E.O. 12866 Ferroalloys RIA 2060-AQ11 Proposal 20111006

Regulatory Impact Analysis (RIA) for the Proposed Manganese Ferroalloys RTR

Final Report

November 2011

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SECTION 1
EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) is proposing amendments to the national emissions standards for hazardous air pollutants (NESHAP) for Ferroalloys Production to address the results of the residual risk and technology review that EPA is required to conduct by the Clean Air Act. These proposed amendments include revisions to particulate matter standards for electric arc furnaces, metal oxygen refining process, and crushing and screening operations. The amendments add hydrochloric acid, mercury, polycyclic aromatic hydrocarbons, and formaldehyde emission limits to electric arc furnaces. The amendments also expand and revise the requirements to control fugitive emissions from furnace operations and casting. Other requirements related to testing, monitoring, notification, recordkeeping, and reporting requirements are included. We are also proposing to revise provisions addressing periods of startup, shutdown, and malfunction to ensure that the rules are consistent with a recent court decision.

This is an economically significant rule as defined by Executive Order 12866 since the annual effects (in this case, benefits) are estimated to exceed $100 million. Therefore, EPA is required to develop a regulatory impact analysis (RIA) as part of the regulatory process. The RIA includes an economic impact analysis (EIA), and a benefits analysis along with documentation for the methods and results.

1.1 Analysis Summary

The key results of the RIA are as follows:

Engineering Cost Analysis: EPA estimates the revised NESHAP's total annualized costs will be $4.0 million ($2010). This estimate includes all of the compliance costs, with both control and administrative (monitoring, testing) costs included.

Economic Impact Analysis: The economic impacts for the firms affected by this proposed rule range are annual compliance costs of less than 0.01 percent of sales. Thus, consumers will also experience minimal changes in the price of ferroalloy output.

Social Cost Analysis: The estimated social cost of the major source rule will be $4.0 million, which is also the total annualized cost of compliance ($2010).

Small Entity Analyses: Neither of the two affected firms are small businesses according to the Small Business Administration's (SBA's) small business size standard for this industry. Thus, there are no small business or entity impacts associated with this proposed rule.

- **Benefits Analysis:**
  - The benefits from reducing some air pollutants have not been monetized in this analysis, including reducing arsenic, chromium, nickel, manganese, mercury, polycyclic aromatic hydrocarbons (PAH) and other HAP emissions. We assessed the benefits of these emission reductions qualitatively later in this analysis.
  - We monetized the benefits from reducing particulate matter (PM). Thus all monetized benefits reported reflect decreases in ambient $PM_{2.5}$ concentrations due to reduction of close to 257 tons of $PM_{2.5}$. Although the monetized benefits likely underestimate the total benefits, the extent of the underestimate is unclear.
  - Using a 3% discount rate, we estimated the total monetized benefits of the proposed rule to be $71 million to $170 million (2010 dollars) in the year of analysis (2015). Using a 7% discount rate, we estimate the total monetized benefits of the proposed rule to be $63 billion to $160 billion (2010 dollars) in 2015. Using alternative relationships between $PM_{2.5}$ and premature mortality supplied by experts, higher and lower benefits estimates are plausible, but most of the expert-based estimates fall between these estimates.

Net Benefits: For the ferroalloys proposal, the net benefits are $67 million to $170 million in 2015 at a 3% discount rate for the benefits and $59 million to $150 million in 2015 at a 7% discount rate for the benefits. These results are shown in Table 1-1.

1.2 Organization of this Report

The remainder of this report supports and details the methodology and the results of the RIA:

- Section 2 describes the proposed regulation.
- Section 3 presents the profile of the affected industry.
- Section 4 describes the baseline emissions and emission reductions for the proposed regulation.
- Section 5 describes the economic impacts and analyses to comply with Executive Orders.
- Section 6 presents the benefits estimates.
- Section 7 presents the net benefits of the proposed rule.
- Section 8 contains the references for the RIA.

Table 1-1. Summary of the Annual Monetized Benefits, Social Costs, and Net Benefits for the Proposed Ferroalloys RTR in 2015 ($2010 millions)[a]

	3% Discount Rate			7% Discount Rate		
			Proposed Standard			
Total Monetized Benefits[b]	$71	to	$170	$63	to	$160
Total Social Costs		$4.0			$4.0	
Net Benefits	$67	to	$170	$59	to	$150
Nonmonetized Benefits	Reduced exposure to HAPs, including arsenic, chromium, nickel, manganese, mercury and polycyclic aromatic hydrocarbons Ecosystem effects Visibility impairment					

[a] All estimates are for the year of implementation (2015) and are rounded to two significant figures. These results include units anticipated to come online and the lowest cost disposal assumption.

[b] The total monetized benefits reflect the human health benefits associated with reducing exposure to $PM_{2.5}$ through reductions of directly emitted $PM_{2.5}$. It is important to note that the monetized benefits include many but not all health effects associated with $PM_{2.5}$ exposure. Benefits are shown as a range from Pope et al. (2002) to Laden et al. (2006). These models assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality because the scientific evidence is not yet sufficient to allow differentiation of effect estimates by particle type.

SECTION 2
INTRODUCTION

2.1 Background for Proposed Rule

2.1.1 What is this source category and how did the MACT regulate its HAP emissions?

The NESHAP (or MACT rule) for Ferroalloys Production: Ferromanganese and Silicomanganese was promulgated on May 20, 1999 (64 FR 27450) and codified at 40 CFR part 63, subpart XXX.[1] The 1999 NESHAP (40 CFR 63.1650(a)) applies to all new and existing ferroalloys production facilities that manufacture ferromanganese or silicomanganese and are major sources or are co-located at major sources of HAP emissions. The rule's product-specific applicability reflected the only known major source at the time of promulgation. Since then, one other producer of silicomanganese has started production.

Today, there are two ferroalloys production facilities that are subject to the MACT rule. No new ferroalloys production facilities have been built in over 20 years, and we anticipate no new ferroalloys production facilities in the foreseeable future, although one facility is currently exploring expanding operations.

Ferroalloys are alloys of iron in which one or more chemical elements (such as chromium, manganese, and silicon) are added into molten metal. Ferroalloys are consumed primarily in iron and steel making and are used to produce steel and cast iron products with enhanced or special properties.

Ferroalloys within the scope of this source category are produced using submerged electric arc furnaces, which are furnaces in which the electrodes are submerged into the charge. The submerged arc process is a reduction smelting operation. The reactants consist of metallic ores (ferrous oxides, silicon oxides, manganese oxides, etc.) and a carbon-source reducing agent, usually in the form of coke, charcoal, high- and low-volatility coal, or wood chips. Raw materials are crushed and sized and then conveyed to a mix house for weighing and blending. Conveyors, buckets, skip hoists, or cars transport the processed material to hoppers above the furnace. The mix is gravity-fed

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[1] The emission limits were revised on March 22, 2001 (66 FR 16024) in response to a petition for reconsideration submitted to EPA following promulgation of the final rule, and a petition for review filed in the U.S. Court of Appeals for the District of Columbia Circuit.

through a feed chute either continuously or intermittently, as needed. At high temperatures in the reaction zone, the carbon source reacts with metal oxides to form carbon monoxide and to reduce the ores to base metal.[2] The molten material (product and slag) is tapped from the furnace, sometimes subject to post-furnace refining, and poured into casting beds on the furnace room floor. Once the material hardens, it is transported to product crushing and sizing systems and packaged for transport to the customer.

HAP generating processes include electrometallurgical (furnace) operations (primary and tapping), other furnace room operations (ladle treatment and casting), building fugitives, raw material handling and product handling. HAP are emitted from ferroalloys production as process emissions, process fugitive emissions, and outdoor fugitive dust emissions.

Process emissions are the exhaust gases from the control devices, primarily the furnace control device, metal oxygen refining control device and crushing operations control device. The HAP in process emissions are primarily composed of metals (mostly manganese, arsenic, nickel, lead and chromium) and also may include organic compounds that result from incomplete combustion of coal or coke that is charged to the furnaces as a reducing agent. There is also evidence of mercury emissions. There are process metal HAP emissions from the product crushing control devices. Process fugitive emissions occur at various points during the smelting process (such as during charging and tapping of furnaces and casting) and are assumed to be similar in composition to the process emissions. Outdoor fugitive dust emissions result from the entrainment of HAP in ambient air due to material handling, vehicle traffic, wind erosion from storage piles, and other various activities. Outdoor fugitive dust emissions are composed of metal HAP only.

The MACT rule applies to process emissions and process fugitive emissions from the submerged arc furnaces, the metal oxygen refining process, and the product crushing equipment and outdoor fugitive dust emissions sources such as roadways, yard areas, and outdoor material storage and transfer operations. For process sources, the NESHAP specifies numerical emissions limits for particulate matter (as a surrogate for metal HAP) from the electric (submerged) arc furnaces (including primary and tapping emissions), depending on furnace type, size, and product being made. Particulate matter emission

[2] U.S. Environmental Protection Agency. AP-42, 12.4. Ferroalloy Production. October 1986.

limits (again as a surrogate for metal HAP) are also in place for the metal oxygen refining process and product crushing and screening equipment. Table 2-1 contains a summary of the applicable limits.

Table 2-1. Emission Limits in Subpart XXX

New or Reconstructed or Existing Source	Affected Source	Applicable PM Emission Standards	Subpart XXX Reference
New or reconstructed	Submerged arc furnace	0.23 kilograms per hour per megawatt (kb/hr/MW) (0.51 pounds per hour per megawatt (lb/hr/MW) or 35 milligrams per dry standard cubic meter (mg/dscm) (0.015 grains per dry standard cubic foot (gr/dscf)	40 CFR 63.1652(a)(1) and (a)(2)
Existing	Open submerged arc furnace producing ferromanganese and operating at a furnace power input of 22 MW or less	9.8 kg/hr (21.7 lb/hr)	40 CFR 63.1652(b)(1)
Existing	Open submerged arc furnace producing ferromanganese and operating at a furnace power input greater than 22 MW	13.5 kg/hr (29.8 lb/hr)	40 CFR 63.1652(b)(2)

New or Reconstructed or Existing Source	Affected Source	Applicable PM Emission Standards	Subpart XXX Reference
Existing	Open submerged arc furnace producing silicomanganese and operating at a furnace power input greater than 25 MW	16.3 kg/hr (35.9 lb/hr)	40 CFR 63.1652(b)(3)
Existing	Open submerged arc furnace producing silicomanganese and operating at a furnace power input of 25 MW or less	12.3 kg/hr (27.2 lb/hr)	40 CFR 63.1652(b)(4)
Existing	Semi-sealed submerged arc furnace (primary, tapping, and vent stacks) producing ferromanganese	11.2 kg/hr (24.7 lb/hr)	40 CFR 63.1652(c)
New, reconstructed, or existing	Metal oxygen refining process	69 mg/dscm (0.03 gr/dscf)	40 CFR 63.1652(d)
New or reconstructed	Individual equipment associated with the product crushing and screening operation	50 mg/dscm (0.022 gr/dscf)	40 CFR 63.1652(e)(1)
Existing	Individual equipment associated with the product crushing and screening operation	69 mg/dscm (0.03 gr/dscf)	40 CFR 63.1652(e)(2)

The 1999 NESHAP established a building opacity limit of 20 percent that is measured during the required furnace control device performance test. The rule provides an excursion limit of 60 percent opacity for one 6-munute period during the performance test. The opacity observation is focused only on emissions exiting the shop due solely to operations of any affected submerged arc furnace. In addition, blowing taps, poling and oxygen lancing of the tap hole; burndowns associated with electrode measurements; and maintenance activities associated with submerged arc furnaces and casting operations are exempt from the opacity standards specified in §63.1653.

For outdoor fugitive dust sources, as defined in §63.1651, the 1999 NESHAP requires that plants prepare and operate according to an outdoor fugitive dust control plan that describes in detail the measures that will be put in place to control outdoor fugitive dust emissions from the individual outdoor fugitive dust sources at the facility. The owner or operator must submit a copy of the outdoor fugitive dust control plan to the designated permitting authority on or before the applicable compliance date.

2.1.2 What data collection activities were conducted to support this action?

In April 2010, we issued an information collection request (ICR), pursuant to CAA section 114, to the two companies that own and operate the two ferroalloys production facilities producing ferromanganese and silicomanganese. The ICR requested available information regarding process equipment, control devices, point and fugitive emissions, practices used to control fugitive emissions, and other aspects of facility operations. The two companies completed the surveys for their facilities and submitted the responses to us in the fall of 2010. We also requested that the two facilities conduct additional emissions tests in 2010 for certain HAP from specific processes that were considered representative of the industry. Pollutants tested included most HAP metals, hydrochloric acid, hydrofluoric acid, formaldehyde, mercury, polycyclic aromatic hydrocarbons and dioxins and furans. The results of these tests were submitted to the EPA in the fall of 2010 and are available in the docket for this action.

The proposed rule is economically significant according to Executive Order 12866. As part of the regulatory process of preparing these standards, EPA has prepared a regulatory impact analysis (RIA). This analysis includes an analysis of impacts to small entities as part of compliance with the Small Business Regulatory Enforcement Fairness Act (SBREFA) and analyses to comply with other Executive Orders.

SECTION 3
INDUSTRY PROFILE

EPA has developed this industry profile to provide the reader with a general understanding of the technical and economic aspects of the industry that would be directly affected by this proposal.

Ferroalloys are alloys of iron in which one or more chemical elements (such as chromium, manganese, and silicon) are added into molten metal. Ferroalloys are consumed primarily in iron and steel making and are used to produce steel and cast iron products with enhanced or special properties.

Ferroalloys within the scope of this source category are produced using submerged electric arc furnaces, which are furnaces in which the electrodes are submerged into the charge. The submerged arc process is a reduction smelting operation. The reactants consist of metallic ores (ferrous oxides, silicon oxides, manganese oxides, etc.) and a carbon-source reducing agent, usually in the form of coke, charcoal, high- and low-volatility coal, or wood chips. Raw materials are crushed and sized and then conveyed to a mix house for weighing and blending. Conveyors, buckets, skip hoists, or cars transport the processed material to hoppers above the furnace. The mix is gravity-fed through a feed chute either continuously or intermittently, as needed. At high temperatures in the reaction zone, the carbon source reacts with metal oxides to form carbon monoxide and to reduce the ores to base metal.[1] The molten material (product and slag) is tapped from the furnace, sometimes subject to post-furnace refining, and poured into casting beds on the furnace room floor. Once the material hardens, it is transported to product crushing and sizing systems and packaged for transport to the customer.

Ferroalloys are master alloys containing iron and one or more non-ferrous metals as alloying elements. The ferroalloys are usually classified in two groups: bulk ferroalloys (produced in large quantities in electric arc furnaces), and special ferroalloys (produced in smaller quantities, but with growing importance). Bulk ferroalloys are used in steel making and

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[1] U.S. Environmental Protection Agency. AP-42, 12.4. Ferroalloy Production. October 1986.

steel or iron foundries exclusively, while the use of special ferroalloys is far more varied (used in batteries, animal feed). The U.S. military is a particularly notable consumer of manganese: In its weapons systems and munitions, the Department of Defense uses approximately 25,000 short tons of manganese ore chemical/metal grade, 7,900 short tons of ferro-manganese (either carbon or silicon) and 1,370 short tons of electrolytic manganese metal (EMM) each year. Manganese is a key ingredient in the production of ferroalloys for use in the steel and other industries. According the U.S. Geological Survey, "there are no substitutes for manganese in its major applications - the manufacture of steel, steel alloys, non-steel alloys, batteries, and fertilizers and animal feed." (USGS, 2008). In total, about 87 % of the ferroalloys produced are used in the steel industry (European Commission, 2001).

Very little ferroalloy production takes place in the U.S. and Canada. Less than 1 percent of worldwide ferroalloy production takes place in the United States (SFSA, 2008). The amount of worldwide ferroalloy production occurs in North America has declined over time. As of 2008, more than 56 percent of ferroalloy production took place in Asia (SFSA, 2008). The largest producer of ferroalloys is China, with more than 18 million tons produced in 2008. South Africa is second highest production, but is well behind China at around 4 million tons produced that same year. More than 80 percent of the ferroalloys consumed in the U.S. are imported.

Worldwide, the top four ferroalloys produced are: ferrochromium (7.84 million metric tons), silicomanganese (7.46 million metric tons), ferrosilicon (7.32 million metric tons), and ferromanganese (5.7 million metric tons) (SFSA, 2008).

Today, there are two ferroalloys production facilities that are subject to the MACT rule. No new ferroalloys production facilities have been built in over 20 years, and we anticipate no new ferroalloys production facilities in the foreseeable future, although one facility is currently exploring expanding operations.

The affected facilities are owned by the Eramet Group and Group Privat. The Eramet Group is a French-owned conglomerate with more than 16,000 employees worldwide and revenues in 2010 of around $5 billion. Group Privat is a loose conglomerate of several large Ukrainian firms that have interests in metals, chemicals, banking, and other industries in that country and worldwide. There are at least 20,000 employees in this conglomerate and at least $10 billion in revenues generated in 2008. The ferroalloys produced by these firms' U.S. facilities use manganese as an input, and the mines for this manganese are owned by these firms.

SECTION 4
BASELINE EMISSIONS, EMISSION REDUCTIONS, AND COSTS

4.1 Introduction

This section presents the baseline emissions for the pollutants emitted by affected units and also the resulting emissions in 2015 after imposition of the proposed RTR rule. We present the baseline emissions and emission reductions for HAP and other emissions such as $PM_{2.5}$. Emission reductions were calculated from the baseline emissions based on the proposed emissions limits, and the emission reductions were used as inputs to the benefits analysis presented in Section 7.

4.2 Summary Of Cost Estimates And Emissions Reductions For The Regulatory Options Considered For Proposal

Regulatory options were considered for control of emissions of particulate metal hazardous air pollutants (HAP), Mercury (Hg), organic HAP, and Polycyclic Aromatic Hydrocarbons (PAH) from furnace stacks, and metal HAP from product sizing stacks and fugitive sources.

Emissions of each pollutant vary considerably among facilities, and multiple control options are available for different groups of pollutants. Because of this, and the limited number of facilities in the source category (two), specific regulatory options were assessed for each facility based on both technology review and modeled risk. Because of differences in modeled risk and existing controls, some options were not considered for all process lines at all facilities. Emissions reductions were estimated for each facility based on emissions data received in an information collection request (ICR) sent to the industry.

A brief description of the options selected for the proposed revisions to the NESHAP and the associated costs and emissions reductions for each facility in the source category are summarized in Table 4-1. All the options considered in this analysis are summarized in Table 4-2, along with the total estimated cost for implementing each option. A more detailed description of all the regulatory options considered for proposal and their associated cost and emissions reductions estimates are presented in section 2.0 of the cost memorandum for this proposal.

The emissions reductions associated with the control options are calculated as the difference between baseline emissions and the estimated emissions for each control scenario. Details of the methodology employed to calculate these emissions are included in a separate memorandum. All costs are estimated in 2010 dollars. The HAP emission reductions estimated for this proposal are 83.6 tons. PM emissions in this memo refer to total PM. Of the total PM, approximately 41 percent of the emissions are fine particulate ($PM_{2.5}$). Thus, of the 626 tons of total PM reduced, 257 tons are $PM_{2.5}$.

Table 4-1: Summary of the Estimated Costs and Emissions Reductions of Regulatory Options Selected for Proposal

		Annual Cost of Control Technology ($)						Cost Effectiveness		
		Furnace Fabric FIlter Upgrade	Carbon Injection	Tap Hood Upgrade	Casting Capture & Control	Building Ventilation	Product Sizing Fabric Filter Upgrade			
Facility	Pollutant	PM, Metal HAP	Hg, PAH, HCHO	PM, Metal HAP	PM, Metal HAP	PM, Metal HAP	PM, Metal HAP	Total Cost/Yr ($)	HAP Reduction (Tons)	Cost Effectiveness ($/lb HAP)
Eramet			$1,413,952			$1,512,930		$2,926,882	63.8	$23
Felman						$756,465		$756,465	19.8	$19

Note: Shaded options were not selected for proposal.

Table 4-2: Summary of the Estimated Costs and Reductions for All Considered Options

Control Option	PM Emission Reduction (TPY)	$PM_{2.5}$ Emission Reduction[1] (TPY)	HAP Emission Reduction (TPY)	Capital Cost ($)	Annual Cost ($/Yr)	PM Cost Effectiveness ($/Ton)	$PM_{2.5}$ Cost Effectiveness ($/Ton)	HAP Cost Effectiveness ($/lb)	Affected Facilities
Replace Furnace Fabric Filter[2]	24.6	10.1	2.95	$13,237,000	$1,543,603	$62,761	$153,075	$261	Eramet
Install ACI for Hg and PAH	N/A	N/A	3.55	$1,673,836	$1,413,952	N/A	N/A	$199	Eramet
Improve Tapping Capture	63.2	25.9	6.86	$314,922	$81,792	$1,294	$3,155	$6	Eramet, Felman
Casting Capture & Control	100	40.9	22.9	$4,979,039	$1,592,762	$15,949	$38,900	$35	Eramet, Felman
Install Building Ventilation	626	257	80.4	$9,439,500	$2,269,394	$3,623	$8,838	$14	Eramet, Felman
Improve Product Sizing Baghouse	11.4	4.65	4.66	$59,017	$14,394	$1,268	$3,092	$2	Eramet

[1] $PM_{2.5}$ estimated to be approximately 41% of total PM.

[2] The emission reductions and annual cost for fabric filter replacement are based on the incremental difference between operation of a scrubber and a fabric filter. The cost effectiveness values were calculated using the incremental annual cost and the incremental emission reductions between the scrubber and the fabric filter.

4.3 Regulatory Options Considered For Proposal

This section provides a detailed description of all regulatory options that were considered for the proposed revisions to the Ferroalloys NESHAP and their associated costs and emissions reductions.

4.3.1 Furnace Stack Emissions – Metal HAP

The selected standard for furnace stack emissions of PM (as a surrogate for metal HAP) is based on a technology review, and is designed to ensure that the standard in place will reflect actual current performance of existing sources. The selected option is a numeric emission standard with which both facilities are already in compliance through current controls. Although it was not selected for proposal, costs for a beyond-the-floor regulatory option were estimated, and are presented here.

4.3.1.1Replacement of Existing control device with a new negative-pressure fabric filter

This option was considered for a single furnace at one of the facilities, and represents a scenario of reducing fugitive PM emissions from the facility by 25 tons per year (and HAP emissions by 3 tons per year) by replacing a wet scrubber with a large negative pressure fabric filter. The total estimated capital cost for the replacement fabric filter is $13.2 million. Annualized capital cost and operational and maintenance costs are estimated at $2.5 million or $1.5 million above the current annual cost for the existing scrubber, according to the facility ICR response.

4.3.2 Furnace Stack Emissions – Hg, PAH, Formaldehyde[1]

The selected standards for Hg and PAH are numeric emission standards that represent a beyond-the-floor option considered under section 112(d) of the Clean Air Act (the Act). We selected this option largely based on the potential risk impacts based on multi-pathway screening and because of the potential to reduce the global pool of mercury. We determined that only one

[1] The Hg and PAH controls will also achieve co-control of formaldehyde. We propose to set a MACT floor limit for this pollutant because there are no compelling risk or environmental reasons to control the relatively low levels of formaldehyde emitted at a beyond-the-floor level.

of the facilities would be required to implement controls for these pollutants.[2] Estimated costs associated with these controls are presented here.

4.3.2.1Addition of Activated Carbon Injection for Fabric Filters and Scrubbers

This option was selected for two furnaces at one facility, and it represents a scenario of reducing emissions of Hg, PAH, and Formaldehyde from the facility by 3.2 tpy by installation of activated carbon injection (ACI). The total estimated capital cost for the retrofit of ACI is $1.7 million. Annualized capital cost and operational and maintenance costs are estimated at $1.4 million.

[2] Memorandum from Bradley Nelson, Ec/R to Conrad Chin, US EPA/OAQPS/SPPD/MMG, Methodology Used to Estimate Mercury Control Costs for the Ferroalloys Production Industry, September 8, 2011.

4.3.3 Process Fugitive Emissions – Metal HAP

Several regulatory options were considered for control of fugitive metal HAP emissions, based on modeled risk. We focused the options on the individual emissions sources at each plant that appeared to be risk drivers. We looked at several options to capture and control these process fugitives ranging from local ventilation and control, building ventilation and control, and fenceline monitoring. The regulatory options considered for control of process fugitive metal HAP emissions are presented in the following section.

4.3.3.1Improvements to Capture Hoods for Tapping Operations

This option was considered for tapping operations at two furnaces each for both of the facilities, not including some hoods which were recently upgraded. This option represents a scenario of reducing fugitive PM emissions from the facilities by 63 tpy (and HAP emissions by 6.9 tpy) by upgrading the capture efficiency of capture hoods for tapping operations. The total estimated capital cost for the hood upgrades is approximately $315,000. Annualized capital cost and operational and maintenance costs are estimated at approximately $82,000.

4.3.3.2Addition of Capture and Control for Casting Operations

Some casting operations are already controlled at each facility. We developed costs to capture and control casting emissions the remaining uncontrolled casting operations. The estimated costs were based on the assumption that one of the two facilities would require addition of capture and control for two of their three casting operations and the second facility would require addition of capture and control for one of their three casting operations. This scenario would reduce fugitive PM emissions from the facilities by 100 tpy (and HAP emissions by 23 tpy) by adding hoods, ductwork, and fabric filters to capture and control emissions from currently uncontrolled casting operations. The total estimated capital cost for the hoods, ductwork, and fabric filters is approximately $5 million. Annualized capital cost and operational and maintenance costs are estimated at approximately $1.6 million.

4.3.3.3 Building Ventilation

The selected control option involves installation of building ventilation for furnace buildings instead of installing fugitive controls on individual tapping and casting operations. This option would require installation of ductwork from the roof vents of furnace buildings and a new fabric filter for each building. We assumed that one of the two facilities would require building ventilation for two buildings and the second facility would require it for a single building. This option would reduce fugitive PM emissions from the facilities by 626 tpy (and HAP emissions by 80.4 tpy) by adding ductwork and fabric filters to capture and control all fugitive emissions from furnace buildings. The total estimated capital cost for the ductwork, and fabric filters is approximately $9.4 million. Annualized capital cost and operational and maintenance costs are estimated at approximately $2.3 million.

4.3.3.4 Tapping and Casting Control with Fence line Monitoring

This is an alternative regulatory option selected by EPA for proposal in the revised NESHAP for the Ferroalloys Production source category. This option allows facilities who may have already implemented improved capture and control of tapping and casting emissions to avoid installation of building ventilation by performing ambient monitoring for manganese at or near the boundaries of the facilities. Estimated emissions reductions would be the same as for the tapping and casting capture/control options described previously. Cost estimates were not prepared for this option.

4.3.5 Product Sizing Operations– Metal HAP – Improvements to Fabric Filters

The selected standard for product sizing stack emissions of PM (as a surrogate for metal HAP) is based on a technology review, and is designed to ensure that the standard in place will reflect actual current performance of existing sources. The selected option is a numeric emission standard with which both facilities are already in compliance through current controls (fabric filters). Although it was not selected for proposal, costs for a beyond-the-floor regulatory option were estimated, and are presented here.

4.3.5.1Upgrade fabric filter

For one facility, improvements to product sizing fabric filters were considered, and represent a scenario of reducing fugitive PM emissions from the facility by 11 tpy (and HAP emissions by 4.6 tpy) by upgrading the bag material of fabric filters and conversion to reverse-air cleaning. The total estimated capital cost for the fabric filter upgrades is approximately $59,000. Annualized capital cost and operational and maintenance costs are estimated at approximately $14,400.

4.3.6 Metal Oxygen Refining (MOR) Operations– Metal HAP

Metal Oxygen Refining (MOR) is a post-tapping process applied to the molten metal at one of the facilities. The selected standard for MOR stack emissions of PM (as a surrogate for metal HAP) is based on a technology review, and is designed to ensure that the standard in place will reflect actual current performance of existing sources. The selected option is a numeric emission standard with which the facility is already in compliance through current controls (a fabric filter). Modeled risk did not indicate any need for consideration of a beyond-the-floor control option, so no costs were estimated for this emission source.

4.4 Methodology For Estimating Control Costs

The following sections present the methodologies used to estimate the costs associated with the regulatory options considered for proposal in the revised NESHAP for the Ferroalloys Production source category.

4.4.1 Furnace Stack Emissions – Metal HAP

The primary technologies used to control furnace stack emissions of metal HAP in the Ferroalloys source category are fabric filters (also known as baghouses). One facility uses a wet scrubber to control emissions from one of their furnaces. Data from emission tests performed in conjunction with the ICR indicate that baghouses that are properly designed, installed, maintained and operated can meet all of the metal HAP stack emissions limits selected for proposal in the revised NESHAP.

In order to estimate the capital cost associated with a particular option, we first determined which stacks would be required to reduce emissions. Only one stack was considered for any emission reductions, the one with a wet scrubber, for which an above-the-floor option was considered – replacing the stack with a large negative pressure fabric filter. Because the required fabric filter would be a large, custom model, we contacted a vendor who had recently supplied a similar model for installation at a ferroalloys facility to obtain assistance in developing a cost estimate. The equipment-only cost supplied by the vendor was used in conjunction with techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual[3] to estimate total installed capital cost and annual costs.

Our cost model included installation of the fabric filter and any necessary fans, ductwork, and site work. The total installed capital cost of a fabric filter designed for a flow-rate of 180,000 actual cubic feet per minute (acfm) was estimated at $13.2 million. The annualized capital cost and operational and maintenance costs are estimated at $2.5 million, via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual. The annualized cost assumes a 20 year life expectancy for the unit and, to be consistent with OMB Guidance in Circular A-4, a 7 percent cost of capital as an estimate of the annualized capital cost as is commonly done for EPA standards such as this one. All costs for this estimate were based on 2010 dollars from a current vendor estimate. The annual cost for operation of the scrubber was estimated to be $1.0 million based on information obtained from the ICR submitted by the facility. Therefore, the incremental annual cost of replacing the current operating scrubber with a new negative pressure fabric filter was estimated to be $1.5 million. The incremental cost was used to calculate the cost effectiveness of this control option.

4.4.2 Furnace Stack Emissions – Hg, PAH, Formaldehyde

EPA believes that the most appropriate technology for control of exhaust emissions of Hg, PAH, and formaldehyde for the Ferroalloys Production source category is Activated Carbon Injection (ACI). Based on the proposed emission limit, we believe one facility would require installation of controls for Hg and PAH on two furnaces. To minimize generation of potentially

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[3] U.S. Environmental Protection Agency, EPA Air Pollution Control Cost Manual. October 2002, Sixth Edition, Found on the Internet at http://epa.gov/ttn/catc/products.html#cccinfo

hazardous waste (from contaminated carbon media) and avoid contamination of the saleable byproduct baghouse dust, it was assumed that the carbon injection would be performed at the outlet of the negative pressure fabric filter, with the carbon media collected by a second, small polishing baghouse. Activated carbon for the furnace equipped with a scrubber would be injected prior to the scrubber with no additional particulate control required.

Costs for ACI were estimated using cost equations developed for the Utility NESHAP[4] and information provided by activated carbon vendors.[5] The calculated equipment costs for ACI and fabric filters were used in conjunction with techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual to estimate total installed capital cost and annual costs. It was estimated that one facility would require installation of ACI on two furnaces, one exhausting to a fabric filter with an outlet flow rate of 245,000 acfm, and a second exhausting to a scrubber with an outlet flow rate of 184,000 acfm.

Our cost model included installation of the two activated carbon injection systems, one polishing fabric filter, and associated fans, ductwork, and site work. The total installed capital cost was estimated at $1.7 million. The annualized capital cost and operational and maintenance costs were estimated at $1.4 million. Annualized costs assume a 20 year life expectancy for the units and, to be consistent with OMB Guidance in Circular A-4, a 7 percent cost of capital as an estimate of the annualized capital cost as is commonly done for EPA standards such as this one.[6] All costs for this estimate were adjusted to 2010 dollars using Chemical Engineering Plant Cost Indices (CEPCI). [7] We did not consider the downtime associated with installation for the unit in our costs.

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[4] Sargent & Lundy, IPM Model - Revisions to Cost and Performance for APC Technologies, Mercury Control Cost Development Methodology Final, March, 2011. http://www.epa.gov/airmarkt/progsregs/epa-ipm/docs/append5_3.pdf

[5] Contact Report, Daryl Lipscomb, Albemarle, August 22, 2011.

[6] U.S. Office of Management and Budget. Circular A-4, September 17, 2003. Found on the Internet at http://www.whitehouse.gov/omb/circulars_a004_a-4/#e.

[7] Estimates of the Chemical Engineering Plant Cost Index can be found at http://www.che.com. CEPCI values employed were: 539.1 for 2010, 575.4 for 2008, and 361.3 for 1991.

4.4.3 Process Fugitive Emissions – Metal HAP

Fugitive emissions of metal HAP at Ferroalloys Production facilities result from several areas of the process. Process fugitive emissions primarily result from furnace leaks and incomplete capture of emissions during tapping and casting of product. Furnace upsets can result in release of emissions that would normally be contained by negative pressure occurring inside furnace hood. Process fugitive emissions can also result from incomplete capture of emissions by tapping hoods, or from casting operations, some of which are uncontrolled at both facilities.

The 1999 NESHAP established a building opacity limit of 20 percent that is measured during the required furnace control device performance test. The rule provides an excursion limit of 60 percent opacity for one 6-minute period during the performance test. The opacity observation is focused only on emissions exiting the shop due solely to operations of any affected submerged arc furnace. In addition, blowing taps, poling and oxygen lancing of the tap hole; burndowns associated with electrode measurements; and maintenance activities associated with submerged arc furnaces and casting operations are exempt from the opacity standards specified in §63.1653.

Both facilities employ negative-pressure hoods to collect emissions from tapping operations and direct them to a control device. Some casting operations at both facilities capture emissions and direct them to a fabric filter, while some casting operations are currently uncontrolled.

Costs were estimated for several options for process fugitive control:

- Improvements to Capture Hoods for Tapping Operations
- Addition of Capture and Control for Casting Operations
- Building Ventilation

Building ventilation was the option selected for proposal, because it was associated with the lowest levels of modeled risk, and would capture any emissions that would have been collected by improved tapping capture and capture control of casting emissions, in addition to any furnace fugitives which escape current controls.

a) *Improvements to Capture Hoods for Tapping Operations*

Estimated costs for tap hood improvements were assumed to cover only the cost of an improved replacement tapping hood on the assumption that sufficient control device capacity is already in place, since both facilities already have tapping capture and control in place. Because the capture hood equations in EPA's cost manual were insufficient for large, metal hoods of the type required, an equation from a book by Bill Vatavuk (the author of EPA's Air Pollution Control Cost Manual) was used[8], in conjunction with techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual[9] to estimate total installed capital cost and annual costs.

Our cost model included installation of the replacement tap hood. The total installed capital cost of four replacement tapping hoods (two at each facility) was estimated at $315,000. The annualized capital cost and operational and maintenance costs are estimated at $81,000 via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual. The annualized cost assumes a 20 year life expectancy for the equipment and, to be consistent with OMB Guidance in Circular A-4, a 7 percent cost of capital as an estimate of the annualized capital cost as is commonly done for EPA standards such as this one. All costs for this estimate were adjusted to 2010 dollars using Chemical Engineering Plant Cost Indices (CEPCI). We did not consider the downtime associated with installation for the unit in our costs.

b) *Addition of Capture and Control for Casting Operations*

Estimated costs for addition of capture and control of casting emissions were assumed to cover the cost of hoods and ductwork for capture, plus a fabric filter for control of particulate emissions. Because each facility already has installed capture and

[8] Vatavuk, W.M., Estimating Costs of Air Pollution Control. Chelsea, Michigan, Lewis Book Publishers. 1990. P. 92.

[9] http://epa.gov/ttn/catc/products.html#cccinfo

control for some of their casting operations, we estimated that additional capture and control for two casting operations would be required at one facility and for one casting operation at the second. Equipment costs for the hoods and ductwork, plus a fabric filter a fabric filter designed for a flow-rate of 60,000 actual cubic feet per minute (acfm) were estimated via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual[10] to estimate total installed capital cost and annual costs.

Our cost model included installation of casting hoods, ductwork, and a fabric filter. The total installed capital cost to add capture and control for three casting operations was estimated at $5.0 million. The annualized capital cost and operational and maintenance costs are estimated at $1.6 million via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual. The annualized cost assumes a 20 year life expectancy for the equipment and, to be consistent with OMB Guidance in Circular A-4, a 7 percent cost of capital as an estimate of the annualized capital cost as is commonly done for EPA standards such as this one. All costs for this estimate were adjusted to 2010 dollars using Chemical Engineering Plant Cost Indices (CEPCI). We did not consider the downtime associated with installation for the unit in our costs.

c) *Building Ventilation*

To estimate the cost for the building ventilation fabric filter, EPA contacted a vendor who had recently supplied a fabric filter to one of the facilities to obtain assistance in developing a cost estimate for the installation. The equipment-only cost supplied by the vendor was used in conjunction with techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual[11] to estimate total installed capital cost and annual costs.

Our cost model included installation of the baghouse and any necessary fans, ductwork, and site work, including extra ductwork for connection to the building roof monitors. The total installed capital cost of three fabric filters (two at one facility, one at the second facility) designed for a flow-rate of 150,000 actual cubic feet per minute

10 http://epa.gov/ttn/catc/products.html#cccinfo
11 http://epa.gov/ttn/catc/products.html#cccinfo

(acfm) was estimated at $9.4 million. The annualized capital cost and operational and maintenance costs are estimated at $2.3 million, via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual. The annualized cost assumes a 20 year life expectancy for the unit and, to be consistent with OMB Guidance in Circular A-4, a 7 percent cost of capital as an estimate of the annualized capital cost as is commonly done for EPA standards such as this one. All costs for this estimate were based on 2010 dollars from a current vendor estimate. We did not consider the downtime associated with installation for the unit in our costs.

4.4.4 Product Sizing Operations– Metal HAP – Improvements to Fabric Filters

The primary technology used to control emissions of particulate metal HAP from product sizing operations in the Ferroalloys Production source category are fabric filters. The fabric filters currently in use at the facilities are capable of meeting the proposed standard. Although it was not selected for proposal, costs for a beyond-the-floor regulatory option were estimated, and are presented here. The beyond-the-floor option was based on modeled risk, and only one product sizing line at one facility was determined to pose any exiting risk. The option considered was an upgrade to the fabric filter via improved bag materials and conversion to reverse-air cleaning. The costs associated with this upgrade were calculated via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual[12] to estimate total installed capital cost and annual costs. At the end, we concluded that the potential risk reduction was not meaningful compared to the risk reduction achieved by the building ventilation option.

The total installed capital cost of the fabric filter upgrade was estimated at $59,000. The Annualized capital cost and operational and maintenance costs are estimated at $14,000, via techniques described in the sixth edition of the EPA Air Pollution Control Cost Manual. The annualized cost assumes a 5 year life expectancy for the equipment (fabric filter bags) and, to be consistent with OMB Guidance in Circular A-4, a 7 percent cost of capital as an estimate of the annualized capital cost as is commonly done for EPA standards such as this one. All costs for this estimate were adjusted to 2010 dollars using Chemical Engineering Plant Cost Indices (CEPCI). We did not consider the downtime associated with installation for the unit in our costs.

4.5 Summary of Cost By Facility

Table 4-3 summarizes estimated costs for each facility in the Ferroalloys source category, assuming implementation of the emission reduction options selected for proposal.

[12] http://epa.gov/ttn/catc/products.html#cccinfo

Table 4-3: Summary Cost Estimates by Facility*

Facility	Total Capital Cost	Total Annual Cost
Eramet	$7,966,836	$2,926,882
Felman	$3,146,500	$756,465
Total	$11,113,336	$3,683,347

*Overall cost estimates may be overstated since some facilities may be able to comply with the rule under the alternative compliance option (i.e., monitoring at facility boundary and improved casting/tapping capture & control) and may not need to install building ventilation. If so, actual costs would be significantly lower than shown here.

SECTION 5
ECONOMIC IMPACT ANALYSIS AND STATUTORY AND EXECUTIVE ORDER ANALYSES

5.1 Background

In this chapter, we present the results of the economic impact analysis and analyses prepared in adherence to statutory and Executive Order requirements.

5.2 Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this proposed rule on small entities, small entity is defined as: (1) a small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise that is independently owned and operated and is not dominant in its field. For this source category, which has the NAICS code 331112 (i.e., Electrometallurgical ferroalloy product manufacturing), the SBA small business size standard is 750 employees according to the SBA small business standards definitions.

After considering the economic impacts of today's proposed rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities. Neither of the companies affected by this rule is considered to be a small entity per the definition provided in this section.

Although this proposed rule will not have a significant economic impact on a substantial number of small entities, the EPA nonetheless has tried to reduce the impact of this rule on small entities. To reduce the impacts, we are proposing emissions standards in a format that allow companies flexibility on how best to comply with them. Moreover, we are proposing stack limits that are based on a weighted average approach (as described in Sections V.C and V.D of the preamble) and have been established at the least stringent levels that we estimate will still result in acceptable risks to public health. Thus, the proposed stack limits are based on the least costly approach that will still provide an ample margin of safety for human health and the environment. In addition, the proposed compliance testing requirements were established in a way that minimizes the costs for testing and reporting while still providing the Agency the necessary information needed to ensure continuous compliance with the proposed standards. We continue to be interested in the potential impacts of the proposed rule on small entities and welcome comments on issues related to such impacts.

5.3 Energy Impacts

Executive Order 13211 (66 FR 28355, May 22, 2001) provides that agencies will prepare and submit to the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, a Statement of Energy Effects for certain actions identified as "significant energy actions." Section 4(b) of Executive Order 13211 defines "significant energy actions" as any action by an agency (normally published in the *Federal Register*) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices of inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking: (1) (i) that is a significant regulatory action under Executive Order 12866 or any successor order, and (ii) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (2) that is designated by the Administrator of the Office of Information and Regulatory Affairs as a significant energy action.

This rule is not a significant energy action as designated by the Administrator of the Office of Information and Regulatory Affairs because it is not likely to have a significant adverse impact on the supply, distribution, or use of energy. This action will not create any new requirements and therefore no additional costs for sources in the energy supply, distribution, or use sectors.

5.4 Unfunded Mandates Reform Act

5.4.1 Future and Disproportionate Costs

The UMRA requires that we estimate, where accurate estimation is reasonably feasible, future compliance costs imposed by the rule and any disproportionate budgetary effects. Our estimates of the future compliance costs of the proposed rule are discussed previously in this RIA. We do not believe that there will be any disproportionate budgetary effects of the proposed rule on any particular areas of the country, state or local governments, types of communities (e.g., urban, rural), or particular industry segments.

5.4.2 Effects on the National Economy

The UMRA requires that we estimate the effect of the proposed rule on the national economy. To the extent feasible, we must estimate the effect on productivity, economic growth, full employment, creation of productive jobs, and international competitiveness of U.S. goods and services if we determine that accurate estimates are reasonably feasible and that such effect is relevant and material. The nationwide economic impact of the proposed rule is presented earlier in this RIA chapter. This analysis provides estimates of the effect of the proposed rule on most of the categories mentioned above, and these estimates are presented earlier in this RIA chapter. The nature of this rule is such that it is not practical for us to use existing approaches, such as the Morgenstern et al. approach,[1] to estimate the impact on employment to the regulated entities and others from this proposed rule. In addition, we have determined that the proposed rule contains no regulatory requirements that might significantly or uniquely affect small governments. Therefore, today's rule is not subject to the requirements of section 203 of the UMRA.

5.5 Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks" (62 FR 19885, April 23, 1997), applies to any rule that (1) is determined to be "economically significant," as defined under Executive Order 12866, and (2) concerns an environmental health or safety risk that EPA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, EPA must evaluate the environmental health or safety effects of the planned rule on children and explain why the

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[1] Morgenstern, R. D., W. A. Pizer, and J. S. Shih. 2002. "Jobs versus the Environment: An Industry-Level Perspective." *Journal of Environmental Economics and Management* 43(3):412-436.

planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposed rule is not subject to Executive Order 13045 (62 FR 19885, April 23, 1997) because the Agency does not believe the environmental health risks or safety risks addressed by this action present a disproportionate effect on children. If the regulatory action meets both criteria, the EPA must evaluate the environmental health or safety effects of the planned rule on children and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposed rule is not subject to Executive Order 13045 (62 FR 19885, April 23, 1997) because the Agency does not believe the environmental health risks or safety risks addressed by this action present a disproportionate risk to children. The report, Analysis of Socio-Economic Factors for Populations Living Near Ferroalloys Facilities, shows that on a nationwide basis, there are approximately 26,000 people exposed to a cancer risk at or above 1-in-1 million and approximately 28,000 people exposed to a chronic noncancer TOSHI greater than 1 due to emissions from the source category. Except for persons in the “Ages 65 and Up” demographic group which are slightly elevated compared to the national average, the percentages for the other demographic groups, including children 18 years and younger, are similar to or lower than their respective nationwide percentages.

This proposed rule is expected to reduce environmental impacts for everyone, including children. This action proposes emissions limits at the levels based on MACT, as required by the Clean Air Act. Based on our analysis, we believe that this rule does not have a disproportionate impact on children.

The public is invited to submit comments or identify peer-reviewed studies and data that assess effects of early life exposure to manganese, lead, arsenic, nickel, or mercury.

5.6 Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629 (Feb. 16, 1994)) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

For the proposed ferroalloys rule, the EPA has determined that the current health risks posed to anyone by emissions from this source category are unacceptable. There are about 26,000 to 28,000 people nationwide that are currently subject to health risks which are non-negligible (i.e., cancer risks greater than 1 in a million or chronic noncancer TOSHI greater than 1) due to emissions from this source category. The demographic distribution of this “at-risk” population is similar or below the national distribution of demographics for all groups except for the “ages 65 and up” age group, which is 4 percent greater than its corresponding national percentage. The proposed rule will reduce the number of people in this at-risk group from 26,000 - 28,000 people to about 1,000 people, thereby providing disproportionate benefits to a greater percentage of minorities. Therefore, the EPA has determined that the proposed rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations. Further, since it so significantly reduces the at-risk population in the process of ensuring public health protection with an ample margin of safety, it will actually provide disproportionate benefit to people ages 65 and up since they comprise a larger portion of the current at-risk group.

5.7 Employment Impact Analysis

In addition to addressing the costs and benefits of the proposed rule, EPA has analyzed the potential impacts of this rulemaking on employment, which are presented in this section. While a standalone analysis of employment impacts is not included in a standard cost-benefit analysis, such an analysis is of particular concern in the current economic climate of sustained high unemployment. Executive Order 13563, states, “Our regulatory system must protect public health, welfare, safety, and our environment while promoting economic growth, innovation, competitiveness, and job creation” (emphasis added). Therefore, we seek to inform the discussion of labor demand and job impacts by examining labor requirements for the installation, operation, and maintenance of control requirements, as well as reporting and recordkeeping requirements. Unlike several recent RIAs, however, we do not provide estimates based on the study by Morgenstern et al. (2002); we discuss this decision after presenting estimates of the labor requirements associated with reporting and recordkeeping and the installation, operation, and maintenance of control requirements. Nor have we quantified the rule’s effects on labor in other sectors not regulated by the proposed rule, or the effects induced by changes in workers’ incomes. As such, this analysis presents only the gross increase in labor demand caused by the rule. It does not account for possible decreases in labor demand caused by any reduction in output or change in production technology.

What follows is an overview of the various ways that environmental regulation can affect employment, followed by a discussion of the estimated impacts of this rule. EPA continues to explore the relevant theoretical and empirical literature and to seek public comments in order to ensure that such estimates are as accurate, useful and informative as possible.

From an economic perspective labor is an input into producing goods and services; if regulation requires that more labor be used to produce a given amount of output, that additional labor is reflected in an increase in the cost of production. Moreover, when the economy is at full employment, we would not expect an environmental regulation to have an impact on overall employment because labor is being shifted from one sector to another. On the other hand, in periods of high unemployment, an increase in labor demand due to regulation may result in a short-term net increase in overall employment due to the potential hiring of previously unemployed workers by the regulated sector to help meet new requirements (e.g., to install new equipment) or by the environmental protection sector to produce new abatement capital. With significant numbers of workers unemployed, the opportunity costs associated with displacing jobs in other sectors are likely to be smaller.

To provide a partial picture of the employment consequences of this rule, EPA takes two approaches. First, EPA uses information derived from its cost estimation documentation to generate estimates of employment impacts. Second, the analysis considers the results of Morgenstern, Pizer, and Shih (2002) in estimating the effects of the regulation on the regulated industry. This approach has been used by EPA previously in Regulatory Impact Analyses prepared recently. EPA is interested in public comments on the merits of including information derived in this fashion for assessing the employment consequences of regulations.

5.7.1 Employment Impacts from Pollution Control Requirements

When a new regulation is promulgated, a response of industry is to order pollution control equipment and services in order to comply with the regulation when it becomes effective. Revenue and employment in the environmental technology industry have grown steadily between 2000 and 2008, reaching an industry total of approximately $300 billion in revenues and 1.7 million employees in 2008.[2] While these revenues and employment figures represent gains for the environmental technologies industry, they are costs to the regulated industries required to install the equipment. Moreover, it is not clear the 1.7 million employees in 2008 represent new employment as opposed to workers being shifted from the production of goods and services to environmental compliance activities.

Once the equipment is installed, regulated firms may hire workers to operate and maintain the pollution control equipment – much like they hire workers to produce more output. Morgenstern et al. (2002) examined how regulated industries respond to regulation. The authors found that, on average for the industries they studied, employment increases in regulated firms. Of course, these firms may also reassign existing employees to perform these activities.

We do not estimate any potential changes in labor outside of the affected sector. This analysis estimates the employment impacts due to the installation, operation, and maintenance of control equipment, as well as employment associated with new reporting and recordkeeping requirements.

The employment analysis uses a bottom-up engineering-based methodology to estimate employment impacts. The engineering cost analysis summarized earlier in this RIA includes estimates of the labor requirements associated with implementing the proposed regulations. Each of these labor changes may either be required as part of an initial effort to comply with the new regulation or required as a continuous or annual effort to maintain compliance. We estimate up-front and continual, annual labor requirements by estimating hours of labor required and

[2] In 2008, the industry totaled approximately $315 billion in revenues and 1.9 million employees including indirect employment effects, pollution abatement equipment production employed approximately 4.2 million workers in 2008. These indirect employment effects are based on a multiplier for indirect employment = 2.24 (1982 value from Nestor and Pasurka - approximate middle of range of multipliers 1977-1991). Environmental Business International (EBI), Inc., San Diego, CA. Environmental Business Journal, monthly (copyright). http://www.ebiusa.com/ EBI data taken from the Department of Commerce International Trade Administration Environmental Industries Fact Sheet from April 2010: http://web.ita.doc.gov/ete/eteinfo.nsf/068f3801d047f26e85256883006ffa54/4878b7e2fc08ac6d85256883006c452c?OpenDocument

converting this number to full-time equivalents (FTEs) by dividing by 2,080 (40 hours per week multiplied by 52 weeks). We note that this type of FTE estimate cannot be used to make assumptions about the specific number of people involved or whether new jobs are created for new employees.

The results of this employment estimate are presented in Table 5-1 for the proposed NESHAP. The tables breaks down the installation, operation, and maintenance estimates by type of pollution control evaluated in the RIA and present both the estimated hours required and the conversion of this estimate to FTE. For the proposed NESHAP, reporting and recordkeeping requirements were estimated requirements were estimated for the entire rule rather than by anticipated control requirements; the reporting and recordkeeping estimates are consistent with estimates EPA submitted as part of its Information Collection Request (ICR) that is in the Supporting Statement for the proposed rule.

The up-front one-time labor requirement is estimated at 27 FTEs for the proposed NESHAP. These up-front FTE labor requirements can be viewed as short-term labor requirements required for affected entities to comply with the new regulation. Ongoing requirements are estimated at about 4 FTEs for the proposed NESHAP. These ongoing FTE labor requirements can be viewed as sustained labor requirements required for affected entities to continuously comply with the new regulation. It is important to recognize that these seemingly precise estimates are not to be assumed to be exact measures of the employment impacts of this rulemaking. They represent a rough approximation of the small positive impacts that this rule may have on employment.

Table 5-1. Labor-based Employment Estimates for Reporting and Recordkeeping and Installing, Operating, and Maintaining Control Equipment Requirements for Proposed NESHAP

Source/Emissions Point/Requirement	Emission Control Measure	Projected No. of Affected Units	Per-Unit One-Time Labor Estimate (Hours)	Total One-Time Labor Estimate (Hours)	Total Annual Labor Estimate (Hours)	One-Time Full-Time Equivalent	Annual Full-Time Equivalent
Furnace Shop	Building Ventilation	3	13,636	40,909	3,564	19.67	1.71
EAF[1]	ACI	2	545	1,090	904	0.52	0.43
EAF[1]	ACI + Polishing Baghouse	1	13,563	13,563	3,564	6.52	1.71
Monitoring & Testing[2]	N/A	2 Plants			190	0.00	0.09
Reporting & Recordkeeping[2]	N/A	2 Plants	150	300	70	0.14	0.03
TOTAL:			27,895	55,862	8,292	26.9	4.0

Note: Full-time equivalents (FTE) are estimated by first multiplying the projected number of affected units by the per unit labor requirements and then dividing by 2,080 (40 hours multiplied by 52 weeks). Totals may not sum due to independent rounding.
N/A = Not Applicable.
ACI = Activated Carbon Injection.
[1]EAF = Electric Arc Furnace. Estimate is from Draft Cost Impacts of the Revised NESHAP for the Ferroalloys Production Source Category, October 21, 2011.
[2] Supporting Statement for NESHAP for Ferroalloys Production: Ferromanganese and Silicomanganese, October 27, 2011.

5.7.2 Employment Impacts within the Regulated Industry

In recent RIAs we have applied estimates from a study by Morgenstern, Pizer and Shih (2002)[3] to derive the employment effects of new regulations within the regulated industry. (See, for example, the Regulatory Impact Analyses for the recently released proposed MATS and final

[3] Morgenstern, R. D., W. A. Pizer, and J. S. Shih. 2002. Jobs versus the Environment: An Industry-Level Perspective.‖ Journal of Environmental Economics and Management 43(3):412-436.

CSAPR regulations). Determining the direction of employment effects in the regulated industry is also challenging due to competing effects. Complying with the new or more stringent regulation requires additional inputs, including labor, and may alter the relative proportions of labor and capital used by regulated firms in their production processes. Morgenstern, et al. (2002) demonstrate that environmental regulations can be understood as requiring regulated firms to add a new output (environmental quality) to their product mixes. Although legally compelled to satisfy this new demand, regulated firms have to finance this additional production with the proceeds of sales of their other (market) products. Satisfying this new demand requires additional inputs, including labor, and may alter the relative proportions of labor and capital used by regulated firms in their production processes. It should be noted that this study assumes that the regulated entities will comply with the regulation and continue to operate. It does not provide information on potential entry and exit decisions by firms in the regulated sectors and subsequent employment impacts from those decisions.

More specifically, Morgenstern, Pizer, and Shih (2002) decompose the effect of regulation on net employment in the regulated sector into the following three subcomponents:

- *The Demand Effect*: higher production costs from complying with the regulation will raise market prices, reducing consumption (and production), thereby reducing demand for labor within the regulated industry. The "extent of this effect depends on the cost increase passed on to consumers as well as the demand elasticity of industry output." (p. 416)

- *The Cost Effect*: Assuming that the capital/labor ratio in the production process is held fixed, as "production costs rise, more inputs, including labor, are used to produce the same amount of output," (p. 416). For example, to reduce pollutant emissions while holding output levels constant, regulated firms may require additional labor.

- *The Factor-Shift Effect*: Regulated firms' production technologies may be more or less labor intensive after complying with the regulation (i.e., more/less labor is required relative to capital per dollar of output). "Environmental activities may be more labor intensive than conventional production," meaning that "the amount of labor per dollar of output will rise." However, activities may, instead, be less labor intensive because "cleaner operations could involve automation and less employment, for example." (p. 416)

The demand effect is expected to have an unambiguously negative effect on employment, the cost effect to have an unambiguously positive effect on employment, and the factor-shift effect to have an ambiguous effect on employment. Without more information with respect to the magnitudes of these competing effects, it is not possible to predict the total effect environmental regulation will have on overall employment levels in the regulated sector.

Morgenstern et al. estimated the effects of pollution abatement expenditures on net employment in four highly polluting/regulated sectors (pulp and paper, plastics, steel, and petroleum refining in 1980s). They conclude that increased abatement expenditures generally have *not* caused a significant change in net employment in those sectors. More specifically, their results show that, on average across the industries studied, each additional $1 million (in 1987$) spent on pollution abatement results in a (statistically insignificant) net increase of 1.5 jobs. While the specific sectors Morgenstern et al. examined are different than the sectors considered here, the methodology that Morgenstern et al. developed is still an informative way to qualitatively assess the effects of this rulemaking on employment in the regulated sector.

While the theoretical framework laid out by Morgenstern et al. can hold for the ferroalloys industry under this proposal, important differences in the markets and regulatory settings analyzed in their study and the setting presented here lead us to conclude that it is inappropriate to utilize their quantitative estimates to estimate the employment impacts from this proposal. The differences between the underlying regulations motivating the abatement expenditures studied in Morgenstern et al. are potentially too many to allow for the direct transfer of their quantitative estimates for use in analysis of the proposed rule. There are important differences between the ferroalloy industry and the four manufacturing industries studied by Morgenstern et al. While the steel industry is one of the industries studied by Morgenstern et al., and ferroalloys is an important input to steel production, the differences in the two industries are significant enough to lead to questions about how applicable are the parameters in Morgenstern et al. in this analysis. In addition, the fact that this proposal only impacts a small subset of the regulated industry leads to concerns about whether the Morgenstern et al. approach, which uses compliance costs to analyze the impact of environmental compliance expenditures on industry employment levels, can be suitable to estimate employment impacts for this industry as part of this proposed rule. For these reasons we conclude there are too many uncertainties as to the comparability of the Morgenstern et al. study to apply their estimates to quantify the employment impacts within the regulated sector for this proposed regulation.

SECTION 6
HUMAN HEALTH BENEFITS OF EMISSIONS REDUCTIONS

6.1 Synopsis

In this section, we provide an estimate of the monetized benefits associated with reducing particulate matter (PM) for the proposed NESHAP for Ferroalloys Production to address the results of the residual risk and technology review, RTR. For this rule, the PM reductions are the result of emission limits on the $PM_{2.5}$. The total $PM_{2.5}$ reductions are the consequence of the technologies installed to meet these limits. These estimates reflect the monetized human health benefits of reducing cases of morbidity and premature mortality among populations exposed to the $PM_{2.5}$ reduced by this rulemaking. Using a 3% discount rate, we estimate the total monetized benefits of the proposed ferroalloy RTR to be $71 million to $170 million in the implementation year (2015). Using a 7% discount rate, we estimate the total monetized benefits of the Ferroalloy RTR to be $63 million to $160 million in the year of analysis (2015). All estimates are in 2010$.

These estimates reflect EPA's most current interpretation of the scientific literature. Higher or lower estimates of benefits are possible using other assumptions; examples of this are provided in Figure 6-2 below. Data, resource, and methodological limitations prevented EPA from monetizing the benefits from several important benefit categories, including benefits from reducing hazardous air pollutants and visibility impairment. The benefits from reducing other air pollutants have not been monetized in this analysis, including reducing arsenic, chromium, nickel, manganese, mercury, polycyclic aromatic hydrocarbons (PAH) and other HAP emissions.

6.2 Calculation of $PM_{2.5}$ Human Health Benefits

This rulemaking would reduce emissions of $PM_{2.5}$, and the incidence of $PM_{2.5}$-related health effects. For this rule, the PM reductions are the result of emission limits on directly emitted PM, which is used as a surrogate for metal HAP. The total $PM_{2.5}$ reductions are the consequence of the technologies installed to meet these limits. Due to analytical limitations, it was not possible to provide a comprehensive estimate of $PM_{2.5}$-related benefits. Instead, we used the "benefit-per-ton" approach to estimate these benefits. The methodology employed in this analysis is similar to the work described in Fann, Fulcher, and Hubbell (2009), but represents an improvement that EPA feels leads to more reliable estimates of $PM_{2.5}$-related health benefits for emissions reductions in specific sectors. The key assumptions are described in detail below.

These $PM_{2.5}$ benefit-per-ton estimates provide the total monetized human health benefits (the sum of premature mortality and premature morbidity) of reducing one ton of $PM_{2.5}$ from a specified source. EPA has used the benefit per-ton technique in several previous RIAs, including the recent SO_2 NAAQS RIA (U.S. EPA, 2010b). Table 6-1 shows the quantified and unquantified benefits captured in those benefit-per-ton estimates.

Table 6-1. Human Health and Welfare Effects of $PM_{2.5}$

Category	Specific Effect	Effect Has Been Quantified	Effect Has Been Monetized	More Information (refers to CSAPR RIA)
Improved Human Health				
Reduced incidence of premature mortality from exposure to $PM_{2.5}$	Adult premature mortality based on cohort study estimates and expert elicitation estimates (age >25 or age >30)	□	□	Section 5.4
	Infant mortality (age <1)	□	□	Section 5.4
Reduced incidence of morbidity from exposure to $PM_{2.5}$	Non-fatal heart attacks (age > 18)	□	□	Section 5.4
	Hospital admissions—respiratory (all ages)	□	□	Section 5.4
	Hospital admissions—cardiovascular (age >20)	□	□	Section 5.4
	Emergency room visits for asthma (all ages)	□	□	Section 5.4
	Acute bronchitis (age 8-12)	□	□	Section 5.4
	Lower respiratory symptoms (age 7-14)	□	□	Section 5.4
	Upper respiratory symptoms (asthmatics age 9-11)	□	□	Section 5.4
	Asthma exacerbation (asthmatics age 6-18)	□	□	Section 5.4
	Lost work days (age 18-65)	□	□	Section 5.4
	Minor restricted-activity days (age 18-65)	□	□	Section 5.4
	Chronic Bronchitis (age >26)	□	□	Section 5.4
	Emergency room visits for cardiovascular effects (all ages)	--	--	Section 5.4
	Strokes and cerebrovascular disease (age 50-79)	--	--	Section 5.4
	Other cardiovascular effects (e.g., other ages)	--	--	PM ISA[2]
	Other respiratory effects (e.g., pulmonary function, non-asthma ER visits, non-bronchitis chronic diseases, other ages and populations)	--	--	PM ISA[2]
	Reproductive and developmental effects (e.g., low birth weight, pre-term births, etc)	--	--	PM ISA[2,3]
	Cancer, mutagenicity, and genotoxicity effects	--	--	PM ISA[2,3]

[1] We assess these benefits qualitative due to time and resource limitations for this analysis.
[2] We assess these benefits qualitatively because we do not have sufficient confidence in available data or methods.
[3] We assess these benefits qualitatively because current evidence is only suggestive of causality or there are other significant concerns over the strength of the association.

Consistent with the Portland Cement NESHAP (U.S. EPA, 2009a), the $PM_{2.5}$ benefits estimates utilize the concentration-response functions as reported in the epidemiology literature, as well as the 12 functions obtained in EPA's expert elicitation study as a sensitivity analysis.

- One estimate is based on the concentration-response (C-R) function developed from the extended analysis of American Cancer Society (ACS) cohort, as reported in Pope et al. (2002), a study that EPA has previously used to generate its primary benefits estimate. When calculating the estimate, EPA applied the effect coefficient as reported in the study without an adjustment for assumed concentration threshold of 10 $\mu g/m^3$ as was done in recent (2006–2009) Office of Air and Radiation RIAs.
- One estimate is based on the C-R function developed from the extended analysis of the Harvard Six Cities cohort, as reported by Laden et al. (2006). This study, published after the completion of the Staff Paper for the 2006 $PM_{2.5}$ NAAQS, has been used as an alternative estimate in the $PM_{2.5}$ NAAQS RIA and $PM_{2.5}$ benefits estimates in RIAs completed since the $PM_{2.5}$ NAAQS. When calculating the estimate, EPA applied the effect coefficient as reported in the study without an adjustment for assumed concentration threshold of 10 $\mu g/m^3$ as was done in recent (2006–2009) RIAs.
- Twelve estimates are based on the C-R functions from EPA's expert elicitation study (IEc, 2006; Roman et al., 2008) on the $PM_{2.5}$ -mortality relationship and interpreted for benefits analysis in EPA's final RIA for the $PM_{2.5}$ NAAQS. For that study, twelve experts (labeled A through L) provided independent estimates of the $PM_{2.5}$ -mortality concentration-response function. EPA practice has been to develop independent estimates of $PM_{2.5}$ -mortality estimates corresponding to the concentration-response function provided by each of the twelve experts, to better characterize the degree of variability in the expert responses.

Readers interested in reviewing the general methodology for creating the benefit-per-ton estimates used in this analysis should consult the draft Technical Support Document (TSD) on estimating the benefits per ton of reducing PM2.5 and its precursors from the Ferroalloy Sector.[1] The primary difference between the estimates used in this analysis and the estimates reported in Fann, Fulcher, and Hubbell (2009) is the air quality modeling data utilized. While the air quality data used in Fann, Fulcher, and Hubbell (2009) reflects broad pollutant/source category combinations, the source apportionment modeling data used in this analysis is sector-specific. As a result, the benefit-per-ton estimates presented herein better reflect the geographic areas and population likely to be affected by the proposed rule. In this analysis, we apply the national

[1] U.S. Environmental Protection Agency. 2011. *Technical support document: Estimating the benefit per ton of reducing $PM_{2.5}$ precursors from the ferroalloy sector (Draft)*; EPA: Research Triangle Park, NC.

average benefit-per-ton estimate for a 2016 analysis year and multiply it by the corresponding emission reductions of directly emitted $PM_{2.5}$ to quantify the benefits of this rule.

These models assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality because the scientific evidence is not yet sufficient to allow differentiation of effect estimates by particle type (U.S. EPA, 2009b) . Directly emitted PM is the only $PM_{2.5}$ precursor affected by this rule. Even though we assume that all fine particles have equivalent health effects, the benefit-per-ton estimates vary between precursors because each ton of precursor reduced has a different propensity to form $PM_{2.5}$ and a different pattern of transport, resulting geographic distribution of exposure. When more people are exposed, the benefits per ton are greater. For example, VOC emissions have a lower benefit-per-ton estimate than direct $PM_{2.5}$ because it does not directly transform into $PM_{2.5}$ and because particles formed from VOC can transport many miles, including over areas with low populations. The benefit-per-ton coefficients in this analysis were derived using modified versions of the health impact functions used in the PM NAAQS Regulatory Impact Analysis. Specifically, this analysis uses the benefit-per-ton method first applied in the Portland Cement NESHAP RIA (U.S. EPA, 2009a), which incorporated three updates: a new population dataset, an expanded geographic scope of the benefit-per-ton calculation, and the functions directly from the epidemiology studies without an adjustment for an assumed threshold.[2] Removing the threshold assumption is a key difference between the method used in this analysis of PM benefits and the methods used in RIAs prior to the Portland Cement proposal, and we now calculate incremental benefits down to the lowest modeled $PM_{2.5}$ air quality levels.

Based on our review of the current body of scientific literature, EPA estimated PM-related mortality without applying an assumed concentration threshold. EPA's Integrated Science Assessment for Particulate Matter (U.S. EPA, 2009b), which was reviewed by EPA's Clean Air Scientific Advisory Committee (U.S. EPA-SAB, 2009a; U.S. EPA-SAB, 2009b), concluded that the scientific literature consistently finds that a no-threshold log-linear model most adequately portrays the PM-mortality concentration-response relationship while also

[2]These updates were already included in Fann et al. (2009). An example of the effect of these updates is available in the Portland Cement proposal RIA (U.S. EPA, 2009a). The benefit-per-ton estimates have also been updated since the Portland Cement proposal RIA (U.S. EPA, 2009a) to incorporate a revised VSL, as discussed on the next page.

recognizing potential uncertainty about the exact shape of the concentration-response function. Consistent with this finding, we incorporated a "Lowest Measured Level" (LML) assessment, which is a method EPA has employed in several recent RIA's including the Cross-State Air Pollution Rule (U.S. EPA, 2011b). One key feature of this LML assessment is that it arrays the estimated $PM_{2.5}$-related avoided deaths relative to an air quality scenario in which the Ferroalloy-attributable $PM_{2.5}$ would be eliminated entirely. While this is a conservative assumption, the source apportionment air quality modeling informing this LML assessment is not designed to predict $PM_{2.5}$ levels from marginal changes in emissions from each sector.

For this analysis, policy-specific air quality data is not available due to time or resource limitations. For this rule, we are unable to estimate the percentage of premature mortality associated with this specific rule's emission reductions at each $PM_{2.5}$ level. However, we believe that it is still important to characterize the distribution of exposure to baseline air quality levels. As a surrogate measure of mortality impacts, we provide the percentage of the population exposed at each $PM_{2.5}$ level using the air quality baseline used for the source apportionment modeling. Readers interested in a full discussion of the source apportionment air quality modeling may consult "Air Quality Modeling Technical Support Document: Source Sector Assessments" (EPA, 2011c). It is important to note that baseline exposure is only one parameter in the health impact function, along with baseline incidence rates population, and change in air quality. In other words, the percentage of the population exposed to air pollution below the LML is not the same as the percentage of the population experiencing health impacts as a result of a specific emission reduction policy. The most important aspect, which we are unable to quantify for rules without air quality modeling, is the shift in exposure associated with this specific rule. Therefore, caution is warranted when interpreting the LML assessment. For more information on the data and conclusions in the LML assessment for rules without policy-specific air quality modeling, please consult the LML TSD (U.S. EPA, 2010d). The results of this analysis are provided in Section 6.4 of this RIA.

As is the nature of Regulatory Impact Analyses (RIAs), the assumptions and methods used to estimate air quality benefits evolve over time to reflect the Agency's most current interpretation of the scientific and economic literature. For a period of time (2004–2008), the Office of Air and Radiation (OAR) valued mortality risk reductions using a value of statistical life (VSL) estimate derived from a limited analysis of some of the available studies. OAR arrived at a VSL using a range of $1 million to $10 million (2000$) consistent with two meta-analyses of the wage-risk literature. The $1 million value represented the lower end of the interquartile range from the Mrozek and Taylor (2002) meta-analysis of 33 studies. The $10 million value represented the upper end of the interquartile range from the Viscusi and Aldy (2003) meta-analysis of 43 studies. The mean estimate of $5.5 million (2000$)[3] was also consistent with the mean VSL of $5.4 million estimated in the Kochi et al. (2006) meta-analysis. However, the Agency neither changed its official guidance on the use of VSL in rule-makings nor subjected the interim estimate to a scientific peer-review process through the Science Advisory Board (SAB) or other peer-review group.

During this time, the Agency continued work to update its guidance on valuing mortality risk reductions; including commissioning a report from meta-analytic experts to evaluate methodological questions raised by EPA and the SAB on combining estimates from the various data sources. In addition, the Agency consulted several times with the Science Advisory Board Environmental Economics Advisory Committee (SAB-EEAC) on the issue. With input from the meta-analytic experts, the SAB-EEAC advised the Agency to update its guidance using specific, appropriate meta-analytic techniques to combine estimates from unique data sources and different studies, including those using different methodologies (i.e., wage-risk and stated preference) (U.S. EPA-SAB, 2007).

Until updated guidance is available, the Agency determined that a single, peer-reviewed estimate applied consistently best reflects the SAB-EEAC advice it has received. Therefore, the Agency has decided to apply the VSL that was vetted and endorsed by the SAB in the *Guidelines for Preparing Economic Analyses* (U.S. EPA, 2000)[4] while the Agency continues its efforts to update its guidance on this issue. This approach calculates a mean value across VSL estimates derived from 26 labor market and contingent valuation studies published between 1974 and

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[3] After adjusting the VSL to account for a different currency year (2010$) and to account for income growth to 2015, the $5.5 million VSL is $8.0 million. In this analysis, we use 2016 estimates as a surrogate for 2015 estimates, which results in a slight overestimate of the benefits.

[4] In the (draft) update of the Economic Guidelines (U.S. EPA, 2010f), EPA retained the VSL endorsed by the SAB with the understanding that further updates to the mortality risk valuation guidance would be forthcoming in the near future. Therefore, this report does not represent final agency policy.

1991. The mean VSL across these studies is $6.3 million (2000$).[5] The Agency is committed to using scientifically sound, appropriately reviewed evidence in valuing mortality risk reductions and has made significant progress in responding to the SAB-EEAC's specific recommendations.

In implementing these rules, emission controls may lead to reductions in ambient $PM_{2.5}$ below the National Ambient Air Quality Standards (NAAQS) for PM in some areas and assist other areas with attaining the PM NAAQS. Because the PM NAAQS RIAs also calculate PM benefits, there are important differences worth noting in the design and analytical objectives of each RIA. The NAAQS RIAs illustrate the potential costs and benefits of attaining a new air quality standard nationwide based on an array of emission control strategies for different sources. In short, NAAQS RIAs hypothesize, but do not predict, the control strategies that States may choose to enact when implementing a NAAQS. The setting of a NAAQS does not directly result in costs or benefits, and as such, the NAAQS RIAs are merely illustrative and are not intended to be added to the costs and benefits of other regulations that result in specific costs of control and emission reductions. However, some costs and benefits estimated in this RIA account for the same air quality improvements as estimated in the illustrative $PM_{2.5}$ NAAQS RIA.

By contrast, the emission reductions for this RTR rule are from a specific class of well-characterized sources (ferroalloy facilities). In general, EPA is more confident in the magnitude and location of the emission reductions for these rules. It is important to note that emission reductions anticipated from these rules do not result in emission increases elsewhere. Emission reductions achieved under these and other promulgated rules will ultimately be reflected in the baseline of future NAAQS analyses, which would reduce the incremental costs and benefits associated with attaining the NAAQS. EPA remains forward looking towards the next iteration of the 5-year review cycle for the NAAQS, and as a result does not issue updated RIAs for existing NAAQS that retroactively update the baseline for NAAQS implementation. For more information on the relationship between the NAAQS and rules such as analyzed here, please see Section 1.2.4 of the SO_2 NAAQS RIA (U.S. EPA, 2010b).

[5] In this analysis, we adjust the VSL to account for a different currency year (2010$) and to account for income growth to 2015. After applying these adjustments to the $6.3 million value, the VSL is $9.2 million. In this analysis, we use 2016 estimates as a surrogate for 2015 estimates, which results in a slight overestimate of the benefits.

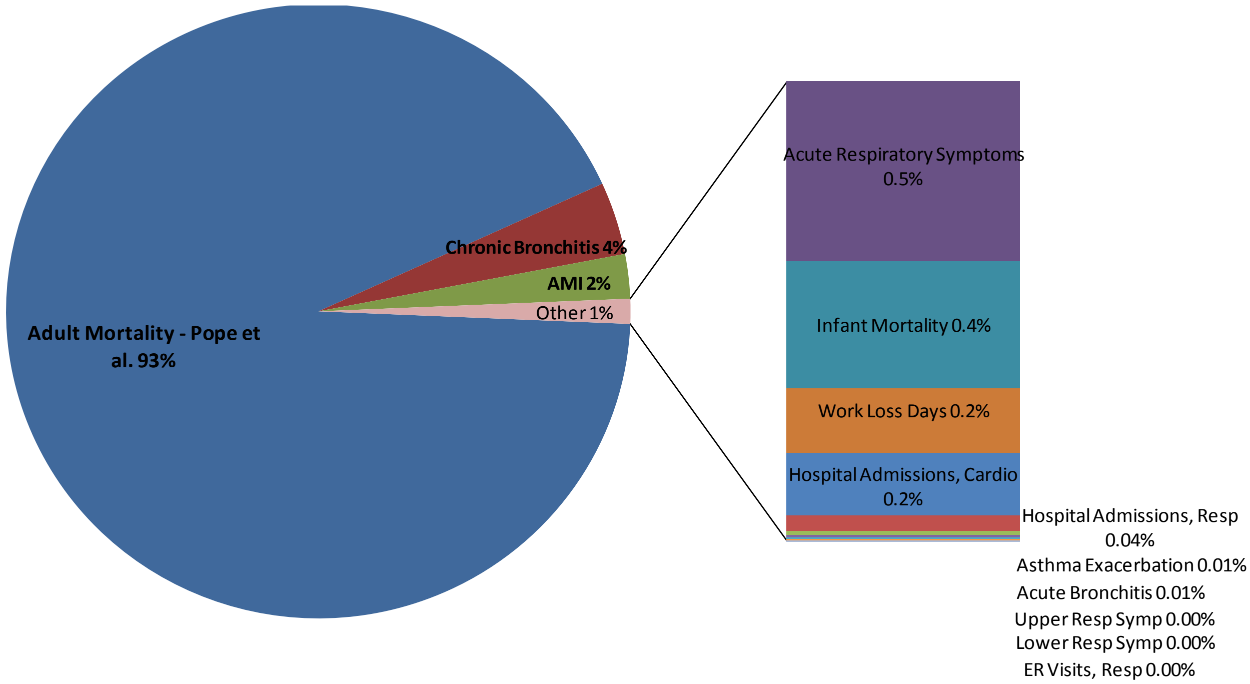

Figure 6-1. Breakdown of Monetized $PM_{2.5}$ Health Benefits Estimates using Mortality Function from Pope et al. (2002)[a]

[a] This pie chart breakdown is illustrative, using the results based on Pope et al. (2002) as an example. Using the Laden et al. (2006) function for premature mortality, the percentage of total monetized benefits due to adult mortality would be 97%. This chart shows the breakdown using a 3% discount rate, and the results would be similar if a 7% discount rate was used.

Table 6-2 provides a general summary of the primary approach results by pollutant, including the emission reductions and monetized benefits-per-ton at discount rates of 3% and 7%.[6] Table 6-3 provides a summary of the reductions in health incidences as a result of the pollution reductions. In Table 6-4, we provide the benefits using our anchor points of Pope et al. and Laden et al. as well as the results from the expert elicitation on PM mortality. Figure 6-2 provides a visual representation of the range of benefits estimates of $PM_{2.5}$ reductions.

[6] To comply with Circular A-4, EPA provides monetized benefits using discount rates of 3% and 7% (OMB, 2003). These benefits are estimated for a specific analysis year (i.e., 2015 using 2016 values as a surrogate), and most of the PM benefits occur within that year with two exceptions: acute myocardial infarctions (AMIs) and premature mortality. For AMIs, we assume 5 years of follow-up medical costs and lost wages. For premature mortality, we assume that there is a "cessation" lag between PM exposures and the total realization of changes in health effects. Although the structure of the lag is uncertain, EPA follows the advice of the SAB-HES to assume a segmented lag structure characterized by 30% of mortality reductions in the first year, 50% over years 2 to 5, and 20% over the years 6 to 20 after the reduction in $PM_{2.5}$ (U.S. EPA-SAB, 2004). Changes in the lag assumptions do not change the total number of estimated deaths but rather the timing of those deaths. Therefore, discounting only affects the AMI costs after the analysis year and the valuation of premature mortalities that occur after the analysis year. As such, the monetized benefits using a 7% discount rate are only approximately 10% less than the monetized benefits using a 3% discount rate.

Table 6-2. Summary of Monetized Benefits Estimates for the Ferroalloy Industry in 2015 (2010$)[a]

Pollutant	Emissions Reductions (tons)	Benefit per ton (Pope, 3%)	Benefit per ton (Laden, 3%)	Benefit per ton (Pope, 7%)	Benefit per ton (Laden, 7%)	Total Monetized Benefits (millions 2010$ at 3%)			Total Monetized Benefits (millions 2010$ at 7%)		
Direct $PM_{2.5}$	257	$280,000	$690,000	$250,000	$620,000	$71	to	$170	$63	to	$160
					Total	**$71**	**to**	**$170**	**$63**	**to**	**$160**

[a] All estimates are for the year of analysis (2015), and are rounded to two significant figures so numbers may not sum across columns. In this analysis, we use 2016 estimates as a surrogate for 2015 estimates, which results in a slight overestimate of the benefits. These models assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality the scientific evidence is not yet sufficient to allow differentiation of effect estimates by particle type. The benefit-per-ton estimates are updated and reflect new air quality modeling specific to the ferroalloys sector. The monetized benefits incorporate the conversion from precursor emissions to ambient fine particles. Confidence intervals are unavailable for this analysis because of the benefit-per-ton methodology.

Table 6-3. Summary of Reductions in Health Incidences from $PM_{2.5}$ Benefits for the Ferroalloy Sector in 2015[a]

	Reductions
Avoided Premature Mortality	
Pope et al.	8
Laden et al.	20
Avoided Morbidity	
Chronic Bronchitis	5
Acute Myocardial Infarction	9
Hospital Admissions, Respiratory	2
Hospital Admissions, Cardiovascular	3
Emergency Room Visits, Respiratory	5
Acute Bronchitis	11
Work Loss Days	950
Asthma Exacerbation	230
Lower Respiratory Symptoms	140
Upper Respiratory Symptoms	100

[a] All estimates are for the year of analysis (2015) and are rounded to whole numbers with two significant figures. In this analysis, we use 2016 estimates as a surrogate for 2015 estimates, which results in a slight overestimate of the benefits. These models assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality because the scientific evidence is not yet sufficient to allow differentiation of effect estimates by particle type.

Table 6-4. All $PM_{2.5}$ Benefits Estimates for the Ferroalloy Sector at Discount Rates of 3% and 7% in 2015 (in millions of 2010$)[a]

	$PM_{2.5}$ Benefits	
	3%	**7%**
Benefit-per-ton Coefficients Derived from Epidemiology Literature		
Pope et al.	$71	$63
Laden et al.	$170	$160
Benefit-per-ton Coefficients Derived from Expert Elicitation		
Expert A	$190	$170
Expert B	$62	$56
Expert C	$140	$130
Expert D	$100	$89
Expert E	$230	$210
Expert F	$54	$48
Expert G	$84	$75
Expert H	$110	$95
Expert I	$140	$130
Expert J	$110	$100
Expert K	$13	$11
Expert L	$39	$35

[a] All estimates are rounded to two significant figures. Estimates do not include confidence intervals because they were derived through the benefit-per-ton technique described above. The benefits estimates from the expert elicitation are provided as a reasonable characterization of the uncertainty in the mortality estimates associated with the concentration-response function. Confidence intervals are unavailable for this analysis because of the benefit-per-ton methodology.

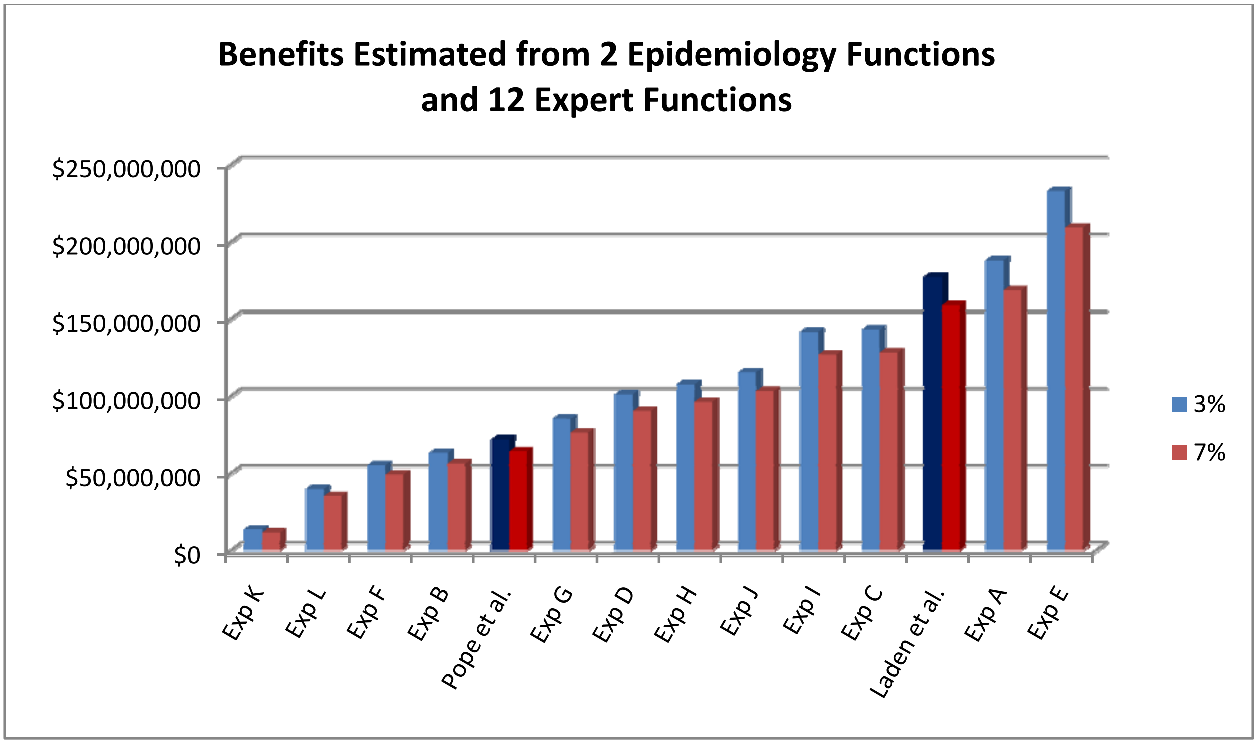

Figure 6-2. Total Monetized $PM_{2.5}$ Benefits Estimates for the Ferroalloy Sector in 2015

[a] This graph shows the estimated benefits at discount rates of 3% and 7% using effect coefficients derived from the Pope et al. (2002) study and the Laden et al. (2006) study, as well as 12 effect coefficients derived from EPA's expert elicitation on PM mortality. The results shown are not the direct results from the studies or expert elicitation; rather, the estimates are based in part on the concentration-response function provided in those studies.

6.3 Unquantified Benefits

The monetized benefits estimated in this RIA only reflect the portion of benefits attributable to the health effect reductions associated with ambient fine particles. Methodological and time limitations prevented EPA from quantifying or monetizing the benefits from several important benefit categories, including benefits from reducing toxic emissions, ecosystem effects, and visibility impairment. The health benefits from reducing hazardous air pollutants (HAPs) including metals, polycyclic aromatic hydrocarbons (PAH), and mercury have not been monetized in this analysis. Because we were unable to monetize the direct benefits associated with reducing HAPs among others, the monetized benefits estimate is an underestimate of the total benefits. The extent of this underestimate, whether small or large, is unknown.

6.3.1 HAP Benefits

Even though emissions of air toxics from all sources in the U.S. declined by approximately 42% since 1990, the 2005 National-Scale Air Toxics Assessment (NATA) predicts that most

Americans are exposed to ambient concentrations of air toxics at levels that have the potential to cause adverse health effects (U.S. EPA, 2011b).[7] The levels of air toxics to which people are exposed vary depending on where people live and work and the kinds of activities in which they engage. In order to identify and prioritize air toxics, emission source types and locations that are of greatest potential concern, U.S. EPA conducts the NATA.[8] The most recent NATA was conducted for calendar year 2005 and was released in March 2011. NATA includes four steps:

1) Compiling a national emissions inventory of air toxics emissions from outdoor sources

2) Estimating ambient and exposure concentrations of air toxics across the United States

3) Estimating population exposures across the United States

4) Characterizing potential public health risk due to inhalation of air toxics including both cancer and noncancer effects

Based on the 2005 NATA, EPA estimates that about 5% of census tracts nationwide have increased cancer risks greater than 100 in a million. The average national cancer risk is about 50 in a million. Nationwide, the key pollutants that contribute most to the overall cancer risks are formaldehyde and benzene.[9] Secondary formation (e.g., formaldehyde forming from other emitted pollutants) was the largest contributor to cancer risks, while stationary, mobile and background sources contribute almost equal portions of the remaining cancer risk.

Noncancer health effects can result from chronic,[10] subchronic,[11] or acute[12] inhalation exposures to air toxics, and include neurological, cardiovascular, liver, kidney, and respiratory

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[7] The 2005 NATA is available on the Internet at http://www.epa.gov/ttn/atw/nata2005/.

[8] The NATA modeling framework has a number of limitations that prevent its use as the sole basis for setting regulatory standards. These limitations and uncertainties are discussed on the 2005 NATA website. Even so, this modeling framework is very useful in identifying air toxic pollutants and sources of greatest concern, setting regulatory priorities, and informing the decision making process. U.S. EPA. (2011d) 2005 National-Scale Air Toxics Assessment. http://www.epa.gov/ttn/atw/nata2005/

[9] Details about the overall confidence of certainty ranking of the individual pieces of NATA assessments including both quantitative (e.g., model-to-monitor ratios) and qualitative (e.g., quality of data, review of emission inventories) judgments can be found at http://www.epa.gov/ttn/atw/nata/roy/page16.html.

[10] Chronic exposure is defined in the glossary of the Integrated Risk Information (IRIS) database (http://www.epa.gov/iris) as repeated exposure by the oral, dermal, or inhalation route for more than approximately 10% of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

effects as well as effects on the immune and reproductive systems. According to the 2005 NATA, about three-fourths of the U.S. population was exposed to an average chronic concentration of air toxics that has the potential for adverse noncancer respiratory health effects. Results from the 2005 NATA indicate that acrolein is the primary driver for noncancer respiratory risk.

Figure 6-3 and Figure 6-4 depict the estimated census tract-level carcinogenic risk and noncancer respiratory hazard from the assessment. It is important to note that large reductions in HAP emissions may not necessarily translate into significant reductions in health risk because toxicity varies by pollutant, and exposures may or may not exceed levels of concern. For example, acetaldehyde mass emissions are more than double acrolein emissions on a national basis, according to EPA's 2005 National Emissions Inventory (NEI). However, the Integrated Risk Information System (IRIS) reference concentration (RfC) for acrolein is considerably lower than that for acetaldehyde, suggesting that acrolein could be potentially more toxic than acetaldehyde. Thus, it is important to account for the toxicity and exposure, as well as the mass of the targeted emissions.

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[11] Defined in the IRIS database as repeated exposure by the oral, dermal, or inhalation route for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days up to approximately 90 days in typically used laboratory animal species).

[12] Defined in the IRIS database as exposure by the oral, dermal, or inhalation route for 24 hours or less.

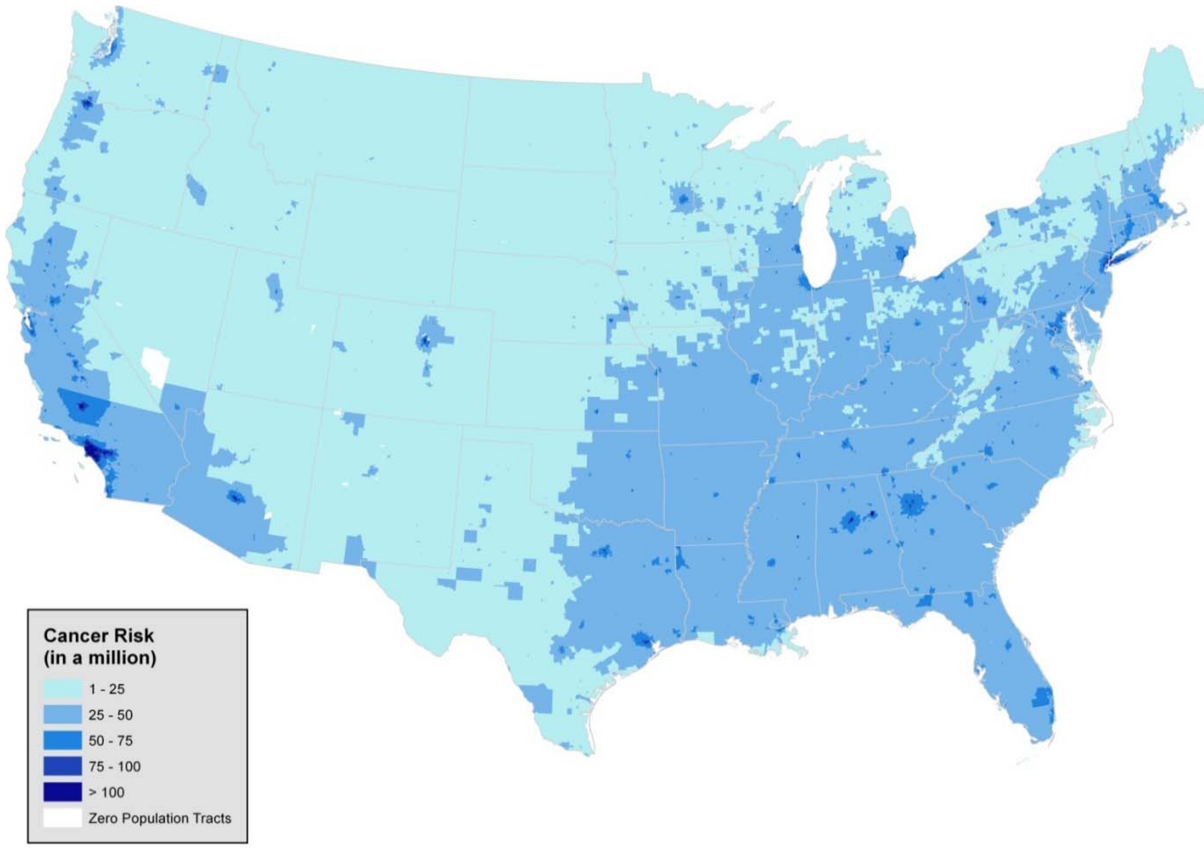

Figure 6-3 Estimated Chronic Census Tract Carcinogenic Risk from HAP exposure from outdoor sources (2005 NATA)

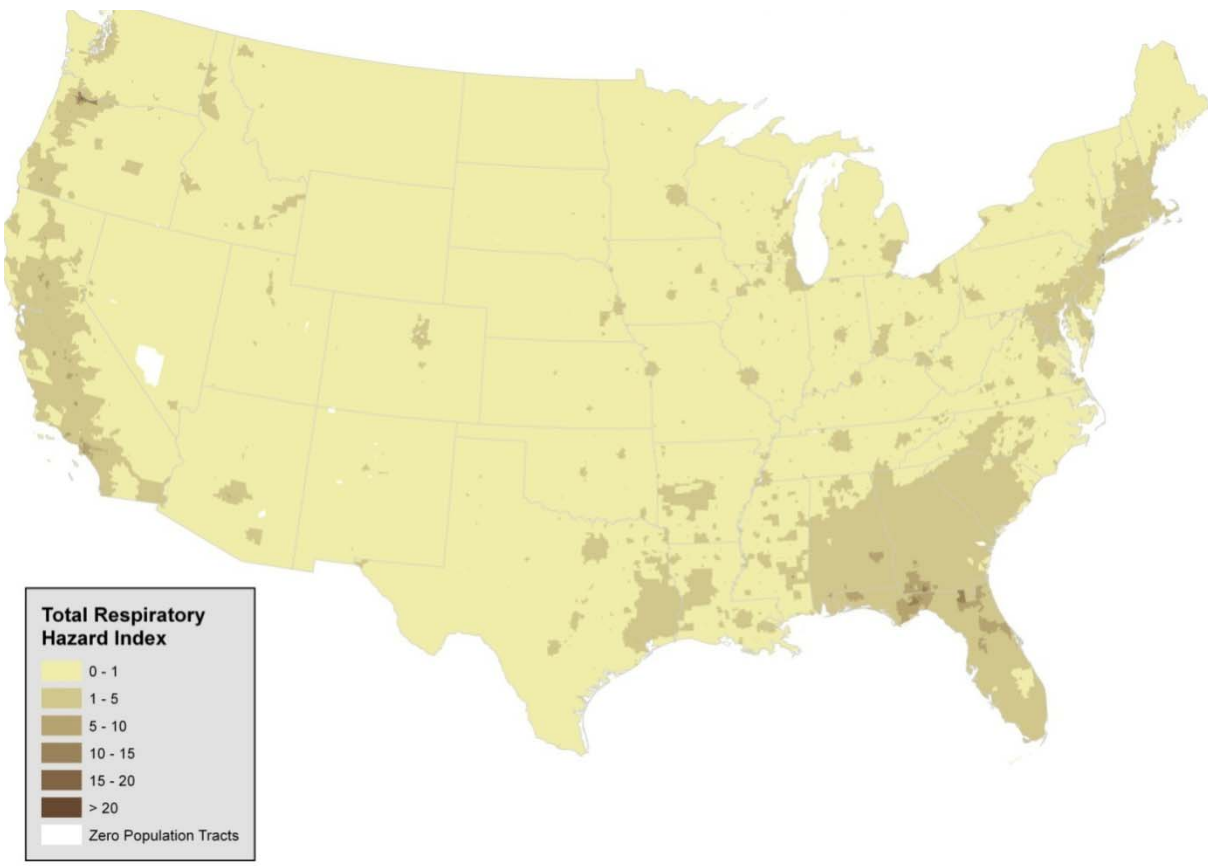

Figure 6-4 Estimated Chronic Census Tract Noncancer (Respiratory) Risk from HAP exposure from outdoor sources (2005 NATA)

Due to methodology and time limitations under the court-ordered schedule, we were unable to estimate the benefits associated with the hazardous air pollutants that would be reduced as a result of these rules. In a few previous analyses of the benefits of reductions in HAPs, EPA has quantified the benefits of potential reductions in the incidences of cancer and non-cancer risk (e.g., U.S. EPA, 1995). In those analyses, EPA relied on unit risk factors (URF) developed through risk assessment procedures.[13] These URFs are designed to be conservative, and as such, are more likely to represent the high end of the distribution of risk rather than a best or most likely estimate of risk. As the purpose of a benefit analysis is to describe the benefits most likely to occur from a reduction in pollution, use of high-end, conservative risk estimates would

[13]The unit risk factor is a quantitative estimate of the carcinogenic potency of a pollutant, often expressed as the probability of contracting cancer from a 70-year lifetime continuous exposure to a concentration of one µg/m^3 of a pollutant.

overestimate the benefits of the regulation. While we used high-end risk estimates in past analyses, advice from the EPA's Science Advisory Board (SAB) recommended that we avoid using high-end estimates in benefit analyses (U.S. EPA-SAB, 2002). Since this time, EPA has continued to develop better methods for analyzing the benefits of reductions in HAPs.

As part of the second prospective analysis of the benefits and costs of the Clean Air Act (U.S. EPA, 2011a), EPA conducted a case study analysis of the health effects associated with reducing exposure to benzene in Houston from implementation of the Clean Air Act (IEc, 2009). While reviewing the draft report, EPA's Advisory Council on Clean Air Compliance Analysis concluded that "the challenges for assessing progress in health improvement as a result of reductions in emissions of hazardous air pollutants (HAPs) are daunting...due to a lack of exposure-response functions, uncertainties in emissions inventories and background levels, the difficulty of extrapolating risk estimates to low doses and the challenges of tracking health progress for diseases, such as cancer, that have long latency periods" (U.S. EPA-SAB, 2008).

In 2009, EPA convened a workshop to address the inherent complexities, limitations, and uncertainties in current methods to quantify the benefits of reducing HAPs. Recommendations from this workshop included identifying research priorities, focusing on susceptible and vulnerable populations, and improving dose-response relationships (Gwinn et al., 2011).

In summary, monetization of the benefits of reductions in cancer incidences requires several important inputs, including central estimates of cancer risks, estimates of exposure to carcinogenic HAPs, and estimates of the value of an avoided case of cancer (fatal and non-fatal). Due to methodology and time limitations under the court-ordered schedule, we did not attempt to monetize the health benefits of reductions in HAPs in this analysis. Instead, we provide a qualitative analysis of the health effects associated with the HAPs anticipated to be reduced by these rules and we summarize the results of the residual risk assessment for the NESHAP. EPA remains committed to improving methods for estimating HAP benefits by continuing to explore additional concepts of benefits, including changes in the distribution of risk.

Available emissions data show that several different HAPs are emitted from this sector. In the subsequent sections, we describe the health effects associated with the main HAPs of concern. This rule is anticipated to reduce 83.6 tons of total HAPs per year as shown in Chapter 4 of this RIA, with 81 tons being metal HAP, 0.2 tons being mercury, and 2.5 tons being PAHs.

6.3.3.1 *Arsenic (As)*

Arsenic, a naturally occurring element, is found throughout the environment and is considered toxic through the oral, inhalation and dermal routes. Acute (short-term) high-level inhalation exposure to As dust or fumes has resulted in gastrointestinal effects (nausea, diarrhea, abdominal pain, and gastrointestinal hemorrhage); central and peripheral nervous system disorders have occurred in workers acutely exposed to inorganic As. Chronic (long-term) inhalation exposure to inorganic As in humans is associated with irritation of the skin and mucous membranes. Chronic inhalation can also lead to conjunctivitis, irritation of the throat and respiratory tract and perforation of the nasal septum.[14] Chronic oral exposure has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, and liver or kidney damage in humans. Inorganic As exposure in humans, by the inhalation route, has been shown to be strongly associated with lung cancer, while ingestion of inorganic As in humans has been linked to a form of skin cancer and also to bladder, liver, and lung cancer. EPA has classified inorganic As as a Group A, human carcinogen.[15]

6.3.3.3 *Chromium (Cr)*[16]

Chromium may be emitted in two forms, trivalent Cr (Cr^{+3}) or hexavalent Cr (Cr^{+6}). The respiratory tract is the major target organ for Cr^{+6} toxicity, for acute and chronic inhalation exposures. Shortness of breath, coughing, and wheezing have been reported from acute exposure to Cr^{+6}, while perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, and other respiratory effects have been noted from chronic exposures. Limited human studies suggest that Cr^{+6} inhalation exposure may be associated with complications during pregnancy and childbirth, but there are no supporting data from animal studies reporting

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[14] Agency for Toxic Substances and Disease Registry (ATSDR). Medical Management Guidelines for Arsenic. Atlanta, GA: U.S. Department of Health and Human Services. Available on the Internet at < http://www.atsdr.cdc.gov/mhmi/mmg168.html#bookmark02>

[15] U.S. Environmental Protection Agency (U.S. EPA). 1998. Integrated Risk Information System File for Arsenic. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at: http://www.epa.gov/iris/subst/0278.htm.

[16] U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Chromium VI. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999a.

reproductive effects from inhalation exposure to Cr^{+6}. Human and animal studies have clearly established the carcinogenic potential of Cr^{+6} by the inhalation route, resulting in an increased risk of lung cancer. EPA has classified Cr^{+6} as a Group A, human carcinogen. Trivalent Cr is less toxic than Cr^{+6}. The respiratory tract is also the major target organ for Cr^{+3} toxicity, similar to Cr^{+6}. EPA has not classified Cr^{+3} with respect to carcinogenicity.

6.3.3.8 *Manganese (Mn)*[17]

Health effects in humans have been associated with both deficiencies and excess intakes of Mn. Chronic exposure to high levels of Mn by inhalation in humans results primarily in central nervous system effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically-exposed workers. Manganism, characterized by feelings of weakness and lethargy, tremors, a masklike face, and psychological disturbances, may result from chronic exposure to higher levels. Impotence and loss of libido have been noted in male workers afflicted with manganism attributed to inhalation exposures. The EPA has classified Mn in Group D, not classifiable as to carcinogenicity in humans.

6.3.3.9 *Mercury (Hg)*

In this section, we provide a qualitative description of human health and environmental effects due to exposure to MeHg. In 2000, the NAS Study was issued which provides a thorough review of the effects of MeHg on human health (NRC, 2000)[18]. Many of the peer-reviewed articles cited in this section are publications originally cited in the MeHg Study. In addition, EPA has conducted literature searches to obtain other related and more recent publications to complement the material summarized by the NRC in 2000.

In its review of the literature, the NAS found neurodevelopmental effects to be the most sensitive and best documented endpoints and appropriate for establishing an RfD (NRC, 2000); in particular NAS supported the use of results from neurobehavioral or neuropsychological tests.

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[17] U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Manganese. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999b.

[18] NRC (2000). *Toxicological Effects of Methylmercury*. National Research Council. Washington, DC: National Academies Press.

The NAS report noted that studies in animals reported sensory effects as well as effects on brain development and memory functions and support the conclusions based on epidemiology studies. The NAS noted that their recommended endpoints for an RfD are associated with the ability of children to learn and to succeed in school. They concluded the following: “The population at highest risk is the children of women who consumed large amounts of fish and seafood during pregnancy. The committee concludes that the risk to that population is likely to be sufficient to result in an increase in the number of children who have to struggle to keep up in school.”

The NAS summarized data on cardiovascular effects available up to 2000. Based on these and other studies, the NRC concluded that “Although the data base is not as extensive for cardiovascular effects as it is for other end points (i.e. neurologic effects) the cardiovascular system appears to be a target for MeHg toxicity in humans and animals.” The NRC also stated that “additional studies are needed to better characterize the effect of methylmercury exposure on blood pressure and cardiovascular function at various stages of life.”

Additional cardiovascular studies have been published since 2000. EPA did not to develop a quantitative dose-response assessment for cardiovascular effects associated with MeHg exposures, as there is no consensus among scientists on the dose-response functions for these effects. In addition, there is inconsistency among available studies as to the association between MeHg exposure and various cardiovascular system effects. The pharmacokinetics of some of the exposure measures (such as toenail Hg levels) are not well understood. The studies have not yet received the review and scrutiny of the more well-established neurotoxicity data base.

The Mercury Study noted that MeHg is not a potent mutagen but is capable of causing chromosomal damage in a number of experimental systems. The NAS concluded that evidence that human exposure to MeHg caused genetic damage is inconclusive; they note that some earlier studies showing chromosomal damage in lymphocytes may not have controlled sufficiently for potential confounders. One study of adults living in the Tapajós River region in Brazil (Amorim et al., 2000) reported a direct relationship between MeHg concentration in hair and DNA damage in lymphocytes; as well as effects on chromosomes[19]. Long-term MeHg exposures in this population were believed to occur through consumption of fish, suggesting that genotoxic effects (largely chromosomal aberrations) may result from dietary, chronic MeHg exposures similar to and above those seen in the Faroes and Seychelles populations.

Although exposure to some forms of Hg can result in a decrease in immune activity or an autoimmune response (ATSDR, 1999), evidence for immunotoxic effects of MeHg is limited (NRC, 2000)[20].

Based on limited human and animal data, MeHg is classified as a “possible” human carcinogen by the International Agency for Research on Cancer (IARC, 1994) and in IRIS (USEPA, 2002) [21,22]. The existing evidence supporting the possibility of carcinogenic effects in humans from low-dose chronic exposures is tenuous. Multiple human epidemiological studies have found no significant association between Hg exposure and overall cancer incidence, although a few studies have shown an association between Hg exposure and specific types of cancer incidence (e.g., acute leukemia and liver cancer) (NRC, 2000).

There is also some evidence of reproductive and renal toxicity in humans from MeHg exposure. However, overall, human data regarding reproductive, renal, and hematological toxicity from MeHg are very limited and are based on either studies of the two high-dose poisoning episodes in Iraq and Japan or animal data, rather than epidemiological studies of chronic exposures at the levels of interest in this analysis.

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[19] Amorim, M.I.M., D. Mergler, M.O. Bahia, H. Dubeau, D. Miranda, J. Lebel, R.R. Burbano, and M. Lucotte. 2000. Cytogenetic damage related to low levels of methyl mercury contamination in the Brazilian Amazon. An. Acad. Bras. Ciênc. 72(4): 497-507.

[20] Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological Profile for Mercury. U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

[21] U.S. Environmental Protection Agency (EPA). 2002. Integrated Risk Information System (IRIS) on Methylmercury. National Center for Environmental Assessment. Office of Research and Development. Available online at http://www.epa.gov/iris/subst/0073.htm

[22] International Agency for Research on Cancer (IARC). 1994. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans and their Supplements: Beryllium, Cadmium, Mercury, and Exposures in the Glass Manufacturing Industry. Vol. 58. Jalili, H.A., and A.H. Abbasi. 1961. Poisoning by ethyl mercury toluene sulphonanilide. Br. J. Indust. Med. 18(Oct.):303-308 (as cited in NRC 2000).

6.3.3.10 *Nickel (Ni)*[23]

Respiratory effects have been reported in humans from inhalation exposure to Ni. No information is available regarding the reproductive or developmental effects of Ni in humans, but animal studies have reported such effects. Human and animal studies have reported an increased risk of lung and nasal cancers from exposure to Ni refinery dusts and nickel subsulfide. The EPA has classified nickel subsulfide as a human carcinogen and nickel carbonyl as a probable human carcinogen[24,25]. The IARC has classified Ni compounds as carcinogenic to humans.

6.3.3.11 *Other Metals*

Metals can cause a range of effects including, mucous membrane irritation (e.g. bronchitis, decreased lung function); gastrointestinal effects; nervous system disorders (from loss of function to tremors and numbness); skin irritation; and reproductive and developmental disorders. Additionally, several of the metals accumulate in the environment and in the human body. Cadmium, for example, is a cumulative pollutant which causes kidney effects after the cessation of exposure. Similarly, the onset of effects from beryllium exposure may be delayed by months to years. Many of the metal listed above are also known (arsenic, chromium (VI), nickel) or probable (cadmium, nickel carbonyl, lead, and beryllium) human carcinogens.

6.3.3.12 *Polycyclic organic matter (POM)*

The term polycyclic organic matter (POM) defines a broad class of compounds that includes the polycyclic aromatic hydrocarbon compounds (PAHs), of which benzo[a]pyrene is a member. POM compounds are formed primarily from combustion and are present in the atmosphere in particulate form. Sources of air emissions are diverse and include cigarette smoke, vehicle exhaust, home heating, laying tar, and grilling meat. Cancer is the major concern from exposure to POM. Epidemiologic studies have reported an increase in lung cancer in humans

[23] Nickel (IARC Summary & Evaluation , Volume 49, 1990), http://www.inchem.org/documents/iarc/vol49/nickel.html

[24] U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Nickel Subsulfide. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999c.

[25] U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Nickel Carbonyl. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999d.

exposed to coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain POM compounds. Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene and forestomach tumors, leukemia, and lung tumors from oral exposure to benzo[a]pyrene. EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens

6.3.3.13 *Other Air Toxics*

In addition to the compounds described above, other compounds from the ferroalloy sector would be affected by this rule. Information regarding the health effects of these compounds can be found in EPA's IRIS database.[26]

6.4 Characterization of Uncertainty in the Monetized $PM_{2.5}$ Benefits

In any complex analysis, there are likely to be many sources of uncertainty. Many inputs are used to derive the final estimate of economic benefits, including emission inventories, air quality models (with their associated parameters and inputs), epidemiological estimates of concentration-response (C-R) functions, estimates of values, population estimates, income estimates, and estimates of the future state of the world (i.e., regulations, technology, and human behavior). For some parameters or inputs it may be possible to provide a statistical representation of the underlying uncertainty distribution. For other parameters or inputs, the necessary information is not available.

The annual benefit estimates presented in this analysis are also inherently variable due to the processes that govern pollutant emissions and ambient air quality in a given year. Factors such as hours of equipment use and weather are constantly variable, regardless of our ability to measure them accurately. As discussed in the $PM_{2.5}$ NAAQS RIA (Table 4-5) (U.S. EPA, 2006b), there are a variety of uncertainties associated with these PM benefits. Therefore, the estimates of annual benefits should be viewed as representative of the magnitude of benefits expected, rather than the actual benefits that would occur every year.

It is important to note that the monetized benefit-per-ton estimates used here reflect specific geographic patterns of emissions reductions and specific air quality and benefits modeling assumptions. However, these estimates better reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors than the

[26] U.S. EPA Integrated Risk Information System (IRIS) database is available at: www.epa.gov/iris

benefit-per-ton estimates previously used, due to the sector-specific air quality modeling utilized. Nonetheless, use of these $/ton values to estimate benefits associated with different emission control programs may lead to higher or lower benefit estimates than if benefits were calculated based on direct air quality modeling. Great care should be taken in applying these estimates to emission reductions occurring in any specific location, as these represent average benefits-per-ton for the sector over the entire United States. The benefits-per-ton for emission reductions in specific locations may be very different than the estimates presented here.

$PM_{2.5}$ mortality benefits are the largest benefit category that we monetized in this analysis. To better characterize the uncertainty associated with mortality impacts that are estimated to occur in areas with low baseline levels of $PM_{2.5}$, we included the LML assessment. This approach summarizes the distribution of avoided PM mortality impacts according to the baseline $PM_{2.5}$ levels experienced by the population receiving the $PM_{2.5}$ mortality benefit (Figures 6-5 and 6-6). We identify on this figure the lowest air quality levels measured in each of the two primary epidemiological studies EPA used to quantify PM-related mortality. This information allows readers to determine the portion of PM-related mortality benefits occurring above or below the LML of each study; in general, our confidence in the estimated PM mortality decreases as we consider air quality levels further below the LML in the two epidemiological studies. While the LML analysis provides some insight into the level of uncertainty in the estimated PM mortality benefits, EPA does not view the LML as a threshold and continues to quantify PM-related mortality impacts using a full range of modeled air quality concentrations. While this figure describes the relationship between baseline $PM_{2.5}$ exposure and mortality for the air quality modeled policy case, we expect the distribution of mortality impacts to be fairly similar between the two cases.

Some proportion of the avoided PM-related impacts we estimate in this analysis occur among populations exposed at or above the LML of the Laden et al. (2006) study, while a majority of the impacts occur at or above the LML of the Pope et al. (2002) study (Figure 6-5), increasing our confidence in the PM mortality analysis. Based on the air quality baseline used for the source apportionment modeling, 31% and 89% of the estimated avoided mortality impacts occur at or above an annual mean $PM_{2.5}$ level of 10 $\mu g/m^3$ (the LML of the Laden et al. 2006 study) and 7.5 $\mu g/m^3$ (the LML of the Pope et al. 2002 study), respectively. As we model mortality impacts among populations exposed to levels of $PM_{2.5}$ that are successively lower than the LML of each study our confidence in the results diminishes.

While the LML of each study is important to consider when characterizing and interpreting the overall level PM-related benefits, as discussed earlier in this chapter, EPA believes that both cohort-based mortality estimates are suitable for use in air pollution health impact analyses. When estimating PM mortality impacts using risk coefficients drawn from the Laden et al. (2006) analysis of the Harvard Six Cities and the Pope et al. (2002) analysis of the American Cancer Society cohorts there are innumerable other attributes that may affect the size of the reported risk estimates—including differences in population demographics, the size of the cohort, activity patterns and particle composition among others. The LML assessment presented here provides a limited representation of one key difference between the two studies.

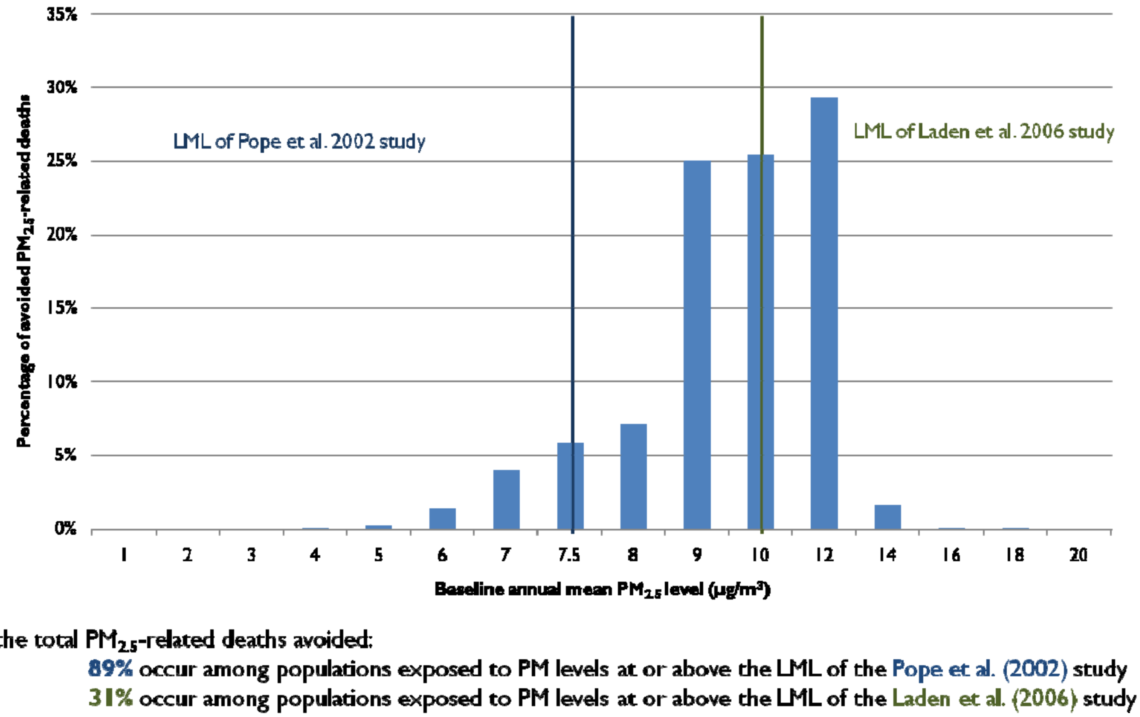

Figure 6-5. Percentage of Total PM-Related Mortalities Avoided by Baseline Air Quality Level

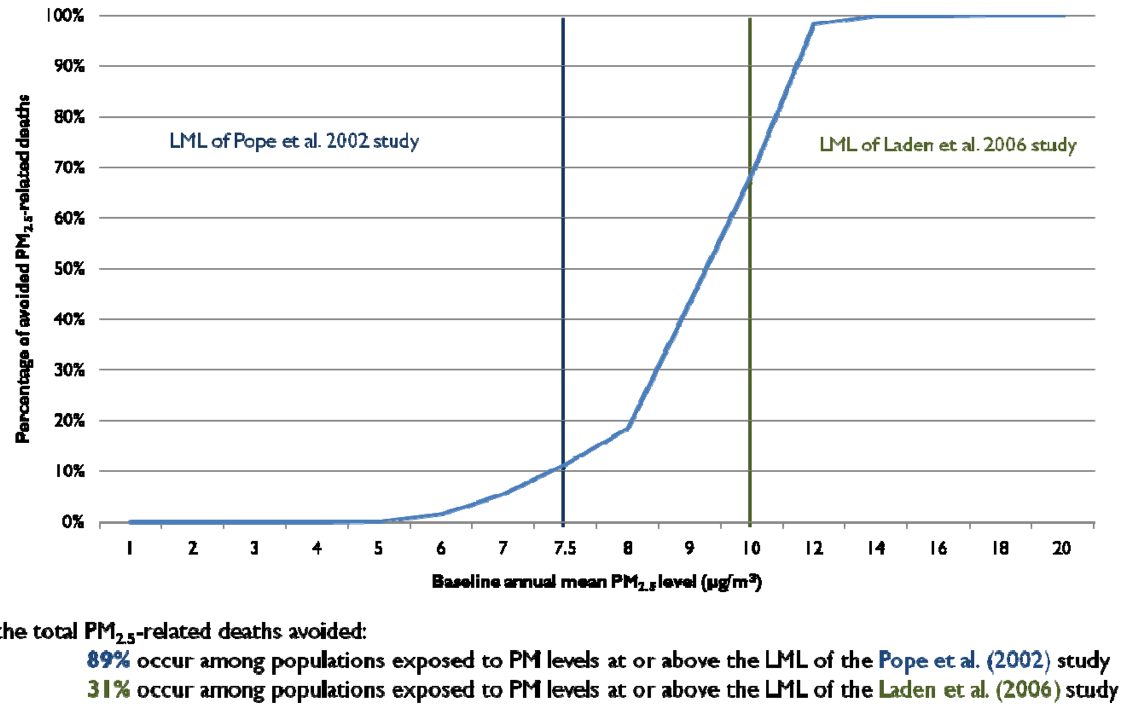

Figure 6-6. Cumulative Percentage of Total PM-Related Mortalities Avoided by Baseline Air Quality Level

Above we present the estimates of the total monetized benefits, based on our interpretation of the best available scientific literature and methods and supported by the SAB-HES and the NAS (NRC, 2002). The benefits estimates are subject to a number of assumptions and uncertainties. For example, for key assumptions underlying the estimates for premature mortality, which typically account for at least 90% of the total monetized benefits, we were able to quantify include the following:

1. $PM_{2.5}$ benefits were derived through benefit per-ton estimates, which in general do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an over-estimate or under-estimate of the actual benefits of controlling directly emitted fine particulates. However, these estimates better reflect variability in these local factors than the benefit-per-ton estimates previously used, due to the sector-specific air quality modeling utilized.

2. We assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because $PM_{2.5}$ produced via transported precursors emitted from EGUs may differ significantly from direct $PM_{2.5}$ released from diesel engines and other industrial

sources, but the scientific evidence is not yet sufficient to allow differentiation of effect estimates by particle type.

3. We assume that the health impact function for fine particles is linear down to the lowest air quality levels modeled in this analysis. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of $PM_{2.5,}$ including both regions that are in attainment with fine particle standard and those that do not meet the standard down to the lowest modeled concentrations.

4. To characterize the uncertainty in the relationship between $PM_{2.5}$ and premature mortality (which typically accounts for 85% to 95% of total monetized benefits), we include a set of twelve estimates based on results of the expert elicitation study in addition to our core estimates. Even these multiple characterizations omit the uncertainty in air quality estimates, baseline incidence rates, populations exposed and transferability of the effect estimate to diverse locations. As a result, the reported confidence intervals and range of estimates give an incomplete picture about the overall uncertainty in the $PM_{2.5}$ estimates. This information should be interpreted within the context of the larger uncertainty surrounding the entire analysis. For more information on the uncertainties associated with $PM_{2.5}$ benefits, please consult the $PM_{2.5}$ NAAQS RIA (Table 5-5).

This RIA does not include the type of detailed uncertainty assessment found in the PM NAAQS RIA (U.S. EPA, 2006b) because we lack the necessary air quality input and monitoring data to run the benefits model. In addition, we have not conducted any air quality modeling for this rule. Moreover, it was not possible to develop benefit-per-ton metrics and associated estimates of uncertainty using the benefits estimates from the PM RIA because of the significant differences between the sources affected in that rule and those regulated here. However, the results of the Monte Carlo analyses of the health and welfare benefits presented in Chapter 5 of the PM RIA can provide some evidence of the uncertainty surrounding the benefits results presented in this analysis.

SECTION 7
COMPARISON OF MONETIZED BENEFITS AND COSTS

7.1 Summary

Because we were unable to monetize the co-benefits associated with reducing HAPs, all monetized benefits reflect improvements in ambient $PM_{2.5}$ concentrations from reductions in $PM_{2.5}$ emissions. This results in an underestimate of the monetized benefits. Using a 3% discount rate, we estimate the total monetized benefits of this proposed rule to be $71 million to $170 million in the year of implementation (2015) as shown in Table 7-1. Using a 7% discount rate, we estimate the total monetized benefits to be $63 million to $160 million in 2015. The annualized social costs are $4.0 million. The net benefits are therefore $67 million to $170 million at a 3% discount rate for the benefits and $59 million to $150 million at a 7% discount rate. All estimates are in 2010$. The benefits from reducing other air pollutants have not been monetized in this analysis, including reducing tons of, black carbon and several HAPs emissions such as formaldehyde, mercury and nickel among others each year.

Figure 7-1 shows the full range of net benefits estimates (i.e., annual benefits minus annualized costs) quantified in terms of $PM_{2.5}$ benefits for the year of implementation (2015).

Table 7-1. Summary of the Annual Monetized Benefits, Social Costs, and Net Benefits for the Proposed Ferroalloys RTR in 2015 ($2010 millions)[a]

	3% Discount Rate			7% Discount Rate		
	Proposed Standard					
Total Monetized Benefits[b]	$71	to	$170	$63	to	$160
Total Social Costs		$4.0			$4.0	
Net Benefits	$67	to	$170	$59	to	$150
Nonmonetized Benefits	Reduced exposure to HAPs, including arsenic, chromium, nickel, manganese, mercury and polycyclic aromatic hydrocarbons Ecosystem effects Visibility impairment					

[a] All estimates are for the year of implementation (2015) and are rounded to two significant figures. These results include units anticipated to come online and the lowest cost disposal assumption.

[b] The total monetized benefits reflect the human health benefits associated with reducing exposure to $PM_{2.5}$ through reductions of directly emitted $PM_{2.5}$. It is important to note that the monetized benefits include many but not all health effects associated with $PM_{2.5}$ exposure. Benefits are shown as a range from Pope et al. (2002) to Laden et al. (2006). These models assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality because the scientific evidence is not yet sufficient to allow differentiation of effect estimates by particle type.

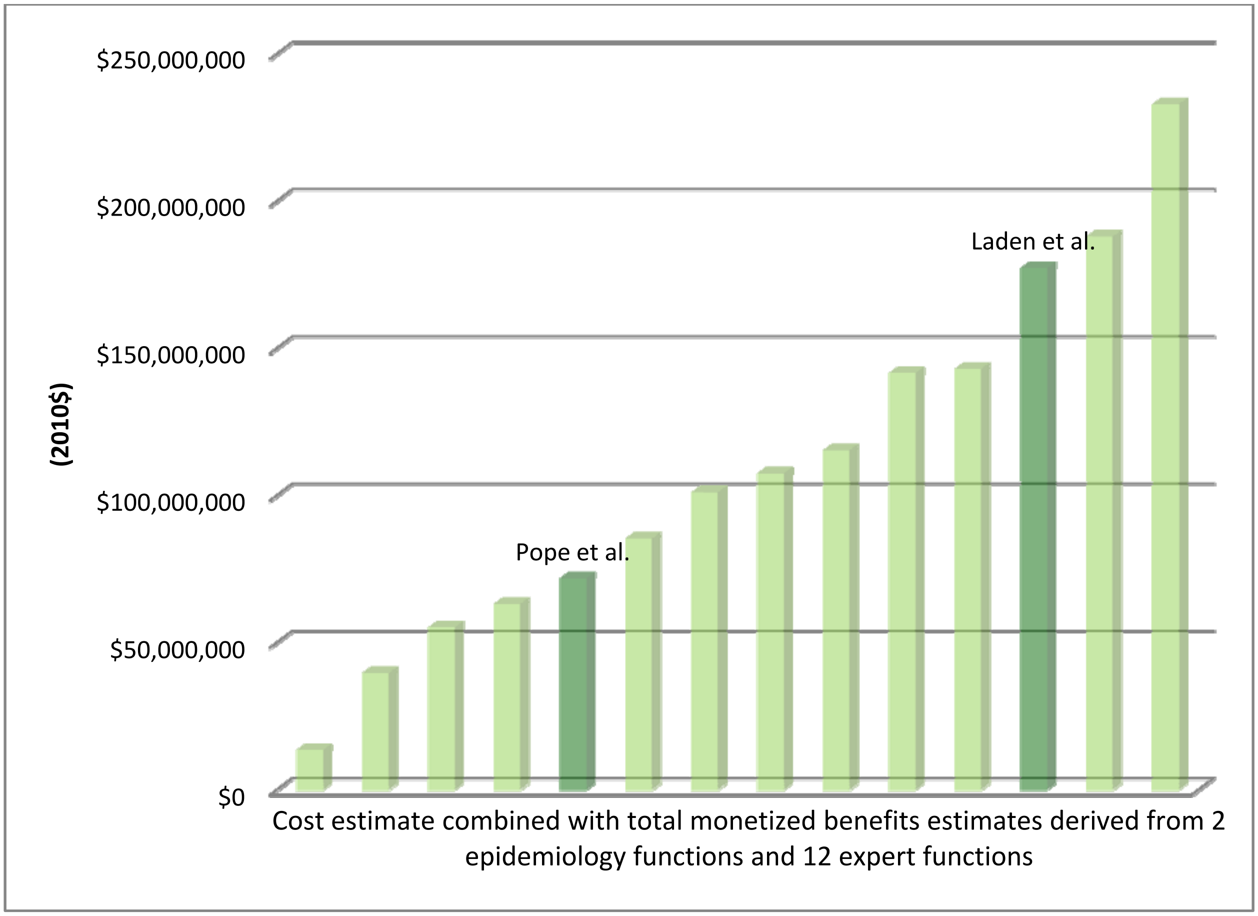

Figure 7-1. Net Annual Benefits Range in 2015 for $PM_{2.5}$ Reductions for the Proposed Standard

SECTION 8
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