manufacturer to retain additional records or submit information not specifically required by this section.

(5) Pursuant to a request made by the Administrator, the manufacturer must submit to the Administrator the information that the manufacturer is required to retain.

(6) EPA may void *ab initio* a certificate of conformity for a LDV/T certified to emission standards as set forth or otherwise referenced in this subpart for which the manufacturer fails to retain the records required in this section or to provide such information to the Administrator upon request.

(b) *Reporting.* (1) Each covered manufacturer must submit an annual report. Except as provided in paragraph (b)(2) of this section, the annual report must contain, for each applicable fleet average NO_X standard, the fleet average NO_X value achieved, all values required to calculate the NO_X value, the number of credits generated or debits incurred, and all the values required to calculate the credits or debits. The annual report must contain the resulting balance of credits or debits.

(2) When a manufacturer calculates compliance with the fleet average NO_X standard using the provisions in § 86.1860–04(c)(2), then the annual report must state that the manufacturer has elected to use such provision and must contain the fleet average NO_X standard as the fleet average NO_X value for that model year.

(3) For each applicable fleet average NO_X standard, the annual report must also include documentation on all credit transactions the manufacturer has engaged in since those included in the last report. Information for each transaction must include:

(i) Name of credit provider;

(ii) Name of credit recipient;

(iii) Date the transfer occurred;

(iv) Quantity of credits transferred; and

(v) Model year in which the credits were earned.

(4) Unless a manufacturer reports the data required by this section in the annual production report required under § 86.1844–01(e) and subsequent model year provisions, a manufacturer must submit an annual report for each model year after production ends for all affected vehicles and trucks produced by the manufacturer subject to the provisions of this subpart and no later than May 1 of the calendar year following the given model year. Annual reports must be submitted to: Director, Vehicle Programs and Compliance Division, U.S. Environmental Protection Agency, 2000 Traverwood, Ann Arbor, Michigan 48105.

(5) Failure by a manufacturer to submit the annual report in the specified time period for all vehicles and trucks subject to the provisions in this section is a violation of section 203(a)(1) of the Clean Air Act for each subject vehicle and truck produced by that manufacturer.

(6) If EPA or the manufacturer determines that a reporting error occurred on an annual report previously submitted to EPA, the manufacturer's credit or debit calculations will be recalculated. EPA may void erroneous credits, unless transferred, and must adjust erroneous debits. In the case of transferred erroneous credits, EPA must adjust the manufacturer's credit or debit balance to reflect the sale of such credits and any resulting generation of debits.

(c) *Notice of opportunity for hearing.* Any voiding of the certificate under paragraph (a)(6) of this section will be made only after EPA has offered the manufacturer concerned an opportunity for a hearing conducted in accordance with § 86.614 for light-duty vehicles or § 86.1014 for light-duty trucks and, if a manufacturer requests such a hearing, will be made only after an initial decision by the Presiding Officer.

[FR Doc. 99–11384 Filed 5–6–99; 11:03 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 80 and 86

[AMS–FRL–6337–4]

RIN 2060–AI32

Control of Diesel Fuel Quality

AGENCY: Environmental Protection Agency.

ACTION: Advance notice of proposed rulemaking.

SUMMARY: Diesel engines used in motor vehicles and nonroad equipment are a major source of nitrogen oxides and particulate matter, both of which contribute to serious health problems in the United States. We are considering setting new quality requirements for fuel used in diesel engines, in order to bring about large environmental benefits through the enabling of a new generation of diesel emission control technologies.

Because the pursuit of diesel fuel quality changes would be a major undertaking for the Agency and affected industries, and because of the many unresolved issues involved, we are publishing this advance notice to summarize the issues, with the goal of helping you to better inform us as we consider how to proceed. To aid this process, we have grouped key questions under issue topic headings that are numbered sequentially throughout this notice.

Although this advance notice solicits comment on all potentially beneficial diesel fuel quality changes, we believe that the most promising change would be fuel desulfurization for the purpose of enabling new engine and aftertreatment technologies that, although highly effective, are sensitive to sulfur.

DATES: You should submit written comments on this advance notice by June 28, 1999.

ADDRESSES: You may submit written comments in paper form and/or by E-mail. To ensure their consideration, all comments must be submitted to us by the date indicated under **DATES** above. Paper copies of comments should be submitted (in duplicate if possible) to Public Docket No. A–99–06 at the following address: U.S. Environmental Protection Agency, Air Docket Section, Room M–1500, 401 M Street, SW, Washington, DC 20460. We request that you also send a separate copy to the contact person listed below. Those submitting a paper copy of their comments are also encouraged to submit an electronic copy (in ASCII format) by E-mail to ''A-and-R-Docket@epa.gov'', or on a 3.5 inch diskette. You may also submit comments by E-mail to the docket at the address listed above (with a copy to the contact person listed below) without the submission of a paper copy. However, we encourage you to send a paper copy as well to ensure the clarity of your submission.

Materials related to this rulemaking are available for review at EPA's Air Docket at the above address (on the ground floor in Waterside Mall) from 8:00 a.m. to 5:30 p.m., Monday through Friday, except on government holidays. The telephone number for EPA's Air Docket is (202) 260–7548, and the facsimile number is (202) 260–4400. A reasonable fee may be charged by EPA for copying docket materials, as provided in 40 CFR part 2.

FOR FURTHER INFORMATION CONTACT:
Carol Connell, U.S. EPA, National Vehicle and Fuels Emission Laboratory, 2000 Traverwood, Ann Arbor, MI 48105; Telephone (734) 214–4349, FAX (734) 214–4050, E-mail connell.carol@epa.gov.

SUPPLEMENTARY INFORMATION:

I. Why Is EPA Considering Diesel Fuel Changes?

Diesel engines contribute greatly to a number of serious air pollution problems, especially the health and welfare effects of ozone and particulate matter (PM).[1] Millions of Americans live in areas that exceed the national air quality standards for ozone or PM. As discussed in detail in the following section, diesel emissions account for a large portion of the country's PM and nitrogen oxides (NO_X), a key precursor to ozone formation. By 2010, we estimate that diesel engines will account for more than one-half of mobile source NO_X emissions, and nearly 70% of mobile source PM emissions (not taking into account emission reductions from proposed Tier 2 emission standards for light-duty vehicles and trucks, discussed below).

Diesel emissions in this country come mostly from heavy-duty trucks and nonroad equipment, but a potentially large 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 will be greatly affected by our own plans to adopt stringent new emission standards for these light-duty highway vehicles (referred to as ''Tier 2'' standards) that we have proposed to phase in between 2004 and 2009. A key approach taken in developing the Tier 2 standards has been ''fuel-neutrality''—applying standards equally to diesel- and gasoline-powered vehicles. As a result, the proposed Tier 2 NO_X and PM standards are far more challenging for diesel engine designers than the most stringent heavy-duty engine standards promulgated to date.

We have proposed Tier 2 standards concurrent with a proposal to reduce the sulfur content of gasoline, in part because gasoline sulfur reduction will enable advanced catalyst technologies needed to achieve the new standards. With this advance notice, we are seeking comment on the merits of improving the quality of diesel fuel as well, as an enabler of advanced technologies for diesel emission control, without which diesel vehicles may not be able to meet Tier 2 standards. These advanced sulfur-sensitive technologies have the potential to reduce diesel engine NO_X emissions by up to 75% and PM emissions by 80% or more.

Thus this potential action on diesel fuel is, like gasoline sulfur control, closely tied to our Tier 2 standard-setting activity. Decisions on diesel fuel quality need to be made quickly so that the Tier 2 program may be implemented in the most coordinated and cost-effective manner. We therefore plan to pursue this action on an accelerated schedule. If, following this advance notice, we decide that a proposal is warranted, we plan to publish a notice of proposed rulemaking later this year, and a final rule as soon as possible after that.

Although the impetus for near-term action on diesel fuel quality comes from our efforts to set fuel-neutral Tier 2 standards for the light-duty market, any emissions control technologies that prove effective in light-duty diesel applications are likely to be effective with heavy-duty highway engines as well. Thus higher quality diesel fuel for heavy-duty applications, combined with more stringent heavy-duty engine emission standards that effectively introduce the new technologies, could provide large environmental benefits, though perhaps on a different implementation schedule than that required for the light-duty program. This might take the form of a phased in program, involving a regulated grade of premium fuel that is initially focused on servicing the light-duty diesel fleet, but that gradually widens its market penetration to fulfill the expanding need created by sales of new heavy-duty vehicles that also employ the advanced technologies. Various possibilities and issues associated with such an approach are discussed in detail below in this notice. In addition to enabling new control technologies, the use of higher quality diesel fuel is likely to improve the emissions performance of the existing fleet of diesel engines as well, as explained below.

Eventually these advanced technologies could also find application in nonroad equipment, although implementation timing would have to consider a number of special challenges in controlling nonroad engine emissions, including the fact that current nonroad diesel fuel is unregulated and has much higher sulfur levels than highway fuel. It may also be necessary to regulate nonroad diesel fuel in an earlier time frame, to a quality level similar to that of current highway fuel (which has sulfur levels capped at 500 parts per million (ppm)), in order to provide for the transfer of advanced highway engine technologies already under development for use with that fuel. This technology transfer is expected to play an important role in the implementation of the recently promulgated Tier 3 nonroad diesel engine emission standards, and of the stringent PM standards planned for promulgation in 2001. (The 2001 rulemaking will also review the feasibility of the recently promulgated Tier 3 standards, and may amend them if appropriate.)

II. Diesel Engines and Air Quality

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. Every year, about a million new diesel engines are put to work in the U.S., and as their utility continues to grow, so too does their annual fuel consumption, now over 40 billion gallons. However, the societal benefits provided by the diesel engine have come at a price—diesels emit millions of tons of harmful exhaust pollutants annually.

Compounding our concerns over emissions from applications in which diesels are currently prevalent, we are aware that manufacturers are considering the introduction of a new generation of diesel engines for use in light-duty highway vehicles. Even at modest projected sales ramp-up rates, this introduction could greatly increase the number of diesel engines in operation over the next several years.

Although in the past much of our attention in addressing the diesel pollution problem has focused on engine design, the role of fuel formulation has been recognized from the beginning. A number of fuel properties and constituents can be varied in the refinery process with varying effects on emissions. Furthermore, some advanced emission control technologies may be degraded by constituents in diesel fuel, even to

[1] In this notice, the term ''diesel engine'' generally refers to diesel-fueled engines, rather than to engines operating on the diesel combustion cycle, some of which use alternative fuels, such as methanol or natural gas, instead of diesel fuel.

the extent of precluding the use of these technologies.

Diesel engines are large contributors to a number of serious air pollution problems, particularly the health and welfare effects caused by ozone and particulate matter. The particulate from diesel exhaust also is thought to pose a potential cancer risk. These concerns for cancer risk and other adverse health effects are discussed in detail below, followed by a discussion of diesel contributions to emissions inventories.

A. Ozone and Particulate Matter

Ground-level ozone, the main ingredient in smog, is formed when volatile organic compounds (VOC) and NO_X react in the presence of sunlight, usually during hot summer weather. Motor vehicles are significant sources of both VOC and NO_X. Diesel engines, in particular, are significant sources of NO_X emissions. Power plants and other combustion sources also are large emitters of NO_X. VOCs are emitted from a variety of sources, including chemical plants, refineries and other industries, consumer and commercial products, and natural sources such as vegetation.

Particulate matter is the term for a mixture of solid particles and liquid droplets found in the air. Particulate matter is distinguished between ''coarse'' particles (larger than 2.5 microns) and ''fine'' particles (smaller than 2.5 microns). Coarse particles generally come from vehicles driven on unpaved roads, materials handling, windblown dust, and crushing and grinding operations. Fine particles result from sources such as fuel combustion (from motor vehicles, power plants and industrial facilities), wood stoves and fireplaces. Fine particles also are formed in the atmosphere from gases such as sulfur dioxide, NO_X and VOC. Particles directly emitted from motor vehicles, including diesel engines, and those formed by motor vehicle gaseous emissions, are in the fine particle range.

Ozone can cause acute respiratory problems, aggravate asthma, cause inflammation in lung tissue, and impair the body's immune system defenses. Particulate matter, especially fine particles, has been linked with a series of significant health problems, including premature death, aggravated asthma, acute respiratory symptoms, chronic bronchitis, and shortness of breath. Furthermore, the particulate matter from diesel engines is thought to pose a potential cancer risk, as discussed in the next section. Fine particles can easily reach the deepest recesses of the lungs. Inhalation of ozone and particulate matter has been associated with increased hospital admissions and emergency room visits. With both ozone and particulate matter, those most at risk are children and people with preexisting health problems, especially asthmatics. Because children's respiratory systems are still developing, they are more susceptible to environmental threats than healthy adults. The elderly also are more at risk from exposure to fine particles, especially those already suffering from heart or lung disease.

In addition to serious public health problems, ozone and particulate matter cause a number of environmental and welfare effects. Fine particles are a major cause of visibility impairment in many of our most treasured national parks and wilderness areas, and many urban areas.[2] Particulate matter also can damage plants and materials such as monuments and statues. Ozone adversely affects crop yield, vegetation and forest growth, and the durability of materials. By weakening sensitive vegetation, ozone makes plants more susceptible to disease, insect attack, harsh weather and other environmental stresses. NO_X itself, one of the key precursors to ozone, contributes to fish kills and algae blooms in the Chesapeake Bay and other sensitive watersheds.

Despite continued improvements in recent years, ozone remains a serious air pollution problem in much of the country. Approximately 48 million people live in the 77 counties where ozone levels exceeded the 1-hour National Ambient Air Quality Standard (NAAQS) in 1997. Moreover, EPA has established a new and more stringent 8-hour ozone standard to better protect Americans from the health and welfare effects associated with longer term exposures to ozone. Ozone and its precursors can be transported into an area from pollution sources found hundreds of miles upwind, resulting in high ozone levels even in areas with relatively low NO_X and VOC emissions. In one of the most significant actions underway to help ensure that many areas of the country are able to attain the new 8-hour ozone standard, EPA is requiring 22 eastern states and the District of Columbia to significantly reduce NO_X emissions from power plants.[3] Yet, even after these significant NO_X emission reductions are achieved, we project that by 2007 approximately 28 metropolitan areas and four rural counties, with a combined population of 80 million people, still will not meet the 8-hour ozone standard, and at least eight metropolitan areas and two rural counties with a combined population of 39 million will exceed the 1-hour ozone standard.[4] The extent of remaining projected ozone nonattainment emphasizes the persistent nature of the ozone air quality problem across much of the country and demonstrates the need for further substantial reductions in ozone's precursors, NO_X and VOC.

In addition to widespread ozone nonattainment, particulate matter continues to be a significant air quality problem. In 1997, 8 million Americans lived in 13 counties that exceeded the air quality standard for particulate matter less than 10 microns in size (PM_{10}). We project that by 2010, 11 counties, with a combined population of about 10 million people, will be in nonattainment for the revised PM_{10} standard.[5] We also have established a new air quality standard for fine particles ($PM_{2.5}$). Monitoring data to determine nonattainment of the new $PM_{2.5}$ standard is not yet available. However, we project that by 2010, 102 counties, with a combined population of 55 million people, will violate the $PM_{2.5}$ air quality standard.[6]

With the significant number of areas projected to exceed the PM_{10} NAAQS in 2010, further particulate emission reductions appear to be needed. Because most of the particulate matter emissions from diesel engines are fine particles, any particulate emission reduction aimed at reducing PM_{10} levels would also reduce ambient $PM_{2.5}$ levels.

[2] The relative contribution of different particle constituents to visibility impairment varies geographically. For example, in most areas of the eastern U.S., sulfates account for more than 60 percent of annual average light extinction, and nitrates, organic carbon, and elemental carbon account for between 10–15 percent of light extinction. In the rural West, sulfates typically account for about 25–40 percent of light extinction, except in certain areas such as the Cascades of Oregon, where sulfates account for over 50 percent of light extinction. For further discussion of the contribution of different particle constituents to visibility impairment, see EPA's ''National Air Quality and Emissions Trends Report, 1997,'' Chapter 6 (http://www.epa.gov/oar/aqtrnd97).

[3] See 63 FR 57356, October 27, 1998, ''Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone''. This action is known as the ''NO_X SIP Call'.

[4] For a full description of this analysis, see ''Draft Regulatory Impact Analysis—Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emission Standards and Gasoline Sulfur Control Requirements;'' Chapter III.B.; (EPA420–R–99–002); hereafter referred to as ''Tier 2/Gasoline Sulfur Draft RIA'' (EPA Docket A–97–10).

[5] Regulatory Impact Analyses for the Particulate Matter and Ozone National Ambient Air Quality Standards and Proposed Regional Haze Rule, Innovative Strategies and Economics Group, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park, N.C., July 16, 1997.

[6] More information about this analysis may be found in the Tier 2 Notice of Proposed Rulemaking preamble and the Tier 2/Gasoline Sulfur Draft RIA.

B. Air Toxics

Diesel exhaust PM typically consists of a solid core, composed mainly of elemental carbon, which has a coating of various organic and inorganic compounds. The diameter of diesel particles is very small with typically 75–95 percent of the particle mass having a diameter smaller than 1.0 µm. The characteristically small particle size increases the likelihood that the particles and the attached compounds will reach and lodge in the deepest and more sensitive areas of the human lung. Both the diesel particle and the attached compounds may be influential in contributing to a potential for human health hazard from long term exposure.

EPA's draft Diesel Health Assessment identifies lung cancer as well as several other adverse respiratory health effects, including respiratory tract irritation, immunological changes, and changes in lung function, as possible concerns for long term exposure to diesel exhaust. The evidence in both cases comes from the studies involving occupational exposures and/or high exposure animal studies; the Health Assessment, when completed, will recommend how the data should be interpreted for lower environmental levels of exposure. The draft Health Assessment is currently being revised to address comments from a peer review panel of the Clean Air Science Advisory Committee.

The California Air Resources Board has identified diesel exhaust PM as a ''toxic air contaminant'' under the state's air toxics program, based on the information available on cancer and non-cancer health effects.[7] California is in the process of determining the need for, and appropriate degree of, control measures for diesel exhaust PM. Note that California limited its finding to diesel PM, as opposed to diesel exhaust. EPA's assessment activities of diesel exhaust PM are coincident with, but independent from, California's evaluation.

The concerns for cancer risk and other adverse health effects from exposure to diesel PM are heightened by the potential expansion of diesels in the light-duty vehicle fleet. Diesel engines are used in a relatively small number of cars and light-duty trucks today. By far, heavy-duty highway and nonroad diesel engines are the larger sources of diesel PM. However, vehicle and engine manufacturers project that diesel engines likely will be used in an increasing share of the light-duty fleet, particularly light-duty trucks. If these projections prove accurate, the potential health risks from diesel PM could increase substantially. EPA's proposed emission standard for PM under the Tier 2 program would limit any increase in potential cancer risks associated with the potential increase in light-duty diesel sales.

C. Diesel Contribution to Emission Inventories

The diesel engine pollutants of most concern are NO_X and PM. Nitrogen and oxygen in the engine's intake air react together in the combustion chamber at high temperatures to form NO_X. Particulate emissions result from incomplete evaporation and burning of the fine fuel droplets which are injected into the combustion chamber, as well as small amounts of lubricating oil that enter the combustion chamber. The VOC emissions from diesel engines are inherently low, because the fuel burns in the presence of excess oxygen which tends to completely burn hydrocarbons.[8] Evaporative emissions also are insignificant due to the low evaporative rate of diesel fuel.

Diesel engines make up a significant portion of the NO_X and PM from mobile sources. Moreover, the contribution of diesel engines to air pollutant emission inventories is expected to grow as more light-duty diesel vehicles and trucks enter the market. The emission inventory discussed below is the same as the ''base case'' prepared for the Tier 2 proposed rulemaking.[9] This inventory accounts for emission standards that have been promulgated already for each of the vehicle categories (e.g., light-duty, heavy-duty highway and nonroad), but does not include the impact of proposed light-duty Tier 2 standards. The Tier 2 standards would tend to decrease the relative contribution of light-duty emissions in the inventory, and thus increase the heavy-duty and nonroad relative contributions. On the other hand, substantial growth in light-duty diesel sales would tend to substantially increase the light-duty vehicle PM inventory, because diesels emit more PM than the gasoline vehicles they replace. Although the fuel-neutral Tier 2 standards would tend to mitigate this impact, growth in diesel sales, especially before and during the phase-in years of the proposed Tier 2 program, would still tend to increase the light-duty PM inventories. These considerations are important in assessing how the focus for diesel fuel control may shift in the future, beyond the 2007–2010 base case view. The inventory is reported in the 2007–2010 time frame because those dates are important for State Implementation Plan purposes in attaining the ozone and PM NAAQS.[10]

Mobile source emissions account for almost one-half of all NO_X emissions nationwide. By 2010, mobile source NO_X emissions will total more than 7.8 million tons. As shown in Figure 1, by 2010, we project that all diesel engines combined will account for 53% (4.1 million tons) of mobile source NO_X emissions. Heavy-duty diesels account for 15% of the mobile source contribution, and nonroad diesels account for 38%.[11] Light-duty vehicles and trucks account for 40% of mobile source NO_X emissions. Currently, almost all of the light-duty fleet is fueled by gasoline, and less than 1% of the NO_X emissions come from light-duty diesels. In the 2007 inventory, the proportion of NO_X emissions from these various vehicle categories is similar.

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[7] State of California, Air Resources Board, Resolution 98–35, August 27, 1998.

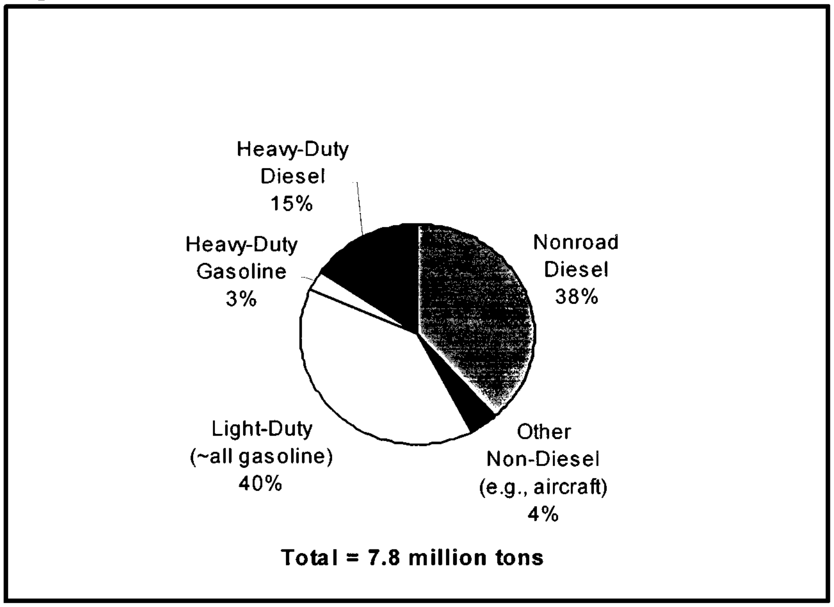
[8] Motor vehicles' contribution to the VOC inventory typically consists of unburned fuel hydrocarbons in the exhaust and evaporative emissions from vehicle fuel systems.

[9] For a further description of the emissions inventory, see Tier 2/Gasoline Sulfur Draft RIA; Chapter III.A. (EPA Docket A–97–10). Note that this is a 47-state emissions inventory, which excludes California, Alaska, and Hawaii.

[10] For further discussion on key ozone/PM State Implementation Plan timelines and attainment dates, see Section III.A. of the preamble to the Tier 2/Gasoline Sulfur proposed rule.

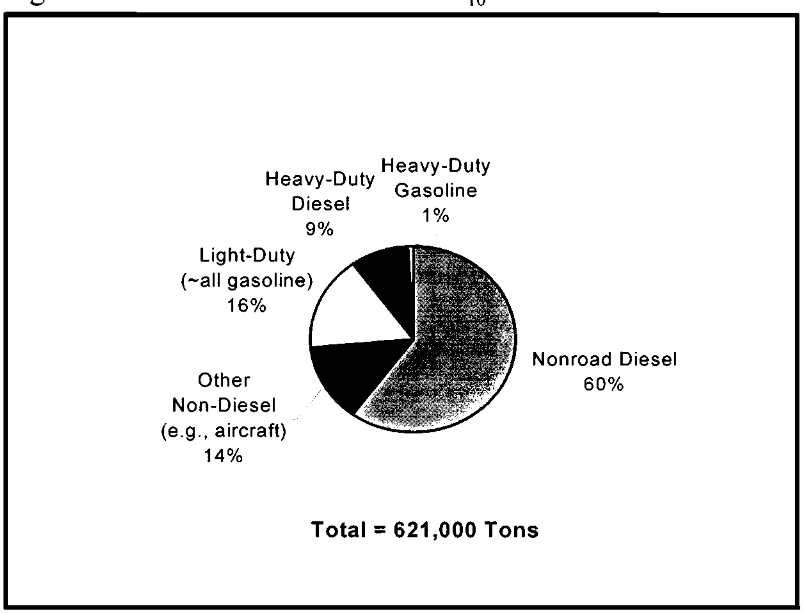
[11] In Figures 1 and 2, the ''Nonroad Diesel'' category includes nonroad equipment, locomotives, and commercial marine. The ''Other Non-Diesel'' category includes aircraft and non-road equipment powered by fuels other than diesel.

Figure 1. Mobile Source NOx Emissions in 2010.



Mobile sources account for 20% of direct PM_{10} emission inventories (excluding natural sources and fugitive dust). By 2010, mobile source direct PM_{10} emissions will total almost 621,000 tons. As shown in Figure 2, by 2010, we project that diesel engines will account for nearly 70% (434,000 tons) of all mobile source PM_{10} emissions. Heavy-duty diesels account for 9% of the mobile source PM_{10} contribution, and nonroad diesels account for 60%. Light-duty vehicles and trucks account for 16% of mobile source PM_{10} emissions. Currently, almost all of the light-duty fleet is fueled by gasoline. However, as more diesels enter the light-duty market, light-duty diesels could become a significant portion of mobile source PM emissions, as discussed above. The proportion of PM_{10} emissions from these various vehicle categories in the 2007 inventory is similar.

Figure 2. Mobile Source Direct PM_{10} Emissions in 2010.



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It is also important to note that mobile source emissions generally make up a larger fraction of the emission inventory for urban areas, where human population and light-duty vehicle travel is more concentrated than in rural areas. We recently conducted a study to compare the level and sources of emissions in four U.S. cities (Atlanta, New York, Chicago, and Charlotte) versus the nationwide inventory.[12] For example, in Atlanta by 2010, mobile sources are expected to account for 81% of all NO_X emissions, while nationally they account for 44%. Similarly, in Atlanta by 2010, mobile sources will account for nearly 60% of all direct PM_{10} emissions[13], while nationally they account for 20%. Highway emissions of

[12] For purposes of this study, the national inventory excludes California, Hawaii and Alaska. For a further description of this study of four cities, see Tier 2/Gasoline Sulfur Draft RIA, Chapter III.A.

[13] This is the portion of the PM_{10} inventory that excludes natural sources and fugitive dust.

NO_X, PM_{10} and $PM_{2.5}$ in Atlanta are more than double the national inventory. Nonroad PM_{10} and $PM_{2.5}$ emissions in Atlanta also are more than double the national inventory. In the other cities studied, mobile source NO_X and PM_{10} emissions also were generally considerably higher than the national inventory.

At this stage, we have not yet evaluated the emission reductions that could be achieved by introducing higher quality diesel fuel and the technologies it may enable, since the effectiveness of these technologies remains uncertain. However, as discussed in Section VI.A., some people involved in the development of these technologies project per vehicle emission reductions of up to 75% for NO_X and over 80% for PM, and so large inventory reductions may be possible.

III. Diesel Emissions Control: Progress and Prospects

Since the 1970's, highway diesel engine designers have employed numerous strategies to meet the challenge presented by our emissions standards, beginning with smoke controls, and focusing in this decade on increasingly stringent NO_X, hydrocarbon, and PM standards. More recently, standards for various categories of nonroad diesel engines, such as those used in farm and construction machines, locomotives, and marine vessels, have also been pursued by the Agency. 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. This action, combined with previous standard-setting actions, will result in engines that emit only a fraction of the NO_X, hydrocarbons, and PM produced by their higher-emitting counterparts manufactured just a decade ago.

Nevertheless, certain characteristics inherent in the way diesel fuel combustion occurs have prevented achievement of emission levels comparable to today's gasoline-fueled vehicles. While diesel engines provide advantages in terms of fuel efficiency, durability, and evaporative emissions, 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 diesel exhaust environment. Similarly, PM emissions, which are inherently low for gasoline engines, are more difficult to control in diesel engines, because the diesel combustion process tends to form soot and other particles. The challenge is compounded by the fact that most diesel NO_X control approaches tend to increase PM, and vice versa.

Considering the air quality impacts of diesel engines and the plans of manufacturers to increase the market penetration of light-duty diesel vehicles, it is imperative that progress in diesel emissions control continue. Fortunately, encouraging progress is now being made in the design of exhaust aftertreatment devices for diesel applications. Aftertreatment devices, such as catalytic converters, which have been employed successfully on gasoline engines for decades, have had only limited use with diesel engines. This is primarily due to the difficulty of making such devices perform well in the diesel's oxygen-rich exhaust stream, and to the great success that diesel engine designers have had up to now in meeting challenging emission standards without aftertreatment. The combination of encouraging progress in effective aftertreatment design and the challenge presented by the proposed stringent Tier 2 standards is changing this situation. As discussed in detail below, promising new technologies may allow a step change in diesel emissions control, of a magnitude comparable to that ushered in by the automotive catalytic converter in the 1970's. However, it appears that changes in diesel fuel quality may be needed to bring this step change about.

IV. What Fuel Changes Might Help?

Debate and research on changing diesel fuel to lower emissions has focused on several fuel specifications: cetane level, aromatics content, fuel density, distillation characteristics (T90 and T95), oxygenates content, and sulfur content. Control of these parameters may have the potential to provide direct benefits by incrementally lowering emissions when the fuel is burned, although the benefit may vary depending on the sophistication of the engine technology involved.

Much of the available data on the effects of fuel parameter changes is for heavy-duty engines. In preparation for the 1999 technology review to assess the ability of heavy-duty diesel engines to meet the combined NO_X and nonmethane hydrocarbon (NMHC) standard in 2004, an industry/EPA workgroup was tasked with evaluating the incremental impact of changes in diesel fuel properties on NO_X and hydrocarbon emissions. This study employed advanced technology heavy-duty diesel engines expected to be used to meet the 2004 standard. These engines depend on exhaust gas recirculation (EGR) and optimization of engine design, but not on advanced aftertreatment. The study focused on separately identifying the emissions impacts of changes in fuel density, aromatics content (both total and polycyclic aromatics), and cetane number (both natural and additive-enhanced).[14]

The results of this study showed that state-of-the-art heavy-duty engines are mostly insensitive to changes in these parameters. Changes in diesel fuel density and aromatics were found to have the greatest beneficial effect on emissions. Yet large concurrent changes in these fuel parameters reduced NO_X emissions by only 10%. Of the total effect, approximately 5% was attributed to the reduction in fuel density, and 5% to the reduction in aromatics content. Increasing the cetane number was found to have no observable emissions benefit, although previous studies on older-technology engines showed a benefit. Changing other fuel parameters was also found to have either no effect, or only a small effect on emissions. Effects on PM emissions were not included in this study.

Another study, documented as the ''EPEFE Report'', examined the effects of fuel parameter changes on NO_X, PM, hydrocarbon, and carbon monoxide emissions in both light- and heavy-duty diesel engines.[15] This study also found only small effects on NOx emissions from changes in density, polycyclic aromatics content, cetane, and T95 (less than 5% for any one parameter change, less than 10% overall). Although the magnitude and even the direction of the emissions changes were different for light- and heavy-duty vehicles, the small magnitude of the impacts was consistent. The largest impacts on PM emissions were from lowering T95 (7% in light-duty testing, no effect in heavy-duty testing) and density (19% in light-duty, 2% in heavy-duty), although the benefit of the density change was determined to be confounded by a physical effect—lower density fuel decreased the fueling rate and engine power which in turn affected emissions. Thus the need for additional data on how fuel changes affect PM emissions appears to be especially pronounced, especially considering the possible need for diesel PM reductions in the existing fleet to address potential air toxics concerns.

A lack of emissions sensitivity to changes in diesel fuel cetane and

[14] ''EPA HDEWG Program Phase 2'', Presentation of the Heavy-Duty Engine Work Group at January 13, 1999 meeting of Clean Air Act Advisory Committee, Mobile Sources Technical Review Subcommittee, Washington, DC.

[15] ''EPEFE Report'', European Programme On Emissions, Fuels, and Engine Technologies, ACEA/Europia Auto/Oil Programme.

aromatics content was observed in another recently-published paper, which reported on testing conducted with an advanced technology heavy-duty engine (designed to achieve a 2.5 grams/horsepower-hour (g/hp-hr) NO_X emissions level).[16] A recent literature review of diesel emissions studies sought to decouple the incremental impact on emissions of changes in one fuel parameter from the impacts of changes in other fuel parameters.[17] This review also found that the incremental effects on emissions (NO_X, PM, hydrocarbons, and carbon monoxide) of changes in diesel fuel composition are small or nonexistent for more advanced engine technologies. However, the review noted that any conclusion regarding the effect on emissions of adding oxygenates to diesel fuel must be considered tentative pending further investigative work. Of particular interest may be the impact on PM emissions of the use of oxygenates that contain a large fraction of oxygen per unit volume.

Reducing the sulfur content of diesel fuel has the potential to provide large indirect technology-enabling benefits in addition to some amount of direct emission benefits. In fact, sulfur reduction appears to be the only fuel change with potential to enable new technologies needed to meet Tier 2 light-duty or anticipated future heavy-duty standards. Therefore, although other specifications changes are under consideration, at this point we believe that sulfur control is the most likely means of achieving cost-effective diesel fuel emission reductions, as discussed in detail in the remainder of this notice.

Because we have more complete information on the effects that diesel fuel changes have on emissions from heavy-duty engines than from light-duty engines, we believe that any preliminary conclusions one might draw regarding changes other than sulfur are more tentative for light-duty applications. We welcome any information that would help us to assess the potential benefits and costs of changes other than sulfur in light-duty diesel fuel. Such information may become especially relevant if we pursue an implementation plan that treats this fuel separately, as discussed in Section XI.

Issue 1: Fuel Changes Other Than Sulfur.— *Should EPA pursue diesel fuel changes other than sulfur control? What costs and emission reductions would be involved? Are there additional data on emissions impacts of fuel changes, especially for light-duty applications? Should a diesel fuel quality program be structured to encourage gas-to-liquid or other non-petroleum blends?*

V. Diesel Fuel Quality in the U.S. and Other Countries

A. Current Diesel Fuel Requirements in the U.S.

EPA set standards for diesel fuel quality in 1990 (55 FR 34120, August 21, 1990). These standards, effective since 1993, apply only to fuel used in highway diesel engines. The standards limit the sulfur concentration in fuel to a maximum of 500 ppm, compared to a pre-regulation average of 2500 ppm. They also protect against a rise in the fuel's aromatics level from the then-existing levels by setting a minimum cetane index of 40 (or, alternatively, a maximum aromatics level of 35%). Aromatics tend to increase the emissions of harmful pollutants. These regulations were established in response to a joint proposal from members of the diesel engine manufacturing and petroleum refining industries to reduce emissions and enable the use of catalysts and particulate traps in meeting EPA's PM standards for diesel engines. As a result of our diesel fuel regulation, highway diesel fuel sulfur levels average about 340 ppm outside of California.[18] Alaska has an exemption from our existing 500 ppm limitation (permanent in some areas, temporary in others) and is currently seeking a permanent exemption for all areas of the state, because of special difficulties in supplying lower sulfur diesel fuel for that market (63 FR 49459, September 16, 1998). Similarly, American Samoa and Guam also have permanent exemptions from our existing 500 ppm limitation (July 20, 1992, 57 FR 32010 and September 21, 1993, 58 FR 48968). We currently do not regulate diesel fuels that are not intended for use in highway engines. Diesel fuel sold for use in most nonroad applications such as construction and farm equipment has sulfur levels on the order of 3300 ppm.[19]

California set more stringent standards in 1988 for motor vehicle diesel fuels for the South Coast air basin. These standards took effect statewide in 1993. They apply to both highway and nonroad fuels (excluding marine and locomotive use), and limit sulfur levels to 500 ppm and aromatics levels to 10%, with some flexibility provisions to accommodate small refiners and alternative formulations.

B. Diesel Sulfur Changes in Other Countries

Progress toward diesel fuel with very low sulfur levels has advanced rapidly in some parts of the world. The European Union's ''Auto Oil Package'' was adopted recently in an effort to improve air quality, by establishing an integrated approach to setting requirements for fuels in such a way that vehicles can produce their best environmental performance.[20] As part of the Auto Oil Package, the European Union adopted new fuel specifications for diesel fuel.[21] These specifications contain a diesel fuel sulfur limit of 50 ppm by 2005, with an interim limit of 350 ppm by 2000. The Member States will be required to monitor fuel quality to ensure compliance with the specifications.

In the United Kingdom, the entire diesel fuel supply soon will be at sulfur levels of 50 ppm, based on recent announcements by major refiners.[22] The United Kingdom currently offers a two-penny tax break for diesel fuel. Finland and Sweden also have tax incentives encouraging low sulfur diesel fuel. Finland's tax incentive applies to diesel with sulfur levels below 50 ppm, which accounts for 90% of the Finnish market.[23] Sweden's tax incentive applies to diesel with sulfur levels below 10 ppm.[24]

Japan recently proposed to limit sulfur in diesel fuel to 50 ppm.[25] The proposal allows a phase-in of about 10 years, to give refineries time to invest in new facilities. Japan's Environment

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[16] ''The Effects of Fuel Properties on Emissions from a 2.5 gm NO_X Heavy-Duty Engine'', Thomas Ryan III, Janet Buckingham, Lee Dodge, and Cherian Olikara, Society of Automotive Engineers Technical Paper No. 982491.

[17] Fuel Quality Impact on Heavy-Duty Diesel Emissions: A Literature Review, Rob Lee, Joanna Pedley, and Christene Hobbs, Society of Automotive Engineers Technical Paper No. 982649.

[18] ''A Review of Current and Historical Nonroad Diesel Fuel Sulfur Levels'', Memorandum from David J. Korotney, Fuels and Energy Division, March 3, 1998, EPA Air Docket A–97–10, Docket Item II–B–01.

[19] ''A Review of Current and Historical Nonroad Diesel Fuel Sulfur Levels'', Memorandum from David J. Korotney, Fuels and Energy Division, March 3, 1998, EPA Air Docket A–97–10, Docket Item II–B–01.

[20] ''Newsletter from Ritt Bjerregaard, the EU's Commissioner for the Environment,'' European Commission, September 1998.

[21] European Union Directive 98/69/EC published on December 28, 1998 (OJ L350, Volume 41, page 1).

[22] Hart's European Fuels News, ''All Change! Standard diesel dropped by UK as majors announce phase-out within weeks'', February 10, 1999.

[23] ''International Activities Directed at Reducing Sulphur in Gasoline and Diesel, A Discussion Paper,'' Dr. Mark Tushingham, Environment Canada, 1997.

[24] CONCAWE, Report No. 6/97, ''Motor Vehicle Emission Regulations and Fuel Specifications—Part 2—Detailed Information and Historic Review (1970–1996).''

[25] ''Sulfur Limit for Diesel Fuel May Be Lowered'', *Japan Times Online,* June 2, 1998.

Agency is expected to decide on the new diesel sulfur limit after holding hearings and consulting with the Central Environment Council, an advisory panel to the prime minister.

In North America, Mexico and Canada have regulated diesel sulfur levels to a maximum of 500 ppm, as in the U.S. Canada recently announced a proposal to lower gasoline sulfur, but the proposal does not address diesel fuel at this time. However, Canada recognized that a lower diesel sulfur level may be necessary to protect public health and to support future diesel engine technologies. The Canadian Government Working Group recommended that emissions from on-road diesel fuels be examined further to determine their impact on public health.[26]

Issue 2: Experience Outside the U.S.—*What lessons can we learn from the experience of other countries in planning for and producing low sulfur diesel fuel?*

VI. Potential Benefits of Reducing Sulfur

We believe that diesel fuel desulfurization should be evaluated primarily for its potential to enable new engine and aftertreatment technologies with large air quality benefits. However, there may be other effects as well, as discussed further below.

A. Technology Enablement

Sulfur-sensitive technology enablements can be further grouped into two categories: those that can be achieved with some success using current fuel but which have significantly improved emissions performance with low sulfur fuel, and those that must have low sulfur fuel. The following discussion provides our current understanding of prospective technologies in both categories, built from a review of the technical literature and from numerous discussions with the people who are developing these concepts.

Note that we believe the viability and sulfur-sensitivity of these technologies are, to varying degrees, still open issues; also, there may be other promising technologies not included here. A major goal of this advance notice is to establish the degree of confidence warranted in claims that robust, cost-effective emission control technologies will be made viable or greatly enhanced by fuel desulfurization. Another major goal is to ascertain what sulfur levels may be needed. Manufacturers have suggested that sulfur should be capped at 30 ppm, although the need for even lower levels has also been discussed. Even for those technologies that require low-sulfur fuel to function, there may be a range of operation in which the technologies may be able to tolerate higher sulfur levels but emissions performance may be further enhanced by additional reductions in fuel sulfur. We are interested in information that will help us understand both the range of sulfur levels over which operation of the relevant control technologies is possible, and the relationship between emissions performance and fuel sulfur levels within this range.

Issue 3: Sulfur-Tolerant Technologies.—*What full useful life NO_X and PM emission levels may be achievable for diesel passenger cars and light-duty trucks, and for heavy-duty engines, without a change in diesel fuel? At what costs? When could these levels be achieved in production vehicles and engines?*

Issue 4: Sulfur-Sensitive Technologies.—*How feasible are the sulfur-sensitive technologies (discussed below) for light-duty and heavy-duty applications? Are there others? What full useful life PM and NO_X emission levels could they achieve and when? What sulfur levels do they require? Are any of them substantially enhanced by additional sulfur reductions beyond the sulfur levels required just for proper functioning? What is the relationship between fuel sulfur levels and emissions performance associated with these technologies? How durable are they? What maintenance is required? What is the potential that they could eventually be made sulfur-tolerant? What are the cost implications? What is their fuel economy impact, if any? What problems might occur due to sulfur derived from lube oil being introduced into the combustion chamber, either through intentional mixing of used oil with fuel or from vaporization off of the cylinder wall?*

Issue 5: In-Use Emissions.—*How well will sulfur-sensitive emission control technologies perform over the complete range of operating cycles and environmental conditions encountered by vehicles in use? For example, will there be functional problems or high emissions during periods of sustained high loads or idling, or at extremes of ambient temperature and humidity?*

1. Technologies Improved By Sulfur Reduction

Technologies that may derive benefit from diesel fuel desulfurization include cooled EGR, lean-NO_X catalysts, PM filters, oxidation catalysts, and selective catalytic reduction (SCR). None of these technologies appear to have a threshold low sulfur level, above which the technology is simply not viable. Rather, every degree of sulfur reduction would provide correspondingly greater latitude for engine or aftertreatment designers to target their designs for aggressive emission reductions. Thus, we need to be able to quantify the expected emission reductions in order to assess the effectiveness, including incremental cost-effectiveness analysis where appropriate, of various levels of control.

The application of electronically controlled EGR to diesel engines is an effective means of controlling NO_X emissions. Cooling the recirculated exhaust gas before it reenters the combustion chamber can greatly increase EGR efficiency. NO_X emissions reductions of up to 90% are believed possible with cooled EGR systems for heavy-duty diesel applications.[27] However, manufacturers have claimed that one of the primary limiters on how extensively cooled EGR can be used is the potential for condensation of sulfuric acid and associated corrosion-related durability problems. We have not yet received any durability data to support these claims using realistic in-use operating conditions and corrosion-resistant materials. Acid aerosol formation may also increase the frequency of oil changes due to increased acidification of engine lubricating oil. It is not clear at this time that removing sulfur from fuel is the only solution to these problems, if they indeed exist. Any actual oil acidification problem may be addressable by increasing alkaline oil additives, and corrosion-resistant materials are available for durable EGR cooler construction.

Various types of lean-NO_X catalysts are either in production or under investigation for reduction of NO_X emissions in lean exhaust environments such as those present in diesel exhaust. These catalysts include two types: (1) Active catalysts require a post-combustion fuel injection event and (2) passive catalysts require no post-injection. Although some active catalyst systems have higher NO_X removal efficiencies than similar passive catalyst systems, NO_X removal efficiencies are still only in the range of 15 to 35% on average. It is more likely that these systems will be used for incremental NO_X reduction for light-duty applications in combination with other

[26] "Final Report of the Government Working Group on Sulphur in Gasoline and Diesel Fuel—Setting a Level for Sulphur in Gasoline and Diesel Fuel," July 14, 1998.

[27] Dickey, D.W., et al., NO_X Control in Heavy-Duty Diesel Engines—What is the Limit? SAE Technical Paper Series, No. 980174, 1998.

technologies, such as cooled EGR. Lean-NO_X catalysts are prone to long-term efficiency loss due to sulfur-induced deactivation or ''poisoning''. They may also produce unwanted sulfate PM. Both of these problems can be mitigated by reducing fuel sulfur, though higher sulfur fuel can be accommodated by using less effective catalyst formulations.

One method of exhaust aftertreatment for controlling diesel PM emissions is to pass diesel exhaust through a ceramic or metallic filter (sometimes called a ''soot filter'' or ''PM trap'') to collect the PM, and to use some means of burning the collected PM so that the filter can be either periodically or continuously regenerated. Filter designs have used catalyzed coatings, catalytic fuel additives, electrical heating, and fuel burners to assist trap regeneration. Failure to consistently regenerate the filter can lead to plugging, excessive exhaust back-pressure, and eventually overheating and permanent damage to the filter. Inconsistent regeneration due to the low frequency of adequately high temperature exhaust transients has been a particular problem in applying PM filters to light-duty diesel vehicles. Although PM filters have been used with current fuels, some designs, especially those that use catalyst materials susceptible to sulfate generation, can be made more effective with lower sulfur fuel. In addition, some PM filter system concepts may *require* low sulfur fuel, as discussed below.

Oxidation catalysts are a proven technology already in widespread use on diesel engines. They reduce exhaust PM by removing volatile organics, some of which are adsorbed onto soot particles. They also reduce emissions of gaseous hydrocarbons. Oxidation catalysts have utility not only for direct reduction of PM and hydrocarbons, but also as a potential clean-up device to preclude hydrocarbon slip downstream of NO_X catalysts or PM filters that inject diesel fuel. In the relatively low-temperature environments characteristic of diesel engine exhaust streams, catalyst formulations containing precious metals such as platinum are particularly useful, because they function at fairly low temperatures. Unfortunately, these metals also promote the conversion of SO_X to sulfate PM, thus potentially *increasing* PM emissions, so oxidation catalyst designers must work a careful balance to succeed with current fuel. Sulfur reduction can obviously mitigate this problem and enable more aggressive oxidation catalyst formulations.

SCR for NO_X control is currently used on stationary diesel engines, and has been proposed for mobile applications. SCR uses ammonia as a NO_X reducing agent. The ammonia is typically supplied by introducing a urea/water mixture into the exhaust upstream of the catalyst. The urea/water mixture is stored in a separate tank that must be periodically replenished. These systems can be very effective, with NO_X reductions of 70 to 90%, and appear to be tolerant of current U.S. on-highway diesel fuel sulfur levels. However, there is concern that applying current SCR technology to highway vehicles will require use of catalyst formulations that are sensitive to sulfur, such as those employing platinum, to deal with the broad range of operating temperatures typical of highway diesel engines in use. There is also potential for formation of ammonia sulfate, which is undesirable because it is a component of fine PM.[28] In addition, SCR systems bring some unique concerns. First, precise control of the quantity of urea injection into the exhaust, particularly during transient operation, is very critical. Injection of too large of a quantity of urea leads to a condition of ''ammonia slip'', whereby excess ammonia formation can lead to both direct ammonia emissions (with accompanying health and odor concerns) and oxidation of ammonia to produce (rather than reduce) NO_X. Second, there are potential hurdles to overcome with respect to the need for frequent replenishment of the urea supply. This raises issues related to supply infrastructure, tampering, and the possibility of operating with the urea tank dry. Third, there may be modes of engine operation with substantial NO_X generation in which SCR does not function well. Finally, there is concern that SCR systems may produce N_2O, a gas that has been associated with greenhouse-effect emissions.

Issue 6: Selective Catalytic Reduction—*How could the discussed difficulties with SCR ammonia slip, infrastructure, reductant maintenance, robustness, and N_2O production be resolved?*

2. Technologies Likely To Require Low Sulfur Fuel

Technologies that are not currently considered feasible with current fuel, but which might become feasible if the sulfur content of diesel fuel were lowered, include NO_X storage catalyst systems and continuously regenerable PM filter systems.

Although still in early stages of development, NO_X storage catalyst technology shows promise for NO_X reductions of 50 to 75% in use. Some projections of ultimate efficiency range as high as 90%.[29] However, these catalysts are also very prone to sulfur poisoning due to sulfate buildup. Diesel engines employing NO_X storage catalyst systems will probably be limited to the use of diesel fuels with less than 30 to 50 ppm sulfur. Even at such fairly low sulfur levels, frequent sulfate purging cycles may be needed to restore catalyst function. Alternatively, even lower fuel sulfur levels, on the order of 5 to 10 ppm, may be needed to manage the frequency of purging cycles. Manufacturers have suggested that further development of NO_X catalyst systems could eventually enable diesel engines to reach the fuel-neutral Tier 2 fleet average NO_X standard of 0.07 grams/mile (see discussion below on Diesel Sulfur Control and Tier 2).

The recently developed continuously regenerating PM filter has shown considerable promise for light-duty diesel applications due to its ability to regenerate even at fairly low exhaust temperatures. This filter technology is capable of a large step change in PM emissions, with typical PM reductions exceeding 80%.[30] However, these systems are also fairly intolerant of fuel sulfur, and are effectively limited to use with diesel fuel with sulfur levels below 50 ppm. Given that these filter designs appear to have similar efficiencies to less sulfur-sensitive PM filter concepts, it is important for us to better understand potential advantages and disadvantages of the various trap concepts in determining whether or not low sulfur fuel is needed for effective PM control.

B. Other Effects

In addition to the primary benefits associated with the enablement or improved utilization of technologies discussed above, desulfurization could have other effects that should be assessed as well. Desulfurization will reduce the direct emissions of sulfate PM and SO_X, both of which are harmful pollutants. Sulfate PM emissions contribute to the overall inventory of PM_{10} and $PM_{2.5}$, both pollutants for which EPA has set National Ambient Air Quality Standards. SO_2 (one component of SO_X) is also a criteria pollutant, and some portion of emitted

[28] ''The Impact of Sulfur in Diesel Fuel on Catalyst Emission Control Technology'', Manufacturers of Emission Controls Association, March 15, 1999.

[29] ''The Impact of Sulfur in Diesel Fuel on Catalyst Emission Control Technology'', Manufacturers of Emission Controls Association, March 15, 1999.

[30] Hawker, P., et al., SAE Technical Papers 980189 and 970182.

SO_X is chemically transformed in the atmosphere to sulfate PM, and is therefore considered a secondary PM source. Although we do not directly regulate the emissions of SO_X from diesel engines, because the overwhelming majority of these emissions are from stationary sources like powerplants, diesel SO_X reductions would nevertheless be of some benefit to the environment.

The introduction of desulfurized highway diesel fuel would provide immediate SO_X and PM emission reductions from the large and growing population of heavy-duty diesel engines in the United States. These emission reductions would even extend to some portion of the nonroad equipment fleet because some significant, though undetermined, portion of this fleet is fueled with highway diesel fuel rather than the generally less expensive nonroad diesel fuel, for reasons of convenience. In contrast to technology-enabling benefits, these direct emission reductions derive added air quality value from the fact that they are realized immediately as existing vehicles are refueled with the new fuel, rather than gradually over many years as new technology vehicles replace older models in the fleet.

On the other hand, although this secondary benefit from sulfate and SO_X reductions in the existing fleet would result whether or not we set new engine emission standards, it would not be expected to carry over to engines built after new sulfur controls take effect. This is because testing of these engines to verify compliance with motor vehicle emission standards would be expected to be conducted using a low sulfur test fuel, reflective of the in-use fuel. A low sulfur test fuel, with no change in emission standards, allows the engine manufacturer to back off on emissions controls to optimize engine cost, performance, or fuel economy. Thus earlier model year engines designed for higher sulfur fuel could actually run cleaner than later engines designed to the same standards, once sulfur controls take effect.

Issue 7: Direct Benefits of Sulfur Reduction—*How much direct incremental environmental benefit can be achieved by diesel fuel sulfur reduction?*

Manufacturers have claimed that lower sulfur fuel will improve the durability of engines and emissions controls, and will reduce the need for maintenance, including oil changes. These benefits would produce a cost savings to vehicle owners. They may also produce an indirect emissions benefit because, although manufacturers must take steps to ensure durable emissions controls (such as providing warranties and assuming liability over a set useful life), many engines may have high emissions because they last well beyond the regulatory useful life or because they are poorly maintained. Therefore, provisions that inherently extend emission controls' life or reduce the need for emissions-affecting maintenance can be beneficial. Some manufacturers have claimed that this is especially relevant for engines employing an extensive degree of cooled EGR, although this is yet to be proven. As discussed above, we have not yet received any durability data to support these claims using realistic in-use operating conditions and corrosive resistant materials. On the other hand, because reduced sulfur appears to enhance the durability of the engines, and not just that of the emission controls, environmental disbenefits may result from diesel fuel sulfur reduction, due to the potential that higher-quality fuel will make older, higher-emitting engines last longer in the field. Furthermore, fuel changes may inadvertently and detrimentally alter fuel system components such as o-ring seals, and may also reduce the helpful lubricating effect that some sulfur compounds have on fuel system components, although it also appears that steps can be taken to preclude these effects, such as the use of lubricity additives.

Issue 8: Durability and Maintenance Impacts—*Are there quantifiable environmental benefits or disbenefits from such secondary effects as more durable controls, reduced maintenance needs, or longer-lived high-emitting trucks? What steps, if any, need to be taken to ensure that fuel changes would not degrade fuel system components in the existing fleet? Would lubricity additives be required to restore any loss in fuel lubricity characteristics compared to current fuel? If so, what would the environmental and cost impacts of these additives be?*

VII. Diesel Sulfur Control and Tier 2

Although almost all highway diesel engines used in the United States today are in heavy-duty trucks and buses, the impetus for near-term action on diesel fuel quality arises from our efforts to set stringent new Tier 2 emission standards for passenger cars and light trucks. These standards will apply to vehicles powered by any fuel—including both gasoline and diesel. As part of the Tier 2 rulemaking, we also are proposing to lower gasoline sulfur levels, in part to enable the use of advanced catalytic converters. Manufacturers of diesel engines and vehicles have argued that setting Tier 2 standards without concurrent diesel fuel changes will be unfair to diesels, because diesel fuel quality would be worse than gasoline fuel quality. Some argue that, beyond fuel-neutrality considerations, diesel fuel quality improvement is needed to combat global warming because it will facilitate the marketing of more diesel vehicles and, in their opinion, thereby reduce emissions of global warming gases. Others counter that diesel vehicles should be discouraged because diesel exhaust is a serious health hazard that improvements in diesel fuel quality will do little to mitigate. Some also believe that any fuel economy improvements from diesels will be offset by manufacturers' sale of more large vehicles, resulting in no net improvement in fleetwide fuel economy, and thus no net reduction in global warming emissions.[31]

In establishing the Tier 1 light-duty vehicle standards currently in place, the Clean Air Act made special, explicit provision for diesel vehicles. However, the framework it provided us for the setting of Tier 2 standards made no special reference to diesel engines. In our July 1998 Tier 2 Report to Congress, we therefore concluded that Congress did not intend special treatment for diesel engines after 2003.

Under the Tier 2 proposal's fuel-neutral approach, there are not separate emission standards for diesels. However, the proposed Tier 2 program allows manufacturers to sell some engines with higher emissions—in the range achievable by both gasoline and diesel vehicles with current fuel quality—during the early phase-in years of the program. Table 1 summarizes the proposed Tier 2 emission standards. Manufacturers would have to meet a corporate average NO_X standard for the entire fleet of vehicles sold, but would have the flexibility to certify different vehicle models to different sets of emission standards (referred to as "bins"). Some bins have a NO_X emission standard that is higher, and some lower, than the corporate average NO_X standard. The proposed Tier 2 standards would be phased in over time, allowing a portion of a manufacturer's vehicle sales to meet the less stringent "interim" standards. During the phase-in years, the program would establish

[31] Fleetwide fuel economy (for light-duty vehicles and light-duty trucks) is constrained by the Corporate Average Fuel Economy (CAFE) standards established by the government.

separate interim standards for the following vehicle categories:

- LDVs and light light-duty trucks (LLDTs), less than 6000 pounds GVWR.
- Heavy light-duty trucks (HLDTs), 6000 pounds GVWR or greater.

Table 2 shows when the interim and Tier 2 standards would be phased in, by indicating the percentage of manufacturers' vehicle sales required to meet the respective standards each year. Even when the Tier 2 standards are fully phased in, manufacturers still would be able to certify vehicles in the higher-emitting bins. However, sales of vehicles in the higher-emitting bins would be limited by a manufacturer's ability to comply with the proposed corporate average NO_X standard.

TABLE 1.—PROPOSED TIER 2 EXHAUST EMISSION STANDARDS [32]

	Corporate average NO_X (grams/mile)	Highest-emitting certification bin (grams/mile)	
		NO_X	PM
LDV/LLDT			
Interim	0.30	0.60	0.06
Tier 2	0.07	0.20	0.02
HLDT			
Interim	0.20	0.60	0.06
Tier 2	0.07	0.20	0.02

[32] This table does not reflect all proposed Tier 2 standards; it shows full useful life standards for categories and pollutants relevant to the discussion in this notice.

TABLE 2.—PROPOSED PHASE-IN FOR TIER 2 STANDARDS

	Model year (percent)					
	2004	2005	2006	2007	2008	2009 & later
LDV/LLDT						
Interim	75	50	25			
Tier 2	25	50	75	100	100	100
HLDT						
Interim*	25	50	75	100	50	
Tier 2					50	100

*0.60 grams/mile NO_X cap applies to balance of these vehicles during the 2004–2006 phase-in years.

As shown in Tables 1 and 2, some diesel and gasoline LDV/LLDTs could be certified to emission standards of 0.60 grams/mile NO_X and 0.06 grams/mile PM through the 2006 model year. HLDTs, where diesels are most likely to find a large market, could be certified to these same emission standards through 2008. We expect that these ''highest bin'' emission standards, although challenging, could be met by diesel vehicles without fuel changes. In model year 2007 and beyond for LDV/LLDTs, and in model year 2009 and beyond for HLDTs, the highest emission standards available for vehicle certification would be 0.20 grams/mile for NO_X and 0.02 grams/mile for PM. It is likely that diesel fuel sulfur control would be needed to enable diesels to achieve these more stringent emission standards.[33]

Furthermore, even though some HLDTs can be marketed in the highest bin (0.60 NO_X/0.06 PM) through model year 2008, by model year 2007, or perhaps even 2006, the phase-in percentage of the more stringent interim corporate average NO_X standard (0.20 grams/mile) becomes great enough that it may start to curtail sales of vehicles in the highest bin. Thus, diesel fuel changes may be critical for continued sales of diesel-powered HLDTs in these earlier model years.

In summary, it appears most likely that the need for diesel vehicles to employ technologies dependent on low sulfur diesel fuel under the Tier 2 program will occur by the 2006 or 2007 model year, implying that low sulfur fuel should be available for these vehicles sometime in 2005 or 2006. This presumes of course that the development of robust, sulfur-sensitive diesel technologies achieving the Tier 2 emission levels will be successful. There may also be merit in providing for an early introduction of the low sulfur fuel, at least perhaps on a limited basis, to allow proveout of technologies that require this fuel.

Issue 9: Diesels In Tier 2—*If diesel fuel changes were not adopted, when and to what extent would the anticipated diesel market growth be curtailed under the proposed phased in approach to Tier 2? What is the likelihood that diesels will not be able to meet proposed Tier 2 standards even with fuel changes? What is the likelihood that advances in sulfur-tolerant control technologies would negate the need for low sulfur fuel after a few years? Would an early introduction phase of low sulfur fuel to demonstrate technologies be of value? How soon and on what scale might this be implemented?*

[33] It should be noted that the Tier 2 proposal also includes elimination of the highest bin after 2007 for LDV/LLDTs and 2009 for HLDTs, thus requiring compliance with a NO_X standard of 0.15 grams/mile. This would further reinforce the need for advanced technologies.

VIII. Heavy-Duty Highway Engines

The sulfur-sensitive technologies discussed above show promise in a wide range of diesel applications, including light- and heavy-duty vehicles and nonroad equipment. Heavy-duty engines typically have different operating characteristics than light-duty engines, most notably more frequent occurrences of higher temperature exhaust stream flows that can facilitate catalysis. These differences may affect design decisions, such as what catalyst formulations and devices to use, but do not appear to be so great as to rule out technology-enabling sulfur control for any class of diesel applications. Particularly if sulfur-sensitive technologies work well on light-duty vehicles, we would expect them also to find application with heavy-duty engines.

Engine designers are now developing engines to meet the 2004 heavy-duty highway engine NO_X + NMHC emission standard that we set in 1997. We are currently conducting a technology review, to be completed later this year, to re-evaluate the appropriateness of this standard. Although low-sulfur fuel would add to the control options available for engines designed for this standard, we do not expect it to provide corresponding new-engine emissions benefits without changes in the engine emissions standards. Manufacturers would be likely to design engines to emit at roughly the same NO_X levels either way—low enough to meet the standards with some compliance margin—and take advantage of the higher quality fuel to improve fuel economy or other performance parameters. Engine changes that improve fuel economy, such as timing advance, may incidentally decrease PM emissions as well, but the degree to which this would happen without a change in standards is uncertain.

Although we have not yet performed an assessment of the feasibility of more stringent NO_X and PM standards for heavy-duty highway engines in model years after 2004, the technologies discussed above show great promise for large further reductions in these emissions. The concurrent need for diesel fuel changes to enable these technologies would, of course, be an important part of any Agency activity directed toward setting more stringent standards, as would an evaluation of the air quality need for further diesel engine emission reductions and of the need for adequate leadtime for engine manufacturers to implement new standards. The earliest that EPA could implement more stringent than current NO_X standards that might be enabled by low sulfur diesel fuel is the 2007 model year. More stringent PM standards based on such fuel could be evaluated for implementation as early as model year 2004. The Agency would address these issues further in a separate regulatory action.

Issue 10: Future Heavy-Duty Highway Engine Standards—*How do emission control challenges and solutions differ for light-and heavy-duty diesel engines? How might these differences affect fuel quality requirements? What heavy-duty NO_X and PM emission standards may be feasible with low sulfur fuel? When could they be implemented? What would be the cost of such heavy-duty emission standards?*

Low sulfur fuel may also bring about a potentially very large environmental benefit in the existing fleet of diesel engines. There are programs under consideration by some states through which older diesel engines would be retrofitted with emission-reducing technologies. Some of the sulfur-sensitive technologies discussed above may be useful for this purpose. Aftertreatment devices have proven especially adaptable to retrofit situations, although some of the more sophisticated systems that require careful control of engine parameters may not be as suitable. Thus sulfur reduction could potentially enable not just incremental emission reductions from the existing fleet, but large, step-change reductions in PM and NO_X as well, in areas where incentives for retrofitting are provided. Note that this benefit could be extended to nonroad diesel engines, provided the retrofit program ensures fueling with low sulfur fuel as well.

Issue 11: Retrofit Potential—*Can the sulfur-sensitive emission control technologies be retrofit to existing engines? At what cost? What environmental benefits might be achieved?*

IX. Nonroad Engines

We are interested in improvements in the quality of fuel consumed in nonroad diesel engines for several reasons:

- Nonroad diesel engines are a major contributor to air quality problems.
- Many of the technologies under development to meet the 2004 heavy-duty highway NO_X + NMHC emission standard are transferable to these engines.
- Many of the advanced aftertreatment technologies discussed above could be applied to them as well.
- Nonroad diesel fuel currently is unregulated and typically has high sulfur levels.[34]
- Refiners may make different plant changes to meet highway fuel regulations if action is taken on nonroad fuel quality as well.

The diesel engine dominates the nonroad equipment market above 50 horsepower (hp). These engines are used in such applications as farming and construction. A large and growing market for diesel engines below 50 hp also exists. Consistent with the less advanced state of nonroad engine emission regulations, we currently do not regulate nonroad diesel fuels. However, some sizeable but unknown portion of nonroad equipment uses lower sulfur highway fuel for reasons of user convenience, and in California nonroad diesel fuel is regulated to the same specifications as highway fuel. Locomotives and marine vessels use separate diesel fuel stocks, which are unregulated as well.

Our recent rulemaking setting new nonroad diesel engine standards established the feasibility of these standards without requiring changes to nonroad diesel fuel (see 63 FR 56968, October 23, 1998). That rule set multiple tiers of standards with increasing stringency: Tiers 1 and 2 for smaller engines (below 50 hp) and Tiers 2 and 3 for larger engines. (Tier 1 standards for larger engines were set in a previous rule.) However, due to a lack of available information on PM emissions during transient operation, the rule deferred action on Tier 3 PM standards until another rulemaking, planned for completion in 2001. That rule will also review the feasibility of the Tier 3 NO_X + NMHC standards and the smaller engine Tier 2 standards, and will consider moving the Tier 3 standards for engines at or above 300 hp forward in time, as discussed in the October 1998 final rule. These standards are currently set to be implemented in 2006.

Our ability to set stringent Tier 3 PM standards while maintaining an effective program of NO_X control may be limited by the high sulfur levels in nonroad diesel fuel. The intended transfer of technology developed to meet the heavy-duty highway 2004 standard for NO_X + NMHC, such as cooled EGR, may be jeopardized, unless nonroad fuel sulfur levels, and also perhaps cetane/aromatics levels, are controlled to levels similar to those available on-highway—maximum 500 ppm sulfur and minimum 40 cetane

[34] Diesel fuel sold in most nonroad applications has sulfur levels on the order of 3300 ppm, as discussed in Section V.A.

index (or, alternatively, maximum 35% aromatics content). Of course, we are concerned about the ability of refiners to provide higher quality nonroad fuel in Tier 3, which begins in roughly the same time frame in which large sulfur reductions for gasoline and highway diesel fuel may be implemented. This concern and the potential benefits of a coordinated, phased approach, are discussed further in the section on refinery impacts below.

Beyond fuel changes needed for Tier 3 nonroad engines, it is reasonable to expect that advanced aftertreatment technologies, should they prove effective in highway engines, could be used in many nonroad applications as well. If, in the future, we determine that more stringent nonroad diesel engine emission standards beyond Tier 3 are appropriate, further desulfurization of nonroad diesel fuel would also therefore need to be considered. The timing of such standards and fuel requirements would need to provide adequate leadtime after the implementation of Tier 3 nonroad diesel engine emission standards in 2006–2008. Retrofit opportunities similar to those discussed above for highway engines may also exist, perhaps on an earlier time frame than post-Tier 3 nonroad emission standards, making use of highway fuel.

Issue 12: Future Nonroad Diesel Engine Standards—*If EPA were to adopt Tier 3 PM standards on the order of the current highway PM standard (0.10 g/hp-hr measured over a transient test), would nonroad fuel sulfur regulation to 500 ppm or less be needed? Would the highway fuel cetane/aromatics specification need to be adopted as well? Are there differences between highway and nonroad applications that would affect fuel specifications? What nonroad* NO_X *and PM emission standards beyond Tier 3 may be feasible with very low sulfur fuel? When could they be implemented? What would the cost of these standards be? What sulfur levels would be needed? What information is available about the relationship between nonroad fuel sulfur levels and nonroad engine emissions?*

Even if we do not adopt regulations in the near term to improve the quality of nonroad diesel fuel, it may be necessary at least to consider capping nonroad diesel fuel sulfur levels as part of any highway fuel sulfur reduction program, in order to preclude a shift of unwanted sulfur to nonroad fuel in the petroleum refining process. This shift could occur either through sulfur dumping or through redirection of higher sulfur blendstock streams to nonroad fuel production.

Issue 13: A Cap On Nonroad Diesel Fuel Sulfur Levels—*Will there be a tendency for nonroad diesel fuel sulfur levels to increase if highway fuel sulfur is reduced? Would we need to cap nonroad fuel sulfur levels?*

X. Refinery Impacts and Costs

A. Investments and Costs

Desulfurization of diesel fuel to very low levels is expected to involve substantial capital investments and added operating expenses by petroleum refiners. Improvements in nonroad fuel to a quality level similar to that of current highway diesel fuel would also be a major undertaking for refiners. We are interested in any information that would help us to assess these costs, both on an industry-wide scale and for segments of the industry that might experience special challenges, such as small refiners and small refineries. We also welcome suggestions on means by which such impacts can be softened, while still achieving the intended environmental benefit, such as by delaying requirements for small refiners. The following discussion outlines some of the issues we are aware of.

Some refineries, especially those with modern hydrotreating plants, may be able to accomplish the needed sulfur removal by upgrading existing units. Such upgrades could be accomplished by such means as increasing catalyst density, employing more active catalysts, operating at higher temperatures, and reducing the level of hydrogen sulfide in the recycled hydrogen gas. Other refineries may need to build new hydrodesulfurization units and require time for planning, permitting, and construction. The degree to which new plants must be built will, of course, depend on how much of the diesel fuel pool must be desulfurized and to what levels. Both retrofits and new units will require additional hydrogen and energy supply, as well as additional processing of the sulfur removed in the hydrotreater. The prospect of widescale gasoline and diesel fuel desulfurization activity is spurring research and development in innovative hydrotreating technologies, such as countercurrent processing employed in the SynSat process and catalytic distillation being developed by CDTech. Such developments are expected to lower the cost of desulfurization.

One novel technology that shows promise involves the use of enhanced biological agents to convert sulfur compounds in the fuel to removable and marketable byproducts. This method, though still unproven on a large scale, has experienced rapid progress over the last several years. Even if it does not prove cost-effective as a primary desulfurization solution, it may find utility in partially desulfurizing selected blendstocks to an intermediate sulfur level before hydrotreating, or in small refineries unable to afford large capital outlays. We are interested in information that would help us to assess the feasibility and costs of this technology and, considering that it appears to be much less energy-intensive than traditional methods, its potential for reducing global warming gas emissions.

Issue 14: Sulfur Reduction Methods—*How would refiners accomplish diesel fuel sulfur reduction to various maximum sulfur specifications, for examples, 5, 10, 30 and 50 ppm? What capital investments would be required and how would they be financed? How soon could it be accomplished? How would a shift in the relative demand for diesel fuel and gasoline affect these decisions? How much additional energy would be needed to produce the fuel? What other operating costs would be incurred? What would be done with the removed sulfur? How would these answers change if only the sulfur levels in light-duty diesel fuel were further controlled? Is there value in regulating average sulfur levels in a refinery's diesel fuel production, in addition to or instead of maximum fuel sulfur levels?*

In addition to requiring changes at the refinery, diesel fuel quality improvement may affect the fuel distribution system as well. All phases of the distribution process would likely need to maintain the quality of the fuel leaving the refinery. This may be particularly challenging if a very low sulfur level is required, considering that other refinery products carried in the same transportation network may continue to have very high sulfur levels. Additional storage tanks might also be required.

Issue 15: Distribution System Quality Control—*What if any problems (beyond those already experienced in handling multiple fuels in the distribution system) arise in ensuring that low sulfur fuel supplies leaving the refinery remain low in sulfur in a distribution system that may also carry fuels with much higher sulfur levels? Will complete separation of supply infrastructures be necessary? Is there a minimum practical sulfur level that distributors can comply with, considering limitations of available measurement and segregation methods?*

One element in the assessment of refinery impacts is our recently proposed gasoline sulfur reduction program, associated with proposed Tier 2 vehicle standards. The proposed gasoline sulfur control requirements would cause refiners to undertake substantial investments to upgrade their processing facilities in roughly the same time frame as that envisioned under a diesel desulfurization program. Gasoline and diesel fuel production operations are not independent, and a refiner's choice of desulfurization methods or of specific equipment configurations may be affected by how desulfurization requirements for the two fuels are implemented. Even more significantly, any shift toward more diesel fuel demand due to the introduction of new diesels into the light-duty market will have a major effect on refiners' capital investment plans.

Sulfur exists naturally in crude oil. The extent to which sulfur ends up in gasoline and diesel fuel is dependent on the amount of sulfur in the crude and on the refinery processes used. One option to reduce sulfur in both gasoline and diesel is to use crude oil with a lower sulfur content. However, the availability and cost of low sulfur crude substantially limit the ability of refiners to use such an approach.

Regarding refinery processes, refiners would need to decide where in the process to perform desulfurization steps. Absent more stringent diesel sulfur control, many refiners may choose to add (or upgrade) process units that remove sulfur selectively from blendstocks used to manufacture gasoline to meet the proposed reduction in gasoline sulfur. If a reduction in diesel sulfur is also required, some refiners may choose to add (or upgrade) process units that selectively remove sulfur from the blendstocks used to manufacture diesel fuel. Although such blendstock processing units have no functional overlap, refiners could benefit from knowing whether reductions in both diesel and gasoline sulfur would be needed before investing in new facilities to remove sulfur from gasoline blendstocks. Upgrades in hydrogen production facilities, basic utilities, and waste treatment facilities are needed to support the addition or expansion of gasoline and diesel fuel blendstock desulfurization units. If a refiner knew that reducing diesel fuel sulfur was to be required in addition to reducing gasoline sulfur, it might save money by building a single support facility to supply the hydrogen and other needs of both the diesel and gasoline blendstock desulfurization units rather than building separate support facilities.

Other refiners may choose to add (or upgrade existing) process units that remove sulfur from the crude oil fractions used to manufacture both gasoline and diesel fuel blendstocks. Such units could be useful in meeting a refiner's desulfurization needs either in addition to, or in place of, units that remove sulfur from diesel or gasoline blendstocks. If a reduction in diesel sulfur is required, refiners might choose to invest more heavily in processing units that remove sulfur upstream in the refinery process rather than in ''end of pipe'' units that remove sulfur from diesel or gasoline blendstocks separately. It should be noted that, although both gasoline and diesel fuel desulfurization may involve large capital investments, aggressive desulfurization of diesel fuel tends to improve the cetane of the final product by removing aromatics, whereas it tends to lower the octane of gasoline, requiring additional steps to restore gasoline fuel quality.

Issue 16: Impact On Gasoline Sulfur Control and Other Refinery Changes—*How would the imposition of more stringent controls on diesel fuel sulfur affect a refiner's strategies to meet the proposed gasoline sulfur requirements? What are the advantages to refiners in being able to plan facility changes to meet more stringent gasoline and diesel sulfur controls at the same time? How would other planned or likely refinery changes relate to diesel fuel sulfur control?*

Issue 17: Costs—*What are the total and per-gallon incremental costs to produce highway diesel fuel meeting various maximum sulfur specifications, for example, 5, 10, 30, and 50 ppm? What are the costs to produce nonroad diesel fuel: (1) Meeting a maximum sulfur specification of 500 ppm, and (2) meeting all of the current EPA highway fuel specifications? How do these costs vary if the sulfur reduction projects for diesel and gasoline are implemented together compared to if the diesel sulfur reduction is implemented some time after gasoline sulfur reduction without regard to economies of coordinated planning?*

Issue 18: Small Refiners and Small Refineries—*How might desulfurization requirements uniquely affect a small refiner? How might they affect smaller refinery operations within larger companies? Are special provisions, such as a delayed requirement, appropriate?*

Issue 19: Flexible Strategies—*Are there program strategies that could reduce costs or increase flexibility for refiners? (for example: phase-in of requirements, streamlining of the permitting process, banking and trading of credits for early or excess compliance, refinery averaging with upper limit cap). What limits would need to be placed on these flexibilities to ensure that sulfur-sensitive vehicle technologies are not degraded?*

Issue 20: Petroleum Imports—*Would a requirement for low sulfur fuel affect our degree of reliance on foreign sources of petroleum and diesel fuel?*

Issue 21: Impacts On Other Refinery Products—*How would diesel fuel sulfur reductions impact the quality, cost, and availability of other products such as jet fuel, kerosene, and heating oil, and how would these impacts vary by region?*

Issue 22: Uncertainties—*How will major uncertainties facing diesel engine use, such as health effects concerns and growing interest in nontraditional fuels, affect the demand for diesel fuel? How can these issues be factored into Agency action to preclude expensive short-lived refinery investments?*

B. Refinery Emissions

The technologies used for diesel desulfurization have the potential to increase air pollutants at the refinery. To different degrees, desulfurization technologies involve the use of a furnace and, thus, potentially could increase pollutants associated with combustion, such as NO_X, PM, SO_2, and carbon monoxide. The addition of these technologies also could result in increased process vent emissions and equipment leaks of petroleum compounds, which could increase emissions of VOCs and hazardous air pollutants (HAPs). Increased removal of sulfur from the diesel stream likely will require increased throughput for a number of refinery processes, such as the sulfur recovery unit, which converts hydrogen sulfide into elemental sulfur and is associated with SO_2 emissions. Relative to gasoline desulfurization, we expect that diesel desulfurization would result in higher emissions on a per gallon basis, because of the increased temperatures and hydrogen needed to remove sulfur in diesel fuel. Any emission increases associated with diesel desulfurization will vary from refinery to refinery, depending on a number of source-specific factors, such as the specific refinery configuration, choice of desulfurization technology, amount of diesel production, and type of fuel used to fire the furnace.

From a climate change perspective, we also want to better understand the impact on greenhouse gas emissions at the refinery. We are interested in how diesel desulfurization process changes would affect greenhouse gas emissions at refineries.

Issue 23: Refinery Emissions—*What emissions impacts at the refinery would be expected from producing low sulfur diesel fuel (assuming gasoline sulfur reduction is already taken into account)? What are the potential emission increases (or decreases) of regulated air pollutants and greenhouse gases?*

XI. Prospects for a Phased Approach

It is possible that higher quality diesel fuel will be needed for the light-duty Tier 2 program, but would only be needed to meet future heavy-duty engine standards at a later date. This would create a dilemma because currently both light- and heavy-duty applications use the same fuel, sharing a common fueling infrastructure that is vastly dominated by heavy-duty usage. Creation of a separate light-duty diesel fuel pool and infrastructure for an interim period would be the obvious solution. However, requiring a separate high quality grade of diesel fuel for use in vehicles subject to the Tier 2 emissions standards may involve investment by refiners, distributors, and retailers in the new tankage and other facilities necessary to keep such fuel segregated from other on-highway diesel fuel. It also could lead to loss of environmental benefits and even engine or aftertreatment device damage due to misfueling, although fueling nozzle interface requirements could help to mitigate this. Furthermore, the temporary nature of this separate fuel pool would depend on a determination that the same ultimate fuel specifications are appropriate for both light- and heavy-duty applications. As discussed in Section IV, more information is needed in order to assess this.

Despite the issues involved in creating a light-duty fuel infrastructure, we are interested in evaluating this approach for several reasons. First, we would expect it to allow for the introduction of low sulfur fuel for the light-duty vehicle market at an earlier date. Second, such a limited fuel pool may allow for other fuel quality improvements, besides reduced sulfur, if deemed appropriate. Third, the availability of this fuel would facilitate the early introduction of low-emitting heavy-duty technologies in demonstration, credit banking, or retrofit fleets. Finally, the production costs would be reduced because refiners could focus desulfurization activities on those diesel blendstock streams easiest to desulfurize. This would save on operational costs for hydrogen, energy, and byproduct treatment, and, more importantly, would allow refiners to phase in major capital outlays, if needed, for future heavy-duty fuel programs.

A phased approach could be carried still further by introducing the low sulfur fuel into the heavy-duty fuel pool gradually, as needed to support new trucks and buses employing the sulfur-sensitive technologies. Eventually, as the fleet turned over, so would the fuel pool, in a fashion similar to the turnover to unleaded gasoline. The benefit of such phased approaches would be offset somewhat by the need for a separate refueling interface, for additional tankage and plumbing to segregate product streams, and perhaps by additional dyeing requirements.

A parallel approach could be used to introduce nonroad diesel fuel regulated to similar quality levels as current highway fuel, to support the nonroad Tier 3 emission standards program, if such fuel is found to be needed for this program. With the adoption of a refueling interface to avoid misfueling, new Tier 3 engines could use the higher quality fuel, while pre-Tier 3 engines could continue to use the unregulated fuel, thus allowing a gradual phase-in of the Tier 3 fuel to match the growing population of these engines in the fleet. Again, the benefit of this approach would need to be evaluated against the disadvantage of added complexity.

Distributors and retailers clearly would take on an additional burden to support a light-duty fuel. If light-duty diesel fuel were not easily available to consumers, people would be unlikely to buy diesel cars and light-trucks. However, we would expect that many urban/suburban service stations that currently provide diesel fuel would simply switch to the low sulfur fuel and not install additional pumps because their heavy-duty diesel fuel volume is not large. Some highway truck stops already have separate pumps for the convenience of drivers of smaller diesel vehicles, though owners of these stations may need to make changes in tankage utilization to segregate fuels. Vehicle and fuel pump nozzle manufacturers would need to create a new fueling interface to preclude misfueling, similar to what was done when unleaded gasoline was introduced.

Issue 24: Phased Approach—*What would the challenges be to refiners and distributors associated with introducing a separate ''light-duty low-sulfur grade'' of diesel? How soon could it be done? How much would it cost? How large would the fleet of vehicles using this fuel have to be to make it cost-effective? Would the relatively small fraction of a refiner's total diesel output needed for this market make it possible for refiners to produce it without significant additional facility investments? To what extent would additional storage tanks and fuel pumps need to be installed to accommodate a separate grade of fuel? What pump/vehicle refueling interface changes (or other measures) are needed to preclude misfueling? What fuel dyeing requirements would need to be adopted? What are the merits of a program in which the sulfur level is reduced in two or more steps, especially if very low sulfur levels are determined to be needed eventually?*

Issue 25: Coverage—*Would widespread geographic coverage have to be mandated to ensure success? Based on current light-duty diesel experience, are there segments of the retail diesel fuel market that could be exempted from providing this fuel without discouraging vehicle sales? Could the phased concept be extended to accommodate a gradual turnover of the heavy-duty fuel pool? Should requirements during a phase-in be focused on sales at retail outlets (thus providing the opportunity for smaller businesses to defer implementation), or on refiner production?*

Although a phased approach covering all of the diesel fuel pools could take many forms, it may be helpful to consider an example of such an approach to better understand how it might work. For example, fuel desulfurized to technology-enabling levels (30 ppm for the sake of this example) might be provided in 2004 at a small number of urban and rural locations, to support the limited production and sale of advanced technology diesel light-duty (and perhaps heavy-duty) vehicles. This would comprise an early introduction program to prove and perfect these technologies. In 2005 this offering would expand to supply the light-duty diesel vehicles requiring it under the Tier 2 program. More stations and fuel would be involved to ensure that the fuel is widely available to consumers buying these vehicles. Also in 2005, 500 ppm nonroad fuel would begin phasing in, with broad nationwide coverage but only in quantities needed to meet the demand created by the sales of new Tier 3 equipment. Unregulated nonroad diesel fuel also would continue to be sold, but would gradually be phased out as demand for it declined. In 2006 and 2007, the supply of 30 ppm sulfur fuel would continue to expand to support the introduction of heavy-duty vehicles equipped with advanced technologies needed to meet new heavy-duty emission standards. This expansion would increasingly focus on truck stops that had not already transitioned to supplying the 30 ppm sulfur fuel in the earlier years of the programs. At some point over the following years, the demand for higher sulfur highway fuel would decline to a point at which it would no longer be cost-effective to maintain two highway fuel pools, and its production would cease. Throughout the phase-in period, separate high and low sulfur refueling interfaces, and perhaps other measures, would need to be maintained to avoid misfueling.

Issue 26: Example Phase In Scenario—*Would a comprehensive need-based phase-in such as the one in the example work? What measures could be taken to facilitate it?*

XII. Vehicle Operation With Higher Sulfur Fuel

Many line-haul diesel trucks regularly or occasionally cross our borders with Canada and Mexico. Canada recently adopted the 500 ppm sulfur limit that has been in effect in the U.S. since 1993. Further fuel quality regulation is under consideration but may not take effect until well after a desulfurization program begins here, if at all. Mexico also has regulations intended to control diesel fuel sulfur to the 500 ppm level, but we are not aware of activity there aimed at achieving further reductions. In addition to potential cross-border differences, Alaska, American Samoa and Guam currently have exemptions from our existing 500 ppm limitation because of special difficulties in supplying low-sulfur diesel fuel for those markets. A long-term decision whether Alaska, American Samoa and Guam should continue to have exemptions will need to be made in this rulemaking once a decision is made on the appropriate diesel fuel sulfur level.

Cross border traffic will impact prospects for effective emissions control based on low sulfur diesel fuel. If a truck with sulfur-sensitive emission controls is fueled in Canada or Mexico with higher sulfur fuel, the emission controls may be reversibly or irreversibly degraded by catalyst poisoning, sulfate PM production, or some other mechanism. If the degradation is severe or irreversible enough, that truck may actually pollute for long periods at levels higher than earlier generation trucks, thus contributing to the air quality problems of our neighbors, and to our own problems after the truck's return to the U.S. In addition, trucks with sulfur-sensitive emission controls that are permanently operated in a state exempt from fuel sulfur controls might likewise emit at very high levels, thus either resulting in a disbenefit to the local environment or forcing adoption of a program that requires the continued marketing of earlier generation, non-sulfur sensitive truck engines in that state. A similar issue arises in considering whether or not there is a need for a complete turnover of the diesel fuel inventory to low sulfur formulations before any introduction of low-sulfur technologies can occur, thus precluding any economy derived from a gradual phase-in or from any sort of regional flexibility in implementing the program.

These concerns would be greatly mitigated by evidence that sulfur-sensitive technologies will be robust enough to quickly recover from episodes of operation with higher sulfur fuel, and that their continuous operation on higher sulfur fuel will not result in more emissions than those from comparable engines not equipped sulfur-sensitive technologies.

Issue 27: Ability To Accommodate Some Higher Sulfur Fuel—*What is the potential for irreversible damage to sulfur-sensitive emission control hardware due to fueling with higher sulfur fuel? How might this vary with the length of exposure and the age of this equipment? What is the potential for high sulfate PM production while burning this fuel?*

Issue 28: Alaska Exemption—*Should Alaska be exempted from any future low sulfur fuel requirements? Why or why not? What provisions could be made to ensure that such an exemption does not cause unacceptable emissions in and outside Alaska? What about the U.S. territories that also currently have an exemption (Guam and American Samoa)?*

Issue 29: Cross-Border Traffic—*What percentage of U.S. trucks refuel in Canada or Mexico and how often? How will this change in the future? What are the prospects for diesel fuel desulfurization in these countries? Are there reasonable measures that can be taken to avoid damage to sulfur-sensitive emissions controls?*

XIII. Stakeholder Positions

Over the past year or so, various interested groups have expressed their positions on sulfur levels in diesel fuel. Here, we summarize only those positions that have been communicated formally (either to EPA or other governmental entities). One goal of this notice is to generate discussion that will help us better understand the positions of these and other stakeholders.

Together, the (then existing) American Automobile Manufacturers Association, the European Automobile Manufacturers Association, and the Japan Automobile Manufacturers Association proposed a World-Wide Fuel Charter in June 1998.[35] The goal of this global fuels harmonization effort is to develop common, worldwide recommendations for ''quality fuels'', considering customer requirements and vehicle emissions technologies. Three categories of fuel quality are proposed for diesel fuel, based on the extent of emission control requirements. Category 3 fuel quality is for markets with advanced requirements for emission controls (such as California Low and Ultra-Low Emission Vehicles). The sulfur content recommended for Category 3 diesel is 30 ppm.

The Ford Motor Company, Chrysler Corporation (now DaimlerChrysler) and General Motors Corporation further urged the Administration to make significant progress in bringing about low sulfur diesel and gasoline fuels. These companies stressed the importance of low sulfur diesel and gasoline fuels in reducing vehicle emissions and enabling the successful introduction of advanced engine and emission control technologies.[36]

The State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO) adopted a resolution urging us to pursue the most stringent highway and nonroad diesel fuel sulfur standards that are technologically and economically feasible.[37] These associations believe that stringent national standards for diesel sulfur, combined with stringent standards for low sulfur gasoline and vehicle emissions, are essential to address the full range of the country's air pollution problems— including ozone, particulate matter, regional haze and toxics. STAPPA/ALAPCO recommended that such diesel sulfur standards take effect by 2003. They

[35] ''Proposed World-Wide Fuel Charter'', issued by the American Automobile Manufacturers Association, the European Automobile Manufacturers Association, and the Japan Automobile Manufacturers Association, June 1998.

[36] Letter from Robert J. Eaton, Chrysler Corporation, Alex Trotman, Ford Motor Company and John F. Smith, Jr., General Motors Corporation, to Vice President Al Gore, July 16, 1998.

[37] ''STAPPA/ALAPCO Resolution on Sulfur in Diesel Fuel,'' October 13, 1998. Letter from S. William Becker, Executive Director of STAPPA/ALAPCO, to Carol Browner, Administrator of U.S. EPA, October 16, 1998.

urged us to announce our intention to adopt such standards as soon as possible, so that petroleum refiners could consider the least-cost ways of complying with both gasoline and diesel sulfur controls. They also urged us to consider nonroad diesel fuel changes and to adopt the most stringent sulfur standards feasible to enable emerging control technologies.

The Engine Manufacturers Association (EMA) also urged us to reduce the sulfur content of diesel fuel.[38] EMA cited the need for low sulfur diesel fuel to enable the introduction of new catalytic aftertreatment devices, reduce fine particulate emissions, and improve engine emissions durability. EMA is involved in a number of activities with other organizations to support low sulfur diesel fuel requirements. EMA offered to share the data from each of these projects with us as they become available. These activities include:

• Requesting the Manufacturers of Emission Control Association (MECA) to draft a ''White Paper'' addressing the technical need for low sulfur diesel fuel from an aftertreatment perspective.[39]

• Conducting a joint test program with the U.S. Department of Energy to evaluate four levels of diesel sulfur (350 ppm, 150 ppm, 30 ppm and 10 ppm) with five different aftertreatment technologies and four different diesel engines.

• Examining the impact of fuel sulfur on engine life, particularly the corrosive effects.

• Analyzing the environmental impact of reduced sulfate conversion and effects on the particulate matter emissions inventory from diesel engines.

• Preparing an economic analysis of the refining costs associated with lowering diesel sulfur levels, considering proposed changes to gasoline sulfur and potential synergies from reducing sulfur in the input stream rather than individual distillate streams.

[38] Letter from Jed R. Mandel, Engine Manufacturers Association, to Margo T. Oge, Director, Office of Mobile Sources, EPA, November 6, 1998.

[39] This paper is available in Docket A–99–06: ''The Impact of Sulfur in Diesel Fuel on Catalyst Emission Control Technology'', Manufacturers of Emission Controls Association, March 15, 1999.

XIV. Public Participation

We are committed to a full and open regulatory process with input from a wide range of interested parties. If we proceed with a proposed rule, opportunities for input will include a formal public comment period and a public hearing.

With today's action, we open a comment period for this advance notice (see **DATES**). We encourage comment on all issues raised here, and on any other issues you consider relevant. The most useful comments are those supported by appropriate and detailed rationales, data, and analyses. All comments, with the exception of proprietary information, should be directed to the docket (see **ADDRESSES**). If you wish to submit proprietary information for consideration, you should clearly separate such information from other comments by (1) labeling proprietary information ''Confidential Business Information'' and (2) sending proprietary information directly to the contact person listed (see **FOR FURTHER INFORMATION CONTACT**) and not to the public docket. This will help ensure that proprietary information is not inadvertently placed in the docket. If you want us to use a submission of confidential information as part of the basis for a proposal, then a nonconfidential version of the document that summarizes the key data or information should be sent to the docket.

We will disclose information covered by a claim of confidentiality only to the extent allowed and in accordance with the procedures set forth in 40 CFR part 2. If no claim of confidentiality accompanies the submission, it will be made available to the public without further notice to the commenter.

XV. Administrative Designation and Regulatory Analysis

Under Executive Order 12866 (58 FR 51735 (Oct. 4, 1993)), the Agency must determine whether this regulatory action is ''significant'' and therefore subject to Office of Management and Budget (OMB) review and the requirements of the Executive Order. The order defines ''significant regulatory action'' as any regulatory action (including an advanced notice of proposed rulemaking) that is likely to result in a rule that may:

(1) 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;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or,

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

This Advance Notice was submitted to OMB for review as required by Executive Order 12866. Any written comments from OMB and any EPA response to OMB comments are in the public docket for this Notice.

XVI. Statutory Provisions and Legal Authority

Statutory authority for the fuel controls discussed in this notice comes from section 211(c) of the Clean Air Act. Section 211(c) allows EPA to regulate fuels where emission products of the fuel cause or contribute to air pollution which reasonably may be anticipated to endanger public health or welfare or where emission products of the fuel will impair to a significant degree emission control equipment.

List of Subjects

40 CFR Part 80

Environmental protection, Administrative practice and procedure, 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 1, 1999.

Carol M. Browner,

Administrator.

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