Summary of EPA's Proposal for Nonroad Diesel Engines and Fuel

1. **Overview**

Nonroad diesel engines are the largest remaining contributor to the overall mobile source emissions inventory. EPA has already taken steps to dramatically reduce emissions from light-duty vehicles and heavy-duty vehicles and engines through the Tier 2 and 2007 highway diesel programs. With expected growth in the nonroad sector, the relative emissions contribution from nonroad diesel engines is projected to be even larger in future years. This proposed rule sets out emissions standards for nonroad diesel engines used mainly in construction, agricultural, industrial, and mining operations that will achieve reductions in PM and NOx emissions levels from today's engines in excess of 95% and 90%, respectively. Nonroad diesel fuel is currently unregulated. This proposal represents the first time nonroad diesel fuel will be regulated. EPA is proposing to reduce sulfur levels in nonroad diesel fuel by more than 99 percent to 15 parts per million (ppm). Taken together, controls included in this proposal would result in large public health and welfare benefits.

The proposed standards for nonroad diesel engines and sulfur reductions for nonroad diesel fuel represent a dramatic step in emissions control, based on the use of advanced emissions control technology. Until the mid-90's, these engines had no emissions requirements. As a comparison, cars and trucks have been subject to a series of increasingly stringent emissions control programs since the 1970s. In terms of fuel quality requirements, nonroad diesel fuel is currently uncontrolled at the federal level. EPA has already issued rules ending these disparities for diesel engines used in highway applications. Starting in 2007, these engines will meet standards of the same level of stringency as comparable gasoline vehicles, based on the use of advanced aftertreatment technologies and ultra low sulfur diesel fuel (containing no more than 15 ppm sulfur). This proposal is largely based on the performance of the same advanced aftertreatment technologies, and would bring nonroad diesel fuel to the same 15-ppm cap for sulfur that will be required for highway diesel fuel starting in 2006. EPA believes it is highly appropriate to propose dramatic steps forward in emissions standards and reductions in sulfur levels in nonroad diesel fuel. As discussed throughout this proposal, such steps represent a feasible progression in the application of advanced emissions control technologies, would achieve needed production of low sulfur diesel fuel to enable the advanced emission control technologies, the standards are cost-effective, and provide very large public health and welfare benefits.

EPA followed certain principles when developing the elements of this proposal. First, the program must achieve reductions in NOx, SOx, and PM emissions as early as possible. This includes reductions from the in-use fleet of nonroad diesel engines. Second, as EPA did in the 2007 highway diesel program, EPA is treating vehicles and fuels as a system since EPA believes this is the best way to achieve the greatest emissions reductions. Third, the implementation of low sulfur requirements for nonroad diesel fuel must in no way interfere with the implementation and expected benefits of introducing ultra low sulfur fuel in the highway market, as required by the 2007 highway diesel program. Lastly, the program must provide sufficient lead time to allow the integration of advanced emissions control technologies from the highway sector onto nonroad diesel engines as well as the expansion of ultra low sulfur fuel production to the nonroad market.

This proposal sets out new engine exhaust emissions standards, emissions test procedures, including not-to-exceed requirements, for nonroad engines, and sulfur control requirements for nonroad, locomotive, and marine diesel fuel. The proposed exhaust standards would result in particulate matter (PM) and nitrogen oxide (NOx) emissions levels that are in excess of 95 percent and 90 percent, respectively, below comparable levels in effect today. They will begin to take effect in the 2008 model year, with a phase-in of standards across five different engine power rating groupings. New engine emissions test procedures are proposed to take effect with these new standards to better ensure emissions control over real-world engine operation and to help provide for effective compliance determination. Diesel fuel used in nonroad, locomotive, and marine applications would meet a 500-ppm cap starting in June 2007, a reduction of approximately 90%. There are large benefits to taking this first sulfur reduction action, especially in the reduction of particulate matter from the in-use fleet. In 2010, sulfur levels in nonroad diesel fuel (though not locomotive or marine diesel fuel) would meet a 15-ppm cap, for a total reduction of over 99%. While there are important health and welfare benefits associated with the reduction from 500 ppm to 15 ppm, the main benefit will be to facilitate the introduction of advanced aftertreatment devices on nonroad engines, which would in turn lead to significant benefits. **EPA is also seeking comment on and seriously considering applying the 15-ppm cap to locomotive and marine diesel fuel.**

The requirements in this proposal would result in substantial benefits to public health and welfare and the environment through significant reductions in emissions of NOx and PM, as well as nonmethane hydrocarbons (NMHC), carbon monoxide (CO), sulfur oxides (SOx) and air toxics. EPA projects that by 2030, this program would reduce annual emissions of NOx, and PM by 827,000, and 127,000 tons, respectively. These annual emission reductions would prevent 9,600 premature deaths, over 8,300 hospitalizations, and almost a million work days lost, among quantifiable benefits. The overall quantifiable benefits of this rule would be approximately $81 billion annually by 2030. Costs for both the engine and fuel requirements would be significantly less, at approximately $1.5 billion annually.

A. The Proposed Standards

There are two basic parts to this proposed program: (1) new exhaust emission standards and test procedures for nonroad diesel engines, and (2) new sulfur limits for nonroad, locomotive, and marine diesel fuel. The systems approach of combining the engine and fuel standards into a single program is critical to the success of the overall efforts to reduce emissions, because the emission standards will not be feasible without the fuel change. This proposal is largely based on the 2007 highway diesel program.

i. Engine Standards

EPA's action proposes standards for nonroad diesel engines ranging from 3 to over 3,000 horsepower. Applicable emissions standards are determined by year for each of five engine power band categories. For engines less than 25 hp, EPA is proposing new engine standards for PM (0.30 g/bhp-hr) and CO (4.9 g/bhp-hr) to go along with existing NOx standards beginning in 2008. For engines between 25-75 hp, EPA is proposing standards reflecting approximately 50% reduction in PM control from today's engines applicable in 2008. Then, starting in 2013, PM standards of 0.02 g/bhp-hr and NOx standards of 3.5 g/bhp-hr would apply. For engines between 75-175 hp, the proposed standards would be 0.01 g/bhp-hr for PM, 0.30 g/bhp-hr for NOx, and 0.14 g/bhp-hr for HC beginning in 2012. These same standards would apply for both engines between 175-750 hp and greater than 750 hp starting in 2011. These PM, NOx, and NMHC standards are similar in stringency to the final standards included in the 2007 highway diesel program and are expected to require the use of high-efficiency aftertreatment systems to ensure compliance. EPA is phasing in many of these proposed standards over a period of three years in order to address lead time, workload, and feasibility considerations.

EPA is also proposing to continue the averaging, banking, and trading nonroad emissions credits provisions to demonstrate compliance with the standards. In addition, EPA is proposing to include turbocharged diesels in the existing prohibition on crankcase emissions, effective in the same year that the proposed Tier 4 standards first apply in each power category.

To better ensure the benefits of the standards are realized in-use and throughout the useful life of these engines, EPA is also proposing new test procedures and related certification requirements. EPA believes the new supplemental transient test, Constant Speed Variable Load transient duty cycle, cold start transient test, and not-to-exceed test procedures and standards will all help achieve the goal. This is a significant and important aspect of this proposal that would bring greater confidence and certainty to the compliance program.

The proposal also includes provisions to encourage the early introduction of clean technologies. EPA is also including proposed adjustments to various fuel and engine testing and compliance requirements.

ii. Fuel Quality Standards

EPA is proposing that sulfur levels for nonroad diesel fuel be reduced from current uncontrolled levels ultimately to 15 ppm, though EPA is proposing an interim cap of 500 ppm. Beginning June 1, 2007, refiners would therefore be required to produce nonroad, locomotive, and marine diesel fuel that meet a maximum sulfur level of 500 ppm. This does not include diesel fuel for home heating, industrial boiler, or stationary power uses or diesel fuel used in aircraft. Then, beginning in June 1, 2010, fuel used for nonroad diesel applications (excluding locomotive and marine engines) is proposed to meet a maximum sulfur level of 15 ppm, since all 2011 and later model year nonroad diesel-fueled engines with aftertreatment must be refueled with this new ultra low sulfur diesel fuel. EPA is also asking for comment on bringing sulfur levels for locomotive and marine fuel to 15 ppm in 2010 and notes that EPA anticipate beginning the process of developing new engine controls for these two sources in 2004. This proposal includes a combination of provisions available to refiners, especially small refiners, to ensure a smooth transition to ultra low sulfur nonroad diesel fuel.

In addition, this proposal includes unique provisions for implementing the ultra low sulfur diesel fuel program in the State of Alaska. EPA is also proposing that certain U.S. territories be excluded from both the nonroad engine standards and diesel fuel standards.

The compliance provisions for ensuring diesel fuel quality are essentially consistent with those that have been in effect since 1993 for highway diesel fuel, reflecting updated requirements that were included in the 2007 highway diesel program. Additional compliance provisions are proposed for the transition years of the program concerning the interaction of the nonroad, locomotive, and marine sulfur control requirements with existing highway diesel sulfur control provisions. The proposed compliance requirements include provisions that would prohibit equipment operators from fueling their machines with higher sulfur fuels after completion of the shift to lower sulfur nonroad diesel fuels, regardless of the age of their equipment.

B. The Need For The Standards

Emissions from nonroad, locomotive, and marine diesel engines contribute greatly to a number of serious air pollution problems, and these emissions would have continued to do so into the future absent further controls to reduce them. First, these engines contribute to the health and welfare effects associated with ozone, PM, NOx, SOx, and volatile organic compounds (VOCs), including toxic compounds such as formaldehyde. These adverse effects include premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days), changes in lung function and increased respiratory symptoms, changes to lung tissues and structures, altered respiratory defense mechanisms, chronic bronchitis, and decreased lung function. Second and importantly, in addition to its contribution to ambient PM inventories, diesel exhaust is of specific concern because it has been judged to likely pose a lung cancer hazard for humans as well as a hazard from noncancer respiratory effects. The Agency has classified diesel exhaust as likely to be carcinogenic to humans by inhalation at environmental exposures. Third, ozone and PM cause significant public welfare harm. Specifically, ozone causes damage to vegetation which leads to economic crop and forestry losses, as well as harm to national parks, wilderness areas, and other natural systems. PM causes damage to materials and soiling of commonly used building materials and culturally important items such as statues and works of art. Fourth, NOx, SOx and direct emissions of PM contribute to substantial visibility impairment in many parts of the U.S. where people live, work, and recreate, including mandatory Federal Class I areas. Finally, NOx emissions from nonroad diesel engines contribute to the acidification, nitrification and eutrophication of water bodies.

Millions of Americans live in areas with unhealthful air quality that may endanger public health and welfare (i.e., levels not requisite to protect the public health with an adequate margin of safety). Based upon data for 1999 - 2001, there are 291 counties that are violating the 8-hour ozone NAAQS, totaling 111 million people. In addition, at least 65 million people in 129 counties live in areas where annual design values of ambient $PM_{2.5}$ violate the $PM_{2.5}$ NAAQS. There are an additional 9 million people in 20 counties where levels above the $PM_{2.5}$ NAAQS are being measured, but the data are incomplete. Without emission reductions from the proposed new standards for nonroad engines, there is a significant future risk that 32 counties with 47 million people across the country may violate the 8-hour ozone national ambient air quality standard (NAAQS) in 2030, based on the modeling. Similarly, modeled $PM_{2.5}$ concentrations in 107 counties where 85 million people live are above specified levels in 2030. An additional 64 million people are projected to live in counties within 10 percent of the $PM_{2.5}$ standard in 2030, and 44 million people are projected to live in counties within 10 percent of the level of the 8-hour standard in 2030. Thus, the analyses show that these counties face a significant risk of exceeding or failing to maintain the $PM_{2.5}$ and the 8-hour ozone NAAQS without significant additional controls between 2007 and 2030.

Federal, state and local governments are working to bring ozone and particulate levels into compliance with the NAAQS through State Implementation Plan (SIP) attainment and maintenance plans, and to ensure that future air quality reaches and continues to achieve these health- and welfare-based standards. The reductions in this proposed rulemaking will play a critical part in these important efforts to attain and maintain the NAAQS. In addition, reductions from this action will also reduce public health and welfare effects associated with maintenance of the 1-hour ozone and PM_{10} NAAQS.

Emissions from nonroad, locomotive, and marine diesel engines account for substantial portions of the country's ambient PM and NOx levels. NOx is a key precursor to ozone and PM formation. EPA estimates that these engines account for about ten percent of total NOx emissions and about ten percent of total PM emissions. These proportions are even higher in some urban areas, where these engines contribute up to 19 percent of the total NOx emissions and up to 18 percent of the total PM emissions inventory. Over time, the relative contribution of these diesel engines to air quality problems will go even higher unless EPA takes action to further reduce pollution levels. For example, EPA has already taken steps to bring emissions levels from light-duty and heavy-duty vehicles and engines to near-zero levels by the end of this decade. The PM and NOx standards for nonroad, locomotive, and marine diesel engines in this proposal would have a substantial impact on emissions. By 2030, NOx emissions from these diesel engines under today's standards will be reduced by 827,000 tons, and PM emissions will decline by about 127,000 tons, dramatically reducing this source of NOx and PM emissions. Urban areas, which include many poorer neighborhoods, can be disproportionately impacted by such diesel emissions, and these neighborhoods will thus receive a relatively larger portion of the benefits expected from proposed emissions controls. Diesel exhaust is of special concern because it is associated with increased risk of lung cancer and respiratory disease. EPA recently issued its *Health Assessment Document for Diesel Exhaust*. The Agency has classified diesel exhaust as likely to be carcinogenic to humans by inhalation at environmental exposures. State and local governments, in their efforts to protect the health of their citizens and comply with requirements of the Clean Air Act (CAA or "the Act"), have recognized the need to achieve major reductions in diesel PM emissions, and have been seeking Agency action in setting stringent new standards to bring this about.

C. Comments and Hearings

Comments: Send written comments on this proposal by **August 20, 2003**.
Hearings: EPA will hold public hearings at the following three locations:

New York, New York Park Central New York 870 Seventh Avenue at 56th Street New York, NY 10019 Telephone: (212) 247-8000 Fax: (212) 541-8506	June 10, 2003
Chicago, Illinois Hyatt Regency O'Hare 9300 W. Bryn Mawr Avenue Rosemont, IL 60018 Telephone: (847) 696-1234 Fax: (847) 698-0139	June 12, 2003

Los Angeles. California Hyatt Regency Los Angeles 711 South Hope Street Los Angeles, California, USA. 90017 Telephone: (213) 683-1234 Fax: (213) 629-3230	June 17, 2003

2. **Nonroad Engine Standards**

A. The Standards

i. Exhaust Emissions Standards

The PM, NOx, and NMHC emissions standards being proposed for nonroad diesel engines are summarized in Figures III.B-1 and 2. EPA is also making minor adjustments to CO standards. All of these standards would apply to covered nonroad engines over the useful life periods specified in the regulations, except where temporary in-use compliance margins would apply. EPA is not proposing changes to the current useful life periods because EPA does not have any relevant new information that would lead EPA to propose changes. However, EPA does ask for comment on whether or not changes are warranted and, if so, on what the useful life periods should be. In addition EPA is proposing new “not-to-exceed” (NTE) emission standards and associated test procedures to help ensure robust control of emissions in use.

Figure III.B-1 – Proposed PM Standards (g/bhp-hr) and Schedule

Engine Power	Model Year					
	2008	2009	2010	2011	2012	2013
hp < 25 (kW < 19)	0.30 [a]					
25 # hp < 75 (19 # kW < 56)	0.22 [b]					0.02
75 # hp < 175 (56 # kW < 130)					0.01	
175 # hp # 750 (130 # kW # 560)				0.01		
hp > 750 (kW > 560)				0.01 [c]		

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.

[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).

[c] 50% of a manufacturer's U.S.-directed production must meet the 0.01 g/bhp-hr PM standard in this model year. In 2014, 100% must comply.

FIGURE III.B-2 – PROPOSED NOX AND NMHC STANDARDS AND SCHEDULE

Engine Power	Standard (g/bhp-hr)	
	NOx	NMHC
25 # hp < 75 (19 # kW < 56)	3.5 NMHC+NOx a	
75 # hp < 175 (56 # kW < 130)	0.30	0.14
175 # hp # 750 (130 # kW # 560)	0.30	0.14
hp > 750 (kW > 560)	0.30	0.14

Engine Power	Phase-in Schedule			
	2011	2012	2013	2014
25 # hp < 75 (19 # kW < 56)			100%	
75 # hp < 175 (56 # kW < 130)		50% [b]	50% [b]	100% [b]
175 # hp # 750 (130 # kW # 560)	50%	50%	50%	100%
hp > 750 (kW > 560)	50%	50%	50%	100%

Notes:
Percentages are U.S.-directed production required to comply with the Tier 4 standards in the indicated model year.
[a] This is the existing Tier 3 combined NMHC+NOx standard level for the 50-75 hp engines in this category; in 2013 it would apply to the 25-50 hp engines as well.
[b] Manufacturers may use banked Tier 2 NMHC+NOx credits to demonstrate compliance with the proposed 75-175 hp engine NOx standard in this model year. Alternatively, manufacturers may forego this special banked credit option and instead meet an alternative phase-in requirement in 2012, 2013, and part of 2014.

The proposed long-term 0.01 and 0.02 g/bhp-hr Tier 4 PM standards for >75 hp and 25-75 hp engines, respectively, combined with the fuel change and proposed 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. The proposed 0.30 g/bhp-hr Tier 4 NOx standard for >75 hp engines represents a NOx reduction of about 90% from in-use levels expected with Tier 3 engines.

1) Timing

The timing of the Tier 4 NOx, PM, and NMHC standards is closely tied to the proposed timing of fuel quality changes discussed below, in keeping with the systems approach EPA is taking for this program. The earliest Tier 4 standards would 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 emissions for the existing fleet of engines in the field. Second, its widespread availability by the end of 2007 aids engine designers in employing emission controls capable of achieving the proposed 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.

EPA is not, however, proposing new 2008 standards for engines at or above 100 hp because these engines are subject to existing Tier 3 NMHC+NOx standards (Tier 2 for engines above 750 hp) in 2006 or 2007. Setting new 2008 standards would provide only one or two years before another round of design changes would have to be made for Tier 4. Engines between 50-100 hp also have a Tier 3 NMHC+NOx standard, but it takes effect in 2008, providing an opportunity to coordinate with Tier 4 to provide the desired pull-ahead of PM control. EPA believes that EPA can accomplish this PM pull-ahead without hampering manufacturers' Tier 3 compliance efforts by providing two Tier 4 compliance options for 50-75 hp engines. This reflects the splitting of the current 50-100 hp category of engines to match the new rated power categories shown in Figures III.B-1 and 2. EPA is proposing to provide manufacturers with the option to skip the Tier 4 2008 PM standard and instead to focus design efforts on introducing PM filters for these engines one year earlier, in 2012. This option would ensure that a manufacturer's Tier 3 NMHC+NOx compliance plans are not complicated by having to meet a new Tier 4 PM standard in the same timeframe, if that were to become a concern for a manufacturer.

EPA is concerned that this optional approach for 50-75 hp engines might be abused by equipment manufacturers whose engine suppliers opt not to meet the PM pull-ahead standard in 2008, but who then switch engine suppliers to avoid PM filter-equipped engines in 2012. EPA is therefore proposing 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, from the same engine manufacturer or from another engine manufacturer choosing the same compliance option. This restriction would not apply if the 2008-2011 engines at issue were being produced under the equipment manufacturer flexibility provisions discussed below. Also, EPA would not prohibit an equipment manufacturer who is using non-pull-ahead engines in 2008-2011 from making use of available equipment manufacturer flexibility provisions in 2012 or later. That is, they could continue to use Tier 3 engines in 2012 that are purchased under these provisions; they would, however, still be subject to the above-described restriction on switching manufacturers. EPA solicit comment on whether this restriction should have a numerical basis (e.g., the "no switch" restriction in 2012 applies to the same percentage of 50-75 hp machines produced with non-pull-ahead engines in 2008-2011) to avoid further abuse by equipment manufacturers who redefine their product models to dodge the requirement, and on other suggestions for dealing with this concern.

Note that EPA is not proposing the optional 2008 PM standard for engines between 75 and 100 hp, even though they, like the 50-75 hp engines, are subject to a 2008 Tier 3 standard. This is because EPA believes that these larger engines, proposed to be grouped into a new 75-175 hp category, would be subject to stringent new PM and NOx standards beginning in 2012, and adding a 2008 PM component to this program for a quarter of this 75-175 hp range would complicate manufacturers' efforts to comply in 2012 for the overall category.

The second fuel change, to 15-ppm maximum sulfur in mid-2010, and the related engine standards that begin to phase-in in the 2011 model year, provide the large majority of the environmental benefits of the program. These standards are also timed to provide adequate lead time for manufacturers, and to phase in over time to allow for the orderly transfer of technology from the highway sector. EPA believes that the high-efficiency exhaust emission technologies being developed to meet the 2007 emission standards for heavy-duty highway diesel engines can be adapted to nonroad diesel applications. The engines for which EPA believes this adaptation from highway applications will be most straightforward are those in the over 175 hp power range, and thus under the proposal these engines would be 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 between 75 and 175 hp would be subject to the new standards in the following model year, 2012, reflecting the greater effort involved in adapting highway technologies to these engines. Lastly, engines between 25 and 75 hp would be subject to the new PM standard in 2013, reflecting the even greater challenge of adapting PM filter technology to these engines, which typically do not have highway counterparts. There are additional phase-in provisions aimed at further drawing from the highway technology experience.

In addition to addressing technology transfer, this approach reflects the need to distribute the workload for engine and equipment redesign over three model years, as was provided for 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 already on the road), before the new standards take effect.

2) Phase-In of NOx and NMHC Standards

Because the Tier 4 NOx emissions control technology, like PM control technology, is expected to be derived from technology first introduced in highway HDDEs, EPA believes that the implementation of the Tier 4 NOx standard should follow the pattern EPA adopted for the highway program. This will help to ensure a focused, orderly development of robust high-efficiency NOx 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 NOx and NMHC requirements over multiple model years: 50 percent of each manufacturer's U.S.-directed production volume must meet the new standard in 2007-2009, and 100 percent must do so by 2010. EPA also provided flexibility for highway engine manufacturers to meet that program's environmental goals by allowing somewhat less-efficient NOx controls on more than 50% of their production before 2010 via emissions averaging. Similarly, EPA is proposing to phase in the NOx standards for nonroad diesels over 2011-2013 as indicated in Figure III.B-2, based on compliance with the Tier 4 standards for 50% of a manufacturer's U.S.-directed production in each power category at or above 75 hp in each phase-in model year.

With a NOx 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, the phase-in ensures timely progress to the Tier 4 standards levels while providing a great degree of implementation flexibility for the industry.

EPA is proposing this "percent of production phase-in" 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 1,2 and 3 which, though structured to facilitate technology development and transfer, is more aimed at spreading the redesign workload. Because the Tier 4 program would involve substantial challenges in addressing both technology development and redesign workload, EPA believes that incorporating both of these phase-in mechanisms into the proposed program is warranted, resulting in the coordinated phase-in plan shown in Figure III.B-2. Note that this results in EPA's proposing that new NOx requirements for 75-175 hp engines be deferred for the first 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 NOx adsorber-based standard and thus no percentage phase-in is being proposed), while still providing a production-based phase-in for advanced NOx control technologies.

EPA is proposing two compliance flexibility provisions just for 75-175 hp engines. First, EPA proposes to allow manufacturers to use NMHC+NOx credits generated by 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. This would not otherwise be allowed. These Tier 2 credits would be subject to the power rating conversion already established in the ABT program, and to the 20% credit adjustment EPA is proposing for use of NMHC+NOx credits as NOx credits.

Second, EPA is also proposing an alternative flexibility provision. A manufacturer may optionally forego the Tier 2 banked credit use provision described above, and instead demonstrate compliance with a reduced phase-in requirement for NOx and NMHC. Use of credits other than banked Tier 2 credits would still be allowed, in accordance with the other ABT program provisions. In no case could the phase-in compliance demonstration drop below 25% in each of 2012, 2013, and the first 9 months of 2014, except as allowed under the "good faith projection deficit" provision discussed below. Full compliance (100% phase-in) with the Tier 4 standards would need to be demonstrated in the last 3 months of 2014 and thereafter.

In addition, a manufacturer using this reduced phase-in option would not be allowed to generate credits from engines in this power category in 2012, 2013, and the first 9 months of 2014, except for use in averaging within this power category only (no banking or trading, or averaging with engines in other power categories). This restriction would apply throughout this period even if the reduced phase-in option is exercised during only a portion of this period. .

EPA is proposing to phase in the Tier 4 NMHC standard with the NOx standard, as is being done in the highway program. Engines certified to the new NOx requirement would be expected to certify to the NMHC standard as well. The "phase-out" engines (the 50 percent not certified to the new Tier 4 NOx and NMHC standards) would continue to be certified to the applicable Tier 3 NMHC+NOx standard.

Because of the tremendous variety of engine sizes represented in the nonroad diesel sector, EPA is proposing that the 50 percent phase-in requirement be met separately in each of the three power categories for which a phase-in is proposed (75-175 hp, 175-750 hp, and >750 hp). 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 to the proposed NOx and NMHC standards on at least 500 of these engines, regardless of how many complying engines the manufacturer produces in other hp categories. (Note, however, that EPA would allow averaging of emissions across these engine category cutpoints through the use of power-weighted ABT program credits, as provided for in the existing nonroad diesel engine program.) .

3) PM Standards for Smaller Engines

(a) <25 hp

EPA believes that standards based on the use of PM filters should not be proposed at this time for the very small diesel engines below 25 hp. Although this technology could be adapted to these engines, the cost of doing so with known technology could be unacceptably high, relative to the cost of producing the engines themselves. Based on past experience, EPA expects that advancements in reducing these costs will occur over time. EPA plan to reassess the appropriate long-term standards in a technology review as discussed below. For the nearer-term, EPA believes that other proven PM-reducing technologies such as diesel oxidation catalysts and engine optimization can be applied to engines under 25 hp for very cost-efficient PM control. When implemented, the PM standard proposed in Figure III.B-1 for these engines, along with the proposed transient test cycle, 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. EPA invites comment on this proposed approach to controlling harmful emissions from very small nonroad diesel engines.

It is EPA’s assessment that achieving low PM emission levels is especially challenging for one subclass of small engines: the air-cooled, direct injection engines under 11 hp that are startable by hand, such as with a crank or recoil starter. These typically one-cylinder engines find utility in applications such as plate compactors, where compactness and simplicity are needed, but where the ruggedness typical of a diesel engine is also essential. There are a number of considerations in the design, manufacture, and marketing of these engines that combine to make them difficult to optimize for low emissions. These include the air-cooled engine’s need for relatively loose design fit tolerances to accommodate thermal expansion variability (which can lead to increased soluble organic PM), small cylinder displacement and bore sizes that limit use of some combustion chamber design strategies and increase the propensity for PM-producing fuel impingement on cylinder walls, the difficulty in obtaining components for small engines with machining tolerances tight enough to yield consistent emissions performance, and cost reduction pressures caused by competition from cheaper gasoline engines in some of the same applications.

As a result, EPA is proposing an alternative compliance option that 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/hp-hr, rather than to the 0.30 g/hp-hr PM standard applicable to the other engines in this power category beginning in 2008. Engines certified under this alternative compliance requirement would not be allowed to generate credits as part of the ABT program, although credit use by these engines would still be allowed. EPA believes that this ABT restriction is important to avoid potential abuse of this option, and is a reasonable means of dealing with the concern as it would apply only to those air-cooled, hand-startable, direct injection engines under 11 hp that are certified under this special compliance option, and the production of credit-generating engines would be contrary to the option’s purpose. Furthermore, because the proposed 2010 Tier 4 implementation year for these engines is the same year that 15 ppm sulfur nonroad diesel fuel would become available, EPA is also proposing that certification testing and any subsequent compliance testing on engines certified under this option may be conducted using the 7-15 ppm sulfur test fuel. Although this is one year earlier than would be otherwise allowable, EPA believes it would have a minimal impact on the proposed program's environmental benefit considering the extremely small contribution these engines make to emissions inventories, and the fact that these engines would generally operate in the field on higher sulfur fuels for at most a few months.

(b)25-75 hp

EPA believes that the proposed 0.22 g/bhp-hr PM standard for 25-75 hp engines in 2008 is warranted because the Tier 2 PM standards that take effect in 2004 for these engines, 0.45 and 0.30 g/bhp-hr for 25-50 and 50-75 hp engines, respectively, do not represent the maximum achievable reduction using technology which will be available by 2008. However, filter-based technology for these engines is not expected to be available on a widespread basis until the 2013 model year. The proposed 2008 PM standard for these engines should maximize reduction of PM emissions based on technology available in that year. .

EPA requests comment on the proposal to implement Tier 4 PM standards for 25-75 hp engines in the two phases just noted: a non-PM filter based standard in 2008 and a filter-based standard in 2013. In addition, EPA requests comment on whether it would be better not to set a Tier 4 PM standard in 2008 so that engine designers could instead focus their efforts on meeting a PM-filter based standard for these engines earlier, say in 2012. (It should be noted that the proposed rule would provide this as an option for a subgroup of these engines (50-75 hp). EPA would assume that under this approach the proposed new NOx+NMHC standard for 25-50 hp engines in this category would also start in 2012, to avoid requiring two design changes in two years. Any comments in support of this approach should, if possible, include information to support a conclusion that the earlier start date for a PM filter-based standard would be technologically feasible.

EPA believes that the proposed 2008 PM standards for engines under 75 hp can be met either through engine optimization, by the use of diesel oxidation catalysts, or by some combination thereof. For engines that comply through the use of oxidation catalysts, NMHC emissions are expected to be very low because properly designed oxidation catalysts are effective at oxidizing gaseous hydrocarbons as well as the soluble organic fraction of diesel exhaust PM. Engines complying with the proposed 2008 PM standard without the use of oxidation catalysts would, on the other hand, be expected to emit NMHC at about the same levels as Tier 2 engines. Recognizing that NMHC emissions from diesel engines can include a number of toxic compounds, and that there are many of these small diesel engines operating in populated areas, EPA is interested in comment on the appropriateness of setting a more stringent NMHC standard for these engines in 2008 to better control these emissions. EPA expects that doing so would likely result in more widespread use of oxidation catalysts (rather than engine optimization) for these engines. EPA would not, however, expect this to lead to a more stringent PM standard than the one EPA is proposing.

4) Engines Above 750 hp

For engines above 750 hp, additional lead time to fully implement Tier 4 is warranted due to the relatively long product design cycles typical of these high-cost, low-sales volume engines and machines. The long product design cycle issue is the primary reason EPA did not set Tier 3 standards for these engines in the 1998 rule and are not proposing to do so now. Instead, EPA is proposing that these engines move from the Tier 2 standards, which take effect in 2006, to Tier 4 standards beginning in 2011, five years later. Moreover, EPA is proposing that the Tier 4 PM standard be phased in for these engines on the same 50-50-50-100% schedule as the NOx and NMHC phase-in schedule, rather than all at once in 2011 as for engines between 175 and 750 hp. This would provide engine manufacturers with up to 8 years of design stability to address concerns associated with product design cycles and low sales volumes typical of this category. The engine manufacturer ABT program adds additional flexibility.

EPA thinks that, taken together, these provisions appropriately balance the need for expeditious emission reductions with issues relating to lead time, technology development, and cost for these engines and machines. Even so, some engine and equipment manufacturers have expressed concerns to EPA that, though not challenging the Tier 4 program endpoint (high-efficiency PM and NOx exhaust emission controls), in their estimation the proposed program implementation provisions do not adequately address their timing concerns. In particular, they have expressed a view that they need until 2012 (one additional year) before they could begin to phase in Tier 4 standards for this category. They have also expressed the view that mobile machinery such as mine haul trucks and dozers (as differentiated from equipment such as nonroad diesel generators that also use engines in this hp range) present unique challenges that could require more time to resolve than would be afforded by the proposed 2014 phase-in completion date.

Although EPA believes that the implementation schedule and flexibility provisions EPA is proposing will enable the manufacturers to meet these challenges, EPA acknowledges the manufacturers' concerns and asks for comment on this issue. Specifically, EPA requests 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 flexibility provisions, or some combination of these. Technical information backing the commenter's view would be most helpful in this regard.

As with the NOx/NMHC phase-in for all engines at or above 75 hp, EPA is proposing that the PM phase-in for engines above 750 hp would have to be met on the same engines as the Tier 4 NOx and NMHC standards during the phase-in years. That is, engines certified to the Tier 4 NOx and NMHC requirements would be expected to certify to the Tier 4 PM standard as well.

5) CO Standards

EPA is proposing minor changes in CO standards for some engines solely for the purpose of helping to consolidate power categories. These amount to a change for engines under 11 hp from 6.0 to 4.9 g/bhp-hr in 2008 to match the existing Tier 2 CO standard for 11-25 hp engines, and a change for engines at or above 25 hp but below 50 hp from 4.1 to 3.7 g/bhp-hr to match the existing Tier 3 CO standard for 50-75 hp engines, also in 2008.

6) Exclusion of Marine Engines

These proposed emission standards would apply to engines in the same applications covered by

EPA's existing nonroad diesel engine standards, at 40 CFR part 89, except that they would not apply to marine diesel engines. Marine diesel engines below 50 hp were included in the 1998 rule that set nonroad diesel emission standards. In that rule, EPA expected that the engine modifications needed to achieve those standards (e.g., in-cylinder controls) for marine engines would not need to be different from those for land-based engines of this size.

The standards for diesel engines below 50 hp being proposed in this action are likely to require PM filters or diesel oxidation catalysts on many or all engines, and transferring this technology to the marine diesel engines of any size raises unique issues. For example, many marine diesel engines have water-jacketed exhaust which may result in different exhaust temperatures and which could affect aftertreatment efficiency. The modified marine engine designs would also have to meet Coast Guard requirements. These and other conditions may require separate design efforts for marine diesel engines. Therefore, EPA believes it is more appropriate to consider more stringent standards for marine diesel engines below 50 hp in a future action. It should be noted, however, that the existing Tier 2 standards will continue to apply to marine diesel engines under 50 hp until that future action is completed.

ii. Crankcase Controls

Crankcase emissions are the pollutants that are emitted in the gases that are vented from an engine's crankcase. These gases are also referred to as "blowby gases" because they result from engine exhaust from the combustion chamber "blowing by" the piston rings into the crankcase. These gases are often vented to prevent high pressures from occurring in the crankcase. EPA's existing emission standards require control of crankcase emissions from all nonroad diesel engines except turbocharged engines. EPA is therefore proposing to eliminate the exception for turbocharged nonroad diesel engines starting in the same model year that Tier 4 exhaust emission standards first apply in each power category. This is 2008 for engines below 75 hp, except for 50-75 hp engines for which a manufacturer opts to skip the 2008 PM standard. The crankcase requirement applies to "phase-in" engines above 750 hp under the 50% phase-in requirement for 2011-2013, but not to the "phase-out" engines in that power category during those years. This is an environmentally significant proposal since many nonroad machine models use turbocharged engines, and a single engine can emit over 100 pounds of NOx, NMHC, and PM from the crankcase over the lifetime of the engine. EPA also notes that the cost of control is small.

EPA's existing regulatory requirement for controlling crankcase emissions from naturally-aspirated nonroad engines allows manufacturers to route the crankcase gases into the exhaust stream instead of the engine air intake system, provided they keep the combined total of the crankcase emissions and the exhaust emissions below the applicable exhaust emission standards. EPA is proposing to extend this allowance to the turbocharged engines as well. EPA is also proposing to give manufacturers the option to measure crankcase emissions instead of completely eliminating them, and adding the measured emissions to exhaust emissions in assessing compliance with exhaust emissions standards. As in the highway program, manufacturers choosing to use this allowance rather than to seal the crankcase would need to modify their exhaust deterioration factors or to develop separate deterioration factors to account for increases in crankcase emissions as the engine ages. Manufacturers would also be responsible for ensuring that crankcase emissions would be readily measurable in use.

B. Test Procedure Changes

EPA is proposing a number of changes to the certification test procedures by which compliance with emission standards is determined. Two of these are particularly significant: The addition of a supplemental transient emissions test and the addition of a cold start testing component to the proposed transient emissions test. Other proposed changes deal with:

- Adoption of an improved smoke testing procedure, with associated standards levels and exemptions.
- Addition of a steady-state test cycle for transportation refrigeration units.
- Test procedure changes intended to improve testing precision, especially with regards to sampling methods.
- A clarification to existing EPA defeat device regulations.

i. Supplemental Transient Test

Test development has progressed steadily since the 1998 rule was adopted, and has resulted in the creation of a Nonroad Transient Composite (NRTC) test cycle, which EPA is now proposing to adopt in the nonroad diesel program, to supplement the existing steady-state tests. The proposed NRTC cycle will capture transient emissions over much of the typical nonroad engine operating range, and thus help ensure effective control of all regulated pollutants. In keeping with EPA's goal to maximize the harmonization of emissions control programs as much as possible, EPA has developed this cycle in collaboration with nonroad engine manufacturers and regulatory bodies in the United States, Europe, and Japan over the last several years. Further, the NRTC cycle has been introduced as a work item for possible adoption as a potential global technical regulation under the 1998 Agreement for Working Party 29 at the United Nations.

The Agency is proposing that emission standards be met on both the current steady-state duty cycles and the new transient duty cycles. The transient testing would begin in the model year that the trap-based Tier 4 PM standards and/or adsorber-based Tier 4 NOx standards first apply. This would be 2011 for engines at or above 175 hp, 2012 for 75-175 hp engines (2012 for 50-75 hp engines made by a manufacturer choosing the optional approach described in footnote b of Figure III.B-1), and 2013 for engines less than 75 hp. In addition, any engines for which a manufacturer claims credit under the incentive program for early-introduction engines would have to be certified to that program's standards under the NRTC cycle and, in turn, the 2011 or later model year engines that use these engine count-based credits would not need to demonstrate compliance under the NRTC cycle.

Although EPA intend that transient emissions control be an integral part of Tier 4 design considerations, EPA does not believe it appropriate to mandate compliance with the transient test for the engines under 75 hp subject to proposed PM standards in 2008. EPA recognize that transient emissions testing, though routine in highway engine programs, involves a fair amount of new laboratory equipment and expertise in the nonroad engine certification process. As with the transfer of advanced emission control technology itself, EPA believes that the transient test requirement should be implemented first for larger engines more likely to be made by engine manufacturers who also have highway engine markets. EPA does not believe that the smaller engines should be the lead power categories in implementing the new transient test, especially because many manufacturers of these engines do not make highway engines and are not as experienced or well-equipped as their large-engine counterparts for conducting transient cycle testing.

Engines below 25 hp involve an additional consideration for timing of the transient test requirement because EPA is not proposing PM-filter based standards for them. EPA proposes that testing on the NRTC cycle not be required for these engines until the 2013 model year, the last year in which engines in higher power categories are required to use this test. EPA is concerned that manufacturers not view this proposed deferral of the transient test requirement as a structured second level of required control for these engines. To address this concern and because EPA wish to encourage the demonstration of transient emission control as early as possible, EPA is proposing to allow manufacturers to optionally certify engines below 25 hp under the NRTC cycle beginning in the 2008 model year, and to extend this option to 25-75 hp engines subject to engines meeting the transitional PM standard in 2008. EPA requests comment on this proposed approach and on whether it would be better to deal with this concern by requiring compliance under the transient test when the Tier 4 standards begin in 2008.

In applying the NRTC test requirement coincident with the start of PM filter-based standards, EPA does not mean to imply that control of PM from filter-equipped engines is the only or even the primary concern being addressed by transient testing. In fact, EPA believes that advanced NOx emission controls may be more sensitive to transient operation than PM filters. It is, however, EPA's intent that the control of emissions during transient operation be an integral part of Tier 4 engine design considerations, and EPA therefore have proposed that transient testing be applied with the PM filter-based Tier 4 PM standards, because these standards precede or accompany the earliest Tier 4 NOx or NMHC standards in every power category. Even so, EPA requests comment on whether the "phase-out" engines above 75 hp (those engines for which compliance with the Tier 4 NOx standard is not required during the phase-in period) should be exempted from the requirement to meet the applicable NMHC+NOx standard using the transient test. Although EPA's interest in ensuring transient emissions control as quickly as possible in the Tier 4 program, and in avoiding test program complexity, would argue against this approach, EPA is also interested in not diverting engine designers from the challenging task of redesigning engines to meet the proposed 0.30 g/bhp-hr Tier 4 NOx standard before and during the phase-in years by having to deal with transient control under an NMHC+NOx standard that is being phased out.

EPA is in fact not proposing to apply the transient test to phase-out engines above 750 hp that are carried over from pre-2011 Tier 2 engine designs. Unlike phase-out engines at or below 750 hp, these engines are not subject to a Tier 4 PM standard in 2011. They would thus be Tier 2 engine designs and EPA does not believe that subjecting them to transient testing would be appropriate. On the other hand, engines in any power category certified to an average NOx standard under the "split family" provision would all be subject to the transient test requirement, as they would clearly have to be substantially redesigned to achieve Tier 4 compliance, regardless of whether or not they use high-efficiency exhaust emission controls.

The Agency is proposing that engine manufacturers may certify constant-speed engines using EPA's Constant Speed Variable Load (CSVL) transient duty cycle as an alternative to testing these engines under the NRTC provisions. The CSVL transient cycle more closely matches the speed and load operating characteristics of many constant-speed nonroad diesel applications than EPA's proposed

NRTC cycle. However, the manufacturer would be obligated to ensure that such engines would be used only in constant-speed applications.

ii. Cold Start Testing

EPA believes that the proposed move to supplemental transient testing, combined with the proposed Tier 4 standards that will bring about the use of catalytic devices in nonroad diesel engines, makes it imperative that EPA also propose to include such a cold start test as part of the transient test procedure requirement. EPA proposes to weight the cold start emission test results as one-tenth of the total with hot-start emissions accounting for the other nine-tenths. The one-tenth weighting factor is derived from a review of the present nonroad equipment population. EPA requests comment on this approach to ensuring control of cold start emissions.

C. In Use Controls

EPA's goal is to ensure real-world emissions control over the broad range of in-use operation that can occur, rather than just controlling emissions over prescribed test cycles executed under restricted laboratory conditions. An important tool for achieving this in-use emissions control is the setting of Not-To-Exceed (NTE) emission standards, which, in this notice, the Agency is proposing to adopt for new nonroad engines. EPA is also considering two additional means of in-use emissions control that will be proposed in separate notices. These are 1) a manufacturer-run in-use emissions test program and 2) on-board diagnostics (OBD) requirements for new nonroad diesel engines.

i. Not-to-Exceed Requirements

EPA proposes to adopt not-to-exceed (NTE) emission standards for all new nonroad diesel engines subject to the Tier 4 emissions standards beginning in 2011. EPA already has similar NTE standards set for highway heavy-duty diesel engines, compression ignition marine engines, and nonroad spark-ignition engines.

The NTE approach establishes an area (the "NTE zone") under the torque curve of an engine where emissions must not exceed a specified value for any of the regulated pollutants. The NTE standard would apply under any conditions that could reasonably be expected to be seen by that engine in normal vehicle operation and use, within certain broad ranges of real ambient conditions. EPA believes that basing the emissions standards on a set of distinct steady state and transient cycles and using the NTE zone to help ensure in-use control creates a comprehensive program. In addition, the NTE requirements would also be an effective element of an in-use testing program.

In EPA's notice, EPA is proposing an NTE standard that is based on the approach taken for the 2007 highway heavy-duty diesel engines. In addition, EPA is requesting comment on an alternative NTE standard approach that, while different from the highway NTE standard approach, is designed to achieve the same environmental objectives. Both of these approaches are described below.

1) The Proposed Approach

EPA's NTE proposal for nonroad contains the same basic provisions as the highway NTE. The NTE standard would apply under any engine operating conditions that could reasonably be expected to be seen by that engine in normal vehicle/equipment operation and use which occurs within the NTE control zone and which also occurs during the wide range of real ambient conditions specified for the NTE. The NTE standard applies to emissions sampled during a time duration as small as 30 seconds. These requirements would take effect as early as 2011 and would apply to engines at the time of certification as well as in use throughout the useful life of the engine.

TABLE III.D-1 -- NTE STANDARD IMPLEMENTATION SCHEDULE

Power Category	NTE Implementation Model Year[a]
<25 hp	2013
25-75 hp	2013[b]
75-175 hp	2012
175-750 hp	2011
>750 hp	2011[c]

Notes:
[a] The NTE applies for each power category once Tier 4 standards were implemented, such that all engines in a given power category are required to meet NTE standards.
[b] The NTE standard would apply in 2012 for any engines in the 50-75 hp range who choose not to comply with the proposed 2008 transitional PM standard
[c] The NTE standard only applies to the 50 percent of the engines in the >750 hp category which are complying with the proposed Tier 4 standard. Beginning in 2014 the NTE standard would apply to all nonroad engines >750 hp when the remaining 50 percent of the engines must comply with the Tier 4 standard.

In addition, as with the 2007 highway NTE standard, EPA is proposing a transition period during which a manufacturer could apply for an NTE deficiency for a nonroad diesel engine family. The NTE deficiency provisions would allow the Administrator to accept a nonroad diesel engine as compliant with the NTE standards even though some specific requirements are not fully met. EPA is proposing these NTE deficiency provisions because EPA believes that, despite the best efforts of manufacturers, for the first few model years it is possible some manufacturers may have technical problems that are limited in nature but cannot be remedied in time to meet production schedules. EPA is not limiting the number of NTE deficiencies a manufacturer can apply for during the first 3 model years for which the NTE applies. For the fourth through the seventh model year after which the NTE standards are implemented, a manufacturer could apply for no more than three NTE deficiencies per engine family. No deficiency may be applied for or granted after the seventh model year. The NTE deficiency provision will only be considered for failures to meet the NTE requirements. EPA will not consider an application for a deficiency for failure to meet the FTP or supplemental transient standards.

As with the NTE standards EPA has established for the 2007 highway rule, EPA is proposing an NTE standard that is determined as a multiple of the engine families underlying FTP emission standard. In addition, as with the 2007 highway standard, the multiple is either 1.25 or 1.5, depending on the value of the FTP standard (or the engine families FEL). These multipliers are based on EPA's assessment of the technological feasibility of the NTE standard, and EPA's assessment that as the underlying FTP standard becomes more stringent, the NTE multiplier should increase (from 1.25 to 1.5). The proposed standard or FEL thresholds for the 1.25x multiplier and the 1.5x multiplier are specified for each regulated emission in Table III.D-2.

TABLE III.D-2 -- THRESHOLDS FOR APPLYING NTE STANDARD OF 1.25XFTP STANDARD VS. 1.5X FTP STANDARD

Emission	Apply 1.25x NTE when...	Apply 1.5x when...
NOx	NOx std or FEL$ 1.5 g/bhp-hr	NOx std or FEL< 1.5 g/bhp-hr
NMHC	NOx std or FEL$ 1.5 g/bhp-hr	NOx std or FEL< 1.5 g/bhp-hr
NOx+NMHC	NMHC+NOx std or FEL$ 1.6 g/bhp-hr	NMHC+NOx std or FEL< 1.6 g/bhp-hr
PM	PM std or FEL$0.05 g/bhp-hr	PM std or FEL< 0.05 g/bhp-hr
CO	All stds or FELs	No stds or FELs

For example, beginning in 2011, the proposed NTE standard for engines meeting a FTP PM standard of 0.01 g/bhp-hr and a FTP NOx standard of 0.30 g/bhp-hr would be 0.02 g/bhp-hr PM and 0.45 g/bhp-hr NOx.

In addition, the nonroad NTE proposal specifies a number of additional engine operating conditions that are not subject to the NTE standard. Specifically: the NTE does not apply during engine start-up conditions; the NTE does not apply during very cold engine intake conditions defined in the proposed regulations for EGR equipped engines during which the engine may require an engine protection strategy; and, finally, for engines equipped with an exhaust emission control device (such as a CDPF or a NOx adsorber), the NTE does not apply during warm-up conditions for the exhaust emission control device, specifically the NTE does not apply with the exhaust gas temperature on the outlet side of the exhaust emission control device is less than 250 degrees Celsius.

2) Possible Alternative NTE Approach

In addition the Agency requests comment on the following set of NTE specifications as an alternative to those NTE provisions proposed. This alternative NTE would use the same numeric standard values as under the proposed NTE standards discussed above, however, the test procedure itself is quite different, as described below. The Agency believes that these alternative specifications and the range of operation covered by the standard would provide for similar, if not more robust nonroad engine compliance compared to the application of the proposed NTE specifications to nonroad engines. Emissions would be measured over a constant averaging work interval, determined as ten percent (10%) of the total work performed by the engine over a specified period of time (e.g., a minimum of six hours of operation). This 10% window of work "moves" through data at one percent (1%) increments so as to always return about ninety (90) individual data points for direct comparison to the NTE standards.

Comments should address the potential exclusive use of these alternative provisions for nonroad diesel engine NTE compliance.

ii. Plans for In-Use Testing and Onboard Diagnostics

In addition to the proposals in this notice, EPA is currently reviewing several related regulatory provisions concerning control of emissions from nonroad diesel engines. They are not included in this proposal, as EPA believes these aspects of an effective emission control program would benefit from further evaluation and development prior to their proposal. EPA intends to explore these provisions further in the coming months and publish a separate notice of proposed rulemaking dealing with these issues. In particular, there are two issues which will be discussed: 1) a manufacturer-run in-use emissions testing program; and 2) OBD requirements for nonroad diesel engines. The Agency believes that it is appropriate to proceed with the current rulemaking, expecting that these two issues will be proposed in the near future. EPA expects these programs would be adopted in advance of the effective date of the engine emissions standards. This will allow EPA to gather information and work with interested parties in a separate process regarding these issues. EPA will work with all parties involved, including states, environmental organizations and manufacturers, to develop robust, creative, environmentally protective and cost-effective proposals addressing these issues.

D. The Need For 15ppm Sulfur Diesel Fuel

EPA strongly believes that fuel sulfur control is critical to ensuring the success of NOx and PM aftertreatment technologies. In order to evaluate the effect of sulfur on diesel exhaust control technologies, EPA used three key factors to categorize the impact of sulfur in fuel on emission control function - efficiency, reliability, and fuel economy.

The **efficiency** of emission control technologies to reduce harmful pollutants is directly affected by sulfur in diesel fuel. Initial and long term conversion efficiencies for NOx, NMHC, CO and diesel PM emissions are significantly reduced by catalyst poisoning and catalyst inhibition due to sulfur. NOx conversion efficiencies with the NOx adsorber technology in particular are dramatically reduced in a very short time due to sulfur poisoning of the NOx storage bed. In addition, total PM control efficiency is negatively impacted by the formation of sulfate PM. EPA believes that the formation of sulfate PM will be in excess of the total PM standard, unless diesel fuel sulfur levels are at or below 15 ppm.

Reliability refers to the expectation that emission control technologies must continue to function as required under all operating conditions for the life of the engine. Sulfur in diesel fuel can prevent proper operation of both NOx and PM control technologies that can lead to permanent loss in emission control effectiveness and even catastrophic failure of the systems. Sulfur in diesel fuel impacts reliability by decreasing catalyst efficiency (poisoning of the catalyst), increasing diesel particulate filter loading, and negatively impacting system regeneration functions. In the case of the NOx adsorber, failure to regenerate the stored sulfur (desulfate) will lead to rapid loss of NOx emission control as a result of sulfur poisoning of the NOx adsorber bed. In the case of the diesel particulate filter, sulfur in the fuel reduces the reliability of the regeneration function. If regeneration does not occur, catastrophic failure of the filter could occur. It is only by the availability of low sulfur diesel fuels that these technologies become feasible.

Fuel economy impacts due to sulfur in diesel fuel affect both NOx and PM control technologies. The NOx adsorber sulfur regeneration cycle (desulfation cycle) can consume significant amounts of fuel unless fuel sulfur levels are very low. As sulfur levels increase above 15 ppm, the adverse effect on fuel economy becomes more significant, increasing above one percent and doubling with each doubling of fuel sulfur level. Likewise, PM trap regeneration is inhibited by sulfur in diesel fuel. This leads to increased PM loading in the diesel particulate filter and increased work to pump exhaust across this restriction. With low sulfur diesel fuel, diesel particulate filter regeneration can be optimized to give a lower (on average) exhaust backpressure and thus better fuel economy. Thus, for both NOx and PM technologies the lower the fuel sulfur level the lower the operating costs of the vehicle.

E. Technology Review in 2007

EPA believes that a nonroad diesel technology review of the extent being pursued for the heavy-duty highway engine program will not be needed. Nevertheless, EPA believes that a future review of particulate filter technology for engines under 75 hp may be warranted. At this time EPA has not decided what the long-term PM standards should be for engines under 25 hp. Likewise, EPA has not decided what the long-term NOx standards should be for engines under 75 hp. As part of the technology review, EPA plans to thoroughly evaluate progress made toward applying advanced PM and NOx control technologies to these smaller engines.

EPA proposes to conduct the technology review in 2007, and to conclude it by the end of that year, to give manufacturers lead time should an adjustment in the program be considered appropriate.

EPA expects that any changes to the level or timing of emission standards found appropriate in the 2007 review would be made as part of a rulemaking process, and that process would take additional time after the review is completed. EPA would expect the rulemaking implementing such changes to provide for adequate lead time. EPA solicits comment on the scope, timing, and need for a future reassessment of emissions control technology for nonroad diesel engines.

3. **Nonroad, Locomotive and Marine Diesel Fuel Sulfur**

EPA is proposing to reduce the sulfur content of nonroad, locomotive and marine (NRLM) diesel fuel to no more than 500 ppm beginning in 2007. EPA is also proposing to reduce the sulfur content of nonroad diesel fuel to no more than 15 ppm beginning in 2010. These provisions mirror controls on highway diesel fuel to 500 ppm in 1993 and 15 ppm in 2006.

In developing the proposed diesel fuel program, EPA identified several principles that it wanted the program to achieve:

1) Maintain the benefits and program integrity of the highway diesel fuel program;

2) Achieve the greatest reduction in sulfate PM and sulfur dioxide emissions from nonroad, locomotive, and marine diesel engines as early as practicable;

3) Provide for a smooth transition of the nonroad diesel fuel pool to 15-ppm sulfur;

4) Ensure that 15-ppm sulfur diesel fuel is produced and distributed widely for use in all 2011 and later model year nonroad engines;

5) Enable the efficient distribution of all diesel fuels; and

6) Ensure that the program's requirements are enforceable and verifiable.

A. Proposed Fuel Quality Standards

i. Fuels Covered and Not Covered

The proposed standards generally cover all the diesel fuel that is used in mobile applications but is not already covered by the previous standards for highway diesel fuel. This fuel is defined primarily by the type of engine that it is used to power: nonroad, locomotive, and marine diesel engines. These fuels typically include:

1) Any number 1 and 2 distillate fuels used, intended for use, or made available for use in nonroad, locomotive or marine diesel engines,
2) Any number 1 distillate fuel (e.g., kerosene) added to such number 2 diesel fuel, e.g., to improve its cold flow properties, and
3) Any other fuel used in or blended with diesel fuel for use in nonroad, locomotive, or marine diesel engines that has comparable chemical and physical characteristics.

This proposal would not apply to:

1) Number 1 distillate fuel used to power jet aircraft,
2) Number 1 or number 2 distillate fuel used for other purposes, such as to power stationary diesel engines or for heating,
3) Number 4 and 6 fuels (e.g., bunker or residual fuels, IFO Heavy Fuel Oil Grades 30 and higher, ASTM DMB and DMC fuels), and
4) Any fuel used to power equipment for which a national security exemption has been approved.

States, not the Agency, have responsibility for any fuel sulfur specifications for heating oil, so this fuel would not be covered by this proposal.[1] However, EPA does propose a number of provisions, as

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[1] For the purposes of this proposal, the term heating oil refers to any number 1 or number 2 distillate other than jet fuel and diesel fuel used in highway, nonroad, locomotive, or marine applications. For example, heating oil includes fuel which is suitable for use in furnaces, boilers, stationary diesel engines and similar

described below, that would ensure that heating oil would not be used in nonroad, locomotive, or marine applications.

ii. Standards and Deadlines for Refiners, Importers, and Fuel Distributors

1) The First Step to 500 ppm

Under this proposal NRLM diesel fuel produced by refiners or imported into the U.S. would be required to meet a 500-ppm sulfur standard beginning June 1, 2007. Refiners and importers could comply by either producing such fuel at or below 500 ppm, or could comply by obtaining credits.

EPA is proposing that at the terminal level, NRLM diesel fuel would be required to meet the 500-ppm sulfur standard beginning August 1, 2007. At bulk plants, wholesale purchaser-consumers, and any retail stations carrying NRLM diesel, this fuel would have to meet the 500-ppm sulfur standard by October 1, 2007.[2] The only exceptions to these dates would be for high sulfur NRLM produced under the hardship and fuel credit provisions discussed below.[3]

EPA seeks comment on this proposed schedule.

2) The Second Step to 15 ppm

In order to enable the application of high efficiency exhaust emission control technologies to nonroad diesel engines beginning with the 2011 model year, EPA is proposing that all nonroad diesel fuel produced or imported after June 1, 2010 would have to meet a 15 ppm sulfur cap. EPA is proposing that diesel fuel used for locomotive and marine diesel engines could continue to the meet the 500 ppm cap first applicable in 2007.

EPA is proposing that at the terminal level, nonroad diesel fuel would be required to meet the 15-ppm sulfur standard beginning July 15, 2010. At bulk plants, wholesale purchaser-consumers, and any retail stations carrying nonroad diesel, this fuel would have to meet the 15-ppm sulfur standard by September 1, 2010.

As with the 500 ppm standard, refiners and importers could comply with this standard by either

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applications and is commonly or commercially known or sold as heating oil, fuel oil, and other similar trade names.

[2] A bulk plant is a secondary distributor of refined petroleum products. They typically receive fuel from terminals and distribute fuel in bulk by truck to end users. Consequently, while for highway fuel, bulk plants often serve the role of a fuel distributor, delivering fuel to retail stations, for nonroad fuel, they often serve the role of the retailer, delivering fuel directly to the end-user.

[3] Furthermore, EPA proposes that high sulfur nonroad diesel fuel which is produced after June 1, 2007 due to the small refiner and fuel credit provisions could be commingled with 500-ppm nonroad diesel fuel after it has been dyed to the IRS specifications. Thus, at some points in the distribution system, nonroad fuel higher than the 500 ppm standard would remain until it is precluded from production beginning June 1, 2010.

physically producing 15 ppm fuel or by obtaining sulfur credits.

EPA is seriously considering bringing the sulfur level of locomotive and marine diesel fuel to 15 ppm as early as June 1, 2010 along with nonroad diesel fuel. There are several advantages associated with this alternative. First, it would provide important sulfate PM and SO2 emission reductions and the estimated benefits from these reductions would outweigh the costs by a considerable margin. Second, it would simplify the fuel distribution system and the design of the fuel program. Third, it would help reduce the potential opportunity for misfueling of 2007 and later model year highway vehicles and 2011 and later model year nonroad equipment with higher sulfur fuel. Finally, it would allow refiners to coordinate plans to reduce the sulfur content of all of their nonroad diesel fuel at one time.

However, discussions with refiners have suggested there are advantages to leaving locomotive and marine diesel fuel at 500 ppm, at least in the near-term and until EPA set more stringent standards for those engines. The locomotive and marine diesel fuel markets could provide a market for off-spec product, which is important for refiners, particularly during the transition to 15 ppm for highway and nonroad diesel fuel in 2010. Waiting just a year or two beyond 2010 would address the critical near term needs during the transition. Second, waiting just another year or two beyond 2010 is also projected to allow virtually all refiners to take advantage of the new lower cost technology.

In addition to seeking comment on whether to apply the 15 ppm standard to locomotive and marine diesel fuel in 2010, EPA also seek comment on other timing for doing so, and especially on how the Agency should coordinate a 15 ppm standard for locomotive and marine with the nonroad diesel fuel standard being proposed. It is the Agency's intention to propose in the near future new emission standards for locomotive and marine engines that could require the use of high efficiency exhaust emission control technology, and thus, also require the use of 15 ppm sulfur diesel fuel. EPA anticipates that such engine standards would likely take effect in the 2011-13 time frame, requiring 15-ppm locomotive and marine diesel fuel in the 2010-12 time frame. EPA intends to publish an advanced notice of proposed rulemaking (ANPRM) for such a rule in the Spring of 2004 and complete action on a final rule by 2007.

3) Other Standard Provisions

EPA is proposing that the 500-ppm NRLM and 15 ppm nonroad diesel fuel standards would apply to the areas of Alaska served by the Federal Aid Highway System (FAHS). Rural areas, those outside the FAHS, would not be subject to either the 15 or 500-ppm standards. Market forces in these areas would be relied upon to provide 15-ppm diesel fuel for 2011 and later nonroad diesel engines used in these areas. This is consistent with the approach that is in the process of being developed by the State of Alaska for implementing the 2007 highway diesel fuel program. EPA can revisit this issue when it takes action on Alaska's plan for implementation of the highway sulfur requirements, allowing for coordination of the nonroad and highway fuel requirements. In addition, these proposed 500 and 15-ppm sulfur caps would not apply to diesel fuel sold in three Pacific U.S. territories.

The early credits and other special provisions create the probability that high sulfur NRLM diesel fuel would be produced and sold after June 1, 2007 and that 500 ppm nonroad diesel fuel would be produced and sold after June 1, 2010. Under the proposal, fuel distributors would be responsible for ensuring the necessary product segregations and that statements on product transfer documents and fuel product labels are consistent with the corresponding fuel quality.

4) Cetane Index or Aromatics Standard

Currently, in addition to containing no more than 500 ppm sulfur, EPA requires that highway diesel fuel meet a minimum cetane index level of 40 or, as an alternative contain no more than 35 volume percent aromatics. EPA is proposing to extend this cetane index/aromatics content specification to NRLM diesel fuel. Extension of these content specifications would reduce NOx and PM emissions from the current nonroad equipment fleet slightly, providing associated public health and welfare benefits.

EPA requests comment on the costs and benefits of the proposal to extend the cetane index and alternative aromatics standard applicable to highway diesel fuel to NRLM diesel fuel.

B. Program Design and Structure

In order to avoid adding unnecessary cost to the fuel distribution system, EPA is proposing that the current requirement that non-highway distillate fuels be dyed at the refinery gate be made voluntary effective June 1, 2006. However, in its place EPA is proposing an alternate means for refiners to differentiate their highway diesel fuel from NRLM diesel fuel. Where it is feasible and cost effective to continue to dye and segregate their nonroad fuel, EPA proposes that refiners and importers may continue this option.

Since 500-ppm highway and NRLM diesel fuel would physically be the same, without some means of differentiating highway diesel fuel from NRLM diesel fuel, it would be impossible to maintain the benefits and program integrity of the 2006 highway diesel fuel program. Pre-2007 model year highway vehicles are free to continue using 500-ppm fuel until 2010 as long as it is available. However, if a refiner produced all 500-ppm fuel, designating it as nonroad fuel, that refiner would have no obligation to produce any 15-ppm highway diesel fuel. Without an effective way of limiting the use in the highway market of 500 ppm diesel fuel produced as NRLM fuel (provided currently by the refinery gate dye requirement), much more 500 ppm fuel could, and likely would find its way into the highway market than would otherwise happen under the current highway program, displacing 15 ppm that would have otherwise been produced. This likely series of events would circumvent the 80/20 intent of the highway rule and sacrifice some of the resulting PM and SO2 emission benefits of that program. Perhaps more importantly, if this occurred to any significant degree, it could also undermine the integrity of the highway program by failing to ensure adequate availability of 15-ppm fuel nationwide for the vehicles that need it.

EPA proposes therefore, that a baseline volume percentage of non-highway diesel fuel would be established and enforced for each refinery and importer. The baseline percentage would be based on a historical average for a refinery or importer. The baseline percentage of non-highway diesel fuel would then be used to identify the amount of 500 ppm diesel fuel produced by that refinery or importer that is subject to the NRLM requirements and the amount of 500 ppm fuel is subject to the highway requirements. As detailed below, in conjunction with a marker to prevent the use of heating oil in nonroad equipment, the baseline percentage would effectively protect the benefits and integrity of the highway program, ensure that the benefits of the first step of NRLM diesel fuel to 500 ppm sulfur would be obtained, and would enable the efficient, fungible distribution of like grades of fuel.

i. Use of A Marker to Differentiate Heating Oil from NRLM

To ensure that the only high sulfur diesel fuel used in nonroad, locomotive, and marine diesel engines is high sulfur NRLM and not heating oil, it would be necessary for parties in the distribution system, and for EPA, to be able to distinguish heating oil from high-sulfur NRLM diesel fuel. One way of ensuring that these fuels remain segregated in the distribution system would be to require that either a dye or a marker be added to heating oil to distinguish it from NRLM diesel fuel during the period of 2007 through 2010.[4] The dye or marker would have to be different from the current red dye requirement.

Effective in August 2002, the European Union (EU) enacted a marker requirement for diesel fuel that is taxed at a lower rate (which applies in all of the EU member states). The marker selected by the EU is N-ethyl-N- [2-[1-(2-methylpropoxy) ethoxyl]-4-phenylazo]-benzeneamine. This compound is also referred to as solvent yellow 124 or the Euromarker. EPA proposes that beginning June 1, 2007 solvent yellow 124 must be added to heating oil in the U.S. EPA proposes that it be added in a concentration of 6 milligrams per liter, the same treatment rate as required by the EU. This would ensure adequate detection in the distribution system even if diluted by a factor of 50. A level of 0.1 milligrams per liter would therefore be used as a threshold level to identify heating oil - below this level incidental contamination would be assumed to have occurred and the prohibition on use in highway, nonroad, locomotive, or marine applications would not apply. Despite its name, solvent yellow 124 does not impart a strong color to diesel fuel when used at the proposed concentration. Therefore, EPA does not expect that its use in diesel fuel containing the IRS-specified red dye would interfere with the use of the red dye by IRS to identify non-taxed fuels. EPA requests comment on this assessment.

EPA requests comment on whether there are unique public health concern regarding the use of distillate fuel containing solvent yellow 124. The European Union intends to review the use of Solvent yellow 124 after December 2005, or earlier if any health and safety or environmental concerns about its use are raised. EPA intend to keep abreast of such activities and may initiate it’s own review of the use of solvent yellow 124 depending on the European Union’s findings.

EPA also requests comment on the extent to which jet fuel might become contaminated with solvent yellow 124 due to the presence of solvent yellow 124-containing fuels and jet fuel in the U.S. common carrier pipeline distribution system, and whether such contamination would raise concerns for the operation of jet engines. Due to safety concerns, jet fuel is held to very strict standards regarding the allowable presence of contaminants and additives. For example, the Department of Defense maintains a zero-tolerance for any contamination of jet fuel with the red dye required by the IRS (and EPA), which is chemically similar to solvent yellow 124. EPA is not aware that any testing has been done to date to assess whether solvent yellow 124 does raise similar concerns, and EPA requests

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[4] A marker is an additive that is phosphorescent or has some other property that allows it to be easily detected, though not necessarily visible to the naked eye. A dye is intended to be visibly identified by the naked eye.

comment with any supporting data on this issue.

EPA does not believe that there any significant pathways for such contamination to take place other than by potential human error. EPA requests comment on this assessment.

EPA requests comment on whether there are product licensing or other concerns regarding the manufacture of solvent yellow 124 for use under this proposed rule.

EPA requests comment on other potential markers that might be used to identify and segregate heating oil from NRLM fuel. In particular, EPA ask that as commenters raise potential concerns with the use of solvent yellow 124 that they also identify other possible markers that could overcome their concerns without raising others. One potential alternative EPA has identified is the Clir-Code® marker system manufactured by ISOTAG Technologies Inc. The Clir-Code® marker system has been used extensively in U.S. fuel and includes a field test that employs a hand-held near infrared detector which does not require the use of any reagents. EPA deferred proposing the use of the Clir-Code® marker because EPA believes that the advantage of a simpler field test would not compensate for the increased treatment cost relative to the use of solvent yellow 124. EPA furthermore seeks comment on whether more than one marker could be selected, but which could all be detected using the same detection method. In this manner refiners would not be dependent on a sole supplier for the marker.

ii. Non-highway Distillate Baseline Cap

In order to allow for the fungible distribution of highway diesel fuel and NRLM, and continue to have enforceable highway diesel fuel standards in the absence of a NRLM dye requirement, EPA is proposing that a non-highway distillate baseline percentage be established for each refinery and importer in the country. This non-highway baseline would be defined as the volume percentage of all diesel fuel and heating oil (number 1 and number 2) that a refinery or importer produced or imported during the specified baseline period that was dyed for non-highway purposes.

EPA proposes that if a refiner chooses to fungibly distribute its NRLM and highway fuels, then under the first step of the nonroad program (June 1, 2007 - June 1, 2010), the volume of diesel fuel represented by its non-highway baseline percentage would have to either meet the 500 ppm NRLM standard or be marked as heating oil. All the remaining production would have to meet the requirements of the highway fuel program (i.e., 80 percent of this fuel would have to meet a 15 ppm sulfur cap). As EPA recognized in the highway rule, some variation in the production of highway and non-highway diesel fuel is normal from year to year. As a result, in any given year it may be possible that a refiner is unable to produce the amount of 15-ppm diesel fuel required to meet its highway requirement (80% of 100% minus the non-highway baseline) simply because of this normal variation. The provisions of the highway diesel rule already allow for a 5% shortfall in the production of 15-ppm fuel in a year as long as it is made up in the following year. EPA seeks comment on whether any additional flexibility beyond that provided in the highway rule is appropriate to account for normal fluctuations in refinery output.

EPA proposes that a refiner, for each of its refineries, would need to choose either to continue to dye all of its NRLM fuel at the refinery gate, or to apply the non-highway baseline approach to all of its production. If a refinery's production could be split between these two options, the refiner could avoid the cap on NRLM imposed by the baseline percentage by dyeing additional volumes over its baseline, for example at their refinery rack or co-located terminal. The result could be a diversion of extra 500-ppm fuel to the highway market while the dyed 500-ppm fuel was used to serve the nonroad market, resulting in little or no production of 15-ppm highway diesel fuel. Therefore, the choice of whether to dye all of their 500 ppm NRLM fuel at the refinery gate, or comply with the non-highway distillate baseline would have to be made in advance. EPA proposes that compliance with the baseline be determined on an annual basis. EPA therefore also propose that the decision of whether to dye NRLM 500 ppm fuel at the refinery gate or comply with the baseline could also be made on an annual basis.

iii. Setting the Non-highway Distillate Baseline

EPA proposes to determine the non-highway baseline percentage for each refinery by averaging the volume of dyed diesel fuel and heating oil (number 1 and number 2, excluding jet fuel and exported fuel) that it produced or imported annually over the three year period from January 1, 2003 through December 31, 2005, and dividing that volume by the average of all diesel fuel and heating oil (number 1 and number 2, excluding jet fuel and exported fuel) it produced or imported annually over the same period (and then multiplied by 100).[5] By using a multi-year average, variations that might otherwise occur from year to year in a refinery's production will get averaged out. Importers would establish a separate baseline for each area of importation.[6]

EPA proposes that refiners would be allowed to set their non-highway baseline percentage using June 1, 2006 through May 31, 2007 as the baseline time period. By doing so the refinery's baseline would automatically take into account changes made for compliance with the 2006 highway standard. It would, however, preclude that refinery from participating in the early NRLM credit program prior to June 1, 2007 using the baseline approach, and would require them to continue dyeing their NRLM at the refinery gate until June 1, 2007, since that is the period during which the baseline was being established. Since the purpose of this option is to provide an opportunity to account for the physical changes refineries make in complying with the highway rule, EPA proposes that this option would only apply to refiners and not importers.

Each refinery and importer would have to submit its application for a non-highway baseline to EPA by February 28, 2006 along with the supporting information. If the refinery elected to use the optional baseline period, EPA proposes that the refinery would have to submit its application for a non-highway baseline to EPA by August 1, 2007. EPA would then approve these baselines by June 1, 2006 and any optional baselines by December 1, 2007. EPA proposes that any refinery or importer which was not in operation for the full period of January 1, 2003 through December 31, 2005 would

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[5] Specialty fuels such as JP-5, JP-8 and F76 are in some instances also used in nonroad diesel equipment today. However, EPA's expectation is that the majority of this fuel is today and will be in the future continue to be used in tactical military equipment that would be exempted from the provisions of this proposal. Consequently, EPA proposes that these fuels would not be counted in either setting the baseline or in determining compliance with the baseline.

[6] The areas would be defined as the credit trading areas (CTAs) as defined in the highway rule.

establish their baseline using data from the period they were in operation, as long as that period was greater than or equal to 12 months. The 12 months need not be continuous. Any refinery or importer unable to establish a baseline during this period would have to comply using the dye alternative. In the case of a new or restarted refinery or new importer, EPA proposes to assign a non-highway baseline percentage reflecting the projected average production of non-highway fuel in 2004 for their region of the country. EPA proposes to use the credit trading areas (CTAs) based on data from the Department of Energy's Energy Information Agency (EIA) on the current production of low and high sulfur diesel fuel and heating oil, and EIA and EPA projections of future fuel use, these PADD average non-highway baseline would be as shown in Table IV-1.

TABLE IV-1 -- NON-HIGHWAY BASELINE FOR NEW REFINERIES

PADD 1	PADD 2	PADD 3	PADD 4	Oregon and Washington	Alaska	Hawaii	California[7]
41%	20%	26%	13%	21%	68%	40%	0%

EPA is not proposing to allow nationwide aggregation of the non-highway baselines. However, in the highway rule, EPA does allow credit trading within certain credit trading areas (CTAs). EPA seeks comment on allowing the aggregation of non-highway baselines within the same CTA and how such aggregation could be accomplished. EPA also seek comment on whether a trading program could be established that allowed for refiners with only one refinery within a CTA to benefit from similar flexibility, and whether some reasonable restrictions on refiners who aggregate baselines are needed to protect the integrity of the highway program.

EPA requests comments on the provisions described above for establishing the non-highway baseline percentage for each refinery and importer. EPA also requests comment on any alternative provisions that could be used to accomplish the objectives discussed above.

iv. Diesel Sulfur Credit Banking, and Trading Provisions for 2007

This proposal includes provisions for refiners and importers to generate early credits for production of 500 ppm NRLM fuel prior to June 1, 2007. This will provide implementation flexibility at the start of the 500-ppm NRLM standard in 2007. These credits would be tradable and could be used to delay compliance with either the 500-ppm NRLM standard in 2007 or the 15-ppm nonroad standard in 2010. The proposed banking and trading provisions would allow an individual refinery to purchase credits and delay compliance. This would allow for a somewhat smoother transition at the start of the program, with some refineries complying early, others on time, and others a little later. Nevertheless, on average the overall benefits of the program would be obtained or perhaps increased, and some environmental benefits could be achieved earlier than expected. Perhaps the most advantageous use of these credit provisions, however, might be for individual refineries to utilize available credits to permit the continued sale of otherwise off-spec product during the start up of the program when they are still adjusting their operations for consistent production to the new sulfur standards.

[7] A value of zero is proposed for California, since EPA anticipates that all non-highway diesel fuel in California will be covered by the same State standards applicable to highway diesel fuel during this time period.

Credit Generation:

EPA proposes two ways to generate credits that can be used to allow for high sulfur NRLM fuel to be produced after June 1, 2007. First, EPA proposes that a refinery or importer can generate credit for early production of NRLM diesel fuel to the 500 standard from June 1, 2006 through May 31, 2007. Credits would be calculated either using the non-highway baseline approach or by counting 500 ppm NRLM dyed at the refinery gate. Refiners that chose to establish their non-highway baseline using the June 1, 2006 - May 31, 2007 baseline period would be precluded from generating any early credits using the non-highway baseline approach. Second, under the small refiner hardship provisions described below, small refiners could generate credits for any production of NRLM fuel to the 500 ppm standard from June 1, 2007 through May 31, 2010. In either case, credits could be banked for future use, or traded to any other refinery or importer nationwide. For early credits and small refinery credits generated using the non-highway baseline approach, these credits would be calculated according to the following formula:

High-Sulfur NRLM credits[8] = (15 ppm production volume + 500 ppm production volume) - (100% - non-highway baseline percentage) * (total #1 and #2 distillate production excluding jet fuel and exported fuel).

Early credits or small refinery credits generated using the dye option would be calculated using the following formula:

High-Sulfur NRLM credits = 500 ppm production volume dyed at the refinery gate.

If the excess production was 15-ppm fuel instead of 500-ppm fuel, the refiner would of course still have the option of using it to generate 500-ppm highway credits under the existing highway diesel provisions. Credit could not be earned under both programs.

Credit Use:

There would be two ways in which refiners could use high-sulfur NRLM credits. First, EPA proposes that these credits could be used during the period from June 1, 2007 - May 31, 2010 to continue to produce high sulfur NRLM diesel fuel. Any high sulfur NRLM fuel produced, however, would have to be dyed red at the refinery gate, kept segregated from other fuels in the distribution system, and tracked through the use of unique codes on product transfer documents.

Only at the point in the distribution system where NRLM fuel has been dyed to IRS specifications for excise tax purposes (e.g., after a terminal or bulk plant) does EPA propose that high sulfur and 500 ppm sulfur NRLM fuels could be commingled. However, in order to ensure that owners of nonroad equipment can be confident in knowing whether the fuel being purchased meets the 500-ppm cap, the PTD and labels for any commingled fuel will have to indicate that the sulfur level exceeds 500

[8] For the purposes of this proposal, the credits are labeled on the basis of their use in order to follow the convention used in the highway rule. A high-sulfur credit is generated through the production of one gallon of 500 ppm NRLM fuel and allows the production of one gallon of high sulfur NRLM fuel.

ppm.

In most cases EPA anticipates that the distribution costs associated with segregating such a small volume product will prevent high-sulfur NRLM from being carried in the fungible distribution system. As a result, EPA anticipates that only those refineries that have their own segregated distribution system could continue to produce solely high sulfur NRLM fuel after June 1, 2007. Since there are few refineries set up to accomplish this, EPA's expectation is that the most likely manner in which refiners will be able to use high-sulfur NRLM credits will be through sales made directly from their on-site fuel rack or co-located terminal. Nevertheless, in order to have confidence that refiners are making the transition to 500 ppm for NRLM uses, EPA seeks comment on whether caps on the use of credits would be necessary. In particular, EPA seeks comment on placing a cap on the use of credits at 25 percent of its non-highway baseline, less marked heating oil, beginning June 1, 2008.

The second way in which refiners and importer could use high-sulfur NRLM credits is by banking them for use during the June 1, 2010 - May 31, 2012 period. During this period they could continue producing 500-ppm fuel subject to the usage restrictions that apply during that period. This use of high-sulfur credits would provide a cost-effective environmental benefit, since credits generated from the reduction of sulfur levels from high sulfur to 500 ppm would be used to offset the much smaller increment of sulfur control from 500 ppm down to 15 ppm.

v. 2010

After June 1, 2010, the fuel standards situation is simplified considerably and the fuel program structure can therefore also be simplified. The need for the non-highway baseline percentage disappears, since all highway and nonroad diesel fuel must meet the same 15-ppm cap. Furthermore, the only high sulfur distillate remaining in the market should be heating oil, since EPA is proposing that high sulfur diesel fuel no longer be permitted to be used in any NRLM equipment. Heating oil would have to be kept segregated. Preventing its use in NRLM equipment could be enforced on the basis of sulfur level, avoiding the need for a unique marker to be added to heating oil.

After June 1, 2010, under this proposal locomotive and marine diesel fuel would be allowed to remain at the 500-ppm level. In addition, assuming EPA allowed the continued production and use of 500 ppm nonroad diesel fuel through the small refiner hardship provisions and fuel credit provisions, 500 ppm nonroad fuel would continue to exist in the distribution system as late as May 31, 2014. A refiner could produce 500-ppm diesel fuel without the use of credits for the intended use in locomotive and marine applications, but if this 500-ppm fuel later made its way into nonroad equipment, less 15 ppm nonroad fuel would be produced and the full benefits of the 15 ppm nonroad standard would not be achieved. If this happened to a large enough extent it could call into question the adequate supply of 15 ppm for nonroad purposes beginning in 2010. Thus, some method is needed to differentiate locomotive and marine 500-ppm diesel fuel from nonroad 500-ppm diesel fuel after June 1, 2010. EPA has proposed to use a marker for this purpose.

1) A Marker to Differentiate Locomotive and Marine Diesel from Nonroad Diesel

This proposal would allow the limited production of 500-ppm nonroad diesel fuel by small refiners and by other refiners through the use of credits between 2010 and 2014. This 500-ppm fuel could only be used in pre-2011 model year nonroad diesel engines, and would have to be segregated from 15-ppm nonroad diesel fuel and 500-ppm locomotive and marine diesel fuel. To ensure compliance with the proposed segregation requirements for such fuel, it would be necessary for parties in the distribution system, and for EPA, to be able to distinguish such 500-ppm nonroad diesel fuel from 500 ppm locomotive and marine diesel fuel. Differentiating locomotive and marine diesel fuel from nonroad diesel fuel presents a very analogous situation, though perhaps on a smaller scale, to that described above for heating oil prior to June 1, 2010.[9] As a result, EPA proposes to use a marker to segregate locomotive and marine diesel fuel from 500-ppm nonroad diesel fuel beginning June 1, 2010. Since both fuels need to be dyed red for tax purposes prior to sale, for the reasons discussed above with respect to heating oil, EPA proposes that solvent yellow 124 be used as the marker for locomotive and marine diesel fuel beginning June 1, 2010. EPA proposes that the marker would be required to be added at the refinery gate just as visible evidence of the red dye is required today, and fuel containing more than the trace concentration of 0.1 mg/l of the marker would be prohibited from use in any nonroad application.

Specifically, EPA seeks comment on whether to just limit supply of 500 ppm locomotive and marine diesel fuel to segregated shipments, with refineries being liable to ensure and keep records demonstrating that 500 ppm fuel produced for locomotive and marine purposes was distributed solely for these purposes.

2) Diesel Sulfur Credit Banking and Trading Provisions for 2010

EPA proposes that refiners and importers could generate early credit for production of 15-ppm nonroad diesel fuel prior to June 1, 2010. These credits could be used to delay compliance with the 15-ppm nonroad diesel standard in 2010.

Credit Generation:

EPA is proposing that credits for production of early 15-ppm nonroad diesel fuel prior to June 1, 2010 be determined using the non-highway baseline. Any volume up to a refinery's total highway requirement (100 percent minus the non-highway baseline) would continue to be counted under the provisions of 2007 highway diesel fuel program.[10] Any production of 15-ppm fuel greater than this amount (100% minus the non-highway baseline) beginning June 1, 2009 could be used to generate

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9 Without the proposed marker requirement for locomotive and marine diesel fuel, EPA expects that there would be no physical difference between 500 ppm nonroad diesel fuel and 500 ppm locomotive and marine diesel fuel.

10 Under the highway program four gallons of excess 15-ppm diesel fuel produced or imported would generate one 500-ppm diesel fuel credit. This credit grants the refiner or importer the right to produce one additional gallon of undyed 500-ppm diesel fuel between June 1, 2006 and May 31, 2010. These credits can be used (or traded within the PADD in which they were generated) to produce or import less than 80% of its highway volume as 15-ppm fuel. This would continue under this proposal for any production up to (100% minus the non-highway baseline). For any volume of 15-ppm fuel greater than 100% minus the non-highway baseline a refiner could either receive gallon-for-gallon nonroad credit under this proposal, or treat it as highway fuel and receive 1:4 credit under the provisions of the highway rule.

early nonroad credits.

EPA proposes two other sources of credits to allow production of 500-ppm nonroad diesel fuel after June 1, 2010. First, high-sulfur NRLM credits generated prior to June 1, 2010 could be converted into 500-ppm nonroad credits and carried over for use beginning June 1, 2010. Second, under the small refiner hardship provisions, small refiners could generate credits for any production of NRLM fuel to the 15 ppm standard from June 1, 2010 through May 31, 2012. These credits could be traded to any other refinery or importer nationwide.

EPA seeks comment on whether credits should be permitted to be generated prior to June 1, 2009. EPA's proposal would restrict the early credit period to just one year for two main reasons. First, any 15-ppm fuel produced prior to June 1, 2009 can be treated as highway diesel fuel and any credits generated on the fuel under the highway program can be traded under the highway credit program. EPA does not want the early nonroad credit provisions to detract from the smooth functioning of the highway diesel credit program. Second, EPA does not want the early credit provisions to undermine the availability of 15-ppm diesel fuel for nonroad applications in 2010. Allowing more than a years worth of credits to be generated, plus up to a years worth of high sulfur credits to be generated and carried over for use in 2010 would raise concerns that insufficient 15 ppm nonroad diesel fuel might be produced in 2010 to ensure availability everywhere nationwide. Nevertheless, EPA seeks comment on extending the period for early credit generation and on this assessment.

Credit Use:

EPA proposes that 500-ppm nonroad credits could be used on a gallon for gallon basis during the period from June 1, 2010 - May 31, 2012, allowing continued production of 500-ppm nonroad diesel fuel. Small refiners could continue to produce 500-ppm nonroad diesel until June 1, 2014 without credits. Any 500 ppm nonroad fuel produced would have to be dyed red at the refinery gate, kept segregated from other fuels in the distribution system, and tracked through the use of unique codes on product transfer documents all the way through to the end-user. Refiners wishing to produce 500-ppm fuel and sell it as nonroad would have to get EPA approval in advance demonstrating how they will ensure such segregation.

EPA requests comment on all aspects of the proposed credit trading system.

vi. 2014

Beginning June 1, 2014, after all small refiner and credit provisions have ended, both the 15 ppm nonroad diesel fuel standard and the 500 ppm locomotive and marine diesel fuel standard could be enforced based on sulfur level throughout the distribution system and at the end-user. There would no longer be a need for a baseline, a marker, or a dye. Consequently, EPA is proposing that after May 31, 2014 the different grades of diesel fuel, 15 ppm, 500 ppm, and high-sulfur would merely have to be kept segregated in the distribution system.

vii. Other Options Considered

In developing the proposed program structure described above, EPA also evaluated a number of other possible approaches. Some of the alternatives would allow for even greater fuel fungibility, for example, extending to smaller volume products such as those produced through the use of credits. However, these alternative approaches would either place more restrictions on refinery operations, or raise significant enforcement and program integrity concerns. As a result, EPA is not proposing the following alternatives but seeks comment on them, including ways to minimize or alleviate the concerns associated with them.

1) Highway Baseline and a NRLM baseline for 2007

2) Locomotive and Marine Baseline for 2010

3) Designate and Track Volumes in 2007

C. Hardship Provisions for Qualifying Refiners

i. Hardship Provisions for Qualifying Small Refiners[11]

1) Qualifying Small Refiners

Today, refiners that EPA expects would qualify as small refiners represent only about 6 percent of all high-sulfur diesel production.

The definition of small refiner for the proposed nonroad diesel program is basically the same as the small refiner definitions in the Tier 2/Gasoline Sulfur and Highway Diesel rules. A small refiner must demonstrate that it meets **both** of the following criteria:

- No more than 1,500 employees corporate-wide, based on the average number of employees for all pay periods from January 1, 2002 to January 1, 2003.

- A corporate crude oil capacity less than or equal to 155,000 barrels per calendar day (bpcd) for 2002.

The dates for the employee count and for calculation of the crude capacity represent the latest complete years prior to the issuing of the proposed rule. In determining the total number of employees and crude oil capacity, a refiner must include the number of employees and crude oil capacity of any subsidiary companies, any parent company and subsidiaries of the parent company, and any joint venture partners.

EPA proposes that a refiner that acquires a refinery from an approved small refiner be provided 24 additional months from the date of the completion of the purchase transaction (or until the end of the

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[11] The proposed small refiner provisions would not apply to importers, as the burden from capital expenditures for physical refinery improvements are not imposed on importers.

applicable small refiner relief interim period if it is within 24 months -- June 1, 2010 for 500 ppm fuel and June 1, 2014 for 15 ppm fuel). During this interim period, production at the newly acquired refinery could remain at the interim sulfur levels that applied to that refinery for the previous small refiner owner under the small refiner options. At the end of this period, the refiner would need to comply with the "non-small refinery" sulfur standards.

If a refiner believed that the technical characteristics of its planned desulphurisation project would require additional lead time, the refiner could apply for additional time and EPA would consider such requests on a case-by-case basis. Such an application would be based on the technical factors supporting the need for more time and include detailed technical information and projected schedules for engineering, permitting, construction, and startup. Based on information provided in such an application and other relevant information, EPA would decide whether additional time was technically necessary and, if so, how much additional time would be appropriate. In no case would compliance dates be extended beyond the time frame of the applicable small refiner relief provisions (June 1, 2010 for 500 ppm fuel and June 1, 2014 for 15 ppm fuel).

b. Small Refiner Losing Its Small Refiner Status

EPA recognize that a small refiner that loses its small refiner status because of a merger or acquisition would face the same type of lead time concerns in complying with the non-small refiner standards as would a non-small refiner that acquired a small refiner's refinery, as discussed above. Therefore, EPA proposes that the additional lead time proposed above for non-small refiners purchasing a small refiner's refinery also apply in this situation.

EPA is inviting comment on several other related provisions EPA is considering:

(1) EPA proposes above that a small refiner that loses its small refiner status be granted 24 months of lead time at its existing refineries. Should such a small refiner instead be allowed to "grandfather in" its existing small refiner relief program for its existing refinery or refineries? An argument can be made that in purchasing a new refinery or other assets, the small refiner would no longer demonstrate the kind of financial hardship that was the basis for general small refiner relief. However, EPA also does not intend to stifle normal growth of small refiners, and "grandfathering in" the small refiner interim relief program would have no environmental impact, since would merely continue an existing program at that refinery.

(2) If a small refiner exceeds the small refiner criteria due to the purchases of a non-small refiner, should the proposed additional lead time apply to that refinery? Or should the refiner be required to meet the non-small refiner standards on schedule at the "new" refinery, since the previous owner could be assumed to have anticipated the new standards and taken steps to accomplish this prior to the purchase?

2) Options Available for Small Refiners

EPA proposes several provisions intended to reduce the burdens on small refiners discussed above as well as to encourage their early compliance whenever possible. These proposed small refiner provisions consist of additional time for compliance and, for small refiners that choose to comply earlier than required, the option of either generating diesel sulfur credits or receiving a limited relaxation of gasoline sulfur requirements.

ii. General Hardship Provisions

EPA is proposing a provision which, at it's discretion, would permit any domestic or foreign refiner to seek a temporary waiver from the nonroad, locomotive, or marine diesel sulfur standards under certain rare circumstances. This waiver provision is intended to provide refiners short-term relief in unanticipated circumstances – such as a refinery fire or a natural disaster – that cannot be reasonably foreseen now or in the near future.

In addition to the provision for short-term relief in extreme unforeseen circumstances, EPA is proposing a provision for relief based on extreme hardship circumstances that is very similar to those established in the gasoline sulfur and highway diesel sulfur programs.

D. States or Territories Excluded From This Rule

i. Alaska

EPA proposes that the diesel fuel sulfur standards - the 500-ppm cap for NRLM diesel fuel beginning June 1, 2007 and the 15-ppm cap for nonroad diesel fuel beginning June 1, 2010 - and the aromatics and cetane standards apply to the portion of Alaska served by the Federal Aid Highway System. However, EPA proposes that Alaska's rural areas be excluded from these proposed fuel content standards. The engine standards would apply to all nonroad engines throughout Alaska. Consequently, even in rural Alaska EPA would still require 2011 and later model year nonroad diesel engines and equipment to be fueled with 15-ppm diesel fuel.

ii. American Samoa, Guam, and the Commonwealth of Northern Mariana Islands

EPA is proposing to exclude American Samoa, Guam and the Commonwealth of the Northern Mariana Islands from the proposed NRLM diesel fuel sulfur standard of 500 ppm sulfur in 2007 and 15 ppm sulfur nonroad standard in 2010, as well as the cetane index and aromatics requirements. EPA also proposes to exclude these territories from the Tier 4 nonroad vehicle, engine and equipment emissions standards, and other requirements associated with those emission standards.

E. The Effect On State Diesel Fuel Programs

This proposal would not preempt state controls or prohibitions respecting characteristics or components of fuel or fuel additives used in nonroad engines or nonroad vehicles under the provisions of section 211(c)(4)(A). At the same time, a state control that regulates both highway fuel and nonroad fuel is preempted to the extent the state control respects a characteristic or component of highway fuel regulated by EPA under section 211(c)(1).

4. **Program Costs and Benefits**

This rule would be highly beneficial to society, with net present value benefits through 2030 of $550 billion, compared to a net present value of social cost of only about $16.5 billion (net present values in the year 2004). The impact of these costs on society should be minimal, with the prices of goods and services produced using equipment and fuel affected by the proposal being expected to increase about 0.02 percent.

A. Refining and Distribution Costs

Nonroad, locomotive and marine diesel fuel would be subject to a 500-ppm sulfur cap beginning June 1, 2007, while nonroad diesel fuel would be subject to a 15-ppm sulfur cap beginning June 1, 2010. Meeting these standards would generally require refiners adding hydrotreating equipment and possibly new or expanded hydrogen and sulfur plants in their refineries for desulfurizing their nonroad diesel fuel and dispensing of the removed sulfur.

Costs are in 2002 dollars. EPA requests comment on the cost estimates presented and the methodologies used to develop them.

The cost to provide nonroad, locomotive and marine diesel fuel under the proposed fuel program is summarized in Table V-A-1 below. The costs shown only apply to the roughly 65 percent of current nonroad, locomotive and marine diesel fuel that contains more than 500 ppm sulfur (hereafter referred to as the affected volume). EPA estimates that the other 35 percent of this fuel is actually fuel certified to the highway diesel fuel standards and project that this will continue.

Table V-A-1 Increased Cost of Providing Nonroad, Locomotive and Marine Diesel Fuel

	Cents per gallon of affected fuel			Affected Fuel Volume (million gallons/year)[a]
	Refining	Lubricity and Distribution	Total	
Step One 500 ppm NRLM diesel fuel	2.2	0.3	2.5	9,504
Step Two 15 ppm Nonroad diesel fuel	4.4	0.4	4.8	7,803
Step Two 500 ppm Locomotive and Marine diesel fuel	2.2	0.2 [b]	2.4	4,093

Notes:
[a] 2008 for Step One (without consideration of small refiner provisions), 2015 for Step Two
[b] 0.4 cent per gallon from mid-2010 to mid-2014 due to need for marker

The majority of the fuel-related cost of the proposal is refining-related. These costs include required capital investments amortized at 7 percent per annum before taxes. EPA requests comment on the estimated cost of meeting the 15 ppm and 500 ppm sulfur caps.

EPA also projects that the increased cost of refining and distributing 15 ppm and 500-ppm fuel would be substantially offset by reductions in maintenance costs. These savings would apply to all diesel engines in the field, not just new engines.

i. Refining Costs

EPA projects that the capital cost involved to meet the 2007 500 ppm sulfur cap would be $600 million, or $9.7 million per refinery building a new hydrotreater. The bulk of this capital would be invested in 2007 ($500 million), with the remainder being invested in 2010. Operating costs would be about $3 million per year for the average refinery. EPA requests comment on the number of refiners who would need to build new equipment to meet the 500-ppm sulfur cap, the capital cost for this new equipment and the cost of operating this equipment.

Starting in mid-2010, EPA projects that 25 refineries would add or revamp equipment to meet the 15-ppm cap on nonroad diesel fuel, while 20 refineries (nearly all of them small refiners) would add or revamp equipment to produce 500-ppm nonroad or locomotive and marine diesel fuel. Finally, an additional 12 refineries (again nearly all of them small refiners) would begin producing 15-ppm nonroad diesel fuel in 2014.

EPA projects that 80 percent of the 15 ppm nonroad diesel fuel volume would be desulfurized by advanced technologies, while the remaining 20 percent would be desulfurized by conventional hydrotreaters.

The total capital cost of new equipment and revamps related to the proposed 2010 sulfur standard would be $640 million, or $17 million per refinery adding or revamping equipment. Total operating costs would be about $5 million per year for the average refinery. The total refining cost, including the amortized cost of capital, would be 4.4 cents per gallon of new 15-ppm nonroad fuel. This cost is relative to the cost of producing high sulfur fuel today, and includes the cost of meeting the 500-ppm standard beginning in 2007. EPA requests comment on the number of refiners who would need to build new equipment to meet the 15-ppm sulfur cap, the capital cost for this new equipment and the cost of operating this equipment. The average cost of continuing to meet the 500-ppm standard for locomotive and marine fuel would continue at 2.2 cents per gallon.

The above costs reflect national averages for the fully phased in program for each control step. Some refiners would face lower costs while others would face higher costs. Excluding small refiners because they are able to take advantage of the proposed small refiner provisions, the average refining costs by refining region are shown in the table below. Combined costs are shown for PADDs 1 and 3 because of the large volume of diesel fuel that is shipped from PADD 3 to PADD 1.

TABLE V-A-3 -- AVERAGE REFINING COSTS BY REGION (CENTS PER GALLON)

	2007 500 ppm Cap	2010 15 ppm Cap
PADDs 1 and 3	1.4	2.6
PADD 2	2.9	5.7
PADD 4	4.0	8.5
PADD 5	2.6	5.4
Nationwide	2.2	4.4

EPA requests comment on the range of estimated refining costs for the various regions for both the proposed 500 and 15-ppm sulfur caps.

ii. Cost of Lubricity Additives

EPA projects that the cost of additional lubricity additives for the affected 500-ppm NRLM diesel fuel would be 0.01 cent per gallon. EPA projects that all nonroad diesel fuel meeting a 15-ppm cap would require treatment with lubricity additives. Thus, the projected cost would be 0.2 cent per affected gallon of 15-ppm nonroad diesel fuel.

iii. Distribution Costs

Overall, EPA estimates that the total additional distribution would be 0.3 cent per gallon of nonroad, locomotive and marine fuel during the first step of the proposed program (from 2007 through 2010). EPA projects that distribution costs would increase to 0.4 cent gallon for 500 ppm locomotive and marine diesel fuel from 2010 to 2014, but decrease to 0.2 cent per gallon thereafter. Finally, EPA projects that distribution costs for 15-ppm nonroad diesel fuel would be 0.2 cent per gallon.

EPA has generally not attempted to project the impact of its rules on fuel prices. However, in response to Executive Order 13211, EPA is doing so for this proposed rule. To reflect the inherent uncertainty in making such projections, EPA developed three projections for the potential impact of the proposed fuel program on fuel prices. The range of potential long-term price increases is shown in Table V-A-4. Short-term price impacts are highly volatile, as are short-term swings in absolute fuel prices, and much too dependent on individual refiners' decisions, unexpected shutdowns, etc. to be predicted even with broad ranges.

TABLE V-A-4 RANGE OF POSSIBLE TOTAL DIESEL FUEL PRICE INCREASES (CENTS PER GALLON) [a]

	Lower Limit	Mid-Point	Maximum
2007 500 ppm Sulfur Cap: Nonroad, Locomotive and Marine Diesel Fuel			
PADDs 1 and 3	0.9	1.5	3.4
PADD 2	2.3	3.0	4.8
PADD 4	1.7	4.1	5.8
PADD 5	1.0	2.8	4.3
2010 15 ppm Sulfur Cap: Nonroad Diesel Fuel			
PADDs 1 and 3	1.8	3.0	5.4
PADD 2	2.9	6.1	7.4
PADD 4	3.0	8.9	9.3
PADD 5	1.7	5.9	8.4

Notes:
[a] At the current wholesale price of approximately $1.00 per gallon, these values also represent the percentage increase in diesel fuel price.

The lower end of the range assumes that prices within a PADD increased to reflect the highest operating cost increase faced by any refiner in that PADD. In this case, this refiner with the highest operating cost would not recover any of his invested capital, but all other refiners would recover some or all of their investment. In this case, the price of nonroad, locomotive and marine diesel fuel would increase in 2007 by 1-2 cents per gallon, depending on the area of the country. In 2010, the price of nonroad diesel fuel would increase a total of 2-3 cents per gallon. Locomotive and marine diesel fuel prices would continue to increase by 1-2 cents per gallon.

The mid-range estimate of price impacts assumes that prices within a PADD increase by the average refining and distribution cost within that PADD, including full recovery of capital (at 7 percent per annum before taxes). Lower cost refiners would recover more than their capital investment, while those with higher than average costs recover less. Under this assumption, the price of nonroad, locomotive and marine diesel fuel would increase in 2007 by 2-4 cents per gallon, depending on the area of the country. In 2010, the price of nonroad diesel fuel would increase a total of 3-9 cents per gallon. Locomotive and marine diesel fuel prices would continue to increase by 2-4 cents per gallon.

The upper end estimate of price impacts assumes that prices within a PADD increase by the maximum total refining and distribution cost of any refinery within that PADD, including full recovery of capital (at 7 percent per annum before taxes). All other refiners would recover more than their capital investment. Under this assumption, the price of nonroad, locomotive and marine diesel fuel would increase in 2007 by 3-6 cents per gallon, depending on the area of the country. In 2010, the price of nonroad diesel fuel would increase a total of 5-9 cents per gallon. Locomotive and marine diesel fuel prices would continue to increase by 3-6 cents per gallon.

In addition to the differences noted above, there are a number of assumptions inherent in all three of the above price projections. First, both the lower and upper limits of the projected price impacts described above assume that the refinery facing the highest compliance costs is currently the price setter in their market. This is a worse case assumption, which is impossible to validate.

Second, EPA assumed that a single refinery's costs could affect fuel prices throughout an entire PADD. This is a conservative estimate as high cost refineries are more likely to have a more limited geographical impact on market pricing than an entire PADD.

Third, by focusing solely on the cost of desulfurizing NRLM diesel fuel, EPA assumed that the production of NRLM diesel fuel is independent of the production of other refining products, such as gasoline, jet fuel and highway diesel fuel. However, this is clearly not the case.

Fourth, all three of the above price projections are based on the projected cost for U.S. refineries of meeting the proposed NRLM diesel fuel sulfur caps. Thus, these price projections assume that imports of NRLM fuel, which are currently significant in the Northeast, are available at roughly the same cost as those for U.S. refineries in PADDs 1 and 3.

B. Cost Savings to the Existing Fleet from the Use of Low Sulfur Fuel

EPA estimates that reducing fuel sulfur to 500 ppm would reduce engine wear and oil degradation to the existing nonroad diesel equipment fleet and that a further reduction to 15-ppm sulfur would result in even greater reductions. These maintenance savings have been conservatively estimated to be greater than 3 cents per gallon for the use of 15-ppm sulfur fuel when compared to the use of today's unregulated nonroad diesel fuel. A summary of the benefits of low-sulfur fuel is presented in Table V.B-1.

TABLE V.B-1 -- ENGINE COMPONENTS POTENTIALLY AFFECTED BY LOWER SULFUR LEVELS IN DIESEL FUEL

Affected Components	Effect of Lower Sulfur	Potential Impact on Engine System
Piston Rings	Reduced corrosion Wear	Extended engine life and less frequent rebuilds
Cylinder Liners	Reduced corrosion Wear	Extended engine life and less frequent rebuilds
Oil Quality	Reduced deposits, reduced acid build-up, and less need for alkaline additives	Reduce Wear on piston ring and cylinder liner and less frequent oil changes
Exhaust System (tailpipe)	Reduced corrosion Wear	Less frequent part replacement
Exhaust Gas Recirculation System	Reduced corrosion Wear	Less frequent part replacement

The monetary value of these benefits over the life of the equipment will depend upon the length of time that the equipment operates on low-sulfur diesel fuel and the degree to which engine and equipment manufacturers specify new maintenance practices and the degree to which equipment operators change engine maintenance patterns to take advantage of these benefits. For equipment near the end of its life in the 2008 time frame, the benefits will be quite small. However, for equipment produced in the years immediately preceding the introduction of 500-ppm sulfur fuel, the savings would be substantial. Additional savings would be realized in 2010 when the 15-ppm sulfur fuel would be introduced

EPA estimates the single largest savings would be the impact of lower sulfur fuel on oil change intervals. Taken together, when compared to today's relatively high nonroad diesel fuel sulfur levels, EPA estimates the use of 15-ppm sulfur fuel will enable an oil change interval extension of 35 percent from today's products.

EPA estimates that an oil change interval extension of 31 percent, as would be enabled by the use of 500-ppm sulfur fuel in 2007, results in a fuel operating costs savings of 3.0 cents per gallon for the nonroad fleet. EPA projects an additional cost savings of 0.3 cents per gallon for the oil change interval extension which would be enabled by the use of 15 ppm sulfur beginning in 2010. Thus, for the nonroad fleet as a whole, beginning in 2010 nonroad equipment users can realize an operating cost savings of 3.3 cents per gallon compared to today's engine. This means that the end cost to the typical user for 15ppm sulfur fuel is approximately 1.5 cents per gallon (4.8 cent per gallon cost for fuel minus 3.3 cent per gallon maintenance savings). For a typical 100 horsepower nonroad engine this represents a net present value lifetime savings of more than $500.

These savings will occur without additional new cost to the equipment owner beyond the incremental cost of the low-sulfur diesel fuel, although these savings are dependent on changes to existing maintenance schedules. Such changes seem likely given the magnitude of the savings. EPA has not estimated the value of the savings from the other benefits listed in Table V.B-1, and therefore EPA believes the 3.3 cents per gallon savings is conservative as it only accounts for the impact of low sulfur fuel on oil change intervals.

C. Engine and Equipment Cost Impacts

To illustrate the engine and equipment cost impacts EPA is estimating for the proposed standards, EPA has chosen several example pieces of equipment and presented the estimated costs for them. Using these examples, EPA can calculate the costs for a specific piece of equipment in several horsepower ranges and better illustrate the cost impacts of the proposed standards. These costs along with information about each example piece of equipment are shown in Table V.C-1. Costs presented are near-term and long-term costs for the final standards to which each piece of equipment would comply. Long-term costs are only variable costs and, therefore, represent costs after all fixed costs have been recovered and all projected learning has taken place. Included in the table are estimated prices for each piece of equipment to provide some perspective on how the estimated control costs relate to existing equipment prices.

TABLE V.C-1 -- NEAR-TERM AND LONG-TERM COSTS FOR SEVERAL EXAMPLE PIECES OF EQUIPMENT[a]
($2001, FOR THE FINAL EMISSION STANDARDS TO WHICH THE EQUIPMENT MUST COMPLY)

	GenSet	Skid/Steer Loader	Backhoe	Dozer	Ag Tractor	Dozer	Off-Highway Truck
Horsepower	9 hp	33 hp	76 hp	175 hp	250 hp	503 hp	1000 hp
Incremental Engine & Equipment Cost							
Long-Term	$120	$760	$1,210	$2,590	$2,000	$4,210	$6,780
Near-Term	$170	$1,100	$1,680	$3,710	$2,950	$6,120	$10,100
Estimated Equipment Price when New[b]	$3,500	$13,500	$50,000	$235,000	$130,000	$575,000	$700,000
Incremental Operating Costs[c]	-$90	$40	$370	$1,550	$1,320	$4,950	$12,550
Baseline Operating Costs (Fuel & Oil only)[c]	$940	$2,680	$7,960	$77,850	$23,750	$77,850	$179,530

Notes:
[a] Near-term costs include both variable costs and fixed costs; long-term costs include only variable costs and represent those costs that remain following recovery of all fixed costs.
[b] "Estimated Price of New Nonroad Example Equipment," memorandum from Zuimdie Guerra to docket A-2001-28.
[c] Present value of lifetime costs.

D. Annual Costs and Cost Per Ton

i. Annual Costs for the 500 ppm Fuel Program

As can be seen in Figure V.D-1, the costs for refining and distributing the 500-ppm fuel range from $250 million in 2008 to nearly $400 million in 2036. These control costs are largely offset by the maintenance savings that range from $200 million in 2008 to $380 million in 2036. Despite the fact that the costs of the 500 ppm fuel for nonroad diesel fuel is 2.5 cents/gallon and the maintenance savings are 3 cents per gallon, the net costs are positive because of the costs for the locomotive and marine fuel is not off-set by the maintenance savings. As a whole, the net cost of the program in each year is essentially zero, ranging from $50 million in the early years to only $18 million in 2036. The net present value of the net costs and savings associated with the proposed 500-ppm fuel program during the years 2007 to 2036 is estimated at $510 million.

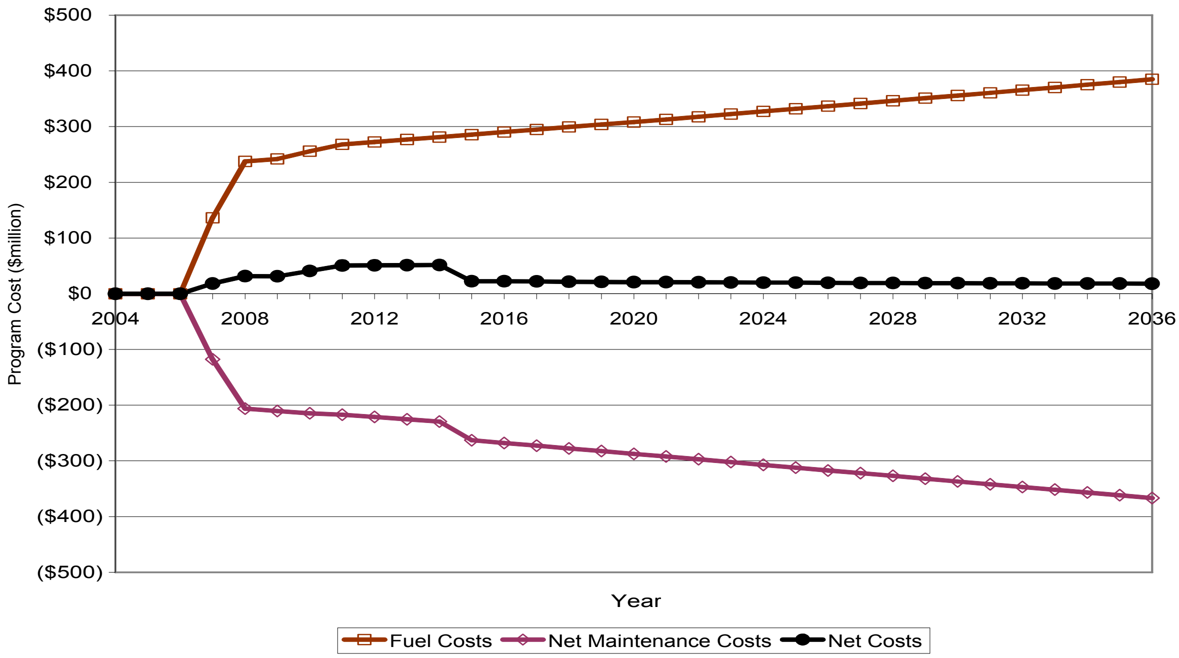


FIGURE V.D-1 -- ANNUAL COSTS OF THE 500 PPM FUEL PROGRAM

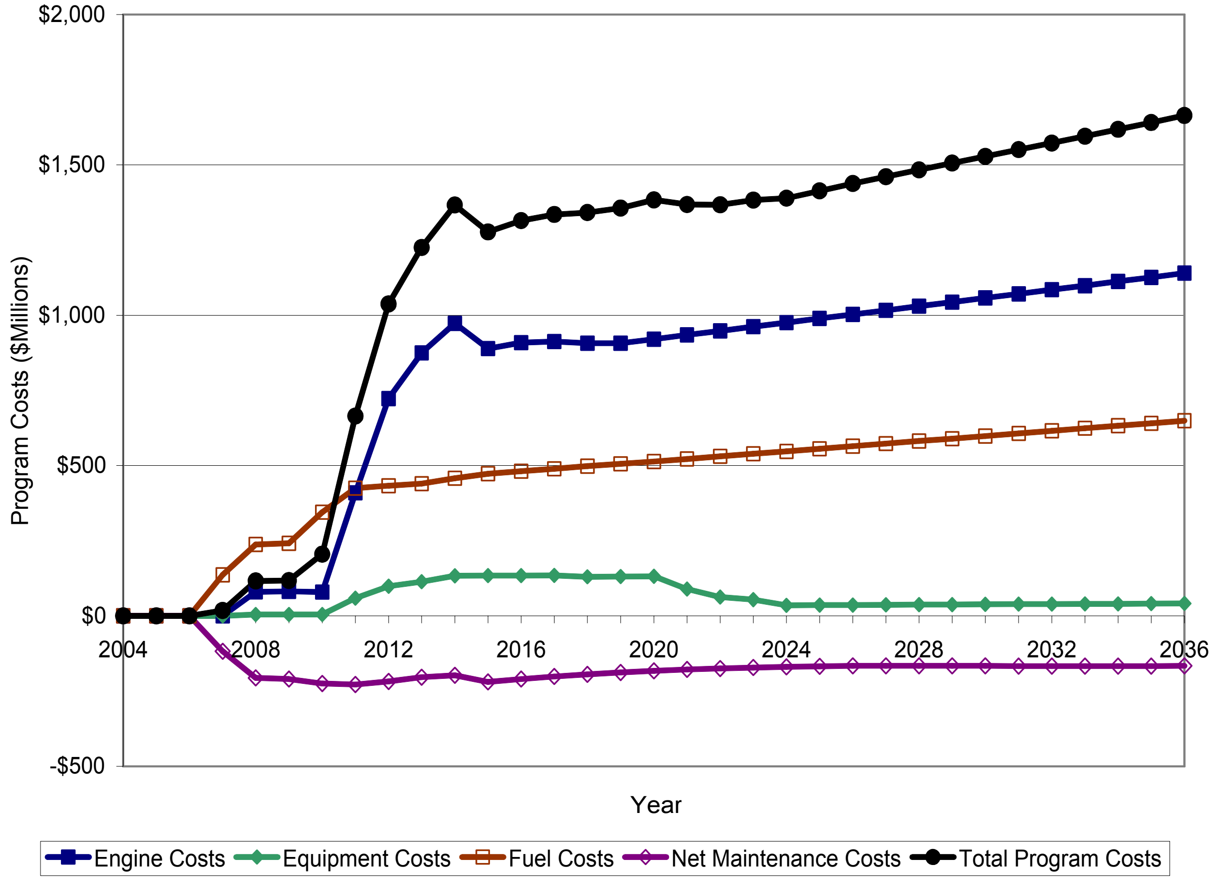
2. Cost Per Ton for the 500 ppm Fuel Program

Table V.D-1 shows the cost per ton of emissions reduced as a result of the proposed 500-ppm fuel program. The cost per ton numbers include costs and emission reductions that would occur from both the new and the existing fleet (i.e., those pieces of nonroad equipment that were sold into the market prior to the proposed emission standards) of nonroad, locomotive, and marine engines.

TABLE V.D-1 -- 500 PPM FUEL PROGRAM
AGGREGATE COST PER TON AND LONG-TERM ANNUAL COST PER TON
($2001)

Pollutant	2004-2036 Discounted Lifetime Cost per ton	Long-Term Cost per Ton in 2036
SO_x	$90	$50

EPA also considered the cost per ton of the 500-ppm fuel program without taking credit for the



expected maintenance savings associated with low sulfur fuel. Without the maintenance savings, the cost per ton of SO_x reduced would be $990 per ton for each year of the program.

ii. Annual Costs for the Proposed Two-Step Fuel Program and Engine Program

The costs of the total proposed engine and fuel program include costs associated with both steps in the fuel program – the reduction to 500-ppm sulfur in 2007 and the reduction to 15-ppm sulfur in 2010. Also included are costs for the proposed 2008 engine standards for <75 horsepower engines, the proposed 2013 standards for 25 to 75 horsepower engines, and costs for the proposed engine standards for >75 horsepower engines. Included are all maintenance costs and savings realized by both the existing fleet (nonroad, locomotive, and marine) and the new fleet of engines complying with the proposed standards.

Figure V.D-2 presents these results. All capital costs for fuel production and engine and equipment fixed costs have been amortized. The figure shows that total annual costs are estimated to be $120 million in the first year the new engine standards apply, increasing to a peak of $1.7 billion in 2036 as increasing numbers of engines become subject to the new standards and an ever increasing amount of fuel is consumed. The net present value of the annualized costs over the period from 2007 to 2036 is $20.7 billion.

FIGURE V.D-2 -- ANNUAL COSTS OF THE PROPOSED TWO-STEP FUEL AND ENGINE PROGRAM

4. Cost per Ton of Emissions Reduced for the Total Program

EPA has calculated the cost per ton of emissions reduced associated with the proposed engine and fuel program. EPA has done this using the net present value of the annualized costs of the program through 2036 and the net present value of the annual emission reductions through 2036. EPA has also calculated the cost per ton of emissions in the year 2036 using the annual costs and emission reductions in that year alone. This number represents the long-term cost per ton of emissions reduced after all fixed costs of the program have been recovered by industry leaving only the variable costs of control. The cost per ton numbers includes costs and emission reductions that would occur from the existing fleet (i.e., those pieces of nonroad equipment that were sold into the market prior to the proposed emission standards). These results are shown in Table V.D-2. EPA did the cost analysis using a 3% discount rate. EPA will also be conducting a similar analysis using a 7% discount rate and including this information in the docket.

TABLE V.D-2 -- TOTAL PROPOSED FUEL AND ENGINE PROGRAM AGGREGATE COST PER TON AND LONG-TERM ANNUAL COST PER TON ($2001)

Pollutant	2004-2036 Discounted Lifetime Cost per ton	Long-Term Cost per Ton in 2036
NOx+NMHC	$810	$530
PM	$8,700	$6,900
SO_x	$200[a]	$170

Notes:
[a] This result does not match that in Table 8.4-2 because the nonroad portion of the fuel is reduced to 15 ppm and does not stay at 500 (locomotive and marine portions are kept at 500ppm). The costs to reduce fuel sulfur from uncontrolled to 15ppm were assigned 50/50 to NOx+NMHC and PM for the reduction to 15 ppm is to enable aftertreatment technology.

E. The Benefits Far Outweigh the Costs of the Standards

EPA's analysis projects major benefits throughout the period from initial implementation of the rule through 2030, the last year analyzed. As described below, thousands of deaths and other serious health effects would be prevented, yielding a net present value in 2004 of those benefits EPA could monetize of approximately $550 billion dollars. These benefits exceed the net present value of the social cost of the proposal ($17 billion) by a factor of over 30 to one.

E. The results of the benefit-cost analysis

Table V.E-1 presents the primary estimate of reduced incidence of PM-related health effects for the years 2020 and 2030. Specifically, the table lists the PM-related benefits associated with the reduction of several health effects.[12] In 2030, EPA estimates that there will be 9,600 fewer fatalities per year associated with fine PM, and the rule will result in about 5,700 fewer cases of chronic bronchitis, 8,300 fewer hospitalizations (for respiratory and cardiovascular disease combined), and result in significant reductions in days of restricted activity due to respiratory illness (with an estimated 5.7 million fewer cases). EPA also estimate substantial health improvements for children from reduced upper and lower respiratory illness, acute bronchitis, and asthma attacks.[13]

Table V.E-2 presents the total monetized benefits for the years 2020 and 2030. This table also indicates with a “B” those additional health and environmental effects which EPA was unable to quantify or monetize. These effects are additive to estimates of total benefits, and EPA believes there is considerable value to the public of the benefits that could not be monetized. A full listing of the benefit categories that could not be quantified or monetized in the estimate are provided in Table V.E-5.

In summary, EPA's primary estimate of the benefits of the rule are approximately $81 + B billion in 2030. In 2020, total monetized benefits are approximately $43 + B billion. These estimates account for growth in real gross domestic product (GDP) per capita between the present and the years 2020 and 2030. As the table indicates, total benefits are driven primarily by the reduction in premature fatalities each year, which account for over 90 percent of total benefits.

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[12] Based upon recent preliminary findings by the Health Effects Institute, the concentration-response functions used to estimate reductions in hospital admissions may over- or underestimate the true concentration-response relationship. See Letter from Dan Greenberg, President, Health Effects Institute, May 30, 2002, attached to letter from Dr. Hopke, dated August 8, 2002.

[13] EPA’s estimate incorporates significant reductions of 150,000 fewer cases of lower respiratory symptoms in children ages 7 to 14 each year, 110,000 fewer cases of upper respiratory symptoms (similar to cold symptoms) in asthmatic children each year, and 14,000 fewer cases of acute bronchitis in children ages 8 to 12 each year. In addition, EPA estimates that this rule will reduce almost 6,000 emergency room visits for asthma attacks in children each year from reduced exposure to particles. Additional incidents would be avoided from reduced ozone exposures. Asthma is the most prevalent chronic disease among children and currently affects over seven percent of children under 18 years of age.

TABLE V.E-1 -- REDUCTIONS IN INCIDENCE OF PM-RELATED ADVERSE HEALTH EFFECTS ASSOCIATED WITH THE PROPOSED NONROAD DIESEL ENGINE AND FUEL STANDARDS

Endpoint	Avoided Incidence[a] (cases/year)	
	2020	2030
Premature mortality[b] - Base estimate: Long-term exposure (adults, 30 and over)	5,200	9,600
Chronic bronchitis (adults, 26 and over)	3,600	5,700
Non-fatal myocardial infarctions (adults, 18 and older)	9,200	16,000
Hospital admissions – Respiratory (adults, 20 and older)[c]	2,400	4,500
Hospital admissions – Cardiovascular (adults, 20 and older)[d]	1,900	3,800
Emergency Room Visits for Asthma (18 and younger)	3,600	5,700
Acute bronchitis (children, 8-12)	8,400	14,000
Lower respiratory symptoms (children, 7-14)	92,000	150,000
Upper respiratory symptoms (asthmatic children, 9-11)	77,000	110,000
Work loss days (adults, 18-65)	650,000	960,000
Minor restricted activity days (adults, age 18-65)	3,900,000	5,700,000

Notes:
[a] Incidences are rounded to two significant digits.
[b] Premature mortality associated with ozone is not separately included in this analysis
[c] Respiratory hospital admissions for PM includes admissions for COPD, pneumonia, and asthma.
[d] Cardiovascular hospital admissions for PM include total cardiovascular and subcategories for ischemic heart disease, dysrhythmias, and heart failure.

TABLE V.E-2 -- EPA PRIMARY ESTIMATE OF THE ANNUAL QUANTIFIED AND MONETIZED BENEFITS ASSOCIATED WITH IMPROVED PM AIR QUALITY RESULTING FROM THE PROPOSED NONROAD DIESEL ENGINE AND FUEL STANDARDS

Endpoint	Monetary Benefits[a,b] (millions 2000$, Adjusted for Income Growth)	
	2020	2030
Premature mortality[c] Long-term exposure, (adults, 30 and over)	$39,000	$74,000
Chronic bronchitis (WTP valuation; adults, 26 and over)	$1,600	$2,600
Non-fatal myocardial infarctions	$750	$1,300
Hospital Admissions from Respiratory Causes[d]	$38	$74
Hospital Admissions from Cardiovascular Causes[e]	$40	$80
Emergency Room Visits for Asthma	$1	$2
Acute bronchitis (children, 8-12)	$3	$5
Lower respiratory symptoms (children, 7-14)	$2	$3
Upper respiratory symptoms (asthmatic children, 9-11)	$2	$3
Work loss days (adults, 18-65)	$90	$130
Minor restricted activity days (adults, age 18-65)	$210	$320
Recreational visibility (86 Class I Areas)	$1,200	$1,900
Total Monetized Benefits[f]	$43,000 + B	$81,000 + B

Notes:
[a] Monetary benefits are rounded to two significant digits.
[b] Monetary benefits are adjusted to account for growth in real GDP per capita between 1990 and the analysis year (2020 or 2030).
[c] Valuation assumes the 5 year distributed lag structure described earlier. Results reflect the use of two different discount rates; a 3% rate, which is recommended by EPA's Guidelines for Preparing Economic Analyses (US EPA, 2000a), and 7%, which is recommended by OMB Circular A-94 (OMB, 1992).
[d] Respiratory hospital admissions for PM includes admissions for COPD, pneumonia, and asthma.
[e] Cardiovascular hospital admissions for PM include total cardiovascular and subcategories for ischemic heart disease, dysrhythmias, and heart failure.
[f] B represents the monetary value of the unmonetized health and welfare benefits. A detailed listing of unquantified PM, ozone, CO, and NMHC related health effects is provided in Table V.E-5.

The estimated social cost (measured as changes in consumer and producer surplus) in 2030 to implement the final rule from Table V.F-2 is $1.5 billion (2000$). Thus, the net benefit (social benefits minus social costs) of the program at full implementation is approximately $79 + B billion. In 2020, partial implementation of the program yields net benefits of $42 + B billion. Therefore, implementation of the final rule is expected to provide society with a net gain in social welfare based on economic efficiency criteria. Table V.E-3 presents a summary of the benefits, costs, and net benefits of the proposed rule. Figure V-E.1 displays the stream of benefits, costs, and net benefits of the Nonroad Land-based Diesel Vehicle Rule from 2007 to 2030. In addition, Table V-E.4 presents the net present value of the stream of benefits, costs, and net benefits associated with the rule for this 23 year period (using a three percent discount rate). The total net present value in 2004 of the stream of net benefits (benefits minus costs) is $530 billion.

TABLE V.E-3 -- SUMMARY OF BENEFITS, COSTS, AND NET BENEFITS OF THE PROPOSED NONROAD DIESEL ENGINE AND FUEL STANDARDS

	2020[a] (Billions of 2000 dollars)	2030 [a] (Billions of 2000 dollars)
Social Costs[b]	$1.4	$1.5
Social Benefits[b, c, d]:		
CO, VOC, Air Toxic-related benefits	Not monetized	Not monetized
Ozone-related benefits	Not monetized	Not monetized
PM-related Welfare benefits	$1.2	$1.9
PM-related Health benefits	$42+ B	$79 + B
Net Benefits (Benefits-Costs)[c]	$42 + B	$79 + B

Notes:
[a] All costs and benefits are rounded to two significant digits.
[b] Note that costs are the total costs of reducing all pollutants, including CO, VOCs and air toxics, as well as NOx and PM. Benefits in this table are associated only with PM, NOx and SO2 reductions.
[c] Not all possible benefits or disbenefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table V.E-5. B is the sum of all unquantified benefits and disbenefits.

FIGURE V.E-1 -- STREAM OF BENEFITS, COSTS, AND NET BENEFITS OF THE PROPOSED NONROAD DIESEL ENGINE AND FUEL STANDARDS

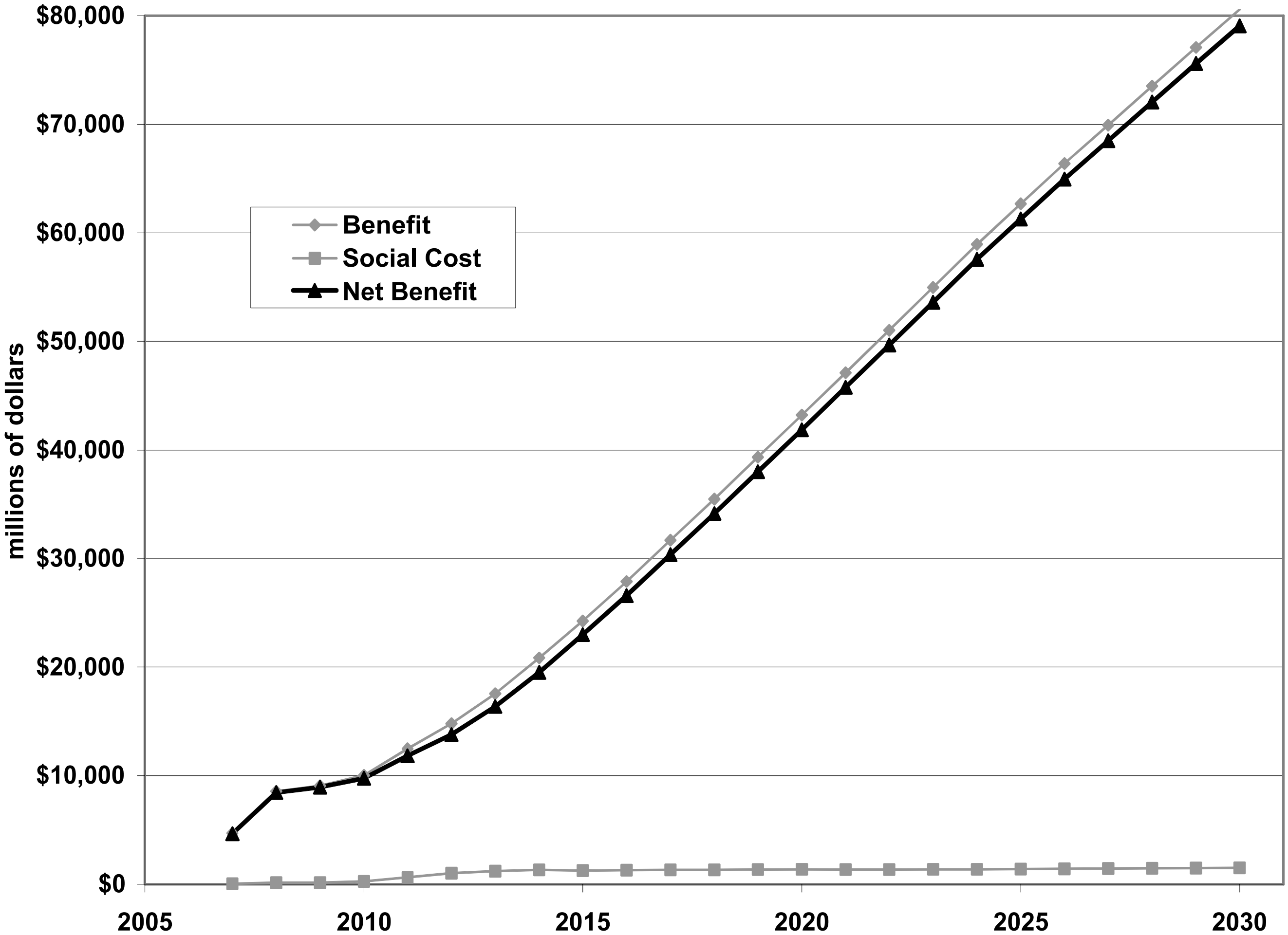

TABLE V.E-4 -- NET PRESENT VALUE IN 2004 OF THE STREAM OF BENEFITS, COSTS, AND NET BENEFITS FOR THE PROPOSED NONROAD DIESEL ENGINE AND FUEL STANDARDS (BILLIONS OF 2000$)

Social Costs	$17
Social Benefits	$550
Net Benefits	$530[a]

Notes:
[a] Numbers do not add due to rounding.

Although EPA expects economic benefits to exist, EPA was unable to quantify or to value specific changes in ozone, CO or air toxics because EPA did not perform additional air quality modeling.

A full appreciation of the overall economic consequences of the proposed rule requires consideration of all benefits and costs expected to result from the new standards, not just those benefits and costs which could be expressed here in dollar terms. A complete listing of the benefit categories that could not be quantified or monetized in EPA's estimate is provided in Table V.E-5. These effects are denoted by "B" in Table V.E-3 above, and are additive to the estimates of benefits.

TABLE V.E-5 -- ADDITIONAL, NON-MONETIZED BENEFITS OF THE PROPOSED NONROAD DIESEL ENGINE AND FUEL STANDARDS

Pollutant	Unquantified Effects
Ozone Health	Premature mortality[a] Increased airway responsiveness to stimuli Inflammation in the lung Chronic respiratory damage Premature aging of the lungs Acute inflammation and respiratory cell damage Increased susceptibility to respiratory infection Non-asthma respiratory emergency room visits Increased school absence rates
Ozone Welfare	Decreased yields for commercial forests (for example, EPA stern US) Decreased yields for fruits and vegetables Decreased yields for non-commercial crops Damage to urban ornamental plants Impacts on recreational demand from damaged forest aesthetics Damage to ecosystem functions
PM Health	Infant mortality Low birth weight Changes in pulmonary function Chronic respiratory diseases other than chronic bronchitis Morphological changes Altered host defense mechanisms Cancer Non-asthma respiratory emergency room visits
PM Welfare	Visibility in many Class I areas Residential and recreational visibility in non-Class I areas Soiling and materials damage Damage to ecosystem functions
Nitrogen and Sulfate Deposition Welfare	Impacts of acidic sulfate and nitrate deposition on commercial forests Impacts of acidic deposition to commercial freshwater fishing Impacts of acidic deposition to recreation in terrestrial ecosystems Reduced existence values for currently healthy ecosystems Impacts of nitrogen deposition on commercial fishing, agriculture, and forests Impacts of nitrogen deposition on recreation in estuarine ecosystems Damage to ecosystem functions
CO Health	Premature mortality[a] Behavioral effects

Pollutant	Unquantified Effects
HC Health[b]	Cancer (benzene, 1,3-butadiene, formaldehyde, acetaldehyde) Anemia (benzene) Disruption of production of blood components (benzene) Reduction in the number of blood platelets (benzene) Excessive bone marrow formation (benzene) Depression of lymphocyte counts (benzene) Reproductive and developmental effects (1,3-butadiene) Irritation of eyes and mucus membranes (formaldehyde) Respiratory irritation (formaldehyde) Asthma attacks in asthmatics (formaldehyde) Asthma-like symptoms in non-asthmatics (formaldehyde) Irritation of the eyes, skin, and respiratory tract (acetaldehyde) Upper respiratory tract irritation and congestion (acrolein)
HC Welfare	Direct toxic effects to animals Bioaccumulation in the food chain Damage to ecosystem function Odor

Notes:
[a] Premature mortality associated with ozone and carbon monoxide is not separately included in this analysis. In this analysis, EPA assume that the ACS/Krewski, et al. C-R function for premature mortality captures both PM mortality benefits and any mortality benefits associated with other air pollutants. A copy of Krewski, et a., can be found in Docket A-99-06, Document No. IV-G-75.
[b] Many of the key hydrocarbons related to this rule are also hazardous air pollutants listed in the Clean Air Act.

F. Economic Impact Analysis

The market impacts of this rule suggest that the overall economic impact of the proposed emission control program on society is expected be small, on average. According to this analysis, the average prices of goods and services produced using equipment and fuel affected by the proposal are expected to increase by about 0.02 percent.

The estimated market impacts for 2013, 2020, and 2030 are presented in Table V.F-1. The market-level impacts presented in this table represent production-weighted averages of the individual market-level impact estimates generated by the model: the average expected price increase and quantity decrease across all of the units in each of the engine, equipment, fuel, and final application markets.

The market impact model predicts that even with these increase in engine prices, total demand is not expected to change very much. The expected average change in quantity is only about 69 engines per year in 2013, out of total sales of more than 500,000 engines. The average decrease in the quantity of all engines produced as a result of the regulation is estimated to be about 0.013 percent. This decrease ranges from 0.010 percent for engines less than 25 hp to 0.016 percent for engines 175 to 600 hp.

In 2013, the average price increase for nonroad diesel equipment is estimated to be about 5.2 percent. This percentage is expected to decrease to about 4.5 percent for 2020 and beyond.

The output reduction for nonroad diesel equipment is estimated to be very small and to average about 0.014 percent for all years. This decrease ranges from 0.005 percent for general manufacturing equipment to 0.019 percent for construction equipment. The largest expected decrease in quantity in 2013 is 13 units of construction equipment per year for construction equipment between 100 and 175 hp, out of about 62,800 units. The smallest expected decrease in quantity in 2013 is less than one unit per year in all hp categories of pumps and compressors.

TABLE V.F-1 -- SUMMARY OF MARKET IMPACTS ($2001)

Market	Engineering Cost	Change in Price		Change in Quantity	
	Per Unit	Absolute ($million)	Percent	Absolute	Percent
2013					
Engines	$1,087	$840	22.9	–69[a]	–0.013
Equipment	$1,021	$1,017	5.2	–118	–0.014
Application Markets[b]			0.02		–0.010
No. 2 Distillate Nonroad	$0.039	$0.038	4.1	–1.38[c]	–0.013
2020					
Engines	$1,028	$779	19.5	–79[a]	–0.013
Equipment	$1,018	$1,013	4.4	–135	–0.014
Application Markets[b]			0.02		–0.010
No. 2 Distillate Nonroad	$0.039	$0.039	4.1	–1.58[c]	–0.014
2030					
Engines	$1,027	$768	19.4	–92[a]	–0.013
Equipment	$1,004	$999	4.5	–156	–0.014
Application Markets[b]			0.02		–0.010
No. 2 Distillate Nonroad	$0.039	$0.039	4.1	–1.84[c]	–0.014

Notes:
[a] The absolute change in the quantity of engines represents only engines sold on the market. Reductions in engines consumed internally by integrated engine/equipment manufacturers are not reflected in this number but are captured in the cost analysis. For this reason, the absolute change in the number of engines and equipment does not match.
[b] The model uses normalized commodities in the application markets because of the great heterogeneity of products. Thus, only percentage changes are presented.
[c] Units are in million of gallons.

Application Market Results: The estimated price increase associated with the proposed standards in all three of the application markets is very small and averages about 0.02 percent for all years. In other words, on average, the prices of goods and services produced using the engines, equipment, and fuel affected by this proposal are expected to increase only negligibly. This is because in all of the application markets the compliance costs passed on through price increases represent a very small share of total production costs.

Fuel Markets Results: The estimated average price increase across all nonroad diesel fuel is about 4 percent for all years. For 15-ppm fuel, the estimated price increase for 2013 ranges from 3.2 percent in the East Coast region (PADD 1&3) to 9.3 percent in the mountain region (PADD 4). The average national output decrease for all fuel is estimated to be about 0.01 percent for all years, and is relatively constant across all four regional fuel markets.

5. Appendix A: Feasibility of the Proposed Standards

The range of technologies available to reduce PM emissions is broad, extending from improvements to existing combustion system technologies to oxidation catalyst technologies to complete CDPF systems. The CDPF technology along with 15ppm or less sulfur diesel fuel is the system that EPA believes will allow engine manufacturers to comply with the 0.01 g/bhp-hr PM standard that EPA has proposed for a wide range of nonroad diesel engines. While it may be possible to apply CDPFs across the full range of nonroad diesel engine sizes, the complexity of full diesel particulate filter systems makes application to the smallest range of diesel engines difficult to accurately forecast at this time. The Agency has given consideration to the engineering complexity, cost and packaging of these systems in setting emission standards for various nonroad engine power categories.

In the case of NOx adsorber technology, EPA has performed an analysis that leads it to conclude the technology can be successfully applied to nonroad engines provided there is some additional lead time for further engine and catalyst system technology development beyond that provided to highway vehicles and engines. Similarly, EPA acknowledges that the diverse nature and sheer number of different nonroad equipment types makes the challenge of packaging advanced emission control technologies more difficult. Therefore, EPA has included a number of equipment manufacturer flexibilities in the proposed program in order to allow equipment manufacturers to manage the engineering resource challenges imposed by these regulations.

Another NOx catalyst based emission control technology is selective catalytic reduction (SCR). With the appropriate control system to meter urea in proportion to engine-out NOx emissions, urea SCR catalysts can reduce NOx emissions by over 90 percent for a significant fraction of the diesel engine operating range.[14] Although EPA has not done an extensive analysis to evaluate its effectiveness, EPA believes it may be possible to reduce NOx emissions with a urea SCR catalyst to levels consistent with compliance with the proposed NOx standards.

However, EPA has significant concerns regarding a technology that requires extensive user intervention in order to function properly and the lack of the urea delivery infrastructure necessary to support this technology. Urea SCR systems consume urea in proportion to the engine-out NOx rate. The urea consumption rate can be on the order of five percent of the engine fuel consumption rate. Therefore, unless the urea tank is prohibitively large, the urea must be replenished frequently. Most urea systems are designed to be replenished every time fuel is added or at most every few times that fuel is added. Today, there is not a system in place to deliver or dispense automotive grade urea to diesel fueling stations. One study conducted for the National Renewable Energy Laboratory (NREL), estimated that if urea were to be distributed to every diesel fuel station in the United States, the cost would be more than $30 per gallon.[15]

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[14] "Demonstration of Advanced Emission Control Technologies Enabling Diesel-Powered Heavy-Duty Engines to Achieve Low Emission Levels", Manufacturers of Emissions Controls Association, June 1999 Air Docket A-2001-28.

[15] Fable, S. et al, "Subcontractor Report - Selective Catalytic Reduction Infrastructure Study,"

EPA is not aware of a proven mechanism that ensures that the user will replenish the urea supply as necessary to maintain emissions performance. Further, EPA believes given the additional cost for urea, that there will be significant disincentives for the end-user to appropriately replenish the urea because the cost of urea could be avoided without equipment performance loss. Due to the lack of an infrastructure to deliver the needed urea, and the lack of a track record of successful ways to ensure urea use, EPA has concluded that the urea SCR technology is not likely to be available for general use in the time frame of the proposed standards. Therefore, EPA has not based the feasibility or cost analysis of this emission control program on the use or availability of the urea SCR technology. However, EPA would not preclude its use for compliance with the emission standards provided that a manufacturer could demonstrate satisfactorily to the Agency that urea would be used under all conditions. EPA believes that only a few unique applications will be able to be controlled in a manner such that urea use can be assured, and therefore believe it is inappropriate to base a national emission control program on a technology which can serve effectively only in a few niche applications.

A. Engines of 75 hp or Higher

The standards for nonroad engines with rated power greater than or equal to 75 horsepower are based upon the technologies and standards for highway diesel engines that go into effect in 2007. EPA believes these technologies, namely NOx 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. EPA acknowledges that there are additional constraints on nonroad diesel engines which must be considered in setting these standards, and EPA has addressed those issues by allowing 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 constraints).

EPA has proposed 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 15ppm sulfur diesel fuel. This is the same emissions level as for highway diesel engines in the HD2007 program. While baseline soot (the solid carbon fraction of PM) emission levels 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 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, C1 and 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

AD Little under contract to National Renewable Energy Laboratory, July 2002, NREL/SR-5040-32689. Copy available in EPA Air Docket A-2001-28.

of temperature (for reliable regeneration) and low sulfur diesel fuel (for reliable regeneration and low PM emissions).

The most challenging PM emissions control conditions for a CDPF are encountered under high engine load operation where high exhaust temperatures promote conversion of sulfur in diesel fuel to sulfate PM emissions. Under these high load conditions, soot and SOF oxidation rates will be very high and control of those portions of PM emissions will be highly effective. Sulfate PM emissions, however, will be higher than for other operating conditions. In a worst-case scenario, where all of the sulfur is converted to sulfate, it could be perhaps as high as 0.02 g/bhp-hr. This level of PM emissions would comply with EPA's proposed NTE provisions once consideration is given to the 1.5 times multiplier on the emission standard for NTE test conditions. Since this estimate is made at a worst-case condition (assuming 100% conversion of sulfur to sulfate), EPA feels confident that the PM NTE provisions of this proposal can be met.

The implementation dates for the standards were selected in part based upon the time EPA believes will be necessary to transfer and further develop these highway technologies to nonroad diesel engines and equipment.

EPA is proposing a NOx standard of 0.3 g/bhp-hr for engines in this category based upon the emission reductions possible from the application of NOx adsorber catalysts and the expected emission levels for Tier 3 compliant engines that form the baseline technology for Tier 4 engines. The Tier 3 emission standards are a combined NOx+NMHC 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 NOx+NMHC emission standard is 3.5 g/bhp-hr. For engines greater than 750 horsepower there is no Tier 3 NOx+NMHC standard. EPA believes that in the time frame of the Tier 4 emission standards, all engines of 75 horsepower or higher can be developed to control NOx emissions to engine-out levels of 3.0 g/bhp-hr or lower. 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, even those engines without a Tier 3 standard (i.e., >750hp engines). EPA's analysis of the NRTC and the ISO C1 cycles indicates that the NOx adsorber catalyst can provide a 90 percent or greater NOx reduction level on the cycles. The proposed standard of 0.3 g/bhp-hr reflects a baseline emissions level of 3.0 g/bhp-hr and a 90 percent or greater reduction of NOx emissions through the application of the NOx 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 EPA confident that the proposed NOx standards can be met.

The proposed standard is 50 percent higher than the corresponding HD2007 standard of 0.2 g/bhp-hr because of the higher baseline NOx emissions for Tier 3 engines. The higher baseline (engine-out) NOx level is due primarily to a lack of ram-air for improved charge-air cooling for nonroad diesel engines when compared to highway diesel engines compliant with the 2004 highway emission standards. Although nonroad engine manufacturers may be able to lower engine-out NOx emissions below the levels required for Tier 3, EPA continue to expect that the lack of ram air will limit nonroad engine-out NOx performance, and therefore EPA has accounted for that difference by proposing this higher NOx emissions level.

EPA believes that the NOx adsorber technology developed for highway engines can be applied with equal effectiveness to nonroad diesel engines with additional developments in engine thermal management to address the more widely varied nonroad operating cycles. In fact, as discussed previously, the NOx adsorber catalyst temperature window is particularly well matched to transient operating conditions as typified by the NRTC.

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. Controlling NOx 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. EPA knows of no technical impediment that would prevent achieving the NTE standard under the full range of operating conditions.

The proposed NOx standard is phased in over a number of years in a manner similar to the HD2007 NOx phase-in. In the early years of the program half of the engines produced by a manufacturer must be certified to the new emission standard while the remaining engines can continue to be sold at the previous standard. EPA provided this phase-in period for highway engines in the HD2007 rulemaking to allow manufacturers to focus resources on the portion of their products best suited to NOx catalysts first and then to apply the learning to the remainder of their products three years later. Provisions of the averaging program in the HD2007 rulemaking allow manufacturers to alternatively comply with some engine families at an "averaged" standard that is approximately halfway between the old and new NOx standards. In fact, EPA has learned from a number of engine manufacturers that they are likely to employ this strategy for some fraction of their new highway engines in 2007. The averaging provisions that EPA has proposed for Tier 4 would also allow for compliance with the proposed Tier 4 NOx standard with a single engine product during the transitional NOx phase-in period. This provision allows manufacturers to transfer the same highway NOx technologies to nonroad engines and to comply with an appropriately stringent standard. EPA believes as with the HD2007 rule that this provision is necessary in order to manage resource requirements to develop the necessary technologies and that this provision provides significant additional flexibility for manufacturers to comply with the proposed NOx standards. Similarly, EPA has proposed a modified phase-in schedule for the greater than 750 horsepower engines in part because of the lack of a Tier 3 standard for those engine and the extra work required to develop a full Tier 4 emission control system from a Tier 2 baseline.

Meeting the proposed NMHC standard under the lean operating conditions typical of the biggest portion of NOx adsorber operation should not present any special challenges to nonroad diesel engine manufacturers. Since CDPFs and NOx 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.[16] Given that typical engine-out NMHC is expected to be in the 0.40 g/bhp-hr range

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[16] "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.

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.

The NOx regeneration strategies for the NOx adsorber technology may prove difficult to control precisely, leading to a possible increase in NMHC emissions under the rich operating conditions required for NOx regeneration. Even with precise control of the regeneration cycle, NMHC slip may prove to be a difficult problem due to the need to regenerate the NOx adsorber under net rich conditions (excess fuel) rather than the stoichiometric (fuel and air precisely balanced) operating conditions typical of a gasoline three-way catalyst. It seems possible therefore, that in order to meet the NMHC standards EPA has proposed, an additional clean up catalyst may be required. A diesel oxidation catalyst, like those applied historically for NMHC and partial PM control, can reduce NMHC emissions (including toxic HCs) by more than 90 percent.[17] This amount of additional control along with optimized NOx regeneration strategies will ensure very low NMHC emissions. EPA's cost analysis includes the cost for the application of a clean-up DOC catalyst for all engines that must comply with the 0.3 g/bhp-hr NOx standard.

Based on EPA's engineering judgment and experience testing integrated NOx adsorber and PM filter systems with DOC clean-up catalyst technologies, EPA can conclude that the 0.14 g/bhp-hr NMHC standard will be feasible in the Tier 4 time frame.

The proposed standards include a cold start provision with the transient test procedures. 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 proposed standards. The proposed weightings are 1/10 cold start and 9/10 for the hot start. Because exhaust temperatures are so important to catalyst performance the cold start provision is an important tool to ensure that the emissions realized in use are consistent with the expectations of this program and represents an additional technical challenge for NOx control and to a lesser extent CO and NMHC control. PM control with a CDPF is not expected to be significantly impacted by cold-start provisions. NOx control in the period before temperatures exceed the catalyst light-off temperature is reduced significantly. As a result, exhaust stack NOx emissions will be higher over the cold start portion of the test. However, EPA believes that this increase in NOx emissions will not be high enough to preclude compliance with the proposed NOx standard once the 1/10 weighting is applied.

There are number of technologies available to the engine manufacturer to promote rapid warm-up of the exhaust and emission control system. These include retarding injection timing, increasing EGR, and potentially late cycle injection all of which are technologies EPA expects manufacturers to apply as part of the normal operation of the NOx adsorber catalyst system. These are the same technologies EPA expects 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, EPA expects the transfer of highway technology to be well matched to accomplish this control need for nonroad engines as well. Using these

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17 "Demonstration of Advanced Emission Control Technologies Enabling Diesel-Powered Heavy-Duty Engines to Achieve Low Emission Levels", Manufacturers of Emissions Controls Association, June 1999.

technologies EPA expects nonroad engine manufacturers to be able to comply with the proposed NOx, NMHC and CO emissions including the cold start provisions of the transient test procedure.

Although EPA has proposed a unique phase-in schedule for >750hp engines, EPA does not doubt that these engines, like engines <750hp, can be developed to meet the standards. These large engines are fundamentally similar to other nonroad engines. The project emissions control mechanisms are the same. Retrofits of PM filter systems have been applied to large locomotives and other similar size engines. EPA is unaware of any fundamental difference in technology function that would lead EPA to conclude that the proposed standards are inappropriate for engines >750hp. However, given the need to apply both new engine-out control technologies (i.e., Tier 3 type technologies) in addition to the new catalyst based technologies in order to comply with the proposed standards, and given the low sales volumes for these engines, EPA does believe it is appropriate to have a different phase-in structure for these engines. EPA invites comment supported by data on this issue, particularly if a commenter believes there are fundamental technology differences which would make alternate standards more appropriate for >750hp nonroad engines.

B. Engines $25 hp and <75 hp

EPA's proposal for standards for engines between 25 and 75 hp consists of a 2008 transitional standard and long-term 2013 standards. The proposed 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+NOx standard. The transitional standard is optional for 50-75 hp engines, as the proposed 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.

In addition, EPA has proposed a minor revision to the CO standard for the 25-50 hp engines beginning in 2008 to align these engines with the 50-75 hp engines. This proposed CO standard is 3.7 g/bhp-hr.

i. Unique Characteristics

Many of the nonroad diesel engines $75 hp are either a direct derivative of highway heavy-duty diesel engines, or share a number of common traits with highway diesel engines. These include similarities in displacement, aspiration, fuel systems, and electronic controls. Table III.E-3 contains a summary of a number of key engine parameters from the 2001 engines certified for sale in the U.S.

TABLE III.E-3: SUMMARY OF MODEL YEAR 2001 KEY ENGINE PARAMETERS BY POWER CATEGORY

Engine Parameter	Percent of 2001 U.S. Production[a]			
	0-25 hp	25-75 hp	75-100 hp	>100 hp
IDI Fuel System	83%	47%	4%	<0.1%
DI Fuel System	17%	53%	96%	>99%
Turbocharged	0%	7%	62%	91%
1 or 2 Cylinder Engines	47%	3%	0%	0%
Electronic fuel systems (estimated)	Not available today	Limited availability today	Available today	Commonly available today

Notes:
[a] Based on sales weighting of 2001 engine certification data.

The 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. The distinction is particularly marked with respect to electronically controlled fuel systems. These are commonly available in the $ 75 hp power categories, but, based on the available certification data as well as EPA's discussions with engine manufacturers, EPA believes 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. 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 <25 hp category).

ii. Current Technologies

Engines in the 25-75 hp category use either indirect injection (IDI) or direct injection (DI) fuel systems. The IDI system injects fuel into a pre-chamber rather than directly into the combustion chamber as in the DI system. This difference in fuel systems results in substantially different emission characteristics, as well as differences in several important operating parameters. In general, the IDI engine has lower engine-out PM and NOx emissions, while the DI engine has better fuel efficiency and lower heat rejection.

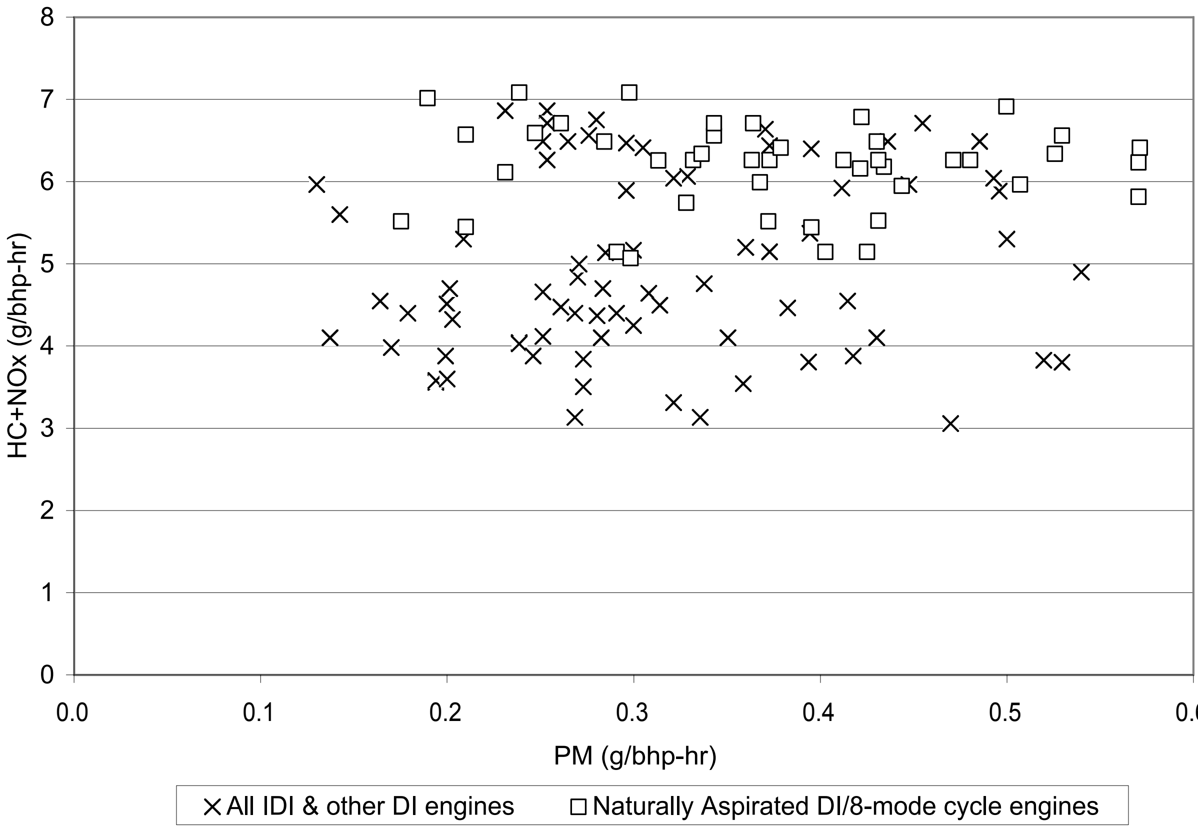
EPA expects a significant shift in the engine technology that will be used in this power category as a result of the upcoming Tier 2 and Tier 3 standards, in particular for the 50-75 hp engines. In the 50-75 hp category, the 2008 Tier 3 standards will likely result in the significant use of turbocharging and electronic fuel systems, as well as the introduction of both cooled and uncooled exhaust gas recirculation by some engine manufacturers and possibly the use of charge-air-cooling. In addition, EPA has heard from some engine manufactures that the engine technology used to meet Tier 3 for engines in the 50-75 hp range will also be made available on those engines in the 25-50 hp range which are built on the same engine platform. For the Tier 2 standards for the 25-50 hp products, a large number of engines meet these standards today, and therefore EPA expects to see only moderate changes in these engines, including the potential additional use of turbocharging on some models.

iii. Technological Feasibility

1) 2008 PM Standards

The model year 2002 engines in this power range use well known engine-out emission control technologies, such as optimized combustion chamber design and fuel injection timing control strategies, to comply with the existing standards. These data have a two-fold significance. First, they indicate that a number of engines in this power range can already achieve the proposed 2008 standard for PM using only engine-out technology, and that other engines should be able to achieve the standard making improvements just to engine-out performance. Despite being certified to the same emission standards with similar engine technology, the emission levels from these engines vary widely. Figure III.E-1 is a graph of the model year 2002 HC+NOx and PM data for engines in the 25-50 hp range. As can be seen in the figure, the emission levels cover a wide range. Figure III.E-1 highlights a specific example of this wide range: engines using naturally aspirated DI technology and tested on the 8-mode test cycle. Even for this subset of DI engines achieving approximately the same HC+NOx level of ~6.5 g/bhp-hr, the PM rates vary from approximately 0.2 to more than 0.5 g/bhp-hr. There is limited information available to indicate why for these small diesel engines with similar technology operating at approximately the same HC+NOx level the PM emission rates cover such a broad range. EPA is therefore not predicating the proposed 2008 PM standard on the combination of diesel oxidation catalysts and the lowest engine-out emissions being achieved today, because it is uncertain whether or not additional engine-out improvements would lower all engines to the proposed 2008 PM standard. Instead, EPA believes there are two likely means by which companies can comply with the proposed 2008 PM standard. First, some engine manufacturers can comply with this standard using known engine-out techniques (e.g., optimizing combustion chamber designs, fuel-injection strategies). However, based on the available data it is unclear whether engine-out techniques will work in all cases. Therefore, EPA believes some engine companies will choose to use a combination of engine-out techniques and diesel oxidation catalysts, as discussed below.

FIGURE III.E-1 -- EMISSION CERTIFICATION DATA FOR 25-50 HP MODEL YEAR 2002 ENGINES



For those engines that do not already meet the proposed 2008 Tier 4 PM standard, a number of engine-out technologies are available to achieve the standards by 2008. In the recent Staff Technical Paper on the feasibility of the Tier 2 and Tier 3 standards, EPA projected that in order to comply with the Tier 3 standards, engines greater than 50 hp would rely on some combination of a number of technologies, including electronic fuel systems such as electronic rotary pumps or common-rail fuel systems.[18] In addition to enabling the Tier 3 NMHC+NOx standards, electronic fuel systems with high injection pressure and the capability to perform pilot-injection and rate shaping, have the potential to substantially reduce PM emissions. Even for mechanical fuel systems, increased injection pressures can reduce PM emissions substantially. EPA is projecting that the Tier 3 engine technologies used in engines between 50 and 75 hp, such as turbocharging and electronic fuel systems, will make their way into engines in the 25-50 hp range. However, EPA does not believe this technology will be required to achieve the proposed 2008 PM standard. As demonstrated by the 2002 certification data, engine-out techniques such as optimized combustion chamber design, fuel injection pressure

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[18] 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.

increases and fuel injection timing can be used to achieve the proposed standards for many of the engines in the 25-75 hp category without the need to add turbocharging or electronic fuel systems.

For those engines which are not able to achieve the proposed standards with known engine-out techniques, EPA projects that diesel oxidation catalysts can be used to achieve the proposed standards. DOCs are passive flow-through emission control devices that 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.

Certain DOC formulations can be sensitive to diesel fuel sulfur level, and depending on the level of emission reduction necessary, sulfur in diesel fuel can be an impediment to PM reductions. Precious metal oxidation catalysts can oxidize the sulfur in the fuel and form particulate sulfates. With the availability of 500-ppm sulfur fuel, DOC's can be designed to provide PM reductions on the order of 20 to 50%, while suppressing particulate sulfate reduction. The 2008 PM standard must be met on the existing nonroad steady-state cycle; the supplemental standards (nonroad transient cycle and NTE) are not implemented until 2013 for this power category. As discussed above, 24 engine families in the 25-50 hp range are within 30 percent of the proposed 2008 PM standard and are at or below the 2008 NMHC+NOx standard for this power range, indicating that use of DOCs should readily achieve the incremental improvement necessary to meet the proposed 2008 PM standard.

Based on the existence of a number of engine families which already comply with the proposed 0.22 g/bhp-hr PM standard (and the 2008 NMHC+NOx standard), and the availability of well known PM reduction technologies such as engine-out improvements and diesel oxidation catalysts, EPA projects the proposed 0.22 g/bhp-hr PM standards is technologically feasible by model year 2008. All of these are conventional technologies that have been used on both highway and nonroad diesel engines in the past. As such, EPA does not expect there to be any negative impacts with respect to noise or safety. In addition, PM reduction technologies such as improved combustion through the use of higher pressure fuel injection systems have the potential to improve fuel efficiency. DOCs are not predicted to have any substantial impact on fuel efficiency.

EPA has also proposed a minor change in the CO standard for the 25-50 hp engines, in order to align it with the standard for the 50-75 hp engines. The current CO standard for this category is 4.1 g/bhp-hr, and the proposed standard is 3.7 g/bhp-hr (i.e., the current standard for engines in the 50-75 hp range). The model year 2002 certification data shows that more than 95 percent of the engine families in the 25-50 hp engine range meet the proposed CO standard today. In addition, a recent EPA test program run by a contractor on two nonroad diesel engines in this power range showed that CO emissions were well below the proposed standards not only when tested on the existing steady-state 8-mode test procedure, but also when tested on the nonroad transient duty cycle EPA is proposing in today's action.[19] Finally, DOCs typically reduce CO

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[19] See Tables 6, 8, and 14 of "Nonroad Emission Study of Catalyzed Particulate Filter Equipped Small Diesel Engines" Southwest Research Institute, September 2001. Copy available in EPA

emissions on the order of 50 percent or more, on both transient and steady state conditions. Given that more than 95 percent of the engines in this category meet the proposed standard today, and the ready availability of technology that can easily achieve the proposed standard, EPA projects this CO standard will be achievable by model year 2008.

2) 2013 Standards

PM Standard

Particulate filter technology, with the requisite trap regeneration technology, can also be applied to engines in the 25 to 75 hp range. The fundamentals of how a filter is able to reduce PM emissions are not a function of engine power, and CDPF's are just as effective at capturing soot emissions and oxidizing SOF on smaller engines as on larger engines. Particulate sulfate generation rates are slightly higher for the smaller engines, however, EPA has addressed this issue in the proposal. The PM filter regeneration systems are also applicable to engines in this size range and are therefore likewise feasible. There are specific trap regeneration technologies that EPA believes engine manufacturers in the 25-75 hp category may prefer over others. Specifically, 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 technology companies have tested other systems.[20]

EPA is, however, proposing a slightly higher PM standard (0.02 g/bhp-hr rather than 0.01) for these engines. The PM emissions emitted by the filter are primarily derived from the fuel sulfur. The smaller power category engines tend to have higher fuel consumption than larger engines. Because of the higher fuel consumption rate, EPA expects a higher particulate sulfate level, and therefore EPA has proposed a 0.02 g/bhp-hr standard.

NMHC+NOx Standard

A number of technologies that are capable of achieving a 3.5 g/bhp-hr standard exist, including cooled EGR, uncooled EGR, as well as advanced in-cylinder technologies relying on electronic fuel systems and turbocharging.[21] These technologies are capable of reducing NOx emission by as much as 50 percent. Given the Tier 2 NMHC+NOx 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+NOx standard proposed in this action. In addition, because this NMHC+NOx standard is concurrent with the 0.02 g/bhp-hr PM standards which EPA projects will be achievable with the use of particulate

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Air Docket A-2001-28.

[20] "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.

[21] 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.

filters, engine designers will have significant additional flexibility in reducing NOx because the PM filter will eliminate the traditional concerns with the engine-out NOx vs. PM trade-off.

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, EPA has concluded the proposed 0.02 g/bhp-hr PM standard for engines in the 25 - 75 hp category and the 3.5 g/bhp-hr NMHC+NOx standards for the 25-- - 50 hp engines are achievable.

iv. Are more stringent Tier 4 NOx standards Feasible?

Engines <75 hp include a significant fraction of naturally aspirated engines and engines with indirect-injection fuel systems, and EPA is not predicting a significant shift away from IDI technology engines. Given the relatively unsophisticated level of technology used in this power category today, as well as EPA's prediction that even in the 2011-13 time frame these engines will lag significantly behind the $75 hp engines, EPA believes it is appropriate not to propose NOx adsorber based standards at this time. Rather, EPA has proposed to undertake a technology assessment in the 2007 time frame that would evaluate the status of emission control technologies for engines less than 75 hp, and such a review would revisit this issue. EPA invites further comment on the above discussion, and also solicits comment on the cost impacts of NOx aftertreatment devices, including unit costs, on these engines.

C. Engines <25 hp

i. Unique Characteristics

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 50 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 EPA knows today and taking into account the Tier 2 standards which have not yet been implemented, EPA is 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.

EPA has proposed a PM standard for engines in the <25 hp category that is higher than the standard proposed for engines in the 25-75 hp category (0.30 g/bhp-hr vs. 0.22 g/bhp-hr). EPA has done this for a number of reasons. First, the existing Tier 2 PM standards specifies standards that become numerically higher for the smaller power categories. Specifically, for engines >175 hp, the Tier 2 PM standard is 0.15 g/bhp-hr, which increases to 0.30 g/bhp-hr for engines in the 50-100hp range, 0.45 g/bhp-hr for engines in the 25-50hp range, and finally 0.60 g/bhp-hr for engines <25 hp. In the Tier 2 time frame, engines in the higher power categories are expected to use more sophisticated technologies such as turbocharging and high pressure electronically controlled fuel systems. These technologies are more capable of reducing PM emissions as compared to naturally aspirated engines with lower pressure mechanical fuel systems. To some extent this same trend is expected to continue in the 2008 time frame. As discussed above, EPA expects that many engines in the 25-75hp engine category will use turbocharging, and some engines will have electronic fuel systems. However, EPA is not predicting that any engines in the <25hp category will use either of these technologies. In addition, very small diesel engines present a number of unique challenges for reducing PM emissions. First, the smaller engines inherently have high combustion chamber surface-to-volume ratios. This results in higher heat loss, which results in a quenching of the oxidation process earlier than for larger engines, and therefore higher PM emission rates. In addition, the small diesel engines are more limited in the PM reduction that can be achieved by higher fuel injection pressures. Due to the very small size of the combustion chamber, high-pressure injection (which is intended to improve fuel atomization and mixing, both of which lower PM emissions) will result in fuel impaction on the combustion chamber, which will not improve fuel atomization. The benefits of higher pressure fuel injection as a PM reduction technology therefore reaches a point of diminishing returns with higher and higher pressures, and this point of diminishing returns is reached much quicker for the smaller engines than for the larger engines. For these reasons EPA has proposed a 2008 PM standard for engines <25 hp that is higher than the proposed 2008 PM standard for engines in the 25-75 hp category.

ii. Current Technology

EPA is not predicting that Tier 2 will require electronic fuel systems, EGR, or turbocharging. A large number of engines in this power category already meet the Tier 2 standards by a wide margin.[22]

Two basic types of engine fuel injection technologies are currently present in the less than 25 hp category, mechanical indirect injection (IDI) and mechanical direct injection (DI). The IDI system injects fuel into a pre-chamber rather than directly into the combustion chamber as in the DI system. This difference in fuel systems results in substantially different emission characteristics, as well as several important operating parameters. In general, the IDI engine has lower engine-out PM and NOx emissions, while the DI engine has better fuel efficiency and lower heat rejection.

iii. Available data indicates that the proposed standards are feasible

EPA projects the proposed Tier 4 PM standard can be met by 2008 based on:

- The existence of a large number of engine families which meet the proposed standards today;
- The use of engine-out reduction techniques; and
- The use of diesel oxidation catalysts.

EPA has examined the recent model year (2002) engine certification data for nonroad diesel engines less than 25 hp. These data indicate that a number of engine families meet the proposed Tier 4 PM standard (and the 2008 NMHC+NOx standard, unchanged from Tier 2)

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[22] See Table 3-2 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.

today. The current data indicates approximately 28% of the engine families are at or below the proposed PM standard today, while meeting the 2008 NMHC+NOx standard. These include both IDI and DI engines, as well as a range of certification test cycles. Many of the engine families are certified well below the proposed Tier 4 standard while meeting the 2008 NMHC+NOx level. Specifically, 15 percent of the engine families exceed the proposed 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.

These model year 2002 engines use well known engine-out emission control technologies, such as combustion chamber design and fuel injection timing control strategies, to comply with the existing standards. As with 25-75 hp engines, these data have a two-fold significance. First, they indicate that a number of engines in this power category can already achieve the proposed 2008 standard for PM using only engine-out technology, and that other engines should be able to achieve the standard making improvements just to engine-out performance. Second, despite being certified to the same emission standards with similar engine technology, the emission levels from these engines vary widely. Figure III.E-2 is a graph of the model year 2002 HC+NOx and PM data. As can be seen in the figure, the emission levels cover a wide range. Figure III.E-2 highlights a specific example of this wide range: engines using naturally aspirated IDI technology and tested on the 6-mode test cycle. Even for this subset of IDI engines achieving approximately the same HC+NOx level of~4.5 g/bhp-hr, the PM rates vary from approximately 0.15 to 0.5 g/bhp-hr. There is limited information available to indicate why for these small diesel engines with similar technology operating at approximately the same HC+NOx level the PM emission rates cover such a broad range. EPA is therefore not predicating the proposed 2008 PM standard on the combination of diesel oxidation catalysts and the lowest engine-out emissions being achieved today, because it is uncertain whether or not additional engine-out improvements would lower all engines to the proposed 2008 PM standard. Instead, EPA believes there are two likely means by which companies can comply with the proposed 2008 PM standard. First, some engine manufacturers can comply with this standard using known engine-out techniques (e.g., optimizing combustion chamber designs, fuel-injection strategies). However, based on the available data it is unclear whether engine-out techniques will work in all cases. Therefore, EPA believes some engine companies will choose to use a combination of engine-out techniques and diesel oxidation catalysts.

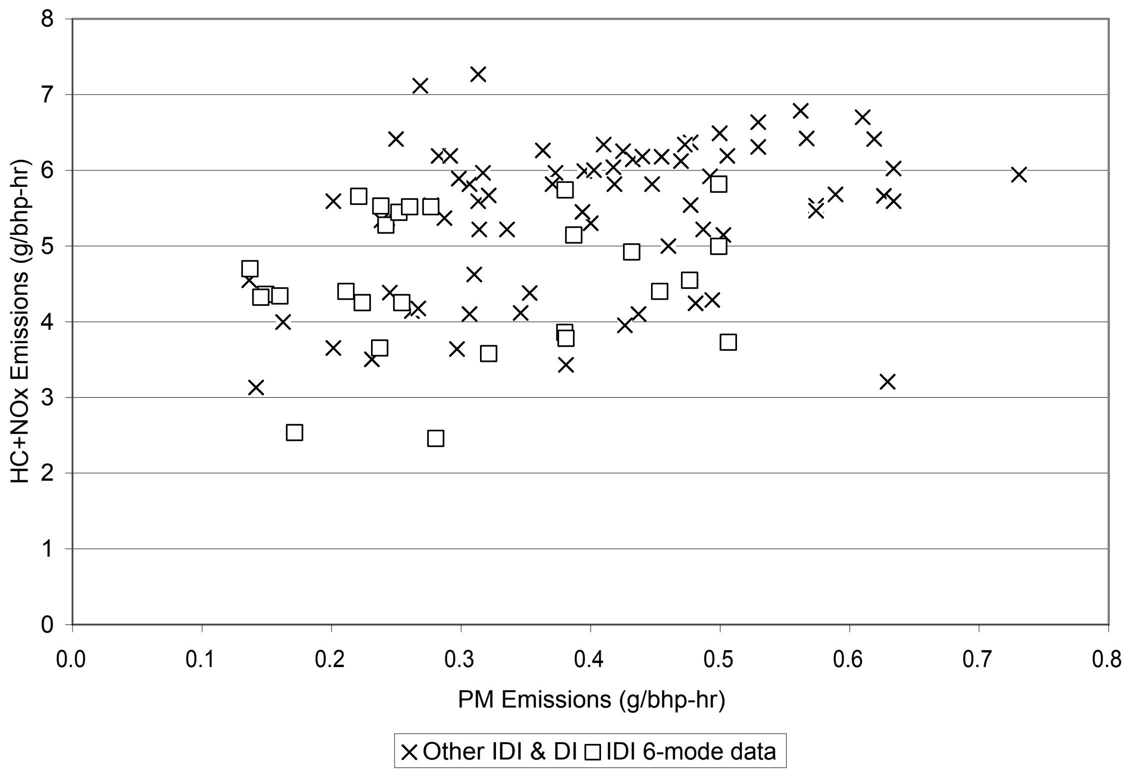

FIGURE III.E-2 -- EMISSION CERTIFICATION DATA FOR <25 HP MODEL YEAR 2002 ENGINES

PM emissions can be reduced through in-cylinder techniques for small nonroad diesel engines using similar techniques as used in larger nonroad and highway engines.

There are a number of technologies that exist that can influence oxygen content and in-cylinder mixing (and thus lower PM emissions) including improved fuel injection systems and combustion system designs. For example, increased injection pressure can reduce PM emissions substantially. The wide-range of emission characteristics present in the existing engine certification data is likely a result of differences in fuel systems and combustion chamber designs. For many of the engines that have higher emission levels, further optimization of the fuel system and combustion chamber can provide additional PM reductions.

Diesel oxidation catalysts (DOC) also offer the opportunity to reduce PM emissions from the engines in this power category. DOCs are passive flow through emission control devices that are typically coated with a precious metal or a base-metal wash-coat. 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. Given the high level of sulfur in nonroad fuel today, the use of DOCs as a PM reduction technology is severely limited. Without the availability of 500-ppm sulfur fuel in 2008, DOCs would be of limited use for nonroad engine manufacturers and would not provide the emissions necessary to meet the proposed standards for most engine manufacturers. With the availability of 500-ppm sulfur fuel, DOC's can be designed to provide PM reductions on the order of 20 to 50%, while suppressing particulate sulfate reduction. These levels of reductions have been seen on transient duty cycles as well as highway and nonroad steady-state duty cycles. EPA is proposing to apply supplemental test procedures and standards (nonroad transient test cycle and not-to-exceed requirements) to engines in the <25 hp category beginning in 2013. The supplemental test procedures and standards will apply not only to PM, but also to NMHC+NOx. While EPA believes the engine technology necessary to comply with the supplemental test procedures and standards is the same as the technology necessary to comply with the 2008 standard, EPA is delaying the implementation of the supplemental test procedures and standards until 2013 in order to implement the supplemental requirements on the larger powered nonroad engines before the smallest power category. 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. Nevertheless, the technologies described above are capable of complying with both the proposed nonroad transient test cycle and the NTE standard.

1) Why not more stringent PM or NOx standards for engines < 25 hp?

The proposal contains a detailed discussion of why EPA doesn't believe it is appropriate at this time to revise the NOx standards based on NOx absorber technology for engines between 25 and 75 hp. These same arguments apply for engines below 25 hp. In addition, EPA has not proposed to revise the NOx standard for <25 hp engines in this action, nor does EPA believe PM standards based on particulate filters are appropriate for this power category based on a number of factors, as discussed below.

In order to set more stringent NOx standards for <25 hp engines without increasing PM emissions, the most logical list of technologies is turbocharging, electronically controlled hot or cooled EGR, an electronic fuel system, and possibly charge-air-cooling. No nonroad diesel engine <25 hp uses any combination of these technologies today. While EPA is able to postulate that some of this technology could be applied to the <25 hp engines, the application of some of the technology (such as turbocharging) is technologically uncertain. It is the combination of these two issues (the traditional NOx-PM trade-off and the difficulties with turbocharging 1 and 2 cylinder engines), which is the primary reason EPA is not proposing to revise the NOx standard for engines in this size range. NOx reduction control technologies such as advancing fuel injection timing or using EGR will increase PM emissions. In order to reduce NOx emissions and reduce or maintain current PM levels additional technologies must be used. Fundamental among these is the need to increase oxygen content, which can be achieved principally with turbocharging. However, turbocharging systems do not lend themselves to 1 and 2 cylinder products, which are approximately 50 percent of the engines in this power category. In addition, even if these technologies could be applied to engines in the < 25 hp category, the costs would be substantial relative to both the base engine cost and to the cost of the nonroad equipment itself. Therefore, EPA has not proposed to revise the NOx standard for these engines at this time. EPA has proposed that a technology assessment occur in 2007, which would evaluate the status of emission control technologies for engines less than 75 hp, and such a review would revisit this issue.

In addition, EPA has not proposed to apply particulate filter based standards for engines less than 25 hp. As discussed above, there are two basic types of particulate filter systems EPA believes could be used by engine manufacturers. The first is a CDPF that uses post-injection from a common-rail electronic fuel injection system in order to ensure filter regeneration. The second type of system would use a CDPF with a stand-alone (i.e., independent from the engine's fuel system) fuel injection system to ensure filter regeneration. In either case, an electronic control system is required, as well as the CDPF. Such systems are not being developed for engines of this size for either highway light-duty or heavy-duty diesel applications, and (as noted earlier) it is unclear whether the technology development which is being done for the highway market will transfer down to engines in this power category. In addition, based on currently available information, EPA believes the costs of these technologies are relatively high compared to the overall cost of the equipment. EPA has proposed that a technology assessment occur in 2007, which would evaluate the status of emission control technologies for engines less than 75 hp, and such a review would revisit this issue.

D. 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, EPA has required that crankcase emissions be controlled only on naturally aspirated diesel engines. EPA 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 70hp use turbocharged engines, and a single engine can emit over 100 pounds of NOx, NMHC, and PM from the crankcase over its lifetime.

Given the available means to control crankcase emissions, EPA eliminated this exception for highway engines in 2007 and is proposing to eliminate the exception for nonroad diesel engines as well. EPA anticipates 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 proposed provision has 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. EPA proposes to limit this provision for controlling emissions from open crankcases to turbocharged engines, which is the same as for heavy-duty highway diesel engines. EPA requests comment on extending this provision to naturally aspirated engines, as EPA did for marine diesel engines in the 1999 final rule.

6. **Appendix B: Requirements for Engine and Equipment Manufacturers**

A. Averaging, Banking, and Trading

In an effort to make information on the ABT program more available to the public, EPA intends to issue periodic reports summarizing use of the proposed ABT program by engine manufacturers. The information contained in the periodic reports would be based on the information submitted to EPA by engine manufacturers, and summarized in a way that protects the confidentiality of individual engine manufacturers. EPA believes this information will also be helpful to engine manufacturers by giving them a better indication of the availability of credits.

The existing ABT program for nonroad diesel engines covers NMHC+NOx emissions as well as PM emissions. With EPA's notice EPA is proposing to make the ABT program available for the proposed NOx standards and proposed PM standards. (For engines less than 75 horsepower where EPA is proposing combined NMHC+NOx standards, the ABT program would continue to be available for the proposed NMHC+NOx standards as well as the proposed PM standards.) ABT would not be available for the proposed NMHC standards for engines above 75 horsepower or for the proposed CO standards for any engines.

To ensure that the ABT provisions are not used to continue producing old-technology high-emitting engines under the new program, the proposed FEL caps would not, in general, be set at the previous standards. An exception is for the proposed NMHC+NOx standard for engines between 25 and 50 horsepower effective in model year 2013, where EPA is proposing to use the previously applicable NMHC+NOx standard for the FEL cap since the gap between the previous and proposed standards is approximately 40 percent (rather than 90 percent for engines above 75 horsepower).

For engines above 75 horsepower certified during the phase-in period, there would be two separate sets of engines with different FEL caps. For engines certified to the existing (Tier 3) NMHC+NOx standards during the phase-in, the FEL cap would necessarily continue to be the existing FEL caps as adopted in the October 1998 rule. For engines certified to the proposed Tier 4 NOx standard during the phase-in, the FEL cap would be 3.3 g/bhp-hr for engines between 75 and 100 horsepower, 2.8 g/bhp-hr for engines between 100 and 750 horsepower, and 4.6 g/bhp-hr for engines above 750 horsepower. These proposed NOx FEL caps represent an estimate of the NOx emission level that is expected under the combined NMHC+NOx standards that apply with the existing previous tier standards. Beginning in model year 2014 when the proposed Tier 4 NOx standard for engines above 75 horsepower take full effect, EPA is proposing a NOx FEL cap of 0.60 g/bhp-hr for engines above 75 horsepower. (As described below, EPA is proposing to allow a small number of engines greater than 75 horsepower to have NOx FELs above the 0.60 g/bhp-hr cap beginning in model year 2014.) Given the fact that the proposed Tier 4 NOx standard is approximately a 90 percent reduction from the existing standards for engines above 75 horsepower, EPA does not believe the previous standard would be appropriate as the FEL cap for all engines once the Tier 4 standards are fully phased-in. EPA believes that the proposed NOx FEL caps will ensure that manufacturers adopt NOx aftertreatment technology across all of their engine designs (with the exception of a limited number) but will also allow for some meaningful use of averaging during the phase-in period.

When compared to the proposed 0.30 g/bhp-hr NOx standard, the proposed NOx FEL cap of 0.60 g/bhp-hr (effective when the Tier 4 standards are fully phased-in) is consistent with FEL caps set in previous rulemakings.

For the transitional PM standards being proposed for engines between 25 and 75 horsepower effective in model year 2008 and for the Tier 4 PM standards for engines below 25 horsepower, EPA is proposing the previously applicable Tier 2 PM standards (which do vary within the 25 to 75 horsepower category) for the FEL caps since the gap between the previous and proposed standards is approximately 50 percent (rather than in excess of 90 percent for engines above 75 horsepower). For the proposed Tier 4 PM standard effective in model year 2013 for engines between 25 and 75 horsepower, EPA is proposing a PM FEL cap of 0.04 g/bhp-hr, and for the proposed Tier 4 PM standard effective in model years 2011 and 2012 for engines between 75 and 750 horsepower, EPA is proposing a PM FEL cap of 0.03 g/bhp-hr. (As described below, EPA is proposing to allow a small number of Tier 4 engines greater than 25 horsepower to have PM FELs above these caps.) Given the fact that the proposed Tier 4 PM standards for engines above 25 horsepower are less than 10 percent of the previous standards, EPA does not believe the previous standards would be appropriate as FEL caps once the Tier 4 standards take effect. EPA believes that the proposed 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.

For the proposed Tier 4 PM standards for engines above 750 horsepower there is a phase-in period during model years 2011 through 2013. During the phase-in period, there would be two separate sets of engines with different FEL caps. For engines certified to the existing Tier 2 PM standard, the FEL cap would continue to be the existing PM FEL cap adopted in the October 1998 rule. For engines certified to the proposed Tier 4 PM standard during the phase-in, the FEL cap would be 0.15 g/bhp-hr (the PM standard for the previous tier). Beginning in model year 2014, when the proposed Tier 4 PM standard for engines above 750 horsepower takes full effect, consistent with the proposed caps for lower horsepower categories, EPA is proposing a PM FEL cap of 0.03 g/bhp-hr. (As described below, EPA is proposing to allow a small number of engines greater than 750 horsepower to have PM FELs above the 0.03 g/bhp-hr cap beginning in model year 2014.) EPA believes that the proposed PM FEL caps for engines above 750 horsepower will ensure that manufacturers adopt PM aftertreatment technology across all of their engine designs once the standard is fully phased-in (with the exception of a limited number) while allowing for some meaningful use of averaging during the phase-in period.

Table VII.A-1 contains the proposed FEL caps and the effective model year for the FEL caps (along with the associated standards proposed for Tier 4). EPA requests comment on the need for and the levels of these proposed FEL caps. It should be noted that for Tier 4, where EPA is proposing a new transient test, as well as retaining the current steady-state test, the FEL established by the engine manufacturer would 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 would be used as the enforceable limit for the purpose of such compliance testing.

Table VII.A-1 -- Proposed FEL Caps for the Proposed Tier 4 Standards in the ABT Program (g/bhp-hr)

Power Category	Effective Model Year	NOx Standard	NOx FEL Cap	PM Standard	PM FEL Cap
hp <25 (kW <19)	2008+	–[a]	–[a]	0.30[b]	0.60
25 # hp < 50 (19 # kW < 37)	2008-2012[c]	–[a]	–[a]	0.22	0.45
25 # hp < 50 (19 # kW < 37)	2013+[d]	3.5[e]	5.6[e]	0.02	0.04[f]
50 # hp < 75 (37 # kW < 56)	2008-2012	–[a]	–[a]	0.22	0.30
50 # hp < 75 (37 # kW < 56)	2013+	–[a]	–[a]	0.02	0.04[f]
75 # hp < 175 (56 # kW <130)	2012-2013[g]	0.30	3.3 for hp < 100 2.8 for hp $ 100	0.01	0.03[f]
75 # hp < 175 (56 # kW <130)	2014+	0.30	0.60[f]	0.01	0.03[f]
175 # hp # 750 (130 # kW # 560)	2011-2013	0.30	2.8	0.01	0.03[f]
175 # hp # 750 (130 # kW # 560)	2014+	0.30	0.60[f]	0.01	0.03[f]
hp > 750 (kW >560)	2011-2013	0.30	4.6	0.01	0.15
hp > 750 (kW >560)	2014+	0.30	0.60[f]	0.01	0.03[f]

Notes:

[a] The existing NMHC+NOx standard and FEL cap apply (see CFR Title 40, section 89.112).

[b] A PM standard of 0.45 g/bhp-hr would apply to air-cooled, hand-startable, direct injection engines less than 11 horsepower, effective in 2010.

[c] The proposed FEL caps do not apply if the manufacturer elects to comply with the optional standards. The existing FEL caps continue to apply.

[d] FEL caps apply in model year 2012 if the manufacturer elects to comply with the optional standards.

[e] These are a combined NMHC+NOx standard and FEL cap.

[f] A small number of engines are allowed to exceed these FEL caps.

[g] This period would extend through the first nine months of 2014 under the alternative, reduced phase-in requirement.

As noted above, EPA is proposing to allow a limited number of engines to have a higher FEL than the caps noted in Table VII.A-1 in certain instances. Table VII.A-2 presents the model years, percent of engines, and higher FEL caps that would apply under this allowance. Because the engines certified with the higher FEL caps are certified to the Tier 4 standards (albeit through the use of credits), they would be considered Tier 4 engines and all other requirements for Tier 4 engines would also apply, including the Tier 4 NMHC standard. EPA invites comment on whether additional provisions may be necessary for the limited number of engines certified to the higher FELs, including whether an averaging program for NMHC would be needed.

TABLE VII.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	NOx FEL Cap (g/bhp-hr)	PM FEL Cap (g/bhp-hr)
25 # hp < 75 (19 # kW < 56)	2013-2016	10%	Not applicable	0.22
	2017+	5%		
75 # hp < 175 (56 # kW <130)	2012-2013[a]	10%	Not applicable	0.30 for hp <100 0.22 for hp $100
	2014-2015	10%	3.3 for hp <100 2.8 for hp $100	
	2016+	5%		
175 # hp # 750 (130 # kW # 560)	2011-2013	10%	Not applicable	0.15
	2014	10%	2.8	
	2015+	5%		
hp > 750 (kW >560)	2014-2017	10%	4.6	0.15
	2018+	5%		

Notes:
[a] This period would extend through the first nine months of 2014 under the alternative, reduced phase-in requirement.

EPA requests comment on the proposed provisions to allow higher FELs on a limited number of Tier 4 engines, including whether the proposed allowance limits of 10 percent and 5 percent have been set at the right levels and whether the allowance to use a higher FEL cap is appropriate for the Tier 4 program. EPA also requests comment on allowing manufacturers to use the allowances in a slightly different manner over the first four years. Instead of allowing manufacturers to certify up to ten percent for each of the first four years, manufacturers could certify up to 40 percent of one year's production but spread it out over four years in an unequal manner (e.g., 15 percent in the first and second years, and 5 percent in the third and fourth years). Last of all, EPA requests comment on whether the allowance should be available for NOx during the years EPA a proposing a phase-in for the Tier 4 NOx standards. As proposed, EPA would not cover NOx during the phase-in years because manufacturers already can certify up to 50 percent of their engines to the Tier 3 NMHC+NOx standards.

Under the proposed Tier 4 program, for engines above 75 horsepower there will be two different groups of engines during the phase-in period. In one group, engines would certify to the applicable Tier 3 NMHC+NOx standard (or Tier 2 standard for engines above 750 horsepower), and would be subject to the ABT restrictions and allowances previously established for those tiers. In the other group, engines would certify to the 0.30 g/bhp-hr NOx standard, and would be subject to the restrictions and allowances in this proposed program. While engines in each group are certified to different standards, EPA is proposing to allow manufacturers to transfer credits across these two groups of engines with the following adjustment. As proposed, manufacturers could use credits generated during the phase-out of engines subject to the Tier 3 NMHC+NOx standard (or Tier 2 NMHC+NOx standard for engines above 750 horsepower) to average with engines subject to the 0.30 g/bhp-hr NOx standard, but these credits will be subject to a 20 percent discount. In other words, each gram of NMHC+NOx credits from the phase-out engines would be worth 0.8 grams of NOx credits in the new ABT program. (The 20 percent discount would also apply to NMHC+NOx credits generated on less than 75 horsepower engines and used for averaging purposes with the NOx standards for engines greater than 75 horsepower.)

EPA is proposing to allow engine manufacturers to demonstrate compliance with the NOx phase in requirements for engines above 75 horsepower and the PM phase in requirements for engines above 750 horsepower by certifying “split” engine families (i.e., an engine family that is split into two equal-sized subfamilies, one that generates a number of credits and one that uses an equal number of credits). In order to facilitate compliance with the proposed standards, EPA is proposing that this option be available to all engine manufacturers (i.e., both foreign and domestic manufacturers). Manufacturers would be allowed to certify split engine families with FELs no higher than the levels specified in Table VII.A-3. Manufacturers certifying split engine families would exclude those engines from end of the year ABT calculations (and therefore would not need to determine actual U.S. sales of such engine families for ABT credit calculation purposes). Manufacturers certifying split engine families would also exclude those engines from the calculations demonstrating compliance with the phase-in percentage requirements as well.

TABLE VII.A-3 -- MAXIMUM FEL FOR ENGINE FAMILIES CERTIFIED AS "SPLIT" ENGINE FAMILIES

Power Category	Pollutant	Maximum FEL, g/bhp-hr
75 # hp > 175 (56 # kW < 130)	NOx	1.7[a]
175 # hp # 750 (130 # kW < 560)	NOx	1.5
hp > 750 (kW > 560)	NOx	2.3
hp > 750 (kW > 560)	PM	0.08

Notes:
[a] A limit of 2.5 g/bhp-hr would apply under the alternative, reduced phase-in requirement.

For the proposed Tier 4 standards EPA is proposing that manufacturers may only use credits generated from other Tier 4 engines or from engines certified to the previous 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).

Manufacturers that choose to demonstrate compliance with the proposed phase-in requirements (i.e., 50 percent in 2012 and 2013 and 100 percent in 2014) would be allowed to use Tier 2 NMHC+NOx credits generated by engines above 50 horsepower (along with any other allowable credits) to demonstrate compliance with the Tier 4 standards for engines between 75 and 175 horsepower during model years 2012, 2013 and 2014 only. Manufacturers that choose to demonstrate compliance with the optional reduced phase-in requirement for engines between 75 and 175 horsepower, would not be allowed to use Tier 2 credits generated by engines above 50 horsepower to demonstrate compliance with the Tier 4 standards. In addition, manufacturers choosing the reduced phase-in option would not be allowed to generate NOx credits from engines in this power category in 2012, 2013, and the first 9 months 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 would be permitted). This restriction would apply throughout this period even if the reduced phase-in option is exercised during only a portion of this period.

Under this proposal, EPA is not proposing any averaging set restrictions for Tier 4 engines.

EPA is also proposing a separate PM standard for air-cooled, hand-startable, direct injection engines less than 11 horsepower. In order to avoid potential abuse of this standard, engines certified under this proposed requirement would not be allowed to generate credits as part of the ABT program. Credit use by these engines would be allowed.

Under this proposal, EPA is not proposing the restriction that prohibits 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, EPA does not believe there is the potential for manufacturers to generate significant credits from their currently certified engines against the proposed Tier 4 standards.

EPA is not proposing to apply a specific discount to Tier 3 PM credits used to demonstrate compliance with the Tier 4 standards. EPA believes 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 probably higher than measured in the Tier 2 test procedure).

B. Retrofit Credits

EPA is considering expanding the scope of the standards by setting voluntary new engine standards applicable to the retrofit of nonroad diesel engines, and allowing these nonroad diesel engines to generate PM and NOx credits available for use by other nonroad diesel engines. Specifically, EPA would allow existing in-use nonroad diesel engines that are retrofitted to achieve more stringent levels of emissions than are otherwise required to generate credits available for use in the ABT program by new nonroad engines. Credit-generating engines electing to participate in the program would be considered new nonroad diesel engines, subject to the normal compliance mechanisms applicable to other new nonroad diesel engines. These new nonroad engines could generate credits that could be used in the ABT program for other new nonroad diesel engines. **Any such program would also have to ensure that credits are surplus, verifiable, quantifiable, and enforceable.** EPA requests comment on whether such a program would be feasible and appropriate for the Tier 4 nonroad standards, and on how such a program might be structured.

EPA is considering an approach for credit generation based on the use of advanced exhaust emission control technology/engine system combinations that would provide significant emissions reductions. To accomplish this, simple changes that are easy to circumvent accidentally or to defeat intentionally would not be eligible to generate credits, and essentially, only changes involving introduction of post combustion emissions control technology would be eligible. Also, as noted, for purposes of a nonroad retrofit ABT program, in order to generate credits, the manufacturer of the nonroad retrofit engine system choosing to participate in the program would accept that the retrofit engine would be considered a new nonroad engine, subject to enforceable standards and normal certification and compliance requirements. EPA has outlined in a memorandum to the docket it's ideas for meeting these objectives, including possible ways to structure the program.[23] This memorandum describes potential procedures for credit generation, credit use, and a number of compliance, implementation, and enforcement measures.

EPA is seeking comment on whether such an expansion of the ABT program is feasible and appropriate, as well as on the details of how a program could be structured. The level of detail provided below and in the memorandum to the docket does not indicate that EPA has made any

[23] Memorandum to the Docket, Chris Lieske and Joseph McDonald, EPA, Additional Information on Nonroad Retrofit Engine ABT Credit Concepts, Docket A-2001-28.

decisions on whether nonroad retrofit credits are appropriate for the ABT program or about how the program should function. EPA invites comment not only on the provisions described below and in the memorandum to the docket, but also on alternative approaches that commenters believe would lead to a better overall program.

EPA is also seeking comment on the timing of a retrofit credits approach. EPA believes that if such a program were adopted, credit generation could start in 2004 at the earliest, and request comment on ending the program in the 2015 time frame. EPA view this as primarily a transitional program that could be most useful in the early years of the nonroad program. Ending the program in 2015 may also ease concerns about long-term impact of such a program on the environment.

EPA encourage commenters to carefully address all aspects of a nonroad retrofit credits program including its usefulness, feasibility, compliance and enforcement measures, environmental benefits, and potential cost savings. EPA specifically request comment on the potential for such a program to provide additional emissions reductions than would otherwise be obtained and request comment on the potential impacts such provisions would have on emissions reductions associated with the proposed nonroad standards. EPA is also interested in comments on practical issues and details regarding how the program would operate and be enforced.

i. The environmental impact of allowing retrofit credits?

EPA would structure any nonroad credit ABT program in a way that provides greater overall emissions reductions over the life of the group of nonroad engines involved than would otherwise be achieved. These additional overall reductions would be achieved by applying a discount of 20 percent to ABT retrofit credits that are used to meet nonroad standards. The result of applying a discount would be that each ABT retrofit credit generated would translate to less than one nonroad engine credit available for consumption in the nonroad program.

EPA requests comment on whether a discount of 20 percent would be appropriate given the expectation that the discount will generate cost-effective emissions reductions that would otherwise not occur, as well as the more prevalent uncertainties associated with trading credits between nonroad retrofits and new nonroad engines.

ii. Compliance assurance

If this program were adopted, EPA would expect to require the retrofit manufacturer to specify all emissions related maintenance and to list the type of fuel used to certify its retrofit-engine system and whether a particular fuel sulfur level is necessary to meet the standard and to maintain emissions compliance of the retrofit-engine system in-use. If such a fuel is necessary to maintain emissions compliance in-use, EPA would also consider the fuel to be “critical emission related scheduled maintenance” under a retrofit engine program. As a result of such classification, the manufacturer would be required to demonstrate that proper fueling will be performed in-use. Such a demonstration would include a showing that the required fuel is available to, and would be used by, the ultimate consumer or fleet operator receiving the retrofitted engines. Such retrofitted engines would also have to be labeled appropriately to reflect the new engine family and may also require labeling for the type of fuel to be used. In general, EPA would require the manufacturer to submit a plan for implementing all relevant aspects of the retrofit to ensure proper installation and emissions compliance throughout the useful life period EPA requests comment on these approaches for ensuring in-use compliance with possible nonroad retrofit emissions standards and requirements.

iii. Legal authority

Allowing use by new nonroad engines of credits generated by retrofit of in-use nonroad engines is justified legally as an aspect of EPA's standard setting authority. As EPA envisions a program, a retrofit nonroad engine would be considered to be a new nonroad engine when the manufacturer opts into a voluntary retrofit program (if established). Upon such opt-in, this new engine would be subject to enforceable standards under CAA section 213, somewhat similar to opting into the voluntary Blue Sky series standards. Thus, the generation of credits by nonroad retrofits and their use by new engines subject to Tier 4 would be similar to conventional ABT. Put another way, the generation of credits by retrofitting in-use non-road engines and their subsequent use by new nonroad engines subject to the Tier 4 standards is an averaging program involving emission credits generated by one type of new nonroad engine and used by other new nonroad engines, similar to conventional ABT programs. With a nonroad retrofit credit program, and the emissions reductions associated with it, the overall emission reductions from Tier 4 nonroad engines and nonroad retrofit engines, taken together, would be the greatest achievable considering cost, noise, safety and energy factors, and would also be appropriate after considering those same factors.

C. Encouraging Innovative Technologies

i. Incentive Program for Early or Very Low Emission Engines

EPA is proposing that manufacturers be permitted to take credit for engines certified to this rule's proposed standards prior to the 2011 model year in exchange for making fewer engines certified to these standards in or after the 2011 model year. In other words, a clean engine sold earlier than required reduces the requirement to sell similar engines later. The emission standards levels must actually be met by qualifying engines to earn the early introduction credit, without use of ABT credits. Therefore, the early introduction engine credit is an alternative to the ABT program in that any early engines or vehicles can earn either the engine credit or the ABT emission credit, but not both. The purpose of the incentive is to encourage introduction of clean technology engines earlier than required in exchange for added flexibility during the phase-in years.

Any early engine credits earned for a diesel-fueled engine would be predicated on the assurance by the manufacturer that the engine would indeed be fueled with low sulfur diesel fuel in the marketplace. EPA expects this would occur through selling such engines into fleet applications, such as municipal maintenance fleets, large construction company fleets, or any such well-managed centrally fueled fleet. Because obtaining a reliable supply of 15 ppm maximum sulfur diesel fuel prior to the 2011 model year will require some effort by nonroad diesel machine operators, EPA believes it is necessary and appropriate to provide a greater incentive for early introduction of clean diesel technology. Therefore, EPA proposes to count one early diesel engine as 1.5 diesel engines later. This extra early credit for diesel engines means that fewer clean diesel engines than otherwise would be required may enter the market during the years 2011 and later. But it means that emission reductions would be realized earlier than under the base program.

EPA is proposing to provide this early introduction credit to diesel engines at or above 25 hp that meet all of EPA's Tier 4 emissions standards (NOx, PM, and NMHC) in the applicable power category. EPA is also providing this early introduction credit to diesel engines that pull-ahead compliance with only the PM standard. However, a PM-only early engine would offset only the "phase-out" engines during the phase-in years (those required to meet the Tier 4 standard for PM but not for NOx or NMHC); it would not offset engines required to meet the Tier 4 NOx, NMHC, and PM standards. Tier 4 engines certified to, or required to meet, the 2008 PM standard would not participate in this program, either as credit generators or as credit users.

An important aspect of the early incentive provision is that it must be done on an engine count basis. That is, a diesel engine meeting new standards early would count as 1.5 such diesel engines later. This contrasts with a provision done on an engine percentage basis, which would count one percent of diesel engines early as 1.5 percent of diesel engines later. Basing the incentive on an engine count would alleviate any possible influence of fluctuations in engine sales in different model years.

Another important aspect of this proposed program is that it would be limited to engines sold prior to the 2011 model year for engines at or above 175 hp, prior to the 2012 model year for engines between 75 and 175 hp, or prior to the 2013 model year for engines between 25 and 75 hp. In other words, as in the highway program, nonroad diesel engines sold during the transitional "phase-in" model years would not be considered "early" introduction engines and would therefore receive no early introduction credit. However, such engines and vehicles would still be able to generate ABT credits. As with the phase-in itself, and for the same reasons, EPA is proposing that an early introduction credit could only be used to offset requirements for engines in the same power category as the credit-generating engine.

As a further incentive to introduce clean engines and vehicles early, EPA is also proposing a provision that would give manufacturers an early introduction credit equal to two engines during or after the phase-in years. This "Blue Sky" incentive would apply for diesel engines achieving standards levels at one-half of the proposed long-term NOx standard while also meeting the NMHC and PM standards. Due to the extremely low emission levels to which these Blue Sky series engines and vehicles would need to certify, EPA believes that the double engine count credit is appropriate. Table VII.E-1 shows the emission levels that would be required for diesel engines to earn any early introduction credits (other than ABT credits).

TABLE VII.E-1 – PROPOSED PROGRAM FOR EARLY INTRODUCTION OF CLEAN ENGINES AT OR ABOVE 25 HP		
Category	Must Meet a	Per Engine Credit
Early PM-only [b]	0.01 g/bhp-hr PM ($ 75 hp) or 0.02 g/bhp-hr PM (< 75 hp)	1.5-to-1 PM-only
Early Engine [b]	above-indicated PM standard + 0.30 / 0.14 g/bhp-hr NOx / NMHC ($ 75 hp) or 3.5 g/bhp-hr NMHC + NOx (< 75 hp)	1.5-to-1
Blue Sky Series Engine	as above for Early Engine, except must meet 0.15 g/bhp-hr NOx standard	2-to-1

Notes:
[a] Engines in all 3 categories must also meet the Tier 4 crankcase emissions requirements.
[b] Engine count credits must be earned prior to the start of phase-in requirements in applicable power categories (prior to 2103 for 25-75 hp engines).

EPA welcomes comment on these proposed provisions, as well as other ideas for encouraging the introduction of Tier 4 engines early, or of engines cleaner than Tier 4 levels. One area EPA especially seeks comment on is whether or not engines below 25 hp that achieve the proposed long-term Tier 4 PM standard for 25-75 hp engines of 0.02 g/bhp-hr, or engines below 75 hp that achieve the proposed long-term Tier 4 NOx standard for >75 hp engines of 0.30 g/bhp-hr, should gain credits under this program that could be used to offset requirements for larger engines, as a means of encouraging the migration of clean technologies to smaller engines.

ii. Continuance of the Existing Blue Sky Program

EPA is asking for comment on extending or revising the existing Blue Sky Series engine program. EPA believes that the levels set for the existing Blue Sky program are not stringent enough to warrant their continuance into the Tier 4 years, but EPA also notes that the lack of a transient certification test in Tier 3 may make continuance of this program beyond 2004, perhaps through Tier 3 (and Tier 2 for engines under 50 hp), useful. EPA welcomes comment on this, as well as on any experience with the program thus far, plans to use it in the future, whether the standards and test cycle should be changed and, if so, beginning in what model year.

7. Appendix C: Vehicle and Engine Compliance Program

A. Not-To-Exceed Requirements

EPA has proposed to adopt not-to-exceed (NTE) emission standards for new non-road diesel engines that are similar to those the Agency set for highway heavy-duty diesel engines. For new nonroad diesel engines, EPA proposes that manufacturers state in their application for certification that they are able to meet the NTE standards under all conditions that may reasonably be expected to occur in normal equipment operation and use. Manufacturers will have to maintain a detailed description of any testing, engineering analysis, and other information that forms the basis for their statement. This information may include a variety of steady-state emission measurements not included in the prescribed emission testing duty cycles. It may also include a continuous trace showing how emissions vary during the transient test or operation manufacturers believe are representative of the way their engines normally operate in the field. This data may also consist of field testing data. Any of the aforementioned data may be analyzed using the NTE data reduction procedures proposed in this regulation; with the final emissions data set then compared to the appropriate NTE standards.

EPA requests comment on an alternative NTE specification that differs from the highway NTE specification. If adopted, this would be the sole NTE test procedure for Tier 4 nonroad diesel engines. The alternative utilizes all engine operation to determine compliance. Other differences in its data reduction procedures would eliminate the need for measuring engine torque for the alternative NTE, which can be particularly difficult on-board nonroad vehicles. These alternative procedures would also eliminate the need for an absolute exhaust flow measurement for these engines by relying on a signal linearly proportional to standard exhaust flow. This alternative approach would address some concerns of the ease of practical in-use implementation of NTE testing.

B. Certification Fuel

It is well-established that measured emissions may be affected by the properties of the fuel used during the test. For this reason, EPA has historically specified allowable ranges for test fuel properties such as cetane and sulfur content. These specifications are intended to represent most typical fuels that are commercially available in use. This helps to ensure that the emissions reductions expected from the standards occur in use as well as during emissions testing. Because EPA is proposing to lower the upper limit for in-use nonroad diesel fuel sulfur content to 500 ppm in 2007, and again to 15 ppm in 2010, EPA is also proposing to establish new ranges of allowable sulfur content for testing. These are proposed to be 300 to 500 ppm (by weight) for model year 2008 to 2010 engines, and 7 to 15 ppm (by weight) for 2011 and later model year engines. EPA believes that these ranges best correspond to the fuels that diesel machines will potentially see in use. These specifications will apply to emission testing conducted for certification, selective enforcement audits, in-use, and NTE testing, as well as any other laboratory engine testing for compliance purposes for engines in the designated model years. Any compliance testing of previous model year engines will be done with the fuels designated in the regulations for those model years.

EPA is also proposing two options for early use of the new 7 to 15 ppm diesel test fuel. The first would be available beginning in the 2007 model year for engines employing sulfur-sensitive technology. This allowance to use the new fuel in model years before 2011 would only be available for engines which the manufacturer demonstrates will be operated in use on fuel with 15 ppm sulfur or less. Any testing that EPA performs on these engines would also use fuel meeting this lower sulfur specification. This optional certification fuel provision is intended to encourage the introduction of low-emission diesel technologies in the nonroad sector. These engines will be able to use the lower sulfur fuel throughout their operating life, given the early availability of this fuel under the highway program, and the assured availability of this fuel for nonroad engines by mid-2010.

Considering that EPA's proposed Tier 4 program would subject engines under 75 hp to new emission standards in 2008 when 15 ppm maximum sulfur fuel will be readily available from highway fuel pumps (and will enter the nonroad fuel market shortly after in 2010), EPA believes it is appropriate to provide a second, less proscriptive, option for use of 15 ppm sulfur certification fuel. This option would be available to any manufacturers willing to take extra steps to encourage the use of this fuel before it is required in the field. EPA is proposing to allow the early use of 15 ppm certification fuel for 2008-2010 engines under 75 hp, provided the certifying manufacturer ensures that ultimate purchasers of equipment using these engines are informed that the use of fuel meeting the 15 ppm specification is recommended, and also recommends to equipment manufacturers buying these engines that labels be applied at the fuel inlet to remind users of this recommendation. This option would not apply to those 50-75 hp engines not being certified to the 0.22 g/bhp-hr PM standard, under the manufacturers' option discussed earlier. Comment is requested on whether or not application of this label should be mandatory for the equipment manufacturers, and on whether the engine manufacturers should supply the labels.

EPA believes that there may be a very small loss of emissions benefit from any of these engines for which the operator chooses to ignore the recommendation. This is because the engine manufacturer will be designing the engine to comply with the emissions standards when tested using 15-ppm fuel, potentially resulting in slightly higher emissions when it is not operated on the 15-ppm fuel. EPA also believe, however, that this is more than offset overall by the encouragement this provision provides for early use of 15 ppm fuel. EPA is not proposing that this option be available for engine designs employing oxidation catalysts or other sulfur-sensitive exhaust emission control devices except under the more restrictive provision for early use of 15 ppm fuel described above, involving a demonstration by the manufacturer that the fuel will indeed be used. Because these devices could potentially have very high sulfur-to-sulfate conversion rates, and because very high-sulfur fuels will still be available to some extent, EPA believes that allowing this provision for these engines would risk very high PM emissions until the 15-ppm nonroad fuel is introduced. Comment is requested on whether or not EPA should deal with early use of 15-ppm test fuel to certify catalyst-equipped engines in some other way, such as through a weighted-average emissions criterion using results from testing on both higher- and lower-sulfur fuels. EPA is also not proposing to make this second early 15 ppm test fuel option available for engines not subject to a new Tier 4 standard in 2008 as these engines should already be designed to meet applicable standards in earlier years without need for the 15 ppm fuel.

EPA is also proposing a similar provision for use of certification fuel meeting the proposed 300-500 ppm sulfur specification before the 2008 model year. EPA believes certification of model year 2006 and 2007 engines being designed to meet new Tier 2 or Tier 3 emission standards taking effect in those years (2006 for engines at or above 175 hp and 2007 for 100-175 hp engines) should be able to use this fuel, provided the certifying manufacturer is willing to take measures equivalent to those discussed above to encourage the early use of this fuel (a recommendation to the ultimate purchaser to use fuel with 500 ppm maximum sulfur and a recommendation to equipment manufacturers to so label their equipment). EPA also requests comment as above on whether the labeling should be mandatory. The widespread availability of 500 ppm sulfur highway fuel, the short time that these 2006 and 2007 engines could use higher sulfur fuels if an operator were to ignore the recommendation, and the eventual use of 15 ppm sulfur fuel in most of these engines for most of their operating lives, gives EPA confidence that this provision to encourage early use of lower sulfur fuel would be beneficial to the environment overall. As with the proposed change to 300-500 ppm cert fuel for model years 2008-2010, engine manufacturers would design their engines to comply based on the test fuel specifications for certification and compliance testing. The change from a fuel specification for compliance testing that ranges up to 2000 ppm sulfur for Tier 2 and 3 engines to a specification of 500 ppm sulfur maximum could have some limited effect on the emissions control designs used on these Tier 2 and 3 engines, in that it would be slightly easier to meet the Tier 2 and 3 standards using the lower sulfur test fuel. In general, it is reasonable to set specifications of test fuel reflecting representative in-use fuels, and here the engines are expected to be using fuel with sulfur levels of 500 ppm or lower until 2010, and 15 ppm or lower after that. In this case, any impact on expected engine emissions from this change in test fuel for Tier 2 and 3 is expected to be slight.

EPA note that under current regulations manufacturers are already allowed to conduct testing with certification fuel sulfur levels as low as 300 ppm. The additional proposed provision for early use of 300-500 ppm sulfur test fuel would, however, result in any compliance testing conducted by the Agency being done with fuel meeting the 300-500 ppm specification. Likewise choice of the option for early use of 15-ppm sulfur test fuel would result in any Agency testing being done using that fuel. However, under both of these early certification fuel options involving a recommended fuel use provision, the Agency would not reject engines from in-use testing for which there was evidence or suspicion that the engine had been fueled at some time with higher sulfur fuel.

Finally, EPA is proposing to extend a provision adopted in the 1998 final rule. In that rule EPA set a 2000 ppm upper limit on the test fuel sulfur concentration for any testing to be performed by the Agency on Tier 1 engines under 50 hp and Tier 2 engines at or above 50 hp. EPA did not extend this provision to later model year engines at that time because EPA felt that more time was needed to assess trends in fuel sulfur levels for fuels used in nonroad diesels. At this time EPA is not aware of any additional information that would indicate that a change in this test specification is warranted. More importantly, because the fuel regulation EPA is proposing would make 500 ppm maximum sulfur nonroad diesel fuel available by mid-2007, Tier 3 engines at or above 50 hp (which phase in beginning in 2006) will be in the field for only 1½ years prior to the in-use introduction of 500 ppm fuel, and Tier 2 engines under 50 hp (which phase in beginning in 2004) will be in the field for at most 3½ years prior to this time. EPA believes it is appropriate to avoid adding the unnecessary complication of frequent multiple changes to the test fuel specification. EPA is therefore proposing to extend the 2000 ppm limit to testing conducted on engines until the 2008 model year when the 500 ppm maximum test fuel sulfur level takes effect as discussed above.

C. Labeling and Notification Requirements

EPA is proposing that manufacturers notify each purchaser that the nonroad engine must be fueled only with the applicable low-sulfur diesel fuel, and ensure that the equipment is labeled near the refueling inlet to indicate that low sulfur fuel is required. EPA believes that these measures would help owners find and use the correct fuel and would be sufficient to address misfueling concerns. Thus, more costly provisions, such as fuel inlet restrictors, should not be necessary.

D. Temporary In-Use Compliance Margins

EPA believes that for a limited number of model years after new standards take effect it is appropriate to adjust the compliance levels for assessing in-use compliance for diesel engines equipped with particulate traps or NOx adsorbers. This would provide assurance to the manufacturers that they will not face recall if they exceed standards by a small amount during this transition to clean technologies. This approach is very similar to that taken in the light-duty highway Tier 2 final rule and the highway heavy-duty rule, both of which involve similar approaches to introducing the new technologies.

Table VII.J-1 shows the in-use adjustments that EPA proposes to apply. These adjustments would be added to the appropriate FELs or, for engines certified to the standards without the use of credits, to the standards themselves, in determining the in-use compliance level for a given in-use hours accumulation. These adjustment levels were chosen to be roughly equivalent to the temporary in-use standard adjustments adopted for the heavy-duty highway program. Note also the limiting of these adjustments to engines certified to FELs below certain threshold levels. This is similar to the approach taken in the heavy-duty rule, which applied the in-use standards only to vehicles using advanced low-emission technologies. EPA’s intent is that these add-on levels be available only for highly effective advanced technologies such as particulate traps and NOx adsorbers. As in EPA’s other mobile source programs, EPA does not believe that the standards are stringent enough or the required technology change radical enough to warrant add-ons for other proposed standards changes (the NOx standard for 25-75 hp engines, the 2008 PM standards for engines below 75 hp, or the NMHC standards).

TABLE VII.J-1 – ADD-ON LEVELS USED IN DETERMINING IN-USE STANDARDS

Engine power	Model years	NOx Add-on Level to FEL[a] (g/bhp-hr)	PM Add-on Level to FEL[b] (g/bhp-hr)
25 # hp < 75 (19 # kW < 56)	2013-2014	none	
75 # hp < 175 (56 # kW < 130)	2012-2015	0.10 for operating hours # 4000 0.20 for operating hours > 4000	0.01
hp $ 175 (kW $ 130)	2011-2015	0.10 for operating hours # 4000 0.20 for operating hours > 4000	

Notes:
[a] Applicable only to those engines with FELs at or below 1.5 g/bhp-hr NOx.
[b] Applicable only to those engines with FELs at or below the Tier 4 PM standard.

Note that these in-use add-on levels apply only to engines certified through the first few model years of the new standards and having FELs below the specified levels. The in-use add-ons are available through model year 2015 for such engines above 75 hp because the proposed implementation schedule does not complete the phase-in process in these power categories until 2014. The 2015 date provides 2 years for the designers of those engine models that are last to be phased in (which may comprise upwards of 50% of sales and a large number of low-volume engine models) to discover and resolve any problems not showing up in the certification process or developmental testing.[24] This is the same period as that provided in the highway HDDE rule.

During the certification demonstration, manufacturers will still be required to demonstrate compliance with the unadjusted Tier 4 certification standards using deteriorated emission rates. Therefore, the manufacturer will not be able to use these in-use standards as the design targets for the engine. They will need to project that most engines would meet the standards in-use without adjustment. The in-use adjustments will merely provide some assurance that they would not be forced to recall engines because of some small miscalculation of the expected deterioration rates.

E. Monitoring and Reporting of Emissions Related Defects

EPA is proposing to apply the defect reporting requirements of §1068.501 to replace the provisions of 40 CFR part 85 for nonroad engines. The requirements obligate manufacturers to

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[24] Flexibility provisions such as the ABT program and the incentive program for early or very low emission engines may result in some engines that incorporate the advanced emission control technologies even later. However, EPA does not believe it is appropriate to adjust the in-use compliance levels for engines on which achieving the standard is delayed by manufacturer's choice, nor did EPA do so in the highway HDDE program.

tell EPA when they learn that emission control systems are defective and to conduct investigations under certain circumstances to determine if an emission-related defect is present. EPA is also proposing a requirement that manufacturers initiate these investigations when warranty information, parts shipments, and any other information which is available indicates that a defect investigation may be fruitful. For this purpose, EPA considers defective any part or system that does not function as originally designed for the regulatory useful life of the engine or the scheduled replacement interval specified in the manufacturer's maintenance instructions.

EPA is requesting comment on this approach, especially with respect to the thresholds. Should EPA adopt slightly higher thresholds for nonroad engines given their relatively small engine family sizes? Should EPA focus the defect reporting requirements more on aftertreatment defects since such defects will generally have more significant impacts than other defects? EPA is also requesting comment on whether these reporting requirements should also apply to the current Tier 2/Tier 3 compliance program, and if so, when these provisions should be applied.

F. Rated Power

EPA is proposing to add a definition of "maximum engine power" to the regulations. This term would be used instead of previously undefined terms such as "rated power" or "power rating" to specify the applicability of the standards. The addition of this definition is intended to allow for more objective applicability of the standards. More specifically, EPA is proposing that:

<u>Maximum engine power</u> means the measured maximum brake power output of an engine. The maximum engine power of an engine configuration is the average maximum engine power of the engines within the configuration. The maximum engine power of an engine family is the highest maximum engine power of the engines within the family.

Currently, since rated power and power rating are undefined, the engine manufacturer determines them. This makes the applicability of the standards too subjective and confusing. One manufacturer may choose to define rated power as the maximum measured power output, while another may define it as the maximum measured power at a specific engine speed. Using this second approach, an engine's rated power may be somewhat less than the true maximum power output of the engine. Given the importance of engine power in defining which standards an engine must meet and when, EPA believes that it is critical that a singular power value be determined objectively according to a specific regulatory definition.

EPA is also adding a clarification to the regulations recognizing that actual engine power will vary to some degree during production. The proposed regulations would require manufacturers to specify a range of actual maximum engine power for each engine configuration. As noted above, EPA would base the applicability of the standards on the average maximum power of the engines.

G. Hydrocarbon Measurement and Definition

Both the existing standards and the proposed Tier 4 standards apply to nonmethane hydrocarbons, rather than total hydrocarbons. Methane emissions generally are considered to be nonreactive with respect to ozone, and are not regulated under part 89. However, excluding methane requires that it be separately measured, which complicates the measurement procedures. While EPA is not proposing to change the standards to total hydrocarbons EPA is requesting comment on the need to measure methane and the appropriateness of excluding it from the standards.

H. Auxiliary Emission Control Devices and Defeat Devices

Existing nonroad regulations prohibit the use of a defeat device in nonroad diesel engines. The defeat device prohibition is intended to ensure that engine manufacturers do not use auxiliary emission control devices (AECD) that sense engine operation in a regulatory test procedure and as a result reduce the emission control effectiveness[25] of that procedure. In EPA's notice EPA is proposing to supplement existing nonroad test procedures with a transient engine test cycle and NTE emission standards with associated test requirements. As such, the Agency believes that a clarification of the existing nonroad diesel engine regulations regarding defeat devices is required in light of these proposed additional emission test requirements. The defeat device prohibition makes it clear that AECDs that reduce the effectiveness of the emission control system are defeat devices, unless one of several conditions is met. One of these conditions is that an AECD that operates under conditions "included in the test procedure"[26] is not a defeat device. While the existing defeat device definition does contain the term "test procedure", and therefore should be interpreted as including the supplemental testing requirements, EPA want to make it clear that both the supplemental transient test cycle and NTE emission test procedures are included within the defeat device regulations as conditions under which an operational AECD will not be considered a defeat device. Therefore, EPA is proposing to clarify the defeat device regulations by specifying the appropriate test procedures (i.e., the existing steady-state procedures and the supplemental tests).

EPA is also proposing today to provide clarification regarding the engine manufacturers certification reporting requirements with respect to the description of AECDs. The proposed clarification will aid engine manufacturers in preparing a complete application for certification that will allow EPA to review the application in a timely manner. Under the existing nonroad engine regulations, manufacturers are required to provide a generalized description of how the emissions control system operates and a "detailed" description of each AECD installed on the engine. This proposal is intended to clarify what is meant by "detailed."

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[25] Auxiliary emission control device is defined at 40 CFR 89.2 as " any element of design that senses temperature, vehicle speed, engine RPM, transmission gear, or any other parameter for the purpose of activating, modulating, delaying or deactivating the operation of any part of the emission control system."

[26] 40 CFR 89.107(b)(1) states "Defeat device includes any auxiliary emission control device (AECD) that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal operation and use unless such conditions are included in the test procedure."

Under the nonroad diesel Tier 1 standards there was limited use of AECDs. AECDs have begun to be much more common with the Tier 2 standards, and EPA expects this trend to continue. Engines designed to meet the significantly more stringent Tier 4 standards will certainly rely on sophisticated technologies that will likely employ very complex AECDs. EPA has seen a similar trend with highway heavy-duty diesel engines. In the late 1980's, few highway HDDEs had electronic controls and most manufacturers relied on in-cylinder techniques to control emissions. However, with the application of technologies such as electronically controlled fuel systems, electronically controlled EGR systems, and variable geometry turbochargers, highway HDDEs now have numerous AECDs which are used both for performance as well as emissions control.

A thorough disclosure of the presence and purpose of AECDs is essential in allowing EPA to evaluate the AECD and determine whether it represents a defeat device. Clearly, any AECD that is not fully identified in the manufacturer's application for certification cannot be appropriately evaluated by EPA and therefore cannot be determined to be acceptable by EPA. The proposed clarifications to the certification application requirements include additional detail specific to those AECDs which the manufacturer believes are necessary to protect the engine or the equipment in which it is installed against damage or accident ("engine protection" AECDs). While the definition of a defeat device allows as an exception strategies needed to protect the engine and equipment against damage or accident, EPA intend to continue the policy of closely reviewing the use of this exception. In evaluating whether a reduction in emissions control effectiveness is needed for engine protection, EPA will closely evaluate the actual technology employed on the engine family, as well as the use and availability of other emission control technologies across the industry, taking into consideration how widespread the use is, including its use in similar engines and similar equipment. While EPA has specified additional information related to engine protection AECDs in the proposed regulations, EPA reserves the right to request additional information on a case-by-case basis as necessary.

In the last several years, EPA has issued extensive guidance on the disclosure of AECDs for both highway and nonroad diesel engine manufactures.[27] This proposal does not impose any new certification burden on engine manufacturers; rather, it clarifies the existing certification application regulations by specifying what type of information manufacturers must submit regarding AECDs.

Finally, EPA take this opportunity to emphasize that the information submitted must be specific to each engine family. The practice of describing AECDs in a "common" section, wherein the strategies are described in general for all the manufacturer's engines, is acceptable as long as each engine family's application contains specific references to the AECDs in the common section which clearly indicate which AECDs are present on that engine family, and the application contains specific calibration information for that engine family's AECDs.

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[27] See EPA Dear Manufacturer Letter VPCD-98-13, "Heavy-duty Diesel Engines Controlled by Onboard Computers: Guidance on Reporting and Evaluating Auxiliary Emission Control Devices and the Defeat Device Prohibition of the Clean Air Act", October 15, 1998 and EPA Advisory Circular 24-3, "Implementation of Requirements Prohibiting Defeat Devices for On-Highway Heavy-Duty Diesel Engines." A copy of both of these documents is available in EPA Air Docket A-2001-28

EPA is requesting comment on whether these clarifications should also be applied to the current Tier 2/Tier 3 compliance program, and if so, when these provisions should be applied.

I. Other Issues

EPA is also proposing other minor changes to the compliance program for Tier 4 nonroad engines. For example, EPA is proposing that engine manufacturers be required to provide installation instructions to equipment manufacturers to ensure that engine cooling systems, aftertreatment exhaust emission controls, and related sensors are properly installed by the equipment manufacturer. Proper installation of these systems is critical to the emission performance of the equipment. Equipment manufacturers would be expected to follow the instructions to avoid improper installation that could render emission controls inoperative, and subject the equipment manufacturer to penalties for t violation of a prohibited act.

Under the existing regulations and the proposed new regulations, engine manufacturers are responsible for all emission-related components, both in terms of emission performance during certification and in-use testing, and emission-related warranties. This requires that engine manufacturers provide their engines with the necessary emission controls before selling them to equipment manufacturers. EPA is proposing to use the same approach as is used with highway engines, where the engine manufacturer is required to either install catalysts or traps before selling the engine to a vehicle manufacturer, or to ship the catalyst or trap with the engine, with appropriate installation instructions. EPA is requesting comment on whether this is appropriate for nonroad engines equipped with traps and other aftertreatment exhaust emission controls. EPA is concerned that allowing engine manufacturers to sell engines without traps included might lead to equipment being introduced into service without the emission controls properly installed. EPA is requesting comment on whether it is sufficient to require manufacturers to fully describe in their installation instructions all necessary emission control hardware, and whether the engine manufacturer should be held responsible for ensuring the aftertreatment is properly installed, including requiring some management by the engine manufacturers of the installation process, such as auditing the installations and reporting the results to EPA.

In §89.109, EPA limits the amount of maintenance that manufacturers can perform during service accumulation. EPA is proposing to continue these limits in the proposed new section§1039.125. However, EPA is not carrying over the provisions of §89.109(h)(2)(iii) and (iv) that are related to allowances for additional maintenance for engines equipped with onboard diagnostic systems that include visible warning lights. EPA believes that these provisions would be better addressed in a rulemaking addressing onboard diagnostic standards.

Both the existing regulations and the proposed regulations specify default criteria to define engine family groups, but allow exceptions for cases where other groups would more appropriately represent similar emission characteristics. The proposed regulations specify the same criteria as part 89, plus two new criteria. EPA is proposing that mechanically controlled engines and electronically controlled engines generally be certified in separate engine families. EPA is also proposing that engines in different power categories generally must be in separate engine families.

EPA is proposing to clarify the applicability of the nonroad CI standards to engines operating on alcohols and other oxygenated fuels. As part of this, EPA is proposing to add a requirement that compression-ignition alcohol-fueled engines be required to comply with the evaporative emission control requirements in 40 CFR 1048.105. That section allows manufacturers to comply with the requirement by incorporating simple emission controls. This requirement is not expected to have a significant impact on manufacturers since EPA is not aware of any alcohol-fueled nonroad engines currently in production. The proposed provision is merely intended to prevent new emission problem from occurring in the future.

EPA is proposing to change the way in which manufacturers specify deterioration factors (DFs) for Tier 4 trap-equipped engines. The current regulations specify that the DFs for engines with aftertreatment devices must be multiplicative. They must be expressed as a proportion of the engine's initial emission rate. Manufacturers have indicated in past discussions that, given the general operating mechanism of PM traps and the very low PM levels emitted, trap deterioration is not expected to depend on the initial emission rate, as increased emissions from deterioration that tend to be non-sulfate PM, and therefore not related to the initial emissions rate. Therefore, EPA is proposing to specify additive DFs for PM that account for a fixed amount of deterioration and are independent of the engine's initial emission rate.

EPA is proposing to extend to CI engines that operate on unrefined natural gas the same provisions EPA has adopted for similar SI engines. Such engines are sometimes used to operate pumps at oil fields where unrefined natural gas is a readily available and inexpensive fuel source. This provision would allow manufacturers greater flexibility with respect to engine adjustment to address variability in fuel properties.

In addition, EPA is proposing to require that manufacturers label uncertified engines that they import for stationary applications. Because these engines look the same as or very similar to regulated nonroad engines, it can be difficult to distinguish the two without labels. These labels will also help manufacturers and others who import these engines to avoid potential problems with customs inspections.

Another labeling issue relates to the primary emission control information label that engine manufacturers put on every certified engine they produce. The current regulations require equipment manufacturers to put a duplicate label on the equipment if the engine is installed in a way that obscures the label on the engine. EPA is proposing to clarify this requirement for duplicate labels to ensure that labels are accessible without creating a supply of duplicate labels that are not authentic and used appropriately. Specifically, EPA is proposing to require engine manufacturers to supply duplicate labels to equipment manufacturers that request them and keep records to show how many labels they supply. Similarly, EPA is proposing to require equipment manufacturers to request from engine manufacturers a specific number of duplicate labels, with a description of which engine and equipment models are involved and why the duplicate labels are necessary. Equipment manufacturers would need to destroy any excess labels and keep records to show the disposition of all the labels they receive. EPA requests comment on these provisions. In addition, EPA requests comment on an alternative approach to labeling equipment. If equipment manufacturers were required to add a label to each piece of equipment with basic information related to the engine's emission controls, the information would be most accessible in all situations. Such a label would need to at least identify the engine manufacturer, engine family and serial number, manufactured date, power rating, and any important engine specifications. This would make it easier for EPA to verify that engines are meeting requirements and it would be easier for U.S. Customs (Bureau of Customs and Border Protection) to clear imported equipment with certified engines. Note that some equipment manufacturers have already been voluntarily attaching such labels or plates to their equipment. EPA requests comment on a uniform requirement to apply labels to equipment using nonroad diesel engines to uniquely identify the installed engine.

EPA is also clarifying the general requirement that all engines subject to this final rule may not cause or contribute to an unreasonable risk to public health, welfare, or safety, especially with respect to noxious or toxic emissions that may increase as a result of emission-control technologies. The proposed regulatory language, which addresses the same general concept as the existing §89.106, implements sections 202(a)(4) and 206(a)(3) of the Act and clarifies that the purpose of this requirement is to prevent control technologies that would cause unreasonable risks, rather than to prevent trace emissions of any noxious compounds. This requirement prevents the use of emission-control technologies that produce high levels of pollutants for which EPA has not set emission standards, but nevertheless pose a risk to the public.

In the part 89 regulations EPA use the same definition for “aircraft” as is used in 40 CFR part 87. The definition, which is used to exclude aircraft engines from the part 89 regulations, states that aircraft means, “any airplane a U.S. airworthiness certificate or equivalent foreign airworthiness certificate has is issued.” EPA is proposing to use this same definition for the new part 1039 regulations. EPA believes that this definition encompasses all vehicles that are capable of sustained air travel above treetop heights using compression ignition engines. EPA requests comment on whether there are any aircraft that do not meet this definition, and use compression-ignition engines, but that should not be regulated under part 1039.

Finally, EPA is not revising at this time the regulation on preemption of state and local controls currently found in Part 89. This regulation will continue in effect. EPA is, however, considering whether EPA should clarify the binding regulatory nature of this language, consistent with the decision of the court in Engine Manufacturers Association v. EPA, 88 F.3d 1075 (D.C.Cir. 1996).

8. **Appendix D: Alternative Program Options**

While EPA is interested in comments on all of the alternatives presented, EPA is especially interested in comments on two alternative scenarios which EPA believes merit further consideration in developing the final rule: a program in which sulfur levels are required to be reduced to 15 ppm in essentially a single step, and a variation on the proposed two-step fuel control program, in which the second step of sulfur control to 15 ppm in 2010 would apply to locomotive and marine diesel fuel in addition to nonroad diesel fuel.

A. Summary of Alternatives

Table VI-1 contains a summary of a number of the alternatives investigated and the expected emission reductions, costs, and monetized benefits associated with them in comparison to the proposal. These alternatives cover a broad range of possible approaches and serve to provide insight into the many other program design alternatives not expressly evaluated further. The analysis was done using a 3% discount rate. If EPA were to use another rate, the values would change but not to such a degree as to change the conclusions regarding the various options.

TABLE VI-1 – SUMMARY OF ALTERNATIVE PROGRAM OPTIONS (INCREMENTAL TO THE PROPOSAL)

Option	Fuel Standards	Engine Standards	Estimated Relative Inventory Impacts[c] (NPV tons thru 2030:	Estimated Cost Impacts -	Estimated Benefits Stream -
Proposal ***(inventory impacts, costs and benefits reported below for the options are compared to the proposal)***					
	C 500 PPM in 2007 for NR, loco/marine C 15 ppm in 2010 NR	C >25 hp: PM AT introduced 2013 C >75 hp: NOx AT introduced and phased in 2011-2013	Relative to baseline: 1,126,000 PM 4,952,000 SO2	$16.7	$550[b]
1-Step Fuel Options					
1	C 15 ppm in 2008 for NR only C 500 ppm in 2008 for	C < 50 hp: PM stds only in 2009 C 25-75 hp: PM AT stds and EGR or equivalent NOx technology in 2013; no	6,000 PM -191,000 SO2 11,000 NOx+NMHC	$1.7[d]	$.2[b]
1a	C 15 ppm in 2008 for NR, loco/marine	C PM AT introduced in 2009-10 C NOx AT introduced in 2011-12	129,000 PM -63,000 SO2 1,843,000	a	$59
1b	C 15 ppm in 2006 for NR, loco/marine	Same as 1a	a		
2-Step Fuel Options					
2a	Same as proposal except – C 500 ppm in 2006 for	Same as proposal	18,000 PM 228,000 SO2 0 NOx+NMHC	a	$7[b]
2b	Same as proposal except – C 15 ppm in 2009 for	Same as proposal except – C Move PM AT up 1 year for all engines > 25 hp (phase in starts 2010)	54,000 PM 17,000 SO2 36,000 NOx+NMHC	$1.2[d]	$16[b]

Option	Fuel Standards	Engine Standards	Estimated Relative Inventory Impacts[c] (NPV tons thru 2030;	Estimated Cost Impacts -	Estimated Benefits Stream -
2c	Same as proposal except – C 15 ppm in 2009 for	Same as proposal except – C Move PM AT up 1 year for all engines 175-750 hp (phase in starts 2010)	20,000 PM 17,000 SO2 16,000 NOx+NMHC	$0.8[d]	$6[b]
2d	C Same as proposal	Same as proposal except – C Phase-in NOx AT for 25-75hp beginning in 2013	0 PM 0 SO2 751,000 NOx+NMHC	a	$10[b]
Other Options					
3	C Same as proposal	Same as proposal except – C Mining equipment over 750 hp left at Tier 2	-30,000 PM 0 SO2 -751,000	-$0.5	-$18[b]
4	Same as proposal except – C loco/marine fuel to 15	Same as proposal	9,000 PM 114,000 SO2 0 NOx+NMHC	$1.8	$6[b]
5a	C Same as proposal	Same as proposal except- C No Tier 4 standards <75 hp	-209,000 PM 0 SO2 -334,000	-$3.8	-$70
5b	C Same as proposal	Same as proposal except- C No new <75hp standards after 2008 (i.e., no CDPFs in 2013)	-121,000 PM 0 SO2 -333,000	-$2.6	-$43

Notes:
[a] Qualitative analysis only. Option is impractical due to infeasibility or other significant concerns. See the draft RIA for a detailed discussion.

B. Introduction of 15 ppm Nonroad Diesel Sulfur Fuel in One Step

Instead of the proposed two-step reduction in nonroad diesel sulfur, one alternative would require that the nonroad diesel sulfur level be reduced to 15ppm beginning June 1, 2008. This alternative would have the advantage of enabling use of high efficiency exhaust emission control technology for nonroad engines as early as the 2009 model year. It also would have several disadvantages, which have prompted EPA not to propose it. The disadvantages in comparison to the proposal include inadequate lead-time for engine and equipment manufacturers and refiners, leading to increased costs and potential market disruptions.

i. Description of the One-Step Alternative

While numerous engine standards and phase-in schedules are possible, EPA considered the standards shown in Tables VI-2 and VI-3 as being the most stringent one-step program that could be considered potentially feasible considering cost, lead-time, and other factors. These standards are similar to those in the proposed option, the primary difference being the generally earlier phase-in dates for the PM standards.

TABLE VI-2 – PM STANDARDS FOR 1-STEP FUEL SCENARIO (G/BHP-HR)

<table>
<tr><th rowspan="2">Engine Power</th><th colspan="6">Model Year</th></tr>
<tr><th>2009</th><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th></tr>
<tr><td>hp <25</td><td>0.30</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>25 # hp < 50</td><td>0.22</td><td></td><td></td><td></td><td>0.02</td><td></td></tr>
<tr><td>50 # hp < 75</td><td></td><td></td><td></td><td></td><td>0.02</td><td></td></tr>
<tr><td rowspan="2">75 # hp < 175</td><td rowspan="2"></td><td colspan="3">0.01</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>50%[a]</td><td>50%[a]</td><td>100%[a]</td></tr>
<tr><td rowspan="2">175 # hp < 750</td><td colspan="3">0.01</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>50%[a]</td><td>50%[a]</td><td>100%[a]</td></tr>
<tr><td rowspan="2">hp $ 750</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="4">0.01</td></tr>
<tr><td>50%[a]</td><td>50%[a]</td><td>50%[a]</td><td>100%[a]</td></tr>
<tr><td colspan="7">Notes:
[a] Percentages are the model year sales required to comply with the indicated standard.</td></tr>
</table>

TABLE VI-3 – NOX AND NMHC STANDARDS FOR 1-STEP FUEL SCENARIO (G/BHP-HR)

Engine Power	Model Year			
	2011	2012	2013	2014
25 # hp < 75			3.5 [a]	
75 # hp < 175		0.30 NOx 0.14 NMHC		
		50% [b]	50% [b]	100% [b]
175 # hp < 750	0.30 NOx 0.14 NMHC			
	50% [b]	50% [b]	50% [b]	100% [b]
Hp $ 750	0.30 NOx 0.14 NMHC			
	50% [b]	50% [b]	50% [b]	100% [b]

Notes:
[a] A 3.5 NMHC + NOx standard would apply to the 25-50 hp engines. Engines greater than 50hp are already subject to this standard in 2008 under the existing Tier 3 program.
[b] Percentages are the model year sales required to comply with the indicated standards.

ii. Engine Emission Impacts

The main advantage associated with this one-step approach is pulling ahead the long-term PM engine standards. By making 15 ppm sulfur fuel widely available by late 2008, EPA could accelerate the long-term PM engine standards, leading to the introduction of precious metal catalyzed PM traps as early as 2009, two years earlier than possible under the two-step sulfur reduction approach. Some stakeholders have expressed the concern that a two-step approach leads to later than desired introduction of high-efficiency exhaust emissions controls on nonroad diesels because this cannot happen until the 15-ppm fuel standard goes into effect. As shown in Table VI-1, there would be additional public health benefits associated with this one-step approach. However, in comparison to the proposal, the additional benefits are relatively small, less than one percent or about $3 billion more than the proposed program.[28]

Even though 15 ppm fuel would be available beginning June 1, 2008 under this one-step

[28] A variation on this one-step approach would be to also require the sulfur content of locomotive and marine fuel to meet the 15-ppm standard in 2008. The decision of whether or not to require the sulfur content of locomotive and marine fuel to also be reduced to 15 ppm, however, is not unique to the one step approach, and, as discussed below is an alternative also being evaluated under it's proposed 2-step program. Were EPA to require locomotive and marine diesel fuel to also meet the 15-ppm standard in 2008 under a one-step approach, there would be additional inventory reductions of about 10,000 tons of PM and 128,000 tons of SO_2 (NPV 3% through 2030).

approach, EPA does not believe it would be feasible to propose an aggressive turnover of new engines to trap-equipped versions in 2009. Nor would it be possible to introduce NOx controls any earlier than EPA is already proposing, model year 2011. The proposed standards need to be coordinated with Tier 3 standards, and with the heavy-duty highway diesel standards. The coordination of Tier 4 standards with Tier 3 standards and with the development of emissions control technology for highway diesel engines is of critical importance to successful implementation of the Tier 4 standards. Even those manufacturers who do not make highway engines are expected to gain substantially from the highway PM and NOx control development work, provided they can plan for standards set at a similar level of stringency and timed in a way to allow for the orderly migration of highway engine technology to nonroad applications.

Thus, although the application of high-efficiency exhaust PM emission controls to nonroad diesels would be enabled with the introduction of 15 ppm sulfur nonroad fuel in 2008 under a one-step program, EPA believes that to require the application of PM controls across the wide spectrum of nonroad engines shortly thereafter would raise serious feasibility concerns that could only be resolved, if at all, through a very large additional R&D effort undertaken roughly in parallel with the similarly large highway R&D effort. Nonroad engine designers would need to accomplish much of this development well before the diesel experience begins to accumulate in earnest in 2007, in order to be ready for a 2009 first introduction date. Waiting until 2007 before initiating 2009 model year design work would risk the possibility of product failures, limited product availability and major market disruptions. At the same time, for those engine manufacturers who participate in both the highway and nonroad diesel engine markets, attempting to have concurrent engine product developments for highway and nonroad, could result in the possibility of product failures, limited product availability and major disruptions for the highway market as well. Thus, in balancing their costs and burden, many manufacturers may be forced to choose which products would be available for 2009 and which products would be delayed for release. Manufacturers would also incur large additional costs to redesign hundreds of engine models and thousand of machine types to meet Tier 4 standards only one to three years after Tier 3 standards take effect in 2006-2008. These cost impacts are reflected in Table VI-1. This extra expenditure could only be modestly mitigated by phasing in the standards, since a crash R&D effort with limited benefit from highway experience would still be necessary.

Moreover, with respect to NOx, it would be impractical or simply infeasible to pull the standards ahead on the same schedule. This is because EPA's highway diesel program allows manufacturers to phase in NOx technology over 2007-2010. As a result, EPA does not expect that the high-efficiency NOx control technology could reasonably be applied to nonroad engines any earlier under a one-step program than under a two-step program (i.e., beginning in 2011).

In summary, this option would lead EPA to apply PM and NOx standards in two different model years, or else forgo any opportunity to apply PM traps in 2009. Redesigning engines and emission controls for early PM control and then again a couple of years later for NOx control, on top of shortened Tier 3 stability periods, would likely add substantial costs to the program. As manufacturers attempt to avoid these costs and optimize their development they may simply have to restrict product offerings for some period, leading to price spikes and shortages due to lack of product availability. Having the NOx and PM standards phase in simultaneously under the proposed approach avoids cost and design stability issues for both engine and equipment manufacturers. In addition, the longer leadtime for the engine standards under the proposed program will allow greater economic efficiencies for engine manufacturers as they transfer highway emission reduction technology to nonroad engines.

iii. Fuel Impacts

In addition to the challenges associated with pulling ahead the PM standards described above, there are also some concerns regarding the practicality of an early 15-ppm nonroad diesel sulfur standard. A one-step approach may result in several economic inefficiencies that would increase the cost of the program. For example, refiners will have little opportunity to take advantage of the newer desulphurisation technologies currently being developed. As described above, refiners will only begin to be able to take advantage of these new technologies in 2008. By 2010, the ability to incorporate them into their refinery modifications is expected to double. If refiners have to take steps to reduce the sulfur content of nonroad diesel fuel earlier, they will likely have to use more expensive current technology. The cost impacts of this decision will persist, since the choice of technology is a long term decision. If a refiner is forced by the effective date of the standards to employ a more expensive technology, that choice will affect that refiner's output indefinitely, since the cost of upgrading to the new technologies will be prohibitive. EPA estimates that the cost of achieving a 15-ppm standard in 2008 is approximately 0.4 c/gal greater than for the proposal. While difficult to quantify there are also considerable advantages to allowing refiners some operating time in producing 15-ppm diesel fuel for the highway program prior to requiring them to solidify their designs for producing nonroad diesel fuel to 15 ppm. The primary advantage is that the design of desulphurisation equipment used to produce 15-ppm nonroad diesel fuel can reflect the operating experience of the equipment used to produce 15-ppm highway diesel fuel starting in 2006. This extra time would also provide current refiners of high sulfur diesel fuel with highly confident estimates of the cost of producing 15-ppm diesel fuel, reducing uncertainty and increasing their likelihood of investing to produce this fuel. With a start date of June 1, 2008 refiners would have to solidify their designs and start construction prior to getting any data on the performance of their highway technology. This would increase the cost of producing 15-ppm nonroad diesel fuel for the life of the new desulphurisation equipment, as well as potentially delaying some refiners' decision to invest in new desulphurisation equipment due to uncertainties in cost, performance, etc.

iv. Emission and Benefit Impacts

EPA used the nonroad model to estimate the emission inventory impacts associated with this one-step option, as well as the other options listed in Table VI-1. As for all the alternatives, EPA then used the benefits transfer method to estimate the monetized benefits of the alternative. The results are shown in Table VI-1. As is evidenced by the values in Table VI-1, the one-step alternative would achieve slightly greater PM and NOx emission reductions through 2030 than the proposed 2-step program, with 6,000 and 11,000 additional tons reduced, respectively (or less than 0.5 percent). Unlike the proposed 2-step program, however, there would be no SO2 emission reductions in 2007 due to the delay in fuel sulfur control, although 2009 and later emission are slightly greater due primarily to the earlier introduction of engines using PM filters. Nevertheless, the SO2 benefits of the one-step program are slightly less than the proposed 2-step program in the long run, by about 191,000 tons (about 4 percent) through 2030.

After careful consideration of these matters, EPA has decided to propose the two-step approach in EPA's notice. The two-step program avoids adverse risks to the smooth implementation of the entire Tier 4 nonroad program that could be caused by the significantly shortened lead-time and stability of the one-step program. There are also concerns about the potential negative impacts the one-step option may have on the 2007 highway program, including the implications of the overlap of implementation schedules. Nevertheless, EPA believes that the one-step approach is a regulatory alternative worth considering. In addition to seeking comment on the proposed program, EPA also seek comment on the relative merits and shortcomings of a one-step approach to regulating nonroad diesel fuel and the associated schedule for implementing the engine standards.

C. Applying 15 ppm Requirement to Locomotive and Marine Diesel Fuel

To enable the high efficiency exhaust emission control technology to begin to be applied to nonroad diesel engines beginning with the 2011 model year, EPA is proposing that all nonroad diesel fuel produced or imported after June 1, 2010 would have to meet a 15 ppm sulfur cap. Although locomotive and marine diesel engines are similar in size to some of the diesel engines covered in this proposal, there are many differences that have caused EPA to treat them separately in past EPA programs. These include differences in duty cycles and exhaust system design configurations, size, and rebuild and maintenance practices. Because of these differences, EPA is not proposing new engine standards today for these engine categories. Since EPA is not proposing more stringent emission standards, EPA is also not proposing that the second step of sulfur control to 15 ppm in 2010 be applied to locomotive and marine diesel fuel. Instead, EPA is proposing to set a sulfur fuel content standard of 500 ppm for diesel fuel used in locomotive and marine applications. This fuel standard is expected to provide considerable sulfate PM and SO2 benefits even without establishing more stringent emission standards for these engines. EPA estimates that, cumulatively through 2030, reducing the sulfur content of locomotive and marine diesel fuel would eliminate about 102,000 tons of sulfates PM (net present value, based on a 3 percent discount rate).

EPA is seriously considering the option of extending the 15-ppm sulfur standard to locomotive and marine fuel as early as June 1, 2010, including them in the second step of the proposed two-step program. There are several advantages associated with this alternative. First, as reflected in Table VI-1, it would provide important additional sulfate PM and SO2 emission reductions and the estimated benefits from these reductions would outweigh the costs by a considerable margin. Second, in some ways it would simplify the fuel distribution system and the design of the fuel program since a marker would not be required for locomotive and marine diesel fuel. Furthermore, the prices for locomotive and marine diesel fuel may be virtually unaffected. Under the proposal, EPA expects that a certain amount of marine fuel will be 15-ppm sulfur fuel regardless of the standard due to limitations in the production and distribution of unique fuel grades. Where 500-ppm fuel is available, the possible suppliers of fuel will likely be more constrained, limiting competition and allowing prices to approach that of 15-ppm fuel. If EPA were to bring locomotive and marine fuel to 15 ppm, the pool of possible suppliers could expand beyond those today, since highway diesel fuel will also be at the same standard. Third, it would help reduce the potential opportunity for misfueling of 2007 and later model year highway vehicles and 2011 and later model year nonroad equipment with higher sulfur fuel. Finally, it would allow refiners to coordinate plans to reduce the sulfur content of all of their nonroad, locomotive, and marine diesel fuel at one time. While in many cases this may not be a significant advantage, it may be a more important consideration here since it is probably not a question of whether locomotive and marine fuel must meet a 15-ppm cap, but merely when. As discussed above, it is the Agency's intention to propose action in the near future to set new emission standards for locomotive and marine engines that could require the use of high efficiency exhaust emission control technology, and thus, also require the use of 15 ppm sulfur diesel fuel. EPA anticipates that such engine standards would likely take effect in the 2011-13 timeframe, requiring 15 ppm locomotive and marine diesel fuel in the 2010-12 timeframe. EPA intends to publish an advance notice of proposed rulemaking for such standards by the Spring of 2004 and finalize those standards by 2007.

However, discussions with refiners have suggested there are significant advantages to leaving locomotive and marine diesel fuel at 500 ppm, at least in the near-term and until EPA set more stringent standards for those engines. The locomotive and marine diesel fuel markets could provide an important market for off-specification product, particularly during the transition to 15 ppm for highway and nonroad diesel fuel in 2010. Waiting just a year or two beyond 2010 would address the critical near-term needs during the transition. In addition, waiting just another year or two beyond 2010 is also projected to allow virtually all refiners to take advantage of the new lower cost technology.

After careful consideration of these matters, EPA has decided not to propose to apply the second step of sulfur control of 15 ppm to locomotive and marine diesel fuel at this time. Nevertheless, for the reasons described above, EPA is carefully weighing whether it would be appropriate to do so. Therefore, EPA seeks comment on this alternative and the various advantages, disadvantages, and implications of it.

D. Other Alternatives

EPA has also analyzed a number of other alternatives, as summarized in Table VI-1. Some of these focus on control options more stringent than EPA's proposal while others reflect modified engine requirements that result in less stringent control. EPA has evaluated these options in terms of the feasibility, emissions reductions, costs, and other relevant factors. EPA believes the proposed approach is the proper one with respect to these factors, and believes the options discussed above while having possible merit in some areas, raise what EPA believes are different and significant concerns with respect to these factors compared to the proposed approach. Hence EPA did not include these options. EPA is interested in comment on these alternatives, especially information regarding their feasibility, costs, and other relevant concerns.

9. Appendix E: Provisions for Other Test and Measurement Changes

This section contains further detail and explanation regarding several related nonroad diesel engine emissions test and measurement provisions. There are five topics which will be discussed: 1) EPA's proposed supplemental nonroad transient test; 2) an additional cold start transient test requirement for nonroad diesel engines; 3) a provision for control of smoke testing; 4) steady-state testing; 5) maximum test speed; and 6) general improvements to test procedure precision.

A. Supplemental Transient Test

EPA has proposed to supplement its steady-state emission testing in nonroad diesel engines with a transient duty emission test procedure for nonroad diesel engines, the Nonroad Transient Composite (NRTC)[29] test cycle. Like current nonroad diesel standards, any new emission standards would apply to certification, Selective Enforcement Audits (SEAs), and equipment in actual use for engines covered by the standards.

EPA's supplemental nonroad transient test will apply to a nonroad diesel engine when that engine must first show compliance with EPA's proposed Tier 4 PM and NOx+NMHC emissions standards which are based on the performance of the advanced post-combustion emissions control systems (e.g. CDPFs and NOx adsorbers), with the specific exception of engines under 25 hp for PM and under 75 hp for NOx. The transient duty cycle would be applicable to Tier 4 phase-in engines, as well as the phase-out engines. However, EPA is seeking comment on whether the transient test procedure should only be required for the PM standard for phase out engines. The table VII.F.-1 below outlines the dates for implementation of this requirement and notes specific exceptions for phase-in of some engine standards.

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[29] Memoranda to Docket A-2001-28: "Speed and Load Operating Schedule for the Nonroad Transient Composite test cycle" and "NRTC Cycle Construction"

Table VII.F.-1. Implementation Model Year for Nonroad Transient Testing

Power Category	Transient Test Implementation Model Year[a]
< 25 hp	2013
25 # hp < 75	2013[b]
75 # hp < 175	2012
175 # hp # 750 hp	2011
>750 hp	2011[c]

NOTE: a). EPA is taking comment on whether the transient test procedure should only be required for the PM standard for phase out engines under 750 hp and EPA is seeking comment on not requiring the transient test procedure for carry over engines over 750 hp.
b). The transient test would apply in 2012 for any engines in the 50-75 hp range that choose not to comply with the proposed 2008 transitional PM standard.
c). Beginning in 2014, when the phase-in has been completed, the transient test would apply to all nonroad engines >750 hp, however EPA is taking comment on this approach.

The Agency notes that some manufacturers have reported difficulties measuring transient PM emissions in 750 hp and over engines under full-flow constant volume sampling (CVS) emission measurement systems. It has been reported that this may be due to difficulties apportioning the large exhaust volumes to sample emissions. Additionally, manufacturers have raised concerns regarding a requirement to conduct transient testing for engines over 750 hp, based on concerns related to facility impacts and sales volumes that are particular for engines over 750 hp. To address the concerns raised, the Agency is taking comment on not requiring the engine manufacturer to conduct transient testing for engines over 750 hp for purposes of certification. Manufacturers would have the option to submit an engineering analysis that demonstrates compliance with the applicable transient standard. This engineering analysis would have to include relevant test data, such as steady state test data, that would support the engineering analysis.

Similarly, PM exhaust emissions gathered from these large engines using partial flow sampling systems (PFSS) tend to be high in volatile PM fractions[30] under some low load operating modes. To date, volatile PM measured from PFSS has not been proven to be consistently comparable to volatile PM measured by a full-flow CVS. The pressure across the filter and other sample zone conditions, coupled with differences in the dilution rate and method and residence time, may combine to yield a different PM composition in PFSS than in full-flow CVS systems at these operating conditions. EPA requests comment from manufacturers on the use of PFSS test practices for PM emission data collection in these large displacement engines.

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[30] Memorandum to Docket "Partial Flow Testing Concerns in Large Nonroad Diesel Engines as Regards Emission Testing Through Partial Flow Sampling", Docket A-2001-28.

EPA recognizes that there may be practical difficulties with emission testing in large nonroad diesel engines over 750 hp, systems that often have multiple exhaust manifolds and may incorporate several catalysts or other pieces of emission control equipment. Further, the Agency does not intend at this time to require that manufacturers use PFSS to determine PM emissions from their engines for certification. A large engine manufacturer may, however, choose to submit PM data to the Agency using PFSS as an alternative test method, if that manufacturer can demonstrate test equivalency using a paired-T test, as outlined in regulations at 40 CFR 86.1306-07.

EPA is also proposing, as an alternative to the NRTC for a limited class of engines, a Constant Speed Variable Load (CSVL) transient duty cycle. The CSVL transient duty cycle is derived from the EPA's Arc Welder Highly Transient Torque application duty cycle. The CSVL cycle is described in the proposed regulations at 40 CFR 1039.510. Because of the more limited range of engine operation in the CSVL cycle, manufacturers must ensure that engines certified with data generated with this cycle are used exclusively in constant-speed applications. Accordingly, these engines must include labeling information indicating this limited emission certification. An example of engines in this category of nonroad diesel equipment includes power generating sets that are very tightly governed for operating speed changes. Other "constant speed" equipment may be less closely regulated for changes in speed such as those that utilize a 3% droop-type of engine speed governor. One might expect that this latter group would more easily pass cycle performance statistics over a constant speed transient test than the more speed change-sensitive former group, represented by electrical generating sets, for example. However, both types of constant speed engines experience some fluctuations in speed and load during operation in-use and the CSVL duty cycle would capture emissions from these infrequent modes of operation, as well.

Transient testing requires consideration of statistical parameters for verifying that test engines adequately follow the prescribed schedule of speed and load values. The proposed regulations in §1065.530 detail these statistical parameters (or "cycle statistics") for nonroad diesel engines. These values are somewhat different than the comparable values for highway diesel engines to take into account the characteristics of the nonroad composite cycle and the CSVL cycle. Note also that EPA is proposing to modify certain cycle statistics previously established for nonroad spark-ignition engines. These changes generally allow testing spark-ignition engines in a way that follows the speed and load traces somewhat less precisely than previously established. All of the proposed changes for spark-ignition engines are consistent with the comparable cycle statistics EPA is proposing for nonroad diesel engines.

While designed to control for a broad range of constant-speed nonroad engines, the Agency's CSVL cycle has an average speed that may be lower than the speed that a manufacturer considers optimal for their engines in-use. Further, EPA recognizes that some constant speed equipment may operate near or at its rated engine rpm during much of that equipment's useful life. As such, EPA has proposed that constant-speed engines tested in the laboratory with installed speed governors be required to meet cycle statistics for engine load, but not for engine speed. This addresses the concern that different engines may have different degrees of engine speed variation and that some engines may be set to operate at speeds slightly different than the defined point of maximum test speed. At the same time, the installed governor forces the test engine to operate in a way that is representative of in-use operation.

Engine manufacturers have raised additional concerns about designing constant-speed engines to meet emission standards over the CSVL cycle. These concerns generally focus on the fact that the cycle has relatively light engine loads and is derived from an arc Welder powered by a naturally aspirated engine. Manufacturers questioned the representativeness of this cycle for generators, which is a more common application for constant-speed engines. EPA continues to believe that transient testing of these engines will add assurance that they control emissions under real in-use operation. While the CSVL cycle does not capture the full operating experience of every engine application, EPA believes that engines designed to this cycle will control emissions effectively under other types of transient operation not specifically included in the certification procedure. Especially given the anticipated emission-control technologies, EPA believes engines that are capable of meeting emission standards on the CSVL cycle will have the transient-response characteristics that are appropriate for controlling emissions at higher engine loads and for less dynamic transient operation. At the same time, EPA share engine manufacturers' interest in creating duty cycles that achieve in-use emission reductions without requiring approaches that lead to laboratory improvements unrelated to an engine's in-use operation. EPA is therefore expecting to continue discussions with engine manufacturers to pursue the possibility of developing a constant-speed transient cycle that addresses these concerns. EPA requests comment on the extent to which the CSVL cycle will pose design burdens or constraints unrelated to improving in-use emission control.

EPA recently adopted a similar transient duty cycle for spark-ignition constant-speed engines. This duty cycle, which is based on the same underlying engine operation of an arc Welder powered by a diesel engine, includes a combination of equal parts typical and high-transient operation. There was no effort to modify the schedule of engine operation to make it more representative of spark-ignition engines, so the expectation was that the same cycle would eventually apply to nonroad diesel engines. Aside from the different selection of engine operation from the available operating Welder described above, the proposed constant-speed transient cycle includes several adjustments that would need to be factored into the "spark-ignition" cycle before it could be applied to nonroad diesel engines. These adjustments include renormalization with a more robust engine map (based on updated specifications of the original engine) and "I-alpha" corrections to synchronize measurements made with and without a flywheel. EPA requests comment on whether the previously adopted constant-speed transient cycle (in modified form) should apply equally to nonroad diesel engines. Conversely, if EPA adopts the proposed constant-speed transient cycle for nonroad diesel engines, EPA would expect to change the regulations for spark-ignition engines to align with the conclusions in this rulemaking. EPA accordingly requests comment on these same issues as they relate to spark-ignition engines.

EPA has proposed an optional test cycle specifically for engines used in transport refrigeration units (TRUs). These engines would be certified to a four-mode steady-state duty cycle, developed by the California-EPA Air Resources Board.[31] Two modes would be run at the

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[31] Information on the proposed TRU cycle may be found on the California ARB website at http://www.arb.ca.gov/diesel/dieselrrp.htm.

engine's maximum test speed, one mode at 50% of observed engine torque and the other mode at 75% of observed engine torque. The third and fourth modes would be run at the engine's intermediate test speed and, again, one mode would be run at 50% of observed engine torque and the other mode at 75% of observed engine torque. All four modes would be weighted equally in determining an operating mode's contribution to the engine's emissions.

Manufacturers certifying engines to the TRU cycle would need to state on the emission control label that the engines may only be used in TRUs, provide installation instructions to ensure they will operate only in the modes covered by the test cycle, and keep records on delivery destinations for these engines. Although these engines would not be subject to a transient duty cycle, they would be subject to not-to-exceed standards based on any normal operation that they might experience in the field. Manufacturers of these engines may petition EPA at certification for a waiver of the requirement to provide smoke emission data for their constant-torque engines. EPA requests comment on whether different modes, or different weighting factors, would be more appropriate for characterizing TRU emissions.

B. Cold Start Testing

EPA has proposed to include a requirement for a cold start transient test to be run in conjunction with the Agency's proposed nonroad diesel engine transient test. While EPA does not have available a database of emission information to characterize cold start emissions from all power categories of nonroad diesel engines, EPA has been able to analyze the second-by-second in-use operation of some forty pieces of Tier 1 and older nonroad equipment. Using a subset of equipment from this study, the Agency characterized the "average" workday of each piece of equipment in the data set[32] and attempted to define the role "cold start" operation, generally characterized by lower exhaust temperatures and higher-than-idle engine speeds, played in engine emissions. Generally, the Agency found that times when the engine was operating at cold start, higher engine emission rates were seen than during normal, temperature-stabilized operation of the engine. These cold start, or "warming-up", periods were seen to last on average ten minutes after equipment key-on for the units in EPA's study.

The Agency found, that over an eight to ten hour workday, a piece of nonroad equipment would spend between 25 and 35 percent of its in-use day running in idle operation at a relatively low rate of emission output. With downtime on the equipment for operator lunch times and equipment transport, there could be a further period of an hour or more of low to no emissions from the equipment in-use. At first key-on of the workday, and with each additional "key-on" cold start event during the day, the equipment experiences a period of higher emissions until it reaches a stabilized operating temperature. Start-up of the equipment after a period of downtime, which lasted an hour or more, was generally seen to experience rates of engine emissions similar to those seen at first key-on, or cold start, and were considered periods of cold start emissions, as well. The total time the equipment in the study spent at these higher rates of "cold start" engine emissions could be estimated to generate approximately one-tenth of the engine emissions that the equipment would be expected to produce over the whole

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[32] Memorandum to Docket, "Analysis of Second-by-Second Emission and Activity Data for a Private Rental Fleet of Construction Equipment" Docket A-2001-28.

workday. Therefore, EPA proposes to weight the emission test results from its additional cold start transient test requirement as one tenth of the composite transient emission test results for a particular engine. The Agency requests comments as to the robustness of this weighting factor and as to its applicability across the spectrum of nonroad diesel equipment.

In addition, EPA requests comment on the potential to apply an approach adopted for commercial spark-ignition engines, in which engines operate over a single "warm-start" cycle to nonroad diesel engines. The regulations for these spark-ignition engines address cold-start emissions indirectly through a combination of provisions. First, the warm-up period before emission measurement can start is limited to three minutes of operation. As a result, any engine operation after this three-minute period is fully accounted for by emission measurements. Second, the regulations direct manufacturers to design their emission-control systems to start working as soon as possible after engine starting and to describe in their application for certification how their engines meet this objective. For engines that take advantage of the period of unmeasured emissions with a design that has unnecessarily high emissions, EPA can consider this a defeat device and deny certification. Manufacturers therefore need to take steps to design their engines and any emission-control equipment to control emissions during the warm-up period without the additional effort of supplemental cold-start testing. EPA requests comment on whether this approach would be appropriate for nonroad diesel engines. In particular, EPA requests comment on how long the warm-up period prior to start of emissions measurement should be for diesel engines. The three-minute warm-up period specified for these spark-ignition engines reflects the time needed for their catalysts to start working. The emission-control technologies anticipated for diesel engines under this proposal would need additional time, perhaps 10 minutes, before they achieved nearly full effectiveness in controlling diesel emissions. Any comments regarding this approach should address how the changed procedure would affect measured emission levels and how the emission standard should be adjusted to reflect these changes.

C. Control of Smoke

Manufacturers are currently responsible for testing and reporting results for nonroad "peak acceleration" and "lugging" smoke emissions. This rulemaking however proposes to replace the present Federal Smoke Procedure for nonroad engines with the ISO 8178 Part 9 nonroad smoke procedure as the method and standards by which engine manufacturers will certify their nonroad engines. This new smoke testing procedure with its related smoke standards will become effective for a particular engine when that engine is certified to EPA's proposed Tier 4 or transition PM and NOx-NMHC standards.

The ISO-TC70/SC8/WG1 committee developed a nonroad smoke test procedure, ISO 8178-9 and finalized it on October 15, 2000. Recognizing the value of harmonized test procedures and limit standards, EPA has proposed through this rulemaking to use ISO 8178-9 for smoke testing of nonroad diesel engines. EPA has analyzed ISO 8178-9 and concluded that it is appropriate for adoption within the Agency's nonroad test procedures. It is important to note that the ISO 8178-9 smoke emissions test procedure is very different from the procedure specified in Subpart I of Part 86. As a consequence, in adopting the ISO 8178-9 procedure, EPA proposes to revise the numerical limit value associated with this ISO procedure. EPA proposes that the appropriate (maximum) numerical standard for ISO 8178-9 peak (acceleration) smoke value measurement will be 20 percent opacity, peak smoke values at 3x, 6x, and 9x will be 18 percent opacity, 16 percent opacity and 14 percent opacity, respectively, and the lug smoke value will be 10 percent opacity. The Agency has determined this value on review of data from smoke tests on various engines across differing programs and requests comment as to the appropriateness of these particular limit values.

Some state governments have expressed a desire for a federal smoke regulatory program that would enable them to test in-use nonroad engines in a manner that would permit action against gross emitters of smoke. In a like manner, EPA could propose additional smoke testing regulations as part of any future rulemaking which would address manufacturer's in-use smoke test requirements. The main elements of any in-use smoke program would be a new Federal smoke standard(s) and test procedure for new engines, guidance from EPA for state in-use smoke control programs (including a full smoke test procedure and accompanying state limit values), and a means by which the data from the two programs could be related. The current smoke test procedure from Part 86, Subpart I does not provide data comparable to the most practical in-use smoke test procedure, a snap-idle acceleration test with measured opacity. However, based on the current ISO 8178-9 procedure, EPA believes data from an ISO 8178-9 certification smoke test could provide the desired link.

In applying nonroad smoke standards and procedures to engines rated 50 hp and under, EPA has chosen to exempt one-cylinder engines, the large majority of which are being used in generator sets and other constant-speed applications, from the smoke standards. EPA still believes that testing of these engines is unique in ways that would need to be addressed before requiring smoke standards and testing for this class of engines. These engines tend to produce puffs of smoke that may make the smoke measurement erratic. The Agency believes the air quality impact of this decision will be minimal. EPA expects to reconsider this issue in the future in relation to other in-use testing concerns.

Finally, the Agency proposes to exempt from smoke standards those nonroad diesel engines that have certified PM emission levels or Family Emission Limits (FELs) below 0.05 g/hp-hr. The Agency believes that engines meeting an FEL below 0.05 g/hp-hr would utilized control technology, such as particulate traps, that would provide adequate smoke control.

D. Steady-State Testing

Recognizing the variety of both power classes and work applications to be found within the nonroad vehicle and engine population, EPA will retain current Federal steady-state test procedures for nonroad engines. The steady state duty cycle applicable in each of the following categories: 1) nonroad engines 25 hp and greater; 2) nonroad engines less than 25 hp; and 3) nonroad engines having constant-speed, variable-load applications, (e.g., generator sets) as set out in Table VII.F-2. The steady-state cycles remain, respectively, the 8-mode cycle, the 6-mode cycle and the 5-mode cycle.[33] EPA envision manufacturers that satisfy the requirements

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[33] The three proposed steady-state test cycles are similar to test cycles found in the International Standard ISO 8178-4:1996 (E) and remain consistent with the existing 40 CFR part 89 steady state duty

to certify on the steady state ISO 8178-D2 duty cycle might likewise satisfy the requirements to test over the Constant Speed Variable Load Duty Cycle (CSVL). Manufacturers will be required to meet emission standards under steady-state conditions, in addition to meeting emission standards under the proposed supplemental transient test cycle. Steady-state test cycles are needed so that testing for certification will reflect the broad range of operating conditions experienced by these engines. A steady-state test cycle represents an important type of modern engine operation, in power and speed ranges that are typical in-use. The mid-to-high speeds and loads represented by present steady-state testing requirements are the speeds and loads at which these engines are designed to operate for extended periods for maximum efficiency and durability.

Manufacturers would perform each steady-state test following all applicable test procedures in proposed regulations at proposed 40 CFR part 1039, e.g., procedures for engine warm-up and exhaust emissions measurement. EPA is proposing that the testing must be conducted with all emission-related engine control variables in the maximum NOx-producing condition which could be encountered for a 30 second or longer averaging period at a given test point. Table VII.F.-2 below summarizes the steady-state testing requirements by individual engine power categories.

Table VII.F-2 – Summary of Steady-State Test Requirements

Nonroad Engine Power Classes	Steady-State Testing Requirements		
	8-Mode Cycle (ISO 8178-4 C1)	6-Mode Cycle (ISO 8178-4 G3)	5-Mode Cycle (ISO 8178-4 D2)
hp < 25 (kW < 19)	NA [a]	applies	applies [b]
25 # hp < 75 (19 # kW < 56)	applies	NA[a]	applies [b]
75 # hp < 175 (56 # kW < 130)	applies	NA[a]	applies [b]
175 # hp # 750 (130 # kW # 560)	applies	NA[a]	applies [b]
hp > 750 (kW > 560)	applies	NA[a]	applies [b]

[a] Testing procedure not applicable to this class of engines.
[b] For constant, or nearly constant, speed engines and equipment with variable, or intermittent, load.

i. Maximum Test Speed

EPA is proposing to make a slight change to how test cycles are specified. EPA is proposing to apply the existing definition of maximum test speed in part 1065 to nonroad CI engines. This definition of maximum test speed is the single point on an engine's normalized maximum power versus speed curve that lies farthest away from the zero-power, zero-speed point. This is intended to ensure that the maximum speed of the test is representative of actual engine operating characteristics and is not improperly used to influence the parameters under which

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cycles.

their engines are certified. In establishing this definition of maximum test speed, it was EPA's intent to specify the highest speed at which the engine is likely to be operated in use. Under normal circumstances this maximum test speed should be close to the speed at which peak power is achieved. However, in past discussions, some manufacturers have indicated that it is possible for the maximum test speed to be unrepresentative of in-use operation. Since EPA were aware of this potential during the original development of this definition, EPA included provisions to address issues such as these. Part 1065 allows EPA to modify test procedures in situations where the specified test procedures would otherwise be unrepresentative of in-use operation. Thus, in cases in which the definition of maximum test speed resulted in an engine speed that was not expected to occur with in-use engines, EPA would work with the manufacturers to determine the maximum speed that would be expected to occur in-use.

E. Improvements to the Test Procedures

EPA is proposing changes to the test procedures to improve the precision of emission measurements. These changes address the potential effect of measurement precision on the feasibility of the standards. It is important to note that these changes are not intended to bias results high or low, but only to improve the precision of the measurements. Based on EPA's experience with these modified test procedures, and it's discussions with manufacturers about their experiences, EPA is confident that these changes will not affect the stringency of the standards.

If finalized, manufacturers would be allowed to use the new procedures immediately for all certifications of all engines (i.e. to certify any nonroad engine, not just Tier 4 engines), and manufacturers will also be able to use their current procedures up to a certain transition date to allow for a gradual transition to the new procedures. The reason for this is that some of these changes may not be convenient or cost-effective in the short term, and manufacturers may be willing to live with some slightly lower measurement precision in order to lower short-term testing costs. EPA believes, though, that manufacturers should be able to individually optimize their test facilities in this manner. In addition, it is important for manufacturers to understand that EPA will conduct it's confirmatory testing in the manner specified in these regulations.

EPA is also proposing a new regulatory provision that specifies the steps that someone would need to follow to demonstrate that their own alternate measurement procedure is as good as or better than the procedure specified by it's regulations.

10. Appendix F: Nonroad Diesel Fuel Program: Compliance and Enforcement Provisions

In general, this proposal would require refiners and importers to meet a 500-ppm sulfur standard for nonroad, locomotive, and marine diesel fuel starting June 1, 2007 and to meet a 15-ppm standard for nonroad diesel fuel beginning June 1, 2010. Locomotive and marine diesel fuel would remain subject to the 500 ppm standard. Among other provisions, the proposal provides for a temporary non-highway distillate baseline percentage method to differentiate volumes of diesel fuel subject to the NRLM standards and volumes of diesel fuel subject to the highway fuel standards; provisions to identify unregulated fuel such as heating oil; provisions for diesel fuel credit generation and use; and special provisions for small refiners, refiners seeking hardship relief, and parties supplying diesel fuel to Alaska and U.S. territories.

As with earlier fuel programs, EPA has developed a comprehensive set of compliance and enforcement provisions designed to promote effective and efficient implementation of this fuel program and thus to achieve the full environmental potential of the program. The proposed compliance provisions are designed to ensure that nonroad, locomotive, and marine diesel fuel sulfur content requirements are met throughout the distribution system, from the refiner or importer through the end user, subject to certain provisions applicable during the early transition years.

The proposed compliance and enforcement provisions fall into several broad categories:

- -Fuel uses covered and not covered under the proposed program;
- -Provisions applicable to refiners and importers;
- -Provisions applicable to parties downstream of the refinery or importer;
- -Special provisions regarding additives, kerosene, and the use of motor oil in fuel;
- -Fuel testing and sampling requirements;
- -Records required to be kept (including those applying under the small refiner and refiner hardship provisions);
- -Reporting requirements;
- -Exemptions from the program; and
- -Provisions concerning liability, defenses, and penalties for noncompliance.