emission control technology package used for compliance with the Tier 4 standards for these engines in 2013. Our cost analysis reflects the additional cost to apply these technologies for NO_X and PM control.

loading, and operated in harsh environments. In the normal course of equipment operation the engine and its associated hardware will experience levels of vibration, impacts, and dust that may exceed conditions typical of highway diesel vehicles. For this reason, some commenters said that the PM filter technology was infeasible for nonroad equipment. We disagree with this assertion and continue to believe that PM filter technologies can be applied to a wide range of nonroad equipment.

Specific efforts to design for the nonroad operating conditions will be required in order to ensure that the benefits of these new emission control technologies are realized for the life of nonroad equipment. Much of the engineering knowledge and experience to address these issues already exists with the nonroad equipment manufacturers. Vibration and impact issues are fundamentally mechanical durability concerns (rather than issues of technical feasibility of achieving emissions reductions) for any component mounted on a piece of equipment (*e.g.*, an engine coolant overflow tank). Equipment manufacturers must design mounting hardware such as flanges, brackets, and bolts to support the new component without failure. Further, the catalyst substrate material itself must be able to withstand the conditions encountered on nonroad equipment without itself cracking or failing. There is a large body of real world testing with retrofit emission control technologies on engines up to 750 hp that demonstrate the durability of the catalyst components themselves even in the harshest of nonroad equipment applications. The evidence for even larger engines (*i.e.*, those above 750 hp) is less conclusive because of the limited number of applications.

Deutz, a nonroad engine manufacturer, sold approximately 2,000 diesel particulate filter systems for nonroad equipment in the period from 1994 through 2000. The very largest of these systems were limited to engine sizes below 850 hp. The majority of these systems were sold into significantly smaller applications. Many of these systems were sold for use in mining equipment. Mining equipment is exposed to extraordinarily high levels of vibration, experiences impacts with the mine walls and face, and encounters high levels of dust. Yet in meetings with the Agency, Deutz shared their experience that no system had failed due to mechanical failure of the catalyst or catalyst housing.[42] The Deutz system utilized a conventional cordierite PM filter substrate as is commonly used for heavy-duty highway truck CDPF systems. The canning and mounting of the system was a Deutz design. Deutz was able to design the catalyst housing and mounting in such a way as to protect the catalyst from the harsh environment as evidenced by its excellent record of reliable function.

A number of commenters asserted that it was not possible to apply conventional CDPF technologies (*i.e.*, ceramic wall-flow filter media) to the largest diesel engines with power ratings above 750 hp. In the draft RIA for the proposal, we described our expectation that these highway-based systems could be assembled into larger systems to work well for these largest diesel engines. While we continue to believe that it may be possible in the time frame of this rulemaking for these conventional CDPFs to be applied to engines with more than 750 hp, based on the evidence provided by the commenters, we now agree that too much uncertainty remains for us to reach that conclusion today. We cannot clearly today describe a method to monitor the soot loading of individual filter elements in a parallel system made up of a significant number of smaller components. This is because for parallel systems the pressure drop (the best current method to monitor filter condition) across all of the parallel components is exactly the same. If a single filter begins to plug and needs to be regenerated it may not be detected in such a system. Therefore, we believe that instead of a massively parallel filter system, an alternate PM filtering media may be more appropriate in order to address issues of scalability, durability and packaging for these largest engines. Fortunately, there are other filter media technologies (*e.g.*, wire or fiber mesh depth filters) that can be successfully scaled to any size and which we have confidence in projecting today will be a more appropriate solution for the bulk of the engines in this size category. Because these depth filtration technologies are not quite as efficient at filtering PM as the ceramic systems that are the dominant solution for the smaller highway diesel engines, we are finalizing a set of PM filter-based standards for engines greater than 750 hp which are slightly higher than the proposed PM standards for these engines. Those standards are discussed in sections II.A and II.B.3 below. Our cost estimates summarized in section VI for engines greater than 750 hp are consistent with the use of either silicon carbide or wire mesh PM filter technologies.

Certain nonroad applications, including some forms of harvesting equipment, consumer lawn and garden equipment, and mining equipment, may have specific limits on maximum surface temperature for equipment components in order to ensure that the components do not serve as ignition sources for flammable dust particles (*e.g.,* coal dust or fine crop/lawn dust). Some commenters have raised concerns that these design constraints might limit the equipment manufacturers ability to install advanced diesel catalyst technologies such as NO_X adsorbers and CDPFs. This concern seems to be largely based upon anecdotal experience with gasoline catalyst technologies where under certain circumstances catalyst temperatures can exceed 1,000 °C and without appropriate design considerations could conceivably serve as an ignition source. We do not believe that these concerns are justified in the case of either the NO_X adsorber catalyst or the CDPF technology. Catalyst temperatures for NO_X adsorbers and CDPFs should not exceed the maximum exhaust manifold temperatures already commonly experienced by diesel engines (*i.e.,* catalyst temperatures are expected to be below 800 °C).[43] CDPF temperatures are not expected to exceed approximately 700 °C in normal use and are expected to only reach the 650 °C temperature during periods of active regeneration. Similarly, NO_X adsorber catalyst temperatures are not expected to exceed 700 °C and again only during periods of active sulfur regeneration as described in section III.C below. Under conditions where diesel exhaust temperatures are naturally as high as 650 °C, no supplemental heat addition from the emission control system will be necessary for regeneration and therefore exhaust temperatures will not exceed their natural level. When natural exhaust temperatures are too low for effective emission system regeneration

[42] ''Summary of Conference Call between U.S. EPA and Deutz Corporation on September 19, 2002 regarding Deutz Diesel Particulate Filter System'', EPA Memorandum to Air Docket A–2001–28 Item II–B–31.

[43] The hottest surface on a diesel engine is typically the exhaust manifold which connects the engines exhaust ports to the inlet of the turbocharger. The hot exhaust gases leave the engine at a very high temperature (800 °C at high power conditions) and then pass through the turbocharger where the gases expand driving the turbocharger providing work. The process of extracting work from the hot gases cools the exhaust gases. The exhaust leaving the turbocharger and entering the catalyst and the remaining pieces of the exhaust system is cooler (as much as 200 °C at very high loads) than in the exhaust manifold.

then supplemental heating, as described earlier, may be necessary but would not be expected to produce temperatures higher than the maximum levels normally encountered in diesel exhaust. Furthermore, even if it were necessary to raise exhaust temperatures to a higher level in order to promote effective emission control, there are technologies available to isolate the higher exhaust temperatures from flammable materials such as dust. One approach would be the use of air-gapped exhaust systems (*i.e.*, an exhaust pipe inside another concentric exhaust pipe separated by an air-gap) that serve to insulate the inner high temperature surface from the outer surface which could come into contact with the dust. The use of such a system also may be desirable in order to maintain higher exhaust temperatures inside the catalyst in order to promote better catalyst function. Another technology to control surface temperature already used by some nonroad equipment manufacturers is water cooled exhaust systems.[44] This approach is similar to the air-gapped system but uses engine coolant water to actively cool the exhaust system.

We thus do not believe that flammable dust concerns will prevent the use of either a NO_X adsorber or a CDPF because catalyst temperatures are not expected to be unacceptably high and because remediation technologies exist to address these concerns. In fact, exhaust emission control technologies (*i.e.*, aftertreatment) have already been applied on both an original equipment manufacturer (OEM) basis and for retrofit to nonroad equipment for use in potentially explosive environments. Many of these applications must undergo Underwriters Laboratory (UL) approval before they can be used.[45] Therefore, while we appreciate the commenters' concerns regarding safety, we remain convinced that the application of these emission control technologies will not compromise (or decrease) equipment safety.

We agree that nonroad equipment must be designed to address safety and durable performance for a wide range of operating conditions and applications that would not commonly be experienced by highway vehicles. We believe further as demonstrated by retrofit experiences around the world that technical solutions exist which allow catalyst-based emission control technologies to be applied to nonroad equipment.

2. Are the Standards for Engines 75–750 hp Feasible?

There are three primary test provisions and associated standards in the Tier 4 program we are finalizing today. These are the Nonroad Transient Cycle (NRTC), the existing International Organization for Standardization (ISO) C1 steady-state cycle, and the highway-based Not-To-Exceed (NTE) provisions.[46] Under today's rules, most nonroad diesel engines must meet the new standards for each of these three test cycles (the exceptions are noted below). Compliance on the transient test cycle includes weighting the results from a cold start and hot start test with the cold start emissions weighted at 1/20 and hot start emissions weighted at 19/20. Additionally, we have alternative optional test cycles including the existing ISO–D2 steady-state cycle and the Transportation Refrigeration Unit (TRU) cycle which a manufacturer can choose to use for certification in lieu of the NRTC and the ISO–C1, provided that the manufacturer can demonstrate to the Agency that the engine will only be used in a limited range of nonroad equipment with known operating conditions. A complete discussion of these various test cycles can be found in chapter 4.2, 4.3, and 4.4 of the RIA.

The standards we are finalizing today for nonroad engines with rated power from 75 to 750 hp are based upon the performance of technologies and standards for highway diesel engines which go into effect in 2007. As explained above, we believe these technologies, namely NO_X adsorbers and catalyzed diesel particulate filters enabled by 15 ppm sulfur diesel fuel, can be applied to nonroad diesel engines in a similar manner as for highway diesel engines. The combustion process and the means to modify that process are fundamentally the same for highway and nonroad diesel engines regardless of engine size. The formation mechanism and quantity of pollutants formed in diesel engines are fundamental characteristics of engine design and are not inherently different for highway and nonroad engines regardless of engine size. The effectiveness of NO_X adsorbers to control NO_X emissions and CDPFs to control PM, NMHC, and CO emissions are determined by fundamental catalyst and filter characteristics. Therefore, we disagree with commenters who suggest that these highway technology based emission standards are infeasible for nonroad engines. We acknowledge the comments raised regarding the unique characteristics nonroad diesel engines which must be considered in setting these standards, and we have addressed those issues by allowing (where appropriate) for additional lead time or slightly less stringent standards for nonroad diesel engines in comparison to highway diesel engines (and likewise have made appropriate cost estimates to account for the technology and engineering needed to address these issues).

PM Standard. We are finalizing a PM standard for engines in this category of 0.01 g/bhp-hr based upon the emissions reductions possible through the application of a CDPF and 15 ppm sulfur diesel fuel. This is the same emissions level as for highway diesel engines in the heavy-duty 2007 (HD2007) program (66 FR 5001, January 18, 2001). While emission levels of engine-out soot (the solid carbon fraction of PM) may be somewhat higher for some nonroad engines when compared to highway engines, these emissions are virtually eliminated (reduced by 99 percent) by the CDPF technology. With application of the CDPF technology, the soluble organic fraction (SOF) portion of diesel PM is predicted to be all but eliminated. The primary emissions from a CDPF equipped engine are sulfate PM emissions formed from sulfur in diesel fuel. The emissions rate for sulfate PM is determined primarily by the sulfur level of the diesel fuel and the rate of fuel consumption. With the 15 ppm sulfur diesel fuel, the PM emissions level from a CDPF equipped nonroad diesel engine will be similar to the emissions rate of a comparable highway diesel engine. Therefore, the 0.01 g/bhp-hr emission level is feasible for nonroad engines tested on the NRTC cycle and on the steady-state cycles, ISO–C1 and ISO–D2. Put another way, control of PM using CDPF technology is essentially independent of duty cycle given active catalyst technology (for reliable regeneration and SOF oxidation), adequate control of temperature (for reliable regeneration) and low sulfur diesel fuel (for reliable regeneration and low PM emissions). While some commenters argued that PM filters will

[44] "Engine Technology and Application Aspects for Earthmoving Machines and Mobile Cranes," Dr. E. Brucker, Liebherr Machines Bulle, SA, AVL International Commercial Powertrain Conference, October 2001. Copy available in EPA Air Docket A–2001–28, Docket Item # II–A–12.

[45] Phone conversation between Byron Bunker, United States Environmental Protection Agency and Dale McKinnon, Manufacturers of Emission Control Association (MECA), 9 April, 2003 confirming the use of emission control technologies on nonroad equipment used in coal mines, refineries, and other locations where explosion proofing may be required.

[46] As an alternative to compliance with the ISO C1 test procedure, a manufacturer can show compliance with the standards by testing over the Ramped Modal Cycle (RMC) as described in section III.F.

not enable the 0.01 PM emission standard for nonroad engines, we remain convinced by the demonstration of 0.01 or lower PM emission levels from a number of diesel engines described in the RIA, that the standard is feasible given the leadtime provided and the availability of 15 ppm sulfur diesel fuel. Likewise, the NTE provisions for nonroad engines are the same as for on-highway engines meeting an equivalent PM control level. The maximum PM emission level from a CDPF equipped diesel engine is primarily determined by the maximum fuel sulfur conversion level experienced at the highest operating conditions. As documented in RIA chapter 4.1.1.3, testing of diesel engines at conditions representative of the highest sulfate PM formation rates shows PM levels below the level required by the NTE provisions when tested on less than 15 ppm sulfur diesel fuel.

NO_X Standard. We are finalizing a NO_X standard of 0.30 g/bhp-hr for engines in this category based upon the emission reductions possible from the application of NO_X adsorber catalysts and the expected emission levels for Tier 3 compliant engines which form the baseline technology for Tier 4 engines. The Tier 3 emission standards are a combined NMHC+NO_X standard of 3.0 g/bhp-hr for engines greater than 100 hp and less than 750 horsepower. For engines less than 100 hp but greater than 50 horsepower the Tier 3 NMHC+NO_X emission standard is 3.5 g/bhp-hr. We believe that in the time-frame of the Tier 4 emission standards, all engines from 75 to 750 hp can be developed to control NO_X emissions to engine-out levels of 3.0 g/bhp-hr or lower.[47] This means that all engines will need to apply Tier 3 emission control technologies (*i.e.*, turbochargers, charge-air-coolers, electronic fuel systems, and for some manufacturers EGR systems) to get to this baseline level. As discussed in more detail in the RIA, our analysis of the NRTC and the ISO–C1 cycles indicates that the NO_X adsorber catalyst can provide a 90 percent or greater NO_X reduction level on the cycles. The standard of 0.30 g/bhp-hr reflects a baseline emissions level of 3.0 g/bhp-hr and a greater than 90 percent reduction of NO_X emissions through the application of the NO_X adsorber catalyst. The additional lead time available to nonroad engine manufacturers and the substantial learning that will be realized from the introduction of these same technologies to highway diesel engines, plus the lack of any fundamental technical impediment, makes us confident that the new NO_X standards can be met.

Given the fundamental similarities between highway and nonroad diesel engines, we believe that the NO_X adsorber technology developed for highway engines can be applied with equal effectiveness to nonroad diesel engines with additional developments in engine thermal management (as discussed in section II.B.2 above) to address the more widely varied nonroad operating cycles. In fact, as discussed previously, the NO_X adsorber catalyst temperature window is particularly well matched to transient operating conditions as typified by the NRTC.

As pointed out by some commenters, compliance with the NTE provisions will be challenging for the nonroad engine industry due to the diversity of nonroad products and operating cycles. However, the technical challenge is reduced somewhat by the 1.5 multiplier used to calculate the NTE standard as discussed in section III.J. Controlling NO_X emissions under NTE conditions is fundamentally similar for both highway and nonroad engines. The range of control is the same and the amount of reduction required is also the same. We know of no technical impediment, nor were any raised by commenters, that would prevent achieving the NTE standard under the zone of operating conditions required by the NTE.

NMHC Standard. Meeting the NMHC standard under the lean operating conditions typical of the biggest portion of NO_X adsorber operation should not present any special challenges to nonroad diesel engine manufacturers. Since CDPFs and NO_X adsorbers contain platinum and other precious metals to oxidize NO to NO_2, they are also very efficient oxidizers of hydrocarbons. NMHC reductions of greater than 95 percent have been shown over transient and steady-state test procedures.[48] Given that typical engine-out NMHC is expected to be in the 0.40 g/bhp-hr range or lower for engines meeting the Tier 3 standards, this level of NMHC reduction will mean that under lean conditions emission levels will be well below the standard. For the same reasons, there is no obstacle which would prevent achieving the NTE standard.

Under the brief episodic periods of rich operation necessary to regenerate NO_X adsorber catalysts, it is possible to briefly experience higher levels of NMHC emissions. Absent a controlling standard, it is possible that these NMHC emissions could be high. There are two possible means to control the NMHC emissions during these periods in order to meet the NMHC standard finalized today. Manufacturers can design the regeneration system and the oxygen storage (oxidation function under rich conditions) of the NO_X adsorber catalyst such that the NMHC emissions are inherently controlled. This is similar to the control realized on today's three-way automotive catalysts which also experience operation that toggles between rich and lean conditions. Secondly, a downstream clean-up catalyst can be used to oxidize the excess NMHC emissions to a level below the standard. This approach has been used in the NO_X adsorber demonstration program at EPA described in the RIA. Our cost analysis for engines in the 75 to 750 hp category includes a cost for a clean-up catalyst to perform this function.

Cold Start. The standards include a cold start provision for the NRTC procedure. This means that the results of a cold start transient test will be weighted with the emissions of a hot start test in order to calculate the emissions for compliance against the standards. In a change from the proposed rule, the weightings are 1/20 cold start and 19/20 for the hot start (as opposed to the proposed weightings of 1/10 and 9/10, respectively) as described more fully in chapter 4.2 of the RIA and section III.F below. Because exhaust temperatures are so important to catalyst performance, a cold start provision is an important tool to ensure that the emissions realized in use are consistent with the expectations of this program. Achieving this standard represents an additional technical challenge for NO_X control and to a lesser extent CO and NMHC control (*i.e.*, control of gaseous pollutants). PM control with a CDPF is not expected to be significantly impacted by cold-start provisions due to the primary filter mechanism being largely unaffected by temperature.

With respect to achievability of the NO_X, CO and NMHC standards, during the initial start and warmup period for a diesel engine, the exhaust temperatures are typically below the light-off temperature of a catalyst. As a result, exhaust stack emissions may initially be higher during this period of

[47] For engines between 75 and 100 horsepower, this may require re-optimization of the engine to lower NO_X emissions if they are higher than 3.0, but we would not expect any new hardware beyond the Tier 3 hardware to be required in the Tier 4 timeframe to accomplish this reduction.

[48] "The Impact of Sulfur in Diesel Fuel on Catalyst Emission Control Technology," report by the Manufacturers of Emission Controls Association, March 15, 1999, pp. 9 & 11. Copy available in EPA Air Docket A–2001–28 Item II–A–67.

operation. The cold start test procedure is designed to quantify these emissions to ensure that emission control systems are designed appropriately to minimize the contribution of cold-start emissions. Cold-start emissions can be minimized by improving catalyst technology to allow for control at lower exhaust temperatures (*i.e.*, by lowering the catalyst light-off temperature) and by applying strategies to quickly raise the exhaust temperature to a level above the catalyst light-off temperature.

There are a number of technologies available to the engine manufacturer to promote rapid warmup of the exhaust and emission control system. These include retarding injection timing, increasing EGR, and potentially late cycle injection, all of which are technologies we expect manufacturers to apply as part of the normal operation of the NO_X adsorber catalyst system. These are the same technologies we expect highway engine manufacturers to use in order to comply with the highway cold start FTP provision which weights cold start emissions more heavily with a 1/7 weighting. As a result, we expect the transfer of highway technology to be well matched to accomplish this control need for nonroad engines as well. Using these technologies we expect nonroad engine manufacturers to be able to comply with the new Tier 4 NO_X, CO, and NMHC emission standards including the cold start provisions of the transient test procedure.

One commenter has raised the concern that if diesel engines are no cleaner than 3 g/bhp-hr NO_X and if NO_X adsorbers can be no more efficient than 90 percent, then any increase in NO_X emissions above the 0.30 g/bhp-hr level on a cold-start test will make the emission standards infeasible. We should clarify, when discussing the emission reduction potential of the NO_X adsorber catalyst generically in the NPRM, we have sometimes simply stated that it is 90 percent or more effective without plainly saying that this refers to our expectation for average performance considering both cold and hot start emissions. More precisely then, we would expect lower effectiveness over the cold-start test procedure with somewhat higher effectiveness realized over the hot-start test procedure. Because of the relative weightings of the two test cycles (*i.e.*, 1/20 for the cold-start and 19/20 for the hot-start), although the degradation of performance below 90 percent over the cold-start cycle can be substantially greater than the performance above 90 percent realized over the hot-start cycle, the standards remain feasible. For example, even if the average NO_X adsorber performance over the cold-start test cycle was only 70 percent, the average NO_X adsorber performance over the hot-start portion of the test cycle would only need to be 91 percent in order to realize a weighted average performance of 90 percent. Similarly, were the cold-start test cycle performance only 50 percent, the hot-start performance would only need to be 92 percent in order to realize a weighted average performance of 90 percent.[49] We are confident, based on our estimates of NO_X adsorber performance over the nonroad test cycle summarized in the RIA, that NO_X adsorber performance in excess of 92 percent can be expected in the time frame of the requirements finalized today.

Complying with the PM standard given consideration of the cold start test procedure is not expected to be as challenging as compliance with the NO_X standard. The effectiveness for PM filtration is not significantly effected by exhaust temperatures, as noted earlier. Thus, PM emission levels are similar over the cold and hot start tests.

The standards that we are finalizing today for nonroad engines with rated horsepower levels from 75 to 750 hp are based upon the same emission control technologies, clean 15 ppm or lower sulfur diesel fuel, and relative levels of emission control effectiveness as the HD 2007 emission standards. We have given consideration to the diversity of nonroad equipment for which these technologies must be developed and the timing of the Tier 3 emissions standards in determining the appropriate timing for the Tier 4 standards. Based upon the availability of the emission control technologies, the proven effectiveness of the technologies to control diesel emissions to these levels, the technology paths identified here to address constraints specific to nonroad equipment, and the additional lead time afforded by the timing of the standards, we have concluded that the standards are technically feasible in the leadtime provided.

3. Are the Standards for Engines Above 750 hp Feasible?

The preceding discussion of the standards for engines of 75 to 750 hp highlights the main thrust of our new Tier 4 program, a focus on realizing very low on-highway like emission levels for the vast majority of nonroad diesel engines. The emission standards and the combination of technologies that we expect will be used to meet those standards are virtually identical to the HD2007 program for on-highway engines. The following three sections (II.B.3, II.B.4, and II.B.5) describing the feasibility of the standards for engines above 750 hp, from 25 to 75 hp, and below 25 hp, while following the same pattern and objective, take additional consideration of the fact that engines and equipment in these size categories have no direct on-highway equivalent and differ from highway engines in substantial ways that cause us to reach differing conclusions regarding the appropriate standards and timing for those standards. Whether in scale, or use, or operating conditions, the characteristics of these engines and equipment are such that we have taken particular consideration of them in setting the timing and level of the standards. The remainder of this section (II.B.3) discusses what makes the above 750 hp category unique and why the standards which we are adopting are technologically feasible.

a. What Makes the Over 750 hp Category Different?

The first and most obvious difference for engines in this horsepower category is scale. No on-highway engines come close to the size of the largest engines in this category which can produce in excess of 3,000 horsepower, consist of 16 or more cylinders and have 12 or more turbochargers. The engines, and the equipment that they power, are quite simply significantly larger than any on-highway diesel engine. Many commenters argued that emission technologies from on-highway vehicles could not be simply scaled up for these larger engines and that if they were, the consequences of this resizing would include structural weakness and reduced system robustness. As discussed below, our review of the information provided with these comments and our subsequent analysis of the technical characteristics of some emission control components has led us to conclude that revised emission standards (based on performance of different technologies that those whose performance formed the basis for the proposed rule) from those we proposed for this horsepower category are appropriate and available.

We have concluded that it is appropriate to distinguish between two broad categories of engines over 750 hp grouped by application: Mobile machines and generator sets. Mobile machines include the very largest nonroad equipment used in mining trucks and large excavation equipment.

[49] The combined weighted average performance is calculated as 1/20 (cold-start) + 19/20 (hot-start). Hence it can be seen that 1/20 (70%) + 19/20 (91%) = 90% and likewise that 1/20 (50%) + 19/20 (92%) = 90%.

The environment and operating conditions (especially for vibration) represent the harshest application into which nonroad engines are applied. Design considerations for technologies used to control emissions from engines in these applications must first consider robustness to the harsh environments that will be experienced in use. In contrast, mobile nonroad generator sets operate in relatively good operating environments. In addition, while mobile nonroad generator sets can, and are moved between operating locations, they are always stationary during actual operation. Thus the levels of vibration and the general environment for engine operation are significantly less demanding for generator sets than for mobile machines. Also the dynamic range of operation is significantly narrower and less demanding for generator sets. Designed to operate at a set engine speed, synchronous to the frequency cycle desired for electric generation (*i.e.*, 1200 or 1800 RPM for 60 hz), diesel engines designed for generator set applications can be optimized for operation in this narrow range.

We have given specific consideration to the unique engineering challenges for engines in this horsepower category in determining the appropriate emission standards set in today's action. We have also taken into account the important differences between generator set applications and other mobile applications in developing standards for this horsepower category.

b. Are the New Tier 4 Standards for Over 750 hp Engines Technologically Feasible?

The emission standards described in section II.A above describe a comprehensive program for engines over 750 hp that give consideration to both the physical size of these engines and the applications into which these engines are applied. Engines in this power category must show compliance with the C1 or D2 steady-state test cycles as appropriate as well as with the NTE provisions finalized today. As described in sections III.F and III.G, these engines will not be tested over the NRTC nor will they be subject to a cold-start test procedure. The feasibility discussion in this section describes expected performance of the engines over the required test cycles and the NTE. This section will briefly summarize the feasibility analysis contained in the RIA for these engines.

PM Standards. Beginning in 2011 all nonroad diesel engines above 750 hp must meet a PM standard of 0.075 g/bhp-hr. We believe that this PM standard is feasible based on the substantial reductions in sulfate PM due to the use of 15 ppm sulfur diesel fuel and the potential to improve the combustion process to reduce PM emissions formed in the engine. Specifically, we believe based on the evidence in the RIA that increasing fuel injection pressure, improving electronic controls and optimizing the combustion system geometry will allow engine manufacturers to meet this level of PM control in 2011. Some engine manufacturers have in fact indicated to the Agency that this level of control represents an achievable goal by 2011. One commenter argued however, that a more relaxed standard of 0.1 g/bhp-hr based on today's on-highway diesel engine performance would be appropriate. We disagree with this comment, believing that given the substantial leadtime available and the potential for further improvements in combustion systems, that it is appropriate to set a forward looking PM standard of 0.075 g/bhp-hr. Conversely, other commenters argued that future on-highway PM filter technology should be applied to this class of engines as early as 2011 (*i.e.*, that a standard of 0.01 g/bhp-hr PM is appropriate). While we agree with the commenters that in the long-term it will be appropriate to apply filter-based emission control technologies to these engines, we do not agree that such control is appropriate as early as 2011. As the following section explains, we believe that there are remaining technical challenges to be addressed prior to the application of PM filters to these engines and that it is necessary to allow additional leadtime for those challenges to be addressed.

Beginning in 2015 all nonroad engines over 750 hp must meet stringent PM filter technology-based emission standards of 0.02 g/bhp-hr for engines used in generator set applications and 0.03 g/bhp-hr for engines used in mobile machine applications. We are predicating these emission standards based on the application of a different form of diesel particulate filter technology, a wire or fiber mesh depth filter rather than a ceramic wall flow filter. Wire mesh filters are capable of reducing PM by 70 percent or more. We have not based these standards upon the more efficient (>90 percent) control possible from ceramic wall flow style PM filters, because we believe that the application of the wall flow filter technology on engines of this size has not been adequately demonstrated at this time. While it would certainly be possible to apply the ceramic-based technology to these larger engines, we cannot today conclude with certainty that such systems would be as robust in-use as needed (see earlier discussion in section II.B.1.b). Considering the information available to the Agency today, we believe it appropriate to set the long term PM standard for these very large engines based on technologies which we can project with confidence will give high levels of emission reduction, durability, and robustness when scaled to these very large engine sizes.

The 0.01 g/bhp-hr difference in the PM emission standards between the standard for generator sets and for other mobile applications in this category (0.01 g/bhp-hr lower for generator sets) reflects our expectation that engine-out emissions from generator sets can be reduced below the level for mobile machines due to generator set operation at a single engine speed. Without the need to provide full power and control over the wider range of possible operating conditions that mobile machines must deliver, we believe that the air handling systems (especially the turbocharger match to the engine) can be improved to provide a moderate reduction in engine-out emissions. This, coupled with the reduction afforded by the PM filter technology, would allow generator sets to meet a more stringent 0.02 g/bhp-hr standard. Diesel engines designed for use in generator sets meeting this standard will need to demonstrate compliance over the appropriate test cycles, either the ISO C1 or D2 tests. As discussed in RIA chapter 4.3.6.2, PM emission rates are nearly the same for steady-state testing or for alternative ramped modal cycle (RMC) testing. These test cycles, like the engines, are designed to be representative of the range of operation expected from a generator set.

As discussed previously, PM emission control over the NTE region for PM filter equipped diesel engines is predominantly a function of sulfate formation at high exhaust temperatures. Given that fuel consumption (and thus sulfur) consumption rates on a brake specific basis tend to be lower for engines above 750 hp, we can conclude that the increase in PM emissions over the NTE region will likely be lower for these engines than for engines meeting the 0.01 g/bhp-hr standard. Thus, we can conclude based on the evidence in the RIA that compliance with the NTE provisions for PM is feasible for engines over 750 hp.

Although we are projecting that manufacturers will comply with this standard using a slightly less efficient PM filter technology, we remain convinced that 15 ppm sulfur diesel fuel will still be a necessity for this technology to be applied. Regardless of the filter media chosen for the PM filter, the filter will still require catalyst-based systems to ensure robust regeneration and adequate control of the SOF portion of PM. As these catalyst-based technologies are adversely impacted by sulfur in diesel fuel as described in II.C below, 15 ppm sulfur diesel fuel will be required in order to ensure compliance with the PM standards finalized here for engines over 750 hp.

NO_X Standards. As with the PM standards, we are setting distinct NO_X standards for this category of engines reflecting particular concerns with the application of technologies to engines of this size and our desire to realize significant NO_X reductions as soon as possible. There are two sets of NO_X standards that we are finalizing today, a 0.50 g/bhp-hr NO_X standard for engines used in generator set applications and a 2.6 g/bhp-hr NO_X standard for mobile machines.

For engines used in generator set applications we are finalizing a 0.50 g/bhp-hr standard that goes into effect for engines above 1,200 hp in 2011 and in 2015 for engines above 750 hp. We see two possible technology options for manufacturers to meet these standards. First, compliance with this NO_X standard will be possible through the application of a dual bed NO_X adsorber system (*i.e.,* a system that allows regeneration to be controlled external to the engine). This approach can work well for generator set applications where packaging constraints and vibration issues are greatly reduced. Since this approach requires limited engine redesign, it would be an appealing approach for these large engines sold in very low volumes. NO_X adsorber systems for stationary power generation (systems that never move) are available today on a retrofit basis, and we believe with further development to address packaging and durability concerns that similar systems can be applied to mobile generator sets.[50]

A second possible technology option for engines in this category is urea SCR. The challenges for urea SCR in mobile applications are well known, specifically a lack of urea infrastructure to provide urea refill at diesel fueling locations and a need to ensure that urea is added as necessary in use.[51] These hurdles can be addressed more easily for generator sets than for virtually any other mobile source emission category. Although nonroad generator sets are mobile, in operation they remain at a fixed location where fuel is delivered to them periodically (*i.e.,* a 1,200 hp generator set does not and cannot pull into the local truck stop for a fuel fill). Therefore, the same infrastructure that currently provides urea delivery for stationary power generation can also be utilized for nonroad generator set applications.[52] It would still remain for the manufacturer to develop a mechanism to ensure urea refill, but we believe it is likely that solutions to this problem can be addressed through monitoring as for stationary source emissions or other technology options (*e.g.,* a urea interlock that precludes engine operation without the presence of urea).

Either of these technology approaches could be applied to realize an approximately 90 percent reduction from the current Tier 2 emission levels for these engines in order to comply with an emission standard of 0.50 g/bhp-hr. The 0.50 g/bhp-hr standard is different from our proposed level of 0.30 g/bhp-hr reflecting the changes we have made in this final action to the implementation schedule for this class of engines and therefore our projections for a technology path. At the time of the proposal, we projected that this class of engine would follow an integrated two-step technology path. We are now finalizing a program that anticipates the application of 90 percent effective NO_X control to diesel engines for use in generator sets without a reduction in engine-out NO_X levels beyond Tier 2. This reflects our desire to focus on getting the largest emission reduction possible in the near term (beginning in 2011) from these engines. Where we believe additional technology development is needed, as is the case for mobile machines over 750 hp, we are finalizing a more gradual emission reduction technology pathway anticipating further reductions in engine-out NO_X emissions followed by a possible future action to reduce emissions further as described in section II.A. RIA chapter 4.1.2.3.3 describes NO_X adsorber effectiveness to control NO_X emissions including effectiveness over the NTE region. The discussion there is equally applicable to engines above and below 750 hp regarding NTE performance because the key attribute of NTE performance (exhaust temperature) is similar for engines across the horsepower range.

For engines over 750 hp used in mobile machines (and for 750–1200 hp generator sets from 2011 until 2015) we are setting a new NO_X standard of 2.6 g/bhp-hr beginning in 2011. We are predicating this level of emission control (an approximate 50 percent reduction from Tier 2) on an improved combustion system and proven engine-based NO_X control technologies. Specifically, we believe manufacturers can apply either proven cooled EGR technology, or apply additional levels of engine boost, a limited form of Miller Cycle operation, and increased intercooling capacity for the two-stage turbocharging systems that are used on these engines. The second approach for in-cylinder emissions reductions is similar in description at least to the Caterpillar ACERT technology which we believe could be another path for compliance with this standard. We are projecting a modest increase in heat-rejection to the engine coolant for these in-cylinder emission control solutions and have accounted for those costs in our cost analysis. These approaches for NO_X reduction have been proven for on-highway diesel engines since 2003 including compliance with NTE provisions similar to those for nonroad engines finalized here. We can conclude based on the on-highway experience that the NTE provisions can be met for engines in this horsepower category. One commenter suggested that a standard of 3.5 g/bhp-hr would be achievable in this time frame. As described here, we believe that further emission reductions to 2.6 g/bhp-hr are possible in this time frame. Engine manufacturers have indicated to the Agency that they believe this level of in-cylinder emission control can be realized for these very large diesel engines by 2011. We are deferring any decision on setting aftertreatment based NO_X standards for mobile machinery above 750 hp to allow additional time to evaluate the technical issues involved, as discussed in section II.A.4.

NMHC Standards. We are setting two different NMHC emission standards for engines in this category linked to the technologies used to control PM emissions. We are requiring all engines over 750 hp to meet an NMHC standard of 0.30 g/bhp-hr starting in 2011. As explained earlier, in 2011 all engines over 750 hp must meet a PM emission standard of 0.075 g/bhp-hr. We are projecting that manufacturers will meet this standard through improvements in in-cylinder emission control of PM (in conjunction with use of 15 ppm sulfur diesel fuel). These PM control technologies, increased fuel injection

[50] Emerachem EMx™ Datasheet—Describing the EMx IC (Internal Combustion) System Air Docket OAR–2003–0012–0948.

[51] See for example 68 FR 28375, May 23, 2003.

[52] Fleetguard StableGuard™ Urea Premix for use with SCR NO_X Reduction Systems, Air Docket A–2001–28 Item IV–A–04.

pressure, improved electronic controls and enhanced combustion system designs will concurrently lower NMHC emissions to the NMHC standard of 0.30 g/bhp-hr.

The second step in our NMHC standards is to a level of 0.14 g/bhp-hr, consistent with the standard for on-highway diesels beginning in 2007 and for other nonroad diesel engines from 75 to 750 hp beginning in 2011. This change in NMHC standards is timed to coincide with the requirement that engines over 750 hp meet stringent PM emission standards that we believe will require the use of catalyst-based diesel particulate filter systems. These systems are expected to incorporate oxidation catalyst functions to control the SOF portion of diesel PM and to promote robust soot regeneration within the filter. This same oxidation function is highly effective at controlling NMHC emissions (the RIA documents reductions of more than 80 percent) and will result in a reduction in NMHC emissions below the 0.14 g/bhp-hr standard for these engines. As the high level of NMHC control afforded by the application of this technology is broadly realized across the wide range of diesel engine operation, it will allow for compliance with the NTE provisions as well. Although in practice we expect that NMHC emissions may be lower than the 0.14 g/bhp-hr standard, we have not finalized a more stringent standard for NMHC in order to maintain consistency with the NMHC standard we are finalizing for engines from 75 hp to 750 hp, for which the NMHC standard is in part based on feasibility considerations for NO_X adsorber catalyst systems that use diesel fuel to regenerate themselves (with consequent increased NMHC emissions during regeneration events). We believe this is appropriate considering our expectation that NO_X adsorber technology will be found feasible for all nonroad engines over 750 hp.

4. Are the New Tier 4 Standards for Engines 25–75 hp Feasible?

As discussed in section II.B, our standards for 25–75 hp engines consist of a 2008 transitional standard and long-term 2013 standards. The transitional standard is a 0.22 g/bhp-hr PM standard. The 2013 standards consist of a 0.02 g/bhp-hr PM standard and a 3.5 g/bhp-hr NMHC+NO_X standard.[53] As discussed in section II.A, the transitional standard is optional for 50–75 hp engines, as the 2008 implementation date is the same as the effective date of the Tier 3 standards. Manufacturers may decide, at their option, not to undertake the 2008 transitional PM standard, in which case their implementation date for the 0.02 g/bhp-hr PM standard begins in 2012. The remainder of this section discusses what makes the 25–75 hp category unique and why the standards are technologically feasible.

a. What Makes the 25–75 hp Category Unique?

As EPA explained in the proposal, and as discussed in section II.A, one cannot assume that highway technologies are automatically transferable to 25–75 hp nonroad engines. In contrast with 75–750 hp engines, which share similarities in displacement, aspiration, fuel systems, and electronic controls with highway diesel engines, engines in the 25–75 hp category have a number of technology differences from the larger engines. These include a higher percentage of indirect-injection fuel systems, and a low fraction of turbocharged engines (see generally RIA chapter 4.1). The distinction in the under 25 hp category is even more pronounced, with no turbocharged engines, nearly one-fifth of the engines have two cylinders or less, and a significant majority of the engines have indirect-injection fuel systems.

The distinction is particularly marked with respect to electronically controlled fuel systems. These are commonly available in the power categories greater than or equal to 75 hp, but, based on the available certification data as well as our discussions with engine manufacturers, we believe there are very limited numbers, if any, in the 25–75 hp category (and no electronic fuel systems in the less than 25 hp category). The research and development work being performed today for the heavy-duty highway market is targeted at engines which are 4-cylinders or more, direct-injection, electronically controlled, turbocharged, and with per-cylinder displacements greater than 0.5 liters. As discussed in more detail below, as well as in section II.B.5 (regarding the under 25 hp category), these engine distinctions are important from a technology perspective and warrant a different set of standards for the 25–75 hp category (as well as for the under 25 hp category).

b. Are the New Tier 4 Standards for 25–75 hp Engines Technologically Feasible?

This section will discuss the technical feasibility of both the interim 2008 PM standard and the 2013 standards. For an explanation and discussion of the implementation dates, please refer to section II.A.

i. 2008 PM Standards[54]

We are today finalizing the interim PM control program as proposed for engines in the power category from 25–75 hp. The new PM standard for 2008 is 0.22 g/bhp-hr over the appropriate steady-state test cycle (the NRTC and NTE do not apply, for the reasons explained below).[55] The standard is premised on the use of 500 ppm sulfur diesel fuel and the potential for improvements in engine-out emission control where possible or the application of a diesel oxidation catalyst (DOC). Some commenters raised concerns that this level of emission control from diesel engines may not be possible in 2008 without fuel cleaner than 500 ppm or without changes in the Tier 3 NMHC+NO_X emission standards. Other commenters, including some engine manufacturers, supported this interim program. As explained in the following sections, we continue to believe that these standards are appropriate and feasible in the leadtime provided.

Engines in the 25–50 hp category must meet Tier 2 NMHC+NO_X and PM standards today. We have examined the model year 2004 engine certification data for engines in the 25–50 hp category. These data indicate that over 35 percent of the engine families meet the 2008 0.22 g/bhp-hr PM standard and 5.6 g/bhp-hr NMHC+NO_X standard (unchanged from Tier 2 in 2008) today (even without 500 ppm sulfur diesel fuel). At the time of the proposal, we had analyzed model year 2002 data for this power range, which at that time indicated approximately 10 percent of the engine families complied with the 2008 requirements. The most recent data for model year 2004 indicates substantial progress has already been made in just the past few year in lowering emissions from these engines. This is primarily due to the implementation of the Tier 2 standards in model year 2004. The model year

[53] The 2013 NO_X+NMHC standard is a new standard only for engines in the 25–50 hp category. For engines in the 50–75 hp category, 3.5 g/bhp-hr NO_X+NMHC is the existing Tier 3 emission standard which will now also apply across the new regulated test cycles (*e.g.*, NRTC).

[54] As discussed in section II.B., manufacturers can choose, at their option, to pull-ahead the 2013 PM standard for the 50–75 hp engines to 2012, in which case they do not need to comply with the transitional 2008 PM standard.

[55] However, a manufacturer can choose to comply over the TRU cycle including the associated NTE provisions. Compliance with the NTE for engines selecting to certify on the TRU cycle is straightforward because by the very nature of the products, their operation is directly limited to a small range of operating modes over which compliance with the emission standard has already been shown.

2001 certification data also showed the 2008 standard were achievable using a mix of engine technologies (IDI and DI, turbocharged and naturally aspirated) tested on a variety of certification test cycles.[56] A detailed discussion of these data is contained in the RIA.

At the time of the proposal, no certification data was available for engines in the 50–75 hp range, because those engines were not subject to a Tier 1 standard and were not subject to Tier 2 standards until model year 2004. We have now had an opportunity to analyze the model year 2004 certification data for engines in the 50–75 hp range. These data shows that more than 70 percent of the engine families in this power range are capable of meeting the 2008 PM standards today. However, most of these engines do not yet meet the 3.5 g/bhp-hr Tier 3 NMHC+NO_X standard, which is required in 2008. We expect that to comply with the Tier 3 standards, these engines will use technologies such as EGR and electronically controlled fuel injection systems (and we included the costs of these technologies in assessing the costs of the Tier 3 standards). These technologies have been shown to reduce NO_X emissions by 50 percent without increasing PM emissions. The certification data show that for the 70 percent of the engine families which meet the 2008 Tier 4 PM standard (0.22 g/bhp-hr), a NO_X reduction of less than 50 percent is needed for most of these engines to meet the 2008 Tier 4 NMHC+NO_X standard. A detailed discussion of these data is contained in the RIA.

In addition to using known engine-out techniques, we also project that the 2008 standards can be achieved with the use of DOCs. DOCs are passive flow-through emission control devices which are typically coated with a precious metal or a base-metal washcoat. DOCs have been proven to be durable in use on both light-duty and heavy-duty diesel applications. In addition, DOCs have already been used to control carbon monoxide on some nonroad applications.[57] Some commenters raised concerns that DOCs could actually increase PM emissions when used on 500 ppm sulfur diesel fuel due to the potential for oxidation of the sulfur in the fuel to sulfate PM. While we agree with the commenters that sulfur reductions are important to control PM and in the long term that a 15 ppm fuel sulfur level will be the best solution, we disagree with the assertion that the amount of sulfate PM formed from a DOC will be such that compliance with the 0.22 g/bhp-hr standard will be infeasible. While commenters shared data showing increased PM emissions when DOCs are used, we have similarly found data (included in the RIA) that shows an overall reduction in emissions. To understand this discrepancy, it is important to realize that DOCs can be designed for operation on a range of fuel sulfur levels. The lower the fuel sulfur level, the more effective the PM oxidation function, but even at 500 ppm sulfur a properly designed DOC will realize a net reduction in PM emissions. DOCs have been successfully applied to diesel engines for on-highway applications for PM control on 500 ppm fuel since 1994 through careful design of the DOC trading-off PM reduction potential and sulfur oxidation potential. The RIA contains additional analysis describing DOC function, and its expected effectiveness when applied to nonroad diesel engines.

Other commenters argued that the application of DOC to diesel engines in this category would lead to an even greater emission reduction than estimated in our proposal, thus allowing the Agency to finalize a lower PM standard. While we agree that some engines will have lower emissions than required to meet the standard and that in the long term (once 15 ppm fuel is widely available) the PM emissions will be further reduced, we do not believe that an emission level lower than 0.22 g/bhp-hr will be generally feasible in 2008 due to the sulfur level of diesel fuel of 500 ppm sulfur and the potential for sulfate PM formation.

In summary then, there are two likely means by which companies can comply with the interim 2008 PM standard. First, engine manufacturers can comply with this standard using known engine-out techniques (*e.g.*, optimizing combustion chamber designs, fuel-injection strategies). In fact, some fraction of engines already would comply with the emission standard. In addition, some engine manufacturers may choose to use diesel oxidation catalysts to meet this standard. Our cost analysis makes the conservative assumption (*i.e.*, the higher cost assumption) that all manufacturers will use DOC catalysts to comply with these emission standards.

Based on the existence of a number of engine families which already comply with the 0.22 g/bhp-hr PM standard (and the 2008 NMHC+NO_X standard), and the availability of well known PM reduction technologies such as engine-out improvements and diesel oxidation catalysts, we project that the 0.22 g/bhp-hr PM standards is technologically feasible by model year 2008.

ii. 2013 Standards

For engines in the 25–50 range, we are finalizing standards commencing in 2013 of 3.5 g/bhp-hr for NMHC+NO_X and 0.02 g/bhp-hr for PM. For the 50–75 hp engines, we are finalizing a 0.02 g/bhp-hr PM standard which will be implemented in 2013, and for those manufacturers who choose to pull-ahead the standard one-year, 2012 (manufacturers who choose to pull-ahead the 2013 standard for engines in the 50–75 range do not need to comply with the transitional 2008 PM standard). A more complete discussion of the options available to manufacturers and the nature of the transitional program can be found in section II.A. These standards are measured using the NRTC and steady-state tests. These engines also will be subject to the NTE starting with the 2013 model year.

PM Standard. For engines in the horsepower category from 25–75 hp, we are finalizing a PM standard of 0.02 g/bhp-hr based on the application of catalyzed diesel particulate filters to engines in this category. We received a wide range of comments on our proposal with some arguing that the emission standard could be met earlier than 2013 and others arguing that while technically possible to apply PM filters to engines in this category, that it was not economically or otherwise practical to do so.

The RIA discusses in detail catalyzed diesel particulate filters, including explanations of how CDPFs reduce PM emissions, and how to apply CDPFs to nonroad engines. We have concluded, as explained above, that CDPFs can be used to achieve the 0.01 g/bhp-hr PM standard for 75–750 hp engines. As also discussed in section II.B.2.a above, PM filters will require active back-up regeneration systems for many nonroad applications above and below 75 hp because low temperature operation is an issue across all power categories. One commenter raised concerns regarding the low exhaust temperatures possibly experienced by small nonroad engines and argued that such low temperatures make PM filter regeneration impossible absent the use of active regeneration technologies. We agree with the commenter that active regeneration, as described previously, may be necessary and have included the cost for such

[56] The Tier 1 and Tier 2 standards for this power category must be demonstrated on one of a variety of different engine test cycles. The appropriate test cycle is selected by the engine manufacturer based on the intended in-use application of the engine.

[57] EPA Memorandum "Documentation of the Availability of Diesel Oxidation Catalysts on Current Production Nonroad Diesel Equipment," William Charmley. Copy available in EPA Air Docket A–2001–28 Item II–B–15.

systems in our cost estimates. See section II.B.1.a. A number of secondary technologies are likely required to enable proper regeneration, including possibly electronic fuel systems such as common rail systems which are capable of multiple post-injections which can be used to raise exhaust gas temperatures to aid in filter regeneration.

Particulate filter technology, with the requisite trap regeneration technology, can also be applied to engines in the 25 to 75 hp range. As explained earlier, the fundamentals of how a filter is able to reduce PM emissions are not a function of engine power, so that CDPF's are just as effective at capturing soot emissions and oxidizing SOF on smaller engines as on larger engines. The PM filter regeneration systems described in section II.B.2 are also applicable to engines in this size range and are likewise feasible. There are specific trap regeneration technologies which we believe engine manufacturers in the 25–75 hp category may prefer over others. For example, some manufacturers may choose to apply an electronically-controlled secondary fuel injection system (*i.e.*, a system which injects fuel into the exhaust upstream of a PM filter). Such a system has been commercially used successfully by at least one nonroad engine manufacturer, and other systems have been tested by technology companies.[58] However, we recognize that the application of these technologies will be challenging and will require additional time to develop. We therefore disagree with commenters who say that the standard could be met sooner and have decided to finalize the implementation schedule as proposed.

As we proposed, we are finalizing a slightly higher PM standard (0.02 g/bhp-hr rather than 0.01) for engines in this power category. As discussed in the preamble to the proposed rule and in some detail in the RIA, with the use of a CDPF, the PM emissions emitted by the filter are primarily derived from the fuel sulfur (68 FR 28389–28390, May 23, 2003). The smaller power category engines tend to have higher fuel consumption per unit of work than larger engines. This occurs for a number of reasons. First, the lower power categories include a high fraction of IDI engines which by their nature consume approximately 15 percent more fuel than a DI engine. Second, as engine displacements get smaller, the engine's combustion chamber surface-to-volume ratio increases. This leads to higher heat-transfer losses and therefore lower efficiency and higher fuel consumption. In addition, frictional losses are a higher percentage of total power for the smaller displacement engines which also results in higher fuel consumption. Because of the higher fuel consumption rate, we expect a higher particulate sulfate level, and therefore we have set a 0.02 g/bhp-hr standard for engines in this power category. We did not receive any comments on our proposal arguing that the technical basis for this higher PM level was inappropriate.

The 0.02 g/bhp-hr standard applies to all of the test cycles applicable to engines in this power category (*i.e.*, the NRTC including cold-start, the ISO C1, D2 and G2 cycles and the alternative TRU and RMC cycles, as appropriate). Our feasibility analysis summarized here and detailed in the RIA takes into consideration these different test cycles. The control technologies work in a similar manner and provide the same high level of emission control across these different operating regimes including the NTE. The most significant effect on emission performance is related to sulfate PM formation at high load, high temperature operating conditions. As the RIA details, this level of high sulfate formation rate is not high enough to preclude compliance with the PM emission standard with 15 ppm fuel sulfur on the regulated test cycles nor is it high enough to preclude compliance with the NTE provisions. At higher fuel sulfur levels however, compliance with the PM emission standard would not be feasible.

The majority of negative comments on our proposal to set a PM standard based on the control possible from PM filter technologies focused on the economic and technical challenges to apply these technologies and the major engine technology enabler, electronic fuel systems, to smaller diesel engines. Some commenters acknowledged that the technologies were ''technically feasible'' but not economically feasible or practical for engines in this power category. While we acknowledge that the application of these technologies to diesel engines in this horsepower category will be challenging and have given consideration to this in setting the timing for the new standard, we believe that the technical path for compliance is clear and that the cost estimates we have made for these engines accurately represent this technical path. As discussed in the RIA, at the time of the proposal we projected no significant penetration of electronic fuel systems for engines in the 50–100 hp range prior to the Tier 3 standards (2008). Since the proposal, new information regarding model year 2004 engine certifications has become available. That data show 18 percent of the engines in the 75–100 hp category already use electronically controlled fuel systems. In model year 2001, no engines in this category used electronic fuel systems. We believe this strong trend toward the introduction of more advanced electronic fuel system technology will continue in the future and, importantly for engines in the 25–75 hp category, will extend to ever smaller engine categories due to the user benefits provided by the technology and the falling cost for such systems. However, acknowledging the substantial time between now and 2012, and the potential for technologies to mature faster or slower than we are estimating here, we have decided to conduct a technology review of these standards as described in section II.A above. This review will provide EPA with another opportunity to confirm that the technical path laid out here is indeed progressing in a manner consistent with our expectations.

NMHC+NO_X Standard. As we proposed, we are finalizing a 3.5 g/bhp-hr NMHC+NO_X standard for engines in the 25–50 hp range for 2013. We received limited comments arguing that the NMHC+NO_X standard should be less stringent. Like the PM standard, some commenters argued that the NO_X standard would be costly and complicated, although not necessarily infeasible to apply. Other commenters argued that the NO_X standard for engines in this category like the new standard for larger engines, should be based upon the application of advanced NO_X catalyst-based technologies. As described previously in section II.A, we do not believe that the catalyst-based NO_X technologies have matured to a state were we can accurately define a feasible technical path for compliance for engines in this power category. We intend to revisit this question in our technology review and if we find that a viable technical path can be described we will consider the appropriateness of a more stringent catalyst-based standard.

The new standard aligns the NMHC+NO_X standard for engines in this power range with the Tier 3 standard for engines in the 50–75 hp range which are implemented in 2008. EPA's recent Staff Technical paper which reviewed the technological feasibility of the Tier 3 standards contains a detailed discussion of a number of technologies which are capable of achieving a 3.5 g/bhp-hr standard. These include cooled EGR, uncooled EGR, as well as advanced in-

[58] ''The Optimized Deutz Service Diesel Particulate Filter System II,'' H. Houben *et. al.*, SAE Technical Paper 942264, 1994 and ''Development of a Full-Flow Burner DPF System for Heavy Duty Diesel Engines,'' P. Zelenka *et. al.*, SAE Technical Paper 2002–01–2787, 2002.

cylinder technologies relying on electronic fuel systems and turbocharging.[59] These technologies are capable of reducing NO_X emissions by as much as 50 percent. Given the Tier 2 NMHC+NO_X standard of 5.6 g/bhp-hr, a 50 percent reduction would allow a Tier 2 engine to comply with the 3.5 g/bhp-hr NMHC+NO_X standard set in this action. Therefore, we are projecting that 3.5 g/bhp-hr NO_X+NMHC standard is feasible with the addition of cooled EGR (the basis for our cost analysis) or other equally effective in-cylinder NO_X control technology as described in the RIA and our recent Staff Technical Paper. In addition, because this NMHC+NO_X standard is concurrent with the 0.02 g/bhp-hr PM standards which we project will be achievable with the use of particulate filters, engine designers will have significant additional flexibility in reducing NO_X because the PM filter will lessen the traditional concerns with the engine-out NO_X vs. PM trade-off.

Our recent highway 2004 standard review rulemaking (see 65 FR 59896, October 2000) demonstrated that a diesel engine with advanced electronic fuel injection technology as well as NO_X control technology such as cooled EGR is capable of complying with an NTE standard set at 1.25 times the laboratory-based FTP standard. We project that the same technology (electronic fuel systems and cooled EGR) are also capable for engine in the 25–75 hp range of complying with the NTE standard of 4.4 g/bhp-hr NMHC+NO_X (1.25×3.5) in 2013. This is based on the broad NO_X reduction capability of cooled EGR technology, which is capable of reducing NO_X emissions across the engine operating map (including the NTE region) by at least 30 percent even under high load conditions.[60]

Based on the information available to EPA and presented here, and giving appropriate consideration to the lead time necessary to apply the technology as well, we have concluded the 0.02 g/bhp-hr PM standard for engines in the 25–75 hp category and the 3.5 g/bhp-hr NMHC+NO_X standards for the 25–50 hp engines are achievable.

5. Are the Standards for Engines Under 25 hp Feasible?

As we explained at proposal and as discussed in section II.A, the new PM standard for engines less than 25 hp is 0.30 g/bhp-hr beginning in 2008. The certification test cycle for this standard is the ISO C1 cycle (or other appropriate steady-state test as defined by the engine's intended use) from 2008 through 2012. Beginning in 2013, the NRTC (with cold-start) and the NTE will also apply to engines in this category. As discussed below, we are not setting a new standard more stringent than the existing Tier 2 NMHC+NO_X standard for this power category at this time. This section describes what makes the less than 25 hp category different and why the standards are technologically feasible.

a. What Makes the Under 25 hp Category Unique?

As we explained at proposal and in the RIA, nonroad engines less than 25 hp are the least sophisticated nonroad diesel engines from a technological perspective. All of the engines currently sold in this power category lack electronic fuel systems and turbochargers. Nearly 20 percent of the products have two-cylinders or less, and 14 percent of the engines sold in this category are single-cylinder products, a number of these have no batteries and are crank-start machines, much like today's simple walk behind lawnmower engines. In addition, given what we know today and taking into account the Tier 2 standards which have not yet been implemented, we are not projecting any significant penetration of advanced engine technology, such as electronically controlled fuel systems, into this category in the next 5 to 10 years.

b. What Data Indicate That the Standards Are Feasible?

We project the Tier 4 PM standard can be met by 2008 based on: The existence of a large number of engine families which meet the new standards today; the use of engine-out reduction techniques; and the use of diesel oxidation catalysts.

Engines in the less than 25 hp category must meet Tier 1 NMHC+NO_X and PM standards today. We have examined the 2004 model year engine certification data for nonroad diesel engines less than 25 hp. These data indicate that a number of engine families meet the new Tier 4 PM standard (and the 2008 NMHC+NO_X standard, unchanged from Tier 2) today. The data show that 31 percent of the engine families are at or below the PM standard today, while meeting the 2008 NMHC+NO_X standard. At the time of the proposal, we examined the model year 2002 certification, which indicated approximately 30 percent of the engine families were at or below the 2008 emission standards. This certification data includes both IDI and DI engines, as well as a range of certification test cycles.[61] Many of the engine families are certified well below the Tier 4 standard while meeting the 2008 NMHC+NO_X level. Specifically, for the model year 2002 data, 15 percent of the engine families are cleaner than the new Tier 4 PM standard by more than 20 percent. The public certification data indicate that these engines do not use turbocharging, electronic fuel systems, exhaust gas recirculation, or aftertreatment technologies. We saw little change between the model year 2002 and 2004 data for this power category primarily because both model years are subject to the Tier 1 standards, and many engine families are simply carried over from the previous model year. Tier 2 standards for these engines will not be implemented until model year 2005. A detailed discussion of these data is contained in the RIA.

In summary then, there are two likely means by which companies can comply with the 2008 PM standard for engines under 25 hp. First, engine manufacturers can comply with this standard using known engine-out techniques (*e.g.*, optimizing combustion chamber designs, fuel-injection strategies). In fact, some fraction of engines already would comply with the emission standard. In addition, some engine manufacturers may choose to use diesel oxidation catalysts to meet this standard. Our cost analysis makes the conservative assumption (*i.e.*, the higher cost assumption) that all manufacturers will use DOCs to comply with these emission standards.

As discussed in section II.A, we are finalizing supplemental test procedures and standards (nonroad transient test cycle and not-to-exceed requirements) for engines in the under 25 hp category beginning in 2013. The supplemental test procedures and standards will apply not only to PM, but also to NMHC+NO_X. The engine technologies necessary to comply with the supplemental test procedures and standards are the same as the technology necessary to comply with the 2008 standard, and we have given

[59] See section 2.2 through 2.3 in "Nonroad Diesel Emission Standards—Staff Technical Paper," EPA Publication EPA420–R–01–052, October 2001. Copy available in EPA Air Docket A–2001–28.

[60] See section 8 of "Control of Emissions of Air Pollution from 2004 and Later Model Year Heavy-Duty Highway Engines and Vehicles: Response to Comments," EPA document EPA420–R–00–011, July 2000, and chapter 3 of "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Highway Heavy-duty Engines," EPA document EPA420–R–00–010, July 2000. Copies of both documents available in EPA docket A–2001–28.

[61] The Tier 1 and Tier 2 standards for this power category must be demonstrated on one of a variety of different engine test cycles. The appropriate test cycle is selected by the engine manufacturer based on the intended in-use application(s) of the engine.

consideration to these test conditions in setting this standard. The range of operating conditions covered by the various test cycles and the mechanism for emission control over those ranges of operation are substantially similar allowing us to conclude that emission control will be substantially uniform across these test procedures. However, we are delaying the implementation of the supplemental test procedures and standards until 2013, as proposed, in order to implement these supplemental requirements on the larger powered nonroad engines before the smallest power category. (There were no adverse comments on this aspect of the proposed rule.) This will also provide engine manufacturers with additional time to install any emission testing equipment upgrades they may need in order to implement the new nonroad transient test cycle.

Based on the existence of a number of engine families which already comply with the new Tier 4 PM standard (and the 2008 NMHC+NO_X standard), and the availability of PM reduction technologies such as improved mechanical fuel systems, combustion chamber improvements, and in particular diesel oxidation catalysts, we project that the 0.30 g/bhp-hr PM standards is technologically feasible by model year 2008.

6. Meeting the Crankcase Emissions Requirements

The most common way to eliminate crankcase emissions has been to vent the blow-by gases into the engine air intake system, so that the gases can be recombusted. Prior to the HD2007 rulemaking, we have required that crankcase emissions be controlled only on naturally aspirated diesel engines. We had made an exception for turbocharged diesel engines (both highway and nonroad) because of concerns in the past about fouling that could occur by routing the diesel particulates (including engine oil) into the turbocharger and aftercooler. However, this is an environmentally significant exception since most nonroad equipment over 75 hp use turbocharged engines, and a single engine can emit over 100 pounds of NO_X, NMHC, and PM from the crankcase over its lifetime.

Given the available means to control crankcase emissions, we eliminated this exception for highway engines in 2007 and similarly in today's action are eliminating the exception for nonroad diesel engines as well. A number of commenters supported this provision noting that the necessary technologies are already in application in Europe and will be required for heavy-duty diesel trucks in the United States beginning in 2007.

We anticipate that the diesel engine manufacturers will be able to control crankcase emissions through the use of closed crankcase filtration systems or by routing unfiltered blow-by gases directly into the exhaust system upstream of the emission control equipment. However, the provisions have been written such that if adequate control can be had without "closing" the crankcase then the crankcase can remain "open." Compliance would be ensured by adding the emissions from the crankcase ventilation system to the emissions from the engine control system downstream of any emission control equipment. We have limited this provision for controlling emissions from open crankcases to turbocharged engines, which is the same as for heavy-duty highway diesel engines.

Some commenters in essence argued that the Agency was obligated to show that all potential compliance paths were feasible and absent that showing that the Agency should reconsider this provision. Our feasibility analysis is based on the use of closed crankcase technologies designed to filter crankcase gases sending the clean gas to the engine intake for combustion and returning the oil filtered from the gases to the engine crankcase. These systems are proven in use and the use of this technology to eliminate crankcase emissions is acceptable to demonstrate compliance. The other options, the option to vent crankcase emissions into the exhaust or to continue to vent crankcase emissions to the atmosphere provided the total emissions including tailpipe and crankcase emissions do not exceed the standards are provided as alternate solutions that are clearly effective to control emissions (*i.e.*, if the emissions are measured and are below the standard they are adequately controlled). The commenter suggests however, that they may not be able to control the emissions to the required level using these alternate approaches. In this case, a manufacturer would need to use the primary approach identified by EPA, closing the crankcase and routing the filtered gases to the engine's intake (this is the approach we used in the cost analysis summarized in section VI). We have allowed the alternative approaches at the recommendation of some in industry, because if they prove to be effective we accept that resulting total emissions will be acceptably low.

C. Why Do We Need 15 ppm Sulfur Diesel Fuel?

The new Tier 4 emission standards for most categories of nonroad diesel engines are predicated on the application of advanced diesel emission control technologies that are being developed for on-highway diesel engines to meet the HD2007 emission standards, namely catalyzed diesel particulate filters and NO_X adsorber catalysts. Sulfur in diesel fuel significantly impacts the durability, efficiency and cost of applying these technologies. Therefore, we required that on-highway diesel fuel produced for use in 2007 or newer on-highway diesel engines have sulfur content no higher than 15 ppm. Based on the same concerns outlined in the 2007 rulemaking, discussed in the proposal at 68 FR 28395–28400, set out in the RIA, and briefly summarized below, we today are finalizing a requirement that diesel fuel for nonroad engines be reduced to no higher than 15 ppm beginning in 2010. There was consensus among commenters that such standards were necessary if the proposed standards based on advanced diesel emission control technologies were to be achievable.

Sulfur in diesel fuel acts to poison the oxidation function of platinum-based catalysts including DOCs and CDPFs reducing the oxidation efficiency substantially, especially at lower temperatures. This poisoning limits the effectiveness of DOCs and CDPFs to oxidize CO and HC emissions. Of even greater concern is the reduction in NO oxidation efficiency of the CDPF due to sulfur poisoning. NO oxidation to NO_2 is a fundamental mechanism for PM filter regeneration necessary to ensure robust operation of the CDPF (*i.e.*, to prevent filter plugging). Sulfur poisoning from sulfur in diesel fuel at levels higher than 15 ppm has been shown to increase the likelihood of PM filter failure due to a depressed NO to NO_2 oxidation efficiency of the CDPF. The RIA documents substantial field experience in Europe regarding this phenomenon.

Sulfur in diesel fuel can itself be oxidized to form sulfate PM emitted into the environment. CDPFs in particular are designed for robust regeneration and are highly effective at oxidizing sulfur to sulfate PM (approaching 100 percent conversion under some circumstances). The sulfate PM emissions from a CDPF when operated on 350 ppm fuel can be so high as to actually increase the PM emission rate above the baseline level for an engine without a PM filter. In spite of more than ten years of research, no effective means has been found to provide the NO to NO_2 oxidation efficiency needed to ensure robust filter regeneration without similarly increasing efficiency to oxidize sulfur to sulfate PM. Conversely, technologies developed to suppress sulfate PM formation (*e.g.*, the addition of vanadium to DOCs designed to operate on 500 ppm sulfur fuel) also suppress NO to NO_2 formation. Therefore, it is not possible to apply the robust CDPF technology to achieve the PM standards without first having lower diesel fuel sulfur levels. The RIA documents substantial test data showing the impact of sulfur in diesel fuel on total PM emissions due to an increase in sulfate PM emissions.

Sulfur from diesel fuel likewise poisons the storage function of the NO_X adsorber catalyst. Sulfur in the exhaust in the form of SO_X is stored on the catalyst in the same way as the NO_X emissions are stored. Unfortunately, due to the chemical properties of the materials, the sulfur is stored preferentially to the NO_X and will actually displace the stored NO_X emissions. The stored sulfur is not easily removed from the catalyst. A sulfur removal step, called a desulfation, can be accomplished by raising exhaust temperatures to a very high level while simultaneously increasing the reductant content of the exhaust above the stoichiometric level (*i.e.*, more fuel than oxygen in the exhaust). This process can be effective to remove sulfur from the catalyst but at the expense of damaging the catalyst slightly. Over the lifetime of a diesel engine the cumulative damage from repeated desulfation events, as would be required if operation on higher than 15 ppm sulfur fuels were attempted, would lead to excessive damage and loss in NO_X control. The RIA contains an extensive description of this phenomena including the tradeoff between higher fuel sulfur levels and more frequent desulfation events.

The damage that sulfur inflicts on both the CDPF and NO_X adsorber technologies not only reduces their effectiveness but also impacts the fuel economy of their application. Reduced soot regeneration potential due to sulfur poisoning would lead to the need for more frequent active CDPF regeneration. As each active soot regeneration event consumes fuel, more frequent regeneration events with higher fuel sulfur levels leads to an increase in fuel consumption. Similarly, higher fuel sulfur levels would necessitate more frequent NO_X adsorber desulfation events and thus higher fuel consumption. An estimate of the impact of higher fuel sulfur levels on fuel economy due to more frequent desulfation events can be found in the RIA.

For all of the reasons documented in the RIA and summarized here, we remain convinced that a cap of 15 ppm fuel sulfur is necessary for both on-highway and nonroad diesel engines in order to apply the advanced emission control technologies necessary to meet the emission standards we are finalizing today.

III. Requirements for Engine and Equipment Manufacturers

This section describes the regulatory changes being made for the engine and equipment compliance program. A number of specific items are discussed in this section, including test procedures, certification fuels, and credit program provisions. These provisions are important in that they help us ensure the engines and equipment will meet the new requirements throughout their entire useful life, thus achieving the expected emission and public health benefits.

One of the most obvious changes from the Tier 2/Tier 3 program is that the regulations for Tier 4 engines have been written in a plain language format. They are structured to contain the provisions that are specific to nonroad compression ignition (CI) engines in a new part 1039, and to apply the general provisions of existing parts 1065 and 1068. The plain language regulations, however, are not intended to significantly change the compliance program, except as specifically noted in today's notice and supporting documents. These plain language regulations will only apply for Tier 4 engines. The changes from the existing nonroad program are described below along with other notable aspects of the compliance program.

As described below, we received comments from a broad range of commenters for some of these issues. For other issues, we received only manufacturer comments or no comments at all. See Chapter 9 of the Summary and Analysis of Comments for more information about the comments received and our responses to them.

A. Averaging, Banking, and Trading

1. Why Are We Adopting an ABT Program for Tier 4 Nonroad Diesel Engines?

EPA has included averaging, banking, and trading (ABT) programs in almost all of its recent mobile source emission control programs. Our existing regulations for nonroad diesel engines include an ABT program (40 CFR 89.201 through 89.212). With today's action we are retaining the basic structure of the existing nonroad diesel ABT program, though we are adopting a number of changes to accommodate implementation of the newly adopted Tier 4 emission standards. The ABT program is intended to enhance the ability of engine manufacturers to meet the stringent standards adopted today. The program is also structured to limit production of very high-emitting engines and to avoid unnecessary delay of the transition to the new exhaust emission control technologies.

We view the ABT program as an important element in setting emission standards that are appropriate under CAA section 213(a) with regard to technological feasibility, lead time, and cost, given the wide breadth and variety of engines covered by the standards. As we noted at proposal, if there are engine families that will be particularly costly or have a particularly hard time coming into compliance with the standard, this flexibility allows the manufacturer to adjust the compliance schedule accordingly, without special delays or exceptions having to be written into the rule. Emission-credit programs also create an incentive for the early introduction of new technology (for example, to generate credits in early years to create compliance flexibility for later engines), which allows certain engine families to act as trailblazers for new technology. This can help provide valuable information to manufacturers on the technology before they apply the technology throughout their product line. This early introduction of clean technology improves the feasibility of achieving the standards and can provide valuable information for use in other regulatory programs that may benefit from similar technologies. Early introduction of such engines also secures earlier emission benefits.

In an effort to make information on the ABT program more available to the public, we intend to issue an annual report summarizing use of the ABT program by engine manufacturers. The information contained in the reports will be based on the information submitted to us by engine manufacturers in their annual reports, and summarized in a way that protects the confidentiality of individual engine manufacturers. We believe this information will also be helpful to engine manufacturers by giving them a better indication of the availability of credits.

2. What Are the Provisions of the ABT Program?

The following section describes the ABT provisions being adopted with today's action. Areas in which we have made changes to the proposed ABT program are highlighted. A complete summary of comments received on the proposed ABT program and our response to those comments are contained in the Summary and Analysis of Comments document for this rule.

The ABT program has three main components. Averaging means the exchange of emission credits between engine families within a given engine manufacturer's product line. Engine manufacturers divide their product line into ''engine families'' that are comprised of engines expected to have similar emission characteristics throughout their useful life. Averaging allows a manufacturer to certify one or more engine families at levels above the applicable emission standard, but below a set upper limit. However, the increased emissions must be offset by one or more engine families within that manufacturer's product line that are certified below the same emission standard, such that the average emissions from all the manufacturer's engine families, weighted by engine power, regulatory useful life, and production volume, are at or below the level of the emission standard. (The inclusion of engine power, useful life, and production volume in the averaging calculations is designed to reflect differences in the in-use emissions from the engines.) Averaging results are calculated for each specific model year. The mechanism by which this is accomplished is certification of the engine family to a ''family emission limit'' (FEL) set by the manufacturer, which may be above or below the standard. An FEL that is established above the standard may not exceed an upper limit specified in the ABT regulations. Once an engine family is certified to an FEL, that FEL becomes the enforceable emissions limit for all the engines in that family for purposes of compliance testing. Averaging is allowed only between engine families in the same averaging set, as defined in the regulations.

Banking means the retention of emission credits by the engine manufacturer for use in future model year averaging or trading. Trading means the exchange of emission credits between nonroad diesel engine manufacturers which can then be used for averaging purposes, banked for future use, or traded to another engine manufacturer.

The existing ABT program for nonroad diesel engines covers NMHC+NO_X emissions as well as PM emissions. With today's action and as proposed, we are making the ABT program available for the Tier 4 NO_X standards (and NMHC+NO_X standards, where applicable) and the Tier 4 PM standards. As proposed, ABT will not be available for the Tier 4 NMHC standards for engines above 75 horsepower.

Engine manufacturers commented that ABT will most likely be necessary for the Tier 4 CO standards, given the reductions in PM and NO_X emissions. In the Tier 4 proposal, we proposed minor changes in CO standards for some engines solely for the purpose of helping to consolidate power categories and improving administrative efficiency. However, as noted earlier in section II.A.6, we have withdrawn this aspect of the proposal. We do note, however, that we are applying new certification tests to all pollutants covered by the rule, the result being that Tier 4 engines will have to certify to CO standards measured by the transient test (including a cold start component), and the NTE. However, as shown in RIA chapter 4.1.1.2 (see *e.g.*, note F), we believe that application of Tier 4 technologies will lead to a reduction in CO emissions over the Tier 3 baseline. We thus believe the CO standards will be readily achievable under the transient test and NTE. Moreover, we believe that there will not be any associated costs: The CO standards can be met without any further technological improvements (*i.e.*, improvements other than those already necessary to meet the Tier 4 standards) and these tests will already be used for certification. Since CO standards measured by the new certification tests are achievable without cost, there is no basis for allowing ABT because no additional lead time is needed.

As noted earlier, the existing ABT program for nonroad diesel engines includes FEL caps—limits on how high the emissions from credit-using engine families can be. No engine family may be certified above these FEL caps. These limits provide manufacturers with compliance flexibility while protecting against the introduction of unnecessarily high-emitting engines. In the past, we have generally set the FEL caps at the emission levels allowed by the previous standard, unless there was some specific reason to do otherwise. With today's action, we are taking a different approach because the level of the standards being adopted for most engines are significantly lower than the current level of the standards. The transfer to new technology is feasible and appropriate. Thus, as proposed, to ensure that the ABT provisions are not used to continue unnecessarily to produce old-technology high-emitting engines under the new program, the FEL caps are not, in general, set at the previous standards. Exceptions have been made for the NMHC+NO_X standard for engines between 25 and 50 horsepower effective in model year 2013 and the NO_X standards applicable to engines above 750 horsepower in 2011, where we are using the estimated NO_X-only equivalent for the previously applicable NMHC+NO_X standard for the FEL cap since the gap between the previous and newly adopted standards is approximately 40 percent (rather than 90 percent for engines between 75 and 750 horsepower), and because the technology basis for these standards can be a form of engine-out control, like the previous tier standards. This approach of setting FEL caps at lower levels than the previously applicable standards is consistent with the level of the FEL limits set in the 2007 on-highway heavy-duty diesel engine program.

STAPPA/ALAPCO supported the proposed FEL caps. The Engine Manufacturers Association (EMA) commented that EPA should eliminate the FEL caps altogether. They believe FEL caps are unnecessary because the zero-sum requirement of ABT will ensure that there are no adverse emission impacts. Short of eliminating the FEL caps, they commented that EPA should set FEL caps at the level of the previous standards, not the more stringent levels proposed. With today's action, EPA is adopting the FEL caps as proposed, with some exceptions for engines above 750 horsepower (where we are adopting different standards than originally proposed) and for phase-in engines between 75 and 750 horsepower (where we have adopted an option for manufacturers to certify to alternative NO_X standards during the phase-in period). We continue to believe that it is important to ensure that technology turns over in a timely manner and that manufacturers do not continue producing large numbers of high-emitting, old technology engines once the Tier 4 standards become fully effective. (As noted below, however, we are adopting provisions that allow manufacturers to produce a limited number of 75 to 750 horsepower engines for a limited period that are certified with FELs as high as the previous tier of standards.) For the Tier 4 standards, where the standards are being reduced by an order of magnitude, we believe this goal to be particularly important, and in keeping with the technology-forcing provisions of section 213(a). It simply would not be appropriate to have long-term FEL caps that allowed engines to indefinitely have emissions as high as ten times the level of the standard.

For engines between 75 and 750 horsepower certified using the phase-in/phase-out approach, there will be two separate sets of engines with different FEL caps. For engines certified to the existing (Tier 3) NMHC+NO_X standards during the NO_X phase-in (referred to generally as ''phase-out'' engines), the FEL cap for these pollutants will (almost necessarily) be the existing FEL caps adopted in the October 1998 Tier 3 rule. For engines certified to the newly adopted Tier 4 NO_X standard during the phase-in (referred to generally as ''phase-in'' engines), we have revised the proposed FEL cap to be 0.60 g/bhp-hr, consistent with the proposed long-term Tier 4 NO_X FEL cap. As described in section II.A.2.c above, we have used the creation of alternative NO_X standards for engines between 75 and 750 horsepower to restate the phase-in/phase-out concept as a path truly focused on achieving high-efficiency NO_X aftertreatment during the phase-in years. Setting the NO_X FEL cap at 0.60 g/bhp-hr for phase-in engines will ensure this happens if a manufacturer chooses to certify to the phase-in provisions. In contrast, the higher FEL caps which we proposed (see 68 FR 28467–28468) would not have achieved this objective.

Beginning in model year 2014 when the Tier 4 NO_X standards for engines between 75 and 750 horsepower take full effect, we are adopting a NO_X FEL cap of 0.60 g/bhp-hr for all engines. We reiterate that given the fact that the Tier 4 NO_X standard is approximately a 90 percent reduction from the existing standards for engines between 75 and 750 horsepower, we do not believe the previous standard is appropriate as the FEL cap for engines having to comply with the Tier 4 NO_X standard of 0.30 g/bhp-hr. We believe that the NO_X FEL caps will ensure that manufacturers adopt NO_X aftertreatment technology across all of their engine designs.

For the interim PM standards for engines between 25 and 75 horsepower effective in model year 2008 and for the Tier 4 PM standards for engines below 25 horsepower, we are adopting the previously applicable Tier 2 PM standards for the FEL caps (which do vary within the 25 to 75 horsepower category) because the gap between the previous standards and the newly adopted standards is approximately 50 percent (rather than in excess of 90 percent for engines between 75 and 750 horsepower), and the technology basis for the 2008 PM standards can be a form of engine-out control, like the previous tier standard. For the Tier 4 PM standard effective in model year 2013 for engines between 25 and 75 horsepower, we are adopting a PM FEL cap of 0.04 g/bhp-hr, and for the Tier 4 PM standard effective in model years 2011 and 2012 for engines between 75 and 750 horsepower, we are adopting a PM FEL cap of 0.03 g/bhp-hr. As with the Tier 4 NO_X standards for these engines, given the fact that these Tier 4 aftertreatment-based PM standards for engines between 25 and 750 horsepower are over 90 per cent more stringent than the previous standards, we do not believe the previous standards are appropriate as FEL caps once the Tier 4 standards take effect. We believe that the newly adopted PM FEL caps will ensure that manufacturers adopt PM aftertreatment technology across all of their engine designs (except for a limited number of engines), yet will still provide substantial flexibility in meeting the standards.

The final Tier 4 standards for engines above 750 horsepower have been revised from the proposal. We similarly revised a number of the proposed ABT provisions for engines above 750 horsepower. Beginning in 2011, all engines above 750 horsepower will be required to meet a NO_X standard of 2.6 g/bhp-hr, except for those above 1200 horsepower used in generator sets which will be required to meet a NO_X standard of 0.50 g/bhp-hr. The NO_X FEL cap for the 2011 standards will be 4.6 g/bhp-hr, which is an estimate of the NO_X emissions level that is expected under the combined NMHC+NO_X standards that apply with the previously applicable tier for engines above 750 horsepower. Beginning in 2011, all engines above 750 horsepower will have to meet a PM standard of 0.075 g/bhp-hr. The PM FEL cap for the 2011 PM standard will be the previously-applicable Tier 2 standard of 0.15 g/bhp-hr. As noted above, because the 2011 NO_X and PM standards are approximately 50 percent lower than the previous standard (rather than in excess of 90 percent for engines between 75 and 750 horsepower), and for most engines are based on performance of the same type of technology (engine-out), we are adopting the previously applicable Tier 2 standards for the FEL caps.

Beginning in model year 2015, the 0.50 g/bhp-hr NO_X standard will apply to all engines above 750 horsepower used in generator sets. Beginning in model year 2015, the PM standard drops to 0.02 g/bhp-hr for engines greater than 750 horsepower used in generator sets and 0.03 g/bhp-hr for engines greater than 750 horsepower used in other machines. Consistent with the Tier 4 FEL caps for lower horsepower categories where the new standards are significantly lower than the previously applicable standards and reflect performance of aftertreatment technology, we are adopting a NO_X FEL cap of 0.80 g/bhp-hr for engines used in generator sets and PM FEL caps of 0.04 g/bhp-hr for engines used in generator sets and 0.05 g/bhp-hr for engines used in other machines (*i.e.*, mobile machines). We believe that the FEL caps for engines above 750 horsepower will ensure that manufacturers adopt PM aftertreament technology across all of their engine designs and NO_X aftertreatment for generator sets once the 2015 standards are adopted, while allowing for some meaningful use of averaging beginning in 2015.

Table III.A–1 contains the FEL caps and the effective model year for the FEL caps (along with the associated standards adopted for Tier 4). It should be noted that for Tier 4, where we are adopting a new transient test for most engines, as well as retaining the current steady-state test, the FEL established by the engine manufacturer will be used as the enforceable limit for the purpose of compliance testing under both test cycles. In addition, under the NTE requirements, the FEL times the appropriate multiplier will be used as the enforceable limit for the purpose of such compliance testing. This is consistent with how FELs are used for compliance purposes in the 2007 on-highway heavy-duty diesel engine program.

TABLE III.A–1.—FEL CAPS FOR THE TIER 4 STANDARDS IN THE ABT PROGRAM (G/BHP-HR)

Power category	Effective model year	NO_X standard	NO_X FEL cap	PM standard	PM FEL cap
hp <25 (kW <19)	2008+	[a] 5.6	7.8 [a] for <11hp 7.1 [a] for >11hp	[c] 0.30	0.60
25 ≤ hp < 50 (19 ≤ kW <37)	2008–2012	[a] 5.6	7.1 [a]	0.22	0.45
25 ≤ hp < 50 (19 ≤ kW <37)	2013+	[b] 3.5	5.6 [b]	0.02	[f] 0.04
50 ≤ hp < 75 (37 ≤ kW <56)	2008–2012 [d]	[a] 3.5	5.6 [a]	0.22	0.30
50 ≤ hp < 75 (37 ≤ kW <56)	2013+ [e]	[a] 3.5	5.6 [a]	0.02	[f] 0.04
75 ≤ hp < 175 (56 ≤ kW <130)	2012+	0.30	0.60 [f g h]	0.01	[f] 0.03
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)	2011+	0.30	0.60 [f g h]	0.01	[f] 0.03
hp > 750 (kW >560)	2011–2014	2.6 [i] 0.50	4.6 4.6	0.075	0.15
Generator Sets hp > 750 (kW >560)	2015+	0.50	0.80 [f]	0.02	[f] 0.04
Other Machines hp > 750 (kW >560)	2015+	[j] 2.6	4.6 [j]	0.03	[f] 0.05

Notes:

[a] These are the previous tier NMHC+NO_X standards and FEL caps. These levels are not being revised with today's rule and are printed here solely for readers' convenience.

[b] These are a combined NMHC+NO_X standard and FEL cap.

[c] A manufacturer may delay implementation until 2010 and then comply with a PM standard of 0.45 g/bhp-hr for air-cooled, hand-startable, direct injection engines under 11 horsepower.

[d] These FEL caps do not apply if the manufacturer opts out of the 2008 standards. In such cases, the existing Tier 3 standards and FEL caps continue to apply.

[e] The FEL caps apply in model year 2012 if the manufacturer opts out of the 2008 standards.

[f] As described in this section, a small number of engines are allowed to exceed these FEL caps.

[g] For engines certified as phase-out engines, the NMHC+NO_X FEL caps for the Tier 3 standards apply.

[h] For engines certified to the alternative NO_X standards during the phase-in, the NO_X FEL caps shown in tables III.A–3 and III.A–4 apply.

[i] The 0.50 g/bhp-hr NO_X standard applies only to engines above 1200 horsepower used in generator sets.

[j] The 2011 NO_X standard and FEL cap continue to apply unless and until revised by EPA in a future action.

As noted above, we are allowing a limited number of engines to have a higher FEL than the caps noted in Table III.A–1 in certain instances. The FEL cap for such engines would be set based on the level of the standards that applied in the year prior to the new standards and will allow manufacturers to produce a limited number of engines certified to these earlier standards in the Tier 4 timeframe. The allowance to certify up to these higher FEL caps will apply to Tier 4 engines between 25 and 750 horsepower beginning as early as the 2011 model year, and will apply to engines above 750 horsepower starting with the 2015 model year. The provisions are intended to provide some limited flexibility for engine manufacturers as they make the transition to the aftertreatment-based Tier 4 standards while ensuring that the vast majority of engines are converted to the advanced low-emission technologies expected under the Tier 4 program.

Under the proposal, manufacturers would have been allowed to certify at levels up to these FEL caps for ten percent of its engines in each of the first four years after the Tier 4 standards took effect and then five percent for subsequent years. The California Air Resources Board supported the proposed allowance. The Engine Manufacturers Association commented that the percentages of engines allowed to the higher FEL caps may not be sufficient, noting that it is too early to tell if the proposed amounts provided enough flexibility.

In an effort to provide flexibility to engine manufacturers while preserving the effective number of engines allowed to certify at levels up to the higher FEL caps, we are revising the proposed provisions with today's action. The revised provisions are intended to allow manufacturers to produce the same number of engines certified to the higher FEL caps as would have been allowed under the proposal, but provide added flexibility in how they distribute the allowances over the first four years of the transition to the new standards. This additional lead time appears appropriate, given the potential that a limited set of nonroad engines may face especially challenging compliance difficulties. Under the provisions adopted today and subject to the limitations explained below, a manufacturer would be allowed to certify up to 40 percent of its engines above the FEL caps shown in Table III.A–1 over the first four years the aftertreatment-based Tier 4 standards take effect (calculated as a cumulative total of the percent of engines exceeding these FEL caps in each year over the four years), with a maximum of 20 percent allowed in any given year (provided the FELs for these engines do not exceed levels specified below). During this four year period, manufacturers would not be required to perform transient testing or NTE testing on these engines because we expect these engines would be carried over directly from the previous tier without any modification. (NTE testing would apply to engines above 750 horsepower because the previously applicable set of standards required NTE testing.) Similarly, for engines between 75 and 750 horsepower, manufacturers would not be required to have closed crankcase controls on these engines because we also expect that these engines would be carried over directly from the previous tier without any modification. (Engines between 25 and 75 horsepower, and engines above 750 horsepower, would be required to have closed crankcase controls because the previously applicable set of standards require closed crankcase controls.)

For the purpose of calculating the number of credits such engines would use, the manufacturer would include an adjustment to the FEL to be used in the credit calculation equation. The adjustment would be included by multiplying the steady-state FEL by a Temporary Compliance Adjustment Factor (TCAF) of 1.5 for PM and 1.1 for NO_X. (The NO_X TCAF would not apply to engines that are not subject to the transient testing requirements for NO_X as discussed in section III.F.) We are adopting TCAFs in part to assure in-use control of emission from these engines in the absence of transient and NTE testing, and also to assure that any credits these engines use reflect the level of reductions expected in use. The level of the TCAFs are based on data from pre-control, Tier 1, and Tier 2 engines which show that the emissions from such engines tested over transient test cycles which are more representative of real in-use operation are higher than emissions from those engines tested over the steady-state certification test cycle. This is a sales weighted version of the Transient Adjustment Factor used in the NONROAD model. For compliance purposes, a manufacturer would be held accountable to the unadjusted steady-state FEL established for the engine family.

As proposed, after the fourth year the Tier 4 standards apply, the allowance to certify engines using the higher FEL caps shown in Table III.A–2 will still be available but for no more than five percent of the engines a manufacturer produces in each power category in a given year. When the 5 percent allowance takes effect, these engines will be considered Tier 4 engines and all other requirements for Tier 4 engines will also apply, including the Tier 4 NMHC standard, transient testing, NTE testing, and closed crankcase controls. TCAFs thus do not apply when calculating the number of credits such engines would use.

In the two power categories where we are adopting phase-in provisions (*i.e.*, 75 to 175 horsepower engines and 175 to 750 horsepower engines), the allowance to use a higher FEL cap will only apply to PM from phase-out engines during the phase-in years. We originally proposed that the allowance to use a higher FEL cap would apply to PM from either phase-in or phase-out engines during the phase-in years. On reflection, this is inconsistent with our policy that phase-in engines truly have low emissions reflecting use of aftertreatment (see also the discussion above where we explain that, for the same reason, we are adopting a NO_X FEL cap of 0.60 g/bhp-hr for phase-in engines). We consequently are revising the proposed allowance so that it is available for PM emissions only from phase-out engines. As proposed, the allowance to use a higher FEL cap for NO_X will apply starting in 2014 when the phase-in period is complete.

For the power category between 25 and 75 horsepower, this allowance to certify engines at levels up to the higher FEL caps will apply beginning with the Tier 4 standards taking effect in the 2013 model year and will apply to PM only. For manufacturers choosing to opt out of the 2008 model year Tier 4 standards for engines between 50 and 75 horsepower and instead comply with the Tier 4 standards beginning in 2012, the 40% allowance would apply to model years 2012 through 2015, and the 5% allowance would apply to model year 2016 and thereafter. The allowance to use the higher FEL caps is not applicable for the 2008 standards or the 2013 NMHC+NO_X standards for these engines because the FEL caps for those standards already are set at the level of the standard which previously applied.

For engines above 750 horsepower, the allowance to certify a limited number of engines at levels up to the higher FEL caps would apply beginning in model year 2015. (As noted, this is because the FEL caps being adopted for the 2011 standards for engines above 750 horsepower are the previous tier PM standard and the NO_X-only equivalent of the previous tier standard.) For NO_X, the allowance to certify a limited number of engines above the FEL cap beginning in model year 2015 will apply only to engines used in generator sets. Engines used in other machines are still subject to the model year 2011 NO_X standard and FEL caps. For PM, the allowance to certify a limited number of engines above the FEL caps beginning in model year 2015 will apply to all engines above 750 horsepower.

Table III.A–2 presents the model years, percent of engines, and higher FEL caps that will apply under these allowances. As noted above, engines certified under these higher FEL caps during the first four years would not be required to perform transient testing or NTE testing and engines between 75 and 750 horsepower would not be required to have closed crankcase controls on these engines. However, as also noted earlier, beginning in the fifth year, when the 5 percent allowance takes effect, these engines will be considered Tier 4 engines and all other requirements for Tier 4 engines will also apply, including the Tier 4 NMHC standard, transient testing, NTE testing, and closed crankcase controls.

TABLE III.A–2.—ALLOWANCE FOR LIMITED USE OF AN FEL CAP HIGHER THAN THE TIER 4 FEL CAPS

Power category	Model years	Engines allowed to have higher FELs (%)	NO_X FEL cap (g/bhp-hr)	PM FEL cap (g/bhp-hr)
25 ≤ hp < 75	2013–2016 [a]	[b] 40	Not applicable	0.22
(19 ≤ kW < 56)	2017+ [a]	5		
75 ≤ hp < 175	2012–2015	[b] 40	3.3 [c] for hp <100	0.30 [d] for hp <100
(56 ≤ kW <130)	2016+	5	2.8 [c] for hp ≥100	0.22 [d] for hp ≥100
175 ≤ hp ≤ 750	2011–2014	[b] 40	2.8 [c]	0.15 [d]
(130 ≤ kW ≤ 560)	2015+	5		
>750 hp	2015–2018	[b c] 40	2.6	0.075
(>560 kW)	2019+	[e] 5	.	

[a] For manufacturers choosing to opt out of the 2008 model year Tier 4 standards for engines between 50 and 75 horsepower and instead comply with the Tier 4 standards beginning in 2012, the 40% allowance would apply to model years 2012 through 2015, and the 5% allowance would apply to model year 2016 and thereafter.

[b] Compliance with the 40% limit is determined by adding the percent of engines that have FELs above the FEL caps shown in Table III.A.–1 in each of the four years. A manufacturer may not have more than 20% of its engines exceed the FEL caps shown in Table III.A–1 in any model year in any power category.

[c] The allowance to certify to these higher NO_X FEL caps is not applicable during the phase-in period.

[d] These higher PM FEL caps are applicable to phase-out engines only during the phase-in period.

[e] The limits of 40% or 5% allowed to exceed the NO_X FEL cap would apply to engines used in generator sets only. (Engines >750 hp used in other machines are allowed to have an NO_X FEL as high as 4.6 g/bhp-hr.) The limits of 40% or 5% allowed to exceed the PM FEL cap would apply to all engines above 750 hp.

Under the Tier 4 program, there will be two different groups of 75–750 horsepower engines during the NO_X phase-in period. In one group (''phase-out engines''), engines will certify to the applicable Tier 3 NMHC+NO_X standard and will be subject to the $NMHC+NO_X$ ABT restrictions and allowances previously established for Tier 3. In the other group (''phase-in engines''), engines will certify to the 0.30 g/bhp-hr NO_X standard, and will be subject to the restrictions and allowances in this program. Although engines in each group are certified to different standards, we are (as proposed) allowing manufacturers to transfer credits across these two groups of engines with the following adjustment to the amount of credits generated. Manufacturers will be able to use credits generated during the phase-out of engines subject to the Tier 3 $NMHC+NO_X$ standard to average with engines subject to the 0.30 g/bhp-hr NO_X standard, but these credits will be subject to a 20 percent discount, the adjustment reflecting the NMHC contribution. Thus, each gram of $NMHC+NO_X$ credits from the phase-out engines will be worth 0.8 grams of NO_X credits in the new ABT program. The ability to average credits between the two groups of engines will give manufacturers a greater opportunity to gain experience with the low-NO_X technologies before they are required to meet the final Tier 4 standards across their full production. The 20 percent discount will also apply, for the same reason, to all $NMHC+NO_X$ credits used for averaging purposes with the NO_X standards for engines greater than 75 horsepower.

The California Air Resources Board supported the proposed discount of 20 percent on $NMHC+NO_X$ credits used for NO_X compliance. The Engine Manufacturer's Association commented that we should eliminate the 20 percent ''discount'' on $NMHC+NO_X$ credits used for NO_X compliance.

We disagree with the Engine Manufacturer's Association comments. As noted in the proposal, we have two main reasons for adopting this adjustment. First, the discounting addresses the fact that NMHC reductions can provide substantial $NMHC+NO_X$ credits, which are then treated as though they were NO_X credits. For example, a 2010 model year 175 horsepower engine emitting at 2.7 g/bhp-hr NO_X and 0.3 g/bhp-hr NMHC meets the 3.0 g/bhp-hr $NMHC+NO_X$ standard in that year, but gains no credits. In 2011, that engine, equipped with a PM trap to meet the new PM standard, will have very low NMHC emissions because of the trap, an emission reduction already accounted for in our assessment of the air quality benefit of this program. As a result, without substantially redesigning the engine to reduce NO_X or NMHC, the manufacturer could garner nearly 0.3 g/bhp-hr of $NMHC+NO_X$ credit for each of these engines produced. Allowing these NMHC-derived credits to be used undiscounted to offset NO_X emissions on the phase-in engines in 2011 (for which each 0.1 g/bhp-hr of margin can make a huge difference in facilitating the design of engines to meet the 0.30 g/bhp-hr NO_X standard) would be inappropriate. Therefore, while we are reducing the value of credits earned from Tier 2/Tier 3 engines, the adjustment accounts for the NMHC fraction of the credits which we do not believe should be used to demonstrate compliance with the NO_X-only Tier 4 standards (such credits would be ''windfalls'' because they would necessarily occur by virtue of the technology needed to meet the PM standard) (68 FR 28469, May 23, 2003). Second, the discounting will work toward providing a small net environmental benefit from the ABT program, such that the more manufacturers use banked and averaged credits, the greater the potential emission reductions overall. Most basically, it is inherently reasonable, in using NO_X+NMHC reductions to show credit with a NO_X-only standard, to use only that portion which represents NO_X reductions. (Indeed, for this reason, terming the 20 per cent a ''discount factor'' is a misnomer; it apportions the NMHC fraction of the reduction.) As noted, this is further supported by the fact that the NMHC reductions for phase-out engines are not extra reductions above and beyond what would otherwise occur, and therefore don't warrant eligibility as credits.

We are adopting one additional restriction on the use of credits under the ABT program. For the Tier 4 standards, we proposed that manufacturers could only use credits generated from other Tier 4 engines or from engines certified to the previously applicable tier of standards (*i.e.*, Tier 2 for engines below 50 horsepower, Tier 3 for engines between 50 and 750 horsepower, and Tier 2 engines above 750 horsepower). This proposed restriction was similar to a restriction we currently have that prohibits the use of Tier 1 credits to demonstrate Tier 3 compliance. STAPPA/ALAPCO and the Natural Resources Defense Council supported the proposed approach that limited the use of previous-tier credits for Tier 4. The Engine Manufacturer's Association commented that by limiting the use of previous-tier credits, we are engaged in an unconstitutional taking because EPA had guaranteed in the previous Tier 2/Tier 3 rulemaking that such credits would not expire. We disagree that adopting a restriction on the use of the previous tier ABT credits is an unconstitutional taking. EPA did not, and could not, decide in the Tier 2/3 rulemaking that Tier 2/3 credits could be used to show compliance with some future standards that had not yet even been adopted. Thus, EPA in this rulemaking is not taking away something previously given. We are not revisiting the Tier 2/3 standards but establishing a new set of engine standards. In doing so, we necessarily must evaluate the provisions of previous rules and their potential impact on the future standards being considered. We are reasonably concerned that credits from engines certified to relatively high standards could be used to significantly delay the implementation of the final Tier 4 program and its benefits, resulting in a situation where the standards would no longer reflect the greatest degree of emission reduction available as required under section 213(a)(3) of the Clean Air Act, or would no longer be appropriate under section 213(a)(4) of the Clean Air Act. Therefore, with today's action, we are adopting the proposed provisions regarding the use of credits from previous tier engines, with one minor revision.

Under today's action, manufacturers may only use credits generated from other Tier 4 engines or from engines certified to the previously applicable tier of standards—except for engines between 50 and 75 horsepower. Because we are adopting Tier 4 standards that take effect as early as 2008 for those engines, the same year the previously-adopted Tier 3 standards are scheduled to take effect (see section II.A.1.a above), there is no possibility to earn credits against the Tier 3 standards for manufacturers that certify with the pull-ahead standards in 2008 for engines between 50 and 75 horsepower. Therefore, we will allow manufacturers to use credits from engines in the Tier 2 power category that includes 50 to 75 horsepower (*i.e.*, the 50 to 100 horsepower category) that are certified to the Tier 2 standards if they choose to demonstrate compliance with the pull-ahead Tier 4 standards in 2008 for engines between 50 and 75 horsepower. Manufacturers that do not choose to comply with the 2008 Tier 4 standards for engines between 50 and 75 horsepower and instead comply with the 2012 Tier 4 standards for such engines will not be allowed to use Tier 2 credits in Tier 4, but instead will be allowed to use Tier 3 credits as allowed under the standard provisions regarding use of previous-tier credits only for Tier 4 compliance demonstration.

With regard to other restrictions on the use of ABT credits, we are adopting one restriction on the use of credits across the 750 horsepower threshold. In previous rulemakings, EPA has defined ''averaging sets'' within which manufacturers may use credits under the ABT program. Credits may not be used outside of the averaging set in which they were generated. As described in section II.A.4 of today's action, we have revised the Tier 4 standards for engines above 750 horsepower. Because the standards for Tier 4 engines greater than 750 horsepower will not be based on the use of PM aftertreatment technology in 2011 or NO_X aftertreatment technology for all mobile machinery engines in 2015, we are adopting provisions that prevent manufacturers from using credits from model year 2011 and later model year engines greater than 750 horsepower to demonstrate compliance with engines below 750 horsepower. Without such a limit, we are concerned that manufacturers could use credits from such engines to significantly delay compliance with the numerically lower standards for engines below 750 horsepower. In addition, without such a limit, we are concerned that manufacturers could use credits from engines below 750 horsepower to delay implementation of aftertreatment technology for engines above 750 horsepower.

One engine manufacturer commented that EPA should include a barrier to trading credits across the 75 horsepower level. They cited concerns over the ability of manufacturers that produce a large range of engine sizes to use credits from high horsepower engines to offset emissions from their small horsepower engines. We are not adopting any averaging set restrictions for Tier 4 engines below 750 horsepower in today's action. In the current nonroad diesel ABT program, there are averaging set restrictions. The current averaging sets consist of engines less than 25 horsepower and engines greater than or equal to 25 horsepower. We adopted this restriction because of concerns over the ability of manufacturers to generate significant credits from the existing engines and use the credits to delay compliance with the newly adopted standards (63 FR 56977, October 23, 1998). We believe the Tier 4 standards for engines below 750 horsepower are sufficiently rigorous to limit the ability of manufacturers to generate significant credits from their engines. In addition, we believe the FEL caps being adopted today provide sufficient assurance that low-emissions technologies will be introduced in a timely manner. Therefore, we believe averaging can be allowed between all engine power categories below 750 horsepower without restriction effective with the Tier 4 standards. (It should be noted that the averaging set restriction placed on credits generated from Tier 2 and Tier 3 engines will continue to apply if they are used to demonstrate compliance for Tier 4 engines.)

EPA also proposed to allow engine manufacturers to demonstrate compliance with the NO_X phase-in requirements by certifying evenly split engine families at, or below, specified NO_X FELs (68 FR 28470, May 23, 2003). As described in section II.A.2.c above, EPA is revising the evenly split family provisions for the Tier 4 program and is now codifying them as alternative standards. (As described in section III.L, we also are adopting the proposed provisions allowing manufacturers to certify ''split'' engine families during the phase-in years.) Because the evenly split family provision has evolved into a set of alternative NO_X standards, we believe it is appropriate to allow manufacturers to use ABT for them. Table III.A–3 presents the FEL caps that will apply to engines certified to the alternative NO_X standards during the phase-in years. The FEL caps for these alternative standards have been set at levels reasonably close to the alternative standards and are intended to ensure sizeable emission reductions from the previously-applicable Tier 3 standards. (For engines between 75 and 175 horsepower certified under the reduced phase-in option, the FEL cap is the NO_X-only equivalent of the previously applicable NMHC+NO_X standards because the alternative standard is sufficiently close to the Tier 3 standard.)

TABLE III.A–3.—NO_X FEL CAPS FOR ENGINES CERTIFIED TO THE ALTERNATIVE NO_X STANDARDS

Power category	Alternative NO_X standard (g/bhp-hr)	NO_X FEL cap (g/bhp-hr)
50/50/100 phase-in option for 75 ≤ hp < 175 (56 ≤ kW <130)	1.7	2.2.
25/25/25/100 phase-in option for 75 ≤ hp < 175 (56 ≤ kW <130)	2.5	3.3 (for 75–100 hp). 2.8 (for 100–175 hp)
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)	1.5	2.0.

Because we are allowing manufacturers to use ABT for demonstrating compliance with the alternative standards for engines between 75 and 750 horsepower, we are allowing manufacturers to exceed the FEL caps noted in table III.A–3 and include them in the count of engines allowed to exceed the FEL caps (*i.e.*, the 40 percent over the first four years the Tier 4 standards take effect as described earlier). Table III.A–4 presents the NO_X FEL caps that would apply to engines certified under the alternative standards (limited by the 40 percent cap over the first four years). The higher NO_X FEL caps are set at the estimated NO_X-only equivalent of the previous-tier NMHC+NO_X standards. For manufacturers certifying under the reduced phase-in (25 percent) option, because the FEL caps are the NO_X-only equivalent of the Tier 3 NMHC+NO_X standards, they may not exceed the FEL cap during the years the alternative standard applies.

TABLE III.A–4.—LIMITED-USE NO_X FEL CAPS UNDER THE ALTERNATIVE NO_X STANDARDS

Power category	Model years	NO_X FEL cap (g/bhp-hr)
50/50/100 phase-in option for 75 ≤ hp < 175[a] (56 ≤ kW <130)	2012–2013	3.3 for hp <100. 2.8 for hp ≥100.
175 ≤ hp ≤ 750	2011–2013	2.8.

TABLE III.A–4.—LIMITED-USE NO_X FEL CAPS UNDER THE ALTERNATIVE NO_X STANDARDS—Continued

Power category	Model years	NO_X FEL cap (g/bhp-hr)
(130 ≤ kW ≤ 560)		

For reasons explained in section II.A.1.b.i above, we are also adopting unique phase-in requirements for NO_X standards for engines between 75 and 175 horsepower in order to ensure appropriate lead time for these engines. Because of these unique phase-in provisions, as proposed, we are adopting slightly different provisions regarding 75 to 175 horsepower engines' use of previous-tier credits. Under today's action, manufacturers that choose to demonstrate compliance with these phase-in requirements (*i.e.*, 50 percent in 2012 and 2013 and 100 percent in 2014) or the 1.7 g/bhp-hr alternative NO_X standard (which is based on the 50 percent phase-in option) will be allowed to use Tier 2 NMHC+NO_X credits generated by engines between 50 and 750 horsepower (even though they are not generated by previous-tier engines), along with any other allowable credits, to demonstrate compliance with the Tier 4 NO_X standards for engines between 75 and 175 horsepower during model years 2012, 2013 and 2014 (the years of the phase-in) only. These Tier 2 credits will be subject to the power rating conversion already established in our ABT program, and to the 20% credit adjustment being adopted today for use of NMHC+NO_X credits as NO_X credits.

The requirements for manufacturers that choose to demonstrate compliance with the optional reduced phase-in requirement for engines between 75 and 175 horsepower (i.e, the 25/25/25 percent phase-in option; see Table II.A.–2, note b) or the 2.5 g/bhp-hr alternative NO_X standard (which is based on the 25 percent phase-in option) are different. Under the reduced phase-in requirement, use of credits will be allowed in accordance with the general ABT program provisions. In other words, manufacturers will not have the special allowance to use Tier 2 NMHC+NO_X credits generated by engines between 50 and 750 horsepower noted above to demonstrate compliance with the Tier 4 standards. In addition, manufacturers choosing the reduced phase-in option will not be allowed to generate NO_X credits from engines in this power category in 2012, 2013, and most of 2014, except for use in averaging within this power category (*i.e.*, no banking or trading, or averaging with engines in other power categories will be permitted). This restriction will apply throughout this period even if the reduced phase-in option is exercised during only a portion of this period. We believe that this restriction is important to avoid potential abuse of the added flexibility allowance, considering that larger engine categories will be required to demonstrate substantially greater compliance levels with the 0.30 g/bhp-hr NO_X standard several years earlier than engines built under the reduced phase-in option.

As described in section II.A.3.a of today's action, and as proposed, we are adopting an optional PM standard for air-cooled, hand-startable, direct injection engines under 11 horsepower effective in 2010. In order to avoid potential abuse of this standard, engines certified under this requirement will not be allowed to generate any credits as part of the ABT program. Credit use by these engines will be allowed. The restriction on generating credits should not be a burden to manufacturers, as it will apply only to those air-cooled, hand-startable, direct injection engines under 11 horsepower that are certified under the optional approach, and the production of credit-generating engines would be contrary to the standard's purpose. No adverse comments were submitted to EPA on this issue.

The current ABT program contains a restriction on trading credits generated from indirect injection engines greater than 25 horsepower. The restriction was originally adopted because of concerns over the ability of manufacturers to generate significant credits from existing technology engines (63 FR 56977, October 23, 1998). With today's action, there will be no restriction prohibiting manufacturers from trading credits generated on Tier 4 indirect fuel injection engines greater than 25 horsepower. Based on the certification levels of indirect injection engines, we do not believe there is the potential for manufacturers to generate significant credits from their currently certified engines against the Tier 4 standards. Therefore, as proposed, we are not adopting any restrictions on the trading of credits generated on Tier 4 indirect injection engines to other manufacturers. The restriction placed on the trading of credits generated from Tier 2 and Tier 3 indirect injection engines will continue to apply in the Tier 4 timeframe. No adverse comments were submitted to EPA on this issue.

As explained in the proposal, we are not applying a specific discount to Tier 3 PM credits used to demonstrate compliance with the Tier 4 standards (68 FR 28471, May 23, 2003). PM credits generated under the Tier 3 standards are based on testing performed over a steady-state test cycle. Under the Tier 4 standards, the test cycle is being supplemented with a transient test (see section III.F.1 below). Because in-use PM emissions from Tier 3 engines will vary depending on the type of application in which the engine is used (most applications having higher in-use PM emissions, some having lower in-use PM emissions), the relative ''value'' of the Tier 3 PM credits in the Tier 4 timeframe will differ. Instead of requiring manufacturers to gather information to estimate the level of in-use PM emissions compared to the PM level of the steady-state test, we believe allowing manufacturers to bring Tier 3 PM credits directly into the Tier 4 time frame without any adjustment is appropriate because it discounts their value for use in the Tier 4 timeframe (since the initial baseline being reduced is higher than measured in the Tier 2 test procedure for most applications). No adverse comments were submitted to EPA on this issue.

3. Are We Expanding the Nonroad ABT Program To Include Credits From Retrofit of Nonroad Engines?

In the proposal, we requested comment on expanding the scope of the standards by setting voluntary new engine emission standards applicable to the retrofit of nonroad diesel engines (68 FR 28471, May 23, 2003). As described in the proposal, retrofit nonroad engines would be able to generate PM and NO_X credits which would be available for use by new nonroad engines in the certification ABT program. We received a significant number of comments on a retrofit ABT program. A number of commenters associated with the agricultural sector were concerned retrofits would be mandatory. Some commenters were opposed to a retrofit credit program that would allow use of the credits under the certification ABT program. However, a number of commenters supported the concept of a retrofit program, but noted a number of concerns regarding the details of such a program, including making sure that any credits earned would be verifiable and enforceable. Some commenters suggested that EPA consider the establishment of a retrofit credit program through a separate rulemaking because there were many details of the program that needed to be explored more fully before adopting such a program. In response to the comments, we are not adopting a retrofit credit program with today's action. Although we provided a detailed explanation of a potential program at proposal,[62] we believe it is important to more fully consider the details of a nonroad engine retrofit credit program and work with interested parties in determining whether a viable program can be developed. EPA intends to explore the possibility of a voluntary, opt-in nonroad retrofit credit program through a separate action later this year. Such a program would be based on the generation of credits beyond the scope of any existing retrofit program. The final rule contains no requirements for retrofitting existing engines or equipment.

B. Transition Provisions for Equipment Manufacturers

1. Why Are We Adopting Transition Provisions for Equipment Manufacturers?

As EPA developed the 1998 Tier 2/3 standards for nonroad diesel engines, we determined, as an aspect of determining an appropriate lead time for application of the requisite technology (pursuant to section 213(b) of the Act), that provisions were needed to avoid unnecessary hardship and to create additional flexibility for equipment manufacturers. The specific concern is the amount of work required and the resulting time needed for equipment manufacturers to incorporate all of the necessary equipment redesigns into their applications in order to accommodate engines that meet the new emission standards. We therefore adopted a set of provisions for equipment manufacturers to provide them with reasonable lead time for the transition process to the newly adopted standards. The program consisted of four major elements: (1) A percent-of-production allowance, (2) a small-volume allowance, (3) availability of hardship relief, and (4) continuance of the allowance to use up existing inventories of engines (63 FR 56977–56978, October 23, 1998 and 68 FR 28472–28476, May 23, 2003).

Given the levels of the newly adopted Tier 4 standards, we believe that there will be engine design and other changes at least comparable in magnitude to those involved during the transition to Tier 2/3. Therefore, with a few exceptions described in more detail below, we are adopting transition provisions for Tier 4 that are similar to those adopted with the previous Tier 2/3 rulemaking. We also note that opportunities for greater flexibility arises from the structure of the Tier 4 rule. For example, Tier 4 consolidates the nine power categories in Tier 2/3 into five categories, providing opportunities for more flexibility by allowing more engine families within each power category, with consequent increased averaging possibilities. The NO_X phase-in also provides increased flexibility opportunities, as do the longer Tier 4 lead times.

We are adding new notification, reporting, and labeling requirements to the Tier 4 program. We believe these additional provisions are necessary for EPA to gain a better understanding of the extent to which these provisions will be used and to ensure compliance with the Tier 4 transition provisions. We are also adopting new provisions dealing specifically with foreign equipment manufacturers and the special concerns raised by the use of the transition provisions for equipment imported into the U.S. The following section describes the Tier 4 transition provisions available to equipment manufacturers. (Section III.C of this preamble describes all of the provisions that will be available specifically for small businesses.)

As under the existing Tier 2/Tier 3 provisions, equipment manufacturers are not obligated to use any of these provisions, but all equipment manufacturers are eligible to do so. Also, as under the existing program, all entities under the control of a common entity, and that meet the regulatory definition of a nonroad vehicle or nonroad equipment manufacturer, must be considered together for the purpose of applying exemption allowances. This will not only provide certain benefits for the purpose of pooling exemptions, but will also preclude the abuse of the small-volume allowances that would exist if companies could treat each operating unit as a separate equipment manufacturer.

2. What Transition Provisions Are We Adopting for Equipment Manufacturers?

The following section describes the transition provisions being adopted with today's action. Areas in which we have made changes to the proposed transition program are highlighted. A complete summary of comments received on the proposed transition program and our response to those comments are contained in the Summary and Analysis of Comments document for this rule.

EPA believes that the lead time provided through the equipment maker transition flexibilities, as adopted in this rule, will be sufficient, as has proved the case in past tiers. These flexibilities provide equipment manufacturers with the selective ability to delay use of the Tier 4 engines in those applications where additional time is needed to successfully incorporate the redesigned engines into their equipment.

Ingersoll-Rand, an equipment manufacturer, submitted a number of comments arguing that significant expansions of the proposed flexibility program are needed if equipment manufacturers are to produce compliant applications within the effective dates of the standards. One suggestion was for EPA to include provisions that provide a definitive period of lead time for incorporation of Tier 4 engines into nonroad equipment. Ingersoll-Rand would have the rules specify a "made available" date before which each engine supplier must provide technical and performance specifications, complete drawings, and a final compliant engine to EPA and the open market. After the mandated "made available" date, equipment manufacturers should be provided a minimum 18 months of lead time to incorporate the new engines into nonroad equipment. One form of the suggestion also entailed a prohibition on design changes once the engine, specifications, drawings, etc. had been initially provided to EPA and to the open market. As an alternative, Ingersoll-Rand urged that the percent of production allowance flexibility be expanded to 150 percent for the power categories between 75 and 750 horsepower and 120 percent for the power category between 25 and 75 horsepower. Ingersoll-Rand believes these levels correspond proportionately to the increased challenges facing equipment manufacturers during Tier 4 as opposed to Tier 2 and Tier 3.

As discussed in greater detail in the Summary and Analysis of Comments, as well as in later parts of this section of this preamble and elsewhere in the administrative record, we disagree with most of Ingersoll-Rand's suggestions. Our fundamental disagreement is with Ingersoll-Rand's premise that Tier 4 will create a situation where need for

[62] *See* memorandum referenced at 68 FR 28471 (May 23, 2003), footnote 299.

expanded equipment maker lead time is the norm rather than the exception so that the rule must provide a drastic, across-the-board expansion of equipment manufacturer lead time. We believe that the lead time provided for equipment makers in this rule is adequate, and that the equipment maker flexibilities we are adopting provide a reasonable and targeted safety valve to deal with isolated problems. There is no across-the-board problem necessitating a drastic expansion of equipment manufacturer lead time, or a drastic expansion of equipment manufacturer flexibilities. We base these conclusions largely on three factors: (a) Our investigation and understanding of the engineering process by which engine makers and equipment manufacturers bring new products to market; (b) the specific engineering challenges which equipment manufacturers will address in complying with the Tier 4 rule; and (c) past practice of equipment manufacturers under previous rules providing transition flexibilities for nonroad equipment.

Because it is in both parties' interest for new engines and new equipment applications to reach the market expeditiously, engine makers and equipment manufacturers usually adopt concurrent engineering programs whereby the new equipment design process occurs simultaneous to the new engine development process. We believe that this concurrent process should work well for Tier 4 because, in many important ways, the engineering challenges facing equipment manufacturers can be anticipated and dealt with early in the design process. We expect that relatively early in the design process, engine manufacturers will be able to define the size and characteristics of the emission control technologies (e.g., NO_X adsorbers and CDPFs), based on the same systems that will be in production for on-highway engines. The equipment manufacturers will concurrently redesign their equipment to accommodate these new technologies, including designing, mounting and supporting the catalytic equipment similar to current exhaust muffler systems.

Moreover, while we expect the redesign challenge for Tier 4 equipment to be similar to that for Tier 2/3, we also expect the redesign to be better and more clearly defined well in advance of the Tier 4 introduction dates. This is because we do not expect the catalyst system size or shape to change significantly during the last 24 months of the engine design and validation process.[63]

We also have studied the extent to which equipment manufacturers have used their flexibilities under the Tier 2/3 program. Although at an early stage in the Tier 2/3 process, initial indications are that the flexibility program is being used by many equipment manufacturers, but in general, manufacturers do not appear to be using the full level of allowances.[64] It appears that the flexibilities are being used as EPA intended, providing manufacturers with flexibility to deal with specific limited situations, rather than to deal with an across-the-board problem.

The emerging pattern is thus the one on which the flexibility program is predicated: there is not a need for across-the-board drastic expansion of equipment manufacturer lead time. Indeed, such an expansion would be inconsistent with the lead time-forcing nature of section 213 (b) of the Act. This is not to say that there is no need for equipment manufacturer flexibilities, or that the Tier 2/3 flexibility format need not be adjusted to accommodate potential problems to be faced under the Tier 4 regime. Instances where additional lead time could be justified are where resource constraints prevent completion of certain applications, or where for business reasons it makes sense for equipment manufacturers to delay completion of small volume families in order to complete larger volume equipment applications. In addition, the Tier 2/3 experience illustrates that there can be instances where emission control optimization which necessitates equipment design changes occurs late in the design cycle, resulting in a need for additional equipment manufacturer lead time. The equipment manufacturer flexibilities adopted in today's rule accommodate these possibilities.

We have specific objections to Ingersoll-Rand's preferred approach of a mandated made available date, followed by 18 months of additional lead time for equipment manufacturers. Superimposing a government mandate on the engine maker—equipment manufacturer business relationship insinuates EPA into the middle of contractual/market relationships (e.g., when is an objectively reasonable delivery date?), forcing EPA to prejudge myriad differing business relationships/engineering situations. Moreover, selection of any single made available date is bound to be arbitrary in most situations. We also believe that the 18-month lead time following a made available date entails a mandated 18-month period (at least) with no return on investment to engine suppliers (i.e. the period between when the Tier 4 engine would be produced and when it could lawfully be sold), which would increase the engine cost, and discourage design changes (since such changes would entail more investment with delayed return on that investment). The ultimate result would be a costlier rule and less environmental benefit due to the delay in introducing Tier 4 engines. Even were EPA to put forth such a regulation, it is not clear that it could be enforced or that it would help the situation. It would only be natural for engine manufacturers to continue to improve its products even after the predefined ''made available date'' and equipment manufacturers would want to use this improved product even if it meant they had to make last minute changes to the equipment design. For EPA to preclude engine manufacturers from changing their product designs over the period between the certification date and the equipment manufacturer date would be both unusual and counterproductive to our goal of seeing the best possible products available in the market. Moreover, EPA sees no need to interfere with the concurrent design market mechanism, which allows engine makers and equipment manufacturers to negotiate optimal solutions. We believe it is better to leave to the market participants the actual decision for how and when to conduct concurrent engineering designs.

The California Air Resources Board commented that EPA should eliminate or reduce the amount of flexibilities provided for less than 25 horsepower engines, because the Tier 4 engine standards are not aftertreatment-based. The Engine Manufacturers Association commented that we should expand the amount of flexibilities for engines greater than 750 horsepower, given the difficulty of complying with the proposed standards for engines above 750 horsepower. With today's action, we are applying the same flexibility for all power categories, including engines below 25 horsepower and engines above 750 horsepower. While it is true that the Tier 4 standards for engines below 25 horsepower are not aftertreatment-based, we believe there will be changes in engine design for many of those engines in response to the Tier 4 standards. As engine designs change, there is the potential for impacts on

[63] ''Tier 4 Nonroad Diesel Equipment Flexibility Provisions,'' memorandum from Byron Bunker, et al., (EPA) to EPA Air Docket OAR–2003–0012.

[64] ''Tier 4 Nonroad Diesel Equipment Flexibility Provisions,'' memorandum from Byron Bunker, et al., (EPA) to EPA Air Docket OAR–2003–0012.

equipment design as well (as shown in implementing the Tier 2/3 rule). Therefore, we believe providing equipment manufacturer flexibility for engines below 25 horsepower is appropriate and we are adopting the same flexibilities for engines below 25 horsepower as for other power categories. With regard to engines above 750 horsepower, we are retaining the same flexibilities for those engines as for other power categories. As described in section II.A.4, the Tier 4 standards being adopted today for engines above 750 horsepower have been revised from the proposal. We believe that these revisions have appropriately accommodated concerns for the most difficult to design applications (i.e., NO_X adsorbers for engines in mobile applications), so that additional equipment flexibilities are not warranted for these engines.

The Engine Manufacturers Association commented that some equipment manufacturers may be capable of making an on-time transition to the interim Tier 4 standards (e.g. the 2011 standards applicable for 175–750 horsepower engines) without the use of flexibilities. Such equipment manufacturers would like the ability to start the seven-year period in which they may use flexibilities in the year the final Tier 4 standards (the aftertreatment-based standards for both PM and NO_X) take effect. Put another way, they would not need more lead time for equipment to meet the interim standards, but could need more lead time for equipment required to meet the final standards. In addition, the commenter suggested a modified approach that could lead to earlier emission reductions than under the proposed rule: Requiring delayed flexibility engines to meet the interim Tier 4 standards instead of meeting the Tier 2/3 standards (as would have been allowed under the proposal if the flexibilities started in the first year of the interim Tier 4 standards).

EPA wants to encourage the implementation of the Tier 4 standards as early as possible. Therefore, we believe it makes sense to provide incentives to equipment manufacturers to use interim Tier 4 compliant engines in their equipment during the transition to the final Tier 4 standards. Moreover, it is reasonable to expect that more lead time will be needed for the aftertreatment-based standards than for the interim standards. Therefore, in response to these comments, we are revising the proposed flexibility provisions to allow equipment manufacturers to have the option of starting the seven-year period in which flexibility engines may be used in either the first year of the interim Tier 4 standards or the first year of the final Tier 4 standards. For engines between 25 and 75 horsepower, the final Tier 4 standards may begin in 2012 or 2013 depending on whether the manufacturer chooses to comply with the interim 2008 Tier 4 standards. An equipment manufacturer who does not use flexibilities in 2008 thus may need flexibilities as early as 2012. Therefore, the seven-year period for the final Tier 4 standards for engines between 25 and 75 horsepower will begin in 2012 instead of 2013. Moreover, it is clearly appropriate that these delayed flexibility engines meet the interim Tier 4 standards, in order not to backslide from existing levels of performance.

Table III.B–1 shows the years in which manufacturers could choose to start the Tier 4 flexibilities given the standards being adopted today. (The seven-year period for engines below 25 horsepower takes effect in 2008 as proposed, because there are no interim standards for such engines.)

TABLE III.B–1.—FLEXIBILITY PERIODS FOR THE TIER 4 STANDARDS

Power category	Model year flexibility period options	Standards to which flexibility engines would have to certify
25 ≤ hp < 75	2008–2014	Tier 2 standards.
(19 ≤ kW < 56)	2012–2018	Model Year 2008 Tier 4 standards.
75 ≤ hp < 175	2012–2018	Tier 3 standards.
(56 ≤ kW <130)	2014–2020	Model Year 2012 Tier 4 standards.
175 ≤ hp ≤ 750	2011–2017	Tier 3 standards.
(130 ≤ kW ≤ 560)	2014–2020	Model Year 2011 Tier 4 standards.
>750 hp	2011–2017	Tier 2 standards.
(>560 kW)	2015–2021	Model Year 2011 Tier 4 standards.

Under today's action, and as proposed, only those nonroad equipment manufacturers that install engines and have primary responsibility for designing and manufacturing equipment will qualify for the allowances or other relief provided under the Tier 4 transition provisions. As a result of this definition, importers that have little involvement in the manufacturing and assembling of the equipment will be ineligible to receive any allowances. The Engine Manufacturers Association and one engine manufacturer commented that the proposed definition of equipment manufacturer needed to be revised to cover situations in which a manufacturer contracts out the design and production of equipment to another manufacturer. While we understand there are many different types of relationships between equipment manufacturers, we believe it is important to establish firm criteria for determining eligibility to use the equipment manufacturer allowances. We are concerned that the change to the equipment manufacturer definition suggested by the commenters would allow entities that have little or no involvement in the actual design, manufacture and assembly of equipment (*e.g.*, companies that only import equipment) to claim they contracted with an equipment manufacturer to produce equipment for them and therefore claim allowances. This is the exact situation we are attempting to prevent with the changes to the eligibility requirements for the allowances. Therefore, we are adopting the proposed requirement that only those nonroad equipment manufacturers that install engines and have primary responsibility for designing, and manufacturing equipment will qualify for the allowances or other relief provided under the Tier 4 transition provisions. However, we are revising the provisions regarding which engines an equipment manufacturer may include in its total count of U.S.-directed equipment production, which in turn affects the number of allowances an equipment manufacturer may claim. Under today's action, an equipment