Federal Register

Friday,
June 2, 2000

Part II

Environmental Protection Agency

40 CFR Parts 69, 80, and 86

Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards; Highway Diesel Fuel Sulfur Control Requirements; Proposed Rules

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 69, 80, and 86

[AMS–FRL–6705–2]

RIN 2060–AL69

Control of Air Pollution From New Motor Vehicles: Proposed Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements

AGENCY: Environmental Protection Agency.

ACTION: Notice of proposed rulemaking.

SUMMARY: Diesel engines contribute considerable pollution to our nation's continuing air quality problems. Even with more stringent heavy-duty highway engine standards set to take effect in 2004, these engines will continue to emit large amounts of nitrogen oxides and particulate matter, both of which contribute to serious public health problems in the United States. These problems include premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. Numerous studies also link diesel exhaust to increased incidence of lung cancer.

The diesel engine is a vital workhorse in the United States, moving much of the nation's freight, and carrying out much of its farm, construction, and other labor. Diesel engine sales have grown over the last decade, so that now about a million new diesel engines are put to work in the U.S. every year. Diesels overwhelmingly dominate the bus and large truck markets and have been capturing a growing share of the light heavy-duty vehicle market over the last decade.

We are proposing a comprehensive national control program that would regulate the heavy-duty vehicle and its fuel as a single system. We are proposing new emission standards that would begin to take effect in 2007, and would apply to heavy-duty highway engines and vehicles. These proposed standards are based on the use of high-efficiency catalytic exhaust emission control devices or comparably effective advanced technologies. Because these devices are damaged by sulfur, we are also proposing to reduce the level of sulfur in highway diesel fuel significantly by the middle of 2006.

Diesel engines are more durable and get better fuel economy than gasoline engines, but also pollute significantly more. If this program is implemented as proposed, diesel trucks and buses will have dramatically reduced emission levels. This proposed program will bring heavy-duty diesel emissions on par with new cars. The results of this historic proposal would be comparable to the advent of the catalytic converter on cars, as the proposed standards would, for the first time, result in the widespread introduction of exhaust emission control devices on diesel engines.

By 2007, we estimate that heavy-duty trucks and buses will account for as much as 30 percent of nitrogen oxides emissions from transportation sources and 14 percent of particulate matter emissions. In some urban areas, the contribution will be even greater. The standards for heavy-duty vehicles proposed in this rule would have a substantial impact on the mobile source inventories of oxides of nitrogen and particulate matter. Beginning the program in the 2007 model year ensures that emission reductions start early enough to counter the upward trend in heavy-duty vehicle emissions that would otherwise occur because of the increasing number of vehicle miles traveled each year.

This proposed program would result in particulate matter and oxides of nitrogen emission levels that are 90% and 95% below current standards levels, respectively. In order to meet these more stringent standards for diesel engines, the proposal calls for a 97% reduction in the sulfur content of diesel fuel. As a result, diesel vehicles would achieve gasoline-like exhaust emission levels, in addition to their inherent advantages over gasoline vehicles with respect to fuel economy, lower greenhouse gas emissions, and lower evaporative hydrocarbon emissions. We are also proposing more stringent standards for heavy-duty gasoline vehicles.

The clean air impact of this program would be dramatic when fully implemented. By 2030, this program would reduce annual emissions of nitrogen oxides, nonmethane hydrocarbons, and particulate matter by a projected 2.8 million, 305,000 and 110,000 tons, respectively. We project that these reductions and the resulting significant environmental benefits of this program would come at an average cost increase of about $1,700 to $2,800 per new vehicle in the near term and about $1000 to $1600 per new vehicle in the long term, depending on the vehicle size. In comparison, new vehicle prices today can range up to $250,000 for larger heavy-duty vehicles. The cost of reducing the sulfur content of diesel fuel would result in an estimated increase of approximately four cents per gallon.

DATES: *Comments:* We must receive your comments by August 14, 2000.

Hearings: We will hold public hearings on June 19, 20, 22, 27, and 29, 2000. See **ADDRESSES** below for the locations of the hearings.

ADDRESSES: *Comments:* You may send written comments in paper form and/or by e-mail. We must receive them by the date indicated under ''DATES'' above. Send paper copies of written comments (in duplicate if possible) to the contact person listed below. Send e-mail comments to diesel@epa.gov.

EPA's Air Docket makes materials related to this rulemaking available for review in Docket No. A–99–06 located at U.S. Environmental Protection Agency (EPA), Air Docket (6102), Room M–1500, 401 M Street, SW, Washington, DC 20460 (on the ground floor in Waterside Mall) from 8 a.m. to 5:30 p.m., Monday through Friday, except on government holidays. You can reach the Air Docket by telephone at (202) 260–7548 and by facsimile at (202) 260–4400. We may charge a reasonable fee for copying docket materials, as provided in 40 CFR part 2.

Hearings: We will hold five public hearings at the following locations:

June 19, 2000, Crowne Plaza Hotel, 1605 Broadway, New York, NY, 10019
June 20, 2000, Rosemont Convention Center, 5555 N. River Rd., Rosemont, IL 60018
June 22, 2000, Renaissance Atlanta Hotel, 590 W. Peachtree St, NW, Atlanta, GA, 30308
June 27, 2000, Hyatt Regency, 711 S. Hope Street, Los Angeles, CA, 90017
June 29, 2000, Doubletree Hotel, 3203 Quebec St., Denver, CO, 80207

We request that parties who want to testify at a hearing notify the contact person listed below ten days before the date of the hearing. Please see section X, ''Public Participation'' below for more information on the comment procedure and public hearings.

FOR FURTHER INFORMATION CONTACT: Margaret Borushko, U.S. EPA, National Vehicle and Fuel Emissions Laboratory, 2000 Traverwood, Ann Arbor MI 48105; Telephone (734) 214–4334, FAX (734) 214–4816, E-mail borushko.margaret@epa.gov.

SUPPLEMENTARY INFORMATION:

Regulated Entities

This proposed action would affect you if you produce or import new heavy-duty engines which are intended for use in highway vehicles such as trucks and buses or heavy-duty highway vehicles, or convert heavy-duty vehicles or heavy-duty engines used in highway vehicles to use alternative fuels. It would also affect you if you produce, distribute, or sell highway diesel fuel.

The table below gives some examples of entities that may have to follow the proposed regulations. But because these are only examples, you should carefully examine the proposed and existing regulations in 40 CFR parts 69, 80, and 86. If you have questions, call the person listed in the **FOR FURTHER INFORMATION CONTACT** section above.

Category	NAICS Codes [a]	SIC Codes [b]	Examples of potentially regulated entities
Industry	336112	3711	Engine and truck manufacturers.
	336120		
Industry	811112	7533	Commercial importers of vehicles and vehicle components.
	811198	7549	
Industry	324110	2911	Petroleum refiners.
Industry	422710	5171	Diesel fuel marketers and distributors.
	422720	5172	
Industry	484220	4212	Diesel fuel carriers.
	484230	4213	

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

Access to Rulemaking Documents Through the Internet

Today's proposal is available electronically on the day of publication from the Environmental Protection Agency Internet Web site listed below. Electronic copies of the preamble, regulatory language, Draft Regulatory Impact Analysis, and other documents associated with today's proposal are available from the EPA Office of Transportation and Air Quality (formerly the Office of Mobile Sources) Web site listed below shortly after the rule is signed by the Administrator. This service is free of charge, except any cost that you incur for connecting to the Internet.

Environmental Protection Agency Web Site:

http://www.epa.gov/fedrgstr/

(Either select a desired date or use the Search feature.)

Office of Transportation and Air Quality (OTAQ) Web Site:

http://www.epa.gov/otaq/

(Look in ''What's New'' or under the ''Heavy Trucks/Busses'' topic.)

Please note that due to differences between the software used to develop the document and the software into which document may be downloaded, changes in format, page length, etc. may occur.

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I. A Brief Overview

This proposal covers the second of two phases in a comprehensive nationwide program for controlling emissions from heavy-duty engines (HDEs) and vehicles. It builds upon the phase 1 program we proposed last October (64 FR 58472, October 29, 1999). That action reviewed and proposed to confirm the 2004 model year emission standards set in 1997 (62 FR 54693, October 21, 1997), proposed stringent new emission standards for gasoline-fueled heavy-duty vehicles (HDVs), and proposed other changes to the heavy-duty program, including provisions to ensure in-use emissions control. Today's proposal takes the provisions of the October 1999 proposal as a point of departure.

This second phase of the program looks beyond 2004, based on the use of high-efficiency exhaust emission control devices and the consideration of the vehicle and its fuel as a single system. In developing this proposal, we took into consideration comments received in response to an advance notice of proposed rulemaking (ANPRM) published in May of last year (64 FR 26142, May 13, 1999), and comments we received in response to our discussion of future standards in the heavy-duty 2004 standards proposal last October. We welcome comment on all facets of this proposal and its supporting analyses, including the levels and timing of the proposed emissions standards and diesel fuel quality requirements. We ask that commenters provide any technical information that supports the points made in their comments.

This proposed program would result in particulate matter (PM) and oxides of nitrogen (NO_X) emission levels that are 90% and 95% below current standards levels, respectively. In order to meet these more stringent standards for diesel engines, the proposal calls for a 97% reduction in the sulfur content of diesel fuel. This proposal would make clean diesel fuel available in time for implementation of the light-duty Tier 2 standards. The heavy-duty engine standards would be effective starting in the 2007 model year and the low sulfur diesel fuel needed to facilitate the standards would be widely available by the middle of 2006. As a result, diesel vehicles would achieve gasoline-like exhaust emission levels, in addition to their inherent advantages over gasoline vehicles with respect to fuel economy, lower greenhouse gas emissions, and lower evaporative hydrocarbon emissions. We are also proposing more stringent standards for heavy-duty gasoline vehicles.

The standards proposed would result in substantial benefits to public health and welfare and the environment through significant reductions in emissions of NO_X, PM, nonmethane hydrocarbons (NMHC), carbon monoxide (CO), sulfur oxides (SO_X), and air toxics. We project that by 2030, this proposed phase 2 program would reduce annual emissions of NO_X, NMHC, and PM by 2.8 million, 305,000 and 110,000 tons, respectively. Especially in the early years of this program, large reductions in the amount of direct and secondary PM caused by the existing fleet of heavy-duty vehicles would occur because of the improvement in diesel fuel quality.

A. What Is Being Proposed?

There are two basic parts to this proposal: (1) New exhaust emission standards for heavy-duty highway engines and vehicles, and (2) new quality standards for highway diesel fuel. The systems approach of combining the engine and fuel standards into a single program is critical to the success of our overall efforts to reduce emissions, because the emission standards would not be feasible without the fuel change. This is because the emission standards, if promulgated, are expected to result in the use of high-efficiency exhaust emission control devices that would be damaged by sulfur in the fuel. This proposal, by providing extremely low sulfur diesel fuel, would also enable cleaner diesel passenger vehicles and light-duty trucks. This is because the same pool of highway diesel fuel also services these light-duty diesel vehicles, and these vehicles can employ technologies similar to the high-efficiency heavy-duty exhaust emission control technologies that would be enabled by the fuel change. We believe these technologies are needed for diesel vehicles to comply with our recently adopted Tier 2 emissions standards for light-duty highway vehicles (65 FR 6698, February 10, 2000).

We believe that this systems approach is a comprehensive way to enable promising new technologies for clean diesel affecting all sizes of highway diesel engines and, eventually, diesel engines used in nonroad applications too. The fuel change, in addition to enabling new technologies, would also produce emissions and maintenance benefits in the existing fleet of highway diesel vehicles. These benefits would include reduced sulfate and sulfur oxides emissions, reduced engine wear and less frequent oil changes, and longer-lasting exhaust gas recirculation (EGR) components on engines equipped with EGR. Heavy-duty gasoline vehicles would also be expected to reach cleaner levels due to the transfer of recent technology developments for light-duty applications, and the recent action taken to reduce sulfur in gasoline as part of the Tier 2 rule.

The basic elements of the proposal are outlined below. Detailed provisions and justifications for our proposal are discussed in subsequent sections.

1. Heavy-Duty Emission Standards

We are proposing a PM emissions standard for new heavy-duty engines of 0.01 grams per brake-horsepower-hour (g/bhp-hr), to take full effect in the 2007 HDE model year. We are also proposing standards for NO_X and NMHC of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. These NO_X and NMHC standards would be phased in together between 2007 and 2010, for diesel engines. The phase-in would be on a percent-of-sales basis: 25 percent in 2007, 50 percent in 2008, 75 percent in 2009, and 100 percent in 2010. Because of the more advanced state of gasoline engine emissions control technology, gasoline engines would be fully subject to these standards in the 2007 model year, although we request comment on phasing these standards in as well. A potential delay in the implementation date of the gasoline engine and vehicle standards to the 2008 model year arising from issues connected with the 2004 model year standards is discussed in section III.D.2. In addition, we are proposing a formaldehyde (HCHO) emissions standard of 0.016 g/bhp-hr for all heavy-duty engines, to be phased in with the NO_X and NMHC standards, and the inclusion of turbocharged diesels in the existing crankcase emissions prohibition, effective in 2007.

Proposed standards for complete HDVs would be implemented on the same schedule as for engine standards. For certification of complete vehicles between 8500 and 10,000 pounds gross vehicle weight rating (GVWR), the proposed standards are 0.2 grams per mile (g/mi) for NO_X, 0.02 g/mi for PM, 0.195 g/mi for NMHC, and 0.016 g/mi for formaldehyde.[1] For vehicles between 10,000 and 14,000 pounds, the proposed standards are 0.4 g/mi for NO_X, 0.02 g/mi for PM, 0.230 g/mi for NMHC, and 0.021 g/mi for formaldehyde. These standards levels are roughly comparable to the proposed engine-based standards in these size ranges. Note that these standards would not apply to vehicles above 8500 pounds that we classify as medium-duty passenger vehicles as part of our Tier 2 program.

Finally, we are proposing to revise the evaporative emissions standards for heavy-duty engines and vehicles, effective on the same schedule as the gasoline engine and vehicle exhaust emission standards. The proposed standards for 8500 to 14,000 pound vehicles are 1.4 and 1.75 grams per test for the 3-day diurnal and supplemental 2-day diurnal tests, respectively. Slightly higher standards levels of 1.9 and 2.3 grams per test would apply for vehicles over 14,000 pounds. These proposed standards represent more than a 50 percent reduction in the numerical standards as they exist today.

[1] Vehicle weight ratings in this proposal refer to GVWR (the curb weight of the vehicle plus its maximum recommended load of passengers and cargo) unless noted otherwise.

2. Fuel Quality Standards

We are proposing that diesel fuel sold to consumers for use in highway vehicles be limited in sulfur content to a level of 15 parts per million (ppm), beginning June 1, 2006. This proposed sulfur standard is based on our assessment of how sulfur-intolerant advanced exhaust emission control technologies will be, and a corresponding assessment of the feasibility of low-sulfur fuel production and distribution. We are seeking comment on voluntary options for providing refiners with flexibility in complying with the low sulfur highway diesel fuel program. In addition, we request comment on some potential flexibility provisions to assist small refiners in complying with the program.

With minor exceptions, existing compliance provisions for ensuring diesel fuel quality that have been in effect since 1993 would remain unchanged (55 FR 34120, August 21, 1990).

B. Why Is EPA Making This Proposal?

1. Heavy-Duty Vehicles Contribute to Serious Air Pollution Problems

As will be discussed in detail in section II, emissions from heavy-duty vehicles contribute greatly to a number of serious air pollution problems, and will continue to do so into the future absent further controls to reduce these emissions. First, heavy-duty vehicles contribute to the health and welfare effects of ozone, PM, NO_X, SO_X, 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. Ozone also causes crop and forestry losses, while PM also causes damage to materials, and soiling. Second, both NO_X and PM contribute to substantial visibility impairment in many parts of the U.S. Third, NO_X emissions from heavy-duty trucks contribute to the acidification, nitrification and eutrophication of water bodies.

Millions of Americans live in areas with unhealthful air quality that currently endangers public health and welfare. Without emission reductions from the proposed standards for heavy-duty vehicles, there is a significant risk that an appreciable number of areas across the country will violate the 1-hour ozone national ambient air quality standard (NAAQS) during the period when these standards will take effect. Furthermore, our analysis shows that PM_{10} concentrations in 10 areas with a combined population of 27 million people face a significant risk of exceeding the PM_{10} NAAQS without significant additional controls in 2007 or thereafter. Under the mandates and authorities in the Clean Air Act, federal, State, and local governments are working to bring ozone and particulate levels into compliance with the 1-hour ozone and PM_{10} NAAQS through State Implementation Plan (SIP) attainment and maintenance plans, and to ensure that future air quality reaches and continues to achieve these health-based standards. The reductions proposed in this rulemaking would play a critical part in these important efforts.

Emissions from heavy-duty vehicles account for substantial portions of the country's ambient PM and NO_X levels. (NO_X is a key precursor to ozone formation). By 2007, we estimate that heavy-duty vehicles will account for 29 percent of mobile source NO_X emissions and 14 percent of mobile source PM emissions. These proportions are even higher in some urban areas, such as in Albuquerque, where HDVs contribute 37 percent of the mobile source NO_X emissions and 20 percent of the mobile source PM emissions. The PM and NO_X standards for heavy-duty vehicles proposed in this rule would have a substantial impact on these emissions. By 2030, NO_X emissions from heavy-duty vehicles under today's proposed standards would be reduced by 2.8 million tons, and PM emissions would decline by about 110,000 tons, dramatically reducing this source of NO_X and PM emissions. Urban areas, which include many poorer neighborhoods, can be disproportionately impacted by HDV emissions, and these neighborhoods would thus receive a relatively larger portion of the benefits expected from new HDV emissions controls. Over time, the relative contribution of diesel engines to air quality problems will go even higher if diesel-equipped light-duty vehicles become more popular, as is expected by some automobile manufacturers.

In addition to its contribution to PM inventories, diesel exhaust PM is of special concern because it has been implicated in an increased risk of lung cancer and respiratory disease in human studies. The EPA draft Health Assessment Document for Diesel Emissions is currently being revised based on comments received from the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board. The current EPA position is that diesel exhaust is a likely human carcinogen and that this cancer hazard applies to environmental levels of exposure.[2] In the draft Health Assessment Document for Diesel Emissions, EPA provided a qualitative perspective that the upper bounds on environmental cancer risks may exceed 10^{-6} and could be as high as 10^{-3}. Several other agencies and governing bodies have designated diesel exhaust or diesel PM as a ''potential'' or ''probable'' human carcinogen. In addition, diesel PM poses nonmalignant respiratory hazards to humans, not unlike, in some respects, hazards from exposure to ambient $PM_{2.5}$, to which diesel PM contributes. 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.[3]

2. Technology-Based Solutions

Although the air quality problems caused by diesel exhaust are formidable, we believe they can be resolved through the application of high-efficiency emissions control technologies. As discussed in detail in section III, the development of diesel emissions control technology has advanced in recent years so that very large emission reductions (in excess of 90 percent) are possible, especially through the use of catalytic emission control devices installed in the vehicle's exhaust system (and integrated with the engine controls). These devices are often referred to as ''exhaust emission control'' or ''aftertreatment'' devices. Exhaust emission control devices, in the form of the well-known catalytic converter, have been used in gasoline-fueled automobiles for 25 years, but have had only limited application in diesel vehicles.

Because the Clean Air Act requires us to set heavy-duty engine standards that reflect the greatest degree of emission reduction achievable through the application of available technology (subject to a number of criteria as discussed in section I.B.3), this notice proposes these standards, and proposes a justification for their adoption based on the air quality need, their technological feasibility, costs, and other criteria listed in the Act (see section III of this document). As part of this proposal, we are also proposing changes to diesel fuel quality in order to enable these advanced technologies (section IV). Heavy-duty gasoline engines would also be able to reach the significantly cleaner levels envisioned in this proposal by relying on the transfer of recent technology developments for light-duty applications, given the recent action taken to reduce sulfur in gasoline (65 FR 6698, February 10, 2000).

We believe the proposed standards would require the application of high-efficiency PM and NO_X exhaust emission controls to heavy-duty diesel vehicles. High-efficiency PM exhaust emission control technology has been available for several years, although engine manufacturers have generally not needed this technology in order to meet our PM emission standards. This technology has continued to improve over the years, especially with respect to durability and robust operation in use. It has also proven extremely effective in reducing exhaust hydrocarbon emissions. Thousands of such advanced-technology systems are now in use in fleet programs, especially in Europe. However, as discussed in detail in section III, these advanced-technology systems are very sensitive to sulfur in the fuel. For the technology to be viable and capable of meeting the proposed standards, we believe, based on information currently available, that it will require diesel fuel with sulfur content at the 15 ppm level.

Similarly, high-efficiency NO_X exhaust emission control technology will be needed if heavy-duty vehicles are to attain the proposed standards. We believe this technology, like the PM technology, is dependent on 15 ppm diesel fuel sulfur levels to be feasible, marketable, and capable of achieving the proposed standards. High-efficiency NO_X exhaust emission control technology has been quite successful in gasoline direct injection engines that operate with an exhaust composition fairly similar to diesel exhaust. However, as discussed in section III, application of this technology to diesels has some additional challenges and so has not yet gotten to the field trial stage. We are confident that the certainty of low-sulfur diesel fuel that would be provided by promulgation of the proposed fuel standard would allow the application of this technology to diesels to progress rapidly, and would result in systems capable of achieving the proposed standards. However, we acknowledge that our proposed NO_X standard represents an ambitious target for this technology, and so we are asking for comment on the appropriateness of a technology review of diesel NO_X exhaust emission controls.

The need to reduce the sulfur in diesel fuel is driven by the requirements of the exhaust emission control technology that we project would be needed to meet the proposed standards. The challenge in accomplishing the sulfur reduction is driven by the feasibility of needed refinery modifications, and by the costs of making the modifications and running the equipment. In consideration of the impacts that sulfur has on the efficiency, reliability, and fuel economy impact of diesel engine exhaust emission control devices, we believe that controlling the sulfur content of highway diesel fuel to the 15 ppm level will be necessary. Furthermore, although the refinery modifications and process changes needed to meet a 15 ppm restriction are expected to be substantial, we propose that this level is both feasible and cost effective. However, we are asking for comment on various concepts to provide implementation flexibility for refiners.

3. Basis for Action Under the Clean Air Act

Section 202(a)(1) of the Act directs us to establish standards regulating the emission of any air pollutant from any class or classes of new motor vehicles or engines that, in the Administrator's judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. Section 202(a)(3) requires that EPA set standards for heavy-duty trucks that reflect the greatest degree of emission reduction achievable through the application of technology which we determine will be available for the

[2] Environmental Protection Agency (1999) Health Assessment Document for Diesel Emissions: SAB Review Draft. EPA/600/8–90/057D Office of Research and Development, Washington, D.C. The document is available electronically at www.epa.gov/ncea/diesel.htm

[3] For example, see letter dated July 13, 1999 from John Elston and Richard Baldwin on behalf of the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (docket A–99–06, item II–D–78).

model year to which the standards apply. We are to give appropriate consideration to cost, energy, and safety factors associated with the application of such technology. We may revise such technology-based standards, taking costs into account, on the basis of information concerning the effects of air pollution from heavy-duty vehicles or engines and other sources of mobile source related pollutants on the public health and welfare. Section 202(a)(3)(C) requires that promulgated standards apply for no less than three years and go into effect no less than 4 years after promulgation. This proposal has been developed in conformance with these statutory requirements.

We believe the evidence provided in section III and the draft Regulatory Impact Analysis (RIA) indicates that the stringent technology-forcing standards proposed today are feasible and reflect the greatest degree of emission reduction achievable in the model years to which they apply. We have given appropriate consideration to costs in choosing these standards. Our review of the costs and cost-effectiveness of these proposed standards indicate that they would be reasonable and comparable to the cost-effectiveness of other emission reduction strategies that have been required or could be required in the future. We have also reviewed and given appropriate consideration to the energy factors of this rule in terms of fuel efficiency and effects on diesel production and distribution, as discussed below, as well as any safety factors associated with these proposed standards.

The information regarding air quality and the contribution of heavy-duty engines to air pollution in section II and the Draft RIA provides strong evidence that emissions from such engines significantly and adversely impact public health or welfare. First, there is a significant risk that several areas will fail to attain or maintain compliance with the NAAQS for 1-hour ozone concentrations or PM_{10} concentrations during the period that these proposed new vehicle and engine standards would be phased into the vehicle population, and that heavy-duty engines contribute to such concentrations, as well as to concentrations of other NAAQS-related pollutants. Second, EPA currently believes that diesel exhaust is a likely human carcinogen. The risk associated with exposure to diesel exhaust includes the particulate and gaseous components. Some of the toxic air pollutants associated with emissions from heavy-duty vehicles and engines include benzene, formaldehyde, acetaldehyde, dioxin, acrolein, and 1,3-butadiene. Third, emissions from heavy-duty engines contribute to regional haze and impaired visibility across the nation, as well as acid deposition, POM deposition, eutrophication and nitrification, all of which are serious environmental welfare problems.

Based on this evidence, EPA believes that, for purposes of section 202(a)(1), emissions of NO_X, VOCs, SO_X and PM from heavy-duty trucks can reasonably be anticipated to endanger the public health or welfare. In addition, this evidence indicates that it would not be appropriate to modify the technology based standards pursuant to section 202(a)(3)(B). EPA believes that it is required under section 202(a)(3)(A) to set technology based standards that meet the criteria of that provision, and is not required to make an affirmative determination under section 202(a)(1). Instead EPA is authorized to take air quality into consideration under section 202(a)(3)(B) in deciding whether to modify or not set standard under section 202(a)(3)(A). In this case, however, EPA believes the evidence would fully support a determination under section 202(a)(1) to set standards, and a determination not to modify such standards under section 202(a)(3)(B).

In addition, there is significant evidence that emissions from heavy-duty trucks contribute to levels of ozone such that large segments of the national population are expected to experience prolonged exposure over several hours at levels that present serious concern for the public health and welfare. The same is true for exposure to fine PM. These public health and welfare problems are expected to occur in many parts of the country, including areas that are in compliance with the 1-hour ozone and PM_{10} NAAQS (PM_{10} is particulate matter that is 10 microns or smaller). This evidence is an additional reason why the controls proposed today are justified and appropriate under the Act. While EPA sees this as additional support for this action, EPA also believes that the evidence of air pollution problems summarized above and described in greater detail elsewhere is an adequate justification for this rule independent of concern over prolonged exposure to ozone levels.

Section 211(c) of the CAA allows us to regulate fuels where emission products of the fuel either: (1) Cause or contribute to air pollution that reasonably may be anticipated to endanger public health or welfare, or (2) will impair to a significant degree the performance of any emission control device or system which is in general use, or which the Administrator finds has been developed to a point where in a reasonable time it would be in general use were such a regulation to be promulgated. This proposal meets each of these criteria. The discussion of the first test is substantially the same as the above discussion for the heavy-duty engine standards, because SOx emissions from heavy-duty diesel vehicles are due to sulfur in diesel fuel. The substantial adverse effect of high diesel sulfur levels on diesel control devices or systems expected to be used to meet the heavy-duty standards is discussed in depth in section III.F and in the Draft RIA. In addition, our authority under section 211(c) is discussed in more detail in appendix A to the draft RIA.

C. Putting This Proposal in Perspective

There are several helpful perspectives to establish in understanding the context for this proposal: the growing popularity of diesel engines, past progress and new developments in diesel emissions control, Tier 2 light-duty emission standards and other related EPA initiatives (besides the above-discussed rulemaking for highway heavy-duty engine emission standards in 2004), and recent actions and plans to control diesel emissions by the States and in other countries.

1. Diesel Popularity

The diesel engine is increasingly becoming a vital workhorse in the United States, moving much of the nation's freight, and carrying out much of its farm, construction, and other labor. Diesel engine sales have grown impressively over the last decade, so that now about a million new diesel engines are put to work in the U.S. every year. Unfortunately, these diesel engines emit large quantities of harmful pollutants annually.

Furthermore, although diesel emissions in this country come mostly from heavy-duty trucks and nonroad equipment, an additional source may grow out of auto manufacturers' plans to greatly increase the sales of diesel-powered light-duty vehicles (LDVs) and especially of light-duty trucks (LDTs), a category that includes the fast-selling sport-utility vehicles, minivans, and pickup trucks. These plans reflect the continuation of an ongoing dieselization trend, a trend recently most evident in the growing popularity of diesel-powered light heavy-duty trucks (8500 to 19,500 pounds). Diesel market penetration is working its way from larger to smaller highway applications and to a broader array of nonroad equipment applications. Finally, especially in Europe where diesels have already gained a broad consumer acceptance, the diesel engine is increasingly viewed as an attractive technology option for reducing emissions of gases that contribute to global warming, because it has greater operating efficiency than a gasoline engine.

2. Past Progress and New Developments

Since the 1970's, highway diesel engine designers have employed numerous strategies to meet our emissions standards, beginning with smoke controls, and focusing in the 1990's on increasingly stringent NO_X, hydrocarbon, and PM standards. These strategies have generally focused on reducing engine-out emissions and not on exhaust emission controls, although low-efficiency oxidation catalysts have been applied in some designs to reduce PM (and even their effectiveness has been limited by sulfur in the fuel). On the fuel side, we set quality standards that provided emissions benefits by limiting the amount of sulfur and aromatics in highway diesel fuel beginning in 1993 (55 FR 34120, August 21, 1990). Our most recent round of standard setting for heavy-duty highway diesels occurred in 1997 (62 FR 54693, October 21, 1997), effective with the 2004 model year. These standards were recently reviewed in a proposed rulemaking (64 FR 58472, October 29, 1999), which proposed to confirm them. These actions will result in engines that emit only a fraction of the NO_X, hydrocarbons, and PM produced by engines manufactured just a decade ago. We consider this an important first phase of our current initiative to reconcile the diesel engine with the environment.

Nevertheless, certain characteristics inherent in the way diesel fuel combustion occurs have prevented achievement of emission levels comparable to those of today's gasoline-fueled vehicles. Although diesel engines provide advantages in terms of fuel economy, durability, and evaporative emissions, and have inherently low exhaust emissions of hydrocarbons and carbon monoxide, controlling NO_X emissions is a greater challenge for diesel engines than for gasoline engines, primarily because of the ineffectiveness of three-way catalysis in the oxygen-rich and relatively cool diesel exhaust environment. Similarly, PM emissions, which are inherently low for properly operating gasoline engines, are more difficult to control in diesel engines, because the diesel combustion process tends to form soot particles. The challenge is somewhat complicated by the fact that historical diesel NO_X control approaches tend to increase PM, and vice versa, but both are harmful pollutants that need to be controlled.

Considering the air quality impacts of diesel engines and the potential for growth of diesels in the lighter-duty portion of the market, it is imperative that progress in diesel emissions control continue. Fortunately, encouraging progress is now being made in the design of exhaust emission control devices for diesel applications, driven in part by the challenge presented by the stringent Tier 2 standards for light-duty vehicles. As discussed in detail in section III, promising new exhaust emission control technologies for NO_X, PM, and hydrocarbon reduction show potential for a major advancement in diesel emissions control of a magnitude comparable to that ushered in by the automotive catalytic converter in the 1970's. However, changes in diesel fuel quality will be needed to enable these high-efficiency exhaust emission control devices. With these promising technologies, diesel vehicles have potential to achieve gasoline-like exhaust emission levels, in addition to their inherent advantages over gasoline vehicles with respect to fuel economy, lower greenhouse gas emissions, and lower evaporative hydrocarbon emissions.

3. Tier 2 Emissions Standards

Auto manufacturers' design plans for new light-duty diesel vehicle models will be greatly affected by our recent adoption of stringent new emission standards for light-duty highway vehicles (referred to as "Tier 2" standards) that will phase in between 2004 and 2009. These Tier 2 standards will require significant improvements in electronic engine controls and catalysts on gasoline vehicles. (We anticipate that these advances will be transferred over to heavy-duty gasoline vehicles in meeting the standards proposed in this document). The Tier 2 NO_X and PM standards (that apply equally to gasoline and diesel vehicles) are far more challenging for diesel engine designers than the most stringent light- or heavy-duty vehicle standards promulgated to date, and so will require the use of advanced emission control technologies. However, the low sulfur highway diesel fuel proposed in this notice would make it possible for designers to employ advanced exhaust emission control technologies in these light-duty applications, and the timing of the proposed fuel change provides for the use of these devices in time to satisfy Tier 2 phase-in requirements.

The Tier 2 program phases in interim and final standards over a number of years, providing manufacturers the option of delaying some of their production of final Tier 2 designs until later in the phase-in. For vehicles up to 6000 lbs GVWR (LDVs) and light light-duty trucks (LLDTs)), the interim standards begin in 2004 and phase out by 2007, as they are replaced by the final Tier 2 standards. For vehicles between 6000 and 8500 lbs (heavy light-duty trucks (HLDTs)), the interim standards begin in 2004 and phase out by 2009 as they are replaced by the final Tier 2 standards. A new category of vehicles between 8,500 and 10,000 lbs, medium-duty passenger vehicles (MDPVs), will follow the same phase-in schedule as HLDTs.

Our assessment in the Tier 2 final rule is that the interim standards are feasible for diesel vehicles without a need for fuel quality changes. Manufacturers can take advantage of the flexibilities provided in the Tier 2 program to delay the need for light-duty diesels to meet the final Tier 2 levels until late in the phase-in period (as late as 2007 for LDVs and LLDTs, and 2009 for HLDTs and MDPVs). However, low sulfur fuel is expected to be needed for diesel vehicles designed to meet the final NO_X and PM standards, because these vehicles are likely to employ light-duty versions of the sulfur-sensitive exhaust emission control technologies discussed in Section III. The gasoline quality changes and light-duty gasoline engine developments that will result from the Tier 2 rule would also help make it feasible for heavy-duty gasoline engines to meet the standards proposed in this document.

4. Mobile Source Air Toxics Rulemaking

Passenger cars, on-highway trucks, and nonroad equipment emit hundreds of different compounds and elements. Several of these are considered to be known, likely, or possible human carcinogens. These include diesel exhaust, plus several VOCs such as acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and acrolein. Trace metals may also be present in heavy-duty diesel engine emissions, resulting from metals in fuels and lubricating oil, and from engine wear. Several of these metals have carcinogenic and mutagenic effects.

These and other mobile source air toxics are already controlled under existing programs established under Clean Air Act sections 202(a) (on-highway engine requirements), 211 (the fuel requirements), and 213 (nonroad engine requirements). Although these programs are primarily designed for control of criteria pollutants, especially ozone and PM_{10}, they also achieve important reductions in air toxics through VOC and hydrocarbon controls.

In addition to these programs, section 202(l)(2) of the Act directs us to consider additional controls to reduce emissions of hazardous air pollutants from motor vehicles, their fuels, or both. Those standards are to reflect the greatest degree of emission reduction achievable through the application of technology which will be available, taking into account existing standards, costs, noise, energy, and safety factors. We anticipate that this section 202(l)(2) rulemaking, which we expect to propose in July 2000 and finalize in December 2000, will consist of three parts. First, we will identify a list of hazardous air pollutants emitted from motor vehicles and determine which of these endanger human health and welfare. Diesel particulate matter will be considered as part of this determination because, as discussed in section II, human epidemiological studies have suggested that diesel exhaust is associated with increased risk of adverse respiratory effects and lung cancer. Second, we will consider more comprehensively the contribution of mobile sources to the nation's air toxics inventory and evaluate the toxics benefits of existing and proposed emission control programs. The benefits of the program proposed in today's action will be included in this analysis. Finally, we will consider whether additional controls are appropriate at this time, given technological feasibility, cost, and the other criteria specified in the Act.

5. Nonroad Engine Standards and Fuel

Although this proposal covers only highway diesel engines and fuel, it is clear that potential requirements for nonroad diesel engines and fuel are related. It is expected that nonroad diesel fuel quality, currently unregulated, may need to be controlled in the future in order to reduce the large contribution of nonroad engines to NO_X and PM inventories. Refiners, fuel distributors, states, environmental organizations, and others have asked that we provide as much information as possible about the future specifications for both types of fuel as early as possible.

We do plan to give further consideration to further control of nonroad engine emissions. As discussed below in section IX, an effective control program for these engines requires the resolution of several major issues relating to engine emission control technologies and how they are affected by fuel sulfur content. The many issues connected with any rulemaking for nonroad engines and fuel warrant serious attention, and we believe it would be premature today for us to attempt to propose resolutions to them. We plan to initiate action in the future to formulate thoughtful proposals covering both nonroad diesel fuel and engines.

6. Actions in California

The California Air Resources Board (ARB) and local air quality management districts within California are also pursuing measures to better control diesel emissions. Key among these efforts is work resulting from the Board's designation of particulate emissions from diesel-fueled engines as a toxic air contaminant (TAC) on August 27, 1998. TACs are air pollutants that may cause or contribute to an increase in death or serious illness or may pose a present or future hazard to human health. The TAC designation was based on research studies showing that emissions from diesel-fueled engines may cause cancer in animals and humans, and that workers exposed to higher levels of emissions from diesel-fueled engines are more likely to develop lung cancer.

The ARB has now begun a public process to evaluate the need to further reduce the public's exposure to organic gases and PM emissions from diesel-fueled engines, and the feasibility and cost of doing so.[4] This evaluation is being done in consultation with the local air districts, affected industries, and the public, and will result in a report on the appropriate degree of control. Based on this report, if cost effective measures are identified that will reduce public exposure, then specific control measures applicable in California will be developed in a public process.

The ARB also recently adopted stringent new emission requirements for urban transit buses and is considering similar requirements for school buses.[5] This program is aimed at encouraging the use of clean alternative fuels and high-efficiency diesel emission control technologies. Their program includes requirements for zero-emissions buses, fleet average NO_X levels, and retrofits for PM control, as well as model year 2007 NO_X and PM standards levels of 0.2 and 0.01 g/bhp-hr, respectively (equal to the levels proposed in this document). It also requires that all diesel fuel used by transit agencies after July 1, 2002 must meet a cap of 15 ppm sulfur. This is the same as the sulfur level proposed in this document, but in batch amounts and on a much earlier schedule to support the ARB's proposed PM retrofit schedule.

California's urban bus program is focused on only a portion of the highway diesel fleet and fuel, characterized by short-range trips and captive fuel supplies. The large amount of interstate truck traffic in California and the fact that these trucks can travel many miles between refuelings would dramatically reduce the effectiveness of a more comprehensive State program, and would also subject California businesses to competitive disadvantages. As a result, the ARB has stressed the need for action at a Federal level, and is depending on our efforts to control HDV NO_X and PM emissions and to regulate diesel fuel. We agree that a national program is appropriate to ensure the effectiveness of such a program.

7. Retrofit Programs

Many States facing air quality improvement challenges have expressed strong interest in programs that would reduce emissions from existing highway and nonroad diesel engines through the retrofitting of these engines with improved emission control devices. The urban bus program proposed by the California ARB includes such a retrofit requirement as one of its major components (see section I.C.6). These retrofit programs are appealing because the slow turnover of the diesel fleet to the new low-emitting engines makes it difficult to achieve near-term air quality goals through new engine programs alone. Some of the exhaust emission control technologies discussed in this proposal are especially appealing for use in retrofits because they can be fitted to an existing vehicle as add-on devices without major engine modifications, although some of the more sophisticated systems that require careful control of engine parameters may be more challenging.

Because of the uncertainty at this time in how and when such programs may be implemented, this proposal does not calculate any benefits from them. Nevertheless, we believe that this proposed program can enable the viability of these retrofit technologies. We expect that large emission benefits from the existing fleet could be realized as a result of the fuel changes we are proposing here, combined with retrofit versions of the technologies that would be developed in response to the proposed engine standards. These

[4] Regularly updated information on this effort can be obtained at a website maintained by the ARB staff: www.arb.ca.gov/toxics/diesel/diesel.htm

[5] ''Notice of Public Hearing To Consider the Adoption of a Public Transit Bus Fleet Rule and Emission Standards For New Urban Buses'', California ARB, November 30, 1999, and ARB Resolution 00–2, dated February 24, 2000.

benefits would be especially important in the early years of the program when new vehicles standards are just beginning to have an impact, and when States and local areas need to gain large reductions to attain air quality goals.

8. Actions in Other Countries

There is substantial activity taking place in many countries of the world related to the regulation of diesel fuel and engines. The large light-duty vehicle market share enjoyed by diesels in many European countries has helped to stir innovation in dealing with diesel emissions problems. Advanced emissions control technologies are being evaluated there in the in-use fleet and experience gained from these trials is helping to inform the diesel emissions control discussion in the U.S. In addition, several European countries have low sulfur diesel fuel, with maximum sulfur levels varying from 10 to 50 ppm, and so experience gained from the use of these fuels, though not completely transferable to the U.S. situation, also helps to inform the discussion. European Union countries will limit sulfur in diesel fuel to 50 ppm by 2005, and even more aggressive plans are being discussed or implemented. The United Kingdom made a rapid conversion to 50 ppm maximum sulfur diesel fuel last year by offering tax incentives. This change occurred with much smaller refinery investments than had been predicted, and some refinery production there is actually at levels well below the 50 ppm cap. Germany is moving forward with plans to introduce a 10 ppm sulfur cap for diesel fuel by 2003, also via tax incentives, and is attempting to get the 50 ppm specification that was adopted by the European Commission revised downward to the 10 ppm cap level.

One European country has had extensive experience with the transition to low sulfur diesel fuel. In the early 1990's, Sweden decided to take advantage of the environmental benefits of 10 ppm sulfur/low aromatics fuel by introducing it with a reduction in the diesel fuel tax. The program has been quite successful, and in excess of 90 percent of the road fuel used there is of this 10 ppm maximum sulfur class.[6] The ability of the Swedish fuel distributors to maintain these low sulfur levels at the fuel stations has also been quite good.

Section VII.H discusses how differences between the future fuel specifications in the U.S. and those in Canada and Mexico may affect the emissions control program proposed in this document.

II. The Air Quality Need and Projected Benefits

A. Overview

Heavy-duty vehicle emissions contribute to air pollution with a wide range of adverse health and welfare impacts. Emissions of VOC, CO, NO_X, SO_X, and PM from HD vehicles contribute a substantial percentage to ambient concentrations of ozone, PM, sulfur and nitrogen compounds, aldehydes, and substances known or considered likely to be carcinogens. VOC and diesel PM emissions include some specific substances known or suspected to cause cancer, and diesel exhaust emissions are associated with non-cancer health effects. These ambient concentrations in turn cause human health effects and many welfare effects including visibility reductions, acid rain, nitrification and eutrophication of water bodies.

Emissions from heavy-duty vehicles, which are predominantly diesel-powered, account for substantial portions of the country's ambient PM and ground-level ozone levels. (NO_X is a key precursor to ozone formation). By 2007, we estimate that heavy-duty vehicles would account for 29 percent of mobile source NO_X emissions, and 14 percent of mobile source PM emissions. These proportions are even higher in some urban areas, such as New York and Los Angeles. Urban areas, which include many poorer neighborhoods, can be disproportionately impacted by HDV emissions because of heavy traffic in and out of densely populated urban areas. Of particular concern is human epidemiological evidence linking diesel exhaust to an increased risk of lung cancer. Based on information provided in the draft Health Assessment Document for Diesel Emissions[7] and other sources of information, we believe that emissions from heavy-duty diesel vehicles contribute to air pollution that warrants regulatory attention under section 202(a)(3) of the Act.

Thirty-six metropolitan areas with a total population of 111 million people have recently violated or are currently violating the 1-hour ozone NAAQS, and have ozone modeling or other factors which indicate a risk of NAAQS violations in 2007 or beyond. Another six areas with 11 million people have recently experienced ozone concentrations within 10 percent of exceeding the NAAQS between 1996 and 1998 and have some evidence of a risk of future violations. Ten PM_{10} nonattainment areas with 27 million people face a significant risk of experiencing particulate matter levels that violate the PM_{10} standard during the time period when this proposal would take effect. Without reductions from these proposed standards, there is a significant risk that an appreciable number of these areas would violate the 1-hour ozone and PM_{10} standards during the time period when these proposed standards would apply to heavy-duty vehicles. Under the mandates and authorities in the Clean Air Act, federal, State, and local governments are working to bring ozone and particulate levels into compliance with the 1-hour ozone and PM_{10} NAAQS through SIP attainment and maintenance plans, and to ensure that future air quality continues to achieve these health-based standards. The reductions proposed in this rulemaking would assist these efforts.

The proposed heavy-duty vehicle and engine emission standards, along with the diesel fuel sulfur standard proposed today, would have a dramatic impact in reducing the large contribution of HDVs to air pollution. The proposed standards would result in substantial benefits to public health and welfare through significant annual reductions in emissions of NO_X, PM, NMHC, carbon monoxide, sulfur dioxide, and air toxics. For example, we project a 2 million ton reduction in NO_X emissions from HD vehicles in 2020, which would increase to 2.8 million tons in 2030 when the current HD vehicle fleet is completely replaced with newer HD vehicles that comply with these proposed emission standards. When coupled with the emission reductions projected to result from the Phase 1 (model year 2004) HDV standards, the emission reductions from heavy-duty vehicles are projected to be as large as the substantial reductions the Agency expects from light-duty vehicles as a result of its recently promulgated Tier 2 rulemaking.

B. Public Health and Welfare Concerns

The following subsections present the available information on the air pollution situation that is likely to exist without this rule for each ambient pollutant. We also present information on the improvement that would result from this rule. The Agency's analysis and this proposal are supported by the numerous letters received from States and environmental organizations calling for significant emission reductions from heavy-duty vehicles in order to enable

[6] Memo from Thomas M. Baines to Docket A–99–06, October 29, 1999, Docket #A–99–06, Item II–G–12.

[7] EPA is revising this draft document in response to comments by the CASAC.

these areas to achieve and sustain clean, healthful air.[8]

1. Ozone and Its Precursors

a. Health and Welfare Effects From Short-Term Exposures to Ozone

NO_X and VOC are precursors in the photochemical reaction which forms tropospheric ozone. A large body of evidence shows that ozone can cause harmful respiratory effects including chest pain, coughing, and shortness of breath, which affect people with compromised respiratory systems most severely. When inhaled, ozone can cause acute respiratory problems; aggravate asthma; cause significant temporary decreases in lung function of 15 to over 20 percent in some healthy adults; cause inflammation of lung tissue; may increase hospital admissions and emergency room visits; and impair the body's immune system defenses, making people more susceptible to respiratory illnesses. Children and outdoor workers are likely to be exposed to elevated ambient levels of ozone during exercise and, therefore, are at greater risk of experiencing adverse health effects. Beyond its human health effects, ozone has been shown to injure plants, reducing crop yields.

b. Current and Future Nonattainment Status With the 1-Hour Ozone NAAQS

Exposure to levels of ozone that are not in compliance with the 1-hour ozone NAAQS are a serious public health and welfare concern. The following sections discuss the present situation and outlook regarding attainment in areas of the country where ozone levels presently fail to comply with this NAAQS, or where they have come close to failing to comply in recent years.

Over the last decade, emissions have declined and national air quality has improved for all six criteria pollutants, including ozone.[9] Some of the greatest emissions reductions have taken place in densely-populated urban areas, where emissions are heavily influenced by mobile sources such as cars and trucks. For example, VOC and NO_X emissions in several urban areas in the Northeast declined by 15 percent and 14 percent from 1990 to 1996.[10] However, when ozone trends are normalized for annual weather variations between 1989 and 1998, they reveal a downward trend in the early 1990's followed by a leveling off, or an upturn in ozone levels, over the past several years in many urban areas.[11]

Despite impressive improvements in air quality over the last decade, present concentrations of ground-level ozone continue to endanger public health and welfare in many areas. As of December, 1999, 92 million people (1990 census) lived in 32 metropolitan areas designated nonattainment under the 1-hour ozone NAAQS.[12] In addition, there are 14 areas with a 1996 population of 17 million people not currently listed as non-attainment areas because the 1-hour ozone standard was revoked for these areas (we have proposed to re-instate the standard).[13] These 14 areas are relevant to this proposal because ozone concentrations above the health-based ozone standard, should they occur, endanger public health and welfare independent of the applicability of the 1-hour standard or an area's official attainment or nonattainment status. Ozone also has negative environmental impacts. For example, exposure of vegetation to ozone can inhibit photosynthesis, and alter carbohydrate allocation, which in turn can suppress the growth of crops, trees, shrubs and other plants.

The next two sections present lists of metropolitan areas, in two tables, with potential for violating the ozone standard in the future. The first section presents a table with 33 metropolitan areas that were predicted by Tier 2 modeling to have exceedances in either 2007 or 2030, and accompanying text identifies an additional nine areas for which we have other evidence of a risk of future exceedances. The second section discusses the air quality prospects for these 42 areas, which are divided into several groups. These groups are presented in Table II.B–2.

i. Ozone Predictions Made in the Tier 2 Rulemaking and Other Information on Ozone Attainment Prospects

In conjunction with its Tier 2 rulemaking efforts, the Agency performed ozone air quality modeling for nearly the entire Eastern U.S. covering metropolitan areas from Texas to the Northeast, and for a western U.S. modeling domain. The ozone modeling we did as part of the Tier 2 rulemaking predicted that without further emission reductions, a significant number of areas recently experiencing ozone exceedances across the nation are at risk of failing to meet the 1-hour ozone NAAQS in 2007 and beyond, even with Tier 2 and other controls currently in place.

The general pattern observed from the Tier 2 ozone modeling is a broad reduction between 1996 and 2007 in the geographic extent of ozone concentrations above the 1-hour NAAQS, and in the frequency and severity of exceedances. Despite this improvement from 1996 to 2007, many ozone exceedances were predicted to occur in 2007 even with reductions from Tier 2 standards and other controls currently in place, affecting 33 metropolitan areas across the nation. Assuming no additional emission reductions beyond those that will be achieved by current control programs,[14] a slight decrease below 2007 levels in modeled concentrations and frequencies of exceedances was predicted for 2030 for most areas. Exceedances were still predicted in 2030 in most of the areas where they were predicted in 2007.[15]

Although we did not model ozone concentrations for years between 2007 and 2030, we may expect that they would broadly track the national emissions trends. Based on these emission trends alone, national ozone concentrations, on average, would be projected to decline after 2007 largely due to penetration of Tier-2 compliant vehicles into the light duty vehicle fleet, but begin to increase around 2015 or 2020 due to economic growth until they reach the 2030 levels just described. However, the change in ozone levels from the expected NO_X reduction is relatively small compared to the effects of variations in ozone due to meteorology. Furthermore, in some areas, where growth exceeds national averages, emissions levels would begin increasing sooner and reach higher levels in 2030.

[8] Letters from States and environmental organizations are located in the docket for this proposal.

[9] National Air Quality and Emissions Trends Report, 1997, US EPA, December 1998.

[10] National Emissions Trends database.

[11] Trends in Daily Maximum 1-hour Ozone in Selected Urban Areas, 1989–1998.

[12] Memorandum to Air Docket, January 12, 2000. Information on ozone nonattainment areas and population as of December 13, 1999 from US EPA website www.epa.gov/airs/nonattn.html, USA Air Quality Nonattainment Areas, Office of Air Quality Planning and Standards. The reader should note that the 32 areas mentioned here are designated nonattainment areas, while the 36 areas noted in the overview section have recent (1995–1998) or current violations, and predicted exceedances in 2007 or 2030 based on air quality modeling or other evidence discussed in more detail later in this preamble, and in the draft RIA.

[13] 64 FR 57424 (October 25, 1999)

[14] Current control programs assumed for the predictions summarized here included the Tier 2/ Gasoline Sulfur program and some specific programs that are legally required but not yet fully adopted, such as the regional Ozone Transport Rule and not-yet-adopted MACT standards that will affect VOC emissions.

[15] Achieving attainment with the ozone standard is only one measure of air quality improvement. EPA found that the Tier 2 program significantly lowers the model-predicted number of exceedances of the ozone standard by one tenth in 2007, and by almost one-third in 2030 across the nation (Tier 2 RIA).

Table II.B–1 lists the 33 areas with predicted 1-hour ozone exceedances in 2007 and/or 2030 based on the Tier 2 modeling, after accounting for the emission reductions from the Tier 2 program and other controls.[16] There are areas that are not included in this table that will be discussed shortly. A factor to consider with respect to the ozone predictions in Table II.B–1 is that recent improvements to our estimates of the current and future mobile source NO_X inventory have resulted in an increase in our estimate of aggregate NO_X emissions from all sources by more than eight percent since the air quality modeling performed for the Tier 2 rule. The adjusted NO_X inventory level in 2015 is greater than the NO_X inventory used in the Tier 2 air quality analysis for 2030. If we were to repeat the ozone modeling now for the 2015 time frame, using the new emissions estimates, it would most likely predict exceedances in 2015 for all the areas that had 2030 exceedances predicted in the modeling done for the Tier 2 rulemaking. As summarized in Table II.B–1, the Tier 2 modeling predicted that there will be 33 areas in 2007 or 2030 with about 89 million people predicted to exceed the 1-hour ozone standard, even after Tier 2 and other controls currently in place. Additional information on ozone modeling is found in the draft RIA and the technical support document for the Tier 2 rule, which is in the docket for this rulemaking. We request comment on the inventory estimates and ozone air quality modeling analysis described in this proposal.

TABLE II.B–1.—METROPOLITAN AREAS WITH PREDICTED EXCEEDANCES IN 2007 OR 2030 FROM TIER 2 AIR QUALITY MODELING INCLUDING EMISSION REDUCTIONS FROM TIER 2 AND OTHER CURRENT/COMMITTED CONTROLS

CMSA/MSAs	2007 Control case	2030 Control case	1996 Population (millions)
Boston, MA CMSA	X	X	5.6
Chicago, IL CMSA	X	X	8.6
Cincinnati, OH CMSA**	X		1.9
Cleveland, OH CMSA*	X	X	2.9
Detroit, MI CMSA*	X	X	5.3
Houston, TX CMSA	X	X	4.3
Milwaukee, WI CMSA	X	X	1.6
New York City, NY CMSA	X	X	19.9
Philadelphia, PA CMSA	X	X	6.0
Washington,-Baltimore, DC-VA-WV-MD CMSA	X	X	7.2
Atlanta, GA MSA	X	X	3.5
Barnstable, MA MSA	X	X	0.2
Baton Rouge, LA MSA	X	X	0.6
Benton Harbor, MI MSA	X	X	0.2
Biloxi, MS MSA*	X	X	0.3
Birmingham, AL MSA	X	X	0.9
Charlotte, NC MSA	X	X	1.3
Grand Rapids, MI MSA	X	X	1.0
Hartford, CT MSA	X	X	1.1
Houma, LA MSA	X	X	0.2
Huntington, WV MSA	X		0.3
Indianapolis, IN MSA	X		1.5
Louisville, KY MSA	X	X	1.0
Memphis, TN MSA	X	X	1.1
Nashville, TN MSA	X	X	1.1
New London, CT MSA	X	X	1.3
New Orleans, LA MSA*	X	X	0.3
Pensacola, FL MSA*	X		0.4
Pittsburgh, PA MSA	X		2.4
Providence, RI MSA	X	X	1.1
Richmond, VA MSA	X		0.9
St. Louis, MO MSA	X	X	2.5
Tampa, FL MSA*	X	X	2.2
33 areas / 88.7 million people	32 areas/86.3 million people	28 areas/83.7 million people	

*These areas have registered recent (1995–1998) ozone levels within 10% of the 1-hour ozone standard.
**Based on more recent air quality monitoring data not considered in the Tier 2 analysis, and on 10-year emissions projections, we expect to redesignate Cincinnati-Hamilton to attainment soon.

Ozone modeling for the Tier 2 rulemaking did not look at the effect on ozone attainment and maintenance beyond current/committed controls and the Tier 2/Gasoline Sulfur Program itself. Therefore, Table II.B–1 should be interpreted as indicating what areas are at risk of ozone violations in 2007 or 2030 without federal or state measures that may be adopted and implemented after this rulemaking is proposed. We expect many of the areas listed in Table

[16] Table II.B–1 excludes areas for which the Tier 2 modeling predicted exceedances in 1996 but for which the actual ozone design values in 1995–1997 and 1996–1998 were both less than 90 percent of the NAAQS. For these areas, we considered the ozone model's predictions of 2007 or 2030 exceedances to be too uncertain to play a supportive role in our rulemaking determinations. Also, 2007 ozone was not modeled for western areas. For 2030, all areas were modeled for fewer episode days which, along with a general model under-prediction bias, may result in an underestimation of 2030 exceedances. Without these factors, there could have been more western areas listed in Table II.B–1, and more areas with predicted exceedances in 2030.

II.B-1 to adopt additional emission reduction programs, but the Agency is unable to quantify the future reductions from additional State programs since they have not yet been adopted.

In addition, Table II.B–1 reflects only the ozone predictions made in the modeling for the Tier 2 rulemaking. The Tier 2 modeling did not predict (or did not provide information regarding) 2007 or 2030 violations for a number of areas for which other available ozone modeling has shown 2007 violations, or for which the history and current degree of nonattainment indicates some risk of ozone violations in 2007 or beyond. These nine areas had a 1996 population of 30 million people. They include seven ozone nonattainment areas in California (Los Angeles, San Diego, Southeast Desert, Sacramento, Ventura County, San Joaquin Valley, and San Francisco), and two Texas areas (Beaumont-Port Arthur and Dallas). A more detailed discussion is presented in the Draft RIA. The following section will discuss the air quality prospects of these 42 areas (*i.e.,* the 33 shown in Table II.B–1, plus the nine additional areas identified in this paragraph).

For the final rule, the Agency plans to use the same modeling system as was used in its Tier 2 air quality analysis with updated inventory estimates for 2030 and a further characterization of the inventory estimates for the interim period between 2007 and 2030 We plan to release the products of these revised analyses into the public record on a continuous basis as they are developed. Interested parties should check docket number A–99–06 periodically for updates.

ii. Areas At Risk of Exceeding the 1-Hour Ozone Standard

This section presents the Agency's conclusions about the risk of future nonattainment for the 42 areas identified above. These areas are listed in Table II.B–2, and are subdivided into three groups. The following discussion follows the groupings from top to bottom. A more detailed discussion is found in the Draft RIA.

In general, EPA believes that the proposed new standards for heavy-duty vehicles are warranted by a sufficient risk that without these standards, some areas would experience violations of the 1-hour NAAQS at some time during the period when this rulemaking would achieve its emission reductions, despite efforts that EPA, States and localities are now making through SIPs to reach attainment and to preserve attainment by developing and implementing maintenance plans. Because ozone concentrations causing violations of the 1-hour ozone standard are well established to endanger public health and welfare, this indicates that it is appropriate for the Agency to propose setting new standards for heavy-duty vehicles.

Our belief regarding the risk of future violations of the 1-hour NAAQS is based upon our consideration of predictive ozone air quality modeling and analysis we performed for U.S. metropolitan areas for the recent Tier 2 rulemaking, and the predictive ozone modeling and other information that has come to us through the SIP process, and other local air quality modeling for certain areas. We have assessed this information in light of our understanding of the factors that influence ozone concentrations, taking due consideration of current and future federal, state and local efforts to achieve and maintain the ozone standard through air quality planning and implementation.

Ten metropolitan areas that fall within ozone nonattainment areas have statutorily-defined attainment dates of 2007 or 2010, or have requested attainment date extensions to 2007 (including two requests on which we have not yet proposed any action). These 10 areas are listed at the top of Table II.B–2, and are New York City, Houston, Hartford, New London, Chicago, Milwaukee, Dallas, Beaumont-Port Arthur, Los Angeles, and Southeast Desert. The Los Angeles (South Coast Air Basin) ozone attainment demonstration is fully approved, but it is based in part on reductions from new technology measures and actions that have yet to be identified. Accordingly, the State will be able to benefit from, and will need, the reductions from this proposed rule in order to meet the NO_X and VOC shortfalls identified in the South Coast Air Basin's SIP. The 2007 attainment demonstration for the Southeast Desert area is also approved. However, because ozone travels from the South Coast to the Southeast Desert, attainment in the Southeast Desert may depend on progress in reducing ozone levels in the South Coast Air Basin.

The process of developing adequate attainment plans has been difficult. While the efforts by EPA and the States have been more prolonged than expected, they are nearing completion. Of the remaining eight areas discussed above, two—Chicago and Milwaukee—do not have EPA-identified shortfalls in their 1998 attainment demonstrations. However, these two areas are revising their local ozone air quality modeling, which will be taken into account in the final rule. We have recently proposed to approve attainment plans for New York, Houston, Hartford and New London, and we hope to receive attainment plans and propose such approval soon for Dallas and Beaumont-Port Arthur. EPA has proposed, or expects to propose, that attainment in 2007 in each of these six areas depends upon either achieving specified additional emission reductions in the area itself, or achieving ozone reductions in an upwind nonattainment area that has such a shortfall. Those areas with shortfalls will be able to take credit for the expected reductions from the proposed rule in their attainment demonstrations, once the rule is promulgated. We expect to rely in part on these reductions in reaching our final conclusion as to whether each of the eight areas for which we have reviewed an attainment demonstration, or expect to review an attainment demonstration soon, is more likely than not to attain on its respective date, whether or not the State formally relies on these reductions as part of its strategy to fill the identified shortfall in its attainment demonstration, if any.

The proposed new standards for heavy-duty vehicles would help address some of the uncertainties and risks that are inherent in predicting future air quality over a long period. Actual ozone levels may be affected by increased economic growth, unusually severe weather conditions, and unexpectedly large changes in vehicle miles traveled. For example, the emissions and air quality modeling that forms the basis for the 2007-to-2030 emissions and ozone trend described earlier used a 1.7 percent national VMT growth rate. Historical growth in national VMT for LDVs over the last 30 years has averaged 2.7 percent per year, but over the past 10 years, annual VMT growth has fluctuated from 1.2 percent to 3.5 percent. The growth rates can also vary from locality to locality. The reported annual VMT growth rate experienced in Atlanta, a fast-growing metropolitan area, was six percent from 1986–1997, or more than twice the 30-year national average, and year-to-year variations in Atlanta's reported annual VMT ranged from a 12% increase to no increase over the same period. While some factors influencing previous VMT growth rates, such as increased participation of women in the workforce, may be declining, other factors, such as widening suburbanization, more suburb-to-suburb commuting and the rise of healthier and wealthier older age drivers, may result in increased VMT growth rates.[17] Activity by other source

[17] See Tier 2 Response to Comments document for a longer decision.

types also varies due to economic factors. Actual future VMT and other economic growth in specific areas may vary from the best predictions that have been used in each attainment demonstration. Over a number of years, differences in annual growth can cause substantial differences in total emissions. These uncertainties, and others, dictate that a prudent course for the Agency is to protect public health by increasing our confidence that the necessary reductions will be in place. This proposed rulemaking would provide significant and needed reductions to those areas at risk of violating the 1-hour ozone standard during the time period when this rule would take effect.

The reductions from this proposal would begin in 2007 and would continue to grow over time as the existing heavy-duty fleet is replaced by newer vehicles meeting the proposed emission standards. Even assuming attainment is achieved, areas that wish a redesignation to attainment may rely on further reductions generated by this rulemaking to support their 10-year maintenance plan. Even if an area does not choose to seek redesignation, the continuing reductions from this proposed rulemaking would help ensure maintenance with the 1-hour standard after attainment is reached.

Thus, a total of six metropolitan areas need additional measures to meet the shortfalls in the applicable attainment demonstrations, or are subject to ozone transport from an upwind area that has an identified shortfall. In addition, two areas are expected to need additional emission reductions to demonstrate attainment in future SIPs. EPA believes that the States responsible may need, among other reductions, the level of reductions provided by this rule in order to fill the shortfalls. We expect to rely in part on these reductions in reaching our final conclusion as to whether each of the eight areas for which we have reviewed an attainment demonstration is more likely than not to attain on its respective date, whether or not the State formally relies on these reductions as part of its strategy to fill the identified shortfall in its attainment demonstration. As to all ten areas, even if all shortfalls were filled by the States, there is some risk that at least some of the areas will not attain the standards by their attainment dates of 2007, or 2010 for Los Angeles. In that event, the reductions associated with this proposed program, which increase substantially after 2007, would help assure that any residual failures to attain are remedied. Finally, there is also some risk that the areas will be unable to maintain attainment after 2007. Considered collectively, there is a significant risk that some areas would not be in attainment throughout the period when the proposed rule would reduce heavy-duty vehicle emissions.

The next group of 26 areas have required attainment dates prior to 2007, or have no attainment date but are subject to a general obligation to have a SIP that provides for attainment and maintenance. EPA and the States are pursuing the established statutory processes for attaining and maintaining the ozone standard where it presently applies. EPA has also proposed to re-apply the ozone standard to the remaining areas. The Agency believes that there is a significant risk that future air quality in a number of these areas would exceed the ozone standard at some time in the 2007 and later period. This belief is based on three factors: (1) Recent exceedances in 1995–1997 or 1996–1998, (2) predicted exceedances in 2007 or 2030 after accounting for reductions from Tier 2 and other local or regional controls currently in place or required, and (3) our assessment of the magnitude of recent violations, the variability of meteorological conditions, transport from areas with later attainment dates, and other variables inherent in predicting future attainment such as the potential for some areas to experience unexpectedly high economic growth rates, growth in vehicle miles traveled, varying population growth from area to area, and differences in vehicle choice.

Only a subset of these areas have yet adopted specific control measures that have allowed the Agency to fully approve an attainment plan. For some of these areas, we have proposed a finding, based on all the available evidence, that the area will attain on its attainment date. In one case, we have proposed that an area will maintain over the required 10-year time period. However, in many cases, these proposals depend on the State adopting additional emission reduction measures. The draft RIA provides more information on our recent proposals on attainment demonstrations and maintenance plans.[18] Until the SIPs for these areas are actually submitted, reviewed and approved, there is some risk that these areas will not adopt fully approvable SIPs. Furthermore, some of these areas are not under a current requirement to obtain EPA approval for an attainment plan. The mechanisms to get to attainment in areas without a requirement to submit an attainment demonstration are less automatic, and more uncertain. Even with suitable plans, implementation success is uncertain, and therefore there is some risk that 2007 attainment, or maintenance thereafter, would not happen.

Finally, there are six additional metropolitan areas, with another 11.4 million people in 1996, for which the available ozone modeling and other evidence is less clear regarding the need for additional reductions. These areas include Biloxi-Gulfport-Pascagoula, MS, Cleveland-Akron, OH, Detroit-Ann Arbor-Flint, MI, New Orleans, LA, Pensacola, FL, and Tampa, FL. Our own ozone modeling predicted these six areas to need further reductions to avoid exceedances in 2007 or 2030. The recent air quality monitoring data for these six areas shows ozone levels with less than a 10 percent margin below the NAAQS. This suggests that ozone concentrations in these areas may remain below the NAAQS for some time, but we believe there is still a risk of that future ozone levels will be above the NAAQS because meteorological conditions may be more severe in the future.

In sum, without these reductions, there is a significant risk that an appreciable number of the 42 areas, with a population of 123 million people in 1996, will violate the 1-hour ozone standard during the time period when these proposed standards will apply to heavy-duty vehicles. The 42 areas consist of the 27 areas with predicted exceedances in 2007 or 2030 under Tier 2 air quality modeling and recent violations of the 1-hour ozone standard, plus seven California areas (South Coast Air Basin, San Diego, Ventura County, Southeast Desert, San Francisco, San Joaquin Valley, Sacramento), two Texas areas (Dallas and Beaumont-Port Arthur), and six areas that have recent ozone concentrations within 10% of exceeding the standard and predicted exceedances. Additional information about these areas is provided in the draft RIA.

iii. Conclusion

We have reviewed the air quality situation of three broad groups of areas: (1) Those areas with recent violations of the ozone standard and attainment dates in 2007 or 2010, (2) those areas with recent violations and attainment dates (if any) prior to 2007, and (3) those areas with recent ozone concentrations within 10% of a violation of the 1-hour ozone

[18] We have recently proposed favorable action, in some cases with a condition that more emission reductions be obtained, on attainment demonstrations in these areas with attainment dates prior to 2007: Philadelphia, Washington-Baltimore, Atlanta, and St. Louis. We expect to give final approval soon to a maintenance plan and redesignation to attainment for Cincinnati.

standard, with predicted exceedances, and without proposed or approved SIP attainment demonstrations. In general, the evidence summarized in this section, and presented in more detail in the draft RIA, supports the Agency's belief that emissions of NO_X and VOC from heavy-duty vehicles in 2007 and later will contribute to a national ozone air pollution problem that warrants regulatory attention under section 202(a)(3) of the Act.

TABLE II.B–2

Metropolitan area/State	Proposed reinstatement of ozone standard	1996 population (in millions)
Areas with 2007/2010 Attainment Dates (Established or Requested):		
New York City, NY-NJ-CT		19.9
Houston, TX		4.3
Hartford, CT		1.1
New London, CT		1.3
Chicago, IL-IN		8.6
Milwaukee, WI		1.6
Dallas, TX		4.6
Beaumont-Port Arthur, TX		0.4
Los Angeles, CA		15.5
Southeast Desert, CA		0.4
Subtotal of 10 areas		57.7
Areas with Pre-2007 Attainment Dates or No Specific Attainment Date, with a Recent History of Nonattainment:**		
Atlanta, GA		3.5
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD		6.0
Sacramento, CA		1.5
San Joaquin Valley, CA *possible future reclassification and change of attainment date to 2005		2.7
Ventura County, CA		0.7
Washington-Baltimore, DC-MD-VA-WV		7.2
Charlotte-Gastonia, NC	X	1.3
Grand Rapids, MI	X	1.0
Huntington-Ashland, WV-KY	X	0.3
Indianapolis, IN	X	1.5
Memphis, TN	X	1.1
Nashville, TN	X	1.1
Barnstable-Yarmouth, MA	X	0.2
Boston-Worcester-Lawrence, MA	X	5.6
Houma, LA	X	0.2
Providence-Fall River-Warwick, RI-MA	X	1.1
Richmond-Petersburg, VA	X	1.0
Benton Harbor, MI	X	0.2
Baton Rouge, LA		0.6
Birmingham, AL		0.9
Cincinnati-Hamilton, OH-KY-IN*		1.9
Louisville, KY-IN		0.3
Pittsburgh, PA MSA		2.4
San Diego, CA		2.8
San Francisco Bay Area, CA		6.2
St. Louis, MO-IL		2.5
Subtotal of 26 areas		53.8
Areas with Pre-2007 Attainment Dates and Recent Concentrations within 10% of an Exceedance, But With No Recent History of Nonattainment:		
Biloxi-Gulfport-Pascagoula, MS MSA	X	0.3
Cleveland-Akron, OH CMSA	X	2.9
Detroit-Ann Arbor-Flint, MI CMSA	X	5.3
New Orleans, LA MSA	X	0.3
Pensacola, FL MSA	X	0.4
Tampa, FL MSA	X	2.2
Subtotal of 6 areas		11.4
Total 1996 Population of All Areas at Risk of Exceeding the Ozone Standard in 2007 or Thereafter:		
42 Areas—total population		122.9

*Based on more recent air quality monitoring data not considered in the Tier 2 analysis, and on 10-year emissions projections, we expect to redesignate Cincinnati-Hamilton to attainment soon.

**The list includes certain areas that are currently not violating the 1-hour NAAQS.

c. Public Health and Welfare Concerns From Prolonged and Repeated Exposures to Ozone

A large body of scientific literature regarding health and welfare effects of ozone has associated health effects with certain patterns of ozone exposures that do not include any hourly ozone concentration above the 0.12 parts per million (ppm) level of the 1-hour NAAQS. The science indicates that there are health effects attributable to prolonged and repeated exposures to lower ozone concentrations. Studies of 6 to 8 hour exposures showed health effects from prolonged and repeated exposures at moderate levels of exertion to ozone concentrations as low as 0.08

ppm. Prolonged and repeated ozone concentrations at these levels are common in areas throughout the country, and are found in areas that are exceeding, and areas that are not exceeding, the 1-hour ozone standard. For example, in 1998, almost 62 million people lived in areas with 2 or more days with concentrations of 0.09 ppm or higher, excluding areas currently violating the 1-hour NAAQS. Since prolonged exposures at moderate levels of ozone are more widespread than exceedances of the 1-hour ozone standard, and given the continuing nature of the 1-hour ozone problem described above, adverse health effects from this type of ozone exposure can reasonably be anticipated to occur in the future in the absence of this rule. Adverse welfare effects can also be anticipated, primarily from damage to vegetation. See the draft RIA for further details.

Studies of acute health effects have shown transient pulmonary function responses, transient respiratory symptoms, effects on exercise performance, increased airway responsiveness, increased susceptibility to respiratory infection, increased hospital and emergency room visits, and transient pulmonary respiratory inflammation. Such acute health effects have been observed following prolonged exposures at moderate levels of exertion at concentrations of ozone well below the current standard of 0.12 ppm. The effects are more pronounced at concentrations above 0.09 ppm, affecting more subjects or having a greater effect on a given subject in terms of functional changes or symptoms. A more detailed discussion may be found in the Draft RIA.

With regard to chronic health effects, the collective data have many ambiguities, but provide suggestive evidence of chronic effects in humans. There is a biologically plausible basis for considering the possibility that repeated inflammation associated with exposure to ozone over a lifetime, as can occur with prolonged exposure to moderate ozone levels below peak levels, may result in sufficient damage to respiratory tissue that individuals later in life may experience a reduced quality of life, although such relationships remain highly uncertain.

We believe that the evidence in the Draft RIA regarding the occurrence of adverse health effects due to prolonged and repeated exposure to ozone concentrations in the range discussed above, and regarding the populations that are expected to receive exposures at these levels, supports a conclusion that emissions of NO_X, and VOC from heavy-duty vehicles in 2007 and later will be contributing to a national air pollution problem that warrants regulatory attention under section 202(a)(3) of the Act.

Ozone has many welfare effects, with damage to plants being of most concern. Plant damage affects crop yields, forestry production, and ornamentals. The adverse effect of ozone on forests and other natural vegetation can in turn cause damage to associated ecosystems, with additional resulting economic losses. Ozone concentrations of 0.10 ppm can be phytotoxic to a large number of plant species, and can produce acute injury and reduced crop yield and biomass production. Ozone concentrations at or below 0.10 ppm have the potential over a longer duration of creating chronic stress on vegetation that can result in reduced plant growth and yield, shifts in competitive advantages in mixed populations, decreased vigor, and injury from other environmental stresses. The forestry, crop and other environmental damage from ozone in times and places where the 1-hour NAAQS is attained adds support to the Agency's belief that there will be air pollution in 2007 and thereafter that warrants regulatory attention under section 202(a)(3) of the Act.

2. Particulate Matter

a. Health and Welfare Effects

i. Particulate Matter Generally

Particulate matter (PM) represents a broad class of chemically and physically diverse substances. It can be principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size. All particles equal to and less than 10 microns are called PM_{10}. Fine particles can be generally defined as those particles with an aerodynamic diameter of 2.5 microns or less (also known as $PM_{2.5}$), and coarse fraction particles are those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns. The health and environmental effects of PM are strongly related to the size of the particles.

The emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters of fine and coarse particles are distinct. Fine particles are directly emitted from combustion sources and are formed secondarily from gaseous precursors such as sulfur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulfate, nitrate, chloride and ammonium compounds; organic and elemental carbon; and metals. Combustion of coal, oil, diesel, gasoline, and wood, as well as high temperature process sources such as smelters and steel mills, produce emissions that contribute to fine particle formation. In contrast, coarse particles are typically mechanically generated by crushing or grinding and are often dominated by resuspended dusts and crustal material from paved or unpaved roads or from construction, farming, and mining activities. Fine particles can remain in the atmosphere for days to weeks and travel through the atmosphere hundreds to thousands of kilometers, while coarse particles deposit to the earth within minutes to hours and within tens of kilometers from the emission source.

Particulate matter, like ozone, has been linked to a range of serious respiratory health problems. Scientific studies suggest a likely causal role of ambient particulate matter (which is attributable to a number of sources including diesel) in contributing to a series of health effects. The key health effects categories associated with ambient particulate matter 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), aggravated asthma, acute respiratory symptoms, including aggravated coughing and difficult or painful breathing, chronic bronchitis, and decreased lung function that can be experienced as shortness of breath. For additional information on health effects, see the draft RIA. Both fine and coarse particles can accumulate in the respiratory system. Exposure to fine particles is most closely associated with such health effects as premature mortality or hospital admissions for cardiopulmonary disease. PM also causes damage to materials and soiling. It is a major cause of substantial visibility impairment in many parts of the U.S.

Diesel particles are a component of both coarse and fine PM, but fall mostly in the fine range. Noncancer health effects associated with exposure to diesel PM overlap with some health effects reported for ambient PM including respiratory symptoms (cough, labored breathing, chest tightness, wheezing), and chronic respiratory disease (cough, phlegm, chronic bronchitis and some evidence for decreases in pulmonary function).

ii. Special Considerations for Diesel PM

Primary diesel particles mainly consist of carbonaceous material, ash (trace metals), and sulfuric acid. Many of these particles exist in the atmosphere as a carbon core with a coating of organic carbon compounds, sulfuric acid and ash, sulfuric acid aerosols, or sulfate particles associated with organic carbon.

Most diesel particles are in the fine and ultrafine size range. Diesel PM contains small quantities of numerous mutagenic and carcinogenic compounds. While representing a very small portion (less than one percent) of the national emissions of metals, and a small portion of diesel particulate matter (one to five percent), we note that several trace metals of toxicological significance are also emitted by diesel engines in small amounts including chromium, manganese, mercury and nickel. In addition, small amounts of dioxins have been measured in diesel exhaust, some of which may partition into the particle phase, though the impact of these emissions on human health is not clear.

Because the chemical composition of diesel PM includes these hazardous air pollutants, or air toxics, diesel PM emissions are of concern to the agency beyond their contribution to general ambient PM. Moreover, as discussed in detail in the draft RIA, there have been health studies specific to diesel PM emissions which indicate potential hazards to human health that appear to be specific to this emissions source. For chronic exposure, these hazards included respiratory system toxicity and carcinogenicity. Acute exposure also causes transient effects (a wide range of physiological symptoms stemming from irritation and inflammation mostly in the respiratory system) in humans though they are highly variable depending on individual human susceptibility.

b. Potential Cancer Effects of Diesel Exhaust

The EPA draft Health Assessment Document for Diesel Emissions (draft Assessment) is currently being revised based on comments received from the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board.[19] The current EPA position is that diesel exhaust is a likely human lung carcinogen and that this cancer hazard exists for occupational and environmental levels of exposure.[20]

In evaluating the available research for the draft Assessment, EPA found that individual epidemiological studies numbering about 30 show increased lung cancer risks associated with diesel emissions within the study populations of 20 to 89 percent depending on the study. Analytical results of pooling the positive study results show that on average the risks were increased by 33 to 47 percent. Questions remain about the influence of other factors (e.g., effect of smoking), the quality of the individual epidemiology studies, exposure levels, and consequently the precise magnitude of the increased risk of lung cancer. From a weight of the evidence perspective, EPA believes that the epidemiology evidence, as well as supporting data from certain animal and mode of action studies, support the Agency's proposed conclusion that exposure to diesel exhaust is likely to pose a human health hazard at occupational exposure levels, as well as to the general public exposed to typically lower environmental levels of diesel exhaust.

Risk assessments on epidemiological studies in the peer-reviewed literature which have attempted to assess the lifetime risk of lung cancer in workers occupationally exposed to diesel exhaust suggests that lung cancer risk may range from 10^{-4} to 10^{-}.[21] [22] [23] The Agency recognizes the significant uncertainties in these studies, and has not used these estimates to assess the possible cancer unit risk associated with ambient exposure to diesel exhaust.

While available evidence supports EPA's conclusion that diesel exhaust is a likely human lung carcinogen, and thus is likely to pose a cancer hazard to humans, the absence of quantitative estimates of the lung cancer unit risk for diesel exhaust limits our ability to quantify with confidence the actual magnitude of the cancer risk. In the draft 1999 Assessment, EPA acknowledged these limitations and provided a discussion of the possible cancer risk consistent with general occupational epidemiological findings of increased lung cancer risk and relative exposure ranges in the occupational and environmental settings.[24] The Agency believes that the techniques that were used in the draft Assessment to qualitatively gauge the potential for and possible magnitude of risk are reasonable. The details of this approach are provided in the draft RIA.

In the absence of a quantitative unit cancer risk to assess environmental risk, EPA has considered the relevant epidemiological studies and principles for their assessment, the risk from occupational exposure as assessed by others, and relative exposure margins between occupational and ambient environmental levels of diesel exhaust exposure. Based on this epidemiological and other information, there is the potential that upper bounds on environmental cancer risks from diesel exhaust may exceed 10^{-6} and could be as high as 10^{-3}.[25] While uncertainty exists in estimating risk, the likely hazard to humans together with the potential for significant environmental risks leads the Agency to believe that diesel exhaust emissions should be reduced in order to protect the public's health. We believe that this is a prudent measure in light of the designation of diesel exhaust as a likely human carcinogen, the exposure of almost the entire population to diesel exhaust, the significant and consistent finding of an increase in lung cancer risk in workers exposed to diesel exhaust, and the potential overlap and/or small difference between some occupational and environmental exposures.

As discussed in section I.C.6, ''Actions in California'', the Office of Environmental Health Hazard

[19] U.S. EPA (1999) Health Assessment Document for Diesel Emissions: SAB Review Draft. EPA/600/8–90/057D Office of Research and Development, Washington, DC. The document is available electronically at www.epa.gov/ncea/diesel.htm.

[20] The EPA designation of diesel exhaust as a likely human carcinogen is subject to further comment by CASAC in 2000. The designation of diesel exhaust as a likely human carcinogen under the 1996 Proposed Guidelines for Carcinogen Risk Assessment is very similar to the current 1986 Guidelines for Carcinogen Risk Assessment that designate diesel exhaust as a probable carcinogen (B–1 carcinogen). The new guidelines, once finalized, will incorporate a narrative approach to assist the risk manager in the interpretation of the carcinogen's mode of action, the weight of evidence, and any risk related exposure-response or protective exposure recommendations.

[21] California Environmental Protection Agency, Office of Health Hazard Assessment (CAL-EPA, OEHHA) (1998) Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Appendix III Part B Health Risk Assessment for Diesel Exhaust. April 22, 1998.

[22] Steenland, K., Deddens, J., Stayner, L. (1998) Diesel Exhaust and Lung Cancer in the Trucking Industry: Exposure-Response Analyses and Risk Assessment. Am. J Indus. Medicine 34:220–228.

[23] Harris, J.E. (1983) Diesel emissions and Lung Cancer. Risk Anal. 3:83–100.

[24] See Chapter 8.3 and 9.6 of the draft Health Assessment for Diesel Exhaust. U.S. EPA (1999) Health Assessment Document for Diesel Emissions: SAB Review Draft. EPA/600/8–90/057D Office of Research and Development, Washington, D.C. The document is available electronically at www.epa.gov/ncea/diesel.htm.

[25] As used in this proposal, environmental risk is defined as the risk (i.e. a mathematical probability) that lung cancer would be observed in the population after a lifetime exposure to diesel exhaust. Exposure levels may be occupational lifetime or environmental lifetime exposures. A population risk in the magnitude of 10^{-6} translates as the probability of lung cancer being evidenced in one person in one million over a lifetime exposure.

Assessment (OEHHA, California EPA) has identified diesel PM as a toxic air contaminant.[26] California is in the process of determining the need for, and appropriate degree of control measures for diesel PM. Apart from the EPA draft Assessment and California EPA's actions, several other agencies and governing bodies have designated diesel exhaust or diesel PM as a ''potential'' or ''probable'' human carcinogen.[27] [28] [29] The International Agency for Research on Cancer (IARC) considers diesel exhaust a ''probable'' human carcinogen and the National Institutes for Occupational Safety and Health have classified diesel exhaust a ''potential occupational carcinogen.'' Thus, the concern for the health hazard resulting from diesel exhaust exposures is widespread.

c. Noncancer Effects of Diesel Exhaust

The noncancer effects of diesel exhaust emissions are also of concern to the Agency. EPA believes that chronic diesel exhaust exposure, at sufficient exposure levels, increases the hazard and risk of an adverse consequence (including respiratory tract irritation/ inflammation and changes in lung function). The draft 1999 Assessment discussed an existing inhalation reference concentration (RfC) for chronic effects that EPA intends to revise in the next draft Assessment in response to CASAC comments. The revised RfC will be reviewed by CASAC at a future meeting. An RfC provides an estimate of the continuous human inhalation exposure (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious noncancer effects during a lifetime.

d. Attainment and Maintenance of the PM_{10} NAAQS

Under the CAA, we are to regulate HD emissions if they contribute to air pollution that can reasonably be anticipated to endanger public health and welfare. We have already addressed the question of what concentration patterns of PM endanger public health, in setting the NAAQS for PM_{10} in 1987. The PM NAAQS were revised in 1997, largely by adding new standards for fine particles ($PM_{2.5}$) and modifying the form of the daily PM_{10} standard. On judicial review, the revised standards were remanded for further proceedings, and the revised PM_{10} standards were vacated. EPA has sought Supreme Court review of that decision; pending final resolution of the litigation, the 1987 PM_{10} standards continue to apply.

i. Current PM_{10} Nonattainment

The most recent PM_{10} monitoring data indicates that 12 designated PM_{10} nonattainment areas, with a population of 19 million in 1990, violated the PM_{10} NAAQS in the period 1996–1998. Table II.B–3 lists the 12 areas. The table also indicates the classification and 1990 population for each area.

TABLE II.B–3.—PM_{10} NONATTAINMENT AREAS VIOLATING THE PM_{10} NAAQS IN 1996–1998 [a]

Area	Classification	1990 population (millions)
Clark Co., NV	Serious	0.741
El Paso, TX [b]	Moderate	0.515
Hayden/Miami, AZ	Moderate	0.003
Imperial Valley, CA [b]	Moderate	0.092
Owens Valley, CA	Serious	0.018
San Joaquin Valley, CA	Serious	2.564
Mono Basin, CA	Moderate	0.000
Phoenix, AZ	Serious	2.238
Fort Hall Reservation, ID	Moderate	0.001
Los Angeles South Coast Air Basin, CA	Serious	13.00
Nogales, AZ	Moderate	0.019
Wallula, WA [c]	Moderate	0.048
Total population		19.24

[a] In addition to these designated nonattainment areas, there are 15 unclassified counties, with a 1996 population of 4.2 million, for which States have reported PM_{10} monitoring data for this period indicating a PM_{10} NAAQS violation. Although we do not believe that we are limited to considering only designated nonattainment areas as part of this rulemaking, we have focused on the designated areas in the case of PM_{10}. An official designation of PM_{10} nonattainment indicates the existence of a confirmed PM_{10} problem that is more than a result of a one-time monitoring upset or a result of PM_{10} exceedances attributable to natural events. We have not yet excluded the possibility that one or the other of these is responsible for the monitored violations in 1996–1998 in the 15 unclassified areas. We adopted a policy in 1996 that allows areas whose PM_{10} exceedances are attributable to natural events to remain unclassified if the State is taking all reasonable measures to safeguard public health regardless of the source of PM_{10} emissions. Areas that remain unclassified areas are not required to submit attainment plans, but we work with each of these areas to understand the nature of the PM_{10} problem and to determine what best can be done to reduce it.

[b] EPA has determined that PM_{10} nonattainment in these areas is attributable to international transport. While reductions in heavy-duty vehicle emissions cannot be expected to result in attainment, they will reduce the degree of PM_{10} nonattainment to some degree.

[c] The violation in this area has been determined to be attributable to natural events.

ii. Risk of Future Exceedances of the PM_{10} Standard

The proposed new standards for heavy-duty vehicles will benefit public health and welfare through reductions in direct diesel particles and NO_X, VOCs, and SO_X which contribute to secondary formation of particulate matter. Because ambient particle concentrations causing violations of the PM_{10} standard are well established to endanger public health and welfare, this information supports the proposed new standards for heavy-duty vehicles. The Agency's recent PM modeling analysis

[26] Office of Environmental Health Hazard Assessment (1998) Health risk assessment for diesel exhaust, April 1998. California Environmental Protection Agency, Sacramento, CA.

[27] National Institute for Occupational Safety and Health (NIOSH) (1988) Carcinogenic effects of exposure to diesel exhaust. NIOSH Current Intelligence Bulletin 50. DHHS, Publication No. 88–116. Centers for Disease Control, Atlanta, GA.

[28] International Agency for Research on Cancer (1989) Diesel and gasoline engine exhausts and some nitroarenes, Vol. 46. Monographs on the evaluation of carcinogenic risks to humans. World Heath Organization, International Agency for Research on Cancer, Lyon, France.

[29] World Health Organization (1996) Diesel fuel and exhaust emissions: International program on chemical safety. World Health Organization, Geneva, Switzerland.

performed for the Tier 2 rulemaking predicts that a significant number of areas across the nation are at risk of failing to meet the PM_{10} NAAQS even with Tier 2 and other controls currently in place. These reductions will assist states as they work with the Agency through SIP development and implementation of local controls to move their areas into attainment by the applicable deadline, and maintain the standards thereafter.

The Agency believes that the PM_{10} concentrations in 10 areas shown in Table II.B–4 have a significant risk of exceeding the PM_{10} standard without further emission reductions during the time period when this rulemaking would take effect. This belief is based on the PM_{10} modeling conducted for the Tier 2 rulemaking. Table II.B–4 presents information about these 10 areas and subdivides them into two groups. The first group of six areas are designated PM_{10} nonattainment areas which had recent monitored violations of the PM_{10} NAAQS in 1996–1998 and were predicted to be in nonattainment in 2030 in our PM_{10} air quality modeling. These areas have a population of over 19 million. Included in the group are the nonattainment areas that are part of the Los Angeles, Phoenix, and Las Vegas metropolitan areas, where traffic from heavy-duty vehicles is substantial. These six areas would clearly benefit from the reductions in emissions that would occur from the proposed new standards for heavy-duty vehicles.

The second group of four counties listed in Table II.B–4 with a total of 8 million people in 1996 also had predicted exceedances of the PM_{10} standard. However, while these four areas registered, in either 1997 or 1998, single-year annual average monitored PM_{10} levels of at least 90 percent of the PM_{10} NAAQS, these areas did not exceed the formal definition of the PM_{10} NAAQS over the three-year period ending in 1998.[30] Unlike the situation for ozone, for which precursor emissions are generally declining over the next 10 years or so before beginning to increase, we estimate that emissions of PM_{10} will rise steadily unless new controls are implemented. The small margin of attainment which the four areas currently enjoy will likely erode; the PM air quality modeling suggests that it will be reversed. We therefore consider these four areas to each individually have a significant risk of exceeding the PM_{10} standard without further emission reductions. The emission reductions from the proposed new standards for heavy-duty vehicles would help these areas with attainment and maintain in conjunction with other processes that are currently moving these areas towards attainment.

TABLE II.B–4.—AREAS WITH SIGNIFICANT RISK OF EXCEEDING THE PM_{10} NAAQS WITHOUT FURTHER EMISSION REDUCTIONS

Area	1990 population (millions)
Areas Currently Exceeding the PM_{10} Standard:	
Clark Co., NV	0.741
El Paso, TX [a]	0.515
Imperial Valley, CA [a]	0.092
San Joaquin Valley, CA	2.564
Phoenix, AZ	2.238
Los Angeles South Coast Air Basin, CA	13.00
Subtotal for 6 Areas	19.15
Areas within 10% of Exceeding the PM_{10} Standard:	
New York Co., NY	1.49
Cuyahoga Co., OH	1.41
Harris, Co., TX	2.83
San Diego Co., CA	2.51
Subtotal for 4 Areas	8.24
Total 1996 Population of All 10 Areas at Risk of Exceeding the PM_{10} Standard: 10 Areas, Total 1990 Population	27.39

[a] EPA has determined that PM_{10} nonattainment in these areas is attributable to international transport. While reductions in heavy-duty vehicle emissions cannot be expected to result in attainment, they will reduce the degree of PM_{10} nonattainment to some degree.

Future concentrations of ambient particulate matter may be influenced by the potentially significant influx of diesel-powered cars and light trucks into the light duty vehicle fleet. At the present time, virtually all cars and light trucks being sold are gasoline fueled. However, the possibility exists that diesels will become more prevalent in the car and light-duty truck fleet, since automotive companies have announced their desire to increase their sales of diesel cars and light trucks. For the Tier 2 rulemaking, the Agency performed a sensitivity analysis using A.D.Little's ''most likely'' increased growth scenario of diesel penetration into the light duty vehicle fleet which culminated in a 9 percent and 24 percent penetration of diesel vehicles in the LDV and LDT markets, respectively, in 2015 (see Tier 2 RIA, Table III.A.–13). This scenario is relevant for the purpose of this rulemaking because, according to the analysis performed in Tier 2, an increased number of diesel-powered light duty vehicles will increase LDV PM emissions by about 13 percent in 2010 rising to 19 percent in 2030, even with the stringent new PM standards established under the Tier 2 rule. If manufacturers elect to certify a portion of their diesel-powered LDVs to the least-stringent PM standard available under the Tier 2 bin structure, the increase in LDV PM emissions could be

[30] In fact, in two of these areas, New York Co., NY and Harris Co., TX, the average PM_{10} level in 1998 was above the 50 micrograms per cubic meter value of the NAAQS. These two areas are not characterized in Table II.B–4 as areas with a high risk of failing to attain and maintain because lower PM_{10} levels in 1996 and 1997 caused their three-year average PM_{10} level to be lower than the NAAQS. Official nonattainment determinations for the annual PM_{10} NAAQS are made based on the average of 12 quarterly PM_{10} averages.

even greater, thus potentially exacerbating PM_{10} nonattainment problems.

EPA recognizes that the SIP process is ongoing and that many of the six current nonattainment areas in Table II.B–4 are in the process of, or will be adopting additional control measures to achieve the PM_{10} NAAQS in accordance with their attainment dates under the Clean Air Act. EPA believes, however, that as in the case of ozone, there are uncertainties inherent in any demonstration of attainment that is premised on forecasts of emission levels and meteorology in future years. Therefore, even if these areas adopt and submit SIPs that EPA is able to approve as demonstrating attainment of the PM_{10} standard, the modeling conducted for Tier 2 and the history of PM_{10} levels in these areas indicates that there is still a significant risk that these areas would need the reductions from the proposed heavy-duty vehicle standards to maintain the PM_{10} standards in the long term. The other four areas in Table II.B–4 also have a significant risk of experiencing violations of the PM_{10} standard.

In sum, the Agency believes that all 10 areas have a significant risk of experiencing particulate matter levels that violate the PM_{10} standard during the time period when this proposed rule would take effect. These 10 areas have a combined population of 27 million, and are located throughout the nation. In addition, this list does not fully consider the possibility that there are other areas which are now meeting the PM_{10} NAAQS that have at least a significant probability of requiring further reductions to continue to maintain it.

e. Public Health and Welfare Concerns From Exposure to Fine PM

Many epidemiologic studies have shown statistically significant associations of ambient PM levels with a variety of human health endpoints in sensitive populations, including mortality, hospital admissions and emergency room visits, respiratory illness and symptoms measured in community surveys, and physiologic changes in mechanical pulmonary function. These effects have been observed in many areas with ambient PM levels at or below the current PM_{10} NAAQS. The epidemiologic science points to fine PM as being more strongly associated with some health effects, such as premature mortality, than coarse fraction PM.

Associations of both short-term and long-term PM exposure with most of the above health endpoints have been consistently observed. (A more detailed discussion may be found in the RIA.) The general internal consistency of the epidemiologic data base and available findings have led to increasing public health concern, due to the severity of several studied endpoints and the frequent demonstration of associations of health and physiologic effects with ambient PM levels at or below the current PM_{10} NAAQS. The weight of epidemiologic evidence suggests that ambient PM exposure has affected the public health of U.S. populations. Specifically, increased mortality associated with fine PM was observed in cities with longer-term average fine PM concentrations in the range of 16 to 21 ug/m3. For example, over 113 million people (46 percent of continental US population, 1990) lived in areas in 1996 where long term ambient fine particulate matter levels were at or above 16 $\mu g/m^3$, which is the long term average $PM_{2.5}$ concentration that prevailed in Boston during the study which found that acute mortality was statistically significantly associated with daily fine PM concentrations.[31] It is reasonable to anticipate that sensitive populations exposed to similar or higher levels, now and in the 2007 and later time frame, will also be at increased risk of premature mortality associated with exposures to fine PM. In addition, statistically significant relationships have also been observed in U.S. cities between PM levels and increased respiratory symptoms and decreased lung functions in children.

While uncertainty remains in the published data base regarding specific aspects about the nature and magnitude of the overall public health risk imposed by ambient PM exposure, we believe that the body of health evidence is supportive of our view that PM exposures that can reasonably be anticipated to occur in the future are a serious public health concern warranting a requirement to reduce emissions from heavy-duty vehicles, even at levels below the PM_{10} NAAQS. EPA believes the risk is significant from an overall public health perspective because of the large number of individuals in sensitive populations that we expect to be exposed to ambient fine PM in the 2007 and later time frame, as well as the importance of the negative health affects.

We believe the evidence regarding the occurrence of adverse health effects due to exposure to fine PM concentrations, and regarding the populations that are expected to receive exposures at these levels, supports a proposed conclusion that emissions from heavy-duty vehicles that lead to the formation of fine PM in 2007 and later will be contributing to a national air pollution problem that warrants action under section 202(a)(3).

f. Visibility and Regional Haze Effects of Ambient PM

Visibility impairment, also called regional haze, is a complex problem caused by a variety of sources, both natural and anthropogenic (*e.g.,* motor vehicles). Regional haze masks objects on the horizon and reduces the contrast of nearby objects. The formation, extent, and intensity of regional haze are functions of meteorological and chemical processes, which sometimes cause fine particle loadings to remain suspended in the atmosphere for several days and to be transported hundreds of kilometers from their sources (NRC, 1993).

Visibility has been defined as the degree to which the atmosphere is transparent to visible light (NRC, 1993). Visibility impairment is caused by the scattering and absorption of light by particles and gases in the atmosphere. Fine particles (0.1 to 1.0 microns in diameter) are more effective per unit mass concentration at impairing visibility than either larger or smaller particles (NAPAP, 1991). Most of the diesel particle mass emitted by diesel engines falls within this fine particle size range. Light absorption is often caused by elemental carbon, a product of incomplete combustion from activities such as burning diesel fuel or wood. These particles cause light to be scattered or absorbed, thereby reducing visibility.

Heavy-duty vehicles contribute a significant portion of the emissions of direct PM, NO_X, and SO_X that result in ambient PM that contributes to regional haze and impaired visibility. The Grand Canyon Visibility Transport Commission's report found that reducing total mobile source emissions is an essential part of any program to protect visibility in the Western U.S. The Commission identified mobile source pollutants of concern as VOC, NO_X, and elemental and organic carbon. The Western Governors Association, in later commenting on the Regional Haze Rule and on protecting the 16 Class I

[31] In the absence of quality-assured $PM_{2.5}$ monitoring data, we have used an air quality model called Regional Modeling System for Aerosols and Deposition (REMSAD) to estimate recent $PM_{2.5}$ concentrations across the U.S. for 1996. Essentially, REMSAD is a three-dimensional grid-based Eulerian air quality model designed to simulate long-term (*e.g.,* annual) concentrations and deposition of atmospheric pollutants (*e.g.,* particulates and toxics) over large spatial scales (e.g., over the contiguous United States). A more detailed explanation of the methodology is found in the draft RIA.

areas on the Colorado Plateau, stated that the federal government, and particularly EPA, must do its part in regulating emissions from mobile sources that contribute to regional haze in these areas. As described more fully later in this section, today's proposal would result in large reductions in these pollutants. These reductions are expected to provide an important step towards improving visibility across the nation. Emissions reductions being achieved to attain the 1-hour ozone and PM_{10} NAAQS will assist in visibility improvements, but not substantially. Moreover, the timing of the reductions from the proposed standards fits very well with the goals of the regional haze program. We will work with the regional planning bodies to make sure they have the information to take account of the reductions from any final rule resulting from this proposal in their planning efforts.

The Clean Air Act contains provisions designed to protect national parks and wilderness areas from visibility impairment. In 1999, EPA promulgated a rule that will require States to develop plans to dramatically improve visibility in national parks. Although it is difficult to determine natural visibility levels, we believe that average visual range in many Class I areas in the United States is significantly less (about 50–66% of natural visual range in the West, about 20% of natural visual range in the East) than the visual range that would exist without anthropogenic air pollution. The final Regional Haze Rule establishes a 60-year time period for planning purposes, with several near term regulatory requirements, and is applicable to all 50 states. One of the obligations is for States to conduct visibility monitoring in mandatory Class I Federal areas and determine baseline conditions using data for year 2000 to 2004. Reductions of particles, NO_X, sulfur, and VOCs from this rulemaking would have a significant impact on moving all states towards achieving long-term visibility goals, as outlined in the 1999 Regional Haze Rule.

g. Other Welfare Effects Associated With PM

The deposition of airborne particles reduces the aesthetic appeal of buildings, and promotes and accelerates the corrosion of metals, degrades paints, and deteriorates building materials such as concrete and limestone. This materials damage and soiling are related to the ambient levels of airborne particulates, which are emitted by heavy-duty vehicles. Although there was insufficient data to relate materials damage and soiling to specific concentrations, and thereby to allow the Agency to establish a secondary PM standard for these impacts, we believe that the welfare effects are real and that heavy-duty vehicle PM, NO_X, SO_X, and VOC contribute to materials damage and soiling.

h. Conclusions Regarding PM

There is a significant risk that, despite statutory requirements and EPA and state efforts towards attainment and maintenance, some areas of the U.S. will violate the PM_{10} NAAQS in 2007 and thereafter. We believe that the information provided in this section shows that there will be air pollution that warrants regulatory attention under section 202(a)(3) of the Act. Heavy-duty vehicles contribute substantially to PM_{10} levels, as shown in section II.C below.

It is also reasonable to anticipate that concentrations of fine PM, as represented for example by $PM_{2.5}$ concentrations, will endanger public health and welfare also even if all areas attain and maintain the PM_{10} NAAQS. Heavy-duty vehicles will also contribute to this air pollution problem.

There are also important environmental impacts of PM_{10}, such as regional haze which impairs visibility. Furthermore, while the evidence on soiling and materials damage is limited and the magnitude of the impact of heavy-duty vehicles on these welfare effects is difficult to quantify, these welfare effects support our belief information that this proposal is necessary and appropriate.

3. Other Criteria Pollutants

The standards being proposed today would help reduce levels of three other pollutants for which NAAQS have been established: carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). The extent of nonattainment for these three pollutants is small, so the primary effect of today's proposal would be to provide areas concerned with maintaining their attainment status a greater margin of safety. As of 1998, every area in the United States has been designated to be in attainment with the NO_2 NAAQS. As of 1997, only one area (Buchanan County, Missouri) did not meet the primary SO_2 short-term standard, due to emissions from the local power plant. In 1997, only 6 of 537 monitoring sites reported ambient CO levels in excess of the CO NAAQS. There are currently 20 designated CO nonattainment areas, with a combined population of 34 million. There are also 23 designated maintenance areas with an additional combined population of 34 million. The broad trends indicate that ambient levels of CO are declining.

4. Other Air Toxics

In addition to NO_x and particulates, heavy-duty vehicle emissions contain several other substances that are known or suspected human or animal carcinogens, or have serious noncancer health effects. These include benzene,1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and dioxin. For some of these pollutants, heavy-duty engine emissions are believed to account for a significant proportion of total nation-wide emissions. Although these emissions will decrease in the short term, they are expected to increase in 2007–2020 without the proposed emission limits, as the number of miles traveled by heavy-duty trucks increases. In the Draft RIA, we present current and projected exposures to benzene, 1,3-butadiene, formaldehyde, and acetaldehyde from all on-highway motor vehicles.

By reducing hydrocarbon and other organic emissions, both in gas phase and bound to particles, the emission control program proposed in today's action would have a significant impact on direct emissions of air toxics from HDVs. We are also proposing a new formaldehyde standard for heavy-duty vehicles. Today's action would reduce exposure to these substances and therefore help reduce the impact of HDV emissions on cancer and non-cancer health effects. We are currently conducting a risk assessment to assess the risk of cancer in the population that can be attributed to motor vehicle emissions of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde.

a. Benzene

Highway mobile sources account for 52 percent of nationwide emissions of benzene and HDVs account for 7 percent of all highway vehicle benzene emissions.[32] The EPA has recently reconfirmed that benzene is a known human carcinogen by all routes of exposure (including leukemia at high, prolonged air exposures), and is associated with additional health effects including genetic changes in humans and animals and increased proliferation

[32] 1990 Emissions Inventory of Forty Potential Section 112(k) Pollutants: Supporting Data for EPA's Section 112(k) Regulatory Strategy—Final Report. Emission Factors and Inventory Group, Office of Air Quality Planning and Standards, May, 1999.

of bone marrow cells in mice.[33] [34] [35] EPA believes that the data indicate a causal relationship between benzene exposure and acute lymphocytic leukemia and suggest a relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia. Respiration is the major source of human exposure and at least half of this exposure is attributable to gasoline vapors and automotive emissions. A number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with low-dose, long-term exposure to benzene.

b. 1,3-Butadiene

Highway mobile sources account for 51 percent of the annual emissions of 1,3-butadiene and HDVs account for 15 percent of the highway vehicle portion. Today's program would play an important role in reducing in the mobile contribution of 1,3-butadiene. This compound causes a variety of reproductive and developmental effects in mice and rats exposed to long-term, low doses. There is, however, no human data on 1,3-butadiene. EPA's recently prepared draft health assessment document presents evidence that suggests this substance is a known human carcinogen.[36] The Environmental Health Committee of EPA's Science Advisory Board, in reviewing EPA's draft Health Assessment for 1,3-butadiene, recommended that 1,3-butadiene should be classified as a probable human carcinogen.[37]

c. Formaldehyde

Highway mobile sources contribute 27 percent of the national emissions of formaldehyde, and HDVs account for 35 percent of the highway portion. EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[38] Epidemiological studies in occupationally exposed workers suggest that long-term inhalation of formaldehyde may be associated with tumors of the nasopharyngeal cavity (generally the area at the back of the mouth near the nose), nasal cavity, and sinus. Formaldehyde exposure also causes a range of noncancer health effects, including irritation of the eyes (tearing of the eyes and increased blinking) and mucous membranes. Sensitive individuals may experience these adverse effects at lower concentrations than the general population and in persons with bronchial asthma, the upper respiratory irritation caused by formaldehyde can precipitate an acute asthmatic attack.

d. Acetaldehyde

Highway mobile sources contribute 20 percent of the national acetaldehyde emissions and HDVs are responsible for approximately 33 percent of these highway mobile source emissions. Acetaldehyde is classified as a probable human carcinogen and is considered moderately toxic by the inhalation, oral, and intravenous routes. The primary acute effect of exposure to acetaldehyde vapors is irritation of the eyes, skin, and respiratory tract. At high concentrations, irritation and pulmonary effects can occur, which could facilitate the uptake of other contaminants.

e. Acrolein

HDVs are responsible for approximately 53 percent of the mobile source highway emissions and about 8% of the total inventory (1996 NTI). Acrolein is extremely toxic to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation and congestion. The Agency has developed a reference concentration for inhalation (RfC) of acrolein of 0.02 micrograms/m^3.[39] Although no information is available on its carcinogenic effects in humans, based on laboratory animal data, EPA considers acrolein a possible human carcinogen.

f. Dioxins

Recent studies have confirmed that dioxins are formed by and emitted from heavy-duty diesel trucks. These trucks are estimated to account for 1.2 percent of total dioxin emissions. In general, dioxin exposures of concern have primarily been noninhalation exposures associated with human ingestion of certain foods (*e.g.,* beef, vegetables, and dairy products contaminated by dioxin). EPA has classified dioxin as a probable human carcinogen. Acute and chronic effects have also been reported for dioxin from oral and inhalation routes of exposure.[40]

5. Other Environmental Effects

a. Acid Deposition

Acid deposition, or acid rain as it is commonly known, occurs when SO_2 and NO_X react in the atmosphere with water, oxygen, and oxidants to form various acidic compounds that later fall to earth in the form of precipitation or dry deposition of acidic particles.[41] It contributes to damage of trees at high elevations and in extreme cases may cause lakes and streams to become so acidic that they cannot support aquatic life. In addition, acid deposition accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. To reduce damage to automotive paint caused by acid rain and acidic dry deposition, some manufacturers use acid-resistant paints, at an average cost of $5 per vehicle—a total of $61 million per year if applied to all new cars and trucks sold in the U.S.

Acid deposition primarily affects bodies of water that rest atop soil with a limited ability to neutralize acidic compounds. The National Surface Water Survey (NSWS) investigated the effects of acidic deposition in over 1,000 lakes larger than 10 acres and in thousands of miles of streams. It found that acid deposition was the primary cause of acidity in 75 percent of the acidic lakes and about 50 percent of the acidic streams, and that the areas most sensitive to acid rain were the Adirondacks, the mid-Appalachian highlands, the upper Midwest and the high elevation West. The NSWS found that approximately 580 streams in the Mid-Atlantic Coastal Plain are acidic primarily due to acidic deposition. Hundreds of the lakes in the Adirondacks surveyed in the NSWS

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

[34] Irons, R.D., W.S. Stillman, D.B. Calogiovanni, and V.A. Henry, Synergistic action of the benzene metabolite hydroquinone on myelopoietic stimulating activity of granulocyte/macrophage colony-stimulating factor *in vitro*, Proc. Natl. Acad. Sci. 89:3691–3695, 1992.

[35] Environmental Protection Agency, Carcinogenic Effects of Benzene: An Update, National Center for Environmental Assessment, Washington, DC. 1998.

[36] Environmental Protection Agency, Health Risk Assessment of 1,3-Butadiene. EPA/600/P–98/001A, February 1998.

[37] An SAB Report: Review of the Health Risk Assessment of 1,3-Butadiene. EPA–SAB–EHC–98, August, 1998.

[38] Environmental Protection Agency, Assessment of health risks to garment workers and certain home residents from exposure to formaldehyde, Office of Pesticides and Toxic Substances, April 1987.

[39] U.S. EPA (1993) Environmental Protection Agency, Integrated Risk Information System (IRIS), Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

[40] U.S. EPA (1994) Health Assessment Document for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds: Volume III Summary Draft Document. EPA/600/BP–92/001c.

[41] Much of the information in this subsection was excerpted from the EPA document, Human Health Benefits from Sulfate Reduction, written under Title IV of the 1990 Clean Air Act Amendments, U.S. EPA, Office of Air and Radiation, Acid Rain Division, Washington, DC 20460, November 1995.

have acidity levels incompatible with the survival of sensitive fish species. Many of the over 1,350 acidic streams in the Mid-Atlantic Highlands (mid-Appalachia) region have already experienced trout losses due to increased stream acidity. Emissions from U.S. sources contribute to acidic deposition in eastern Canada, where the Canadian government has estimated that 14,000 lakes are acidic. Acid deposition also has been implicated in contributing to degradation of high-elevation spruce forests that populate the ridges of the Appalachian Mountains from Maine to Georgia. This area includes national parks such as the Shenandoah and Great Smoky Mountain National Parks.

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

b. Eutrophication and Nitrification

Nitrogen deposition into bodies of water can cause problems beyond those associated with acid rain. The Ecological Society of America has included discussion of the contribution of air emissions to increasing nitrogen levels in surface waters in a recent major review of causes and consequences of human alteration of the global nitrogen cycle in its Issues in Ecology series.[42] Long-term monitoring in the United States, Europe, and other developed regions of the world shows a substantial rise of nitrogen levels in surface waters, which are highly correlated with human-generated inputs of nitrogen to their watersheds. These nitrogen inputs are dominated by fertilizers and atmospheric deposition.

Human activity can increase the flow of nutrients into those waters and result in excess algae and plant growth. This increased growth can cause numerous adverse ecological effects and economic impacts, including nuisance algal blooms, dieback of underwater plants due to reduced light penetration, and toxic plankton blooms. Algal and plankton blooms can also reduce the level of dissolved oxygen, which can also adversely affect fish and shellfish populations. This problem is of particular concern in coastal areas with poor or stratified circulation patterns, such as the Chesapeake Bay, Long Island Sound, or the Gulf of Mexico. In such areas, the ''overproduced'' algae tends to sink to the bottom and decay, using all or most of the available oxygen and thereby reducing or eliminating populations of bottom-feeder fish and shellfish, distorting the normal population balance between different aquatic organisms, and in extreme cases causing dramatic fish kills.

Collectively, these effects are referred to as eutrophication, which the National Research Council recently identified as the most serious pollution problem facing the estuarine waters of the United States (NRC, 1993). Nitrogen is the primary cause of eutrophication in most coastal waters and estuaries.[43] On the New England coast, for example, the number of red and brown tides and shellfish problems from nuisance and toxic plankton blooms have increased over the past two decades, a development thought to be linked to increased nitrogen loadings in coastal waters. Airborne NO_X contributes from 12 to 44 percent of the total nitrogen loadings to United States coastal water bodies. For example, approximately one-quarter of the nitrogen in the Chesapeake Bay comes from atmospheric deposition.

Excessive fertilization with nitrogen-containing compounds can also affect terrestrial ecosystems.[44] Research suggests that nitrogen fertilization can alter growth patterns and change the balance of species in an ecosystem. In extreme cases, this process can result in nitrogen saturation when additions of nitrogen to soil over time exceed the capacity of the plants and microorganisms to utilize and retain the nitrogen. This phenomenon has already occurred in some areas of the U.S.

Deposition of nitrogen from heavy-duty vehicles contributes to these problems. In the Chesapeake Bay region, modeling shows that mobile source deposition occurs in relatively close proximity to highways, such as the I–95 corridor which covers part of the Bay surface. The proposed new standards for heavy-duty vehicles would reduce total NO_X emissions by 2.8 million tons in 2030. The NO_X reductions should reduce the eutrophication problems associated with atmospheric deposition of nitrogen into watersheds and onto bodies of water, particularly in aquatic systems where atmospheric deposition of nitrogen represents a significant portion of total nitrogen loadings.

c. POM Deposition

EPA's Great Waters Program has identified 15 pollutants whose deposition to water bodies has contributed to the overall contamination loadings to the these Great Waters.[45] One of these 15 pollutants, a group known as polycyclic organic matter (POM), are compounds that are mainly adhered to the particles emitted by mobile sources and later fall to earth in the form of precipitation or dry deposition of particles. The mobile source contribution of the 7 most toxic POM is at least 62 tons/year and represents only those POM that adhere to mobile source particulate emissions.[46] The majority of these emissions are produced by diesel engines.

POM is generally defined as a large class of chemicals consisting of organic compounds having multiple benzene rings and a boiling point greater than 100°C. Polycyclic aromatic hydrocarbons are a chemical class that is a subset of POM. POM are naturally occurring substances that are byproducts of the incomplete combustion of fossil fuels and plant and animal biomass (e.g., forest fires). Also, they occur as byproducts from steel and

[42] Vitousek, Peter M., John Aber, Robert W. Howarth, Gene E. Likens, et al. 1997. Human Alteration of the Global Nitrogen Cycle: Causes and Consequences. Issues in Ecology. Published by Ecological Society of America, Number 1, Spring 1997.

[43] Much of this information was taken from the following EPA document: Deposition of Air Pollutants to the Great Waters-Second Report to Congress, Office of Air Quality Planning and Standards, June 1997, EPA–453/R–97–011. A Third Report to Congress on Deposition of Air Pollutants to the Great Waters will be forthcoming the the next month. We will update this section with information from the Third Report in the final rule.

[44] Terrestrial nitrogen deposition can act as a fertilizer. In some agricultural areas, this effect can be beneficial.

[45] Much of this information was taken from the following EPA document: Deposition of Air Pollutants to the Great Waters-Second Report to Congress, Office of Air Quality Planning and Standards, June 1997, EPA–453/R–97–011. You are referred to that document for a more detailed discussion. A Third Report to Congress on Deposition of Air Pollutants to the Great Waters will be forthcoming the the next month. We will update this section with information from the Third Report in the final rule.

[46] The 1996 National Toxics Inventory, Office of Air Quality Planning and Standards, October 1999.

coke productions and waste incineration.

Evidence for potential human health effects associated with POM comes from studies in animals (fish, amphibians, rats) and in human cells culture assays. Reproductive, developmental, immunological, and endocrine (hormone) effects have been documented in these systems. Many of the compounds included in the class of compounds known as POM are classified by EPA as probable human carcinogens based on animal data.

The particulate reductions from today's proposal would help reduce not only the particulate emissions from highway diesel engines but also the deposition of the POM adhering to the particles, thereby helping to reduce health effects of POM in lakes and streams, accelerate the recovery of affected lakes and streams, and revive the ecosystems adversely affected.

C. Contribution from Heavy-Duty Vehicles

Nationwide, heavy-duty vehicles contribute about 15 percent of the total NO_X inventory, and 29 percent of the mobile source inventory. Heavy-duty NO_X emissions also contribute to fine particulate concentrations in ambient air due to the transformation in the atmosphere to nitrates. The NO_X reductions resulting from today's proposed standards would therefore have a considerable impact on the national NO_X inventory. Light and heavy-duty mobile sources account for 24 percent of the PM_{10} (excluding the contribution of miscellaneous and natural sources), and heavy-duty vehicles account for 14 percent of the mobile source portion of national PM_{10} emissions. The heavy-duty portion of the inventory is often greater in the cities, and the reductions proposed in this rulemaking would have a relatively greater benefit in those areas.

1. NO_X Emissions

Heavy-duty vehicles are important contributors to the national inventories of NO_X emissions, and they contribute moderately to national VOC pollution. The Draft RIA for this proposal describes in detail recent emission inventory modeling completed by EPA. HDVs are expected to contribute approximately 15 percent of annual NO_X emissions in 2007 (Table II.C–1).

TABLE II.C–1.—2007 HEAVY-DUTY VEHICLE CONTRIBUTION TO URBAN NO_X INVENTORIES

[Amounts in percent]

Metropolitan statistical area	Portion of total NO_X	Portion of mobile source NO_X
National	15%	29%
Albuquerque	25%	38%
Atlanta	23%	36%
San Francisco	23%	29%
Spokane	23%	29%
Seattle	22%	26%
Dallas	22%	28%
Charlotte	21%	34%
Washington	20%	37%
Los Angeles	20%	26%
San Antonio	20%	31%
New York	19%	30%
Miami	18%	23%
Phoenix	18%	28%
Philadelphia	18%	30%
Cleveland	17%	30%
St. Louis	16%	34%

The contribution of heavy-duty vehicles to NO_X inventories in many MSAs is significantly greater than that reflected in the national average. For example, HDV contributions to NO_X in Albuquerque, Atlanta, San Francisco, Spokane, Seattle, and Dallas are projected to be 22 to 25 percent of the MSA-specific inventories in 2007, which is significantly higher than the national average. These data are based largely on our Tier 2 inventories and have been adjusted to reflect new information regarding the VMT split between light-duty and heavy-duty vehicles as discussed in the draft RIA. These data will be further updated for the final rule to reflect more recent modeling.

2. PM Emissions

Nationally, we estimate that primary emissions of PM_{10} to be about 33.2 million tons/year in 2007. Fugitive dust, other miscellaneous sources and crustal material (wind erosion) comprise approximately 90 percent of the 2007 PM_{10} inventory. However, there is evidence from ambient studies that emissions of these materials may be overestimated and/or that once emitted they have less of an influence on monitored PM concentration than this inventory share would suggest. Mobile sources account for 24 percent of the PM_{10} inventory (excluding the contribution of miscellaneous and natural sources) and highway heavy-duty engines, the subject of today's action, account for 14 percent of the mobile source portion of national PM_{10} emissions.

The contribution of heavy-duty vehicle emissions to total PM emissions in some metropolitan areas is substantially higher than the national average. This is not surprising, given the high density of these engines operating in these areas. For example, in Albuquerque, Pittsburgh, St. Louis, and Atlanta, the estimated 2007 highway heavy-duty vehicle contribution to mobile source PM_{10} ranges from 16 to 21 percent, and the national percent contribution to mobile sources for 2007 is projected to be about 14 percent. As illustrated in Table II.C–2 , heavy-duty vehicles operated Washington, Fairbanks, Billings, and Detroit also account for a slightly higher portion of the mobile source PM inventory than the national average. These data are based largely on our Tier 2 inventories and have been adjusted to reflect new information regarding the VMT split between light-duty and heavy-duty vehicles as discussed in the draft RIA. These data will be further updated for the final rule to reflect more recent modeling. Importantly, these estimates do not include the contribution from secondary PM which is an important component of diesel PM.

TABLE II.C–2.—2007 HEAVY-DUTY VEHICLE CONTRIBUTION TO URBAN MOBILE SOURCE PM INVENTORIES

Metropolitan statistical area	PM_{10} contribution from HDVs (in percent)
National	14
Albuquerque	21
Pittsburgh	18
St. Louis	17
Atlanta	16
Washington	15
Fairbanks	15
Billings	15
Detroit	15

In addition to the national inventories, investigations have been conducted in certain urban areas which provide information about the contribution of HD diesel vehicles and engines to ambient $PM_{2.5}$ concentrations. This is particularly relevant as diesel PM, for the most part, is composed of fine particles under 2.5 microns. Information about ambient concentrations of diesel PM and the relative contribution of diesel engines to ambient PM levels is available from source-receptor models, dispersion models, and elemental carbon measurements. The most commonly used receptor model for quantifying concentrations of diesel PM at a receptor site is the chemical mass balance model (CMB). Input to the CMB model includes PM measurements made at the receptor site as well as measurements made of each of the source types suspected to impact the site. Because of problems involving the elemental similarity between diesel and gasoline emission profiles and their co-emission in time and space, it is necessary to carefully quantify chemical molecular species that provide markers for separation of these sources. Recent advances in chemical analytical techniques have facilitated the development of sophisticated molecular source profiles, including detailed speciation of organic compounds, which allow the apportionment of PM to gasoline and diesel sources with increased certainty. Older studies that made use of only elemental source profiles have been published and are summarized here, but are subject to more uncertainty. It should be noted that since receptor modeling is based on the application of source profiles to ambient measurements, this estimate of diesel PM concentrations does not distinguish between on-road and non-road sources for diesel PM. In addition, this model accounts for primary emissions of diesel PM only; the contribution of secondary aerosols is not included.

Dispersion models estimate ambient levels of PM at a receptor site on the basis of emission factors for the relevant sources and the investigator's ability to model the advection, mixing, deposition, and chemical transformation of compounds from the source to the receptor site. Dispersion models can provide the ability to distinguish on-highway from off-highway diesel source contributions and can be used to estimate the concentrations of secondary aerosols from diesel exhaust. Dispersion modeling is being conducted by EPA to estimate county-specific concentrations of, and exposures to, several toxic species, including diesel PM. Results from this model are expected in 2000.

Elemental carbon is a major component of diesel exhaust, contributing approximately 60-80 percent of diesel particulate mass, depending on engine technology, fuel type, duty cycle, lube oil consumption, and state of engine maintenance.[47 48 49 50] In most ambient environments, diesel PM is one of the major contributors to elemental carbon, with other potential sources including gasoline exhaust; combustion of coal, oil, or wood; charbroiling; cigarette smoke; and road dust. Because of the large portion of elemental carbon in diesel PM, and the fact that diesel exhaust is one of the major contributors to elemental carbon in most ambient environments, diesel PM concentrations can be bounded using elemental carbon measurements. One approach for calculating diesel PM concentrations from elemental carbon measurements is presented in the draft Health Assessment Document for Diesel Emissions. The surrogate diesel PM calculation is a useful approach for estimating diesel PM in the absence of a more sophisticated modeling analysis for locations where elemental carbon concentrations are available.

Ambient concentrations of diesel PM reported for the period before 1990 when no nationwide PM controls were in place for HDVs suggest that annually averaged diesel PM levels in urban and suburban environments ranged from approximately 1.9 to 11.6 micrograms/m^3 (Table II.C–3a and Table II.C–3b). On individual days, diesel PM concentrations as high as 22 micrograms/m^3 were reported. Studies reporting annual average diesel PM concentrations in urban and suburban areas after 1990 indicate that diesel PM concentrations range from approximately 0.5 to 3.6 micrograms/m^3, with studies over short periods amidst dense bus traffic averaging 29.2 micrograms/m^3 and ranging up to 46.7 micrograms/m^3 (Table II.C–3a and Table II.C–3b). Dispersion modeling conducted in Southern California reported that the highway contribution to the reported diesel PM levels ranged from 63–89 percent of the total diesel PM (Table II.C–3b). In the two dispersion model studies reporting diesel PM in Southern California in August 1987 and September 1996, secondary formation of diesel PM accounted for 27 percent to 67 percent of the total diesel PM (Table II.C–3b). Using elemental carbon as a surrogate for diesel PM suggests that diesel PM concentrations measured in some urban and rural areas in the 1990s range from approximately 0.4 to 4.5 micrograms/m^3 in urban environments and 0.2 to 1.3 micrograms/m^3 in rural environments (Table II.C–3c).

TABLE II.C–3a.—AMBIENT DIESEL PM CONCENTRATIONS AND CONTRIBUTION TO TOTAL AMBIENT PM_{10} AND $PM_{2.5}$ FROM CHEMICAL MASS BALANCE STUDIES

Location	Year of sampling	Diesel $PM_{2.5}$ μg/m^3	Diesel PM % of total PM
West LA, CA	1982, annual	4.4	13
Pasadena, CA	1982, annual	5.3	19
Rubidoux, CA	1982, annual	5.4	13
Downtown LA, CA [a]	1982, annual	11.6	36
Phoenix area, AZ [b]	1989–90, Winter	*4–22	50
Phoenix, AZ [c]	1994–95, Winter	0–5.3	0–27
California, 15 Air Basins [d]	1988–92, annual	*0.2–3.6	†
Manhattan, NY [e]	1993, Spring, 3 d	*13.2–46.7	31–68
Welby and Brighton, CO [f]	1996–97, Winter, 60 d	0–7.3	0–26

* PM_{10}. The reader should note that 80–95% of diesel PM is $PM_{2.5}$.
† Not Available.
[a] Schauer, J.J., Rogge, W.F., Hildemann, L.M., Mazureik, M.A., Cass, G.R., and B.R.T. Simoneit (1996) Source Apportionment of Airborne particulate Matter Using Organic Compounds as Tracers. Atmos. Environ. 30(22):3837–3855.

[47] Zaebst, D.D., Clapp D.E., Blake L.M., Marlow D.A., Steenland K., Hornung R.W., Scheutzle D. and J. Butler (1991) Quantitative Determination of Trucking Industry Workers Exposures to Diesel Exhaust Particles. Am. Ind. Hyg. Assoc. J., 52:529–541.

[48] Graboski, M. S., McCormick, R.L., Yanowitz, J., and L.B.A. Ryan (1998) Heavy-Duty Diesel Testing for the Northern Front Range Air Quality Study. Colorado Institute for Fuels and Engine Research.

[49] Warner-Selph, M. A., Dietzmann, H.E. (1984) Characterization of Heavy-Duty Motor Vehicle Emissions Under Transient Driving Conditions. Southwest Research Institute. EPA–600/3–84–104.

[50] Pierson, W.R., Brachazek, W. W. (1983) Particulate Matter Associated with Vehicles on the Road. Aerosol Sci. & Tech. 2:1–40.

[b] Chow, J.C., Watson, J.G., Richards, L.W., Haase, D.L., McDade, C., Dietrich, D.L., Moon, D., and C. Sloane (1991) The 1989–1990 Phoenix PM_{10} Study. Volume II: Source Apportionment. Final Report. DRI Document No. 8931.6F1, prepared for Arizona Department of Environmental Air Quality, Phoenix, AZ, by Desert Research Institute, Reno, NV.
[c] Maricopa Association of Governments. The 1999 Brown Cloud Project for the Maricopa Association of Governments Area, Revised Draft Report, November 1999.
[d] California Environmental Protection Agency (1998) Report to the Air Resources Board on the Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Appendix III, Part A: Exposure Assessment, April 1998.
[e] Wittorff, D.N., Gertler, A.W., Chow, J.C., Barnard, W.R. Jongedyk, H.A. The Impact of Diesel Particulate Emissions on Ambient Particulate Loadings. Air & Waste Management Association 87th Annual Meeting, Cincinnati, OH, June 19–24, 1994.
[f] Fujita, E., Watson, J.G., Chow, J.C., Robinson, N.F., Richards, L.W., Kumar, N. (1998) The Northern Front Rage Air Quality Study Final Report Volume C: Source Apportionment and Simulation Methods and Evaluation. http://nfraqs.cira.colostate.edu/

TABLE II.C–3b.—AMBIENT DIESEL PM CONCENTRATIONS AND CONTRIBUTION TO TOTAL AMBIENT $PM_{2.5}$ FROM DISPERSION MODELING STUDIES

Location	Year of sampling	Diesel $PM_{2.5}$ μ/m^3	Diesel PM % of total PM
Azusa, CA	1982, annual	** 1.4	5
Pasadena, CA	1982, annual	** 2.0	7
Anaheim, CA	1982, annual	** 2.7	12
Long Beach, CA	1982, annual	** 3.5	13
Downtown LA, CA	1982, annual	** 3.5	11
Lennox, CA	1982, annual	** 3.8	13
West LA, CA [a]	1982, annual	** 3.8	16
Claremont, CA [b]	18–19 Aug 1987	2.4	8
Long Beach, CA	24 Sept 1996	+ 1.9(2.6)	8
Fullerton, CA	24 Sept 1996	+ 2.4(3.9)	9
Riverside, CA [c]	25 Sept 1996	+ 4.4(13.3)	12

+ Value in parenthesis includes secondary diesel PM (nitrate, ammonium, sulfate and hydrocarbons) due to atmospheric reactions of primary diesel emissions of NO_X, SO_2 and hydrocarbons.
** On-road diesel vehicles only; All other values are for on-road plus nonroad diesel emissions.
[a] Cass, G.R. and H.A. Gray (1995) Regional Emissions and Atmospheric Concentrations of Diesel Engine Particulate Matter: Los Angeles as a Case Study. In: Diesel Exhaust: A Critical Analysis of Emissions, Exposure, and Health Effects. A Special Report of the Institute's Diesel Working Group. Health Effects Institute, Cambridge, MA, pp. 125–137.
[b] Kleeman, M.J., Cass, G.R. (1999a) Identifying the Effect of Individual Emissions Sources on Particulate Air Quality Within a Photochemical Aerosol Processes Trajectory Model. Atmos. Eviron. 33:4597–4613.
[c] Kleeman, M.J., Hughes, L.S., Allen, J.O., Cass, G.R. (1999b) Source Contributions to the Size and Composition Distribution of Atmospheric Particles: Southern California in September 1996. Environ. Sci. Technol. 33:4331–4351.

TABLE II.C–3C.—AMBIENT DIESEL PM CONCENTRATIONS AND CONTRIBUTION TO TOTAL AMBIENT $PM_{2.5}$ FROM ELEMENTAL CARBON MEASUREMENTS

Location	Year of sampling	Diesel $PM_{2.5}$ μg/m^3	Diesel PM % of total PM
Boston, MA	1995, annual	0.7–1.7	3–15
Rochester, NY	1995, annual	0.4–0.8	2–9
Quabbin, MA	1995, annual	0.2–0.6	1–6
Reading, MA	1995, annual	0.4–1.3	2–7
Brockport, NY [a]	1995, annual	0.2–0.5	1–5
Washington, DC [b]	1992–1995, annual	1.3–1.8	6–10
South Coast Air Basin [c]	1995–1996, annual	‡ 2.4–4.5	†

‡ The Multiple Air Toxics Exposure Study in the South Coast Air Basin reported average annual values for 8 sites in the South Coast Basin.
† Not Available.
[a] Salmon, L.G., Cass, G.R., Pedersen, D.U., Durant, J.L., Gibb, R., Lunts, A., and M. Utell (1997) Determination of fine particle concentration and chemical composition in the northeastern United States, 1995. Progress Report to Northeast States for Coordinated Air Use Management (NESCAUM), September 1999.
[b] Sisler, J.F. (1996) Spatial and Seasonal Patterns and Long Term Variability of the Composition of the Haze in the United States: An Analysis of Data from the IMPROVE Network. Cooperative Institute for Research in the Atmosphere. Colorado State University. ISSN: 0737–5352–32.
[c] South Coast Air Quality Management District (2000) Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES–II), Final Report and Appendices, March 2000.

The city-specific emission inventory analysis and independent investigations of ambient $PM_{2.5}$ summarized here indicate that the contribution of diesel engines to PM inventories in several urban areas around the U.S. is much higher than indicated by the national PM emission inventories only. One possible explanation for this is the concentrated use of diesel engines in certain local or regional areas which is not well represented by the national, yearly average presented in national PM emission inventories. Another reason may be underestimation of the in-use diesel PM emission rates. Our current modeling incorporates deterioration only as would be experienced in properly maintained, untampered vehicles. We are currently in the process of reassessing the rate of in-use deterioration of diesel engines and vehicles which could greatly increase the contribution of HDVs to diesel PM.

Moreover, heavy-duty vehicles will have a more important contributing role in ambient $PM_{2.5}$ concentrations than in ambient PM_{10} concentrations. In addition, the absolute contribution from heavy-duty vehicles is larger in relationship to the numerically lower $PM_{2.5}$ standard, making them more important to attainment and maintenance.

3. Environmental Justice

Environmental justice is a priority for EPA. The Federal government documented its concern over this issue through issuing Executive Order 12898, Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994). This Order requires that federal agencies make achieving environmental justice part of their mission. Similarly, the EPA created an Office of Environmental Justice (originally the Office of Environmental Equity) in 1992, commissioned a task force to address environmental justice issues, oversees a Federal Advisory Committee addressing environmental justice issues (the National Environmental Justice Advisory Council), and has developed an implementation strategy as required under Executive Order 12898.

Environmental justice is a movement promoting the fair treatment of people of all races, income, and culture with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no person or group of people should shoulder a disproportionate share of any negative environmental impacts resulting from the execution of this country's domestic and foreign policy programs.

For the last several years, environmental organizations and community-based citizens groups have been working together to phase out diesel buses in urban areas. For example, the Natural Resources Defense Council initiated a ''Dump Dirty Diesel'' campaign in the mid-1990s to press for the phase out of diesel buses in New York City. Other environmental organizations operating in major cities such as Boston, Newark, and Los Angeles have joined this campaign. The Coalition for Clean Air worked with NRDC and other experts to perform exposure monitoring in communities located near distribution centers where diesel truck traffic is heavy. These two organizations concluded that facilities with heavy truck traffic are exposing local communities to diesel exhaust concentrations far above the average levels in outdoor air. The report states: ''These affected communities, and the workers at these distribution facilities with heavy diesel truck traffic, are bearing a disproportionate burden of the health [51-62] risks.'' [63] Other diesel ''hot spots'' identified by the groups are bus terminals, truck and bus maintenance facilities, retail distribution centers, and busy streets and highways.

Although the new standards proposed in this rulemaking would not reroute heavy-duty truck traffic or relocate bus terminals, they would be expected to improve air quality across the country and would provide increased protection to the public against a wide range of health effects, including chronic bronchitis, respiratory illnesses, and aggravation of asthma symptoms. These air quality and public health benefits could be expected to mitigate some of the environmental justice concerns related to heavy-duty vehicles since the proposal would provide relatively larger benefits to heavily impacted areas.

D. Anticipated Emissions Benefits

This subsection presents the emission benefits we anticipate from heavy-duty vehicles as a result of our proposed NO_X, PM, and NMHC emission standards for heavy-duty engines. The graphs and tables that follow illustrate the Agency's projection of future emissions from heavy-duty vehicles for each pollutant. The baseline case represents future emissions from heavy-duty vehicles at present standards (including the MY2004 standards). The controlled case quantifies the future emissions of heavy-duty vehicles if the new standards proposed in this rulemaking are finalized and implemented.

1. NO_X Reductions

The Agency expects substantial NO_X reductions on both a percentage and a tonnage basis from this proposal. As illustrated in the following graph, the air quality benefit expected from this proposal is a reduction in NO_X emissions from HDVs of 2.0 million tons in 2020.[64] The Draft RIA provides additional projections between 2007 and 2030. As stated previously, HDVs contribute about 15 percent to the national NO_X inventory for all sources. The NO_X standards proposed in this rule would have a substantial impact on the total NO_X inventory so that in 2030, HDVs under today's proposed standards would account for only 3 percent of the national NO_X inventory. Figure II.D–1 shows our national projections of total NO_X emissions with and without the proposed engine controls. This includes both exhaust and crankcase emissions. The proposed standards should result in about a 90 percent reduction in NO_X from new engines.[65]

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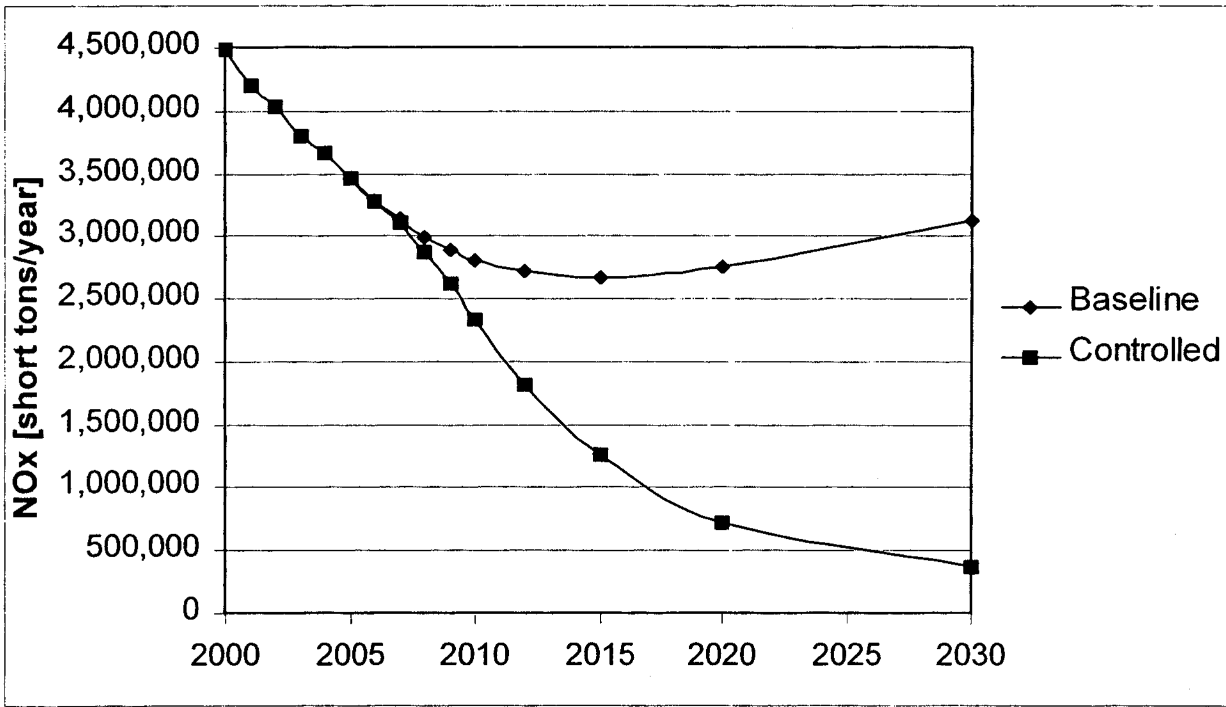
[51-62] [Reserved]

[63] *Exhausted by Diesel: How America's Dependence on Diesel Engines Threatens Our Health,* Natural Resources Defense Council, Coalition for Clean Air, May 1998.

[64] The baseline used for this calculation is the 2004 HDV standards (64 FR 58472). These reductions are in addition to the NO_X emissions reductions projected to result from the 2004 HDV standards.

[65] We include in the NO_X projections excess emissions, developed by the EPA's Office of Enforcement and Compliance, that were emitted from many model year 1988–98 diesel engines. This is described in more detail in Chapter 2 of the draft RIA.

Figure II.D-1: Projected Nationwide Heavy-Duty Vehicle NOx Emissions



2. PM Reductions

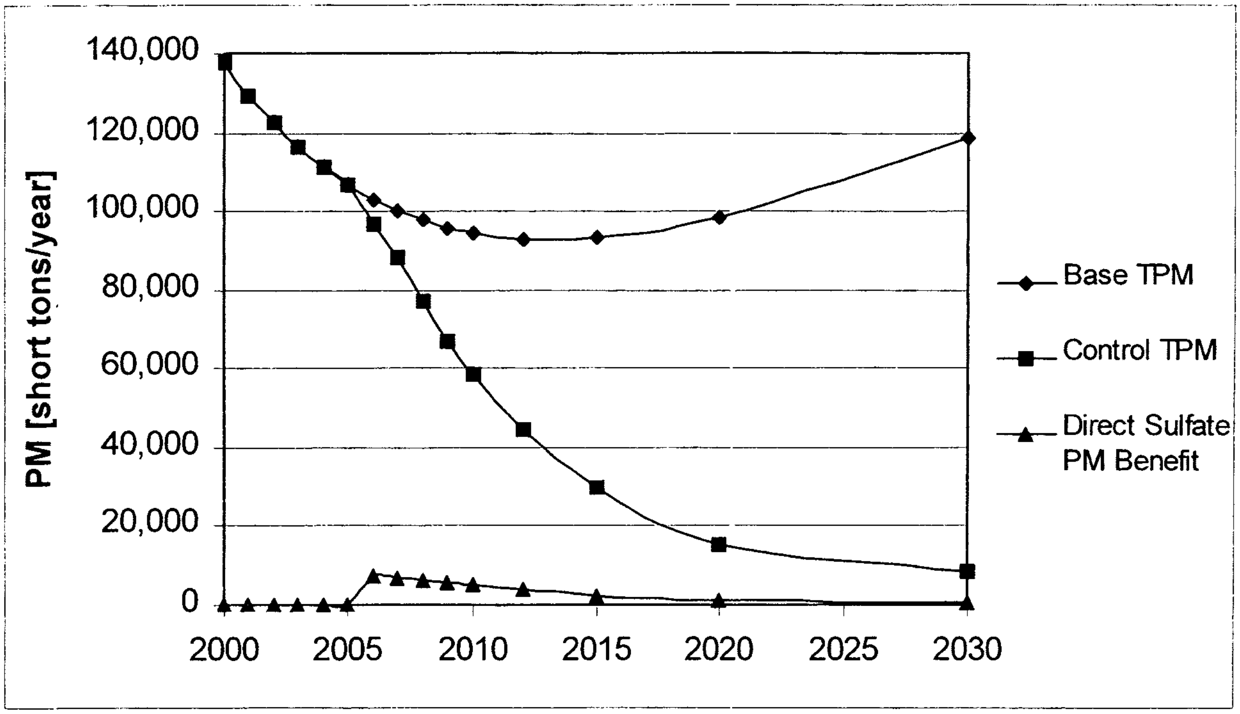
As stated previously, HDVs contribute about 14 percent to the national PM_{10} inventory for mobile sources. The 90 percent reduction in the PM standard for HDVs proposed in this rule would have a substantial impact on the mobile source PM inventory, so that in 2030 HDVs under today's proposed standards would account for only 3 percent of the national mobile source PM inventory.

The majority of the projected PM reductions are directly a result of the proposed exhaust PM standard. However, a modest amount of PM reductions would come from reducing sulfur in the fuel. For the existing fleet of heavy-duty vehicles, a small fraction of the sulfur in diesel fuel is emitted directly into the atmosphere as direct sulfate, and a portion of the remaining fuel sulfur is transformed in the atmosphere into sulfate particles, referred to as indirect sulfate. Reducing sulfur in the fuel decreases the amount of direct sulfate PM emitted from heavy-duty diesel engines and the amount of heavy-duty diesel engine SO_X emissions that are transformed into indirect sulfate PM in the atmosphere.[66] For engines meeting the proposed standards, we consider low sulfur fuel to be necessary to enable the PM control technology. In other words, we do not claim an additional benefit beyond the proposed standard for reductions in direct sulfate PM. However, once the proposed low sulfur fuel requirements go into effect, pre-2007 model year engines would also be using low sulfur fuel. Because these engines would be certified with high sulfur fuel, they would achieve reductions in PM beyond their certification levels.

Figure II.D–2 shows our national projections of total HDV PM emissions with and without the proposed engine controls. This figure includes crankcase emissions and the direct sulfate PM benefits due to the use of low sulfur fuel by the existing fleet. These direct sulfate PM benefits from the existing fleet are also graphed separately. The proposed standards should result in about a 90 percent reduction in total PM from new engines. The proposed low sulfur fuel should result in about a 95 percent reduction in direct sulfate PM from pre-2007 engines. Due to complexities of the conversion and removal processes of sulfur dioxide, we do not attempt to quantify the indirect sulfate reductions that would be derived from this rulemaking. Nevertheless, the Agency believes that these indirect sulfate PM reductions are likely to contribute significant additional benefits to public health and welfare. The air quality benefit of the new PM standards and low sulfur diesel fuel are presented in Figure II.D–2, indicating a 83,000 ton direct PM reduction in 2020.

[66] Sulfate forms a significant portion of total fine particulate matter in the Northeast. Chemical speciation data in the Northeast collected in 1995 shows that the sulfate fraction of fine particulate matter ranges from 20 and 27 percent of the total fine particle mass. *Determination of Fine Particle and Coarse Particle Concentrations and Chemical Composition in the Northeastern United States, 1995,* NESCAUM, prepared by Cass, et al., September 1999.

Figure II.D-2: Projected Nationwide Heavy-Duty Vehicle PM Emissions and Direct Sulfate Emission Reductions

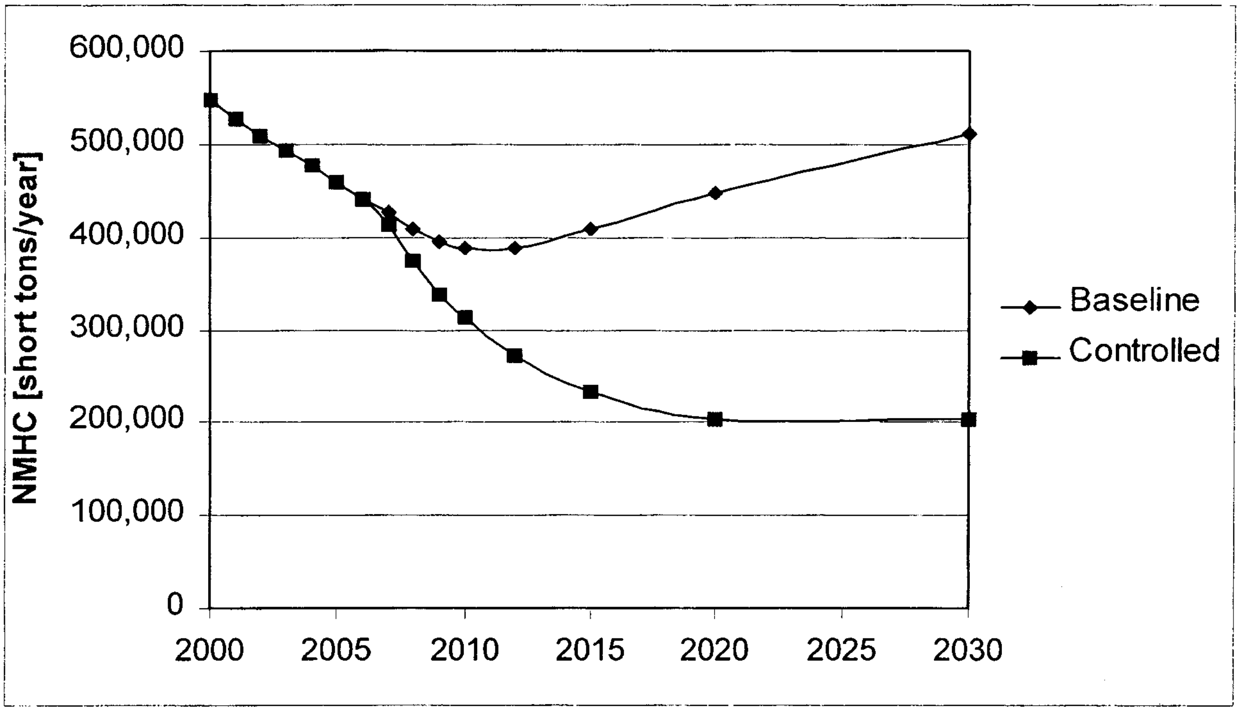


3. NMHC Reductions

The standards described in section III are designed to be feasible for both gasoline and diesel heavy-duty vehicles. The NMHC standards are expected to be more of a challenge for the gasoline vehicles than for the diesel vehicles, however. (The converse is true for the PM standards.) Based on our analysis of the aftertreatment technology described in section III, diesel engines meeting the proposed PM standard are expected to have NMHC emissions levels well below the standard in use. Furthermore, although the proposed standards give manufacturers the same phase-in for NMHC as for NO_X, we model the NMHC reductions for diesel vehicles to be fully in place in 2007. We believe the use of aftertreatment for PM control would cause the NMHC levels to be below the proposed standards as soon as the PM standard goes into effect in 2007. We request comment on this assumption.

HDVs account for about 3 percent of national VOC and 8 percent from mobile sources in 2007. Figure II.D–3 shows our national projections of total NMHC emissions with and without the proposed engine controls. This includes both exhaust emissions and evaporative emissions. As presented in Figure II.D–3, the Agency projects a reduction of 230,000 tons of NMHC in 2020 due to the proposed standards.

Figure II.D-3: Projected Nationwide Heavy-Duty Vehicle NMHC Emissions



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4. Additional Emissions Benefits

This subsection looks at tons/year emission inventories of CO, SO_X, and air toxics from HDEs. Although we are not including stringent standards for these pollutants in our proposed standards, we believe the proposed standards would result in reductions in CO, SO_X, and air toxics. Here, we present our anticipated benefits.

a. CO Reductions

In 2007, HDVs are projected to contribute to approximately 5 percent of national CO and 9 percent of CO from mobile sources. Although it does not propose new CO emission standards, today's proposal would nevertheless be expected to result in a considerable reduction in CO emissions from heavy-duty vehicles. CO emissions from heavy-duty diesel vehicles, although already very low, would likely be reduced by an additional 90 percent due to the presence of aftertreatment devices. CO emissions from heavy-duty gasoline vehicles would also likely decline as the NMHC emissions are decreased. Table II.D–1 presents the projected reductions in CO emissions from HDVs.

TABLE II.D–1.—ESTIMATED REDUCTIONS IN CO

Calendar year	CO benefit (thousand short tons)
2007	71
2010	405
2015	911
2020	1,250
2030	1,640

b. SO_X Reductions

HDVs are projected to emit approximately 0.5 percent of national SO_X and 7 percent of mobile source SO_X in 2007. We are proposing significant reductions in diesel fuel sulfur to enable certain emission control devices to function properly. We expect SO_X emissions to decline as a direct benefit of low sulfur diesel fuel. The majority of these benefits would be from heavy-duty highway diesel vehicles; however, some benefits would also come from highway fuel burned in other applications. As discussed in greater detail in the section on PM reductions, the amount of sulfate particles (direct and indirect) formed as a result of diesel exhaust emissions would decline for all HD diesel engines operated on low sulfur diesel fuel, including the current on-highway HD diesel fleet, and those non-road HD diesel engines that may operate on low sulfur diesel fuel in the future. Table II.D–2 presents our estimates of SO_X reductions resulting from the proposed low sulfur fuel.

TABLE II.D–2.—ESTIMATED REDUCTIONS IN SO_X DUE TO LOW SULFUR FUEL

Calendar year	SO_X benefit (thousand short tons)
2007	101
2010	106
2015	115
2020	124
2030	139

c. Air Toxics Reductions

This proposal establishes new hydrocarbon and formaldehyde standards for heavy-duty vehicles. Hydrocarbons are a broad class of chemical compounds containing carbon and hydrogen. Many forms of hydrocarbons, such as formaldehyde, are directly hazardous and contribute to what are collectively called ''air toxics.'' Air toxics are pollutants known to cause or suspected of causing cancer or other serious human health effects or ecosystem damage. The Agency has identified as least 20 compounds emitted from on-road gasoline vehicles that have toxicological potential, 19 of which are emitted by diesel vehicles as well as an additional 20 compounds which have been listed as toxic air contaminants by California ARB.[67] [68] This proposal also seeks to reduce emissions of diesel exhaust and diesel particulate matter (see section II.B for a discussion of health effects).

Our assessment of heavy-duty vehicle (gasoline and diesel) air toxics focuses on the following compounds with cancer potency estimates that have significant emissions from heavy-duty vehicles: benzene, formaldehyde, acetaldehyde, and 1,3-butadiene. These compounds are an important, but limited, subset of the total number of air toxics that exist in exhaust and evaporative emissions from heavy-duty vehicles. The reductions in air toxics quantified in this section represent only a fraction of the total number and amount of air toxics reductions expected from the proposed new hydrocarbon standards.

For this analysis, we estimate that air toxic emissions are a constant fraction of hydrocarbon exhaust emissions. Because air toxics are a subset of hydrocarbons, and new emission controls are not expected to preferentially control one type of air toxic over another, the selected air toxics chosen for this analysis are expected to decline by the same percentage amount as hydrocarbon exhaust emissions. We have not performed a separate analysis for the new formaldehyde standard since compliance with the hydrocarbon standard should result in compliance with the formaldehyde standard for all petroleum-fueled engines. The Draft RIA provides more detail on this analysis. Table II.D–3 shows the estimated air toxics reductions associated with the anticipated reductions in hydrocarbons.

TABLE II.D–3.—ESTIMATED REDUCTIONS IN AIR TOXICS

[Short tons]

Calendar year	Benzene	Formaldehyde	Acetaldehyde	1,3-Butadiene
2007	153	831	318	65
2010	932	4,750	1,870	382
2015	2,080	11,400	4,460	909
2020	2,780	15,800	6,120	1,250
2030	3,510	20,500	7,850	1,600

E. Clean Heavy-Duty Vehicles and Low-Sulfur Diesel Fuel Are Critically Important for Improving Human Health and Welfare

Despite continuing progress in reducing emissions from heavy-duty engines, emissions from these engines continue to be a concern for human health and welfare. Ozone continues to be a significant public health problem, and affects not only people with impaired respiratory systems, such as asthmatics, but healthy children and adults as well. Ozone also causes damage to plants and has an adverse impact on agricultural yields. Diesel exhaust also continues to be a significant public health concern.

Today's proposal would reduce NO_X, VOC, CO, PM, and SO_X emissions from these heavy-duty vehicles substantially. These reductions would help reduce ozone levels nationwide and reduce the frequency and magnitude of predicted exceedances of the ozone standard. These reductions would also help reduce PM levels, both by reducing direct PM emissions and by reducing emissions that give rise to secondary PM. The NO_X and SO_X reductions would help reduce acidification problems, and the NO_X reductions would help reduce eutrophication problems. The PM and NO_X standard proposed today would help improve visibility. All of these reductions could be expected to have a beneficial impact on human health and welfare by reducing exposure to ozone, PM, and other air toxics and thus reducing the cancer and noncancer effects associated with exposure to these substances.

III. Heavy-Duty Engine and Vehicle Standards

In this section, we describe the vehicle and engine standards we are proposing today to respond to the serious air quality needs discussed in section II. Specifically, we discuss:

- The CAA and why we are proposing new heavy-duty standards.
- The technology opportunity for heavy-duty vehicles and engines.
- Our proposed HDV and HDE standards, and our proposed phase-in of those standards.
- Why we believe the stringent standards being proposed today are feasible in conjunction with the low-sulfur gasoline required under the recent Tier 2 rule and the low-sulfur diesel fuel being proposed today.
- The effects of diesel fuel sulfur on the ability to meet the proposed standards, and what happens if high sulfur diesel fuel is used.
- A possible reassessment of the technology and diesel fuel sulfur level needed for diesels to comply with today's proposed NO_X standard.

We welcome comment on the levels and timing of the proposed emissions standards, and on the technological feasibility discussion and supporting analyses. We also request comment on the timing of the proposed diesel fuel standard in conjunction with these proposed emission standards. We ask that commenters provide any technical information that supports the points made in their comments.

A. Why Are We Setting New Heavy-Duty Standards?

We are proposing heavy-duty vehicle and engine standards and related provisions under section 202(a)(3) of the CAA which authorizes EPA to establish emission standards for new heavy-duty motor vehicles (see 42 U.S.C. 7521(a)(3)). Section 202(a)(3)(A) requires that such standards ''reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology.'' Section 202(a)(3)(B) allows EPA to take into account air quality information in revising such standards. Because heavy-duty engines contribute greatly to a number of serious air pollution problems, especially the health and welfare effects of ozone, PM, and air toxics, and because millions of Americans live in areas that exceed the

[67] National Air Quality and Emissions Trends Report, 1997, (EPA 1998), p. 74.

[68] California Environmental Protection Agency (1998) Report to the Air Resources Board on the Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Appendix III, Part A: Exposure Assessment, April 1998.

national air quality standards for ozone or PM, we believe the air quality need for tighter heavy-duty standards is well founded. This, and our belief that a significant degree of emission reduction from heavy-duty vehicles and engines is achievable through the application of new diesel emission control technology, further refinement of well established gasoline emission controls, and reductions of diesel fuel sulfur levels, leads us to believe that new emission standards are warranted.

B. Technology Opportunity for Heavy-Duty Vehicles and Engines

For the past 30 or more years, emission control development for gasoline vehicles and engines has concentrated most aggressively on exhaust emission control devices. These devices currently provide as much as or more than 95 percent of the emission control on a gasoline vehicle. In contrast, the emission control development work for diesels has concentrated on improvements to the engine itself to limit the emissions leaving the combustion chamber.

However, during the past 15 years, more development effort has been put into diesel exhaust emission control devices, particularly in the area of PM control. Those developments, and recent developments in diesel NO_X control devices, make the advent of diesel exhaust emission controls feasible. Through use of these devices, we believe emission control similar to that attained by gasoline applications will be possible with diesel applications. However, without low-sulfur diesel fuel, these technologies cannot be implemented on heavy-duty or light-duty diesel applications.

Several exhaust emission control devices have been developed to control harmful diesel PM constituents—the diesel oxidation catalyst (DOC), and the many forms of particulate filters, or traps. DOCs have been shown to be durable in use, but they control only a relatively small fraction of the total PM and, consequently, do not address our PM concerns sufficiently. Uncatalyzed diesel particulate traps demonstrated high efficiencies many years ago, but the level of the PM standard was such that it could be met through less costly ''in-cylinder'' control techniques. Catalyzed diesel particulate traps have the potential to provide major reductions in diesel PM emissions and provide the durability and dependability required for diesel applications. Therefore, as discussed in the feasibility portion of this section, at this time we believe the catalyzed PM trap will be the control technology of choice for future control of diesel PM emissions. However, as discussed in detail in the draft RIA, we believe that catalyzed PM traps cannot be brought to market on diesel applications unless low-sulfur diesel fuel is available.

Diesel NO_X control is arguably at an earlier stage of development than is diesel PM control. Even so, several exhaust emission control technologies are being developed to control NO_X emissions, and the industry seems focused on a couple of these as the most promising technologies for enabling lower NO_X emission standards. Diesel selective catalytic reduction, or SCR, has been developed to the point of nearing market introduction in Europe. SCR has significant NO_X control potential, but it also has many roadblocks to marketability in this country. These roadblocks, discussed in more detail in the draft RIA, include infrastructure issues that we believe would prove exceedingly difficult and potentially costly to overcome. Because of that, we believe that the NO_X adsorber is the best technology for delivering significant diesel NO_X reductions while also providing market and operating characteristics necessary for the U.S. market.[69] However, as is discussed in detail in the draft RIA, the NO_X adsorber, like the catalyzed PM trap, cannot be brought to market on diesel applications unless low-sulfur diesel fuel is available.

Improvements have also been made to gasoline emission control technology during the past few years, even the past 12 months. Such improvements include those to catalyst designs in the form of improved washcoats and improved precious metal dispersion. Much effort has also been put into improved cold start strategies that allow for more rapid catalyst light-off. This can be done by retarding the spark timing to increase the temperature of the exhaust gases, and by using air-gap manifolds, exhaust pipes, and catalytic converter shells to decrease heat loss from the system.

These improvements to gasoline emission control have been made in response to the California LEV–II standards and the federal Tier 2 standards. Some of this development work was contributed by EPA in a very short timeframe and with very limited resources in support of our Tier 2 program.[70] These improvements should transfer well to the heavy-duty gasoline segment of the fleet. With such migration of light-duty technology to heavy-duty vehicles and engines, we believe that considerable improvements to heavy-duty emissions can be realized, thus enabling much more stringent standards.

The following discussion provides more detail on the technologies we believe are most capable of enabling very stringent heavy-duty emission standards. The goal of this discussion is to highlight the emission reduction capability of these emission control technologies and to highlight their critical need for diesel sulfur levels as low as those being proposed today. But first, we present the details of the emission standards being proposed today.

C. What Engine and Vehicle Standards Are We Proposing?

1. Heavy-Duty Engine Standards

a. Federal Test Procedure

The emission standards being proposed today for heavy-duty engines are summarized in Table III.C–1.

TABLE III.C–1.—PROPOSED FULL USEFUL LIFE HEAVY-DUTY ENGINE EMISSION STANDARDS AND PHASE-INS

		Standard (g/bhp-hr)	Phase-in by model year (In percent)			
			2007	2008	2009	2010
Diesel	NO_X	0.20	25	50	75	100
	NMHC	0.14				
	HCHO	0.016				
Gasoline	NO_X	0.20	100			
	NMHC	0.14				

[69] The NO_X adsorber was originally developed for stationary source emission control and was subsequently developed for use in the lean operating environment of gasoline direct injection engines.

[70] See Chapter IV.A of the final Tier 2 Regulatory Impact Analysis, contained in Air Docket A–97–10.

TABLE III.C–1.—PROPOSED FULL USEFUL LIFE HEAVY-DUTY ENGINE EMISSION STANDARDS AND PHASE-INS—Continued

		Standard (g/bhp-hr)	Phase-in by model year (In percent)			
			2007	2008	2009	2010
Diesel & Gasoline	HCHO PM	0.016 0.01	100			

With respect to PM, this proposed new standard would represent a 90 percent reduction for most heavy-duty diesel engines from the current PM standard, which was not proposed to change in model year 2004.[71] The current PM standard for most heavy-duty engines, 0.1 g/bhp-hr, was implemented in the 1994 model year; the PM standard for urban buses implemented in that same year was 0.05 g/bhp-hr. The proposed PM standard of 0.01 g/bhp-hr is projected to require the addition of a highly efficient PM trap to diesel engines, including urban buses; it is not expected to require the addition of any new hardware for gasoline engines. We request comment on the feasibility and appropriateness of this proposed PM standard.

With respect to NMHC and NO_X, these new standards would represent roughly a 90 percent reduction in diesel NO_X and roughly a 70 percent reduction in diesel NMHC levels compared to the 2004 heavy-duty diesel engine standard. The 2004 heavy-duty diesel engine standard is 2.5 g/bhp-hr NMHC+NO_X, with a cap on NMHC of 0.5 g/bhp-hr. Like the PM standard, the proposed NO_X standard is projected to require the addition of highly efficient NO_X aftertreatment to diesel engines. For gasoline engines, the standard proposed in the 2004 heavy-duty rule is 1.0 g/bhp-hr NMHC+NO_X. Therefore, for gasoline engines, the standards proposed today would represent roughly a 70 percent reduction. We request comment on the feasibility and appropriateness of these proposed NO_X and NMHC standards.

With respect to formaldehyde, a hazardous air pollutant that is emitted by heavy-duty engines and other mobile sources, we are proposing standards to prevent excessive emissions. The standards are comparable in stringency to the formaldehyde standards recently finalized in the Tier 2 rule for passenger vehicles; they are also consistent with the CARB LEV II formaldehyde standards. These standards would be especially important for methanol-fueled engines because formaldehyde is chemically similar to methanol and is one of the primary byproducts of incomplete combustion of methanol. Formaldehyde is also emitted by engines using petroleum fuels (i.e., gasoline or diesel fuel), but to a lesser degree than is typically emitted by methanol-fueled engines. We recognize that petroleum-fueled engines able to meet the proposed NMHC standards should comply with the formaldehyde standards with large compliance margins. Based upon the analysis of similar standards recently finalized for passenger vehicles, we believe that formaldehyde emissions from petroleum-fueled engines when complying with the PM, NMHC, and NO_X standards should be as much as 90 percent below the standards.[72] Thus, to reduce testing costs, we are proposing a provision that would permit manufacturers of petroleum-fueled engines to demonstrate compliance with the formaldehyde standards based on engineering analysis. This provision would require manufacturers to make a demonstration in their certification application that engines having similar size and emission control technology have been shown to exhibit compliance with the applicable formaldehyde standard for their full useful life. This demonstration would be similar to that recently finalized for light-duty vehicles to demonstrate compliance with the Tier 2 formaldehyde standards.

Because the NO_X exhaust emission control technology we expect would be required to meet the proposed NO_X standard is at an early stage of development, we believe a phase-in of the NO_X standard is appropriate. With a phase-in, manufacturers are able to introduce the new technology on a limited number of engines, thereby gaining valuable experience with the technology prior to implementing it on their entire fleet. Also, we are proposing that the NO_X, HCHO, and NMHC standards be phased-in together for diesel engines. That is, engines would be expected to meet each of these proposed new standards, not just one or the other. We propose this because the standard as proposed in the 2004 heavy-duty rule would be a combined NMHC+NO_X standard. Separating the phase-ins for NMHC and NO_X would create a problem because it would not be clear to what NMHC standard an engine would certify were it to certify to the proposed NO_X standard independent of certifying to the proposed NMHC standard (and vice versa for engines certifying to the proposed NMHC standard independent of the proposed NO_X standard).[73] We request comment on the phase-in for diesel engines of these proposed NO_X, HCHO, and NMHC standards and the requirement that they be phased-in together. We also request comment on alternative phase-in schedules and percentages, such as a phase-in over three years (2007–2009), a phase-in over two years (2007–2008), and no phase-in (100% in 2007). We are not proposing a phase-in for gasoline engines because we want to maintain consistency with the proposed heavy-duty gasoline vehicle standards which are not phased-in; those standards are discussed below.[74] Nonetheless, we request comment on possible alternative phase-ins for the proposed gasoline engine standards, such as a phase-in consistent with the proposed phase-in for diesel engine standards shown in Table III.C–

[71] From 64 FR 58472, October 29, 1999, ''* * * diesel fuel quality, and in particular, diesel fuel sulfur level, can play an important role in enabling certain PM and NO_X control technologies. Some DOCs and continuously regenerable PM traps, as well as current generation lean NO_X adsorber catalysts can be poisoned by high sulfur levels. Given this information, EPA has not included more stringent PM standards for the 2004 model year or later in today's proposal.''

[72] See the Tier 2 Response to Comments document contained in Air Docket A–97–10.

[73] Note that, despite the concurrent phase-in of NO_X and NMHC standards for diesel engines, the NMHC standards should be easily met through use of a PM trap as is fully discussed in section III.E. Since the PM standards would be implemented on 100 percent of new engines in the 2007 model year, all new engines would have a PM trap and would, therefore, control NMHC emissions to levels below the proposed standards. Therefore, while the NMHC standard is phased-in with NO_X due to the 2004 combining of the NO_X and NMHC standards, the proposed NMHC standards would be met by all new engines in the 2007 model year. This is reflected in our emission inventory analysis as was discussed in section II.

[74] Please refer to section III.D.2 below for a discussion of implementing these proposed standards in the 2007 or 2008 model years, and the relationship between today's proposed implementation and the implementation of the proposed 2004 emission standards.

1, or a phase-in consistent with that used for heavy light-duty trucks and medium-duty passenger vehicles under the light-duty highway Tier 2 program.

The specifics of the Averaging, Banking, and Trading program associated with today's proposed standards are discussed in section VII of this preamble. The reader should refer to that section for more details.

b. Not-to-Exceed and Supplemental Steady-State Test

To help ensure that heavy-duty engine emissions are controlled over the full range of speed and load combinations commonly experienced in use, we have previously proposed to apply Not-To-Exceed (NTE) limits to heavy-duty diesel engines (64 FR 58472, October 29, 1999). As proposed, 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.[75] As proposed, the specified value under which emissions must remain is 1.25 times the FTP standards. 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. In addition, we have proposed that the whole range of real ambient conditions be included in NTE testing.

Similarly, to help ensure that heavy-duty engine emissions are controlled during steady-state type driving (such as a line-haul truck operating on a freeway), we have previously proposed a new supplemental steady-state test (64 FR 58472, October 29, 1999). The supplemental steady-state test consists of 13 steady-state modes, each weighted according to the amount of time that might be expected at each mode during typical real world conditions. As proposed, the supplemental steady-state test has emission limits of 1.0 times the FTP standards.

Today's document proposes to apply the heavy-duty diesel NTE and supplemental steady-state test provisions intended to be finalized as part of the 2004 standards rulemaking. The October 29, 1999, proposal for that rule contained the description of these provisions. We expect that a number of modifications will be made to those provisions in the FRM for that rule based on feedback received during the comment period. While the details of the final provisions are not yet available, we will provide the necessary information in the docket for this rule as soon as it becomes available in order to allow for comment.

We have not proposed that the NTE requirements, or the supplemental steady-state test, apply to heavy-duty gasoline engines. However, we are working with several industry members to pursue a proposal in a separate action with the intention of having NTE requirements in place for heavy-duty gasoline engines beginning in the 2004 model year.[76] Today's proposal intends that those provisions, when developed, would apply to the gasoline engines subject to today's proposed standards as well. We currently have no intention of pursuing supplemental steady-state test requirements for heavy-duty gasoline engines.

We request comment and data on the feasibility of technology meeting the proposed emission standards in the context of the NTE and supplemental steady-state tests as proposed in the 2004 heavy-duty rule, and the potential changes to the supplemental tests should changes be made from what was proposed. As stated above, should such changes be made, we will provide the necessary information in the docket for this rule as soon as it becomes available in order to allow for comment.

c. Crankcase Emissions Control

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 vented to prevent high pressures from occurring in the crankcase. Our existing emission standards prohibit crankcase emissions from all highway engines except turbocharged heavy-duty diesel engines. The most common way to eliminate crankcase emissions has been to vent the blowby gases into the engine air intake system, so that the gases can be recombusted. We made the exception for turbocharged heavy-duty diesel engines because of concerns in the past about fouling that could occur by routing the diesel particulates (including engine oil) into the turbocharger and aftercooler. Our concerns are now alleviated by newly developed closed crankcase filtration systems, specifically designed for turbocharged heavy-duty diesel engines. These new systems (discussed more fully in section III.E and in Chapter III of the draft RIA) are already required for new on-highway diesel engines under the EURO III emission standards.

We are proposing to eliminate the exception for turbocharged heavy-duty diesel engines starting in the 2007 model year. This is an environmentally significant proposal since most heavy-duty diesel trucks use turbocharged engines, and a single engine can emit over 100 pounds of NO_x, NMHC, and PM from the crankcase over the lifetime of the engine. We request comment on this proposal.

2. Heavy-Duty Vehicle Standards

a. Federal Test Procedure

The emission standards being proposed today for heavy-duty vehicles are summarized in Table III.C–2. We have already proposed that all complete heavy-duty gasoline vehicles, whether for transporting passengers or for work, be chassis certified (64 FR 58472, October 29, 1999). Current federal regulations do not require that complete diesel vehicles over 8,500 pounds be chassis certified, instead requiring certification of their engines. Today's proposal does not make changes to those requirements.

The Tier 2 final rule created a new vehicle category called ''medium-duty passenger vehicles''.[77] These vehicles, both gasoline and diesel, are required to meet requirements of the Tier 2 program, which carries with it a chassis certification requirement. As a result, applicable complete diesel vehicles must certify using the chassis certification test procedure. Today's proposed chassis standards for 2007 and later model year heavy-duty gasoline vehicles would apply to the remaining (work-oriented) complete gasoline vehicles under 14,000 pounds.

[75] Torque is a measure of rotational force. The torque curve for an engine is determined by an engine ''mapping'' procedure specified in the Code of Federal Regulations. The intent of the mapping procedure is to determine the maximum available torque at all engine speeds. The torque curve is merely a graphical representation of the maximum torque across all engine speeds.

[76] Letters from Margo Oge, EPA, to Kelly Brown, Ford Motor Company, and Samuel. Leonard, General Motors Corp., both dated September 17, 1999; and letter from Samuel. Leonard, GM, and Kelly Brown, Ford, to Margo Oge, EPA, dated August 10,1999; all of these letters are available in EPA Air Docket #A–98–32.

[77] Medium-duty passenger vehicles are defined as any complete vehicle between 8,500 and 10,000 pounds GVWR designed primarily for the transportation of persons. The definition specifically excludes any vehicle that (1) has a capacity of more than 12 persons total or, (2) is designed to accommodate more than 9 persons in seating rearward of the driver's seat or, (3) has a cargo box (e.g., pick-up box or bed) of six feet or more in interior length. (See the Tier 2 final rulemaking, 65 FR 6698, February 10, 2000)

TABLE III.C–2.—PROPOSED 2007+ FULL USEFUL LIFE HEAVY-DUTY VEHICLE EXHAUST EMISSION STANDARDS FOR COMPLETE GASOLINE VEHICLES*

[grams/mile]

Weight range (GVWR)	NO_X	NMHC	HCHO	PM
8500 to 10,000 lbs	0.2	0.195	0.016	0.02
10,000 to 14,000 lbs	0.4	0.230	0.021	0.02

* Does not include medium-duty passenger vehicles.

These NO_X standards represent a 78 percent reduction and a 60 percent reduction from the standards for 8,500–10,000 pound and 10,000–14,000 pound vehicles, respectively, proposed in the 2004 heavy-duty rule. The 2004 heavy-duty rule would require such vehicles to meet the California LEV–I NO_X standards of 0.9 g/mi and 1.0 g/mi, respectively. The proposed NO_X standards shown in Table III.C–2 are consistent with the CARB LEV–II NO_X standard for low emission vehicles (LEVs). We have proposed, and CARB has put into place in their LEV–II program, a slightly higher NO_X standard for 10,000 to 14,000 pound vehicles because these vehicles are tested at a heavier payload. The increased weight results in using more fuel per mile than vehicles tested at lighter payloads; therefore, they tend to emit slightly more grams per mile than lighter vehicles.[78]

The NMHC standards represent a 30 percent reduction from the proposed 2004 standards for 8500–10,000 and 10,000–14,000 pound vehicles. The 2004 heavy-duty rule would require such vehicles to meet NMHC standard levels of 0.28 g/mi and 0.33 g/mi, respectively (equal to the California LEV–I nonmethane organic gases (NMOG) standard levels). The proposed NMHC standards are consistent with the CARB LEV–II NMOG standards for LEVs in each respective weight class. The NMHC standard for 10,000–14,000 pound vehicles is higher than for 8,500–10,000 pound vehicles for the same reason as stated above for the higher NO_X standard for such vehicles.

The formaldehyde standards are comparable in stringency to the formaldehyde standards recently finalized in the Tier 2 rule for passenger vehicles; they are also consistent with today's proposed engine standards and the CARB LEV II formaldehyde standards. Formaldehyde is a hazardous air pollutant that is emitted by heavy-duty vehicles and other mobile sources, and we are proposing these formaldehyde standards to prevent excessive formaldehyde emissions. These standards would be especially important for methanol-fueled vehicles because formaldehyde is chemically similar to methanol and is one of the primary byproducts of incomplete combustion of methanol. Formaldehyde is also emitted by vehicles using petroleum fuels (i.e., gasoline or diesel fuel), but to a lesser degree than is typically emitted by methanol-fueled vehicles. We recognize that petroleum-fueled vehicles able to meet the proposed NMHC standards should comply with the formaldehyde standards with large compliance margins. Based upon the analysis of similar standards recently finalized for passenger vehicles, we believe that formaldehyde emissions from petroleum-fueled vehicles when complying with the PM, NMHC and NO_X standards should be as much as 90 percent below the standards.[79] Thus, to reduce testing costs, we are proposing a provision that would permit manufacturers of petroleum-fueled vehicles to demonstrate compliance with the formaldehyde standards based on engineering analysis. This provision would require manufacturers to make a demonstration in their certification application that vehicles having similar size and emission control technology have been shown to exhibit compliance with the applicable formaldehyde standard for their full useful life. This demonstration would be similar to that recently finalized for light-duty vehicles to demonstrate compliance with the Tier 2 formaldehyde standards.

The PM standard represents over an 80 percent reduction from the CARB LEV–II LEV category PM standard of 0.12 g/mi. Note that the PM standard shown in Table III.C–2 represents not only a stringent PM level, but a new standard for federal HDVs where none existed before. The California LEV–II program for heavy-duty vehicles, and the federal Tier 2 standards for over 8,500 pound vehicles designed for transporting passengers, both contain PM standards. The PM standard proposed today is consistent with the Tier 2 bin 8 level of 0.02 g/mi.

The standards shown in Table III.C–2 are, we believe, comparable in stringency to the proposed diesel and gasoline engine standards shown in Table III.C–1. We request comment on this issue, including any supporting data. We also request comment on other possible vehicle exhaust emission standards. For example, the CARB LEV–II ULEV standards are identical in NO_X levels, but have NMOG levels of 0.143 and 0.167 g/mi for 8,500 to 10,000 pound and 10,000 to 14,000 pound vehicles, respectively. We request comment on whether these standards (0.143 and 0.167 g/mi NMHC for 8,500 to 10,000 pound and 10,000 to 14,000 pound vehicles, respectively), or lower standards, may be more appropriate emission standards. We also request comment on whether we should instead include a 40 percent/60 percent split of standards at the LEV–II LEV and ULEV levels, respectively. To clarify, the CARB LEV–II program requires a compliance split of vehicles certified to the LEV versus the ULEV levels; that split is 40 percent LEV and 60 percent ULEV. We request comment on whether we should employ such a split.

We are not proposing a phase-in for the HDV standards. As proposed, the HDV standards would apply only to complete gasoline vehicles, consistent with our current regulations. We believe that emission control technology for gasoline engines is in an advanced enough state to justify a simple implementation requirement in the 2007 model year. However, please refer to section III.D.2, below, for a discussion of the appropriate implementation schedule associated with these proposed standards, and the relationship between today's proposed implementation and the implementation of the proposed 2004 emission standards. We believe that our proposed implementation schedule provides consistency with our Tier 2 standards and our expectation of probable certification levels for similarly sized light-duty trucks and medium-duty

[78] Engine standards, in contrast, are stated in terms of grams per unit power rather than grams per mile. Therefore, engine emission standards need not increase with weight because heavier engines do not necessarily emit more per horsepower even though they tend to emit more per mile.

[79] See the Tier 2 Response to Comments document contained in Air Docket A–97–10.

passenger vehicles. Although these vehicles are allowed to certify at fairly high emission levels under the Tier 2 bin structure, we believe that Tier 2 gasoline applications will be designed to certify to standards of 0.20 g/mi NO_X and 0.09 g/mi NMHC by the 2007 model year, and possibly lower to allow for diesels certifying in higher emission bins within the NO_X averaging scheme. This makes the proposed HDV standards and associated phase-in consistent with Tier 2. We request comment on the appropriateness of not having a phase-in associated with the vehicle standards. We also request comment on possible alternative phase-ins for the proposed gasoline vehicle standards, such as a phase-in consistent with the proposed phase-in for diesel engine standards shown in Table III.C–1, or a phase-in consistent with that used for heavy light-duty trucks and medium-duty passenger vehicles under the light-duty highway Tier 2 program.

Consistent with current regulations, we are not proposing to allow complete heavy-duty diesel vehicles to certify to the heavy-duty vehicle standards. Instead, manufacturers would be required to certify the engines intended for such vehicles to the engine standards shown in Table III.C–1. However, we request comment on whether complete heavy-duty diesel vehicles should be allowed, or perhaps should be required, to certify to the vehicle standards. Any comments on this topic should also address whether a phase-in, consistent with the phase-in of engine standards, would be appropriate.

The specifics of the Averaging, Banking, and Trading program associated with today's proposed standards are discussed in section VII of this document. The reader should refer to that section for more details.

We request comment on the feasibility and appropriateness of the proposed standards for heavy-duty complete vehicles shown in Table III.C–2.

b. Supplemental Federal Test Procedure

We are not proposing new supplemental FTP (SFTP) standards for heavy-duty vehicles. The SFTP standards control off-cycle emissions in a manner analogous to the NTE requirements for engines. We believe that the SFTP standards are an important part of our light-duty program just as we believe the NTE requirements will be an important part of our heavy-duty diesel engine program. Although we are not proposing SFTP standards for heavy-duty vehicles, we intend to do so via a separate rulemaking. We request comment on such an approach, and on appropriate SFTP levels for heavy-duty vehicles along with supporting data.

3. Heavy-Duty Evaporative Emission Standards

We are proposing new evaporative emission standards for heavy-duty vehicles and engines. The proposed standards are shown in Table III.C–3. These standards would apply to heavy-duty gasoline-fueled vehicles and engines, and methanol-fueled heavy-duty vehicles and engines. Consistent with existing standards, only the standard for the three day diurnal test sequence would apply to liquid petroleum gas (LPG) fueled and natural gas fueled HDVs.

TABLE III.C–3.—PROPOSED HEAVY-DUTY EVAPORATIVE EMISSION STANDARDS*

[Grams per test]

Category	3 day diurnal + hot soak	Supplemental 2 day diurnal + hot soak**
8,500–14,000 lbs	1.4	1.75
>14,000 lbs	1.9	2.3

* Proposed to be implemented on the same schedule as the proposed gasoline engine and vehicle exhaust emission standards shown in Tables III.C–1 and III.C–2. These proposed standards would not apply to medium-duty passenger vehicles, and would not apply to diesel fueled vehicles.

** Does not apply to LPG or natural gas fueled HDVs.

These proposed standards represent more than a 50 percent reduction in the numerical standards as they exist today. The 2004 heavy-duty rule (64 FR 58472, October 29, 1999) proposed no changes to the numerical value of the standard, but it did propose new evaporative emission test procedures for heavy-duty complete gasoline vehicles.[80] Those test procedures would effectively increase the stringency of the standards, even though the numerical value was not proposed to change. For establishing evaporative emission levels from complete heavy-duty vehicles, the standards shown in Table III.C–3 presume the test procedures proposed in the 2004 heavy-duty rule.

The proposed standards for 8,500 to 14,000 pound vehicles are consistent with the Tier 2 standards for medium-duty passenger vehicles (MDPV). MDPVs are of consistent size and have essentially identical evaporative emission control systems as the remaining work-oriented HDVs in the 8,500 to 10,000 pound weight range. Therefore, the evaporative emission standards should be equivalent. We are proposing those same standards for the 10,000 to 14,000 pound HDVs because, historically, the evaporative emission standards have been consistent throughout the 8,500 to 14,000 pound weight range. We believe that the HDVs in the 10,000 to 14,000 pound range are essentially equivalent in evaporative emission control system design as the lighter HDVs; therefore, continuing this historical approach is appropriate.

We are proposing slightly higher evaporative emission standards for the over 14,000 pound HDVs because of their slightly larger fuel tanks and vehicle sizes. This is consistent with past evaporative emission standards. The levels chosen for the over 14,000 pound HDVs maintains the same ratio relative to the 8,500 to 14,000 pound HDVs as exists with current evaporative standards. To clarify, the current standards for the 3 day diurnal test are 3 and 4 grams/test for the 8,500 to 14,000 and the over 14,000 pound categories, respectively. The ratio of 3:4 is maintained for the proposed 2007 standards, 1.4:1.9.

The proposed standards levels are slightly higher than the California LEV–II standards levels. The California standards levels are 1.0 and 1.25 for the 3-day and the 2-day tests, respectively. We believe that our standards are appropriate for federal vehicles certified on the higher-volatility federal test fuel.

We are proposing that the proposed evaporative emission standards be implemented on the same schedule as the proposed gasoline engine and vehicle exhaust standards shown in Tables III.C–1 and III.C–2. We request comment on this proposal. Also, we are proposing the revised durability provisions finalized in the Tier 2 rulemaking, which require durability demonstration using fuel containing at least 10 percent alcohol. Alcohol can break down the materials used in evaporative emission control systems. Therefore, a worst case durability demonstration would include a worst case alcohol level in the fuel (10 percent) as some areas of the country

[80] The proposed test procedure changes sought to codify a commonly approved waiver allowing heavy-duty gasoline vehicles to use the light-duty driving cycle for demonstrating evaporative emission compliance. The urban dynamometer driving schedule (UDDS) used for heavy-duty vehicles is somewhat shorter than that used for light-duty vehicles, both in terms of mileage covered and minutes driven. This results in considerably less time for canister purge under the heavy-duty procedure than under the light-duty procedure. We recognize this discrepancy and have routinely provided waivers under the enhanced evaporative program that allow the use of the light-duty procedures for heavy-duty certification testing. We do not believe that this approach impacts the stringency of the standards. Further, it is consistent with CARB's treatment of equivalent vehicles.

use alcohol fuels to improve their air quality. We request comment on extending this durability provision to HDVs.

We request comment on the feasibility and appropriateness of the proposed evaporative emission standards shown in Table III.C–3.

D. Standards Implementation Issues

1. Alternative Approach to Phase-In

Although we are proposing the standards and diesel phase-ins shown in Section III.C, we request comment on the possibility of structuring the proposed diesel engine standards as a ''declining'' standard rather than the standard level ''phase-in'' being proposed. Under such an approach, the final NO_X and NMHC standards of 0.20 and 0.14 g/bhp-hr would be achieved via a ramping down of the standards from the NO_X and NMHC levels assumed under the 2004 NMHC+NO_X standard (i.e., 2.0 g NO_X and 0.5 g NHMC) to the final levels provided it did not compromise the air quality benefits in any given year. Such a declining standard would result in 2007 standards for all engines lower than the 2004 standards, but not as low as today's proposed standards. The 2008 standards for all engines would then be lower than the 2007 standards, and the 2009 standards for all engines would be lower than the 2008 standards. In 2010, the standards would become 0.20 g/bhr-hr NO_X and 0.14 g/bhp-hr NMHC.

Under such a declining standard approach, an engine manufacturer would probably have to redesign most, if not all, of its engines to reduce their emissions from the 2004 standard levels to the 2007 model year declining standard levels. In contrast, under the proposed approach, 25 percent of an engine manufacturer's engines would have to certify to the 0.20/0.14 g/bhp-hr standards. Although the phase-in levels would be more stringent, the manufacturer would have to redesign only that 25 percent of its engines during the 2007 model year. The same would be true for the ensuing years. Under the declining standard approach, some level of redesign would probably have to be done on every engine in every year to meet the declining standard unless a manufacturer had extensive ABT credits at its disposal to apply against the standard. Under the phase-in, each new model year would entail a redesign of only 25 percent of a manufacturer's engines. In the end, both approaches result in the entire fleet meeting the proposed standard levels in 2010, but both achieve that in different ways.

We request comment on this declining standard approach for the diesel engine standards. We also request suggestions on appropriate declining standards for each model year that would result in stringency levels and emission reductions consistent with those of the proposed phase-in approach.

We also request comment on the possibility of structuring the phase-in of the proposed diesel engine standards as a ''cumulative'' phase-in rather than the 25–50–75–100 percent phase-in being proposed. Under such an approach, a manufacturer could phase-in compliance with the proposed standards in whatever percentages were most beneficial to that manufacturer, provided the cumulative total in each year met or exceeded the cumulative total of the proposed phase-in. Whatever the phase-in schedule chosen by the manufacturer, all of its engines sold in model year 2010 would be required to demonstrate compliance with the proposed standards. For example, a manufacturer could phase-in its engines according to a schedule of 50–50–50–100 percent, or 35–50–65–100 percent, or 30–60–60–100, etc. Note that the cumulative percentages would have to be based on cumulative engine sales to avoid the possibility that variations in market conditions would not compromise air quality benefits. We believe that such a phase-in could provide manufacturers with more flexibility in product planning while possibly enhancing the air quality benefits of the proposed standards because some manufacturers may accelerate their phase-in. Manufacturers should indicate their interest in such an approach in their comments and should indicate how they might utilize it.

2. Implementation Schedule for Gasoline Engine and Vehicle Standards

The October 1999 proposal of new heavy-duty engine and vehicle standards included revised standards for gasoline heavy-duty engines and vehicles (64 FR 58472, October 29, 1999). These standards were proposed to take effect in the 2004 model year. Commenters on that proposal raised concerns that these standards could not take effect until model year 2005 or later because of the applicability of Clean Air Act section 202(a)(3)(C) to these engines and vehicles. Those commenters argued that this provision requires 4 years of implementation leadtime following the promulgation of new or revised standards, and that these standards had not been promulgated in a final rule in time to satisfy this leadtime provision. We are still in the process of finalizing this rule and so at this time we are not able to announce the outcome of the leadtime issue. However, we do expect that, should the gasoline engine and vehicle standards be delayed to model year 2005, the standards being proposed today for gasoline engines and vehicles would first apply in model year 2008, rather than 2007, due to another part of the Clean Air Act section 202(a)(3)(C) provision that requires 3 model years of stability between changed standards. We invite comment on the appropriateness of this expectation and on any issues that might arise in connection with the model year 2008 implementation schedule.

E. Feasibility of the Proposed New Standards

For more detail on the arguments supporting our assessment of the technological feasibility of today's proposed standards, please refer to the Draft RIA in the docket for this rule. The following discussion summarizes the more detailed discussion found in the Draft RIA.

1. Feasibility of Stringent Standards for Heavy-Duty Diesel

Diesel engines have made great progress in lowering engine-out emissions from 6.0 g/bhp-hr NO_X and 0.6 g/bhp-hr PM in 1990 to 4.0 g/bhp-hr NO_X and 0.1 g/bhp-hr PM in 1999. These reductions came initially with improvements to combustion and fuel systems. Introduction of electronic fuel systems in the early 1990s allowed lower NO_X and PM levels without sacrificing fuel economy. This, combined with increasing fuel injection pressures, has been the primary technology that has allowed emission levels to be reduced to current 1999 levels. Further engine-out NO_X reductions to the levels necessary to comply with the 2004 standard of 2.5 g/bhp-hr NO_X+NMHC will come primarily from the addition of cooled EGR.

Engine out emission reductions beyond the 2.5 g/bhp-hr level are expected with low sulfur fuel and more experience with cooled EGR systems. Low sulfur fuel will allow more EGR to be used at lower temperatures because of the reduced threat of sulfuric acid formation. In addition, recirculating the exhaust gases from downstream of a PM trap may allow different EGR pumping configurations to be feasible. Such pumping configurations could provide a better NO_X/fuel consumption tradeoff.

These potential engine-out emission reductions are expected to be modest and are not expected to be sufficient to meet the emission standards proposed today. However, they would allow greater flexibility in choosing the combination of technologies used to meet the proposed emission standards. With lower engine-out emissions, it might be most cost effective to use smaller and less expensive exhaust emission control devices, for instance. Also, the combination of engine-out and exhaust emission control could be chosen for the best fuel economy. The fuel economy trade-offs between lower engine-out emissions and more effective exhaust emission control might be such that a combination of the two methods provide fuel economy that is better than either method on its own. As a result, additional engine-out emission reductions are expected to add additional flexibility in combination with exhaust emission control in jointly optimizing costs, fuel economy, and emissions.

a. Meeting the Proposed PM Standard

Diesel PM consists of three primary constituents: unburned carbon particles, which make up the largest portion of the total PM; the soluble organic fraction (SOF), which consists of unburned hydrocarbons that have condensed into liquid droplets or have condensed onto unburned carbon particles; and sulfates, which result from oxidation of fuel borne sulfur in the engine's exhaust.

Several exhaust emission control devices have been developed to control harmful diesel PM constituents—the diesel oxidation catalyst (DOC), and the many forms of particulate filters, or traps. DOCs have been shown to be durable in use, but they effectively control only the SOF portion of the total PM which, especially on today's engines, constitutes only around 10 to 30 percent of the total PM. Therefore, the DOC does not address our PM concerns sufficiently.

At this time, only the PM trap is capable of providing the level of control sought by today's proposed PM standards. In the past, the PM trap has demonstrated highly efficient trapping efficiency, but regeneration of the collected PM has been a serious challenge. The PM trap works by passing the exhaust through a ceramic or metallic filter to collect the PM. The collected PM, mostly carbon particles but also the SOF portion, must then be burned off the filter before the filter becomes plugged. This burning off of collected PM is referred to as "regeneration," and can occur either:

- on a periodic basis by using base metal catalysts or an active regeneration system such as an electrical heater, a fuel burner, or a microwave heater; or,
- on a continuous basis by using precious metal catalysts.

Uncatalyzed diesel particulate traps demonstrated high PM trapping efficiencies many years ago, but the level of the PM standard was such that it could be met through less costly "in-cylinder" control techniques. Also, the regeneration characteristics were not dependable. As a result, some systems employed electrical heaters or fuel burners to improve upon regeneration, but these complicated the system design and still could not provide the durability and dependability required for HD diesel applications.

We believe the most desirable PM trap, and the type of trap that will prove to be the industry's technology of choice, is one capable of regenerating on an essentially continuous basis. We also believe that such traps are the most promising for enabling very low PM emissions because:

- They are highly efficient at trapping all forms of diesel PM;
- They employ precious metals to reduce the temperature at which regeneration occurs, thereby allowing for passive regeneration under normal operating conditions typical of a diesel engine;[81]
- Because they regenerate continuously, they have lower average backpressure thereby reducing potential fuel economy impacts; and,
- Because of their passive regeneration characteristics, they need no extra burners or heaters like would be required by an active regeneration system thereby reducing potential fuel economy impacts.

These catalyzed PM traps are able to provide in excess of 90 percent control of diesel PM. However, as discussed in detail in the Draft RIA, the catalyzed PM trap cannot regenerate properly with current fuel sulfur levels as such sulfur levels inhibit the NO to NO_2 reaction to the point of stopping trap regeneration.[82] Also, because SO_2 is so readily oxidized to SO_3, very low PM standards cannot be achieved with current sulfur levels because of the resultant increase in sulfate PM emissions.[83]

More than one exhaust emission control manufacturer is known to be developing these precious metal catalyzed, passively regenerating PM traps and to have them in broad field test programs in areas where low sulfur diesel fuel is currently available. In field trials, they have demonstrated highly efficient PM control and promising durability with some units accumulating in excess of 360,000 miles of field use.[84] The experience gained in these field tests also helps to clarify the need for very low sulfur diesel fuel. In Sweden and some European city centers where below 10 ppm diesel fuel sulfur is readily available, more than 3,000 catalyzed diesel particulate filters have been introduced into retrofit applications without a single failure. The field experience in areas where sulfur is capped at 50 ppm has been less definitive. In regions without extended periods of cold ambient conditions, such as the United Kingdom, field tests on 50 ppm cap low sulfur fuel have been extremely positive, matching the success at, 10 ppm. However, field tests in Finland where colder winter conditions are sometimes encountered (similar to northern parts of the United States) have revealed a failure rate of 10 percent. This 10 percent failure rate has been attributed to insufficient trap regeneration due to fuel sulfur in combination with low ambient temperatures.[85] As the ambient conditions in Sweden are expected to be no less harsh than Finland, we are left to conclude that the increased failure rates noted here are due to the higher fuel sulfur level in a 50 ppm cap fuel versus a 10 ppm cap fuel. From these results, we can also theorize that lighter applications (such as large pick-up trucks and other light heavy-duty applications), having lower exhaust temperatures than heavier applications, may experience similar results and would, therefore, need very low sulfur fuel. These results are understood to be due to the effect of sulfur on the trap's ability to create sufficient NO_2 to carry out proper trap regeneration. Without the NO_2, the trap continues to trap at high efficiency, but it is unable to oxidize, or regenerate, the trapped PM. The possible result is a plugged trap.

Diesel particulate traps reduce particulate matter (PM) by capturing and burning particles. Ninety percent of

[81] For PM trap regeneration without precious metals, temperatures in excess of 650°C must be obtained. At such high temperatures, carbon will burn provided sufficient oxygen is present. However, although the largest heavy-duty diesels may achieve temperatures of 650°C under some operating conditions, smaller diesel engines, particularly light-duty and light heavy-duty diesel engines, will rarely achieve such high temperatures. For example, exhaust temperatures on the HDE Federal Test Procedure cycle typically range from 100°C to 450°C. Precious metal catalyzed traps use platinum to oxidize NO in the exhaust to NO_2, which is capable of oxidizing carbon at temperatures as low as 250°C to 300°C.

[82] Cooper and Thoss, Johnson Matthey, SAE 890404.

[83] See the Draft RIA for more detail on the relationship of fuel sulfur to sulfate make.

[84] Allansson, et at., SAE 2000–01–0480.

[85] Letter from Dr. Barry Cooper to Don Lopinski US EPA, EPA Docket A–99–06.

the PM mass resides in particle sizes that are less than 1000 nanometers (nm) in diameter, and half of these particles are less than 200 nm. Fortunately, PM traps have very high particle capture efficiencies. PM less than 200 nm is captured efficiently by diffusion onto surfaces within the trap walls. Larger particles are captured primarily by inertial impaction onto surfaces due to the tortuous path that exhaust gas must take to pass through the porous trap walls. Capture efficiency for elemental carbon (soot) and metallic ash is nearly 100 percent; therefore, significant PM can only form downstream of the trap. Volatile PM forms from sulfate or organic vapors via nucleation, condensation, and/or adsorption during initial dilution of raw exhaust into the atmosphere. Kleeman,[86] et. al., and Kittelson,[87] et. al., independently demonstrated that these volatile particles reside in the ultra-fine PM range (i.e. <100 nm range).

Modern catalyzed PM traps have been shown to be very effective at reducing PM mass. In addition, they can significantly reduce the overall number of emitted particles when operated on low sulfur fuel. Hawker, et al., found that a modern catalyzed PM trap reduced particle count by over 95 percent, including ultrafine particles (< 50 nm) at most of the tested conditions. The lowest observed efficiency in reducing particle number was 86 percent. No generation of particles by the PM trap was observed under any tested conditions.[88] Kittelson, et al., confirmed that ultrafine particles can be reduced by a factor of ten by oxidizing volatile organics, and by an additional factor of ten by reducing sulfur in the fuel. Catalyzed PM traps efficiently oxidize nearly all of the volatile organic PM precursors, and elimination of as much fuel sulfur as possible will dramatically reduce the number of ultrafine PM emitted from diesel engines. Therefore, the combination of PM traps with low sulfur fuel is expected to result in a very large reduction in PM mass, and ultrafine particles will be almost completely eliminated.

Now that greater than 90 percent effective PM emission control has been demonstrated, focus has turned to bringing PM exhaust emission control to market. One of the drivers is the Euro IV PM standard set to become effective in 2005.[89] This standard sets a PM trap forcing emission target. In anticipation of the 2005 introduction date, field tests are already underway in several countries with catalyzed particulate filters. We believe the experience gained in Europe with these technologies will coincide well with the emission standards in this proposal. The timing of today's proposal harmonizes the heavy-duty highway PM technologies with those expected to be used to meet the light-duty highway Tier 2 standards. Our own testing with fuel sulfur levels below 10 ppm shows that these systems are viable.[90] With this level of effort already under way, we believe that the proposed PM standards which would require a 90 percent reduction in the mass of particulate emissions could be met provided low sulfur fuel is made available.

The data currently available show that catalyzed particulate filters can provide significant reductions in PM. Catalyzed particulate filters, in conjunction with low sulfur fuel, have been shown to be more than 90 percent efficient over the FTP and at most supplemental steady-state modes.[91] However, with the application of exhaust emission control technology and depending on the sulfur level of the fuel, there is the potential for sulfate production during some operating modes covered by the NTE and the supplemental steady-state test. We believe that, with the 15 ppm diesel sulfur level proposed today, the NTE and the supplemental steady-state test, as proposed in the 2004 heavy-duty rule, would be feasible. This belief, as discussed in greater detail in the draft RIA, is supported by data generated as part of the Diesel Emission Control Sulfur Effects (DECSE) test program.[92] We request comment and relevant data on this issue.

We request comment on the potential need to remove, clean, and reverse these traps at regular intervals to remove ash build-up resulting from engine oil. Small amounts of oil can enter the exhaust via the combustion chamber (past the pistons, rings and valve seals), and via the crankcase ventilation system. This can lead to ash build-up, primarily as a result of the metallic oil additives used to provide pH control. Such pH control is necessary, in part, to neutralize sulfuric acid produced as a byproduct of burning fuel containing sulfur. However, with reduced fuel sulfur, these oil additives could be reduced, thereby reducing the rate of ash build-up and lengthening any potential cleaning intervals. It may also be possible to use oil additives that are less prone to ash formation to reduce the need for periodic maintenance. We believe that catalyzed PM traps should be able to meet the required emissions reduction goals over their useful life with minimal maintenance. Nonetheless, we request comment on the appropriate minimum allowable maintenance interval for PM traps. Commenters should consider whether the maintenance interval should include design provisions to ensure quick and easy maintenance and should make suggestions for how performance of the maintenance by the owner would be ensured.

b. Meeting the Proposed NO_X Standard

The NO_X standard proposed today requires approximately a 90 percent reduction in NO_X emissions beyond the levels expected from the 2004 emission standards. Historically, catalytic reduction of NO_X emissions in the oxygen-rich environment typical of diesel exhaust has been difficult because known NO_X reduction mechanisms tend to be highly selective for oxygen rather than NO_X. Nonetheless, there are exhaust emission control devices that reduce the NO_X to form harmless oxygen and nitrogen. These devices are the lean NO_X catalyst, the NO_X adsorber, selective catalytic reduction (SCR), and non-thermal plasma.

The lean NO_X catalyst has been shown to provide up to a 30 percent NO_X reduction under limited steady-state conditions. Despite a large amount of development effort, NO_X reductions over the heavy-duty transient federal test procedure (FTP) have been demonstrated only on the order of 12 percent.[93] Consequently, the lean NO_X

[86] Kleeman, M.J., Schauer, J.J., Cass, G.R., 2000, Size and Composition Distribution of Fine Particulate Matter Emitted From Motor Vehicles, Environmental Science and Technology, Vol. 34, No. 7.

[87] Kittelson, D.B., 2000, Presentation on Fuel and Lube Oil Sulfer and Oxidizing Aftertreatment System Effects on Nano-particle Emissions from Diesel Engines. Presented in United Kingdom April 12, 2000.

[88] Hawker, P., et al., Effect of a Continuously Regenerating Diesel Particulate Filter on Non-Regulated Emissions and Particle Size Distribution, SAE 980189.

[89] The Euro IV standards are 2.6 g/hp-hr NO_X and 0.015 g/hp-hr PM.

[90] Memorandum from Charles Schenk, EPA, to Air Docket A–99–06, "Summary of EPA PM Efficiency Data," May 8, 2000.

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

[92] Diesel Emission Control Sulfur Effects (DECSE) Program—Phase II Interim Data Report No. 4, Diesel Particulate Filters—Final Report, January 2000, Table C1, www.ott.doe.gov/decse.

[93] Kawanami, M., et al., Advanced Catalyst Studies of Diesel NO_X Reduction for On-Highway Trucks, SAE 950154.

catalyst does not appear to be capable of enabling the significantly lower NO_X emissions required by the proposed NO_X standard.

NO_X adsorbers were first introduced in the power generation market less than five years ago. Since then, NO_X adsorber systems in stationary source applications have enjoyed considerable success. In 1997, the South Coast Air Quality Management District of California determined that a NO_X adsorber system provided the ''Best Available Control Technology'' NO_X limit for gas turbine power systems.[94] Average NO_X control for these power generation facilities is in excess of 92 percent.[95]

Recently, the NO_X adsorber's stationary source success has caused some to turn their attention to applying NO_X adsorber technology to lean burn engines in mobile source applications. With only a few years of development effort, NO_X adsorber catalysts have been developed and are now in production for gasoline direct injection vehicles in Japan. The 2000 model year will see the first U.S. application of this technology with the introduction of the Honda Insight, which will be certified to the California LEV–I ULEV category standard.

Although diesel vehicle manufacturers have not yet announced production plans for NO_X adsorber-based systems, they are known to have development efforts underway to demonstrate their potential. In Europe, both Daimler-Chrysler and Volkswagen, driven by a need to meet stringent Euro IV emission standards, have published results showing how they would apply the NO_X adsorber technology to their diesel powered passenger cars. Volkswagen reports that it has already demonstrated NO_X emissions of 0.137 g/km (0.22 g/mi) on a diesel powered Passat passenger car equipped with a NO_X adsorber catalyst.[96]

Likewise, in the United States, heavy-duty engine manufacturers have begun investigating the use of NO_X adsorber technologies as a more cost effective means to control NO_X emissions when compared to more traditional in-cylinder approaches. Cummins Engine Company reported, at DOE's 1999 Diesel Engine Emissions Reduction workshop, that they had demonstrated an 80 percent reduction in NO_X emissions over the Supplemental Steady State test and 58 percent over the heavy-duty FTP cycle using a NO_X adsorber catalyst.

In spite of these promising developments, work in the United States on NO_X adsorbers has been limited in comparison to the rest of the world for at least a couple of reasons: (1) prior to today's proposal, emission standards have not necessitated the use of NO_X exhaust emission controls on heavy-duty diesel engines; and, (2) there has not been a commitment in the U.S. to guarantee the availability of low sulfur diesel fuel. This is in stark contrast to Europe where the Euro IV and Euro V emission standards, along with the commitment to low sulfur diesel fuel, have led to rapid advancements of NO_X exhaust emission control technology. We believe, based on input from industry members that develop and manufacture emission control devices such as NO_X adsorbers, that the prospect of low sulfur diesel fuel in the U.S. market will drive rapid advancement of this promising NO_X control technology.[97]

NO_X adsorbers work by providing a NO_X storage feature, a NO_X adsorber, during periods of fuel lean operation. This is then combined with the typical three-way catalyst, like those used for years in stoichiometric gasoline applications. The combination of adsorber plus three-way catalyst allows storage of NO_X on the adsorber during fuel lean-oxygen rich operation, then removal of NO_X from the adsorber and reduction of NO_X over the three-way catalyst during fuel rich-oxygen lean operation. This removal of NO_X from the adsorber is termed ''NO_X regeneration'' and generally requires purposeful controlled addition of small amounts of fuel into the exhaust stream at regular intervals.

Improving NO_X reduction efficiencies over the diesel exhaust temperature range is key to meeting the proposed standards. Current NO_X adsorbers, for instance, have a high reduction efficiency (over 90 percent NO_X reduction) over a fairly broad temperature range (exhaust temperatures from 250°C to 450°C) allowing today's proposed standard to be met over this range.[98] Extending the range of high NO_X reduction efficiency at both high temperatures and low temperatures will allow higher average reduction efficiencies over the FTP and in use. The performance of the NO_X adsorber may vary somewhat with exhaust temperature across the NTE. For that reason, engine-out NO_X emissions will have to be flattened over the NTE to accommodate these variations in NO_X reduction performance. We believe that such an approach would allow the NO_X NTE and supplemental steady-state composite to be met. We seek comment and data on the relationship between NO_X adsorber performance and engine operating mode.

The greatest hurdle to the application of the NO_X adsorber technology has been its sensitivity to sulfur in diesel fuel. The NO_X adsorber stores sulfur emissions in a manner directly analogous to its storage of NO_X under lean conditions. Unfortunately, the stored sulfur is not readily removed from the adsorber during the type of operating conditions under which NO_X is readily removed. This leads to an eventual loss of NO_X adsorber function and, thus, a loss of NO_X emission control. This potential loss of NO_X adsorber function can most effectively be addressed through the reduction of sulfur in diesel fuel. For a more complete description of the sensitivity of this technology to sulfur in diesel fuel, and for an explanation of the need for low sulfur diesel fuel, please refer to section III.F.

The preceding discussion of NO_X adsorbers assumes that SO_X (SO_2 and SO_3) emissions will be ''trapped'' on the surface of the catalyst effectively poisoning the device and requiring a ''desulfation'' (sulfur removal event) to recover catalyst efficiency. We believe that, at the proposed 15 ppm cap fuel sulfur level, this strategy will allow effective NO_X control with moderately frequent desulfation and with a modest fuel consumption of one percent, which we anticipate will be more that offset by reduced reliance on current more expensive (from a fuel economy standpoint) NO_X control strategies (see discussion in section III.F for estimates of overall fuel economy impacts). In order to reduce the fuel economy impact and to simplify engine control, some manufacturers are investigating the use of SO_X ''traps'' (sometimes called SO_X ''adsorbers'') to remove sulfur from the exhaust stream prior to it flowing through the NO_X adsorber catalyst.

The SO_X trap is, in essence, a modified NO_X adsorber designed to preferentially store (trap) sulfur on its surface rather than NO_X. It differs from a NO_X adsorber in that it is not effective at storing NO_X and it more easily releases stored sulfur. A SO_X trap placed upstream of a NO_X adsorber could effectively remove very modest

[94] Letter from Barry Wallerstein, Acting Executive Officer, SCAQMD, to Rober Danziger, Goal Line Environmental Technologies, dated December 8, 1997, www.glet.com.

[95] Reyes and Cutshaw, SCONO$_X$ Catalytic Absorption System, December 8, 1998. www.glet.com.

[96] Pott, E., et al., Potential of NO_X-Trap Catalyst Application for DI–Diesel Engines.

[97] Letter from Bruce Bertelsen, Executive Director, Manufacturers of Emission Controls Association, to Margo Oge, EPA, dated April 5, 2000.

[98] Dou, D., Bailey, O., Investigation of NO_X Adsorber Catalyst Deactivation, SAE 982594.

amounts of sulfur from the exhaust, thereby limiting sulfur's effect on the NO_X adsorber. Unfortunately, the SO_X trap like the NO_X adsorber, will eventually fill every available storage site with sulfate and will cease to function unless the sulfur is removed. Desulfating the SO_X adsorber on the vehicle is problematic since it would be upstream of the NO_X adsorber which could then be poisoned quite rapidly by the SO_X released from the SO_X trap. This problem could presumably be solved through some form of NO_X adsorber by-pass during SO_X trap desulfation (although control of NO_X during this event may be problematic). Alternatively, removal and replacement of the SO_X adsorber on a fixed service interval would solve this problem, albeit at some cost. In an oral presentation made to EPA, an engine manufacturer estimated the storage capacity of a SO_X trap at approximately one pound of SO_2 per cubic foot of catalyst.[99] For fuel with a seven ppm average sulfur level, this would mean replacement of a 48 liter SO_X trap approximately every 100,000 miles.[100] This more than doubles the catalyst size we have projected for a typical heavy heavy-duty vehicle in this proposal, while only providing protection for a small fraction of its useful life. Because of practical limitations on SO_X trap size, we do not believe that the use of SO_X traps can avoid the need for very low-sulfur diesel fuel, and we have received no information from manufacturers that contradicts this belief. We invite comment on the use of a SO_X trap to protect NO_X adsorbers and on the appropriateness of SO_X traps being replaced on a fixed interval as described here. Further, we request comment and supporting data to indicate the interval at which SO_X traps would require replacement.

Selective Catalytic Reduction (SCR), like NO_X adsorber technology, was first developed for stationary applications and is currently being refined for the transient operation found in mobile applications.[101] With the SCR system, a urea solution is injected upstream of the catalyst which breaks down the urea into ammonia and carbon dioxide. Catalysts containing precious metals (platinum) can be used at the inlet and outlet of SCR systems designed for mobile applications to improve low temperature NO_X reduction performance and to oxidize any ammonia that may pass through the SCR, respectively. Such SCR systems are referred to as "Compact SCR." The use of these platinum catalysts enable Compact SCR systems to achieve large NO_X reductions, but introduce sensitivity to sulfur in much the same way as for diesel particulate filter technologies. Sulfur in diesel fuel inhibits low temperature performance and results in high sulfate make leading directly to higher particulate emissions. For a further discussion of Compact SCR system sensitivity to sulfur in diesel fuel, and of its need for low sulfur diesel fuel, refer to section III.F.

The reduction efficiency window for Compact SCR is similar to the NO_X adsorber, with greater than 80 percent efficiency at exhaust temperatures as low as 250°C.[102] Peak efficiency values of over 90 percent are possible under certain conditions, but the cool exhaust temperature characteristics of diesel engines make excursions outside the optimum efficiency window of current Compact SCR systems quite frequent. As a result, the cycle average NO_X reduction efficiency is on the order of 77 percent over the heavy-duty FTP.[103] Over the Supplemental Steady State test modes, the SCR has been shown to have 65–99 percent efficiency.[104] The high efficiency over a broad temperature range should also allow the NTE to be met. With additional development effort, we believe the NO_X reduction efficiency of SCR can be further improved to meet NO_X levels as low as those proposed today.

However, significant challenges remain for Compact SCR systems to be applied to mobile source applications. In addition to the need for very low sulfur diesel fuel to achieve high NO_X conversion efficiencies and to control sulfate PM emissions, Compact SCR systems require vehicles to be refueled with urea. The infrastructure for delivering urea at the pump needs to be in place for these devices to be feasible in the marketplace; and before development of the infrastructure can begin, the industry must decide upon a standardized method of delivery for the urea supply. In addition to this, there would need to be adequate safeguards in place to ensure the urea is used throughout the life of the vehicle, since, given the added cost of urea, there would be incentive not to refill the urea tank. Because urea is required for the SCR system to function, urea replenishment would need to be assured.

Another, very recent approach to NO_X reduction is the non-thermal plasma assisted catalyst. This system works by applying a high voltage across two metal plates in the exhaust stream to form ions that serve as oxidizers. Essentially, the plasma would displace a conventional platinum based oxidation catalyst in function. Once oxidized to NO_2, NO_X can be more readily reduced over a precious metal catalyst. While the concept is promising, this technology is so new that essentially no data exists showing its effectiveness at controlling NO_X. We expect that, if and when the non-thermal plasma approach to NO_X control becomes viable, it will also require the use of low sulfur diesel fuel due to its reliance on a precious metal catalyst to reduce the NO_2.[105]

Based on the discussion above, we believe that NO_X aftertreatment technology, in combination with low sulfur diesel fuel, is capable of meeting the very stringent NO_X standards we have proposed. The clear intent that this proposal provides to make very low sulfur diesel fuel available in the future and to establish emission standards which necessitate advanced NO_X controls should enable rapid development of these technologies. The NO_X adsorber technology has shown incredible advancement in the last five years, moving from stationary source applications to lean-burn gasoline, and now to heavy-duty diesel engines. Given this rapid progress, the availability of very low sulfur diesel fuel, and the lead time provided by today's proposal, we believe that applying NO_X adsorbers to heavy-duty diesel engines would enable manufacturers to comply with our proposed standards. Compact SCR has been slower in developing than NO_X adsorbers but could be applied to mobile source applications if the

[99] Memorandum from Byron Bunker, US EPA to Air Docket A–99–06, "Meeting between EPA, OMB, representatives of major oil companies, and representatives of major diesel engine manufacturers," Item II–E–17.

[100] This estimate assumes that a heavy-duty vehicle averages six miles per gallon of fuel, that diesel fuel weighs seven pounds per gallon, that diesel fuel has seven ppm sulfur, and that a sulfur trap could store one pound of SO_2 in a cubic foot of catalyst.

[101] SRC systems being developed for mobile applications are more appropriately called "compact SCR" systems, which incorporate on oxidation catalyst. Generally, reference to SCR throughout this preamble should be taken to mean compact SCR.

[102] Klein, H., et al., NO_X Reduction for Diesel Vehicles, Degussa-Huls AG, Corning Clean Diesel Workshop, Sept. 27–29, 1999.

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

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

[105] "The Impact of Sulfur in Diesel Fuel on Catalyst Emission Control Technology," report by the Manufacturers of Emission Controls Association, March 15, 1999.

difficult urea infrastructure issues can be addressed.

c. Meeting the Proposed NMHC Standard

Meeting the NMHC standards proposed today should not present any special challenges to diesel manufacturers. Since all of the devices discussed above—catalyzed particulate filters, NO_X adsorbers, and SCR—contain platinum and other precious metals to oxidize NO to NO_2, they are also very efficient oxidizers of hydrocarbons. Reductions of greater than 95 percent have been shown over transient FTP and supplemental steady-state modes.[106] Given that typical engine-out NMHC is expected to be in the 0.2 g/bhp-hr range for engines meeting the 2004 standards, this level of NMHC reduction will easily allow the 0.14 g/bhp-hr NMHC standard to be met over the transient FTP, the supplemental steady-state test, and the NTE zone.

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. Until today's proposal, we have required that crankcase emissions be controlled only on naturally aspirated diesel engines. We have made an exception for turbocharged heavy-duty diesel engines 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 heavy-duty diesel trucks use turbocharged engines, and a single engine can emit over 100 pounds of NO_X, NMHC, and PM from the crankcase over the lifetime of the engine.

Therefore, we have proposed to eliminate this exception. We anticipate that the heavy-duty 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. The closed crankcase filtration systems work by separating oil and particulate matter from the blow-by gases through single or dual stage filtration approaches, routing the blow-by gases into the engine's intake manifold and returning the filtered oil to the oil sump. These systems are required for new heavy-duty diesel vehicles in Europe starting this year. Oil separation efficiencies in excess of 90 percent have been demonstrated with production ready prototypes of two stage filtration systems.[107] By eliminating 90 percent of the oil that would normally be vented to the atmosphere, the system works to reduce oil consumption and to eliminate concerns over fouling of the intake system when the gases are routed through the turbocharger. An alternative approach would be to route the blow-by gases into the exhaust system upstream of the catalyzed diesel particulate filter which would be expected to effectively trap and oxidize the engine oil and diesel PM. This approach may require the use of low sulfur engine oil to ensure that oil carried in the blow-by gases does not compromise the performance of the sulfur sensitive emission control equipment. We request comment on the use of either approach to crankcase emissions control.

e. The Complete System

We expect that the technologies described above would be integrated into a complete emission control system. The engine-out emissions will be traded off against the exhaust emission control package in such a way that the result is the most beneficial from a cost, fuel economy and emissions standpoint. The engine-out characteristics will also have to be tailored to the needs of the exhaust emission control devices used. The NO_X adsorber, for instance, will require periods of oxygen depleted exhaust flow in order to regenerate. This may be most efficiently done by reducing the air-fuel ratio that the engine is operating under during the regeneration to reduce the oxygen content of the exhaust. Further, it is envisioned that the PM device will be integrated into the exhaust system upstream of the NO_X reduction device. This placement would allow the PM trap to take advantage of the engine-out NO_X as an oxidant for the particulate, while removing the particulate so that the NO_X exhaust emission control device will not have to deal with large PM deposits which may cause a deterioration in performance. Of course, there is also the possibility of integrating the PM and NO_X exhaust emission control devices into a single unit to replace a muffler and save space. Particulate free exhaust may also allow for new options in EGR system design to optimize its efficiency.

We expect that the exhaust emission control emission reduction efficiency will vary with temperature and space velocity[108] across the NTE zone. Consequently, to maintain the NTE emission cap, the engine-out emissions would have to be calibrated with exhaust emission control performance characteristics in mind. This would be accomplished by lowering engine-out emissions where the exhaust emission control was less efficient. Conversely, where the exhaust emission control is very efficient at reducing emissions, the engine-out emissions could be tuned for higher emissions and better fuel economy. These trade-offs between engine-out emissions and exhaust emission control performance characteristics are similar to those of gasoline engines with three-way catalysts in today's light-duty vehicles. Managing and optimizing these trade-offs will be crucial to effective implementation of exhaust emission control devices on diesel applications.

2. Feasibility of Stringent Standards for Heavy-Duty Gasoline

Gasoline emission control technology has evolved rapidly in recent years. Emission standards applicable to 1990 model year vehicles required roughly 90 percent reductions in exhaust NMHC and CO emissions and a 75 percent reduction in NO_X emissions compared to uncontrolled emissions. Today, some vehicles' emissions are well below those necessary to meet the current federal heavy-duty gasoline standards, the proposed 2004 heavy-duty gasoline standards, and the California Low-Emission Vehicle standards for medium-duty vehicles. The continuing emissions reductions have been brought about by ongoing improvements in engine air-fuel management hardware and software plus improvements in exhaust system and catalyst designs.

We believe that the types of changes being seen on current vehicles have not yet reached their technological limits and continuing improvement will allow them to meet today's proposed standards. The Draft RIA describes a range of specific emission control techniques that we believe could be used. There is no need to invent new technologies, although there will be a need to apply existing technology more effectively and more broadly. The focus of the effort will be in the application and optimization of these existing technologies.

[106] ''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.

[107] Letter from Marty Barris Donaldson Corporation to Byron Bunker US EPA, March 2000. EPA Air Docket A–99–06.

[108] The term, ''space velocity,'' is a measure of the volume of exhaust gas that flows through a device.

In our light-duty Tier 2 rule, we have required that gasoline sulfur levels be reduced to a 30 ppm average, with an 80 ppm maximum. This sulfur level reduction is the primary enabler for the Tier 2 standards. Similarly, we believe that the gasoline sulfur reduction, along with refinements in existing gasoline emission control technology, will be sufficient to allow heavy-duty gasoline vehicles and engines to meet the emission standards sought by today's proposal.

However, we recognize that the emission standards are stringent, and considerable effort would have to be undertaken. For example, we expect that every engine would have to be recalibrated to improve upon its cold start emission performance. Manufacturers would have to migrate their light-duty calibration approaches to their heavy-duty offerings to provide cold start performance in line with what they will have to achieve to meet the Tier 2 standards.

We also project that the proposed 2007 heavy-duty standards would require the application of advanced engine and catalyst systems similar to those projected for their light-duty counterparts. Historically, manufacturers have introduced technology on light-duty gasoline applications and then applied those technologies to their heavy-duty gasoline applications. The proposal would allow manufacturers to take this same approach for 2007. In other words, we expect that manufacturers would meet the proposed 2007 standards through the application of technology developed to meet light-duty Tier 2 standards for 2004.

Improved calibration and systems management would be critical in optimizing the performance of the engine with the advanced catalyst system. Precise air/fuel control must be tailored for emissions performance and must be optimized for both FTP and SFTP type driving. Calibration refinements may also be needed for EGR system optimization and to reduce cold start emissions through methods such as spark timing retard. We also project that electronic control modules with expanded capabilities would be needed on some vehicles and engines.

We also expect increased use of other technologies in conjunction with those described above. We expect some increased use of air injection to improve upon cold start emissions. We may also see air-gap manifolds, exhaust pipes, and catalytic converter shells as a means of improving upon catalyst light-off times thereby reducing cold start emissions. Other, non-catalyst related improvements to gasoline emission control technology include, as already stated, higher speed computer processors which enable more sophisticated engine control algorithms and improved fuel injectors providing better fuel atomization thereby improving fuel combustion.

Catalyst system durability is, and will always be, a serious concern. Historically, catalysts have deteriorated when exposed to very high temperatures. This has long been a concern especially for heavy-duty work vehicles. However, catalyst manufacturers continue to make strides in the area of thermal stability and we expect that improvements in thermal stability will continue for the next generation of catalysts.

We believe that, by optimizing all of these technologies, manufacturers will be able to achieve the proposed emission levels. Advanced catalyst systems have already shown potential to reduce emissions to close to the proposed levels. Some current California vehicles are certified to levels below 0.2 g/mi NO_X. California tested an advanced catalyst system on a vehicle loaded to a test weight comparable to a heavy-duty vehicle test weight and achieved NO_X and NMOG levels of 0.1 g/mi and 0.16 g/mi, respectively. The California vehicle with the advanced catalyst had not been optimized as a system to take full advantage of the catalyst's capabilities.

The ABT program can also be an important tool for manufacturers in implementing a new standard. The program allows manufacturers to transition to the more stringent standards by introducing emissions controls over a longer period of time, as opposed to a single model year. Manufacturers plan their product introductions well in advance. With ABT, manufacturers can better manage their product lines so that the new standards don't interrupt their product introduction plans. Also, the program allows manufacturers to focus on higher sales volume vehicles first and use credits for low sales volume vehicles.

We request comment on the feasibility of the proposed standards and request data that would help us evaluate advanced system durability.

3. Feasibility of the Proposed Evaporative Emission Standards

The proposed evaporative emission standards appear to be feasible now. Many designs have been certified that already meet these standards. A review of 1998 model year certification data indicates that five of eight evaporative system families in the 8,500 to 14,000 pound range comply with the proposed 1.4 g/test standard, while all evaporative system families in the over 14,000 pound range comply with the proposed 1.9 g/test standard.

The proposed evaporative emission standards would not require the development of new materials or, in many cases, even the new application of existing materials. Low permeability materials and low loss connections and seals are already used to varying degrees on current vehicles. Today's proposed standards would likely ensure their consistent use and discourage manufacturers from switching to cheaper materials or designs to take advantage of the large safety margins they have under current standards.

There are two approaches to reducing evaporative emissions for a given fuel. One is to minimize the potential for permeation and leakage by reducing the number of hoses, fittings and connections. The second is to use less permeable hoses and lower loss fittings and connections. Manufacturers are already employing both approaches.

Most manufacturers are moving to "returnless" fuel injection systems. Through more precise fuel pumping and metering, these systems eliminate the return line in the fuel injection system. The return line carries unneeded fuel from the fuel injectors back to the fuel tank. Because the fuel injectors are in such close contact with the hot engine, the fuel returned from the injectors to the fuel tank has been heated. This returned fuel is a significant source of fuel tank heat and vapor generation. The elimination of the return line also reduces the total length of hose on the vehicle through which vapors can permeate, and it reduces the number of fittings and connections through which fuel can leak.

Low permeability hoses and seals, and low loss fittings are available and are already used on many vehicles. Fluoropolymer materials can be added as liners to hose and component materials to yield large reductions in permeability over such conventional materials as monowall nylon. In addition, fluoropolymer materials can greatly reduce the adverse impact of alcohols in gasoline on permeability of evaporative components, hoses and seals.

F. Need for Low-Sulfur Diesel Fuel

The following discussion will build upon the brief sulfur sensitivity points made earlier in this section by providing a more in depth discussion of sulfur's effect on the most promising diesel exhaust emission control technologies. In order to evaluate the effect of sulfur on diesel exhaust control technologies, we used three key factors to categorize the impact of sulfur in fuel on emission control function. These factors were efficiency, reliability, and fuel economy. Taken together these three factors lead us to believe that diesel fuel sulfur levels of 15 ppm will be required in order to make feasible the proposed heavy-duty vehicle emission standards (a discussion of higher sulfur fuel standards, and what they might mean is included in Section VI.B). Brief summaries of these factors are provided below. A more in-depth review is given in the following subsections and the RIA associated with this proposal.

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 NO_X, NMHC, CO and diesel PM emissions are significantly reduced by catalyst poisoning and catalyst inhibition due to sulfur. NO_X conversion efficiencies with the NO_X adsorber technology in particular are dramatically reduced in a very short time due to sulfur poisoning of the NO_X storage bed. In addition, total PM control efficiency is negatively impacted by the formation of sulfate PM. As explained in detail in the following sections, all of the advanced NO_X and PM technologies described here have the potential to make significant amounts of sulfate PM under operating conditions typical of heavy-duty vehicles. The formation of sulfate PM is likely to be in excess of the total PM standard proposed today, unless diesel fuel sulfur levels are at or below 15 ppm. Based on the strong negative impact of sulfur on emission control efficiencies for all of the technologies evaluated, we believe that 15 ppm represents an upper threshold of acceptable diesel fuel sulfur levels.

Reliability refers to the expectation that emission control technologies must continue to function as required under all operating conditions for the life of the vehicle. As discussed in the following sections, sulfur in diesel fuel can prevent proper operation of both NO_X and PM control technologies. This 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. Among the most serious reliability concerns with sulfur levels greater than 15 ppm are those associated with failure to properly regenerate. In the case of the NO_X adsorber, failure to regenerate will lead to rapid loss of NO_X emission control as a result of sulfur poisoning of the NO_X 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 very low-sulfur diesel fuels that these technologies become feasible. The analysis given in the following section makes clear that diesel fuel sulfur levels will need to be consistent with today's proposed standard in order to ensure robust operation of the technologies under the variety of operating conditions anticipated to be experienced in the field.

Fuel economy impacts due to sulfur in diesel fuel affect both NO_X and PM control technologies. The NO_X adsorber sulfur regeneration cycle (desulfation cycle) can consume significant amounts of fuel unless fuel sulfur levels are very low. The larger the amount of sulfur in diesel fuel, the greater the adverse effect on fuel economy. 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 very 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 NO_X and PM technologies the lower the fuel sulfur level the better.

1. Diesel Particulate Filters and the Need for Low-Sulfur Fuel

As discussed earlier in this section, un-catalyzed diesel particulate filters require exhaust temperatures in excess of 650°C in order for the collected PM to be oxidized by the oxygen available in diesel exhaust. That temperature threshold for oxidation of PM by exhaust oxygen can be decreased to 450°C through the use of base metal catalytic technologies. Unfortunately, for a broad range of operating conditions diesel exhaust is significantly cooler than 400°C. If oxidation of the trapped PM could be assured to occur at exhaust temperatures lower than 300°C, then diesel particulate filters would be expected to be robust for most applications and operating regimes. The only means that we are aware of to ensure oxidation of PM (regeneration of the trap) at such low exhaust temperatures is by using oxidants which are more readily reduced than oxygen. One such oxidant is NO_2.

NO_2 can be produced in diesel exhaust through the oxidation of the nitrogen monoxide (NO), created in the engine combustion process, across a catalyst. The resulting NO_2-rich exhaust is highly oxidizing in nature and can oxidize trapped diesel PM at temperatures as cool as 250°C.[109] Some platinum group metals are known to be good catalysts to promote the oxidation of NO to NO_2. Therefore in order to ensure passive regeneration of the diesel particulate filters, significant amounts of platinum group metals (primarily platinum) are being used in the wash-coat formulations of advanced diesel particulate filters. The use of platinum to promote the oxidation of NO to NO_2 introduces several system vulnerabilities affecting both the durability and the effectiveness of the catalyzed diesel particulate filter when sulfur is present in diesel exhaust. The two primary mechanisms by which sulfur in diesel fuel limits the robustness and effectiveness of diesel particulate filters are inhibition of trap regeneration (i.e., inhibition of the oxidation of NO to NO_2) and a dramatic loss in total PM control effectiveness due to the formation of sulfate PM. Unfortunately, these two mechanisms trade-off against one another in the design of diesel particulate filters. Changes to improve the reliability of regeneration by increasing catalyst loadings lead to increased sulfate emissions and thus loss of PM control effectiveness. Conversely, changes to improve PM control by reducing the use of platinum group metals and, therefore, limiting ''sulfate make'' leads to less reliable regeneration. We believe the only means of achieving good PM emission control and reliable operation is to reduce sulfur in diesel fuel to the level proposed today, as shown in the following subsections.

a. Inhibition of Trap Regeneration Due to Sulfur

The passively regenerating diesel particulate filter technologies rely on the generation of a very strong oxidant, NO_2, to ensure that the carbon captured by the PM trap's filtering media is oxidized under normal operating conditions. NO_2 is produced through the oxidation of NO in the exhaust across a platinum catalyst. This oxidation is inhibited by the presence of

[109] Hawker, P. et al, Experience with a New Particulate Trap Technology in Europe, SAE 970182.

SO_2 in the exhaust stream because the preferential reaction across the platinum is oxidation of SO_2 to SO_3, rather than oxidation of NO to NO_2.[110] This inhibition limits the total amount of NO_2 available for oxidation of the trapped diesel PM, thereby raising the minimum exhaust temperature required to ensure trap regeneration. Without sufficient NO_2, the amount of PM trapped in the diesel particulate filter will continue to increase and can lead to excessive exhaust back pressure, low engine power, and even catastrophic failure of the diesel particulate filter itself.

Full field test evaluations and retrofit applications of these catalytic trap technologies are occurring in parts of Europe where low-sulfur diesel fuel is already available.[111] The experience gained in these field tests helps to clarify the need for very low-sulfur diesel fuel. In Sweden and some European city centers where below 10 ppm diesel fuel sulfur is readily available, more than 3,000 catalyzed diesel particulate filters have been introduced into retrofit applications without a single failure. Given the large number of vehicles participating in these test programs and the extended time periods of operation (some vehicles have been operating with traps for more than 4 years and in excess of 300,000 miles [112]), this is a strong indication of the robustness of this technology on 10 ppm low-sulfur diesel fuel. The field experience in areas where sulfur is capped at 50 ppm has been less definitive. In regions without extended periods of cold ambient conditions, such as the United Kingdom, field tests on 50 ppm cap low-sulfur fuel have also been positive, matching the success at 10 ppm. However, field tests in Finland where colder winter conditions are sometimes encountered (similar to many parts of the United States) have revealed a failure rate of 10 percent. This 10 percent failure rate has been attributed to insufficient trap regeneration due to fuel sulfur in combination with low ambient temperatures.[113] As the ambient conditions in Sweden are expected to be no less harsh than Finland, we are left to conclude that the increased failure rates noted here are due to the higher fuel sulfur level in a 50 ppm cap fuel versus a 10 ppm cap fuel. The failure of some fraction of the traps to regenerate on 50 ppm cap fuel is believed to be primarily due to inhibition of the NO to NO_2 conversion as described here.

The failure mechanisms experienced by diesel particulate filters due to low NO_2 availability vary significantly in severity and long term consequences. In the most fundamental sense, the failure is defined as an inability to oxidize the stored particulate at a rate fast enough to prevent net particulate accumulation over time. The excessive accumulation of PM over time blocks the passages through the filtering media, making it more restrictive to exhaust flow. In order to continue to force the exhaust through the now more restrictive filter the exhaust pressure upstream of the filter must increase. This increase in exhaust pressure is commonly referred to as increasing ''exhaust backpressure'' on the engine.

The increased exhaust backpressure represents increased work being done by the engine to force the exhaust gas through the increasingly restrictive particulate filter. Unless the filter is frequently cleansed of the trapped PM, this increased work can lead to reductions in engine performance and increases in fuel consumption. This loss in performance may be noted by the vehicle operator in terms of poor acceleration and generally poor driveability of the vehicle. In some cases, engine performance can be so restricted that the engine stalls, stranding the vehicle. This progressive deterioration of engine performance as more and more PM is accumulated in the filter media is often referred to as ''trap plugging.'' Trap plugging also has the potential to cause engine damage. If the exhaust backpressure gets high enough to open the exhaust valves prematurely, the exhaust valves can then strike the piston causing catastrophic engine failure. Whether trap plugging occurs, and the speed at which it occurs, will be a function of many variables in addition to the fuel sulfur level; these variables include the vehicle application, its duty cycle, and ambient conditions. However, if the fuel sulfur level is sufficient to prevent trap regeneration in any real world conditions experienced, trap plugging can occur. This is not to imply that any time a vehicle is refueled once with high sulfur fuel trap plugging will occur. Rather, it is important to know that the use of fuel with sulfur levels higher than 15 ppm significantly increases the chances of particulate filter failure.

Catastrophic failure of the filter can occur when excessive amounts of PM are trapped in the filter due to a lack of NO_2 for oxidation. This failure occurs when excessive amounts of trapped PM begin to oxidize at high temperatures (combustion-like temperatures of over 1000°C) leading to a ''run-away'' combustion of the PM. This can cause temperatures in the filter media to increase in excess of that which can be tolerated by the particulate filter itself. For the cordierite material commonly used as the trapping media for diesel particulate filters, the high thermal stresses caused by the high temperatures can cause the material to crack or melt. This can allow significant amounts of the diesel particulate to pass through the filter without being captured during the remainder of the vehicle's life. That is, the trap is destroyed and PM emission control is lost.

As shown above, sulfur in diesel fuel inhibits NO oxidation leading to increased exhaust backpressure, reduced fuel economy, compromised reliability, and potentially engine damage. Therefore, we believe that, in order to ensure reliable and economical operation over a wide range of expected operating conditions, diesel fuel sulfur levels should be at or below 15 ppm. With these very low sulfur levels we believe, as demonstrated by experience in Europe, that catalyzed diesel particulate filters will prove to be both durable and effective at controlling diesel particulate emissions to the very low levels that would be required by today's proposed standard. We request comment on the inhibition of trap regeneration due to fuel sulfur, along with supporting data.

b. Loss of PM Control Effectiveness

In addition to inhibiting the oxidation of NO to NO_2, the sulfur dioxide (SO_2) in the exhaust stream is itself oxidized to sulfur trioxide (SO_3) at very high conversion efficiencies by the precious metals in the catalyzed particulate filters. The SO_3 serves as a precursor to the formation of hydrated sulfuric acid (H_2SO_4+H_2O), or sulfate PM, as the exhaust leaves the vehicle tailpipe. Virtually all of the SO_3 is converted to sulfate under dilute exhaust conditions in the atmosphere as well in the dilution tunnel used in heavy-duty engine testing. Since virtually all sulfur present in diesel fuel is converted to SO_2, the precursor to SO_3, as part of the combustion process, the total sulfate PM is directly proportional to the amount of sulfur present in diesel fuel. Therefore, even though diesel particulate filters are very effective at trapping the carbon and the SOF portions of the total PM, the

[110] Hawker, P. et al, Experience with a New Particulate Trap Technology in Europe, SAE 970182.

[111] Through tax incentives 50 ppm cap sulfur fuel is widely available in the United Kingdom and 10 ppm sulfur fuel is available in Sweden and in certain European city centers.

[112] Allansson, et al. SAE 2000–01–0480.

[113] Letter from Dr. Barry Cooper, Johnson Matthey, to Don Kopinski, US EPA, Air Docket A–99–06.

overall PM reduction efficiency of catalyzed diesel particulate filters drops off rapidly with increasing sulfur levels due to the production of sulfate PM.

SO_2 oxidation is promoted across a catalyst in a manner very similar to the oxidation of NO, except it is converted at higher rates, with peak conversion rates in excess of 50 percent. The SO_2 oxidation rate for a platinum based oxidation catalyst typical of the type which might be used in conjunction with, or as a washcoat on, a catalyzed diesel particulate filter can vary significantly with exhaust temperature. At the low temperatures typical of some urban driving and the heavy-duty federal test procedure (HD–FTP), the oxidation rate is relatively low, perhaps no higher than ten percent. However at the higher temperatures that might be more typical of non-urban highway driving conditions and the Supplemental Steady State Test (also called the EURO III or 13 mode test), the oxidation rate may increase to 50 percent or more. These high levels of sulfate make across the catalyst are in contrast to the very low SO_2 oxidation rate typical of diesel engines (less than 2 percent). This variation in expected diesel exhaust temperatures means that there will be a corresponding range of sulfate production expected across a catalyzed diesel particulate filter.

The U.S. Department of Energy in cooperation with industry conducted a study entitled Diesel Emission Control Sulfur Effects (DECSE) to provide insight into the relationship between advanced emission control technologies and diesel fuel sulfur levels. Interim report number four of this program gives the total particulate matter emissions from a heavy-duty diesel engine operated with a diesel particulate filter on several different fuel sulfur levels. A straight line fit through this data is presented in Table III.F–1 below showing the expected total direct PM emissions from a heavy-duty diesel engine on the supplemental steady state test cycle.[114]

[114] Note that direct emissions are those pollutants emitted directly from the engine or from the tailpipe depending on the context in which the term is used, and indirect emissions are those pollutants formed in the atmosphere through the combination of direct emissions and atmospheric constituents.

TABLE III.F–1.—ESTIMATED PM EMISSIONS FROM A HEAVY-DUTY DIESEL ENGINE AT THE INDICATED AVERAGE FUEL SULFUR LEVELS

Avg. Fuel Sulfur [ppm]	Supplemental steady state	
	Tailpipe PM [g/bhp-hr]	Relative to 3 ppm sulfur
3	0.003	
7*	0.006	100%
15*	0.009	200%
30	0.017	470%
150	0.071	2,300%

*The PM emissions at these sulfur levels are based on a straight-line fit to the DECSE data; PM emissions at other sulfur levels are actual DECSE data. (Diesel Emission Control Sulfur Effects (DECSE) Program—Phase II Interim Data Report No. 4, Diesel Particulate Filters-Final Report, January 2000, Table C1.) Although DECSE tested diesel particulate filters at these fuel sulfur levels, they do not conclude that the technology is feasible at all levels, but they do note that testing at 150 ppm is a moot point as the emission levels exceed the engine's baseline emission level.

Table III.F–1 makes it clear that there are significant PM emission reductions possible with the application of catalyzed diesel particulate filters and low-sulfur diesel fuel. At the observed sulfate PM conversion rates, the DECSE program results show that the proposed total PM standard is feasible for diesel particulate filter equipped engines operated on fuel with a sulfur level at or below 15 ppm. The results also show that diesel particulate filter control effectiveness is rapidly degraded at higher diesel fuel sulfur levels due to the high sulfate PM make observed with this technology.

It is clear that PM reduction efficiencies are limited by sulfur in diesel fuel and that, in order to realize the PM emissions benefits sought in this rule, diesel fuel sulfur levels must be as low as possible. As discussed in Section IV, we believe that a 15 ppm sulfur cap for highway diesel fuel is the correct level given consideration to all factors. We request comment on the loss of PM control effectiveness due to fuel sulfur along with supportive data.

c. Increased Maintenance Cost for Diesel Particulate Filters Due to Sulfur

In addition to the direct performance and durability concerns caused by sulfur in diesel fuel, it is also known that sulfur can lead to increased maintenance costs, shortened maintenance intervals, and poorer fuel economy for particulate filters. Diesel particulate filters are highly effective at capturing the inorganic ash produced from metallic additives in engine oil. This ash is accumulated in the filter and is not removed through oxidation, unlike the trapped carbonaceous PM. Periodically the ash must be removed by mechanical cleaning of the filter with compressed air or water. This maintenance step is anticipated to occur on intervals of well over one hundred thousand miles. However, sulfur in diesel fuel increases this ash accumulation rate through the formation of metallic sulfates in the filter, which increases both the size and mass of the trapped ash. By increasing the ash accumulation rate, the sulfur shortens the time interval between the required maintenance of the filter and negatively impacts fuel economy. We request comment on the issue of PM filter maintenance costs and maintenance intervals along with supportive data.

2. Diesel NO_X Catalysts and the Need for Low-Sulfur Fuel

All of the NO_X exhaust emission control technologies discussed previously in Section III are expected to utilize platinum to oxidize NO to NO_2 to improve the NO_X reduction efficiency of the catalysts at low temperatures or as in the case of the NO_X adsorber, as an essential part of the process of NO_X storage. This reliance on NO_2 as an integral part of the reduction process means that the NO_X exhaust emission control technologies, like the PM exhaust emission control technologies, will have problems with sulfur in diesel fuel. In addition NO_X adsorbers have the added constraint that the adsorption function itself is blocked by the presence of sulfur. These limitations due to sulfur in the fuel affect both overall performance of the technologies and, in fact, the very feasibility of the NO_X adsorber technology.

a. Sulfate Particulate Production for NO_X Control Technologies

Two advanced NO_X control technologies that are likely to be able to meet the NO_X emission standard being proposed today are advanced NO_X adsorber catalyst systems and advanced Compact-SCR systems. The NO_X adsorber technology relies on an oxidation function to convert NO to NO_2 over the catalyst bed. For the NO_X adsorber this is a fundamental step prior to the storage of NO_2 in the catalyst bed as a nitrate. Without this oxidation function the catalyst will only trap that small portion of NO_X emissions from a diesel engine which is NO_2. This would reduce the NO_X adsorber effectiveness for NO_X reduction from in excess of 90 percent to something well below 20 percent. The NO_X adsorber relies on platinum to provide this oxidation function due to the need for high NO oxidation rates under the relatively cool exhaust temperatures typical of diesel engines.

The Compact-SCR technology, like the NO_X adsorber technology, uses an oxidation catalyst to promote the oxidation of NO to NO_2 at the low temperatures typical of much of diesel engine operation. By converting a portion of the NO_X emissions to NO_2 upstream of the ammonia SCR reduction catalyst, the overall NO_X reductions are improved significantly at low temperatures. As discussed previously in section III, platinum group metals, primarily platinum, are known to be good catalysts to promote NO oxidation, even at low temperatures. Therefore, future Compact-SCR systems are expected to rely on a platinum oxidation catalyst in order to provide the required NO_X emission control.

The NO_X adsorber technology may be able to limit its impact on sulfate PM emissions by releasing stored sulfur as SO_2 under rich operating conditions. The Compact-SCR technology, on the other hand, has no means to limit sulfate emissions other than through lower catalytic function or lowering sulfur in diesel fuel. The degree to which the NO_X control aftertreatment technologies increase the production of sulfate PM through oxidation of SO_2 to SO_3 varies somewhat from technology to technology, but it is expected to be similar in magnitude and environmental impact to that for the PM control technologies discussed previously. Thus, we believe that diesel fuel sulfur levels will likely need to be below 15 ppm in order to apply these advanced NO_X control technologies (see discussion in section III.F.1). Without this low-sulfur fuel, the advanced NO_X control technologies are expected to create PM emissions in excess of the PM standard regardless of the engine-out PM levels. We invite comment on sulfate PM production by NO_X control technologies due to fuel sulfur along with supportive data.

b. Sulfur Poisoning (Sulfate Storage) on NO_X Adsorbers

The NO_X adsorber technology relies on the ability of the catalyst to store NO_X as a nitrate on the surface of the catalyst, or adsorber (storage) bed, during lean operation. Because of the similarities in chemical properties of SO_X and NO_X, the SO_2 present in the exhaust is also stored by the catalyst surface as a sulfate. The sulfate compound that is formed is significantly more stable than the nitrate compound and is not released and reduced during the NO_X release and reduction step. Since the NO_X adsorber is essentially 100 percent effective at capturing SO_2 in the adsorber bed, the poisoning of the catalyst occurs rapidly. As a result, sulfate compounds quickly occupy all of the NO_X storage sites on the catalyst thereby rendering the catalyst ineffective for NO_X reduction (poisoning the catalyst).

The stored sulfur compounds can be removed by exposing the catalyst to hot (over 650 °C) and rich (air-fuel ratio below the stoichiometric ratio of 14.5 to 1) conditions for a brief period.[115] [116] Under these conditions, the stored sulfate is released and reduced in the catalyst.[117] Because the exhaust must be taken to a hot and rich condition, there is a fuel consumption impact associated with the desulfation cycle. We have developed a spreadsheet model that estimates the frequency of desulfation cycles from published data and then estimates the fuel economy impact from this event.[118] Table III–F.2 shows the estimated fuel economy impact for desulfation of a NO_X adsorber at different fuel sulfur levels assuming a desired 90 percent NO_X conversion efficiency. The estimates in the table are based on assumed average fuel sulfur levels associated with different sulfur level caps.

TABLE III.F–2.—ESTIMATED FUEL ECONOMY IMPACT FROM DESULFATION OF A 90% EFFICIENT NO_X ADSORBER

Fuel sulfur cap [ppm]	Average fuel sulfur [ppm]	Fuel economy penalty
500	350	27%
50	30	2%
25	15	1%
15	7	<1%
5	2	<<<1%

The table highlights that the fuel economy penalty associated with sulfur in diesel fuel is noticeable even at average sulfur levels as low as 15 ppm and increases rapidly with higher sulfur levels. It also shows that the use of a NO_X adsorber at the proposed 15 ppm sulfur cap would be expected to result in a fuel economy impact of less than 1 percent absent other changes in engine design. However, as discussed in Section G below, we anticipate that other engine modifications could be made to offset this fuel economy impact. For example, a NO_X control device in the exhaust system could allow use of fuel saving engine strategies, such as advanced fuel injection timing, that could be used to offset the increased fuel consumption associated with the NO_X adsorber. The result is that low-sulfur fuel enables the NO_X adsorber, which in turn enables fuel saving engine modifications. Such a system level fuel economy impact, which we estimate to be zero under a 15 ppm cap program, is discussed below in section III.G.

Future improvements in the NO_X adsorber technology are expected and needed if the technology is to provide the environmental benefits we have projected today. Some of these improvements are likely to include improvements in the means and ease of removing stored sulfur from the catalyst bed. However because the stored sulfate species are inherently more stable than the stored nitrate compounds (from stored NO_X emissions), we expect that a separate release and reduction cycle (desulfation cycle) will always be needed in order to remove the stored sulfur. Therefore, we believe that fuel with a sulfur level at or below 15 ppm sulfur will be necessary in order to avoid an unacceptable fuel economy impact. We request comment on sulfur poisoning of NO_X adsorbers by fuel sulfur along with supportive data.

c. Sulfur Impacts on Catalytic Efficiency

The technologies discussed in today's proposal generally rely on some form of catalytic function in order to promote favorable chemical reactions needed in order to accomplish the desired NO_X emission reductions. In each case platinum and/or other precious group metal catalysts are anticipated to be used to accomplish these functions. From our experience with gasoline three-way catalysts and from the extensive body of work in the literature we know that these catalytic functions are inhibited by sulfur. Sulfur deposits on the precious metal sites in the catalyst and causes a decrease in the catalytic function of the device. This causes an increase in the light-off temperature for the catalyst along with a significant reduction in the oxidation and reduction efficiencies of all of the devices.[119] As discussed at length in the Tier 2 rulemaking, sulfur reductions in the fuel are a very effective way to reduce catalyst poisoning of this type in

[115] [Reserved]

[116] Dou, Danan and Bailey, Owen, ''Investigation of NO_X Adsorber Catalyst Deactivation,'' SAE 982594.

[117] Guyon, M. et al., ''Impact of Sulfur on NO_X Trap Catalyst Activity—Study of the Regeneration Conditions,'' SAE 982607.

[118] Memo from Byron Bunker, to docket A–99–06, ''Estimating Fuel Economy Impacts of NO_X Adsorber De-Sulfurization.''

[119] The Impact of Sulfur in Diesel Fuel on Catalyst Emissions Control Technology—Manufacturers of Emission Controls Association (MECA), March 15, 1999, www.meca.org.

order to maintain high catalyst efficiency and to ensure reliable operation. We invite comment on fuel sulfur impact on catalyst efficiency along with supportive data.

3. What About Sulfur in Engine Lubricating Oils?

Current engine lubricating oils have sulfur contents which can range from 2,500 ppm to as high as 8,000 ppm by weight. Since engine oil is consumed by heavy-duty diesel engines in normal operation, it is important that we account for the contribution of oil derived sulfur in our analysis of the need for low-sulfur diesel fuel. One way to give a straightforward comparison of this effect is to express the sulfur consumed by the engine as an equivalent fuel sulfur level. This approach requires that we assume specific fuel and oil consumption rates for the engine. Using this approach, estimates ranging from two to seven ppm diesel fuel sulfur equivalence have been made for the sulfur contribution from engine oil.[120, 121] If values at the upper end of this range accurately reflect the contribution of sulfur from engine oil to the exhaust this would be a concern as it would represent 50 percent of the total sulfur in the exhaust under a 15 ppm diesel fuel sulfur cap (with an average sulfur level assumed to be approximately seven ppm). However, we believe that this simplified analysis, while valuable in demonstrating the need to investigate this issue further, overstates the likely sulfur contribution from engine oil by a significant amount.

Current heavy-duty diesel engines operate with open crankcase ventilation systems which ''consume'' oil by carrying oil from the engine crankcase into the environment. This consumed oil is correctly included in the total oil consumption estimates, but should not be included in estimates of oil entering the exhaust system for this analysis, since as currently applied this oil is not introduced into the exhaust. At present we estimate that the majority of lube oil consumed by an engine meeting the 0.1 g/bhp-hr PM standard is lost through crankcase ventilation, rather than through the exhaust. Based on assumed engine oil to PM conversion rates and historic soluble organic fraction breakdowns we have estimated the contribution of sulfur from engine oil to be less than two ppm fuel equivalency. With the proposal today to close the crankcase, coupled with the use of closed crankcase ventilation systems that separate in excess of 90 percent of the oil from the blow-by gases, we believe that this very low contribution of lube oil to sulfur in the exhaust can be maintained. For a further discussion of our estimates of the sulfur contribution from engine oil refer to the draft RIA associated with this proposal.

Although there are good indications to date that oil borne sulfur is not a significant contributor to exhaust sulfur, EPA remains concerned about this issue. We invite comment on the potential for engine lubricating oils to introduce significant amounts of sulfur into the exhaust. Of particular value to EPA is data indicating the expected oil consumption rates of future engines and estimates of future engine oil characteristics specifically with regard to sulfur content. We also invite comment on the potential for new ''low-sulfur'' engine oils to be developed for these vehicles equipped with sulfur sensitive emission control technologies.

G. Fuel Economy Impact of Advanced Emission Control Technologies

The advanced emission control technologies expected to be applied in order to meet the proposed NO_X and PM standards involve wholly new system components integrated into engine designs and calibrations, and as such may be expected to change the fuel consumption characteristics of the overall engine design. After reviewing the likely technology options available to the engine manufacturers, we believe that the integration of the engine and exhaust emission control systems into a single synergistic emission control system will lead to heavy-duty vehicles which can meet demanding emission control targets without increasing fuel consumption beyond today's levels.

1. Diesel Particulate Filters and Fuel Economy

Diesel particulate filters are anticipated to provide a step-wise decrease in diesel particulate (PM) emissions by trapping and oxidizing the diesel PM. The trapping of the very fine diesel PM is accomplished by forcing the exhaust through a porous filtering media with extremely small openings and long path lengths.[122] This approach results in filtering efficiencies for diesel PM greater than 90 percent but requires additional pumping work to force the exhaust through these small openings. The additional pumping work is anticipated to increase fuel consumption by approximately one percent.[123] However, we believe this fuel economy impact can be regained through optimization of the engine-PM trap-NO_X adsorber system, as discussed below. We request comment and data on the magnitude of the fuel economy impact of diesel particulate filters.

2. NO_X Control Technologies and Fuel Economy

NO_X adsorbers are expected to be the primary NO_X control technology introduced in order to provide the reduction in NO_X emissions envisioned in this proposal. NO_X adsorbers work by storing NO_X emissions under fuel lean operating conditions (normal diesel engine operating conditions) and then by releasing and reducing the stored NO_X emissions over a brief period of fuel rich engine operation. This brief periodic NO_X release and reduction step is directly analogous to the catalytic reduction of NO_X over a gasoline three-way-catalyst. In order for this catalyst function to occur the engine exhaust constituents and conditions must be similar to normal gasoline exhaust constituents. That is, the exhaust must be fuel rich (devoid of excess oxygen) and hot (over 250C). Although it is anticipated that diesel engines can be made to operate in this way, it is assumed that fuel economy while operating under these conditions will be worse than normal. We have estimated that the fuel economy impact of the NO_X release and reduction cycle would, all other things being equal, increase fuel consumption by approximately one percent. Again, we believe this fuel economy impact can be regained through optimization of the engine-PM trap-NO_X adsorber system, as discussed below.

In addition to the NO_X release and regeneration event, another step in NO_X adsorber operation may affect fuel economy. As discussed earlier, NO_X adsorbers are poisoned by sulfur in the fuel even at the low sulfur levels we are proposing. As discussed in the draft RIA, we anticipate that the sulfur poisoning of the NO_X adsorber can be reversed through a periodic ''desulfation'' event. The desulfation of the NO_X adsorber is accomplished in a similar manner to the NO_X release and regeneration cycle described above. However it is anticipated that the

[120] Whitacre, Shawn. ''Catalyst Compatible'' Diesel Engine Oils, DECSE Phase II, Presentation at DOE/NREL Workshop ''Exploring Low Emission Diesel Engine Oils.'' January 31, 2000.

[121] This estimate assumes that a heavy-duty diesel engine consumes 1 quart of engine oil in 2,000 miles of operation, consumes fuel at a rate of 1 gallon per 6 miles of operation and that engine oil sulfur levels range from 2,000 to 8,000 ppm.

[122] Typically the filtering media is a porous ceramic monolith or a metallic fiber mesh.

[123] Engine, Fuel, and Emissions Engineering, Incorporated, ''Economic Analysis of Diesel Aftertreatment System Changes Made Possible by Reduction of Diesel Fuel Sulfur Content,'' December 14, 1999, Air Docket A–99–06.

desulfation event will require extended operation of the diesel engine at rich conditions.[124] This rich operation will, like the NO_X regeneration event, require an increase in the fuel consumption rate and will cause an associated decrease in fuel economy. With a 15 ppm fuel sulfur cap, we are projecting that fuel consumption for desulfation would increase by one percent or less, which we believe can be regained through optimization of the engine-PM trap-NO_X adsorber system as discussed below.

While NO_X adsorbers require non-power producing consumption of diesel fuel in order to function properly and, therefore, have an impact on fuel economy, they are not unique among NO_X control technologies in this way. In fact NO_X adsorbers are likely to have a very favorable NO_X to fuel economy trade-off when compared to other NO_X control technologies like cooled EGR and injection timing retard that have historically been used to control NO_X emissions. EGR requires the delivery of exhaust gas from the exhaust manifold to the intake manifold of the engine and causes a decrease in fuel economy for two reasons. The first of these reasons is that a certain amount of work is required to pump the EGR from the exhaust manifold to the intake manifold; this necessitates the use of intake throttling or some other means to accomplish this pumping. The second of these reasons is that heat in the exhaust, which is normally partially recovered as work across the turbine of the turbocharger, is instead lost to the engine coolant through the cooled EGR heat exchanger. In the end, cooled EGR is only some 50 percent effective at reducing NO_X. Nonetheless, cooled EGR, which we anticipate to be the technology of choice for meeting the proposed 2004 heavy-duty standards, still has a considerable advantage over the previous solutions such as injection timing retard. Injection timing retard is the strategy that has historically been employed to control NO_X emissions. By retarding the introduction of fuel into the engine, and thus delaying the start of combustion, both the peak temperature and pressure of the combustion event are decreased; this lowers NO_X formation rates and, ultimately, NO_X emissions. Unfortunately, this also significantly decreases the thermal efficiency of the engine (decreases fuel economy) while also increasing PM emissions. As an example, retarding injection timing eight degrees can decrease NO_X emissions by 45 percent, but this occurs at a fuel economy penalty of more than seven percent.[125]

Today, most diesel engines rely on injection timing control (retarding injection timing) in order to meet the 4.0 g/bhp-hr NO_X emission standard. For 2002/2004 model year compliance, we expect that engine manufacturers will use a combination of cooled EGR and injection timing control to meet the 2.0 g/bhp-hr NO_X standard. Because of the more favorable fuel economy trade-off for NO_X control with EGR when compared to timing control, we have forecast that less reliance on timing control will be needed in 2002/2004. Therefore, fuel economy will not be changed even at this lower NO_X level.

NO_X adsorbers have a significantly more favorable NO_X to fuel economy trade-off when compared to cooled EGR or timing retard alone, or even when compared to cooled EGR and timing retard together.[126] We expect NO_X adsorbers to be able to accomplish greater than 90 percent reduction in NO_X emissions, while only increasing fuel consumption by a very reasonable two percent or less. Therefore, we expect manufacturers to take full advantage of the NO_X control capabilities of the NO_X adsorber and project that they will decrease reliance on the more expensive (from a fuel economy standpoint) technologies, especially injection timing retard. We would therefore predict, that the fuel economy impact currently associated with NO_X control from timing retard would be decreased by at least three percent. In other words, through the application of advanced NO_X exhaust emission control technologies, which are enabled by the use of low-sulfur diesel fuel, we expect the NO_X trade-off with fuel economy to continue to improve significantly when compared to today's technologies. This will result in both much lower NO_X emissions, and potentially overall improvements in fuel economy. Improvements could easily offset the fuel consumption of the NO_X adsorber itself and, in addition, the one percent fuel economy loss projected to result from the application of PM filters. Consequently, we are projecting no fuel economy penalty to result from this rule. We invite comment and data concerning the relationships between the various types of NO_X control technologies and fuel economy as described here and in the cited references. In particular we ask for comments and data on NO_X adsorber fuel economy and methods of recovering that fuel economy through injection timing changes.

3. Emission Control Systems for 2007 and Net Fuel Economy Impacts

We anticipate that, in order to meet the stringent NO_X and PM emission standards proposed today, the manufacturers would integrate engine-based emission control technologies and post-combustion emission control technologies into a single systems-based approach that would fundamentally shift historic trade-offs between emissions control and fuel economy. As outlined in the preceding two sections, individual components in this system would introduce new constraints and opportunities for improvements in fuel efficient control of emissions. Having considered the many opportunities to fundamentally improve these relationships, we believe that it is unlikely that fuel economy will be lower than today's levels and, in fact, may improve through the application of these new technologies and this new systems approach. Therefore, for our analysis of economic impacts in section V, no penalty or benefit for changes to fuel economy are considered. We request comment on our analysis of the likely fuel economy offsets of the NO_X and PM emission control technologies that would be needed in order to meet today's proposed standards.

H. Future Reassessment of Diesel NO_X Control Technology

We are considering conducting a future reassessment of diesel NO_X control technologies and associated fuel sulfur requirements, and we request comment on the need for such a reassessment. Given the relative state of development of NO_X emission control technology versus PM and NMHC control technologies, we would expect to focus the control technology reassessment solely on NO_X control technologies. We believe that the clear intent of this proposal to provide low-sulfur diesel fuel will allow the development of this technology to progress rapidly, and will result in systems capable of achieving the proposed standards. However, we acknowledge that our proposed NO_X standard represents an ambitious target for this technology, and that the degree of uncertainty surrounding the feasibility of high-efficiency NO_X control technology would be higher if

[124] Dou, D. and Bailey, O., ''Investigation of NO_X Adsorber Catalyst Deactivation'' SAE982594.

[125] Herzog, P. et al., NO_X Reduction Strategies for DI Diesel Engines, SAE 920470, Society of Automotive Engineers 1992 (from Figure 1).

[126] Zelenka, P. et al., Cooled EGR—A Key Technology for Future Efficient HD Diesels, SAE 980190, Society of Automotive Engineers 1998. Figure 2 from this paper gives a graphical representation of how new technologies (including aftertreatment technologies) can shift the trade-off between NO_X emissions and fuel economy.

fuel sulfur levels higher than the proposed level were adopted. We also recognize that technology evolution may affect the sulfur level at which these technologies are enabled.

Therefore, we are evaluating whether or not the proposed program could benefit from a future reassessment of the control effectiveness of diesel NO_X exhaust emission control technologies and associated fuel sulfur requirements. We would expect to conduct such a reassessment in the 2003 timeframe, though we welcome comment on whether such a reassessment will be needed and on the appropriate timing for it. We also welcome comment on the extent to which a review of NO_X control technology should also include a review of the appropriate diesel fuel sulfur level for enabling the NO_X control technology, including consideration of impacts that a revised fuel requirement would have on PM control technology. Another possible area for consideration during the reassessment could be non-conformance penalties (NCPs) and the role they might play in this program. NCPs would allow engine manufacturers to produce and sell noncomplying engines under limited circumstances in exchange for paying a penalty to the government. We welcome comment on the role NCPs may play.

In conducting the review, we would expect to determine whether or not there was a need to formally consider a change in the final regulations adopted for this program. If such a change were determined to be necessary, we would conduct a formal rulemaking, including conducting public hearings.

I. Encouraging Innovative Technologies

We encourage comments on approaches that could provide increased incentives for the development and introduction of clean advanced engine technologies. Some such approaches have been suggested by stakeholders or have been a part of other EPA rules. One of these would be to develop a program for providing a special designation for engines or vehicles that are significantly below the standards or use specific innovative propulsion technologies. EPA finalized such a designation, the ''Blue Sky Series Engine'' program, as a part of the 1998 nonroad diesel standards final rule. Incorporating such a designation could be very valuable for use in programs developed by states, municipalities, or corporations to highlight or reward the purchase and use of especially clean or innovative vehicles and engines. We request comment on how we might structure a program like the ''Blue Sky Series'' program in the context of today's proposal, including what criteria we should use to qualify an engine or vehicles for such a designation.

It has also been suggested that we might adapt the proposed ABT program described in section VII.C. below to provide extra incentives for manufacturers that encourage innovative technologies. For example, manufacturers might get additional credits under the ABT program if they introduce extra clean models or if they meet future standards early. We believe our current ABT program, with the proposed revisions discussed below, should encourage manufacturers to seriously consider any technologies that can economically reach the very low emission levels proposed today. Nevertheless, we request comment on the need for and appropriateness of such additional provisions under the ABT program.

IV. Diesel Fuel Requirements

As discussed in section III above, we believe that advanced exhaust emission control technology exists and is being developed that can reduce emissions of NO_X and PM to very low levels. However, those exhaust emission control technologies will require changes to diesel fuel in order to operate efficiently and reach the new engine emissions standards we are proposing in today's NPRM. This section will present our proposed changes to diesel fuel that are intended to enable heavy-duty engines to meet our proposed new emission standards. We will also describe the extent and applicability of the proposed diesel fuel program, the means through which we expect refiners to meet the new diesel fuel standards, and incentives we are providing refiners for early introduction. The economic and environmental impacts of the proposed diesel fuel program will be covered in subsequent sections in combination with the implications of the proposed engine standards.

A. Why Do We Believe New Diesel Fuel Sulfur Controls Are Necessary?

In section III, we discussed our proposed finding that new standards for heavy-duty engines can be established on the basis of exhaust emission controls which we believe will be fully viable and widely available for the 2007 model year. However, we also discussed our understanding that those exhaust emission control technologies have a significant and irreversible sensitivity to the sulfur content of the fuel. Deep sulfur reductions are necessary to enable both the NO_X and PM emission control technology that we believe vehicles would need to use to achieve the emission standards we are proposing today. Since we believe that new standards for heavy-duty engines are an appropriate next step for reducing ambient pollution, and it is these very exhaust emission control technologies which manufacturers are likely to use in order to reach these low emission levels, we are proposing to reduce the sulfur content of highway diesel fuel.

Engine manufacturers and representatives of States, and environmental and public health organizations have expressed general support for a highway diesel fuel sulfur reduction strategy similar to the gasoline sulfur reduction program. However, some stakeholders, in particular refiners, have expressed concern that the sulfur sensitivity of heavy-duty diesel exhaust emission controls has not been quantified with a sufficient degree of certainty to provide a basis for setting a specific low sulfur standard. Although it is likely that the efficiency of exhaust emission control technology improves with decreasing fuel sulfur levels all the way down to nominally zero levels, we believe that it is possible to set a non-zero sulfur standard that sufficiently enables high-efficiency control technology. The sulfur standard we are proposing and the associated justification is described in more detail in section IV.B below.

Sulfur appears to be the only diesel fuel property that must be changed in order for the prospective exhaust emission control technologies to operate effectively. Changes in other fuel properties, such as cetane, aromatics, density, and high-end distillation, might all provide small emission benefits for engines meeting our proposed standards, but those benefits would be very small in comparison to the sulfur standard. They would also not enable new advances in emission control technology, and so would not likely produce significant step changes in heavy-duty engine emissions. See section VI.B for a more complete discussion of non-sulfur property changes for diesel fuel.

Finally, there is also an expectation on the part of some automobile manufacturers that diesel engines will be used more frequently in light-duty vehicles in the coming decade. However, any light-duty diesel vehicles will be required to meet our final Tier 2 standards, which we believe will require the use of the same high efficiency exhaust emission control technologies envisioned for heavy-duty applications. Although we are not proposing a change to diesel fuel specifically for light-duty diesel vehicles, it is our expectation that the availability of a low-sulfur fuel intended primarily to enable heavy-duty engines to meet our proposed new standards would enable automobile manufacturers to produce light-duty diesel vehicles that could meet the Tier 2 standards. We would like comment on whether any other changes to diesel fuel specifically for light-duty diesel vehicles are necessary, and on the appropriateness, benefits, and costs of doing so.

B. What New Sulfur Standard Are We Proposing for Diesel Fuel?

We are proposing to require substantial reductions in diesel fuel sulfur levels nationwide. Our proposal would require that all highway diesel fuel produced or imported by refiners and importers be subject to a maximum sulfur level of 15 ppm by weight. The technological need for low-sulfur diesel fuel and the reasons for our proposed sulfur standard are discussed in section III above. However, we are also seeking comment on whether the sulfur standard should be set as high as 50 ppm or as low as 5 ppm, as well as what the associated costs and benefits would be of a higher or lower level. (See section VI.B. for further discussion of various sulfur standards.)

We believe our proposed diesel fuel sulfur program balances the goal of achieving dramatic reductions in emissions from heavy-duty vehicles with the goal of providing sufficient lead-time for the engine emission control technology to develop and for the refining industry to transition to a lower sulfur diesel fuel. Nevertheless, as noted elsewhere, we are seeking comments on all these issues. We are aware of diesel fuel industry concerns about their ability to consistently deliver fuel meeting this low cap requirement. We are also aware that some engine manufacturers are concerned that even fuel meeting the 15 ppm cap requirement may not adequately enable the exhaust emission control technologies. In determining the appropriate sulfur level and scope for our proposed program, we considered the implications of diesel fuel sulfur on the emission control hardware of both heavy-duty and light-duty vehicles (that is, light-duty diesel vehicles that are required to meet our Tier 2 emission standards). Specifically, we analyzed the degree to which the emission control devices described in section III, above, may tolerate diesel fuel sulfur. We also evaluated the environmental implications of sulfur control beyond the expected NO_X and PM benefits (see section II) and the costs of controlling fuel sulfur content, and we considered the ability of all refiners and importers to meet the proposed diesel fuel sulfur standard at essentially the same time (see section IV.D). We hope to benefit from further discussion of all of these issues during the public comment period.

The following sections describe in more detail the standard we are proposing and the reasons why we are proposing a program that applies year-round and nationwide.

1. Why Is EPA Proposing a 15 ppm Cap and Not a Higher or Lower Level?

There are five key factors which, when taken together, lead us to propose that a diesel fuel sulfur cap of 15 ppm is both necessary to enable the NO_X and PM exhaust emission control technology (and thereby allow the proposed emission standards to be met), and appropriate, taking into consideration the challenges involved in providing low-sulfur fuel. These factors, as discussed in more detail in sections III and IV.D, are the implications that sulfur levels in excess of 15 ppm would have for the efficiency, reliability, and fuel economy impacts of the exhaust emission control systems, and the feasibility and costs of producing low-sulfur diesel fuel.

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

The reliability of the emission control technologies to continue to function as required under all operating conditions for the life of the vehicle is also directly impacted by sulfur in diesel fuel. As discussed in section III, sulfur in diesel fuel can prevent proper operation and regeneration of both NO_X and PM control technologies leading to permanent loss in emission control effectiveness and even catastrophic failure of the systems. We believe that diesel fuel with sulfur levels less than 15 ppm will be required to provide a level of reliability for these technologies to allow their introduction into the marketplace.

The sulfur content of diesel fuel will also affect the fuel economy of vehicles equipped with NO_X and PM exhaust emission control technologies. As discussed in detail in section III, NO_X adsorbers are expected to consume diesel fuel in order to cleanse themselves of stored sulfates and maintain efficiency. The larger the amount of sulfur in diesel fuel, the greater this impact on fuel economy. As sulfur levels increase above 15 ppm the fuel economy impact transitions from merely noticeable to levels most diesel vehicle operators would consider unacceptable (see discussion in section III). Likewise PM trap regeneration is inhibited by sulfur in diesel fuel. This leads to increased PM loading in the diesel particulate filter, increased exhaust backpressure, and poorer fuel economy. Thus for both NO_X and PM technologies the lower the fuel sulfur level the better the fuel economy of the vehicle.

As a result of these factors, we believe that 15 ppm represents an upper threshold of diesel fuel sulfur levels that would make these technologies viable, and are therefore proposing to cap in-use sulfur levels there. In comments received on the ANPRM, as well as in subsequent meetings and discussions, however, we have often heard different points of view on this issue expressed by the vehicle and engine manufacturers, and by oil refiners.

Some vehicle and engine manufacturers have argued for a maximum cap on the sulfur content of diesel fuel of 5 ppm, believing that this level is necessary. As we discuss in section III, however, we believe that a cap of 15 ppm (likely resulting in an in-use sulfur level 7 to 10 ppm) would be sufficient to ensure the reliability of PM exhaust emission control technology (avoid potential for irreversible failure) and enable it to reach the very high efficiencies needed over the wide range of vehicle operation and conditions that would be needed for the engines to comply with our proposed standards. Although at the current stage of development, high efficiency NO_X technology is extremely sulfur intolerant, work is already underway to develop capability in the technology to tolerate at least some sulfur in the fuel. As discussed in section III, however, it is likely that to maintain the very high operational efficiencies of the emission control equipment that we believe would be needed to meet the proposed emission standards, and to avoid a significant fuel economy penalty, the sulfur level in the fuel would still have to be very low.

We believe that requiring a cap lower than 15 ppm would not be necessary to enable the exhaust emission control technology to meet the very low NO_X and PM emission standards proposed. A cap lower than 15 ppm would provide little additional emission reduction but would increase the cost. Consequently, requiring a sulfur cap lower than that necessary to enable the exhaust emission control technology to meet the emission standards would be inappropriate. Further discussion and analysis of alternative sulfur standards is contained in section VI.

Conversely, many oil refiners have argued for a higher maximum cap (if any) on the content of sulfur in diesel fuel, typically on the order of 50 ppm. They argue that the cost of reducing the sulfur level below a cap of 50 ppm (and average of 30 ppm) becomes prohibitively high. They further argue that diesel engine exhaust emission control technology is still in its infancy and will likely develop rapidly over the next several years to the point where it is much less sulfur sensitive than the technology of today. As discussed in section III, we also believe that the diesel engine exhaust emission control technology will develop rapidly over the coming years, and in particular are projecting that the sensitivity of NO_X adsorber technology to fuel sulfur will improve considerably through the development of techniques to effectively regenerate themselves of stored sulfur compounds. The Manufacturers of Emission Controls Association (MECA) recently sent a letter strongly supporting this position, stating ''we strongly believe that NO_X adsorber technology will be commercially available in 2007 to help heavy-duty diesel engines meet the stringent NO_X standards being considered by EPA and that any current engineering challenges involved with this technology will be addressed provided that very low sulfur fuel is available.'' [127] Based on available information and our projections from that information, we believe that a cap higher than 15 ppm sulfur, and in particular a cap as high as 50 ppm would not enable the exhaust emission control technology needed to achieve the proposed emission standards and furthermore may severely compromise the reliability of the systems and result in unacceptable fuel economy impacts. In addition, as discussed in section IV.D below, although we acknowledge that the cost to desulfurize diesel fuel does increase with more stringent sulfur levels, we believe that these costs would not be prohibitively high, and maintain that the environmental benefits of the program are sufficient to justify the costs of the program at a sulfur cap level of 15 ppm.

Based on our assessment of the efficiency, reliability, and fuel economy impacts of sulfur on diesel engine exhaust emission control technology, and the cost and feasibility factors associated with reducing the sulfur content of diesel fuel, we propose to adopt 15 ppm as the appropriate sulfur cap. However, we have analyzed the impacts on technology enablement, costs, and benefits from controlling fuel sulfur to a 15 ppm average level with a 25 ppm cap, as well as from capping fuel sulfur at 5 ppm and 50 ppm. These levels have been put forward by various stakeholders as either necessary (in the case of a 5 ppm cap) or adequate (in the case of a 50 ppm cap) for enabling high-efficiency diesel exhaust emission controls, and so we believe that assessments of these levels is appropriate. These assessments are discussed in section VI.B. We request comment on the appropriate level of the highway diesel fuel sulfur standard, and on our assessment of alternative standards.

2. Why Propose a Cap and Not an Average?

We are proposing a cap on the sulfur content of diesel fuel in order to protect the vehicle aftertreatment technologies that we expect would be used to meet the proposed standards for heavy-duty engines and vehicles. An average standard by itself would not be sufficient to ensure that sulfur levels higher than those that could be tolerated by the exhaust emission control technology would not be used in vehicles for extended periods of time. Consequently, we do not believe that an average standard can stand by itself and would at minimum have to be coupled with a cap.

3. Should the Proposed 15 ppm Cap Standard Also Have an Average Standard?

Although our current 500 ppm sulfur limit for diesel fuel provides no averaging flexibility, in the years since that limit was set our motor vehicle fuel regulations have frequently incorporated provisions allowing regulated industries to average regulated parameters around a standard, often with a capped upper limit. In fact this approach was taken in the recently promulgated control of gasoline sulfur levels, in which we adopted a 30 ppm average level with an 80 ppm cap.

Despite the ability of averaging provisions in some programs to increase compliance flexibility and in some cases reduce overall costs while still achieving the environmental objectives, we are not proposing such provisions for the diesel fuel sulfur standard we are proposing today. Basing the fuel program around an average sulfur level could risk failure in meeting the whole objective of sulfur control (the enablement of sulfur-sensitive technologies) and thereby the environmental objectives of the program, or else could require the adoption of a cap so low as to make the average level largely irrelevant. The exhaust emission control technologies enabled by diesel sulfur control appear to be far more sensitive to and far less forgiving of variations in fuel sulfur level than advanced Tier 2 gasoline technologies. Enough is known about the exhaust emission control technologies to convince us that the proposed sulfur level will likely represent an enablement threshold level, above which increases in emissions and potentially system failures could be expected. Consumption of diesel fuel with sulfur levels above this threshold could be very problematic.

Some commenters who responded to our diesel fuel ANPRM did express interest in an averaged fuel sulfur standard, but only from the viewpoint that the flexibility provided by averaging is generally desirable, and not with specific solutions to the above-discussed problems created by this approach. Other commenters opposed an averaging requirement due to the test burden associated with demonstrating compliance under such a program. We request specific suggestions on how to structure a viable averaging requirement in conjunction with a 15 ppm cap, and whether it would be desirable to do so. One benefit of having only a cap instead of an average is that it allows for a simplified enforcement scheme. Imposing an average standard in addition to the cap would require additional product sampling, recordkeeping, and reporting requirements to demonstrate compliance with the standard. Thus, depending on how the program is structured, the flexibility of an average standard may not be worth the additional cost and complexity that would result, particularly with a cap set at 15 ppm.

Some have suggested that it may be possible to set an average standard of 10 ppm coupled with a higher cap. They

[127] Letter to Carol Browner, Administrator of EPA from Bruce Bertelsen, Executive Director of Manufacturers of Emission Controls Association, May 3, 2000.

suggest that a 10 ppm average would achieve essentially the same average in-use sulfur level as the proposed 15 ppm cap, and that as long as the cap is sufficiently protective of the exhaust aftertreatment technology, then the refining and distribution systems may have greater flexibility in complying with the standard, allowing for lower costs and less potential for disruptions of fuel supply. We request comment on whether it would be possible to have a higher cap as long as the average remained essentially unchanged and if so, what cap would be appropriate. If such an approach could enable the technology, we seek comment on the extent to which it would help address the concerns refiners have raised with very low sulfur levels with respect to the potential for fuel shortages and price increases.

If an averaged fuel sulfur standard were to be adopted (at any sulfur level), one added flexibility option that has been suggested to facilitate it is an averaging, banking and trading program. Because we believe that the exhaust emission control devices would require ultra-low sulfur diesel fuel, this flexibility would be focused on the average component of the standard, rather than on the cap component. Refineries would have the option to average across batches, to bank credits for use in the future, and to purchase credits from other refineries. In addition, under this concept the Agency could offer additional ''average credits'' at a predetermined price to refineries. This could provide more certainty about the cost of complying with the average component of the standard by establishing a ceiling price on these tradable and bankable credits. These credits could be used for a refinery to comply with the average requirement; however, refineries' use of these credits would still be subject to the cap standard. We request comment on the concept of an averaging, banking, and trading program in the context of an average standard, including: (1) whether the additional flexibility of offering additional ''average credits'' at a predetermined price would benefit refineries; and, (2) what the appropriate predetermined price for EPA-offered ''average credits'' should be.

4. Why We Believe Our Diesel Fuel Sulfur Program Should Be Year-round and Nationwide

We believe it is necessary for all highway diesel fuel to meet the proposed 15 ppm sulfur limit at all times. To relax this requirement would jeopardize many of the environmental benefits of the proposed program. Although NO_X benefits are only realized in the summer, PM and air toxics benefits are realized year-round. Moreover, the exhaust emission control devices require low-sulfur diesel fuel year-round. The use of highway fuel with a sulfur content greater than our proposed sulfur standard could damage the emission control technology of 2007 and later model year vehicles and engines. Once vehicles are equipped with the new exhaust emission control devices, they can only be fueled with the low-sulfur fuel. This precludes any consideration of a seasonal program. In addition, because diesel vehicles travel across the country transporting goods from region to region and state to state, low-sulfur diesel fuel will have to be available nationwide (see discussion in section VI.C. for possible exceptions. The health effects associated with diesel PM emissions are not area-specific, nor are the adverse effects of high sulfur diesel on engines with exhaust emission control. For these reasons, we do not believe that any regional or seasonal exemptions from the proposed sulfur requirements would be practical.

C. When Would the New Diesel Sulfur Standard Go Into Effect?

Since the need for low-sulfur diesel is dictated by the implementation of new engine standards, the proposed sulfur standard would become effective commensurate with the introduction of the first heavy-duty engines meeting our proposed standards. As described in section III.H, the phase-in of the engine standards is proposed to begin with the 2007 model year. Since light-heavy-duty trucks might be introduced as early as January 2 of the previous calendar year but are often introduced beginning about July 1, we are proposing that all highway diesel fuel sold at retail stations and wholesale purchaser-consumers meet the proposed sulfur standard by June 1, 2006. We believe that this one month lead time will be sufficient to provide confidence that the fuel available for purchase on July 1 will comply with the proposed sulfur cap. We are also proposing that highway diesel fuel at the terminal level be required to meet the proposed sulfur standard as of May 1, 2006, and that highway diesel fuel produced by refiners (and imported) meet the proposed sulfur standard by April 1, 2006. We believe these earlier compliance requirements at terminals and refineries would be necessary to provide an orderly transition to low-sulfur fuel and to avoid the market disruptions that occurred when the sulfur level of diesel fuel was lowered to 500 ppm in 1993 with only a retail compliance date. The three months between April and July should allow sufficient time for fuel to move through the distribution system, for existing tankage to transition down to the lower sulfur level that would be required. It would also ensure that all fuel is complying with the proposed sulfur standard and is available for use in heavy-duty engines when 2007 model year engines are introduced to the market. We request comment on this proposed approach.

We believe that the lead-time issue is particularly important, because not only would failure to meet the standards at the retail level cause emission increases from new technology vehicles, but violations of the standard due to insufficient turnover in the distribution system could potentially permanently disable the emission control systems of new technology vehicles and could cause driveability problems for the operators of such vehicles. We would like to take comment on these dates for the start of our low-sulfur diesel program, and in particular on whether the three-month lead time is more than adequate, adequate, or less than adequate for an orderly transition.

Some parties have suggested that low-sulfur diesel should be required at the same time as low-sulfur gasoline, in 2004. They point out that refinery synergies are optimized when refiners are forced to address both requirements at the same time instead of sequentially. The earlier introduction of low-sulfur diesel would also provide both reductions in sulfur dioxide and sulfate PM emissions for the in-use fleet prior to 2007, and would give engine manufacturers greater flexibility to make use of sulfur-sensitive technologies such as cooled EGR.

We do not believe that it is appropriate to require all on-highway diesel fuel to meet our proposed sulfur standard prior to the introduction of heavy-duty engines meeting our proposed standards. By proposing a 2006 start year for the low-sulfur diesel program, we are giving refiners a long lead-time to begin the planning process for meeting our proposed requirements. They always have the flexibility to make a single set of refinery changes prior to 2004 that will allow them to meet both the low-sulfur gasoline and our proposed low-sulfur diesel requirements by 2004. Although we are not requiring it, we would encourage the introduction of highway diesel fuel that meets the proposed sulfur standard prior to 2006, as discussed in section IV.F.

Finally, some parties have suggested that low-sulfur diesel is necessary by 2004 to ensure that light-duty vehicles can meet our Tier 2 standards using diesel fuel. Although some analysts have predicted a greater proportion of diesel-powered light-duty vehicles in the coming decade, we do not believe that they can justify the introduction of low-sulfur diesel prior to 2006. As discussed in more detail in section VI.A.2, we believe diesel-powered light-duty vehicles will not actually need low-sulfur diesel fuel prior to 2006, given the flexibility offered by the Tier 2 program's bin structure. It would also appear that light-duty vehicles would not produce lower emissions using lower-sulfur diesel fuel than they would using gasoline, since all light-duty must meet the same Tier 2 standards. There would be no emission benefits associated with introducing low-sulfur diesel fuel prior to 2006, for use in light-duty vehicles, and thus it would be difficult to justify the costs. We welcome comments on requiring low-sulfur diesel fuel prior to 2006 for use in light-duty vehicles. We also welcome comments on the appropriateness of a 2006 start date for the diesel fuel sulfur standard.

D. Why We Believe the Proposed Diesel Sulfur Standard Is Technologically Feasible

In addition to evaluating the merits of diesel powered highway vehicles operating on low-sulfur diesel fuel, we also considered the ability of refiners to reduce diesel fuel sulfur in essentially every gallon of highway diesel fuel by mid-2006. Based on this evaluation, we believe it is technically feasible for refiners to meet the proposed standards and that it is possible for them to do so in the proposed time frame. We are summarizing our analysis here and we refer the reader to the Draft RIA for more details. We welcome comments on all aspects of this analysis.

1. What Technology Would Refiners Use?

Conventional diesel desulfurization technologies have been available and in use for many years. Conventional hydrotreating technology involves combining hydrogen with the distillate (material falling into the boiling range of diesel fuel) at moderate pressures and temperatures and flowing the mixture through a fixed bed of catalyst. EPA required refiners and diesel fuel distributors and marketers to provide diesel fuel for highway vehicles which does not exceed 500 ppm by weight in sulfur starting in October 1993. As a result, most U.S. refiners installed diesel desulfurization units to reduce their onroad diesel fuel from the pre-control average of about 3000 ppm, to the current average of about 350 ppm.

Based on our review of the literature and discussions with vendors of catalyst technology and desulfurization technology, the most difficult challenge to reducing sulfur to extremely low levels via conventional hydrotreating is the presence of certain aromatic compounds. These aromatic compounds are referred to as sterically hindered, because the physical arrangement of the atoms of these compounds hinders interaction between the sulfur atom and the catalyst.[128] One method to desulfurize these compounds is to design the shape of catalyst surfaces so that these sterically hindered compounds can more easily approach the catalytic material. Another approach is to saturate one or more of the aromatic rings present, which makes the sulfur atom more accessible to the catalytic surface.

Refiners produce diesel fuel from a variety of distillate blending streams in the refinery. The largest component is straight run distillate, which comes straight from crude oil, hence the name straight run. The second largest component is light cycle oil (LCO) which comes from the fluidized catalytic cracker, or FCC unit. This unit primarily produces gasoline from material having a higher molecular weight than either gasoline or diesel fuel, but also produces a significant amount of distillate. About 62 percent of today's highway diesel fuel contains some LCO. The third largest component is light coker gas oil, which comes from the coker, which also produces lighter molecular weight material from heavier material. Both straight run distillate and light coker gas oil contain relatively low levels of sterically hindered compounds. LCO contains a much higher concentration of sterically hindered compounds. Thus, the difficulty of achieving the 15 ppm sulfur cap being proposed today is primarily a function of the amount of light cycle oil (LCO) that a refiner processes into its highway diesel pool.[129]

We project that all refiners would be technically capable of meeting the proposed sulfur cap with extensions of the same conventional hydrotreating which they are using to meet the current highway diesel fuel standard. This extension would likely mean adding a second stage of conventional hydrotreating. In a two-stage process, hydrogen sulfide is removed from the treated distillate after the first reactor and fresh hydrogen added prior to the second reactor. This stripping of the hydrogen sulfide serves two purposes. First and foremost, it reduces the concentration of hydrogen sulfide throughout the second reactor. This speeds up the desufurization reactions substantially. Second, it reduces the concentration of hydrogen sulfide at the end of the second reactor. This is the point where hydrogen sulfide can react with the treated distillate, forming new sulfur compounds (essentially adding sulfur back into the fuel). This process is termed recombination and low hydrogen sulfide concentrations decrease it dramatically. Finally, reducing the concentration of hydrogen sulfide increases the concentration of hydrogen, again speeding up the desulfurization reactions.

Converting an existing one-stage hydrotreater into a two-stage hydrotreater would involve adding an additional reactor, a hot hydrogen sulfide stripper, modifications to the compressor to increase pressure to the new reactor and possibly a pressure-swing adsorption (PSA) unit to increase hydrogen purity. Essentially all of the units comprising the existing hydrotreater would still be used.

We project that all refiners could utilize recently developed, high activity catalysts, which increase the amount of sulfur which can be removed relative to the catalysts which were available when the current desulfurization units were designed and built. The cost of these advanced catalysts is very modest relative to less active catalysts, but they would significantly reduce the size of the new reactors described above. We also project that refiners and technology vendors could achieve the 15 ppm cap without significant saturation of aromatic compounds. This will be achieved through the selection of catalysts and through the control of operating conditions, particularly temperature.

The above projections are based primarily on information received from a number of refining technology vendors, supported by published literature, as no operating experience at sulfur levels below 10 ppm currently exists with this technology on diesel fuel feedstocks typical of U.S. refiners. All the vendors supplying information to EPA and others studying diesel fuel desulfurization projected that the 15 ppm cap can be met using diesel fuel

[128] Typical compounds which are difficult to desulfurize are 4-methyl, dibenzothiophene and 4,6-dimethyl, dibenzothiophene. The methyl group(s) attached to the aromatic rings make it very difficult for the sulfur atom to physically approach the catalyst, which is essential for the desulfurization process to proceed.

[129] LCOs are not homogeneous and can vary dramatically in chemical composition from refiner to refiner. The discussion here applies to a typical LCO composition.

hydrotreaters which operate at hydrogen pressures ranging from 600–900 pounds per square inch (psi) and with total reactor volumes of roughly 2–3 times those of current diesel fuel hydrotreaters. A number of oil refiners informed us that they believe that much larger reactors would be required. API believes that both higher pressures and larger reactors will be needed. Either change would increase our projected costs (described in section V.D.1 below).

Based on our review of the literature, we do not believe that these extremely large reactors would be required to meet the proposed sulfur cap. However, 15 ppm sulfur diesel fuel is not yet being produced commercially from feedstocks typical of the U.S. Thus, we request comments on the sufficiency of 600–900 psi operating pressures for diesel fuel hydrotreaters to meet the proposed sulfur cap. We also request comment on the sufficiency of total reactor volumes which are 2–3 times greater than those currently being utilized under the 500 ppm sulfur cap in order to meet a 15 ppm cap.

Other options are available to refiners. Some refiners could choose to add an FCC feed hydrotreater. This improves the yield of high value products from the FCC unit and reduces the sulfur content of both FCC naphtha and LCO. FCC naphtha is the primary source of sulfur in gasoline, for which EPA recently set stringent standards. However, while hydrotreating the FCC feed reduces the sulfur content of the LCO produced by the FCC unit, it can increase the concentration of sterically hindered compounds. Also, FCC feed hydrotreating is much more costly than distillate hydrotreating or ring opening technology. Thus, we are not projecting that any refiners would utilize this technology to meet the proposed diesel fuel sulfur cap.

Refiners could also add a hydrocracker to process their LCO if they have not already done so. This would increase the production of high value gasoline with a very low sulfur content. However, hydrocrackers are very costly to build and operate, so a refiner choosing to do so would likely do so for reasons beyond removing sulfur from diesel fuel.

In addition to these major technological options, most refiners would also have to add other more minor units to support the new desulfurization unit. These units could include hydrogen plants, sulfur recovery plants, amine plants and sour water scrubbing facilities. All of these units are already operating in refineries but may have to be expanded or enlarged.

2. Are These Technologies Commercially Demonstrated?

As mentioned above, conventional diesel desulfurization technologies have been available and in use for many years. U.S. refiners have roughly seven years of experience with this technology in producing highway diesel fuel with less than 500 ppm sulfur. Refiners in California also have the same length of experience with meeting the California 500 ppm cap on sulfur and an additional aromatics standard.[130] In order to meet both sulfur and aromatics standards, refineries in California are producing highway and nonroad diesel fuel with an average sulfur level of 150 ppm.

Some refiners in Europe are producing a very low-sulfur, low aromatics diesel fuel for use in the cities in Sweden (Class I Swedish Diesel) using two-stage hydrotreating. This ''Swedish city diesel'' is averaging under 10 ppm sulfur and under 10 volume percent aromatics. While clearly demonstrating the feasibility of consistently producing diesel fuel with less than 10 ppm sulfur from selected feedstocks, there are a few differences between the Swedish fuel and typical U.S. diesel fuel. First, the tight aromatics specification applicable to Swedish City diesel fuel usually requires the use of ring-opening or dearomatization catalysts in the second stage of the two-stage hydrotreating unit. This eases the task of desulfurizing any sterically hindered compounds present. Second, Swedish Class I diesel fuel also must meet a tight density specification. This, coupled with the fact that European diesel fuel contains less LCO than U.S. diesel fuel, significantly reduces the amount of sterically hindered compounds present in the feed to the desulfurization unit. Third, it is not clear whether any refiner is producing a large fraction of their distillate production to this specification. Thus, the European experience demonstrates the efficacy of the two-stage process and its ability to produce very low sulfur diesel fuel. However, doing so without saturating most of the aromatics present and with heavier feedstock has only been demonstrated in pilot plants and not commercially.

Europe has adopted a 50 ppm cap sulfur standard for all diesel fuel which takes effect in 2005. Some countries, including England, have implemented tax incentives for refiners to produce this fuel sooner. The great majority of diesel fuel in England already meets the 50 ppm specification. Refiners have reported no troubles with this technology. This diesel fuel is being produced in one-stage hydrotreaters. However, as mentioned above, European diesel fuel contains less LCO than diesel fuel in the U.S., so the use of one-stage conventional hydrotreating to meet very low sulfur levels is applicable, but not sufficient to demonstrate feasibility in the U.S. Germany has also established a tax incentive, but for diesel fuel containing 10 ppm or less sulfur. One European technology vendor indicated that they have already licensed two desulfurization units to German refiners planning to produce diesel fuel to obtain this tax credit.

Overall, conventional diesel desulfurization ring-opening and dearomatization technologies have all been installed and are operating in one or more refineries. Thus, there should not be much concern among refiners whether these technologies will work reliably in general. Refiners' primary concern would be focused on the treatment of any LCO currently being blended into highway diesel fuel. They would be particularly concerned with the ability to desulfurize this material to very low sulfur levels using conventional technology and, absent that, ways to shift this material to other valuable fuel pools or treat it more severely in available hydrotreaters or hydrocrackers. Of course, refiners would also be concerned with the reliability of the technology in complying with a 15 ppm cap day in and day out.

In addition to these more traditional technologies, Energy Biosystems recently announced the availability of their biodesulfurization technology for desulfurizing diesel fuel. Biodesulfurization is a process which uses bacteria which has been genetically enhanced to biologically remove the sulfur atoms from petroleum compounds. This process is still being developed and is expected to begin commercial demonstration in the next couple of years. At the present time, the goal of the developers is to produce diesel fuel with less than 50 ppm sulfur. It is not known whether this technology would be capable of meeting the proposed cap of 15 ppm. This process has the advantage of operating at ambient temperature and pressures, and requires no hydrogen. The economics of the process, however, rely on a market for its by-products, which may limit its widespread application. Because of

[130] California allows refiners to use an engine test to certify an alternative fuel mixture which meets or exceeds the NOx reducing performance of a 10 volume percent maximum aromatics and a 500 ppm maximum sulfur diesel fuel.

uncertainties in this technology's ability to achieve the proposed 15 ppm cap, we did not factor it into our cost projections. We request comment on the availability of this technology in the relevant time frame for this proposed rulemaking.

3. Are There Unique Concerns for Small Refiners?

We have heard concerns that small refiners would bear proportionately higher economic burdens if they were required to produce diesel fuel meeting the same sulfur levels as larger refineries. The most significant concern expressed to us has been their more limited ability to obtain the capital necessary to make the refinery modifications necessary to produce low sulfur diesel fuel compared to the larger refiner. To address these and other concerns related to small refiners, we have participated in a review and evaluation process specific to small businesses under the Small Business Regulatory Enforcement Flexibility Act (SBREFA). More information can be found in our response to the Regulatory Flexibility Act (see section XI.B). In short, we are seeking comment on provisions that would assist small refiners in addressing unique challenges, as discussed in section VIII.E.

4. Can Refiners Comply with an April 1, 2006 Start Date?

We believe that our proposal that the program begin on April 1, 2006 would provide more than an adequate amount of time for refiners to plan their investment, complete the design package and complete the construction and startup of the new or modified desulfurization unit and other associated units in their refineries. In response to our proposed Tier 2 gasoline desulfurization rulemaking, the American Petroleum Institute (API) commented that 4 years is needed for refiners to complete this cycle of planning, design, construction and startup. While we believe 4 years to be more than sufficient, we have initiated this rulemaking sufficiently early to provide over 5 years of lead time. We recognize that most refiners will have to make investments in their refineries to desulfurize their gasoline during this time, so the additional time from final rule to implementation is expected to be valuable for refiners. Similarly, by informing refiners now (i.e., before they make their gasoline desulfurization investments) of our proposed highway diesel fuel desulfurization program we hope to allow refiners to coordinate their investments and produce both low-sulfur gasoline and low-sulfur onroad diesel at a lower cost. The additional time between promulgation and implementation is important because of the number of refiners which are expected to have to make these investments. Unlike the gasoline sulfur program which really only affected refineries outside of California, this program would affect the California refiners as well, in addition to a number of refineries which produce onroad diesel fuel but no gasoline.[131] However, the total capital cost of the investments projected to be required to meet the proposed diesel fuel sulfur cap is less than that for the Tier 2 gasoline sulfur standards.

A particular concern has been raised to the Agency regarding the capability of the engineering and construction (E&C) industries to be able to design and build diesel fuel hydrotreaters while at the same time doing the same for gasoline, as well as accomplishing their other objectives. We believe that the E&C industry is capable of supplying the oil refining industry with the equipment necessary to comply with the proposed diesel fuel sulfur cap on time.[132] We believe that this is facilitated by the extended phase-in we allowed regarding compliance with the Tier 2 gasoline sulfur standards. For example, we project that only roughly a third of all gasoline-producing refineries outside of California will be building gasoline desulfurization equipment for start-up in early 2006 and 2007. Thus, most of the construction related to gasoline desulfurization will be completed prior to the proposed implementation of the diesel fuel sulfur cap. Also, low sulfur gasoline and diesel fuel standards scheduled for Europe and Canada become effective in 2005. We believe that this precedes the proposed highway diesel fuel sulfur cap sufficiently to enable the availability of European equipment fabrication capacity to be available to meet the needs of the proposed sulfur cap in the U.S. Thus, we do not foresee any shortage in either E&C industry personnel or equipment fabrication capacity. We request comment on these findings.

We are aware that the National Petroleum Council (NPC) is conducting a Refining Study which also addresses this issue. It appears from a publically available draft final report that the NPC may conclude otherwise. We plan to consider the findings of this study once it becomes final.

Another issue related to the feasibility of the April 1, 2006 start date relates to refiners' ability to hook up their new equipment to their existing diesel fuel hydrotreaters while still providing the nation with diesel fuel during the transition. This issue is relevant since: (1) we expect most refiners to revamp their current equipment, as opposed to building entirely new equipment and (2) all refiners face the same April 1, 2006 deadline. We expect that any new equipment required as part of the revamp would be able to be constructed on-site while the current equipment is operating. Inter-connecting the new and old equipment would occur prior to April 2006 when the current hydrotreater is scheduled to be down for maintenance. Existing equipment which would require modification, such as compressors and heat exchangers, would be modified during this time, as well. Diesel fuel hydrotreaters currently operate roughly two years in between scheduled maintenance. Thus, there should be at least one and possibly two scheduled maintenance periods between the time when refiners could have project designs completed, permits issued, as appropriate, and April 2006. Under this schedule of refinery maintenance, modifying current diesel fuel hydrotreaters to meet the proposed sulfur cap should not impact diesel fuel production. If refiners had to schedule additional down time in order to complete the revamp, then diesel fuel production could be affected. We expect that any such shortfall would be made up by other refiners or the previous build-up of inventory. We request comment on the ability of the industry to continue to supply highway diesel fuel while it is modifying equipment in order to comply with the proposed sulfur cap.

Concerns have also been raised with respect to the refining industry's ability to raise the capital necessary to make the refinery modifications necessary to meet a 15 ppm sulfur cap on diesel fuel, while at the same time expending capital to reduce the sulfur level in gasoline as a result of the recently promulgated Tier 2 standards. This has led to concerns that some refiners may refrain from investing to continue to produce highway diesel fuel, which could cause a shortage when the program is implemented. As discussed in section IV.B. of the draft RIA, we have designed these programs in a

[131] By far most of California gasoline meets a 30 ppm averaging standard, except for a small volume which is exported out of the state. However, since the California refiners already have the desulfurization units in place to desulfurize the majority of their gasoline, they are expected to use those same units to desulfurize the exported gasoline as well.

[132] Rykowski, Richard A., ''Implementation of Ultra Low Sulfur Diesel Fuel: Construction Capacity and Aggregate Capital Investment,'' EPA Memorandum to the Record, Docket A–99–06.

manner which will serve to maximize refiner flexibility and minimize costs. Furthermore, as discussed in section V.D.1., we believe that despite the capital cost of desulfurizing their highway diesel fuel, other options for marketing the distillate streams from their refineries will be limited. Finally, as discussed in section VI.A., we are also considering various phase-in approaches for implementing the low sulfur diesel standard. A phase-in could help spread out the design, construction, and capital expenditure of refinery modifications necessary to comply with the proposed diesel fuel sulfur standard. We request comment on the necessity and ability of a phase-in to address these concerns.

In summary, we believe that meeting a 15 ppm cap is achievable with the diesel desulfurization technologies available now. We are confident that we are providing more than a sufficient amount of time between when this rule is expected to be finalized and the proposed startup date of the program. This timing should allow for a smooth transition of low-sulfur fuel into the marketplace. We request comments on all of these issues. In particular, we request comment and supporting information on the challenges refiners would face in competing for engineering and construction resources and obtaining capital for diesel fuel sulfur control. We also seek comment with supporting information on the potential for diesel fuel shortages at the beginning of the program that some believe might result from individual refinery decisions to shift all or a portion of their production to other distillate products or export, and on the ability of the market to self correct if a shortage does occur.

5. Can a 15 ppm Cap on Sulfur Be Maintained by the Distribution System?

The proposed cap on sulfur content would apply to on-highway diesel fuel at the refinery gate, and at every point along the distribution system through to the end-user. The current distribution system for petroleum distillates currently carries products with sulfur contents that range from 30 ppm to over 10,000 ppm. The system includes pipelines, tankers, tanks, and delivery trucks. To date, this system has not been required to deliver a product with the purity which would be required under this proposal. Consequently, to ensure the sulfur standard is not exceeded during the fuel's journey to the end-user, the refiner would actually produce diesel fuel sufficiently below the cap to account for its own compliance margin (estimated to be 7 ppm on average), as well as for test variability and potential downstream contamination. Under the current sulfur cap of 500 ppm, refiners typically provide ample margin, producing fuel with roughly 350 ppm sulfur. With a sulfur cap of 15 ppm, the absolute magnitude of the margin refiners could provide would obviously be much smaller. In addition, the impact of contamination in the distribution system would be potentially much more severe. If the proposed 15 ppm cap on the sulfur content of on highway diesel fuel were adopted, other products in the distribution system such as nonroad diesel fuel would have sulfur concentrations over 200 times that of highway diesel fuel instead of the 10-fold factor at present. Additives to diesel fuel added in small amounts downstream which sometimes contain high sulfur concentrations levels may also become much more of a concern (see section IV.D.6.c). If as expected, refiners would produce highway diesel fuel with an average sulfur content of approximately 7 ppm to comply with the proposed sulfur standard, and variability in measuring diesel sulfur content is limited to less than +/−4 ppm, downstream sulfur contamination would need to be limited to less than 3 ppm to maintain compliance with the proposed 15 ppm cap. Petroleum marketers and distributors have cautioned that the distribution system is unfamiliar with limiting sulfur contamination to such a low level.

Current industry practices may need to be modified to control and limit sulfur contamination in the distribution system. Current practices which are critical to minimizing contamination and which may need to be more carefully performed include:

—Properly leveling tank trucks to ensure that they can drain completely of high-sulfur product prior to being filled with the proposed diesel fuel.
—Allowing sufficient time for transport tanks to drain of high-sulfur product prior to being filled with the proposed diesel fuel.
—Purging delivery hoses of higher sulfur product prior to their use to deliver the proposed diesel fuel.

To adequately limit sulfur contamination, we believe that such practices would need to be followed each and every time with adequate care taken to ensure their successful and full completion. Some distributors may find it necessary to conduct an employee education program to emphasize their importance. We request comment on our assessment for each segment in the distribution chain, including tank trucks, tank wagons, rail tankers, barges, and marine tankers.

As discussed in section V.D.3 of today's document, there may be an increase in distribution costs associated with an increase in pipeline interface volumes and the need to sample and test each batch of on highway diesel fuel at the terminal level for its sulfur content. There could also be an increase in the occurrence of noncomplying fuel showing up in the distribution system. As is the case today, this could cause temporary, local market shortages of fuel meeting the proposed sulfur cap. This off-specification fuel would also either have to be downgraded to off-highway, or re-refined, though we have assumed that the frequency of such occurrence would be low enough as to not impact the costs of the program noticeably. The potential sources of sulfur contamination in the distribution system, what controls we believe would be necessary to ensure downstream compliance with the proposed sulfur standard, and the costs associated with such controls are discussed in more detail in the Draft RIA. We request comment on the challenges that each segment of the distribution chain would face in controlling sulfur contamination, on the extent that each segment might reasonably be expected to limit sulfur contamination, and on the associated costs.

6. What Are the Potential Impacts of the Proposed Sulfur Change on Lubricity, Other Fuel Properties, and Specialty Fuels?

a. What Is Lubricity and Why Might It be a Concern?

Diesel fuel lubricity properties are depended on by the engine manufacturers to lubricate and protect moving parts within fuel pumps and injection systems for reliable performance. Unit injector systems and in-line pumps, commonly used in heavy-duty engines, are actuated by cams lubricated with crankcase oil, and have minimal sensitivity to fuel lubricity. However, rotary and distributor type pumps, commonly used in light and medium-duty diesel engines, are completely fuel lubricated, resulting in high sensitivity to fuel lubricity.

Experience has shown that it is very rare for a naturally high-sulfur fuel to have poor lubricity, although, most studies show relatively poor overall correlation between sulfur content and lubricity. Considerable research remains to be performed for a better understanding of the fuel components most responsible for lubricity.

Consequently, we are uncertain about the impact of today's proposal on fuel lubricity. Nevertheless, there is evidence that the typical process used to remove sulfur from diesel fuel (hydrotreating) can impact lubricity depending on the severity of the treatment process and characteristics of the crude. If refiners use hydrotreating to achieve the proposed sulfur limit, there may be reductions in the concentration of those components of diesel fuel which contribute to adequate lubricity. As a result, the lubricity of some batches of fuel may be reduced compared to today's levels, resulting in an increased need for the use of lubricity additives in highway diesel fuel.

Blending small amounts of lubricity-enhancing additives increases the lubricity of poor-lubricity fuels to acceptable levels. At the present time, it is believed that oil companies are treating diesel fuel in this way on a batch to batch basis, when poor lubricity fuel is expected. This practice of treating fuel on an as-needed and voluntary basis has been effective in ensuring good diesel fuel lubricity for the diesel heavy-duty vehicle fleet. Our review of the technical literature [133] indicates that the U.S. military also uses lubricity-enhancing additives in its diesel fuel. The U.S. military has found that the traditional corrosion inhibitor additives that it uses have been highly effective in reducing fuel system component wear. Consequently, the U.S. Army now blends MIL–I–25017E corrosion inhibitor additive to all fuels when poor lubricity is expected, and regularly for Jet A–1, JP–5 and JP–8 fuels. We believe that this practice would continue, with some portion of the fuel refined to the proposed standard being treated with lubricity-enhancing additives. For a more detailed discussion of diesel fuel lubricity and current industry practices, please refer to the Draft RIA for this proposal. We have included a 0.2 cents per gallon cost in our calculations to account for the potential increased use of lubricity additives (see section V.D.2).

b. Voluntary Approach for the Maintenance of Fuel Lubricity

If action on fuel lubricity does prove necessary, we believe a voluntary approach would provide customer protection from engine failures due to low lubricity, while providing the maximum flexibility for industry. In a voluntary approach we would encourage, but not require, fuel producers and distributors to monitor and provide fuel with adequate lubricity to protect diesel engine fuel systems. This approach recognizes the uncertainties of measuring fuel lubricity, and allows flexibility as research produces better information and improved test methods. The voluntary approach discussed here would be a continuation of current industry practices for diesel fuel produced to meet the current Federal and California 500 ppm sulfur diesel fuel specifications, and benefits from the considerable experience gained since 1993. The advantage of this approach is avoidance of an additional regulatory scheme and associated burdens. On the down side, voluntary measures do not guarantee results. We believe the risk in this case is small. Refiners and distributors have an incentive to supply fuel products that will not damage consumer equipment. Even if occasional batches of poor lubricity fuel are distributed, they would likely be "treated" with residual quantities of good lubricity fuel in storage tanks, tanker trucks, retail tanks, and vehicle fuel tanks (even at very low treatment levels lubricity enhancing additives provide significant protection; see the discussion in the Draft RIA for this proposal). Further, we expect that the American Society for Testing and Materials intends to address lubricity in its ASTM D–975 specifications for diesel fuel quality after its concerns about test issues have been resolved.

We are asking for comments on the alternative of specifying minimum fuel lubricity, and suggestions for the appropriate lubricity standard and test method. Under this approach, we would require fuel producers to monitor and provide minimum lubricity. This would be similar to the approach of Canada and our understanding of the usage requirements of the U.S. military. The advantage of this approach is to guarantee the minimum quality of fuel in the market. On the down side, such a new specification would need to be tied specifically to emissions or emission control hardware, and we question whether such a requirement is appropriate considering the uncertainty about the adequacy of the existing test methods. The American Society for Testing and Materials has declined to specify a lubricity standard in its ASTM D–975 specifications for diesel fuel quality until its concerns about test issues have been resolved. Also, this approach would require an enforcement scheme and associated compliance burden. Further, we believe that this approach would probably not be significantly more effective than the voluntary approach. Refiners and distributors have an incentive to supply fuel products that will not damage consumer equipment, and the U.S. commercial market has adequately addressed similar concerns in the past.

The U.S. Department of Defense (DOD) expressed strong reservations about the ability of the proposed voluntary approach to ensure adequate fuel lubricity and requested that EPA establish a uniform requirement to ensure that diesel fuel introduced into commerce has adequate lubricity. Absent such a requirement, DOD related that the military would face a considerable burden to ensure that highway diesel fuel used in military vehicles provides sufficient lubricity. DOD stated that since they rely on the commercial market to supply highway diesel to military users and are currently experiencing lubricity problems in certain parts of the country during the winter months, a reduction in diesel sulfur would increase the risk and scope of lubricity problems. DOD also stated that due to harsher operating conditions, engines used in their vehicles (especially tactical vehicles) are more vulnerable to lubricity problems than the same engines operated in commercial vehicles. In addition, at some U.S. military installations DOD uses highway diesel fuel in their off highway vehicles as well as their highway vehicles. We request comment on the unique challenges that our proposed voluntary approach would place on the military and on the appropriate means to address DOD's concerns.

c. What Are the Possible Impacts of Potential Changes in Fuel Properties Other Than Sulfur on the Materials Used in Engines and Fuel Supply Systems?

With the introduction of low-sulfur diesel fuel in the United States in 1993, some diesel engine fuel pumps with a Nitrile material for O-ring seals began to leak. Fuel pumps using a Viton material for the seals did not experience leakage. The leakage from the Nitrile seals was determined to be due to low aromatics levels in some low-sulfur fuel, not the low sulfur levels. In the process of lowering the sulfur content of some fuel, some of the aromatics had been removed. Normally, the aromatics in the fuel penetrate the Nitrile material and cause it to swell, thereby providing a seal with the throttle shaft. When low-aromatics fuel is used after conventional fuel has been used, the aromatics already in the swelled O-ring will leach out into the low-aromatics fuel.

[133] See the draft RIA for a more detailed discussion.

Subsequently, the Nitrile O-ring will shrink and pull away, thus causing leaks, or the stress on the O-ring during the leaching process will cause it to crack and leak. Not all low-sulfur fuels caused this problem, because the amount and type of aromatics varied. Although manufacturers have apparently resolved this issue, and we have no evidence that further desulfurization will cause further changes in O-ring shape or other concerns, we request comments on this or other potential impacts of fuel properties on the materials used in engines and fuel supply systems.

d. What Impact Would the 15 ppm Cap Have on Diesel Performance Additives?

Our proposal to limit the sulfur content of performance additives used in diesel fuel to less than 15 ppm (see section VIII) would require that the use of certain high-sulfur diesel fuel additives be discontinued. Our review of EPA's Fuel and Fuel Additives database indicates that alternative additives that perform the same function and which do not contain sulfur are readily available. Our evaluation suggests that discontinuing the use of the limited number of diesel additives with a high sulfur content would not result in significant increased costs or an undue hardship to additive and fuel manufacturers (see the draft RIA). We request comment on the difference in price between high- and low-sulfur performance additives and whether there are differences in their efficiency. As an alternative to the proposed 15 ppm cap on the sulfur content of performance additives, we are requesting comment on whether additives not meeting the 15 ppm sulfur cap should be allowed to be added to diesel fuel downstream in de minimis amounts, as long as the final blend still meets the 15 ppm cap.

e. What Are the Concerns Regarding the Potential Impact on the Availability and Quality of Specialty Fuels?

The Department of Defense (DOD) has expressed concerns regarding the potential impact of today's proposed rule on the availability and quality of military fuels, especially the aviation fuels JP–5 and JP–8. DOD is concerned that today's rule might reduce the number of refineries that produce military fuels by limiting the slate of fuels that refiners can economically produce or the number of refiners that continue to produce military fuels. DOD notes that the special flash point requirement for military JP–5 fuel already limits DOD's supply base and that the proposed rule may make some refiners opt out of manufacturing this speciality fuel, which would reduce supply availability and increase costs. DOD also states that the increased hydroprocessing severity and other refinery process modifications necessary to meet the proposed sulfur standard could impact certain chemical/physical characteristics that are part of their fuel specifications. DOD relates that previous environmentally-driven changes to gasoline and diesel specifications have caused a degradation in the quality of the jet fuel. For example, DOD states that they have noticed a reduction and continued decline in jet fuel stability.

DOD is also concerned that refiners that currently blend more than 10 percent light cycle oil (LCO) into their highway diesel fuel might shift some LCO into off-highway distillate fuels. DOD relates that this would adversely affect the quality of off highway fuels used by the military such as their naval distillate fuel F–76. DOD states that they have experienced quality problems with LCO component streams that were not adequately hydrotreated causing a highly unstable finished product. Storage stability is an important issue for DOD since military naval fuel F–76 is often stored for extended periods (longer than six months) and unstable LCO used to manufacture F–76 could compromise mission readiness. The potential changes that refiners might make in the way they process LCO streams and incorporate such streams into their slate of distillate fuels is discussed in section V.D.1 and in the Draft RIA.

We believe that concerns related to the quality of specialty fuels can continue to be addressed by actions taken by the manufacturers and purchasers of such fuels without the need for intervention by EPA. We also anticipate that demand for such fuels will be sufficient to encourage their continued availability. We request comment on the potential impact of today's proposed rule on the quality and availability of specialty fuels such as those used by the U.S. military, on what actions might be necessary to mitigate such impacts, and on the associated costs. Comment is specifically requested on the need for the military to modify its specifications and/or enhance enforcement of these specifications to achieve their fuel quality goals if the proposed sulfur standards are adopted, and on the costs associated with such changes.

E. Who Would Be Required to Meet This Proposed New Diesel Sulfur Standard?

As discussed earlier, the highway diesel fuel sulfur content standard being proposed today is a per-gallon cap of 15 ppm. We believe that heavy-duty diesel trucks subject to the standards we are proposing today would require the consistent use of diesel fuel with a sulfur cap of 15 ppm to avoid the potentially severe emission, performance, and durability problems that arise from operation on higher-sulfur fuel. On this basis we believe that the proposed sulfur standard should apply to the diesel fuel at the point of sale to the ultimate consumer. In other words, the proposed cap on sulfur content should apply at all points in the diesel fuel production and distribution system, including the retail level.

We understand that there are production and distribution practices, such as blending of additives and winter viscosity improvers such as kerosene or No. 1 diesel fuel, that could cause the sulfur level of diesel fuel to vary as it travels from refinery to end-point consumers. Along with concerns about contamination and test method reproducibility, these issues suggest that we should include some sort of tolerance along with our proposed sulfur cap. However, we are concerned that such tolerances on top of the 15 ppm cap may not be appropriate given the sensitivity of diesel exhaust emission control technology to fuel sulfur above the proposed sulfur cap. In practice, therefore, refiners will likely be required by the downstream distribution system to produce diesel fuel having a sulfur content significantly below the proposed sulfur cap to ensure that downstream practices do not end up producing a retail-level fuel with sulfur levels higher than the proposed maximum. Thus, all parties in the distribution system, including refiners and importers, would be prohibited from selling, storing, transporting, dispensing, introducing, or causing or allowing the introduction of highway diesel fuel whose sulfur content exceeds the proposed sulfur cap. The advantage of such an approach is that, as downstream distribution practices and sulfur measurement accuracy improves, refiners will be able to reduce production costs by producing fuel closer to the proposed sulfur cap. Alternatively, we could enforce the proposed 15 ppm sulfur cap at retail and enforce a lower cap at the refinery level. This cap would likely have to be less than 10 ppm to allow for downstream contamination, additive blending, and test method variability.

However, we believe it is more appropriate to leave this tolerance to the market.

F. What Might Be Done To Encourage the Early Introduction of Low-Sulfur Diesel Fuel?

As discussed in section IV.C, we are proposing that the entire highway diesel pool be required to meet a lower standard on sulfur content beginning June 1, 2006.[134] This should provide certainty that low-sulfur diesel fuel will be available for model year (MY) 2007 heavy-duty diesel engines by July 1, 2006. If low-sulfur diesel fuel was available prior to July 1, 2006, engine manufacturers have indicated that fleet trials might be conducted of the sulfur-sensitive exhaust emission control equipment intended for use in heavy-duty vehicles to meet the proposed MY 2007 emissions standards. The information gained from these trials could be used to improve the efficiency and durability of such exhaust emission control equipment. This could lower the cost of the exhaust emission control equipment and help ensure the smooth implementation of the proposed MY 2007, heavy-duty standards. If low-sulfur diesel fuel was available earlier than July 1, 2006, it might also facilitate the early introduction of sulfur-sensitive exhaust emission control equipment in light-duty diesel vehicles. Automobile manufacturers expressed interest in using sulfur-sensitive exhaust emission control equipment in some of their light-duty vehicles beginning in MY 2004, so that they might benefit from in-use experience prior to the anticipated use of such equipment in all MY 2007, light-duty diesel vehicles. In addition, early availability of some low sulfur diesel fuel would have the added advantage of allowing the distribution system a chance to develop experience handling diesel fuel with such a low sulfur level before the standards would take effect.

We believe that some low-sulfur diesel fuel meeting the proposed 15 ppm sulfur cap would be available in advance of when we are proposing that it must be produced by refiners. Most refiners will need to install new equipment to meet the proposed sulfur standard. Since the technical and construction resources needed for such refinery upgrades is limited, a number of refiners are likely to have the new desulfurization equipment installed well in advance of the proposed compliance date. Refiners who produce low-sulfur diesel early would want to market it as a premium fuel rather than losing the added value by selling it as current highway diesel fuel. Some refiners have already begun programs to market low-sulfur diesel as a premium fuel. For example, ARCO Products Company recently announced a fleet program to demonstrate the emissions benefits of its EC—D (emission control) diesel which has a lower sulfur and aromatics content, and a higher cetane rating than current highway diesel fuel.[135] Engine and vehicle manufacturers are assisting in the overall program design and implementation of the program. Emission control equipment manufacturers are supplying exhaust emission control equipment which works more effectively with low-sulfur fuel. ARCO has also begun marketing diesel fuel in California with a maximum sulfur content of 15 ppm. This fuel is being made available, upon request, to operators of urban municipal fleets retrofitted with catalytic exhaust emission controls in connection with the California ARB's proposed urban bus program (see section I.C.6).[136] Mobil Corporation, Ford Motor Company, Navistar, and Volkswagen also have a cooperative program underway to evaluate the emissions benefits of new engine/aftertreatment technologies using a lower-sulfur diesel fuel (also with reduced polynuclear aromatic content). We are interested in encouraging additional programs between refiners and vehicle manufacturers to introduce vehicles equipped with exhaust emission control technologies which benefit from the use of low-sulfur diesel fuel prior to the date when we are proposing that such fuel must be made available.

There are numerous strategies involving voluntary market incentives that could help promote the early introduction of low-sulfur diesel fuel. Under existing voluntary emission credits programs, a system might be created whereby refiners that produce low-sulfur fuel early could generate emission reduction credits that could then be sold through a market mechanism to other entities that could use such credits to meet their emission compliance goals. We welcome comments on whether additional incentives are needed and feasible to encourage the early introduction of low-sulfur diesel fuel for use in vehicles equipped to provide lower emissions with the use of such a fuel. We also request comments on how such incentives might be structured under a phase in of low sulfur highway diesel fuel (see section VI.A).

V. Economic Impact

This section discusses the projected economic impact and cost effectiveness of the proposed emission standards and low-sulfur fuel requirement. We welcome comment on the estimated cost for research and development and the necessary lead time to develop these technologies for heavy-duty vehicles. Additionally we invite the reader to review all of the underlying cost assumptions made in the accompanying draft RIA and ask for comment on the validity of these assumptions. Full details of our cost and cost effectiveness analyses can be found in the Draft RIA.

A. Cost for Diesel Vehicles To Meet Proposed Emissions Standards

1. Summary of New System and Operating Costs

The technologies described in section III show a good deal of promise for controlling emissions, but also make clear that much effort remains to develop and optimize these new technologies for maximum emission-control effectiveness with minimum negative impacts on engine performance, durability, and fuel consumption. On the other hand, it has become clear that manufacturers have a great potential to advance beyond the current state of understanding by identifying aspects of the key technologies that contribute most to hardware or operational costs or other drawbacks and pursuing improvements, simplifications, or alternatives to limit those burdens. To reflect this investment in long-term cost savings potential, the cost analysis includes an estimated $385 million in R&D outlays for heavy-duty engine designs and $220 million in R&D for catalysts systems giving a total R&D outlay for improved emission control of more than $600 million. The cost and technical feasibility analyses accordingly reflect substantial improvements on the current state of technology due to these future developments.

Estimated costs are broken into additional hardware costs and life-cycle operating costs. The incremental hardware costs for new engines are comprised of variable costs (for hardware and assembly time) and fixed costs (for R&D, retooling, and certification). Total operating costs include the estimated incremental cost for low-sulfur diesel fuel, any expected

[134] This is the proposed retail-level compliance date. The proposed compliance date at the refinery level is April 1, 2006.

[135] ARCO Products Company news release dated October 7, 1999, Docket A–99–06 Item II–G–13.

[136] ARCO Products Company news release dated December 15, 1999.

increases in maintenance cost, or fuel consumption costs along with any decreases in operating cost expected due to low-sulfur fuel. Cost estimates based on these projected technology packages represent an expected incremental cost of engines in the 2007 model year. Costs in subsequent years would be reduced by several factors, as described below. Separate projected costs were derived for engines used in three service classes of heavy-duty diesel engines. All costs are presented in 1999 dollars.

The costs of these new technologies for meeting the proposed 2007 model year standards are itemized in the Draft RIA and summarized in Table V.A–1. For light heavy-duty vehicles, the cost of a new 2007 model year engine is estimated to increase by $1,688 and operating costs over a full life-cycle to increase by about $431. For medium heavy-duty vehicles the cost of a new engine is estimated to increase by $2,213, with life-cycle operating costs increasing to $826. Similarly, for heavy heavy-duty engines, the vehicle cost is expected to increase by $2,768, and estimated additional life-cycle operating costs are $3,362. The higher incremental increase in operating costs for the heavy heavy-duty vehicles is due to the larger number of miles driven over their lifetime (714,000 miles on average) and their correspondingly high lifetime fuel usage. Emission reductions are also proportional to VMT and so are significantly higher for heavy heavy-duty vehicles.

We also believe there are factors that would cause cost impacts to decrease over time, making it appropriate to distinguish between near-term and long term costs. Research in the costs of manufacturing has consistently shown that as manufacturers gain experience in production, they are able to apply innovations to simplify machining and assembly operations, use lower cost materials, and reduce the number or complexity of component parts.[137] Our analysis, as described in more detail in the draft RIA, incorporates the effects of this learning curve by projecting that the variable costs of producing the low-emitting engines decreases by 20 percent starting with the third year of production (2009 model year) and by reducing variable costs again by 20 percent starting with the fifth year of production. We invite comment on this methodology to account for the learning curve phenomena and also request comment on whether learning is likely to reduce costs in this industry. Additionally, since fixed costs are assumed to be recovered over a five-year period, these costs are not included in the analysis after the first five model years. Finally, manufacturers are expected to apply ongoing research to make emission controls more effective and to have lower operating cost over time. However, because of the uncertainty involved in forecasting the results of this research, we have conservatively not accounted for it in this analysis. Table V.A–1 lists the projected costs for each category of vehicle in the near- and long-term. For the purposes of this analysis, ''near-term'' costs are those calculated for the 2007 model year and ''long term'' costs are those calculated for 2012 and later model years.

We welcome comment on the degree to which this program may influence sales of new heavy-duty vehicles in the early years of the program, and the resulting impact this would have on our projected program benefits and costs. Costlier model year 2007 vehicles may induce some potential purchasers of these vehicles to instead buy 2006 models to save money, or to defer a purchase longer than they otherwise might have. On the other hand, we would anticipate that the very low emissions characteristics of these new vehicles would cause many buyers for whom cleaner diesels would be good for business (for example, urban transit authorities and touring or shuttle services) to retire older higher-emitting vehicles early.

TABLE V.A–1.—PROJECTED INCREMENTAL SYSTEM COST AND LIFE CYCLE OPERATING COST FOR HEAVY-DUTY DIESEL VEHICLES

[Net present values in the year of sale, 1999 dollars]

Vehicle class	Model year	Hardware cost	Life-cycle operating cost*
Light heavy-duty	Near term	$1,688	$431
	Long term	982	413
Medium heavy-duty	Near term	2,213	826
	Long term	1,188	800
Heavy heavy-duty	Near term	2,768	3,362
	Long term	1,572	3,265
Urban Bus	Near term	2,268	3,942
	Long term	1,252	3,874

*Incremental life-cycle operating costs include the incremental costs to refine and distribute low sulfur diesel fuel, the service cost of closed crankcase filtration systems, and the lower maintenance costs realized through the use of low sulfur diesel fuel (see discussion in section V.3).

2. New System Costs for NO_X and PM Emission Control

Several new technologies are projected for complying with the proposed 2007 model year emission standards. We are projecting that NO_X adsorbers and catalyzed diesel particulate filters would be the most likely technologies applied by the industry in order to meet our proposed emissions standards. The fact that manufacturers would have several years before implementation of the proposed new standards ensures that the technologies used to comply with the standards would develop significantly before reaching production. This ongoing development could lead to reduced costs in three ways. First, we expect research will lead to enhanced effectiveness for individual technologies, allowing manufacturers to use simpler packages of emission control technologies than we would predict given the current state of development. Similarly, we anticipate that the continuing effort to improve the emission control technologies will include innovations that allow lower-

[137] ''Learning Curves in Manufacturing,'' Linda Argote and Dennis Epple, Science, February 23, 1990, Vol. 247, pp. 920–924.

cost production. Finally, we believe that manufacturers would focus research efforts on any drawbacks, such as fuel economy impacts or maintenance costs, in an effort to minimize or overcome any potential negative effects.

We anticipate that in order to meet the proposed standards, industry would introduce a combination of primary technology upgrades for the 2007 model year. Achieving very low NO_X emissions will require basic research on NO_X emission control technologies and improvements in engine management to take advantage of the exhaust emission control system capabilities. The manufacturers are expected to take a systems approach to the problem optimizing the engine and exhaust emission control system to realize the best overall performance possible. Since most research to date with exhaust emission control technologies has focused on retrofit programs there remains room for significant improvements by taking such a systems approach. The NO_X adsorber technology in particular is expected to benefit from re-optimization of the engine management system to better match the NO_X adsorbers performance characteristics. The majority of the $600 million dollars we have estimated for research is expected to be spent on developing this synergy between the engine and NO_X exhaust emission control systems. PM control technologies are expected to be less sensitive to engine operating conditions as they have already shown good robustness in retrofit applications with low-sulfur diesel fuel.

The NO_X adsorber system that we are anticipating would be applied in 2007 consists of a catalyst which combines traditional gasoline three-way conversion technology with a newly developed NO_X storage function, a reductant metering system and a means to control engine air fuel (A/F) ratio. The NO_X adsorber catalyst itself is a relatively new device, but is benefitting in its development from over 20 years of gasoline three-way catalyst development. In order for it to function properly, a systems approach that includes a reductant metering system and control of engine A/F ratio is also necessary. Many of the new air handling and electronic system technologies developed in order to meet the 2004 heavy-duty engine standards can be applied to accomplish the NO_X adsorber control functions as well. Some additional hardware for exhaust NO_X or O_2 sensing and for fuel metering will likely be required. We have estimated that this additional hardware will increase new engine costs by approximately $350 for a heavy heavy-duty diesel engine. The Draft RIA also calculates an increase in warranty costs for this additional hardware. In total the new NO_X control technologies required in order to meet the proposed 2007 emission standards are estimated to increase light heavy-duty engine costs by $890, medium heavy-duty engine costs by $1,047 and heavy heavy-duty engine costs by $1,410 in the year 2007. In the year 2012 and beyond the incremental costs are expected to decrease to $570 for a light heavy-duty engine, $670 for a medium heavy-duty engine and to $902 for a heavy heavy-duty engine.

Catalyzed diesel particulate filters are experiencing widespread retrofit use in much of Europe as low-sulfur diesel fuel becomes readily available. These technologies are proving to be robust in their non-optimized retrofit applications requiring no modification to engine or vehicle control functions. We therefore anticipate that catalyzed diesel particulate filters can be integrated with new diesel engines with only a minimal amount of engine development. We do not anticipate that additional hardware beyond the diesel particulate filter itself and an exhaust pressure sensor for OBD will be required in order to meet the proposed PM standard. We estimate in 2007 that diesel particulate filter systems will add $633 to the cost of a light heavy-duty vehicle, $796 to the cost of a medium heavy-duty vehicle and $1,028 to the cost of a heavy heavy-duty vehicle. By 2012 these costs are expected to decrease to $389, $491, and $638 respectively. These cost estimates are comparable to estimates made by the Manufacturers of Emission Controls Association for these technologies.[138]

We have proposed to eliminate the exemption that allows turbo-charged heavy-duty diesel engines to vent crankcase gases directly to the environment, so called open crankcase systems, and have projected that manufacturers will rely on engineered closed crankcase ventilation systems which filter oil from the blow-by gases. We have estimated the initial cost of these systems in 2007 to be $37, $42, and $49 for light, medium and heavy heavy-duty diesel engines respectively. Additionally we expect a portion of the oil filtration system to be a service replacement oil filter which will be replaced on a 30,000 mile service interval with a service cost of $10, $12, and $15 for light, medium, and heavy heavy-duty diesel engines respectively. These cost are summarized with the other cost for emission controls in Table V.A–1 and are included in the aggregate cost reported in section V.E.

3. Operating Costs Associated With NO_X and PM Control

The Draft RIA assumes that a variety of new technologies will be introduced to enable heavy-duty vehicles to meet the new emissions standards we are proposing. Primary among these are advanced emission control technologies and low-sulfur diesel fuel. The many benefits of low-sulfur diesel fuel are described in section III, and the incremental cost for low-sulfur fuel is described in section V.D. The new emission control technologies are themselves not expected to introduce additional operating costs in the form of increased fuel consumption. Operating costs are estimated in the Draft RIA over the life of the vehicle and are expressed as a net present value (NPV) in 1999 dollars for comparison purposes.

Total operating cost estimates include both the expected increases in maintenance and fuel costs (both the incremental cost for low-sulfur fuel and any fuel consumption penalty) due to the emission control systems application and the predicted decreases in maintenance cost due to the use of low-sulfur fuel. Today's proposal estimates some increase in operating costs due to the incremental cost of low-sulfur diesel fuel but no net increase in fuel consumption with the application of the new emission control technologies (see discussion in section III.G). The net increase in operating costs are summarized in Table V.A–1. While we are using these incremental operating cost estimates for our cost effectiveness calculations, it is almost certain that the manufacturers will improve existing technologies or introduce new technologies in order to offset at least some of the increased operating costs. We request comment on these operating cost estimates and on ways in which industry may be able to offset these operating costs.

We estimate that the low-sulfur diesel fuel we are proposing to require in order to enable these technologies would have an incremental cost of approximately $0.044/gallon as discussed in section V.D. The proposed low-sulfur diesel fuel may also provide additional benefits by reducing the engine maintenance costs associated with corrosion due to sulfur in the current diesel fuel. These benefits, which are discussed further in section V.C and in the draft RIA, include extended oil

[138] Letter from Bruce Bertelsen, Manufacturers of Emission Controls Association (MECA) to William Charmley, US EPA, December 17, 1998. The letter documents a MECA member survey of expected diesel particulate filter costs. EPA Air Docket A–99–06.

change intervals due to the slower acidification rate of the engine oil with low-sulfur diesel fuel. Service intervals for the EGR system are also expected to increase due to lower-sulfur induced corrosion than will occur with today's higher-sulfur fuel. This lengthening of service intervals provides a significant savings to the end user. As described in more detail in the Draft RIA we anticipate that low-sulfur diesel fuel would provide additional cost savings to the consumer of $153 for light heavy-duty vehicles, $249 for medium heavy-duty vehicles and $610 for heavy heavy-duty vehicles. The operating costs for replacement filters in the closed crankcase filtration systems are estimated to be $48 for light heavy-duty vehicles, $72 for medium heavy-duty vehicles and $268 for heavy heavy-duty vehicles in 2007 and in the long term are expected to decrease to $31 for a light heavy-duty vehicle, $46 for a medium heavy-duty vehicle and $172 for a heavy heavy-duty vehicle. Factoring the cost savings due to low sulfur diesel fuel into the additional cost for low-sulfur diesel fuel and the service cost of the closed crankcase ventilation system yields a net increase in vehicle operating costs of $431 for a light heavy-duty vehicle, $826 for a medium heavy-duty vehicle and $3,362 for a heavy heavy-duty vehicle. These life cycle operating costs are also summarized in Table V.A–1. The net increase in operating cost can also be expressed as an average annual operating cost for each class of heavy-duty vehicle. Expressed as an approximate annual per vehicle cost, the additional operating cost is estimated as $50 for a light heavy-duty vehicle, $100 for a medium heavy-duty vehicle, and $400 for a heavy heavy-duty vehicle.

B. Cost for Gasoline Vehicles to Meet Proposed Emissions Standards

1. Summary of New System Costs

To perform a cost analysis for the proposed standards, we first determined a package of likely technologies that manufacturers could use to meet the proposed standards and then determined the costs of those technologies. In making our estimates we have relied on our own technology assessment which included publicly available information, such as that developed by California, as well as confidential information supplied by individual manufacturers, and the results of our own in-house testing.

In general, we expect that heavy-duty gasoline vehicles would (like Tier 2 light duty vehicles) be able to meet these standards through refinements of current emissions control components and systems rather than through the widespread use of new technology. More specifically, we anticipate a combination of technology upgrades such as the following:

- Improvements to the catalyst system design, structure, and formulation, plus an increase in average catalyst size and loading.
- Air and fuel system modifications including changes such as improved oxygen sensors, and calibration changes including improved precision fuel control and individual cylinder fuel control.
- Exhaust system modifications, possibly including air gapped components, insulation, leak free exhaust systems, and thin wall exhaust pipes.
- Increased use of fully electronic exhaust gas recirculation (EGR).
- Increased use of secondary air injection.
- Use of ignition spark retard on engine start-up to improve upon cold start emission control.
- Use of low permeability materials and minor improvements to designs, such as the use of low-loss connectors, in evaporative emission control systems.

We expect that the technologies needed to meet these proposed heavy-duty gasoline standards would be very similar to those required to meet the Tier 2 standards for vehicles over 8,500 pounds GVWR. Few heavy-duty gasoline vehicles currently rely on technologies such as close coupled catalysts and secondary air injection, but we expect they would do so to in order to meet the proposed 2007 standards.

For each group we developed estimates of both variable costs (for hardware and assembly time) and fixed costs (for R&D, retooling, and certification). Cost estimates based on the current projected costs for our estimated technology packages represent an expected incremental cost of vehicles in the near-term. For the longer term, we have identified factors that would cause cost impacts to decrease over time. First, since fixed costs are assumed to be recovered over a five-year period, these costs disappear from the analysis after the fifth model year of production. Second, the analysis incorporates the expectation that manufacturers and suppliers would apply ongoing research and manufacturing innovation to making emission controls more effective and less costly over time. Research in the costs of manufacturing has consistently shown that as manufacturers gain experience in production and use, they are able to apply innovations to simplify machining and assembly operations, use lower cost materials, and reduce the number or complexity of component parts.[139] These reductions in production costs are typically associated with every doubling of production volume. Our analysis incorporates the effects of this ''learning curve'' by projecting that a portion of the variable costs of producing the new vehicles decreases by 20 percent starting with the third year of production. We applied the learning curve reduction only once since, with existing technologies, there would be less opportunity for lowering production costs than would be the case with the adoption of new technology. We did not apply the learning curve reduction to precious metal costs, nor did we apply it for the evaporative standards. We invite comment on this methodology to account for the learning curve phenomena and also request comment on whether learning is likely to reduce costs in this industry.

We have prepared our cost estimates for meeting the new heavy-duty gasoline standards using a baseline of current technologies for heavy-duty gasoline vehicles and engines. Finally, we have incorporated what we believe to be a conservatively high level of R&D spending at $2,500,000 per engine where no California counterpart exists. We have included this large R&D effort because calibration and system optimization is likely to be a critical part of the effort to meet the standards. However, we believe that the R&D costs may be generous because the projection probably underestimates the carryover of knowledge from the development required to meet the light-duty Tier 2 and CARB LEV–II standards.

Table V.B–1 provides our estimates of the per vehicle increase in purchase price for heavy-duty gasoline vehicles and engines. The near-term cost estimates in Table V.B–1 are for the first years that vehicles meeting the standards are sold, prior to cost reductions due to lower productions costs and the retirement of fixed costs. The long-term projections take these cost reductions into account. We request comment on the costs shown in Table V.B–1 and the analysis behind them.

[139] See Chapter V of the final Tier 2 Regulatory Impact Analysis, contained in Air Docket A–97–10.

TABLE V.B–1.—PROJECTED INCREMENTAL SYSTEM COST AND LIFE CYCLE OPERATING COST FOR HEAVY-DUTY GASOLINE VEHICLES

[Net present values in the year of sale, 1999 dollars]

Vehicle class	Model year	Incremental system cost	Life-cycle operating cost
Heavy-Duty Gasoline	Near term	$182	$0
	Long term	152	0

2. Operating Costs Associated With Meeting the Heavy-Duty Gasoline Standard

Low sulfur gasoline is a fundamental enabling technology which will allows heavy-duty gasoline vehicles to meet the very low emission standards being proposed today. The low sulfur gasoline required under the Tier 2 proposal will enable advanced exhaust emission control for heavy-duty vehicles as well. Today's proposal puts no additional requirements on gasoline sulfur levels and as such should not directly increase gasoline fuel costs. Additionally, the new technologies being employed in order to meet the new standards are not expected to increase fuel consumption for heavy-duty gasoline vehicles. In fact, there may be some small improvement in fuel economy from the application of improved fuel and air control systems on these engines. Therefore, in the absence of changes to gasoline specifications and with no decrease in fuel economy, we do not expect any increase in vehicle operating costs.

C. Benefits of Low-Sulfur Diesel Fuel for the Existing Diesel Fleet

We estimate that the proposed low-sulfur diesel fuel would provide additional benefits to the existing heavy-duty vehicle fleet as soon as the fuel is introduced. We believe these benefits could offer significant cost savings to the vehicle owner without the need for purchasing any new technologies. The Draft RIA has catalogued a variety of benefits from the proposed low-sulfur diesel fuel. These benefits are summarized in Table V.C–1.

TABLE V.C–1.—COMPONENTS POTENTIALLY AFFECTED BY LOWER SULFUR LEVELS IN DIESEL FUEL

Affected components	Effect of lower sulfur	Potential impact on engine system
Piston Rings	Reduce corrosion wear	Extended engine life and less frequent rebuilds.
Cylinder Liners	Reduce corrosion wear	Extended engine life and less frequent rebuilds.
Oil Quality	Reduce deposits and less need for alkaline additives.	Reduce wear on piston ring and cylinder liner and less frequent oil changes.
Exhaust System (tailpipe)	Reduces corrosion wear	Less frequent part replacement.
EGR	Reduces corrosion wear	Less frequent part replacement.

The actual value of these benefits over the life of the vehicle would depend upon the length of time that the vehicle operates on low-sulfur diesel fuel and the degree to which vehicle operators change engine rebuild patterns to take advantage of these benefits. For a vehicle near the end of its life in 2007 the benefits would be quite small. However for vehicles produced in the years immediately preceding the introduction of low-sulfur fuel the savings would be substantial. The Draft RIA estimates that a heavy heavy-duty vehicle introduced into the fleet in 2006 would realize savings of $610 over its life. This savings could alternatively be expressed in terms of fuel costs as approximately 1 cent per gallon as discussed in the draft RIA. These savings would occur without additional new cost to the vehicle owner beyond the incremental cost of the low-sulfur diesel fuel, although these savings would require changes to existing maintenance schedules. Such changes seem likely given the magnitude of the savings and the nature of the regulated industry.

The maintenance benefits we project come primarily from extended oil change intervals. We have no quantitative data on how much longer these intervals might be. Based on discussions with some engine manufacturers, we believe it is reasonable to assume that engine oil change intervals will increase by 10 percent for each class of engine (in both new and existing fleets). We seek comment on this key assumption and on these projected savings and all of the assumptions behind them; details of the analysis behind these savings can be found in the draft RIA contained in the docket for this rule.

D. Cost of Proposed Fuel Change

We estimate that the overall cost associated with lowering the sulfur cap from the current level of 500 ppm to the 15 ppm level proposed today will be approximately 4.4 cents per gallon. As discussed in sections V.A. and V.C., this cost would be offset by a one cent per gallon savings (or more) from the reduction in vehicle maintenance savings that result from the use of the cleaner fuel. The fuel cost is comprised of a number of components associated with refining and distributing the fuel. The majority of the fuel cost is expected to be the refining cost which is estimated to be approximately 4.0 cents per gallon, which includes the cost of producing more volume of diesel fuel because desulfurization decreases the energy density of the fuel. The remaining 0.4 cents per gallon in fuel costs is associated with an anticipated increase in the use of additives to maintain fuel lubricity at a cost of 0.2 cents per gallon, and an increase in distribution costs of 0.2 cents per gallon. The increase in distribution costs comprises 0.1 cents per gallon to distribute the additional volume of diesel fuel needed to compensate for the decrease in fuel energy density, and 0.1 cents per gallon to maintain product integrity in the distribution system. These cost estimates are discussed in more detail below and in the Draft RIA.

When the 4.4 cent per gallon cost is applied to the expected low sulfur diesel fuel sales volume of approximately 40 billion gallons at the start of the program, it equates to an annual cost of roughly $1.8 billion per year. This fuel cost would be offset by a reduction in maintenance costs of roughly $0.4 billion per year.

1. Refinery Costs

As explained in Section IV, refiners would have to install capital equipment to meet the proposed diesel fuel sulfur standard. Presuming that refiners will want to minimize the cost involved and use conventional technology, refiners are expected to build onto their existing desulfurization unit by adding another hydrotreating reactor and other related equipment.

In our analysis, we estimated the cost of lowering onroad diesel fuel sulfur levels for a national average refinery starting from the current national average sulfur level of about 350 ppm down to 7 ppm. We believe that a refinery's average diesel fuel sulfur level would be roughly 7 ppm under a 15 ppm cap standard. We then calculated a national aggregate cost and cents-per-gallon cost. Based on this analysis we estimate that, on average, individual refiners in the years 2004–05 would be expected to invest about $30 million for capital equipment and spend about $8 million per year for each refinery to cover the operating costs associated with these desulfurization units. Since this average represents a diverse size range of refineries, some refineries would pay more and others less than this average cost. When the average per-refinery cost is aggregated for all the onroad diesel fuel expected to be produced in this country in 2007, we estimate that the total investment for desulfurizing diesel fuel would be about $1.9, $2.0, and $0.2 billion in 2004, 2005, and 2006, respectively, as discussed in section IV.B. Operating costs for these units are expected to be about $1.1 billion per year.

Using our estimated capital and operating costs we calculated the average per-gallon cost of reducing diesel fuel sulfur down to meet the proposed 15 ppm cap standard. Using a capital cost amortization factor based on a seven percent rate of return on investment before taxes, we estimated the average national cost for desulfurizing onroad diesel sulfur to be about 4.0 cents per gallon. This cost is our estimated cost to society of producing onroad diesel to meet a 15 ppm cap standard that we used for estimating cost effectiveness.

There is currently no commercial experience in the U.S. and only a limited amount of information in the public literature on the costs associated with reducing the sulfur level in diesel fuel to very low levels on an ongoing operational basis. Experience in Sweden involves other changes to the fuel as well that would tend to drive up the costs considerably. The EMA recently commissioned a study by Mathpro of the economics of controlling the sulfur content of highway and nonroad diesel fuel to various sulfur levels as low as 2 ppm. Unfortunately, none of the scenarios modeled in the EMA study are consistent with our proposal today. Furthermore, some of the assumptions made in the analysis are inconsistent with our standard assumptions for economic analysis. For example, Mathpro used a higher rate of return on new capital than the rate we use. Nevertheless, some insight can be gained from a broad comparison of Mathpro's and our cost projections. The proposed sulfur cap for highway diesel fuel is very roughly bracketed by two Mathpro sulfur control scenarios: (1) a highway diesel fuel standard of 20 ppm on average with a nonroad diesel fuel standard of 350 ppm on average, and (2) an highway diesel fuel standard of 2 ppm on average with a nonroad diesel fuel standard of 20 ppm on average. Mathpro's projected refining costs for these two scenarios range from 4 to just under 6 cents per gallon (citing their costs for revamping current diesel fuel hydrotreaters with reactors in series, which is equivalent to our technology projections). Considering that Mathpro uses a higher rate of return on capital and that both of their scenarios included controlling nonroad diesel fuel, the two sets of cost projections appear to be roughly consistent. This serves to give us some confidence that our cost estimate for a sulfur cap of 15 ppm on highway diesel fuel is reasonable. This is discussed in further detail in the Draft RIA.

Although API assisted in the study, API has expressed some concern about the accuracy of the EMA cost estimates. API highlighted their concerns on the EMA study in a memo to the Director the Office of Transportation Air Quality, which is included in the docket.[140] While API expressed their belief that the cost outcomes of the EMA study are, in general, reasonable, they expressed serious concerns about the cost of producing diesel with sulfur levels below 20 ppm (roughly equivalent to a 30 ppm cap). API believes that, particularly at extremely low sulfur levels, the measures needed to be taken would result in significantly higher costs than estimated by EMA. We request comment on this assessment.

We acknowledge that some refiners likely face higher desulfurization costs than others. This is generally the case with any fuel quality regulation, since the crude oils processed by, as well as the configurations and product slates of individual refineries vary dramatically. As mentioned in section IV, API believes that those refiners facing higher than average costs may decide to leave the highway diesel fuel market. They argue this is especially a possibility if they are faced with a sulfur standard below a 30 ppm average (or 50 ppm cap), which they believe will require very large investments for high pressure hydrotreating to maintain current highway diesel production volumes. API also believes that many refiners may reduce their production of highway diesel fuel, by switching the feedstocks (i.e., LCO) which are most difficult to desulfurize to other markets, thus avoiding the higher investments associated with high pressure hydrotreating. If some refiners reduce highway diesel fuel production, that could present an opportunity for other refiners, who choose to make the investment, of higher prices for the new 15 ppm sulfur product. Whether the potential for higher prices would be sufficient and be apparent with sufficient leadtime to allow refiners to make an added investment by the time the proposed rule is effective is currently unclear.

For example, the refining industry actually overbuilt desulfurization capacity for the current 500 ppm standard, as evidenced by the significant use in the off-highway market of diesel fuel produced to the current highway diesel sulfur standard of 500 ppm. Some of this overproduction may have been due to limitations in the distribution system to distribute both highway and off-highway grades of diesel fuel. Despite the overall market overproduction, a number of small refiners did decide to switch from the highway diesel fuel market to the off-highway diesel fuel market, presumably for economic reasons.

Another incentive for refiners to invest in highway diesel fuel desulfurization equipment is the potential for a growing light-duty diesel market. Many vehicle manufacturers have announced plans to equip their light-duty vehicles and, particularly, light-duty trucks with diesel engines. Refiners may want to ensure their

[140] Edward H. Murphy, API to Margo Oge, US EPA, October 26,1999.

presence in this growing and potentially profitable market.

Alternative markets for distillate products are limited in the U.S. The domestic off-highway diesel fuel and heating oil markets are much smaller than the highway diesel fuel market. The domestic off-highway diesel fuel and heating oil markets are currently in balance, considering the fact that some highway diesel fuel is currently being sold into these markets. Assuming that the distribution system can be changed to segregate highway and other distillate fuels more economically, some amount of current highway diesel fuel production could switch to these other markets with no loss of highway diesel fuel supply. In addition, although the off-highway diesel fuel market is growing, this growth will occur gradually over the next 6 years and not occur on April 1, 2006. The heating oil market is very seasonal (strong in the winter and weak in the summer), regional (strong in the Northeast) and not growing. Thus, overall, we do not see much opportunity for large domestic producers of highway diesel fuel to be able to shift their production to these other domestic markets.

Export opportunities for diesel fuel are also limited to some degree. Japan and Europe will have stringent sulfur caps in place by 2005 and have cetane requirements well beyond the cetane levels of current U.S. diesel fuel. Asia, while growing in demand for diesel fuel, has also been the focus of new grassroots refinery production and again has high cetane requirements. Thus, the primary areas for export of diesel fuel of average U.S. quality would appear to be Africa and Latin America.

Refiners have also raised the possibility of exporting some of their more difficult to desulfurize diesel feedstocks such as LCO to other distillate markets. While this may be a possibility to some degree as discussed in Section IV and the draft RIA, the opportunities to do so appear to be limited. We have not conducted a detailed analysis of the potential for this exportation. Refiners would have to hydrotreat this material to lower its sulfur content in order to meet the European Union 50 ppm sulfur cap (and increase its cetane) in order for it to be used as a diesel fuel blendstock. Otherwise, its only use without additional treating would be in heating fuel. With Europe and developing countries expected to experience increasing demand for non-diesel, distillate fuel, there may be economic opportunities for exporting such fuel.

We request comments on the possibility that the proposed sulfur cap would cause some refiners to abandon the U.S. highway diesel fuel market or to reduce highway diesel fuel production, as well as on the impact that this would have on diesel fuel supply and price in the U.S. We also request comment on whether refiners would likely desire to shift all their LCO to non-highway diesel fuel markets or just the heavier portion which contains the most sterically hindered compounds. We also request comment on the economic viability of alternative markets for current highway diesel fuel or its more difficult to desulfurize components. We also request comments on the ability of overseas refiners providing highway diesel fuel under the proposed sulfur cap should domestic refiners reduce production. Finally, as discussed in section VI.A., we are also considering various phase-in approaches for implementing the low sulfur diesel standard. A phase-in could help spread out the design, construction, and capital expenditure of refinery modifications necessary to comply with the proposed diesel fuel sulfur standard, and in so doing could further minimize any risk of supply shortages. We request comment on the appropriateness and ability of a phase-in to address these concerns.

2. Cost of Possibly Needed Lubricity Additives

As discussed in section IV, the refinery processes needed to achieve the sulfur standard have some potential to degrade the natural lubricity characteristics of the fuel. Consequently an increase in the use of lubricity additives for diesel fuel may be anticipated over the amounts used today. We contacted various producers of lubricity additives to get their estimates of what costs might be incurred for this increase in the use of lubricity additives. The cost estimates varied from 0.1 to 0.5 cents per gallon. This range is to be expected since the cost will be a strong function of not only the additive type, but also the assumed treatment rate and the volume of fuel that needs to be treated, both of which will be, to some extent, a function of the sulfur cap. As described in more detail in the Draft RIA, we have included in the fuel cost estimate an average cost of 0.2 cents per gallon for lubricity additives over the entire pool of low-sulfur highway diesel fuel. This estimate is comparable to an estimate made by Mathpro in a study sponsored by the EMA. We request comment on our cost estimate. In particular, we request comment on whether there may be unique costs for the military to maintain the lubricity of their distillate fuels. We request that such comments addressing this issue include a detailed discussion of the volumes of fuel effected, current lubricity additive use, and the additional measures that might be needed (and associated costs) to maintain the appropriate level of fuel lubricity.

3. Distribution Costs

Under the proposed 15 ppm sulfur cap, we project that distribution costs would increase by a total of 0.2 cents per gallon as discussed below.

If the proposed sulfur standard is adopted, there would be a greater difference between the sulfur content of highway diesel fuel and other distillate products than presently exists.[141] For example, off-highway diesel fuel currently has a sulfur content that is approximately ten times that of highway diesel. Under the proposed sulfur standard, off-highway diesel fuel would have a sulfur content over two hundred times that of highway diesel fuel. This could potentially make it more difficult to limit the sulfur contamination of highway diesel fuel with other distillate products as the fuel travels through the distribution system. As discussed in section IV, standard industry practices, if followed carefully, should be able to virtually eliminate the potential contamination. To do so, however, is expected to result in slightly increased costs in a few different parts of the distribution system.

We identified three segments in the distribution system (pipeline operators, terminal operators, and tank-truck operators) that might experience increased costs due to increased difficulty in limiting sulfur contamination under the proposed sulfur standard. As discussed in the Draft RIA, we estimate that the total increase in diesel distribution costs associated with adequately limiting sulfur contamination under today's proposal would be no more than 0.1 cents per gallon for the distribution system as a whole. The majority of this increased cost is attributed to the unavoidable mixing of highway diesel with other products that occurs in pipeline shipments. The amount of interface (e.g., mixture of a highway diesel batch and a nonroad diesel batch) that must be downgraded to a lower

[141] Highway diesel fuel currently must have a sulfur content of no more than 500 ppm and typically has an average sulfur content of 350 ppm. Off-highway diesel fuel sulfur content is currently unregulated and is approximately 3,500 ppm on average. The maximum allowed sulfur content of heating oil is 5,000 ppm. The maximum allowed sulfur content of kerosene (and jet fuel) is 3,000 ppm.

price product is expected to grow with a lower sulfur cap for highway diesel, resulting in a slightly increased cost for pipeline shipments. A slight increase in distribution costs is also expected to result at terminals due to the anticipated need for additional quality assurance testing at very low sulfur levels. We believe that, although tank-truck operators may need to more carefully observe current industry practices used to limit product contamination, this will not result in a significant increase in costs.

We invite comment on the amount of sulfur contamination which might be expected from each segment of the distribution system, the measures that might be taken to limit contamination, and the costs associated with these measures. We also request comment on the level of sulfur contamination in the distribution system that might be considered unavoidable without the imposition of an undue burden on diesel distributors and how this bears on the question of what sulfur level the refiner would need to meet at the refinery gate (the compliance margin) to ensure that highway diesel fuel does not exceed the proposed cap on sulfur content. Please refer to section IV.E for discussion of the compliance margin that we anticipate refiners will need to provide.

The energy density of diesel fuel would be decreased as a side effect of reducing sulfur content to the proposed 15 ppm cap. Consequently, to meet the same level of consumer demand an increased volume of diesel fuel would need to move through the distribution system. The cost of distributing this increased volume of diesel fuel was calculated within the model that used to evaluate refining costs (see the Draft RIA). Spread over the total volume of diesel fuel distributed, the additional cost is estimated at 0.1 cents per gallon. We request comment on this cost estimate.

E. Aggregate Costs

Using current data for the size and characteristics of the heavy-duty vehicle fleet and making projections for the future, the diesel per-engine, gasoline per-vehicle, and per-gallon fuel costs described above can be used to estimate the total cost to the nation for the emission standards in any year. Figure V.E–1 portrays the results of these projections.[142] All capital costs have been amortized.

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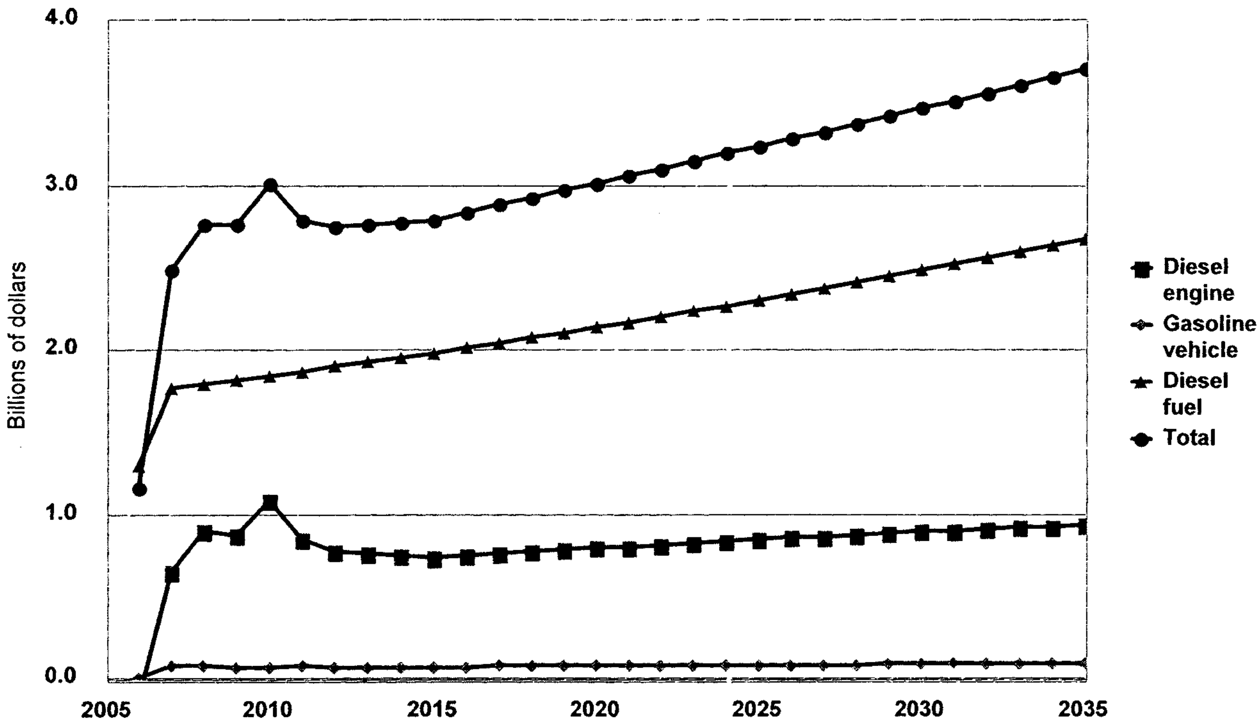
Figure V.E-1 Total Annualized Costs



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As can be seen from the figure, the annual costs start out at less than a billion dollars in year 2006 and increase over the phase-in period to about $2.8 billion in 2015. Thereafter, total annualized costs are projected to continue increasing due to the effects of projected growth in engine sales and fuel consumption. The Draft RIA provides further detail regarding these cost projections.

Future consumption of today's proposed low sulfur diesel fuel may be influenced by a potential influx of diesel-powered cars and light trucks into the light-duty fleet. At the present time, virtually all cars and light trucks being sold are gasoline fueled. However, the possibility exists that diesels will become more prevalent in the car and light-duty truck fleet, since automotive companies have announced their desire to increase their sales of diesel cars and light trucks. For the Tier 2 rulemaking, the Agency performed a sensitivity analysis using A.D.Little's "most likely" increased growth scenario of diesel penetration into the light-duty vehicle fleet which culminated in a 9 percent and 24 percent penetration of diesel vehicles in the LDV and LDT markets,

[142] Figure V.E–1 is based on the amortized engine, vehicle and fuel costs as described in the Draft RIA. Actual capital investments, particularly important for fuels, would occur prior to and during the initial years of the program.

respectively, in 2015 (see Tier 2 RIA, Table III.A. 13). Were this scenario to play out, the increased number of diesel-powered cars and light-duty trucks would increase the societal costs (those costs, in total, paid by consumers) for the proposed higher priced diesel fuel because more diesel fuel would be consumed. However, were more diesel vehicles to penetrate the light-duty fleet, less gasoline would be consumed than was estimated in our Tier 2 cost analysis. Also, diesel vehicles tend to get higher fuel economy. In the end, the effect of increased dieselization of the light-duty fleet may have little or no impact on the aggregate costs estimated for today's proposal. While we have not fully analyzed this light-duty diesel penetration scenario, we request comment on it and relevant data which would allow us to perform a sensitivity analysis.

F. Cost Effectiveness

One tool that can be used to assess the value of new standards for heavy-duty vehicles and engines is cost effectiveness, in which the costs incurred to reach the standards are compared to the mass of emission reductions. This analysis results in the calculation of a $/ton value, the purpose of which is to show that the reductions from the engine and fuel controls being proposed today are cost effective, in comparison to alternative means of control. This analysis involves a comparison of our program not only to past measures, but also to other potential future measures that could be implemented. Both EPA and states have already adopted numerous control measures, and remaining measures tend to be more expensive than those previously employed. As we and States tend to employ the most cost effective available measures first, more expensive ones must be adopted to achieve further emission reductions.

1. What Is the Cost Effectiveness of This Proposed Program?

We have calculated the cost-effectiveness of our proposed diesel engine/gasoline vehicle/diesel sulfur standards based on two different approaches. The first considers the net present value of all costs incurred and emission reductions generated over the life of a single vehicle meeting our proposed standards. This per-vehicle approach focuses on the cost-effectiveness of the program from the point of view of the vehicles and engines which will be used to meet the new requirements. However, the per-vehicle approach does not capture all of the costs or emission reductions from our proposed diesel engine/gasoline vehicle/diesel sulfur program since it does not account for the use of low sulfur diesel fuel in current diesel engines. Therefore, we have also calculated an 30-year net present value cost-effectiveness using the net present value of costs and emission reductions for all in-use vehicles over a 30-year time frame. The baseline or point of comparison for this evaluation is the previous set of engine, vehicle, and diesel sulfur standards (in other words, the applicable 2004 model year standards).

As described earlier in the discussion of the cost of this program, the cost of complying with the new standards will decline over time as manufacturing costs are reduced and amortized capital investments are recovered. To show the effect of declining cost in the per-vehicle cost-effectiveness analysis, we have developed both near term and long term cost-effectiveness values. More specifically, these correspond to vehicles sold in years one and six of the vehicle and fuel programs. Chapter VI of the RIA contains a full description of this analysis, and you should look in that document for more details of the results summarized here.

The 30-year net present value approach to calculating the cost-effectiveness of our program involves the net present value of all nationwide emission reductions and costs for a 30 year period beginning with the start of the diesel fuel sulfur program and introduction of model year 2007 vehicles and engines in year 2006. This 30-year timeframe captures both the early period of the program when very few vehicles that meet our proposed standards will be in the fleet, and the later period when essentially all vehicles in the fleet will meet our proposed standards. We have calculated the 30-year net present value cost-effectiveness using the net present value of the nationwide emission reductions and costs for each calender year. These emission reductions and costs are given for every calendar year in the RIA, in addition to details of the methodology we used to calculate the 30-year net present value cost-effectiveness.

Our per-vehicle and 30-year net present value cost-effectiveness values are given in Tables V.F–1 and V.F–2. Table V.F–1 summarizes the per-vehicle, net present value lifetime costs, NMHC + NO_X and PM emission reductions, and resulting cost-effectiveness results for our proposed diesel engine/gasoline vehicle/diesel sulfur standards using sales weighted averages of the costs (both near term and long term) and emission reductions of the various vehicle and engine classes affected. Table V.F–2 provides the same information from the program 30-year net present value perspective. It includes the net present value of the 30 year stream of vehicle and fuel costs, NMHC + NO_X and PM emission reductions, and the resulting 30-year net present value cost-effectiveness. Diesel fuel costs applicable to diesel engines have been divided equally between the adsorber and trap, since low sulfur diesel is intended to enable all technologies to meet our proposed standards. In addition, since the trap produces reductions in both PM and hydrocarbons, we have divided the total trap costs equally between compliance with the proposed PM standard and compliance with the proposed NMHC standard.

Tables V.F–1 and V.F–2 also display cost-effectiveness values based on two approaches to account for the reductions in SO_2 emissions associated with the reduction in diesel fuel sulfur. While these reductions are not central to the program and are therefore not displayed with their own cost-effectiveness, they do represent real emission reductions due to our program. The first set of cost-effectiveness numbers in the tables simply ignores these reductions and bases the cost-effectiveness on only the emission reductions from our proposed program. The second set accounts for these ancillary reductions by crediting some of the cost of the program to SO_2. The amount of cost allocated to SO_2 is based on the cost-effectiveness of SO_2 emission reductions that could be obtained from alternative, potential future EPA programs. The SO_2 credit was applied only to the PM calculation, since SO_2 reductions are primarily a means to reduce ambient PM concentrations.

TABLE V.F–1.—PER-ENGINE COST EFFECTIVENESS OF THE PROPOSED STANDARDS FOR 2007 AND LATER MY VEHICLES

Pollutants	Discounted lifetime vehicle & fuel costs	Discounted lifetime emission reductions (tons)	Discounted lifetime cost effective-ness per ton	Discounted lifetime cost effective-ness per ton with SO_2 credit [a]
Near-term costs [b]:				
NO_X+NMHC	$1535	0.8838	$1,736	$1,736
PM	872	0.0672	12,977	6,338
Long-term costs:				
NO_X+NMHC	1121	0.8838	1,268	1,268
PM	652	0.0672	9,704	3,065

[a] $446 credited to SO_2 (at $4800/ton) for PM cost effectiveness.
[b] As described above, per-engine cost effectiveness does not include any costs or benefits from the existing, pre-control, fleet of vehicles that would use the low sulfur diesel fuel proposed in this document.

TABLE V.F–2.—30-YEAR NET PRESENT VALUE [a] COST EFFECTIVENESS OF THE STANDARDS

	30-year n.p.v. engine, vehicle, & fuel costs (in billions)	30-year n.p.v. reduction (tons) (in millions)	30-year n.p.v. cost effective-ness per ton	30-year n.p.v. cost effective-ness per ton with SO_2 credit [b]
NO_X + NMHC	$28.9	18.9	$1,531	$1,531
PM	8.8	0.79	11,248	1,850

[a] This cost effectiveness methodology reflects the total fuel costs incurred in the early years of the program when the fleet is transitioning from pre-control to post-control diesel vehicles. In 2007 <10% of highway diesel fuel is anticipated to be consumed by 2007 MY vehicles. By 2012 this increases to >50% for 2007 and later MY vehicles.
[b] $7.4 billion credited to SO_2 (at $4800/ton).

2. Comparison With Other Means of Reducing Emissions

In comparison with other mobile source control programs, we believe that our program represents a cost effective strategy for generating substantial NO_X, NMHC, and PM reductions. This can be seen by comparing the cost effectiveness of today's program with a number of mobile source standards that EPA has adopted in the past. Table V.F–3 summarizes the cost effectiveness of several past EPA actions for NO_X+ NMHC. Table V.F–4 summarizes the cost effectiveness of several past EPA actions for PM.

TABLE V.F–3.—COST EFFECTIVENESS OF PREVIOUS MOBILE SOURCE PROGRAMS FOR NO_X+NMHC

Program	$/ton
Tier 2 vehicle/gasoline sulfur	1,311–2,211
2004 Highway HD diesel	207–405
Nonroad diesel engine	416–660
Tier 1 vehicle	2,010–2,732
NLEV	1,888
Marine SI engines	1,146–1,806
On-board diagnostics	2,263
Marine CI engines	23–172

Note.—costs adjusted to 1998 dollars.

TABLE V.F–4.—COST EFFECTIVENESS OF PREVIOUS MOBILE SOURCE PROGRAMS FOR PM

Program	$/ton
Marine CI engines	511–3,797
1996 urban bus	12,000–19,200
Urban bus retrofit/rebuild	29,600
1994 highway HD diesel	20,450–23,940

Note.—costs adjusted to 1998 dollars.

We can see from these tables that the cost effectiveness of our proposed diesel engine/gasoline vehicle/diesel sulfur standards falls within the range of these other programs for both NO_X+NMHC and PM. Our proposed program overlaps the range of the recently promulgated standards for Tier 2 light-duty vehicles and gasoline sulfur shown in Table V.F–3. Our proposed program also overlaps the cost-effectiveness of past programs for PM. It is true that some previous programs have been more cost efficient than the program we are proposing today. However, it should be expected that the next generation of standards will be more expensive than the last, since the least costly means for reducing emissions is generally pursued first.

In evaluating the cost effectiveness of our proposed diesel engine/gasoline vehicle/diesel sulfur program, we also considered whether our proposal is cost effective in comparison with possible stationary source controls. In the context of the Agency's rulemaking which would have revised the ozone and PM NAAQS,[143] the Agency compiled a list of additional known technologies that could be considered in devising new emission reductions strategies.[144] Through this broad review, over 50 technologies were identified that could reduce NOx, VOC, or PM. The cost effectiveness of these technologies averaged approximately $5,000/ton for VOC, $13,000/ton for NO_X, and $40,000/ton for PM. Although a $10,000/ton limit was actually used in the air quality analysis presented in the NAAQS revisions rule, these values clearly indicate that, not only are future emission control strategies likely to be more expensive (less cost effective) than past strategies, but the cost effectiveness of our proposed program falls well

[143] This rulemaking was remanded by the DC Circuit Court on May 14, 1999. However, the analyses completed in support of that rulemaking are still relevant, since they were designed to investigate the cost effectiveness of a wide variety of potential future emission control strategies.

[144] "Regulatory Impact Analyses for the Particulate Matter and Ozone National Ambient Air Quality Standards and Proposed Regional Haze Rule," Appendix B, "Summary of control measures in the PM, regional haze, and ozone partial attainment analyses," Innovative Strategies and Economics Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 17, 1997.

below the average of those choices, and is near the lower end of the range of potential future strategies.

In summary, we believe that the weight of the evidence from alternative means of providing substantial NO_X+NMHC and PM emission reductions indicates that our proposed diesel engine/gasoline vehicle/diesel sulfur program is cost effective. We believe this is true from the perspective of other mobile source control programs and from the perspective of other stationary source technologies that might be considered. We request comment on the cost-effectiveness of this program.

G. Does the Value of the Benefits Outweigh the Cost of the Proposed Standards?

In addition to cost-effectiveness, further insight regarding the merits of the standards can be provided by benefit-cost analysis. The purpose of this section is to propose the methods to be used in conducting an analysis of the economic benefits of the final rule for heavy-duty vehicles and diesel fuel, and to discuss the potential for economic benefits associated with the rule. While the quantification of the benefits will not be available until the final rule, it is our belief that, based on the similarity between today's proposed rule and Tier 2/gasoline sulfur rule in terms of the costs per ton of emissions reduced and types of health and welfare benefits expected, the health and welfare benefits would substantially outweigh the costs.

1. What Is the Purpose of This Benefit-Cost Comparison?

Benefit-cost analysis (BCA) is a useful tool for evaluating the economic merits of proposed changes in environmental programs and policies. In its traditional application, BCA estimates the economic ''efficiency'' of proposed changes in public policy by organizing the various expected consequences and representing those changes in terms of dollars. Expressing the effects of these policy changes in dollar terms provides a common basis for measuring and comparing these various effects. Because improvement in economic efficiency is typically defined to mean maximization of total wealth spread among all members of society, traditional BCA must be supplemented with other analyses in order to gain a full appreciation of the potential merits of new policies and programs. These other analyses may include such things as examinations of legal and institutional constraints and effects; engineering analyses of technology feasibility, performance and cost; or assessment of the air quality need.

In addition to the economic efficiency focus of most BCAs, the technique is also limited in its ability to project future economic consequences of alternative policies in a definitive way. Critical limitations on the availability, validity, or reliability of data; limitations in the scope and capabilities of environmental and economic effect models; and controversies and uncertainties surrounding key underlying scientific and economic literature all contribute to an inability to estimate the economic effects of environmental policy changes in exact and unambiguous terms. Under these circumstances, we consider it most appropriate to view BCA as a tool to inform, but not dictate, regulatory decisions such as the ones reflected in today's proposed rule.

Despite the limitations inherent in BCA of environmental programs, we consider it useful to analyze the potential benefits of today's proposed action both in terms of physical changes in human health and welfare and environmental change, and in terms of the estimated economic value of those physical changes.

2. What Is Our Overall Approach to the Benefit-Cost Analysis?

The basic question we will seek to answer in the BCA is: ''What are the net yearly economic benefits to society of the reduction in air pollutant emissions likely to be achieved by the proposed rule for heavy-duty vehicles and diesel fuel?'' In designing an analysis to answer this question, we will model the benefits in a future year (2030) that is representative of full-implementation of the program. We will also adopt an analytical structure and sequence similar to that of the benefit analysis for the Tier 2/gasoline sulfur rulemaking and used for the ''section 812 studies'' [145] to estimate the total benefits and costs of the entire Clean Air Act. Moreover, we will use many of the same models and assumptions actually used in the section 812 studies, and other Regulatory Impact Analyses (RIA's) prepared by the Office of Air and Radiation. By adopting the major design elements, models, and assumptions developed for the section 812 studies and other RIA's, we will largely rely on methods which have already received extensive review by the independent Science Advisory Board (SAB), by the public, and by other federal agencies. In addition to the 2030 analysis, we plan to provide further characterization of the benefits for the interim period between 2007 and 2030.

3. What Are the Significant Limitations of the Benefit-Cost Analysis?

Every BCA examining the potential effects of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Deficiencies in the scientific literature often result in the inability to estimate changes in health and environmental effects, such as potential increases in premature mortality associated with increased exposure to carbon monoxide. Deficiencies in the economics literature often result in the inability to assign economic values even to those health and environmental outcomes which can be quantified, such as changes in visibility in residential areas. While these general uncertainties in the underlying scientific and economics literatures will be discussed in detail in the RIA for the final action, the key uncertainties are:

- The exclusion of potentially significant benefit categories (*e.g.,* health and ecological benefits of incidentally controlled hazardous air pollutants),
- Errors in measurement and projection for variables such as population growth,
- Variability in the estimated relationships of health and welfare effects to changes in pollutant concentrations.

In addition to these uncertainties and shortcomings which pervade all analyses of criteria air pollutant control programs, a number of limitations apply specifically to a BCA. Though we will use the best data and models available, we will likely be required to adopt a number of simplifying assumptions and to use data sets which, while reasonably close, will not match precisely the conditions and effects expected to result from implementation of the standards. For example, to estimate the effects of the program at full implementation we will need to project vehicle miles traveled and populations in the year 2030. These assumptions may play a significant role in determining the magnitude of the benefits estimate. In addition, the emissions data sets which

[145] The ''section 812 studies'' refers to (1) US EPA, Report to Congress: The Benefits and Costs of the Clean Air Act, 1970 to 1990, October 1997 (also known as the ''section 812 Retrospective); and (2) the first in the ongoing series of prospective studies estimating the total costs and benefits of the Clean Air Act (see EPA report number: EPA–410–R–99–001, November 1999).

will be used for the analysis may not anticipate the emissions reductions realized by other future actions and by expected near-future control programs. For example, it is possible that the proposed heavy-duty vehicle and diesel fuel sulfur standards will not be the governing vehicle emissions standards in 2030. In the years before 2030, the benefits from the proposed rule for heavy-duty vehicles and diesel fuel will be less than in 2030 because the heavy-duty fleet will not be fully phased in.

The key limitations and uncertainties unique to the BCA of the final rule, therefore, will include:

• Uncertainties in the estimation of future year emissions inventories and air quality,

• Uncertainties associated with the extrapolation of air quality monitoring data to some unmonitored areas required to better capture the effects of the standards on affected populations, and

• Uncertainties associated with the effect of potential future actions to limit emissions.

Despite these uncertainties, we believe the BCA will provide a reasonable indication of the expected economic benefits of the proposed rule for heavy-duty vehicles and diesel fuel in 2030 under one set of assumptions. This is because the analysis will focus on estimating the economic effects of the *changes* in air quality conditions expected to result from today's proposed action, rather than focusing on developing a precise prediction of the *absolute* levels of air quality likely to prevail in 2030. An analysis focusing on the changes in air quality can give useful insights into the likely economic effects of emission reductions of the magnitude expected to result from today's proposed rule.

4. How Will the Benefit-Cost Analysis Change From the Tier 2 Benefit-Cost Analysis?

We will evaluate the economics and scientific literature prior to conducting the benefit-cost analysis for the final rule. Our final benefit-cost methodology will reflect the most up to date set of health and welfare effects and the most current economic valuation methods. In addition, we will use updated emission inventories. We will also be evaluating the air quality models used to predict changes in future air quality for use in the benefits analysis.

5. How Will We Perform the Benefit-Cost Analysis?

The analytical sequence begins with a projection of the mix of technologies likely to be deployed to comply with the new standards, and the costs incurred and emissions reductions achieved by these changes in technology. The proposed rule for heavy-duty vehicles and diesel fuel has various cost and emission related components. These components would begin at various times and in some cases would phase in over time. This means that during the early years of the program there would not be a consistent match between cost and benefits. This is especially true for the vehicle control portions of the program, where the full vehicle cost would be incurred at the time of vehicle purchase, while the cost for low sulfur diesel fuel along with the emission reductions and benefits would occur throughout the lifetime of the vehicle.

To develop a benefit-cost number that is representative of a fleet of heavy-duty vehicles, we need to have a stable set of cost and emission reductions to use. This means using a future year where the fleet is fully turned over and there is a consistent annual cost and annual emission reduction. For the proposed rule for heavy-duty vehicles and diesel fuel, this stability would not occur until well into the future. For this analysis, we selected the year 2030. The resulting analysis will represent a snapshot of benefits and costs in a future year in which the heavy-duty fleet consists almost entirely of heavy-duty vehicles meeting the proposed standards. As such, it depicts the maximum emission reductions (and resultant benefits) and among the lowest costs that would be achieved in any one year by the program on a ''per mile'' basis. (Note, however, that net benefits would continue to grow over time beyond those resulting from this analysis, because of growth in population and vehicle miles traveled.) Thus, based on the long-term costs for a fully turned over fleet, the resulting benefit-cost ratio will be close to its maximum point (for those benefits which we have been able to value).

To present a BCA, we are designing the cost estimate to reflect conditions in the same year as the benefit valuation. Costs, therefore, will be developed for the year 2030 fleet. For this purpose we will use the long term cost once the capital costs have been recovered and the manufacturing learning curve reductions have been realized, since this will be the case in 2030.

We will also make adjustments in the costs to account for the fact that there is a time difference between when some of the costs are expended and when the benefits are realized. The vehicle costs are expended when the vehicle is sold, while the fuel related costs and the benefits are distributed over the life of the vehicle. We will resolve this difference by using costs distributed over time such that there is a constant cost per ton of emissions reduction and such that the net present value of these distributed costs corresponds to the net present value of the actual costs.

The resulting adjusted costs will be somewhat greater than the expected actual annual cost of the program, reflecting the time value adjustment. Thus, the costs will not represent expected actual annual costs for 2030. Rather, they will represent an approximation of the steady-state cost per ton that would likely prevail in that time period. The benefit cost ratio for the earlier years of the program would be expected to be lower than that based on these costs, since the per-vehicle costs are larger in the early years of the program while the benefits are smaller.

In order to estimate the changes in air quality conditions which would result from these emissions reductions, we will develop two separate, year 2030 emissions inventories to be used as inputs to the air quality models. The first, baseline inventory, will reflect the best available approximation of the county-by-county emissions for NO_X, VOC, and SO_2 expected to prevail in the year 2030 in the absence of the standards. To generate the second, control case inventory, we will first estimate the change in vehicle emissions, by pollutant and by county, expected to be achieved by the 2030 control scenario described above. We will then take the baseline emissions inventory and subtract the estimated reduction for each county-pollutant combination to generate the second, control case emissions inventory. Taken together, the two resulting emissions inventories will reflect two alternative states of the world and the differences between them will represent our best estimate of the reductions in emissions which would result from our control scenario.

With these two emissions inventories in hand, the next step will be to ''map'' the county-by-county and pollutant-by-pollutant emission estimates to the input grid cells of appropriately selected air quality and deposition models. One such model, called the Urban Airshed Model (UAM), is designed to estimate the tropospheric ozone concentrations resulting from a specific inventory of emissions of ozone precursor pollutants, particularly NO_X and NMHC. Another model, called the Climatological Regional Dispersion Model Source-Receptor Matrix model (S–R Matrix), is designed to estimate the changes in ambient particulate matter and visibility which would result from a specific set of changes in emissions of primary particulate matter and secondary particulate matter precursors, such as SO_2, NO_X, and NMHC. Also, nitrogen loadings to watersheds can be estimated using factors derived from previous modeling from the Regional Acid Deposition Model (RADM). By running both the baseline and control case emissions inventories through models such as these, we will be able to estimate the expected 2030 air quality conditions and the changes in air quality conditions which would result from the emissions reductions expected to be achieved by the proposed rule for heavy-duty vehicles and diesel fuel.

After developing these two sets of year 2030 air quality profiles, we will use the same health and environmental effect models used in the section 812 studies to calculate the differences in human health and environmental outcomes projected to occur with and without the proposed standards. Specifically, we will use the Criteria Air Pollutant Modeling System (CAPMS) to estimate changes in human health outcomes, and the Agricultural Simulation Model (AGSIM) to estimate changes in yields of a selected few agricultural crops. In addition, the impacts of reduced visibility impairment and estimates of the effect of changes in nitrogen deposition to a selection of sensitive estuaries will be estimated using slightly modified versions of the methods used in the section 812 studies. At proposal, we expect that several air quality-related health and environmental benefits, however, will not be able to be calculated for the BCA of today's proposed standards. Changes in human health and environmental effects due to changes in ambient concentrations of carbon monoxide (CO), gaseous sulfur dioxide (SO_2), gaseous nitrogen dioxide (NO_2), and hazardous air pollutants will likely not be included. In addition, some health and environmental benefits from changes in ozone and PM may not be included in our analysis (i.e., commercial forestry benefits). However, if our review of the economics and scientific literature reveals new information that will allow us to quantify these effects, they will be considered for inclusion in the estimate of total benefits for the final rule. Table IV–X lists the set of effects that we expect to be able to quantify for the BCA of the final rule, along with those effects which are known to exist, but that are currently unquantifiable.

To characterize the total economic value of the reductions in adverse effects achieved across the lower 48 states, we plan to use the same set of economic valuation coefficients and models used in the section 812 studies and the Tier 2 benefits analysis, as approved by the SAB. The set of coefficients and their sources are listed in the final Tier 2 RIA. However, any new methods uncovered in our evaluation of the economic and scientific literature may be incorporated into our final analysis. The net monetary benefits of the proposed rule for heavy-duty vehicles and diesel fuel will then be calculated by subtracting the estimated costs of compliance from the estimated monetary benefits of the reductions in adverse health and environmental effects.

The last step of the analysis will be to characterize the uncertainty surrounding our estimate of benefits. Again, we will follow the recommendations of the SAB for the presentation of uncertainty. They recommend that a primary estimate should be presented along with a description of the uncertainty associated with each endpoint.

Therefore, for the final rule for heavy-duty vehicles and diesel fuel, the benefit analysis will adopt an approach similar to the section 812 study and the final Tier 2/gasoline sulfur benefit-cost analysis. Our analysis will first present our estimate for a primary set of benefit endpoints followed by a presentation of "alternative calculations" of key health and welfare endpoints to characterize the uncertainty in this primary set. However, the adoption of a value for the projected reduction in the risk of premature mortality is the subject of continuing discussion within the economic and public policy analysis community within and outside the Administration. In response to the sensitivity on this issue, we will provide estimates reflecting two alternative approaches. The first approach—supported by some in the above community and preferred by EPA—uses a Value of a Statistical Life (VSL) approach developed for the Clean Air Act section 812 benefit-cost studies. This VSL estimate of $5.9 million (1997$) was derived from a set of 26 studies identified by EPA using criteria established in Viscusi (1992), as those most appropriate for environmental policy analysis applications.

TABLE V.G–1.—HUMAN HEALTH AND WELFARE EFFECTS OF POLLUTANTS AFFECTED BY THE PROPOSED HEAVY-DUTY VEHICLE RULE

Pollutant	Quantified and monetized effects	Alternative quantified and/or monetized effects	Unquantified effects
Ozone Health	Minor restricted activity days/acute respiratory symptoms; Hospital admissions—respiratory and cardio-vascular; Emergency room visits for asthma.		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.
Ozone Welfare	Decreased worker productivity; Decreased yields for commercial crops.		Decreased yields for commercial forests; Decreased yields for fruits and vegetables.
PM Health	Premature mortality; Bronchitis—chronic and acute; Hospital admissions—respiratory and cardio-vascular; Emergency room visits for asthma; Lower and upper respiratory illness; Shortness of breath; Minor restricted activity days/acute respiratory symptoms; Work loss days.		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.

TABLE V.G–1.—HUMAN HEALTH AND WELFARE EFFECTS OF POLLUTANTS AFFECTED BY THE PROPOSED HEAVY-DUTY VEHICLE RULE—Continued

Pollutant	Quantified and monetized effects	Alternative quantified and/or monetized effects	Unquantified effects
PM Welfare	Visibility in California, Southwestern, and Southeastern Class I areas.	Visibility in Northeastern, Northwestern, and Midwestern Class I areas; Household soiling.	
Nitrogen and Sulfate Deposition Welfare.		Costs of nitrogen controls to reduce eutrophication in selected eastern estuaries.	Impacts of acidic sulfate and nitrate deposition on commercial forests; Impacts of acidic deposition to commercial freshwater fishing; Impacts of acidic deposition in terrestrial ecosystems; Impacts of nitrogen deposition on commercial fishing, agriculture, and forests; Impacts of nitrogen deposition on recreation in estuarine ecosystems; Reduced existence values for currently healthy ecosystems.
CO Health			Premature mortality;[a] Behavioral effects; Hospital admissions—respiratory, cardiovascular, and other; Other cardiovascular effects; Developmental effects; Decreased time to onset of angina.
HAPS Health			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).
HAPS Welfare			Direct toxic effects to animals; Bioaccumlation in the food chain.

[a] Premature mortality associated with ozone is not separately included in this analysis. It is assumed that the Pope, et al. C–R function for premature mortality captures both PM mortality benefits and any mortality benefits associated with other air pollutants.

An alternative, age-adjusted approach is preferred by some others in the above community both within and outside the Administration. This approach was also developed for the Section 812 studies and addresses concerns with applying the VSL estimate—reflecting a valuation derived mostly from labor market studies involving healthy working-age manual laborers—to PM-related mortality risks that are primarily associated with older populations and those with impaired health status. This alternative approach leads to an estimate of the value of a statistical life year (VSLY), which is derived directly from the VSL estimate. It differs only in incorporating an explicit assumption about the number of life years saved and an implicit assumption that the valuation of each life year is not affected by age.[146] The mean VSLY is $360,000 (1997$); combining this number with a mean life expectancy of 14 years yields an age-adjusted VSL of $3.6 million (1997$).

Both approaches are imperfect, and raise difficult methodological issues which are discussed in depth in the recently published Section 812 Prospective Study, the draft EPA Economic Guidelines, and the peer-review commentaries prepared in support of each of these documents. For example, both methodologies embed assumptions (explicit or implicit) about which there is little or no definitive scientific guidance. In particular, both methods adopt the assumption that the risk versus dollars trade-offs revealed by available labor market studies are applicable to the risk versus dollar trade-offs in an air pollution context.

EPA currently prefers the VSL approach because, essentially, the method reflects the direct application of what EPA considers to be the most reliable estimates for valuation of premature mortality available in the current economic literature. While there are several differences between the labor market studies EPA uses to derive a VSL estimate and the particulate matter air pollution context addressed here, those differences in the affected populations and the nature of the risks imply both upward and downward adjustments. For example, adjusting for age differences may imply the need to adjust the $5.9 million VSL downward as would adjusting for health differences, but the involuntary nature of air pollution-related risks and the lower level of risk-aversion of the

[146] Specifically, the VSLY estimate is calculated by amortizing the $5.9 million mean VSL estimate over the 35 years of life expectancy asssociated with subjects in the labor market studies. The resulting estimate, using a 5 percent discount rate, is $360,000 per life-year saved in 1997 dollars. This annual average value of a life-year is then multiplied times the number of years of remaining life expectancy for the affected population (in the case of PM-related premature mortality, the average number of $ life-years saved is 14).

manual laborers in the labor market studies may imply the need for upward adjustments. In the absence of a comprehensive and balanced set of adjustment factors, EPA believes it is reasonable to continue to use the $5.9 million value while acknowledging the significant limitations and uncertainties in the available literature. Furthermore, EPA prefers not to draw distinctions in the monetary value assigned to the lives saved even if they differ in age, health status, socioeconomic status, gender or other characteristic of the adult population.

Those who favor the alternative, age-adjusted approach (i.e. the VSLY approach) emphasize that the value of a statistical life is not a single number relevant for all situations. Indeed, the VSL estimate of $5.9 million (1997 dollars) is itself the central tendency of a number of estimates of the VSL for some rather narrowly defined populations. When there are significant differences between the population affected by a particular health risk and the populations used in the labor market studies—as is the case here—they prefer to adjust the VSL estimate to reflect those differences. While acknowledging that the VSLY approach provides an admittedly crude adjustment (for age though not for other possible differences between the populations), they point out that it has the advantage of yielding an estimate that is not presumptively biased. Proponents of adjusting for age differences using the VSLY approach fully concur that enormous uncertainty remains on both sides of this estimate—upwards as well as downwards—and that the populations differ in ways other than age (and therefore life expectancy). But rather than waiting for all relevant questions to be answered, they prefer a process of refining estimates by incorporating new information and evidence as it becomes available.

The presentation of the alternative calculations for certain endpoints will demonstrate how much the overall benefit estimate might vary based on the value EPA gives to a parameter (which has some uncertainty associated with it) underlying the estimates for human health and environmental effect incidence and the economic valuation of those effects. These alternative calculations will represent conditions that are possible to occur, however, EPA has selected the best supported values based on current scientific literature for use in the primary estimate. The alternate calculations will include:

- Presentation of an estimated confidence interval around the Primary estimate of benefits to characterize the standard error in the C–R and valuation studies used in developing benefit estimates for each endpoint;
- Valuing PM-related premature mortality based on a different C–R study;
- Value of avoided premature mortality incidences based on statistical life years;
- Consideration of reversals in chronic bronchitis treated as lowest severity cases;
- Value of visibility changes in all Class I areas;
- Value of visibility changes in Eastern U.S. residential areas;
- Value of visibility changes in Western U.S. residential areas;
- Value of reduced household soiling damage; and
- Avoided costs of reducing nitrogen loadings in east coast estuaries.

For instance, the estimate of the relationship between PM exposure and premature mortality from the study by Dockery, et al. is a plausible alternative to the Pope, et al. study used for the Primary estimate of benefits. The SAB has noted that ‘‘the study had better monitoring with less measurement error than did most other studies’’ (EPA–SAB–COUNCIL–ADV–99–012, 1999). The Dockery study had a more limited geographic scope (and a smaller study population) than the Pope, et al. study and the Pope study appears more likely to mitigate a key source of potential confounding. The Dockery study also covered a broader age category (25 and older compared to 30 and older in the Pope study) and followed the cohort for a longer period (15 years compared to 8 years in the Pope study). For these reasons, the Dockery study is considered to be a plausible alternative estimate of the avoided premature mortality incidences that are expected to be associated with the final heavy-duty rule rule. The alternative estimate for mortality can be substituted for the valuation component in our primary estimate of mortality benefits to observe how the net benefits of the program may be influenced by this assumption. Unfortunately, it is not possible to combine all of the assumptions used in the alternate calculations to arrive at different total benefit estimates because it is highly unlikely that the selected combination of alternative values would all occur simultaneously. Therefore, it will be more appropriate to consider each alternative calculation individually to assess the uncertainty in the estimate.

In addition to the estimate for the primary set of endpoints and alternative calculations of benefits, our RIA for the final rule will also present an appendix with supplemental benefit estimates and sensitivity analyses of other key parameters in the benefit analysis that have greater uncertainty surrounding them due to limitations in the scientific literature. Supplemental estimates will be presented for premature mortality associated with short-term exposures to PM and ozone, asthma attacks, occurrences of moderate or worse asthma symptoms, and the avoided incidences of premature mortality in infants.

Even with our efforts to fully disclose the uncertainty in our estimate, this uncertainty presentation method does not provide a definitive or complete picture of the true range of monetized benefits estimates. This proposed approach, to be implemented in the BCA for the final rule, will not reflect important uncertainties in earlier steps of the analysis, including estimation of compliance technologies and strategies, emissions reductions and costs associated with those technologies and strategies, and air quality and deposition changes achieved by those emissions reductions. Nor does this approach provide a full accounting of all potential benefits associated with the proposed rule for heavy-duty vehicles and diesel fuel, due to data or methodological limitations. Therefore, the uncertainty range will only be representative of those benefits that we will be able to quantify and monetize.

6. What Types of Results Will Be Presented in the Benefit-Cost Analysis?

The BCA for the final rule for heavy-duty vehicles and diesel fuel will reflect a single year ‘‘snapshot’’ of the yearly benefits and costs expected to be realized once the standards have been fully implemented and non-compliant vehicles have all been retired. Near-term costs will be higher than long-run costs as vehicle manufacturers and oil companies invest in new capital equipment and develop and implement new technologies. In addition, near-term benefits will be lower than long-run benefits because it will take a number of years for compliant heavy-duty vehicles to fully displace older, more polluting vehicles. However, we will adjust the cost estimates upward to compensate for some of this discrepancy in the timing of benefits and costs and to ensure that the long-term benefits and costs are calculated on a consistent basis. Because of the adjustment process, the cost estimates should not be interpreted as reflecting the actual costs expected to be incurred in the year 2030. Actual program costs can be found earlier in this preamble.

With respect to the benefits, the BCA for the final rule for heavy-duty vehicles and diesel fuel will follow the presentation format used in the Tier 2 BCA, presenting several different measures of benefits which will be useful to compare and contrast to the estimated compliance costs. These benefit measures include (a) the tons of emissions reductions achieved, (b) the reductions in incidences of adverse health and environmental effects, and (c) the estimated economic value of those reduced adverse effects. Calculating the cost per ton of pollutant reduced is particularly useful for comparing the cost-effectiveness of the new standards or programs against existing programs or alternative new programs achieving reductions in the same pollutant or combination of pollutants. Considering the absolute numbers of avoided adverse health and environmental effects can also provide valuable insights into the nature of the health and environmental problem being addressed by the proposed rule as well as the magnitude of the total public health and environmental gains potentially achieved. Finally, when considered along with other important economic dimensions—including environmental justice, small business financial effects, and other outcomes related to the distribution of benefits and costs among particular groups—the direct comparison of quantified economic benefits and economic costs can provide useful insights into the potential magnitude of the estimated net economic effect of the rule, keeping in mind the limited set of effects we expect to be able to monetize.

VI. Alternative Program Options

In the course of developing the proposal, we considered a broad range of options, many of which were raised by commenters on the ANPRM. Various options were considered for the best manner to implement a change to diesel fuel, on how to structure a sulfur standard, on fuel changes other than sulfur, and on the geographic scope of the program. This section helps to explain many alternative program options that we considered in designing today's proposal. In this section, we also are seeking comment on voluntary phase-in options for implementing the fuel program (see section VI.A.2), and on issues connected with the use of JP–8 fuel in highway-going military vehicles (see section VI.D).

A. What Other Fuel Implementation Options Have We Considered?

A broad spectrum of approaches for implementing the fuel program were either raised by the Agency in the ANPRM, received as public comments on the ANPRM, or raised by various parties during the development of this proposal. Below, we discuss some of the options we have considered, including alternatives on which we are seeking comment.

1. What Are the Advantages and Disadvantages of a Phase-in Approach to Implementing the Low Sulfur Fuel Program?

EPA is proposing, as discussed in section IV.C., that the entire pool of highway diesel fuel be converted to low sulfur diesel fuel all at once in 2006. In the early years of the program, the use of low sulfur diesel fuel will result in reductions in the amount of direct and secondary particulate matter from the existing fleet of heavy-duty vehicles. Nevertheless, the primary benefit of the fuel change is the emission reductions that would occur over time from the new vehicle fleet as a result of the enablement of advanced aftertreatment exhaust emission control technologies. Consequently, we believe there may be some advantages, particularly in the early years, to allowing some flexibility in the program so that not all of the highway diesel fuel pool must be converted to low sulfur all at once. First, owners of old vehicles could continue to refuel on higher-sulfur (500 ppm) diesel fuel, potentially saving money for consumers. Second, we believe a phase-in approach, if designed properly, has the potential to be beneficial for refiners, by reducing the fuel production costs in the early years of the program. This flexibility could reduce operating costs, if the entire volume of highway fuel does not have to meet the low sulfur standard. If coupled with averaging, banking and trading provisions, some refineries may be able to delay desulfurization investments for several years. Even for refiners planning to desulfurize their entire highway fuel pool to low sulfur levels at the beginning of the program, there may be circumstances where the actual fuel produced is slightly off-spec (i.e., above the low sulfur standard). A phase-in approach could allow refiners to continue selling that fuel to the highway market (as 500 ppm fuel), rather than to other distillate markets. Refiners could also have more flexibility to continue producing highway diesel (as 500 ppm fuel) during unit downtime (e.g., turnarounds and upsets).

While a phase-in approach could provide flexibility for refiners and potentially lower costs for consumers, a number of concerns would need to be addressed before such an approach could be implemented. These include: ensuring sufficient availability of the low sulfur fuel when and where it is needed, minimizing the potential for misfueling, minimizing the risk of spot outages, and minimizing impacts on the fuel distribution and retail industries. These issues are discussed further below. It is not obvious at what level the fuel production and distribution systems can provide two grades of highway diesel fuel while minimizing the potential for localized supply shortages and price spikes, and misfueling problems. For example, we expect that in the first year of the program only about 10 percent of highway diesel fuel would be consumed by 2007 model year vehicles requiring the use of low sulfur fuel. In a perfect world where the distribution system could, without additional cost, make low sulfur diesel fuel widely available (in addition to the current 500 ppm fuel), only about 10 percent of the highway diesel fuel produced by refiners in the first year would then have to be low sulfur. Unfortunately, since this perfect world does not exist, the question remains whether, and to what extent, the system can distribute two grades of highway diesel fuel in a way that takes advantage of any flexibilities offered, and ensures sufficient supply of fuel for the new vehicles that need it.

During the process of developing this proposal (including comments received on the ANPRM), many industry stakeholders (many diesel distributors, marketers, larger refiners, and end-users such as truckers and centrally-fueled fleets) have commented on ways to implement the fuel program. While each stakeholder may have had different assumptions behind their position (including assumptions about the structure of a phase-in, and expectations about the resulting costs and fuel prices), many stakeholders have encouraged EPA to implement any fuel change all at once, rather than incur the added distribution costs and marketplace complication of phasing in a new grade of highway diesel fuel. The following sections discuss some of the challenges in implementing a phase-in approach.

a. Availability of Low Sulfur Diesel Fuel

Because new vehicles would need to be fueled exclusively with low sulfur diesel, for a phase-in approach to be workable, low sulfur diesel fuel would have to be available in all parts of the country. It is not clear what minimum level of availability would be necessary to meet the needs of diesel vehicles. The trucking industry has indicated that a limited number of phased-in fueling locations would not meet the needs of the trucking industry.

We seek comment on what level of availability would be appropriate under a phase-in approach, to ensure that the low sulfur diesel fuel is available, within a reasonable distance, to all consumers in all parts of the country. For example, would sufficient availability be achieved if all major truck stops across the country offered low sulfur fuel, or if some minimum percentage of diesel retailers in different geographic areas offered low sulfur fuel? Are there studies on fuel availability that would serve to inform efforts to assure adequate availability? We request that commenters consider what fraction of truck stops and other retail outlets would need to make low sulfur fuel available within any given area in order to ensure reasonable availability from the public's perspective.

b. Misfueling

Any phase-in approach would introduce an additional grade of highway diesel fuel into the market, by allowing both high and low-sulfur grades to coexist, with a potential for a price differential between the grades. Many industry stakeholders, including diesel marketers, truck stop operators, and engine manufacturers, have commented that misfueling would be significant under a phase-in approach.[147] That is, customers with new vehicles that need low-sulfur fuel might use the higher-sulfur fuel, mistakenly or deliberately, which could increase emissions and damage the emissions control technology on the vehicle. Diesel marketers have also raised the issue that a phase-in system could create incentives for consumers to tamper with the emission control equipment of new vehicles, if they believe that will enable them to use a lower priced fuel. Therefore, we are concerned about the potential for misfueling, as it could reduce the emission benefits of the program. However, if a phase-in approach were to work well and misfueling were not an issue, we would expect to achieve the same environmental benefits as the proposed single fuel approach.

Some degree of misfueling occurs even today with a single grade of highway diesel fuel, due to the availability of tax exempt off-highway diesel fuel. The opportunity for misfueling with off-highway diesel fuel, however, is somewhat limited by the limited number of highway diesel refueling locations that market both grades of diesel fuel. Nevertheless, since off-highway diesel fuel will still be available even under a complete switch of highway diesel fuel to low sulfur, the problem of misfueling is not entirely unique to the phase-in approach. It is, however, true that the greater availability of 500 ppm diesel fuel alongside the low sulfur fuel will make misfueling easier. Thus, the appropriate question to ask when considering a phase-in approach is not ''will people misfuel?'' but ''to what extent?'' and ''how can the design of the program minimize the potential for misfueling?''

One factor that might encourage misfueling would be the existence of a price differential between low sulfur diesel fuel and 500 ppm fuel. For many diesel vehicles, particularly line-haul tractor trailers, the fuel cost can be as much as 20 percent of annual operating costs, so drivers have a strong incentive to save on fuel costs. On the other hand, there are also several factors that might serve as a deterrent to misfueling. First, the potential risk associated with voiding a manufacturer emission warranty or damaging the engine and exhaust system on an expensive vehicle might cause owners and operators of heavy-duty trucks to be more circumspect in ensuring that their vehicles are fueled properly. Second, misfueled vehicles could experience a loss in performance, such as poor acceleration or even engine stalling (as discussed in section III.F.1.a). Third, under the proposed regulations it would be unlawful for any person to misfuel.

Depending on the potential for misfueling, EPA may need to require that new vehicles be fitted with a unique nozzle interface, with a corresponding size nozzle for the low-sulfur diesel. This would be analogous to the nozzle interface approach used to discourage misfueling in the unleaded gasoline program. However, diesel marketers have indicated that they do not support the use of unique nozzle interfaces for the low sulfur fuel, particularly if it would affect volume delivery. They have expressed the concern that a smaller nozzle size would reduce the volume of fuel delivered, result in slower refuelings, and increase wait times at retail stations. Further, based on our experience with unleaded gasoline,[148] it is likely that people intent on misfueling would quickly find ways around a unique nozzle/nozzle interface. We request comment on ways to structure a unique nozzle/nozzle interface approach that would discourage misfueling while avoiding these problems. We also request comment on any alternative methods that could be used to discourage misfueling.

We invite comment on the potential for misfueling under phase-in approaches, what factors would influence misfueling, and how the potential for misfueling might vary under the different phase-in approaches described in subsection 2 below. We further seek comment on how these phase-in approaches could be designed to minimize the potential for misfueling.

c. Distribution System Impacts

While providing flexibility for refiners and potentially lower costs to consumers, a phase-in approach would rely on the fuel distribution infrastructure being able to accommodate the second grade of highway diesel fuel. The economics of modifying the distribution infrastructure to handle two grades of highway diesel fuel would affect the extent to which refiners can take advantage of the flexibility, and consumers enjoy the cost-savings, of a phase-in. There are a vast array of businesses in the diesel fuel distribution system, encompassing thousands of companies, including pipelines, bulk terminals, bulk plants, petroleum marketers (who carry the fuel from bulk terminals and bulk plants via transport trucks and fuel tank wagons to retail outlets and fleet customers), fuel oil dealers, service stations, truck stops, and centrally-fueled fleets (commercial fleets, federal/state/local government fleets, and farms). Based on available data, the vast majority of these are small businesses according to the Small Business Administration's definitions.[149] These businesses may make investments and change their practices to accommodate two grades of highway diesel fuel. The economics of a phase-in could be viewed as follows: Through intermediate price mark-ups on the product, the system would distribute some of the cost savings experienced by the refiners and consumers to those making capital investments. If the potential cost savings

[147] Comment letters from the Engine Manufacturers Association (Item II–D–35), National Association of Truck Stop Operators (Included in Report of the Small Business Advocacy Review (SBAR) Panel, Appendix B, Page 30), and Petroleum Marketers Association of America (Included in SBAR Panel Report, Appendix B, Page 38).

[148] ''An Analysis of the Factors Leading to the Use of Leading to the Use of Leaded Gasoline in Automobiles Requiring Unleaded Gasoline,'' September 29, 1978, Sobotka & Company, Inc. See also ''Motor Vehicle Tampering Survey—1983,'' July 1984, U.S. EPA, Office of Air and Radiation, Docket A–99–06. See also ''Anti-Tampering and Anti-Misfueling Programs to Reduce In-Use Emissions From Motor Vehicles,'' May 25, 1983 (EPA/AA/83–3). Contained in Docket A–99–06.

[149] For more information, see the Report of the Small Business Advocacy Review Panel, contained in the docket.

were not sufficient to justify such investments, then those investments would not occur and the entire system would convert to low sulfur diesel. We seek comment on how the economics of a phase-in would actually play out.

If the cost savings of a phase-in are substantial, many bulk terminals and bulk plants may find it economical to add new tank capacity to accommodate a second grade of highway diesel fuel. However, if the cost savings of a phase-in are modest, fewer terminal operators would profit from such investments, since some have commented on the costs, space constraints, and permitting difficulties associated with new tankage.[150] The magnitude of the cost savings also affects the role of diesel marketers in this market. Some marketers have commented that if some terminals offer two grades while others offer only one grade, the costs of transporting fuel would increase since some trucks would have to travel greater distances to alternate terminals or bulk plants.[151] The share of the cost savings that marketers could enjoy from the mark-up on diesel products would have to at least equal the higher transport costs for them to offer to handle two grades of fuel.

Similarly, many service stations, truck stops, and centrally-fueled fleets would be faced with a decision of whether to add additional underground storage tanks to carry the extra grade of diesel fuel. Retailers with more than one diesel tank, such as many truck stops and some fleets, could choose to demanifold existing tanks (involving breaking concrete) in order to dedicate one or more tanks to the new fuel. Those that find it economical to do so will undertake the investment and offer two grades, while those that would not find the investment profitable would forego this option.

Generally we would expect that where businesses could profit from managing two grades they would do so and provide some 500 ppm diesel to the market. Thus, the impact to the distribution system of a phase-in would include costs from new investments, but these could be compensated by higher profits. Where the costs of handling two fuels in the distribution system are larger than the cost savings enjoyed by refineries (and passed down to consumers in lower fuel prices), then only low sulfur diesel would be offered. Some refiners and distributors have expressed the concern, however, that these additional investments would be ''stranded'' after the phase-in period ends. A key question will be whether each party in the refining/distribution system can accurately anticipate what the others will do, so as to avoid unnecessary investments (e.g., if the system should switch over the low sulfur more quickly than expected). Since the diesel fleet transitions over relatively quickly (greater than 50 percent of VMT is typically driven by new diesel vehicles after just 5 years), there may be limited time to recoup any investment made to handle an additional grade of highway diesel fuel. We request comment overall on the economics of a phase-in approach.

In addition to overall impacts on the distribution system, an additional grade of highway diesel fuel could reduce the flexibility of the distribution system to carry all grades of fuels that it does today. This may particularly be a concern with specialty fuels or segregated shipments of fuel through pipelines that require separate tankage such as those utilized by the Department of Defense (DOD). DOD stated that since its specialty fuels (F–76, JP–5, and JP–8) are not fungible fuels, if today's rule places additional stress on an already capacity-strained pipeline system, it may limit DOD's ability to transport adequate volumes of their specialty fuels to meet operational readiness requirements. Consequently we request comment on this particular impact on the distribution system in regard to accommodating a second grade of highway diesel fuel.

d. Uncertainty in the Transition to Low Sulfur

We believe the proposed single fuel approach provides more certainty to the market for making the large investments needed to introduce low-sulfur fuel. Yet even under a single fuel approach, refiners have indicated that there is uncertainty in refiner decisions to invest or not (or to underinvest) in desulfurization, which could lead to a risk of supply shortfalls and high prices. Refiners may make this choice to exit the highway diesel market, or to reduce production volume of highway diesel fuel, especially if faced with uncertainty about the ability to recover their investments (see further discussion in section V.D.1). A phase-in approach could minimize any potential for such a shortfall in the overall highway diesel fuel supply. Under a phase-in, the level of uncertainty is different, however, in that since the highway diesel pool would be split into two grades, refiners would need to predict in advance the relative demand for each grade.

Under the phase-in flexibility approaches (described in the following section), the presumption is that the fuel production and distribution system will react to both the market demand and the incentive of the various programs to produce and distribute the low sulfur fuel at reasonable prices to all parts of the country. Turning any of these approaches into a reality requires embracing the possibility that the market reacts differently than anticipated. For example, diesel retailers have indicated that it would be extremely difficult to predict how retailers would respond to making low sulfur fuel available, given the many factors that influence retail decisions. Consequently, refiners might have little certainty about continued markets for 500 ppm fuel when making their investment decisions and all of them might choose to convert to low sulfur. Given the lead time needed for additional desulfurization capacity at refineries to come on line, it is important for a smooth transition to low sulfur diesel fuel that predictions of demand be similar to the actual demand. Each of the phase-in approaches described in the following section is intended to be designed to allow the market the flexibility to find a lower cost option than full initial conversion to low sulfur fuel if such a solution exists, and to default to a full low sulfur program if such a solution does not exist. Each approach is, however, subject to different sources of uncertainty. We request comment on the ability of refiners to accurately predict demand for desulfurization capacity under a phase-in approach. Commenters should discuss this issue in the context of the phase-in approaches described below and in the context of the proposed single fuel approach.

e. Cost Considerations Under a Phase-in Approach

Because it avoids the need to produce all of the fuel to the low sulfur standard in the first year, a phase-in approach could provide an opportunity for cost savings to refiners and could significantly lower overall diesel fuel production costs. Consumers of pre-2007 diesel vehicles could also realize a savings if the current 500 ppm fuel were still available and priced lower than the new low sulfur fuel. In a perfect world with a distribution system capable of distributing a second grade of highway diesel fuel at no cost, if low sulfur production could be matched with the demand from new vehicles, the fraction of highway diesel fuel that would have to be low sulfur would increase from approximately 9% in

[150] Letter from Independent Terminal Operators Association, July 13, 1999 (Item # II–D–80).

[151] Letter from Petroleum Marketers Association of America, November 8, 1999, Docket A–99–06.

2007 to approximately 60% in 2012 based on typical fleet turnover rates. Thus, the amount of low sulfur fuel refiners would have to produce in the early years of the program could be reduced significantly, with a corresponding reduction in production costs theoretically as high as $4 billion, using our estimated per gallon fuel costs discussed in section IV. This theoretical distribution system does not exist and there would be a number of important and potentially significant costs incurred in the distribution system that could impact these savings. As discussed above, a wide array of entities in the distribution system, including refiners, bulk terminals, pipelines, bulk plants, petroleum marketers, fuel oil dealers service stations, truck stops, and centrally fuelled fleets would have to make investment decisions in order to distribute a second grade of highway diesel fuel. We seek comment on the potential cost savings associated with a phase-in approach, including the potential costs of managing two grades of highway diesel fuel in the distribution system, how these costs would vary depending on the relative volumes of the two grades of highway diesel fuel, the necessary margin for businesses in the distribution system to find it economic to manage two grades of highway fuel, and how these cost savings and margins could vary depending on the range of ways the distribution system might respond.

2. What Phase-in Options Is EPA Seeking Comment on in Today's Proposal?

In this section, we are requesting comment on three different phase-in approaches for implementing a program for low sulfur highway diesel fuel.

a. Refiner Compliance Flexibility

Despite the concerns described above with a phase-in approach for implementing the diesel fuel sulfur control program, EPA nevertheless believes that a program, if voluntary, can be devised which can address these concerns and take advantage of at least some of the benefits a phase-in approach has to offer. Consequently, as part of our proposed program for implementing low sulfur highway diesel, as described in section IV.C, we also are seeking comment on a voluntary option that would provide compliance flexibilities for refiners, while still achieving the environmental benefits of the program. In this section, we describe this refiner compliance flexibility concept and seek comment on all aspects of its design. We also discuss how this compliance flexibility relates to the options for small refiner flexibility (which we're seeking comment on in section VIII.E).

i. Overview of Compliance Flexibility

We are seeking comment on a voluntary compliance flexibility that would allow refiners to continue producing fuel at the 500 ppm level for a fraction of their total highway diesel fuel volume in the first few years of the program. The fraction of 500 ppm fuel allowed to be produced by refiners would phase-down over a period of several years. Specifically, we request comment on the appropriate fraction of highway diesel fuel allowed to be produced as 500 ppm fuel beginning in 2006. Three possible scenarios are shown in Table VI.A–1 below. The level at which this flexibility begins would significantly affect its design. We are seeking comment on a range of production percentages for the 500 ppm fuel. We are particularly interested in the degree to which percentages of 500 ppm at the higher end of this range could pose challenges for ensuring sufficient availability of the low sulfur fuel and minimizing the potential for misfueling. In addition, we request comment on the extent to which different proportions of 500 ppm fuel will pose different challenges for the distribution system. Several issues and implications of setting the 500 ppm production limits at higher or lower levels are discussed below. We seek comment on our assumptions and the implications of these issues for the design of such a compliance flexibility program. Further, we request comment on the number of years this flexibility should be provided.

TABLE VI.A–1.—TWO POSSIBLE SCENARIOS FOR IMPLEMENTING THE COMPLIANCE FLEXIBILITY

	Percent of highway diesel fuel permitted to be 500 ppm						
	2006	2007	2008	2009	2010	2011	2012
Scenario A	20	20	10	10	0	0	0
Scenario B	50	50	30	15	0	0	0
Scenario C	75	75	60	45	30	15	0

We believe this compliance flexibility would be potentially beneficial for refiners. This flexibility could reduce operating costs, by not requiring the entire volume of highway fuel to meet the low sulfur standard. With averaging, banking and trading provisions as a component of this compliance flexibility (as discussed below), some refineries may be able to delay desulfurization investments for several years. Even for refiners planning to desulfurize their entire highway fuel pool to low sulfur levels at the beginning of the program, there may be circumstances where the actual fuel produced is slightly off-spec (i.e., above the low sulfur standard). This flexibility would allow refiners to continue selling that fuel to the highway market (as 500 ppm fuel), rather than to other distillate markets. Refiners would also have more flexibility to continue producing highway diesel (as 500 ppm fuel) during unit downtime (e.g., turnarounds and upsets).

This approach would need appropriate safeguards to minimize contamination of the low sulfur fuel and misfueling. Thus, low sulfur highway diesel would have to remain a segregated product throughout its distribution (see further discussion of segregation requirements in section VI.A.2.a.v). Further, any retail pumps carrying 500 ppm fuel would have to be prominently labeled to prevent misfueling of 2007 and later model year vehicles. We seek comment on whether other measures to discourage misfueling might also be necessary. For example, the use of a unique refueling nozzle/vehicle nozzle interface could further discourage misfueling, although we question the need to pursue this approach if the 500 ppm fuel were in the market in relatively low volumes and only during the initial years when new vehicles still comprise a relatively small percent of the fleet. Other issues regarding the potential for misfueling are discussed in subsection 1 above.

We also propose an averaging, banking and trading (ABT) program as part of this compliance flexibility. Refiners owning more than one refinery would be allowed to average their production volumes across refineries in determining compliance. This could provide flexibility for some refining companies to delay making desulfurization investments at some smaller refineries for several years. Refiners also could generate credits based on the volume of low sulfur fuel produced above the required percentage. For example, if a refinery were required to produce a minimum of 80 percent of its highway diesel pool as low sulfur in the first year, and that refinery actually produced 100 percent of its highway diesel as low sulfur that year, it could generate credits based on the volume of the ''extra'' 20 percent of low sulfur fuel it produced. Those credits could be sold or traded with another refinery, which could in turn use the credits to produce a greater percentage of 500 ppm sulfur highway diesel fuel. More details on how these ABT provisions could be structured are discussed in section VI.A.2.a.iv below.

We believe a credit trading program may be particularly beneficial for refiners whose volumes of highway diesel are relatively small. It is possible that the credits generated by a refiner producing a large volume of low sulfur diesel could potentially be sufficient to offset a smaller refiner's entire highway diesel production, thereby enabling a smaller refiner to comply solely by the use of credits—and avoid desulfurization investments—for several years.

While we believe that a credit trading program could add meaningful flexibility under this approach, we are concerned about the potential for shortfalls in supply of low sulfur highway diesel in those areas supplied exclusively or primarily by refiners complying by the use of credits (i.e., producing only 500 ppm fuel). This situation could potentially occur, for example, in the Rocky Mountain area, or other areas served primarily by smaller refineries, or areas with relatively isolated fuel distribution systems. This concern becomes more salient as the percentage of 500 ppm fuel allowed to be produced increases. If the flexibility were to begin with 20 percent (of 500 ppm fuel) in the first year, the likelihood of a supply shortfall would be less likely than if the program begins with 50 percent (of 500 ppm fuel). Therefore, we seek comment on the extent to which this situation could occur and ways to structure the credit trading system to prevent low sulfur fuel supply shortfalls in any area, perhaps through regional restrictions in credit trading, or providing incentives for refiners to supply sufficient volumes of low sulfur fuel. We have been, and will continue, working with the Western states (for example, through the Western Governors Association) to discuss the best ways of implementing the program in that area.

Alternatively, we request comment on a regional approach to designing a compliance flexibility (for example, different refiner production levels and/or availability provisions for different areas of the country). We seek comment on whether and how this compliance flexibility could be enhanced by such a regional approach, including information and data that would help us to better understand regional differences in highway diesel fuel supply, demand and distribution.

Refiners have expressed concern that under some phase-in approaches it might be difficult for them to recover their capital investments. We request comment this issue, including how the potential for cost recovery under a phase-in approach compares with that under the single-fuel approach, and what the implications are for the optimal production level of low sulfur diesel under the compliance flexibility approach.

We also invite comment on an alternative in which we simply establish a minimum production percentage for low sulfur fuel in the beginning of the program, and allow the market to take over in determining the appropriate supply and distribution from that point on. One concern with this approach is that it would perpetuate the potential for misfueling for as long as two grades of highway fuel remained in the market. We request comment on how long two grades of highway diesel would likely coexist in the market under this approach. Further, the level of this minimum low sulfur production percentage would have to be carefully designed to assure sufficient availability throughout the country. If you believe this or other alternative approaches would make the program more useful, please share your specific suggestions with us.

ii. What Are the Key Considerations in Designing the Compliance Flexibility?

A key consideration in designing this compliance flexibility is whether or not it should be accompanied by a retailer availability requirement. Under an availability requirement, diesel retailers would have to offer low sulfur fuel, but would have the flexibility to offer the 500 ppm fuel as well. We believe the need for an availability requirement is linked to the refiners' 500 ppm fuel production limits. At a 500 ppm fuel production limit beginning at 20 percent, our concerns for lack of availability and misfueling would likely be low enough not to warrant a retailer availability requirement or additional misfueling controls such as special nozzles. Our presumption is that if at least 80 percent of the highway fuel volume is low sulfur (i.e., a maximum 20 percent is 500 ppm), the low sulfur fuel should be sufficiently available across the country. Alternatively, if refiners were allowed to produce some greater proportion of their highway diesel fuel as 500 ppm fuel in the first few years, there would be a greater likelihood of low sulfur fuel supply shortfalls, lack of availability, and misfueling , and there would be a more compelling need to ensure that some minimum fraction of diesel retailers offered the low sulfur fuel. We request comment on the level of the 500 ppm fuel production limit at which concerns about low sulfur shortfalls, lack of availability, and misfueling would be great enough to warrant imposing a retailer availability requirement. We ask that commenters also consider whether they would prefer a ''blended'' program (i.e., a program with both a production limit on 500 ppm fuel and some form of a retailer availability requirement) to a program that permits a slightly lower level of 500 ppm fuel, but with no availability requirement.

In considering this issue, note that the percentage of low sulfur diesel fuel produced would not necessarily match the availability level. For example, if 80 percent of the highway fuel pool were low sulfur, this would not necessarily translate into the low sulfur fuel being available at 80 percent of retail stations currently selling diesel fuel. Since large retail stations (e.g., large truck stops) and centrally-fueled fleets represent a disproportionate share of the diesel sales volume, it is possible that the percentage of retail stations offering low sulfur fuel could be much lower than 80 percent of the diesel retail stations. If this were the case, would there still be concerns with lack of availability of the low sulfur fuel (e.g., even with 20 percent of highway fuel as low sulfur)?

We believe there are merits to designing this compliance flexibility in a way that avoids the need for a retailer availability requirement. With no availability requirement, retailers would be free to choose to sell 500 ppm fuel only, low sulfur fuel only, or both. We have heard from refiners and diesel marketers that they believe that retailers, if faced with an availability requirement, would likely decide not to carry both grades of fuel but, rather, would switch over to the low sulfur fuel to avoid the expense of installing new tanks and pumps. If this were true, an availability requirement could have the effect of significantly limiting a refiner's markets for its 500 ppm fuel, thus, limiting the benefits of the compliance flexibility approach. Nevertheless, we seek comment on whether an availability requirement for low sulfur diesel fuel should be a condition for retailers marketing 500 ppm fuel.

We seek comment on whether a retailer availability requirement would diminish the utility of the compliance flexibility approach, and at what point in designing this option (e.g., at what 500 ppm fuel production limit) a retailer availability requirement would become necessary to encourage sufficient availability of low sulfur fuel.

Since this compliance flexibility is voluntary, we anticipate that refiners would only produce and market 500 ppm fuel under the allowed percentages to the extent that the costs of distributing it are offset by savings elsewhere. The distribution system has only a limited ability to accommodate a second grade of highway diesel without incurring significant costs (e.g., installing new tankage). Therefore, while refiners may be able to reduce the costs of diesel fuel production if higher percentages of high sulfur diesel fuel are permitted, they may find it difficult to market 500 ppm fuel in volumes much above even the 20 percent level, due to distribution system costs. We request comment on the degree to which the distribution and retail costs associated with accommodating two grades of highway diesel fuel depend on the relative volumes of those fuels. For example, how would the costs incurred in the distribution system vary as the amount of 500 ppm fuel produced by refiners increases from zero to 50 percent, or even beyond?

iii. How Does This Compliance Flexibility Relate to the Options for Small Refiner Flexibility?

In section VIII.E., we seek comment on three approaches for small refiner flexibility. One of these approaches would allow small refiners to continue selling 500 ppm fuel for an unspecified period of time (although we seek comment on an appropriate duration for this flexibility). If the compliance flexibility approach described here were implemented for the refining industry as a whole, we seek comment on the best ways to meld this flexibility with approaches for minimizing the burden on small refiners. For example, we seek comment on whether it would be appropriate to either relax or remove any 500 ppm production limits for small refiners. In other words, we may consider allowing small refiners to continue selling their full production volume of highway diesel as 500 ppm fuel for some period of time (likely at least as long as the compliance flexibility provided to the refining industry as a whole, if not for some or an unlimited number of years beyond that). We request comment on the appropriate duration of this flexibility for small refiners. Further, we seek comment on whether small refiners should be allowed to generate and sell credits under the compliance flexibility's ABT program, even if small refiners are not required to produce any portion of their highway fuel as low sulfur diesel. The ABT approach could minimize the burden on small refiners by allowing them to make some additional profit to offset their desulfurization investments, thus giving them an incentive to produce low sulfur highway diesel fuel earlier than they otherwise would. We seek comment on other ways this compliance flexibility could be crafted to minimize burden on small refiners and to better meld with the approaches for small refiner flexibility described in section VIII.E.

It should be noted that our approach to allow small refiners to continue selling 500 ppm highway diesel (on which we're seeking public comment in section VIII.E.1.) does not include a retailer availability requirement. During the SBREFA process, small refiners expressed concern that an availability requirement would significantly limit their potential markets for 500 ppm fuel, since they believe that few retail outlets would be willing to offer both grades of highway diesel due to the significant costs of installing new tanks and pumps. Therefore, if this option for small refiner flexibility is promulgated in the final rule, we would reconsider its design in light of any decisions made for compliance flexibilities for the whole refining industry (e.g., the issue of whether an availability requirement would be necessary).

iv. How Would the Averaging, Banking and Trading Program Work?

This section discusses in more detail how we envision an averaging, banking and trading (ABT) program working in conjunction with the compliance flexibility approach. The goal of the ABT provisions is to maximize the flexibility provided by the program without diminishing its environmental benefits. We envision that this ABT program could apply to the program regardless of the actual level of the minimum refiner production requirement for low sulfur highway diesel. We request comment on all aspects of these ABT provisions. If you have ideas on how these provisions could be structured differently to enhance the program, please share your specific suggestions with us.

Averaging

Refiners and importers could be allowed to meet the required minimum percentage of low sulfur fuel production averaged over their entire corporate highway diesel pool. The minimum required percentage of low sulfur fuel production under the compliance flexibility would be determined on an annual average basis, across all refineries owned by that refiner (or all highway diesel fuel imported by the importer in the calendar year). Thus, within a given refining company, the volume of low sulfur fuel produced at one refinery could be below the minimum required percentage, so long as the volume produced at another refinery exceeded the minimum percentage by a sufficient amount such that the minimum required percent of low sulfur volume was met at the corporate level.

Generating Credits

Beginning in 2006, refineries and importers could generate credits based on the volume of low sulfur fuel produced above the required percentage. For example, a refinery produced 10 million gallons of highway diesel fuel in 2006 and was required to produce a minimum of 80 percent of its highway diesel volume (8 million gallons) as low sulfur that year. That refinery actually produced 100 percent of its highway diesel as low sulfur that year. Thus, it could generate credits based on the volume of the ''extra'' 20 percent of low sulfur fuel it produced above the required minimal percentage '' that is, 2 million gallons of credits. Under this program, we do not envision a need to establish a baseline volume of diesel fuel, since credits would be generated based on the volume of low sulfur diesel fuel actually produced above the required percentage.

Credits could be generated in each year that the compliance flexibility provisions are in place. In other words, if the duration of the compliance flexibility were for four years (i.e., refiners were allowed to continue producing some specified percentage of 500 ppm fuel for four years after the start of the low sulfur program), from 2006 through 2009, credits could be generated in each of those years.

We seek comment on whether there could be circumstances where the use of low sulfur highway diesel could be shown to demonstrate environmental benefits significant enough to warrant the generation of early credits. To the extent there may be circumstances that warrant early credit generation, we seek comment on whether there should be an appropriate discount factor applied to such credits, to ensure they would be comparable with the environmental benefits achieved by the use of low sulfur fuel in vehicles meeting today's proposed standards. See section IV.F.

As an additional aspect to implementing the compliance flexibility program, we seek comment on whether it would be advantageous for EPA to offer to sell additional ABT credits to refineries at a predetermined price. This would provide more certainty about the cost of supplying low sulfur diesel fuel by establishing a ceiling price on the ABT credits. We request comment on (1) what should be the appropriate predetermined price for these ABT credits; (2) whether there should be a cap on the total number of credits available from EPA to assure availability of low sulfur diesel; and (3) if there is a cap, whether credits should be sold on a first-come, first-serve basis.

Using Credits

Refiners and importers would be able to use credits to demonstrate compliance with the minimum required percentage of low sulfur highway diesel fuel, if they are unable to meet this requirement with actual highway diesel fuel production. Although credits would not officially exist until the end of the calendar year (based on the generating refinery's actual low sulfur fuel production) there is nothing to prevent companies from contracting with each other for credit sales prior to the end of the year, based on anticipated production. The actual credit transfer would not take place until the end of the year. All credit transfer transactions would have to be concluded by the last day of February after the close of the annual compliance period (e.g., February 28, 2007 for the 2006 compliance period).

For example, refiners who wish to purchase credits to comply with the 2006 required percentage of low sulfur fuel could do so based on the generating refinery's projections of low sulfur fuel production. By the end of February the following year, both the purchaser and the seller would need to reconcile the validity of the credits, as well as their compliance with the required percentages of low sulfur fuel produced.

We seek comment on allowing an individual refinery that does not meet the required percentage of low sulfur fuel production in a given year to carry forward a credit deficit for one year. Under this provision, the refinery would have to make up the credit deficit and come into compliance with the required low sulfur production percentage in the next calendar year, or face penalties. This provision would give some relief to refiners faced with an unexpected shutdown or that otherwise were unable to obtain sufficient credits to meet the required percentage of low sulfur fuel production.

We recognize that there is potential for credits to be generated by one party and subsequently purchased and used in good faith by another party, yet later found to have been calculated or created improperly, or otherwise determined to be invalid. Our preference would be to hold the credit seller, as opposed to the credit purchaser, liable for the violation. Generally, we would anticipate enforcing a compliance shortfall (caused by the good faith purchase of invalid credits) against a good faith purchaser only in cases where the seller is unable to recover valid credits to cover the compliance shortfall. Moreover, in settlement of such cases, we would strongly encourage the seller to purchase credits to cover the good faith purchaser's credit shortfall.

We believe that any person could act as a broker in facilitating credit transactions, whether or not such person is a refiner or importer, so long as the title to the credits are transferred directly from the generator to the purchaser. Whether credits are transferred directly from the generator to the purchaser, or through a broker, the purchaser needs to have sufficient information to fully assess the likelihood that credits would be valid. Any party that can generate and hold credits could also resell them, but the credits should not be resold more than twice. Repeated sales of credits could significantly reduce the ability to verify the validity of those credits.

How Long Would Credits Last?

The goal of these ABT provisions is to provide refiners additional flexibility in the early years of the low sulfur fuel program. After the first few years of the program, there would be a significantly greater proportion of aftertreatment-equipped vehicles in the fleet. It would be important to ensure a full transition to the new low sulfur fuel to prevent misfueling of those vehicles and preserve the environmental benefits of the program. Therefore, we do not currently envision allowing credits to be used more than a few years beyond the compliance flexibility period. We seek comment on whether credit lifetime should be limited, and if so on the appropriate length of time credits should be allowed to be used (in other words, the ''lifetime'' of credits).

v. Compliance, Recordkeeping, and Reporting Requirements

This section describes the types of provisions we believe the regulations would need to include if a compliance flexibility approach were adopted, to ensure that diesel fuel subject to the 500 ppm sulfur standard would not be introduced into model year 2007 and later diesel vehicles.

Refiners and importers of 500 ppm highway diesel fuel would be required to designate all highway diesel fuel produced as meeting the 500 ppm sulfur standard or meeting the proposed 15 ppm standard. Such refiners and importers would be required to maintain records regarding each batch of motor vehicle diesel fuel produced or imported, including the volume of each batch, and would be required to maintain records, and to report regarding credits earned and credit transactions. Reporting would also be required regarding volumes of highway diesel fuel produced or imported.

All parties in the distribution system that chose to carry 500 ppm fuel would be required to segregate that fuel from 15 ppm sulfur fuel, and would be responsible for ensuring that fuel designated as 15 ppm or 500 ppm meets the respective sulfur standards, throughout the distribution system. Such segregation requirements would likely be modeled after those of the reformulated gasoline (RFG) program (e.g., the RFG program's requirements for product transfer documents, refiners' designations of the standards to which each batch of fuel applies, and registration requirements for refiners producing both highway diesel fuels). However, the RFG program's segregation provisions are somewhat different, in that they were designed to segregate RFG from conventional gasoline by geographic area. In the highway diesel program, the segregation provisions would be much more widespread, because both grades of highway fuel could be distributed throughout the country, depending on how refiners choose to take advantage of the compliance flexibility. We seek comment on the need to require refiners producing 500 ppm fuel to conduct some form of downstream quality assurance sampling, similar to the surveys required under the RFG program.

Further, all parties in the distribution system would be subject to prohibitions against selling, transporting, storing, or introducing or causing or allowing the introduction of diesel fuel having a sulfur content greater than: (1) the proposed 15 ppm standard into highway diesel vehicles manufactured in the 2007 model year and beyond; and (2) 500 ppm into any highway vehicle. Under the proposed presumptive liability scheme (as discussed in section VIII.A.8), if a violation is found at any point in the distribution system, all parties in the distribution system for the fuel in violation are responsible unless they can establish a defense. Because of our concerns for contamination and misfueling with having two grades of highway diesel in the market, we seek comment on whether a refiner should lose its flexibility to continue producing 500 ppm fuel if it is found liable for a violation.

All parties handling 500 ppm fuel also would be required to maintain product transfer documents for five years that indicate to which highway diesel fuel standard the fuel is subject. Pump labels would be required at retail outlets and wholesale purchaser-consumer facilities providing notice regarding the different highway fuel types and the vehicles they may/may not be used in. As mentioned above, nozzle requirements might also be considered if the minimum volume requirement for low sulfur diesel is low enough to warrant it.

The rule would prohibit any refiner from producing more 500 ppm highway diesel fuel than allotted, and would prohibit any party from distributing or selling diesel fuel not meeting the proposed 15 ppm standard unless it is properly designated and accompanied by appropriate product transfer documents. The rule would also prohibit any person from introducing or causing or allowing the introduction of highway diesel fuel not meeting the 15 ppm sulfur standard into any model year 2007 or later vehicle.

As with any ABT program, we would need refiners to keep appropriate records, and to file necessary reports, to ensure compliance as well as the integrity of any credit generation, trading, and use. If this program is promulgated in the final rule, we would envision that refiners would likely be required to keep records of key information pertaining to the ABT program. Beginning the first year that credits are generated, any refiner for each of its refineries, and any importer for the highway diesel fuel it imports, would keep information regarding credits generated, separately kept according to the year of generation. We envision that refiners would keep records of the following information, at a minimum, and report such information to EPA on an annual basis, for any year in which credits are generated, transferred, or used:

- The total volume of highway diesel fuel produced
- The total volume of highway diesel fuel produced meeting the 500 ppm sulfur standard
- The total volume of highway diesel fuel produced meeting the low sulfur standard
- The total volume of highway diesel fuel produced (delineating both 500 ppm fuel and low sulfur fuel) after inclusion of any credits
- The number of credits in the refiner's or importer's possession at the beginning of the averaging period
- The number of credits used
- If any credits were obtained from or transferred to other parties, for each other party, its name, its EPA refiner or importer registration number, and the number of credits obtained from or transferred to the other party;
- The number of credits in the refiner's or importer's possession that will carry over into the next averaging period
- Contracts or other commercial documents that establish each transfer of credits from the transferor to the transferee
- The calculations used to determine compliance with the minimum required percentage of low sulfur highway diesel fuel
- The calculations used to determine the number of credits generated

b. Refiner-Ensured Availability

An alternative concept suggested to the Agency to accomplish the objective of ensuring widespread availability of low sulfur diesel fuel while still allowing flexibility for producing less than all of the diesel fuel pool as low sulfur is to have the refiners ensure that it is widely available. The base program would still be a requirement that refiners produce only highway diesel fuel which meets the sulfur standard proposed today. However, refiners could voluntarily choose to participate in a program where they would be allowed to sell a larger fraction of their highway diesel fuel as 500 ppm fuel, in exchange for ensuring that low sulfur diesel fuel is made widely available at the retail level.

This concept may entail a refinery contracting with, or purchasing credits from, retailers, who in exchange for incentives from the refiner, agree to make low sulfur diesel fuel available. This could mean that the retailer decides to switch over entirely to selling low sulfur diesel fuel, or that they offer both low sulfur and high sulfur diesel fuel simultaneously. The retailer would have to make a showing that: (1) the low sulfur diesel was ''meaningfully'' available; (2) there was an assured supply chain for obtaining low sulfur diesel fuel; and (3) the diesel fuels were segregated and properly labeled at the pumps. ''Meaningfully'' available might mean having dedicated pumps and tankage for low sulfur diesel with a capacity in the thousands of gallons range, and operating all year long. To be clear, the contract/credits would be for making low sulfur diesel available for sale, not necessarily selling a given volume of low sulfur diesel.

The relief that refiners receive in exchange for providing for low sulfur availability could be calculated on the basis of the retailer's total diesel sales volume. For example, the refiner would be permitted to produce a certain volume of highway diesel fuel at the current 500 ppm cap in proportion to the total diesel sales volume of the retailers that the refiner contracts with (or purchases credits from). A ratio could be applied to the retailer's sales volume to ensure sufficient retail availability.

An example of how this concept might work is as follows: A refinery producing highway diesel fuel contracts with several truck stops and service stations to make low sulfur fuel available at their stations. The refiner would then be permitted to produce 500 ppm grade diesel fuel in an amount up to the combined diesel sales volume (or some multiple thereof) for these retailers. The retailers may receive their low sulfur diesel fuel from this refiner or from other refiners to comply with the contract.

Under this approach, refiners would likely make arrangements with, or purchase credits from, the largest retailers (since they have the largest fuel volumes), in order to minimize transaction costs. Because the largest 5 percent of diesel retail stations represent 60 percent of the sales volume,[152] to achieve any meaningful availability of low sulfur fuel at retail stations, the program may require a considerably larger percentage of the sales volume to be targeted by weighting more heavily credits generated by smaller retail outlets.

We ask for comment on this concept, on its advantages and disadvantages compared to other implementation options, on the percentage of retail outlets that may be sufficient under this concept to achieve satisfactory low

[152] Memorandum to Docket A–99–06 from Jeffrey Herzog, EPA, entitled: ''Diesel Throughput Volume by Percentage of Diesel Fuel Retailers,'' May 5, 2000.

sulfur diesel fuel availability, on means of ensuring adequate geographic distribution of low sulfur diesel fuel throughout the year, and on the appropriate means of calculating the volumes that refiners should be permitted to produce as high sulfur in exchange for making low sulfur available. We also request comment on how such a program could be implemented and enforced. In particular, we request comment on the type of recordkeeping and reporting EPA should require in ensuring a refiner actually has legitimate credits, contracts or other binding arrangements with retailers to make low sulfur diesel fuel ''meaningfully'' available. We further request comment on whether and what type of recordkeeping and reporting may be necessary for retailers and distributors, particularly if the program were structured to allow retailers to generate and sell credits.

c. Retailer Availability Requirement

One way of ensuring widespread availability of the low sulfur fuel under a phase-in approach would be to require retailers selling highway diesel to make available the low-sulfur diesel (i.e., a retailer availability requirement). Retailers would be free to sell the current 500 ppm sulfur fuel as well, but at a minimum would have to offer the low sulfur fuel. This approach could either be a stand-alone program design (i.e., with no refiner production requirement for a minimum amount of low sulfur diesel), or could be coupled with a refiner production requirement. Retailers would be responsible for getting low-sulfur diesel from the distribution system. The premise of this approach is that the fuel distribution system would react to the market demands, and supply and distribute the second grade of fuel in all parts of the country.

In order to turn this premise into a reality, the fundamental issues associated with a phase-in approach, as discussed in subsection 1 above, would have to be addressed. Consequently, in the context of an availability requirement, we seek comment on how to resolve the concerns raised in subsection 1. With regard to the structure of such an availability requirement, we seek comment on when it should begin, whether it could be limited to just a fraction of the diesel fuel retail outlets, and what fraction would constitute acceptable availability in the marketplace. We specifically request comment on the merits of limiting an availability requirement to the larger diesel retailers. Under such an approach, the larger diesel retailers would have to carry low sulfur diesel, but could also choose to carry the 500 ppm grade as well. Smaller retailers not subject to the availability requirement would have the flexibility to choose to carry only the low sulfur grade, only the 500 ppm grade, or both. For example, we seek comment on the merits of limiting the requirement to only truck stops selling more than 200,000 gallons of diesel fuel per month, and other retail outlets selling more than 20,000 gallons of diesel per month, as suggested by some Panel members during the Small Business Advocacy Review process. We encourage commenters to consider other appropriate throughput thresholds, for both truck stops and service stations that could limit an availability requirement to the larger retailers, while still ensuring sufficient availability.

While desirable to limit the fraction of retailers subject to an availability requirement, ensuring sufficient availability is complicated by the fact that diesel fuel is sold at a portion of all retail outlets today.[153] If less than 100 percent of diesel retail outlets are required to make the new fuel available, how would we ensure availability in all parts of the country? Commenters should consider the distribution of diesel fuel outlets around the country, and the distances between outlets in addressing this issue. How would the rest of the distribution system respond to supply the low sulfur fuel to the retail outlets needing to make it available? To help protect against fuel shortages either nationally or regionally, would an availability requirement need to be coupled with a production requirement on refiners to ensure supply of a minimum amount of low-sulfur diesel fuel? If so, how should such a production requirement be structured? Conversely, could an availability requirement be coupled with a production requirement in a way that would allow a larger percentage of 500 ppm fuel production in the early years? (See the discussion above in subsection 2.a.ii)

With regard to the impacts on the diesel fuel retail and distribution system, numerous parties in the industry have commented that managing two grades of highway diesel in the distribution system would raise their costs. We seek comment on what actions retailers, centrally fueled fleets, wholesalers, terminals, pipelines, and refiners would take to manage two grades of highway diesel, and in particular on the cost impacts resulting from those actions. We especially seek comment on what cost savings refiners might realize under such an approach, and whether these savings would be greater than the costs incurred by the distribution system to distribute a second grade of highway diesel fuel. In this context, we also seek comment on how refiners would plan their refinery changes given the uncertainty of low sulfur diesel demand from retailers under such a phase-in approach. When would they make their capital investments, and for what volume of fuel would they plan to build desulfurization capacity? How would they predict demand in the time frame when they would need to make their capital investments? How would they adjust to different volumes from predicted demand levels, and what would be the implications?

Commenters should address this approach from the perspective of the issues discussed above in subsection A.1 (including misfueling, distribution system impacts, potential costs, etc). We are also interested in the implications of such an approach on prices in the wholesale and retail markets, and on the ability of retailers and distributors to recover costs under such an approach.

We also invite comment on the merits of applying an averaging, banking and trading program within the context of a retailer availability requirement. Such a credit trading program could entail elements similar to the program described in subsection 2.a.v. for refiners under the compliance flexibility approach, but would be tailored specifically to retailers subject to an availability requirement. Commenters should address how such a credit trading program might be structured, if they believe it should differ significantly from the refiner-based approach discussed above.

Finally, the trucking industry and diesel marketers have also commented that an availability requirement would be administratively intensive for the Agency to implement and enforce, especially in verifying actual fuel availability. Therefore, we ask comment on ways to streamline the enforcement of such a program to avoid unnecessary burden on both industry and the Agency.

2. Why Is a Regulation Necessary to Implement the Fuel Program?

Some commenters on the ANPRM suggested simply leaving it up to the market to introduce low-sulfur highway diesel fuel—that is, establish no regulatory requirements for refiners to produce the fuel and no requirements for retailers to sell the fuel. The

[153] ''Summary Data on Diesel Fuel Retailers,'' Memo to the docket from Jeffrey Herzog, EPA, March 23, 2000 (Docket item # II–B–07).

commenters' line of reasoning for this suggestion is as follows. The vehicle and engine manufacturers would be forced by emission standards to introduce vehicles meeting stringent emission standards. Since the engines and vehicles would need low-sulfur diesel fuel to meet the emission standards, then the vehicle purchasers would have to refuel only with low-sulfur diesel fuel. The fuel production and distribution system would then respond to the demand and provide the fuel if, when, and where necessary.

Such an approach raises many of the same issues discussed above with respect to phase-in approaches (*e.g.,* fuel availability, misfueling, and uncertainties in the transition to low sulfur). These concerns, however, would be heightened by the fact that no regulatory measures would be in place to mitigate them. We seek comment on whether a market-based approach could adequately ensure availability of the low sulfur fuel for the vehicles that need it.

3. Why Not Just Require Low-Sulfur Diesel Fuel for Light-Duty Vehicles and Light-Duty Trucks?

In the ANPRM, we requested and received considerable comment on focusing the rulemaking effort on providing low-sulfur diesel fuel for light-duty vehicles and trucks only. By providing a clean grade of diesel fuel, exhaust emission control technology would be enabled. This in turn would give light-duty diesel vehicles a much better chance of meeting the final Tier 2 emission standards. The appeal of a light-duty only approach is that the program would be relatively small and could set the stage for future expansion of low-sulfur diesel fuel into the heavy-duty market if the demand developed.

Based on the comments received on the ANPRM and our own analysis, however, there appears to be little justification for such a regulatory approach. First, and most importantly, such an approach would provide no environmental benefit to justify the costs of the program. Under the Tier 2 program, all LDVs and LDTs must meet on average a certain NO_X emission standard. There are a number of emission standards or ''bins'' that individual vehicles can be certified to, but an overall fleet average emission standard must still be met. Consequently, regardless of whether or not the Tier 2 fleet is comprised of a large number of diesel vehicles, the same overall fleet average NO_X emission rate will be achieved. The only anticipated difference would be in particulate emissions where, even though the emission standards are the same, in-use emissions are assumed to be somewhat lower for gasoline vehicles than for diesel vehicles. In contrast, today's proposed program for setting new emission standards for heavy-duty engines and vehicles in conjunction with lower sulfur highway diesel fuel would achieve significant reductions in NO_X and particulate matter, as discussed further in section II.

Secondly, the comments received on the ANPRM from the fuel production and distribution system indicated that such an approach would be very costly. The Engine Manufacturers Association conducted a study of the cost increase associated with distributing a unique grade of diesel fuel for just light-duty vehicles and trucks.[154] The results of this study indicated that the distribution costs alone (i.e., not including refiner production costs) for such a fuel could be 3 to 4 cents per gallon. Moreover, this study made some simplifying assumptions that served to underestimate actual volume of highway diesel fuel that would have to be produced and the costs. The study assumed a production volume of 5 percent low sulfur diesel, which is not realistic because many retailers might choose to switch over entirely to the low sulfur fuel. Thus, refiners would have to make the investments to produce a considerably larger volume of low sulfur diesel fuel than might be required for new light-duty vehicles and trucks only.

Third, commenters indicated that such an approach may be impractical. In areas where there are few fuel distribution options (e.g., areas not served by pipelines, areas with few diesel retail outlets), the low-sulfur diesel fuel may not be made available or, if it is, it could only be sold at retail prices considerably higher than the refiners' cost to produce the fuel. Consumer demand for light-duty diesel vehicles could be reduced by both unavailability of the low sulfur fuel and uncertainty about it being available at reasonable prices.

Finally, a light-duty only approach would appear to be inappropriate in light of our demonstrated air quality need for additional emission reductions and the opportunity available with recent advancements in diesel engine exhaust emission control technology to obtain these emission reductions from heavy-duty engines. If the technology necessary to meet very low emission standards for light-duty diesel vehicles is feasible with the control of diesel fuel sulfur, and if that same technology is applicable to heavy-duty diesel vehicles, then we have an obligation under the Clean Air Act to consider emission standards for heavy-duty vehicles that would be enabled by that technology as well. Given the air quality need, we would be remiss in our obligations under section 202(a)(3)(A) of the Act which requires us to set the most stringent standards feasible for heavy-duty vehicles, taking into consideration cost and other factors. EPA can revise such standards, however, based on available information regarding the effects of air pollutants from heavy-duty engines on public health or welfare.

[154] ''Very-Low-Sulfur Diesel Distribution Cost,'' Baker & O'Brien Inc., for the Engine Manufacturers Association, August 1999.

4. Why Not Phase-Down the Concentration of Sulfur in Diesel Fuel Over Time as Was Done With Gasoline in the Tier 2 Program?

There are a number of ways a fuel change can be introduced over time. The most recent example is in the Tier 2 rulemaking where the concentration of sulfur in gasoline was phased-down over time. Such an approach is not workable for diesel fuel, however, due to the demands of the exhaust emission control technology. As discussed in section III, the efficiency of both the NO_X and PM exhaust emission control drops off quickly if the vehicle is operated on sulfur levels higher than the standard proposed. Thus, the vehicles would be unable to meet the emission standards, and there would be very little if any emission benefit to be gained until the end of any such phase-down. Furthermore, as discussed in section III, in some applications it is possible that operation on higher sulfur levels may not only cause permanent damage to the PM trap, but also could result in vehicle driveability and safety concerns. Consequently, it is imperative that aftertreatment-equipped vehicles are fueled exclusively with fuel meeting the proposed low sulfur levels, and that the low sulfur fuel remain segregated in the distribution system.

This contrasts with the gasoline sulfur control program, where the impact of sulfur on the exhaust emission control technology was thought to be less severe and emission benefits accrued even at the phased-down sulfur levels. Furthermore, if gasoline vehicles are operated on higher sulfur fuel, no driveability concerns are anticipated; higher sulfur diesel would have detrimental effects on the driveability of diesel engines. Thus, in the gasoline sulfur program there was not a need to require that low sulfur gasoline remain segregated from the remaining gasoline pool while sulfur levels are being phased-down. Here there is a need to segregate low sulfur highway diesel fuel to ensure the new technology vehicles are not damaged by higher sulfur levels.

B. What Other Fuel Standards Have We Considered in Developing This Proposal?

1. What About Setting the 15 ppm Sulfur Level as an Average?

We have considered several potential diesel fuel sulfur alternatives in developing today's proposed rulemaking, including two alternatives centered around a 15 ppm sulfur level: a cap at this level as proposed, and an average at this level with a 25 ppm cap to ensure that sulfur levels would not exceed a 15 ppm average level by too much. The analyses of technology enablement, costs, emission reductions, and cost effectiveness discussed in the preceding sections are based on a 15 ppm cap. In this section we provide the results of these analyses for the 15 ppm average sulfur level case.

a. Emission Control Technology Enablement Under a 15 ppm Average Standard

Having a 15 ppm average standard with a 25 ppm cap would increase uncertainty around the advanced technologies required here and would therefore be less attractive to diesel engine and vehicle manufacturers. As discussed at length in Section III, fuel sulfur adversely impacts the effectiveness of all known and projected exhaust emission control devices. Despite these adverse effects, it may be possible that the design, precious metal loading, and application of exhaust emission control devices could be fundamentally similar under both a 15 ppm cap and a 15 ppm average. However, we would expect that the exhaust emission control devices would not operate at the same level of efficiency as expected under the 15 ppm cap program and there would be some sacrifice in the durability and reliability of these devices due to the higher sulfur level.

PM trap regeneration would be compromised due to sulfur's adverse impacts on the NO to NO_2 conversion necessary for completely passive PM trap regeneration.[155] Because of this effect, concerns have been raised that a 15 average/25 cap program would require that some vehicle applications, particularly lighter applications having lower operating temperatures, incorporate some form of active PM trap regeneration strategy. Such an active regeneration strategy could take the form of a fueling strategy capable of increasing exhaust temperature as opposed to an electrical heater or some other "added" hardware. The active regeneration scheme would likely be incorporated into the design as a backup, or protective measure, and would not function at all times. Instead, the active regeneration would kick in under conditions such as very cold ambient temperature conditions or extended idles where exhaust temperatures might be too low for too long to enable passive regeneration. There are also concerns that fuel economy would be reduced both due to the use of active regeneration and due to the higher, on average, PM trap backpressure. This would likely occur due to the slightly higher soot loading, on average, resulting from less efficient passive trap regeneration. This higher backpressure would probably occur on all applications, not just the lighter applications. Nonetheless, we believe that the fuel economy effect would probably not be greater than one percent.

Under a 15 ppm average standard, we would expect the in-use average sulfur level to be roughly double the in-use average under a 15 ppm cap program. The higher in-use sulfur level would roughly double in-use PM emissions. Since an average limit would be in place and be enforced, and since in-use emissions would be expected to approximate the average, we might consider allowing engine manufacturers to certify their engines on diesel fuel meeting the average sulfur level rather than the cap. If this approach were taken, setting the sulfur standard at a 15 ppm average instead of a 15 ppm cap would not necessitate an increase in the PM standard. However, in-use PM emissions would nearly double due to the increased average fuel sulfur level (when compared to the 15 ppm cap base case).

Regarding the NO_X adsorber, we believe that a 15 average/25 cap program may have the potential to enable NO_X adsorber technology, though with increased uncertainty. However, while the NO_X adsorber would continue to adsorb and subsequently reduce NO_X despite the higher sulfur fuel, the frequency of sulfur regeneration events, referred to as desulfation in section III, would roughly double relative to the rate with a 15 ppm cap. The increased frequency of desulfation would increase fuel consumption probably on the order of one percent and would be realized on all diesel applications equipped with NO_X adsorber technology.[156] Additionally, the increased frequency of desulfation may adversely impact NO_X adsorber durability because the thermal strain placed on the adsorber during any desulfation event would increase in frequency. Also, because of the increased frequency of desulfation events, there would be a corresponding decrease in the likelihood of being able to perform the desulfation during ideal operating conditions. This may cause more thermal strain on the NO_X adsorber and/or less efficient desulfation with a corresponding increase in fuel usage. The result would be a decrease in our level of confidence that the NO_X adsorber would be capable of fulfilling the demands of heavy-duty diesel engines in terms of fuel consumption and durability.

Note that, although the analysis finds that a 15 ppm average/25 ppm cap standard has potential to be adequate for enabling high-efficiency exhaust emissions controls, this finding involves a significantly higher level of uncertainty than the proposed 15 ppm sulfur cap, because it is based on the assumption that exhaust emission control designs could be focused on the average fuel sulfur levels. Manufacturers have commented that the possibility of some in-use fuel at near-cap levels would necessitate designing to accommodate this level, and they contend that this would not allow the high-efficiency technology to be enabled. If so, the technology enablement for this case would likely be similar to that for the 50 ppm cap case.

b. Vehicle and Operating Costs for Diesel Vehicles To Meet the Proposed Emissions Standards With a 15 ppm Average Standard

As pointed out above, we believe it may be possible that the design, precious metal loading, and application of exhaust emission control devices could be fundamentally similar under both a 15 ppm cap and a 15 ppm average. Therefore, we believe that having a 15 ppm average sulfur standard would have no quantifiable impact on the cost of emission control hardware relative to the costs associated with a 15 ppm cap standard. However, as mentioned, we would expect a one percent fuel economy decrease (*i.e.,* a one percent increase in fuel consumption) due to the increased frequency of desulfation of the NO_X adsorber. This reduction in fuel economy would result in consumption

[155] Cooper and Thoss, Johnson Matthey, SAE 890404.

[156] See section III and Table III.F–2 for more detail on desulfation and the associated fuel economy impacts.

of more fuel and, therefore, higher costs. We have estimated the discounted lifetime cost of this one percent fuel economy impact at $108, $207, $755, and $893 for a light, medium, and heavy heavy-duty diesel, and urban buses, respectively. See the draft RIA for details on how this cost was calculated.

c. Diesel Fuel Costs Under a 15 ppm Average Standard

Having a 15 ppm average with a 25 ppm cap sulfur standard would be directionally more attractive to the petroleum industry because of the slightly higher sulfur levels. Overall, we would expect this approach to provide more flexibility to refiners and distributors, and directionally help in addressing concerns that have been expressed about the difficulties of distributing diesel fuel with very low sulfur specifications. The cost of meeting a 15 ppm sulfur average at the refinery (with a 25 ppm cap) would be significantly less than meeting the proposed cap of 15 ppm. We project that roughly half of all refiners would be able to meet a 15 ppm average by modifying their existing one-stage hydrotreating unit by adding a hydrogen sulfide scrubbing unit, a PSA unit to increase hydrogen purity and a second reactor. A new, high activity catalyst would also replace today's catalyst. Refiners who would be capable of meeting a 15 ppm average with a one-stage unit would likely be those blending low amounts of light cycle oil (LCO) into their diesel fuel or those having substantial excess hydrotreating capacity in their current unit. The remaining refiners would require essentially the same two-stage hydrotreating unit that would be required to meet the proposed 15 ppm cap. In all cases, hydrogen consumption would be somewhat less than that required to meet the proposed 15 ppm cap standard.

As for fuel distribution, under the proposed 15 ppm cap on diesel sulfur content, we estimate that sulfur contamination in the distribution system can be adequately controlled at modest additional cost through the consistent and careful observation of current industry practices. A 0.2 cent per gallon increase in distribution cost is anticipated due to the need for an increase in pipeline shipment interface volumes, increased quality testing at product terminals, and the need to distribute an increased volume of fuel to meet the same level of consumer demand due to a reduction in energy density. Having a 15 ppm average standard would mean that the increase in pipeline interface volumes would likely be somewhat smaller than under the proposed 15 ppm cap. However, we do not expect that the savings in interface volumes would be proportional to the difference between the standards. This is due to the similarity of the alternative standards with the proposed 15 ppm sulfur cap relative to their comparison with the sulfur level of other products in the distribution system such as nonroad diesel fuel (3,400 ppm average sulfur content). Consequently, we estimate that distribution costs under a 15 ppm average standard would only be marginally lower (approximately 0.003 cents per gallon less) than under the proposed 15 ppm cap.

Overall, we project that the average cost of meeting the 15 ppm average at the refinery would be about 3.0 cents per gallon, about 1.0 cents per gallon less than the corresponding cost for fuel meeting a 15 ppm sulfur cap. Adding the cost of lubricity additives and increase in distribution costs, the final cost for the 15 ppm average/25 ppm cap fuel would be 3.4 cents/gallon, as compared to 4.4 cents per gallon under the proposed 15 ppm cap standard.

d. Emission Reductions Under a 15 ppm Average Standard

As discussed above, we believe that the same basic exhaust emission control technology could be used to reduce exhaust emissions from HDDEs even if we required a 15 ppm average rather than a 15 ppm cap. However, as pointed out above, there would likely be penalties in durability, fuel consumption, and emissions.

At this higher fuel sulfur level, we believe that the particulate trap will still result in large reductions of HC, CO, and carbon soot. We also believe that the 0.2 g/bhp-hr NO_X standard may be achieved using a NO_X adsorber. Nonetheless, the total PM reductions would be lower under a 15 ppm average standard. Sulfur in the fuel impacts the amount of direct sulfate PM in the exhaust gas. We estimate that a 15 ppm average standard would result in almost double the total PM emissions as compared to a 15 ppm cap standard because the 15 ppm cap is assumed to result in a 7 ppm in-use average. Table VI.B–1 presents projected nationwide HDDE PM emissions for the baseline and control case for a 15 ppm average/25 ppm sulfur cap standard along with the corresponding reductions. For comparison, the same information is shown for the proposed 15 ppm cap. Refer to the draft RIA for details of this analysis.

TABLE VI.B–1.—HDDE PM EMISSIONS WITH A 15 PPM AVERAGE/25 PPM SULFUR CAP

[Thousand short tons]

Calendar year	Baseline	15 ppm average	15 ppm cap (for comparison)
		Controlled	Controlled
2007	100	89	88
2010	94	60	59
2015	93	33	30
2020	98	19	15
2030	119	13	8

A higher average sulfur level also results in lower SO_X emission reductions. We assume that the sulfur in the fuel that is not converted to sulfate PM is converted to SO_2. Because we base SO_X emissions on the amount of sulfur flowing through the engine, the increase in fuel consumption also negatively impacts SO_X emissions. Table VI.B–2 presents projected nationwide HDDE SO_X reductions for a 15 ppm average/25 ppm sulfur cap standard and for the proposed 15 ppm cap.

TABLE VI.B–2.—HDDE SO_X EMISSION REDUCTIONS WITH A 15 PPM AVERAGE/25 PPM SULFUR CAP

[Thousand short tons]

Calendar year	15 ppm average	15 ppm cap
2007	86	88
2010	91	93
2015	99	102
2020	107	109
2030	120	123

e. Cost Effectiveness of a 15 ppm Average Standard

The methodology used to determine the cost-effectiveness of a 15 ppm average sulfur standard follows that described in Section V for our proposed 15 ppm cap standard. The alternative standard of 15 ppm on average does have impacts on specific values in the calculations, including lower desulfurization and distribution, lower in-use PM benefits, and lower SO_2 benefits all of which were pointed out above. Engine costs are assumed not to change under either a 15 ppm cap or 15 ppm average standard. We have calculated cost-effectiveness using both the per-vehicle and aggregate approaches, consistent with our cost-effectiveness presentation in Section V for our proposed program. The results are shown in Tables VI.B–3 and VI.B–4 which can be directly compared to Tables V.F–1 and V.F–2, respectively, showing values for the proposed 15 ppm cap standard. Details of the calculations are presented in the draft RIA which can be found in the docket for this rulemaking.

TABLE VI.B–3.—PER-VEHICLE COST-EFFECTIVENESS OF A 15 PPM AVERAGE/25 PPM CAP SULFUR STANDARD

Pollutants	Discounted lifetime vehicle & fuel costs	Discounted lifetime emission reductions (tons)	Discounted lifetime cost effectiveness per ton	Discounted lifetime cost effectiveness per ton with SO_2 credit [a]
Near-term costs:[b]				
NO_X + NMHC	$1,565	0.88	$1,800	$1,800
PM	774	0.064	12,100	5,200
Long-term costs:				
NO_X + NMHC	$1,151	0.88	$1,300	$1,300
PM	554	0.064	8,700	1,800

[a] $440 credited to SO_2 (at $4800/ton) for PM cost effectiveness.

[b] As described above, per-engine cost effectiveness does not include any costs or benefits from the existing, pre-control, fleet of vehicles that would use the low sulfur diesel fuel proposed in this document.

TABLE VI.B–4.— 30-YEAR NET PRESENT VALUE COST-EFFECTIVENESS OF A 15 PPM AVERAGE/25 PPM CAP SULFUR STANDARD

	30-year NPV costs (billion)	30-year NPV reduction (million tons)	30-year NPV cost effectiveness per ton	30-year NPV cost effectiveness per ton with SO_2 credit [a]
NO_X + NMHC	$26.4	18.9	$1,400	$1,400
PM	$8.0	0.75	$10,700	$1,100

[a] $7.2 billion credited to SO_2 (at $4800/ton).

2. What About a 5 ppm Sulfur Level?

Some diesel engine and automobile manufacturers have expressed support for a sulfur cap of 5 ppm (sometimes termed ''near-zero'') for some or all of the highway diesel fuel pool.[157] They view the technology solutions envisioned in this rulemaking to be infeasible at higher fuel sulfur levels. Although the feasibility analysis results of this proposal lead us to disagree with this conclusion, we have evaluated the impact that a 5 ppm sulfur cap would have on technology enablement, vehicle and fuel costs, and emissions reductions. The results of this analysis are provided below. Analysis details are provided in the Draft RIA. We encourage comment on our assessment, preferably accompanied by data and analysis supporting the commenter's views.

Capping diesel fuel sulfur at 5 ppm would clearly strengthen the viability of new emissions control technologies enabled at 15 ppm, although we are aware of no additional technologies that this lower sulfur level would enable. PM traps would emit somewhat less sulfate PM, but non-sulfate PM emissions and certification test measurement tolerances would effectively limit the extent to which the standard could be lowered from the proposed 0.01 g/bhp-hr level at this time. Given the level of precision implicit in the 0.01 numerical standard, we would not expect a 5 ppm sulfur cap to result in a lower PM standard. Nevertheless, there would be an in-use benefit compared to a 15 ppm cap, because the average fuel sulfur would be lower (perhaps 2–3 ppm compared to about 7 ppm) and so new vehicles

[157] See for example letter from Patrick Charbonneau of Navistar to Robert Perciasepe of EPA dated July 21, 1999, EPA, docket A–99–06.

would emit less sulfate PM, providing a projected 86,000 ton per year PM benefit in these vehicles in 2020, compared to 83,000 tons per year achieved under a 15 ppm cap. We have assumed that the small margins involved and the extremely high trapping efficiencies of filters that are already readily available would give manufacturers no incentive to take advantage of the lower sulfate emissions to design for higher non-sulfate emissions under the standard.

Lower sulfate PM emissions in the *existing fleet* would provide a 105 tons per year additional PM benefit (in 2007 when this benefit peaks) from adoption of a 5 ppm sulfur cap compared to a 15 ppm cap. However this is quite small compared to the corresponding 7100 ton per year existing fleet PM benefit of reducing fuel sulfur from typical current average levels of around 340 ppm to levels near 15 ppm, which in turn is a small fraction of the total direct PM emissions benefit of the 15 ppm cap, most of which comes from enabling PM traps on new engines (see Figure II.D–2). SO_X and SO_X-derived secondary PM would also be reduced in about the same small proportion.

The robustness of the PM trap regeneration process would also be directionally aided by the near zero sulfur fuel, because less of the catalyst sites that promote regeneration would be blocked by sulfur poisoning. (This phenomenon is described in section III.F.1.a). In fact, designers could further increase regeneration robustness by increasing precious metal loading without fear of inordinate sulfate production because of the lower fuel sulfur level (though at added cost). However, we have not quantified this directional benefit or cost difference because we deem the 15 ppm level adequate for robust regeneration already.

Five ppm sulfur fuel would also benefit NO_X adsorber technology. Adsorber desulfation would be needed about four times less often than that required under a 15 ppm sulfur cap, providing a projected 1 percent improvement in fuel economy. There may also be a small gain in NO_X adsorber durability due to the less frequent thermal cycling built into the desulfation process. However, available evidence suggests that at any fuel sulfur level under 15 ppm, these cycles are not likely to be so numerous or severe over the vehicle life as to seriously constrain durability. NO_X emissions would not be much affected because the basic NO_X storage and removal processes would occur in much the same way, and desulfation events would be programmed to occur frequently enough to maintain NO_X reduction efficiencies high enough to meet the standard with a minimum of fuel consumption.

We have not performed an extensive analysis of the refining cost of meeting a 5 ppm sulfur cap. However, Mathpro, under contract to EMA, did estimate the refining cost of producing diesel fuel with an average sulfur level of 2 ppm, a reasonable average under a 5 ppm cap. Mathpro examined two sets of cases where average on-highway diesel fuel sulfur levels were reduced from 20 ppm to 2 ppm, one with nonroad diesel fuel sulfur at 350 ppm (Cases 1 and MP1) and the other with nonroad diesel fuel sulfur at 20 ppm (Cases 4 and 8). From these cases, Mathpro's estimated cost of reducing highway diesel fuel sulfur from 20 ppm to 2 ppm ranges from 1.7 to 2.1 cents per gallon. Assuming a linear relationship between sulfur and cost per gallon in this range, the cost of reducing average sulfur levels from 7 ppm (that projected under the proposed 15 ppm cap) to 2 ppm would be 0.7–0.8 cents per gallon. Although it is possible that the cost per ppm of sulfur reduced would actually increase as sulfur was reduced, the extent of this increase is difficult to estimate. Thus, the best cost that we can project at this time is 0.7–0.8 cents per gallon, incremental to the cost of the 15 ppm sulfur cap program.

Although we have not attempted to analyze in detail the cost impacts of distributing a fuel with a cap on sulfur content as low as 5 ppm, the American Petroleum Institute recently had a contractor do so.[158] That study estimated that, compared to current costs, distribution costs would increase by 0.9 to 2.1 cents per gallon if a 5 ppm standard were adopted for the entire highway diesel pool.[159] The following reasons were cited for why, as the sulfur specification is decreased, it becomes more difficult to maintain product purity and supply:

—There is increased difficulty and cost associated with correcting off-specification batches in the distribution system.
—Measurement accuracy becomes more limiting.
—The pipeline compliance margin becomes more limiting at refineries.
—Supply outages due to off-specification product will become more common.
—The difference between the sulfur content of highway diesel fuel and that of abutting higher sulfur products in the pipeline system becomes larger.

Even with the estimated increase in distribution costs, the report still concluded that it was probably impractical to attain continuous supply availability of diesel fuel in all areas and outlets within the current distribution system at a 5 ppm cap on fuel sulfur content. If such problems are to be avoided, additional, more costly measures may be necessary. Should a segregated distribution system be needed to control contamination, including dedicated pipelines and tank trucks, the costs would be considerably higher than the 0.9 to 2.1 cents per gallon estimated in the report.

We too are concerned that the measures which form the basis for the 0.9 to 2.1 cents per gallon cost estimate in the API-sponsored study may not ensure widespread compliance. Under a 5 ppm standard, sulfur measurement variability would need to be reduced appreciably from current tolerances, perhaps to a level of 1 ppm or less, and the test equipment purchases and quality control steps needed to attain this could prove costly. Yet the bulk of the impact would come from the major shift likely to be needed in the practices used to avoid contamination in the distribution system. Assuming an extremely demanding maximum sulfur specification of 3 ppm at the refinery gate and a test variability of 1 ppm, only 1 ppm contamination through the distribution system could be tolerated, and this would need to be maintained nationwide and year round in a distribution system that routinely handles products with sulfur levels of up to several thousand ppm. Refiners would also need to take additional measures to meet the 3 ppm refinery gate standard that would likely be set by pipeline operators. Similar to the distribution system, the measures that refiners would need to take to further reduce sulfur content and limit process variability are unclear, and might prove quite costly.

The overall cost of a program with a 5 ppm sulfur cap is comprised of the program's cost in producing and distributing the fuel, offset by the cost of the projected 1 percent fuel economy gain. As the sulfur level reaches this very low level, the types of process changes in the refinery and fuel distribution systems necessary to eliminate contamination and maintain sufficient process flexibility in the system become much more uncertain. Consequently, serious concerns have

[158] "Costs/Impacts of Distributing Potential Ultra Low Sulfur Diesel, Turner, Mason, & Company Consulting Engineers," February 2000. EPA Docket A–99–06, item II–G–49.

[159] "Costs/Impacts of Distributing Potential Ultra Low Sulfur Diesel, Turner, Mason, & Company Consulting Engineers," February 2000. EPA Docket A–99–06, item II–G–49.

been raised concerning the ability to achieve a 5 ppm sulfur cap without drastic and costly changes to how diesel fuel is produced and distributed today. Nevertheless, assuming the average of the per gallon production and distribution cost ranges discussed above, this corresponds to a net $47.1 billion 30-year NPV cost, compared to $37.7 billion for the 15 ppm sulfur cap proposal. Considering the NO_X emissions benefits (unchanged from the 15 ppm sulfur cap case) and the PM emissions benefits (slightly improved), the resulting aggregate cost effectiveness is projected to be $1900 per ton of NO_X+NMHC and $4500 per ton of PM (including the SO_2 credit). These compare to $1500 per ton of NO_X+NMHC and $1900 per ton of PM for the 15 ppm sulfur cap proposal.

3. What About a 50 ppm Sulfur Level?

The American Petroleum Institute has proposed that we set a sulfur cap for highway diesel fuel of 50 ppm with a required refinery output average of 30 ppm, along with other proposal elements.[160] API's proposal is based on their assessment of technological need and viability. Key to API's position is the view that, ''while EPA may set standards to encourage advanced technology, EPA must not base a sulfur level on a particular technology the Agency predicts might prove viable.'' However, we believe that we must set standards in the context of real technologies that can be expected to be feasible, rather than as a means of generally encouraging advanced technology. With this in mind, we have analyzed the impact that a 50 ppm sulfur cap would have on technology enablement, vehicle and fuel costs, and emissions reductions. The results of this analysis are provided below. Analysis details are provided in the Draft RIA. We encourage comment on this assessment, preferably accompanied by data and analysis supporting the commenter's views.

As discussed in detail in section III.F, we believe that diesel fuel needs to be desulfurized to the 15 ppm level to enable emission control technologies capable of meeting the proposed standards. Setting a fuel sulfur cap of 50 ppm would require that the PM standard be set at a less stringent level to accommodate the approximate tripling of sulfate PM production in the trap compared to a 15 ppm cap. However, we believe increased fuel sulfur would have an even larger effect on robust trap regeneration than on sulfate production, bringing into question the very viability of PM traps at the higher sulfur levels. As discussed in section III.F.1, field experience in Sweden, where below 10 ppm diesel fuel sulfur is readily available, has been good. Experience has also been good in regions without extended periods of cold ambient conditions (such as the United Kingdom) using 50 ppm cap low sulfur fuel. However, field tests in Finland, where colder winter conditions are sometimes encountered (similar to many parts of the United States), have revealed a failure rate of 10 percent, due to insufficient trap regeneration. We believe that failures of the severity experienced with 50 ppm fuel in Finland would be unacceptable. These problems could become even more pronounced in light-duty applications, which tend to involve cooler exhaust streams, making regeneration more difficult. Field data with such applications is still sparse.

One means of attempting to resolve these problems is through use of an active regeneration mechanism, such as electric heaters or fuel burners. These could potentially introduce additional hardware and fuel consumption costs. They would also raise reliability concerns, based on past experience with such approaches. Active regeneration failures in PM traps would be of more concern than in NO_X exhaust emission control devices because they involve the potential for complete exhaust stream plugging, runaway regeneration at very high temperatures, trap melting, engine stalling, and stranding of motorists in severe weather. As a result, we do not consider dependence on active PM trap regeneration to be a sufficient basis for establishing PM trap feasibility.

NO_X adsorber technology would likely be infeasible with 50 ppm sulfur fuel as well, due to the rapid poisoning of NO_X storage sites. Desulfation would be needed much more frequently and with a much higher resulting fuel consumption. Even if the fuel economy penalty could somehow be justified, we expect that overly frequent desulfation could cause unacceptable adsorber durability or driveability problems (because of the difficulty in timing the desulfation to avoid driving modes in which it might be noticed by the driver). A less stringent NO_X standard could help to mitigate these concerns by allowing the NO_X storage bed to sulfate up to a greater degree before desulfating. However, this might then cause deeper sulfate penetration into the storage bed and thus possible long-term degradation because of the difficulty of removing this deeper sulfate.

Instead, we expect that diesel fuel with an average fuel sulfur level of 30 ppm and a cap of 50 ppm could enable lean NO_X catalyst technology (described in section III.E). These devices can provide modest NO_X reductions and, because of their reliance on precious metal catalyst, also serve the function of a diesel oxidation catalyst, removing some of the gaseous hydrocarbons and the soluble organic fraction of PM. Unfortunately, lean NO_X catalysts also share the oxidation catalyst's tendency to convert fuel sulfur into sulfate PM, and do so even more aggressively because they require higher precious metal loadings to reduce NO_X. They also require a fairly large addition of diesel fuel to accomplish NO_X reduction, typically about 4 percent or more of total fuel consumption. The injected fuel also makes it difficult to achieve an overall hydrocarbon reduction, despite the potential to convert much of the engine-out hydrocarbons over the catalyst. Typically, current lean NO_X catalyst designs actually show a net hydrocarbon increase.

We have assumed that lean NO_X catalysts could be developed over time to deliver 20 percent reductions in NO_X (well beyond their current proven performance over the Federal Test Procedure) with a net PM reduction of 20 percent and no net increase in gaseous hydrocarbons with a 4 percent fuel economy penalty. Although this PM reduction level is below that achieved by current diesel oxidation catalysts, it represents an ambitious target to designers attempting to balance NO_X reduction with sulfate production from the still substantial sulfur in the fuel. We have estimated that lean NO_X catalysts (including their diesel oxidation catalyst function) would add an average long term cost of $603 to a heavy-duty vehicle, inclusive of maintenance savings realized through the use of low sulfur fuel. This is lower than the cost increase for technologies enabled by 15 ppm sulfur fuel.

Based on the 20% expected emission reductions, we believe the appropriate emissions standards at a 30 ppm average / 50 ppm cap diesel sulfur level would be 1.8 g/bhp-hr NO_X and 0.08 g/hp-hr PM. Because the enabled technologies do not allow very large emission reductions and stringent emission standards, it is conceivable that continued progress in engine design may eventually allow these standards to be met through improvements in EGR and combustion optimization, although we cannot outline such a technology path at this time. It is likely that such a path would still involve a substantial fuel economy penalty.

[160] Letter from Red Cavaney of API to EPA Administrator Carol Browner, dated February 7, 2000, EPA docket A–99–06.

The 50 ppm sulfur cap would therefore result in projected NO_X and PM emission reductions in 2020 of 540,000 and 17,000 tons per year, respectively, compared to 2.0 million and 83,000 tons per year for a 15 ppm cap. It should be noted that virtually none of the PM reduction comes from a reduction in the soot component of PM.

The cost of meeting a 50 ppm sulfur cap at the refinery would be substantially less costly than meeting the proposed cap of 15 ppm. In some cases, refiners may be able to meet a 50 ppm cap with only relatively minor capital investment of a few million dollars for a new hydrogen sulfide scrubbing unit and a PSA unit to increase hydrogen purity. New, high activity catalyst would also replace today's catalyst. In other cases, refiners would also have to add a second reactor. Finally, some refiners would require essentially the same two-stage hydrotreating unit that would be required to meet the proposed 15 ppm standard. In all cases, hydrogen consumption would be somewhat less than that required to meet the proposed 15 ppm standard.

Refiners who would be capable of meeting a 50 ppm cap with only minor capital investment would likely be those not blending any LCO into their diesel fuel, or those having substantial excess hydrotreating capacity in their current unit. We estimate that about 15 percent of on-highway diesel fuel production would fall into this category. Refiners blending some LCO into their diesel fuel (e.g., 15 percent or less), or with somewhat greater levels of LCO but also having significant excess current hydrotreating capacity, would likely be capable of meeting a 50 ppm cap with an additional reactor. We estimate that about 35 percent of on-highway diesel fuel production would fall into this category. Finally, about 50 percent of on-highway diesel fuel production would likely require a two-stage hydrotreating unit due to their higher LCO fraction or lack of excess current hydrotreating capacity. Overall, we project that the average cost of meeting the 50 ppm standard at the refinery would be about 2.3 cents per gallon, about 1.7 cents per gallon less than the corresponding cost for fuel meeting a 15 ppm sulfur cap.

It would be slightly less expensive to distribute the 50 ppm sulfur fuel than the15 ppm sulfur fuel. The pipeline interface between highway diesel fuel and higher sulfur products that must be sold with the higher sulfur product to ensure quality of the highway diesel fuel could be reduced. We estimate the cost savings per gallon of diesel fuel to be about 0.01 cents.

The overall cost of a program with a 50 ppm sulfur cap with a 30 ppm average is comprised of the hardware cost of lean NO_X catalyst technology, the cost increase in producing and distributing the fuel, and the cost of the projected 4% fuel economy loss. This corresponds to a net $35.4 billion 30-year NPV cost, compared to $37.7 billion for the 15 ppm sulfur cap proposal. Considering the PM and NO_X emissions benefits, the resulting aggregate cost effectiveness is projected to be $3600 per ton of NO_X+NMHC and $56,700 per ton of PM (including the SO_2 credit). These compare to $1500 per ton of NO_X+NMHC and $1900 per ton of PM for the 15 ppm sulfur cap proposal. The large difference in PM cost effectiveness is primarily due to the fuel economy penalty and the fact that none of the fuel cost could be allocated to hydrocarbon control, because of the lack of a hydrocarbon benefit.

Table VI.B–5 summarizes key emissions and cost impacts of a program adopting the sulfur levels analyzed. Note that, although the analysis finds that a 15 ppm average/25 ppm cap standard has potential to be adequate for enabling high-efficiency exhaust emissions controls, this finding involves a significantly higher level of uncertainty than the proposed 15 ppm sulfur cap, because it is based on the assumption that exhaust emission control designs could be focused on the average fuel sulfur levels. We believe that the possibility of some in-use fuel at near-cap levels would necessitate designing to accommodate this level, and they contend that this would not allow the high-efficiency technology to be enabled. If so, the technology enablement for this case would likely be similar to that for the 50 ppm cap case. The analysis results show that the 50 ppm cap case does not enable high-efficiency exhaust control technology at all.

TABLE VI.B–5.—SUMMARY OF EMISSIONS AND COST IMPACTS AT DIFFERENT FUEL SULFUR LEVELS

Sulfur level	2020 emission reductions (thousand tons/year)		Cost impacts			
	NO_X	PM	Vehicle [c]	Fuel consumption (percent)	Fuel (¢/gal)	Aggregate 30-yr NPV ($ billion)
5 ppm cap	2,020	86	$1,133	–1	[d] 6.0–7.3	[d] 47.1
15 ppm cap	2,020	83	1,133	0	4.4	37.7
25 ppm cap w/15 ppm average [a]	2,020	79	1,133	1	3.4	34.5
50 ppm cap w/30 ppm average [b]	538	17	603	4	2.7	35.4

[a] Note that this sulfur level involves significant increased uncertainty with respect to technology enablement. Manufacturers have commented that the possibility of some in-use fuel at or near the 25 ppm cap level would necessitate designing to accommodate this level, thus precluding high-efficiency technology enablement, and making technology for this case similar to that for the 50 ppm cap case.

[b] This sulfur level is not expected to enable high-efficiency exhaust control technology.

[c] Costs of added hardware combined with lifetime maintenance cost impacts; figures shown for comparison purposes are long-term costs for heavy heavy-duty vehicles.

[d] Fuel cost based on industry analyses of refinery and distribution costs; costs could range much higher depending on fuel segregation measures required.

We welcome comments on all aspects of these analyses for alternative fuel sulfur standards, including the technology enablement assessments, vehicle and fuel costs, emissions reductions, and cost effectiveness.

4. What Other Fuel Properties Were Considered for Highway Diesel Fuel?

In addition to changes in highway diesel fuel sulfur content, we also considered changes to other fuel properties such as cetane number, aromatics, density, or distillation. Each of these fuel properties has the potential to affect the combustion chemistry within the engine, and so aid in reducing emissions of regulated pollutants. Indeed, some manufacturers have made public statements to the effect that an idealized highway diesel fuel is necessary in order to optimize the efficiency of the next generation of heavy-duty diesel vehicles.

The focus of the fuel changes we are proposing today is to enable diesel engines to meet much more stringent emission standards. As described earlier in this section, we believe that diesel engines can meet much more stringent emission standards using advanced exhaust emission control systems, but the performance of these systems is dramatically reduced by sulfur. Thus, we have determined that sulfur in diesel fuel would need to be lowered. It does not appear that other fuel properties have the same sort of effect on advanced exhaust emission controls, and as a result we do not believe that changes in fuel properties other than sulfur are necessary in order for heavy-duty engines to reach the low emission levels offered by the advanced exhaust emission controls discussed above. In fact, after conducting a research study on this topic, industry members concluded that, ''If in the future, fuel sulfur levels are significantly reduced in order to enable efficient exhaust emission controls, then it should be recognized that the exhaust emission control device becomes the primary driver on tailpipe emissions and that all other fuel properties will have only minor or secondary effects on the tailpipe emissions.'' [161]

Emission reductions can also be achieved through changes in diesel fuel properties as a direct means for reducing engine-out emissions. In this approach, it is not the exhaust emission control which is being ''enabled,'' but rather the combustion process itself which is being optimized. This approach has the advantage that the effects are fleet-wide and immediate upon introduction of the new fuel, whereas new engine standards do not produce significant emission reductions until the fleet turns over. However, regulated changes in diesel fuel properties may produce emission reductions that disappear over time, if compliance test fuel is changed concurrently with the changes to in-use fuel (to assure that such fuel remains representative of in-use fuels). Manufacturers will redesign their new engines to take advantage of any benefit a cleaner fuel provides, resulting in engines still meeting the same emission standards in-use. Consequently, it would only be those engines sold before the compliance test fuel changes that would be likely to produce emission benefits, and as these engines drop out of the fleet, so also would the benefit of changes to diesel fuel.

Even so, it is useful to consider what emission reductions are achievable through changes to non-sulfur diesel fuel properties. The non-sulfur fuel properties most often touted as good candidates for producing emission reductions from heavy-duty engines are cetane number and aromatics content. According to correlations between these fuel properties and emissions that have been presented in various published documents, the effects are rather small. We have estimated that an increase in cetane number from 44 to 50 would reduce both NO_X and PM emissions by about 1 percent for the in-use fleet in calender year 2004.[162] Likewise a reduction in total aromatics content from 34 volume percent to 20 volume percent would reduce both NO_X and PM emissions by about 3 percent. We expect changes in other fuel properties to produce emission reductions that are no greater than these effects. These reductions are insignificant in comparison to the emission benefits projected to result from today's proposal, and would come at a considerable refining cost. As a result, at this time we do not believe that it is appropriate to require changes to non-sulfur diesel fuel properties as a means for producing reductions in engine-out emissions. There may, however, be performance or engine design optimization benefits associated with non-sulfur changes to diesel fuel that could justify their cost. Therefore we welcome cross-industry collaboration on voluntary diesel fuel improvements beyond the sulfur reduction proposed in this notice, and we continue to solicit information on the impact of non-sulfur fuel changes on exhaust emission control, engine-out emissions, and engine design and performance.

C. Should Any States or Territories Be Excluded From This Rule?

1. What Are the Anticipated Impacts of Using High-Sulfur Fuel in New and Emerging Diesel Engine Technologies if Areas Are Excluded From This Rule?

Section III discusses the technological feasibility of the emission standards being proposed today and the critical need to have sulfur levels reduced to 15 ppm for the technology to achieve these emission standards. The implications to be drawn from section III with regard to exemptions from the sulfur standards for States and Territories is fairly straightforward. If vehicles and engines employing these technologies to achieve the proposed emission standards will be operated in these states or territories, then low-sulfur diesel fuel must be available for their use.

Some have suggested allowing persons in Alaska to remove emission control equipment to enhance the viability of using high-sulfur fuel. In addressing this issue, we note that, under the Clean Air Act, it is prohibited in all 50 states to remove emission control equipment from an engine, unless that equipment is damaged or not properly functioning, and then is replaced with equivalent properly functioning equipment.

2. Alaska

a. Why is Alaska Unique?

There are important nationwide environmental and public health benefits that can be achieved with cleaner diesel engines and fuel, particularly from reduced particulate emissions, nitrogen oxides, and air toxics (as further discussed in section II). Therefore, it is also important to implement this program in Alaska. Any 2007 and later model year diesel vehicles in Alaska would have to be fueled with low sulfur highway diesel, or risk potential damage to the aftertreatment technologies or even the engines themselves. Although the engine standards proposed today do not have different technology and cost implications for Alaska as compared to the rest of the country, the low sulfur fuel program would have different implications (described below). Therefore, in evaluating the best approach for implementing the low sulfur fuel program, it is important to consider the extremely unique factors in Alaska.

Section 211(i)(4) provides that the states of Alaska and Hawaii may seek an exemption from the 500 ppm sulfur standard in the same manner as provided in section 325 of the Clean Air Act. Section 325 provides that upon request of Guam, American Samoa, the Virgin Islands, or the Commonwealth of the Northern Mariana Islands, EPA may exempt any person or source, or class of persons or sources, in that territory from any requirement of the CAA, with some specific exceptions. The requested exemption could be granted if EPA determines that compliance with such requirement is not feasible or is unreasonable due to unique geographical, meteorological, or economic factors of the territory, or other local factors as EPA considers significant.

Unlike the rest of the nation, Alaska is currently exempt from the 500 ppm

[161] Lee, et al., SAE 982649.

[162] ''Exhaust emissions as a function of fuel properties for diesel-powered heavy-duty engines,'' memorandum from David Korotney to EPA Air Docket A–99–06, September 13, 1999.

sulfur standard for highway diesel fuel (as discussed in section c below). Since the beginning of the 500 ppm highway diesel fuel program, we have granted Alaska exemptions from meeting the sulfur standard and dye requirements, because of its unique geographical, meteorological, air quality, and economic factors. These unique factors are described in more detail in the Draft Regulatory Impact Analysis contained in the docket.

Second, in Alaska, unlike in the rest of the country, diesel fuel consumption for highway use represents only five percent of the State's total distillate fuel consumption, because of the relatively small numbers of vehicles in the State. Most of this fuel is produced by refineries located in Alaska, primarily because of the more severe cloud point specification needed for the extremely low temperatures experienced in much of Alaska during the winter. There are four commercial refineries in Alaska. Only one of these refineries currently has any desulfurization capacity, which is relatively small. Consequently, because these refineries would have to reduce sulfur from uncontrolled levels to meet the proposed 15 ppm standard, these refineries could incur substantially higher costs than those in the rest of the nation. Given the very small highway diesel demand, however, it is doubtful that more than one or two Alaska refineries would choose to produce low sulfur highway fuel, and these refiners could even decide to import it from refineries outside of Alaska.

Third, Alaska's highway diesel vehicle fleet is relatively small, particularly outside the Federal Aid Highway System. The State estimates that there are less than 9000 diesel vehicles in the entire State, with less than 600 of these vehicles in all of rural Alaska. The State also indicates that these vehicles are predominantly older than the average elsewhere.[163]

Finally, Alaska's fuel distribution system faces many unique challenges. Unlike the rest of the country, because of its current exemption from the 500 ppm sulfur standard, Alaska does not currently segregate highway diesel fuel from that used for off-road, marine, heating oil, and other distillate uses. Therefore, the distribution system costs for segregating a low sulfur grade of diesel for highway uses will be significant. The existing fuel storage facilities limit the number of fuel types that can be stored. In addition to significant obstacles to expanding tankage in Alaska, the cost of constructing separate storage facilities, and providing separate tanks for transporting low-sulfur diesel fuel (e.g., by barge or truck), could be significant. Most of Alaska's communities rely on barge deliveries, and ice formation on the navigable waters during the winter months restricts fuel delivery to these areas. Construction costs are 30 percent higher in Alaska than in the lower-48 states, due to higher costs for freight deliveries, materials, electrical, mechanical, and labor. There is also a shorter period of time during which construction can occur, because of seasonal extremes in temperature and the amount of daily sunlight.

b. What Flexibilities Are We Proposing for Alaska?

Because of the unique circumstances in Alaska, we are proposing an alternative option for implementing the low sulfur fuel program in Alaska. We are proposing to provide the State an opportunity to develop an alternative low sulfur transition plan for Alaska. We would intend to facilitate the development of this plan by working in close cooperation with the State and key stakeholders. This plan would need to ensure that sufficient supplies of low sulfur diesel fuel are available in Alaska to meet the demand of any new 2007 and later model year diesel vehicles. Given that Alaska's demand for highway diesel fuel is very low and only a small number of new diesel vehicles are introduced each year, it may be possible to develop an alternative implementation plan for Alaska in the early years of the program that provides low sulfur diesel only in sufficient quantities to meet the demand from the small number of new diesel vehicles. This would give Alaska refiners more flexibility during the transition period because they would not have to desulfurize the entire highway diesel volume. Our goal in offering this additional flexibility would be to transition Alaska into the low sulfur fuel program in a manner that minimizes costs, while still ensuring that the new vehicles receive the low sulfur fuel they need. We expect that the transition plan would begin to be implemented at the same time as the national program, but the State would have an opportunity to determine what volumes of low sulfur fuel would need to supplied, and in what timeframes, in different areas of the State.

At a minimum, such a transition plan would need to: (1) Ensure an adequate supply (either through production or imports), (2) ensure sufficient retail availability of low sulfur fuel for new vehicles in Alaska, (3) address the growth of supply and availability over time as more new vehicles enter the fleet, (4) include measures to prevent misfueling, and (5) ensure enforceability. We would anticipate that, to develop a workable transition plan, the State would likely work in close cooperation with refiners and other key stakeholders, including retailers, distributors, truckers, engine manufacturers, environmental groups, and other interested groups. For example, the State would likely rely on input from the trucking industry in determining the expected low sulfur fuel volume needed in Alaska, based on the anticipated number of new vehicles, and how this volume is expected to grow during the first few years of the program. Similarly, the State would likely rely on the Alaska refiners' input regarding plans for supplying (either through production or imports) low sulfur fuel to meet the expected demand. Further, the State would likely rely on input and cooperation from retailers and distributors to determine at which locations the low sulfur fuel should be made available. Retailers offering low sulfur fuel would have to take measures to prevent misfueling, such as pump labeling. All parties in the distribution system would need to ensure the low sulfur fuel remains segregated and take measures to prevent sulfur contamination, in the same manner as described for the national program in section VIII.

If the State anticipates that the primary demand for low sulfur fuel will be along the highway system (*e.g.*, to address truck traffic from the lower 48 states) in the early years of the program, then the initial stages of the transition plan could be focused in these areas. We believe it would be appropriate for the State to consider an extended transition schedule for implementing the low sulfur program in rural Alaska, as part of the state's overall plan, based on when they anticipate the introduction of a significant number of 2007 and later model year vehicles in the remote areas.

Under such an approach, the State would be given the opportunity to develop such a transition plan, as an alternative to the national program, and submit it to EPA. Our goal would be to help facilitate the development of the plan, by working closely with the State and the stakeholder group so they would have an opportunity to address EPA's concerns in their submittal. We envision that the State would develop and submit this plan to EPA within about one year of the final diesel rule. Our goal would be to conduct a rulemaking and publish a final rule

[163] See further discussion in the Draft RIA (Chapter VIII).

promulgating a new regulatory scheme for Alaska, if appropriate. The goal would be to issue a final rule within one year of Alaska's submittal of the plan, so that refiners and other affected parties would have certainty as to their regulatory requirements. We request comment on the timing for the State to submit such an alternative plan, and for EPA to conduct the rulemaking action. If the State chose not to submit an alternative plan, or if the plan did not provide a reasonable alternative for Alaska as described above, then Alaska would be subject to the national program.

We seek comment on all aspects of this approach, and on other approaches that may have merit, to provide additional flexibility in transitioning the low sulfur fuel program for Alaska.

c. How Do We Propose to Address Alaska's Petition Regarding the 500 ppm Standard?

Background

On February 12, 1993, Alaska submitted a petition under section 325 of the Act to exempt highway vehicle diesel fuel in Alaska from paragraphs (1) and (2) of section 211(i) of the Act, except for the minimum cetane index requirement.[164] The petition requested that we temporarily exempt highway vehicle diesel fuel in communities served by the Federal Aid Highway System from meeting the sulfur content specified in section 211(i) of the Act and the dye requirement for non-highway diesel fuel of 40 CFR 80.29, until October 1, 1996. The petition also requested a permanent exemption from those requirements for areas of Alaska not reachable by the Federal Aid Highway System—the remote areas. On March 22, 1994, (59 FR 13610), we granted the petition based on geographical, meteorological, air quality, and economic factors unique to Alaska.

On December 12, 1995, Alaska submitted a petition for a permanent exemption for all areas of the State served by the Federal Aid Highway System, that is, those areas covered only by the temporary exemption. On August 19, 1996, we extended the temporary exemption until October 1, 1998 (61 FR 42812), to give us time to consider comments to that petition that were subsequently submitted by stakeholders. On April 28, 1998 (63 FR 23241) we proposed to grant the petition for permanent exemption. Substantial public comments and substantive new information were submitted in response to the proposal. To give us time to consider those comments and new information, we extended the temporary exemption for another nine months until July 1, 1999 (September 16, 1998, 63 FR 49459). During this time period, we started work on a nationwide rule to consider more stringent diesel fuel requirements, particularly for the sulfur content (i.e., today's proposed rule). To coordinate the decision on Alaska's request for a permanent exemption with this nationwide rule on diesel fuel quality, we extended the temporary exemption until January 1, 2004 (June 25, 1999 64 FR 34126).

Today's Proposed Action

As mentioned above, Alaska has submitted a petition for a permanent exemption from the 500 ppm standard for areas not served by the Federal Aid Highway System. Our goal is to take action on this petition in a way that minimizes costs through Alaska's transition to the low sulfur program. The cost of compliance could be reduced if Alaska refiners were given the flexibility to meet the low sulfur standard in one step, rather than two steps (i.e., once for the current 500 ppm sulfur standard in 2004 when the temporary exemption expires, and again for the proposed 15 ppm standard in 2006). Therefore, we propose to extend the temporary exemption for the areas of Alaska served by the Federal Aid Highway System from January 1, 2004 (the current expiration date) to the proposed effective date for the proposed 15 ppm sulfur standard (i.e., April 1, 2006 at the refinery level; May 1, 2006 at the terminal level; and June 1, 2006 at all downstream locations).

As discussed in section b above, we are proposing to allow Alaska to develop a transition plan for implementing the 15 ppm sulfur program. During this transition period, it is possible that both 15 ppm (for proposed 2007 and later model year vehicles) and higher sulfur (for older vehicles) highway fuels might be available in Alaska. To avoid the two-step sulfur program described above, we seek comment on whether we should consider additional extensions to the temporary exemption of the 500 ppm standard beyond 2006 (e.g., for that portion of the highway pool that is available for the older technology vehicles during Alaska's transition period). We would expect that any additional temporary extensions, if appropriate, would be made in the context of the separate rulemaking taking action on Alaska's transition plan (as described in the previous section).

As in previous actions to grant Alaska sulfur exemptions, we would not base any vehicle or engine recall on emissions exceedences caused by the use of high-sulfur (>500 ppm) fuel in Alaska during the period of the temporary sulfur exemption. In addition, manufacturers may have a reasonable basis for denying emission related warranties where damage or failures are caused by the use of high-sulfur (>500 ppm) fuel in Alaska.

Finally, the costs of complying could be reduced significantly if Alaska were not required to dye the non-highway fuel. Dye contamination of other fuels, particularly jet fuel, is a serious potential problem. This is a serious issue in Alaska since the same transport and storage tanks used for jet fuel are generally also used for other diesel products, including off-highway diesel products which are required to be dyed under the current national program. This issue is discussed further in the Draft RIA (Chapter VIII). Therefore, we also propose to grant Alaska's request for a permanent exemption from the dye requirement of 40 CFR 80.29 and 40 CFR 80.446 for the entire State.

We are interested in comments on all aspects of this proposal.

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

a. Why Are We Considering Excluding American Samoa, Guam, and the Commonwealth of Northern Mariana Islands?

Prior to the effective date of the current highway diesel sulfur standard of 500 ppm, the territories of American Samoa, Guam and the Commonwealth of Northern Mariana Islands (CNMI) petitioned EPA for an exemption under section 325 of the Act from the sulfur requirement under section 211(i) of the Act and associated regulations at 40 CFR 80.29. The petitions were based on geographical, meteorological, air quality, and economic factors unique to those territories. We subsequently granted the petitions.[165] With today's proposal we need to evaluate whether to include or exclude the territories in areas for which the fuel sulfur standard would apply.

b. What are the Relevant Factors?

The key relevant factors unique to these territories, briefly discussed below, are discussed in detail in the

[164] Copies of information regarding Alaska's petition for exemption and subsequent requests by Alaska and actions by EPA are available in public docket A–96–26.

[165] See 57 FR 32010, July 20, 1992 for American Samoa; 57 FR 32010, July 30, 1992 for Guam; and 59 FR 26129, May 19, 1994 for CNMI.

Draft RIA. These U.S. Territories are islands with limited transportation networks. Consequently among these three territories there are currently only approximately 1300 registered diesel vehicles. Diesel fuel consumption in these vehicles represents just a tiny fraction of the total diesel fuel volume consumed in these places; the bulk of diesel fuel is burned in marine, nonroad, and stationary applications. Consequently highway diesel vehicles are believed to have a negligible impact on the air quality in these territories, which, with minor exceptions, is very good.

All three of these territories lack internal petroleum supplies and refining capabilities and rely on long distance imports. Given their remote location from the U.S. mainland, petroleum products are imported from east rim nations, particularly Singapore. Although Australia, the Philippines, and certain other Asian countries have or will soon require low-sulfur diesel fuel, this requirement is a 500 ppm sulfur limit, not the proposed 15 ppm sulfur limit. Compliance with low-sulfur requirements for highway fuel would require construction of separate storage and handling facilities for a unique grade of diesel fuel for highway purposes, or importation of low-sulfur diesel fuel for all purposes, either of which would significantly add to the already high cost of diesel fuel in territories which rely heavily on United States support for their economies.

c. What Are the Options and Proposed Provisions for the Territories?

We could include or exclude the territories in the areas for which the proposed diesel fuel sulfur standard would apply. As in the early 1990's when the 500 ppm sulfur standard was implemented, we believe that compliance with the proposed 15 ppm sulfur standard would result in relatively small environmental benefit, but major economic burden. We are also concerned about the impact to vehicle owners and operators of running the new and upcoming engine and emission control technologies using high-sulfur fuel. We believe that for the sulfur exemption to be viable for vehicle owners and operators, they would need access to either low-sulfur fuel or vehicles meeting the pre-2007 HDV emission standards that could be run on high-sulfur fuel without significant engine damage or performance degradation.

We are proposing to exclude American Samoa, Guam and CNMI from the proposed diesel fuel sulfur requirement of 15 ppm because of the high economic cost of compliance and minimal air quality benefits. We are also proposing to exclude, but not prohibit, the territories from the 2007 heavy-duty diesel vehicle and engine emissions standards, and other requirements associated with those emission standards based on the increased costs associated with implementing the vehicle and fuel standards together in these territories. Thus, the territories would continue to have access to 2006 diesel vehicle and engine technologies. This exclusion from standards would not apply to gasoline engines and vehicles because gasoline that complies with our regulations will be available, and so concerns about damage to engines and emissions control systems will not exist. As proposed this exclusion from standards does not apply to light-duty diesel vehicles and trucks because gasoline vehicles meeting the emission standards and capable of fulfilling the same function would be available.

We are proposing to continue requiring all diesel motor vehicles and engines to be certified and labeled to the applicable requirements (either to the 2006 model year standards and associated requirements, or to the standards and associated requirements applicable for the model year of production) and warranted, as otherwise required under the Clean Air Act and EPA regulations. Special recall and warranty considerations due to the use of exempted high-sulfur fuel are proposed to be the same as those proposed for Alaska during its proposed transition period. To protect against this exclusion being used to circumvent the emission requirements applicable to the rest of the United States (i.e., continental United States, Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands) after 2006 by routing pre-2007 technology vehicles and engines through one of these territories, we propose to restrict the importation of vehicles and engines from these territories into the rest of the United States. After the 2006 model year, diesel vehicles and engines certified under this exclusion to meet the 2006 model year emission standards for sale in American Samoa, Guam and CNMI would not be permitted entry into the rest of the United States.

We request comment on these exclusions and particularly on whether it should be extended to light-duty diesel vehicle and truck standards as well.

D. What About the Use of JP–8 Fuel in Diesel-Equipped Military Vehicles?

In 1995, EPA issued a letter to the Deputy Under Secretary of Defense for Environmental Security which concluded that the military specification fuel known as JP–8 did not meet the definition of diesel fuel under EPA's regulations and was, therefore, not subject to the 0.05 percent by weight sulfur standard. EPA also determined that despite the slightly higher sulfur levels, the use of JP–8 in motor vehicles by the military would not be a violation of EPA regulations as a matter of policy. This decision was made after careful consideration of the impact on operational readiness, logistical considerations and cost for the military. EPA also evaluated data presented by the military which compared the emissions of vehicles operated on typical highway diesel and JP–8. These data supported the conclusion that there would not be a significant adverse environmental consequence from the limited use of JP–8 fuel. EPA's evaluation of the emissions impact was, of course, based on the results of tests conducted using vehicles representative of diesel emission control technology and diesel fuel in use at that time.

The technical basis for EPA's decision on this matter may be affected by the prospect of military vehicles equipped with the highly sulfur sensitive technology that is expected to be used on vehicles and engines designed to meet the standards for 2007 and beyond. We request comment from interested parties on how to best deal with this situation, including comment on the extent to which national security exemptions pursued under 40 CFR 85.1708 may affect resolution of the issue.

VII. Requirements for Engine and Vehicle Manufacturers

A. Compliance With Standards and Enforcement

We are not proposing any changes to the enforcement scheme currently applicable to vehicles and engines under Title II of the CAA. Thus, they would continue to apply to the vehicles and engines subject to today's proposed standards. This includes the enforcement provisions relating to the manufacture, importation and in-use compliance of these vehicles and engines (see sections 202–208 of the CAA). Manufacturers are required to obtain a certificate of conformity for their engine designs prior to introducing them into commerce, and are subject to Selective Enforcement Audits during production. Although there are currently no regulatory requirements for manufacturers to test in-use engines, they are responsible for the emission performance of their engines in use. If we determine that a substantial number of properly maintained and used engines in any engine family is not complying with the standards in use, then we may require the manufacturer to recall the engines and remedy the noncompliance. Failure by a manufacturer to comply with the certification, warranty, reporting, and other requirements of Title II can result in sanctions including civil penalties and injunctive relief (see sections 202–208 of the CAA). Other enforcement provisions regulating persons in addition to manufacturers would also be applicable to the affected diesel vehicles, including provisions such as the tampering and defeat device prohibitions. It is also important to note that, because the CAA defines manufacturer to include importers, all of these requirements and prohibitions apply equally to importers.

Consideration has been given to in-use issues that may arise from use of the new exhaust emission control technology. While it is believed that the technology is sufficient to ensure that emission control devices and elements of design will be effective throughout the useful life of the vehicle, some concern has been expressed regarding the possibility that instances of driveability or other operational problems could occur in-use. One example brought up, is the possibility that a vehicle could experience severe driveability problems if the PM trap becomes plugged. At this time, however, we are confident that the technologies will be developed to prevent these types of problems from occurring provided the vehicle is operated on the appropriate fuel. Nevertheless, comments are requested on any in-use problems that may arise as a result of inclusion of exhaust emission control technology. Your comments should address the nature of the problem, likelihood of its occurrence and options for ensuring it does not occur.

Another issue related to certification is what (if any) maintenance we should allow for adsorbers and traps. Our existing regulations define these to be critical emission-related components, which means that the amount of maintenance of them that the manufacturer is allowed to conduct during durability testing (or specify in the maintenance instructions that it gives to operators) is limited. We believe that this is appropriate because, as we already noted, we expect that these technologies will be very durable in use and will last the full useful life with little or no scheduled maintenance. However, our existing regulations (40 CFR 86.004–25) would allow a manufacturer to specify something as drastic as replacement of the adsorber catalyst bed or the trap filter after as little as 100,000–150,000 miles if there was a ''reasonable likelihood'' that the maintenance would get done. We are concerned that some manufacturers may underdesign the adsorbers and traps compared to the level of durability that is achievable. If this occurred, even if most users replaced their adsorber or trap according to the manufacturer's schedule, there would certainly be some users that did not. Therefore, we are proposing to require that these technologies be designed to last for the full useful life of the engine. More specifically, the proposed regulations state that scheduled replacement of the PM filter element or catalyst bed is not allowed during the useful life. Only cleaning and adjustment will be allowed as scheduled maintenance.

It may be appropriate to establish non-conformance penalties (NCPs) for the standards being proposed today. NCPs are monetary penalties that manufacturers can pay instead of complying with an emission standard. In order for us to establish NCPs for a specific standard, we would have to find that: (1) Substantial work will be required to meet the standard for which the NCP is offered; and (2) there is likely to be a ''technological laggard'' (*i.e.*, a manufacturer that cannot meet the standard because of technological (not economic) difficulties and, without NCPs, might be forced from the marketplace). According to the CAA (section 206(g)), such NCPs ''shall remove any competitive disadvantage to manufacturers whose engines or vehicles achieve the required degree of emission reduction.'' We also must determine compliance costs so that appropriate penalties can be established. We have established NCPs in past rulemakings. However, since the implementation of our averaging, banking and trading program, their use has been rare. We believe manufacturers have taken advantage of the averaging, banking and trading program as a preferred alternative to incurring monetary losses. At this time, we have insufficient information to evaluate these criteria for heavy-duty engines. While we believe that substantial work will be required to meet the 2007 standards, we currently have no information indicating that a technological laggard is likely to exist. Recognizing that it may be premature for manufacturers to comment on these criteria, since implementation of these standards is still more than six years away, we expect to consider NCPs in a future action. We welcome comment on this approach.

Today's proposal includes PM standards for heavy-duty gasoline engines. Because gasoline engines have inherently low PM emissions, it may be appropriate in some cases to waive the requirement to measure PM emissions. Therefore, we are proposing to maintain the flexibility to allow manufacturers to certify gasoline engines without measuring PM emissions, provided they have previous data, analyses, or other information demonstrating that they comply with the standards. The flexibility is the same as that allowed for PM emissions from light-duty gasoline vehicles and for CO emissions from heavy-duty diesel engines.

B. Certification Fuel

It is well established that measured emissions are affected by the properties of the fuel used during the test. For this reason, we have historically specified allowable ranges for test fuel properties such as cetane and sulfur content. These specifications are intended to represent most typical fuels that are commercially available in use. Because today's action is proposing to lower the upper limit for sulfur content in the field, we are also proposing a new range of allowable sulfur content for testing that would be 7 to 15 ppm (by weight). Beginning in the 2007 model year, these specifications would apply to all emission testing conducted for Certification and Selective Enforcement Audits, as well as any other laboratory engine testing for compliance purposes. Because the same in use fuel is used for light-and heavy-duty highway diesel vehicles, we are also proposing to change the sulfur specification for light-duty diesel vehicle testing to the same 7 to 15 ppm range, beginning in the 2007 model year. We request comment on these test fuel specifications. We also request comment regarding whether the range of allowable test fuel properties should include the full range of in-use properties or include the most typical range around the average properties (*e.g.*, 7 to 10 ppm sulfur).

C. Averaging, Banking, and Trading

We are proposing to continue the basic structure of the existing ABT program for heavy-duty diesel engines. (Note that this includes the Otto-cycle engine and vehicle ABT programs that were proposed on October 29, 1999, 64 FR 58472.) This program allows manufacturers to certify that their engine families comply with the applicable standards on average. More specifically, manufacturers are allowed to certify their engine families with various family emission limits (FELs), provided the average of the FELs does not exceed the standard when weighted by the numbers of engines produced in each family for that model year. To do this, they generate certification emission credits by producing engine families that are below the applicable standard. These credits can then be used to offset the production of engines in engine families that are certified to have emissions in excess of the applicable standards. Manufacturers are also allowed to bank these credits for later use or trade them to other manufacturers. We are proposing some restrictions to prevent manufacturers from producing very high-emitting engines and unnecessarily delaying the transition to the new exhaust emission control technology. These restrictions are described below. We are continuing this ABT program because we believe that it would provide the manufacturers significant compliance flexibility. This compliance flexibility would be a significant factor in the manufacturers' ability to certify a full line of engines in 2007 and would help to allow implementation of the new, more stringent standard as soon as permissible under the CAA. This is especially true given the very low levels of the proposed standards. In some ways the ABT program is intended to serve the same purpose as the phase-in for diesel engines. As is described below, we have proposed some restrictions to make this program compatible with the phase-in. Thus your comments on this ABT program should address how it fits with the phase-in, and vice versa.

The existing ABT program includes limits on how high the emissions from credit-using engines can be. These limits are referred to as FEL caps. No engine family may be certified above these caps using credits. These limits provide the manufacturers compliance flexibility while protecting against the introduction of unnecessarily high-emitting engines. In today's action, we are proposing to establish lower caps for those engines that are required to comply with the proposed standards. Specifically, we are proposing that the engines subject to the new standards have NO_X emissions no higher than 0.50 g/bhp-hr, and PM emissions no higher than 0.02 g/bhp-hr. Without this cap, we are concerned that one or more manufacturer(s) could use the ABT program to unnecessarily delay the introduction of exhaust emission control technologies. Allowing this would be contrary to one of the goals of the phase-in program, which is to allow manufacturers to gain experience with these technologies on a limited scale before they are applied to their full production. Similarly, we are proposing FEL caps of 1.0 g/mi NO_X and 0.03 g/mi PM for chassis-certified heavy-duty vehicles. We request comment on the need for and the levels of these FEL caps.

We are proposing separate averaging sets during the phase-in period. In one set, engines would be certified to the 2.4 g/bhp-hr NO_X+NMHC standard (which applies for model years 2004–2006), and would be subject to the restrictions and allowances established for those model years. In the other set, engines would be certified to the proposed 0.20 g/bhp-hr NO_X standard, and would be subject to the restrictions and allowances proposed today. Averaging would not be allowed between these two sets within the same model year. The reason for this is similar to that for the low FEL caps. Allowing averaging between the sets would be contrary to one of the goals of the phase-in program, which is to allow manufacturers to introduce engines with ultra-low emission technologies on a limited scale before they are applied to their full production. We are concerned that manufacturers could delay the introduction of NO_X aftertreatment technology, diminishing the projected benefits of the proposed program during the phase-in. We request comment on the need for this restriction. As a part of this restriction of cross-set averaging, we are also proposing that banked NO_X+NMHC and PM credits generated from 2006 and earlier engines may not be used to comply with the stricter standards that apply to 2007 and later engines (unless such credits are generated from engines that meet all of the stricter standards early). We are also requesting comments on alternatives to these restrictions, such as only allowing banked credits generated from engines below some threshold (*e.g.,* 1.5 g/bhp-hr NO_X+NMHC or 0.05 g/bhp-hr PM) to be used for compliance with the 2007 standards. Under the threshold approach, the credits would be calculated in reference to the threshold rather than the applicable standard. Your alternatives should address our two primary concerns: (1) Ensuring that manufacturers produce engines during the phase-in period that are equipped with the advanced NO_X aftertreatment controls; and (2) ensuring that the program produces equivalent or greater emission reductions during the phase-in period.

We propose to apply these same restrictions to the 2007 chassis-based standards. This would affect the averaging program that was proposed previously for model year 2004 (October 29, 1999, 64 FR 58472). We believe that these restrictions are equally necessary for the chassis-based program, but are also open to alternatives. We are particularly interested in the possibility of using the Tier 2 pull-ahead approach that would allow manufacturers to phase in the new standards on a per-vehicle basis rather than on a total gram basis. Under this approach, for each ''2007-technology'' vehicle that a manufacturer introduced before 2007, it could produce one ''2006-technology'' vehicle in 2007 or later. We recognize that this approach would be complicated for heavy-duty vehicles because of the different weight classes, but believe that this problem could be addressed with appropriate weighting factors (*e.g,* setting one 14,000 lb vehicle as equivalent to two 8,500 lb vehicles). While it is less clear that such an approach would work for the engine programs, we would welcome such comments.

The Agency continues to be interested in the potential of early benefits to be gained from retrofitting highway engines. Thus, we are also asking for comment on various concepts by which manufacturers could earn credits potentially to be used in a variety of programs. An example of such credits in the 2007 MY program might include consideration by EPA of the retiring of retrofit credits in deciding whether to make a discretionary determination under section 207(c) of substantial non-conformity. For discussion of related issues, see the final rule for spark-ignition marine engines (61 FR 52088, 52095, October 4, 1996), and the final rule for locomotive engines (63 FR 18978, 18988, April 16, 1998). We ask for comment as to what emission benefits could be achieved by this concept and by what legal authority such credits could be applied. Such systems would bring existing highway engines into compliance with the standards being proposed for new engines, or alternately with some less stringent standards levels that still achieve large emission reductions. We ask comment on how such an emissions reduction calculation should be formulated and how such benefits and resulting credits should be applied. Certification requirements for such retrofit systems could be developed along the lines of those adopted in EPA's urban bus retrofit program (58 FR 21359, April 21, 1993). Credits would be calculated based on the expected lifetime emissions benefits of the retrofit systems. Because this benefit depends on the remaining life of the retrofitted vehicle, and this could vary considerably, any emission reduction formula would require the certainty to account for this in the calculation, such as by estimating an average remaining life for retrofits in each engine family, or by using a vehicle age-dependent proration factor for each retrofitted system, similar to the approach taken in the locomotive emissions rule (see Appendix K of the Regulatory Support Document for the locomotives final rule. 63 FR 18977, April 16, 1998).

D. Chassis Certification

Heavy-duty vehicles under 14,000 pounds can generally be split into two groupings, complete and incomplete vehicles. Complete vehicles are those that are manufactured with their cargo carrying container attached. These vehicles consist almost entirely of pick-up trucks, vans, and sport utility vehicles. Incomplete vehicles are those chassis that are manufactured by the primary vehicle manufacturer without their cargo carrying container attached. These chassis may or may not have a cab attached. The incomplete chassis are then manufactured into a variety of vehicles such as recreational vehicles, tow trucks, dump trucks, and delivery vehicles.

Recently, we proposed to require all complete Otto-cycle vehicles between 8,500 and 14,000 pounds to be certified to vehicle-based standards rather than engine-based standards beginning in model year 2004 (October 29, 1999, 64 FR 58472). Under this proposal manufacturers would test the vehicles in essentially the same manner light-duty trucks are tested. We continue to believe this approach is reasonable and are thus proposing to continue it with the more stringent standards. We request comment regarding the possible mandatory or voluntary application of this program to complete diesel vehicles under 14,000 pounds.

E. FTP Changes to Accommodate Regeneration of Aftertreatment Devices

It is possible that some of the exhaust emission control devices used to meet the proposed standard will have discrete regeneration events that could effect emission characteristics. For example, NO_X adsorbers and actively regenerated PM traps each incorporate discrete regenerations. The NO_X adsorber stores NO_X under normal conditions until the NO_X storage capacity is nearly full, at which point, the regeneration event is triggered to purge the stored NO_X and reduce it across a catalyst. Actively regenerated PM traps incorporate heating devices to periodically initiate regeneration. In both cases, we would expect that these regeneration events would be controlled by the engine computer, and would thus be generally predictable. Even passively regenerating catalytic PM trap designs can have discrete regeneration events.

Discrete regeneration events can be important because it is possible for exhaust emissions to increase during the regeneration process. The regeneration of a NO_X adsorber for instance, could result in increased particulates, NMHC and NO_X due to the rich exhaust gas required to purge and reduce the NO_X. We expect that in most cases, the regeneration events would be sufficiently frequent to be included in the measured emissions. Our feasibility analysis projects very frequent regeneration of the NO_X adsorbers, and continuously regenerating PM traps. Nevertheless, this issue becomes a regulatory concern because it is also conceivable that these emission storage devices could be designed in such a way that a regeneration event would not necessarily occur over the course of a single heavy-duty FTP cycle, and thus be unmeasured by the current test procedure. Since these regeneration events could produce increased emissions during the regeneration process, it will be important to make sure that regeneration is captured as part of the certification testing. We seek comment on the need to measure regeneration emissions as part of each emission test, and the best method of making such measurements.

In order to verify the emission levels during regeneration, we propose that the transient FTP applicable for certification be repeated until a regeneration occurs. The transient FTP will be repeated until a regeneration event is confirmed. The emissions measured during the cycle in which the regeneration occurs must be below the applicable transient cycle standard. For example, if an actively regenerated heavy-duty PM trap does not regenerate over the cold-soak-hot cycle, the hot portion of the cycle will be repeated until a regeneration is observed. The specific hot cycle with the highest emissions would be used as the representative hot cycle, and its emissions would be weighted with the cold cycle emissions (as is currently required) to determine compliance with the composite emission standard for the cold-soak-hot cycle. We seek comment on the proposed method of capturing regeneration emissions and whether we should allow the manufacturers to use the average hot-start emissions rather than the worst case.

This proposal is based on the assumption that the systems would include a fairly high frequency of regeneration events (*e.g.,* one regeneration event per hour). We seek comment on the need to capture regeneration emissions as part of the certification testing if the regeneration events occur much less frequently. Similarly, we request comment on the need to measure emissions during desulfurization of the NO_X adsorber. Would it be appropriate to allow manufacturers to use a mathematical adjustment of measured emissions to account for increased emissions during infrequent regeneration or desulfurization events? For example, if a system required a desulfurization after every 20 transient cycles, and PM emissions increased by 20 percent during desulfurization, would it be appropriate to adjust measured emissions upward by one percent (20 percent divided by 20 cycles)?

F. On-Board Diagnostics

OBD systems help ensure continued compliance with emission standards during in-use operation, and they help mechanics to properly diagnose and repair malfunctioning vehicles while minimizing the associated time and effort. We implemented OBD requirements on light-duty applications in the 1994 model year (58 FR 9468, February 19, 1993). We recently proposed OBD requirements for 8500 to 14,000 pound heavy-duty gasoline and diesel applications (October 29, 1999, 64 FR 58472). The 8500 to 14,000 pound requirements are scheduled for implementation in the 2004 model year with a phase-in running through the 2006 model year; the 2007 model year would be the first year of 100 percent OBD compliance on 8500 to 14,000 pound applications. We are currently working with industry to develop OBD requirements for the over 14,000 pound heavy-duty gasoline and diesel engines. Those requirements will be proposed in a separate rulemaking and are anticipated to be effective on or before the 2007 model year; consequently, we are not proposing them here.

As discussed in the October 29, 1999, proposed rule, OBD system requirements would allow for potential inclusion of heavy-duty vehicles and engines in inspection/maintenance programs via a simple check of the OBD system. The OBD system must monitor emission control components for any malfunction or deterioration that could cause exceedance of certain emission thresholds. The OBD system also notifies the driver when repairs are needed via a dashboard light, or malfunction indicator light (MIL), when the diagnostic system detects a problem.

An OBD system is important on heavy-duty vehicles and engines for many reasons. In the past, heavy-duty diesel engines have relied primarily on in-cylinder modifications to meet emission standards. For example, emission standards have been met through changes in injection timing, piston design, combustion chamber design, use of four valves per cylinder rather than two valves, and piston ring pack design and location improvements. In contrast, the proposed 2004 and 2007 standards represent a significant technological challenge that would require use of EGR and exhaust emission control devices whose deterioration or malfunction can easily go unnoticed by the driver. The same argument is true for heavy-duty gasoline vehicles and engines; while emission control is managed both with engine design elements and exhaust emission control devices, the latter are the primary emission control features. Because deterioration and malfunction of these devices can go unnoticed by the driver, and because their sole purpose is emissions control, some form of detection is crucial. An OBD system is well suited to detect such deterioration or malfunction.

Today's proposal does not contain any new OBD requirements. The vehicles and engines designed to comply with today's proposed emission standards would be required to comply with the OBD requirements already in place or proposed for implementation in the 2004 model year (*i.e.,* light-duty and heavy-duty through 14,000 pounds). However, because some of the existing OBD requirements are based on multipliers of the applicable emission standards, we request comment regarding the effect of the low levels of the proposed standards on these OBD requirements. We believe that these requirements will be feasible for these engines. If you believe that the OBD requirements will not be feasible, you should include in your comments suggestions for how they should be revised to make them feasible.

We are also requesting comment regarding whether there are new OBD requirements that should be adopted for these exhaust emission control technologies. Comments supporting new requirements should indicate whether they would be intended only to prevent emission problems, or would also be intended to prevent performance problems, such as exhaust emission control plugging.

G. Supplemental Test Procedures

To ensure better control of in-use emissions, we recently proposed (October 29, 1999, 64 FR 58472)[166] to add two supplemental sets of requirements for heavy-duty diesel engines: (1) A supplemental steady-state test and accompanying limits; and (2) NTE Limits. Both types of these proposed supplemental emission requirements are expressed as multiples of the normal duty cycle-weighted emission standards, or FEL if the engine is certified under the ABT program, whichever is applicable. For example, the diesel engine NTE limit for NO_X + NMHC emissions from 2004 engines would be 1.25 times the 2.4 g/bhp-hr emission standard, or 1.25 times the applicable FEL. Although we are not proposing any changes to these requirements, we are requesting comment on the feasibility of technologies needed to meet the standards being proposed in this notice, in the context of applying these multipliers to these new standards.

Like current requirements, these new requirements would apply to certification, production line testing, and vehicles in actual use. All existing provisions regarding standards (*e.g.,* warranty, certification, recall) would be applicable to these new requirements as well. The steady-state test was proposed because it represents a significant portion of in-use operation of heavy-duty diesel engines that is not adequately represented by the FTP. The combination of these supplemental requirements is intended to provide assurance that engine emissions achieve the expected level of in-use emissions control over expected operating regimes in-use. We stated in the previous NPRM that we believed that compliance with these requirements would not require manufacturers to add additional emission control technologies, but would require manufacturers to put forth some effort to better optimize their engines with respect to emissions over a broader range of operating conditions. You should read the previous NPRM for more detail. You should also read the comments that we received in response to this proposal. In those comments, some engine manufacturers raised concerns regarding the feasibility of implementing these requirements in the 2004 model year, in the context of the technologies expected to be seen in the 2004 time frame (principally cooled EGR, advanced fuel injection systems, advanced turbo-charging systems).[167] Many of these comments question the feasibility of meeting the proposed NTE emission limits under the high-load regions of the proposed NTE zone, particularly under conditions of high temperature and/or altitude. These comments are highlighted here because the resolution of these issues for the 2004 diesel engine standards, may also be relevant to today's rulemaking.

We plan to apply these requirements with the proposed 2007 standards in the same manner as they would be applied with the 2004 standards, if adopted. There is some concern that certain exhaust emission control devices, though capable of providing large emission reductions and performing robustly over a wide range of expected operating conditions, may have degraded performance in some conditions included in the NTE or supplemental steady-state testing requirements. We are thus asking for comments and supporting data related to this concern. Your comments should address the following questions:

—What is the relative ability of the emission control technologies being considered in today's action to control emissions over the full range of speeds and loads typically encountered in actual use? Are there areas of the map in which the emission controls are significantly less effective?

—What is the relative need for emission reduction for different areas of the speed-load map?

—How do the emission control technologies being considered in today's action perform at different ambient conditions?

—Are the multipliers proposed previously the most appropriate multipliers for ensuring in-use emissions control on exhaust emission control-equipped engines?

—Are there other cost effective approaches to controlling in-use emissions for engines equipped with exhaust emission controls?

—Are the technological issues raised in the 2004 rulemaking equally applicable to diesel engines featuring

[166] Today's notice proposes to apply the heavy-duty diesel NTE and supplemental steady-state test provisions intended to be finalized as part of the 2004 standards rulemaking. The October 29, 1999 proposal for that rule contained the description of these provisions. We expect that a number of modifications will be made to those provisions in the FRM for that rule based on feedback received during the comment period. While the details of the final provisions are not yet available, we will provide the necessary information in the docket for this rule as soon as it becomes available in order to allow for comment.

[167] See, for example, comments from Engine Manufacturers Association, Detroit Diesel Corporation, Navistar International Transportation Corp., Mack Trucks Inc., in EPA Air Docket No. A–98–32.

advanced exhaust emission controls and designed to meet the proposed 2007 standards?

H. Misfueling Concerns

As explained in Section III, the emissions standards contained in this proposal will likely make it necessary for manufacturers to employ exhaust emission control devices that require low-sulfur fuel to ensure proper operation. This proposal therefore restricts the sulfur content of highway diesel fuel sold in the U.S. There are, however, some situations in which vehicles requiring low-sulfur fuel may be accidentally or purposely misfueled with higher-sulfur fuel. Vehicles operated within the continental U.S. may cross into Canada and Mexico, countries which have not confirmed that they plan to adopt the same low sulfur requirements we are proposing here. In addition, high-sulfur nonroad fuel may illegally be used by some operators to fuel highway vehicles. Any of these misfueling events could seriously degrade the emission performance of sulfur-sensitive exhaust emission control devices, or perhaps destroy their functionality altogether.

There are, however, some factors that help to mitigate concerns about misfueling. Most operators are very conscious of the need to ensure proper fueling and maintenance of their vehicles. The fear of large repair and downtime costs may often outweigh the temptation to save money through misfueling.

The likelihood of misfueling in Canada and Mexico is lessened by current cross-border shipment practices and prospects for eventual harmonization of standards. Canada has historically placed a priority on harmonization with U.S. vehicle emission standards. They have also placed a priority on harmonization with U.S. fuels standards, as they import a significant amount of fuel from the U.S. and do not want to become a ''dumping ground'' for fuel that does not comply with U.S. fuel standards. We think it likely therefore that Canada will harmonize with the U.S. revised engine standards and the fuel sulfur levels required to support those standards. This will offer vehicle owners the option of refueling with low-sulfur fuel there. Even if Canada were to lag the U.S. in mandating low-sulfur fuels, these fuels would likely become available along major through routes to serve the needs of U.S. commercial traffic that have the need to purchase it. In addition, there is less potential for U.S. commercial vehicles needing low-sulfur fuel to refuel in Canada because Canadian fuel is currently more costly than U.S. fuel. As a result, most vehicles owners will prefer to purchase fuel in the U.S., prior to entering Canada, whenever possible. This is facilitated by large tractor-trailer trucks that can have long driving ranges—up to 2,000 miles or so—and the fact that most of the Canadian population lives within 100 miles of the United States/Canada border.

In Mexico, the entrance of trucks beyond the border commercial zone has been prohibited since before the conclusion of the North American Free Trade Agreement in 1994. This prohibition applies in the U.S. as well, as entrance of trucks into the U.S. beyond the border commerce zone is also not allowed. Since these prohibitions are contrary to the intent of the Free Trade Agreement, a timetable was established to eliminate them.[168] However, these prohibitions are a point of contention between the U.S. and Mexico and remain in force at this time.

The NAFTA negotiations included creation of a ''corridor'' where commercial truck travel occurs, and where Mexico is obligated to provide ''low-sulfur'' fuel. At the time of the NAFTA negotiations, ''low-sulfur'' fuel was considered 500 ppm, which was the level needed to address the needs of engines meeting the 1994 emission standards. The travel prohibition currently in place may be lifted at some point. At that time, the issue of assuring, for U.S. vehicles, fuel with a sulfur level needed by the technology that results from this regulation may need to be addressed.

Even considering these mitigating factors, we believe it is reasonable to propose two additional measures with very minor costs to manufacturers and consumers. First, we are proposing a requirement that heavy-duty vehicle manufacturers notify each purchaser of a model year 2007 or later diesel-fueled vehicle that the vehicle must be fueled only with the low-sulfur diesel fuel meeting our regulations. We believe this requirement is necessary to alert vehicle owners to the need to seek out low-sulfur fuel when operating in areas such as Canada and Mexico where it may not be widely available. We are also proposing that model year 2007 and later heavy-duty diesel vehicles must be equipped by the manufacturer with labels on the dashboard and near the refueling inlet that say: ''Ultra-Low Sulfur Diesel Fuel Only.'' We request comment on the need for these measures, alternative suggestions for wording, whether or not these requirements should exist for only a limited number of years, and whether any vehicles certified to the new standards without the need for low-sulfur fuel should be exempted. We also request comment on whether additional measures are needed to preclude misfueling, such as requiring that the new technology vehicles be equipped with refueling inlet restrictors that can only accept refueling nozzles from pumps that dispense low-sulfur fuel. We would also need to require that these pumps (or the high-sulfur fuel pumps) be correspondingly equipped with specialized nozzles or other devices to complement the vehicle refueling inlet restrictor.

[168] See NAFTA, Volume II, Annex I, Reservations for Existing Measures and Liberalization Commitments, Pages I–M–69 and 70, and Pages I–U–19 and 20.

I. Light-Duty Provisions

We are proposing that the heavy-duty vehicle labeling and purchaser notification requirements discussed in section VII.H be applied to the light-duty diesel vehicles certified to the final Tier 2 standards as well, because these vehicles are expected to require the low-sulfur fuel and so would be equally susceptible to misfueling damage.

J. Correction of NO_X Emissions for Humidity Effects

Engine-out emissions of NO_X are known to be affected significantly by the amount of moisture in the intake air. The water absorbs heat which lowers combustion temperatures, and thus lowers NO_X emissions. Our existing regulations include equations that give correction factors to eliminate this effect. For example, if the equation indicated that NO_X emissions measured on a relatively high humidity day would be about three percent lower than would be expected with standard humidity, they would be multiplied by 1.03 to correct them to standard conditions. However, these equations were developed many years ago, based on data from older technology engines. We are concerned that these equations may not be valid for engines equipped with catalytic emission controls. It is possible that with catalytic systems, the effect may be very different. Perhaps with these newer technologies, the effect will not be significant and correction factors will not be needed. Therefore, we are requesting comment regarding the accuracy of the existing equations for engines equipped with NO_X adsorbers, and the need for such correction factors for the 2007 standards. To the extent possible, your comments should address the broader issue of the need for correction factors for NO_X and other pollutants based on changing ambient conditions. This issue was also discussed in the October 29, 1999 proposal (64 FR 58472). You should read that discussion and the comments that we received in response to that proposal.

VIII. Requirements for Refiners, Importers, and Fuel Distributors

A. Compliance and Enforcement

1. Overview

The proposed rule would create a national, industry-wide sulfur cap standard for highway diesel fuel of 15 ppm. This standard could be enforced through sampling and testing at all points in the distribution system, combined with inspection of fuel delivery records and other commercial documents. The compliance requirements of this proposed rule would thus be very similar to the current diesel sulfur rule, except that the sulfur standard would be substantially more stringent.[169] Since the 15 ppm cap would be the maximum acceptable sulfur level at the retail level, pipelines might set more stringent refiner specifications to account for test variability and contamination. See section VIII.A.2 for a discussion of the refinery level standard and enforcement testing.

Under the proposed rule, all parties in the distribution system would continue to be subject to the current diesel fuel requirements and prohibitions concerning aromatics and cetane (40 CFR 80.29(a)). Furthermore, until the proposed implementation dates, all of the requirements and prohibitions of the presently effective diesel fuel control rule will remain in effect with the limited modification concerning sulfur test methods as discussed in section VIII.A.4.

Diesel fuel not covered by today's proposed rule includes that used for off-highway mobile source purposes such as aircraft, off-road machinery and equipment, locomotives, boats and marine vessels, and for stationary source purposes such as utilities (electrical power generation), portable generators, air compressors, steam boilers, etc. Also excluded is highway diesel fuel exported for sale outside the United States and its territories, and that specified for research and development subject to certain restrictions. Today's proposal would allow the use of used motor oil in pre-2007 model year and specially certified 2007 and later model year highway engines subject to certain restrictions (see section VIII.A.3.b).

It should be noted that, while this preamble uses the common vernacular "highway diesel fuel," the terminology used in the proposed regulations refers to "motor vehicle diesel fuel" in order to be consistent with the definitions and authorities under the Clean Air Act (see sections 202(a), 211(c), and 216(2)). The definition of "motor vehicle diesel fuel" clarifies that nonroad engines and nonroad vehicles are not motor vehicles or motor vehicle engines. This is intended to clarify the definition. Diesel fuel that is available for use by both motor vehicles and engines and nonroad vehicles and engines would be treated as motor vehicle diesel fuel and still subject to the low sulfur diesel standard. For example, a diesel fuel pump used by nonroad equipment and motor vehicles must carry diesel fuel meeting the low sulfur diesel fuel requirements for motor vehicles.

2. What Are the Requirements for Refiners and Importers?

a. General Requirements

The sulfur sensitivity of emission controls on model year 2007 and later vehicles requires that the sulfur content of diesel fuel at the retail pump must not exceed 15 ppm (see section III). Thus, the proposed rule would require refiners and importers, and all other parties in the distribution system, to comply with the industry-wide sulfur cap standard of 15 ppm for all highway diesel fuel, unless specifically exempted (see sections VIII.A.6 and 7).

Under the proposed approach, there would be no published enforcement test tolerance. If an enforcement test tolerance were allowed, a more stringent refinery level sulfur standard would be required to ensure the proposed 15 ppm retail level cap is attained. We expect that the diesel fuel refining and distribution industry would establish appropriate upstream commercial specifications to ensure the 15 ppm standard is met downstream. These parties are in the best position to determine what the refinery level commercial specifications need to be, and they are in control of the means to achieve those specifications. Further, they may take advantage of improvements over time in testing precision and contamination prevention measures to adjust their operations to minimize costs. However, we recognize that because of concerns about test variability and contamination in the fuel distribution system, pipelines may set sulfur specifications that would be more stringent than the regulatory standard.[170]

As discussed below, we are not proposing that refiners or importers engage in mandatory sampling and testing of every batch of diesel fuel they produce or import under the proposed industry-wide sulfur cap program. However, if some approach is finalized other than what has been proposed, then every-batch testing by refiners and importers, and associated recordkeeping and reporting requirements, may be necessary.

b. Dyes and Markers

Under the federal tax code requirements and the current EPA diesel fuel rule, diesel fuel intended for highway use can generally be distinguished by its color from fuel intended for off-highway use.[171] The current EPA diesel fuel regulations, at 40 CFR 80.29(b), provides that any diesel fuel that does not show visible evidence of dye solvent red 164 (which has a characteristic red color in fuel) is considered to be available for use as diesel highway fuel and is subject to the requirements and prohibitions associated with diesel highway fuel. However, under the tax code, highway diesel fuel sold for certain tax exempt uses may also be dyed red. Therefore, some red-dyed diesel fuel is legal highway fuel under the EPA diesel fuel rule.

Diesel fuel for off-highway use would continue to be dyed red under today's proposal, except in Alaska (see section VI.C). We do not believe that any additional dye requirement is needed to enhance compliance or enforcement effectiveness of the proposed rule.

3. What Requirements Apply Downstream?

a. General Requirements

Due to the adverse effects of diesel fuel containing more than 15 ppm sulfur on model year 2007 and later vehicles, as discussed in section III, diesel fuel at all levels of the distribution system would be required to meet the 15 ppm standard. The proposed rule would stagger the implementation dates for compliance with the standard, based on a facility's position in the distribution system as a refiner, distributor, or retailer. As with other fuels programs, EPA enforcement personnel would sample and test for compliance with

[169] 40 CFR 80.29–80.30.

[170] See section IV.D. regarding the anticipated sulfur level at the refinery gate necessary to accommodate variability in production, variability in the proposed sulfur measurement procedure (discussed in detail in section VII.A.), and contamination in the distribution system.

[171] See section 4082 of the Internal Revenue Code.

this downstream standard at all points in the distribution system. Under the proposed presumptive liability scheme, if a violation is found at any point in the distribution system, all parties in the distribution system for the fuel in violation are responsible unless they can establish a defense. See section VIII.A.8 regarding liability, penalty and defense provisions.

Under the proposed diesel sulfur program, it is imperative that distribution systems segregate highway diesel fuel from high sulfur distillate products such as home heating oil and nonroad diesel fuel. The sulfur content of those products is frequently as high as 3,000 ppm. Our concern extends to potential misfueling at retail outlets and wholesale purchaser-consumer facilities, even if segregation of the different grades of diesel fuel has been maintained in the distribution system.

Misfueling model year 2007 and later diesel vehicles with higher sulfur fuel could severely damage their emission controls and cause driveability problems. In order to discourage accidental misfueling of highway vehicles with higher sulfur distillates such as nonroad diesel fuel we are proposing that these fuel pumps be labeled. The proposed rule would require that retailers and wholesale purchaser-consumers selling or dispensing nonroad diesel fuel or other high sulfur distillates in addition to highway diesel fuel must label any dispensers of this higher sulfur fuel. The label would have to indicate that the fuel is high sulfur and state that the fuel is illegal for use in motor vehicles.

All parties in the distribution system would be subject to prohibitions against selling, transporting, storing, or introducing or causing or allowing the introduction of diesel fuel having a sulfur content exceeding 15 ppm into highway diesel vehicles. Certain product transfer document (PTD) information requirements would apply to all parties in the distribution system. See section VIII.A.5.

b. Use of Used Motor Oil in Diesel-Fueled New Technology Vehicles

We are aware of the practice of disposing of used motor oil by blending it with diesel fuel for use as fuel in diesel vehicles. Such practices range from dumping used motor oil directly into the vehicle fuel tank, to dumping it into the fuel storage tanks, to blending small amounts of motor oil from the vehicle crank case into the fuel system as the vehicle is being operated. To the extent such practices could cause vehicles to exceed their emissions standards, the person blending the oil, or causing or permitting such blending, could be considered to be rendering emission controls inoperative in violation of section 203 of the CAA and potentially liable for a civil penalty.[172]

With today's proposal our concerns with this practice are increased considerably. Today's formulations of motor oil contain very high levels of sulfur. Depending on how the oil is blended, it could increase the sulfur content of the fuel burned in the vehicle by as much as 200 ppm. As discussed elsewhere in this notice, we believe this practice would render inoperative not only the emission control technology on the vehicle, but potentially render the vehicle undriveable as well. Therefore, in today's notice we are proposing to prohibit any person from introducing or causing or allowing the introduction of used motor oil, or diesel fuel containing used motor oil, into the fuel delivery systems of vehicles manufactured in model year 2007 and later. The only exception to this would be where the engine is explicitly certified to the emission standard with oil added, the oil is added in a manner consistent with the certification, and the sulfur level of the oil is representative of commercially available oils. Today's proposal would not change existing requirements regarding the use of used motor oil in pre-2007 model year engines. However, the proposal would prevent the addition of used oil to diesel fuel prior to its introduction into the vehicle fuel tank. We request comment on this proposal, and in particular on whether an additional constraint can or should be placed on the sulfur content of motor oil to preclude the possibility that vehicle exhaust emission control technology would not be adversely impacted should used motor oil be added to a vehicle's fuel tank.

c. Use of Kerosene and Other Additives in Diesel Fuel

We are aware that kerosene is commonly added to diesel fuel to reduce fuel viscosity in cold weather. Other additives are added to diesel fuel for various purposes, including viscosity, lubricity, and pour point. We are not proposing to limit this practice. However under today's proposal, additives used in highway diesel fuel would be required to meet the same 15 ppm standard proposed for highway diesel fuel. To help ensure this, we are proposing that kerosene or other additives meeting the 15 ppm standard, and distributed for use in motor vehicles would be required to be accompanied by PTDs accurately stating that the additive meets the 15 ppm standard. As an alternative for such additives sold in cans or other containers, the required sulfur content identification could be posted on the container itself. This identification would be necessary to allow downstream parties to be able to determine if additives such as kerosene meet the required 15 ppm sulfur limit. Any party who blends high sulfur additives into highway diesel fuel, uses such additives as highway diesel fuel, or who causes highway diesel fuel to exceed the standard due to the addition of kerosene or other additives, would be subject to liability for violating the rule. We are requesting comment on this proposal and any alternative that would inform transferees of diesel fuel additives of the appropriateness of their use in highway diesel fuel.

We are not proposing that refiners or importers of kerosene or other additives which could be used in highway diesel fuel, would have an affirmative duty to produce additives that meet the proposed 15 ppm sulfur standard. This is because we believe that refiners will produce low sulfur kerosene, for example, in the same refinery processes that produce low sulfur diesel fuel, and that the market will drive supply of low sulfur kerosene for those areas and seasons where the product is needed for blending with highway diesel fuel. We request comment on whether there should be an affirmative requirement for refiners or terminals to supply low sulfur kerosene or whether all number one kerosene should be required to meet the 15 ppm sulfur standard.

We also request comment on whether additives not meeting the 15 ppm sulfur cap should be allowed to be added to diesel fuel downstream in de minimis amounts, and if so, how such a program could be structured to ensure that the additives would not cause the 15 ppm sulfur cap to be exceeded. In addition we request comment on whether any regulatory constraint at all need be placed on the sulfur level of diesel additives, and whether instead the liability mechanisms contained in this proposal are sufficient to protect against downstream parties adding additives to diesel fuel that would cause the fuel delivered to consumers to exceed the cap.

4. What Are the Proposed Testing and Sampling Methods and Requirements?

a. Testing Requirements and Test Methods

We do not believe an every-batch testing requirement for refiners and

[172] Section 203(a)(3) of the Act, 42 U.S.C. 7522(a)(3).

importers is necessary under the proposed rule. This is primarily because refiners will likely voluntarily test every batch of fuel produced to ensure it meets the 15 ppm sulfur standard, and because pipeline operators will require test results before agreeing to ship low sulfur highway diesel fuel. However, we are proposing to designate a test method that would be used as the benchmark for all compliance testing. We are requesting comment on whether every-batch testing should be required in light of the requirement (discussed in section VIII.A.5) for refiners to issue PTDs stating that the product meets the applicable sulfur standard.

We propose to designate ASTM D 2622–98 with the minor modification discussed below as the benchmark test method for quantifying the sulfur content of diesel fuel for compliance determination. We are also proposing that this test method would be the benchmark method to determine compliance under the current sulfur control regulations. This method is an updated version of the designated method under the current highway diesel fuel rule. This test method is currently in wide use by refiners and laboratories both for gasoline and diesel testing. This method does not currently include test repeatability or reproducibility information for diesel fuel having a sulfur content below 60 ppm.[173] Nevertheless, in EPA's review of the test method, we believe that when applied to low sulfur diesel fuel with the proposed modification, the method has acceptable precision at sulfur levels below 15 ppm.

We have had success in improving the precision of the ASTM D 2622–98 procedure in measuring low levels of diesel fuel sulfur through a simple modification of the calibration method. This modification includes two small changes. The first is the substitution of a measurement blank that more closely resembles the boiling point range and density of diesel fuel. The second is a change to the calibration line to ensure that it goes through zero. This modification is detailed in the proposed regulatory text. Using this modification, we have had success in the correlation of test results with industry laboratories on samples with sulfur content in the range of 1 to 20 ppm. We will continue to investigate the proposed modification to the ASTM D 2622–98 procedure. Based on current information, we believe that lab-to-lab reproducibility can be limited to a maximum of +/−4 ppm at sulfur levels in the 1–20 ppm range. We do not anticipate that this modification will add appreciably to the cost of sulfur testing.

We are requesting comments on performance data for diesel fuel analysis using ASTM D 2622 at sulfur levels below 60 ppm, on additional modifications to the procedure which might be needed to limit variability, and on the cost of such modifications. Specifically, comment is requested on whether only end-window type scanning instruments should be used because additional variability is introduced through the use side-window type instruments.[174] If the use of side-window type scanning instruments must be disallowed, comment is requested on the extent such instruments are used and on the cost of changing them to an end-window configuration.

While we are proposing to designate the modified ASTM D 2622–98 procedure as the designated test method, we do not believe that such designation should preclude regulated parties from using alternative methods that afford them sufficient confidence that they are demonstrably in compliance. Therefore, we are proposing that alternative methods may be used for quality assurance purposes provided that the proper correlation is established between the alternative method and the benchmark method.[175] Since EPA enforcement testing would be conducted using the modified ASTM D 2622 procedure, parties would need to have considerable confidence in any alternative methods they may use. We believe that for quality assurance testing, an approach that could provide more flexibility and potentially save costs for industry would be to allow other appropriate ASTM test methods, so long as they are conducted properly and the results correlate to the designated method. Although these test results could be used by the government to demonstrate noncompliance, this should not be a substantial concern since any test result that demonstrates noncompliance should lead to appropriate action on the part of the regulated party, as would a test result from the use of the designated method. We seek comment on this approach.

EPA's proposed designation of the modified ASTM D 2622–98 procedure is based on a review of currently available methods. Should superior methods be developed in the future, EPA will certainly consider an orderly process of redesignation to take advantage of newer technologies.

One commenter to the ANPRM stated that ASTM D 2622 may not be suitable for determining the sulfur content of biodiesel. We request comment on whether ASTM D 2622–98 is appropriate for determining the sulfur content of biodiesel, or mixtures of biodiesel and conventional diesel fuel, and if not, what test methods are appropriate, and any data supporting these conclusions.

We are also proposing a test method for the determination of sulfur in motor oil, since that may be relevant if any engine manufacturers choose to certify engines with the addition of motor oil to the fuel. The test method we are proposing is ASTM D 4927–96, Standard Test Methods for Elemental Analysis of Lubricant and Additive Components—Barium, Calcium, Phosphorus, Sulfur, and Zinc by Wavelength-Dispersive Fluorescence Spectroscopy. This method uses the same apparatus as D 2622–998, but includes specific methodology to compensate for interferences caused by the additives present in motor oil. We request comment on this test method.

b. Sampling Methods

We are proposing the use of sampling methods that were proposed for use in the Tier 2/gasoline sulfur rule.[176] These proposed sampling methods are ASTM D 4057–95 (manual sampling) and D 4177–95 (automatic sampling from pipelines/in-line blending). We are proposing to require the use of these ASTM methods instead of the methods currently provided in 40 CFR part 80, appendix G, for determining compliance under both the newly proposed 15 ppm sulfur standard, and the 500 ppm standard currently in place. That is because the proposed methods have been updated by ASTM, and the

[173] Repeatability is defined by ASTM as the difference between two test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test material, that would, in the long run, in the normal and correct operation of the test method, be exceeded only in one case in twenty. Reproducibility is defined by ASTM as the difference between two single and independent results obtained by different operators working in different laboratories on identical test materials that would, in the long run, in the normal and correct operation of the test method, be exceeded only in one case in twenty.

[174] Side-window vs end-window refers to the location of the sample cup.

[175] EPA is preparing to propose, in another action, a set of criteria by which alternative methods for measuring fuel parameters may be evaluated and controlled in practice. We are not proposing to prescribe these criteria and statistical quality control methods in this rulemaking, but suggest that their use will enhance the credibility of measurements made with alternative methods and offered in situations where testing is necessary to establish a defense.

[176] 64 FR 26004, at 26098 (May 13, 1999). These methods are also proposed for use under the RFG and CG rules. See 62 FR 37337 (July 11, 1997).

updates have provided clarification and have eliminated certain requirements that are not necessary for sampling petroleum products such as diesel fuel.

5. What Are the Proposed Recordkeeping Requirements?

We are proposing that refiners and importers provide information on commercial PTDs that identify diesel fuel for highway use and that it complies with the 15 ppm sulfur standard (unless exempted). We believe this additional information on commercial PTDs is necessary because of the importance of avoiding commingling of high sulfur distillate products with highway diesel fuel. It is proposed that all parties in the distribution chain, from the refiner or importer to the retailer or wholesale purchaser-consumer would be required to retain copies of these PTDs for a period of 5 years. This is the same period of time required in other fuels rules, and it coincides with the applicable statute of limitations. We believe that for other reasons, most parties in the distribution system would maintain such records for this length of time even without the requirement.

We are proposing that the current diesel rule's PTD requirement regarding the identification of dyed, tax-exempt highway diesel fuel would be retained. This provision is useful for wholesale purchaser-consumers who need to know that the tax exempt highway diesel fuel is appropriate for highway use despite the presence of red dye. We are also proposing that product codes may be used to convey the information required to be included in PTD's, for all parties except for transfers to truck carriers, retailers or wholesale purchaser-consumers. This provision is consistent with other fuel programs. However, we are seeking comment on also allowing product codes to be used for transfers to truck carriers, retailers or wholesale purchaser-consumers.

We are proposing that records of any test results performed by any regulated party for quality assurance purposes or otherwise, must be maintained for 5 years, along with supporting documentation such as date of sampling and testing, batch number, tank number, and volume of product. Also, business records regarding actions taken in response to any violations discovered would be required to be maintained.

As noted above, we are also proposing that commercial PTDs for kerosene or other products sold for blending into highway diesel fuel must indicate that the product meets the 15 ppm federal sulfur standard for use in diesel motor vehicles. We believe that such PTDs are already a part of normal business practices and therefore such a requirement would add little if any burden. We invite comment on this proposal.

Given the importance of avoiding highway diesel fuel sulfur contamination under today's proposed rule, we are also concerned that additional measures may be needed to assure off-highway distillates are not commingled with, or used as, highway diesel fuel. Such high sulfur products could easily raise the sulfur level of low sulfur highway diesel fuel, and damage emission controls on new vehicles and cause driveability problems. Therefore, we request comment on whether shipment of distillate products such as nonroad diesel fuel and home heating oil should be required to be accompanied by PTDs stating that the products do not meet highway diesel standards and are illegal for use in highway vehicles.

6. Are There Any Proposed Exemptions Under This Subpart?

We are proposing to exempt from the sulfur requirements diesel fuel used for research, development, and testing purposes. We recognize that there may be legitimate research programs that require the use of diesel fuel with higher sulfur levels than allowed under today's proposed rule. As a result, today's proposal contains provisions for obtaining an exemption from the prohibitions for persons distributing, transporting, storing, selling, or dispensing diesel fuel that exceeds the standards, where such diesel fuel is necessary to conduct a research, development, or testing program.

Under the proposal, parties would be required to submit to EPA an application for exemption that would describe the purpose and scope of the program and the reasons why the use of the higher-sulfur diesel fuel is necessary. Upon presentation of the required information, the exemption would be granted at the discretion of the Administrator, with the condition that EPA could withdraw the exemption ab initio in the event the Agency determines the exemption is not justified. Fuel subject to this exemption would be exempt from the other provisions of this subpart, provided certain requirements are met. These requirements include such conditions as the segregation of the exempt fuel from non-exempt highway diesel fuel, identification of the exempt fuel on product transfer documents, and the replacement, repair, or removal from service of emission systems damaged by the use of the high sulfur fuel.

We believe that the proposal includes the least onerous requirements for industry that also would ensure that higher-sulfur diesel fuel would be used only for legitimate research purposes. We request comment on these proposed provisions.

We are requesting comment on the need to provide an exemption from the sulfur content and other requirements of this proposal for diesel fuel used in racing vehicles. We see no advantage to racing vehicles for having fuel with higher sulfur levels (or lower cetane or higher aromatic levels) than would be required by today's proposal. Conversely, we are concerned about the potential for misfueling that could result from having a racing fuel with higher sulfur in the marketplace that would be intended for use only in racing or competition versions of highway vehicles. Consequently, we are not proposing that diesel fuel used in racing vehicles be exempted from the diesel fuel requirements proposed today. We request comment on this decision and whether an exemption should be allowed for racing diesel fuel.

7. Would California Be Exempt From the Rule?

Although California is currently considering diesel fuel regulations, we do not propose to exempt California from the federal rule at this time.[177] California has received an exemption from certain compliance related provisions under the Federal reformulated gasoline (RFG) program, on the grounds that California has implemented a program in covered areas that meets or exceeds Federal RFG standards and because the California ARB has sufficient resources and authority to enforce the program to ensure equivalent environmental benefits are realized. These exemptions cover such enforcement provisions as recordkeeping, reporting, and test methods. California gasoline is not exempted from the standards for Federal RFG or conventional gasoline. See 40 CFR 80.81. We have also proposed full exemption for California from the proposed gasoline sulfur standards and other provisions of that rule because California has an effective gasoline sulfur program that is different from the

[177] On November 10, 1998, The California ARB held a workshop to comply with the Governor's Executive Order W–144–97. At that workshop the ARB discussed the possibility of amending Title 13 of the California Code of Regulations, Section 2281, ''Sulfur Content of Diesel Fuel.'' Under that section, California currently enforces a 500 ppm sulfur standard for highway diesel fuel. The ARB is considering a diesel fuel standard that may be as stringent as, or more stringent than, the standard we are proposing today.

proposed federal rule. Although it would be premature to grant similar exemptions to the California low-sulfur diesel program at this time, EPA may revisit the issue of enforcement exemptions when such action is timely, and we invite public comment on this approach. Exemptions for other states and territories are discussed in section VI.C.

8. What Are the Proposed Liability and Penalty Provisions for Noncompliance?

Today's proposed rule contains provisions for liability and penalties that are similar to the liability and penalty provisions of the other EPA fuels regulations. Under the proposed rule, regulated parties would be liable for committing certain prohibited acts, such as selling or distributing diesel fuel that does not meet the sulfur standards, or causing others to commit prohibited acts. In addition, parties would be liable for a failure to meet certain affirmative requirements, or causing others to fail to meet affirmative requirements. All parties in the diesel fuel distribution system, including refiners, importers, distributors, carriers, retailers, and wholesale purchaser-consumers, would be liable for a failure to fulfill the recordkeeping requirements and the PTD requirements.

a. Presumptive Liability Scheme of Current EPA Fuels Programs

All EPA fuels programs include a presumptive liability scheme for violations of prohibited acts. Under this approach, liability is imposed on two types of parties: (1) The party in the fuel distribution system that controls the facility where the violation was found or had occurred; and (2) those parties, typically upstream in the fuel distribution system from the initially listed party, (such as the refiner, reseller, and any distributor of the fuel), whose prohibited activities could have caused the program non-conformity to exist.[178] This presumptive liability scheme has worked well in enabling us to enforce our fuels programs, since it creates comprehensive liability for substantially all the potentially responsible parties. The presumptions of liability may be rebutted by establishing an affirmative defense.

To clarify the inclusive nature of these presumptive liability schemes, today's proposed rule would explicitly include causing another person to commit a prohibited act and causing the presence of non-conforming diesel fuel (or kerosene or other additives for motor vehicle use) to be in the distribution system as prohibitions. This is consistent with the provisions and implementation of other fuels programs.

Today's proposed rule, therefore, provides that most parties involved in the chain of distribution would be subject to a presumption of liability for actions prohibited, including causing non-conforming diesel fuel to be in the distribution system and causing violations by other parties. Like the other fuels regulations, a refiner also would be subject to a presumption of vicarious liability for violations by any downstream facility that displays the refiner's brand name, based on the refiner's ability to exercise control at these facilities. Carriers, however, would be liable only for violations arising from product under their control or custody, and not for causing non-conforming diesel fuel to be in the distribution system, except where specific evidence of causation exists.

b. Affirmative Defenses for Liable Parties

The proposal includes affirmative defenses for each party that is deemed liable for a violation, and all presumptions of liability are refutable. The proposed defenses are similar to the defenses available to parties for violations of the RFG regulations. We believe that these defense elements set forth reasonably attainable criteria to rebut a presumption of liability. The defenses include a demonstration that: (1) The party did not cause the violation; (2) the party has PTDs indicating that the fuel was in compliance at its facility; and (3) except for retailers and wholesale purchaser-consumers, the party conducted a quality assurance program. For parties other than tank truck carriers, the quality assurance program would be required to include periodic sampling and testing of the diesel fuel. For tank truck carriers, the quality assurance program would not need to include periodic sampling and testing, but in lieu of sampling and testing, the carrier would be required to demonstrate evidence of an oversight program for monitoring compliance, such as appropriate guidance to drivers on compliance with applicable requirements and the periodic review of records concerning diesel fuel quality and delivery.

As in the other fuels regulations, branded refiners would be subject to more stringent standards for establishing a defense because of the control such refiners have over branded downstream parties. Under today's rule, in addition to the other presumptive liability defense elements, branded refiners would be required to show that the violation was caused by an action by another person in violation of law, an action by another person in violation of a contractual agreement with the refiner, or the action of a distributor not subject to a contract with the refiner but engaged by the refiner for the transportation of the diesel fuel.

Based on experience with other fuels programs, we believe that a presumptive liability approach would increase the likelihood of identifying persons who cause violations of the sulfur standards. We normally do not have the information necessary to establish the cause of a violation found at a facility downstream of the refiner or importer. We believe that those persons who actually handle the fuel are in the best position to identify the cause of the violation, and that a refutable presumption of liability would provide an incentive for parties to be forthcoming with information regarding the cause of the violation. In addition to identifying the party that caused the violation, providing evidence to rebut a presumption of liability would serve to establish a defense for the parties who are not responsible. Presumptive liability is familiar to both industry and to EPA, and we believe that this approach would make the most efficient use of EPA's enforcement resources. For these reasons, we are proposing a liability scheme for the diesel fuel sulfur program based on a presumption of liability. We request comment on the proposed liability provisions.

c. Penalties for Violations

Section 211(d)(1) of the CAA provides for penalties for violations of the fuels regulations.[179] Today's rule proposes penalty provisions that would apply this CAA penalty provision to the diesel fuel sulfur rule. The proposal would subject any person who violates any requirement or prohibition of the diesel fuel sulfur rule to a civil penalty of up

[178] An additional type of liability, vicarious liability, is also imposed on branded refiners under these fuels programs.

[179] Section 211(d)(1) reads, in pertinent part: ''(d)(1) Civil Penalties.—Any person who violates . . the regulations prescribed under subsection (c) . . of this section . . shall be liable to the United States for a civil penalty of not more than the sum of $25,000 for every day of such violation and the amount of economic benefit or saving resulting from the violation. . . . Any violation with respect to a regulation prescribed under subsection (c). . . of this section which establishes a regulatory standard based upon a multi-day averaging period shall constitute a separate day of violation for each and every day in the averaging period. . . . '' Pursuant to the Debt Collection Improvement Act of 1996 (31 U.S.C. 3701 note), the maximum penalty amount prescribed in section 211(d)(1) of the CAA was increased to $27,500. (See 40 CFR part 19.)

to $27,500 for every day of each such violation and the amount of economic benefit or savings resulting from the violation. A violation of a sulfur cap standard would constitute a separate day of violation for each day the diesel fuel giving rise to the violation remains in the diesel fuel distribution system. The length of time the diesel fuel in question remains in the distribution system would be deemed to be twenty-five days unless there is evidence that the diesel fuel remained in the diesel fuel distribution system for fewer than or more than twenty-five days. The penalty provisions proposed in today's rule are similar to the penalty provisions for violations of the RFG regulations and the Tier 2 gasoline sulfur rule. EPA requests comment on these provisions.

9. How Would Compliance with the Diesel Sulfur Standards Be Determined?

We have often used a variety of evidence to establish non-compliance with the requirements imposed under our current fuels regulations. Test results of the content of diesel fuel or gasoline have been used to establish violations, both in situations where the sample has been taken from the facility at which the violation occurred, and where the sample has been obtained from other parties' facilities when such test results have had probative value of the fuel's characteristics at points upstream or downstream. The Agency has also commonly used documentary evidence to establish non-compliance or a party's liability for non-compliance. Typical documentary evidence has included PTDs identifying the fuel as inappropriate for the facility it is being delivered to, or identifying parties having connection with the non-complying fuel.

We propose that compliance with the sulfur standards would be determined based on the sulfur level of the diesel fuel, as measured using the regulatory testing method. We further propose that any evidence from any source or location could be used to establish the diesel fuel sulfur level, provided that such evidence is relevant to whether the sulfur level would have been in compliance if the regulatory sampling and testing methodology had been correctly performed.

Compliance with the standard would be determined using the specified sampling and test methodologies. While other information could be used, including test results using different test methods, such other information may only be used if it is relevant to determining whether the sulfur level would meet the standard had compliance been properly measured using the specified test method. The proposal would establish the regulatory test method as the benchmark against which other evidence is measured. EPA intends to use the regulatory test method for enforcement testing purposes.

Today's proposal is consistent with the approach adopted in the Tier 2 gasoline sulfur rule (65 FR 6698, February 10, 2000). EPA intends to undertake rulemaking in the near future to revise the current fuels regulations to include the same language for the use of other evidence as is proposed today. We seek comment on this approach.

The proposed rule would also clarify that any probative evidence obtained from any source or location may be used to establish non-compliance with requirements other than the sulfur standard, such as recordkeeping requirements, as well as to establish which parties have facility control or some other basis for liability for sulfur rule noncompliance. Since proof of these elements is not predicated on establishing sulfur levels, whether or not regulatory test methods are used is not significant. EPA is seeking comment on this approach for monitoring and determining compliance with the applicable requirements.

To ensure the effectiveness and the ability to adequately enforce the sulfur standards, it is reasonable for EPA to consider evidence other than actual test results using the regulatory test method, where such evidence can be related to the test results. As described above, test results using the regulatory test method are often not available. In such circumstances, it is reasonable to consider other evidence of compliance, such as test results using other methods or commercial documents, if such evidence can be shown to be relevant to determining whether the diesel fuel would meet the standard if tested using the regulatory methods. The proposal would only permit the use of other evidence that is relevant to such a determination, and is therefore reasonably limited to allow for effective enforcement, without creating uncertainty about compliance.

B. Lubricity

We strongly encourage, but do not believe it necessary to require, fuel producers and distributors to voluntarily monitor and provide diesel fuel with lubricity characteristics at least as good as those of current fuel. We believe this voluntary action is reasonable and has a high likelihood of success, because the issues surrounding the impact of sulfur reduction on lubricity are well established. Refiners and distributors have an incentive to supply fuel products that will not damage or create problems with consumer equipment. For a further discussion of diesel fuel lubricity, and why we believe a voluntary approach will be effective, please refer to the earlier discussion in section IV.D.6. We request comment on this approach, on whether or not a regulatory requirement is needed, and on whether there are concerns unique to the military.

C. Would States Be Preempted from Adopting Their Own Sulfur Control Programs for Highway Diesel Fuel?

When we adopt federal fuel standards, states are preempted from adopting state-level controls with respect to the same fuel characteristics or components. Section 211(c)(4)(A) of the CAA prohibits states from prescribing or attempting to enforce controls or prohibitions respecting any fuel characteristic or component if EPA has prescribed a control or prohibition applicable to such fuel characteristic or component under section 211(c)(1) of the Act. This preemption applies to all states except California, as explained in section 211(c)(4)(B) of the Act. For states other than California, the Act provides two mechanisms for avoiding preemption. First, section 211(c)(4)(A)(ii) creates an exception to preemption for a state prohibition or control that is identical to a prohibition or control adopted by EPA. Second, a state may seek EPA approval of a SIP revision containing a fuel control measure, as described in section 211(c)(4)(C) of the Act. EPA may approve such a SIP revision, and thereby ''waive'' preemption, only if it finds the state control or prohibition ''is necessary to achieve the national primary or secondary ambient air quality standard which the plan implements.''

When we adopted the current diesel fuel sulfur standards pursuant to our authority under section 211(c)(1) of the Act in 1990, States were preempted from also doing so under the provisions of section 211(c)(4)(A). The diesel sulfur standards proposed today merely modify the existing standards and as a result do not initiate any new preemption of State authority. The provisions of this proposal would merely continue the already existing State preemption provisions with respect to highway diesel fuel sulfur.

D. Refinery Air Permitting

Prior to making diesel desulfurization changes, some refineries could be required to obtain a preconstruction permit, under the New Source Review (NSR) program, from the applicable state/local air pollution control agency.[180] We believe that today's proposal provides sufficient lead time for refiners to obtain any necessary NSR permits well in advance of the proposed compliance date. For the recently promulgated gasoline sulfur control program, refiners had expressed concerns that permit delays might impede their ability to meet compliance dates. EPA committed to undertake several actions to minimize the possibility of any delays for refineries obtaining major NSR permits for gasoline desulfurization projects. These actions include providing federal guidance on emission control technologies and the appropriate use of motor vehicle emission reductions (resulting from the use of low sulfur fuel), where available, as emission offsets, as well as forming EPA permit teams to assist states in quickly resolving issues, where needed. These three items are discussed in more detail in the Tier 2 final rule and interested parties should refer to that discussion for additional details regarding permitting considerations in the gasoline sulfur program (see 65 FR 6773, Feb. 10, 2000).

However, given that the proposed diesel sulfur program would provide several more years of lead time than was provided under the gasoline sulfur program, refiners should have ample time to obtain any necessary preconstruction permits. As we learned in finalizing the gasoline sulfur program, state/local permitting agencies are prepared to process refinery permits within the needed time frames, so long as refiners begin discussing potential permit issues with them early in the process and submit their permit applications in a timely manner. EPA believes that this will be the case for diesel fuel. We request comment on the interaction of this proposed rule and the permitting process and whether the permitting approaches discussed in the Tier 2 final rule should be continued, and if necessary updated, to assist refineries in obtaining any necessary permits for refinery diesel desulfurization changes.

[180] Hydrotreating diesel fuel involves the use of process heaters, which have the potential to emit pollutants associated with combustion, such as NO_X, PM, CO and SO2. In addition, reconfiguring refinery processes to add desulfurization equipment could increase fugitive VOC emissions. The emissions increases associated with diesel desulfurization will vary widely from refinery to refinery, depending on many source-specific factors, such as crude oil supply, refinery configuration, type of desulfurization technology, amount of diesel fuel produced, and type of fuel used to fire the process heaters.

E. Provisions for Qualifying Refiners

As explained in the Regulatory Flexibility Analysis discussion in section XI.B of this document, we have considered the impacts of these proposed regulations on small businesses. As part of this process, we convened a Small Business Advocacy Review Panel (Panel) for this proposed rulemaking, as required under the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA). The Panel was charged with reporting on the comments of small business representatives regarding the likely implications of possible control programs, and to make findings on a number of issues, including:

- A description and estimate of the number of small entities to which the proposed rule would apply;
- A description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule;
- An identification of other relevant federal rules that may duplicate, overlap, or conflict with the proposed rule; and
- A description of any significant alternatives to the proposed rule that accomplish the objectives of the proposal and that may minimize any significant economic impact of the proposed rule on small entities.

The Panel's final report is available in the docket. In summary, the Panel concluded that small refiners would likely be directly affected by the proposed program.

In addition, the Panel concluded that small diesel distributors and retailers also would likely be directly affected by the fuel program's compliance requirements, but that under the approach we are proposing today these requirements would pose minimal burden. Therefore, the Panel did not recommend any regulatory relief for this group of small businesses under the program proposed today.

We understand that the proposed low sulfur standards will require significant economic investment by the refining industry. We also recognize that refineries owned by small businesses could experience more difficulty in complying with the proposed standards on time because, as a group, they have less ability to raise capital necessary for desulfurization investments, face proportionately higher costs due to economies of scale, and may be less successful in competing for limited construction and engineering resources. Some of the small refiners with whom we and the Panel met indicated their belief that, because of the extreme level of economic hardship their businesses would face in meeting the new standards, their businesses might close without additional time to comply or certain flexibility alternatives. The Panel recommended that EPA seek comment on various flexibilities that potentially could alleviate the burden on small refiners.

Upon evaluating the potential impacts of our proposed diesel sulfur requirements on small refiners and careful review of the Panel's recommendations, we are seeking comment on three approaches that could provide flexibility for small refiners. We believe that these approaches could provide meaningful flexibility for small refiners in meeting the proposed standards, although we do have concerns that certain approaches, to varying extents, may compromise the environmental benefits of the program (as discussed below), while still ensuring that the vast majority of the program is implemented as expeditiously as practical in order to achieve the air quality benefits sooner. Therefore, we invite comment on the appropriateness of any or all of these approaches in light of the environmental goals, the relative usefulness in allowing additional time and flexibility for small refiners to comply with the proposed low sulfur targets, and information and ideas on appropriate implementation mechanisms. These approaches are summarized in subsection 1 below.

Elsewhere, in section VI, we seek comment on various alternatives for phasing in the fuel program. Some small refiners have commented that some form of a phase-in approach could potentially mitigate the hardship they would experience under the proposed fuel standards. (See the discussion in section VI for a discussion of the potential impacts of a phase-in approach on entities in the distribution system).

In addition to considering the following flexibility approaches for small refiners, we are interested in exploring appropriate flexibility options for farmer cooperatives. There are currently four refiner co-ops, yet only one meets SBA's definition of a small business. The farmer cooperatives have expressed concern that they have the same difficulty as small refiners in obtaining access to capital for desulfurization investments. Farmers are both the customer and the member owner of their cooperatives. Because cooperatives do not have an investor/stockholder form of ownership, they are not able to access equity markets that provide capital to larger refiners. The added costs of financing projects through traditional loans is eventually borne by farmers. The refiner co-ops have also expressed concern that the highway diesel sulfur program could result in higher fuel prices for farmers, and could potentially reduce refining capacity and diesel fuel supply in rural America. To help address these concerns, we are requesting comment on the following flexibility approaches for farmer cooperatives as well. We also seek comment on other appropriate flexibility approaches for farmer cooperatives that may have merit.

1. Allow Small Refiners to Continue Selling 500 ppm Highway Diesel

First, we are seeking comment on an option for small refiner flexibility that would allow small refiners to continue selling their current 500 ppm highway diesel, provided there are adequate safeguards to prevent contamination and misfueling. This option would effectively delay the ultra-low sulfur compliance date for small refiners, and allow them to continue selling their current fuel to the highway diesel market. Under this approach, retailers would not have an availability requirement; rather, retailers would be free to choose to sell only 500 ppm fuel (from small refiners), only ultra-low sulfur fuel, or both.

During the Panel process, small refiners expressed varying views on this flexibility approach. At least one small refiner supported this option, while others expressed the concern that they would not be able to find markets for the 500 ppm fuel once large refiners begin producing exclusively ultra-low sulfur highway diesel (*i.e.*, as soon as the rule were implemented). Those small refiners doubtful of continued 500 ppm markets think it is unlikely that retailers would either continue to sell only 500 ppm diesel instead of ultra-low sulfur, or that retailers would make the investments to market both grades. Their key assumption is that there would be no price differential between the ultra-low sulfur fuel and the 500 ppm fuel and, thus, no incentive for marketers to want the ''old'' fuel. Small refiners noted that, although ultra-low sulfur fuel would be more costly to produce than the current grade, vertically integrated refiners with control over the marketing of their refinery products would have incentives to price below cost in order to eliminate the potential for niche markets that would be of value to any small refiners seeking to avail themselves of this flexibility option. Small diesel distributors and retailers commented that marketers also don't anticipate a price differential, but acknowledged that a market for small refiner's 500 ppm likely would last as long as there were a price differential. Nevertheless, most small refiners with whom we and the Panel met strongly supported this option, largely because it potentially could benefit at least a few small refiners. At the same time, they believed it should not be the only flexibility option provided for small refiners. We believe that seeking public comment on this option will give all small refiners an opportunity to continue exploring the extent of potential markets for the 500 ppm fuel, and thus, the potential viability of this flexibility option.

We also request comment on an appropriate duration for this option. We seek comment on the need for, and appropriateness of, an unlimited exemption, as well as whether such an exemption should be limited to a specific timeframe (*e.g.*, two years, ten years, etc.). We note that by limiting this flexibility to two years, for example, during which time the new vehicle fleet would still be relatively small, the potential for misfueling would be minimized. We also question how long this flexibility option may remain viable, since many small refiners commented during the Panel process that they do not expect markets for the 500 ppm fuel to remain after larger refiners begin producing exclusively ultra-low sulfur fuel. Nevertheless, we request comment on the need for, and potential impacts of, a longer exemption. A longer duration for this flexibility option would give participating refiners more time to stagger their diesel desulfurization investments. The number of vehicles potentially affected by misfueling or contamination would still be fairly limited under this approach, since small refiners produce only approximately four percent of all the highway diesel fuel produced in the U.S. Moreover, the potential for misfueling would be further limited because most small refiners distribute highway diesel in a fairly local area. (Some small refiners, however, distribute a portion of their diesel fuel outside their local area via pipeline or barge. See further discussion below about the potential need to prohibit pipeline/barge shipments of 500 ppm highway diesel under this option). An unlimited exemption would allow the market to determine the duration of flexibility provided to small refiners. There would be diminishing returns to small refiners from such an option over time, as a growing portion of the vehicle miles traveled would be from vehicles with emission control devices requiring ultra-low sulfur, and so small refiners would eventually switch over to producing low sulfur highway diesel fuel.

To ensure that this flexibility option would not compromise the expected environmental benefits of today's proposal, there would have to be certain safeguards with refiners as well as downstream parties to prevent contamination of the ultra-low sulfur fuel, and to prevent misfueling of new vehicles. We seek comment on how best to prevent misfueling and contamination of the ultra-low sulfur fuel under this approach for small refiner flexibility. Specifically, we request comment on the following measures to prevent misfueling and contamination:

- Small refiners could make an initial demonstration to EPA of how they would ensure the fuel remains segregated through the distribution system to its end use.
- Small refiners could be prohibited from distributing 500 ppm highway diesel via pipeline or barge. As the fuel is piped or barged to locations further from the refinery, it would likely become more difficult to ensure proper segregation and labeling. We have learned through the Panel process that most small refiners distribute highway diesel in a fairly local area; it appears that only a few small refiners distribute highway diesel via pipeline or barge. All small refiners (even those that distribute highway diesel via pipeline or barge) also distribute fuel to the local area, which should provide adequate potential markets for the 500 ppm fuel. This provision may be less necessary in the context of a broader program, such as the approaches discussed in section VI.A.
- There could be some general requirements on any entities carrying the fuel downstream of the refiner, such as a condition to keep the fuel segregated and maintain records (e.g., product transfer documents).
- Retailers who choose to sell the 500 ppm fuel could be required to label pumps, clearly indicating that the fuel is higher sulfur and should not be used in new (*e.g.*, 2007 model year or later) diesel vehicles.

We also seek comment on how to best prevent small refiners from increasing the refinery's production capacity (selling 500 ppm highway diesel under such a program) without also increasing the refinery's desulfurization capacity. Specifically, we request comment on whether it would be appropriate and necessary to limit the volume of 500 ppm highway fuel produced by a refinery owned by a small refiner to the lesser of: (1) 105 percent of the highway volume it produced on average in 1998 and 1999; or (2) the volume of highway diesel fuel produced from crude oil on average in the calendar year. Such limits to a small refiner's 500 ppm production expansion could also serve to limit the potential for fuel shortages of the ''new'' fuel in local areas where small refiners have or will gain significant market share as a result being allowed to continue producing and selling 500 ppm highway diesel fuel. This issue is discussed further below.

We believe that safeguards such as these would add minimal burden on small refiners or any party choosing to distribute or sell small refiner highway diesel, but would be critical to preventing misfueling and potential damage to new vehicles—and thus critical to preserving the environmental benefits of the program. These types of safeguards are typical of EPA fuel programs where more than one fuel is introduced into commerce.

We also would need to ensure that this type of flexibility would not result in lack of availability of low sulfur highway diesel in markets served primarily by small refiners. We seek comment on whether there is a potential for lack of availability of the low sulfur fuel under this approach and, if so, how to prevent this.

Finally, we seek comment on the appropriate definition of a small refiner under such a program. If such a flexibility option is promulgated under the final rule, EPA would envision considering a refiner as a small refiner if both of the following criteria are met:

- No more than 1500 employees corporate-wide, based on the average number of employees for all pay periods from January 1, 1999 to January 1, 2000.
- A corporate crude capacity less than or equal to 155,000 barrels per calendar day (bpcd) for 1999.

In determining the total number of employees and crude capacity, a refiner would include the employees and crude capacity of any subsidiary companies, any parent company and subsidiaries of the parent company, and any joint venture partners. This definition of small refiner mirrors the one recently promulgated under the Tier 2/gasoline sulfur program, except that the time period used to determine the employee number and crude capacity criteria has been updated to reflect the most recent calendar year. This is consistent with the Small Business Administration's regulations, which specify that, where the number of employees is used as a size standard, the size determination is based on the average number of employees for all pay periods during the preceding 12 months (13 CFR 121.106). However, because the gasoline sulfur standards and the proposed diesel sulfur standards would impact small refiners in relatively the same timeframes, we believe it is reasonable to consider any small refiner approved by EPA as meeting the small refiner definition under the gasoline sulfur program (40 CFR 80.235) as a small refiner under the highway diesel sulfur rule as well. We request comment on this provision.

2. Temporary Waivers Based on Extreme Hardship Circumstances

We are also seeking comment on a case-by-case approach to flexibility that would provide a process for all domestic and foreign refiners, including small refiners, to seek case-by-case approval of applications for temporary waivers to the diesel sulfur standards, based on a demonstration of extreme hardship circumstances. Small refiners have expressed their belief that there may be no ''one size fits all'' approach to flexibility—given the wide variety of refinery circumstances and configurations. Although this option was first raised in the context of small refiner flexibility during the Panel process, we believe that it could be extended to any qualifying refiner meeting the criteria described below. We recognize that there may be case-by-case flexibilities that are feasible, environmentally neutral, and warranted to meet the unique needs of an individual refiner, but that, if applied across the board, might jeopardize the environmental benefits of the program. This provision would further our overall environmental goals of achieving low sulfur highway diesel fuel as soon as possible. By providing short-term relief to those refiners that need additional time because they face hardship circumstances, we can adopt a program that reduces diesel sulfur beginning in 2006 for the majority of the industry that can comply by then. We envision that this option would be modeled after a similar provision in the recently-promulgated gasoline sulfur program. This case-by-case provision could be in addition to or in place of the small refiner option discussed above.

We understand that the ultra-low sulfur standards for highway diesel fuel will require significant economic investments by the refining industry. We recognize that refineries owned by small businesses could experience more difficulty in complying with the standards on time because, as a group, they have less ability to raise capital necessary for desulfurization investments, face proportionately higher costs due to economies of scale, and may be less successful in competing for limited construction and engineering resources. However, because the refining industry encompasses a wide variety of individual circumstances, it is possible that other refiners also may face particular difficulty in complying with the proposed sulfur standards on time. For example, as discussed above the farmer cooperatives have expressed concern that they would face considerable difficulty in obtaining access to capital for desulfurization investments. Because farmer cooperatives do not have an investor/stockholder form of ownership, they are not able to access equity markets that provide capital to larger refiners; thus, the added costs of financing projects through traditional loans is eventually borne by farmers.This option would allow any refiner to request additional flexibility based on a showing of unusual circumstances that result in extreme hardship and significantly affect the refiner's ability to comply by the applicable date, despite its best efforts. However, we would not intend for this waiver provision to encourage refiners to delay planning and investments they would otherwise make in anticipation of receiving relief from the applicable requirements.

An example of case-by-case flexibility under this approach might be to allow a refiner to continue selling 500 ppm highway diesel fuel for an extended time period, so long as that fuel were properly segregated and labeled at pump stands (see the discussion of possible compliance measures in section E.1. above).

To further preserve the environmental benefits of the program, recognizing the constraints it places on any flexibility, we currently believe that it would be necessary to segregate the fuel pool for any highway diesel fuel sold under an approved hardship waiver. Consequently, any additional compliance flexibilities would carry with them certain safeguards for preventing contamination and misfueling. We welcome comment on these compliance measures and any other alternatives. These provisions would be analogous to those discussed above under section E.1. Further, as part of such a flexibility, we would need to ensure that there was not a significant potential for lack of availability of the low sulfur fuel for those refiners that are the primary supplier of highway diesel fuel in a given area (as discussed in section E.1 above). We seek comment on whether there is a significant potential for lack of availability of the low sulfur fuel under this approach and, if so, how to prevent this situation.

During the Panel process, several small refiners that produce both gasoline and highway diesel expressed concern about the difficulty in obtaining financing for the significant capital costs of desulfurizing both these fuels in relatively the same timeframes. Similar concerns have been expressed by farmer cooperatives and other refiners. Small refiners suggested that they might be able to desulfurize highway diesel fuel under the schedule proposed today, if additional flexibility could be provided in meeting the gasoline sulfur standards, which would allow them to stagger their investments. We estimate that approximately nine small refiners (owning 11 refineries) would be subject to both the gasoline and highway diesel sulfur standards. As another example of case-by-case flexibility under the hardship approach, we request comment on whether and to what extent we should consider additional flexibilities in meeting the gasoline sulfur standards, for those refiners that produce both gasoline and highway diesel fuel, and meet the highway diesel fuel standards on time. For example, we invite comment on whether it would be necessary and appropriate to take into consideration compliance with the diesel sulfur rule as part of a small refiner's application demonstrating significant economic hardship under the gasoline sulfur program's small refiner hardship extension provision (40 CFR 80.260). In evaluating applications for any case-by-case consideration of additional flexibility under the gasoline sulfur program, we would fully consider the environmental consequences of such an approach. For example, we would consider such factors as the relative volumes of gasoline and highway diesel fuel produced by the refiner, where these fuels are sold, and the projected emission impacts of vehicles using the refiner's gasoline and diesel fuels. If we were to consider such a case-by-case approach to compliance under the gasoline and diesel sulfur programs, we believe the gasoline sulfur program requirements may have to be changed to allow for the consideration of appropriate criteria related to compliance with the highway diesel sulfur rule. We seek comment on how such an approach could be accommodated under the gasoline sulfur program and the environmental implications of this approach. We also seek comment on the criteria that should be considered in granting gasoline hardship relief based on early diesel compliance.

Small refiners have recommended that the Agency could provide some flexibility by granting the hardship extension on an automatic, rather than case by case basis, if they agree to meet the highway diesel sulfur standards at the same time as the national program. They commented that this approach would provide more certainty for their planning purposes in determining how to comply with the requirements of both programs. The gasoline sulfur program provides that small refiners can apply for and receive an extension of their interim standards, if we determine that the small refiner has made the best efforts possible to achieve compliance with the national standards by January 1, 2008, but has been unsuccessful for unanticipated reasons beyond its control. We would consider granting the hardship extension for a time period not to extend beyond calendar year 2009, based on several factors, including the small refiner's compliance plan and demonstration of progress toward producing gasoline meeting the national sulfur standards by the end of 2009. (See 40 CFR 80.255 and 80.260). We have concerns about making the small refiner gasoline hardship extension ''automatic'', as this approach could undermine some of the environmental benefits of the Tier 2/gasoline sulfur program, and is not consistent with the purpose of the hardship extension. We would need to consider the environmental impacts of such an extension, by evaluating, for example, the small refiners' relative production of highway diesel fuel as compared to gasoline and the air quality concerns in the locations where both products are sold. We believe it would be more environmentally protective to make this determination on a case-by-case basis. Nevertheless, we seek comment on the approach of granting a small refiner an automatic hardship extension under the gasoline sulfur program if they demonstrate that they will comply on time with the national program for highway diesel fuel. We also seek comment on whether this approach should be applied on a case-by-case, rather than automatic, basis.

As another example of case-by-case flexibility under this approach, we request comment on whether it would be appropriate, as part of a review of a refiner's application for hardship relief under the diesel sulfur program, to consider granting a delay of diesel sulfur standards for those refiners that agree to meet the gasoline sulfur standards under a schedule more accelerated than that required under the gasoline sulfur program. Any consideration of such delays would require full consideration of the environmental implications of such a delay, as well as of other relevant factors.

There are several factors we would consider in evaluating an application for a hardship waiver. These factors could include refinery configuration, severe economic limitations, and other factors that prevent compliance in the lead time provided. Applications for a waiver would need to include information that would allow us to evaluate all appropriate factors. We would consider the total crude capacity of the refinery and its parent corporation, whether the refinery configuration or operation is unique or atypical, how much of a refinery's diesel is produced using an FCC unit, its hydrotreating capacity relative to its total crude capacity, highway diesel production relative to other refinery products, and other relevant factors. A refiner also may face severe economic limitations that result in a demonstrated inability to raise the capital necessary to make desulfurization investments by the compliance date, which could be shown by an unfavorable bond rating, inadequate resources of the refiner and its parent and/or subsidiaries, or other relevant factors. Finally, we would consider where the highway diesel would be sold in evaluating the environmental impacts of granting a waiver. We seek comment on these criteria for evaluating a refiner's hardship application, and on whether there are other criteria that should also be considered.

This hardship provision would be intended to address unusual circumstances, such as unique and atypical refinery operations or a demonstrated inability to raise capital. These kinds of circumstances should be apparent soon after the final rule is promulgated, so refiners seeking additional time under this provision should be able to apply for relief within a relatively short timeframe (e.g., nine months to one year) after promulgation of the final rule. We request comment on an appropriate timeframe for refiners to submit hardship applications to EPA. A refiner seeking a waiver would need to show that unusual circumstances exist that impose extreme hardship and significantly affect its ability to meet the standards on time, and that it has made best efforts to comply with the standards. Applicants for a hardship waiver also would need to submit a plan demonstrating how the standards would be achieved as expeditiously as possible. The plan would need to include a timetable for obtaining the necessary capital, contracting for engineering and construction resources, and obtaining permits. We request comment on the information that should be contained in a hardship application, as well as the demonstrations that refiners should be required to make in such applications. Once all applications are received, we would consider the appropriate process to follow in reviewing and acting on applications, including whether to conduct a notice and comment decision-making process. We would review and act on applications, and, if a waiver were granted, would specify a time period for the waiver.

During the SBREFA Panel process, small refiners commented that they need certainty as to their regulatory requirements, and any flexibilities, well in advance of compliance dates so that they can seek financing. Therefore, we also seek comment on how such a hardship provision could be administered in a manner that provides the most certainty to small refiners as to any potential hardship relief, well in advance of the compliance deadline. Specifically, we request comment on an appropriate timeframe within which the Agency should respond to hardship applications (for example, one year from the date of receipt).

Because of the significant environmental benefits of lowering sulfur in highway diesel fuel, we would administer any hardship provision in a manner that continues to ensure the environmental benefits of the regulation. To limit the potential environmental impact of this hardship provision, we would reserve the discretion to deny applications where we find that granting a waiver would result in an unacceptable environmental impact. While any hardship determination would be made on a case-by-case basis, we would not anticipate granting waivers that apply to more than a minimal amount of the total national pool of highway diesel fuel, or to more than a minimal percentage of the highway diesel supply in an area with significant air quality problems. The level of this minimal amount of fuel would be considered in light of any additional flexibility options provided for refiners and would be established in a way that maintains the environmental goals of the program.

As a condition of any waiver granted, we would likely impose other reasonable requirements, such as anti-backsliding requirements to ensure no deterioration in the sulfur level of highway diesel fuel produced, or limitations on the volume of highway diesel fuel produced under the waiver (e.g., at or near current production levels). This latter measure would prevent refiners from increasing the refinery's production capacity without also increasing the desulfurization capacity. Specifically, we would limit the volume of highway diesel produced by a refinery covered by a hardship waiver to the lesser of: (1) 105 percent of the highway volume it produced on average in 1998 and 1999; or (2) the volume of highway diesel fuel produced from crude oil on average in the calendar year. We request comment on the need for such a hardship provision and how it should be structured.

3. 50 ppm Sulfur Cap for Small Refiners

In section IV.B, we fully discuss the basis for the 15 ppm sulfur standard proposed, based on the needs of diesel engine technology and on the criteria mandated by the Clean Air Act, and we seek comment on this level. In section III.F, we also discuss the level of sensitivity these new emission control technologies have to sulfur in the fuel, and potential consequences of the vehicles using fuel with a sulfur content higher than that proposed.

During the Panel process, small refiners expressed strong concern about their ability to meet a sulfur standard in the 5 to 40 ppm range discussed. Several small refiners have commented that capital, operating, and maintenance costs of meeting a 50 ppm cap are significantly less than the costs of meeting more stringent standards. Because small refiners produce relatively smaller volumes, their capital (and other fixed) costs per barrel produced are significantly higher than their larger competitors. They also cannot take advantage of the significant economies of scale that exist in the refining industry and may be less successful in competing for limited construction and engineering resources. Small refiners have suggested that a 50 ppm may afford them the flexibility to purchase sufficient blendstocks on the market to blend with their production and still comply with a 50 ppm cap. However, at the proposed 15 ppm standard this flexibility may no longer exist. Nevertheless, they are still interested in the Agency considering a cap for small refiners of 50 ppm. Therefore, we request comment on a 50 ppm cap for small refiners, and on any underlying data and analyses that would be relevant to a decision in the final rule on whether to incorporate a 50 ppm cap for small refiners. For this approach to work, to keep from damaging the vehicle exhaust emission control technologies and also maintain their effectiveness (as discussed in section III.F.), small refiner's fuel would somehow have to be blended downstream of the refinery to 15 ppm (i.e., in the distribution system). However, we question whether small refiners' 50 ppm fuel could simply be "blended away" with ultra-low sulfur fuel in the distribution system (i.e., after the fuel leaves the refiner's control). Information submitted by small refiners indicates that most sell highway diesel fuel directly via the refinery rack, for distribution to local truck stops, service stations, and fleet customers. Only a few small refiners distribute highway diesel via pipelines. Therefore, small refiners' highway diesel fuel indeed would go directly into vehicles, and commonly would not be "blended" to a significant extent with other refiners' fuel within the distribution system (*i.e.*, downstream of the refinery). Nevertheless, we believe it is appropriate to seek comment on this approach, and welcome any data and analyses that would influence a final decision about this approach.

IX. Standards and Fuel for Nonroad Diesel Engines

Although today's proposal covers only highway diesel engines and highway diesel fuel, our potential plans for nonroad diesel engines—and especially the sulfur content of nonroad diesel fuel—are clearly related. For example, depending on whether and how nonroad diesel fuel is regulated, factors including the costs, leadtime, environmental impacts, and impacts on competitive relationships in the marketplace associated with today's proposed program could be affected. We would need to address these factors in any future regulatory action on nonroad diesel fuel.

Because of these relationships, various stakeholders interested in today's proposal have asked to also know the potential requirements that could apply to nonroad diesel fuel. This section summarizes the background of this issue and our current thinking about future regulation of nonroad diesel engines and fuel.

After establishing an initial set of emission standards for nonroad diesel engines in 1994, EPA proposed in 1997, and finalized in 1998, a comprehensive program of emission standards for most diesel engines designed for nonroad use.[181] This program established $NMHC+NO_X$ and PM standards that are phasing in over the 1999–2006 time frame, with engines of different

[181] See the final rule, 63 FR 56968, October 23, 1998 for more about the history of these regulations.

horsepower ranges coming into the program in different years. At the same time, we set long-term (''Tier 3'') $NMHC+NO_X$ standards—but not PM standards—for medium and high horsepower engines, to begin in 2006. Built into the 1998 final rule was a plan to reassess the Tier 3 $NMHC+NO_X$ standards and to establish PM standards in the 2001 time frame. The 1998 rule also anticipated an EPA reassessment of the Tier 2 $NMHC+NO_X$ standards for the smaller engines (less than 50 horsepower), which are to be phased in beginning in 2004.

EPA did not include nonroad diesel fuel in the diesel fuel sulfur restrictions established in 1993 for highway diesel fuel. We estimate that the average sulfur content for nonroad diesel fuel is currently around 3000 ppm, as compared to the cap for highway diesel fuel of 500 ppm.[182]

We believe that any specific new requirements for nonroad diesel fuel we might propose would need to be carefully considered in the context of a proposal for further nonroad diesel engine emission standards. This is because of the close interrelationship between fuels and engines—the best emission control solutions may not come through either fuel changes or engine improvements alone, but perhaps through an appropriate balance between the two. This is especially significant to the extent that manufacturers would need to address potential challenges related to simultaneously meeting the standards that may be proposed. Thus we need to address issues in both the fuel and engine arenas together.

The many issues connected with any rulemaking for nonroad engines and fuel warrant serious attention, and we believe it would be premature today for us to attempt to propose resolutions to them. We plan to initiate action in the future to formulate thoughtful proposals covering both nonroad diesel fuel and engines.

X. Public Participation

Publication of this document opens a formal comment period on this proposal. You may submit comments during the period indicated under **DATES** above. We encourage everyone who has an interest in the program described in this preamble and the associated rulemaking documents to offer comment on all aspects of the action. Throughout this proposal you will find requests for specific comment on various topics.

We consider and respond in the final rule to every comment we receive before the end of the comment period. We give equal weight to all comments regardless of whether they are submitted on paper, electronically, or in person at a public hearing. The most useful comments are generally those supported by appropriate and detailed rationales, data, and analyses. We also encourage commenters who disagree with the proposed program to suggest and analyze alternate approaches to meeting the air quality goals of this proposed program.

We have previously received many comments from a range of interested parties on our ANPRM and as part of the our outreach to small entities (see section XI.B). These comments are found in the docket, and information gathered from them is reflected in the proposal.

A. Submitting Written and E-mail Comments

If you would like to submit comments in writing, please send them to the contact listed in **FOR FURTHER INFORMATION CONTACT** above on or before the end of the comment period. You can send your comments by e-mail to the following address: diesel@epa.gov. It is usually best to include your comments in the body of the email message rather than as an attachment.

Commenters who wish to submit proprietary information for consideration should clearly separate such information from other comments. Such submissions should be clearly labeled as ''Confidential Business Information'' and be sent to the contact person in **FOR FURTHER INFORMATION CONTACT** (not to the public docket). This will help ensure that proprietary information is not placed in the public docket. If a commenter wants EPA to use a submission of confidential information as part of the basis for the final rule, then a nonconfidential version of the document that summarizes the key data or information must be sent to the contact person for inclusion in the public docket.

We will disclose information covered by a claim of confidentiality only to the extent allowed by the procedures set forth in 40 CFR part 2. If no claim of confidentiality accompanies a submission when we receive it, we will make it available to the public without further notice to the commenter.

B. Public Hearings

We will hold public hearings in New York City, NY, Chicago, IL, Atlanta, GA, Los Angeles, CA, and Denver, CO. See **ADDRESSES** near the beginning of this document for the locations of the hearings. If you would like to present testimony at one or more of the public hearings, we ask that you notify the contact person listed above ten days before the date of the hearing at which you plan to testify. We also suggest that you bring about fifty copies of the statement or material to be presented for the EPA panel and audience. In addition, it is helpful if the contact person receives a copy of the testimony or material before the hearing. An overhead projector and a carousel slide projector will be available.

The hearings will be conducted informally, and technical rules of evidence will not apply. We will, however, prepare a written transcript of each hearing. The official record of the hearings will be kept open until the end of the comment period to allow submittal of supplementary information. Each hearing will begin at 10:00 a.m. local time. In general, we expect to organize the hearings in a panel format, with representatives of several different perspectives on each panel. We will reserve the last part of each hearing for any previously unscheduled testimony. There will be a sign-in sheet, and we will hear the testimony of anyone signed in by 6:30 p.m. local time.

XI. Administrative Requirements

A. Administrative Designation and Regulatory Analysis

Under Executive Order 12866 (58 FR 51735, Oct. 4, 1993), the Agency is required to determine whether this regulatory action would be ''significant'' and therefore subject to review by the Office of Management and Budget (OMB) and the requirements of the Executive Order. The order defines a ''significant regulatory action'' as any regulatory action that is likely to result in a rule that may:

- Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or,
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

[182] Information from recent national fuel surveys by the National Institute for Petroleum and Energy Research (NIPER) and the Alliance of Automobile Manufacturers.

Pursuant to the terms of Executive Order 12866, EPA has determined that this proposal is a ''significant regulatory action'' because the proposed engine standards, diesel fuel sulfur standards, and other proposed regulatory provisions, if implemented, would have an annual effect on the economy in excess of $100 million. Accordingly, a Draft RIA has been prepared and is available in the docket for this rulemaking. This action was submitted to the OMB for review as required by Executive Order 12866. Written comments from OMB on today's action and responses from EPA to OMB comments are in the public docket for this rulemaking.

B. Regulatory Flexibility Act

The Regulatory Flexibility Act, 5 U.S.C. 601–612, was amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Public Law 104–121, to ensure that concerns regarding small entities are adequately considered during the development of new regulations that affect them. In response to the provisions of this statute, EPA has identified industries subject to this proposed rule and has provided information to, and received comment from, small entities and representatives of small entities in these industries. To accompany today's proposal, an Initial Regulatory Flexibility Analysis (IRFA) has been prepared by the Agency to evaluate the economic impacts of today's proposal on small entities.[183] The key elements of the IRFA include:

—The number of affected small entities;
—The projected reporting, recordkeeping, and other compliance requirements of the proposed rule, including the classes of small entities that would be affected and the type of professional skills necessary for preparation of the report or record;
—Other federal rules that may duplicate, overlap, or conflict with the proposed rule; and,
—Any significant alternatives to the proposed rule that accomplish the stated objectives of applicable statutes and that minimize significant economic impacts of the proposed rule on small entities.

The Agency convened a Small Business Advocacy Review Panel (the Panel) under section 609(b) of the Regulatory Flexibility Act as added by SBREFA. The purpose of the Panel was to collect the advice and recommendations of representatives of small entities that could be directly affected by today's proposed rule and to report on those comments and the Panel's findings as to issues related to the key elements of the IRFA under section 603 of the Regulatory Flexibility Act. The report of the Panel has been placed in the rulemaking record.[184] The IRFA can be found in the Draft RIA associated with today's proposal.

The contents of both today's proposal and the IRFA reflect the recommendations in the Panel's report. We summarize our outreach to small entities and our responses to the recommendations of the Panel below. The Agency continues to be interested in the potential impacts of the proposed rule on small entities and welcomes additional comments during the rulemaking process on issues related to such impacts.

1. Potentially Affected Small Businesses

Today's proposed program, which would establish new emission standards for heavy-duty engines and new standards for the sulfur content of highway diesel fuel, would directly affect manufacturers of heavy-duty engines and petroleum refiners that produce highway diesel fuel, respectively. In addition, but to a lesser extent, the program would directly affect diesel distributors and marketers.

We have not identified any manufacturers of heavy-duty engines that meet SBA's definition of a small business. However, we have identified several petroleum refiners that produce highway diesel fuel and meet the SBA's definitions for a small business for the industry category. According to the SBA's definition of a small business for a petroleum refining company (Standard Industrial Classification (SIC) 2911), a company must have 1500 or fewer employees to qualify as an SBA small business. Of the approximately 158 refineries in the U.S. today, we estimate that approximately 22 refiners (owning 26 refineries) have 1500 or fewer employees and produce highway diesel fuel. Two of these refineries are currently shutdown, but have indicated that they expect to reopen this year. We estimate that these 22 small refiners comprise 3.7 percent of nationwide crude capacity and produce approximately four percent of highway diesel fuel.

EPA also has identified several thousand businesses in the diesel distribution and marketing industry that meet SBA's definitions of small business. More information about these industries is contained in the IRFA. Under today's proposal, there are some, fairly minimal, regulatory requirements on these parties downstream of the refineries related to segregating the low sulfur highway diesel fuel throughout the distribution system. However, these proposed compliance provisions for downstream parties are fairly consistent with those in place today for other fuel programs, including the current highway diesel fuel program, and are not expected to impose significant new burdens on small entities.

2. Small Business Advocacy Review Panel and the Evaluation of Regulatory Alternatives

The Small Business Advocacy Review Panel was convened by EPA on November 12, 1999. The Panel consisted of representatives of the Small Business Administration (SBA), the Office of Management and Budget (OMB) and EPA. During the development of today's proposal, EPA and the Panel were in contact with representatives from the small businesses that would be subject to the provisions in today's proposal. In addition to verbal comments from industry noted by the Panel at meetings and teleconferences, written comments were received from each of the affected industry segments or their representatives. The Panel report contains a summary of these comments, the Panel's recommendations on options that could mitigate the adverse impacts on small businesses. Today's proposal requests comment on the alternatives and issues suggested by the Panel for implementing the fuel program.

The Panel considered a range of options and regulatory alternatives for providing small businesses with flexibility in complying with new sulfur standards for highway diesel fuel. As part of the process, the Panel requested and received comment on several early ideas for flexibility that were suggested by SERs and Panel members. Taking into consideration the comments received on these ideas, as well as additional business and technical information gathered about potentially affected small entities, we summarize the Panel's recommendations below.

The Panel recommended that EPA seek comment on an option that would provide a process for refiners to seek case-by-case approval of applications for temporary waivers to the diesel sulfur standards, based on a demonstration of extreme hardship circumstances. Small refiners commented to the Panel that there is no ''one size fits all'' approach to flexibility—given the wide variety of refinery circumstances and

[183] The Initial RFA is contained in Chapter VII of the Draft RIA.

[184] Report of the Small Business Advocacy Review Panel on Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine Standards and Diesel Fuel Sulfur Control Requirements, March 24, 2000.

configurations. Thus, the Panel believed that it would be appropriate for EPA to consider a case-by-case approach to flexibility. The Panel further recognized that there may be case-by-case flexibilities that are feasible, environmentally neutral, and warranted to meet the unique needs of an individual refiner, but that, if applied across the board, might jeopardize the environmental benefits of the program. The Panel envisioned that this option would be modeled after a similar provision in the recently-promulgated gasoline sulfur program. This option would allow domestic and foreign refiners, including small refiners, to request additional flexibility based on a showing of unusual circumstances that result in extreme hardship and significantly affect the ability to comply by the applicable date, despite their best efforts.

In addition, the Panel recommended that EPA seek comment on two options for small refiner flexibility. First, the Panel recommended that EPA seek comment on a 50 ppm cap for small refiners, as well as any data or underlying analyses that could support such a decision. Second, the Panel recommended that EPA seek comment on an option that would allow small refiners to continue selling their current 500 ppm highway diesel, provided there are adequate safeguards to prevent contamination and misfueling. The Panel further recommended that EPA request comment on an appropriate duration for this option. This option would effectively delay the low sulfur compliance date for small refiners, and allow them to continue selling their current fuel to the highway diesel market. To ensure the environmental benefits of the rule were achieved while implementing this flexibility option, there would have to be certain safeguards with refiners as well as downstream parties to prevent contamination of the ultra-low sulfur fuel, and to prevent misfueling of new vehicles.

The Panel also discussed the merits of phasing in the fuel program, and alternatives that could potentially limit the burden of such a program on small refiners and distributors.

The Panel's recommendations are discussed in detail in the Panel Report, contained in the docket. In addition, EPA's request for comment on these options is contained in section VIII.E of this preamble.

The Initial Regulatory Flexibility Analysis evaluates the financial impacts of the proposed heavy-duty engine standards and fuel controls on small entities. EPA believes that the regulatory alternatives we seek comment on in this proposal could provide substantial relief to qualifying small businesses from the potential adverse economic impacts of complying with today's proposed rule.

C. Paperwork Reduction Act

The information collection requirements (ICR) for this proposed rule will be submitted for approval to OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* The Agency may not conduct or sponsor an information collection, and a person is not required to respond to a request for information, unless the information collection request displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR part 9 and 48 CFR chapter 15.

The information collection requirements associated with today's proposed rule pertain to the proposed requirements for diesel fuel sulfur content. A draft information collection request document entitled, ''Draft Information Collection Request—Recordkeeping Requirements for the Fuel Quality Regulations for Diesel Fuel Sold in 2006 and Later Years' has been prepared and is available from the Air Docket at the location indicated in **ADDRESSES** section or from the person(s) listed in **FOR FURTHER INFORMATION CONTACT** section. We request comments on the costs associated with the regulatory language as proposed and with regard to other specific approaches outlined in this notice that may affect information collection burdens.

The Paperwork Reduction Act stipulates that ICR documents estimate the burden of activities that would be required of regulated parties within a three year time period. Consequently, the draft ICR document that accompanies today's proposed rule provides estimates for the activities that would be required under the first three years of the proposed program. Many of the reporting and recordkeeping requirements for refiners and importers regarding the sulfur content of diesel fuel on which the proposed rule would rely currently exist under EPA's 500 ppm highway diesel fuel and anti-dumping programs.[185] The ICR for the 500 ppm program covered start up costs associated with reporting diesel fuel sulfur content under the 500 ppm program. Consequently, much of the cost of the information collection requirements under the proposed diesel sulfur control program has already been accounted for under the 500 ppm program.

We request comments on the Agency's need for the information proposed to be collected, the accuracy of our estimates of the associated burdens, and any suggested methods for minimizing the burden, including the use of automated techniques for the collection of information. Comments on the draft ICR should be sent to: the Office of Policy, Regulatory Information Division, U.S. Environmental Protection Agency (Mail Code 2136), 401 M Street, SW, Washington, DC 20460, marked ''Attention: Director of OP;'' and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW, Washington, DC 20503, marked ''Attention: Desk Officer for EPA.'' Include the ICR number in any such correspondence. OMB is required to make a decision concerning the ICR between 30 and 60 days after publication of a proposed rule. Therefore, comments to OMB on the ICR are most useful if received within 30 days of the publication date of this proposal. Any comments from OMB and from the public on the information collection requirements in today's proposal will be placed in the docket and addressed by EPA in the final rule.

Copies of the ICR documents can be obtained from Sandy Farmer, Office of Policy, Regulatory Information Division, U.S. Environmental Protection Agency (Mail Code 2137), 401 M Street, SW, Washington, DC 20460, or by calling (202) 260–2740. Insert the ICR title and/or OMB control number in any correspondence. Copies may also be downloaded from the Internet at http://www.epa.gov/ncepihom/catalog.html.

D. Intergovernmental Relations

1. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), Public Law 104–4, establishes requirements for federal agencies to assess the effects of their regulatory actions on state, local, and tribal governments, and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with ''federal mandates'' that may result in expenditures to state, local, and tribal governments, in the aggregate, or to the

[185] ''Regulations of Fuel and Fuel Additives; Fuel Quality Regulations for Highway Diesel Sold in 1993 and Later Calendar Years; Recordkeeping Requirements,'' OMB Control Number 2060–0308, EPA ICR Number 1718.12 (expires July 31, 2001). Copies of this ICR may be obtained from Sandy Farmer, Office of Policy, Regulatory Information Division, U.S. Environmental Protection Agency (Mail Code 2137), 401 M Street, SW, Washington, DC 20460. Please mark requests, ''Attention: Desk Officer for EPA'' and include the ICR in any correspondence.

private sector, of $100 million or more for any single year. Before promulgating a rule, for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative that is not the least costly, most cost effective, or least burdensome alternative if EPA provides an explanation in the final rule of why such an alternative was adopted.

Before we establish any regulatory requirement that may significantly or uniquely affect small governments, including tribal governments, we must develop a small government plan pursuant to section 203 of the UMRA. Such a plan must provide for notifying potentially affected small governments, and enabling officials of affected small governments to have meaningful and timely input in the development of our regulatory proposals with significant federal intergovernmental mandates. The plan must also provide for informing, educating, and advising small governments on compliance with the regulatory requirements.

This proposed rule contains no federal mandates for state, local, or tribal governments as defined by the provisions of Title II of the UMRA. The rule imposes no enforceable duties on any of these governmental entities. Nothing in the proposed rule would significantly or uniquely affect small governments.

EPA has determined that this rule contains federal mandates that may result in expenditures of more than $100 million to the private sector in any single year. As discussed at length in section VI of this proposal, EPA considered and evaluated a wide range of regulatory alternatives before arriving at the program proposed today. EPA believes that the proposed program represents the least costly, most cost effective approach to achieve the air quality goals of the proposed rule. Nevertheless, as is clear in section VI and throughout the preamble, we continue to investigate and seek comment on alternatives that may achieve the proposals objectives but at a lower cost. See the ''Administrative Designation and Regulatory Analysis'' (section XI.A) for further information regarding these analyses.

2. Executive Order 13084: Consultation and Coordination With Indian Tribal Governments

Under Executive Order 13084, EPA may not issue a regulation that is not required by statute, that significantly or uniquely affects the communities of Indian Tribal governments, and that imposes substantial direct compliance costs on those communities, unless the federal government provides the funds necessary to pay the direct compliance costs incurred by the tribal governments, or EPA consults with those governments. If EPA complies by consulting, Executive Order 13084 requires EPA to provide to the OMB, in a separately identified section of the preamble to the rule, a description of the extent of EPA's prior consultation with representatives of affected tribal governments, a summary of the nature of their concerns, and a statement supporting the need to issue the regulation. In addition, Executive Order 13084 requires EPA to develop an effective process permitting elected officials and other representatives of Indian tribal governments ''to provide meaningful and timely input in the development of regulatory policies on matters that significantly or uniquely affect their communities.''

Today's rule does not significantly or uniquely affect the communities of Indian Tribal governments. The proposed engine emissions, diesel fuel, and other related requirements for private businesses in this proposal would have national applicability, and thus would not uniquely affect the communities of Indian Tribal Governments. Further, no circumstances specific to such communities exist that would cause an impact on these communities beyond those discussed in the other sections of this proposal. Thus, EPA's conclusions regarding the impacts from the implementation of today's proposed rule discussed in the other sections of this proposal are equally applicable to the communities of Indian Tribal governments. Accordingly, the requirements of section 3(b) of Executive Order 13084 do not apply to this rule.

E. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), section 12(d) of Public Law 104–113, directs EPA to use voluntary consensus standards in its regulatory activities unless it would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) developed or adopted by voluntary consensus standards bodies. The NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rule references technical standards adopted by the Agency through previous rulemakings. No new technical standards are proposed in this proposal. The standards referenced in today's proposed rule involve the measurement of diesel fuel parameters and engine emissions. The measurement standards for diesel fuel parameters referenced in today's proposal are all voluntary consensus standards. The engine emissions measurement standards referenced in today's proposed rule are government-unique standards that were developed by the Agency through previous rulemakings. These standards have served the Agency's emissions control goals well since their implementation and have been well accepted by industry. EPA is not aware of any voluntary consensus standards for the measurement of engine emissions. Therefore, the Agency proposes to use the existing EPA-developed standards found in 40 CFR part 86 for the measurement of engine emissions.

EPA welcomes comments on this aspect of the proposed rulemaking and, specifically, invites the public to identify potentially-applicable voluntary consensus standards and to explain why such standards should be used in this regulation.

F. Executive Order 13045: Children's Health Protection

Executive Order 13045, ''Protection of Children from Environmental Health Risks and Safety Risks'' (62 FR 19885, April 23, 1997) applies to any rule that (1) is determined to be ''economically significant'' as defined under Executive Order 12866, and (2) concerns an environmental health or safety risk that EPA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, section 5–501 of the Order directs the Agency to evaluate the environmental health or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposed rule is subject to the Executive Order because it is an economically significant regulatory action as defined by Executive Order 12866 and it concerns in part an environmental health or safety risk that EPA has reason to believe may have a disproportionate effect on children.

This rulemaking will achieve significant reductions of various emissions from heavy-duty engines, primarily NO_X, but also PM. These pollutants raise concerns regarding environmental health or safety risks that EPA has reason to believe may have a disproportionate effect on children, such as impacts from ozone, PM and certain toxic air pollutants. See section II and the Draft RIA for a further discussion of these issues.

The effects of ozone and PM on children's health were addressed in detail in EPA's rulemaking to establish the NAAQS for these pollutants, and EPA is not revisiting those issues here. EPA believes, however, that the emission reductions from the strategies proposed in this rulemaking will further reduce air toxics and the related adverse impacts on children's health. EPA will also be addressing the issues raised by air toxics from engines and their fuels in a separate rulemaking that EPA will initiate in the near future under section 202(l) of the Act. That rulemaking will address the emissions of hazardous air pollutants from engines and fuels, and the appropriate level of control of HAPs from these sources.

In this proposal, EPA has evaluated several regulatory strategies for reductions in emissions from heavy-duty engines. (See section III of this proposal as well as the Draft RIA.) For the reasons described there, EPA believes that the strategies proposed are preferable under the CAA to other potentially effective and reasonably feasible alternatives considered by the Agency, for purposes of reducing emissions from these sources as a way of helping areas achieve and maintain the NAAQS for ozone and PM. Moreover, EPA believes that it has selected for proposal the most stringent and effective control reasonably feasible at this time, in light of the technology and cost requirements of the Act.

G. Executive Order 13132: Federalism

Executive Order 13132, entitled ''Federalism'' (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure ''meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.'' ''Policies that have federalism implications'' is defined in the Executive Order to include regulations that have ''substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.''

Under section 6 of Executive Order 13132, EPA may not issue a regulation that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by State and local governments, or EPA consults with State and local officials early in the process of developing the proposed regulation. EPA also may not issue a regulation that has federalism implications and that preempts State law, unless the Agency consults with State and local officials early in the process of developing the proposed regulation.

Section 4 of the Executive Order contains additional requirements for rules that preempt State or local law, even if those rules do not have federalism implications (i.e., the rules will not have substantial direct effects on the States, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government). Those requirements include providing all affected State and local officials notice and an opportunity for appropriate participation in the development of the regulation. If the preemption is not based on express or implied statutory authority, EPA also must consult, to the extent practicable, with appropriate State and local officials regarding the conflict between State law and Federally protected interests within the agency's area of regulatory responsibility.

This proposed rule does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. Section 211(d)(4)(A) of the CAA prohibits states from prescribing or attempting to enforce controls or prohibitions respecting any fuel characteristic or component if EPA has prescribed a control or prohibition applicable to such fuel characteristic or component under section 211(c)(1) of the Act. This proposed rule merely modifies existing EPA diesel fuel and heavy-duty vehicle standards and therefore will merely continue an existing preemption of State and local law as discussed in section VIII.C. Thus, Executive Order 13132 does not apply to this rule.

Although section 6 of Executive Order 13132 does not apply to this rule, EPA did consult with representatives of various State and local governments in developing this rule. In particular EPA consulted with the State of Alaska in the design of the program as it applies to them, as discussed in section VI. EPA also talked to representatives from the State of California as well as representatives from STAPPA/ALAPCO, which represents state and local air pollution officials.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed rule from State and local officials.

XII. Statutory Provisions and Legal Authority

Statutory authority for the engine controls proposed in this notice can be found in sections 202, 203, 206, 207, 208, and 301 of the CAA, as amended, 42 U.S.C. 7521, 7522, 7525, 7541, 7542, and 7601.

Statutory authority for the fuel controls proposed in this document comes from section 211(c) and 211(i) of the CAA, which allows EPA to regulate fuels that either contribute to air pollution which endangers public health or welfare or which impair emission control equipment which is in general use or has been in general use. Additional support for the procedural and enforcement-related aspects of the fuel's controls in today's proposal, including the proposed recordkeeping requirements, comes from sections 114(a) and 301(a) of the CAA.

List of Subjects

40 CFR Part 69

Environmental protection. Air pollution control.

40 CFR Part 80

Environmental protection, Diesel fuel, Fuel additives, Gasoline, Imports, Labeling, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements.

40 CFR Part 86

Environmental protection, Administrative practice and procedure, Confidential business information, Labeling, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements.

Dated: May 17, 2000.

Carol M. Browner,

Administrator.

For the reasons set forth in the preamble, we propose to amend Parts 69, 80 and 86 of chapter I of Title 40 of the Code of Federal Regulations to read as follows:

PART 69—[AMENDED]

1. The authority citation for part 69 is revised to read as follows:

Authority: 42 U.S.C. 7545(c), (g) and (i), and 7625–1.

Subpart E—Alaska

2. Section 69.51 of subpart E is revised to read as follows:

§ 69.51 Title II exemptions and exclusions.

(a) Diesel fuel that is designated for use only in Alaska and is used only in Alaska, is exempt from the sulfur standard of 40 CFR 80.29(a)(1)(i) and the dye provisions of 40 CFR 80.29(a)(1)(iii) and 40 CFR 80.29(b) until the implementation dates set out in 40 CFR 80.440, provided that:

(1) The fuel is segregated from non-exempt diesel fuel from the point of such designation; and

(2) On each occasion that any person transfers custody or title to the fuel, except when it is dispensed at a retail outlet or wholesale purchaser-facility, the transferor must provide to the transferee a product transfer document stating:

This diesel fuel is for use only in Alaska. It is exempt from the federal low sulfur standards applicable to motor vehicle diesel fuel and red dye requirements applicable to non-motor vehicle diesel fuel only if it is used in Alaska.

(b) Beginning on the implementation dates set out in § 80.440, diesel fuel that is designated for use only in Alaska or is used only in Alaska, is subject to the applicable provisions of 40 CFR part 80, subpart I, except as provided under paragraph (c) of this section. Alaska may submit for EPA approval an alternative plan for implementing the sulfur standard in Alaska by [date one year after the effective date of the final rule]. EPA shall approve or disapprove the plan within one year of receiving Alaska's submission.

(c) If such diesel fuel is designated as fuel that does not comply with the standards and requirements for motor vehicle diesel fuel under 40 CFR part 80, subpart I, it is exempt from the dye presumption of 40 CFR 80.446(b)(2) provided that:

(1) The fuel is segregated from all motor vehicle diesel fuel.

(2) On each occasion that any person transfers custody or title to the fuel, except when it is dispensed at a retail outlet or wholesale purchaser-facility, the transferor must provide to the transferee a product transfer document complying with the requirements of 40 CFR 80.462(a) and (d) and stating:

This diesel fuel is for use only in Alaska and is not for use in motor vehicles. It is exempt from the red dye requirement applicable to non-motor vehicle diesel fuel only if it is used in Alaska.

(3) Any pump dispensing the fuel must comply with the labeling requirements in 40 CFR 80.453.

PART 80—[AMENDED]

3. The authority citation for part 80 continues to read as follows:

Authority: Sections 114, 211, and 301(a) of the Clean Air Act, as amended (42 U.S.C. 7414, 7545 and 7601(a)).

4. Section 80.2 is amended by revising paragraphs (x) and (y) and adding paragraphs (bb) and (nn), to read as follows:

§ 80.2 Definitions.

* * * * *

(x) *Diesel fuel* means any fuel sold in any state and suitable for use in diesel motor vehicles, diesel motor vehicle engines or diesel nonroad engines, and which is commonly or commercially known as diesel fuel.

(y) *Motor vehicle diesel fuel* means any diesel fuel, or any distillate product, that is used, intended for use, or made available for use, as a fuel in diesel motor vehicles or diesel motor vehicle engines. Motor vehicles or motor vehicle engines do not include nonroad vehicles or nonroad engines.

* * * * *

(bb) *Sulfur percentage* is the percentage of sulfur in diesel fuel by weight, as determined using the applicable sampling and testing methodologies set forth in § 80.461.

* * * * *

(nn) *Batch of motor vehicle diesel fuel* means a quantity of diesel fuel which is homogeneous with regard to those properties that are specified for motor vehicle diesel fuel under subpart I of this part.

* * * * *

5. Section 80.29 is amended by revising paragraphs (a)(1) introductory text and (b), to read as follows:

§ 80.29 Controls and prohibitions on diesel fuel quality.

(a) *Prohibited activities.* (1) Beginning October 1, 1993 and continuing until the implementation dates for subpart I of this part as specified in § 80.440, except as provided in 40 CFR 69.51, no person, including but not limited to, refiners, importers, distributors, resellers, carriers, retailers or wholesale purchaser-consumers, shall manufacture, introduce into commerce, sell, offer for sale, supply, store, dispense, offer for supply or transport any diesel fuel for use in motor vehicles, unless the diesel fuel:

* * * * *

(b) *Determination of compliance.* (1) Any diesel fuel which does not show visible evidence of being dyed with dye solvent red 164 (which has a characteristic red color in diesel fuel) shall be considered to be available for use in diesel motor vehicles and motor vehicle engines, and shall be subject to the prohibitions of paragraph (a) of this section.

(2) Compliance with the sulfur, cetane, and aromatics standards in paragraph (a) of this section shall be determined based on the level of the applicable component or parameter, using the sampling methodologies specified in § 80.330(b), as applicable, and the appropriate testing methodologies specified in § 80.461(a) or (b) for sulfur, § 80.2(w) for cetane index, and § 80.2(z) for aromatic content. Any evidence or information, including the exclusive use of such evidence or information, may be used to establish the level of the applicable component or parameter in the diesel fuel, if the evidence or information is relevant to whether that level would have been in compliance with the standard if the appropriate sampling and testing methodology had been correctly performed. Such evidence may be obtained from any source or location and may include, but is not limited to, test results using methods other than the compliance methods in this paragraph (b), business records, and commercial documents.

(3) Determination of compliance with the requirements of this section other than the standards described in paragraph (a) of this section, and determination of liability for any violation of this section, may be based on information obtained from any source or location. Such information may include, but is not limited to, business records and commercial documents.

* * * * *

6. Section 80.30 is amended by revising paragraphs (g)(2)(ii) and (g)(4)(i), and adding paragraph (h), to read as follows: