CHAPTER 6. COST ANALYSIS APPROACH AND RESULTS

This chapter describes our analysis of the engineering costs and monitoring costs associated with attaining the final National Ambient Air Quality Standard (NAAQS) for lead and the alternative standards outlined in Chapter 1.[1] We present our analysis of these costs in four separate sections. Section 6.1 presents the cost estimates. Sections 6.2 and 6.3 summarize the economic and energy impacts of the Final Rule, respectively, while Section 6.4 outlines the main limitations of the analysis.

Section 6.1 breaks out discussion of cost estimates into five subsections. The first subsection summarizes the data and methods that we employed to estimate the costs associated with the control strategies outlined in Chapter 4. As indicated in Chapter 4, these strategies rely exclusively on the application of point source controls and, in the case of Jefferson County, Missouri, the rebuild of a primary lead smelter with modern, low-emitting lead smelting technology. The second subsection presents county level estimates of the costs of identified controls associated with the regulatory alternatives examined in this RIA. Following this discussion, the third subsection describes the two approaches used to estimate the extrapolated costs of unspecified emission reductions that may be needed to comply with the selected standard. The fourth subsection provides a brief discussion of the monitoring costs associated with the NAAQS. The fifth subsection provides the estimated total costs of the regulatory alternatives examined. This section concludes with a discussion of technological change in regulatory cost estimates.

It should be noted again that overall data limitations are very significant for this analysis. One critical area of uncertainty is the limited TSP-Pb monitoring network (discussed in chapter 2). Because monitors are present in only 86 counties nationwide, the universe of monitors exceeding the various target NAAQS levels is very small—only 21 counties above 0.1 $\mu g/m^3$, the lowest alternative NAAQS level examined in this RIA. Because we know that many of the highest-emitting Pb sources in the 2002 NEI do not have nearby Pb-TSP monitors (see section 2.1.7), it is likely that there may be many more potential nonattainment areas than have been analyzed in this RIA. We should also emphasize that these cost estimates represent hypothetical emission control strategies that, in some cases, reflect assumptions about technological advances that will improve the effectiveness of specific control technologies.

It is important also to note that this chapter presents cost estimates associated with both identified point source measures and unspecified emission reductions needed to reach attainment. For the selected standard of 0.15 $\mu g/m^3$, over 94% of the estimated emission reductions needed for attainment are achieved through application of identified controls, and less than 6% through unspecified emission reductions. Identified point source controls include known measures for known sources that may be implemented to attain the selected standard, whereas the achievement of unspecified emission reductions requires implementation of hypothetical additional measures in areas that would not attain the selected standard following the implementation of identified controls to known sources.

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[1] The costs presented in this chapter represent the direct pollution control expenditures associated with NAAQS compliance. As such, they do not reflect the general equilibrium impacts of the final rule.

Note that the universe of sources achieving unspecified emission reductions beyond identified controls is not completely understood; therefore we are not able to identify known control devices or work practices to achieve these reductions. We calculated extrapolated costs for unspecified emission reductions using two different methods. Both acknowledge the lack of data for this analysis. One estimates the extrapolated cost based upon recognition that the marginal cost of reducing progressively smaller amounts of emissions will increase over time. This approach estimates a total cost curve given the identified control data and estimates the additional incremental extrapolated cost. The other approach estimates extrapolated costs by costing the remaining air quality increment to attainment in each monitor area using an area-specific cost per microgram of air quality improvement. Section 6.1 below describes in more detail our approaches for estimating both the costs of identified controls and the extrapolated costs of unspecified emission reductions needed beyond identified controls.

As is discussed throughout this RIA, the technologies and control strategies selected for this analysis are illustrative of one approach that nonattainment areas may employ to comply with the revised lead standard. Potential control programs may be designed and implemented in a number of ways, and EPA anticipates that State and Local governments will consider those programs that are best suited for local conditions. As such, the costs described in this chapter generally cover the annualized costs of purchasing, installing, and operating the referenced technologies. We also present monitoring costs. Because we are uncertain of the specific actions that State Agencies will take to design State Implementation Plans to meet the revised standard, we do not estimate the costs that government agencies may incur to implement these control strategies.

The methods used in the analysis for the final NAAQS differ from those used in the analysis for the proposed NAAQS in the following ways:

1. As discussed in Chapter 4, we updated the control efficiency and cost information for many of the identified emission controls used in the Proposed Rule RIA. We determined that the values originally provided by AirControlNET were unlikely to reflect the performance and cost of these controls in 2016, the analysis year for this RIA.

2. We changed the way we estimated extrapolated costs of unspecified emission reductions. In the Proposed Rule analysis, we applied a fixed cost/ton of lead emissions reduced beyond identified controls, based on the 98th percentile of the cost/ton for identified controls at large point sources. We recognize that a single fixed cost of control does not account for the different sets of conditions that might describe situations where controls are needed beyond identified controls. In this analysis, we instead estimate extrapolated costs by two approaches, the cost curve approach and the ambient extrapolation approach.

3. Rather than applying particulate matter (PM) emission controls to the primary lead smelter in Jefferson County, Missouri, we simulated a complete rebuild of the smelter to utilize a less-polluting smelting process. We estimated the cost of this rebuild based on the experience of a lead smelter in Trail, British Columbia that underwent a similar process in the mid 1990s.

We describe these changes to the analysis relative to the RIA for the proposed NAAQS in greater detail throughout this chapter.

6.1 Engineering Cost Estimates

6.1.1 Data and Methods: Identified Control Costs

Consistent with the emissions analysis presented in Chapter 3, our analysis of the costs associated with the final lead NAAQS focuses on point source particulate matter (PM) controls. For the purposes of this analysis, these controls largely include measures from the AirControlNET control technology database. The analysis also includes additional measures associated with operating permits, upgrades to existing PM control devices, and/or New Source Performance Review standards applicable to sources similar to those included in our analysis.

6.1.1.1 AirControlNET Control Costs

AirControlNET, a PC based database tool that EPA has used extensively for previous analyses of air pollution control costs, served as the primary source of cost information for our analysis of the final lead NAAQS. For the analysis of the final lead NAAQS, AirControlNET used one of two methods to estimate the costs of a given control:

1. *Dollar per ton of* PM_{10} *controlled.* For minor PM controls (i.e., increased monitoring frequency for PM controls and improvements to continuous emissions monitoring systems), AirControlNET estimates costs by applying a fixed cost per ton value to the tonnage of PM controlled.[2]

2. *Hybrid - cost per ton/detailed cost function.* For several PM emissions controls, AirControlNET includes a detailed cost equation that estimates costs as a function of several key engineering parameters, such as the source's capacity or stack flow rate. AirControlNET uses these equations only if a source's stack flow rate is at least 5 cubic feet/minute. If the stack flow rate is below this threshold, AirControlNET applies a fixed cost per ton value to the tonnage of PM_{10} controlled.[3] AirControlNET employs this hybrid approach for most of the major PM controls included in our analysis.[4]

To estimate costs based on the cost per ton values described under items 1 and 2 above, it was necessary to first estimate the reduction in $PM_{2.5}$ or PM_{10} emissions for each relevant source. Where possible, we developed these estimates based on the baseline PM emissions of each source, as adapted from the 2002 NEI, and the estimated control efficiency of each measure.[5] The 2002 NEI, however, does not include baseline PM emissions data for many of the sources

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[2] In some cases, this cost/ton value is specific to $PM_{2.5}$, while in other cases it is specific to all PM.

[3] This stands in contrast to the cost/ton values for the controls summarized under method 1, which are estimated as a cost/ton of $PM_{2.5}$ controlled or cost/ton of total PM controlled.

[4] By major controls, we mean all controls except for increased monitoring frequency and improvements to continuous monitoring systems.

[5] Chapter 4 describes the adjustments that we made to the 2002 NEI to account for controls expected to be implemented prior to the 2016 target year for this analysis.

included in our analysis. For each of these sources, we employed one of two approaches to estimate baseline PM emissions:

1. *SPECIATE approach.* EPA's SPECIATE database includes sample PM speciation profiles for a variety of sources and maps these profiles to individual source classification codes (SCCs). For lead sources with SCCs represented by these profiles, we estimated baseline $PM_{2.5}$ and PM_{10} emissions based on the baseline lead emissions of these sources and the corresponding PM speciation profile in SPECIATE. For example, if a source has baseline lead emissions of 0.02 tons/year and the SPECIATE database suggests that lead, on average, represents two percent of the PM_{10} emissions for other sources that share its SCC, we assume that the source emits one ton of PM_{10}/year in the baseline. We used this approach to estimate the baseline $PM_{2.5}$ and PM_{10} emissions of all sources for which the 2002 NEI includes no PM emissions data but that are represented by the speciation profiles in SPECIATE.[6]

2. *Average speciation approach*. Although SPECIATE includes speciation profiles for a wide range of sources, the database does not include profiles applicable to all of the sources included in our analysis. Therefore, we were unable to use SPECIATE to estimate the baseline $PM_{2.5}$ and PM_{10} emissions for several of the lead sources for which the 2002 NEI includes no PM data. For these sources, we estimated baseline $PM_{2.5}$ and PM_{10} emissions based on the PM speciation profile of lead sources included in our analysis for which the 2002 NEI includes PM emissions data. Our analysis of these sources suggests that lead represents approximately 1.4 percent of their PM_{10} emissions and 1.9 percent of their $PM_{2.5}$ emissions. We assume that these values apply to all lead sources for which the 2002 NEI includes no PM emissions estimates and for which SPECIATE includes no relevant PM speciation profiles.

Within AirControlNET's standard format, the tool provides estimates of control costs for direct PM controls only for those sources emitting 10 or more tons of PM_{10} per year. Because many of the point sources included in our analysis fall below this emissions threshold, we have changed this standard format so that AirControlNET can apply direct PM controls to sources emitting any amount of PM_{10}.[7] The cost equations and cost per ton values for major controls, however, do not necessarily apply with great accuracy to such controls for sources below this PM emissions threshold.

To better estimate the costs of direct PM controls for such small point sources, we used AirControlNET's technology-specific cost estimates for these sources in order to estimate cost per ton values for small sources. Such costs may be quite high on a per ton basis; for example, applying a pulse-jet fabric filter on a PM_{10} source with less than 10 tons per year yields a cost per ton of $558,000. We expect that application of these point source controls to such small PM

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[6] U.S. EPA, SPECIATE Version 4.0, updated January 18, 2007, http://www.epa.gov/ttn/chief/software/speciate/index.html>.

[7] In this analysis, we apply controls to small point sources with emissions below the 10 tons per year PM_{10} AirControlNET application threshold. We apply controls to small point sources due to the extent of lead nonattainment associated with the alternative standards examined in this RIA and the lack of identified point source and other controls available to examine attainment with these standards as noted in Chapter 4.

sources will be highly limited in actual practice for lead SIPs. More information on these point source controls can be found in the AirControlNET control measures documentation.[8]

As noted above, we adjusted AirControlNET's control efficiency values for a number of the emissions controls used in the Proposed Rule analysis to reflect improvements in control efficiency likely to be realized for these technologies by the 2016 target year of this analysis.[9] A number of recent EPA references provided findings that showed that increases in PM control efficiencies from those applied in our proposal RIA were reasonable for a future year analysis. These references include EPA fact sheets published in 2003 that summarize the capabilities of PM control measures and associated data. This information provided more recent data on control efficiencies and costs for PM control measures than is currently in AirControlNET. All of these fact sheets can be found at http://www.epa.gov/ttn/catc/products.html#aptecfacts. We revised the control efficiencies, and also the capital and annualized costs for these PM control devices as listed above to reflect the increased control efficiencies associated with these control measures.[10]

To account for the costs of these improvements, we also modified AirControlNET's cost estimates for these technologies as follows:

- *Fabric filters:* The estimated cost increase for fabric filters reflects an upgrade of fabric filter bags and an increase in the number of bags used by each fabric filter.
    - Pulse-Jet: Capital costs increased by 75 percent. O&M costs increased by 20 percent.
    - Mechanical Shaker: Capital costs increased by 30 percent. O&M increased by 7 percent.
    - Reverse-Air or Reverse-Jet: Capital costs increased by 40 percent. O&M increased by 5 percent.

- *Paper/Nonwoven Filters - Cartridge Collector Type:* The estimated cost increase for these units reflects the incremental cost of a more advanced filter material.

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[8] Available at http://www.epa.gov/ttnecas1/models/DocumentationReport.pdf.

[9] PM control efficiencies were increased for the following control measures: dry and wet ESPs, all types of fabric filters, venturi scrubbers, impingement-plate/tray-tower scrubbers, and paper/nonwoven filters - cartridge collectors.

[10] These fact sheets are the following: U.S. EPA-CICA Air Pollution Technology Fact Sheet: Paper/Nonwoven Filters - Cartridge Collector Type with Pulse-Jet Cleaning. EPA-452/F-03-004. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Impingement-Plate/Tray-Tower Scrubber. EPA-452/F-03-012. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Venturi Scrubber. EPA-452/F-03-017. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Fabric Filter - Mechanical Shaker Cleaned Type. EPA-452/F-03-024. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Fabric Filter - Pulse-Jet Cleaned Type. EPA-452/F-03-025. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Fabric Filter - Reverse-Air Cleaned Type. EPA-452/F-03-026. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Dry Electrostatic Precipitator (ESP) - Wire-Plate Type. EPA-452/F-03-028. 2003.

U.S. EPA-CICA Air Pollution Technology Fact Sheet: Wet Electrostatic Precipitator (ESP) - Wire-Plate Type. EPA-452/F-03-030. 2003.

  - Capital cost increase: 75 percent.
  - O&M increase: 10 percent.

- *Dry or Wet ESP:* For ESPs, the estimated increase in costs reflects additional charging inside the ESP.
  - Capital cost increase: 25 percent.
  - O&M increase: 10 percent.

- *Venturi Scrubber:* The cost increase for venturi scrubbers reflects an upgrade in scrubber material and higher operating pressure.
  - Capital cost increase: 35 percent.
  - O&M increase: 40 percent.

6.1.1.2 Control Measure Upgrades and Controls Identified from New Source Performance Standards and Recent Operating Permits

In addition to controls included in AirControlNET, our analysis of the costs associated with the final lead NAAQS reflects the potential implementation of controls identified from other sources. These include measures enumerated in recent operating permits for sources similar to those included in this RIA as well as measures that new and modified/reconstructed sources of PM emissions are expected to implement for compliance with New Source Performance Standards. The specific measures identified for these sources include the following:

- *Capture hoods vented to a baghouse at iron and steel mills:*
  - We estimate the annualized costs for this control measure at \$5,000/ton of $PM_{2.5}$ emission reduction.[11]

- *Diesel particulate filter (DPF) (for stationary sources such as diesel generators);*
  - We have taken the control efficiency and cost data from technical support documents prepared for the U.S. EPA as part of analyses undertaken for the final compression-ignition NSPS.[12] The annualized cost for $PM_{2.5}$ reductions from applying DPF is \$9,000/ton.

- *Upgrade of CEMs and increased monitoring frequency of PM controls (for sources where not already identified as a control by ACN).*
  - The annualized costs for this control range from \$600 to \$5,200/ton of $PM_{2.5}$. This control is applicable to ESPs and baghouses at both EGU and non-EGU sources.[13] This

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[11] U.S. Environmental Protection Agency. Regulatory Impact Analysis for the Particulate Matter NAAQS. October, 2006. Chapter 3, p. 3-13. This document is available at http://www.epa.gov/ttn/ecas/regdata/RIAs/Chapter%203--Controls.pdf.

[12] U.S. Environmental Protection Agency. "Emission Reduction Associated with NSPS for Stationary CI ICE." Prepared by Alpha-Gamma, Inc. June 3, 2005, and U.S. Environmental Protection Agency. "Cost per Ton for NSPS for Stationary CI ICE." Prepared by Alpha-Gamma, Inc. June 9, 2005.

[13] U.S. Environmental Protection Agency. Regulatory Impact Analysis for the Particulate Matter NAAQS. October, 2006. Appendix E, pp. E-16 to E-24. This document is available at http://www.epa.gov/ttn/ecas/regdata/RIAs/Appendix%20E--Controls%20List.pdf.

control was applied to existing sources identified as having ESPs and baghouses according to their operating permits.

6.1.1.3 Costs of Rebuilding the Primary Lead Smelter in Jefferson County, Missouri

In the proposed rule RIA, a significant portion of the estimated costs of the rule— ranging from 55 percent for the 0.05 $\mu g/m^3$ standard to 95 percent for the 0.3 $\mu g/m^3$ standard—reflected the implementation of emission reductions beyond identified controls at the primary lead smelter in Jefferson County, Missouri. To reduce the extent to which the estimated costs of the lead NAAQS depend on emission reductions beyond identified controls at a single facility, EPA estimated the cost of replacing the Jefferson County smelter's current lead smelting unit with a more modern, lower-emitting Kivcet furnace, similar to the unit that Teck Cominco built in the mid-1990s at the primary lead smelter it operates in Trail, British Columbia[15]. In addition to the facility in Trail, BC, the Kivcet process is currently employed at plants in Kazakhstan, Bolivia, and Italy.[14] While more targeted measures may allow the smelter in Jefferson County to reduce its lead emissions more cost effectively than the replacement of its smelting unit, information on such measures is not available. In the absence of this information, we use the estimated costs of building and opening a Kivcet furnace at the Jefferson County facility as a reasonable indicator of the facility's *potential* identified control lead abatement costs. Our approach for estimating these costs is as follows:

1. *Obtain cost information on the Teck Cominco Kivcet furnace:* According to Cominco's 1996 annual report, the total cost of building the Kivcet furnace was approximately $152 million (year 1996 Canadian dollars).[15] In addition, based on communications with the facility's management, we estimate that the facility incurred additional costs of approximately $30.4 million (year 1996 Canadian dollars) to address unanticipated operational problems with the Kivcet furnace after it was initially brought online in 1997, bringing the total cost of the project to approximately $182.4 million (year 1996 Canadian dollars).[16] Converting to U.S. dollars and adjusting for inflation, this translates to approximately $184.5 million in year 2006 U.S. dollars.[17]

2. *Scale Teck Cominco's costs to reflect the capacity of the primary smelter in Jefferson County:* The capacity of the primary lead smelter in Jefferson County is significantly higher than that of Teck Cominco's Trail facility—250,000 tons per year for the Jefferson County smelter versus 132,000 tons per year for the Trail facility. Scaling the cost of the Teck Cominco Kivcet furnace to account for this difference in capacity, we estimate that the total upfront cost of building a Kivcet furnace at the Jefferson County smelter would be approximately $349 million.

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[14] The Eastern Mining and Metallurgical Research Institute for Non-Ferrous Metals, Pyrometallurgy. http://vcm.ukg.kz/eng/v3_6.htm. Accessed September 23, 2008.

[15] Cominco Ltd. 1996 Annual Report, p. 12. Cominco and Teck Corporation merged in 2001 to form Teck Cominco Limited.

[16] According to the general manager of Teck Cominco's Trail operations, these additional costs were equal to approximately 20 percent of the construction costs for the Kivcet furnace. Personal communication with Mike Martin, general manager of Teck Cominco's Trail operations, August 25, 2008.

[17] To adjust for inflation, we use the *Engineering News Record* construction cost index.

3. *Annualize Kivcet furnace construction costs:* To annualize the estimated $349 million in costs for the construction of a Kivcet furnace at the primary lead smelter in Jefferson County, we assume that the furnace would have a 30-year lifespan. Based on this assumption, we estimate annualized costs of $31.7 million, using a 3 percent discount rate, and $42.0 million, applying a 7 percent discount rate.

Based on Teck Cominco's experience, transitioning to a Kivcet furnace could potentially reduce O&M costs for the primary lead smelter in Jefferson County. After the Kivcet furnace went online at Teck Cominco's Trail facility in 1997, its O&M costs declined significantly, largely due to reduced labor costs.[18] We do not incorporate potential O&M savings into our cost assessment for the Jefferson County smelter; therefore, we may overestimate the *net* costs associated with installing a Kivcet furnace at the facility.

6.1.2 Engineering Cost Estimates for Identified Controls

Based on the data and methods outlined above, we estimated the costs associated with implementing the control strategies presented in Chapter 4. Table 6-1 summarizes these costs by monitor area. As indicated in the table, the estimated costs of these controls under the selected standard are approximately $150 million per year, assuming a discount rate of seven percent. Applying a three percent discount rate this value becomes $130 million per year. The annual costs of identified controls under the alternative standards included in Table 6-1 range from $57 million under the 0.5 µg/m^3 standard to $180 million under the 0.1 µg/m^3 standard, assuming a discount rate of seven percent. If we apply a three percent discount rate, these values adjust to $46 million and $160 million for the 0.5 and 0.1 µg/m^3 standards, respectively. Consistent with Chapter 4's summary of the air quality impacts associated with identified controls, the cost estimates in Table 6-1 reflect partial attainment with several of the standards examined in this RIA. For the selected standard of 0.15 µg/m^3, the costs in Table 6-1 reflect attainment in 13 of the 21 monitor areas included in this analysis.

The results in Table 6-1 illustrate that the costs of the selected standard are likely to vary by monitor area. The costs of identified measures are expected to be highest in Jefferson County, Missouri. As indicated in Chapter 4, Jefferson County has the highest baseline lead emissions of any county in the U.S. This largely reflects emissions from the primary lead smelter located in the county. Table 6-2 presents the costs of identified controls/pound of lead emissions avoided in each monitor area. The estimates presented in this table suggest that, in general, the cost/pound of avoided lead emissions increases significantly for a given monitor as the standard becomes more stringent. For example, the cost/pound for Delaware County, Indiana steadily increases from $700/pound under the 0.5 µg/m^3 standard to $3,100/pound under the 0.1 µg/m^3 standard, assuming a 7 percent discount rate. This is consistent with local areas first targeting sources where relatively low cost reductions may be achieved and subsequently achieving reductions from sources that are more costly to control (i.e., moving up the area's marginal abatement cost curve).

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[18] Personal communication with Mike Martin, general manager of Teck Cominco's Trail operations, August 25, 2008.

Table 6-1

ANNUAL COSTS RELATED TO IDENTIFIED CONTROLS*

Monitor State	Monitor County	Annual Cost of Identified Controls in 2016 (Millions of 2006$)											
		Standard Alternative: 0.5 µg/m^3 2nd Maximum Monthly Mean**		Standard Alternative: 0.4 µg/m^3 2nd Maximum Monthly Mean**		Standard Alternative: 0.3 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.2 µg/m^3 2nd Maximum Monthly Mean		Selected Standard: 0.15 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.1 µg/m^3 2nd Maximum Monthly Mean	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
AL	Pike	$3.1	$3.3	$3.1	$3.3	$3.1	$3.3	$4.0	$4.2	$4.3	$4.6	$4.3	$4.6
CO	El Paso	-	-	-	-	-	-	-	-	-	-	$0.2	$0.2
FL	Hillsborough	<$0.1	<$0.1	<$0.1	<$0.1	$0.4	$0.4	$0.8	$0.9	$0.8	$0.9	$1.4	$1.5
IL	Madison	-	-	-	-	-	-	-	-	-	-	$13	$14
IN	Delaware	$1.8	$1.9	$1.8	$1.9	$3.6	$3.8	$5.4	$5.7	$6.1	$6.5	$8.5	$9.0
MN	Dakota	-	-	-	-	-	-	-	-	<$0.1	<$0.1	$2.4	$2.5
MO	Iron	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7
MO	Jefferson	$32	$42	$32	$42	$32	$42	$32	$42	$32	$42	$32	$42
NY	Orange	-	-	-	-	-	-	<$0.1	<$0.1	<$0.1	<$0.1	<$0.1	<$0.1
OH	Cuyahoga	-	-	-	-	$30	$32	$30	$32	$30	$32	$30	$32
OH	Fulton	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5
OH	Logan	-	-	-	-	-	-	-	-	-	-	-	-
OK	Ottawa	-	-	-	-	-	-	-	-	-	-	-	-
PA	Beaver	-	-	-	-	-	-	$11	$12	$35	$37	$35	$37
PA	Berks	<$0.1	<$0.1	<$0.1	<$0.1	$11	$12	$11	$12	$11	$12	$11	$12
PA	Carbon	-	-	-	-	-	-	<$0.1	<$0.1	<$0.1	<$0.1	<$0.1	<$0.1
TN	Sullivan	-	-	-	-	-	-	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4
TN	Williamson	$1.0	$1.1	$1.0	$1.1	$1.3	$1.4	$1.3	$1.4	$2.8	$3.0	$3.4	$3.6
TX	Collin	<$0.1	<$0.1	<$0.1	<$0.1	<$0.1	<$0.1	$2.0	$2.1	$2.3	$2.5	$3.3	$3.5
TX	Dallas	-	-	-	-	-	-	-	-	-	-	$7.0	$8.4
UT	Salt Lake	-	-	-	-	-	-	-	-	-	-	<$0.1	<$0.1
Total		**$46**	**$57**	**$46**	**$57**	**$89**	**$100**	**$110**	**$120**	**$130**	**$150**	**$160**	**$180**

*All estimates rounded to two significant figures. As such, totals will not sum down columns.

** Identified Control Costs are the same for alternative standard 0.5 µg/m^3 and for alternative standard 0.4 µg/m^3. This is because the same monitor areas violate both standards and the same controls were chosen in the least cost optimization for both standard alternatives.

Table 6-2.
ANNUAL COST/POUND OF REDUCED LEAD EMISSIONS: IDENTIFIED CONTROLS[*]

		Annual Cost/Pound for Identified Controls in 2016 (2006$)											
		Standard Alternative: 0.5 $\mu g/m^3$ 2nd Maximum Monthly Mean**		Standard Alternative: 0.4 $\mu g/m^3$ 2nd Maximum Monthly Mean**		Standard Alternative: 0.3 $\mu g/m^3$ 2nd Maximum Monthly Mean		Standard Alternative: 0.2 $\mu g/m^3$ 2nd Maximum Monthly Mean		Selected Standard: 0.15 $\mu g/m^3$ 2nd Maximum Monthly Mean		Standard Alternative: 0.1 $\mu g/m^3$ 2nd Maximum Monthly Mean	
Monitor State	Monitor County	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
AL	Pike	$400	$400	$400	$400	$400	$400	$500	$500	$500	$500	$500	$500
CO	El Paso	-	-	-	-	-	-	-	-	-	-	$170,000	$170,000
FL	Hillsborough	<$100	<$100	<$100	<$100	$200	$200	$300	$400	$300	$400	$600	$600
IL	Madison	-	-	-	-	-	-	-	-	-	-	$75,000	$79,000
IN	Delaware	$700	$700	$700	$700	$1,300	$1,400	$1,900	$2,000	$2,100	$2,200	$2,900	$3,100
MN	Dakota	-	-	-	-	-	-	-	-	<$100	<$100	$400	$400
MO	Iron	$300	$300	$300	$300	$300	$300	$300	$300	$300	$300	$300	$300
MO	Jefferson	$300	$500	$300	$500	$300	$500	$400	$500	$400	$500	$400	$500
NY	Orange	-	-	-	-	-	-	<$100	<$100	<$100	<$100	<$100	<$100
OH	Cuyahoga	-	-	-	-	$120,000	$130,000	$120,000	$130,000	$120,000	$130,000	$120,000	$130,000
OH	Fulton	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100	$5,100
OH	Logan	-	-	-	-	-	-	-	-	-	-	-	-
OK	Ottawa	-	-	-	-	-	-	-	-	-	-	-	-
PA	Beaver	-	-	-	-	-	-	$8,300	$9,000	$24,000	$25,000	$24,000	$25,000
PA	Berks	<$100	<$100	<$100	<$100	$3,500	$3,700	$3,500	$3,700	$3,500	$3,700	$3,500	$3,700
PA	Carbon	-	-	-	-	-	-	$1,400	$1,400	$1,400	$1,400	$1,400	$1,400
TN	Sullivan	-	-	-	-	-	-	$120,000	$130,000	$120,000	$130,000	$120,000	$130,000
TN	Williamson	$400	$400	$400	$400	$300	$400	$300	$400	$600	$700	$700	$800
TX	Collin	<$100	<$100	<$100	<$100	<$100	<$100	$400	$400	$400	$500	$600	$600
TX	Dallas	-	-	-	-	-	-	-	-	-	-	$90,000	$1,100,00
UT	Salt Lake	-	-	-	-	-	-	-	-	-	-	<$100	<$100
Total		**$300**	**$400**	**$300**	**$400**	**$600**	**$700**	**$700**	**$800**	**$900**	**$1,000**	**$1,000**	**$1,200**

[*] All estimates rounded to two significant figures. As such, totals will not sum down columns

** Identified Control Costs are the same for alternative standard 0.5 $\mu g/m^3$ and for alternative standard 0.4 $\mu g/m^3$. This is because the same monitor areas violate both standards and the same controls were chosen in the least cost optimization for both standard alternatives.

6.1.3 Extrapolated Costs

Prior to presenting the methodology for estimating costs for unspecified emission reductions, it is important to provide information from EPA's Science Advisory Board Council Advisory on the issue of estimating costs of unidentified control measures.[19]

> *812 Council Advisory, Direct Cost Report, Unidentified Measures (charge question 2.a):*
>
> *"The Project Team has been unable to identify measures that yield sufficient emission reductions to comply with the National Ambient Air Quality Standards (NAAQS) and relies on unidentified pollution control measures to make up the difference. Emission reductions attributed to unidentified measures appear to account for a large share of emission reductions required for a few large metropolitan areas but a relatively small share of emission reductions in other locations and nationwide.*
>
> *"The Council agrees with the Project Team that there is little credibility and hence limited value to assigning costs to these unidentified measures. It suggests taking great care in reporting cost estimates in cases where unidentified measures account for a significant share of emission reductions. At a minimum, the components of the total cost associated with identified and unidentified measures should be clearly distinguished. In some cases, it may be preferable to not quantify the costs of unidentified measures and to simply report the quantity and share of emissions reductions attributed to these measures.*
>
> *"When assigning costs to unidentified measures, the Council suggests that a simple, transparent method that is sensitive to the degree of uncertainty about these costs is best. Of the three approaches outlined, assuming a fixed cost/ton appears to be the simplest and most straightforward. Uncertainty might be represented using alternative fixed costs per ton of emissions avoided."*

EPA has considered this advice and the requirements of E.O. 12866 and OMB circular A-4, which provides guidance on the estimation of benefits and costs of regulations.

EPA estimated the costs of unspecified future controls using two approaches. The first is calculated by estimating a cost curve for the identified control costs and extrapolating the cost of the remaining unspecified emission reductions. The second approach is the ambient extrapolation approach, this approach uses an average cost per microgram for each area. We

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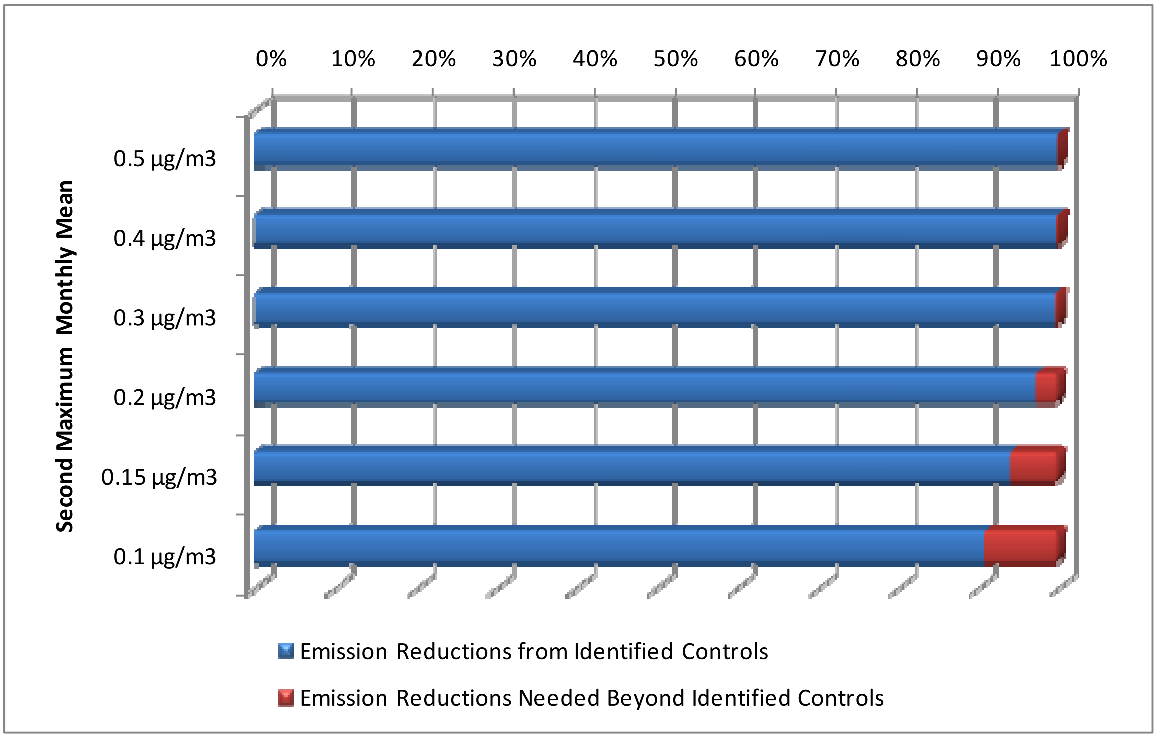
[19] U.S. Environmental Protection Agency, Advisory Council on Clean Air Compliance Analysis (COUNCIL), *Council Advisory on OAR's Direct Cost Report and Uncertainty Analysis Plan*, Washington, DC. June 8, 2007.

believe this approach best represents a fixed cost approach given the data limitations of this analysis. Please note, the fixed cost methodology was preferred by EPA's Science Advisory Board over two other options, including a marginal cost-based approach. Extrapolated costs were calculated for the recent Ozone NAAQS RIA, and they are calculated again here for the final Lead NAAQS. EPA has developed a few approaches to try to estimate the extrapolated costs of future unspecified emissions reductions, which take into account the analysis context and data availability. Now that EPA has gained some additional experience in estimating the extrapolated costs for these two RIAs, we intend to seek additional SAB advice on extrapolated cost approaches after further investigation of these and other approaches.

As indicated above the identified control costs reflected in Tables 6-1 and 6-2 do not result in attainment of the selected or alternative standards in several areas. In these areas, unspecified emission reductions needed beyond identified controls will likely be necessary to reach attainment. As noted in chapter 4, the overwhelming majority of emissions reductions needed to attain the various target NAAQS levels would be obtained from identified controls (see table 4-6). Also, the unspecified emission reductions needed beyond identified controls are small enough to fall within the expected error associated with the precision of the modeling of the emissions. Figure 6-1 below illustrates this point: the percentage of remaining emissions after applying identified controls ranges from a low of 0.03% to a high of only 9.23%.

Figure 6-1.
PERCENTAGE OF REMAINING EMISSION REDUCTIONS NEEDED POST APPLICATION OF IDENTIFIED CONTROLS



The estimation of engineering costs for unspecified emission reductions needed to reach attainment many years in the future is inherently a difficult issue. As described later in this chapter, our experience with Clean Air Act implementation shows that technological advances and development of innovative strategies can make possible emissions reductions that are unforeseen today, and to reduce costs of emerging technologies over time. But we cannot quantitatively predict the amount of technology advance in the future. For areas needing significant additional emission reductions, much of the control must be for sources that historically have not been controlled. The relationship of the cost of such control to the cost of control options available today is not at all clear. Available, current known control measures increase in cost beyond the range of what has ever been implemented and would still not provide the needed additional control for full attainment in the analysis year 2016.

The emission inventories, air quality modeling, and control options that would address these very small remaining increments of lead in ambient air are highly uncertain. In the RIA for the proposed NAAQS, a fixed cost of $32 million/ton, or $16,000/lb. in 2006 dollars was applied to the unspecified emission reductions needed beyond identified controls. This fixed cost was consistent with the 98th percentile of total possible emission reductions for identified controls.

We recognize that a single fixed cost of control does not account for the different sets of conditions that might describe situations where controls are needed beyond identified controls. Recall that we did not cap identified control costs in the final RIA analysis because we lack good information regarding lead emission controls on small emission sources. This same lack of information also makes it difficult to extrapolated costs using either of the techniques described below. Therefore in this RIA for the final Pb NAAQS, we take a broader approach to estimating the costs associated with the remaining increment to attainment.

Finally, it is also important to emphasize here that the universe of sources where unspecified emission reductions beyond identified controls are achieved is not completely understood; therefore, we are not able to identify known control devices or work practices to achieve these reductions.

We expect that additional control measures that we were not able to identify may be available today, or may be developed by 2016. We believe such an expectation is reasonable for the following reasons:

1. Because the revised Pb NAAQS is ten times lower than the previous standard, the Pb emission inventory has not been used in the past for estimating controls for such small sources of lead emissions. Thus the quality control of data in the emission inventory may not have been appropriate for this use of the emission inventory. For example, some sources for which we know of no control may be incorrectly characterized; leading us to believe, incorrectly, that no appropriate control is available.

2. Our knowledge of add-on controls is greater than our knowledge of process modifications. For example in the months since proposal of the revised NAAQS, we conducted additional research and discovered the process modification used in the analysis for Herculaneum. There may be other similar modifications available today that we do not know about.

3. Controls for emission sources other than point sources may be available but are not captured under the data constraints built into the air quality monitor to emissions source relationship used to estimate air quality improvement.

On the other hand, there are several reasons why identified controls may not be sufficient to reach attainment in a given monitor area:

1. There may be no other available controls that are similar to the identified controls. For example, the area might be characterized by emissions from several very large sources. This is true in only a few areas (e.g., Jefferson County, MO). In these areas, there may be large reductions achieved with identified or even pre-existing controls, but there are no further known controls available to reduce the remaining emissions after those identified controls are applied.

2. It is possible that fugitive dust emissions from area sources containing deposited Pb will also contribute to violations of the NAAQS, or that historically deposited Pb, when disturbed, may be re-entrained into the ambient air. These fugitive or area source controls may be more expensive than the identified controls.

3. More expensive process modifications may be the only way to reduce the remaining emissions.

Finally, there is uncertainty inherent in estimating the progress in development of control measures that will occur between today and 2016. For example:

1. Technological change unrelated to this regulation may lead to different baseline emissions or changes in industrial processes (e.g. will battery technology changes lead to fewer lead battery recycling facilities?).

2. Changes in pollution control technology may make more control options available or reduce the costs of current ones.

3. Some emissions sources may close rather than impose the identified controls (in this case the cost of identified controls has been overestimated and the emission reduction has been underestimated).

There are many limitations to each approach taken to estimate the extrapolated costs of unspecified emissions, for example:

- The ambient extrapolation methodology emphasizes control costs that are the most expensive within an area, and assumes that knowledge of control costs from monitor areas that attain have no influence on the average control costs for areas that need unspecified emission reductions. It also assumes there will be no increased knowledge of sources or changed in technology between now and 2016. Lastly, most of the costs are based upon areas that make less than 1% progress towards attainment, indicating what little knowledge we have about controls in those areas.

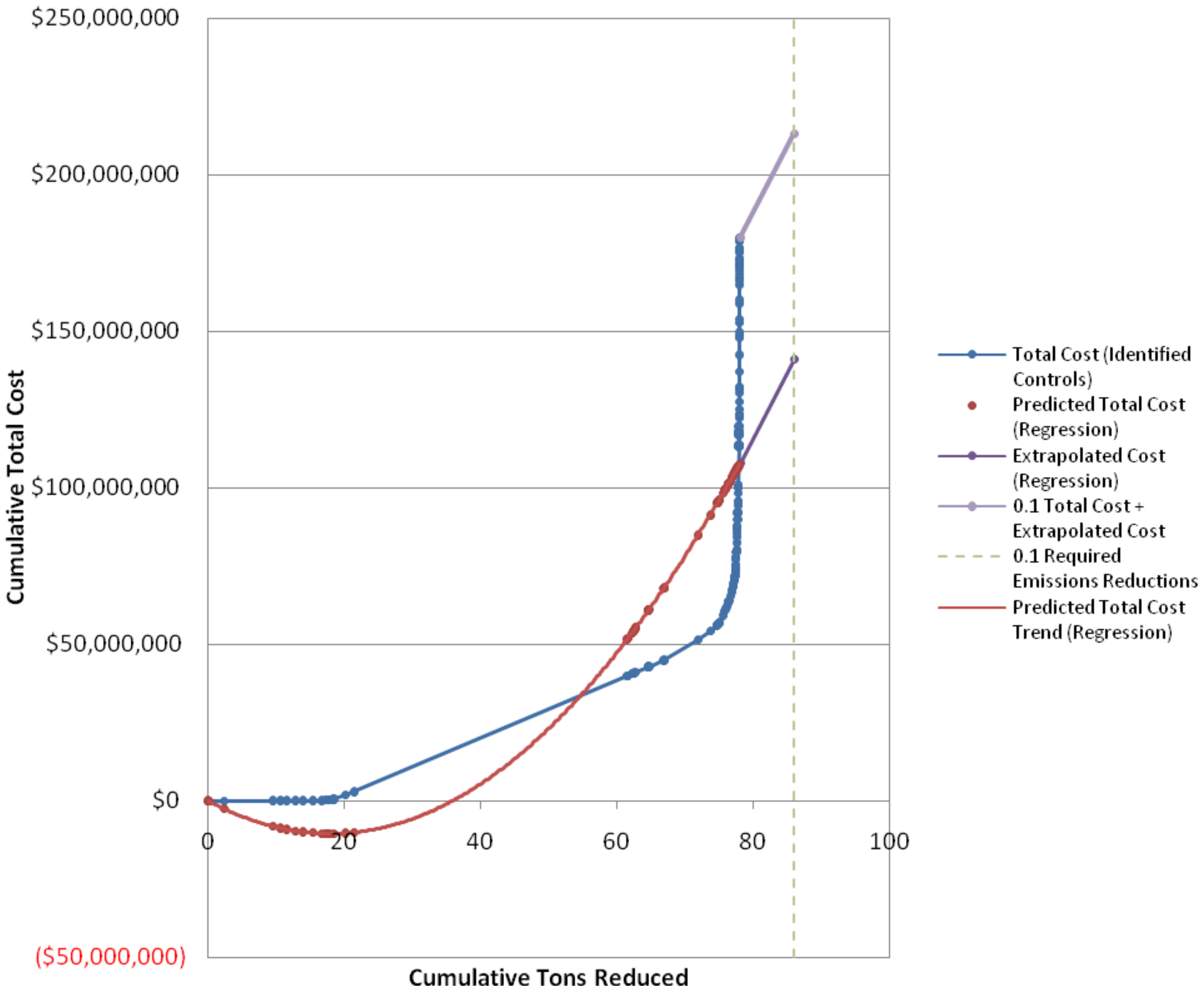
- The cost curve methodology presents a poor conceptual relationship between the costs of identified controls at a national level and the costs of control at a local level. The data this curve is developed upon contains data points which we believe to be invalid (presented as part of the distributional analysis in Section 6.1.3.2). The estimated curve estimates negative costs over a portion of emission reductions. In addition this approach relies heavily on the control strategy for tightest standard alternative analyzed in this RIA, and does not account for variability in control strategies across alternative standards analyzed. Lastly, we do not believe this curve well represents the knowledge of how control costs behave over time.

6.1.3.2 Estimated Cost Curve Approach

The cost curve method was used to estimate extrapolated costs and the associated total cost of meeting the selected and alternative standards analyzed. However, before describing this approach it is again important to note the EPA Science Advisory Board Council's position on the use of similar methods when estimating costs of unidentified control measures (U.S. Environmental Protection Agency. June 2007. Advisory Council on Clean Air Compliance Analysis (COUNCIL), Council Advisory on OAR's Direct Cost Report and Uncertainty Analysis Plan. Washington, DC). The Council advises against any approach that deviates from using a fixed cost/ton estimate such as the approach described below.

This noted, in addition to the SAB advised fixed cost per ton in cases of extreme uncertainty presented earlier, an alternative methods was used to estimate extrapolated costs, involving the use of regression analysis to estimate a total cost curve for the identified controls. The portion of the curve extending beyond emission reductions achieved through identified controls up to the emission reductions required to meet the standard is the extrapolated cost curve. This curve is then appended to the total cost curve whose data was used in the regression to calculate a total cost estimate. These curves can be seen in Figure 6-2 below.

Figure 6-2. COST CURVE APPROACH



The regression approach to estimating extrapolated costs uses the data used to construct the cost curve and estimates the equation *Cumulative Total Cost = Cumulative Emissions Reduced + Cumulative Emissions Reduced*^{2}. The resulting regression equation is *Cumulative Total Cost = -1,175,430 · Cumulative Emissions Reduced + 32,690 · Cumulative Emissions Reduced*^{2}, a graph of which can be seen in Figure 6-2. The adjusted R-squared value for this equation is 0.88, indicating a relatively good fit to the data. All variables are highly significant. Table 6-3 shows the extrapolated costs for each of the analyzed standard levels when using this regression to estimate the cost for the remaining tons required. These estimated costs range from $79,000 for the 0.5 standard to $33 million for the 0.1 standard. For the selected 0.15 standard, the costs are $20 million.

Table 6-3.
EXTRAPOLATED COSTS USING TOTAL COST REGRESSION (7% Discount Rate)

Standard Alternative	Additional emission reductions needed)	Extrapolated cost (M 2006$)
0.5 µg/m^3 2nd Maximum Monthly Mean	0.02	$0.08
0.4 µg/m^3 2nd Maximum Monthly Mean	0.08	$0.32
0.3 µg/m^3 2nd Maximum Monthly Mean	0.29	$1.1
0.2 µg/m^3 2nd Maximum Monthly Mean	2.06	$8.3
0.15 µg/m^3 2nd Maximum Monthly Mean	4.79	$20
0.1 µg/m^3 2nd Maximum Monthly Mean	7.91	$33

6.1.3.2.1 Regression Diagnostics

While the deletion of outliers is a controversial practice in statistics, especially when there is uncertainty as to the underlying distribution of the data, it is an accepted practice in regression to exclude data points that exhibit a large degree of influence on the resulting parameter estimates, while dutifully noting that such exclusions have taken place. Several statistics for measuring the influence of specific data points on estimation results are readily calculated, and for this analysis Cook's Distance, DFFITS, studentized residuals, and leverage statistics were used to identify potentially influential observations.

Before discussion of these results, it may be informative to analyze the descriptive statistics of the variables used to construct the cost curve upon which the extrapolated cost curve using the maximum marginal costs as well as the extrapolated cost curve from the regression analysis are based. These statistics are presented in Table 6-4 below.

Table 6-4.
DESCRIPTIVE STATISTICS FOR VARIABLES USED IN COST CURVE

	Emissions Reduced	Cost per Ton
Number of Observations	211	211
Minimum	0.000000039	2,656
Median	0.0042	12,277,347
Mean	0.37	34,754,959,220
Max	40.05	6,179,483,400,000
Interquartile Range	0.038	224,882,280
Standard Error	2.83	426,342,369,723
Skewness	13.31	14.40
Kurtosis	185.86	208.39

As can be seen by these statistics, these data exhibit a wide range with the median values considerably different from the mean values. The statistics together provide evidence that the distribution of these variables is non-normal. As a result, we may expect the presence of outliers that may bias the regression results.

Estimates of were Cook's Distance, DFFITS, studentized residuals, and leverage were calculated for the regression equation *Cumulative Total Cost = Cumulative Emissions Reduced + Cumulative Emissions Reduced*^{2}. The number of points identified by each of these techniques as influential varied slightly, as seen in Table 6-5.

Table 6-5.
REGRESSION DIAGNOSTICS

Statistic	Cutoff	Identified observations
Cook's Distance	$4/n$	9
DFFITS	$2 \cdot \sqrt{k/n}$	11
Studentized Residuals	±2	19
Leverage	$(2k+2)/n$	0

All of the observations that were deemed influential under the various measures are at the upper portion of the cumulative cost curve (i.e., the last 9, 11, and 19 points on the curve for Cook's Distance, DFFITS, and studentized residuals, respectively). That no points are identified by the leverage statistic is puzzling, and provides some counter-evidence that these points are outliers. Nonetheless, there is significant evidence that the distributions of the underlying variables used to construct the variables used in the regression are non-normal, and three measures of influence identify the upper 10-20 observations as suspect. This calls into question the use of the estimated regression to calculate additional extrapolated costs.

6.1.3.3 Ambient Extrapolation Methodology

To derive costs using this ambient extrapolation methodology, we first examined the seven monitor areas that make some progress towards attainment with identified controls, but cannot reach the target NAAQS. We calculated an average cost per microgram of air quality improvement for each area based upon the identified control costs analysis. For each monitor area, we then applied its area-specific cost per microgram to the remaining air quality increment, in order to calculate the extrapolated cost of attainment. We performed these calculations for each target NAAQS in our analysis.

(Additional ug needed to attain) x ($/ug for identified controls) = Additional cost to attain

There were four areas that made little to no progress towards attainment with identified controls for one or more of the target NAAQS. For these monitor areas, we did not have a cost/ug for identified controls to plug into the above equation. As a surrogate cost/ug, we used the overall average cost/ug of the monitor areas that *had* made some progress towards attainment. To derive the extrapolated costs for each monitor area, we then multiplied that overall average cost/ug by the remaining air quality increment in each of the monitor areas.

(Additional ug needed to attain) x (overall average $/ug for identified controls) =
Additional cost to attain

Table 6-6 presents the cost per air quality improvement for all 11 monitor areas. Table 6-7 presents the total extrapolated costs for each monitor area. As indicated in Table 6-7, the estimated extrapolated costs using this approach are approximately \$3.1 billion per year, assuming a discount rate of seven percent. Applying a three percent discount rate this value becomes \$2.6 billion per year. The annual extrapolated costs for the ambient approach under the each alternative standard analyzed included in Table 6-7 range from \$100 million under the 0.5 $\mu g/m^3$ standard alternative to \$3.9 billion under the 0.1 $\mu g/m^3$ standard alternative, assuming a discount rate of seven percent. If we apply a three percent discount rate, these values adjust to \$89 million and \$3.4 billion for the 0.5 and 0.1 $\mu g/m^3$ standard alternatives, respectively. These costs come out to be much larger than costs under the cost curve approach; this is because they are driven by extremely expensive controls that provide only a very small increment of air quality improvement.

Table 6-6.
COST PER AIR QUALITY IMPROVEMENT BY MONITOR AREA

Monitor State	Monitor County	Annual Cost/Microgram (Millions of 2006$)	
		3% Discount rate	7% Discount rate
CO	El Paso	$330	$340
IL	Madison	$550	$580
MO	Jefferson	$18	$24
OH	Cuyahoga	$730	$780
OH	Fulton *	$3,000	$3,500
OH	Logan *	$3,000	$3,500
PA	Beaver	$1,100	$1,200
PA	Berks	$60	$63
PA	Carbon*	$3,000	$3,500
TN	Sullivan*	$3,000	$3,500
TX	Dallas	$18,000	$22,000

*Represents monitor areas that made less than 1% progress towards attainment with identified controls.

Table 6-7.
AMBIENT APPROACH EXTRAPOLATED COSTS BY MONITOR AREA*

Monitor State	Monitor County	Annual Extrapolated Costs of Emission Reductions Needed Beyond Identified Controls in 2016 (Millions of 2006$)											
		Standard Alternative: 0.5 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.4 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.3 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.2 µg/m^3 2nd Maximum Monthly Mean		Selected Standard: 0.15 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.1 µg/m^3 2nd Maximum Monthly Mean	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
CO	El Paso	-	-	-	-	-	-	-	-	-	-	$10	$10
IL	Madison	-	-	-	-	-	-	-	-	-	-	$2.3	$2.4
MO	Jefferson	-	-	-	-	-	-	$0.7	$0.9	$1.6	$2.1	$2.5	$3.3
OH	Cuyahoga	-	-	-	-	$12	$12	$85	$90	$120	$130	$160	$170
OH	Fulton	$89	$100	$390	$460	$690	$810	$990	$1,200	$1,100	$1,300	$1,300	$1,500
OH	Logan	-	-	-	-	$180	$210	$480	$560	$630	$740	$780	$920
PA	Beaver	-	-	-	-	-	-	-	-	$49	$53	$100	$110
PA	Berks	-	-	-	-	$1.8	$1.9	$7.8	$8.2	$11	$11	$14	$15
PA	Carbon	-	-	-	-	-	-	$280	$330	$430	$510	$580	$690
TN	Sullivan	-	-	-	-	-	-	$110	$130	$260	$300	$410	$480
TX	Dallas	-	-	-	-	-	-	-	-	-	-	$19	$23
Total		**$89**	**$100**	**$390**	**$460**	**$880**	**$1,000**	**$1,900**	**$2,300**	**$2,600**	**$3,100**	**$3,400**	**$3,900**

*All estimates rounded to two significant figures. As such, totals will not sum down columns.

6.1.4 Monitoring Costs

Consistent with the scope of this rulemaking, which includes monitoring provisions, monitoring costs are included here. As part of the regulatory package accompanying the revised standard, revised lead monitoring requirements are being issued. The rule includes revisions to the network design requirements, QA requirements, and the minimum sampling frequency for lead monitoring. These changes will ensure that adequate lead monitoring will be performed to determine compliance with the proposed lead NAAQS. In addition, the level of the standard and the averaging time for the standard directly affect the associated monitoring burden. For the final Pb NAAQS, total monitoring costs are estimated to be $4.2 million, which include $3.2 million for expansion of the monitoring network.

In the final information collection request (ICR), EPA has estimated the potential burden for the final Pb NAAQS (i.e. 0.15 ug/m^3; rolling quarterly average). EPA estimates that there are approximately 260 facilities that would require monitoring at a level of 0.15 µg/m^3 (see: http://www.epa.gov/oar/lead/pdfs/20080502_maps4.pdf). Monitors will also be required in 52 urban areas (those metropolitan statistical areas with a population greater than one million). For more detail, see OMB 2060-0084, ICR #940.21.

6.1.5 Summary of Cost Estimates

Table 6-9 provides a summary of total costs to achieve the selected standard and each alternative standard. As suggested by Tables[20] 6-1, 6-8, the extent to which these costs exceed those associated with identified controls alone increases with the stringency of the standard. This is consistent with the emissions analysis presented in Chapter 4, which suggests that local areas' reliance on emission reductions beyond identified controls would increase as the standard becomes more stringent. Figures 6-3 and 6-4 present the portion of total costs that is represented by identified controls and the portion of costs that is represented by unspecified emission reductions.

The significant difference between the costs of identified controls alone and the cost of achieving attainment (i.e. including both identified controls and emission reductions beyond identified controls) in this and other areas reflects the limited information available to EPA on the control measures that sources may implement. It is important to remember that, compared to recent NAAQS RIAs, our current knowledge of the costs and nature of lead emissions controls is relatively poor. Lead in ambient air has not been a focus for all but a few areas of the country for the last decade or more; the alternative standards represent a substantial tightening of the existing NAAQS. As a result, although AirControlNET contains information on a large number of different point source controls, we would expect that State and local air quality managers would have access to additional information on the controls available to the most significant sources.

It is important to remember also that these cost estimates are highly uncertain. As discussed in the final monitoring provisions, the existing monitoring network will need to be updated. It is possible that some areas shown to be out of attainment based on the current monitoring information will be shown to be in attainment with more recent monitoring. After the revised

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[20] Note there is no breakdown of costs by monitor area for the cost curve approach. This approach was generated at an aggregate level and therefore does not break down costs to local areas.

monitoring network is in place, other areas not identified in this analysis may be found to be violating the new standard. Since many of the existing sources of ambient Pb are relatively small, states are likely to work closely with the sources to reduce emissions in a cost-effective manner.

Note also that if any facility chooses to close rather than incur either the costs associated with identified controls or extrapolated costs then for that facility costs are overestimated and emission reductions are underestimated. We would then also expect the required emission reductions and control costs for other facilities to be lower. We did not attempt to quantify facility closures in this RIA. However, in interpreting the costs, the possibility of savings from closures should be recalled.

Finally, many of the control techniques identified in this analysis do not appear to be cost effective because a high dollar value control has been added to reduce a small amount of Pb emissions – sometimes only a few pounds per year. Rather than applying additional controls, it may be possible for firms emitting small amounts of Pb to modify their production processes or other operational parameters, including pollution prevention techniques, which would be more cost effective than adding additional control technology. Such measures might include increasing the enclosure of buildings, increasing air flow in hoods, modifying operation and maintenance procedures, changing feed materials to lower Pb content, etc. While we have estimated the cost of attainment of this revised NAAQS, we have not accounted for the effect of improvements that tend to occur, such as technology improvement, process changes, efficiency improvements, materials substitution, etc. We believe these typical improvements will tend to result in more cost effective approaches than simply adding extremely expensive pollution controls in many areas by the attainment date of 2016. It is also worth noting that it is possible that fugitive dust emissions from area sources containing deposited Pb will also contribute to violations of the NAAQS, or that historically deposited Pb, when disturbed, may be re-entrained into the ambient air. For areas where point source controls are sufficient to reach attainment, we may have overestimated costs if more cost effective fugitive or area source controls are likely to be available in these areas.

To further inform our understanding of the potential difficulties in reaching attainment, EPA took a closer look at the eight counties for which identified controls are insufficient to attain the final NAAQS of 0.15 ug/m^3 in our analysis. All eight counties contained some type of metals processing facilities, such as battery manufacturers, zinc smelters, and foundries. Some have baghouses for controlling particulate matter, but for others we found no information on applicable controls (possibly because of their relatively low overall particulate emissions). Three of the eight counties host contaminated industrial soil sites that are the focus of significant ongoing remediation efforts (Fulton, OH; Berks, PA; and Carbon, PA). Many of those sites are associated with industrial metals sources including Pb battery manufacturing, Pb battery recycling and disposal, zinc processing, metal alloy production, and iron and steel manufacturing.

Table 6-8. ANNUAL TOTAL COSTS BY MONITOR AREA*
(INCLUDES IDENTIFIED CONTROL COSTS AND EXTRAPOLATED COSTS USING AMBIENT EXTRAPOLATION APPROACH)

Monitor State	Monitor County	Annual Total Costs in 2016 (Millions of 2006$)											
		Standard Alternative: 0.5 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.4 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.3 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.2 µg/m^3 2nd Maximum Monthly Mean		Selected Standard: 0.15 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.1 µg/m^3 2nd Maximum Monthly Mean	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
AL	Pike	$3.1	$3.3	$3.1	$3.3	$3.1	$3.3	$4.0	$4.2	$4.3	$4.6	$4.3	$4.6
CO	Adams	-	-	-	-	-	-	-	-	-	-	$10	$11
CO	Denver	$0.01	$0.01	$0.01	$0.01	$0.38	$0.40	$0.81	$0.87	$0.81	$0.87	$1.4	$1.5
CO	El Paso	-	-	-	-	-	-	-	-	-	-	$16	$16
FL	Hillsborough	$1.8	$1.9	$1.8	$1.9	$3.6	$3.8	$5.4	$5.7	$6.1	$6.5	$8.5	$9.0
IL	Madison	-	-	-	-	-	-	-	-	$0.02	$0.02	$2.4	$2.5
IN	Delaware	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7	$6.3	$6.7
MN	Dakota	$32	$42	$32	$42	$32	$42	$33	$43	$34	$44	$35	$46
MO	Iron	-	-	-	-	-	-	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
MO	Jefferson	-	-	-	-	$42	$44	$110	$120	$150	$160	$190	$200
NY	Orange	$90	$110	$390	$460	$690	$810	$990	$1,200	$1,100	$1,300	$1,300	$1,500
OH	Cuyahoga	-	-	-	-	$180	$210	$480	$560	$630	$740	$780	$920
OH	Fulton	-	-	-	-	-	-	-	-	-	-	-	-
OH	Logan	-	-	-	-	-	-	$11	$12	$84	$90	$140	$150
OK	Ottawa	$0.01	$0.01	$0.01	$0.01	$13	$14	$19	$20	$22	$23	$25	$26
PA	Beaver	-	-	-	-	-	-	$280	$330	$430	$510	$580	$690
PA	Berks	-	-	-	-	-	-	$110	$130	$260	$300	$410	$480
PA	Carbon	$1.0	$1.1	$1.0	$1.1	$1.3	$1.4	$1.3	$1.4	$2.8	$3.0	$3.4	$3.6
TN	Sullivan	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$2.0	$2.1	$2.3	$2.5	$3.3	$3.5
TN	Williamson	-	-	-	-	-	-	-	-	-	-	$26	$31
TX	Collin	-	-	-	-	-	-	-	-	-	-	$0.01	$0.01
TX	Dallas	$3.1	$3.3	$3.1	$3.3	$3.1	$3.3	$4.0	$4.2	$4.3	$4.6	$4.3	$4.6
UT	Salt Lake	-	-	-	-	-	-	-	-	-	-	$10	$11
Total		**$130**	**$160**	**$430**	**$510**	**$970**	**$1,100**	**$2,100**	**$2,400**	**$2,800**	**$3,200**	**$3,500**	**$4,100**

*All estimates rounded to two significant figures. As such, totals will not sum down columns.

Table 6-9.
TOTAL COSTS BY STANDARD*

		Annual Total Costs in 2016 (Millions of 2006$)											
		Standard Alternative: 0.5 μg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.4 μg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.3 μg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.2 μg/m^3 2nd Maximum Monthly Mean		Selected Standard: 0.15 μg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.1 μg/m^3 2nd Maximum Monthly Mean	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
Monitoring Costs**										$4.2	$4.2		
Identified Control Costs***		$46	$57	$46	$57	$89	$100	$110	$120	$130	$150	$160	$180
Extrapolated Costs	**Cost Curve Extrapolation**	**$0.08**	**$0.08**	**$0.32**	**$0.32**	**$1.1**	**$1.1**	**$8.3**	**$8.3**	**$20**	**$20**	**$33**	**$33**
	Ambient Extrapolation	$89	$100	$390	$460	$880	$1,000	$1,900	$2,300	$2,600	$3,100	$3,400	$3,900
Total Costs	**Cost Curve Extrapolation******	**$46**	**$57**	**$46**	**$57**	**$90**	**$100**	**$110**	**$130**	**$150**	**$170**	**$190**	**$210**
	Ambient Extrapolation	**$130**	**$160**	**$430**	**$510**	**$970**	**$1,100**	**$2,100**	**$2,400**	**$2,800**	**$3,200**	**$3,500**	**$4,100**

* All estimates rounded to two significant figures. As such, totals will not sum down columns.

** Consistent with the scope of this rulemaking, which includes monitoring provisions, monitoring costs are included here. See OMB 2060-0084, ICR #940.21 for a complete discussion.

*** Identified Control Costs are the same for alternative standard 0.5 μg/m^3 and for alternative standard 0.4 μg/m^3. This is because the same monitor areas violate both standards and the same controls were chosen in the least cost optimization for both standard alternatives.

**** Estimates for the 0.5 μg/m^3 and the 0.4 μg/m^3 appear similar; this is due to rounding conventions.

Figure 6-3.
PERCENTAGE OF TOTAL COSTS BY EXTRAPOLATED COST APPROACH

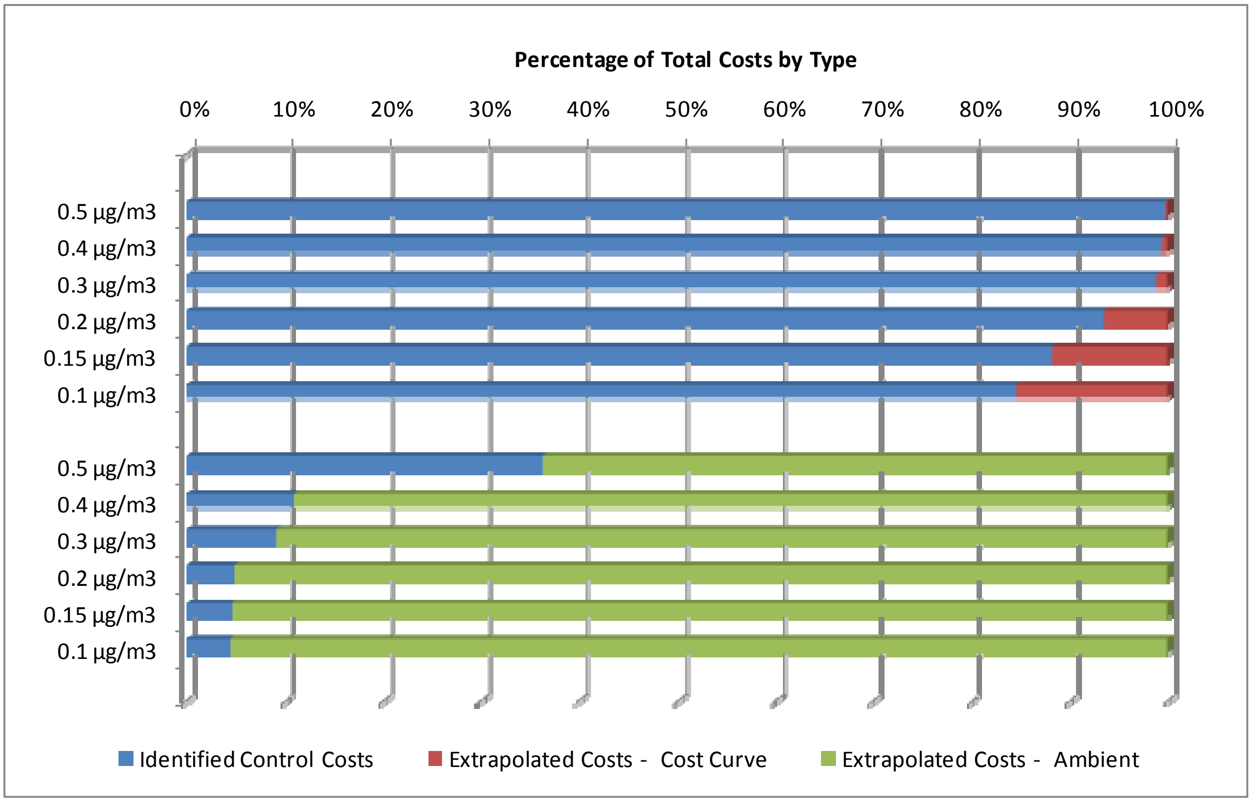
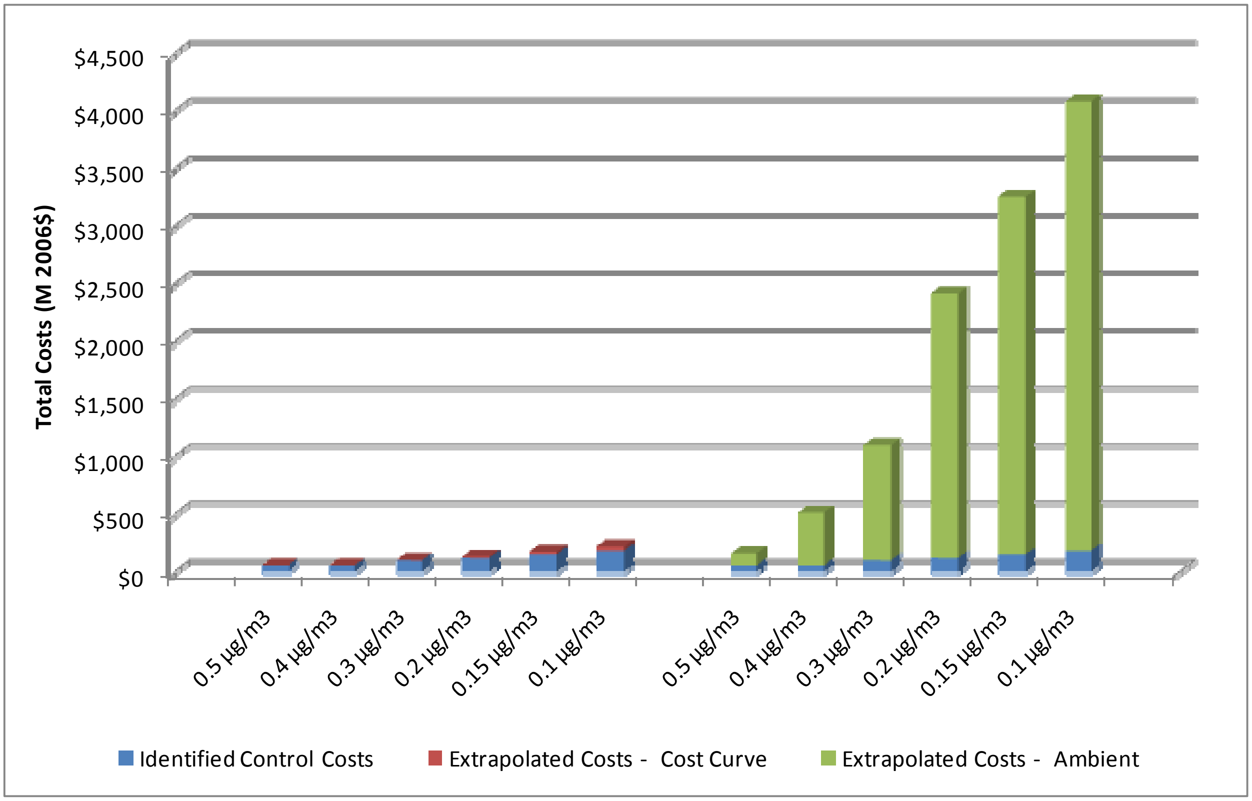


Figure 6-4.
TOTAL COSTS IN 2016 BY EXTRAPOLATED COST APPROACH



6.1.6 Technology Innovation and Regulatory Cost Estimates

There are many examples in which technological innovation and "learning by doing" have made it possible to achieve greater emissions reductions than had been feasible earlier, or have reduced the costs of emission control in relation to original estimates. Studies[21] have suggested that costs of some EPA programs have been less than originally estimated due in part to inadequate inability to predict and account for future technological innovation in regulatory impact analyses.

Constantly increasing marginal costs are likely to induce the type of innovation that would result in lower costs than estimated early in this chapter. Breakthrough technologies in control equipment could by 2016 result in a rightward shift in the marginal cost curve for such equipment (Figure 6-5)[22] as well as perhaps a decrease in its slope, reducing marginal costs per unit of abatement, and thus deviate from the assumption of one constantly increasing marginal cost curve. In addition, elevated abatement costs may result in significant increases in the cost of

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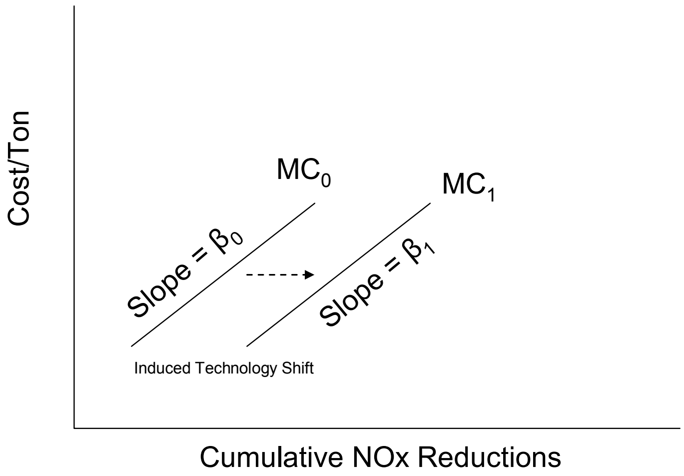
[21] Harrington et al. (2000) and previous studies cited by Harrington.
Harrington, W., R.D. Morgenstern, and P. Nelson. 2000. "On the Accuracy of Regulatory Cost Estimates." *Journal of Policy Analysis and Management* 19(2):297-322.

[22] Figure 5.2 shows a linear marginal abatement cost curve. It is possible that the shape of the marginal abatement cost curve is non-linear.

production and would likely induce production efficiencies, in particular those related to energy inputs, which would lower emissions from the production side.

Figure 6-5.
TECHNOLOGICAL INNOVATION REFLECTED BY MARGINAL COST SHIFT



6.1.6.1 Examples of Technological Advances in Pollution Control

There are numerous examples of low-emission technologies developed and/or commercialized over the past 15 or 20 years, such as:

- Selective catalytic reduction (SCR) and ultra-low NOx burners for NOx emissions
- Scrubbers which achieve 95% and even greater SO2 control on boilers
- Sophisticated new valve seals and leak detection equipment for refineries and chemical plans
- Low or zero VOC paints, consumer products and cleaning processes
- Chlorofluorocarbon (*CFC)* free air conditioners, refrigerators, and solvents
- Water and powder-based coatings to replace petroleum-based formulations
- Vehicles far cleaner than believed possible in the late 1980s due to improvements in evaporative controls, catalyst design and fuel control systems for light-duty vehicles; and treatment devices and retrofit technologies for heavy-duty engines
- Idle-reduction technologies for engines, including truck stop electrification efforts
- Market penetration of gas-electric hybrid vehicles, and clean fuels

These technologies were not commercially available two decades ago, and some were not even in existence. Yet today, all of these technologies are on the market, and many are widely employed. Several are key components of major pollution control programs.

What is known as “learning by doing” or “learning curve impacts” have also made it possible to achieve greater emissions reductions than had been feasible earlier, or have reduced the costs of emission control in relation to original estimates. Learning curve impacts can be defined generally as the extent to which variable costs (of production and/or pollution control) decline as firms gain experience with a specific technology. Such impacts have been identified to occur in a number of studies conducted for various production processes. Impacts such as these would manifest themselves as a lowering of expected costs for operation of technologies in the future below what they may have been.

The magnitude of learning curve impacts on pollution control costs has been estimated for a variety of sectors as part of the cost analyses done for the Draft Direct Cost Report for the second EPA Section 812 Prospective Analysis of the Clean Air Act Amendments of 1990.[23] In that report, learning curve adjustments were included for those sectors and technologies for which learning curve data was available. A typical learning curve adjustment example is to reduce either capital or O&M costs by a certain percentage given a doubling of output from that sector or for that technology. In other words, capital or O&M costs will be reduced by some percentage for every doubling of output for the given sector or technology.

T.P. Wright, in 1936, was the first to characterize the relationship between increased productivity and cumulative production. He analyzed man-hours required to assemble successive airplane bodies. He suggested the relationship is a log linear function, since he observed a constant linear reduction in man-hours every time the total number of airplanes assembled was doubled. The relationship he devised between number assembled and assembly time is called Wright’s Equation (Gumerman and Marnay, 2004)[24]. This equation, shown below, has been shown to be widely applicable in manufacturing:

$$\text{Wright's Equation: } C_N = C_o * N^b,$$

Where:

N = cumulative production

C_N = cost to produce N^{th} unit of capacity

C_o = cost to produce the first unit

B = learning parameter = ln (1-LR)/ln(2), where

LR = learning by doing rate, or cost reduction per doubling of capacity or output.

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[23] E.H. Pechan and Associates and Industrial Economics, Direct Cost Estimates for the Clean Air Act Second Section 812 Prospective Analysis: Draft Report, prepared for U.S. EPA, Office of Air and Radiation, February 2007. Available at http://www.epa.gov/oar/sect812/mar07/direct_cost_draft.pdf.

[24] Gumerman, Etan and Marnay, Chris. Learning and Cost Reductions for Generating Technologies in the National Energy Modeling System (NEMS), Ernest Orlando Lawrence Berkeley National Laboratory, University of California at Berkeley, Berkeley, CA. January 2004, LBNL-52559.

The percentage adjustments can range from 5 to 20 percent, depending on the sector and technology. Learning curve adjustments were prepared in a memo by IEc supplied to US EPA and applied for the mobile source sector (both onroad and nonroad) and for application of various EGU control technologies within the Draft Direct Cost Report.[25] Advice received from the SAB Advisory Council on Clean Air Compliance Analysis in June 2007 indicated an interest in expanding the treatment of learning curves to those portions of the cost analysis for which no learning curve impact data are currently available. Examples of these sectors are non-EGU point sources and area sources. The memo by IEc outlined various approaches by which learning curve impacts can be addressed for those sectors. The recommended learning curve impact adjustment for virtually every sector considered in the Draft Direct Cost Report is a 10% reduction in O&M costs for two doubling of cumulative output, with proxies such as cumulative fuel sales or cumulative emission reductions being used when output data was unavailable.

For this RIA, we do not have the necessary data for cumulative output, fuel sales, or emission reductions for sectors included in our analysis in order to properly generate control costs that reflect learning curve impacts. Clearly, the effect of including these impacts would be to lower our estimates of costs for our control strategies in 2016, but we are not able to include such an analysis in this RIA.

6.1.6.2 Influence on Regulatory Cost Estimates

Studies indicate that it is not uncommon for pre-regulatory cost estimates to be higher than later estimates, in part because of inability to predict technological advances. Over longer time horizons the opportunity for technical advances is greater.

- *Multi-rule study:* Harrington et al. of Resources for the Future[26] conducted an analysis of the predicted and actual costs of 28 federal and state rules, including 21 issued by EPA and the Occupational Safety and Health Administration (OSHA), and found a tendency for predicted costs to overstate actual implementation costs. Costs were considered accurate if they fell within the analysis error bounds or if they fall within 25 percent (greater or less than) the predicted amount. They found that predicted total costs were overestimated for 14 of the 28 rules, while total costs were underestimated for only three rules. Differences can result because of quantity differences (e.g., overestimate of pollution reductions) or differences in per-unit costs (e.g., cost per unit of pollution reduction). Per-unit costs of regulations were overestimated in 14 cases, while they were underestimated in six cases. In the case of EPA rules, the agency overestimated per-unit costs for five regulations, underestimated them for four regulations (three of these were relatively small pesticide rules), and accurately estimated them for four. Based on examination of eight economic incentive rules, “for those rules that employed economic incentive mechanisms, overestimation of per-unit costs seems to be the norm,” the study said.

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[25] Industrial Economics, Inc. Proposed Approach for Expanding the Treatment of Learning Curve Impacts for the Second Section 812 Prospective Analysis: Memorandum, prepared for U.S. EPA, Office of Air and Radiation, August 13, 2007.

[26] Harrington, W., R.D. Morgenstern, and P. Nelson. 2000. “On the Accuracy of Regulatory Cost Estimates.” *Journal of Policy Analysis and Management* 19(2):297-322.

Based on the case study results and existing literature, the authors identified technological innovation as one of five explanations of why predicted and actual regulatory cost estimates differ: "Most regulatory cost estimates ignore the possibility of technological innovation … Technical change is, after all, notoriously difficult to forecast … In numerous case studies actual compliance costs are lower than predicted because of unanticipated use of new technology."

It should be noted that many (though not all) of the EPA rules examined by Harrington had compliance dates of several years, which allowed a limited period for technical innovation.

- *Acid Rain SO2 Trading Program*: Recent cost estimates of the Acid Rain SO2 trading program by Resources for the Future (RFF) and MIT have been as much as 83 percent lower than originally projected by EPA.[27] Note that the original EPA cost analysis also relied on an optimization model like IPM to approximate the results of emissions trading. As noted in the RIA for the Clean Air Interstate Rule, the ex ante numbers in 1989 were an overestimate in part because of the limitation of economic modeling to predict technological improvement of pollution controls and other compliance options such as fuel switching. The fuel switching from high-sulfur to low-sulfur coal was spurred by a reduction in rail transportation costs due to deregulation of rail rates during the 1990'sHarrington et al. report that scrubbing turned out to be more efficient (95% removal vs. 80-85% removal) and more reliable (95% vs. 85% reliability) than expected, and that unanticipated opportunities arose to blend low and high sulfur coal in older boilers up to a 40/60 mixture, compared with the 5/95 mixture originally estimated.

Phase 2 Cost Estimates	
Ex ante estimates	\$2.7 to \$6.2 billion[a]
Ex post estimates	\$1.0 to \$1.4 billion

[a] 2010 Phase II cost estimate in \$1995.

- *EPA Fuel Control Rules:* A 2002 study by two economists with EPA's Office of Transportation and Air Quality[28] examined EPA vehicle and fuels rules and found a general pattern that "all ex ante estimates tended to exceed actual price impacts, with the EPA estimates exceeding actual prices by the smallest amount." The paper notes that cost is not the same as price, but suggests that a comparison nonetheless can be instructive.[29] An example focusing on fuel rules is provided:

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[27] Carlson, Curtis, Dallas R. Burtraw, Maureen, Cropper, and Karen L. Palmer. 2000. "Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?" *Journal of Political Economy* 108(#6):1292-1326. Ellerman, Denny. January 2003. Ex Post Evaluation of Tradable Permits: The U.S. SO2 Cap-and-Trade Program. Massachusetts Institute of Technology Center for Energy and Environmental Policy Research.

[28] Anderson, J.F., and Sherwood, T., 2002. "Comparison of EPA and Other Estimates of Mobile Source Rule Costs to Actual Price Changes," Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Technical Paper published by the Society of Automotive Engineers. SAE 2002-01-1980.

[29] The paper notes: "Cost is not the same as price. This simple statement reflects the fact that a lot happens between a producer's determination of manufacturing cost and its decisions about what the market will bear in terms of price change."

Table 6-10.
COMPARISON OF INFLATION-ADJUSTED ESTIMATED COSTS AND ACTUAL PRICE CHANGES FOR EPA FUEL CONTROL RULES [A]

	Inflation-adjusted Cost Estimates (c/gal)				Actual Price Changes (c/gal)
	EPA	DOE	API	Other	
Gasoline					
Phase 2 RVP Control (7.8 RVP—Summer) (1995$)	1.1	1.8		0.5	
Reformulated Gasoline Phase 1 (1997$)	3.1-5.1	3.4-4.1	8.2-14.0	7.4 (CRA)	2.2
Reformulated Gasoline Phase 2 (Summer) (2000$)	4.6-6.8	7.6-10.2	10.8-19.4	12	7.2 (5.1, when corrected to 5yr MTBE price)
30 ppm sulfur gasoline (Tier 2)	1.7-1.9	2.9-3.4	2.6	5.7 (NPRA), 3.1 (AIAM)	N/A
Diesel					
500 ppm sulfur highway diesel fuel (1997$)	1.9-2.4		3.3 (NPRA)	2.2	
15 ppm sulfur highway diesel fuel	4.5	4.2-6.0	6.2	4.2-6.1 (NPRA)	N/A

[a] Anderson, J.F., and Sherwood, T., 2002. "Comparison of EPA and Other Estimates of Mobile Source Rule Costs to Actual Price Changes," Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Technical Paper published by the Society of Automotive Engineers. SAE 2002-01-1980.

- Chlorofluorocarbon (*CFC) Phase-Out:* EPA used a combination of regulatory, market based (i.e., a cap-and-trade system among manufacturers), and voluntary approaches to phase out the most harmful ozone depleting substances. This was done more efficiently than either EPA or industry originally anticipated. The phaseout for Class I substances was implemented 4-6 years faster, included 13 more chemicals, and cost 30 percent less than was predicted at the time the 1990 Clean Air Act Amendments were enacted.[30]

  The Harrington study states, "When the original cost analysis was performed for the CFC phase-out it was not anticipated that the hydrofluorocarbon HFC-134a could be substituted for CFC-12 in refrigeration. However, as Hammit[31] notes, 'since 1991 most new U.S. automobile air conditioners have contained HFC-134a (a compound for which no commercial production technology was available in 1986) instead of CFC-12" (p.13). He cites a similar story for HCFRC-141b and 142b, which are currently substituting for CFC-11 in important foam-blowing applications."

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[30] Holmstead, Jeffrey, 2002. "Testimony of Jeffrey Holmstead, Assistant Administrator, Office of Air and Radiation, U.S. Environmental Protection Agency, Before the Subcommittee on Energy and air Quality of the committee on Energy and Commerce, U.S. House of Representatives, May 1, 2002, p. 10.

[31] Hammit, J.K. (1997). "Are the costs of proposed environmental regulations overestimated? Evidence from the CFC phaseout." Unpublished paper, Center for Risk Analysis, Harvard School of Public Health, Cambridge, MA.

- Additional examples of decreasing costs of emissions controls include: SCR catalyst costs decreasing from $11k-$14k in 1998 to $3.5k-$5k in 2004, and improved low NOx burners reduced emissions by 50% from 1993-2003 while the associated capital cost dropped from $25-$38/kw to $15/kw[32].

We can not estimate the interplay between EPA regulation and technology improvement, but it is clear that a *priori* cost estimation often results in overestimation of costs because changes in technology (whatever the cause) make less costly control possible.

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[32] ICF Consulting. October 2005. The Clean Air Act Amendment: Spurring Innovation and Growth While Cleaning the Air. Washington, DC. Available at http://www.icfi.com/Markets/Environment/doc_files/caaa-success.pdf.

6.2 Economic Impacts

The assessment of economic impacts was conducted simply based on those source categories which are controlled in this analysis. The impacts presented here are an extension of the engineering costs, where engineering costs are allocated to specific source categories by North American Industry Classification System (NAICS) code. Although the costs outlined in the previous section may affect a range of industries, we expect that most of the costs associated with the selected standard will be concentrated in a limited number of industry sectors. As indicated in Table 6-11, we estimate that primary smelters & refiners of nonferrous metals (NAICS 331419) are expected to incur most of the identified control costs associated with the alternative standards included in this RIA. For primary smelters, the estimated costs of the alternative standards range from \$32 million to \$76 million per year, depending on the standard and the discount rate. This represents 1.2 to 2.9 percent of the industry's value of shipments in 2002. Table 6-11 also shows that other industry sectors expected to incur significant costs include secondary smelting, refining, and alloying of nonferrous metals excluding copper and aluminum (NAICS 331492); iron and steel mills (NAICS 331111); and steam and air-conditioning supply (NAICS 221330). The projected compliance costs for these industries range from 0.0 to 1.3 percent of their total shipments (or receipts, in the case of steam and air-conditioning supply) in 2002.

Table 6-12 presents capital and O&M costs by industry for identified measures under the Final NAAQS.[33] Costs associated with emission reductions beyond identified controls are not reflected in the table because the distribution of costs between capital and O&M is uncertain for these measures. As indicated in the table, O&M represents approximately 54 percent of costs under the selected standard of 0.15μg/m^3. This implies that although the upfront capital costs associated with the selected standard may be significant for affected industries, these costs are expected to represent a fraction of the selected standard's total costs.

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[33] The costs presented in the table reflect a discount rate of seven percent. Because the purpose of the table is to show the approximate distribution of costs between capital and O&M, the table presents costs based on just one discount rate for ease of presentation.

Table 6-11. ANNUAL COSTS OF IDENTIFIED CONTROLS BY INDUSTRY

		Total Cost with Identified Controls (Millions of 2006$)												
		Standard Alternative: 0.5 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.4 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.3 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.2 µg/m^3 2nd Maximum Monthly Mean		Selected Standard: 0.15 µg/m^3 2nd Maximum Monthly Mean		Standard Alternative: 0.1 µg/m^3 2nd Maximum Monthly Mean		Industry Revenue in 2005 (millions of 2006$)[1]
NAICS Code	**Industry Description**	**3% Disc rate**	**7% Disc rate**	**3% Disc rate**	**7% Disc rate**	**3% Disc rate**	**7% Disc rate**	**3% Disc rate**	**7% Disc rate**	**3% Disc rate**	**7% Disc rate**	**3% Disc rate**	**7% Disc rate**	
2211	Electric Power Generation, Transmission and Distribution	-	-	-	-	$2	$2.3	$4.4	$5.1	$4.6	$5.2	$11.2	$13.2	$363,990
331419	Primary Smelting and Refining of Nonferrous Metal (except Copper and Aluminum)	$31.7	$42	$31.7	$42	$31.7	$42	$40	$50.8	$63.9	$76.3	$63.9	$76.3	$2,649
331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)	$12.3	$13	$12.3	$13.1	$23.3	$24.7	$28.4	$30.2	$31.2	$33.3	$35.8	$38.1	$3,009
331111	Iron and Steel Mills	$1.5	$1.5	$1.5	$1.5	$22.1	$23.3	$22.1	$23.3	$22.1	$23.3	$24.4	$25.8	$51,762
221330	Steam and Air-Conditioning Supply	-	-	-	-	$7.3	$7.6	$7.3	$7.6	$7.3	$7.6	$7.3	$7.6	$723
331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	-	-	-	-	-	-	-	-	-	-	$4.6	$4.9	$5,041
331513	Steel Foundries (except Investment)	-	-	-	-	-	-	-	-	-	-	$3.9	$4.0	$2,941
331314	Secondary Smelting and Alloying of Aluminum	-	-	-	-	-	-	-	-	<$0.1	<$0.1	$2.4	$2.5	$4,150
32511	Petrochemical Manufacturing	-	-	-	-	-	-	-	-	-	-	$1.1	$1.1	$23,611
622110	General Medical and Surgical Hospitals	-	-	-	-	-	-	-	-	-	-	-	-	$526,034
335911	Storage Battery Manufacturing	-	-	<$0.1	<$0.1	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$3,961
331511	Iron Foundries	-	-	-	-	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.7	$0.8	$11,541
Other Industries		-	-	-	-	$1.5	$1.8	$2.2	$2.5	$2.2	$2.5	$3.8	$4.2	
Total		**$45.5**	**$56.5**	**$45.5**	**$56.6**	**$89.1**	**$103**	**$105.5**	**$120.7**	**$132.5**	**$149.4**	**$159.9**	**$179.4**	

1. Source: U.S. Census Bureau 2002 Economic Census

Table 6-12.
ANNUAL CAPITAL AND O&M COSTS BY INDUSTRY FOR IDENTIFIED CONTROLS
(7 percent discount rate)

SIC Code	Description	Annual Cost of Identified Controls in 2016 (Millions of 2006$) Final NAAQS: 0.15 µg/m3 2nd Maximum Monthly Mean Capital	O&M	Total Annual Cost
2211	Electric Power Generation, Transmission and Distribution	$3.1	$2.2	$5.2
331419	Primary Smelting and Refining of Nonferrous Metal (except Copper and Aluminum)	$52.4	$24	$76.3
331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)	$10	$23.2	$33.3
331111	Iron and Steel Mills	$0.6	$22.7	$23.3
221330	Steam and Air-Conditioning Supply	$1.5	$6.2	$7.6
331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	-	-	-
331513	Steel Foundries (except Investment)	-	-	-
331314	Secondary Smelting and Alloying of Aluminum	<$0.1	<$0.1	<$0.1
32511	Petrochemical Manufacturing	-	-	-
622110	General Medical and Surgical Hospitals	-	-	-
335911	Storage Battery Manufacturing	$0.2	$0.6	$0.8
331511	Iron Foundries	$0.1	$0.3	$0.4
Other		$0.6	$1.9	$2.5
Total		**$68.5**	**$80.9**	**$149.4**

6.3 Energy Impacts

This section summarizes the energy consumption impacts of the final and alternative lead NAAQS. The Pb NAAQS revisions do not constitute a "significant energy action" as defined in Executive Order 13211; this information merely represents impacts of the illustrative control strategies applied in the RIA. The rule does not prescribe specific control strategies by which these ambient standards will be met. Such strategies will be developed by States on a case-by-case basis, and EPA cannot predict whether the control options selected by States will include regulations on energy suppliers, distributors, or users. Thus, EPA concludes that this rule is not likely to have any adverse energy effects.

For this RIA, implementation of the control measures needed for attainment with the alternative standards will likely lead to increased energy consumption among lead emitting facilities. To control emissions effectively, these measures require a significant amount of electricity that affected facilities are not expected to consume under baseline conditions. The available information on these controls suggests that they are not typically powered by natural gas or other fossil fuels; therefore, our analysis of energy impacts focuses exclusively on electricity consumption. In addition, because the energy consumption associated with emission reductions beyond identified controls is uncertain, we only consider the energy impacts associated with identified controls. Similarly, the electricity consumption associated with the construction of a Kivcet furnace at the primary lead smelter in Jefferson County, MO is also uncertain. We therefore exclude energy impacts for this facility from our analysis of energy impacts.

To assess the electricity consumption impacts associated with identified controls, we relied on the AirControlNET outputs generated for this analysis. For most identified controls, AirControlNET estimates electricity costs separately from other operating and maintenance (O&M) costs. Therefore, for sources expected to implement these controls, AirControlNET provides direct estimates of the additional electricity costs expected under the standard alternatives. We calculate the electricity consumption associated with these costs based on the unit cost of electricity assumed by AirControlNET (7.8 cents/kilowatt hour in 2006 dollars).

For a number of identified controls, AirControlNET does not separate the cost of electricity from other O&M costs. Similarly, the cost data for several controls identified from sources other than AirControlNET do not distinguish between electricity and other O&M costs. We estimate the electricity costs associated with these measures based on electricity's assumed share of total O&M, which we estimate based on AirControlNET's results for those controls where it separates electricity costs from other O&M costs. For some controls, O&M costs are not estimated separately from capital costs. In these cases, we assume that O&M represents a fixed share of annual costs based on the cost data for those controls where O&M and capital are calculated separately.

Table 6-13 summarizes the estimated energy impacts associated with the selected and alternative standards. As indicated in the table, we estimate that sources installing identified controls under the alternative standards will increase their electricity consumption in 2016 by approximately 121,800 megawatt-hours (MWh) under the selected standard. By comparison, the iron and steel industry alone is projected to purchase 66 million MWh of electricity in 2016.[34]

Table 6-13.
SUMMARY OF ENERGY IMPACTS

	Standard Alternative: 0.5 µg/m^3 2nd Maximum Monthly Mean	**Standard Alternative: 0.4 µg/m^3 2nd Maximum Monthly Mean**	**Standard Alternative: 0.3 µg/m^3 2nd Maximum Monthly Mean**	**Standard Alternative: 0.2 µg/m^3 2nd Maximum Monthly Mean**	**Selected Standard: 0.15 µg/m^3 2nd Maximum Monthly Mean**	**Standard Alternative: 0.1 µg/m^3 2nd Maximum Monthly Mean**
Electricity Cost (millions of year 2006$)	$1.4	$1.4	$6.2	$8.7	$9.5	$17.3
Electricity Consumption (Megawatt-hours consumed in 2016)	17,800	18,200	79,900	111,700	121,800	222,000

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[34] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2007*, February 2007.

6.4 Limitations

Although the cost analysis presented in this chapter provides a reasonable approximation of the costs associated with the final lead NAAQS using hypothetical control scenarios given the available information, we note the following limitations of the analysis:

- ***Analysis limited to point source controls.*** Because limited data are available on fugitive and area source emissions, our analysis of the costs associated with the final and alternative lead NAAQS does not consider area source and direct fugitive controls that may be implemented to comply with these standards.[35] Therefore, in the few areas where point source controls are insufficient to attain the standard, and where we were unable to model full compliance with the revised NAAQS, it is possible that fugitive dust emissions from area sources containing deposited Pb will also contribute to violations of the NAAQS, or that historically deposited Pb, when disturbed, may be re-entrained into the ambient air. For areas where point source controls are sufficient to reach attainment, we may have overestimated costs if more cost effective fugitive or area source controls are likely to be available in these areas.

- ***Incomplete information for point source controls.*** To assess the cost of reducing point source lead emissions, this analysis relies upon PM control cost information from AirControlNET. For several sources, however, AirControlNET contains no information on the PM controls available, and we are unable to estimate costs for these sources. Such sources represent approximately 9 percent of the point source lead emissions included in our analysis (i.e., AirControlNET contains control measure data for those lead sources that represent 91 percent of the lead emissions included in the analysis). Costs to control lead emissions from these sources may be less than or greater than the costs to control emissions from other sources.

- ***Uncertainty about methods for reaching tighter control levels in the future.*** It is not known whether industrial sources will in the future make improvements to existing particulate matter controls to control Pb emissions, whether there will be further application of existing control technology in series with controls that might already be employed at a source, or whether we might expect new control technology to be developed.

- ***Uncertainty in the cost estimates for the primary lead smelter in Jefferson County, Missouri:*** To estimate the costs of the selected standard for Jefferson County, Missouri, this analysis models the replacement of the primary lead smelter in that area with a modern, lower emitting Kivcet smelter. We estimate the cost of this project based on the costs of Teck Cominco's Kivcet smelter in Trail, British Columbia, scaling for differences in lead production capacities between the Teck Cominco facility and the smelter in Jefferson County. While this is a reasonable approach for estimating costs for the smelter in Jefferson County, our analysis may not capture facility-specific characteristics that would affect the

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[35] Although our analysis considers the impact of point source controls on certain fugitive emissions, as described in Chapter 4, it does not consider direct fugitive controls.

costs of building and operating a Kivcet smelter at this facility. Furthermore, more targeted measures for reducing lead emissions may be more cost-effective than the construction of a new Kivcet unit. Given these uncertainties, we may overestimate or underestimate costs for Jefferson County.

- ***Uncertainty associated with extrapolated costs of emission reductions beyond identified controls.*** As indicated above, many areas are expected to rely heavily on emission reductions beyond identified controls to reach attainment with the selected and alternative standards. The cost of implementing these measures is uncertain. Many of these sources are already well-controlled for particulate matter, and additional control for the remaining increment of Pb might be difficult to achieve. In addition to these uncertainties there are also many uncertainties associated with the two approaches used in this RIA to estimated extrapolated costs. The ambient extrapolation methodology emphasizes control costs that are the most expensive within an area, and assumes that knowledge of control costs from monitor areas that attain have no influence on the average control costs for areas that need unspecified emission reductions. It also assumes there will be no increased knowledge of sources or changed in technology between now and 2016. Lastly, most of the costs are based upon areas that make less than 1% progress towards attainment, indicating what little knowledge we have about controls in those areas. The cost curve methodology presents a poor conceptual relationship between the costs of identified controls at a national level and the costs of control at a local level. The data this curve is developed upon contains data points which we believe to be invalid (presented as part of the distributional analysis in Section 6.1.3.2). The estimated curve estimates negative costs over a portion of emission reductions. In addition this approach relies heavily on the control strategy for tightest standard alternative analyzed in this RIA, and does not account for variability in control strategies across alternative standards analyzed. Lastly, we do not believe this curve well represents the knowledge of how control costs behave over time.

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