society, with net present value benefits through 2036 of $805 billion using a 3 percent discount rate and $352 billion using a 7 percent discount rate, compared to a net present value of social cost of about $27 billion using a 3 percent discount rate and $14 billion using a 7 percent discount rate. The impact of these costs on society should be minimal, with the prices of goods and services produced using equipment and fuel affected by standards being expected to increase about 0.1 percent.

Further information on these and other aspects of the economic impacts of this emission control program are summarized in the following sections and are presented in more detail in the Final RIA for this rulemaking.

A. Refining and Distribution Costs

Meeting the 500 and 15 ppm sulfur caps will generally require that refiners add hydrotreating equipment and possibly new or expanded hydrogen and sulfur plants in their refineries. We have estimated the cost of building and operating this equipment using the same basic methodology which was described in the NPRM. We have updated that analysis with new information obtained from the vendors of advanced desulfurization technology, to better reflect current crude oil properties and refinery configurations, as well as future hydrogen costs. We have also incorporated information received from refiners regarding their plans to produce 15 ppm highway diesel fuel from 2006–2010. Finally, we incorporated the 15 ppm cap on locomotive and marine fuel in 2012, as well as improving our analysis of the impact of this cap on costs incurred in the distribution system.

The costs to provide NRLM fuel under the two-step fuel program are summarized in Table VI.A–1 below. All of the following costs estimates are in 2002 dollars. Capital investments have been amortized at 7 percent per annum before taxes. These estimates do not include costs associated with fuel sulfur testing, labeling, reporting or record keeping, which we believe will be small relative to those associated with refining, distribution and lubricity additives. A more detailed description of the costs associated with this final rule is presented in the Final RIA.

TABLE VI.A–1.—COST OF PROVIDING NRLM DIESEL FUEL

(cents per gallon of affected fuel)

NRLM diesel fuel	Years	Affected fuel volume (million gallons per year) [a]	Refining	Distribution (and lubricity)	Total
500 ppm	2007–2010	11,860	1.9	0.2	2.1
	2010–2012	3,589	2.7	0.6	3.3
	2012–2014	715	2.9	0.6	3.5
15 ppm	2010–2012	8,145	5.0	0.8	5.8
	2012–2014	12,068	5.6	0.8	6.4
	2014 +	13,399	5.8	1.2	7.0

Notes: [a] Volumes shown are for first full year in each period (2008, 2011, 2013, and 2015).

The costs shown (and all of the costs described in the rest of this section) apply to the 74 percent of current NRLM fuel that currently contains more than 500 ppm sulfur (hereafter referred to as the affected volume).

In 2014, the affected volume of NRLM fuel is 14.6 billion gallons out of total NRLM fuel volume of 19.7 billion gallons. The other 5.1 billion gallons of NRLM fuel is currently spillover from fuel certified to the highway diesel fuel standards. We expect this to continue under the 2007 highway diesel fuel program. Thus, 26 percent of NRLM fuel will already meet at least a 500 ppm sulfur cap by 2007 and a 15 ppm cap by 2010 and will not be affected by today's rule. The costs and benefits of desulfurizing this highway fuel which spills over into the non-highway markets was included in our cost estimates for the 2007 highway diesel fuel rule.

The estimated cost of the first step of the NRLM fuel program is slightly less than that projected in the NPRM (cents per gallon). However, we have increased our estimated cost of the second step significantly in response to comments. These comments and the changes to our cost estimates are discussed in more detail in the next two sections. The combined cost for both steps is therefore somewhat higher than expected in the NPRM, but nevertheless consistent with projections for the cost of 15 ppm highway diesel fuel.

We expect that the increased cost of refining and distributing 500 ppm NRLM fuel will be completely offset by reductions in maintenance costs, while those for 15 ppm NRLM fuel will be significantly offset. These savings will apply to all diesel engines in the fleet due to the reduced fuel sulfur content, not just new engines. Refer to section V.B for a more complete discussion on the projected maintenance savings associated with lower sulfur fuels.

1. Refining Costs

Methodology: We followed the same process that we used in the NPRM to project refining costs, though we have broken down the description into five steps instead of four.

First, we estimate the total volume of NRLM fuel which must be desulfurized during each step of the program, as well as each refinery's future total production of distillate fuel. Current and future demand for all distillate fuels except diesel fuel for land-based equipment were based on estimates from the Energy Information Administration's (EIA) Fuel Oil and Kerosene Survey (FOKS) for 2001 and the 2003 Annual Energy Outlook (AEO). EPA's NONROAD emission model was used to estimate both current and future fuel consumption by land-based nonroad equipment to ensure the consistent treatment of both the costs and benefits associated with this rule. Table VI.A–2 shows our projections of the volumes of fuel affected by today's rule. These volumes exclude NRLM fuel expected to be certified to highway diesel fuel sulfur caps prior to the implementation of this rule. They also exclude distillate fuel meeting a 500 ppm cap which is produced during distribution from highway diesel fuel, jet fuel, etc.

TABLE VI.A–2.—VOLUME OF NRLM FUEL AFFECTED BY TODAY'S RULE

(billion gallons per year)

	Nonroad		Locomotive and marine		Total	
	500 ppm	15 ppm	500 ppm	15 ppm	500 ppm	15 ppm
2008	8,406	0	3,454	0	11,860	0
2011	614	8,145	2,975	0	3,589	8,145
2013	468	8,671	247	3,395	715	12,066
2015	0	10,539		2,860	0	13,399

This marks a change from the proposal, where all distillate fuel volumes were based on EIA FOKS and AEO estimates. Commenters pointed out that this approach underestimated fuel-related costs relative to emission reductions and monetized benefits, since the NONROAD fuel volumes used to estimate the latter were larger. We in fact had acknowledged this inconsistency in the proposal and had said we would address it in the final rule. Our approach to address the inconsistency was to utilize the land-based nonroad fuel volumes estimated by the NONROAD model for both the costs and monetized benefits. However, we also conducted a sensitivity analysis whereby both emissions and costs were estimated using EIA estimates of fuel demand by land-based nonroad equipment. The results of that analysis are discussed in chapter VII of the Final RIA.

We made one other revision to the volume of diesel fuel affected by this rule. In analyzing the impact of the 2007 highway diesel fuel program for the NPRM analysis, we estimated that 4.4 percent of 15 ppm highway diesel fuel would be contaminated during shipment and not available for sale as 15 ppm highway fuel. This increased the volume of 15 ppm highway fuel which had to be produced at refineries before accounting for the production of additional 500 and 15 ppm NRLM fuel in response to the NRLM fuel program. Due to comments made on the NRPM (discussed in section VI.A.3. below), we have improved our analysis to track the disposition of this contaminated 15 ppm fuel. Much of this contaminated fuel can be sold as 500 ppm NRLM from 2007–2014 and as L&M fuel thereafter. Thus, the contaminated 15 ppm fuel reduces the volume of 500 and 15 ppm NRLM fuel which must be produced at refineries.

Second, total distillate production by individual refineries were based on their actual production volumes in 2002, as reported to EIA. This represents a minor revision to the NPRM analysis, which utilized actual refiner production in 2000. The number of refineries needing to produce 500 ppm and 15 ppm diesel fuel under today's final rule was based on the projected diesel fuel and heating oil demand in 2014.[200] To be consistent, the 2002 distillate production volumes of individual refiners were increased to 2014 levels using EPA projections of growth in total distillate production by domestic refiners.

Third, we estimated the cost to desulfurize diesel fuel to both 500 ppm and 15 ppm for each domestic refinery. This considered both the volume of diesel fuel being produced and its composition (*e.g.*, percentage of straight run, light cycle oil, etc.). Estimates of the volumes of diesel fuel already being desulfurized to meet the highway diesel fuel standards in 2006–2010 prior to the implementation of this final rule were based on refiners' pre-compliance reports.[201] This marks a change from the NPRM analysis, where we assumed that refiners would continue to produce their current mix of highway and high sulfur diesel fuel. While many refiners indicated that their plans were preliminary and subject to change, we consider these projections to be more probable than assuming that current producers of diesel fuel will make no change to their product mix in complying with the highway rule. Meeting the 15 ppm highway diesel fuel cap will require significant investment, but some refiners will face more than others. Some refiners will be able to revamp their current hydrotreater, while others will need to build an entirely new unit. Some refiners will be able to expand their production of highway fuel at little incremental cost, while others will be able to reduce their investment substantially by reducing their production volume. Use of refiners' own projections, as opposed to our own cost methodology assumptions, allows us to incorporate as much refinery-specific information as is currently possible.

In projecting desulfurization costs, we updated a number of the inputs to our cost estimation methodology. We increased natural gas and utility costs to reflect those projected in EIA's 2003 AEO. The NPRM analysis utilized projections from 2002 AEO. Forecasted natural gas costs in 2003 AEO are considerable higher than in 2002 AEO, though still lower than current market prices. In response to comments, we also increased the factor for off-site capital costs to better reflect the cost of sulfur plant expansions. The NPRM analysis utilized an off-site factor developed in support of the Tier 2 gasoline and 2007 highway diesel fuel programs, where the amount of sulfur removed per gallon was a fraction of that occurring here with NRLM fuel. We also continued to update our cost estimates for advanced desulfurization technologies, as these technologies continue their evolution. As discussed in Section IV, the latest information concerning Process Dynamics's IsoTherming process indicate somewhat higher costs than earlier estimates. We also reduced our projection of the penetration of these advanced technologies in 2010 from 80 to 60 percent.

Fourth, we estimated which refineries will likely find it difficult to stay in the heating oil market after the implementation of the NRLM sulfur standards, due to their location relative to major pipelines and the size of the heating oil market in their area. Those not located in major heating oil markets and not connected to pipelines serving these areas were projected to have to

[200] The year 2014 represents a mid-point between the initial year of today's fuel program and the end of the expected life of desulfurization equipment (roughly 15 years).

[201] Under EPA's 2007 highway diesel program, refiners are required to submit their production plans for highway diesel fuel for 2006–2010. The first of these reports were due during the summer of 2003. EPA published a summary of the results this past fall. We consider these reports to provide a more accurate projection of individual refinery plans than our projections made during the highway fuel FRM. The latter was based on cost minimization using our refinery-specific desulfurization refinery model.

meet the 500 and 15 ppm caps in 2007 and 2010, respectively.

Fifth, we estimated which of the remaining refineries would likely produce NLRM fuel under today's program. As was done in the proposal, we assumed that those refineries with the lowest projected compliance costs would be the most likely to produce the required fuel until demand was met. Inter-PADD transfers of fuel between PADD 3 and PADD 1 were not constrained. PADD 3 refineries were also assumed to supply PADD 2 with 15 ppm NRLM fuel once all PADD 2 refineries were producing 15 ppm distillate fuel. We also assumed that domestic refineries would preferentially supply the lowest sulfur fuels compared to imports. Thus, imports of 15 and 500 ppm NRLM fuel were only assumed after all refineries in a PADD were projected to produce either 15 or 500 ppm fuel, respectively. The small refiner provisions included in today's NRLM fuel program were considered, as these provisions temporarily reduce the volume of 500 and 15 ppm fuel required to be produced in 2007 and 2010, respectively. This portion of the methodology was the same as that used in the NRPM analysis.

Results: Based on EIA data, in 2002 114 refineries produced highway diesel fuel and 102 refineries produce high sulfur diesel fuel or heating oil. Based on refiners' pre-compliance reports, we project that 100 refineries will produce 15 ppm highway diesel fuel; 96 refineries starting in 2006 and 4 in 2010. Of these 100 refineries, 96 currently produce some volume of highway diesel fuel, while 4 refineries currently only produce high sulfur distillate fuel. Also, 18 refineries will cease to produce highway diesel fuel and shift to producing solely high sulfur distillate fuel. This will leave a total of 92 refineries still producing high sulfur distillate after full implementation of the 2007 highway diesel fuel program.

The number of these 92 domestic refineries expected to produce either 15 or 500 ppm NRLM diesel fuel in response to today's rule is summarized in Table VI.A–3.

TABLE VI.A–3.—REFINERIES PROJECTED TO PRODUCE NRLM DIESEL FUEL UNDER THIS FINAL RULE

Year of program	500 ppm NRLM diesel fuel		15 ppm NRLM diesel fuel	
	All refineries	Small refineries	All refineries	Small refineries
2007–2010	36	0	0	0
2010–2012	26	13	32	2
2012–2014	15	13	47	2
2014+	0	0	63	15

During the four periods shown in table VI.A–3, two roughly parallel sets of standards become effective. For non-small refiners, the 500 ppm NRLM fuel cap starts in 2007, followed by the 15 ppm nonroad fuel cap in 2010, in turn followed by the 15 ppm L&M fuel cap in 2012. For small refiners, the 500 ppm NRLM fuel cap starts in 2010, followed by the 15 ppm nonroad NRLM fuel cap in 2014. As shown, beginning in 2014, 63 refineries are projected to be affected by today's final rule. After complete implementation of today's rule, 29 refineries are expected to be able to produce high sulfur heating oil, some as their entire distillate production, others along with 15 ppm fuel. The number of refineries estimated to be affected by today's rule is one more than that projected in the NPRM. There, we estimated that 62 refineries would have to produce either 15 or 500 ppm NRLM fuel in 2014 and beyond.

We project that the capital cost involved to meet the 2007 500 ppm sulfur cap will be $310 million. This represents about $10 million for each of the 30 refineries building a new hydrotreater. Six refineries are expected to produce 500 ppm NRLM fuel using existing hydrotreaters no longer being used to produce 500 ppm highway fuel. The total investment cost is roughly half that projected in the NPRM ($600 million). The decrease is due to a greater volume of 500 ppm NRLM fuel coming from existing hydrotreaters. This conclusion is based on the number of refineries leaving the highway diesel fuel market according to the refiners' highway program pre-compliance reports. The investment per refinery that we projected in the NPRM ($9.7 million) was essentially unchanged. Operating costs will be about $4.9 million per year for the average refinery, or slightly greater than that projected in the NPRM (due to higher hydrogen costs and a lower percentage of hydrocrackate in the NRLM pool). The average cost of producing 500 ppm NRLM fuel in 2007 will be 1.9 cents per gallon, 0.3 cent per gallon lower than that projected in the NPRM, due primarily to the reduced capital expenditure.

In 2010, an additional $1170 million will be invested in revamped and new desulfurization equipment, $1090 million to meet the 15 ppm nonroad fuel cap and $80 million to produce 500 ppm NRLM fuel no longer eligible for a small refiner exemption to sell high sulfur NRLM fuel. In 2012, an additional $590 million will be invested in revamped and new desulfurization equipment to meet the 15 ppm L&M cap Finally, in 2014 an additional $210 million will be invested in additional 15 ppm fuel capacity. Thus, total capital cost of new equipment and revamps related to the NRLM fuel program will be $2280 million, or $36 million per refinery, roughly 5 percent greater than that projected in the NPRM. Total operating costs will be about $8.1 million per year for the average refinery, slightly lower than that projected in the NPRM ($8.3 million per year). The total refining cost, including the amortized cost of capital, will be 5.0, 5.6 and 5.8 cents per gallon of new 15 ppm NRLM fuel in 2010, 2012, and 2014, respectively.

The 500 pm NRLM fuel being produced in 2010 is projected to cost 2.7 cents per gallon. The cost of this 500 ppm fuel is higher than that projected in the NPRM, due primarily to a higher cost for natural gas in the future. The 500 pm, small refiner fuel being produced in 2012 is projected to cost 2.9 cents per gallon. All of these costs are relative to the cost of producing high sulfur fuel today, and includes the cost of meeting the 500 ppm standard beginning in 2007.

The 15 ppm refining costs are significantly higher than the 4.4 cent per gallon cost projected in the NPRM for the option where L&M fuel was controlled to 15 ppm in addition to nonroad fuel. The increase is due to the changes in refining cost methodology described above, particularly the reduced use of advanced desulfurization technology, reduced synergies with the highway fuel program and increased natural gas costs.

The average refining costs by refining region are shown in table VI.A–4 below. These costs include consideration of the small refiner provisions. Combined costs are shown for PADDs 1 and 3 because of the large volume of diesel fuel which is shipped from PADD 3 to PADD 1.

TABLE VI.A–4.—AVERAGE REFINING COSTS BY REGION

[Cents per gallon]

	500 ppm Cap			15 ppm Cap		
	2007–2010	2010–2012	2012–2014	2010–2012	2012–2014	2014+
PADDs 1 & 3	1.6	3.7	2.5	4.6	4.9	5.1
PADD 2	2.8	2.9	3.7	7.1	7.8	7.8
PADD 4	3.3	9.0	9.0	11.6	11.7	11.8
PADD 5	1.2	2.8	3.5	4.3	4.3	5.7
Nationwide	1.8	2.7	2.9	5.0	5.6	5.8

Fuel-Only Control Programs: We used the same methodology to estimate refining costs for stand-alone 500 ppm and 15 ppm NRLM fuel programs. The fully phased in refining impacts of a 15 ppm NRLM standard are the same as those described above for the final rule in 2014 and beyond. A fully phased in 500 ppm NRLM fuel program is projected to affect 63 refineries, cost 2.0 cents per gallon and require a capital investment of $480 million.

2. Distribution Costs

Today's rule is projected to impact distribution costs in four ways. First, we project that a slightly greater volume of diesel fuel will have to be distributed, due to the fact that some of the desulfurization processes reduce the fuel's volumetric energy density during processing. Total energy is not lost during processing, as the total volume of fuel is increased in the hydrotreater. However, a greater volume of fuel must be consumed in the engine to produce the same amount of power. We project that desulfurizing diesel fuel to 500 ppm will reduce volumetric energy content by 0.7 percent. The cost of which is equivalent to 0.08 cent per gallon of affected NRLM fuel.[202] We project that desulfurizing diesel fuel to 15 ppm will reduce volumetric energy content by an additional 0.52 percent. This will increase the cost of distributing fuel by an additional 0.05 cents per gallon, for a total cost of 0.13 cents per gallon of affected 15 ppm NRLM fuel.

The second impact on distribution costs relates to the disposition of 15 ppm fuel contaminated during pipeline shipment. We received comments that the control of L&M fuel sulfur content, particularly to 15 ppm, would make it difficult to sell off-specification 15 ppm fuel. The comments argued that much of this material would have to be shipped back to refineries and reprocessed to meet the 15 ppm cap. We designed the program finalized today to allow the continued sale of 500 ppm fuel into the NRLM market until June 1, 2014, and into the locomotive and marine market indefinitely. By doing so, we were able to minimize, though not eliminate, much of the reprocessing and distribution cost impacts of concern. We have evaluated both the production and potential sale of distillate interface and estimated the distribution cost impacts of today's final rule provisions. The details of this analysis are contained in chapter 7 of the Final RIA.

In our analysis of the 15 ppm highway fuel program, we projected that the need to protect the quality of 15 ppm highway diesel fuel would increase the volume of highway diesel fuel downgraded to a lower value product, such as high sulfur diesel fuel and heating oil, from its current level of approximately 2.2 percent to 4.4 percent. Under today's rule, we expect that 15 ppm NRLM fuel will be shipped together with 15 ppm highway. Thus, the size of each batch of 15 ppm fuel will increase, but the number of batches will not. As the downgrade occurs at the interface between batches, the volume being downgraded should not increase. At the same time, we are not projecting that interface volume will decrease, as high sulfur fuels, such as jet fuel and, in some cases heating oil, will still be in the system.

The issue here is the market to which this interface volume can be sold. When this interface volume meets the specifications of one of the two fuels being shipped next to each other, the interface is simply added to the batch of that fuel. For example, the interface between regular and premium gasoline is added to the regular grade batch. Or, the interface between jet fuel and heating oil is added to the heating oil batch. One interface which is never added to either adjacent batch is a mixture of gasoline and any distillate fuel, such as jet or diesel fuel. If this interface was added to the distillate batch, the gasoline content in the interface would result in a violation of the distillate's flash point specification. If this interface was added to the gasoline batch, it would cause the gasoline to violate its end point specification. Therefore, this interface must be shipped to a transmix processor to separate the mixture into naphtha (a sub-octane gasoline) and distillate. The 2007 highway diesel fuel program will not change this practice. The naphtha produced by transmix processors from gasoline/distillate mixtures is usually blended with premium gasoline to produce regular grade gasoline. The distillate produced is an acceptable high sulfur diesel fuel or heating oil, though if the feed material was primarily low sulfur distillate and gasoline it will likely also meet the current 500 ppm highway fuel cap.

With the implementation of the highway diesel rule, there is another incompatible interface, that between jet fuel and 15 ppm diesel fuel. This interface can not be cut into jet fuel due to end point and other concerns. However, it can usually be cut into 500 ppm diesel fuel as long as the sulfur level of the jet fuel is not too high. With the lowering of the highway standard to 15 ppm, however, this will no longer be possible. We expect that pipelines minimize this interface by abutting jet fuel and high sulfur distillate in the pipeline whenever possible. However, it will be unavoidable under many circumstances. A substantial part of the pipeline distribution system currently does not handle high sulfur distillate, and we expect that the highway program and today's rule will likely cause additional pipeline systems to discontinue carrying high sulfur distillate. Pipelines that do not carry high sulfur distillates will generate this

[202] *See* chapter 7 of the RIA for further details regarding our estimation of distribution costs.

interface whenever they ship jet fuel.[203] The highway rule, and today's rule projects that pipeline operators will segregate this interface by cutting it into a separate storage tank. Because this interface can be sold as 500 ppm NRLM fuel or heating oil, and because these markets exist nationwide, there is little impact beyond the need for refiners to produce more 15 ppm highway diesel fuel (compared to the volume of highway diesel fuel produced prior to the implementation of the 15 ppm standard), which was considered as part of the refining costs in the highway diesel rule.

With control of nonroad fuel to 15 ppm sulfur in 2010 and LM fuel to 15 ppm sulfur in 2012, the opportunities to downgrade interface to another product become increasing limited. Where limited this will increase costs due to the need to transport the interface to where it can be marketed or to a facility for reprocessing. In areas with large heating oil markets, such as the Northeast and the Gulf Coast, the control of NRLM sulfur content will still have little impact on the sale of this interface. However, in areas lacking a large heating oil market, the sale of this distillate interface will be more restricted. Because this interface will composed of 15 ppm diesel fuel and jet fuel, we estimate that the distillate interface created should nearly always meet a 500 ppm cap.[204] Thus, this interface can be added to 500 ppm NRLM batches (as well as heating oil, where it is present at the terminal) through 2014. After 2014, this 500 ppm interface fuel can only be sold as L&M fuel or heating oil. An exception to this applies in the Northeast/Mid-Atlantic Area, where this interface cannot be sold into the nonroad fuel market after 2010, nor into the L&M fuel market after 2012.

In chapter 7 of the Final RIA, we estimate the costs related to handling this interface fuel during the four time periods (2007–2010, 2010–2012, 2012–2014, and 2014 and beyond). We project that there will be no additional costs prior to 2010, as 500 ppm fuel will be the primary NRLM fuel and be widely distributed. Beyond 2010, we estimate that terminals will have to add a small storage tank for this fuel, as 500 ppm highway diesel fuel and the majority of 500 ppm NRLM disappears from the distribution system. In many places, this interface will be the primary, if not sole source of 500 ppm fuel, so existing tankage to add this interface to will be limited. We have also added shipping costs to transport this fuel to NRLM and heating oil users. The volume of this interface is significant, sometimes a sizeable percentage of the combined NRLM fuel and heating oil markets. In the post-2014 period, the volume of this interface fuel is larger than the combined L&M fuel and heating oil markets in certain PADDs. Also, the volume of interface received at each terminal will vary substantially, depending on where that terminal is on the pipeline. The advantage of this is that where the interface accumulates it may be of sufficient volume to justify marketing as a separate grade of fuel. Conversely, the potential users of this 500 ppm interface fuel may not be located near the terminals with the fuel necessitating additional transportation costs.

Prior to 2014, 500 ppm fuel can be used as NRLM fuel and heating oil outside of the Northeast/Mid-Atlantic Area. Additional storage tanks will be needed in some cases, as this will be the only source of 500 ppm fuel in the marketplace. Amortizing the cost of a range of storage tank sizes over 15 years of weekly shipments at a seven percent rate of return before taxes costs produced an amortized cost of 0.2–1.6 cents per gallon. These costs include the carrying cost of the fuel stored in the tank. We estimate that the average storage cost will be closer to the lower end of this range, or 0.5 cent per gallon. Nonroad fuel users are fairly ubiquitous. Thus, increased shipping distances should be fairly short. We estimated 45 miles at a cost of roughly 1.5 cents per gallon. The distance to L&M fuel users will likely be longer, roughly 100 miles, but cost the same due to greater efficiencies of rail transport. It will likely cost more to deliver interface fuel to heating oil users, as many of these users are smaller, not evenly dispersed geographically, purchase fuel seasonally, and lack rail connections. We estimate that transport distances will increase an average of 85 miles and cost an additional 3.0 cents per gallon over today's costs to deliver this fuel to the end user, in addition to the 0.5 cent per gallon storage cost. When spread over all the 15 and 500 ppm NRLM fuel being produced from 2010–2014 due to today's rule, the additional distribution cost from 2010–2014 is 0.4 cents per gallon.

Starting in 2014, this interface fuel can no longer be sold to the nonroad fuel market. Since the interface volume does not change, this increases the volume of fuel that must be sold to the L&M and heating oil markets. Thus, overall, transportation distances and costs will likely increase. We expect that the transportation cost for fuel sold to the L&M market will increase from 1.5 to 3.0 cents per gallon, while that for heating oil will increase to 5.0 cents per gallon, both including fuel storage. However, in PADD 5, the volume of interface generated exceeds the total fuel demand of these two markets. Thus, we estimate that some fuel will have to be shipped back to refineries and reprocessed to meet a 15 ppm cap and shipped out a second time. We estimate that the cost of this shipping and reprocessing will cost 10 cents per gallon. When spread over all the 15 ppm NRLM fuel being produced after 2014 due to today's rule, the additional distribution cost is 0.8 cent per gallon.

The third impact of today's rule on distribution costs is related to the need for additional storage tanks to market additional product grades at bulk plants. While this final rule minimizes the segregation of similar fuels, some additional segregation of products in the distribution system will still be required. The allowance that highway and NRLM diesel fuel meeting the same sulfur specification can be shipped fungibly until it leaves the terminal obviates the need for additional storage tanks in this segment of the distribution system except for the limited tankage at terminals necessary to handle 500 ppm sulfur interface fuel discussed above.[205] Today's final rule also allows 500 ppm NRLM diesel fuel to be mixed with high-sulfur NRLM (though it can no longer be sold as 500 ppm fuel).

However, we expect that the implementation of the 500 ppm standard for NRLM diesel fuel in 2007 will compel some bulk plants in those parts of the country still distributing heating oil as a separate fuel grade to install a second diesel storage tank to handle this 500 ppm NRLM fuel. These bulk plants currently handle only high-sulfur fuel and hence will need a second tank to continue their current practice of selling fuel into the heating oil market in the winter and into the nonroad market in the summer. We believe that

[203] We expect that only three types of fuel will be carried by such pipeline systems: jet fuel, 15 ppm diesel fuel, and gasoline (premium and regular). Premium and regular gasolines are always shipped next to each other so the interface between premium and regular gasoline can be cut into the batch of regular gasoline. Thus, whenever jet fuel is shipped it will abut 15 ppm diesel fuel on one end and gasoline on the other.

[204] *See* chapter 7.1.7 of the RIA regarding our analysis of the sulfur levels of this interface material. This analysis indicated that although the maximum sulfur specification of jet fuel 3,000 ppm, in-use jet fuel sulfur levels are frequently below 500 ppm.

[205] Including the refinery, pipeline, terminal, marine tanker, and barge segments of the distribution system.

some of these bulk plants will convert their existing diesel tank to 500 ppm fuel in order to avoid the expense of installing an additional tank. However, to provide a conservatively high estimate we assumed that 10 percent of the approximately 10,000 bulk plants in the U.S. (1,000) will install a second tank in order to handle both 500 ppm NRLM diesel fuel and heating oil.

The cost of an additional storage tank at a bulk plant is estimated at $90,000 and the cost of de-manifolding a delivery truck is estimated at $10,000.[206] In the NPRM, we estimated that each bulk plant that needed to install a new storage tank would need to de-manifold a single tank truck. Thus, the NPRM estimated the cost per bulk plant would be $100,000. Fuel distributors stated that the assumptions and calculations made by EPA in characterizing costs for bulk plant operators seem reasonable. However, they also stated that our estimate that a single tank truck would service a bulk plant is probably not accurate. No suggestion was offered regarding what might be a more appropriate estimate other than the number is likely to be much greater. Part of the reason why we estimated that only a single tank truck would need to be de-manifolded, is that we expected that due to the seasonal nature of the demand for heating oil versus nonroad fuel, it would primarily only be at the juncture of these two seasons that both fuels would need to be distributed in substantial quantities. We also expected that the small demand for heating oil in the summer and the small demand for nonroad fuel in the winter could be serviced using a single de-manifolded truck. The primary fuel distributed during a given season would be distributed by single compartment tank trucks. During the crossover between seasons, bulk plant operators would switch the fuel to which such single compartment tank trucks are used from nonroad to heating oil and back again.[207] Nevertheless, we agree that the subject bulk plant operators would likely be compelled to de-manifold more that a single tank truck. Lacking additional specific information, we believe that assuming that each bulk plant operator de-manifolds three tank trucks will provide a conservatively high estimate of the cost to bulk plant operators due to today's rule.

If all 1,000 bulk plants were to install a new tank and de-manifold three tank trucks, the cost for each bulk plant would be $120,000, and the total one-time capital cost would be $120,000,000. To provide a conservatively high estimate of the costs to bulk plant operators, we are assuming that all 1,000 bulk plants will do so. Amortizing the capital costs over 20 years, results in a estimated cost for tankage at such bulk plants of 0.1 cents per gallon of affected NRLM diesel fuel supplied. Although the impact on the overall cost of the program is small, the cost to those bulk plant operators who need to put in a separate storage tank may represent a substantial investment. Thus, we believe many of these bulk plants will search out other arrangements to continue servicing both heating oil and NRLM markets such as an exchange agreement between two bulk plants that serve a common area.

As a consequence of the end of the highway program's temporary compliance option (TCO) in 2010 and the disappearance of high-sulfur diesel fuel from much of the fuel distribution system resulting from the implementation of today's rule, we expect that storage tanks at many bulk plants that were previously devoted to 500 ppm TCO highway fuel and high-sulfur fuel will become available for dyed 15 ppm nonroad fuel service. Based on this assessment, we do not expect that a significant number of bulk plants will need to install an additional storage tank in order to provide dyed and undyed 15 ppm diesel fuel to their customers beginning in 2010 (the implementation date for the 15 ppm nonroad standard).[208] There could potentially be some additional costs related to the need for new tankage in some areas not already carrying 500 ppm fuel under the temporary compliance option of the highway diesel program and which continue to carry high sulfur fuel. However, we expect them to be minimal relative to the above 0.1 cent per gallon cost. Thus, we estimate that the total cost of additional storage tanks at bulk plants that will result from today's rule will be 0.1 cent per gallon of affected NRLM diesel fuel supplied.

The fourth impact on fuel distribution costs is a result of the requirement that high sulfur heating oil be marked beginning June 1, 2007 and that 500 ppm sulfur LM diesel produced by refiners or imported be marked from 2010 through 2012 outside of the Northeast/Mid-Atlantic Area and Alaska. The NPRM projected that there would be no capital costs associated with the proposed marker requirement. We proposed that the marker would be added at the refinery gate, and that the current requirement that non-highway fuel be dyed red at the refinery gate be made voluntary. Thus, we believed that the refiner's additive injection equipment that is currently used to inject red dye into off-highway diesel fuel could instead be used to inject the marker as needed. As a result of the allowance provided in today's final rule that the marker be added at the terminal rather than the refinery gate, and our reevaluation of the conditions for dye injection at the refinery, we are now assessing capital costs for terminals and refiners related to compliance with the fuel marker requirements.

Except for fuel that is distributed directly from a refiner's rack, today's final rule allows the marker to be added at the terminal rather than at the refinery as we proposed (*see* section IV.D for a discussion of the fuel marker requirements).[209] We expect that except for fuel dispensed directly from the refinery rack, the fuel marker will be added to at the terminal to avoid the potential for marked fuel to contaminate jet fuel during distribution by pipeline. Terminals that need to inject the fuel marker will need to purchase a new injection system, including a marker storage tank and a segregated line and injector for each truck loading station at which fuel that is required to be marked is dispensed. Terminals will still be subject to IRS red dye requirements, and thus will not be able to rededicate such injection equipment to inject the fuel marker. Due to concerns regarding the need to maintain a visible evidence of the presence of the fuel marker, today's rule also contains a requirement that nay fuel which contains the fuel marker also contains visible evidence of red dye. Furthermore, there is little chance to adapt parts of the red dye injection system (such as the feed lines and injectors) for the alternate injection of red dye and the fuel marker due to concerns that NRLM fuel become contaminated with the marker.

Terminal operators expressed concern regarding the potential burden on terminal operators from the capital costs of adding new additive injection equipment for heating oil. In response to these comments, today's rule includes provisions that exempt terminal operators from the fuel marker requirements in a geographic ''Northeast/Mid-Atlantic Area'' and

[206] This estimated cost includes the addition of a separate delivery system on the tank truck.

[207] To avoid sulfur contamination of NRLM fuel, the tank compartment would need to be flushed with some NRLM fuel prior to switching from carrying heating oil to NRLM fuel.

[208] *See* Section IV of today's preamble for additional discussion of our rational for this conclusion.

[209] A refinery rack functions similar to a terminal in that it distributes fuel by truck to wholesale purchaser consumers and retailers.

Alaska.[210] These provisions provide that any heating oil or 500 ppm sulfur LM diesel fuel that would otherwise be subject to the fuel marker requirements which is delivered to a retailer or wholesale-purchaser consumer inside the Northeast/Mid-Atlantic Area or Alaska does not need to contain the marker. The costs of the marker requirements for heating oil beginning in 2007 and for 500 ppm sulfur LM diesel fuel from 2010 through 2012 are discussed separately below.

The Northeast/Mid-Atlantic Area was defined to include the region where the majority of heating oil in the country is projected to continue to be supplied through the bulk distribution system (the Northeast and Mid-Atlantic). The vast majority of heating oil consumption in the U.S. will be within the Northeast/Mid-Atlantic Area. Outside of the Northeast/Mid-Atlantic Area, we expect that only limited quantities of heating oil will be supplied, primarily from certain refiner's racks. We estimate that 30 refineries and transmix processor facilities outside of the Northeast/Mid-Atlantic Area will distribute heating oil from their racks (in limited volumes) on a sufficiently frequent basis to warrant the installation of a marker injection system at a total one time cost of $1,500,000.

Terminals outside of the Northeast/Mid-Atlantic Area will mostly be located in areas without continued production and/or bulk shipment of heating oil. Consequently, any high sulfur diesel fuel they sell will typically be NRLM. Terminals located within the Northeast/Mid-Atlantic Area will not need to mark their heating oil, except for those few that choose to ship heating oil outside of the Northeast/Mid-Atlantic Area. The terminals most likely to install marker injection equipment will therefore be those in states outside the Northeast/Mid-Atlantic Area with modest markets for heating oil after the implementation of this program. As discussed in chapter 7 of the RIA, in analyzing the various situations, we project that fewer than 60 terminals nationwide will choose to install marker injection equipment at a total cost of $4,150,000.[211] The total capital cost to refiners and terminals to install marker injection equipment is estimated to be $5,650,000. Thus, the Northeast/Mid-Atlantic Area provisions in today's rule minimizes the number of terminals that will need to install additive injection equipment and its associated cost to comply with the marker requirement for heating oil.

In the NPRM we estimated that the cost to blenders of the fuel marker in bulk quantities would translate to 0.2 cents per gallon of fuel treated with the marker. This estimate was based on the fee charged by a major pipeline to inject red dye at the IRS concentration into its customers diesel fuel. We used this estimate because we lacked specific cost information on the proposed marker, and we believed that it provided a conservatively high estimate of marker cost. Since the proposal, we received input from a major distributor of fuel markers and dyes, regarding the cost of bulk deliveries of the specified fuel marker to terminals which translates to a cost of 0.03 cents per gallon of fuel treated with the marker. The volume of heating oil that we expect will need to be marked has also decreased substantially from that estimated in the NPRM due to the Northeast/Mid-Atlantic Area provisions. We estimate that 1.4 billion gallons of heating oil will be marked annually, for an annual marker cost of $425,000. In the NPRM, we projected that the cost of marking heating oil would continue for three years (2007–2010). Under today's final rule, heating oil must be marked indefinitely beginning in 2007, but only outside of the Northeast/Mid-Atlantic Area and Alaska.

Because heating oil outside of the Northeast/Mid-Atlantic Area is being marked to prevent its use in NRLM engines, for the purposes of estimating the impact of the marker requirement on the cost of the NRLM program we have spread the cost for the marker for heating oil over NRLM diesel fuel. Amortizing the capital costs of marker injection equipment over 20 years, results in an estimated cost of 0.006 cents per gallon of affected NRLM diesel fuel supplied. Spreading the cost of the marker over the volume of affected NRLM fuel results in an estimated cost of 0.003 cents per gallon of affected NRLM fuel. Adding the amortized cost of the injection equipment necessary to add the marker to heating oil and the cost or the marker results in a total estimated cost of the marker requirement for heating oil in today's rule of 0.01 cents per gallon of affected NRLM fuel.

The final NRLM rule also requires that 500 ppm L&M fuel produced at refineries or imported be marked from mid-2010 through mid-2012 outside of the Northeast/Mid-Atlantic Area and Alaska. The adoption of a 15 ppm sulfur standard for LM diesel fuel in 2012 in today's rule allows us to require that LM fuel be marked from 2010 through 2012 rather than from 2010 through 2014 as proposed (*see* section IV.A). In addition, the way in which the program was crafted to avoid requiring the fuel marker be added to heating oil in the Northeast/Mid-Atlantic Area and Alaska allows us to also provide that 500 ppm sulfur LM diesel fuel in these areas is not subject to the marker requirement (see section IV.D). We project that only a small number of refiners will produce 500 ppm sulfur diesel fuel subject to the marker requirements fuel and that it will not be shipped via pipeline. Thus, most of this fuel can be marked at the refinery, limiting the number of facilities which need to add marking equipment in response to this requirement. We estimate that 15 facilities will have to do so, at a cost of $60,000 each, for a total of $900,000. Amortizing this over the total volume of affected NRLM fuel produced from mid-2010 to mid-2012 at seven percent per year before taxes yields a cost for the LM marker requirement of 0.004 cent per gallon. Including the cost of the marker (0.03 cent per gallon of marked fuel) increases this cost to 0.01 cent per gallon of NRLM fuel.

We summed these various costs incurred to the distribution system over four different time periods. As shown in table VI.A–5, the total additional distribution cost will be 0.2 cent per gallon of NRLM fuel during the first step of the fuel program (from 2007 through 2010), 0.6 cents per gallon of NRLM fuel from 2010 to 2012 and from 2012 to 2014, and increase to 1.0 cent per gallon thereafter. A more detailed description of the costs associated with downgraded jet fuel and 15 ppm diesel fuel is presented in chapter 7 of the Final RIA.

[210] Small refiner and credit high sulfur NRLM will not be permitted to be sold in the area where terminals are not required to add the fuel marker to heating oil (the ''Northeast/Mid-Atlantic Area''). See section IV.D.

[211] The estimated marker injection equipment costs include the cost of marker storage tanks, lines, and injectors.

TABLE VI.A–5.—SUMMARY OF DISTRIBUTION COSTS
[Cents per gallon]

Cause of increase in distribution costs	Time period over which costs apply			
	2007–2010	2010–2012	2010–2014	2014+
Distribution of additional NRLM volume	0.08	0.1	0.1	0.1
Distillate interface handling	0	0.4	0.4	0.8
Bulk plant storage tanks	0.1	0.1	0.1	0.1
Heating oil and L&M fuel marker	0.01	0.02	0.01	0.01
Total	0.2	0.6	0.6	1.0

3. Cost of Lubricity Additives

Hydrotreating diesel fuel tends to reduce the natural lubricating quality of diesel fuel, which is necessary for the proper functioning of certain fuel system components. There are a variety of fuel additives which can be used to restore diesel fuel's lubricating quality. These additives are currently used to some extent in highway diesel fuel. We expect that the need for lubricity additives that will result from the proposed 500 ppm sulfur standard for NRLM diesel fuel will be similar to that for highway diesel fuel meeting the current 500 ppm sulfur cap standard.[212] Industry experience indicates that the vast majority of highway diesel fuel meeting the current 500 ppm sulfur cap does not need lubricity additives. Therefore, we expect that the great majority of NRLM diesel fuel meeting the proposed 500 ppm sulfur standard will also not need lubricity additives. In estimating lubricity additive costs for 500 ppm diesel fuel, we assumed that fuel suppliers will use the same additives at the same concentration as we projected will be used in 15 ppm highway diesel fuel. Based on our analysis of this issue for the 2007 highway diesel fuel program, the cost per gallon of the lubricity additive is about 0.2 cents. This level of use is likely conservative, as the amount of lubricity additive needed increases substantially as diesel fuel is desulfurized to lower levels. We also project that only five percent of all 500 ppm NRLM diesel fuel will require the use of a lubricity additive. Thus, we project that the cost of additional lubricity additives for the affected 500 ppm NRLM diesel fuel will be 0.01 cent per gallon. See the Final RIA for more details on the issue of lubricity additives. We have no reason to expect that the implementation of today's NRLM sulfur standards will impact diesel properties other than fuel lubricity in such a way as to require the use of additives.

We project that all NRLM fuel meeting a 15 ppm cap will require treatment with lubricity additives. Thus, the projected cost will be 0.2 cent per affected gallon of 15 ppm NRLM fuel.

4. How EPA's Projected Costs Compare to Other Available Estimates

Historically, the price of highway diesel fuel meeting a 500 ppm sulfur cap has exceeded that of high sulfur diesel fuel, ranging from 0–5 cents per gallon from 1995–99 and averaging 2.2 cents per gallon over this time period (*see* chapter 7 of the Final RIA). Fuel prices are often a function of market forces which might not reflect the cost of producing the fuel. Still, given this is a five-year average price difference, it is likely a reasonable indication of the cost of reducing highway diesel fuel sulfur to 500 ppm. Once the small refiner provisions applicable to 500 ppm fuel expire in 2010, we project that the total cost of the 500 ppm NRLM fuel cap will be 2.4 cents per gallon, well within the range of the historical highway-high sulfur fuel price difference. This similarity exists despite changes in a number of factors. One, our projection of future natural gas costs are significantly higher than those existing during the above price comparison. Two, the refineries producing highway diesel fuel historically likely did so because they faced lower costs than those refineries continuing to produce high sulfur distillate. Three, desulfurization catalyst efficiency has improved dramatically since the highway units were installed and significant operating experience has been obtained on highway units. Four, inflation since the early 1990's will have increased the cost of constructing the same hydrotreater. Five, and perhaps most importantly, the construction of some new hydrotreaters to produce 15 ppm highway diesel fuel will allow the existing hydrotreaters to produce 500 ppm NRLM fuel at no capital cost. Thus, there are at least five significant factors, two of which would tend to decrease costs and three of which would tend to increase costs. It is not surprising that these factors could counter-balance each other, leading to the conclusion that the 500 ppm cap could be extended to NRLM fuel at roughly the same cost as for highway diesel fuel.

The only existing market for 15 ppm diesel fuel is a niche market for fleets and the prices for this fuel likely bear little resemblance to the costs of the 15 ppm highway or NRLM caps. Thus, the only cost comparisons which can be made are those between engineering studies. One such study was performed by Mathpro for the Engine Manufactures Association (EMA). Mathpro estimated the cost of controlling the sulfur content of highway and NRLM fuel to levels consistent with both 500 ppm and 15 ppm cap standards.[213] A detailed evaluation of the Mathpro costs is presented in the Final RIA. There are a number of aspects of the study that make direct comparisons between its estimates and our cost estimates difficult. Nonetheless, a crude comparison of 15 ppm costs indicates that our average cost range of 5.7–5.9 cent per gallon is quite similar to the 5.4–6.6 cents per gallon cost range estimated by Mathpro.

The other available study of 15 ppm fuel costs was performed by Baker and O'Brien for API and submitted in response to the nonroad NPRM. Baker and O'Brien analyzed two NRLM fuel control scenarios, but neither one matched today's final NRLM fuel program. The scenario closest to today's program assumed that a NRLM fuel would be capped at 15 ppm in 2008. In this case, Baker and O'Brien projected that the refinery-specific cost of 15 ppm NRLM fuel would range from 4–17 cents per gallon. This is higher than our projected range of 2–14 cents per gallon. In addition, as described in the next

[212] Please refer to section IV in today's preamble for additional discussion regarding our projections of the potential impact on fuel lubricity of this proposed rule.

[213] Hirshfeld, David, MathPro, Inc., ''Refining economics of diesel fuel sulfur standards,'' performed for the Engine Manufactuers Association, October 5, 1999.

section, Baker and O'Brien projected that the volume of NRLM fuel produced at these costs would not fully satisfy NRLM fuel demand. Presumably, totally fulfilling NRLM fuel demand with domestic production would have cost more.

Baker and O'Brien described portions of their cost methodology and indicated some general assumptions which they made during the study. However, the absence of detail prevents any detailed comparisons of their results to ours. It was clear from their report, though, that Baker and O'Brien made a number of pessimistic assumptions about refiners' willingness to invest in desulfurization capacity and that this limited the number of refineries which they assumed would invest to meet the NRLM sulfur caps. This inevitably led to higher projected costs (and lower production volumes), than if all refineries had been considered. Thus, it is not surprising that they would derive slightly higher costs for a much smaller volume of fuel. A more detailed evaluation of the Baker and O'Brien cost estimates can be found in the Final RIA and RTC.

5. Supply of Nonroad, Locomotive and Marine Diesel Fuel

We have developed today's NRLM fuel program to minimize its impact on the supply of distillate fuel. For example: We have split the control of NRLM fuel to 15 ppm sulfur into two steps, providing 8 years of leadtime for the final step. We are proposing to provide flexibility to refiners through the availability of banking and trading provisions. We have provided relief for small refiners and hardship relief for any qualifying refiner. We are also allowing 500 ppm diesel fuel generated in the distribution system to be sold as L&M fuel indefinitely.

In the NPRM, we evaluated four possible reasons why refiners might reduce their production of NRLM fuel: (1) Chemical processing losses during the desulfurization process, (2) refiners might leave the NRLM fuel market, (3) refiners might stop operations altogether (*i.e.*, shut down), and (4) refiners might remove certain blendstocks from the fuel pool to reduce desulfurization costs. In all four cases, we concluded that the answer was no, that the supply of NRLM fuel would likely remain adequate after implementation of the proposed fuel program. All of these findings started from the position that there would be adequate supply of diesel fuel after implementation of the 2007 highway diesel fuel program.

Several commenters, namely API and NPRA, took issue with the above four sets of arguments, as well as with our conclusion that refiners would not reduce NRLM fuel production. While not requesting any changes to the 2007 highway diesel fuel program, they reiterated previous concerns that supply shortages could occur under the highway diesel fuel program, even without the added challenge of producing low sulfur NRLM fuel. The primary basis for their comments was a study they had sponsored by Baker and O'Brien, which evaluated the costs and likely supply impacts of the proposal.

Baker and O'Brien evaluated two NRLM fuel scenarios: (1) A 15 ppm NRLM fuel cap starting in 2008, and (2) a 500 ppm NRLM fuel cap starting in 2008, followed by a 15 ppm cap only for nonroad fuel in 2010. First, Baker and O'Brien projected that 13 refineries with a total crude oil capacity of 971,000 barrels per day would close in response to the 2007 highway rule, roughly half in 2006 and half in 2010. (Total U.S. refining capacity is currently 16 million barrels per day.) Then Baker and O'Brien projected that adding a 15 ppm NRLM cap would cause all of the refineries shutting down in 2010 to close in 2008, plus one additional refinery (for a total of 14). Delaying the 15 ppm cap until 2010 and leaving L&M fuel at 500 ppm reduced the number of refineries projected to close in 2008, but did not change Baker and O'Brien's projection that 14 refineries would close by 2010. Given the fact that Baker and O'Brien projected the same number of refinery closures for scenarios #1 and #2, it is reasonable to assume that they would project similar results for today's final NRLM fuel program.

TABLE VI.A–6.—PROJECTED REFINERY CLOSURES: API SPONSORED STUDY BY BAKER AND O'BRIEN

	No. of refineries		Lost crude capacity (1000 bbl/day)	
	2008	2010	2008	2010
2007 Highway Fuel Program	[214] 8	13	504	971
Plus One-Step 15 ppm NRLM Program	14	14	1043	1043
Plus Two-Step NRLM Program	12	14	924	1043

As a result of these refinery closures, Baker and O'Brien projected shortfalls in 15 and 500 ppm supply domestic refiners. The net shortfalls are shown in table VI.A–7 below. Baker and O'Brien stated that imports would have to make up the shortfall, with potentially high price impacts.

TABLE VI.A–7.—PROJECTED SHORTFALL IN NEAR-TERM DIESEL FUEL SUPPLY

[1000 barrels per day]

	15 ppm Fuel		500 ppm Fuel	
	2008	2010	2008	2010
2007 Highway Fuel Program	359	579	308	22
Plus One-Step 15 ppm NRLM Program	684	930	165	0
Plus Two-Step NRLM Program	351	639	481	82

[214] Closure would occur at the beginning of the 15 ppm highway fuel program, or 2006.

To put these projected shortfalls in context, Baker and O'Brien projects total diesel fuel demand to be 3.3 million barrels per day in this timeframe (slightly lower than our own projection summarized above). Thus, these projected shortfalls total roughly 10–20 percent of total diesel fuel demand, which if true, would be very significant.

We evaluated the Baker and O'Brien study and their findings. Baker and O'Brien made very pessimistic assumptions regarding the likelihood that refiners would invest in desulfurization capacity. Their judgment that a refinery would close rather than invest also was apparently based only on what they perceived to be excessively high desulfurization costs. Baker and O'Brien presents no information regarding the location of these refineries, the competition they face, costs related to closing down, nor the profits that they would forego by closing. Baker and O'Brien also makes no mention of EPA's special provisions for refiners facing economic hardship, nor the small refiner provisions.

We believe that it is not possible to project refinery closures without considering these factors. This is supported by comments made in response to our proposal of the 2007 highway diesel fuel program by Mathpro and the National Economic Research Associates. While we are aware of a couple of refineries that are being offered for sale and whose plans for producing low sulfur fuels are uncertain, we have no indications of as many as eight refineries closing in 2006 in response to the highway fuel program. In addition, despite uncertainties at a few refineries, refiners' pre-compliance reports for the highway fuel program indicate that they are planning to produce a sufficient supply of 15 and 500 ppm highway diesel fuel from 2006–2010. Therefore, there is ample evidence that Baker and O'Brien's projections for the highway diesel fuel program are overly pessimistic. It therefore appears likely that their projection that the NRLM fuel program will cause an additional refinery to close is also overly pessimistic. The reader is referred to the RTC for a summary of these comments and our detailed response to them.

In their comments, API also challenged our findings that refiners would maintain sufficient supply under the proposed NRLM fuel program. After a careful review of their comments and other information newly available since the NPRM, we do not believe that the arguments presented by API and NPRA justify changing our position that (1) chemical processing losses during the desulfurization process will be very small, (2) refiners will be unlikely to leave the NRLM fuel market, and (3) refiners are unlikely to shut down due to this rule.

Regarding point #1, the distillate material lost during desulfurization, our position is that the amount lost is small (two percent), and most of it is lost in the form of naphtha which can be blended into gasoline. Refiners can then adjust their mix of gasoline and distillate production to compensate. API claimed that in the winter, refiners were already at maximum distillate production and could not shift any additional heavy gasoline material into the distillate pool. API did not present any evidence that this is in fact the case. The fact that some refiners actually crack distillate material into gasoline makes it difficult to accept their position.

Regarding point #2, refiners leaving the NRLM fuel market, we argued that the only high sulfur distillate market remaining after 2007 was heating oil. Heating oil demand is flat or declining over time. We project that over 30 domestic refiners will still be able to produce heating oil after 2007, while other refiners will be able to produce sufficient quantities of NRLM fuel. If more refiners choose to produce heating oil, this market will be oversupplied and prices will drop significantly. Exporting high sulfur distillate is a possibility for some refiners, but this entails both transport costs, as well as relatively low prices overseas. Thus, a decision to not invest in NRLM fuel desulfurization has to be compared to the losses involved with the other options. API argued that some refiners face much higher desulfurization costs than others and this would lead those refiners to leave the NRLM fuel market. API did not estimate the losses that refiners would entail when they left the market. Studies performed for the highway fuel program indicate that these losses can be quite significant and inappropriate conclusions can be drawn if they are ignored. The highway program pre-compliance reports also indicate that some highway fuel refiners are planning on leaving the highway fuel market in 2006, while others will enter it for the first time. Decisions to stay in or leave the NRLM fuel market are analogous. We have no reason to believe refiners would approach this market any differently than the highway market.

Regarding point #3, refineries shutting down, API again pointed towards the high costs faced by some refineries and the fact that a number of refineries have shut down over the past ten years. There have been a number of refinery closures over the past decade, though the trend has slowed considerably. API pointed towards two specific refineries which identified EPA's gasoline and diesel fuel sulfur controls as prime reasons for their shutting down. A closer look at these situations showed that the future capital investment related to the sulfur controls could have been a contributing factor. However, these refineries faced many other challenges and the timing of their closure (2000 and 2001, respectively) showed that the EPA rules were not the direct cause. The refiner involved did not approach EPA concerning any relief from the rules' requirements due to economic hardship. Thus, the connection between their closure and our sulfur controls appears even more tenuous.

Another example of a refinery closure unrelated to desulfurization costs was Shell's recent decision to close their refinery in Bakersfield, California. The reason was an insufficient supply of crude oil being produced locally.

Analogous to a decision to leave the NRLM fuel market, shutting down completely involves the total loss of any profit being made on the production of other fuels. API presented no economic calculations or projections showing that it would be in the best interest of any refiner to shut down rather than invest in NRLM fuel desulfurization.

This leaves point #4, that refiners might shift NRLM fuel blendstocks to other markets. This is really only an issue if the blendstocks are shifted to a non-distillate market.[215] The most likely place that NRLM fuel blendstocks might be shifted is to the residual fuel market. In particular, heavy (material with high densities and high distillation temperatures) LCO and LCGO could be shifted to residual fuel using existing refining equipment. The heavy portions of these two blendstocks contain the greatest concentrations of sulfur which is the most difficult to remove. Shifting this material to residual fuel, which currently does not have a sulfur standard, would reduce the size and cost of desulfurization equipment needed to meet a 15 ppm cap. Or, it would increase the volume of 15 ppm NRLM fuel which could be produced in an existing hydrotreater.

To evaluate this possibility, we estimated the cost of processing LCO (the worse of the two blendstocks) into 15 ppm diesel fuel for each domestic refinery. On average, desulfurizing LCO to 15 ppm sulfur cost 11.4 cents per

[215] Shifting NRLM fuel blendstocks to heating oil is essentially the same as leaving the NRLM market, which was discussed under Point #2 above.

gallon. However, in some cases, this cost reached 15 cents per gallon. The cost to process heavy LCO could be twice these amounts, since the concentration of both total sulfur and the most difficult to remove sulfur are concentrated in the heaviest molecules.

A review of historic fuel prices showed that residual fuel is usually priced 25–30 cents per gallon less than diesel fuel. The highest incremental desulfurization costs for heavy LCO could potentially exceed this loss. Thus, a few refiners could find it economical to shift a portion of their LCO to the residual fuel market. The U.S. residual fuel market is small relative to the distillate fuel market, flat, and already being fulfilled. Worldwide, the residual fuel market is shrinking. Thus, it is unlikely that large volumes of LCO could leave the NRLM fuel market. However, we cannot rule out the possibility that some LCO, particularly that produced by capital-strapped refiners, could be shifted to residual fuel. To estimate the upper limit of this shift, we estimated the volume of heavy LCO produced by refineries whose LCO processing costs exceeded 12 cents per gallon and which were not owned by large, integrated oil companies or small refiners. This costly, heavy LCO represents 0.4 percent of total NRLM fuel demand, a very small volume. In this case, we would expect that this loss could easily be made up by increased imports of 15 ppm diesel fuel or domestic refiners facing lower 15 ppm NRLM fuel costs.

Overall, we expect that domestic refiners will continue to produce sufficient supplies of NRLM fuel. The greatest potential for near term loss will be due to the possibility that some refiners might decide to limit their capital investment in desulfurization capacity by shifting some heavy LCO to the residual fuel market.

Fuel-Only Control Programs: The potential supply impacts of a long-term 500 ppm NRLM cap would necessarily be less than those of today's final NRLM fuel program. In particular, desulfurizing ''difficult'' blendstocks, like LCO, to 500 ppm is not technically challenging and does not have the potential to cost more than would be lost in shifting LCO or heavy LCO to residual fuel. The capital investment to meet a 500 ppm cap is also half of that needed to meet a 15 ppm cap or less. Thus, the likelihood that raising this capital would prove difficult is much less. Given that we expect the final fuel program to have a very minimal impact on supply, a 500 ppm NRLM cap would be negligible.

The potential impact of a long-term 15 ppm NRLM cap is the same as that for today's final fuel program.

6. Fuel Prices

It is well known that it is difficult to predict fuel prices in absolute terms with any accuracy. The price of crude oil dominates the cost of producing gasoline and diesel fuel. Crude oil prices have varied by more than a factor of two in the past two years. In addition, unexpectedly warm or cold winters can significantly affect heating oil consumption, which affects the amount of gasoline produced and the amount of distillate material available for diesel fuel production. Economic growth, or its lack, affects fuel demand, particularly for diesel fuel. Finally, both planned and unplanned shutdowns of refineries for maintenance and repairs can significantly affect total fuel production, inventory levels and resulting fuel prices.

Predicting the impact of any individual factor on fuel price is also difficult. The overall volatility in fuel prices limits the ability to determine the effect of a factor which changed at a specific point in time which might have led to the price change, as other factors continue to change over time. Occasionally, a fuel quality change, such as reformulated gasoline or a 500 ppm cap on diesel fuel sulfur content, only affects a portion of the fuel pool. In this case, an indication of the impact on price can be inferred by comparing the prices of the two fuels at the same general location over time. However, this is still only possible after the fact, and cannot be done before the fuel quality change takes place.

Because of these difficulties, EPA has generally not attempted to project the impact of its rules on fuel prices. However, in response to Executive Order 13211, we are doing so here.[216] To reflect the inherent uncertainty in making such projections, we developed three projections for the potential impact of the proposed fuel program on fuel prices. The range of potential long-term price increases are shown in table VI.A–8. (Due to their similarity, we have grouped the potential price impacts for similar quality fuels in the 2010–2012 and 2012–2014 time periods.) Short-term price impacts are highly volatile, as are short-term swings in absolute fuel prices, and much too dependent on individual refiners' decisions, unexpected shutdowns, etc. to be predicted even with broad ranges.

TABLE VI.A–8.—RANGE OF POSSIBLE TOTAL DIESEL FUEL PRICE INCREASES

[Cents per gallon] [a]

	Maximum operating cost	Average total cost	Maximum total cost
500 ppm Sulfur Cap: Nonroad, Locomotive and Marine Diesel Fuel (2007–2010)			
PADDs 1 and 3	2.9	1.8	4.5
PADD 2	3.0	2.5	3.8
PADD 4	3.7	3.5	6.1
PADD 5	1.2	1.5	1.5
15 ppm Sulfur Cap: NRLM Fuel (2010–2014)			
PADDs 1 and 3	5.6	5.7	9.4
PADD 2	7.3	7.4	10.8
PADD 4	7.9	12.6	13.6
PADD 5	4.5	5.1	5.2

[216] Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use'' (66 FR 28355, May 22, 2001).

TABLE VI.A–8.—RANGE OF POSSIBLE TOTAL DIESEL FUEL PRICE INCREASES—Continued

[Cents per gallon] [a]

	Maximum operating cost	Average total cost	Maximum total cost
15 ppm Sulfur Cap: NRLM Fuel (fully implemented program: 2014 +)			
PADDs 1 and 3	7.7	6.3	9.8
PADD 2	7.7	7.9	11.2
PADD 4	8.3	13.0	13.9
PADD 5	5.1	6.9	7.3

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

The lower end of the range assumes that prices within a PADD increased to reflect the highest operating cost increase faced by any refiner in that PADD (please see the Final RIA for details on this methodology). This refiner with the highest operating cost will not recover any of his invested capital, but all other refiners will recover some or all of their investment. In this case, the price of NRLM fuel will increase in 2007 by 1–3 cents per gallon, depending on the area of the country. In 2010, the price of 15 ppm NRLM fuel will increase a total of 3–7 cents per gallon. In 2014, under this pricing scenario, 15 ppm NRLM fuel prices will increase slightly, to 4–7 cents per gallon. The increase in 2014 is due to the expiration of the small refiner provisions, as well as the fact that 500 ppm fuel created in the distribution system can no longer be sold to the land-based nonroad market.

The mid-range estimate of price impacts assumes that prices within a PADD increase by the average refining and distribution cost within that PADD, including full recovery of capital (at seven percent per annum before taxes). Lower cost refiners will recover more than their capital investment, while those with higher than average costs recover less. Under this assumption, the price of NRLM fuel will increase in 2007 by 1–3 cents per gallon, depending on the area of the country. In 2010, the price of 15 ppm NRLM fuel will increase a total of 4–11 cents per gallon. In 2014, under this pricing scenario, 15 ppm NRLM fuel prices will increase slightly, to 5–11 cents per gallon.

The upper end estimate of price impacts assumes that prices within a PADD increase by the maximum total refining and distribution cost of any refinery within that PADD, including full recovery of capital (at seven percent per annum before taxes). All other refiners will recover more than their capital investment. Under this assumption, the price of NRLM fuel will increase in 2007 by 1–4 cents per gallon, depending on the area of the country. In 2010, the price of 15 ppm NRLM fuel will increase a total of 4–13 cents per gallon. In 2014, under this pricing scenario, 15 ppm NRLM fuel prices will increase further to 6–13 cents per gallon. All these potential price impacts for 500 and 15 ppm fuel, relative to those projected in the NPRM, reflect the differences in cost estimates discussed above.

There are a number of assumptions inherent in all three of the above price projections. First, both the lower and upper limits of the projected price impacts described above assume that the refinery facing the highest compliance costs is currently the price setter in their market. This is a worse case assumption which is impossible to validate. Many factors affect a refinery's total costs of fuel production. Most of these factors, such as crude oil cost, labor costs, age of equipment, etc., are not considered in projecting the incremental costs associated with lower NRLM diesel fuel sulfur levels. Thus, current prices may very well be set in any specific market by a refinery facing lower incremental compliance costs than other refineries. This point was highlighted in a study by the National Economic Research Associates (NERA) for AAM of the potential price impacts of EPA's 2007 highway diesel fuel program.[217] In that study, NERA criticized the above referenced study performed by Charles River Associates, *et al.* for API, which projected that prices will increase nationwide to reflect the total cost faced by the U.S. refinery with the maximum total compliance cost of all the refineries in the U.S. producing highway diesel fuel. To reflect the potential that the refinery with the highest projected compliance costs under the maximum price scenario is not the current price setter, we included the mid-point price impacts above. It is possible that even the lower limit price impacts are too high, if the conditions exist where prices are set based on operating costs alone. However, these price impacts are sufficiently low that considering even lower price impacts was not considered critical to estimating the potential economic impact of this rule.

Second, we assumed in some cases that a single refinery's costs could affect fuel prices throughout an entire PADD. While this is a definite improvement over analyses which assume that a single refinery's costs could affect fuel prices throughout the entire nation, it is still conservative. High cost refineries are more likely to have a more limited geographical impact on market pricing than an entire PADD. In many cases, high cost refiners continue to operate simply because they are in a niche location where transportation costs limit competition.

Third, by focusing solely on the cost of desulfurizing NRLM diesel fuel, we assume that the production of NRLM diesel fuel is independent of the production of other refining products, such as gasoline, jet fuel and highway diesel fuel. However, this is clearly not the case. Refiners have some flexibility to increase the production of one product without significantly affecting the others, but this flexibility is quite limited. It is possible that the relative economics of producing other products could influence a refiner's decision to increase or decrease the production of NRLM diesel fuel under today's fuel program. It is this price response that causes fuel supply to match fuel demand. And, this response in turn could increase or decrease the price impact relative to those projected above.

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

[217] "Potential Impacts of Environmental Regulations on Diesel Fuel Prices," NERA, for AAM, December 2000.

3. We have not performed any analysis of the cost of lower sulfur caps on diesel fuel produced by foreign refiners. However, there are reasons to believe that imports of 500 and 15 ppm NRLM diesel fuel will be available at prices in the ranges of those projected for U.S. refiners.

One recent study analyzed the relative cost of lower sulfur caps for Asian refiners relative to those in the U.S., Europe and Japan.[218] It concluded that costs for Asian refiners will be comparatively higher, due to the lack of current hydrotreating capacity at Asian refineries. This conclusion is certainly valid when evaluating lower sulfur levels for highway diesel fuels which are already at low levels in the U.S., Europe and Japan and for which refineries in these areas have already invested in hydrotreating capacity. It appears to be less valid when assessing the relative cost of meeting lower sulfur standards for NRLM fuels and heating oils which are currently at much higher sulfur levels in the U.S., Europe and Japan. All refineries face additional investments to remove sulfur from these fuels and so face roughly comparable control costs on a per gallon basis.

One factor arguing for competitively priced imports is the fact that refinery utilization rates are currently higher in the U.S. and Europe than in the rest of the world. The primary issue is whether overseas refiners will invest to meet tight sulfur standards for U.S., European and Japanese markets. Many overseas refiners will not invest, instead focusing on local, higher sulfur markets. However, many overseas refiners focus on exports. Both Europe and the U.S. are moving towards highway and nonroad diesel fuel sulfur caps in the 10–15 ppm range. Europe is currently and projected to continue to need to import large volumes of highway diesel fuel. Thus, it seems reasonable to expect that a number of overseas refiners will invest in the capacity to produce some or all of their diesel fuel at these levels. Many overseas refiners also have the flexibility to produce 10–15 ppm diesel fuel from their cleanest blendstocks, as most of their available markets have less stringent sulfur standards. Thus, there are reasons to believe that some capacity to produce 10–15 ppm diesel fuel will be available overseas at competitive prices. If these refineries were operating well below capacity, they might be willing to supply complying product at prices which only reflect incremental operating costs. This could hold prices down in areas where importing fuel is economical. However, it is unlikely that these refiners could supply sufficient volumes to hold prices down nationwide. Despite this expectation, to be conservative, in the refining cost analysis conducted earlier in this chapter, we assumed no imports of 500 ppm or 15 ppm NRLM diesel fuel. All 500 ppm and 15 ppm NRLM fuel was produced by domestic refineries. This raised the average and maximum costs of 500 ppm and 15 ppm NRLM diesel fuel and increased the potential price impacts projected above beyond what would have been projected had we projected that 5–10 percent of NRLM diesel fuel will be imported at competitive prices.

Fuel-Only Control Programs: We used the same methodology to estimate the potential price impacts for stand-alone 500 ppm and 15 ppm NRLM fuel programs. The potential price impacts of long-term 500 ppm and 15 ppm NRLM caps would be the same as those shown in table VI.A–8 above for the 500 ppm NRLM cap in 2007 and for the 15 ppm NRLM cap in 2014 and beyond, respectively.

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

We estimate that reducing fuel sulfur to 500 ppm would reduce engine wear and oil degradation to the existing nonroad diesel equipment fleet and that a further reduction to 15 ppm sulfur would result in even greater reductions. This reduction in wear and oil degradation would provide a dollar savings to users of nonroad equipment. The cost savings would also be realized by the owners of future nonroad engines that are subject to the standards in this proposal. As discussed below, these maintenance savings have been conservatively estimated to be greater than 3 cents per gallon for the use of 15 ppm sulfur fuel when compared to the use of today's unregulated nonroad diesel fuel. A summary of the range of benefits from the use of low-sulfur fuel is presented in Table VI.B–1.[219]

TABLE VI.B–1.—ENGINE COMPONENTS POTENTIALLY AFFECTED BY LOWER SULFUR LEVELS IN DIESEL FUEL[a]

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

Notes: [a] The degree to which all of these benefits may occur for any specific engine will vary. For example, the impact of high sulfur fuel on piston rings, cylinder liners and oil quality are somewhat interdependent. To the extent an end-user lengthens the oil drain interval, the benefit of the low sulfur fuel on piston ring and cylinder liner wear will be lessened (though not eliminated). For users who do not alter oil drain intervals, the benefit of low sulfur fuel on extending piston ring and cylinder liner wear will be greater. The benefit of low sulfur fuel on reducing exhaust system and EGR system corrosion are independent of oil drain intervals.

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

[218] ''Cost of Diesel Fuel Desulfurization In Asian Refineries,'' Estrada International Ltd., for the Asian Development Bank, December 17, 2002.

[219] *See* Heavy-duty 2007 Highway Final RIA, Chapter V.C.5, and ''Study of the Effects of Reduced Diesel Fuel Sulfur Content on Engine Wear,'' EPA report # 460/3–87–002, June 1987.

be realized in 2010 when the 15 ppm sulfur fuel would be introduced.

We estimate the single largest savings would be the impact of lower sulfur fuel on oil change intervals. The RIA presents our analysis for the oil change interval extension which would be realized by the introduction of 500 ppm sulfur fuel in 2007, as well as the additional oil extension which would be realized with the introduction of 15 ppm sulfur nonroad diesel fuel in 2010. As explained in the RIA, these estimates are based on our analysis of publically available information from nonroad engine manufacturers. Due to the wide range of diesel fuel sulfur which today's nonroad engines may see around the world, engine manufacturers specify different oil change intervals as a function of diesel sulfur levels. We have used this data as the basis for our analysis. Taken together, when compared to today's relatively high nonroad diesel fuel sulfur levels, we estimate the use of 15 ppm sulfur fuel will enable an oil change interval extension of 35 percent from today's products.

We received comments on our estimated maintenance savings primarily from a number of end-user groups (*e.g.*, equipment dealers, equipment rental organizations, farming organizations). Several commenters believed our estimates were too high, and one commenter believed the estimate was too low. However, all of the commenters who believed our cost savings estimates were too high provided no data to support their comments, beyond unsubstantiated opinions, nor did they comment on EPA's substantial related technical analysis.

The commenter who suggested the estimates were too low provided an example cost estimate for existing oil change intervals which, if used in our analysis, would have resulted in an estimated cost savings 4 times EPA's estimate. We have not changed our estimate based on the comments we received.

We present here a fuel operating cost savings attributed to the oil change interval extension in terms of a cents per gallon operating cost. We estimate that an oil change interval extension of 31 percent, as would be enabled by the use of 500 ppm sulfur fuel in 2007, results in a fuel operating costs savings of 2.9 cents per gallon for the nonroad fleet. We estimate an additional cost savings of 0.3 cents per gallon for the oil change interval extension which would be enabled by the use of 15 ppm sulfur beginning in 2010. Thus, for the nonroad fleet as a whole, beginning in 2010 nonroad equipment users can realize an operating cost savings of 3.2 cents per gallon compared to today's engine. This means that the end cost to the typical user for 15 ppm sulfur fuel is approximately 3.8 cents per gallon (7.0 cent per gallon cost for fuel minus 3.2 cent per gallon maintenance savings). For a typical 100 horsepower nonroad engine this represents a net present value lifetime savings, excluding the higher fuel costs, of more than $500.

These savings will occur without additional new cost to the equipment owner beyond the incremental cost of the low-sulfur diesel fuel, although these savings are dependent on changes to existing maintenance schedules. Such changes seem likely given the magnitude of the savings. There are many mechanisms by which end-users could become aware of the opportunity to extend oil drain intervals. First, it is typical practice for engine and equipment manufacturers to issue service bulletins regarding lubrication and fueling guidance for end-users.[220] Manufacturers provide these service bulletins to equipment dealerships and large equipment customers (such as rental companies). In addition, the equipment and end-user industries have a number of annual conferences which are used to share information, including information regarding appropriate engine and equipment maintenance practices. The end-user conferences are also designed to help specific industries and business reduce operating costs and maximize profits, which would include information on equipment maintenance practices. There are trade journals and publications which provide information and advice to their users regarding proper equipment maintenance. Finally, some nonroad users perform routine oil sample analysis in order to determine appropriate oil drain intervals, and in some cases to monitor overall engine wear rates in order to determine engine rebuild needs.[221] We have not estimated the value of the savings from all of the benefits listed in table VI.B–1, and therefore we believe the 3.2 cents per gallon savings is conservative as it only accounts for the impact of low sulfur fuel on oil change intervals. While some of these benefits are impacted by changes in oil change interval, a number are independent and not included in our cost savings estimate.

[220] For example, Appendix A of EPA Memorandum ''Estimate of the Impact of Low Sulfur Fuel on Oil Change Intervals for Nonroad Diesel Equipment'' contains a service bulletin from a nonroad diesel engine manufacturer. Copy of memo available in EPA Air Docket A–2001–28, item II–A–194.

[221] For example, Appendix C of EPA Memorandum ''Estimate of the Impact of Low Sulfur Fuel on Oil Change Intervals for Nonroad Diesel Equipment'', which indicates Caterpillar recommends owners use Scheduled Oil Sampling analysis as the best means for users to determine appropriate oil change intervals. Copy of memo available in EPA Air Docket A–2001–28, item II–A–194.

C. Engine and Equipment Cost Impacts

The following sections briefly discuss the various engine and equipment cost elements considered for this final rule and present the total costs we have estimated. The reader is referred to the RIA for a complete discussion. Estimated engine and equipment costs depend largely on both the size of the piece of equipment and its engine, and on the technology package being added to the engine to ensure compliance with the new Tier 4 standards. The wide size variation (*e.g.*, engines under 4 horsepower through engines above 2500 horsepower) and the broad application variation (*e.g.*, lawn equipment through large mining trucks) that exists in the nonroad industry makes it difficult to present here an estimated cost for every possible engine and/or piece of equipment. Nonetheless, for illustrative purposes, we present some examples of engine and equipment cost impacts throughout this discussion. Note that the costs presented here are for those nonroad engines and equipment that are mobile nonroad equipment and are, therefore, subject to nonroad engine standards. These costs would not apply for that equipment that is stationary—some portion of some equipment segments such as generator sets, pumps, compressors—and not subject to nonroad engine standards. The analysis summarized here is presented in detail in chapter 6 of the RIA.

Note that the costs presented here do not reflect any savings that are expected to occur because of the engine ABT program and/or the equipment manufacturer transition program, which are discussed in sections III.A and B. These optional programs have the potential to provide significant savings for both engine and equipment manufacturers. As a result, we consider our cost estimates to be conservative, in the sense that they likely overstate total engine and equipment costs.

In general, the final engine and equipment cost analysis is the same as that done for our proposal. We have made the following changes:

• In response to a comment, we have increased our engine research and development (R&D) costs. In the proposal, we estimated the R&D expenditure that each engine manufacturer would make to comply with the Tier 4 standards. In response to the comment, we have refined that analysis and increased our estimate of engine R&D by roughly 50 percent. We did not receive any other comments with respect to our estimates for engine R&D.

- Because the final standards for engines above 750 horsepower have changed from the proposed standards, we have made changes to the engine R&D expenditures attributed to those engines. For costing purposes, the NO_X portion of the engine R&D expenditures are no longer shared by engines above 750 horsepower. This increases NO_X R&D attributed to other engines because a significant portion of engine R&D costs are costs shared across a wide range of products. We have also reduced the engine variable costs for engines above 750 horsepower since we are no longer projecting that NO_X adsorbers will be added to them.[222] This has no impact on the engine variable costs for other engines. We have also reduced the equipment redesign costs for engines above 750 horsepower since less redesign effort is projected to accommodate only a catalyzed diesel particulate filter (CDPF). This has no impact on the redesign costs of other equipment. Lastly, we have decreased the equipment variable costs for engines above 750 horsepower for the same reason as was done for engine variable costs.
- We have changed the engine operating costs for engines above 750 horsepower to reflect a different fuel economy impact than was associated with the proposed standards and to reflect the new timing for adding the CDPF and therefore incurring the maintenance costs associated with it.
- We have included costs for additional cooling on engines adding cooled EGR systems (engines of 25 to 50 horsepower and greater than 750 horsepower). These costs include the larger radiator and/or engine cooling fan that may be required on engines expected to add cooled EGR to meet the new standards. In the proposal, we had estimated the costs for the EGR system but not the costs for additional cooling.
- We have expressed all costs in 2002 dollars for the final rule rather than the proposal's use of 2001 dollars.

We received comments on other aspects of the proposed engine and equipment cost analysis that are not reflected in the final analysis. Some of the comments were:

- Some commenters claimed that we had underestimated costs for engines under 75 horsepower, and in the 75 to 100 horsepower range. For the engines under 75 horsepower, one commenter suggested the costs were higher than EPA estimated. Please see section 5.4.1 of the Summary and Analysis of Comments for a detailed discussion of the comments and our response. In the 75 to 100 horsepower range, one commenter suggested that we were incorrect in our assumption that those engines would have electronic fuel systems in the NRT4 baseline case, maintaining the electronic fuel systems would have to be added to these engines to comply with the Tier 4 standards and, therefore, are a cost of the Tier 4 rule. From this premise, the commenter argued that the costs for 75 to 100 horsepower engines will be disproportionately high.

We disagree. In the proposal, we estimated that by 2012, engines in this power range would already have electronic fuel injection systems. This estimate was based on our engineering assessment of what technologies would be required to comply with the Tier 2 and Tier 3 emission standards, as well as technical discussions we had with engine manufacturers regarding future product plans. Therefore, the costs of these electronic fuel injection systems are not attributable to the Tier 4 rule. Our assessment at proposal is consistent with our projections in the Tier 2/3 rulemaking where we estimated costs for electronic fuel injection systems as a cost of complying with those standards. In the preamble to the proposed Tier 4 rule, we presented estimates of the penetration of various engine technologies into several power ranges, including 75 to 100 horsepower, based on engine manufacturers' 2001 model year certification data. *See* 68 FR 28386, May 23, 2003. Since then, model year certification data for 2004 are available, and these data substantiate our earlier prediction. These model year 2004 data represent implementation of the Tier 2 standards so these data illustrate the technologies engine manufacturers are using to comply with those standards. These data show that nearly 20 percent of the engines that will be produced in this power range will have electronically controlled fuel systems, while the model year 2001 data show no engines in this power range had electronic fuel systems. This dramatic increase in electronics as a result of the Tier 2 standards, let alone the Tier 3 standards, gives us confidence that our projections regarding 2012 are reasonable. Section 4.1.4 of the RIA contains a detailed discussion of this information; see also the discussions in sections II.B.4.b.i and II.B.5 above. Thus, we continue to believe that we have properly attributed costs of electronic fuel systems to the Tier 3 rule, or, put another way, that the cost of an electronic fuel system is not a cost attributable to this Tier 4 rule for engines in the 75 to 100 horsepower category. Since the cost of electronic fuel systems is the essential difference in the costs we attribute to the Tier 4 rule for these engines versus the costs the commenter would attribute, we therefore disagree with the comment and believe our estimates to be reasonable. *See also* section II.A.5 above.

- One commenter took exception to our method of amortizing fixed costs over a period of years following implementation of the new standards. The commenter suggested that we used such a method to imply to the regulated industries that they would not only recover their investments but would also make a gain on those investments. This is not the case. We use this method of amortization, briefly described here and more fully in the RIA, only to reflect the time value of money so that we can get a more accurate estimate of the cost to the companies.

The Summary and Analysis of Comments document contains the

[222] In order to avoid inconsistencies in the way our emission reductions, and cost-effectiveness estimates are calculated, our cost methodology for engines and equipment relies on the same projections of new nonroad engine growth as those used in our emissions inventory projections. Our NONROAD emission inventory model includes estimates of future engine populations that are consistent with the future engine sales used in our cost estimates. The NONROAD model inputs include an estimate of what percentage of generator sets sold in the U.S. are "mobile" and, thus, subject to the nonroad standards, and what percentage are "stationary" and not subject to the nonroad standards. These percentages vary by power category and are documented in "Nonroad Engine Population Estimates," EPA Report 420–P–02–004, December 2002. For generator sets above 750 horsepower, NONROAD assumes 100 percent are stationary and, therefore, not subject to the new nonroad standards. For generator sets under 750 horsepower, we have assumed other percentages of mobile versus stationary. During our discussions with engine manufacturers after the proposal, it became apparent not only that our estimate for generator sets above 750 horsepower may not be correct and many are indeed mobile, but also that some of our estimates for generator sets above 750 horsepower may also not be correct and many more than we estimate may indeed be mobile. If true, this increased percentage of mobile generator sets will be subject to the new nonroad standards. Unfortunately, we have not received sufficient data to make a conclusive change to the NONROAD model to include the potentially increased percentages of mobile generator sets and, therefore, for the above described purpose of maintaining consistency, we have not included their costs or their emissions reductions in our official estimates for this final rule (costs and emissions reductions for the current percentages in the NONROAD model are included in our estimates for the final rule). Instead, we present a sensitivity analysis in Chapter 8 of the RIA that includes both an estimate of the costs and emissions reductions that would result from including a higher percentage of generator sets as mobile equipment and subject to the new standards.

details of all comments and our responses.

1. Engine Cost Impacts

Estimated engine costs are broken into fixed costs (for research and development, retooling, and certification), variable costs (for new hardware and assembly time), and life-cycle operating costs. Total operating costs include the estimated incremental cost for low-sulfur diesel fuel, any expected increases in maintenance costs associated with new emission control devices, any costs associated with increased fuel consumption, and any decreases in operating cost (*i.e.*, maintenance savings) expected due to low-sulfur fuel. Cost estimates presented here represent an expected incremental cost of engines in the model year of their introduction. Costs in subsequent years will be reduced by several factors, as described below. All engine and equipment costs are presented in 2002 dollars since producer price indexes for 2003 were not available in time for use in this analysis.

a. Engine Fixed Costs

i. Engine and Emission Control Device R&D

The technologies described in Section II represent those technologies we believe will be used to comply with the Tier 4 emission standards. For many manufacturers, these technologies are part of an ongoing research and development effort geared toward compliance with the 2007 heavy-duty diesel highway emission standards. The engine manufacturers making R&D expenditures toward compliance with highway emission standards will have to undergo some additional R&D effort to transfer emission control technologies to engines they wish to sell into the nonroad market. These R&D efforts will allow engine manufacturers to develop and optimize these new technologies for maximum emission-control effectiveness with minimum negative impacts on engine performance, durability, and fuel consumption.

Many nonroad engine manufacturers are not part of the ongoing R&D effort toward compliance with highway emissions standards because they do not sell engines into the highway market. Nonetheless, these manufacturers are expected to benefit from the R&D work that has already occurred and will continue through the coming years through their contact with highway manufacturers, emission control device manufacturers, and the independent engine research laboratories conducting relevant R&D.

We project the use of several technologies for complying with the Tier 4 emission standards. We are projecting that NO_X adsorbers and catalyzed diesel particulate filters (CDPFs) will be the most likely technologies applied by industry to meet our new emissions standards for engines above 75 horsepower. The fact that these technologies are being developed for implementation in the highway market before the Tier 4 implementation dates, and the fact that engine manufacturers will have several years before implementation of the Tier 4 standards, ensures that the technologies used to comply with the nonroad standards will undergo significant development before reaching production. This ongoing development could lead to reduced costs in three ways. First, we expect research will lead to enhanced effectiveness for individual technologies, allowing manufacturers to use simpler packages of emission control technologies than we would predict given the current state of development. Similarly, we anticipate that the continuing effort to improve the emission control technologies will include innovations that allow lower-cost production. Finally, we believe that manufacturers will focus research efforts on any drawbacks, such as fuel economy impacts or maintenance costs, in an effort to minimize or overcome any potential negative effects.

We anticipate that, in order to meet the Tier 4 standards, industry will introduce a combination of primary technology upgrades. Achieving very low NO_X emissions will require basic research on NO_X exhaust emission control technologies and improvements in engine management to take advantage of the new exhaust emission control system capabilities. The manufacturers are expected to address the challenge by optimizing the engine and new exhaust emission control system to realize the best overall performance. This will entail optimizing the engine and emission control system for both emissions and fuel economy performance in light of the presence of the new exhaust emission control devices and their ability to control pollutants previously controlled only via in-cylinder means or with exhaust gas recirculation. Since most research to date with exhaust emission control technologies for nonroad applications has focused on retrofit programs which typically add an exhaust emission control device without making engine control changes, there remains room for significant improvements by taking such a systems approach. The NO_X adsorber technology in particular is expected to benefit from re-optimization of the engine management system to better match the NO_X adsorber's performance characteristics. The majority of the dollars we have estimated for research is expected to be spent on developing this synergy between the engine and NO_X exhaust emission control systems. Therefore, for engines where we project use of both a CDPF and a NO_X adsorber (*i.e.*, 75 to 750 horsepower), we have attributed two-thirds of the R&D expenditures to NO_X control, and one-third to PM control.

As we mentioned earlier, we have further refined our estimate of engine R&D costs since our proposal. We have taken these R&D costs and have broken them into two components. The first of these components estimates the corporate R&D applicable across all engine lines. The second of these estimates the engine line by engine line R&D cost. The estimates of line by line R&D correlate to power range—$1 million for under 75 horsepower engine lines, $3 million for 75 to 750 horsepower engine lines, and $6 million for above 750 horsepower engine lines. We estimated these expenditures based on the confidential information provided by the commenter and our analysis of that information. The end result is consistent with the commenter's suggested expenditure levels. We have applied these engine-line R&D estimates only where CDPFs and/or CDPF/NO_X adsorber systems are expected to be implemented (*i.e.*, this R&D is not applied for the under 75 horsepower engines in 2008 because the R&D already estimated for complying with those standards should not require the same effort to tailor it to each engine). We have also applied these estimates only for those engines without a highway counterpart (note that only 16 of a total 133 nonroad engine lines had a highway counterpart).

In the 2007 HD highway rule, we estimated that each engine manufacturer would expend $36.1 million for R&D to redesign their engines and apply catalyzed diesel particulate filters (CDPF) and NO_X adsorbers.[223] For their nonroad R&D efforts on engines where we project that compliance will require CDPFs and NO_X adsorbers (*i.e.*, 75 to 750 horsepower) and on greater than 750 horsepower engines requiring a CDPF, engine manufacturers that also sell into the highway market will incur some level of R&D effort but not at the

[223] In the 2007 rule, we estimated a value of $35 million in 1999 dollars. Here we have adjusted that value to express it in 2002 dollars.

level incurred for the highway rule. In many cases, the engines used by highway manufacturers in nonroad products are based on the same engine platform as those used in highway products. However, horsepower and torque characteristics are often different so some effort will have to be expended to accommodate those differences. For these manufacturers, we have estimated that they will incur an average R&D expense of $3.6 million [224] not including the nonroad engine line R&D noted above. This $3.6 million R&D expense will allow for the transfer of R&D knowledge from their highway experience to their nonroad engine product line. For the reasons stated above, two-thirds of this R&D is attributed to NO_X control and one-third to PM control for 75 to 750 horsepower engines; for engines above 750 horsepower, all of this R&D is attributed to PM control.

For those manufacturers that sell larger engines only into the nonroad market, and where we project those engines will add a CDPF and a NO_X adsorber (75 to 750 horsepower) or a CDPF-only (above 750 horsepower), we believe that they will incur an R&D expense nearing that incurred by highway manufacturers for the highway rule although not quite at the same level. Nonroad manufacturers will be able to learn from the R&D efforts already underway for both the highway rule and for the Tier 2 light-duty highway rule (65 FR 6698, February 10, 2000). This learning could be done via seminars, conferences, and contact with highway manufacturers, emission control device manufacturers, and the independent engine research laboratories conducting relevant R&D. Therefore, for these manufacturers, we have estimated an average expenditure of $25.3 million [225] not including the nonroad engine line R&D noted above. This lower number—$25.3 million versus $36.1 million in the highway rule—reflects the transfer of knowledge to nonroad manufacturers that will occur from the many stakeholders in the diesel industry. Two-thirds of this R&D is attributed to NO_X control and one-third to PM control.

Note that the $3.6 million and $25.3 million estimates represent our estimate of the average R&D expected by manufacturers to gain knowledge about the anticipated emission control devices. These estimates will be different for each manufacturer—some higher, some lower—depending on product mix and the number of engine lines in their product line.

For those engine manufacturers selling smaller engines that we project will add a CDPF-only (*i.e.*, 25 to 75 horsepower engines in 2013), we have estimated that the average R&D they will incur will be roughly one-third that incurred by manufacturers conducting CDPF/NO_X adsorber R&D. We believe this is a good estimate because CDPF technology is further along in its development than is NO_X adsorber technology and, therefore, a 50/50 split is not appropriate. Using this estimate, the R&D incurred by manufacturers that already have been selling any engines into both the highway and the nonroad markets will be $1.2 million not including their nonroad engine line R&D, and the R&D for manufacturers selling engines into only the nonroad market will be roughly $8.3 million [226] not including their nonroad engine line R&D. All of this R&D is attributed to PM control.

For those engine manufacturers selling engines that we project will add only a DOC or make some engine-out modifications (*i.e.*, engines under 75 horsepower in 2008), we have estimated that the average R&D they will incur will be roughly one-half the amount estimated for their CDPF-only R&D. Using this estimate, the R&D incurred by manufacturers selling any engines into both the highway and nonroad markets will be roughly $600,000, and the R&D for manufacturers selling engines into only the nonroad market will be roughly $4.2 million.[227] All of this R&D is attributed to PM control.

We have assumed that all R&D expenditures occur over a five year span preceding the first year any emission control device is introduced into the market. There is one exception to this assumption in that the expenditures for DOC-only R&D are assumed to occur over the four year span between the final rule and the 2008 standards. Where a phase-in exists (*e.g.*, for NO_X standards on 75 to 750 horsepower engines), expenditures are assumed to occur over the five year span preceding the first year NO_X adsorbers will be introduced, and then to continue during the phase-in years. The expenditures will be incurred in a manner consistent with the phase-in of the standard. All R&D expenditures are then recovered by the engine manufacturer over an identical time span following the introduction of the technology, with the exception that expenditures for DOC-only R&D are recovered over a five year span rather than a four year span. We assume an opportunity cost of capital of seven percent for all R&D. We have apportioned these R&D costs across all engines that are expected to use these technologies, including those sold in other countries or regions that are expected to have similar standards. We have estimated the fraction of the U.S. sales to this total sales at 42 percent. Therefore, we have attributed this amount to U.S. sales. Note that all engine R&D costs for engines under 25 horsepower have been attributed to U.S. sales since other countries are not expected to have similar standards on these engines.

Using this methodology, we have estimated the total R&D expenditures attributable to the new standards at $323 million with $206 million spent on corporate R&D and $118 million spent on engine line R&D. For comparison, our proposal estimated $199 million for basic R&D and none for engine line R&D. The amount for corporate R&D is higher here solely due to the change to 2002 dollars.

ii. Engine-Related Tooling Costs

Once engines are ready for production, new tooling will be required to accommodate the assembly of the new engines. We have indicated below where our tooling cost estimates have changed from the proposal. In the 2007 highway rule, we estimated approximately $1.65 million per engine line for tooling costs associated with CDPF/NO_X adsorber systems.[228] For the nonroad Tier 4 standards, we have estimated that nonroad-only manufacturers will incur the same $1.65 million per engine line requiring a CDPF/NO_X adsorber system and that these costs will be split evenly between NO_X control and PM control. For those systems requiring only a CDPF, we have estimated one-half that amount, or $825,000 per engine line. For those systems requiring only a DOC or some engine-out modifications, we have applied a one-half factor again, or $412,500 per engine line. Tooling costs for CDPF-only and for DOC engines are attributed solely to PM control. None of these estimates have changed since our proposal, with the exception of being

[224] In the proposal, we estimated a value of $3.5 million in 1999 dollars. Here we have adjusted that value to express it in 2002 dollars.

[225] In the proposal, we estimated a value of $24.5 million in 1999 dollars. Here we have adjusted that value to express it in 2002 dollars.

[226] In the proposal, we estimated values of $1.2 million and $8 million in 1999 dollars. Here we have adjusted those values to express them in 2002 dollars.

[227] In the proposal, we estimated values of $600,000 and $4 million in 1999 dollars. Here we have adjusted those values to express them in 2002 dollars.

[228] In the 2007 rule, we estimated a value of $1.6 million in 1999 dollars. Here we have adjusted that value to express it in 2002 dollars.

expressed in 2002 dollars. We received no comments on our tooling cost estimates.

For those manufacturers selling into both the highway and nonroad markets, we have estimated one-half the baseline tooling cost, or $825,000, for those engine lines requiring a CDPF/NO_X adsorber system. We believe this is reasonable since many nonroad engines are produced on the same engine line with their highway counterparts. For such lines, we believe very little to no tooling costs will be incurred. For engine lines without a highway counterpart, something approaching the $1.65 million tooling cost is applicable. For this analysis, we have assumed a 50/50 split of engine product lines for highway manufacturers and, therefore, a 50 percent factor applied to the $1.65 million baseline. These tooling costs will be split evenly between NO_X control and PM control. For engine lines under 75 horsepower and above 750 horsepower, we have used the same tooling costs as the nonroad-only manufacturers because these engines tend not to have a highway counterpart. Therefore, for those engine lines requiring only a CDPF (*i.e.*, those between 25 and 75 horsepower and those above 750 horsepower), we have estimated a tooling cost of $825,000. Note that this is a change from the proposal for engines above 750 horsepower; the proposal used the full $1.65 million since both a CDPF and a NO_X adsorber were being projected. The tooling costs for DOC and/or engine-out engine lines has also been estimated to be $412,500. Tooling costs for CDPF-only and for DOC engines are attributed solely to PM control. With the exception of the greater than 750 horsepower change, none of these tooling estimates have changed since our proposal, with the exception of being expressed in 2002 dollars.

We expect engines in the 25 to 50 horsepower range to apply EGR systems to meet the Tier 4 NO_X standards for 2013. For these engines, we have included an additional tooling cost of $41,300 per engine line, consistent with the EGR-related tooling cost estimated for 50–100 horsepower engines in our Tier 2/3 rulemaking. The EGR tooling costs are applied equally to all engine lines in that horsepower range regardless of the markets into which the manufacturer sells. We have applied this tooling cost equally because engines in this horsepower range tend not to have highway counterparts. Tooling costs for EGR systems are attributed solely to NO_X control.

We have also estimated some tooling costs for engines above 750 horsepower to meet the 2011 standards. We have estimated this amount at ten times the amount for 25 to 50 horsepower engines, or $413,000 per engine line. This cost was not in the proposal since NO_X adsorbers were being projected for engines above 750 horsepower. We have applied this tooling to all engine lines above 750 horsepower, regardless of what markets into which a manufacturer sells, since such engines clearly have no highway counterpart. For the purpose of allocating costs, we have attributed this cost entirely to NO_X control. Note that there is a new 2011 PM standard for engines above 750 horsepower. However, we believe that PM standard could be met via engine-out control which would result in no new tooling costs associated with that standard.

We have applied all the above tooling costs to all manufacturers that appear to actually make engines. We have not eliminated joint venture manufacturers because these manufacturers will still need to invest in tooling to make the engines even if they do not conduct any R&D. We have assumed that all tooling costs are incurred one year in advance of the new standard and are recovered over a five year period following implementation of the new standard; all tooling costs include a capital opportunity cost of seven percent. As done for R&D costs, we have attributed a portion of the tooling costs to U.S. sales and a portion to sales in other countries expected to have similar levels of emission control. Note that all engine tooling costs for under 25 horsepower engines have been attributed to U.S. sales since other countries are not expected to have similar standards on these engines. More information is contained in chapter 6 of the RIA.

Using this methodology, we estimate the total tooling expenditures attributable to the new Tier 4 standards at $74 million. For comparison, our proposal estimated $67 million. The higher value here is a result of: Expressing values in 2002 dollars rather than 2001 dollars; attributing all under 25 horsepower tooling costs to U.S. sales while the proposal attributed 42 percent of those costs to U.S. sales; and, above 750 horsepower tooling is slightly higher because of the proposal's phase-in (50/50/50/100) of one set of standards while the final rule has two sets of standards.

iii. Engine Certification Costs

The comments we received with respect to our estimated certification costs noted that we had underestimated costs associated with new test procedures, especially transient testing for engines above 750 horsepower. For the final rule, we have tripled the costs associated with new test procedures. Because we are not finalizing transient test procedures for engines above 750 horsepower, comments about the cost of these engines certifying using the transient test are now moot.

Manufacturers will incur more than the normal level of certification costs during the first few years of implementation because engines will need to be certified to the new emission standards using new test procedures (at least in some instances). Consistent with our recent standard setting regulations, we have estimated engine certification costs at $60,000 per new engine certification to cover existing testing and administrative costs.[229] The $60,000 certification cost per engine family was used for 25 to 75 horsepower engines certifying to the 2008 standards. For 25 to 75 horsepower engines certifying to the 2013 standards, and for 75 to 750 horsepower engines certifying to their new standards, we have added costs to cover the new test procedures for nonroad diesel engines (*e.g.*, the transient test, the NTE); [230] these costs are estimated at $31,500 per engine family.[231] For engines under 25 horsepower, we have assumed (for cost purposes) that all engines will certify to the transient test and the NTE in 2008. We believe manufacturers may choose to do this rather than certifying all engines again in 2013 when the transient test and NTE requirements actually begin for those engines. This assumption results in higher certification costs in 2008 than if these engines certified only to the steady-state standard. However, we believe manufacturers may choose to do this because it would avoid the need to

[229] In the proposal we added a certification fee to this cost. In the final rule we have not included the certification fee because that cost will be accounted for in the certification fees rulemaking (see 67 FR 51402 for the proposed rule). Including in the proposal was essentially double counting that fee. Similarly, if we were to include it in this final rule, we would be double counting that fee.

[230] Note that the transport refrigeration unit (TRU) test cycle is an optional duty cycle for steady-state certification testing specifically tailored to the operation of TRU engines. Likewise, the ramped modal cycles are available test cycles that can be used to replace existing steady-state test requirements for nonroad constant-speed engines, generally. Manufacturers of these engines who opt to use one of these test cycles would incur no new costs above those estimated here and may incur less cost.

[231] Note that the proposal incorrectly used a value of $10,500 for costs associated with the new test procedures. Here, we have corrected this error by using a value of $31,500. Note also that the proposal erroneously did not include certification costs associated with transient testing and the NTE for engines under 25 horsepower. We have corrected that error in the final analysis.

recertify all engines under 25 horsepower again in 2013. These certification costs—whether it be the $60,000 or the $91,500 per engine family—apply equally to all engine families for all manufacturers regardless of into what markets the manufacturer sells. For engines above 750 horsepower, the certification costs used were $87,000 per family since these engines will not be certifying over the new transient test procedure. We have applied these certification costs to all U.S. sold engine families and then spread the total over U.S. sales. In other words, we have not presumed that certification conducted for U.S. engines would fulfill the certification requirements of other countries and have, therefore, not spread total costs over engine sales outside the U.S.

Applying these costs to each of the 665 engine families as they are certified to a new emissions standard results in total costs of $91 million expended during implementation of the Tier 4 standards. These costs are attributed to NO_X and PM control consistent with the phase-in of the new emissions standards—where new NO_X and PM standards are introduced together, the certification costs are split evenly; where only a new PM standard is introduced, the certification costs are attributed to PM only; where a NO_X phase-in becomes 100 percent in a year after full implementation of a PM standard, the certification costs are attributed to NO_X only. All certification costs are assumed to occur one year prior to the new emission standard and are then recovered over a five year period following compliance with the new standard; all certification costs include a capital opportunity cost of seven percent. For comparison, our proposal estimated certification costs at $72 million. The increase here is a result of using a higher cost associated with the new test procedures than was used in the proposal.

We also received comment that we should estimate certification costs based on use of the ABT program rather than based on the phase-in. Doing this would result in higher certification costs because all engine families would be certified in year one of the phase-in and all families would again be certified in the final year of the phase-in. In contrast, since we have based certification costs on the phase-in, all engine families are certified in year one (PM standards have no phase-in) and only half are again certified in the final year (the 50 percent not meeting the new NO_X standard in year one). We have chosen not to estimate certification or any costs based on use of the ABT program (or the TPEM program) since it is so difficult to predict how this program will be used. Furthermore, we must remain consistent throughout our cost analysis so that, if we estimated certification costs based on use of the ABT program, we should also base engine variable costs and equipment variable costs on use of the ABT program. Doing so, we believe, would decrease engine variable costs since that is the primary reason manufacturers choose to make use of the ABT program. Since engine variable costs, as discussed below, are a much greater fraction of the overall program costs, we believe that we are being conservative by generating our costs based on use of the phase-in. Therefore, we believe that use of the ABT program (and the TPEM program) will provide substantial net savings to industry even though widespread use of ABT might cause certification costs to be higher.

b. Engine Variable Costs

This section summarizes the detailed analysis presented in chapter 6 of the RIA. For our analysis, we have used the 2002 annual average costs for platinum and rhodium (the two platinum group metals (PGMs) we expect will be used) because we believe they represent a better estimate of the cost for PGM than other metrics. In the RIA, we present a cost sensitivity that estimates the recovery value of precious metals returned to the open market upon retirement of an aftertreatment device. We present that analysis to gauge the true social cost of these devices when new.

We have not made any changes to our engine variable costs as a result of public comments. Some commenters (engine manufacturers) claimed that we had underestimated these costs but did not provide any detailed information about where they believed we had erred or what they believed the costs should be. Other commenters (emission control device manufacturers) claimed that we had done a fair job with our estimates. Some commenters (equipment manufacturers) claimed that our assumptions with respect to baseline engine configurations were not accurate. However, as discussed earlier, based on our own engineering judgement and the positive comments of the engine manufacturers—who we consider a better source for such information than equipment manufacturers since engine manufacturers are the directly affected entities—we have maintained our original assumptions for baseline engine configurations. Further, our assumed Tier 4 baseline engine configurations are consistent with our assumed compliant technology packages for T2/3, and those packages included the things equipment manufacturers are claiming will not be present in the Tier 4 baseline. As a result, we have already considered the costs associated with reaching our Tier 4 baseline engine configurations in the context of the T2/3 rule.

We have made changes to engine variable costs to remain consistent with the final program—*i.e.*, we have changed our greater than 750 horsepower cost estimates since the final standards differ from those that were proposed. We have also changed the costs by expressing them in 2002 dollars rather than 2001 dollars.[232]

i. NO_X Adsorber System Costs

The NO_X adsorber system that we are anticipating will be used to comply with Tier 4 engine standards will be the same as that used for highway applications. In order for the NO_X adsorber to function properly, a systems approach that includes a reductant metering system and control of engine A/F ratio is also necessary. Many of the new air handling and electronic system technologies developed in order to meet the Tier 2/3 nonroad engine standards can be applied to accomplish the NO_X adsorber control functions as well (these costs were accounted for in our T2/3 rule). Some additional hardware for exhaust NO_X or O_2 sensing and for fuel metering will likely be required. The cost estimates include a DOC for clean-up of hydrocarbon emissions that occur during NO_X adsorber regeneration events. We have also estimated that warranty costs will increase due to the application of this new hardware. Chapter 6 of the RIA contains the details for how we estimated costs associated with the new NO_X control technologies required to meet the Tier 4 emission standards. These costs are estimated to increase engine costs by roughly $670 in the near-term for a 150 horsepower engine, and $2,040 in the near-term for a 500 horsepower engine. In the long-term, we estimate these costs to be $550 and $1,650 for the 150 horsepower and 500 horsepower engines, respectively. These costs may differ slightly from the proposal due to the adjustments to 2002 dollars. Note that we have estimated costs for all engines in all horsepower

[232] Note that the change to 2002 dollars had different effects on different pieces of hardware. We have used two different PPI adjustments in the analysis: one for motor vehicle catalytic converters which was used to adjust costs for DOCs, NO_X adsorbers, and CDPFs; and another for motor vehicle parts and accessories which was used for all other pieces of hardware. The former of these adjustments actually caused costs to decrease relative to the proposal while the latter caused costs to increase slightly.

ranges, and these estimates are presented in detail in the RIA. Throughout this discussion of engine and equipment costs, we present costs for a 150 and a 500 horsepower engine for illustrative purposes.

ii. Catalyzed Diesel Particulate Filter (CDPF) Costs

CDPFs can be made from a wide range of filter materials including wire mesh, sintered metals, fibrous media, or ceramic extrusions. The most common material used for CDPFs for heavy-duty diesel engines is cordierite. Here we have based our cost estimates on the use of silicon carbide (SiC) even though it is more expensive than other filter materials.[233] We estimate that the CDPF systems will add $760 to engine costs in the near-team for a 150 horsepower engine and $2,710 in the near-term for a 500 horsepower engine. In the long-term, we estimate these CDPF system costs to be $580 and $2,070 for the 150 horsepower and the 500 horsepower engines, respectively. These costs may differ slightly from the proposal due to the adjustments to 2002 dollars.

iii. CDPF Regeneration System Costs

Application of CDPFs in nonroad applications may present challenges beyond those of highway applications. For this reason, we anticipate that some additional hardware beyond the diesel particulate filter itself may be required to ensure that CDPF regeneration occurs. For some engines this may be new fuel control strategies that force regeneration under some circumstances, while in other engines it might involve an exhaust system fuel injector to inject fuel upstream of the CDPF to provide necessary heat for regeneration under some operating conditions. We estimate the near-term costs of a CDPF regeneration system to be $200 for a 150 horsepower engine and $330 for a 500 horsepower engine. In the long-term, we estimate these costs at $150 and $250, respectively. These costs may differ slightly from the proposal due to the adjustments to 2002 dollars.

iv. Closed-Crankcase Ventilation System (CCV) Costs

Today's final rule eliminates the exemption that allows turbo-charged nonroad diesel engines to vent crankcase gases directly to the environment. Such engines are said to have an open crankcase system. We project that this requirement to close the crankcase on turbo-charged engines will force manufacturers to rely on engineered closed crankcase ventilation systems that filter oil from the blow-by gases prior to routing them into either the engine intake or the exhaust system upstream of the CDPF. We have estimated the initial cost of these systems to be roughly $30 for low horsepower engines and up to $90 for very high horsepower engines. These costs are incurred only by turbo-charged engines because today's naturally aspirated engines already have CCV systems. These costs may differ slightly from the proposal due to the adjustments to 2002 dollars.

v. Variable Costs for Engines Below 75 Horsepower and Above 750 Horsepower

The Tier 4 program includes standards for engines under 25 horsepower that begin in 2008, and two sets of standards for 25 to 75 horsepower engines—one set that begins in 2008 and another that begins in 2013.[234] The 2008 standards for all engines under 75 horsepower are of similar stringency and are expected to result in use of similar technologies (*i.e.*, the possible addition of a DOC). The 2013 standards for 25 to 75 horsepower engines are considerably more stringent than the 2008 standards and are expected to force the addition of a CDPF along with some other engine hardware to enable the proper functioning of that new technology. More detail on the mix of technologies expected for all engines under 75 horsepower is presented in section II.B.4 and 5. As discussed there, if changes are needed to comply, we expect manufacturers to comply with the 2008 standards through either engine-out improvements or through the addition of a DOC. From a cost perspective, we have projected that engines will add a DOC. Presumably, the manufacturer will choose the least costly approach that provides the necessary reduction. If engine-out modifications are less costly than a DOC, our estimate here is conservative. If the DOC proves to be less costly, then our estimate is representative of what most manufacturers will do. Therefore, we have assumed that, beginning in 2008, all engines below 75 horsepower add a DOC. Note that this estimate is made more conservative since we have assumed this cost for all engines when, in fact, some engines below 75 horsepower currently meet the Tier 4 PM standard (for 2008) and will not, therefore, incur any incremental costs to meet it. We have estimated this added hardware to result in an increased engine cost of $143 in the near-term and $136 in the long-term for a 30 horsepower engine. These costs may differ slightly from the proposal due to the adjustments to 2002 dollars.

We have also projected that some engines in the 25 to 75 horsepower range will have to upgrade their fuel systems to accommodate the CDPF. We have estimated the incremental costs for these fuel systems at roughly $870 for a three cylinder engine in the 25–50 horsepower range, and around $450 for a four cylinder engine in the 50–75 horsepower range. This difference reflects a different base fuel system, with the smaller engines assumed to have mechanical fuel systems and the larger engines assumed to already be electronic. The electronic systems will incur lower costs because they already have the control unit and electronic fuel pump. Also, we have assumed these fuel changes will occur for only direct injection (DI) engines; indirect injection engines (IDI) are assumed to remain IDI but to add more hardware as part of their CDPF regeneration system to ensure proper regeneration under all operating conditions. Such a regeneration system, described above, is expected to cost roughly twice that expected for DI engines, or around $320 for a 30 horsepower IDI engine versus $160 for a DI engine. These costs may differ slightly from the proposal due to the adjustments to 2002 dollars.

We have also projected that engines in the 25–50 horsepower range will add cooled EGR to comply with their new NO_X standard in 2013. Additionally, we have estimated, for cost purposes, that engines above 750 horsepower will add cooled EGR to comply with their new NO_X standard in 2011. This represents a conservative estimate since we do not necessarily anticipate that cooled EGR will be applied to all, if any, engines above 750 horsepower. Nonetheless, we do expect some changes to be made (most probably some form of engine-out emission control) and, consistent with our approach to costing DOCs for engines below 75 horsepower in 2008, we have conservatively costed cooled EGR for engines above 750 horsepower in 2011. We have estimated that the EGR system will add $100 in the near-term and $70 in the long-term to the cost of a 30 horsepower engine, and $550 and $420, respectively, for engines above 750 horsepower. These costs may differ slightly from the proposal due to

[233] This is particularly true with respect to engines above 750 horsepower where we believe that manufacturers may in fact use a wire mesh substrate rather than the SiC substrate we have costed and, indeed, we have based the level of the 2015 PM standard on this use of wire mesh substrates (*see* section II.B.3.b). We have chosen to remain conservative in our cost estimates by assuming use of a SiC substrate for all engines.

[234] We refer here to PM standards. There also is a NO_X+NMHC standard for 25–50 horsepower engines that takes effect in 2013 and is equivalent to the Tier 3 NO_X+NMHC standard for 50–75 horsepower engines (see section II.A).

the adjustments to 2002 dollars. To these costs, we have added costs associated with additional cooling that may be needed to reject the heat generated by the cooled EGR system or other in-cylinder technologies. These costs were not included in the proposal. Such additional cooling might take the form of a larger radiator and/or a larger or more powerful cooling fan. Based on cost estimates from our Nonconformance Penalty rule (67 FR 51464), we have estimated that the costs associated with additional cooling will add $40 in the near-term and $30 in the long-term to the cost of a 30 horsepower engine, and $710 in the near-term and $560 in the long-term for engine above 750 horsepower. Note that we are also projecting use of a CDPF for engines above 750 horsepower, as was discussed above.

We believe there are factors that will cause variable hardware costs to decrease over time, making it appropriate to distinguish between near-term and long-term costs. Research in the costs of manufacturing has consistently shown that as manufacturers gain experience in production, they are able to apply innovations to simplify machining and assembly operations, use lower cost materials, and reduce the number or complexity of component parts.[235] Our analysis, as described in more detail in the RIA, incorporates the effects of this learning curve by projecting that the variable costs of producing the low-emitting engines decreases by 20 percent starting with the third year of production. For this analysis, we have assumed a baseline that represents such learning already having occurred once due to the 2007 highway rule (*i.e.,* a 20 percent reduction in emission control device costs is reflected in our near-term costs). We have then applied a single learning step from that point in this analysis. Additionally, manufacturers are expected to apply ongoing research to make emission controls more effective and to have lower operating costs over time. However, because of the uncertainty involved in forecasting the results of this research, we conservatively have not accounted for it in this analysis.

c. Engine Operating Costs

We are projecting that a variety of new technologies will be introduced to enable nonroad engines to meet the new Tier 4 emissions standards. Primary among these are advanced emission control technologies and low-sulfur diesel fuel. The technology enabling benefits of low-sulfur diesel fuel are described in Section II, and the incremental cost for low-sulfur fuel is described in section VI.A. The new emission control technologies are themselves expected to introduce additional operating costs in the form of increased fuel consumption and increased maintenance demands. Operating costs are estimated in the RIA over the life of the engine and are expressed in terms of cents/gallon of fuel consumed. In section VI.C.3, we present these lifetime operating costs as a net present value (NPV) in 2002 dollars for several example pieces of equipment.

Total operating cost estimates include the following elements: the change in maintenance costs associated with applying new emission controls to the engines; the change in maintenance costs associated with low sulfur fuel such as extended oil change intervals; the change in fuel costs associated with the incrementally higher costs for low sulfur fuel, and the change in fuel costs due to any fuel consumption impacts associated with applying new emission controls to the engines. This latter cost is attributed to the CDPF and its need for periodic regeneration which we estimate may result in a one percent fuel consumption increase where a NO_X adsorber is also applied, or a two percent fuel consumption increase where no NO_X adsorber is applied (refer to chapter 6, section 6.2.3.3 of the RIA). Maintenance costs associated with the new emission controls on the engines are expected to increase since these devices represent new hardware and, therefore, new maintenance demands. For CDPF maintenance, we have used a maintenance interval of 3,000 hours for smaller engines and 4,500 hours for larger engines and a cost of $65 through $260 for each maintenance event. For closed-crankcase ventilation (CCV) systems, we have used a maintenance interval of 675 hours for all engines and a cost per maintenance event of $8 to $48 for small to large engines. Offsetting these maintenance cost increases will be a savings due to an expected increase in oil change intervals because low sulfur fuel will be far less corrosive than is current nonroad diesel fuel. Less corrosion will mean a slower acidification rate (*i.e.,* less degradation) of the engine lubricating oil and, therefore, more operating hours between needed oil changes. As discussed in section VI.B, the use of 15 ppm sulfur fuel can extend oil change intervals by as much as 35 percent for both new and existing nonroad engines and equipment. We have used a 35 percent increase in oil change interval along with costs per oil change of $70 through $400 to arrive at estimated savings associated with increased oil change intervals.

These operating costs are expressed as a cent/gallon cost (or savings). As a result, operating costs are directly proportional to the amount of fuel consumed by the engine. We have estimated these operating costs—fuel-related refining and distribution costs, maintenance related costs, and fuel economy impacts—to be 5.4 cents/gallon for a 150 horsepower engine and 6.5 cents/gallon for a 500 horsepower engine. More detail on operating costs can be found in Chapter 6 of the RIA.

The existing fleet will also benefit from lower maintenance costs due to the use of low sulfur diesel fuel. The operating costs for the existing fleet are discussed in section VI.B. We did receive comments with respect to our oil change maintenance savings estimates. These comments were address in section VI.B. We received no comments on our CDPF and CCV maintenance costs or our CDPF regeneration costs.

2. Equipment Cost Impacts

In addition to the costs directly associated with engines that incorporate new emission controls to meet new standards, costs will increase due to the need to redesign the nonroad equipment in which these engines are used. Such redesigns will probably be necessary due to the expected addition of new emission control systems, but could also occur if the engine has a different shape or heat rejection rate, or is no longer made available in the configuration previously used. We have accounted for these potential changes in establishing the lead time for the Tier 4 emissions standards. The transition flexibility provisions for equipment manufacturers that are included in this final rule are an element of that lead time. These flexibility provisions are described in detail in section III.B.

In assessing the economic impact of the new emission standards, EPA has made a best estimate of the modifications to equipment that relate to packaging (installing engines in equipment engine compartments). The incremental costs for new equipment will be comprised of fixed costs (for redesign to accommodate new emission control devices) and variable costs (for new equipment hardware to affix the new emission control devices and for labor to install those emission control devices). Note that the fixed costs do not

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

include certification costs because the equipment is not certified to emission standards. The engine is certified by the engine manufacturer; therefore, the related certification costs are counted as an engine fixed cost. We have also attributed all changes in operating costs (*e.g.,* additional maintenance) to the cost estimates for engines. Included in section VI.C.3 is a discussion of several example pieces of equipment (*e.g.,* skid/steer loader, dozer, etc.) and the costs we have estimated for these specific example pieces of equipment. Full details of our equipment cost analysis can be found in chapter 6 of the RIA. All costs are presented in 2002 dollars.

We have made only limited changes relative to the proposal with respect to our estimated equipment costs, as discussed below. We did receive comment that we underestimated costs for equipment redesign and for markups on equipment variable costs. The commenters making these claims relative to equipment redesign costs tended to be those that have relative high equipment sales volumes. Such manufacturers tend to expend levels higher than we estimated in our proposal for equipment redesign because they sell into highly competitive markets and they can spread costs over many units. However, some equipment manufacturers we have met with, most notably those with small sales volumes, do not appear to expend nearly the level we estimated in the proposal. These manufacturers tend to sell into markets with few competitors, produce machines by hand, and expend less redesign effort relative to a high sales volume manufacturer.[236] Our goal in the proposal was to estimate the redesign costs spent by industry (*i.e.,* the average cost per piece of equipment multiplied by all equipment resulting in an estimated total industry cost), rather than estimating the maximum cost to be spent by any particular manufacturer. As a result, our equipment redesign estimates per model may be too low for some manufacturers, but they are also too high for others. We believe this cost methodology provides as accurate an estimate as can be made. We have used the same methodology for the final cost estimates presented here.

As for the comments with respect to equipment variable costs, we did indeed include a markup of 29 percent and disagree with the commenter that a two-to-one markup would be more appropriate. Such a high markup on equipment variable costs is not sustainable in a competitive market, at least on average, and the commenter provided no data nor study that supported the comment.

We have made minor changes to the proposed numbers to express them in 2002 dollars and to reflect where the program has changed (*i.e.,* greater than 750 horsepower mobile machines). We have also attributed all under 25 horsepower redesign costs to U.S. sales since we do not expect other countries to have similar emission standards for these engines/equipment. Lastly, we have corrected some minor errors made in the proposal in determining motive versus non-motive models and determining the number of unique equipment models needing redesign. We now estimate that a total of over 4,500 equipment models will be redesigned as compared to the proposal's estimate of just over 4,100 equipment models. Further discussion of these changes can be found in Chapter 6 of the RIA.

a. Equipment Fixed Costs

As we noted in the proposal, the most significant changes anticipated for equipment redesign are changes to accommodate the physical changes to engines, especially for those engines that add PM traps and NO_X adsorbers. The costs for engine development and the emission control devices are included as costs to the engines, as described above. Equipment manufacturers must still incur the effort and expense of integrating the engine and emissions control devices into the piece of equipment. Therefore, we have allocated extensive engineering time for this effort.

The costs we have estimated are based on engine power and whether an application is non-motive (*e.g.,* a generator set) or motive (*e.g.,* a skid steer loader). The designs we have considered to be non-motive are those that lack a propulsion system. In addition, the new emission standards for engines rated under 25 horsepower and the 2008 standards for 25–75 horsepower engines are projected to require no significant equipment redesign beyond that done to accommodate the Tier 2 standards. As explained earlier, we expect that these engines will comply with the new Tier 4 standards through either engine modifications to reduce engine-out emissions or through the addition of a DOC. We have projected that engine modifications will not affect the outer dimensions of the engine and that a DOC will replace the existing muffler. Therefore, either approach taken by the engine manufacturer should have limited to no impact on the equipment design. Nonetheless, we have conservatively estimated their redesign costs at $53,100 per model.[237]

A number of equipment manufacturers have shared detailed information with us regarding the investments made for Nonroad Tier 2 equipment redesign efforts, as well as redesign estimates for significant changes such as installing a new engine design. These estimates range from approximately $53,100 for some lower powered equipment models to well over $1 million for high horsepower equipment with very challenging design constraints. We believe that the equipment redesign efforts undertaken for the T2/3 are representative of the effort that will be required for Tier 4 because the changes needed are the same in nature—increasing available space within the machine to accommodate new hardware. We have based our Tier 4 estimates, in part, on that industry input and have estimated that equipment redesign costs will range from $53,100 per model for 25 horsepower equipment up to $796,500 per model for 300 horsepower equipment and above. For mobile machines greater than 750 horsepower, we have used a new redesign cost of $106,000 associated with the 2011 standards which is consistent in scale with the estimate used for 25 to 50 horsepower equipment that add both EGR and a CDPF in the 2013 timeframe. This estimate was not in the proposal. For this larger equipment, we have continued with an estimate of $796,500 associated with the 2015 standards even though we project no need to accommodate a NO_X adsorber. We have attributed only a portion of the equipment redesign costs to U.S. sales in a manner consistent with that taken for engine R&D costs and engine tooling costs. In addition, we expect manufacturers to incur some fixed costs to update service and operation manuals to address the maintenance demands of new emission control technologies and the new oil service intervals; we estimate these service manual updates to cost between $2,660 and $10,620 per equipment model.

These equipment fixed costs (redesign and manual updates) were then allocated appropriately to each new model to arrive at a total equipment fixed cost of $828 million. We have assumed that these costs will be

[236] "Meeting between Staff of Eagle Crusher Company, Inc., and EPA," memorandum from Todd Sherwood to Air Docket A–2001–28, Docket Item IV–E–40, EDOCKET OAR–2003–0012–0868, March 16, 2004.

[237] Note that the equipment redesign estimates, and all other equipment related costs, have been adjusted from the NPRM to express them in 2002 dollars.

recovered over a ten year period with a seven percent opportunity cost of capital. By comparison, our proposal estimated equipment fixed costs at $698 million. The costs are higher now because of the changes mentioned above—expressing costs in 2002 dollars; attributing all under 25 horsepower redesign costs to U.S. sales; and, correcting upward the number of equipment models to be redesigned.

b. Equipment Variable Costs

Equipment variable cost estimates are based on costs for additional materials to mount the new hardware (*i.e.,* brackets and bolts required to secure the aftertreatment devices) and additional sheet metal assuming that the body cladding of a piece of equipment (*i.e.,* the hood) might change to accommodate the aftertreatment system. Variable costs also include the labor required to install these new pieces of hardware. For engines above 75 horsepower—those expected to incorporate CDPF and NO_X adsorber technology—the amount of sheet metal is based on the size of the aftertreatment devices.

For equipment of 150 horsepower and 500 horsepower, respectively, we have estimated the costs to be roughly $60 to $150. Note that we have estimated costs for equipment in all horsepower ranges, and these estimates are presented in detail in the RIA. Throughout this discussion of engine and equipment costs, we present costs for a 150 and a 500 horsepower engine for illustrative purposes.

3. Overall Engine and Equipment Cost Impacts

To illustrate the engine and equipment cost impacts we are estimating for the Tier 4 standards, we have chosen several example pieces of equipment and have presented the estimated costs for them. Using these examples, we can calculate the costs for a specific piece of equipment in several horsepower ranges and better illustrate the cost impacts of the new standards. These costs along with information about each example piece of equipment are shown in table VI.C–1. Costs presented are near-term and long-term costs for the final standards to which each piece of equipment will comply. Long-term costs are only variable costs and, therefore, represent costs after all fixed costs have been recovered and all projected learning has taken place. Included in the table are estimated prices for each piece of equipment to provide some perspective on how our estimated control costs relate to existing equipment prices.

TABLE VI.C–1.—NEAR-TERM AND LONG-TERM COSTS FOR SEVERAL EXAMPLE PIECES OF EQUIPMENT [a]

($2002, for the final emission standards to which the equipment must comply)

	Gen-Set	Skid/steer loader	Backhoe	Dozer	Ag tractor	Dozer	Off-highway truck
Horsepower	9 hp	33 hp	76 hp	175 hp	250 hp	503 hp	1000 hp
Incremental Engine & Equipment Cost	$120	$790	$1,200	$2,560	$1,970	$4,140	$4,670
Long-Term	180	1,160	1,700	3,770	3,020	6,320	8,610
Near-Term.							
Estimated Equipment Price when New [b]	4,000	20,000	49,000	238,000	135,000	618,000	840,000
Incremental Operating Costs [c]	−80	70	610	2,480	2,110	7,630	20,670
Baseline Operating Costs (Fuel & Oil only) [c]	940	2,680	7,960	27,080	23,750	77,850	179,530

Notes: [a] Near-term costs include both variable costs and fixed costs; long-term costs include only variable costs and represent those costs that remain following recovery of all fixed costs. [b] "Price Database for New Nonroad Equipment," memorandum from Zuimdie Guerra to EDOCKET OAR–2003–0012–0960. [c] Present value of lifetime costs.

More detail and discussion regarding what these costs and prices mean from an economic impact perspective can be found in section VI.E.

D. Annual Costs and Cost Per Ton

One tool that can be used to assess the value of the Tier 4 standards for NRLM fuel and nonroad engines is the costs incurred per ton of emissions reduced. This analysis involves a comparison of our new program to other measures that have been or could be implemented. As summarized in this section and detailed in the RIA, the program being finalized today represents a highly cost effective mobile source control program for reducing PM, NO_X, and SO_2 emissions.

We have calculated the cost per ton of our Tier 4 program based on the net present value of all costs incurred and all emission reductions generated over a 30 year time window following implementation of the program (*i.e.,* calendar years 2007 through 2036). This approach captures all of the costs and emissions reductions from our new program including those costs incurred and emissions reductions generated by the existing fleet. The baseline for this evaluation is the existing set of fuel and engine standards (*i.e.,* unregulated NRLM fuel and the Tier 2/Tier 3 program). The 30 year time window chosen is meant to capture both the early period of the program when very few new engines that meet the new standards will be in the fleet, and the later period when essentially all engines will meet the new standards.

We have analyzed the cost per ton reduced of several different scenarios. The costs and emissions reductions of each of these scenarios are presented in detail in chapter 8 of the RIA. Here, we present information of the cost and cost effectiveness for the following two scenarios: (1) The full NRLM fuel and nonroad engine program, meaning two steps of fuel control (to 500 ppm and then to 15 ppm) for both NR and L&M fuel and all of the nonroad engine standards; and, (2) the NRLM fuel-only program, meaning two steps of fuel control (to 500 ppm and then to 15 ppm) for both NR and L&M fuel but without any new nonroad engine standards.[238] For the first of these scenarios, the discussion illustrates the costs and relative cost effectiveness of the final NRT4 program to other programs. For the second of these scenarios, the discussion illustrates the costs and cost effectiveness associated with the fuel program as if implemented as a stand alone program without new engine standards.

In sections VI.D.1 and 2, we present the cost of the full NRLM fuel and nonroad engine program and the cost per ton of PM, NO_X+NMHC, and SO_2 reductions that will be realized. The analysis presented in sections VI.D.1 and 2 represents the total Tier 4 program for nonroad diesel engines and NRLM fuel being finalized today. In sections VI.D.3 and 4, we summarize the

[238] We are not analyzing a scenario involving just the engine standards because the nonroad engine standards involving advanced emissions control technologies require the use of the 15ppm fuel.

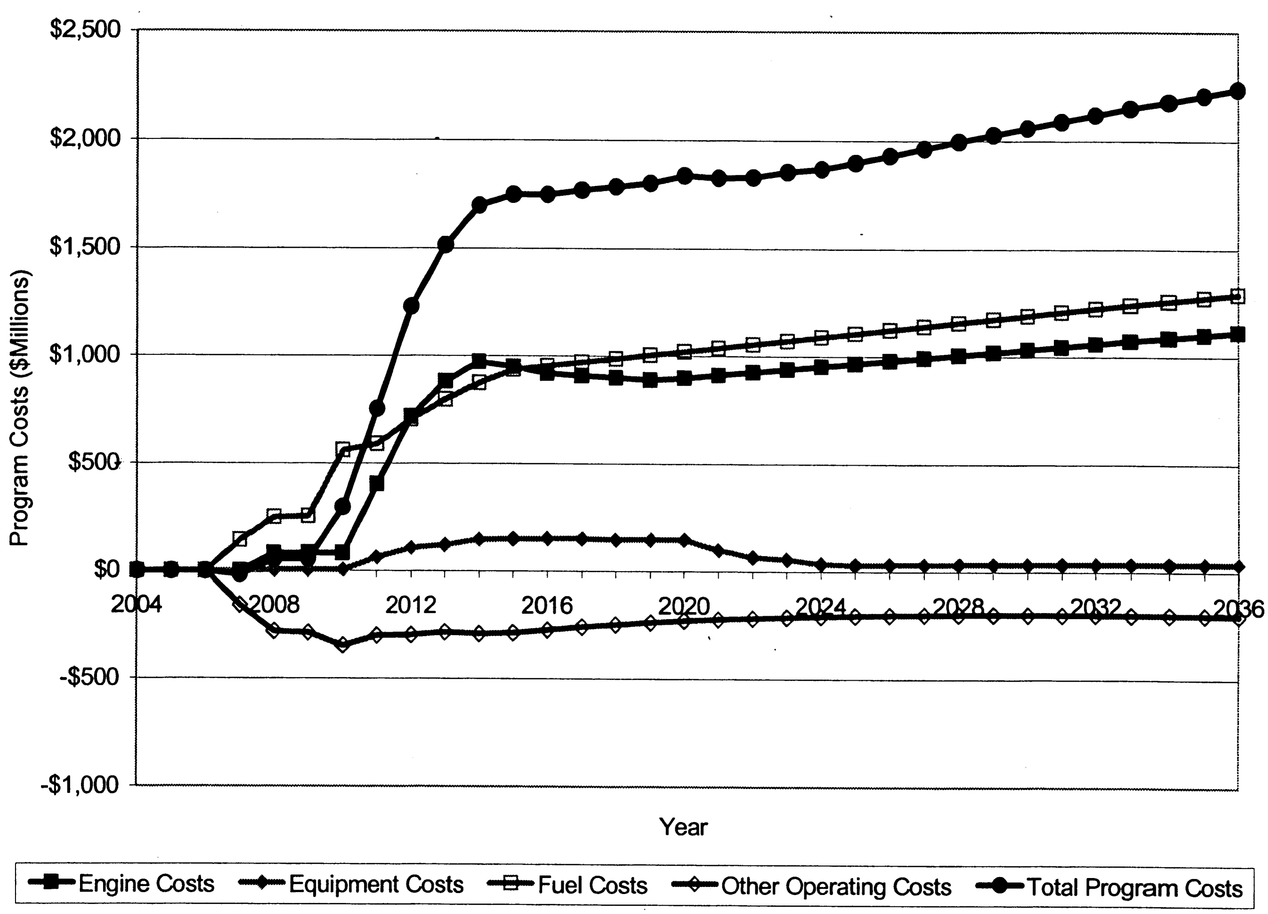
cost for the NRLM fuel-only scenario and the cost per ton of PM and SO_2 reductions that would be realized.

1. Annual Costs for the Full NRLM Fuel and Nonroad Engine Program

The costs of the full NRLM fuel and nonroad engine program include costs associated with both steps in the NRLM fuel program—the NR fuel reduction to 500 ppm sulfur in 2007 and to 15 ppm sulfur in 2010 and the L&M fuel reduction to 500 ppm sulfur in 2007 and to 15 ppm sulfur in 2012. Also included are costs for the 2008 nonroad engine standards for engines less than 75 horsepower, the 2013 standards for 25 to 75 horsepower engines, and costs for the nonroad engine standards for engines above 75 horsepower. All maintenance and operating costs are included along with maintenance savings realized by both the existing fleet (nonroad, locomotive, and marine) and the new fleet of engines complying with the Tier 4 standards.

Figure VI.D–1 presents these results. All capital costs for NRLM fuel production and nonroad engine and equipment fixed costs have been amortized at seven percent. The figure shows that total annual costs are estimated to be $50 million in the first year the new engine standards apply, increasing to a peak of $2.2 billion in 2036 as increasing numbers of engines become subject to the new nonroad standards and an ever increasing amount of NRLM fuel is consumed. The net present value of the annualized costs over the period from 2007 to 2036 is $27 billion using a 3 percent discount rate and $14 billion using a 7 percent discount rate.

Figure VI.D-1. – Annual Costs of the Full NRT4 Fuel and Engine Program



2. Cost per Ton of Emissions Reduced for the Full NRLM Fuel and Nonroad Engine Program

We have calculated the cost per ton of emissions reduced associated with the NRT4 engine and NRLM fuel program. The resultant cost per ton numbers depend on how the costs presented above are allocated to each pollutant. Therefore, we have carefully allocated costs according to the pollutants for which they are incurred. Where fuel changes occur in conjunction with new engine standards (engine standards enabled by those fuel changes), we allocate one-half of the fuel-related costs to fuel-derived emissions reductions (PM and SO_2, with one-third of that half allocated to PM and two-thirds to SO_2) and one-half to engine-derived emissions reductions (NO_X+NMHC and PM, with that half split 50/50 between each pollutant). Where fuel changes occur without new engine standards on which fuel changes are premised (*i.e.*, 500ppm NRLM fuel and 15ppm L&M fuel), we have allocated costs associated with fuel-derived emissions reductions one-third to PM and two-thirds to SO_2. We have allocated costs associated with engine-derived emissions reductions (*i.e.*, engine/equipment costs) directly to the pollutant for which the cost is incurred. These engine and equipment cost allocations are noted throughout the discussion in section VI.C, and are detailed in full in chapter 8 of the RIA.

We have calculated the costs per ton using the net present value of the annualized costs of the program through 2036 and the net present value of the annual emission reductions through 2036. We have also calculated the cost per ton of emissions reduced in the year 2030 using the annual costs and emissions reductions in that year alone. This number represents the long-term cost per ton of emissions reduced. The cost per ton numbers include costs and emission reductions that will occur from the existing fleet (*i.e.*, those pieces of nonroad equipment that were sold into the market prior to the new emission standards). These results are shown in Table VI.D–1 using both a three percent and a seven percent social discount rate.

TABLE VI.D–1.—TOTAL FUEL AND ENGINE PROGRAM 30 YEAR AGGREGATE COST PER TON AND LONG-TERM ANNUAL COST PER TON

($2002)

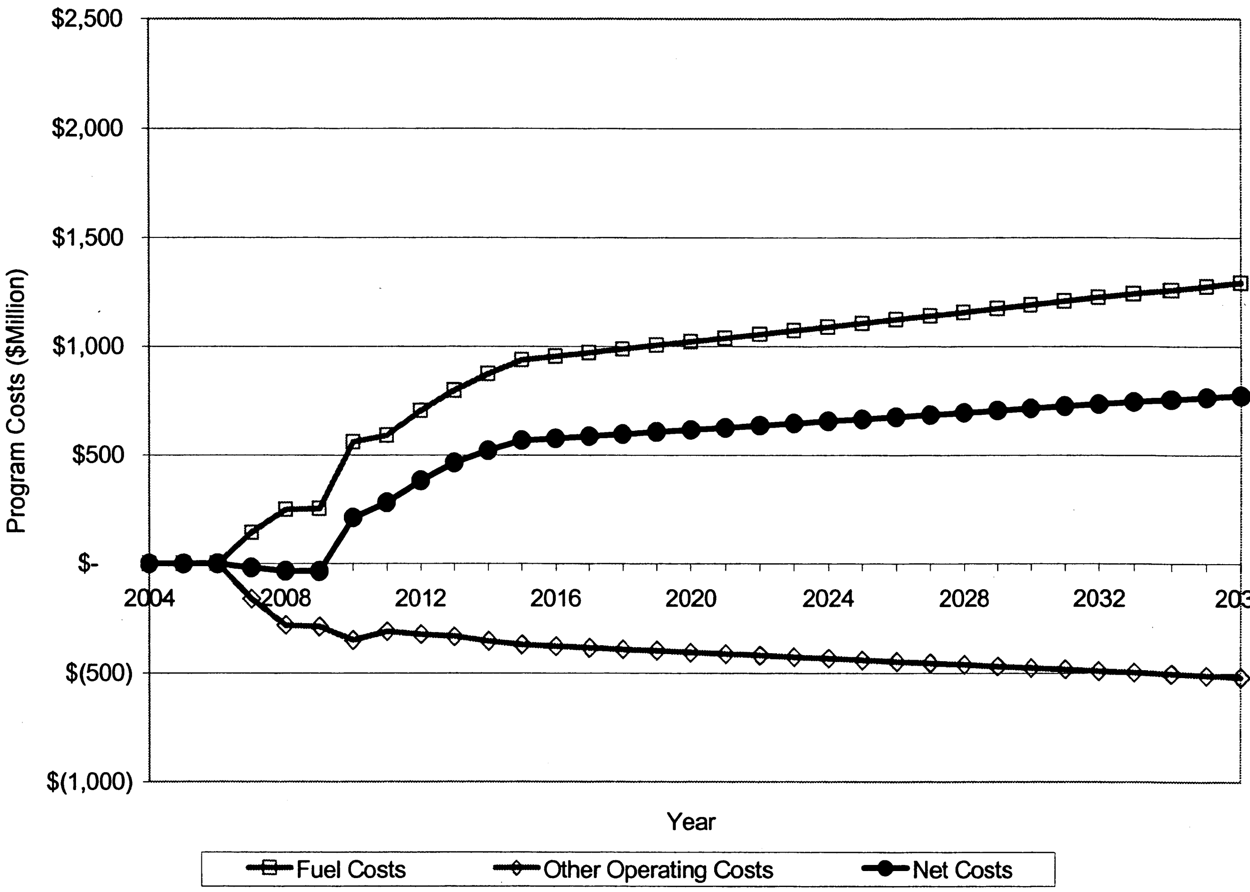
Pollutant	30 year discounted lifetime cost per ton at 3%	30 year discounted lifetime cost per ton at 7%	Long-term cost per ton in 2030
NO_X+NMHC	$1,010	$1,160	$680
PM	11,200	11,800	9,300
SO_X	690	620	810

3. Annual Costs for the NRLM Fuel-only Scenario

Cent per gallon costs for the new 500 ppm NRLM fuel, the new 500 ppm L&M fuel, the new 15 ppm NR fuel, and the new 15 ppm NRLM fuel were presented in section IV.A. Having this fuel will result in maintenance savings associated with increased oil change intervals for both the new and the existing fleet of nonroad, locomotive, and marine engines. These maintenance savings were discussed in section VI.B. There are no engine and equipment costs associated with the NRLM fuel-only scenario because new engine emissions standards are not included in that scenario. Figure VI.D–2 shows the annual costs associated with the NRLM fuel-only program.

As can be seen in figure VI.D–1, the costs for refining and distributing the fuel range from $250 million in 2008 to nearly $1.3 billion in 2036. The increase in fuel costs in 2010 reflect the change to higher cost 15 ppm NR fuel. Fuel costs continue to grow as more fuel is consumed by the increasing number of engines and equipment. The fuel costs are largely offset by the maintenance savings that range from $250 million in 2008 to $500 million in 2036. As a whole, the net cost of the program in each year ranges from a small net savings in 2008 to around $780 million in 2036. The net present value (*i.e.*, the value in 2004) of the net costs associated with the NRLM fuel-only program during the 30 year period from 2007 to 2036 is estimated at $9.2 billion using a 3 percent discount rate and $4.6 billion using a 7 percent discount rate.

Figure VI.D-2. – Annual Costs of the NRLM Fuel-only Scenario



4. Cost Per Ton of Emissions Reduced for the NRLM Fuel-Only Scenario

The fuel-borne sulfur reduction under the NRLM fuel-only scenario will result in significant reductions of both SO_2 and PM emissions. Since there are no new engine standards associated with the NRLM fuel-only scenario, the emissions reductions that result are entirely fuel-derived. Roughly 98 percent of fuel-borne sulfur is converted to SO_2 in the engine with the remaining two percent being exhausted as sulfate PM. We have allocated one-third of the costs of this program to PM control and two-thirds to SO_2 control. This is consistent with the cost accounting we have used throughout our analysis in that costs associated with fuel-derived emissions reductions are attributed one-third to PM control and two-thirds to SO_2 control.

As discussed above, the 30 year net present value of costs associated with the fuel-only program are estimated at $9.2 billion using 3 percent discounting and $4.6 billion using 7 percent discounting. We have estimated the 30 year net present value of the SO_2 emission reductions at 5.7 million tons and PM emission reductions at 462,000 tons using 3 percent discounting, 3.2 million tons and 255,000 tons, respectively, using 7 percent discounting.

Table VI.D–1 shows the cost per ton of emissions reduced as a result of the NRLM fuel-only scenario. The cost per ton numbers include costs and emissions reductions that will occur from both the new and the existing fleet (i.e., those pieces of nonroad equipment that were sold into the market prior to the new fuel standards) of nonroad, locomotive, and marine engines.

TABLE VI.D–2.—NRLM FUEL-ONLY SCENARIO—30-YEAR AGGREGATE COST PER TON AND LONG-TERM ANNUAL COST PER TON

[$2002]

Pollutant	30 year discounted lifetime cost per ton at 3%	30 year discounted lifetime cost per ton at 7%	Long-term cost per ton in 2030
PM	$6,600	$6,000	$7,900
SO_2	1,070	970	1,270

We also considered the cost per ton of the NRLM fuel-only scenario without including the expected maintenance savings associated with low sulfur fuel. Without the maintenance savings, the 30 year discounted cost per ton of PM reduced would be $11,800 and of SO_2 reduced would be $1,900 using 3 percent discounting and $11,200 and $1,800, respectively, using 7 percent discounting. More detail on how the costs and cost per ton numbers associated with the NRLM fuel-only scenario were calculated can be found in the RIA.

5. Comparison With Other Means of Reducing Emissions

In comparison with other emissions control programs, we believe that the Tier 4 programs represent a cost effective strategy for generating substantial NO_X+NMHC, PM, and SO_2 reductions. This can be seen by comparing the cost per ton of emissions reduced by the NRLM fuel-only scenario (*i.e.*, reducing fuel sulfur to 500 ppm in 2007 and 15 ppm in 2010 without any new nonroad engine standards) and the cost per ton of emissions reduced by the full NRLM fuel and nonroad engine program (*i.e.*, fuel control and new engine standards) with a number of standards that EPA has adopted in the past. Tables VI.D–3 and VI.D–4 summarize the cost per ton of several past EPA actions to reduce emissions of NO_X+NMHC and PM from mobile sources, all of which were considered by EPA to be appropriate.

TABLE VI.D–3.—NRT4 COST PER TON COMPARISON TO PREVIOUS MOBILE SOURCE PROGRAMS FOR NO_X + NMHC

Program	$/ton
Tier 4 Nonroad Diesel (full program)	1,010
Tier 2 Nonroad Diesel	630
Tier 3 Nonroad Diesel	430
Tier 2 vehicle/gasoline sulfur	1,400–2,350
2007 Highway HD	2,240
2004 Highway HD	220–430
Tier 1 vehicle	2,150–2,910
NLEV	2,020
Marine SI engines	1,220–1,930
On-board diagnostics	2,410
Marine CI engines	30–190
Large SI Exhaust	80
Recreational Marine	670

Note: Costs adjusted to 2002 dollars using the Producer Price Index for Total Manufacturing Industries.

TABLE VI.D–4. "NRT4 COST PER TON COMPARISON TO PREVIOUS MOBILE SOURCE PROGRAMS FOR PM

Program	$/ton
Tier 4 Nonroad Diesel (full program)	11,200
Tier 4 NRLM fuel-only (fuel-only scenario)	6,800
Tier 1/Tier 2 Nonroad Diesel	2,390
2007 Highway HD	14,180
Marine CI engines	4,040–5,440
1996 urban bus	12,780–20,450
Urban bus retrofit/rebuild	31,530
1994 highway HD diesel	21,780–25,500

Note: Costs adjusted to 2002 dollars using the Producer Price Index for Total Manufacturing Industries.

To compare the cost per ton of SO_2 emissions reduced, we looked at the cost per ton for the Title IV (acid rain) SO_2 trading programs. This information is found in EPA report 430/R–02–004, "Documentation of EPA Modeling Applications (V.2.1) Using the Integrated Planning Model", in Figure 9.11 on page 9–14 (*www.epa.gov/airmarkets/epa-ipm/index.html#documentation*). The SO_2 cost per ton results of the full Tier 4 program presented in table VI.D–2 compare very favorably with the program shown in table VI.D–5.

TABLE VI.D–5.—NRT4 COST PER TON COMPARISON TO SO_2 FROM BOTH THE EPA BASE CASE 2000 FOR THE TITLE IV SO_2 TRADING PROGRAMS AND THE PROPOSED INTERSTATE AIR QUALITY RULE

Program	$/ton
Tier 4 Nonroad Diesel (full program).	$690
Tier 4 Nonroad Diesel (fuel-only scenario).	1,070
Title IV SO_2 Trading Programs.	490 in 2010 to 610 in 2020
Interstate Air Quality Rule (average cost).	730 in 2010 to 830 in 2015

Note: Costs adjusted to 2002 dollars using the Producer Price Index for Total Manufacturing Industries.

As the above comparisons show, both the NRLM fuel-only scenario, when viewed by itself, and the combination of NRLM fuel and nonroad engine standards, are both cost effective strategies to achieve the associated emissions reductions.

E. Do the Benefits Outweigh the Costs of the Standards?

Our analysis of the health and environmental benefits to be expected from this final rule are presented in this section. Briefly, the analysis projects major benefits throughout the period from initial implementation of the rule over a 30 year period through 2036. As described below, thousands of deaths and other serious health effects would be prevented, yielding a net present value in 2004 of those benefits we could monetize of approximately $805 billion dollars using a 3 percent discount rate and $352 billion using a 7 percent discount rate. These benefits exceed the net present value of the social cost of the proposal ($27 billion using a 3 percent discount rate and $14 billion using a 7 percent discount rate) by $780 billion using a 3 percent discount rate and $340 billion using a 7 percent discount rate.

1. What Were the Results of the Benefit-Cost Analysis?

Table VI.E–1 presents the primary estimate of reduced incidence of PM-related health effects for the years 2020 and 2030. In interpreting the results, it is important to keep in mind the limited set of effects we are able to monetize. Specifically, the table lists the PM-related benefits associated with the reduction of several health effects. In 2030, we estimate that there will be 12,000 fewer fatalities in adults [239] and 20 fewer fatalities in infants per year associated with fine PM, and the rule will result in about 5,600 fewer cases of chronic bronchitis, 8,900 fewer hospitalizations (for respiratory and cardiovascular disease combined), and result in 1 million days per year when adults miss work because of their respiratory symptoms and 5.9 million days of when adults must restrict their activity due to respiratory illness. We also estimate substantial health improvements for children from reduced upper and lower respiratory illness, acute bronchitis, and asthma

[239] While we did not include separate estimates of the number of premature deaths that would be avoided due to reductions in ozone levels, recent evidence has been found linking short-term ozone exposures with premature mortality independent of PM exposures. Recent reports by Thurston and Ito (2001) and the World Health Organization (WHO) support an independent ozone mortality impact, and the EPA Science Advisory Board has recommended that EPA reevaluate the ozone mortality literature for possible inclusion in the estimate of total benefits. Based on these new analyses and recommendations, EPA is sponsoring three independent meta-analyses of the ozone-mortality epidemiology literature to inform a determination on inclusion of this important health endpoint. Upon completion and peer-review of the meta-analyses, EPA will make its determination on whether and how benefits of reductions in ozone-related mortality will be included in the benefits analysis for future rulemakings.

attacks.[240] We were unable to quantify the benefits related to ozone and other pollutants for the final rule, although we do present some preliminary ozone modeling in Chapter 9 of the RIA.

Table VI.E–2 presents the total monetized benefits for the years 2020 and 2030. This table also indicates with a "B" those additional health and environmental effects which we were unable to quantify or monetize. These effects are additive to estimate of total benefits, and EPA believes there is considerable value to the public of the benefits that could not be monetized. A full listing of the benefit categories that could not be quantified or monetized in our estimate are provided in table VI.E–6.

In summary, EPA's primary estimate of the benefits of the rule are $83 + B billion in 2030 using a 3 percent discount rate and $78 + B billion using a 7 percent discount rate. In 2020, total monetized benefits are $42 + B billion using a 3 percent discount rate and $41 + B billion using a 7 percent discount rate. These estimates account for growth in real gross domestic product (GDP) per capita between the present and the years 2020 and 2030. As the table indicates, total benefits are driven primarily by the reduction in premature fatalities each year, which account for over 90 percent of total benefits.

TABLE VI.E–1.—REDUCTIONS IN INCIDENCE OF PM-RELATED ADVERSE HEALTH EFFECTS ASSOCIATED WITH THE FINAL NONROAD DIESEL ENGINE AND FUEL STANDARDS FULL PROGRAM

Endpoint	Avoided incidence [a] (cases/year)	
	2020	2030
Premature mortality [b]: Long-term exposure (adults, 30 and over)	6,500	12,000
Infant mortality (infants under one year)	15	22
Chronic bronchitis (adults, 26 and over)	3,500	5,600
Non-fatal myocardial infarctions (adults, 18 and older)	8,700	15,000
Hospital admissions—Respiratory (adults, 20 and older) [c]	2,800	5,100
Hospital admissions—Cardiovascular (adults, 20 and older) [d]	2,300	3,800
Emergency Room Visits for Asthma (18 and younger)	3,800	6,000
Acute bronchitis (children, 8–12)	8,400	13,000
Asthma exacerbations (asthmatic children, 6–18)	120,000	200,000
Lower respiratory symptoms (children, 7–14)	100,000	160,000
Upper respiratory symptoms (asthmatic children, 9–11)	76,000	120,000
Work loss days (adults, 18–65)	670,000	1,000,000
Minor restricted activity days (adults, age 18–65)	4,000,000	5,900,000

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

TABLE VI.E–2.—EPA PRIMARY ESTIMATE OF THE ANNUAL QUANTIFIED AND MONETIZED BENEFITS ASSOCIATED WITH IMPROVED PM AIR QUALITY RESULTING FROM THE FINAL NONROAD DIESEL ENGINE AND FUEL STANDARDS FULL PROGRAM

Endpoint	Monetary Benefits [a, b] (millions 2000$, Adjusted for Income Growth)	
	2020	2030
Premature mortality [c]: (adults, 30 and over)		
3% discount rate	$41,000	$77,000
7% discount rate	38,000	72,000
Infant mortality (infants under one year)	97	150
Chronic bronchitis (adults, 26 and over)	1,500	2,400
Non-fatal myocardial infarctions [d]		
3% discount rate	750	1,200
7% discount rate	720	1,200
Hospital Admissions from Respiratory Causes [e]	49	92
Hospital Admissions from Cardiovascular Causes [f]	51	83
Emergency Room Visits for Asthma	1.1	1.7
Acute bronchitis (children, 8–12)	3.2	5.2
Asthma exacerbations (asthmatic children, 6–18)	5.7	9.2
Lower respiratory symptoms (children, 7–14)	1.7	2.7
Upper respiratory symptoms (asthmatic children, 9–11)	2.0	3.2
Work loss days (adults, 18–65)	92	130
Minor restricted activity days (adults, age 18–65)	210	320
Recreational visibility (86 Class I Areas)	1,000	1,700
Monetized Total [g].		
3% discount rate	44,000+B	83,000+B

[240] Our PM-related estimate in 2030 incorporates significant reductions of 160,000 fewer cases of lower respiratory symptoms in children ages 7 to 14 each year, 120,000 fewer cases of upper respiratory symptoms (similar to cold symptoms) in asthmatic children each year, and 13,000 fewer cases of acute bronchitis in children ages 8 to 12 each year. In addition, we estimate that this rule will reduce almost 6,000 emergency room visits for asthma attacks in children each year from reduced exposure to particles. Additional incidents would be avoided from reduced ozone exposures. Asthma is the most prevalent chronic disease among children and currently affects over seven percent of children under 18 years of age.

TABLE VI.E–2.—EPA PRIMARY ESTIMATE OF THE ANNUAL QUANTIFIED AND MONETIZED BENEFITS ASSOCIATED WITH IMPROVED PM AIR QUALITY RESULTING FROM THE FINAL NONROAD DIESEL ENGINE AND FUEL STANDARDS FULL PROGRAM—Continued

Endpoint	Monetary Benefits[a, b] (millions 2000$, Adjusted for Income Growth)	
	2020	2030
7% discount rate	42,000+B	78,000+B

Notes: [a] Monetary benefits are rounded to two significant digits. [b] Monetary benefits are adjusted to account for growth in real GDP per capita between 1990 and the analysis year (2020 or 2030). [c] Valuation of base estimate assumes discounting over the lag structure described in the RIA Chapter 9. [d] Estimates assume costs of illness and lost earnings in later life years are discounted using either 3 or 7 percent. [e] Respiratory hospital admissions for PM includes admissions for COPD, pneumonia, and asthma. [f] Cardiovascular hospital admissions for PM includes total cardiovascular and subcategories for ischemic heart disease, dysrhythmias, and heart failure. [g] B represents the monetary value of the unmonetized health and welfare benefits. A detailed listing of unquantified PM, ozone, CO, and NMHC related health effects is provided in Table VI.E–6.

The estimated social cost (measured as changes in consumer and producer surplus) in 2030 to implement the final rule from table VI.E–3 is $2.0 billion (2000$). Thus, the net benefit (social benefits minus social costs) of the program at full implementation is approximately $81 + B billion using a 3 percent discount rate and $78 + B billion using a 7 percent discount rate. In 2020, partial implementation of the program yields net benefits of $42 + B billion using a 3 percent discount rate and $41 + B billion using a 7 percent discount rate. Therefore, implementation of the final rule is expected to provide society with a net gain in social welfare based on economic efficiency criteria. Table VI.E–3 presents a summary of the benefits, costs, and net benefits of the final rule's full program. Figure VI–E.1 displays the stream of benefits, costs, and net benefits of the Nonroad Diesel Vehicle Rule from 2007 to 2036 using two different discount rates. In addition, table VI.E–4 presents the net present value of the stream of benefits, costs, and net benefits associated with the rule for this 30 year period. The total net present value in 2004 of the stream of net benefits (benefits minus costs) is $780 billion using a 3 percent discount rate and $340 billion using a 7 percent discount rate.

TABLE VI.E–3.—SUMMARY OF BENEFITS, COSTS, AND NET BENEFITS OF THE FINAL NONROAD DIESEL ENGINE AND FUEL STANDARDS FULL PROGRAM

	2020[a] (Billions of 2000 dollars)	2030[a] (Billions of 2000 dollars)
Social Costs[b]	$1.8	$2.0.
Social Benefits:[b c d]		
CO, VOC, Air Toxic-related benefits	Not monetized	Not monetized.
Ozone-related benefits	Not monetized	Not monetized.
PM-related Welfare benefits	$1.0	$1.7.
PM-related Health benefits [3% discount]	$43 + B	$81 + B.
PM-related Health benefits [7% discount]	$41 + B	$78 + B.
Net Benefits (Benefits-Costs) [3% discount][c]	$44 + B	$81 + B.
Net Benefits (Benefits-Costs) [7% discount][c]	$42 + B	$78 + B.

Notes: [a] All costs and benefits are calculated using 3 and 7 percent discount rates and are rounded to two significant digits. Numbers may appear not to sum due to rounding.

[b] Note that costs are the total costs of reducing all pollutants, including CO, VOCs and air toxics, as well as NO_X and PM. Costs were converted to 2000$ using the PPI for Total Manufacturing Industries. Benefits in this table are associated only with PM endpoints related to direct PM, NO_X and SO_2 reductions in 48-states.

[c] Not all possible benefits or disbenefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in table VI.E–6. B is the sum of all unquantified benefits and disbenefits.

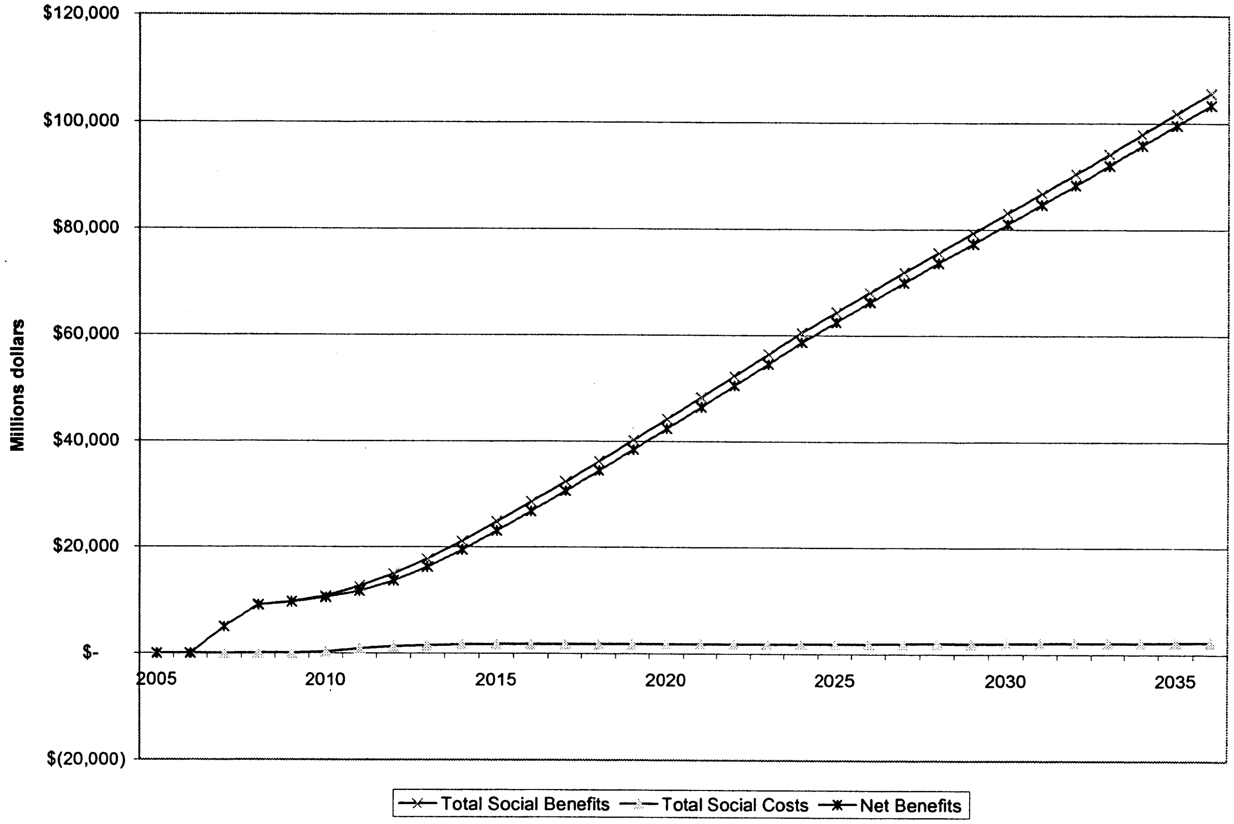


Figure VI.E-1. – Stream of Benefits, Costs, and Net Benefits of the Final Nonroad Diesel Engine and Fuel Standards Full Program

TABLE VI.E–4.—NET PRESENT VALUE IN 2004 OF THE STREAM OF 30 YEARS OF BENEFITS, COSTS, AND NET BENEFITS FOR THE FULL NONROAD DIESEL ENGINE AND FUEL STANDARDS

[Billions of 2000$]

	3% discount rate	7% discount rate
Social Costs	$27	$14
Social Benefits	805	352
Net Benefits [a]	780	340

Notes: [a] Numbers do not add due to rounding. Benefits represent 48-state benefits and exclude home heating oil sulfur reduction benefits, whereas costs include 50-state estimates.

In addition, we analyzed the social benefits and costs of the fuel-only components of the program, as discussed in the RIA. EPA's primary estimate of the benefits of the fuel-only component of the final rule are approximately $28 + B billion in 2030 using a 3 percent discount rate and $25 + B billion using a 7 percent discount rate. In 2020, total monetized benefits are approximately $18 + B billion using a 3 percent discount rate and $16 + B billion using a 7 percent discount rate. These estimates account for growth in real gross domestic product (GDP) per capita between the present and the years 2020 and 2030. We present the engineering costs of implementing the fuel-only components of the rule. Engineering compliance costs are very similar to the total social costs for the entire program. The net benefit (social benefits minus engineering costs) of the fuel-only program at full implementation is approximately $330 + B billion using a 3 percent discount rate and $160 + B billion using a 7 percent discount rate. Therefore, implementation of the fuel-only components of the final rule is expected to provide society with a net gain in social welfare based on economic efficiency criteria. Table VI.E–5 presents a summary of the social benefits, engineering costs, and net benefits of the final rule's fuel-only program for a 30 year period.

TABLE VI.E–5.—NET PRESENT VALUE IN 2004 OF THE STREAM OF BENEFITS, COSTS, AND NET BENEFITS FOR THE FUEL-ONLY STANDARDS

[Billions of 2000$]

	3% Discount rate	7% Discount rate
Costs	$9.2	$4.6
Social Benefits	340	160
Net Benefits	330	160

Notes:

[A] Results are rounded to two significant digits. Sums may differ because of rounding.

[B] Engineering costs are presented instead of social costs. As discussed in previous chapters, total engineering costs include fuel costs (refining, distribution, lubricity) and other operating costs (oil change maintenance savings).

[C] Note that costs are the total costs of reducing all pollutants, including CO, VOCs and air toxics, as well as NO_X and PM. Benefits in this table are associated only with PM, NO_X and SO_2 reductions. The estimates do not include the benefits of reduced sulfur in home heating oil or benefits in Alaska or Hawaii.

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

The basic question we sought to answer in the benefit-cost analysis was, ''What are the net yearly economic benefits to society of the reduction in mobile source emissions likely to be achieved by this proposed rulemaking?'' In designing an analysis to address this question, we selected two future years for analysis (2020 and 2030) that are representative of the stream of benefits and costs at partial and full-implementation of the program.

To quantify benefits, we evaluated PM-related health effects (including directly emitted PM and sulfate, as well as SO_2 and NO_X contributions to fine particulate matter). Our approach requires the estimation of changes in air quality expected from the rule and then estimating the resulting impact on health. In order to characterize the benefits of today's action, given the constraints on time and resources available for the analysis, we adopted a benefits transfer technique that relies on air quality and benefits modeling for a preliminary control option for nonroad diesel engines and fuels. Results from this modeling conducted for 2020 and 2030 are then scaled and transferred to the emission reductions expected from the final rule. We also transferred modeled results by using scaling factors associated with time to examine the stream of benefits in years other than 2020 and 2030.

More specifically, our health benefits assessment is conducted in two phases. Due to the time requirements for running the sophisticated emissions and air quality models, it is often necessary to select an example set of emission reductions to use for the purposes of emissions and air quality modeling early in the development of the proposal. In phase one, we evaluate the PM- and ozone-related health effects associated with a modeled preliminary control option that was a close approximation of the standards in the years 2020 and 2030. Using information from the modeled preliminary control option on the changes in ambient concentrations of PM and ozone, we then estimate the number of reduced incidences of illnesses, hospitalizations, and premature fatalities associated with this scenario and estimate the total economic value of these health benefits. Based on public comment and other data described in the RIA, the standards we are finalizing in this rulemaking are slightly different in the amount of emission reductions expected to be achieved in 2020 and 2030 relative to the modeled scenario. Thus, in phase two of the analysis, we apportion the results of the phase one analysis to the underlying NO_X, SO_2, and PM emission reductions and scale the apportioned benefits to reflect differences in emissions reductions between the modeled preliminary control option and the proposed standards. The sum of the scaled benefits for the PM, SO_2, and NO_X emission reductions provide us with the total benefits of the rule.

The benefit estimates derived from the modeled preliminary control option in phase one of our analysis uses an analytical structure and sequence similar to that used in the benefits analyses for the Heavy Duty Engine/Diesel Fuel final rule and in the ''section 812 studies'' to estimate the total benefits and costs of the full Clean Air Act.[241] We used many of the same models and assumptions used in the Heavy Duty Engine/Diesel Fuel analysis as well as other Regulatory Impact Analyses (RIAs) prepared by the Office of Air and Radiation. By adopting the major design elements, models, and assumptions developed for the section 812 studies and other RIAs, we have largely relied on methods which have already received extensive review by the independent Science Advisory Board (SAB), by the public, and by other federal agencies. In addition, we will be working through the next section 812 study process to enhance our methods.[242]

The benefits transfer method used in phase two of the analysis is similar to that used to estimate benefits in the recent analysis of the Nonroad Large Spark-Ignition Engines and Recreational Engines standards (67 FR 68241, November 8, 2002). A similar method has also been used in recent benefits analyses for the proposed Industrial Boilers and Process Heaters NESHAP and the Reciprocating Internal Combustion Engines NESHAP.

On September 26, 2002, the National Academy of Sciences (NAS) released a report on its review of the Agency's methodology for analyzing the health benefits of measures taken to reduce air pollution. The report focused on EPA's approach for estimating the health benefits of regulations designed to reduce concentrations of airborne PM.

In its report, the NAS panel said that EPA has generally used a reasonable framework for analyzing the health benefits of PM-control measures. It recommended, however, that the Agency take a number of steps to improve its benefits analysis. In particular, the NAS stated that the Agency should:

- Include benefits estimates for a range of regulatory options;
- Estimate benefits for intervals, such as every five years, rather than a single year;
- Clearly state the projected baseline statistics used in estimating health benefits, including those for air emissions, air quality, and health outcomes;
- Examine whether implementation of proposed regulations might cause unintended impacts on human health or the environment;
- When appropriate, use data from non-U.S. studies to broaden age ranges to which current estimates apply and to include more types of relevant health outcomes; and
- Begin to move the assessment of uncertainties from its ancillary analyses into its Base analyses by conducting probabilistic, multiple-source uncertainty analyses. This assessment should be based on available data and expert judgment.

Although the NAS made a number of recommendations for improvement in EPA's approach, it found that the studies selected by EPA for use in its benefits analysis were generally reasonable choices. In particular, the NAS agreed with EPA's decision to use cohort studies to derive benefits estimates. It also concluded that the Agency's selection of the American Cancer Society (ACS) study for the evaluation of PM-related premature mortality was reasonable, although it noted the publication of new cohort studies that should be evaluated by the Agency.

EPA has addressed many of the NAS comments in our analysis of the final rule. We provide benefits estimates for each year over the rule implementation period for a wide range of regulatory alternatives, in addition to our final emission control program. We use the estimated time path of benefits and costs to calculate the net present value of benefits of the rule. In the RIA, we provide baseline statistics for air emissions, air quality, population, and health outcomes. We have examined how our benefits estimates might be impacted by expanding the age ranges to which epidemiological studies are applied, and we have added several new health endpoints, including non-fatal heart attacks, which are supported by both U.S. studies and studies conducted in Europe. We have also improved the documentation of our methods and

[241] The section 812 studies include: (1) U.S. EPA, Report to Congress: The Benefits and Costs of the Clean Air Act, 1970 to 1990, October 1997 (also known as the ''Section 812 Retrospective Report''); and (2) the first in the ongoing series of prospective studies estimating the total costs and benefits of the Clean Air Act (see EPA report number: EPA–410–R–99–001, November 1999). *See* Docket A–99–06, Document II–A–21.

[242] Interested parties may want to consult the webpage: *http://www.epa.gov/science1* regarding components of our analytical blueprint.

provided additional details about model assumptions.

Several of the NAS recommendations addressed the issue of uncertainty and how the Agency can better analyze and communicate the uncertainties associated with its benefits assessments. In particular, the Committee expressed concern about the Agency's reliance on a single value from its analysis and suggested that EPA develop a probabilistic approach for analyzing the health benefits of proposed regulatory actions. The Agency agrees with this suggestion and is working to develop such an approach for use in future rulemakings.

EPA plans to continue to refine its plans for addressing uncertainty in its analyses. EPA conducted a pilot study to address uncertainty in important analytical parameters such as the concentration-response relationship for PM-related premature mortality. EPA is also conducting longer-term elements intended to provide scientifically sound, peer-reviewed characterizations of the uncertainty surrounding a broader set of analytical parameters and assumptions, including but not limited to emissions and air quality modeling, demographic projections, population health status, concentration-response functions, and valuation estimates.

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

Every benefit-cost analysis examining the potential effects of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Deficiencies in the scientific literature often result in the inability to estimate quantitative changes in health and environmental effects, such as potential increases in premature mortality associated with increased exposure to carbon monoxide. Deficiencies in the economics literature often result in the inability to assign economic values even to those health and environmental outcomes which can be quantified. While these general uncertainties in the underlying scientific and economics literatures, which can cause the valuations to be higher or lower, are discussed in detail in the Regulatory Support Document and its supporting documents and references, the key uncertainties which have a bearing on the results of the benefit-cost analysis of this final rule include the following:

- The exclusion of potentially significant benefit categories (such as health, odor, and ecological benefits of reduction in CO, VOCs, air toxics, and ozone);
- Errors in measurement and projection for variables such as population growth;
- Uncertainties in the estimation of future year emissions inventories and air quality;
- Uncertainties associated with the scaling of the results of the modeled benefits analysis to the proposed standards, especially regarding the assumption of similarity in geographic distribution between emissions and human populations and years of analysis;
- Variability in the estimated relationships of health and welfare effects to changes in pollutant concentrations;
- Uncertainties in exposure estimation; and
- Uncertainties associated with the effect of potential future actions to limit emissions.

Despite these uncertainties, we believe the benefit-cost analysis provides a reasonable indication of the expected economic benefits of the final rulemaking in future years under a set of assumptions. Accordingly, we present a primary estimate of the total benefits, based on our interpretation of the best available scientific literature and methods and supported by the SAB–HES and the NAS.

Some of the key assumptions underlying the primary estimate for the premature mortality which accounts for 90 percent of the total benefits we were able to quantify include the following:

(1) Inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis. Although biological mechanisms for this effect have not yet been definitively established, the weight of the available epidemiological evidence supports an assumption of causality.

(2) All fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because PM produced via transported precursors emitted from EGUs may differ significantly from direct PM released from diesel engines and other industrial sources, but no clear scientific grounds exist for supporting differential effects estimates by particle type.

(3) The impact function for fine particles is approximately linear within the range of ambient concentrations under consideration. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of PM, including both regions that are in attainment with fine particle standard and those that do not meet the standard.

(4) The forecasts for future emissions and associated air quality modeling are valid. Although recognizing the difficulties, assumptions, and inherent uncertainties in the overall enterprise, these analyses are based on peer-reviewed scientific literature and up-to-date assessment tools, and we believe the results are highly useful in assessing this rule.

We provide sensitivity analyses to illustrate the effects of uncertainty about key analytical assumptions in the RIA.

In addition, one significant limitation to the benefit transfer method applied in this analysis is the inability to scale ozone-related benefits. Because ozone is a homogeneous gaseous pollutant, it is not possible to apportion ozone benefits to the precursor emissions of NO_X and VOC. Coupled with the potential for NO_X reductions to either increase or decrease ambient ozone levels, this prevents us from scaling the benefits associated with a particular combination of VOC and NO_X emissions reductions to another. Because of our inability to scale ozone benefits, we do not include ozone benefits as part of the monetized benefits of the proposed standards. For the most part, ozone benefits contribute substantially less to the monetized benefits than do benefits from PM, thus their omission will not materially affect the conclusions of the benefits analysis. Although we expect economic benefits to exist, we were unable to quantify or to value specific changes in ozone, CO or air toxics because we did not perform additional air quality modeling.

There are also a number of health and environmental effects which we were unable to quantify or monetize. A full appreciation of the overall economic consequences of the proposed rule requires consideration of all benefits and costs expected to result from the new standards, not just those benefits and costs which could be expressed here in dollar terms. A complete listing of the benefit categories that could not be quantified or monetized in our estimate are provided in Table VI.E–6. These effects are denoted by ''B'' in Table VI.E–3 above, and are additive to the estimates of benefits.

TABLE VI.E–6.—ADDITIONAL, NON-MONETIZED BENEFITS OF THE NONROAD DIESEL ENGINE AND FUEL STANDARDS

Pollutant	Unquantified effects
Ozone Health	Premature mortality [a]. Respiratory hospital admissions. Minor restricted activity days. Increased airway responsiveness to stimuli. Inflammation in the lung. Chronic respiratory damage. Premature aging of the lungs. Acute inflammation and respiratory cell damage. Increased susceptibility to respiratory infection. Non-asthma respiratory emergency room visits. Increased school absence rates.
Ozone Welfare	Decreased yields for commercial forests. Decreased yields for fruits and vegetables. Decreased yields for non-commercial crops. Damage to urban ornamental plants. Impacts on recreational demand from damaged forest aesthetics. Damage to ecosystem functions.
PM Health	Low birth weight. Changes in pulmonary function. Chronic respiratory diseases other than chronic bronchitis. Morphological changes. Altered host defense mechanisms. Cancer. Non-asthma respiratory emergency room visits.
PM Welfare	Visibility in many Class I areas. Residential and recreational visibility in non-Class I areas. Soiling and materials damage. Damage to ecosystem functions.
Nitrogen and Sulfate Deposition Welfare.	Impacts of acidic sulfate and nitrate deposition on commercial forests. Impacts of acidic deposition to commercial freshwater fishing. Impacts of acidic deposition to recreation in terrestrial ecosystems. Reduced existence values for currently healthy ecosystems. Impacts of nitrogen deposition on commercial fishing, agriculture, and forests.
CO Health	Premature mortality [a]. Behavioral effects.
HC Health [b]	Cancer (benzene, 1,3-butadiene, formaldehyde, acetaldehyde). Anemia (benzene). Disruption of production of blood components (benzene). Reduction in the number of blood platelets (benzene). Excessive bone marrow formation (benzene). Depression of lymphocyte counts (benzene). Reproductive and developmental effects (1,3-butadiene). Irritation of eyes and mucus membranes (formaldehyde). Respiratory irritation (formaldehyde). Asthma attacks in asthmatics (formaldehyde). Asthma-like symptoms in non-asthmatics (formaldehyde). Irritation of the eyes, skin, and respiratory tract (acetaldehyde). Upper respiratory tract irritation and congestion (acrolein).
HC Welfare	Direct toxic effects to animals. Bioaccumulation in the food chain. Damage to ecosystem function. Odor.

Notes: [a] Premature mortality associated with ozone and carbon monoxide is not separately included in this analysis. In this analysis, we assume that the Pope, *et al.* C-R function for premature mortality captures both PM mortality benefits and any mortality benefits associated with other air pollutants.

[b] Many of the key hydrocarbons related to this rule are also hazardous air pollutants listed in the Clean Air Act.

F. Economic Impact Analysis

We prepared a draft Economic Impact Analysis (EIA) for this rule to estimate the economic impacts of the proposed control program on producers and consumers of nonroad engines, equipment, fuel, and related industries.[243] We received comments on

[243] This analysis is based on an earlier version of the engineering costs developed for this rule. The

Continued

our draft analysis from stakeholders representing agricultural interests, equipment rental and dealer interests, and equipment manufacturers. The commenters conveyed their concerns about our general analytic approach and some of the model assumptions. As explained in our responses to these comments, which can be found in the Summary and Analysis of Comments document prepared for this final rule, we do not believe these comments require us to adjust our EIA methodology. We did adjust the methodology, however, to estimate the economic impacts of the fuel sulfur content requirements on the locomotive and marine sectors. As explained below, this revision was necessary to correct an oversight in the draft EIA. We also revised the price and quantity data inputs to the model to make them consistent with the revised engine and fuel cost analyses described earlier in this section.

This section briefly describes the methodology we used to estimate the economic impacts of this final rule, including the model revisions for the marine and locomotive fuel sectors, and the results of that analysis. A detailed description of the Nonroad Diesel Economic Impact Model (NDEIM) prepared for this analysis, the model inputs, and several sensitivity analyses can be found in Chapter 10 of Final Regulatory Impact Analysis prepared for this rule.

1. What Is an Economic Impact Analysis?

An Economic Impact Analysis is prepared to inform decision makers within the Agency about the potential economic consequences of a regulatory action. The analysis contains estimates of the social costs of a regulatory program and explores the distribution of these costs across stakeholders. These estimated social costs can then be compared with estimated social benefits (as presented in Section VI.E). As defined in EPA's *Guidelines for Preparing Economic Analyses, social costs* are the value of the goods and services lost by society resulting from (a) the use of resources to comply with and implement a regulation and (b) reductions in output.[244] In this analysis, social costs are explored in two steps. In the first step, called the market analysis, we estimate how prices and quantities of good directly and indirectly affected by the emission control program can be expected to change once the emission control program goes into effect. The estimated price and quantity changes for engines, equipment, fuel, and goods produced using these inputs are examined separately. In the second step, called the economic welfare analysis, we look at the total social costs associated with the program and their distribution across stakeholders. The analysis is based on compliance cost estimates and baseline market conditions for prices and quantities of engines, equipment, and fuel produced presented earlier in this section.

In this EIA, we look at price and quantity impacts for engine, equipment, diesel fuel, and goods produced with these inputs. With regard to the goods produced with these inputs, we distinguish between three application markets: agriculture, construction, and manufacturing. It should be noted from the outset that diesel engines, equipment, and fuel represent only a small portion of the total production costs for each of the three application market sectors (the final users of the engines, equipment and fuel affected by this rule). Other more significant production costs include land, labor, other capital, raw materials, insurance, profits, etc. These other production costs are not affected by this emission control program. This is important because it means that this rule directly affects only a small part of total inputs for the relevant markets. Therefore, the rule is not expected to have a large adverse impact on output and prices of goods produced in the three application sectors.

It should also be noted that our analysis of the impacts on the three application markets is limited to market output. The economic impacts on particular groups of application market suppliers (*e.g.*, the profitability of farm production units or manufacturing or construction firms) or particular groups of consumers (*e.g.*, households and companies that consume agricultural goods, buildings, or durable or consumer goods) are not estimated. In other words, while we estimate that the application markets will bear most of the burden of the regulatory program and we apportion the decrease in application market surplus between application market producers and application market consumers, we do not estimate how those social costs will be shared among specific application market producers and consumers (*e.g.*, farmers and households). In some cases, application market producers may be able to pass most if not all of their increased costs to the ultimate consumers of their products; in other cases, they may be obliged to absorb a portion of these costs. While some commenters requested that we perform a sector-by-sector analysis of application market producers and consumers, we do not believe this is appropriate. The focus on market-level impacts in this analysis is appropriate because the standards in this emission control program are technical standards that apply to nonroad engines, equipment, and fuel regardless of how they are used and the structure of the program does not suggest that different sectors will be affected differently by the requirements. In addition, the results of our EIA suggest that the overall burden on the application market is expected to be small: approximately 0.1 percent increase in prices, on average, and less than 0.02 percent decrease in production, on average. Estimated economic impacts of this size do not warrant performing a sector-by-sector analysis to investigate whether some subsectors may be affected disproportionately.

Finally, as a market-level model, the NDEIM estimates the economic impacts of the rule on the engine, equipment, and application markets and the transportation service sector. It is not a firm-level analysis and therefore the equipment demand elasticity facing any particular manufacturer may be greater than the demand elasticity of the market as a whole. This difference can be important, particularly where the rule affects different firms' costs over different volumes of production. However, to the extent there are differential effects, EPA believes that the wide array of flexibilities provided in this rule are adequate to address any cost inequities that are likely to arise.

2. What Methodology Did EPA Use in This Economic Impact Analysis?

EPA used the same methodology in this final EIA as was used in the draft EIA. The model was revised to accommodate analysis of the locomotive and marine fuel sectors.

a. Conceptual Approach

The Nonroad Diesel Economic Impact Model (NDEIM) uses a multi-market

final cost estimates for the engine program are slightly higher ($142 million) and the final fuel costs are slightly lower ($246 million), resulting in a 30-year net present value of $27.1 billion (30 year net present values in the year 2004, using a 3 percent discount rate, $2002) or $104 million less than the engineering costs used in this analysis. We do not expect that the revised engineering costs would change the overall results of this economic impact analysis given the small portion of engine, equipment, and fuel costs to total production costs for goods and services using these inputs and given the inelastic value of the estimated demand elasticities for the application markets.

[244] *EPA Guidelines for Preparing Economic Analyses,* EPA 240–R–00–003, September 2000, p 113.

analysis framework that considers interactions between regulated markets and other markets to estimate how compliance costs can be expected to ripple through these markets. In the NDEIM, compliance costs are directly borne by engine manufacturers, equipment manufacturers, petroleum refiners and fuel distributors. Depending on market characteristics, some or all of these compliance costs will be passed on through the supply chain in the form of higher input prices for the application markets (in this case, construction, agriculture, and manufacturing) which in turn affect prices and quantities of goods produced in those application markets. Producers in the application markets adjust their demand for diesel engines, equipment, and fuel in response to these input price changes and consumer demand for application market outputs. This information is passed back to the suppliers of diesel equipment, engines, and fuel in the form of purchasing decisions. The NDEIM explicitly models these interactions and estimates behavioral responses that lead to new equilibrium prices and output for all sectors and the resulting distribution of social costs across the modeled sectors.

b. Markets Examined

The NDEIM uses a multi-market partial equilibrium approach to track changes in price and quantity for 62 integrated product markets, as follows:

• 7 diesel engine markets: less than 25 hp, 26 to 50 hp, 51 to 75 hp, 76 to 100 hp, 101 to 175 hp, 176 to 600 hp, and greater than 600 hp. The EIA includes more horsepower categories than the standards to allow more efficient use of the engine compliance costs estimates. The additional categories also allow estimating economic impacts for a more diverse set of markets.

• 42 diesel equipment markets: 7 horsepower categories within 7 application categories: agricultural, construction, general industrial, pumps and compressors, generator and welder sets, refrigeration and air conditioning, and lawn and garden. There are 7 horsepower/application categories that did not have sales in 2000 and are not included in the model, so the total number of diesel equipment markets is 42 rather than 49.

• 3 application markets: agricultural, construction, and manufacturing.

• 8 nonroad diesel fuel markets: 2 sulfur content levels (15 ppm and 500 ppm) for each of 4 PADDs. PADDs 1 and 3 are combined for the purpose of this analysis. It should be noted that PADD 5 includes Alaska and Hawaii. Also, California fuel volumes that are not affected by the program (because they are covered by separate California nonroad diesel fuel standards) are not included in the analysis.

• 2 transportation service markets: locomotive and marine.

As noted above, this final EIA also estimates the economic impact on two additional markets that were not included in the draft analysis: the locomotive and marine diesel transportation service markets. In the NPRM, we proposed to set fuel sulfur standards for locomotive and distillate marine diesel as well as for nonroad diesel fuel. We developed cost estimates for these two types of fuel as well as for nonroad diesel fuel. In the draft EIA, however, we did not consider the economic impacts of these fuel costs on the locomotive and marine sectors separately. Instead, we applied all of these additional fuel costs to the manufacturing application market.

In preparing the final RIA for this rule, we determined that it would be more appropriate to consider the impacts of the fuel program on the diesel marine and locomotive sectors separately. This is because the locomotive and marine markets are directly affected by the higher diesel fuel prices associated with the rule. In addition, production and consumption decisions of downstream end-use markets that use these services are influenced by the prices of transportation services. At the same time, locomotive and marine diesel transportation services are not used solely in the three application markets modeled in the NDEIM. These services are also provided to electric utilities (transporting coal to electric power plants), non-manufacturing service industries (public transportation) and governments. We take this into account and report impacts on those sectors separately.

c. Model Methodology

A detailed description of the model methodology, inputs, and parameters used in this economic impact analysis is provided in Chapter 10 of the Final RIA prepared for this rule. The model methodology is firmly rooted in applied microeconomic theory and was developed following the *OAQPS Economic Analysis Resource Document*.[245]

The NDEIM is a computer model comprised of a series of spreadsheet modules that define the baseline characteristics of the supply and demand for the relevant markets and the relationships between them. The model is constructed based on the market characteristics and inter-connections summarized in this section and described in more detail in Chapter 10 of the RIA. The model is shocked by applying the engineering compliance cost estimates to the appropriate market suppliers, and then numerically solved using an iterative auctioneer approach by ''calling out'' new prices until a new equilibrium is reached in all markets simultaneously. The output of the model is new equilibrium prices and quantities for all affected markets. This information is used to estimate the social costs of the model and how those costs are shared among affected markets.

The NDEIM uses a multi-market partial equilibrium approach to track changes in price and quantity for the modeled product markets. As explained in the *EPA Guidelines for Preparing Economic Analyses*, ''partial'' equilibrium refers to the fact that the supply and demand functions are modeled for just one or a few isolated markets and that conditions in other markets are assumed either to be unaffected by a policy or unimportant for social cost estimation. Multi-market models go beyond partial equilibrium analysis by extending the inquiry to more than just a single market. Multi-market analysis attempts to capture at least some of the interactions between markets.[246]

The NDEIM uses an intermediate run time frame. The use of the intermediate run means that some factors of production are fixed and some are variable. This modeling period allows analysis of the economic effects of the rule's compliance costs on current producers. The short run, in contrast, imposes all compliance costs on the manufacturers (no pass-through to consumers), while the long run imposes all costs on consumers (full cost pass-through to consumers). The use of the intermediate run time frame is consistent with economic practices for this type of analysis.

The NDEIM assumes perfect competition in the market sectors. This assumption was questioned by one commenter, who noted that the 25 to 75 hp engine category does not appear to be competitive based on the number of firms in that subsector. Specifically, one

[245] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Innovative Strategies and Economics Group, *OAQPS Economic Analysis Resource Document*, April 1999. A copy of this document can be found in Docket A–2001–28, Document No. II–A–14.

[246] *EPA Guidelines for Preparing Economic Analyses*, EPA 240–R–00–003, September 2000, p. 125–6.

firm has nearly 29 percent of the market and the top nine firms have about 88 percent. The remaining twelve percent of this market shared among nineteen other firms. While the commenter is correct in noting the limited number of firms in this subsector, we believe it is still appropriate to rely on the perfect competition assumption in this analysis. The perfect competition assumption relies not only on the number of firms in a market but also on other market characteristics. For example, there are no indications of barriers to entry, the firms in these markets are not price setters, and there is no evidence of high levels of strategic behavior in the price and quantity decisions of the firms. In addition, the products produced within each market are somewhat homogeneous in that engines from one firm can be purchased instead of engines from another firm. Finally, according to contestable market theory, oligopolies and even monopolies will behave very much like firms in a competitive market if it is possible to enter particular markets costlessly (*i.e.*, there are no sunk costs associated with market entry or exit). With regard to the nonroad engine market, production capacity is not fully utilized. This means that manufacturers could potentially switch their product line to compete in another segment of the market without a significant investment. For all these reasons, the number of firms in a particular engine submarket does not prevent us from relying on the perfect competition assumption for that submarket. This is true of other engine and equipment subsectors as well. In addition, changing the assumption of perfect competition based on the limited evidence raised by the commenter would break with widely accepted economic practice for this type of analysis.[247]

d. Model Inputs—Elasticities

The estimated social costs of this emission control program are a function of the ways in which producers and consumers of the engines, equipment, and fuels affected by the standards change their behavior in response to the costs incurred in complying with the standards. As the compliance costs ripple through the markets, producers and consumers change their production and purchasing decisions in response to changes in prices. In the NDEIM, these behavioral changes are modeled by the demand and supply elasticities (behavioral-response parameters), which measure the price sensitivity of consumers and producers.

The supply elasticities for the equipment, engine, diesel fuel, and transportation service markets and the demand and supply elasticities for the application markets used in the NDEIM were obtained from peer-reviewed literature sources or were estimated using econometric methods. These econometric methods are well-documented and are consistent with generally accepted econometric practice. Appendix 10H of the RIA contains detailed information on how the elasticities were estimated.

The equipment and engine supply elasticities are elastic, meaning that quantities supplied are expected to be fairly sensitive to price changes. The supply elasticities for the fuel, transportation, and application markets are inelastic or unit elastic, meaning that the quantity supplied/demanded is expected to be fairly insensitive to price changes or will vary one-to-one with price changes. The demand elasticities for the application markets are also inelastic. This is consistent with the Hicks-Allen derived demand relationship, according to which a low cost-share in production combined with limited substitution yields inelastic demand.[248] As noted above, diesel engines, equipment, and fuel represent only a small portion of the total production costs for each of the three application sectors. The limited ability to substitute for these inputs is discussed below.

In contrast to the above, the demand elasticities for the engine, equipment, fuel, and transportation markets are internally derived as part of the process of running the model. This is an important feature of the NDEIM, which allows it to link the separate market components of the model and simulate how compliance costs can be expected to ripple through the affected economic sectors. In the real world, for example, the quantity of nonroad equipment units produced in a particular period depends on the price of engines (the engine market) and the demand for equipment (the application markets). Similarly, the number of engines produced depends on the demand for engines (the equipment market) which depends on the demand for equipment (the application markets). Changes in conditions in one of these markets will affect the others. By designing the model to derive the engine, equipment, transportation market, and fuel demand elasticities, the NDEIM simulates these connections between supply and demand among all the product markets and replicates the economic interactions between producers and consumers.

e. Model Inputs—Fixed and Variable Costs

The EIA treats the fixed costs expected to be incurred by engine and equipment manufacturers differently in the market and social costs analyses. This feature of the model is described in greater detail in Section 10.2.3.3 of the RIA. In the market analysis, estimated engine and equipment market impacts (changes in prices and quantities) are based solely on the expected increase in variable costs associated with the standards. Fixed costs are not included in the market analysis reported in Table VI–F–1 because in an analysis of competitive markets the industry supply curve is based on its marginal cost curve and fixed costs are not reflected in changes in the marginal cost curve. In addition, the fixed costs associated with the rule are primarily R&D costs for design and engineering changes. Firms in the affected industries currently allocate funds for R&D programs and this rule is not expected to lead firms to change the size of their R&D budgets. Therefore, changes in fixed costs for engine and equipment redesign associated with this rule are not likely to affect the prices of engines or equipment. Fixed costs are included in the social cost analysis reported in Table VI–F–2, however, as an additional cost to producers. This is appropriate because even though firms currently allocated funds to R&D those resources are intended for other purposes such as increasing engine power, ease of use, or comfort. These improvements will therefore be postponed for the length of the rule-related R&D program. This is a cost to society.

One commenter recommended that EPA include engine and equipment R&D (fixed) costs in the market analysis. This commenter argued that while in the long run total costs are not determined by changes in fixed costs, total costs are determined initially by both fixed and variable costs. This commenter was concerned that by not including fixed costs, EPA's analysis underestimates the increase in the average price of goods and services produced using engines affected by the rule. In fact, we included

[247] *See*, for example, *EPA Guidelines for Preparing Economic Analyses*, EPA 240–R–00–003, September 2000, p 126. *See also* the Final RIA for this rule, Chapter 10, Section 10.2.3.1.

[248] If the elasticity of demand for a final product is less than the elasticity of substitution between an input and other inputs to the final product, then the demand for the input is less elastic the smaller its cost share. Hicks, J.R., 1961. Marshall's Third Rule: A Further Comment. Oxford Economic Papers 13:262–65; Hicks, J.R., 1963. The Theory of Wages. St. Martins Press, NY, pp. 233–247. *See* Docket A–2001–28, Document No. IV–B–25 for relevant excerpts. *See* Docket A–2001–28, Document No. IV–B–25 for relevant excerpts.

R&D costs in a sensitivity analysis performed for the draft EIA, which has been updated and can be found in Appendix I to Chapter 10 of the Final RIA. Including fixed costs results in a transfer of economic welfare losses from engine and equipment markets to the application markets (engine and equipment producer surplus losses decrease; consumer surplus losses increase), but does not change the overall economic welfare losses associated with the rule.

Unlike for engines and equipment, most of the petroleum refinery fixed costs are for production hardware. Refiners are expected to have to make physical changes to their refineries and purchase additional equipment to produce 500 ppm and then 15 ppm fuel. Therefore, fixed costs are included in the market analysis for fuel price and quantity impacts.

f. Model Inputs—Substitution by Application Suppliers

In modeling the market impacts and social costs of this rule, the NDEIM considers only diesel equipment and fuel inputs to the production of goods in the applications markets. It does not explicitly model alternate production inputs that would serve as substitutes for new nonroad equipment or nonroad diesel fuel. In the model, market changes in the final demand for application goods and services directly correspond to changes in the demand for nonroad equipment and fuel (*i.e.*, in normalized terms there is a one-to-one correspondence between the quantity of the final goods produced and the quantity of nonroad diesel equipment and fuel used as inputs to that production). We believe modeling the market in this manner is economically sound and reflects the general experience for the nonroad market.

Some commenters suggested that the NDEIM should consider substitution to alternate means of production such as pre-buying, delayed buying, extending the life of a current machine, and substituting with different (*e.g.*, gasoline-powered) equipment. These commenters did not provide detailed explanations for their comments or data in support of their substitution arguments. After considering these comments, we conclude that revising the NDEIM to include these effects would be inappropriate.

The term ''pre-buying'' appears to refer to the possibility that the suppliers in the application market may choose to buy additional unneeded quantities of nonroad equipment prior to the beginning of the Tier 4 program, thus avoiding the higher cost for the Tier 4 equipment. It should be noted that this effect is limited to equipment and does not extend to nonroad diesel fuel. We believe that equipment pre-buying will not be economically viable in most cases due to the cost of holding capital (equipment) idle and of maintaining unused equipment. Such strategic purchases, if they occur at all, would be limited to a period of a few months before the effective date of the standards. The NDEIM models market reactions in the intermediate time frame, beyond the scope of any potential pre-buy. For these reasons, we do not believe it is appropriate to revise the model to include pre-buy as a means of substitution in NDEIM.

''Delayed-buying'' appears to refer to the possibility that suppliers in the application market would defer purchasing new equipment initially but would eventually make those purchases. Similarly to pre-buying, this appears to be a short-term effect and would therefore be inappropriate to include in an economic model designed to model the intermediate time frame.

Extending the life of a current machine is suggested as another alternative to purchasing new equipment. We believe this would also be a short term phenomena that is not relevant for the intermediate time frame of the NDEIM. Based on our meetings with equipment users and suppliers, we do not believe that extending the life of nonroad equipment will prove to be an economically viable substitute in the near or long term. Most users of nonroad equipment already extend the life of their equipment to the maximum extent possible and purchase new equipment only when the existing equipment can no longer perform its function, when new demand for production requires additional means for production, or when new equipment offers a cheaper means of production than existing equipment. This situation is not expected to change as a result of this rule. In addition, even if it were possible to extend equipment life even more, this would lower the cost of nonroad equipment as an input to production (because it would be less expensive to maintain old equipment than purchase new equipment) and thus would reduce the economic impact of the Tier 4 program compared to our estimate. For all of the reasons stated here, we have decided not to attempt to model an extended equipment life alternative in the NDEIM.

Finally, some commenters noted that equipment users may chose to substitute with different equipment, particularly gasoline-powered equipment. We believe substitution to gasoline-powered equipment is an alternative only for the smaller power categories (below 75 hp). Based on discussions with equipment manufacturers and users, the dominant reasons for choosing diesel engines over the substantially less expensive gasoline engines include better performance from diesel engines, lower fuel consumption from diesel engines, and the ability to use diesel fuel. The use of diesel fuel is preferable for two reasons: it is safer to store and dispense, and it is compatible with the fuel needed for larger equipment at the same worksite. Where these issues are not a concern, gasoline engines already enjoy a substantial economic advantage over diesel. We do not believe that the incremental increase in new equipment cost associated with this program would provide the necessary economic incentives for switching to gasoline equipment. Equipment users who can use gasoline-fueled equipment already do so, while those who can't due to the high costs of storing and dispensing gasoline fuel already use diesel engines. Therefore, we have not attempted to model the possibility of substitution to gasoline equipment in NDEIM.

g. Model Inputs—Other

Compliance Costs. The NDEIM uses the estimated engine, equipment, and fuel compliance costs described in above and presented in Chapters 6 and 7 of the RIA. Engine and equipment costs vary over time because fixed costs are recovered over five to ten year periods while total variable costs, despite learning effects that serve to reduce costs on a per unit basis, continue to increase at a rate consistent with new sales increases. Similarly, engine operating costs also vary over time because oil change maintenance savings, PM filter maintenance, and fuel economy effects, all of which are calculated on the basis of gallons of fuel consumed, change over time consistent with the growth in nationwide fuel consumption. Fuel-related compliance costs (costs for refining and distributing regulated fuels) also change over time. These changes are more subtle than the engine costs, however, as the fuel provisions are largely implemented in discrete steps instead of phasing in over time. Compliance costs were developed on a ¢/gallon basis; total compliance costs are determined by multiplying the ¢/gallon costs by the relevant fuel volumes. Therefore, total fuel costs increase as the demand for fuel increases. The variable operating costs are based on the natural gas cost of producing hydrogen and for heating diesel fuel for the new desulfurization equipment, and thus would fluctuate along with the price of natural gas.

Operating Savings. Operating savings refers to changes in operating costs that are expected to be realized by users of both existing and new nonroad diesel equipment as a result of the reduced sulfur content of nonroad diesel fuel. These include operating savings (cost reductions) due to fewer oil changes, which accrue to nonroad, marine and locomotive engines that are already in use as well as new nonroad engines that will comply with the standards (*see* Section VI.B). These also include any extra operating costs associated with the new PM emission control technology which may accrue to certain new engines that use this technology. Operating savings are not included in the market analysis because some of the savings accrue to existing engines and because, as explained in Section VI.C.1.c, these savings are not expected to affect consumer decisions with respect to new engines. Operating savings are included in the social cost analysis, however, because they accrue to society. They are added into the estimated social costs as an additional savings to the application and transportation service markets, since it is the users of these engines and fuels who will see these savings. A sensitivity analysis was performed as part of this EIA that includes the operating savings in the market analysis. The results of this sensitivity analysis are presented in Appendix 10.I.

Fuel Marker Costs. Fuel marker costs refers to costs associated with marking high sulfur heating oil to distinguish it from high sulfur diesel fuel produced after 2007 through the use of early sulfur credits or small refiner provisions. Only heating oil sold outside of the Northeast is affected. The higher sulfur NRLM fuel is not allowed to be sold in most of the Northeast, so the marker need not be added in this large heating oil market. These costs are expected to be about $810,000 in 2007, increasing to $1.38 million in 2008, but steadily decreasing thereafter to about $940,000 in 2040 (see Chapter 10 of the RIA). Because these costs are relatively small, they are incorporated into the estimated compliance costs for the fuel program (see discussion of fuel costs, above). They are therefore not counted separately in this economic impact analysis. This means that the costs of marking heating fuel are allocated to all users of the fuel affected by this rule (nonroad, locomotive, and marine) instead of uniquely to heating oil users. This is a reasonable approach since it is likely that refiners will pass the marker costs along their complete nonroad diesel product line and not just to heating oil.

Fuel Spillover. Spillover fuel is highway grade diesel fuel consumed by nonroad equipment, stationary diesel engines, boilers, and furnaces. As described in Section 7.1 of Chapter 7 of the final RIA, refiners are expected to produce more 15 ppm fuel than is required for the highway diesel market. This excess 15 ppm fuel will be sold into markets that allow fuel with a higher sulfur level (*i.e.*, nonroad for a limited period of time, locomotive, marine diesel and heating oil). This spillover fuel is affected by the diesel highway rule and is not affected by this regulation. Therefore, it is important to differentiate between spillover and nonspillover fuel to ensure that the compliance costs for that fuel pool are not counted twice. In the NDEIM, this is done by incorporating the impact of increased fuel costs associated with the highway rule prior to analysis of the final nonroad rule (*see* RIA Section 10.3.8).

Compliance Flexibility Provisions. Consistent with the engine and equipment cost discussion in Section VI.C, the EIA does not include any cost savings associated with the equipment transition flexibility program or the nonroad engine ABT program. As a result, the results of this EIA can be viewed as somewhat conservative.

Locomotive and Marine Fuel Costs. The locomotive and marine transportation sectors are affected by this rule through the sulfur limits on the diesel fuel used by these engines. These sectors provide transportation to the three application markets as well as to other markets not considered in the NDEIM (*e.g.*, public utilities, nonmanufacturing service industries, government). As explained in Section 10.3.1.5 of the RIA, the NDEIM applies only a portion of the locomotive and marine fuel costs to the three application markets. The rest of the locomotive and marine fuel costs are added as a separate item to the total social cost estimates (as Application Markets Not Included in NDEIM).

3. What Are the Results of this Analysis?

Using the revised cost data described earlier in this section and the NDEIM described above and in Chapter 10 of the Final RIA, we estimated the economic impacts of the nonroad engine, equipment and fuel control program. Economic impact results for 2013, 2020, 2030, and 2036 are presented in this section. The first of these years, 2013, corresponds to the first year in which the standards affect all engines, equipment, and fuels. It should be noted that, as illustrated in Table VI–F–3, aggregate program costs peak in 2014; increases in costs after that year are due to increases in the population of engines over time. The other years, 2020, 2030 and 2036, correspond to years analyzed in our benefits analysis. Detailed results for all years are included in the appendices to Chapter 10 of the RIA.

In the following discussion, social costs are computed as the sum of market surplus offset by operating savings. Market surplus is equal to the aggregate change in consumer and producer surplus based on the estimated market impacts associated with the rule. As explained above, operating savings are not included in the market analysis but instead are listed as a separate category in the social cost results tables.

In considering the results of this analysis, it should be noted that the estimated output quantities for diesel engines, equipment, and fuel are not identical to those estimated in the engineering cost described in above and presented in Chapters 6 and 7 of the RIA. The difference is due to the different methodologies used to estimate these costs. As noted above, social costs are the value of goods and services lost by society resulting from: (a) the use of resources to comply with and implement a regulation (*i.e.*, compliance costs); and (b) reductions in output. Thus, the social cost analysis considers both price and output (quantity) effects associated with consumer and producer reaction to increased prices associated with the regulatory compliance costs. The engineering cost analysis, on the other hand, is based on applying additional technology to comply with the new regulations. The engine population in the engineering cost analysis does not reflect consumer and producer reactions to the compliance costs. Consequently, the estimated output quantities from the cost analysis are slightly larger than the estimated output quantities from the social cost analysis.

The results of this analysis suggest that the economic impacts of this rule are likely to be small, on average. Price increases in the application markets are expected to average about 0.1 percent per year. Output decrease in the application markets are expected to average less than 0.02 percent for all years. The price increases for engines, equipment, and fuel are expected to be about 20 percent, 3 percent, and 7 percent, respectively (total impact averaged over the relevant years). The number of engines and equipment produced is expected to decrease by less than 250 units, and the amount of fuel produced annually is expected to decrease by less than 4 million gallons. With respect to the economic welfare analysis, producers and consumers in the application markets are expected to bear about 83 percent of the burden in 2013; this will increase to about 96 percent in 2030 and beyond. In other words, despite the almost total pass-through of costs the average price of goods and services in the application markets is expected to increase by only 0.1 percent. This outcome reflects the fact that diesel engines, equipment, and fuel are only a small part of total costs for the application markets. These results are described in more detail below and in Chapter 10 of the Final RIA.

a. Expected Market Impacts

The estimated market impacts for 2013, 2020, and 2030 are presented in Table VI.F–1. The market-level impacts presented in this table represent production-weighted averages of the individual market-level impact estimates generated by the model: the average expected price increase and quantity decrease across all of the units in each of the engine, equipment, fuel, and final application markets. For example, the model includes seven individual engine markets that reflect the seven different horsepower size categories. The 21.4 percent price change for engines shown in Table VI.F–1 for 2013 is an average price change across all engine markets weighted by the number of production units. Similarly, the equipment impacts presented in Table VI.F–1 are the weighted averages of 42 equipment-application markets, such as small (<25hp) agricultural equipment and large (>600hp) industrial equipment. Note that price increases and quantity decreases for specific types of engines, equipment, application sectors, or diesel fuel markets are likely to be different. The aggregated data presented in this table provide a broad overview of the expected market impacts that is useful when considering the impacts of the rule on the economy as a whole. The individual market-level impacts are presented in Chapter 10 of the Final RIA.[249]

The market impacts of this rule suggest that the overall economic impact of the emission control program on society is expected to be small, on average. According to this analysis, the average prices of goods and services produced using equipment and fuel affected by the rule are expected to increase by about 0.1 percent (as noted above), despite the almost total pass-through of compliance costs to those markets.

Engine Market Results: This analysis suggests that most of the variable costs associated with the rule will be passed along in the form of higher prices. The average price increase in 2013 for engines is estimated to be about 21.4 percent. This percentage is expected to decrease to about 18.3 percent by 2020. In 2036, the last year considered, the average price increase is expected to be about 18.2 percent. This expected price increase varies by engine size because compliance costs are a larger share of total production costs for smaller engines. In 2013, the largest expected percent price increase is for engines between 25 and 50 hp: 29 percent or $850; the average price for an engine in this category is about $2,900. However, this price increase is expected to drop to 22 percent, or about $645, for 2015 and later. The smallest expected percent price increase in 2013 is for engines in the greater than 600 hp category. These engines are expected to see price increases of about 3 percent increase in 2013, increasing to about 7.6 percent in 2015 and then decreasing to about 6.6 percent in 2017 beyond. The expected price increase for these engines is about $2,240 in 2013, increasing to about $6,150 in 2015 and then decreasing to $5,340 in 2017 and later, for engines that cost on average about $80,500.

The market impact analysis predicts that even with these increased in engine prices, total demand is not expected to change very much. The expected average change in quantity is less than 150 engines per year, out of total sales of more than 500,000 engines. The estimated change in market quantity is small because as compliance costs are passed along the supply chain they become a smaller share of total production costs. In other words, firms that use these engines and equipment will continue to purchase them even at the higher cost because the increase in costs will not have a large impact on their total production costs (diesel equipment is only one factor of production for their output of construction, agricultural, or manufactured goods).

Equipment Market Results: Estimated price changes for the equipment markets reflect both the direct costs of the new standards on equipment production and the indirect cost through increased engine prices. In general, the estimated percentage price changes for the equipment are less than that for engines because the engine is only one input in the production of equipment. In 2013, the average price increase for nonroad diesel equipment is estimated to be about 2.9 percent.[250] This percentage is expected to decrease to about 2.5 percent for 2020 and beyond. The range of estimated price increases across equipment types parallels the share of engine costs relative to total equipment price, so the estimated percentage price increase among equipment types also varies. For example, the market price in 2013 for agricultural equipment between 175 and 600 hp is estimated to increase about 1.2 percent, or $1,740 for equipment with an average cost of $143,700. This compares with an estimated engine price increase of about $1,700 for engines of that size. The largest expected price increase in 2013 for equipment is $2,290, or 2.6 percent, for pumps and compressors over 600 hp. This compares with an estimated engine price increase of about $2,240 for engines of that size. The smallest expected price increase in 2013 for equipment is $120, or 0.7 percent, for construction equipment less than 25 hp. This compares with an estimated engine price increase of about $120 for engines of that size.

Again, the market analysis predicts that even with these increased equipment prices total demand is not expected to change very much. The expected average change in quantity is less than 250 pieces of equipment per year, out of a total sales of more than 500,000 units. The average decrease in the quantity of nonroad diesel equipment produced as a result of the regulation is estimated to be about 0.02 percent for all years. The largest expected decrease in quantity in 2013 is 18 units of construction equipment per year for construction equipment between 100 and 175 hp, out of about 63,000 units. The smallest expected decrease in quantity in 2013 is less than

[249] The NDEIM distinguishes between ''merchant'' engines and ''captive'' engines. ''Merchant'' engines are produced for sale to another company and are sold on the open market to anyone who wants to buy them. ''Captive'' engines are produced by a manufacturer for use in its own nonroad equipment line (this equipment is said to be produced by ''integrated'' manufacturers). The market analysis for engines includes compliance costs for merchant engines only. The market analysis for equipment includes equipment compliance costs plus a portion of the engine compliance costs attributable to captive engines.

[250] It should be noted that the equipment prices used in this analysis reflect current market conditions. An increase in equipment prices associated with the nonroad Tier 3 standards would reduce size of the percentage increase in price. In this sense, our Economic Impact Analysis is conservative as it is based on the impact of the Tier 4 program on Tier 1 and Tier 2 equipment prices and therefore overestimates the market impacts of the Tier 4 program.

one unit per year in all hp categories of pumps and compressors.

It should be noted that the absolute change in the number of engines and equipment does not match. This is because the absolute change in the quantity of engines represents only engines sold on the market. Reductions in engines consumed internally by integrated engine/equipment manufacturers are not reflected in this number but are captured in the cost analysis.

TABLE VI.F–1.—SUMMARY OF MARKET IMPACTS ($2002)

Market	Engineering cost	Change in price		Change in quantity	
	Per unit	Absolute ($million)	Percent	Absolute	Percent
2013					
Engines	$1,052	$821	21.4	[a] −79	−0.014
Equipment	1,198	975	2.9	−139	−0.017
Loco/Marine Transp [b]			0.009		−0.007
Application Markets [b]			0.097		−0.015
No. 2 Distillate Nonroad	0.06	0.07	6.0	[c] −2.75	−0.019
2020					
Engines	950	761	18.3	[a] −98	−0.016
Equipment	1,107	976	2.5	−172	−0.018
Loco/Marine Transp [b]			0.001		−0.008
Application Markets [b]			0.105		−0.017
No. 2 Distillate Nonroad	0.07	0.07	7.0	[c] −3.00	−0.021
2030					
Engines	937	751	18.2	[a] −114	−0.016
Equipment	968	963	2.5	−200	−0.018
Loco/Marine Transp [b]			0.010		−0.008
Application Markets [b]			0.102		−0.016
No. 2 Distillate Nonroad	0.07	0.07	7.0	[c] −3.53	−0.022
2036					
Engines	931	746	18.2	[a] −124	−0.016
Equipment	962	956	2.5	−216	−0.018
Loco/Marine Transp [b]			0.010		−0.008
Application Markets [b]			0.101		−0.016
No. 2 Distillate Nonroad	0.07	0.07	7.0	[c] −3.85	−0.022

Notes:

[a] The absolute change in the quantity of engines represents only engines sold on the market. Reductions in engines consumed internally by integrated engine/equipment manufacturers are not reflected in this number but are captured in the cost analysis. For this reason, the absolute change in the number of engines and equipment does not match.

[b] The model uses normalized commodities in the application markets because of the great heterogeneity of products. Thus, only percentage changes are presented.

[c] Units are in million of gallons.

Transportation Market Results: The estimated price increase associated with the proposed standards in the locomotive and marine transportation markets is negligible, at 0.01 percent for all years. This means that these transportation service providers are expected to pass along nearly all of their increased costs to the agriculture, construction, and manufacturing application markets, as well as other application markets not explicitly modeled in the NDEIM. This price increases represent a small share of total application market production costs, and therefore are not expected to affect demand for these services.

Application Market Results: The estimated price increase associated with the new standards in all three application markets is very small and averages about 0.1 percent for all years. In other words, on average, the prices of goods and services produced using the affected engines, equipment, and fuel are expected to increase negligibly. This results from the observation that compliance costs passed on through price increases represent a very small share of total production costs in all the application markets. For example, the construction industry realizes an increase in production costs of approximately $580 million in 2013 because of the price increases for diesel equipment and fuel. However, this represents less than 0.001 percent of the $820 billion value of shipments in the construction industry in 2000. The estimated average commodity price increase in 2013 ranges from 0.08 percent in the manufacturing application market to about 0.5 percent in the construction market. The percentage change in output is also estimated to be very small and averages less than 0.02 percent for all years. Note that these estimated price increases and quantity decreases are average for these sectors and may vary for specific subsectors. Also, note that absolute changes in price and quantity are not provided for the application markets in Table VI.F–1 because normalized commodity values are used in the market model. Because of the great heterogeneity of manufactured or agriculture products, a normalized commodity ($1 unit) is used in the application markets. This has no impact on the estimated percentage change impacts but makes interpretation of the absolute changes less informative.

Fuel Markets Results: The estimated average price increase across all nonroad diesel fuel is about 7 percent for all years. For 15 ppm fuel, the estimated price increase for 2013 ranges from 5.6 percent in the East Coast region (PADD 1&3) to 9.1 percent in the mountain region (PADD 4). The average national output decrease for all fuel is estimated to be about 0.02 percent for all years, and is relatively constant across all four regional fuel markets.

b. Expected Economic Welfare Impacts

Estimated social costs are presented in Table VI.F–2. In 2013, the total social costs are projected to be about $1,510 million ($2002). About 83 percent of the total social costs is expected to be borne by producers and consumers in the application markets in 2013, indicating that the majority of the compliance costs associated with the rule are expected to be passed on in the form of higher prices. When these estimated impacts are broken down, about 58.5 percent of the social costs are expected to be borne by consumers in the application markets and about 41.5 percent are expected to be borne by producers in the application markets. Equipment manufacturers are expected to bear about 9.5 percent of the total social costs. Engine manufacturers and diesel fuel refineries are expected to bear 2.8 percent and 0.5 percent, respectively. The remaining 4.2 percent of the social costs is expected to be borne by the locomotive and marine transportation service sector. In this last sector, about 97 percent of the gross decrease in market surplus is expected to be borne by the application markets that are not included in the NDEIM but that use these services (*e.g.*, public utilities, nonmanufacturing service industries, government) while about 3 percent is expected to be borne by locomotive and marine service providers. Because of the way the NDEIM is structured, with the fuel savings added separately, the results imply that locomotive and marine service provider would see net benefits from the rule due to the operating savings associated with low sulfur fuel. In fact, they are likely to pass along some or all of those operating savings to the users of their services, reducing the size of the welfare losses for those users.

Total social costs continue to increase over time and are projected to be about $2,046 million by 2030 and $2,227 million in 2036 ($2002). The increase is due to the projected annual growth in the engine and equipment populations. Producers and consumers in the application markets are expected to bear an even larger portion of the costs, approximately 96 percent. This is consistent with economic theory, which states that, in the long run, all costs are passed on to the consumers of goods and services.

The present value of total social costs through 2036, contained in Table VI.F–3, is estimated to be $27.2 billion ($2002). This present value is calculated using a social discount rate of 3 percent from 2004 through 2036. We also performed an analysis using a 7 percent social discount rate. Using that discount rate, the present value of the social costs through 2036 is estimated to be $13.9 billion ($2002). As shown in Table VI.F–3, these results suggest that total engineering costs exceed compliance costs by a small amount. This is due primarily to the fact that the estimated output quantities for diesel engines, equipment, and fuel are not identical to those estimated in the engineering cost analysis, which is due to the different methodologies used to estimate these costs (*see* previous discussion in this Section IV.F.3).

TABLE VI.F–2.—SUMMARY OF SOCIAL COSTS ESTIMATES ASSOCIATED WITH PRIMARY PROGRAM 2015, 2020, 2030, AND 2036

[2002, $Million][a, b]

	Market surplus ($10 ^{6})	Operating savings ($10 ^{6})	Total	Percent
2013				
Engine Producers Total	$42.0		$42.0	2.8
Equipment Producers Total	143.1		143.1	9.5
Construction Equipment	64.0		64.0	
Agricultural Equipment	51.8		51.8	
Industrial Equipment	27.2		27.2	
Application Producers & Consumers Total	1,496.7	($243.2)	1,253.5	83.0
Total Producer	620.9			41.5
Total Consumer	875.7			58.5
Construction	584.3	($115.2)	469.2	
Agriculture	430.0	($78.2)	351.8	
Manufacturing	482.4	($49.8)	432.5	
Fuel Producers Total	8.0		8.0	0.5
PADD I&III	4.1		4.1	
PADD II	3.3		3.3	
PADD IV	0.0		0.0	
PADD V	0.6		6.0	
Transportation Services, Total	104.9	($41.5)	63.4	4.2
Locomotive	1.6	($12.4)	($10.8)	
Marine	0.9	($9.9)	($9.0)	
Application markets not included in NDEIM	102.4	($19.2)	$83.2	
Total	1,794.7	($284.7)	$1,510.0	100.0%
2020				
.				
Engine Producers Total	0.1		0.1	0.0
Equipment Producers Total	122.7		122.7	6.7
Construction Equipment	57.8		57.8	
Agricultural Equipment	39.7		39.7	

TABLE VI.F–2.—SUMMARY OF SOCIAL COSTS ESTIMATES ASSOCIATED WITH PRIMARY PROGRAM 2015, 2020, 2030, AND 2036—Continued

[2002, $Million][a, b]

	Market surplus ($10 6)	Operating savings ($10 6)	Total	Percent
Industrial Equipment	25.2		25.2	
Application Producers & Consumers Total	1,826.1	($192.3)	1,633.8	89.4
Total Producer	762.2			41.7
Total Consumer	1,063.8			58.3
Construction	744.0	($91.1)	653.0	
Agriculture	524.3	($61.8)	462.5	
Manufacturing	557.8	($39.4)	518.3	
Fuel Producers Total	11.2		11.2	0.6
PADD I&III	5.6		5.6	
PADD II	4.6		4.6	
PADD IV	0.2		0.2	
PADD V	0.8		0.8	
Transportation Services, Total	95.7	($35.1)	60.6	3.3
Locomotive	2.0	($7.2)	($5.2)	
Marine	1.1	($11.6)	($10.5)	
Application markets not included in NDEIM	92.6	($16.3)	76.3	
Total	2,055.7	($227.4)	$1,828.3	100.0%
2030				
Engine Producers Total	0.1		0.1	0.0
Equipment Producers Total	5.9		5.9	0.3
Construction Equipment	4.0		4.0	
Agricultural Equipment	1.9		1.9	
Industrial Equipment	0.1		0.1	
Application Producers & Consumers Total	2,112.3	($154.2)	1,958.1	95.7
Total Producer	882.2			41.7
Total Consumer	1,230.1			58.3
Construction	863.8	($73.0)	790.8	
Agriculture	606.8	($49.6)	557.2	
Manufacturing	641.6	($31.6)	610.0	
Fuel Producers Total	13.2		13.2	0.6
PADD I&III	6.7		6.7	
PADD II	5.2		5.2	
PADD IV	0.3		0.3	
PADD V	1.0		1.0	
Transportation Services, Total	109.1	($39.9)	69.2	3.4
Locomotive	2.5	($7.8)	($5.3)	
Marine	1.4	($13.6)	($12.2)	
Application markets not included in NDEIM	105.2	($18.5)	86.7	
Total	2,240.6	($194.1)	$2,046.4	100.0%
2036				
Engine Producers Total	0.2		0.2	0.0
Equipment Producers Total	6.4		6.4	0.3
Construction Equipment	4.3		4.3	
Agricultural Equipment	2.0		2.0	
Industrial Equipment	0.1		0.1	
Application Producers & Consumers Total	2,287.4	($155.7)	2,131.7	95.7
Total Producer	955.5			41.7
Total Consumer	1,331.9			58.3
Construction	936.4	($50.0)	862.7	
Agriculture	657.8	($73.7)	607.8	
Manufacturing	693.2	($31.9)	661.3	
Fuel Producers Total	14.5		14.5	0.7
PADD I&III	7.3		7.3	
PADD II	5.8		5.8	
PADD IV	0.3		0.3	
PADD V	1.0		1.0	
Transportation Services, Total	116.9	($42.6)	74.3	3.3
Locomotive	2.8	($8.2)	($5.4)	
Marine	1.6	($14.6)	($13.0)	
Application markets not included in NDEIM	112.5	($19.8)	92.7	

TABLE VI.F–2.—SUMMARY OF SOCIAL COSTS ESTIMATES ASSOCIATED WITH PRIMARY PROGRAM 2015, 2020, 2030, AND 2036—Continued

[2002, $Million][a, b]

	Market surplus ($10^6)	Operating savings ($10^6)	Total	Percent
Total	$2,425.3	($198.4)	$2,227.0	100.0

Notes: [a] Figures are in 2002 dollars.
[b] Operating savings are shown as negative costs.

TABLE VI.F–3.—NATIONAL ENGINEERING COMPLIANCE COSTS AND SOCIAL COSTS ESTIMATES FOR THE RULE (2004–2036)

[$2002; $Million]

Year	Engineering compliance costs	Total social costs
2004	0	0
2005	0	0
2006	0	0
2007	($17)	($18)
2008	54	54
2009	54	54
2010	328	327
2011	923	922
2012	1,305	1,304
2013	1,511	1,510
2014	1,691	1,690
2015	1,742	1,741
2016	1,743	1,743
2017	1,763	1,762
2018	1,778	1,778
2019	1,795	1,795
2020	1,829	1,828
2021	1,816	1,815
2022	1,819	1,818
2023	1,844	1,843
2024	1,858	1,857
2025	1,888	1,887
2026	1,921	1,920
2027	1,954	1,952
2028	1,985	1,984
2029	2,017	2,016
2030	2,047	2,046
2031	2,078	2,077
2032	2,108	2,107
2033	2,139	2,137
2034	2,169	2,167
2035	2,198	2,197
2036	2,228	2,227
NPV at 3%	27,247	27,232
NPV at 7%	13,876	13,868

VII. Alternative Program Options Considered

Our final emission control program for nonroad engines and equipment consists of a two-step program to reduce the sulfur content of nonroad diesel fuel in conjunction with Tier 4 engine standards. The rule also contains limits on sulfur levels in locomotive and marine diesel fuel. As described in the draft Regulatory Impact Analysis for the proposal, we evaluated a number of alternative options with regard to the scope, level, and timing of the standards. This section presents a summary of those alternative program options and our reasons for either adopting or not adopting these options.

A. Summary of Alternatives

For our Notice of Proposed Rulemaking (NPRM), we developed emissions, benefits, and cost analyses for a number of alternative program options involving variations in both the fuel and engine programs. The alternatives we considered can be categorized according to the structure of their fuel requirements: whether the 15 ppm fuel sulfur limit for nonroad diesel fuel is reached in two steps, like the program we are finalizing today, or in one step. Within each of these two broad fuel program categories, we considered a number of different engine programs. This section summarizes the alternatives. A more detailed description of the alternatives can be found in the NPRM and the draft RIA.

One-step alternatives were those in which the 15 ppm fuel sulfur standard for nonroad diesel fuel is applied in a single step. We evaluated three one-step alternatives, summarized in table VII–1. Option 1 represented an engine program that was similar to that in our proposed program, the primary difference being the generally earlier phase-in dates for the PM standards. We considered the Option 1 engine program as being the most stringent one-step program that could be considered even potentially feasible considering cost, lead-time, and other factors. Option 1 also included a June 2008 start date for the 15 ppm sulfur standard applicable to nonroad diesel fuel and the 500 ppm sulfur standard applicable to locomotive and marine fuel. We also considered two other one-step alternatives which differ from Option 1. As described in table VII–1, Option 1b differed from Option 1 regarding the timing of the fuel standards, while Option 1a differed from Option 1 in terms of the engine standards. Options 1a and 1b also differed from Option 1 by extending the 15 ppm fuel sulfur limit to locomotive and marine diesel fuel.

Two-step alternatives were those in which the nonroad diesel fuel sulfur standard was set first at 500 ppm and then was reduced to 15 ppm. The two-step alternatives varied from the proposed program in terms of both the timing and levels of the engine standards and the timing of the fuel standards. Option 2a was the same as the proposed program except the 500 ppm fuel standard was introduced a year earlier, in 2006. Option 2b was the same as the proposed program except the 15 ppm fuel standard was introduced a year earlier (in 2009) and the trap-based PM standards began earlier for all engines. Option 2c was the same as the proposed program except the 15 ppm fuel standard was introduced a year earlier in 2009 and the trap-based PM standards began earlier for engines 175–750 hp. Option 2d was the same as the proposed program except the NO_X standard was reduced to 0.30 g/bhp-hr for engines of 25–75 hp, and this standard was phased in. Finally, Option 2e was the same as the proposed program except there were no new Tier 4 NO_X limits.

In the NPRM, option 3 was identical to the proposed program, except that it would have exempted mining equipment over 750 hp from the Tier 4 standards. We explained in detail in section 12.6.2.2.7 of the draft RIA that we had very serious reservations regarding the legality of this option given these engines' high emission rates of PM, NO_X and NMHC and the availability of further emissions control at reasonable cost. We adhere to these conclusions here. We do note, however, that we are adopting somewhat different provisions for this engine category than we proposed. As explained in sections II.A. and II.B above, although we have adopted aftertreatment-based PM standards for these engines, the standards are slightly higher than those proposed to assure their technical feasibility. We also have deferred a decision on whether to adopt aftertreatment-based standards for NO_X for mobile machines with engines greater than 750 hp. We also have provided ample lead time for these engines to comply with the Tier 4 standards, both in terms of the rule's compliance dates (which include a 2015 date for the final Tier 4 standards, one year later than we proposed) and the ABT and equipment manufacturer flexibilities. This lead time takes into account the long design periods, high cost, and low sales volumes of these engines. Thus, although we strongly disagree with the option of not adopting Tier 4 standards for these engines, we do recognize their need for unique standards and compliance dates.

Option 4 included applying the 15 ppm sulfur limit to both locomotive and marine diesel fuel in addition to nonroad fuel. On the basis of comments received and additional analyses, we have determined that a 15ppm sulfur standard for locomotive and marine fuel is appropriate, though we have included certain options for utilization of off-specification fuel and transmix not represented in our original Option 4. This aspect of our final program is discussed in detail in section IV.

Options 5a and 5b were identical to the proposed program except with respect to standards for engines less than 75 hp. Option 5a was identical to the proposed program except that no new program requirements would be set in Tier 4 for engines under 75 hp. Instead, Tier 2 standards and testing requirements for engines under 50 hp, and Tier 3 standards and testing requirements for 50–75 hp engines, would continue indefinitely. The Option 5b program was identical to the proposed program except that for engines under 75 hp only the 2008 engine standards would be set, *i.e.* there would be no additional PM filter-based standard in 2013 for 25–75 hp engines, and no additional NO_X + NMHC standard in 2013 for 25–50 hp engines. We are not adopting Options 5a or 5b in today's action. As explained at 8.2.3 of the Summary and Analysis of Comments, and in sections 12.6.2.2.9 and 12.6.2.2.10 of chapter 12 of the draft RIA, these options would forego substantial PM and NO_X + NMHC emission reductions (on the order of hundreds of thousands of tons of each pollutant) which are feasible at reasonable cost. We note further that many of these smaller engines operate in populated areas and in equipment without closed cabs—in mowers, small construction machines, and the like—where personal exposures to toxic emissions (both PM and air toxics which are part of the NMHC fraction) may be pronounced well beyond what is indicated simply by a comparison of nationwide emissions inventory estimates. We would also emphasize the remarkable growth in recent sales and usage for these smaller diesel machines, and we expect this trend to continue, pointing up the need for effective PM emissions control from these engines. We thus do not see a basis in law or policy to adopt either of these options.

In response to comments on our NPRM we also investigated a number of other variations in the engine standards as we developed our final rule. These variations were generally related to the phase-in of engine standards in a number of different horsepower categories. A discussion of these variations is provided in section II as well as in various background documents.

Table VII–1 contains a summary of a number of these alternatives. The expected emission reductions, costs, and monetized benefits associated with them in comparison to the proposed program were evaluated for the NPRM. Those analyses were not revised for this final rulemaking to reflect changes in our empirical models or assumptions. We received no new information that would cause us to believe that the relative impacts and differences for those alternative program options relative to our final program would change enough to make an impact on our assessments of the feasibility or appropriateness of the options. The remainder of this section will summarize some of the comments we received on the options and our responses to those comments.

TABLE VII–1.—SUMMARY OF ALTERNATIVE PROGRAM OPTIONS

Option	Fuel Standards	Engine Standards [a]
	Final program	
	• 500 PPM in 2007 for NR, loco/marine • 15 ppm in 2010 for NR • 15 ppm in 2012 for loco/marine	• <75 hp: PM standards in 2008 • 25–75 hp: PM AT-based standards in 2013 • 75–175 hp: PM AT-based standards in 2012 • 175–750 hp: PM AT-based standards in 2011 • 75–175 hp: NO_X AT-based standards phase-in 2012–2014 • 175–750 hp: NO_X AT-based standards phase-in 2011–2014 • >750 hp: PM and NO_X AT phased-in 2011 and 2015
	1-Step Fuel Options	
1	• 15 ppm in 2008 for NR and loco/marine	• <50 hp: PM stds only in 2009 • 25–75 hp: PM AT stds and EGR or equivalent NO_X technology in 2013; no NO_X AT • >75 hp: PM AT stds phasing in beginning in 2009; NO_X AT phasing in beginning in 2011
1a	• 15 ppm in 2008 for NR, loco/marine	• PM AT introduced in 2009–10 • NO_X AT introduced in 2011–12
1b	• 15 ppm in 2006 for NR, loco/marine	Same as 1a
	2-Step Fuel Options	
2a	Same as proposed program except— • 500 ppm in 2006 for NR, loco/marine.	Same as proposed program
2b	Same as proposed program except— • 15 ppm in 2009 for NR and loco/marine	Same as proposed program except— • Move PM AT up 1 year for all engines >25 hp (phase in starts 2010)
2c	Same as proposed program except— • 15 ppm in 2009 for NR and loco/marine	Same as proposed program except— • Move PM AT up 1 year for all engines 175–750 hp (phase in starts 2010)
2d	• Same as proposed program	Same as proposed program except—

TABLE VII–1.—SUMMARY OF ALTERNATIVE PROGRAM OPTIONS—Continued

Option	Fuel Standards	Engine Standards [a]
		• Phase-in NO_X AT for 25–75hp beginning in 2013
	Other Options	
3	• Same as proposed program	Same as proposed program except— • Mining equipment over 750 hp left at Tier 2
4	Same as proposed program except— • Downgrade flexibilities for loco/marine not included.	Same as proposed program
5a	• Same as proposed program	Same as proposed program except— • No Tier 4 standards <75 hp
5b	• Same as proposed program	Same as proposed program except— • No new <75hp standards after 2008 (i.e., no CDPFs in 2013)

Notes: [a] AT = aftertreatment.

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

EPA carefully evaluated an alternative which would require that the nonroad diesel sulfur level be reduced to 15ppm in a single step, beginning June 1, 2008. The one-step fuel options, including the three variations Option 1, Option 1a, and Option 1b, were presented and discussed in detail in the NPRM and in the draft RIA.

Many comments were received about a one step diesel fuel sulfur control approach taking effect in 2008. Refiners commented that they did not think that they could reduce both the highway and nonroad diesel fuel pools down to 15 ppm in the same timeframe while maintaining the supply of these two diesel fuel pools. The refiners went on to say that having a 500 ppm outlet for off-specification material in the nonroad diesel fuel pool is critical in the years after reducing the highway diesel fuel pool to 15 ppm to ensure supply of highway fuel. The refining industry further commented that the one step program would provide fewer environmental benefits and also provide the refining industry less time and flexibility to make the transition to the 15 ppm sulfur level for nonroad diesel fuel compared to a two step approach. While many environmental organizations and the Engine Manufacturers Association (EMA) commented that they preferred a 15 ppm standard as soon as possible, EMA also pointed out that a quick transition to 500 ppm would provide important fleet-wide emission reductions, reduce maintenance costs and enable the use of certain emission control technology such as exhaust gas recirculation and oxidation catalysts. Commenters generally said little about the engine standards associated with the one-step options, other than to point out that earlier introduction of 15 ppm sulfur fuel means that aftertreatment-based standards and nonroad engine retrofits can also be introduced earlier.

The reasons provided in the NPRM for choosing the two step program over the one-step program still apply and generally address the comments received (*see* section 12.6.2 of the draft RIA). Although there would be greater PM and NO_X emission reductions with the one-step approach due to earlier introduction of aftertreatment technology enabled by the 15 ppm sulfur diesel fuel, the SO_2 emission benefits for the two-step approach are greater due to the earlier adoption of the 500 ppm sulfur standard. Thus, even assuming that the one-step approach would not jeopardize implementation of the highway diesel emission rule, the emission impacts of these two options are mixed. Moreover, the costs for achieving the second step (15 ppm) of the two step approach are likely to be lower than under the one step approach. This is because advanced desulfurization technologies are much more likely to be used in 2010 after additional testing and demonstration, while they may hardly be considered at all if they would have to be installed for 2008. One advanced desulfurization technology, Process Dynamics Isotherming, is expected to lower the cost of complying with the 15 ppm step by about one cent per gallon. This cost discrepancy is expected to persist since it is associated with the investment of significant capital which cannot be modified or replaced without significant additional expense. Additionally, under the two step program, refiners will be able to use their experience in complying with 15 ppm highway diesel fuel sulfur standard to better design their nonroad hydrotreaters needed for 2010.

After careful consideration of these matters, we have decided to finalize the two-step approach in today's action.

C. Applying the 15 ppm Sulfur Cap to Locomotive and Marine Diesel Fuel

In the NPRM, we requested comment on extending the 15 ppm cap to locomotive and marine diesel fuel in 2010 or some later year as part of this rule. The costs and inventory impacts of this alternative were explored in the context of Option 4 in the NPRM. A 15ppm sulfur cap for locomotive and marine fuel would increase the long-term PM and SO_2 benefits of the rule and would reduce the number of fuels being carried in the distribution system after 2014, when the small refiner provisions of this rule expire. It would also allow refiners to plan to comply with the 15 ppm cap for locomotive and marine diesel fuel at the same time as they plan to comply with the 500 ppm cap for NRLM fuel and the 15 ppm cap for nonroad fuel.

As a result of comments received and additional analyses performed since the NPRM, we are finalizing a 15 ppm sulfur cap for locomotive and marine fuel in today's notice. A full discussion of the feasibility and benefits of a 15 ppm sulfur cap for locomotive and marine fuel can be found in section IV, along with a summary of the comments we received and our responses to those comments. In addition, we are planning a separate rule to implement new emission standards for locomotive and marine diesel engines that will build upon the 15 ppm sulfur standard applicable to fuel used by these engines. We are publishing an Advanced Notice of Proposed Rulemaking in another section of today's **Federal Register** describing our plans in this area.

D. Other Alternatives

We also analyzed a number of other alternatives in the NPRM, as summarized in table VII–1. Some of these focused on control options more stringent than our final program while others reflect modified engine requirements that result in less stringent control. In the NPRM we presented our assessment of these options in terms of the feasibility, emission reductions, costs, and other relevant factors. Few comments were received on these other alternatives, and no new information arose to alter what we believe are significant concerns with respect to these Options compared to the final program. Hence, with the exception of the few alternative program elements that we did incorporate into our final program as described earlier in this section, we did not include these options into our final program. Our detailed responses to all the comments received on the other alternatives can be found in section 8 of the Summary and Analysis of Comments document.

VIII. Future Plans

The above discussion describes the contents of this final rule. This section addresses a variety of areas not addressed by this rule. In these several areas, we expect to continue our efforts to improve our compliance programs and achieve further reductions in emissions from nonroad engines.

A. Technology Review

As we described in sections III.E and G of the proposal, there are some technology issues that warrant our planning a future review of emissions control technology for engines under 75 hp. Under our implementation schedule presented in section II.A, standards based on the use of PM filter technology will take effect in the 2013 model year for 25–75 hp engines (or in the 2012 model year for manufacturers opting to skip the transitional standards for 50–75 hp engines). However, at this time we have not decided what long-term PM standards for engines under 25 hp are appropriate. No PM filter-based standards are being adopted for these under 25 hp engines in this final rule. Likewise, we have not decided what the long-term NO_X standards for engines under 75 hp should be, and no NO_X adsorber-based standards are being set for these engines in this final rule. As part of the technology review, we plan to thoroughly evaluate progress made toward applying advanced PM and NO_X control technologies to these smaller engines.

We plan to conduct the technology review in 2007, and to conclude it by the end of that year, to give manufacturers lead time should an adjustment in the program be considered appropriate. We do not intend to include in the technology review a reassessment of PM filter technology needed to meet the optional 0.02 g/hp-hr PM standard for 50–75 hp engines in 2012. We assume that manufacturers would only choose this option if they had confidence that they could meet the 0.02 g/hp-hr standard in 2012, a year earlier than otherwise required.

Numerous commenters expressed support for the planned technology review. MECA and STAPPA/ALAPCO stressed that the review should not be limited to considering the need to relax PM filter-based standards for small engines, but should also consider technology innovations that would justify increasing the stringency of small engine standards that are not currently aftertreatment-based. This is indeed our intent. Yanmar suggested that the review be deferred to 2010 or later, because NO_X control experience from highway diesels will not be sufficient by 2007. On the contrary, based on the rate of technology development progress to date for highway engines, we believe that there will be a very large amount of pertinent new information available by 2007, even though widespread field experience may be lacking. Waiting longer to conduct the technology review would, we believe, provide insufficient leadtime to the industry should an adjustment to the 2013 standards be found appropriate. Some engine and equipment manufacturers called for expanding the technology review to other power categories. As discussed in the proposal, we do not believe that a generalized technology review of the sort being conducted for the heavy-duty highway engine program is warranted, primarily due to the very fact that the nonroad standards are modeled on the highway program, and the highway program does include this comprehensive review. We also do not see the specific technical issues for engines above 75 hp that have been identified for smaller engines, such as might warrant our expanding the review at this time. Engine manufacturers also expressed interest in a consultative process in the near future that would establish the scope, outputs, and criteria for the review, possibly including assigning responsibility for the review to an independent entity. Although we plan and hope to have the active participation of all interested parties in the review process, assigning responsibility for the review to groups or individuals outside the Agency would be inappropriate. As the review would be closely tied to potential subsequent rulemaking action by the Agency, it is essential that it adequately cover the relevant issues. To ensure this, it is imperative that we retain overall responsibility for the review. We have not yet worked out process details for the review, but will do so at some later date.

Several commenters strongly stressed the need for EPA to work with governmental standards-setting bodies in other countries to harmonize future standards. As discussed in section II.A.8, we recognize the importance of harmonizing nonroad diesel standards and have worked diligently with our colleagues responsible for setting such standards outside the U.S., thus far with good success. The March 2004 Directive that sets future nonroad diesel standards in the European Union (EU) will very closely align the EU program with our program in the Tier 4 timeframe.[251] Further enhancing prospects for close harmonization, the Directive includes plans for a future technical review: ‘‘There are still some uncertainties regarding the cost effectiveness of using after-treatment equipment to reduce emissions of particulate matter (PM) and of oxides of nitrogen (NO_X). A technical review should be carried out before 31 December 2007 and, where appropriate, exemptions or delayed entry into force dates should be considered.’’

Note that the timing for this review coincides with that of our own planned review. Among other things, both our review and the EU review will consider the appropriate long-term standards for engines between 25 and 50 hp, engines for which we have set PM-filter based standards and for which the EU has not. Furthermore, in addition to re-evaluating the standards, the EU technical review will consider the need to introduce standards for engines below 25 hp and above 750 hp, the two categories for which the EU has not yet set emission standards, and for which harmonization is thus most lacking. We are greatly encouraged by the degree of harmonization achieved thus far, and, given our common interests, issues and planned timing, expect to work closely with Commission staff in carrying out the 2007 technology review, with an aim of preserving and enhancing harmonization of standards.

In response to comments received on the proposal, we wish to clarify that the technology review for engines under 75 hp will be a comprehensive undertaking that may result in adjustments to standards, implementation dates, or other provisions (such as flexibilities) in either direction (that is, toward more or less stringency), depending on conclusions reached in the review about

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

appropriate standards under the Clean Air Act. All relevant factors including technical feasibility and commercial viability of engines and machines designed to meet the standards will be taken into account.

B. Test Procedure Issues

Section III describes two issues related to test procedures that warrant further attention in the future. First, we are adopting transient test procedures for engines subject to Tier 4 emission standards, but we intend to collect data that would help us adopt a duty cycle that would appropriately test constant-speed engines. Second, we are adopting cold-start test procedures, but are interested in collecting additional data that could be used to revise those procedures if appropriate.

C. In-Use Testing

Although this final rule does not include an in-use testing program for nonroad diesel engines, we expect to establish such a program for the future in a separate rulemaking action. The goal of this program will be to ensure that emissions standards are met throughout the useful life of the engines, under conditions normally experienced in-use. The Agency expects to pattern the in-use testing requirements for nonroad diesel engines after a program that is being developed for heavy-duty diesel highway vehicles. This program will be funded and conducted by the manufacturer's of heavy-duty diesel highway engines with our oversight. We expect it will incorporate a two-year pilot program. The pilot program will allow the Agency and manufacturers to gain the necessary experience with the in-use testing protocols and generation of in-use test data using portable emission measurement devices prior to fully implementing program. A similar pilot program is expected to be part of any manufacturer-run, in-use NTE test program for nonroad engines.

The Agency plans to promulgate the in-use testing requirements for heavy-duty highway vehicles in the December 2004 time frame. We anticipate proposing a manufacturer-run, in-use testing program for nonroad diesel engines by 2005 or earlier. As mentioned above, the nonroad diesel engine program is expected to be patterned after the heavy-duty highway program.

D. Engine Diagnostics

We are also in the process of defining diagnostic requirements that would apply to highway diesel engines. Once we have adopted requirements for highway engines, we would aim to adapt the requirements as needed to appropriately address diagnostic needs for nonroad diesel engines. These programs would likely be very similar, but the diagnostics for nonroad engines my need to differ in some ways, depending on the technologies used by different types and sizes of engines and on an assessment of an appropriate level of information and control for engines used in nonroad applications.

E. Future NO_X Standards for Engines in Mobile Machinery Over 750 hp

In section II.A.4, we explain that we are not, at this time, setting Tier 4 NO_X standards for mobile machinery over 750 hp based on the performance of high-efficiency aftertreatment, although we note that the 2.6 g/bhp-hr NO_X standard taking effect for these engines in 2011 represents a more than 60% NO_X reduction from the 6.9 g/bhp-hr Tier 1 level in effect today, and a more than 40% reduction from the 4.8 g/bhp-hr NO_X+NMHC Tier 2 standard level that takes effect in 2006. We are still evaluating the issues involved for these engines to achieve a more stringent NO_X standard, and believe that these issues are resolvable. We intend to continue evaluating the appropriate long-term NO_X standard for mobile machinery over 750 hp and expect to announce further plans regarding these issues, perhaps as early as 2007.

F. Emission Standards for Locomotive and Marine Diesel Engines

This final rule adopts limited requirements to limit sulfur levels in distillate fuels used in locomotive and many marine diesel engines, which will help reduce PM emissions from these engines. In an upcoming rulemaking, we will consider an additional tier of NO_X and PM standards for marine diesel engines less than 30 liters per cylinder and for locomotive engines. These standards would reflect the application of advanced emission-control technology, including the potential to use the high-efficiency catalytic emission-control devices like those described elsewhere in this preamble. In developing these new standards, we will consider the substantial overlap in engine technology between the locomotive and marine engines and the nonroad engines covered by this final rule. We will also take into account the unique features associated with locomotive and marine engines (and their respective markets) and the extent to which these differences may constrain the feasibility of applying advanced emission control technologies to those engines.

We are concurrently publishing an Advance Notice of Proposed Rulemaking that describes the emission-control program we are contemplating for these engines. After consideration of comments submitted on the Advance Notice, we will publish a Notice of Proposed Rulemaking. Our proposal will be subject to comment before its expected completion in the 2006 time frame.

The engine emission control program to be described in the Advance Notice will cover all locomotive engines subject to 40 CFR part 92 and all marine diesel engines with displacement below 30 liters per cylinder. Note that the rule will therefore cover marine diesel engines below 37 kW, which are currently regulated through Tier 3 with land-based nonroad engines in 40 CFR part 89. The rule will also address both recreational and commercial marine diesel engines with displacement below 30 liters per cylinder. Marine engines at or above 30 liters per cylinder typically use a different kind of fuel, residual fuel, and will be considered in a separate rulemaking to be finalized by April 27, 2007, pursuant to a regulatory provision adopted in our recent rule setting standards for those engines (68 FR 9783, February 28, 2003).

G. Retrofit Programs

In the proposal, we requested comment on setting voluntary new engine emission standards applicable to the retrofit of nonroad diesel engines. As described in section III.A, we are not adopting a retrofit credit program with today's action. We believe it is important to more fully consider the details of a retrofit credit program and work with interested parties in determining whether a viable program can be developed. EPA intends to explore the possibility of a voluntary nonroad retrofit credit program through future action.

H. Reassess the Marker Specified for Heating Oil

As discussed in sections IV and V, we are requiring that the chemical marker solvent yellow 124 (SY–124) be added to heating oil outside of the Northeast/ Mid-Atlantic Area. We received comments from the American Society of Testing and Materials (ASTM), the Coordinating Research Council (CRC), the Department of Defense (DoD), and the Federal Aviation Administration (FAA) requesting that we delay finalizing the selection of a specific marker for use in this final rule due to concerns for jet fuel contamination. ASTM withdrew its request for a postponement in the regulation, given that this final rule requires addition of the marker at the terminal, rather than the refinery gate as proposed. This eliminates most of the concern regarding jet fuel contamination. However, ASTM stated that some concern remains regarding jet fuel contamination downstream of the terminal. Nevertheless, ASTM related that these concerns need not delay finalization of the marker requirements in this rule, since a CRC program to evaluate these concerns is expected to be completed well before SY–124 must be added to heating oil. FAA is also undertaking an effort to identify fuel markers that would be compatible for use in jet fuel.

We also received comments from the heating oil industry and the Department of Defense, which expressed concerns regarding the potential health effects and maintenance impacts on heating oil equipment from the use of SY–124 in heating oil. As discussed in section V, we believe these concerns have been adequately addressed for us to specify the use of SY–124 in this final rule. The EU has required the use of SY–124 in heating oil since August 2002. The EU intends to re-evaluate the use of SY–124 after December 2005 or earlier if they learn of any health, safety, or environmental concerns from their in-use experience with SY–124.

We will keep abreast of the ASTM, CRC, FAA, IRS, and EU activities and commit to a review of our use of SY–124 under today's rule based on these findings. If alternative markers are identified that do not raise concerns regarding the potential contamination of jet fuel, we will initiate a rulemaking to evaluate the use of one of these markers in place of SY–124.

IX. Public Participation

Many interested parties provided their input on the proposed rulemaking during our public comment period. This comment period, along with the three public hearings that were held in New York, Chicago, and Los Angeles, provided ample opportunity for public participation. Throughout the rulemaking process, EPA met with stakeholders including representatives from the fuel refining and distribution industry, engine and equipment manufacturing industries, emission control manufacturing industry, environmental organizations, states, agricultural interests, and others.

A detailed Response to Comments document was prepared for this rulemaking that describes the comments that we received on the proposal along with our response to each of these comments. The Response to Comments document is available in the air docket and e-docket for this rule, as well as on the Office of Transportation and Air Quality homepage. In addition, comments and responses for many key issues are included throughout this preamble.

X. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

Under Executive Order 12866 (58 FR 51735, October 4, 1993), the Agency must determine whether the regulatory action is ''significant'' and therefore subject to review by the Office of Management and Budget (OMB) and the requirements of this Executive Order. The Executive Order defines a ''significant regulatory action'' as any regulatory action that is likely to result in a rule that may—

- Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, Local, or Tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs, or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

A final Regulatory Impact Analysis has been prepared and is available in the docket for this rulemaking and at the internet address listed under ''How Can I Get Copies of This Document and Other Related Information?'' above. This action was submitted to the Office of Management and Budget for review under Executive Order 12866. Estimated annual costs of this rulemaking are estimated to be $2 billion per year, thus this proposed rule is considered economically significant. Written comments from OMB and responses from EPA to OMB comments are in the public docket for this rulemaking.

B. Paperwork Reduction Act

The information collection requirements in this rule have been submitted for approval to the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq*. The information collection requirements are not enforceable until OMB approves them. The OMB control number for engine-related information collection is 2060–0460 (EPA ICR number 1897.07) and for fuel-related information collection is 2060–0308 (EPA ICR number 1718.07).

We will use the engine-related information to ensure that new nonroad diesel engines comply with emission standards through certification requirements and various subsequent compliance provisions. This information collection is mandatory under the provisions of 42 U.S.C. 7401–7671(q). We will use the fuel-related information to ensure that diesel fuel meets the sulfur limits and corresponding requirements related to marking and segregating the different types and grades of diesel fuel. This information collection is mandatory under the provisions of 42 U.S.C. 7545(c), (g) and (i), and 7625–1.

In addition, this notice announces OMB's approval of the information collection requirements for other programs, as summarized in Table X.B–1.

TABLE X.B–1—APPROVED INFORMATION COLLECTION REQUESTS FROM OTHER PROGRAMS

Program	Final rule cite	OMB control number	EPA ICR number	OMB approval
Nonroad spark-ignition engines over 19 kW	November 8, 2002 (67 FR 68242).	2060–0460	1897.04	January 31, 2003.
Recreational vehicles	November 8, 2002 (67 FR 68242).	2060–0460	1897.04	January 31, 2003.
Rebuilders of various types of engines	November 8, 2002 (67 FR 68242).	2060–0104	0783.46	June 11, 2003.
Highway motorcycles	January 15, 2004 (69 FR 2398).	2060–0104	0783.46	March 26, 2004.

The estimated annual public reporting and recordkeeping burden for collecting information from all these programs is shown in Table X.B–2. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

TABLE X.B–2.—INFORMATION COLLECTION BURDENS

Engine type	Respondents	Hours per respondent	Hours for all respondents	Capital costs for all respondents	Operating and maintenance costs for all respondents	Total costs for all respondents
Nonroad diesel engine manufacturers	75	3,304	247,783	$0	$5,894,802	$18,661,614
Diesel fuel suppliers	2,615	75	196,288	1,800,000	1,800,000	18,371,600
Nonroad spark-ignition engine manufacturers	12	1,832	21,986	174,419	2,507,790	3,617,683
Recreational vehicle manufacturers	39	684	26,669	1,627,907	2,137,115	4,869,253
Highway motorcycles	46	32	1,449	0	23,686	79,428
Importers	40	13	529	0	150,000	169,223
Rebuilders	200	6	1,200	0	0	38,800

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9. When this ICR is approved by OMB, the Agency will publish a technical amendment to 40 CFR part 9 in the **Federal Register** to display the OMB control number for the approved information collection requirements contained in this final rule. EPA received various comments on the rulemaking provisions covered by the ICRs, but no comments on the paperwork burden or other information in the ICRs. All comments that were submitted to EPA are considered in the relevant Summary and Analysis of Comments, which can be found in the docket. A copy of any of the submitted ICR documents may be obtained from Susan Auby, Collection Strategies Division, U.S. Environmental Protection Agency (2822–T), 1200 Pennsylvania Ave., NW., Washington, DC 20460 or by e-mail at *auby.susan@epa.gov*.

To comment on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques, EPA has a public docket for this rule, which includes this ICR, under Docket ID number OAR–2003–0012. Submit any comments related to the ICR for this rule to EPA and OMB. Address comments to OMB by e-mail to *drostker@omb.eop.gov* or fax to (202) 395–7285. Please do not send comments to OMB via U.S. Mail.

C. Regulatory Flexibility Act (RFA), as Amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), 5 U.S.C. 601 et seq.

EPA has decided to prepare a Regulatory Flexibility Analysis (RFA) in connection with this final rule. For purposes of assessing the impacts of today's rule on small entities, a small entity is defined as: (1) A small business that is primarily engaged in the manufacturing of nonroad diesel engines and equipment that meets the definitions based on the Small Business Administration's (SBA) size standards (*see* table X.C.–1 below); (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

TABLE X.C–1.—SMALL BUSINESS ADMINISTRATION SIZE STANDARDS FOR VARIOUS BUSINESS CATEGORIES

Industry	Defined as small entity by SBA if:	Major SIC [a] Codes
Engine manufacturers	Less than 1,000 employees	Major Group 35.
Equipment manufacturers:		
—Construction equipment	Less than 750 employees	Major Group 35.
—Industrial truck manufacturers (*i.e.* forklifts)	Less than 750 employees	Major Group 35.
—All other nonroad equipment manufacturers	Less than 500 employees	Major Group 35.
Fuel refiners	Less than 1500 employees [b]	2911.
Fuel distributors	<varies>	<varies>

Notes:

[a] Standard Industrial Classification.

[b] EPA has included in past fuels rulemakings a provision that, in order to qualify for the small refiner flexibilities, a refiner must also have a company-wide crude refining capacity of no greater than 155,000 barrels per calendar day. EPA has included this criterion in the small refiner definition for a nonroad diesel sulfur program as well.

Pursuant to 5 U.S.C. 603, EPA prepared an Initial Regulatory Flexibility Analysis (IRFA) for the proposed rule and convened a Small Business Advocacy Review Panel (SBAR Panel, or ''the Panel'') to obtain advice and recommendations of representatives of the regulated small entities pursuant to 5 U.S.C. 609(b) (*see* 68 FR 28518–28521, May 23, 2003). A detailed discussion of the Panel's advice and recommendations can be found in the Panel Report (Docket A–2001–28, Document No. II–A–172). *See also* section III.C above.

We have also prepared a Regulatory Flexibility Analysis for today's rule. The Regulatory Flexibility Analysis addresses the issues raised in public comments on the IRFA, which was part of the proposal of this rule. The Regulatory Flexibility Analysis is available for review in the docket and is summarized below. The key elements of a regulatory flexibility analysis include—

—The need for, and objectives of, the rule;
—The significant issues raised by public comments, a summary of the Agency's assessment of those issues, and a statement of any changes made to the proposed rule as a result of those comments;
—The types and number of small entities to which the rule will apply;
—The reporting, recordkeeping and other compliance requirements of the rule; and
—The steps taken to minimize the impact of the rule on small entities, consistent with the stated objectives of the applicable statute.

1. Need for and Objectives of the Rule

Controlling emissions from nonroad engines and equipment, in conjunction with controls on sulfur concentrations in diesel fuel, has very significant public health and welfare benefits, as explained in section I of this preamble. We are finalizing new engine standards and related provisions under sections 213(a)(3) and (4) of the Clean Air Act which, among other things, direct us to establish (and from time to time revise) emission standards for new nonroad diesel engines. Similarly, section 211(c)(1) authorizes EPA to regulate fuels if any emission product of the fuel causes or contributes to air pollution that may endanger public health or welfare, or that may impair the performance of emission control technology on engines and vehicles. We are finalizing new fuel standards today for both of these reasons.

2. Summary of Significant Public Comments on the IRFA

We received comments from engine and equipment manufacturers, fuel refiners, fuel distributors and marketers, and consumers during the public comment period following the proposal of this rulemaking. All of the following comments were taken into account in developing today's final rule. Responses to these comments are located in subsection 5 below, along with the description of the provisions that we are finalizing to reduce the rule's impact on small businesses. More detailed information in response to these comments can be found in sections III.C. (Engine and Equipment Small Business Provisions) and IV.B (Hardship Relief Provisions for Qualifying Refiners) of this preamble. Additional detail may also be found in the Final Regulatory Flexibility Analysis, located in the Regulatory Impact Analysis, as well as in the Summary and Analysis of Comments for this final rule.

a. Public Comments Received on Engine and Equipment Standards

One small engine manufacturer commented that the proposed provisions for small business engine manufacturers are appropriate and strongly supported their inclusion in the final rule. The manufacturer raised many concerns of why it believes that it is necessary to include provisions, such as: Larger/higher-volume manufacturers will have priority in supply of new technologies and will have more R&D time to complete development of these systems before they are available to smaller manufacturers; smaller manufacturers do not command the same amount of attention from potential suppliers of critical technologies for Tier 4 controls, and are thus concerned that they may not be able to attract a manufacturer to work with them on the development of compliant technologies. This small manufacturer believes that the additional three-year time period proposed for small engine manufacturers in the NPRM is necessary for the company, and is their estimate of the time that it will take for these technologies to be available to small engine manufacturers.

The Small Business Administration's Office of Advocacy (''Advocacy'') raised the concern that the rule would impose significant burdens on a substantial number of small entities producing engines of 75 hp or less, with little corresponding environmental benefit. Advocacy therefore recommended that PM standards for engines in the 25–75 hp range not be based on performance of aftertreatment technologies. Advocacy believed that the proposed flexibilities will not suffice on their own to appropriately minimize the regulatory burdens on small entities; and Advocacy noted that during the SBREFA process some small equipment manufacturers stated that although EPA would allow some equipment to be sold which would not require new emissions controls, engine manufacturers would not produce or sell such equipment. Advocacy also commented that we have not shown that substantial numbers of small businesses have taken advantage of previous small business flexibilities, or that small businesses would be able to take advantage of the flexibilities under this rule. Lastly, Advocacy commented that although full compliance with the more stringent emissions controls requirements would be delayed for small manufacturers, small business manufacturers eventually will be required to produce equipment meeting the new requirements.

b. Public Comments Received on Fuel Standards

i. General Comments on Small Refiner Flexibility

One small refiner commented that it is not feasible at this time to evaluate the impact of the three fuels regulations on the refining industry (and small refiners), however it stated that we should continue to evaluate the impacts and act quickly to avoid shortages and price spikes and we should be prepared, if necessary, to act quickly in considering changes in the regulations to avoid these problems. We also received comment that some small refiners that produce locomotive and marine fuels fear that future sulfur reductions to these markets could be very damaging.

ii. Comments on the Small Refiner Definition

A small refiner commented that the proposed redefinition of a small refiner (to not grandfather as small refiners those that were small for highway diesel) would both negate the benefits afforded under the small refiner provisions in the Highway Diesel Sulfur rule and disqualify its status as a small refiner. The small refiner is, however, in support of the addition of the capacity limit in the small refiner definition which will correct the problem of the inadvertent loop-hole in the two previous fuel rules. Though the refiner is concerned that the wording of the proposed language may result in small