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Regulatory Impact Analysis (RIA) for Proposed Reconsideration Existing Stationary Spark Ignition RICE NESHAP

Final Report

May 2012

U.S. Environmental Protection Agency
Office of Air and Regulation
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division

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Section 1
EXECUTIVE SUMMARY

ES.1 Summary of Impacts for the Proposed Reconsideration

This proposed action is a reconsideration of the promulgated NESHAP for existing stationary SI RICE with a site rating of less than or equal to 500 HP located at major sources, and existing stationary SI RICE of any site rating located at area sources.

EPA estimates that complying with the proposed reconsidered national emission standards for hazardous air pollutants (NESHAP) for stationary spark-ignition (SI) reciprocating internal combustion engines (RICE) will have an annualized cost of approximately $115 million per year (2009 or 2010 dollars) in the year of full implementation of the rule (2013). The total annualized costs of the proposed reconsidered rule are 55% less than those for the final SI RICE NESHAP promulgated in 2010. Using these costs, EPA estimates in its economic impact analysis that the NESHAP will have limited impacts on the industries affected and their consumers. Using sales data obtained for affected small entities in an analysis of the impacts of this rule on small entities, EPA expects that the NESHAP will not result in a SISNOSE (significant economic impacts for a substantial number of small entities), a result consistent with the conclusion for the final SI RICE NESHAP issued in 2010. EPA also does not expect significant adverse energy impacts based on Executive Order 13211, an Executive Order that requires analysis of energy impacts for rules such as this one that are economically significant under Executive Order 12866.

In the year of full implementation (2013), EPA estimates that the total monetized benefits of the proposed reconsidered NESHAP are $62 million to $150 million and $55 million to $140 million, at 3% and 7% discount rates, respectively (Table 1-1). All estimates are in 2010 dollars for the year 2013. These estimates reflect the co-benefits from 9,600 tons of NOx emission reductions associated with implementing the controls to reduce hazardous air pollutants (HAPs) required under this proposed reconsideration. Using alternate 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. The benefits from reducing other air pollutants have not been monetized in this analysis, including reducing 22,200 tons of carbon monoxide (CO) and 1,800 tons of hazardous air pollutants (HAPs) each year. In addition, ecosystem benefits and visibility benefits have not been monetized in this analysis.

In the year of full implementation (2013), EPA estimates the net benefits of the proposed NESHAP are $-53 million to $35 million and $-60 million to $25 million at 3% and 7% discount rates, respectively (Table 1-1). These estimates are “snapshots” of benefits and costs at year 2013 and are in 2010 dollars.

Table 1-1. Summary of the Annualized Monetized Co-Benefits, Social Costs, and Net benefits for the Proposed Reconsideration SI RICE NESHAP in 2013 (millions of 2010$)[1]

	3% Discount Rate			7% Discount Rate		
Total Monetized Benefits[2]	$62	to	$150	$55	to	$140
Total Compliance Costs[3]		$115			$115	
Net Benefits	$-53	to	$35	$-60	to	$25
Non-monetized Benefits	Health effects from HAP exposure Health effects from CO, NO_2, and ozone exposure Ecosystem effects Visibility impairment					

[1] All estimates are for the implementation year (2013), and are rounded to two significant figures.

[2] The total monetized co-benefits reflect the human health co-benefits associated with reducing exposure to $PM_{2.5}$ through reductions of $PM_{2.5}$ precursors such as NOx and VOC. It is important to note that the monetized co-benefits include many but not all health effects associated with $PM_{2.5}$ exposure. 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 there is no clear scientific evidence that would support the development of differential effects estimates by particle type. Because these estimates were generated using benefit-per-ton estimates, we do not break down the total monetized benefits into specific components here. See Figure 7-1 for an illustration of the breakdown, or the RIA for the final Cross-States Air Pollution Rule (EPA, 2011) for more information.

[3] The annual compliance costs serve as a proxy for the annual social costs of this rule given the lack of difference between the two. The annual compliance costs are calculated using a 7 percent discount rate.

ES.2 Comparison of Impacts for Final 2010 SI RICE Final Rule and SI RICE NESHAP Proposed Reconsideration

The EPA analyzed the costs, economic impacts and benefits of this proposed rule using the identical methodology as the RIA for the SI RICE final rule promulgated in October, 2010. Therefore, all changes to the costs, benefits, and economic impacts for this proposed rule are due to changes (or proposed amendments) to this proposed rule for SI RICE, which are fully described later in this RIA and the preamble for the proposed rule. Our baseline does not assume compliance with the 2010 SI RICE final rule. This assumption is based on the fact that full implementation of the final rule has not taken place as of yet (it will take place by October, 2013). In addition, this assumption is consistent with the baseline definition applied in the recently proposed ICI boilers and CISWI NESHAP rulemakings. Monetized benefits are the co-benefits of this proposal from reductions in directly emitted $PM_{2.5}$ emissions.

The following table shows an approximation of the changes in monetized benefits and engineering costs due to changes to the SI RICE rule included in the SI RICE reconsideration proposal, and includes values that show a comparison based on the final rule emissions inventory. All values in this table are in 2010 dollars.

Table 1-2. Comparison of Benefits and Costs for 2012 SI RICE Final Rule and 2012 Proposed Reconsideration SI RICE Rule

	Monetized Benefits in 2013	**Annual Engineering Costs in 2013**
SI RICE Final Rule (May 2010)	\$510 to \$1,200 million	\$253 million
Changes due to the proposed amendments to the final SI RICE rule	-\$448 to \$1,050 million	-\$138 million
Proposed SI RICE rule (2012)	+\$62 to \$150 million	\$115 million

* Monetized benefits are shown at a 3% discount rate and are from reductions in $PM_{2.5}$ emissions. These benefits do not include benefits associated with reduced exposure to HAP, visibility impairment, or ecosystem effects. Monetary estimates are in 2010 dollars.

The results for the economic impacts fall by more than half from those for the SI final rule. This outcome is due to the significant reduction in compliance costs associated with the proposed amendments in this proposal. All of the results for this proposed rule are found in Section 5 in this RIA.

The results for sales tests (i.e. annual cost/sales analysis) for small businesses also fall from those calculated for the final SI RICE rule. This outcome is also due to the overall large reductions in compliance costs. All of the results for this proposed rule are found in Section 6 in this RIA.

We estimate changes in employment for this SI RICE proposed rule. These estimates reflect the employment impacts associated with installation and operation of monitoring equipment, and also activities for recordkeeping, reporting, and testing. We estimate that 200 full-time equivalents (FTEs) will be required as one-time labor for installation of equipment, and 400 FTEs will be required as ongoing labor for compliance with the proposed rule. The results are presented and explained in detail in Section 5 of this RIA. We did not estimate changes in employment for the 2010 final SI RICE rule.

The benefits estimates decreased significantly for the proposal. The range for the 2010 final SI RICE RIA was $510 million (2009$) to $1,200 million (2009$) at 3 percent discount rate. The range for this proposal is $62 million (2010$) to $150 million (2010$) at 3 percent discount rate. The range for the 2010 final SI RICE RIA was $460 million (2009$) to $1,100 million (2009$) at 7 percent discount rate. The range for the proposal was $55 million (2010$) to $140 million (2010$) at 7 percent discount rate.

The health benefits were calculated using a methodology described in the 2010 final SI RICE RIA, using the revised emission reductions estimated for the reconsideration proposal and accounting for other changes discussed in detail in Section 7 of this RIA. We were unable to estimate the benefits from reducing exposure to HAPs, ecosystem impairment, and visibility impairment, including reducing 22,000 tons of carbon monoxide, 9,000 tons of VOC and 1,800 tons of HAPs. Please refer to the full description later in this RIA of the unquantified benefits as well as technical details of the analysis and its limitations and uncertainties. These monetized benefits are approximately 90% lower than the 2010 final SI RICE rule due to the estimated decrease in NOx emission reductions. These benefit-per-ton estimates were calculated for a 2013 analysis year (i.e., using population and income growth for 2013). See Tables 1-2 and 1-3 for the updated benefits results.

Table 1-3: Summary of Monetized $PM_{2.5}$-Related Co-Benefits Estimates for SI RICE Reconsideration Proposal in 2013

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%)
NO_x	9,648	$6,400	$16,000	$5,700	$14,000	$62 to $150	$55 to $140
					Total	**$62 to $150**	**$55 to $140**

*All estimates are for the implementation year (2013), and are rounded to two significant figures so numbers may not sum across columns. It is important to note that the monetized benefits do not include reduced health effects from direct exposure to NO_2, ozone exposure, ecosystem effects, or visibility impairment. All fine particles are assumed to have equivalent health effects, but the benefit per ton estimates vary because each ton of precursor reduced has a different propensity to form $PM_{2.5}$. Confidence intervals are unavailable for this analysis because of the benefit-per-ton methodology.

Table 1-4: Summary of Estimated Reductions in Health Incidences from $PM_{2.5}$ for the SI RICE Reconsideration Proposal in 2013

	Proposed Option
Avoided Premature Mortality	
Pope et al.	7
Laden et al.	18
Avoided Morbidity	
Chronic Bronchitis	5
Emergency Room Visits, Respiratory	5
Hospital Admissions, Respiratory	1
Hospital Admissions, Cardiovascular	3
Acute Bronchitis	11
Lower Respiratory	140
Upper Respiratory	110
Minor Restricted Activity Days	5,600
Work Loss Days	950
Asthma Exacerbation	230
Acute Myocardial Infarction	8

* All estimates are for the analysis year (2013) and are rounded to whole numbers with two significant figures. All fine particles are assumed to have equivalent health effects because the scientific evidence is not yet sufficient to

allow differentiation of effects estimates by particle type. Confidence intervals are unavailable for this analysis because of the benefit-per-ton methodology.

Figure 1-1 provides a breakdown of the total monetized co-benefits from reductions of $PM_{2.5}$ emissions by engine size associated with the reconsideration proposal. Figure 1-2 provides a visual representation of the range of $PM_{2.5}$-related benefits estimates using concentration-response functions supplied by experts.

Figure 1-1: Breakdown of Total Monetized $PM_{2.5}$ Co-Benefits of Proposed SI RICE Reconsideration by Engine Size

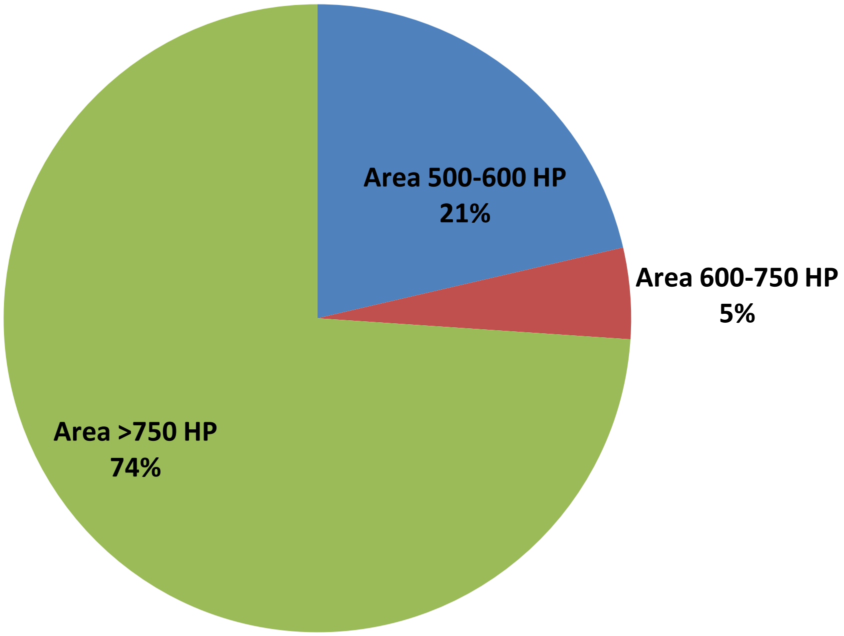
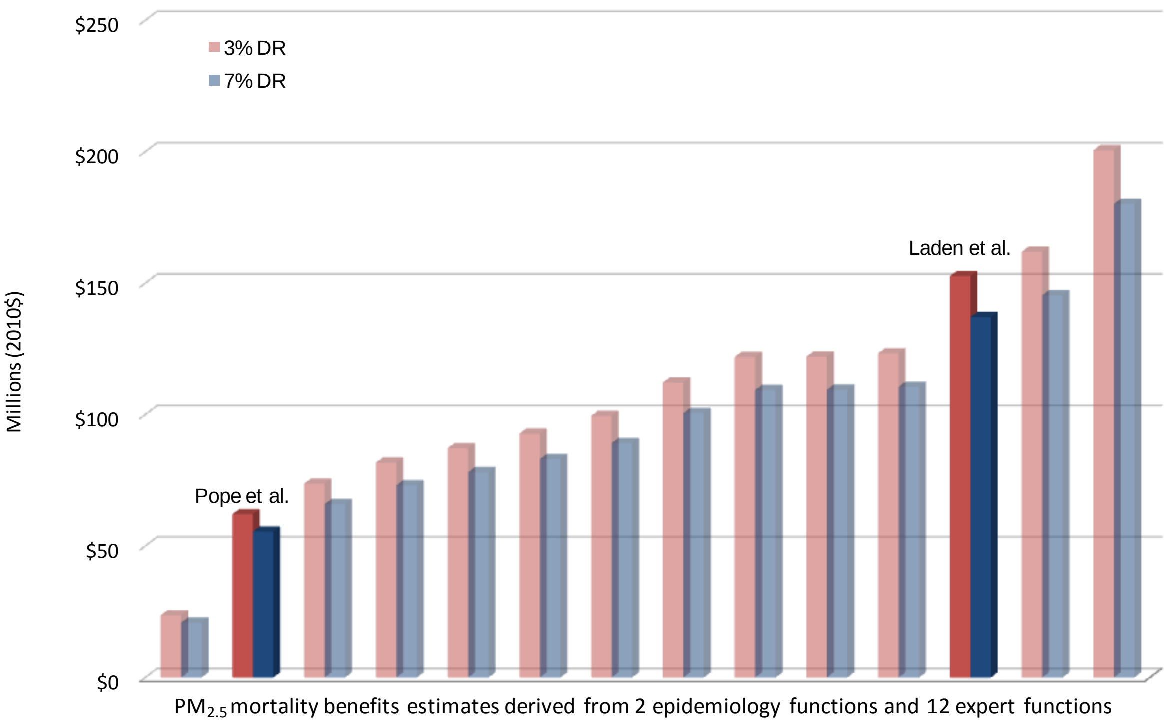


Figure 1-2: Total Monetized $PM_{2.5}$ Co-Benefits Estimates for the SI RICE Reconsideration Proposal in 2013



*This graph shows the estimated benefits at discount rates of 3% and 7% using effect coefficients derived from the Pope et al. study and the Laden et al 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.

Table 1-5 shows the estimated costs and benefits for the 2010 final SI RICE Rule and the reconsideration proposal. The estimated net benefits for the reconsideration proposal are considerably smaller than the range for the 2010 final SI RICE rule RIA, which was $210 million to $860 million at a 7 percent discount rate and was $250 million to $980 billion at 3 percent.

Table 1-5. Summary of the Monetized Benefits, Compliance Costs and Net benefits for the 2010 Rule with the Proposed Amendments to the Stationary SI Engine NESHAP in 2013 (millions of 2010 dollars)[a]

	3% Discount Rate			7% Discount Rate		
2010 Final SI RICE NESHAP						
Total Monetized Benefits	$510	to	$1,200	$460	to	$1,100
Total Social Costs		$253			$253	
Net Benefits	$250	to	$980	$210	to	$860
Proposed Reconsideration SI RICE NESHAP						
Total Monetized Benefits	$62	to	$150	$55	to	$140
Total Social Costs		$115			$115	
Net Benefits	$-53	to	$35	$-60	to	$25

[1] All estimates are for the implementation year (2013), and are rounded to two significant figures. All monetized benefits are from reductions of $PM_{2.5}$ emissions, a co-benefit of this proposal. The annual ized compliance costs are $115 million in 2010$ as noted earlier in this RIA, and are annualized using a 7% interest rate. Compliance costs are used as an approximation for social costs in this RIA.

Section 2
INTRODUCTION

EPA is proposing NESHAP for existing stationary SI RICE that either are located at area sources of hazardous air pollutant emissions or that have a site rating of less than or equal to 500 horsepower and are located at major sources of hazardous air pollutant emissions. The proposed amendments to the SI RICE NESHAP are provided in detail in Section 4 of this RIA.

The 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 an analysis of impacts on energy consumption and production to comply with Executive Order 13211 (Statement of Energy Effects). An analysis of economic impacts, along with an analysis of impacts on employment, is also included in this RIA. Finally, an analysis of the benefits of the rule is included in this RIA. It should be noted that the data that supports the analyses listed above have been updated where possible and appropriate from the data used in the RIA for the SI RICE NESHAP promulgated in 2010.

2.1 Organization of this Report

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

- Section 3 presents a profile of the affected industries.
- Section 4 presents a summary of regulatory alternatives considered in the final rule, and provides the compliance costs of the rule.
- Section 5 describes the estimated costs of the regulation and describes the economic impact analysis (EIA) methodology and reports market, welfare, energy, and employment impacts.
- Section 6 presents estimated impacts on small entities.
- Section 7 presents the benefits and net benefits (benefits- costs) estimates.

Section 3
INDUSTRY PROFILE

This section provides an introduction to the industries affected by the rule, i.e., industries in which the spark-ignition (SI) RICE being regulated are found. SI RICE generate electric power, pump gas or other fluids, or compress air for machinery. The primary non-utility application of internal combustion (IC) engines is in the natural gas industry to power compressors used for pipeline transportation, field gathering (collecting gas from wells), underground storage tanks, and in-gas processing plants. RICEs are separated into three design classes: 2 cycle (stroke) lean burn, 4-stroke lean burn, and 4-stroke rich burn. Each of these have design differences that affect both baseline emissions as well as the potential for emissions control.

These industries include the following:

- electric power generation, transmission, and distribution (NAICS 2211),
- oil and gas extraction (including marginal wells) (NAICS 211), and
- pipeline transportation of natural gas (NAICS 48621).

While this is not an exhaustive list of the industries affected by this proposed reconsideration rule, these three industries incur about 83 percent of the annualized costs of the rule. A full listing of all industries affected in this rulemaking can be found in Chapter 4. The purpose of this profile chapter is to give the reader a general understanding of the economic aspects of the industry; their relative size, relationships with other sectors in the economy, trends for the industries, and financial statistics.

3.1 Electric Power Generation, Transmission, and Distribution

3.1.1 Overview

Electric power generation, transmission, and distribution (NAICS 2211) is an industry group within the utilities sector (NAICS 22). It includes establishments that produce electrical energy or facilitate its transmission to the final consumer.

From 2002 to 2007, revenues from electric power generation grew about 18% to over $440 billion ($2007) (Table 3-1).[1] At the same time, payroll rose about 7% and the number of

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[1] We provide revenues from electric power generation for the years 2002 and 2007 for these are years of the Economic Census. We reference data from these Economic Censuses frequently in this industry profile and show revenues from this industry over this time frame due to availability of such data.

employees decreased by around 4%. The number of establishments rose by about 3%. Industrial production within NAICS 2211 has increased 26% since 1997 (Figure 3-1).

Electric utility companies have traditionally been tightly regulated monopolies. Since 1978, several laws and orders have been passed to encourage competition within the electricity market. In the late 1990s, many states began the process of restructuring their utility regulatory framework to support a competitive market. Following market manipulation in the early 2000s, however, several states have suspended their restructuring efforts. The majority (58%) of power generators controlled by combined heat and power (CHP) or independent power producers are located in states undergoing active restructuring (Figure 3-2).

Table 3-1. Key Statistics: Electric Power Generation, Transmission, and Distribution (NAICS 2211) ($2007)

	2002	2007
Revenue ($\$10^6$)	373,309	440,355
Payroll ($\$10^6$)	40,842	43,792
Employees	535,675	515,335
Establishments	9,394	9,642

Source: U.S. Census Bureau; American FactFinder; “Sector 22: EC0722I2: Utilities: Industry Series: Preliminary Comparative Statistics for the United States (2002 NAICS Basis): 2007 and 2002.” http://factfinder.census.gov

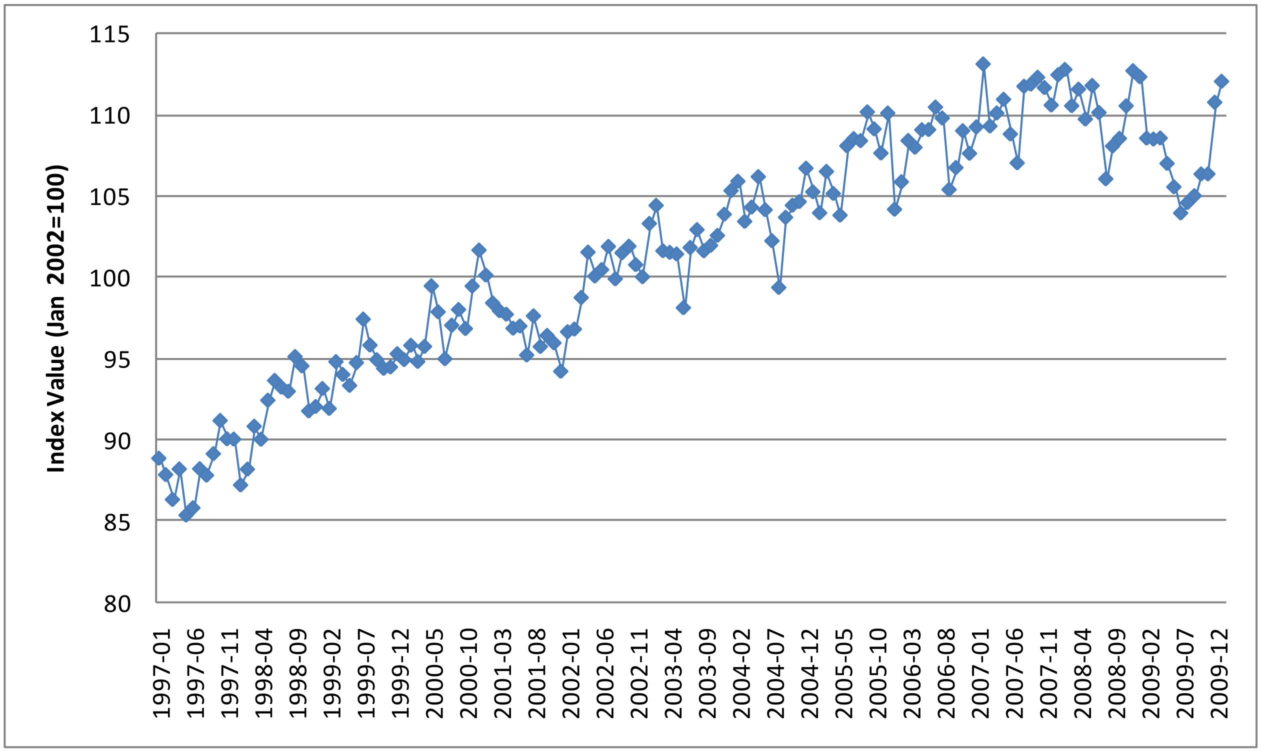

Figure 3-1. Industrial Production Index (NAICS 2211)

Source: The Federal Reserve Board. "Industrial Production and Capacity Utilization: Industrial Production" Series ID: G17/IP_MINING_AND_UTILITY_DETAIL/IP.G2211.S <http://www.federalreserve.gov/datadownload/>. (January 27, 2010).

3.1.2 Goods and Services Used

In Table 3-2, we use the latest detailed benchmark input-output data report by the Bureau of Economic Analysis (BEA) (2002) to identify the goods and services used in electric power generation. As shown, labor and tax requirements represent a significant share of the value of power generation. Extraction, transportation, refining, and equipment requirements potentially

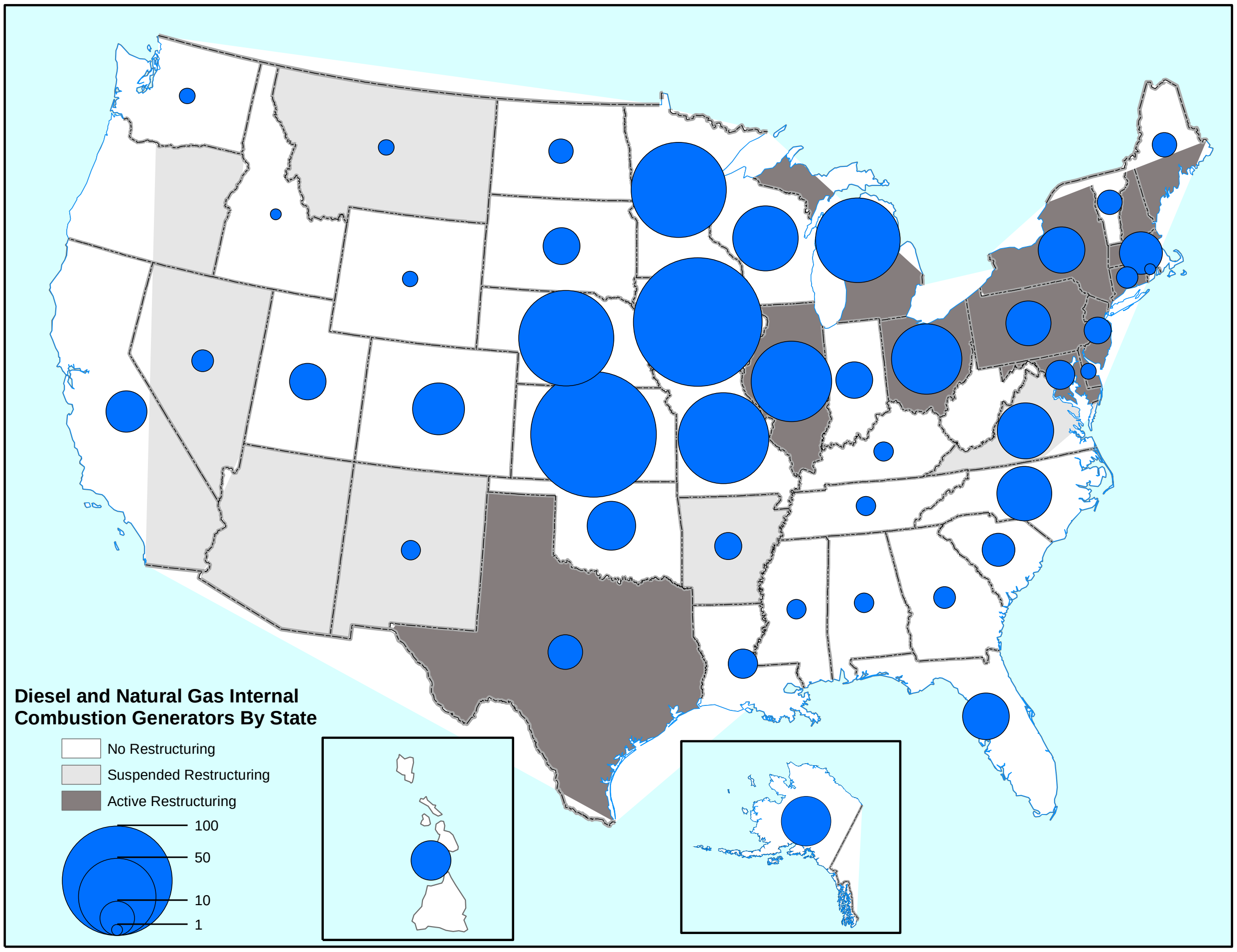

Figure 3-2. Internal Combustion Generators by State: 2006

Source: U.S. Department of Energy, Energy Information Administration. 2007. “2006 EIA-906/920 Monthly Time Series.”

associated with reciprocating internal combustion engines (oil and gas extraction, pipeline transportation, petroleum refineries, and turbine manufacturing) represent around 10% of the value of services.

3.1.3 Business Statistics

The U.S. Economic Census and Statistics of U.S. Businesses (SUSB) programs provide national information on the distribution of economic variables by industry, location, and size of business. Throughout this section and report, we use the following definitions:

- *Establishment*: An establishment is a single physical location where business is conducted or where services or industrial operations are performed.

Table 3-2. Direct Requirements for Electric Power Generation, Transmission, and Distribution (NAICS 2211): 2002

Commodity	Commodity Description	Direct Requirements Coefficients[a]
V00100	Compensation of employees	20.52%
V00200	Taxes on production and imports, less subsidies	13.71%
211000	Oil and gas extraction	6.16%
212100	Coal mining	5.86%
482000	Rail transportation	3.01%
230301	Nonresidential maintenance and repair	2.83%
486000	Pipeline transportation	1.70%
722000	Food services and drinking places	1.40%
52A000	Monetary authorities and depository credit intermediation	1.39%
541100	Legal services	1.13%

[a] These values show the amount of the commodity required to produce $1.00 of the industry's output. The values are expressed in percentage terms (coefficient ×100).

Source: U.S. Bureau of Economic Analysis. 2002. 2002 Benchmark Input-Output Accounts: Detailed Make Table, Use Table and Direct Requirements Table. Tables 4 and 5.

- *Receipts*: Receipts (net of taxes) are defined as the revenue for goods produced, distributed, or services provided, including revenue earned from premiums, commissions and fees, rents, interest, dividends, and royalties. Receipts exclude all revenue collected for local, state, and federal taxes.

- *Firm*: A firm is a business organization consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. The firm and the establishment are the same for single-establishment firms. For each multiestablishment firm, establishments *in the same industry within a state* are counted as one firm; the firm employment and annual payroll are summed from the associated establishments.

- *Enterprise*: An enterprise is a business organization consisting of one or more domestic establishments that were specified under common ownership or control. The enterprise and the establishment are the same for single-establishment firms. Each multiestablishment company forms one enterprise; the enterprise employment and annual payroll are summed from the associated establishments. Enterprise size designations are determined by the summed employment of all associated establishments.

In 2002, Texas had almost 1,000 power establishments, while California, Georgia, and Ohio all had between 400 and 500 (Figure 3-3). Hawaii, Nebraska, and Rhode Island all had fewer than 20 establishments in their states.

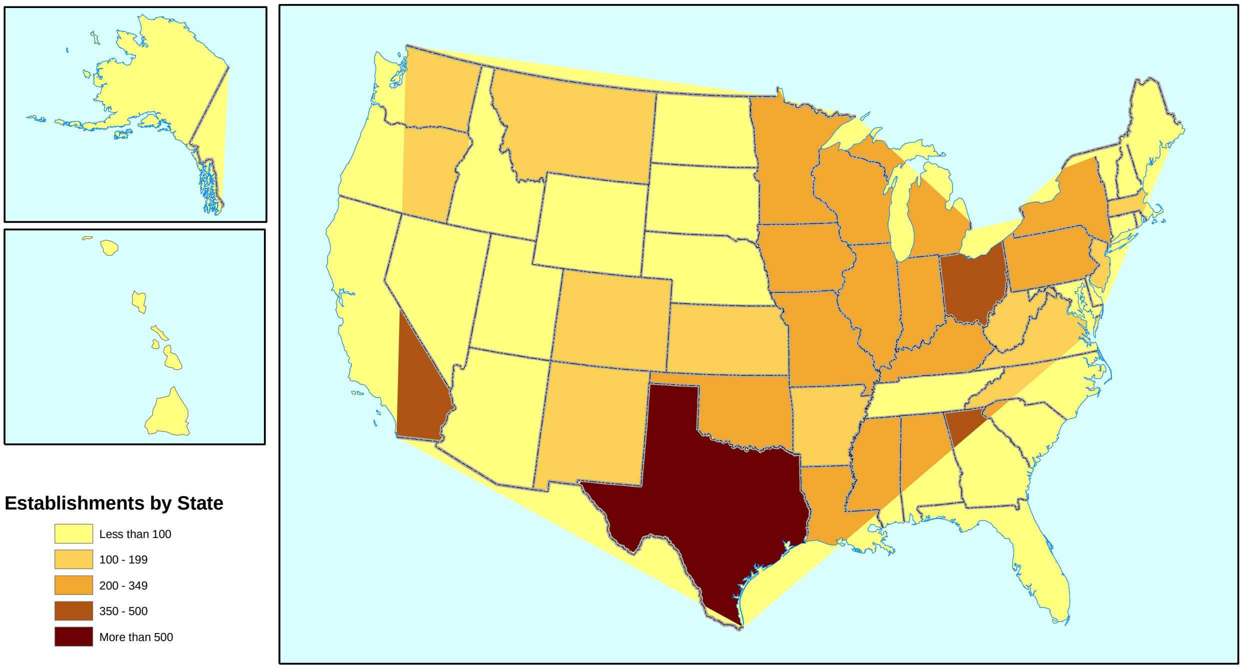

Figure 3-3. 2002 Regional Distribution of Establishments: Electric Power Generation, Transmission, and Distribution Industry (NAICS 2211)

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; “Sector 22: Utilities: Geographic Area Series: Summary Statistics: 2002.” <http://factfinder.census.gov>; (November 10, 2008)..

As shown in Table 3-3, the four largest firms owned over 1,200 establishments and accounted for about 16% of total industry receipts/revenue. The 50 largest firms accounted for almost 6,000 establishments and about 78% of total receipts/revenue.

Investor-owned energy providers accounted for only 2% of retail electricity sold in the United States in 2008 (Table 3-4). In 2008, investor-owned energy provider companies with less than 50% of their assets regulated were unprofitable overall, while other companies in this category were profitable. (Table 3-5). In 2008, enterprises within NAICS 2211 had a pre-tax profit margin of 8.1% (Table 3-6).

In 2002, about 82% of firms generating, transmitting, or distributing electric power had receipts of under $50 million (Table 3-7). However, these firms accounted for only 11% of employment, with 89% of employees working for firms with revenues in excess of $100 million.

Table 3-3. Firm Concentration for Electric Power Generation, Transmission, and Distribution (NAICS 2211): 2002

Commodity	Establishments	Receipts/Revenue Amount ($\$10^6$)	Receipts/Revenue Percentage of Total	Number of Employees	Employees per Establishment
All firms	9,394	$325,028	100.0%	535,675	57
4 largest firms	1,260	$52,349	16.1%	68,432	54
8 largest firms	2,566	$95,223	29.3%	151,575	59
20 largest firms	3,942	$173,207	53.3%	271,393	69
50 largest firms	5,887	$253,015	77.8%	408,021	69

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 22: Utilities: Subject Series—Estab & Firm Size: Concentration by Largest Firms for the United States: 2002." <http://factfinder.census.gov>; (November 21, 2008).

Table 3-4. United States Retail Electricity Sales Statistics: 2008

	Full-Service Providers					Other Providers		
Item	**Investor-Owned**	**Public**	**Federal**	**Cooperative**	**Facility**	**Energy**	**Delivery**	**Total**
Number of entities	3	62	1	25	1	NA	NA	92
Number of retail customers	46,985	2,160,220	36	940,697	1	NA	NA	3,147,939
Retail sales (10^3 megawatthours)	2,257	70,303	9,625	21,868	117	NA	NA	104,170
Percentage of retail sales	2	67	9	21	0	—	—	100
Revenue from retail sales (\$$10^6$)	113	5,934	473	1,994	6	NA	NA	8,520
Percentage of revenue	1.33	69.65	5.55	23.41	0.07	—	—	100
Average retail price (cents/kWh)	5.01	8.44	4.91	9.12	5.25	NA	NA	8.18

Source: U.S. Department of Energy, Energy Information Administration. 2009. "State Electricity Profiles 2008." DOE/EIA-0348(01)/2. p. 260. < http://www.eia.doe.gov/cneaf/electricity/st_profiles/sep2008.pdf>.

Table 3-5. FY 2010 Financial Data for 70 U.S. Shareholder-Owned Electric Utilities

	Profit Margin	**Net Income**	**Operating Revenues**
Investor-Owned Utilities	4.81%	$27,728	$371,545
Regulated[a]	7.25%	$12,341	$158,657
Mostly regulated[b]	8.50%	$17,815	$175,218
Diversified[c]	-16.78%	-$2,429	$37,671

[a] 80%+ of total assets are regulated.

[b] 50% to 80% of total assets are regulated.

[c] Less than 50% of total assets are regulated.

Source: Edison Electric Institute. "Income Statement: Q4 2010 Financial Update. Quarterly Report of the U.S. Shareholder-Owned Electric Utility Industry." <http://www.eei.org>.

Table 3-6. Aggregate Tax Data for Accounting Period 2009: NAICS 2211

Number of enterprises[a]	1,187
Total receipts (10^3)	$323,522,443
Net sales(10^3)	$328,017,143
Profit margin before tax	3.1%
Profit margin after tax	2.0%

[a] Includes corporations with and without net income.

Source: Internal Revenue Service, U.S. Department of Treasury. 2010. "Corporation Source Book: Data Files 2000–2009." <http://www.irs.gov/taxstats/article/0,,id=167415,00.html>; (May 2, 2010).

Table 3-7. Key Enterprise Statistics by Employee Size for Electric Power Generation, Transmission, and Distribution (NAICS 2211): 2007

Variable	All Enterprises	<20 Employees	20–99 Employees	100–499 Employees	500+ Employees
Firms	1,687	630	670	251	136
Establishments	9,611	687	1,110	999	6,815
Employment	503,134	3,622	31,455	42,527	425,530
Receipts ($\$10^3$)	$440,342,284	$8,364,773	$21,825,969	$41,370,375	$368,781,167
Receipts/firm ($\$10^3$)	$261,021	$13,277	$32,576	$164,822	$2,711,626
Receipts/establishment ($\$10^3$)	$45,817	$12,176	$19,663	$41,412	$54,113
Receipts/employment ($)	$875	$2,309	$694	$973	$867

Source: U.S. Census Bureau. 2010. “Firm Size Data from the Statistics of U.S. Businesses: U.S. All Industries Tabulated by Receipt Size: 2007.” <http://www.census.gov/csd/susb/susb07.htm>.

3.2 Oil and Gas Extraction

3.2.1 Overview

Oil and gas extraction (NAICS 211) is an industry group within the mining sector (NAICS 21). It includes establishments that operate or develop oil and gas field properties through such activities as exploring for oil and gas, drilling and equipping wells, operating on-site equipment, and conducting other activities up to the point of shipment from the property.

Oil and gas extraction consists of two industries: crude petroleum and natural gas extraction (NAICS 211111) and natural gas liquid extraction (NAICS 211112). Crude petroleum and natural gas extraction is the larger industry; in 2002, it accounted for 93% of establishments and 75% of oil and gas extraction revenues.

Industrial production in this industry is particularly sensitive to hurricanes in the Gulf Coast. In September of both 2005 and 2008, production dropped 14% from the previous month. (Figure 3-4).

From 2002 to 2007, revenues from crude petroleum and natural gas extraction (NAICS 211111) grew over 117% to almost $215 billion ($2007) (Table 3-8). At the same time, payroll grew 55% and the number of employees grew by 48%. The number of establishments dropped by over 17%; as a result, the average establishment revenue increased by 162%. Materials costs were approximately 18% of revenue over the period.

From 2002 to 2007, revenue from natural gas liquid extraction (NAICS 211112) grew over 26% to about $42 billion (Table 3-9). At the same time, payroll dropped 18% and the number of employees dropped by 24%. The number of establishments dropped by 43%, resulting in an increase of revenue per establishment of about 122%.

3.2.2 Goods and Services Used

The oil and gas extraction industry has similar labor and tax requirements as the electric power generation sector. Extraction, support, power, and equipment requirements potentially associated with RICE (oil and gas extraction, support activities, electric power generation, machinery and equipment rental and leasing, and pipeline transportation) represent around 8% of the value of services (Table 3-10).

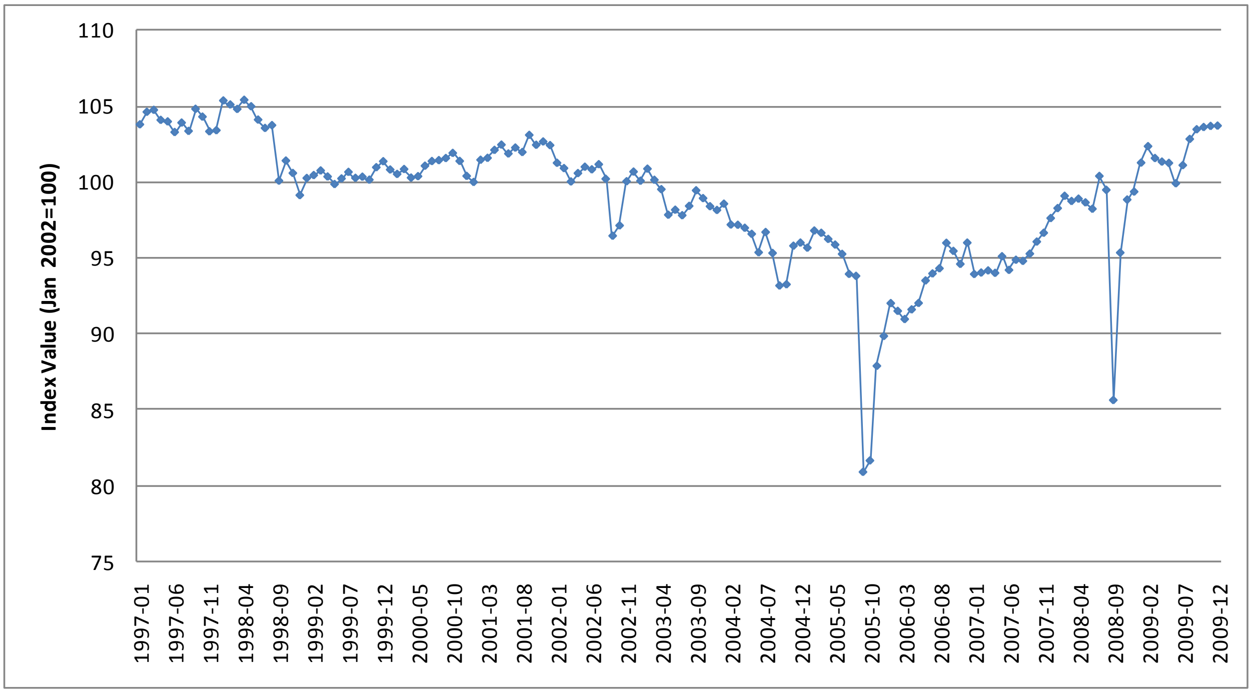

Figure 3-4. Industrial Production Index (NAICS 211)

Source: The Federal Reserve Board. “Industrial Production and Capacity Utilization: Industrial Production” Series ID: G17/IP_MINING_AND_UTILITY_DETAIL/IP.G211.S <http://www.federalreserve.gov/datadownload/>. (January 27, 2010).

Table 3-8. Key Statistics: Crude Petroleum and Natural Gas Extraction (NAICS 211111): ($2007)

	2002	2007
Revenue ($$10^6$)	$98,667	$214,198
Payroll ($$10^6$)	$5,785	$8,980
Employees	94,886	140,160
Establishments	7,178	5,956

Sources: U.S. Census Bureau; generated by RTI International; using American FactFinder; “Sector 21: Mining: Industry Series: Historical Statistics for the Industry: 2002 and 1997.” <http://factfinder.census.gov>; (November 26, 2008).

U.S. Census Bureau; generated by RTI International; using American FactFinder; “Sector 21: EC0721I1: Mining: Industry Series: Detailed Statistics by Industry for the United States: 2007 ” <http://factfinder.census.gov>; (April 27, 2010).

Table 3-9. Key Statistics: Natural Gas Liquid Extraction (NAICS 211112) ($2007)

	2002	2007
Revenue ($$10^6$)	$33,579	$42,363
Payroll ($$10^6$)	$607	$501
Employees	9,693	7,343
Establishments	511	291

Sources: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 21: Mining: Industry Series: Historical Statistics for the Industry: 2002 and 1997." <http://factfinder.census.gov>; (November 26, 2008).

U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 21: EC0721I1: Mining: Industry Series: Detailed Statistics by Industry for the United States: 2007 " <http://factfinder.census.gov>; (April 27, 2010).

Table 3-10. Direct Requirements for Oil and Gas Extraction (NAICS 211): 2002

Commodity	Commodity Description	Direct Requirements Coefficients[a]
V00200	Taxes on production and imports, less subsidies	8.93%
V00100	Compensation of employees	6.67%
230301	Nonresidential maintenance and repair	6.36%
211000	Oil and gas extraction	1.91%
213112	Support activities for oil and gas operations	1.51%
221100	Electric power generation, transmission, and distribution	1.47%
541300	Architectural, engineering, and related services	1.24%
532400	Commercial and industrial machinery and equipment rental and leasing	1.20%
33291A	Valve and fittings other than plumbing	1.10%
541511	Custom computer programming services	0.99%

[a] These values show the amount of the commodity required to produce $1.00 of the industry's output. The values are expressed in percentage terms (coefficient ×100).

Source: U.S. Bureau of Economic Analysis. 2002. 2002 Benchmark Input-Output Accounts: Detailed Make Table, Use Table and Direct Requirements Table. Tables 4 and 5.

3.2.3 Business Statistics

The U.S. Economic Census and SUSB programs provide national information on the distribution of economic variables by industry, location, and size of business. Throughout this section and report, we use the following definitions:

- *Establishment*: An establishment is a single physical location where business is conducted or where services or industrial operations are performed.

- *Receipts*: Receipts (net of taxes) are defined as the revenue for goods produced, distributed, or services provided, including revenue earned from premiums, commissions and fees, rents, interest, dividends, and royalties. Receipts exclude all revenue collected for local, state, and federal taxes.

- *Firm*: A firm is a business organization consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. The firm and the establishment are the same for single-establishment firms. For each multiestablishment firm, establishments in the same industry within a state are counted as one firm; the firm employment and annual payroll are summed from the associated establishments.

- *Enterprise*: An enterprise is a business organization consisting of one or more domestic establishments that were specified under common ownership or control. The enterprise and the establishment are the same for single-establishment firms. Each multiestablishment company forms one enterprise; the enterprise employment and annual payroll are summed from the associated establishments. Enterprise size designations are determined by the summed employment of all associated establishments.

As of 2007, there were 6,563 firms within the NAICS 211111 code, of which 6427 (98 percent) were considered small businesses (Table 3-11). Within NAICS 211111, large firms compose about 2 percent of the firms, but account for 59 percent of employment and generate about 80 percent of estimated receipts listed under the NAICS. Within NAICS 211112, there are 139 firms, of which 95 (71 percent) were considered small businesses (Table 3-12). As shown in this table, large firms compose 29 percent of the firms, but account for 78 percent of employment and generate about 95 percent of estimated receipts.

Enterprises within this industry generated $193 billion in total receipts in 2008. Including those enterprises without net income, the industry averaged an after-tax profit margin of 8.5% (Table 3-13).

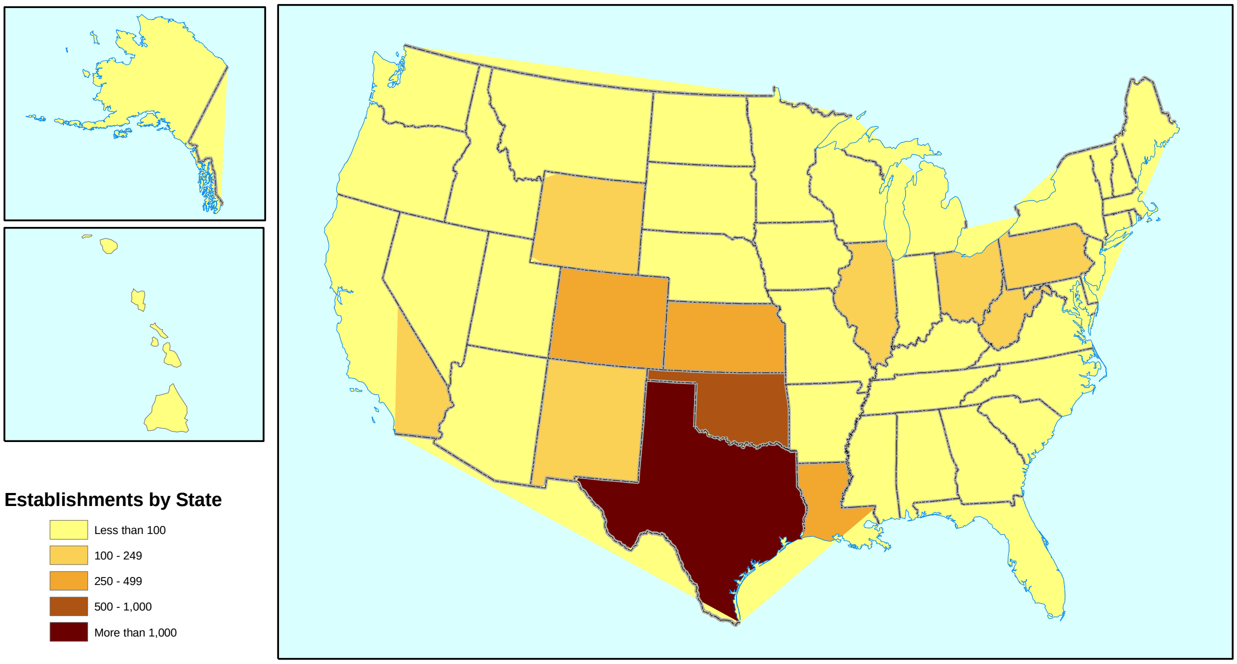

Figure 3-5. **2002 Regional Distribution of Establishments: Crude Petroleum and Natural Gas Extraction Industry (NAICS 211111)**

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 21: Mining: Geographic Area Series: Industry Statistics for the State or Offshore Areas: 2007." <http://factfinder.census.gov>; (January 27, 2010).

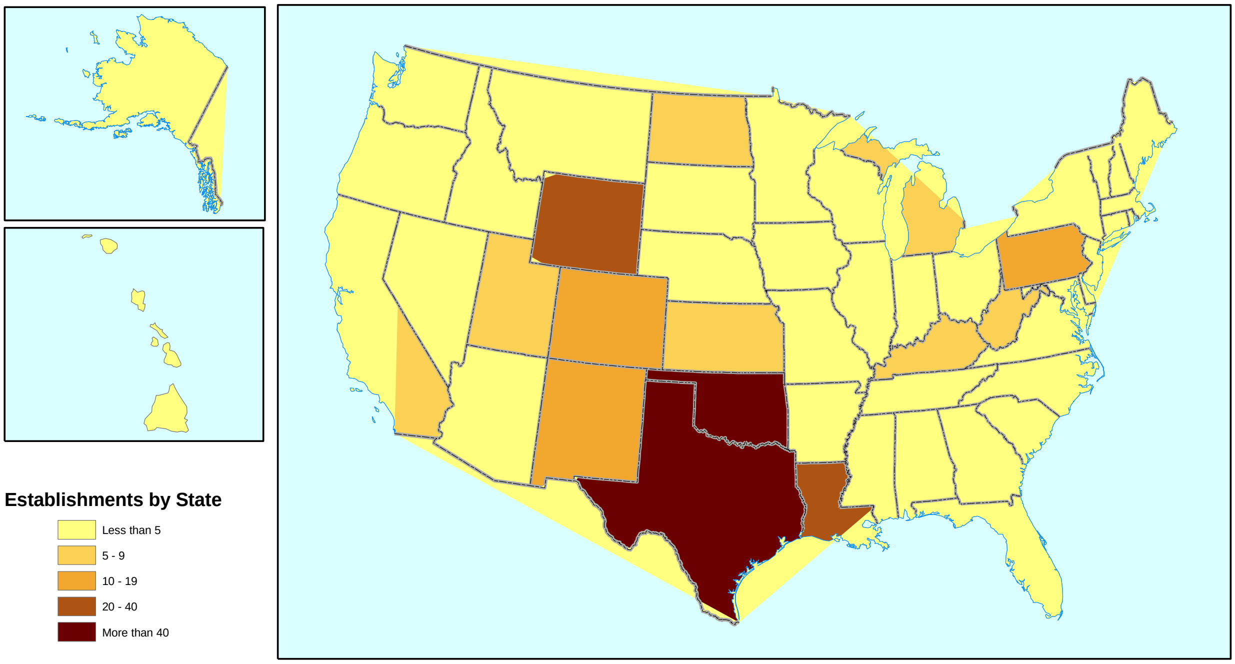

Figure 3-6. **2002 Regional Distribution of Establishments: Natural Gas Liquid Extraction Industry (NAICS 211112)**

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; “Sector 21: Mining: Geographic Area Series: Industry Statistics for the State or Offshore Areas: 2007.” <http://factfinder.census.gov>; (January 27, 2010).

Table 3-11. Key Statistics for Crude Petroleum and Natural Gas Extraction (NAICS 211111): 2007

NAICS	NAICS Description	SBA Size Standard	Small Firms	Large Firms	Total Firms
Number of Firms by Firm Size					
	Crude Petroleum and Natural Gas Extraction	500	6,329	95	6,424
Total Employment by Firm Size					
			55,622	77,664	133,286
Estimated Receipts by Firm Size ($1000)					
			44,965,936	149,141,316	194,107,252

Note: *The counts of small and large firms in NAICS 486210 is based upon firms with less than $7.5 million in receipts, rather than the $7 million required by the SBA Size Standard. We used this value because U.S. Census reports firm counts for firms with receipts less than $7.5 million. **Employment and receipts could not be split between small and large businesses because of non-disclosure requirements faced by the U.S. Census Bureau.
Source: U.S. Census Bureau. 2010. “Number of Firms, Number of Establishments, Employment, Annual Payroll, and Estimated Receipts by Enterprise Receipt Size for the United States, All Industries: 2007.” <http://www.census.gov/econ/susb/>

Table 3-12. Key Statistics for Crude Natural Gas Liquid Extraction (NAICS 211112): 2007

NAICS Description	SBA Size Standard	Small Firms	Large Firms	Total Firms
Number of Firms by Firm Size				
Natural Gas Liquid Extraction	500	98	41	139
Total Employment by Firm Size				
		1,875	6,648	8,523
Estimated Receipts by Firm Size ($1000)				
		2,164,328	37,813,413	39,977,741

Note: *The counts of small and large firms in NAICS 486210 is based upon firms with less than $7.5 million in receipts, rather than the $7 million required by the SBA Size Standard. We used this value because U.S. Census reports firm counts for firms with receipts less than $7.5 million. **Employment and receipts could not be split between small and large businesses because of non-disclosure requirements faced by the U.S. Census Bureau.
Source: U.S. Census Bureau. 2010. “Number of Firms, Number of Establishments, Employment, Annual Payroll, and Estimated Receipts by Enterprise Receipt Size for the United States, All Industries: 2007.” <http://www.census.gov/econ/susb/>

Table 3-13. Aggregate Tax Data for Accounting Period 7/07–6/08: NAICS 211

Number of enterprises[a]	19,441
Total receipts (10^3)	$193,230,241
Net sales(10^3)	$166,989,539
Profit margin before tax	12.9%
Profit margin after tax	8.5%

[a] Includes corporations with and without net income.

Source: Internal Revenue Service, U.S. Department of Treasury. 2010. “Corporation Source Book: Data Files 2004-2007.” <http://www.irs.gov/taxstats/article/0,,id=167415,00.html>; (May 2, 2010).

3.3 Pipeline Transportation of Natural Gas

3.3.1 Overview

Pipeline transportation of natural gas (NAICS 48621) is an industry group within the transportation and warehousing sector (NAICS 48-49), but more specifically in the pipeline transportation subsector (486). It includes the transmission of natural gas as well as the distribution of the gas through a local network to participating businesses.

From 2002 to 2007, natural gas transportation revenues fell by 29% to just over $16 billion ($2007) (Table 3-14). At the same time, payroll decreased by 14%, while the number of paid employees decreased by nearly 25%. The number of establishments also fell by 8% from 1,701 establishments in 2002 to 1,560 in 2007.

3.3.2 Goods and Services Used

The BEA reports pipeline transportation of natural gas only for total pipeline transportation (3-digit NAICS 486). In addition to pipeline transportation of natural gas (NAICS 4862), this industry includes pipeline transportation of crude oil (NAICS 4861) and other pipeline transportation (NAICS 4869). However, the BEA data are likely representative of the affected sector since pipeline transportation of natural gas accounts for 60% of NAICS 486 establishments and 66% of revenues (Figures 3-8 and 3-9).

Table 3-14. Key Statistics: Pipeline Transportation of Natural Gas (NAICS 48621) ($2007)

Year	2002	2007
Revenue ($$10^6$)	16,368	20,797
Payroll ($$10^6$)	2,086	2,064
Employees	24,519	24,683
Establishments	1,560	1,479

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 48: EC0748I1: Transportation and Warehousing: Industry Series: Preliminary Summary Statistics for the United States: 2002 and 2007." http://factfinder.census.gov (January 27, 2010).

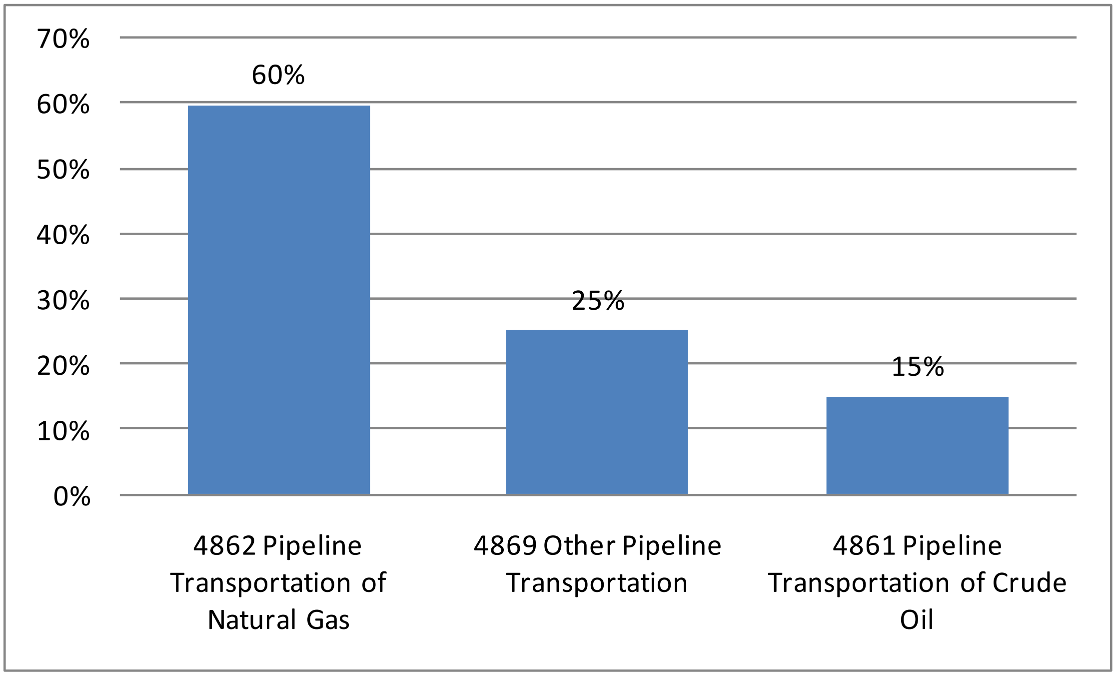

Figure 3-8. Distribution of Establishments within Pipeline Transportation (NAICS 486)

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 48: Transportation and Warehousing: Industry Series: Summary Statistics for the United States: 2002 <http://factfinder.census.gov>; (January 27, 2010).

In Table 3-15, we use the latest detailed benchmark input-output data report by the BEA (2002) to identify the goods and services used by pipeline transportation (NAICS 486). As shown, labor, refineries, and maintenance requirements represent significant share of the cost associated with pipeline transportation. Power and equipment requirements potentially associated with reciprocating internal combustion engines (electric power generation and distribution) represent less than 2% of the value of services.

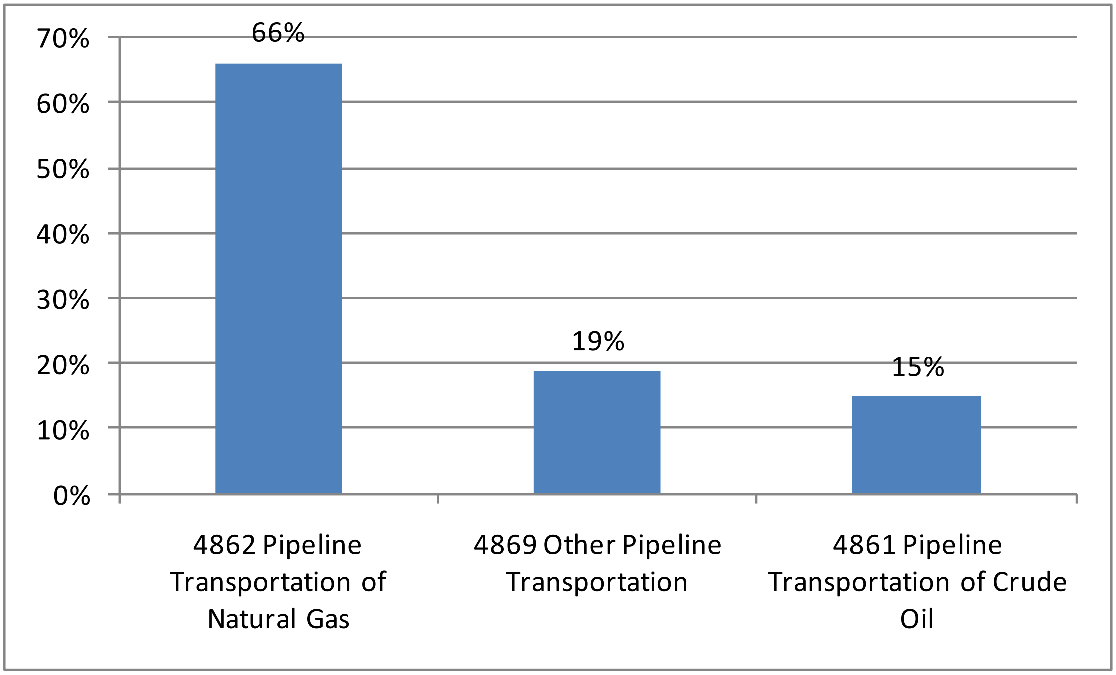

Figure 3-9. Distribution of Revenue within Pipeline Transportation (NAICS 486)

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 48: Transportation and Warehousing: Industry Series: Summary Statistics for the United States: 2002" <http://factfinder.census.gov>; (January 27, 2010).

3.3.3 Business Statistics

The pipeline transportation of natural gas is clearly concentrated in the two states closest to the refineries in the Gulf of Mexico. In 2002, Texas and Louisiana contributed to 31% of all pipeline transportation establishments in the United States (Figure 3-10) and 41% of all U.S. revenues. Other larger contributors with over 50 establishments in their states include Oklahoma, Pennsylvania, Kansas, Mississippi, and West Virginia.

According to 2002 U.S. Census data, about 86% of transportation of natural gas establishments were owned by corporations and about 8% were owned by individual proprietorships. About 6% were owned by partnerships (Figure 3-11). As shown in Table 3-16, the four largest firms accounted for nearly half of the establishments, and just over half, 51%, of total revenue. The 50 largest firms accounted for over 1,354 establishments and about 99% of total revenue. The average number of employees per establishment was approximately 17 across all groups of firms.

Enterprises within pipeline transportation (NAICS 486) generated $11.1 billion in total receipts in 2008. Including those enterprises without net income, the industry averaged an after-tax profit margin of 9.6% (Table 3-17).

Table 3-15. Direct Requirements for Pipeline Transportation (NAICS 486): 2002

Commodity	Commodity Description	Direct Requirements Coefficients[a]
V00100	Compensation of employees	14.78%
324110	Petroleum refineries	13.55%
230301	Nonresidential maintenance and repair	6.07%
211000	Oil and gas extraction	4.94%
333415	Air conditioning, refrigeration, and warm air heating equipment manufacturing	4.40%
561300	Employment services	4.26%
5416A0	Environmental and other technical consulting services	3.04%
541300	Architectural, engineering, and related services	3.04%
420000	Wholesale trade	2.79%
332310	Plate work and fabricated structural product manufacturing	2.72%
5419A0	All other miscellaneous professional, scientific, and technical services	2.48%
524100	Insurance carriers	2.38%
531000	Real estate	2.33%
52A000	Monetary authorities and depository credit intermediation	1.76%
V00200	Taxes on production and imports, less subsidies	1.41%
541100	Legal services	1.19%
221100	Electric power generation, transmission, and distribution	1.13%

[a] These values show the amount of the commodity required to produce $1.00 of the industry’s output. The values are expressed in percentage terms (coefficient ×100).

Source: U.S. Bureau of Economic Analysis. 2002. 2002 Benchmark Input-Output Accounts: Detailed Make Table, Use Table and Direct Requirements Table. Tables 4 and 5.

The 2007 SUSB shows that 47% of all firms in this industry made under $5 million in revenue. Enterprises with revenue over $100 million provided an overwhelming share of employment in this industry (98%) (Table 3-18).

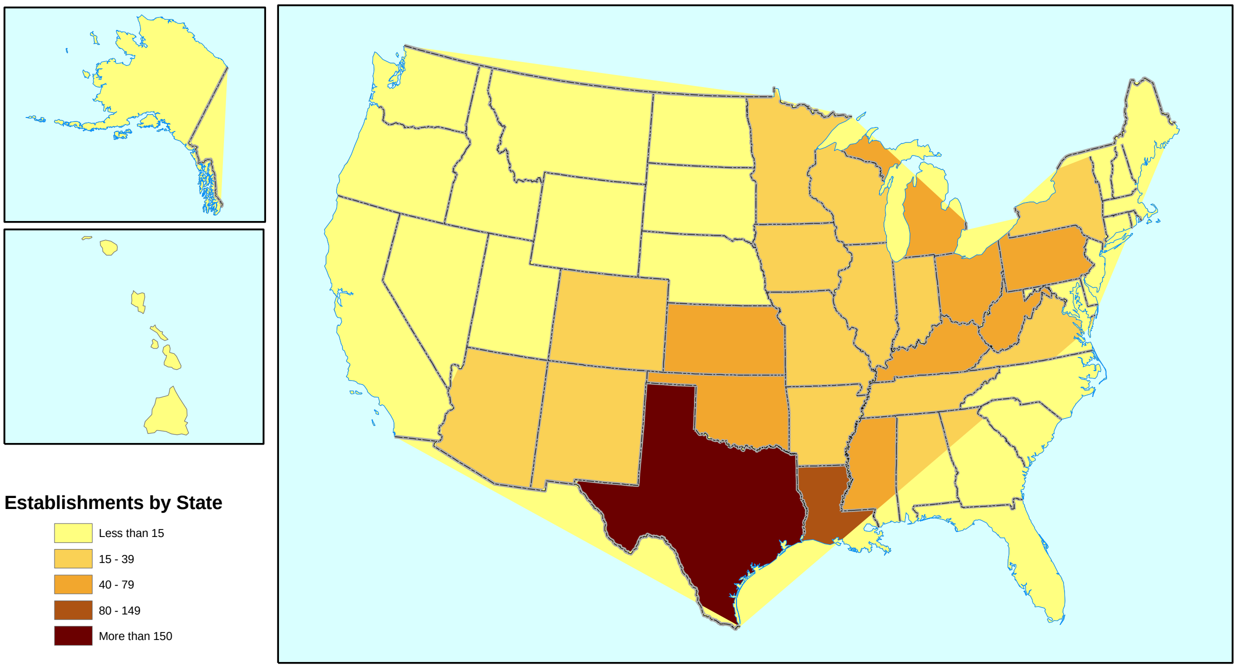

Figure 3-10. 2002 Regional Distribution of Establishments: Pipeline Transportation (NAICS 486)

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 48-49: Geographic Distribution—Pipeline transportation of natural gas: 2002. <http://factfinder.census.gov>; (November 10, 2008).

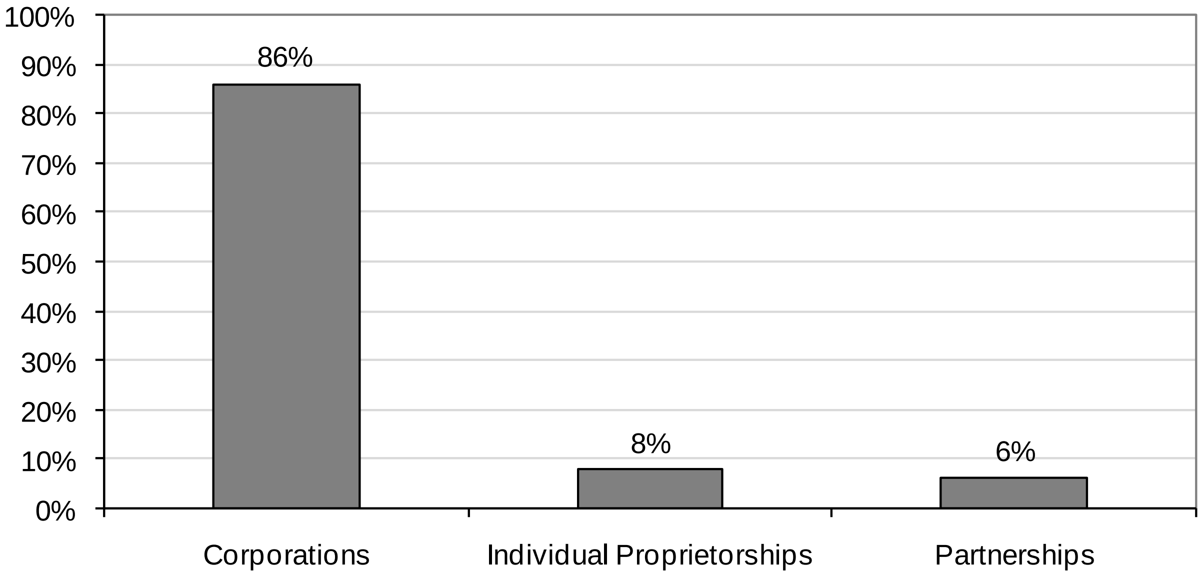

Figure 3-11. Share of Establishments by Legal Form of Organization in the Pipeline Transportation of Natural Gas Industry (NAICS 48621): 2002

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 48-49: Transportation and Warehousing: Subject Series—Estab & Firm Size: Legal Form of Organization for the United States: 2002. <http://factfinder.census.gov>; (December 12, 2008).

Table 3-16. Firm Concentration for Pipeline Transportation of Natural Gas (NAICS 48621): 2002

Commodity	Establishments	Receipts/Revenue: Amount ($\$10^6$)	Receipts/Revenue: Percentage of Total	Number of Employees	Employees per Establishment
All firms	1,431	$14,797	100%	23,677	16.5
4 largest firms	698	$7,551	51%	11,814	16.9
8 largest firms	912	$10,059	68%	15,296	16.8
20 largest firms	1,283	$13,730	93%	21,792	17.0
50 largest firms	1,354	$14,718	99%	23,346	17.2

Source: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 48: Transportation and Warehousing: Subject Series—Estab & Firm Size: Concentration by Largest Firms for the United States: 2002" <http://factfinder.census.gov>; (December 12, 2008).

Table 3-17. Aggregate Tax Data for Accounting Period 7/07–6/08: NAICS 486

Number of enterprises[a]	321
Total receipts (10^3)	$11,062,608
Net sales (10^3)	$10,210,083
Profit margin before tax	13.2%
Profit margin after tax	9.6%

[a] Includes corporations with and without net income.

Source: Internal Revenue Service, U.S. Department of Treasury. 2010. "Corporation Source Book: Data Files 2004-2007." <http://www.irs.gov/taxstats/article/0,,id=167415,00.html>; (May 2, 2010).

Table 3-18. Key Enterprise Statistics by Employee Size for Pipeline Transportation of Natural Gas (NAICS 48621): 2007

Variable	All Enterprises	<20 Employees	20–99 Employees	100–499 Employees	500+ Employees
Firms	126	63	12	9	42
Establishments	1.479	66	26	70	1,317
Employment	24,683	241	382	1,479	22,581
Receipts ($\$10^3$)	\$20,796,681	N/A	\$518,341	\$1,448,020	\$18,498,143
Receipts/firm ($\$10^3$)	\$165,053	N/A	\$43,195	\$160,891	\$440,432
Receipts/establishment ($\$10^3$)	\$14,061	N/A	\$19,936	\$20,686	\$14,046
Receipts/employment (\$)	\$843	N/A	\$1,357	\$979	\$819

Source: U.S. Census Bureau. 2011. Firm Size Data from the Statistics of U.S. Businesses, U.S. All Industries Tabulated by Employee Size: 2007. http://www2.census.gov/csd/susb/2007/usalli_r07.xls.

Section 4
REGULATORY ALTERNATIVES, COSTS, AND EMISSION IMPACTS

4.1 Background

This section of the RIA includes a discussion of the regulatory alternatives considered for the proposed reconsidered rule, the costs associated with these regulatory alternatives, and the impacts on affected emissions (both HAP and non-HAP). All impacts presented are for the year of full implementation, 2013. Costs in this section are in 2009$. Costs in 2010$ presented elsewhere in the RIA are updated values based on the 2009$ costs presented in this section. Although the estimates presented are annualized, they should be understood as a "snapshot" in analyzing costs. Annualized costs are estimated as equal for each year that control equipment is operated.

This proposal was developed to address certain issues that have been raised by different stakeholders through lawsuits, several petitions for reconsideration of the 2010 RICE NESHAP amendments and other communications. After promulgation of the 2010 RICE NESHAP amendments, the EPA received several petitions for reconsideration, legal challenges, and other communications raising issues of practical implementability, and certain factual information that had not been brought to the EPA's attention during the rulemaking. The EPA has considered this information and believes that amendments to the rule to address certain of these issues are appropriate. Therefore, the EPA is proposing amendments to the national emission standards for hazardous air pollutants for stationary reciprocating internal combustion engines under section 112 of the Clean Air Act. The proposed amendments include alternative testing options for certain large spark ignition (generally natural gas-fueled) stationary reciprocating internal combustion engines, management practices for a subset of existing spark ignition stationary reciprocating internal combustion engines in sparsely populated areas, and alternative and less burdensome monitoring and compliance options for the same engines in populated areas. The EPA is also proposing to include a limited temporary allowance for existing stationary emergency area source engines to be used for peak shaving and non-emergency demand response as part of the pre-existing allowance for such engines to be used for non-emergency use for 50 hours annually. In addition, the EPA is proposing, in both the NESHAP and in the new source performance standards for stationary internal combustion engines to increase the hours that stationary emergency engines may be used for emergency demand response. The proposed amendments also correct minor mistakes in the pre-existing regulations. The full preamble for the final SI RICE NESHAP and the rule itself can be reviewed at http://www.epa.gov/ttn/atw/rice/fr20au10.pdf.

4.2 Proposed Amendments to SI RICE NESHAP

4.2.1. Total Hydrocarbon Compliance (THC) Demonstration Option

4.2.1.1. Background

Currently, SI 4SRB non-emergency engines greater than 500 HP and located at major sources and existing SI 4SRB non-emergency engines greater than 500 HP located at area sources have the option of meeting either a formaldehyde percent reduction or a formaldehyde concentration standard. Formaldehyde was established in the original 2004 RICE NESHAP as an appropriate surrogate for HAP emissions from 4SRB engines based on industry test data available at that time. Based on testing conducted at Colorado State University (CSU) of stationary lean burn engines, the EPA was able to establish CO as a surrogate for HAP for lean burn engines. Rich burn engines were not tested at CSU and the data the EPA had available at the time that were used to set the standards for rich burn engines did not support the same relationship between CO and HAP reductions for rich burn engines. Therefore, the EPA was unable to establish CO as a surrogate for HAP emissions for rich burn engines and the emission standard for rich burn engines was specified in terms of formaldehyde, the hazardous air pollutant emitted in the largest quantity from stationary engines.

The EPA has previously acknowledged that it is significantly more expensive and difficult to test for formaldehyde than for CO, but has been unable in the past to support including the same flexibility for rich burn engines as is currently in the rule for lean burn engines with the option to meet the standards in terms of either formaldehyde or CO. For these reasons, and expecting that new data for rich burn engines may become available in the future for the EPA to review and reassess possible surrogates for HAP, the EPA requested comment on this issue when proposing NESHAP for stationary existing engines less than or equal to 500 HP at major sources and all stationary existing engines at area sources in 2009 (74 FR 9698). Specifically, the EPA solicited comment on whether it would be appropriate to include an alternative standard in terms of VOC and asked that commenters submit data supporting the relationship between HAP and VOC. Comments the EPA received back on the proposed rule asked that the formaldehyde standards for rich burn engines be replaced with emission standards for THC. The EPA determined at the time that it was not appropriate to adopt an alternative standard in terms of THC (or VOC) for rich burn engines and discussed the reasons why in the 2010 responses to comments. Compliance with the formaldehyde standard in the rule is, therefore, currently demonstrated by initial and continuous performance testing for formaldehyde.

On October 19, 2010, engine manufacturer Dresser-Waukesha submitted a petition for reconsideration of the formaldehyde requirements. The EPA granted the petition for reconsideration on January 5, 2011. (In addition, on November 3, 2010, the Engine Manufacturers Association submitted a petition for judicial review of these requirements.) In the petition for reconsideration, Dresser-Waukesha argued that formaldehyde is difficult and costly to measure. The petition requested that the HAP surrogate for 4SRB engines should be THC rather than formaldehyde. Dresser-Waukesha submitted data from testing it conducted illustrating that THC reduction across the catalyst is an appropriate surrogate for HAP reduction across the catalyst. According to the petitioner, testing for THC is easier and less costly and would substantially reduce the burden of the rule for owners and operators of these engines. Testing for formaldehyde emissions could cost more than double that of testing for THC emissions and on a nationwide basis the EPA estimates that replacing formaldehyde testing with THC testing would result in substantial compliance cost savings annually while achieving the same reduction in HAP emissions.

The EPA has reviewed the data submitted by Dresser-Waukesha. The data provided indicate that a strong relationship exists between percentage reductions of THC and percentage reductions of formaldehyde (the surrogate for HAP emissions in the NESHAP) on rich burn engines using non-selective catalytic reduction (NSCR). Data analyzed by the EPA indicate that if the NSCR is reducing THC by at least 30 percent from 4SRB engines, formaldehyde emissions are guaranteed to be reduced by at least 76 percent, which is the percentage reduction required for the relevant engines. Indeed, the percentage reduction of formaldehyde is invariably well above the 76 percent level, and is usually above 90 percent. Therefore, the EPA agrees with the petitioner that for SI 4SRB engines using NSCR and meeting the NESHAP by showing a percentage reduction of HAP, it would be appropriate to allow sources to demonstrate compliance with the NESHAP by showing a THC reduction of at least 30 percent. Including an optional THC compliance demonstration option would reduce the burden of compliance significantly while continuing to achieve the same level of HAP emission reduction because the emission standards would remain the same. Consequently, the EPA is proposing amendments to allow owners and operators of certain stationary 4SRB engines (i.e., the ones currently subject to a formaldehyde percent reduction requirement) to show compliance with an optional THC compliance demonstration option. The specific amendments the EPA is proposing are presented below.

4.2.1.2. Proposed Amendments

The EPA is proposing to add an alternative method of demonstrating compliance with the NESHAP for stationary 4SRB non-emergency engines greater than 500 HP that are located at major sources of HAP emissions and for existing stationary 4SRB non-emergency engines greater than 500 HP that are located at area sources of HAP emissions that choose to meet the formaldehyde percent reduction requirement of 76 percent or more.

Based on the arguments and evidence presented in the petition discussed above, the EPA is proposing to add a compliance demonstration option for stationary 4SRB engines meeting a 76 percent or more formaldehyde reduction. The compliance demonstration option would be an alternative to the existing method of demonstrating compliance with the formaldehyde percent reduction standard, which is to test engines for formaldehyde. The alternative for owners and operators of 4SRB engines meeting a 76 percent or more formaldehyde reduction would be to test their engines for THC showing that the engine is achieving at least a 30 percent reduction of THC emissions.

Under the proposed amendments, existing and new stationary 4SRB engines greater than 500 HP and located at major sources would still be required to reduce formaldehyde emissions by 76 percent or more or limit the concentration of formaldehyde in the stationary RICE exhaust to 350 parts per billion by volume, dry basis or less at 15 percent oxygen (O_2). However, owners and operators choosing to meet the formaldehyde concentration limit would not have the THC demonstration compliance option, because EPA could not verify a clear relationship between concentrations of THC and concentrations of formaldehyde in exhaust from these SI 4SRB engines. The EPA is proposing that existing stationary 4SRB non-emergency engines greater than 500 HP located at area sources located in populated areas be subject to an equipment standard and required to install a catalyst. These engines would be subject to testing to demonstrate initially and on an ongoing basis that the catalyst is reducing CO by 75 percent or more, or alternatively that THC emissions are being reduced by 30 percent or more.

Owners and operators of existing stationary 4SRB engines less than or equal to 500 HP who are required to limit the concentration of formaldehyde in the stationary RICE exhaust to 10.3 parts per million by volume, dry basis (ppmvd) or less at 15 percent O_2 do not have the option to demonstrate compliance using THC and must continue to demonstrate compliance by testing for formaldehyde following the methods and procedures specified in the rule.

Owners and operators opting to use the THC compliance demonstration method must demonstrate compliance by showing that the average reduction of THC is equal to or greater than 30 percent. Owners and operators of 4SRB stationary RICE complying with the requirement to reduce formaldehyde emissions and demonstrating compliance by using the THC compliance demonstration option must conduct performance testing using Method 25A of 40 CFR part 60, appendix A – Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer. Measurements of THC at the inlet and the outlet of the NSCR must be on a dry basis and corrected to 15 percent O2 or equivalent carbon dioxide content. To correct to 15 percent O2, dry basis, owners and operators must measure oxygen using Method 3, 3A or 3B of 40 CFR part 60, appendix A, or ASTM Method D6522-00 (2005) and measure moisture using Method 4 of 40 CFR part 60, appendix A, or Test Method 320 of 40 CFR part 63, appendix A, or ASTM D6348-03. Because owners and operators are complying with a percent reduction requirement, the method used must be suitable for the entire range of emissions since pre and post-catalyst emissions must be measured. Method 25A is capable of measuring emissions down to 5 ppmv and is, therefore, an appropriate method for measuring THC emissions for compliance demonstration purposes. The EPA is allowing sources the option to meet a minimum THC percent reduction of 30 percent by using Method 25A of 40 CFR part 60, appendix A to demonstrate compliance with the formaldehyde percent reduction in 40 CFR part 63, subpart ZZZZ.

4.2.2. Proposed Amendment - Emergency Demand Response/Peak Shaving

The EPA is proposing to revise the current provisions for stationary engines used for emergency demand response operation. The provisions the EPA is proposing to amend are in §§63.6640(f) and 63.6675 of 40 CFR part 63, subpart ZZZZ. Currently, §63.6640(f)(1)(iii) allows a maximum of 15 hours per year to be spent towards demand response operation under certain qualifying conditions. Also, §63.6640(f)(1)(ii) currently includes an allowance of 100 hours per year for purposes of maintenance checks and readiness testing. The EPA is proposing that owners and operators of stationary emergency RICE be permitted to operate their engines as part of an emergency demand response program within the 100 hours per year that is permitted for maintenance and testing in §63.6640(f)(1)(ii). Owners and operators of stationary emergency engines can operate for emergency demand response during periods in which the regional transmission authority or equivalent balancing authority and transmission operator has declared an EEA Level 2 as defined in the North American Electric Reliability Corporation Reliability Standard EOP-002-3, Capacity and Energy Emergency and during periods where there is a deviation of voltage or frequency of 5 percent or greater below standard voltage or frequency.

The hours spent for emergency demand response operation are added to the hours spent for maintenance and testing purposes and counted towards the 100 hours per year. If the total time spent for demand response operation and maintenance and testing exceeds 100 hours per year the engine will not be considered an emergency engine under this subpart and will need to meet all requirements for non-emergency engines. The EPA is recognizing that these engines may be called to operate not only by the regional transmission operator or equivalent to maintain the reliability of the bulk power system, but also by the local transmission and distribution system operators to support the local power systems.

For stationary emergency engines above 500 HP that were installed prior to June 12, 2006, there is currently no emergency demand response allowance and there is no time limit on the use of emergency engines for routine testing and maintenance in §63.6640(f)(2)(ii). Those engines were not the focus of the 2010 RICE NESHAP amendments; therefore, the EPA did not make any changes to the requirements for those engines as part of the 2010 amendments. For consistency, the EPA is now also proposing that owners and operators of stationary emergency engines installed prior to June 12, 2006, be permitted to operate their engines as part of a demand response program as well for a total of 100 hours per year, including time spent for maintenance and testing.

The EPA is also proposing to amend the NSPS for stationary CI and SI engines in 40 CFR part 60, subparts IIII and JJJJ, respectively, to provide the same allowance for stationary emergency engines for emergency demand response operation as for engines subject to the RICE NESHAP. The NSPS regulations currently do not include such an allowance for emergency demand response operation. For the reasons discussed as to why the EPA finds it appropriate to allow stationary emergency engines to participate in emergency demand response programs and remain being considered emergency units, and for consistency across engine regulations, the EPA is proposing to add an emergency demand response allowance under the NSPS regulations. Consequently, the EPA is proposing to revise the existing language in §§60.4211(f) and 60.4219 of 40 CFR part 60, subpart IIII, and §§60.4243(d) and 60.4248 of 40 CFR part 60, subpart JJJJ, to specify that emergency engines may participate in demand response programs for up to 100 hours per year, including hours spent towards maintenance and testing of the emergency engines.

In addition to the changes the EPA is proposing related to emergency demand response operation, the EPA is also including a further provision for owners and operators of existing stationary emergency RICE located at area sources for the reasons discussed. Paragraph §63.6640(f) currently allows owners and operators of emergency stationary RICE to operate their engine for 50 hours per year in non-emergency situations. As currently written, the 50 hours per year for non-emergency situations cannot be used for peak shaving or to generate income for a facility to supply power to an electric grid or otherwise supply power as part of a financial arrangement with another entity; except that owners and operators of certain emergency engines may operate the engine for a maximum of 15 hours per year as part of an emergency demand response program. As discussed, the 15 hours per year allowance for emergency engines to participate in emergency demand response programs is being increased to 100 hours per year, but will also include hours spent towards maintaining and conducting readiness testing of the emergency engines. However, additionally, the EPA is also proposing that stationary emergency engines located at area sources be permitted to apply the 50 hours per year that is currently allowed under §63.6640(f) for non-emergency operation towards any non-emergency operation, including operation as part of a financial agreement with another entity. The peak shaving allowance would expire in 2017. The EPA is specifying that the power can only be used at the facility or towards the local system, and the engine can only be operated for peak shaving as part of a program with the local distribution system operator. The EPA is also clarifying that an engine that exceeds the calendar year limitations on non-emergency operation, including emergency demand response or peak shaving, will be considered a non-emergency engine and subject to the requirements for non-emergency engines for the remaining life of the engine.

To estimate emissions from emergency engines the EPA has previously estimated that these types of engines would on average operate for 50 hours per year. The average hours of operation for emergency engines is not expected to change based on the proposed amendments and 50 hours per year is still believed to be representative of emergency engine operation. Therefore, the emissions previously calculated remain appropriate. In terms of any revenue generated from participation in demand response and peak shaving programs, the EPA expects owners and operators will benefit financially, however, the EPA does not know to what extent. The EPA expects there will be savings and/or income generated through participation in emergency demand response programs and peak shaving operation, but the EPA has not accounted for any potential revenue in estimating the costs and benefits of the proposed amendments. It is uncertain how frequently stationary emergency engines would operate if they are called upon. Other factors, such as the annual revenue from demand response programs (which varies), are also uncertain making it problematic to estimate the economic benefit of such programs. As such, the EPA has not estimated any costs associated with the emergency engine amendments.

4.2.3 Proposed Amendment - Non-Emergency Stationary SI RICE Greater than 500 HP Located at Area Sources

4.2.3.1. Background

The EPA is also proposing to amend the requirements that apply to existing stationary non-emergency 4 stroke SI RICE greater than 500 HP located at area sources of HAP emissions, which are generally natural gas fired engines. Currently, the RICE NESHAP requires owners and operators of such engines to 1) either meet a CO concentration limit of 47 parts ppmvd at 15 percent O2 or reduce emissions of CO by 93 percent or more, if the engines are 4SLB; and 2) to meet a formaldehyde concentration limit of 2.7 ppmvd at 15 percent O2 or reduce formaldehyde emissions by 76 percent or more, if the engines are 4SRB. In both cases, the EPA expects that the standards would be met using aftertreatment; oxidation catalysts for 4SLB engines and NSCR for 4SRB engines. In addition to these emission requirements, owners and operators of existing stationary 4-stroke engines greater than 500 HP at area sources are also subject to monitoring, testing, recordkeeping and reporting requirements.

After the final requirements for existing stationary SI engines greater than 500 HP at area sources were published on August 20, 2010 (75 FR 51570), the EPA received petitions from Exterran (EPA-HQ-OAR-2008-0708-0581), the American Petroleum Institute (EPA-HQ-OAR-2008-0708-0582), the Interstate Natural Gas Association of America (EPA-HQ-OAR-2008-0708-0584), and the Gas Processors Association (EPA-HQ-OAR-2008-0708-0587) requesting that the EPA reconsider the requirements of the final rule. The petitioners expressed many similar concerns. As relevant to this rulemaking, petitioners stated that the EPA did not take into account the difference in population density and subsequently did not consider the difference in health impacts in remote versus more heavily populated locations. In the petitioner's opinion, there should be less concern about engines that are located farther away from people; the petitioners believed that the EPA has substantial latitude in requiring less stringent standards for owners and operators of stationary engines in remote areas.

While the EPA does not share all of the views of the petitioners regarding the difference between engines based on their location, the EPA does believe that it is reasonable to create a subcategory of existing stationary SI 4SLB and 4SRB engines above 500 HP located in areas remote from human activity. Engines located in remote areas that are not close to significant human activity may be difficult to access, may not have electricity or communications, and may be unmanned most of the time. The costs of the emission controls, testing, and continuous monitoring requirements may be unreasonable when compared to the HAP emission reductions that would be achieved, considering that the engines are in sparsely populated areas. The EPA believes that establishing a subcategory for SI engines at area sources of HAP located in sparsely populated areas accomplishes the agency’s goals and is adequate in protecting public health.

The EPA is proposing to subcategorize sparsely populated engines using the existing DOT pipeline classification system. This system classifies locations based on their distance to pipelines covered by the Pipeline and Hazardous Materials Safety Administration safety regulations. The DOT system defines a class location unit as an onshore area that extends 220 yards or 200 meters on either side of the centerline of any continuous 1-mile (1.6 kilometers) length of pipeline. The DOT approach further classifies pipeline locations into Class 1 through Class 4 locations based on the number of buildings intended for human occupancy. A Class 1 location is defined as an offshore area or any class location unit that has 10 or fewer buildings intended for human occupancy. The DOT classification system also has special provisions for locations that lie within 100 yards (91 meters) of either a building or a small, well-defined outside area (such as a playground, recreation area, outdoor theater, or other place of public assembly) that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12-month period, and for class location units where buildings with four or more stories above ground are prevalent. To be considered remote, a source could not fall under one of these special provisions.

Stakeholders from the oil and gas industry have indicated to the EPA that the DOT system is well-established and there would be substantial overlap between engines affected by the rule and covered by the DOT pipeline classification system. Incorporating this approach would also create harmonization between the EPA and DOT and would reduce the implementation and enforcement burden for states. Implementation for affected sources would also be less burdensome because the system is already in place and used by industry and covers the majority of these engines. Stakeholders have indicated they are required to review the class location status of pipeline segments annually. The EPA believes this approach is reasonable for defining the subcategory of remote engines for those engines that are associated with natural gas pipelines. For those engines not associated with pipelines, the EPA is using similar criteria. An engine would be considered to be in sparsely populated areas if within 0.25 mile radius of the engine there are 5 or fewer buildings intended for human occupancy. EPA requests comment on whether the use of these DOT classifications are appropriate for airborne emissions and whether, to be considered remote, an engine not associated with a natural gas pipeline should also need to be farther than 100 yards (91 meters) of either a building or a small, well-defined outside area (such as a playground, recreation area, outdoor theater, or other place of public assembly) that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12-month period.

The EPA is proposing management practices as generally available control technologies for existing stationary SI 4SLB and 4SRB area source non-emergency engines located in sparsely populated areas. Given the remote location of the engines from human activity, the EPA believes that it is appropriate not to include requirements that would necessitate aftertreatment and extensive testing and monitoring. The EPA has previously estimated that the costs of oxidation catalyst for existing 4SLB and 4SRB engines above 500 HP at area sources are $310 and $150 million, for capital and annual costs, respectively. The capital and annual costs of the RICE NESHAP for existing 4SLB and 4SRB engines above 500 HP at area sources would be $30 million and $12 million, respectively, if these proposed amendments are incorporated into the rule. Creating a subcategory of these engines for the ones located in sparsely populated areas and not mandating emission controls would significantly reduce the cost of the rule for such engines.

For existing stationary SI 4SLB and 4SRB area source non-emergency engines that are located in populated areas, the EPA is proposing an equipment standard that requires the installation and operation of a catalyst that will have to be tested initially and annually to ensure that the catalyst is working properly and reducing emissions as required. In addition, these units will be required to have devices to shut down the engine if the catalyst is exposed to dangerous temperatures or have continuous monitoring equipment installed to record catalyst inlet temperatures. The EPA is proposing shorter test duration and less rigorous methods than currently required while still ensuring that HAP reductions remain at expected levels for these engines located in populated areas. The specific amendments the EPA is proposing are discussed below.

4.2.3.2. What are the Proposed Amendments?

Owners and operators of engines in sparsely populated areas would have to conduct a review of the surrounding area every 12 months to determine if the nearby population has changedIf the engine no longer meets the criteria for a sparsely populated area the owner and operator must within 1 year comply with the emission standards specified below for populated areas. The EPA requests comment on whether engines that are not associated with pipelines should be required to conduct the review less frequently than every 12 months.

Owners and operators of existing stationary 4SLB and 4SRB greater than 500 HP at area sources that are in sparsely populated areas as described above would be required to perform the following:

- Change oil and filter every 1,440 hours of operation or annually, whichever comes first;

- Inspect spark plugs every 1,440 hours of operation or annually, whichever comes first, and replace as necessary; and

- Inspect all hoses and belts every 1,440 hours of operation or annually, whichever comes first, and replace as necessary.

Sources have the option to use an oil analysis program as described in §63.6625(i) of the rule in order to extend the specified oil change requirement. The oil analysis must be performed at the same frequency specified for changing the oil in Table 2d of the rule. The analysis program must at a minimum analyze the following three parameters: Total Acid Number, viscosity, and percent water content. The condemning limits for these parameters are as follows: Total Acid Number increases by more than 3.0 milligrams of potassium hydroxide per gram from Total Acid Number of the oil when new; viscosity of the oil has changed by more than 20 percent from the viscosity of the oil when new; or percent water content (by volume) is greater than 0.5. If all of these condemning limits are not exceeded, the engine owner or operator is not required to change the oil. If any of the limits are exceeded, the engine owner or operator must change the oil within 2 days of receiving the results of the analysis; if the engine is not in operation when the results of the analysis are received, the engine owner or operator must change the oil within 2 days or before commencing operation, whichever is later. The owner or operator must keep records of the parameters that are analyzed as part of the program, the results of the analysis, and the oil changes for the engine. The analysis program must be part of the maintenance plan for the engine.

Owners and operators of existing stationary 4SLB and 4SRB area source engines above 500 HP in sparsely populated areas would also have to operate and maintain the stationary RICE and aftertreatment control device (if any) according to the manufacturer's emission-related written instructions or develop their own maintenance plan which must provide to the extent practicable for the maintenance and operation of the engine in a manner consistent with good air pollution control practice for minimizing emissions.

For engines in populated areas, i.e., existing stationary 4SLB and 4SRB non-emergency engines greater than 500 HP at area sources that are located on DOT Class 2 through Class 4 pipeline segments or, for engines not associated with pipelines, that do not meet the 0.25 mile radius with 5 or less buildings criteria, the EPA is proposing to adopt an equipment standard requiring the installation of a catalyst to reduce HAP emissions. Owners and operators of existing area source 4SLB non-emergency engines greater than 500 HP in populated areas would be required to install an oxidation catalyst. Owners and operators of existing area source 4SRB non-emergency engines greater than 500 HP in populated areas would be required to install NSCR. Owners and operators must conduct an initial test to demonstrate that the engine achieves at least a 93 percent reduction in CO emissions or a CO concentration level of 47 ppmvd at 15 percent O2, if the engine is a 4SLB engine. Similarly, owners and operators must conduct an initial performance test to demonstrate that the engine achieves at least a 75 percent CO reduction or a 30 percent THC reduction, if the engine is a 4SRB engine. The initial test must consist of three test runs. Each test run must be of at least 15 minute duration, except that each test run conducted using the proposed appendix A to 40 CFR part 63, subpart ZZZZ must consist of one measurement cycle as defined by the method and include at least 2 minutes of test data phase measurement. To measure CO, emission sources must use the CO methods already specified in subpart ZZZZ, or the proposed appendix A to 40 CFR part 63, subpart ZZZZ. The THC testing must be conducted using EPA Method 25A.

The owner or operator of both engine types must also use a high temperature shutdown device that detects if the catalyst inlet temperature is too high, or, alternatively, the owner or operator can monitor the catalyst inlet temperature continuously and maintain the temperature within the range specified in the rule. For 4SLB engines the catalyst inlet temperature must remain at or above 450°F and at or below 1,350°F. For 4SRB engines the temperature range must be greater than or equal to 750°F and less than or equal to 1,250°F at the catalyst inlet.

Owners and operators must in addition to the initial performance test conduct annual checks of the catalyst to ensure proper catalyst activity. The annual check of the catalyst must at a minimum consist of one 15-minute run using the methods discussed above, except that each test run conducted using the proposed appendix A to 40 CFR part 63, subpart ZZZZ must consist of one measurement cycle as defined by the method and include at least 2 minutes of test data phase measurement. Owners and operators of 4SLB engines must demonstrate during the catalyst activity test that the catalyst achieves at least a 93 percent reduction in CO emissions or that the engine exhaust CO emissions are no more than 47 ppmvd at 15 percent O2. Owners and operators of 4SRB engines must demonstrate that their catalyst is reducing CO emissions by 75 percent or more, or alternatively, that THC emissions are being reduced by at least 30 percent during the catalyst activity check.

If the emissions from the engine do not exceed the levels required for the initial test or annual checks of the catalyst, then the catalyst is considered to be working properly. If the emissions exceed the specified pollutant levels in the rule, the exceedance(s) is/are not considered a violation, but the owner or operator would be required to shut down the engine and take appropriate corrective action (e.g., repairs, clean or replace the catalyst, as appropriate). A follow-up test must be conducted within 7 days of the engine being started up again to demonstrate that the emission levels are being met. If the retest shows that the emissions continue to exceed the specified levels, the stationary RICE must again be shut down as soon as safely possible, and the engine may not operate, except for purposes of start-up and testing, until the owner/operator demonstrates through testing that the emissions do not exceed the levels specified.

4.2.3.3 Compliance Date

The EPA has received some questions regarding whether the compliance dates for engines impacted by the 2010 amendments and this proposed reconsideration will be extended. Affected sources that may be impacted by this action have expressed concern about having sufficient time to comply with the rule by the compliance date, which is May 3, 2013, for existing stationary CI RICE and October 19, 2013, for existing stationary SI RICE. Sources impacted by this reconsideration are particularly concerned with compliance in the event that the EPA does not finalize changes that are substantially similar to the changes being proposed in this action. The EPA does not intend to extend the May 3, 2013, and October 19, 2013, compliance dates, because there are many engines that must meet those compliance dates that are not impacted by this reconsideration. However, we note that sources that are affected by the reconsideration and that may need additional time to install controls to comply with the applicable requirements can request up to an additional year to install controls, as specified in 40 CFR 63.6(i).

4.3 What Are the Pollutants Regulated by the Rule?

The proposed reconsideration rule regulates emissions of HAP. Available emissions data show that several HAP, which are formed during the combustion process or which are contained within the fuel burned, are emitted from stationary engines. The HAP which have been measured in emission tests conducted on SI stationary RICE include: formaldehyde, acetaldehyde, acrolein, methanol, benzene, toluene, 1,3-butadiene, 2,2,4-trimethylpentane, hexane, xylene, naphthalene, PAH, methylene chloride, and ethylbenzene. EPA described the health effects of these HAP and other HAP emitted from the operation of stationary RICE in the preamble to 40 CFR part 63, subpart ZZZZ, published on June 15, 2004 (69 FR 33474). These HAP emissions are known to cause, or contribute significantly to air pollution, which may reasonably be anticipated to endanger public health or welfare.

For the standards included in this action, EPA believes that previous determinations regarding the appropriateness of using formaldehyde and carbon monoxide (CO) both in concentration (parts per million (ppm)) levels as surrogates for HAP for stationary RICE are still valid. Consequently, EPA is promulgating CO or formaldehyde standards in order to regulate HAP emissions.

In addition to reducing HAP, the emission control technologies that will be installed on stationary RICE to reduce HAP will also reduce CO and VOC, and for rich burn engines will also reduce NOx.

4.4 Cost Impacts

4.4.1 Introduction

EPA has determined that oxidation catalysts for two-stroke lean burn (2SLB) and four-stroke lean burn (4SLB) engines, and non-selective catalytic reduction (NSCR) for four-stroke rich burn (4SRB) engines are applicable controls for HAP reduction from existing stationary SI RICE. To determine the capital and annual costs for these control technologies, equipment cost information was obtained from industry groups[2] and vendors and manufacturers of SI engine control technology. In some cases, the industry groups provided a breakdown of the capital and annual cost components for each of the retrofit options. Using this cost data, annualized cost and capital cost equations for oxidation catalysts and NSCR were developed.

4.4.2 Control Cost Methodology

The following sections describe the methodology used to derive the total capital and total annual costs for each of the control technology options. These methodologies were used to calculate total capital and total annual costs when only purchased equipment costs were available (e.g., vendor equipment costs). The methodologies were not used for cost data provided by

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[2] Reciprocating Internal Combustion Engine National Emission Standards for Hazardous Air Pollutants (RICE NESHAP) Proposed Revisions – Emission Control Costs Analysis Background for “Above the Floor” Emission Controls for Natural Gas-Fired RICE, Innovative Environmental Solutions Inc., October 2009. (EPA-HQ-OAR-2008-0708-0279).

industry groups because they included a breakdown of the actual total capital and total annual costs. A summary of the methodologies, equations, and assumptions used to estimate the total capital and total annual costs for some of the cost data are described in the following sections.

4.4.2.1 Total Capital Costs

The total capital cost includes the direct and indirect costs of purchasing and installing the control equipment. The direct cost includes the cost of purchasing the equipment and instrumentation, cost of shipping, and the cost of installing the control equipment. The indirect cost includes the costs for engineering, contractor fees, testing costs, and also includes costs for contingencies, such as additional modifications, or delays in startup. The total capital cost equation can be summarized as follows:

Total Capital Cost (TCC) = Direct Costs (DC) + Indirect Costs (IC)

The direct costs include the costs of purchasing and installing the control equipment and can be summarized using the following equation;

DC = Purchased Equipment Cost (PEC) + Direct Installation Costs (DIC).

A summary of the cost assumptions for PEC includes the following:

- Control Device and Auxiliary Equipment (EC);
- Instrumentation (10% of EC);
- Sales Tax (3% of EC);
- Freight (5% of EC);

and can be summarized as:

PEC = 118% EC.

A summary of the cost assumptions for DIC includes the following:

- Foundations and Supports (8% of PEC);
- Handling and Erection (14% of PEC);
- Electrical (4% of PEC);
- Piping (2% of PEC);

- Insulation for Ductwork (1% of PEC);
- Painting (1% of PEC);

and can be summarized as:

DIC = 30% PEC = 0.3 PEC.

Therefore, the direct costs can be simplified using the following equation:

DC = PEC + 0.3 PEC = 1.3 PEC.

The indirect costs include the costs of engineering and contractor fees and contingencies and can be summarized using the following equation:

IC = Indirect Installation Costs (ICC) + Contingencies (C).

A summary of the cost assumptions for ICC includes the following:

- Engineering (10% of PEC);
- Construction and Field Expenses (5% of PEC);
- Contractor Fees (10% of PEC);
- Startup (2% of PEC);
- Performance Test (1% of PEC);

and can be summarized as:

IIC = 28% PEC = 0.28 PEC.

A summary of the cost assumptions for C includes the following:

- Equipment Redesign and Modifications;
- Cost Escalations;
- Delays in Startup;

and is assumed to be:

C = 3% PEC = 0.03 PEC.

Therefore, the IC can be summarized using the following equation:

$$IC = 0.28\ PEC + 0.03\ PEC = 0.31\ PEC,$$

and the simplified TCC equation can be expressed as:

$$TCC = 1.3\ PEC + 0.31\ PEC = 1.61\ PEC = 1.61\ (1.18\ EC) = 1.9\ EC$$

4.4.2.2 Total Annual Costs

The total annual cost includes the direct and indirect annual costs of operating and maintaining the control equipment. The direct annual cost includes the cost of the utilities, operating labor, and control device cleaning and maintenance. The indirect annual cost includes the overhead costs such as spare parts for the control equipment, administrative charges, and the capital recovery of the control technology. The total annual cost equation can be summarized as follows:

Total Annual Cost (TAC) = Direct Annual Costs (DAC) + Indirect Annual Costs (IAC).

The DAC includes the following parameters:

- Utilities;
- Operating Labor;
- Maintenance;
- Annual Compliance Test;
- Catalyst Cleaning;
- Catalyst Replacement;
- Catalyst Disposal.

The IAC includes the following parameters:

- Overhead;
- Fuel Penalty;
- Property Tax;
- Insurance;
- Administrative Charges;

- Capital Recovery = $\{I(1+I)^n/((1+I)^n-1)*TCC\}$ where I is the interest rate, and n is the equipment life.

To calculate DAC, the costs were broken up into three separate costs: operation and maintenance materials cost, operation and maintenance labor cost, and the cost for annual performance testing or downtime or allowance for catalyst washing. Actual annual cost data from the industry groups were used to estimate the DAC for each of the control technologies. The IAC was broken up into three separate costs: administrative, fuel penalty, and capital recovery. Again, cost data from the industry groups was used to estimate these costs for each of the control technologies. No fuel penalty was estimated for the oxidation catalyst control technologies, because this control technology does not increase the fuel usage of the SI engine.

4.4.3 Control Cost Equations

Control cost equations were developed for 2SLB oxidation catalyst, 4SLB oxidation catalyst, and a NSCR for 4SRB engines using the total capital cost and total annual cost data for each control technology. Control cost equations for 2SLB and 4SLB oxidation catalysts were developed separately because the 2SLB oxidation catalyst requires a premium catalyst to reduce the HAP compounds because of the low exhaust temperature of 2SLB engines.

4.4.3.1 2SLB Oxidation Catalyst

The 2SLB oxidation catalyst is an effective control technology that reduces HAP emissions from a 2SLB SI engine by oxidizing organic compounds using a catalyst. The oxidation catalyst unit contains a honeycomb-like structure or substrate with a large surface area that is coated with a premium active catalyst layer such as platinum or palladium. The oxidation catalyst works by oxidizing carbon monoxide (CO) and gaseous hydrocarbons (HAP) in the exhaust gas to carbon dioxide (CO_2) and water. The reduction of CO and HAP varies depending on the type of catalyst used and the exhaust temperature of the pollutant stream.

The cost of retrofitting an oxidation catalyst to an existing 2SLB engine was estimated using cost data obtained from vendors and industry groups covering engines ranging from 58 horsepower (HP) to 4,670 HP. An equipment life of 10 years and an interest rate of 7 percent were used to estimate the capital recovery of the control technology and the fuel penalty was assumed to be negligible. The cost equations are presented in 2009 dollars.

The total annualized cost equation for retrofitting an oxidation catalyst on a 2SLB engine was estimated to be:

$$\text{2SLB Oxidation Catalyst Total Annual Cost} = \$11.4 \times HP + \$13{,}928$$

where

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.8046, which shows the data fits the equation closely. Therefore, this equation was used to estimate annualized cost for an oxidation catalyst on a 2SLB engine.

The total capital cost equation for retrofitting an oxidation catalyst on a 2SLB engine was estimated to be:

2SLB Oxidation Catalyst Total Capital Cost = $47.1 x HP + $41,603

where

HP = engine size in HP.

4.4.3.2 4SLB Oxidation Catalyst

The 4SLB oxidation catalyst is an effective control technology that reduces HAP emissions from a 4SLB SI engine by oxidizing organic compounds using a catalyst. The oxidation catalyst unit contains a honeycomb-like structure or substrate with a large surface area that is coated with a premium active catalyst layer such as platinum or palladium. The oxidation catalyst works by oxidizing CO and gaseous hydrocarbons (HAP) in the exhaust gas to CO_2 and water. The reductions of CO and HAP vary depending on the type of catalyst used and the exhaust temperature of the pollutant stream.

The cost of retrofitting an oxidation catalyst to an existing 4SLB engine was estimated using cost data obtained from vendors and industry groups covering engines ranging from 400 HP to 8,000 HP. Again, an equipment life of 10 years and an interest rate of 7 percent were used to estimate the capital recovery of the control technology and the fuel penalty was assumed to be negligible. The cost equations are presented in 2009 dollars.

The total annualized cost equation for retrofitting an oxidation catalyst on a 4SLB engine was estimated to be:

4SLB Oxidation Catalyst Total Annual Cost = $1.81 x HP + $3,442

where

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.9779, which shows the data fits the equation very closely. Therefore, this equation was used to estimate annualized cost for an oxidation catalyst on a 4SLB engine.

The total capital cost equation for retrofitting an oxidation catalyst on a 4SLB SI engine was estimated to be:

$$\text{4SLB Oxidation Catalyst Total Capital Cost} = \$12.8 \times \text{HP} + \$3{,}069$$

where

HP = engine size in HP.

A summary of the cost calculations, regression analyses, and graphical representations of the annual and capital cost data are presented in Appendix A of the cost memo that is the basis for the cost data presented in this RIA.[3]

4.4.3.3 Non-Selective Catalytic Reduction

The NSCR or three-way catalyst is used to control HAP emissions from 4SRB engines. In addition to HAP reductions, NSCR also reduces the emissions of nitrogen oxides (NOx), CO, and other hydrocarbons (HC). The reduction of HAP and CO takes place through an oxidation reaction that converts HAP to CO_2 and water and converts CO to CO_2. The conversion of NOx takes place through a reduction of the NOx to nitrogen gas and oxygen.

The cost of retrofitting an NSCR on an existing 4SRB engine was estimated based on cost data received from vendors and industry groups. A linear regression analysis was done on the data set and the linear equation for annualized cost was;

$$\text{NSCR Annual Cost} = \$4.77 \times \text{HP} + \$5{,}679$$

where

HP = engine size in HP.

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[3] Memorandum from Bradley Nelson, EC/R to Melanie King, EPA. OAQPS/SPPD/ESG. Impacts Associated with NESHAP for Existing Stationary SI RICE. June 29, 2010.

The linear equation has a correlation coefficient of 0.7987, which shows an acceptable representation of the cost data. Therefore, this equation was used to estimate annualized cost for retrofitting the NSCR control technology on 4SRB engines.

The capital cost equation for retrofitting an air-to-fuel ratio (AFR) controller and NSCR on a 4SRB engine was estimated to be:

$$\text{NSCR Capital Cost} = \$24.9 \times \text{HP} + \$13{,}118$$

where

HP = engine size in HP.

4.4.4 Summary

Table 4-1 presents a summary of the annual and capital control costs as a function of engine size for the control technologies applicable to existing stationary SI engines, as discussed in this memorandum.

Table 4-1. Summary of Annual and Capital Costs Equations for Existing Stationary SI Engines

HAP Control Device	Annual Cost ($2009)	Capital Cost ($2009)
2SLB Oxidation Catalyst	$11.4 x HP + $13,928	$47.1 x HP + $41,603
4SLB Oxidation Catalyst	$1.81 x HP + $3,442	$12.8 x HP + $3,069
NSCR	$4.77 x HP + $5,679	$24.9 x HP + $13,118

A summary of the annual and capital costs associated with the rule and obtained using the methodology described above are presented in Tables 4-2 to 4-5 below.[4] These costs are used as input to the economic impact as well as the small entity analysis.

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[4] Memorandum from Bradley Nelson, EC/R to Melanie King, EPA. OAQPS/SPPD/ESG. Impacts Associated with NESHAP for Existing Stationary SI RICE. June 29, 2010.

Table 4-2. Summary of Major Source and Area Source Costs for the SI RICE NESHAP[a]

Size Range (HP)	Capital Control Cost	Annual Control Cost	Initial Test	Record-keeping	Reporting	Monitoring—Capital Cost	Monitoring—Annual Cost	Total Annual Costs	Total Capital Costs
Major Sources									
25–50	$0	$0	$0	$4,060,795	$0	$0	$0	$4,060,795	$0
50–100	$0	$0	$0	$1,087,540	$0	$0	$0	$1,087,540	$0
100–175	$48,502,361	$37,071,061	$15,971,384	$1,721,899	$5,725,314	$0	$0	$60,489,657	$48,502,361
175–300	$13,225,919	$8,382,568	$3,442,648	$371,157	$1,234,097	$0	$0	$13,430,470	$13,225,919
300–500	$10,934,795	$5,562,872	$2,123,326	$228,919	$761,155	$0	$0	$8,676,262	$10,934,795
500–600	$0	$0	$0	$0	$0	$0	$0	$0	$0
600–750	$0	$0	$0	$0	$0	$0	$0	$0	$0
>750	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	**$72,663,076**	**$51,016,500**	**$21,537,358**	**$7,470,310**	**$7,720,566**	**$0**	**$0**	**$87,744,734**	**$72,663,076**
Area Sources									
25–50	$0	$0	$0	$6,668,944	$0	$0	$0	$6,668,944	$0
50–100	$0	$0	$0	$2,868,511	$0	$0	$0	$2,868,511	$0
100–175	$0	$0	$0	$3,529,711	$0	$0	$0	$3,529,711	$0
175–300	$0	$0	$0	$1,264,799	$0	$0	$0	$1,264,799	$0
300–500	$0	$0	$0	$908,913	$0	$0	$0	$908,913	$0
500–600	$7,547,433	$2,662,805	$248,366	$454,493	$1,26,426	0	0	$3,492,090	$7,547,433
600–750	$1,522,236	$505,221	$44,323	$77,882	$22,562	0	0	$649,988	$1,522,236
>750	$21,075,418	$6,214,397	$472,244	$829,795	$240,387	0	0	$7,756,823	$21,075,418
Total	**$30,145,088**	**$9,382,423**	**$764,933**	**$16,603,048**	**$389,375**	**0**	**0**	**$27,139,780**	**$30,145,088**
Grand Total									
Total	**$102.808,163**	**$60,398,923**	**$22,302,292**	**$24,073,358**	**$8,106,972**	**0**	**0**	**$114,884,514**	**$102,808.163**

[a] Costs are presented in 2009 dollars.

Table 4-3. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP[a]

		Major Source		Area Source		Total (Major + Area)	
NAICS		**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**
2211	Electric Power Generation	$52,905,258	$63,062,494	$11,698,144	$12,138,277	$64,603,403	$75,200,772
48621	Natural Gas Transmission	$1,484,494	$1,462,530	$13,718,381	$6,142,839	$15,202,876	$7,605,369
211111	Crude Petroleum & NG Production	$4,561,236	$6,138,383	$71,439	$951,462	$4,632,675	$7,089,844
211112	Natural Gas Liquid Producers	$4,561,236	$6,138,383	$71,439	$951,462	$4,632,675	$7,089,844
92811	National Security	$5,878,362	$7,006,944	$1, 299,794	$1,348,697	$7,178,1566	$8,355,641
335312	Hydro Power Units	$0	$25,248	$0	$37,872	$0	$63,120
335312	Irrigation Sets	$3,025,050	$3,230,856	$3,285,990	$4,999,041	$6,310,940	$8,229,896
333992	Welders	$247,440	$679,896	$0	$570,130	$247,440	$1,250,027
	Total	$72,663,076	$87,744,734	$30,145,088	$27,139,780	**$102,808,163**	**$114,884,514**

[a] Costs are presented in 2009 dollars.

Table 4-4. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Size[a]

	Major Source		Area Source		Total (Major + Area)	
NAICS	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**
Electric Power Generation (2211)						
25–50 hp	$0	$2,758,459	$0	$4,137,688	$0	$6,896,147
50–100 hp	$0	$606,144	$0	$909,215	$0	$1,515,359
100–175 hp	$33,868,173	$42,238,648	$0	$1,803,548	$33,868,173	$44,042,196
175–300 hp	$10,603,849	$10,767,847	$0	$446,361	$10,603,849	$11,214,209
300–500 hp	$8,433,236	$6,691,397	$0	$264,820	$8,433,236	$6,956,217
500–600 hp	$0	$0	$2,543,944	$1,177,047	$2,543,944	$1,177,047
600–750 hp	$0	$0	$515,514	$220,122	$515,514	$220,122
>750 hp	$0	$0	$8,638,687	$3,179,475	$8,638,687	$3,179,475
Total Electric Power Generation 2211	$52,905,258	$63,062,494	$11,698,144	$12,138,277	$64,603,403	$75,200,772
Natural Gas Transmission (48621)						
25–50 hp	$0	$102	$0	$1,934	$0	$2,036
50–100 hp	$0	$4,872	$0	$92,571	$0	$97,443
100–175 hp	$301,721	$376,291	$0	$203,518	$301,721	$579,809
175–300 hp	$643,157	$653,104	$0	$342,928	$643,157	$996,032
300–500 hp	$539,617	$428,162	$0	$214,637	$539,617	$642,799
500–600 hp	$0	$0	$1,925,560	$890,929	$1,925,560	$890,929
600–750 hp	$0	$0	$949,443	$405,408	$949,443	$405,408
>750 hp	$0	$0	$10,843,377	$3,990,913	$10,843,377	$3,990,913
Total Natural Gas Transmission (48621)	$1,484,494	$1,462,530	$13,781,381	$6,142,839	$15,202,876	$7,605,369
Crude Petroleum & NG Production (211111)						
25–50 hp	$0	$388,115	$0	$582,173	$0	$970,288
50–100 hp	$0	$66,698	$0	$100,047	$0	$166,744
100–175 hp	$4,549,775	$5,674,246	$0	$242,285	$4,549,775	$5,916,531

(continued)

Table 4-4. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Size[a] (continued)

	Major Source		Area Source		Total (Major + Area)	
NAICS	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**
175–300 hp	$1,037	$1,053	$0	$44	$1,037	$1,096
300–500 hp	$10,424	$8,271	$0	$327	$10,424	$8,598
500–600 hp	$0	$0	$3,102	$1,435	$3.102	$1,435
600–750 hp	$0	$0	$0	$0	$0	$0
>750 hp	$0	$0	$68,337	$25,151	$68,337	$25,151
Total Crude Petroleum & NG Production (211111)	$4,561,236	$6,138,383	$71,439	$951,462	$4,632,675	$7,089,844
Natural Gas Liquid Producers (211112)						
25–50 hp	$0	$388,115	$0	$582,173	$0	$970,288
50–100 hp	$0	$66,698	$0	$100,047	$0	$166,744
100–175 hp	$4,549,775	$5,674,246	$0	$242,285	$4,549,775	$5,916,531
175–300 hp	$1,037	$1,053	$0	$44	$1,037	$1,096
300–500 hp	$10,424	$8,271	$0	$327	$10,424	$8,598
500–600 hp	$0	$0	$3,102	$1,435	$3,102	$1,435
600–750 hp	$0	$0	$0	$0	$0	$0
>750 hp	$0	$0	$68,337	$25,151	$68,337	$25,151
Total Natural Gas Liquid Producers (211112)	$4,561,236	$6,138,383	$71,439	$951,462	$4,632,675	$7,089,844
National Security (92811)						
25–50 hp	$0	$306,495	$0	$459,743	$0	$766,239
50–100 hp	$0	$67,349	$0	$101,024	$0	$168,373
100–175 hp	$3,763,130	$4,693,183	$0	$200,394	$3,763,130	$4,893,577
175–300 hp	$1,178,205	$1,196,427	$0	$49,596	$1,178,205	$1,246,023
300–500 hp	$937,026	$743,489	$0	$29,424	$937,026	$772,913
500–600 hp	$0	$0	$282,660	$130,783	$282,660	$130,783

(continued)

Table 4-4. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Size[a] (continued)

	Major Source		Area Source		Total (Major + Area)	
NAICS	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**
600–750 hp	$0	$0	$57,279	$24,458	$57,279	$24,458
>750 hp	$0	$0	$959,854	$353,275	$959,854	$353,275
Total National Security (92811)	$5,878,362	$7,006,944	$1,299,794,	$1,348,697	$7,178,156	$8,355,641
Hydro Power Units (335312)						
25–50 hp	$0	$22,688	$0	$34,032	$0	$56,721
50–100 hp	$0	$2,560	$0	$3,840	$0	$6,399
100–175 hp	$0	$0	$0	$0	$0	$0
175–300 hp	$0	$0	$0	$0	$0	$0
300–500 hp	$0	$0	$0	$0	$0	$0
500–600 hp	$0	$0	$0	$0	$0	$0
600–750 hp	$0	$0	$0	$0	$0	$0
>750 hp	$0	$0	$0	$0	$0	$0
Total Hydro Power Units (335312)	$0	$25,248	$0	$37,872	$0	$63,120
Irrigation Sets (335312)						
25–50 hp	$0	$32,913	$0	$625,338	$0	$658,251
50–100 hp	$0	$65,825	$0	$1,250,677	$0	$1,316,502
100–175 hp	$1,222,348	$1,524,449	$0	$824,505	$1,222,348	$2,348,954
175–300 hp	$798,634	$810,986	$0	$425,827	$798,634	$1,236,813
300–500 hp	$1,004,068	$796,683	$0	$399,376	$1,004,068	$1,196,060
500–600 hp	$0	$0	$2,789,064	$1,290,460	$2,789,064	$1,290,460
600–750 hp	$0	$0	$0	$0	$0	$0
>750 hp	$0	$0	$496,827	$182,857	$496,827	$182,857
Total Irrigation Sets (335312)	$3,025,050	$3,230,856	$3,285,890	$4,999,041	$6,310,940	$8,229,896

(continued)

Table 4-4. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Size[a] (continued)

	Major Source		Area Source		Total (Major + Area)	
NAICS	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**	**Capital Cost**	**Annual Cost**
Welders (333992)						
25–50 hp	$0	$163,908	$0	$245,862	$0	$409,771
50–100 hp	$0	$207,394	$0	$311,091	$0	$518,485
100–175 hp	$247,440	$308,594	$0	$13,177	$247,440	$321,771
175–300 hp	$0	$0	$0	$0	$0	$0
300–500 hp	$0	$0	$0	$0	$0	$0
500–600 hp	$0	$0	$0	$0	$0	$0
600–750 hp	$0	$0	$0	$0	$0	$0
>750 hp	$0	$0	$0	$0	$0	$0
Total Welders (333992)	$247,440	$679,896	$0	$570,130	$247,440	$1,250,027
Total	$72,663,076	$87,744,734	$30,145,088	$27,139,780	$102,808,163	$114,884,514

[a] Costs are presented in 2009 dollars.

Table 4-5. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Number of Engines[a]

	Number of Engines			Total (Major + Area)	
NAICS	**Major**	**Area**	**Total**	**Capital Cost**	**Annual Cost**
Electric Power Generation (2211)					
25–50 hp	37,933	56,900	94,833	$0	$6,896,147
50–100 hp	8,336	12,503	20,839	$0	$1,515,359
100–175 hp	16,534	24,802	41,336	$33,868,173	$44,042,196
175–300 hp	4,092	6,138	10,230	$10,603,849	$11,214,209
300–500 hp	2,428	3,642	6,070	$8,433,236	$6,956,217
500–600 hp	0	2,107	2,107	$2,543,944	$1,177,047
600–750 hp	0	363	363	$515,944	$220,122
>750 hp	0	4,677	4,677	$8,638,687	$3,179,475
Total Electric Power Generation (2211)	69,323	111,132	180,455	$64,603,403	$75,200,772
Natural Gas Transmission (48621)					
25–50 hp	1	27	28	$0	$2,036
50–100 hp	67	1,273	1,340	$0	$97,443
100–175 hp	147	2,799	2,946	$301,721	$579,809
175–300 hp	248	4,716	4,964	$643,157	$996,032
300–500 hp	155	2,952	3,107	$539,617	$642,799
500–600 hp	0	1,595	1,595	$1,925,560	$890,929
600–750 hp	0	668	668	$949,443	$405,408
>750 hp	0	5,871	5,871	$10,843,377	$3,990,913
Total Natural Gas Transmission (48621)	619	19,899	20,519	$15,202,876	$7,605,369
Crude Petroleum & NG Production (211111)					
25–50 hp	5,337	8,006	13,343	$0	$970,288
50–100 hp	917	1,376	2,293	$0	$166,744
100–175 hp	2,221	3,332	5,553	$4,549,775	$5,916,531

(continued)

Table 4-5. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Number of Engines[a] (continued)

	Number of Engines			Total (Major + Area)	
NAICS	**Major**	**Area**	**Total**	**Capital Cost**	**Annual Cost**
175–300 hp	0	1	1	$1,037	$1,096
300–500 hp	3	5	8	$10,424	$8,598
500–600 hp	0	3	3	$3,102	$1,435
600–750 hp	0	0	0	$0	$0
>750 hp	0	37	37	$68,337	$25,151
Total Crude Petroleum & NG Production (211111)	8,479	12,758	21,237	$4,632,675	$7,089,844
Natural Gas Liquid Producers (211112)					
25–50 hp	5,337	8,006	13,343	$0	$970,288
50–100 hp	917	1,376	2,293	$0	$166,744
100–175 hp	2,221	3,332	5,553	$4,549,775	$5,916,531
175–300 hp	0	1	1	$1,037	$1,096
300–500 hp	3	5	8	$10,424	$8,598
500–600 hp	0	3	3	$3,102	$1,435
600–750 hp	0	0	0	$0	$0
>750 hp	0	37	37	$68,337	$25,151
Total Natural Gas Liquid Producers (211112)	8,479	12,758	21,237	$4,632,675	$7,089,844
National Security (92811)					
25–50 hp	4,215	6,322	10,537	$0	$766,239
50–100 hp	926	1,389	2,315	$0	$168,373
100–175 hp	1,837	2,756	4,593	$3,763,130	$4,893,577
175–300 hp	455	682	1,137	$1,178,205	$1,246,023
300–500 hp	270	404	674	$937,026	$772,913
500–600 hp	0	234	234	$282,660	$130,783

(continued)

Table 4-5. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Number of Engines[a] (continued)

	Number of Engines			Total (Major + Area)	
NAICS	Major	Area	Total	Capital Cost	Annual Cost
600–750 hp	0	40	40	$57,279	$24,458
>750 hp	0	520	520	$959.854	$353,275
Total Natural Gas Liquid Producers (211112)	7,702	12,347	20,050	$7,178,156	$8,355,641
Hydro Power Units (335312)					
25–50 hp	312	468	780	$0	$56,721
50–100 hp	35	53	88	$0	$6,399
100–175 hp	0	0	0	$0	$0
175–300 hp	0	0	0	$0	$0
300–500 hp	0	0	0	$0	$0
500–600 hp	0	0	0	$0	$0
600–750 hp	0	0	0	$0	$0
>750 hp	0	0	0	$0	$0
Total Hydro Power Units (335312)	347	521	868	$0	$63,120
Irrigation Sets (335312)					
25–50 hp	453	8,599	9,052	$0	$658,251
50–100 hp	905	17,199	18,104	$0	$1,316,502
100–175 hp	597	11,338	11,935	$1,222,348	$2,348,954
175–300 hp	308	5,856	6,164	$798,634	$1,236,813
300–500 hp	289	5,492	5,781	$1,004,068	$1,196,060
500–600 hp	0	2,310	2,310	$2,789,064	$1,290,460
600–750 hp	0	0	0	$0	$0
>750 hp	0	269	269	$496,827	$182857
Total Irrigation Sets (335312)	2,552	51,063	53,615	$6,310,940	$8,229,896

(continued)

Table 4-5. Summary of Major Source and Area Source NAICS Costs for the SI RICE NESHAP, by Number of Engines[a] (continued)

	Number of Engines			Total (Major + Area)	
NAICS	Major	Area	Total	Capital Cost	Annual Cost
Welders (333992)					
25–50 hp	2,254	3,381	5,635	$0	$409,771
50–100 hp	2,852	4,278	7,130	$0	$518,485
100–175 hp	121	181	302	$247,440	$321,771
175–300 hp	0	0	0	$0	$0
300–500 hp	0	0	0	$0	$0
500–600 hp	0	0	0	$0	$0
600–750 hp	0	0	0	$0	$0
>750 hp	0	0	0	$0	$0
Total Welders (333992)	5,227	7,840	13,067	$247,440	$1,250,027
Total	102,729	228,319	331,047	$382,802,298	$253,374,939

[1] Costs are presented in 2009 dollars.

4.4.5 Caveats and Uncertainties in the Cost Estimates

* Current knowledge about NOx control techniques and costs is applied in this study. Advances such as alternative catalyst formulations may occur between now and when sources comply with this rulemaking that may lower costs. Scale economies can also lower per unit production costs as the market for these NOx control techniques expands.

* The alternative control techniques and corresponding emission reductions and costs may not apply to every unit within the source category. Many factors influence the performance and cost of any control technique. Because control technology references typically evaluate average retrofit situations, costs may be underestimated for the fraction of the source population with difficult to retrofit conditions. Difficult to retrofit conditions may be less of an issue for RICEs than for other point sources, however.

* NOx control efficiency and cost estimates associated with source category-control strategy combinations are represented as point estimates. In practice, control effectiveness and costs will vary by engine.

4.5 Baseline Emissions and Emission Reductions

The baseline emissions, emissions factors and emissions reductions associated with the proposed reconsideration rule are provided in the tables below. Baseline emissions are estimated for 2013 using the emissions dataset generated for the final SI RICE rule in 2010. The baseline emissions thus assume the final SI RICE rule has not been implemented. Emissions are in tons per year.

Table 4-6. Summary of Major Source and Area Source Baseline Emissions for the SI RICE NESHAP in 2013

	Baseline Emissions (TPY)			
Size Range (HP)	**HAP**	**CO**	**NOx**	**VOC**
Major Sources				
25–50 hp	1,107	28,557	41,751	5,696
50–100 hp	593	15,296	22,363	3,051
100–175 hp	1,721	44,399	64,913	8,855
175–300 hp	641	16,530	24,168	3,297
300–500 hp	666	17,171	25,105	3,425
500–600 hp	0	0	0	0
600–750 hp	0	0	0	0
>750 hp	0	0	0	0
Total	**4,728**	**121,953**	**178,301**	**24,323**
Area Sources				
25–50 hp	1,818	46,898	68,566	9,354
50–100 hp	1,564	40,344	58,985	8,047
100–175 hp	3,529	91,013	133,065	18,153
175–300 hp	2,184	56,331	82,359	11,235
300–500 hp	2,643	68,178	99,679	13,598
500–600 hp	1,830	47,273	69,094	9,415
600–750 hp	383	9,876	14,438	1,969
>750 hp	6,041	155,890	227,890	31,076
Total	**19,993**	**515,803**	**754,077**	**102,846**
Major + Area Total	**24,722**	**637,756**	**932,377**	**127,169**

Table 4-7. Emissions Factors

Engine	HAP (lb/hp-hr)	CO (lb/hp-hr)	NOx (lb/hp-hr)	VOC (lb/hp-hr)	Formaldehyde (lb/hp-hr)
2SLB	5.96×10^{-4}	1.06×10^{-2}	4.18×10^{-2}	3.07×10^{-3}	4.29×10^{-4}
4SLB	5.41×10^{-4}	3.92×10^{-3}	1.15×10^{-2}	2.78×10^{-3}	3.96×10^{-4}
4SRB	2.43×10^{-4}	1.93×10^{-2}	1.47×10^{-2}	1.25×10^{-3}	1.75×10^{-4}

Table 4-8. Summary of Major Source and Area Source Emissions Reductions for the SI RICE NESHAP in 2013

	Emission Reductions (TPY)			
Size Range (HP)	**HAP**	**CO**	**NOx**	**VOC**
Major Sources				
25–50 hp	0	0	0	0
50–100 hp	0	0	0	0
100–175 hp	744	7,124	0	3,826
175–300 hp	277	2,653	0	1,424
300–500 hp	288	2,755	0	1,480
500–600 hp	N/A	N/A	N/A	0
600–750 hp	N/A	N/A	N/A	0
>750 hp	N/A	N/A	N/A	0
Total	**1,308**	**12,532**	**0**	**6,730**
Area Sources				
25–50 hp	0	0	0	0
50–100 hp	0	0	0	0
100–175 hp	0	0	0	0
175–300 hp	0	0	0	0
300–500 hp	0	0	0	0
500–600 hp	101	2,070	2,,063	517
600–750 hp	22	453	452	113
>750 hp	347	7,156	7,133	1,787
Total	**470**	**9,679**	**9,648**	**2,418**
Major + Area Total	**1,778**	**22,211**	**9,648**	**9,147**

Section 5

ECONOMIC IMPACT ANALYSIS, ENERGY IMPACTS, AND SOCIAL COSTS

The EIA provides decision makers with social cost estimates and enhances understanding of how the costs may be distributed across stakeholders (EPA, 2010). Although several economic frameworks can be used to estimate social costs for regulations of this size and sector scope, OAQPS has typically used partial equilibrium market models. However, the current data do not provide sufficient details to develop a market model; the data that are available have little or no sector/firm detail and are reported at the national level. In addition, some sectors have unique market characteristics that make developing partial equilibrium models difficult. Given these constraints, we used the direct compliance costs as a measure of total social costs. In addition, we also provide a qualitative analysis of the proposed reconsidered rule's impact on stakeholder decisions, a qualitative discussion on if unfunded mandates occur as a result of this proposed reconsidered rule, and the potential distribution of social costs between consumers and producers.

5.1 Compliance Costs of the Proposed Reconsidered Rule

EPA's engineering cost analysis estimates the total annualized costs of the proposed reconsidered rule are $115 million (in 2010 dollars) (EC/R, 2012).

The majority of the costs are incurred by the electric power sector (65%). The remaining industries each account for less than 8% of the total annualized cost. The industrial classification for each engine is taken from the Power Systems Research (PSR) database, which is the major source of data for the engines affected by this rule. The PSR database used as a basis for the analyses in this RIA contains information on both mobile and stationary engines, among other data, and does so not only for the U.S. but worldwide. PSR has collected such data for more than 30 years. The Office of Transportation and Air Quality (OTAQ) uses this database frequently in the development of their mobile source rules.

The annualized compliance costs per engine vary by the engine size. For 500 hp engines or less, the annualized per-engine costs are below $371 per engine. Per-engine annualized compliance costs for higher horsepower (hp) engines range up to $2,800.

The proposed reconsidered rule will affect approximately 331,000 existing stationary SI engines. As shown in Figure 5-1, most of the affected engines fall within the 25 to 50 hp category (45%). The next highest categories are 100 to 175 hp (22%) and 50 to 100 hp (16%).

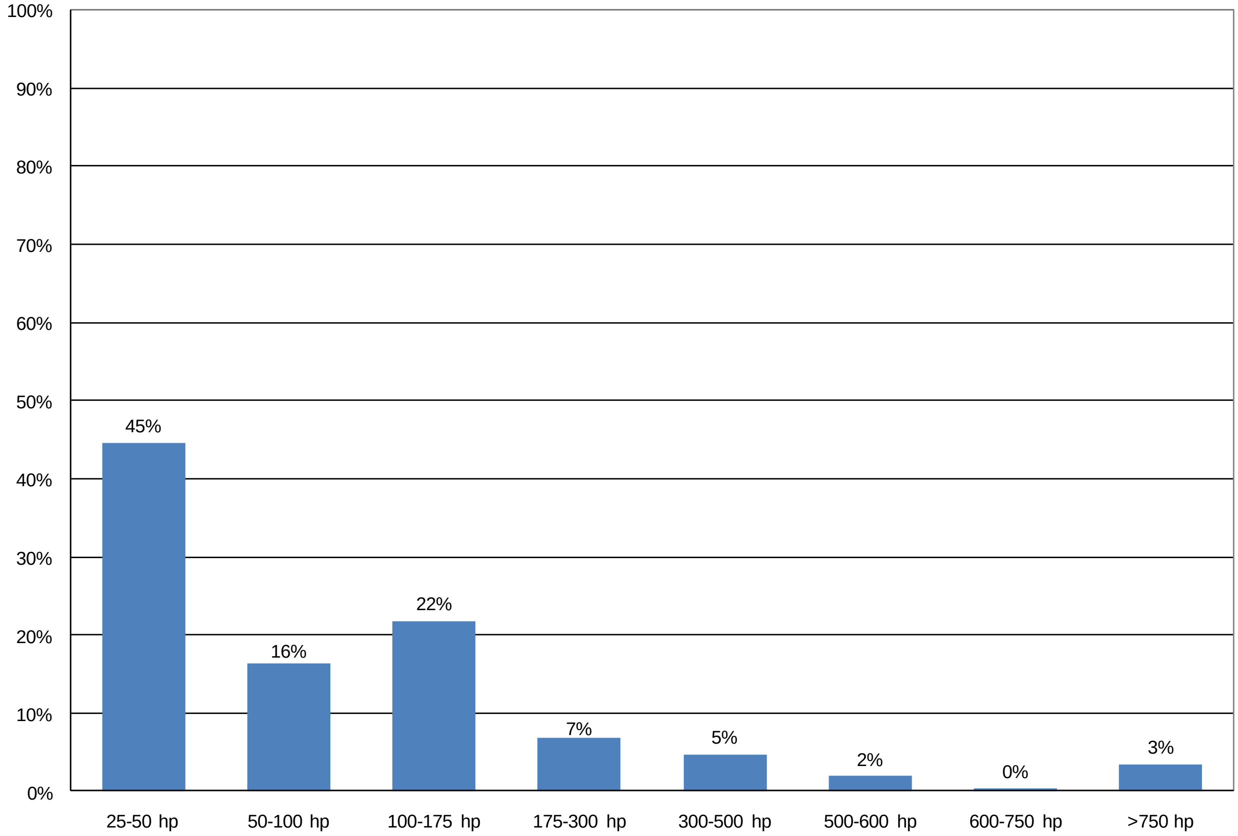


Figure 5-1. Distribution of Engine Population by Horsepower Group

To assess the size of the compliance relative to the value of the goods and services for industries using affected engines, we collected Census data for selected industries. At the industry level, the annualized costs represent a very small fraction of revenue (less than 1%), for all affected industries. Results for affected industries can be found in Table 5-1. These industry level cost-to-sales ratios can be interpreted as an average impact on potentially affected firms in these industries. Based on the cost-to-sales ratios, we can conclude that the annualized cost of this rule should be no higher than 1% of the sales on average for a firm in each of these industries, excluding natural gas transmission and natural gas liquid producers, which face slightly higher costs to sales ratios.

5.2 Social Cost Estimate

As shown in Table 5-1, the compliance costs are only a small fraction of the affected product value; this suggests that shift of the supply curve may also be small and result in small changes in market prices and consumption. EPA believes the national annualized compliance cost estimates provide a reasonable approximation of the social cost of this proposed reconsidered rule. EPA believes this approximation is better for industries whose markets are well characterized as perfectly competitive. This approximation is less well understood for industries where the characterization of markets is not always perfectly competitive such as electric power generation whose legal incidence of this rule is approximately 65 percent of the annualized compliance cost. However, given the data limitation noted earlier, EPA believes the accounting for compliance cost is a reasonable approximation to inform policy discussion in this rulemaking. To shed more light on this issue, EPA ran hypothetical analyses and the results are in Tables 5-2 and 5-3 later in this RIA.

5.3 How Might People and Firms Respond? A Partial Equilibrium Analysis

Markets are composed of people as consumers and producers trying to do the best they can given their economic circumstances. One way economists illustrate behavioral responses to pollution control costs is by using market supply and demand diagrams. The market supply curve describes how much of a good or service firms are willing and able to sell to people at a

Table 5-1. Selected Industry-Level Annualized Compliance Costs as a Fraction of Total Industry Revenue: 2009

		Total Annualized Costs	Sales, Shipments, Receipt, or Revenue ($Billion)		
Industry (NAICS)	**Industry Name**	**($ million)[a]**	**($2007)**	**($2009)**	**Cost-to-Sales Ratio**
2211	Electric Power Generation	$128.4	$440.4	$453.7	0.004%
48621	Natural Gas Transmission	$68.9	$16.4	$16.9	0.41%
211111	Crude Petroleum & NG Production	$7.4	$214.2	$220.5	0.001%
211112	Natural Gas Liquid Producers	$7.4	$42.4	$43.6	0.005%
92811	National Security	$14.3	#N/A	#N/A	#N/A
333992	Welders	$1.3	$5.2	$5.5	0.025%
111 and 112	Agriculture using irrigation systems[a]	$25.7	$27.9	$28.8	0.09%

[a] Irrigation engine costs assumed to be passed on to agricultural sectors that use irrigation systems.

N/A: receipts are Not Available for National Security

Sources: U.S. Census Bureau; generated by RTI International; using American FactFinder; "Sector 00: All sectors: Geographic Area Series: Economy-Wide Key Statistics: 2007" <http://factfinder.census.gov>; (July 7th , 2010).

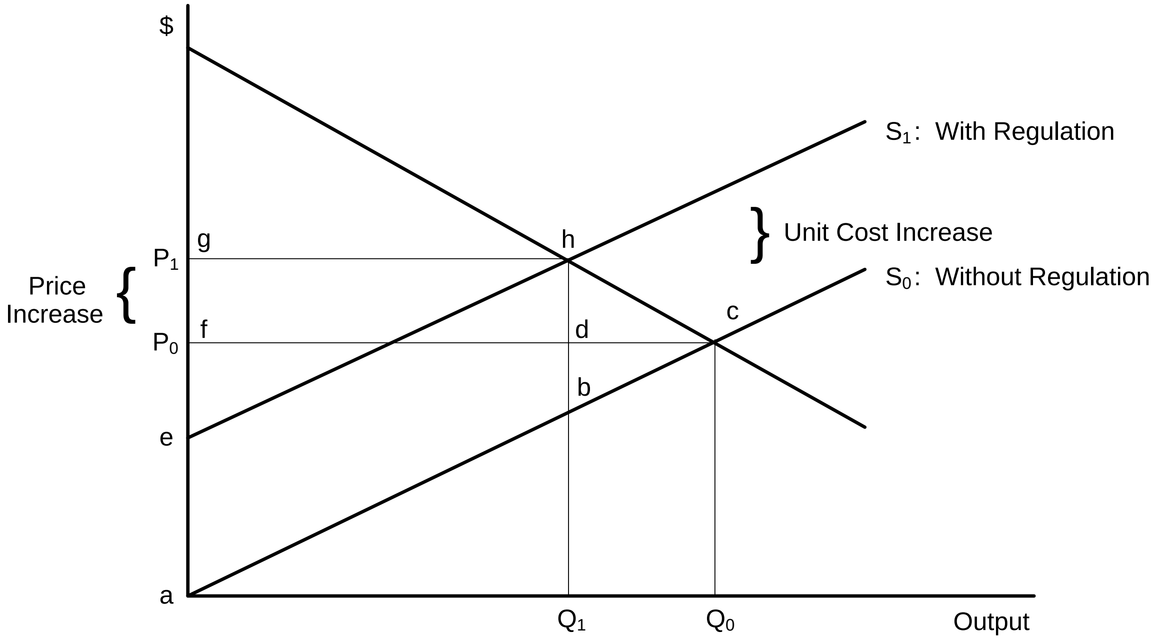
U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). 2009. "2008 Farm and Ranch Irrigation Survey." Washington, DC: USDA-NASS.

Costs from Existing SI RICE NESHAP Impacts received from EPA 1/26/12

particular price; we often draw this curve as upward sloping because some production resources are fixed. As a result, the cost of producing an additional unit typically rises as more units are made. The market demand curve describes how much of a good or service consumers are willing and able to buy at some price. Holding other factors constant, the quantity demand is assumed to fall when prices rise. In a perfectly competitive market, equilibrium price (P_0) and quantity (Q_0) is determined by the intersection of the supply and demand curves (see Figure 5-4).

5.3.1 Changes in Market Prices and Quantities

To qualitatively assess how the regulation may influence the equilibrium price and quantity in the affected markets, we assumed the market supply function shifts up by the additional cost of producing the good or service; the unit cost increase is typically calculated by dividing the annual compliance cost estimate by the baseline quantity (Q_0) (see Figure 5-4). As shown, this model makes two predictions: the price of the affected goods and services are likely to rise and the consumption/production levels are likely to fall.



consumer surplus = –[fghd + dhc]

producer surplus = [fghd – aehb] – bdc

total surplus = consumer surplus + producer surplus = –[aehb + dhc + bdc]

Figure 5-2. Market Demand and Supply Model: With and Without Regulation

The size of these changes depends on two factors: the size of the unit cost increase (supply shift) and differences in how each side of the market (supply and demand) responds to changes in price. Economists measure responses using the concept of price elasticity, which represents the percentage change in quantity divided by the percentage change in price. This dependence has been expressed in the following formula:[5]

$$\textit{Share of per-unit } \textbf{cost} = \frac{\text{Price Elasticity of Supply}}{\left(\text{Price Elasticity of Supply} - \text{Price Elasticity of Demand}\right)}$$

As a general rule, a higher share of the per-unit cost increases will be passed on to consumers in markets where

- goods and services are necessities and people do not have good substitutes that they can switch to easily (demand is inelastic) and

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[5] For examples of similar mathematical models in the public finance literature, see Nicholson (1998), pages 444–447, or Fullerton and Metcalf (2002).

- suppliers have excess capacity and can easily adjust production levels at minimal costs, or the time period of analysis is long enough that suppliers can change their fixed resources; supply is more elastic over longer periods.

Short-run demand elasticities for energy goods (electricity and natural gas), agricultural products, and construction are often inelastic. Specific estimates of short-run demand elasticities for these products can be obtained from existing literature. For the short-run demand of energy products, the National Energy Modeling System (NEMS) buildings module uses values between 0.1 and 0.3; a 1% increase in price leads to a 0.1 to 0.3% decrease in energy demand (Wade, 2003). For the short-run demand of agriculture and construction, the EPA has estimated elasticities to be 0.2 for agriculture and approximately 1 for construction (U.S. EPA, 2004). As a result, a 1% increase in the prices of agriculture products would lead to a 0.2% decrease in demand for those products, while a 1% increase in construction prices would lead to approximately a 1% decrease in demand for construction. Given these demand elasticity scenarios (shaded in gray), approximately a 1% increase unit costs would result in a price increase of 0.1 to 1% (Table 5-2). As a result, 10 to 100% of the unit cost increase could be passed on to consumers in the form of higher goods/services prices. This price increase would correspond to a 0.1 to 0.8% decline in consumption in these markets (Table 5-3).

Table 5-2. Hypothetical Price Increases for a 1% Increase in Unit Costs

Market Demand Elasticity	Market Supply Elasticity						
	0.1	**0.3**	**0.5**	**0.7**	**1**	**1.5**	**3**
−0.1	**0.5%**	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%
−0.3	0.3%	**0.5%**	0.6%	0.7%	0.8%	0.8%	0.9%
−0.5	0.2%	0.4%	**0.5%**	0.6%	0.7%	0.8%	0.9%
−0.7	0.1%	0.3%	0.4%	**0.5%**	0.6%	0.7%	0.8%
−1.0	0.1%	0.2%	0.3%	0.4%	**0.5%**	0.6%	0.8%
−1.5	0.1%	0.2%	0.3%	0.3%	0.4%	**0.5%**	0.7%
−3.0	0.0%	0.1%	0.1%	0.2%	0.3%	0.3%	**0.5%**

53.2 Regulated Markets: The Electric Power Generation, Transmission, and Distribution Sector

Given that the electric power sector bears majority of the estimated compliance costs and the industry is also among the last major regulated energy industries in the United States (EIA, 2010), the competitive model is not necessarily applicable for this industry.

Table 5-3. Hypothetical Consumption Decreases for a 1% Increase in Unit Costs

Market Demand Elasticity	Market Supply Elasticity						
	0.1	**0.3**	**0.5**	**0.7**	**1**	**1.5**	**3**
−0.1	**−0.1%**	−0.1%	−0.1%	−0.1%	−0.1%	−0.1%	−0.1%
−0.3	−0.1%	**−0.2%**	−0.2%	−0.2%	−0.2%	−0.3%	−0.3%
−0.5	−0.1%	−0.2%	**−0.3%**	−0.3%	−0.3%	−0.4%	−0.4%
−0.7	−0.1%	−0.2%	−0.3%	**−0.4%**	−0.4%	−0.5%	−0.6%
−1.0	−0.1%	−0.2%	−0.3%	−0.4%	**−0.5%**	−0.6%	−0.8%
−1.5	−0.1%	−0.3%	−0.4%	−0.5%	−0.6%	**−0.8%**	−1.0%
−3.0	−0.1%	−0.3%	−0.4%	−0.6%	−0.8%	−1.0%	**−1.5%**

Although the electricity industry continues to go through a process of restructuring, whereby the industry is moving toward a more competitive framework (see Figure 5-3 for the status of restructuring by state),[6] in many states, electricity prices continue to be fully regulated by Public Service Commissions. As a result, the rules and processes outlined by these agencies would ultimately determine how these additional regulatory costs would be recovered by affected entities.

5.3.3 Partial Equilibrium Measures of Social Cost: Changes Consumer and Producer Surplus

In partial equilibrium analysis, the social costs are estimated by measuring the changes in consumer and producer surplus, and these values can be determined using the market supply and demand model (Figure 5-2). The change in consumer surplus is measured as follows:

$$\Delta CS = -\,[\Delta Q_1 \times \Delta p] + [0.5 \times \Delta Q \times \Delta p]. \qquad (5.1)$$

Higher market prices and lower quantities lead to consumer welfare losses. Similarly, the change in producer surplus is measured as follows:

$$\Delta PS = [\Delta Q_1 \times \Delta p] - [\Delta Q_1 \times \mathrm{t}] - [0.5 \times \Delta Q \times (\Delta p - t)]. \qquad (5.2)$$

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[6] http://tonto.eia.doe.gov/energy_in_brief/print_pages/electricity.pdf.

Higher unit costs and lower production level reduce producer surplus because the net price change (Δp – t) is negative. However, these losses are mitigated because market prices tend to rise.

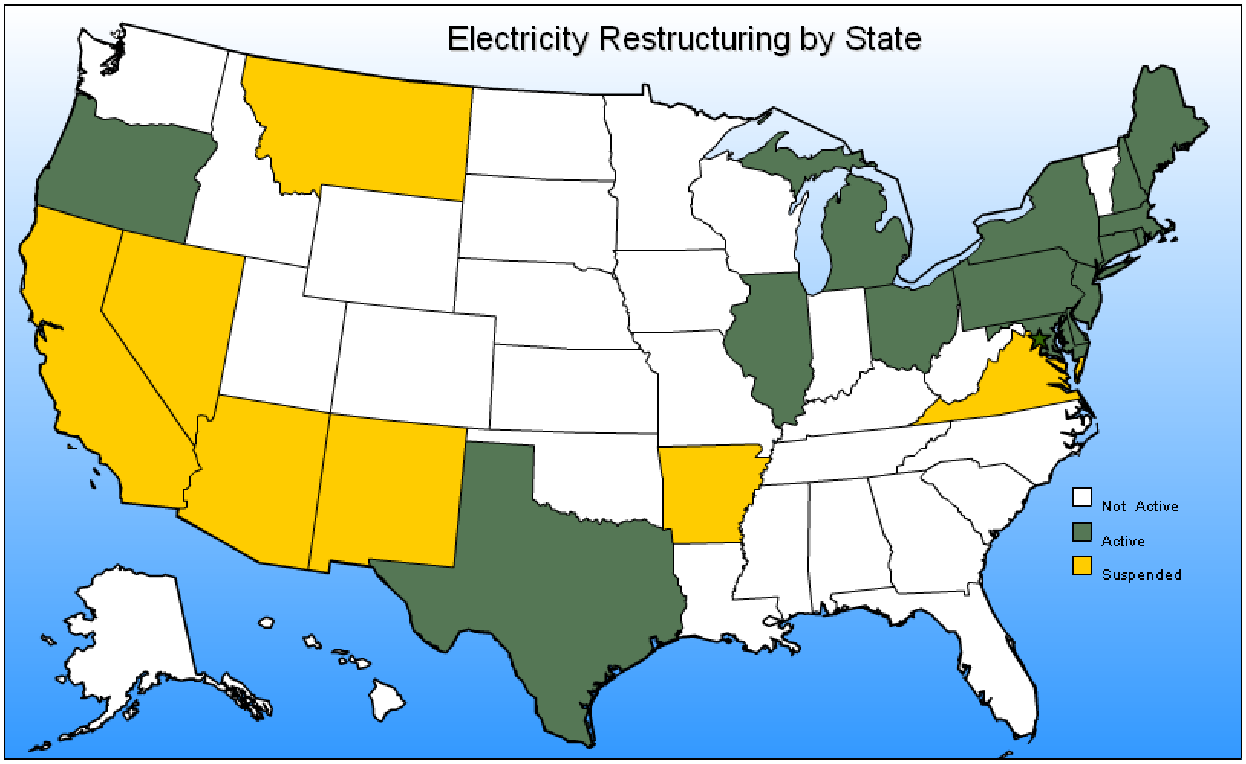

Figure 5-3. Electricity Restructuring by State

Source. U.S. Energy Information Administration. 2010b. <http://www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html>. Last updated September 2010.

5.4 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. EPA has prepared an analysis of energy impacts that explains this conclusion as follows below.

With respect to energy supply and prices, the analysis in Table 5-4 suggests at the industry level, the annualized costs represent a very small fraction of revenue (all industries are impacted under 1%). As a result, we can conclude supply and price impacts should be small.

To enhance understanding regarding the regulation’s influence on energy consumption, we examined publicly available data describing energy consumption for the electric power sector that will be affected by this rule. The Annual Energy Outlook 2011 (EIA, 2011) provides energy consumption data. As shown in Table 5-4, this industry account for less than 0.3% of the U.S. total liquid fuels and less than 8.0% of natural gas. As a result, any energy consumption changes attributable to the regulatory program should not significantly influence the supply, distribution, or use of energy.

Table 5-4. U.S. Electric Power[a] Sector Energy Consumption (Quadrillion BTUs): 2013

	Quantity	**Share of Total Energy Use**
Distillate fuel oil	0.09	0.1%
Residual fuel oil	0.22	0.2%
Liquid fuels subtotal	0.31	0.3%
Natural gas	7.63	7.9%
Steam coal	17.37	18.0%
Nuclear power	8.50	8.8%
Renewable energy[b]	4.63	4.8%
Electricity Imports	0.12	0.1%
Total Electric Power Energy Consumption[c]	38.77	40.1%
Delivered Energy Use	70.56	73.2%
Total Energy Use	96.66	100.0%

[a] Includes consumption of energy by electricity-only and combined heat and power plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes small power producers and exempt wholesale generators.

[b] Includes conventional hydroelectric, geothermal, wood and wood waste, biogenic municipal solid waste, other biomass, petroleum coke, wind, photovoltaic and solar thermal sources. Excludes net electricity imports.

[c] Includes non-biogenic municipal waste not included above.

Source: U.S. Energy Information Administration. 2011a. Supplemental Tables to the Annual Energy Outlook 2011. Table 2. Available at: <http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html>.

5.5 Unfunded Mandates

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 Section 4 of 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.

5.5.1 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 Chapter 4 of 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.

5.5.2 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 the 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. 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.

5.6 Environmental Justice

Executive Order (EO) 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.

Assuming that our baseline for this RIA does not include implementation of the final 2010 SI RICE rule, as we state earlier in this document, EPA has determined that this proposed rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. This rule is a nationwide standard that reduces air toxics emissions from existing stationary SI engines, thus decreasing the amount of such emissions to which all affected populations are exposed.

5.7 Employment Impact Analysis

In addition to addressing the costs and benefits of the proposed reconsideration rule, EPA has analyzed the 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, and consistent with recent efforts to characterize the employment effects of economically significant rules, the Agency has provided this analysis to inform the discussion of labor demand and employment impacts.

This employment impact analysis includes estimates of certain short-term and on-going labor requirements (increase in labor demand) associated with reporting and recordkeeping, and the installation, operating and maintenance of control devices. EPA estimates that about 200 full-time equivalents (FTE) will be created or supported in the short-term and about 400 FTEs will be created or supported annually on a permanent basis. EPA also provides a qualitative discussion of other potential employment effects, including both increases and decreases.

Because of the uncertainties involved, these sets of estimates should not be added in an attempt to characterize the overall employment effect.

We have not quantified the rule's net effects on the overall labor market, or the potential changes to workers' incomes. 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.[7] When an increase in employment occurs as a result of a regulation, it is a cost to firms. 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. When significant numbers of workers are 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 such as monitoring, recordkeeping, and reporting estimates derived from its cost analysis 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 recent Regulatory Impact Analyses. 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

Regulations set in motion new orders for pollution control equipment and services. When a new regulation is promulgated, one typical response of industry is to order pollution control equipment and services in order to comply with the regulation when it becomes effective, while

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[7] It should be noted that if more labor must be used to produce a given amount of output, then this implies a decrease in labor productivity. A decrease in labor productivity will cause a short-run aggregate supply curve to shift to the left, and businesses will produce less, all other things being equal.

closure of plants that choose not to comply is assumed to occur after the compliance date. With such a response by industry as a basis, this section presents estimates for short term labor requirement needed associated with the monitoring, recordkeeping, and reporting requirements for this proposed rule. Environmental regulation may increase revenue and employment in the environmental technology industry. While these increases represent gains for that industry, they are costs to the regulated industries required to install the equipment. As with any pool of labor, the gross size of the labor pool does not reflect the net impact on overall employment after adjusting for shifts in other sectors.

Regulated firms may hire workers to design and build pollution controls. Once the equipment is installed, regulated firms may hire workers to operate and maintain the pollution control equipment – much like they may hire workers to produce more output. Of course, these firms may also reassign existing employees to do these activities. A study including an analysis of environmental protection employment in six U.S. states in 2003 by Bezdek, Wendling, and DiPernab (2008) found that "investments in environmental protection create jobs and displace jobs, but the net effect on employment is positive."[8]

Once the equipment is installed, regulated firms may hire workers to operate and maintain the pollution control equipment – much like they may hire workers to produce more output.

The focus of this part of the analysis is on labor requirements related to the compliance actions of the affected entities within the affected sector. The employment analysis uses a bottom-up engineering-based methodology to estimate employment impacts. The engineering cost analysis summarized in Section 4 of 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 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.

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[8] Environmental protection, the economy, and jobs: National and regional analyses, Roger H. Bezdek, Robert M. Wendling and Paula DiPerna, Journal of Environmental Management Volume 86, Issue 1, January 2008, Pages 63-79.

The results of this employment estimate are presented in Table 5-5 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 reconsideration rule.

The up-front labor requirement is estimated at 200 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 400 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. All of this data is found in the cost memorandum for this proposed reconsidered rule, and can be found in the docket for the rulemaking. 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 5-5. Labor-based Employment Estimates for Reporting and Recordkeeping and Installing, Operating, and Maintaining Control Equipment Requirements for Proposed Reconsideration SI RICE NESHAP

Source	Emission Control Measure	Projected No. of Affected Units	Per-Unit One-Time Labor Estimate (Hours)	Total One-Time Labor Estimate (Hours)	Per-Unit Annual Labor Estimate (Hours)	Total Annual Labor Estimate (Hours)	One-Time Full-Time Equivalent
Major Sources							
SI RICE <100 HP							
-O&M/Recordkeeping	N/A	70,798	N/A	N/A	1	70,798	N/A
2SLB RICE 100-500 HP	N/A	7,398	N/A	N/A	N/A	92,480	N/A
-O&M/Recordkeeping					1		
-Testing					8		
-Reporting					3.5		
Emergency 4SRB SI RICE 100-500 HP	N/A	1,597	N/A	N/A	1	1,597	N/A
Non-Emergency 4SRB SI RICE 100-500 HP	N/A	12,740	N/A	N/A	N/A	146,515	N/A
-Testing					8		
-Reporting					3.5		
4SLB SI RICE 100-500 HP	Oxidation Catalyst	14,257	21	300,255	15	163,956	144
-Testing					8		
-Reporting					3.5		
Area Sources							
All SI RICE							
-O&M/Recordkeeping	N/A	228,318	N/A	N/A	1	228,318	N/A
Non-Emergency 4SLB SI RICE >500 HP in Populated Areas	Oxidation Catalyst	768	37	28,117	15	15,734	14
-Testing					2		
-Reporting					3.5		
Non-Emergency 4SRB SI RICE >500 HP in Populated Areas	NSCR	578	86	49,918	33	22,236	24
-Testing					2		
-Reporting					3.5		
Total			144	378,290	113	741,633	182

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.
HP = horsepower
N/A = Not Applicable.
O&M = Operating and Maintenance

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)[1] to derive the employment effects of new regulations within the regulated industry. (See, for example, the Regulatory Impact Analyses for the recent final MATS and final 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.

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.

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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.

- *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 three competing effects, it is not possible to predict the net environmental employment effect in the regulated sector.

Using plant-level Census information between the years 1979 and 1991, Morgenstern et al. estimate the effects of pollution abatement expenditures on net employment in four highly polluting/regulated sectors (pulp and paper, plastics, steel, and petroleum refining). 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 1.55 (+/- 2.24) jobs. As a result, the authors conclude that increases in pollution abatement expenditures can have positive effects on employment and do not necessarily cause economically significant employment changes. The conclusion is similar to Berman and Bui (2001), who found that increased air quality regulation in Los Angeles did not cause large employment changes.

Ideally, the EPA would first apply the methodology of Morgenstern et al. to current pollution expenditure and market data for the regulated firms to identify the relationship between abatement costs and employment, then use this relationship to extrapolate the effect of new projected abatement costs on these firms. Unfortunately, current firm-level abatement cost and market characteristics are not available. In addition, there are important differences in the markets and regulatory settings analyzed in their study and the setting presented here that lead us to conclude that it is inappropriate to utilize their quantitative estimates to estimate the employment impacts from this reconsideration 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 also important differences between the industries affected by this proposed rule and the four manufacturing industries studied by Morgenstern et al. 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

SMALL ENTITY SCREENING ANALYSIS

The Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) 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 governmental jurisdictions, and small not-for-profit enterprises.

After considering the economic impact of the proposed rule on small entities, the screening analysis indicates that this proposed rule will not have a significant economic impact on a substantial number of small entities (or "SISNOSE"). Under the analyses EPA considered, sales and revenue tests for establishments owned by model small entities are less than 1% except electric power generation (NAICS 2211 with receipts less than $100,000 per year) and crop and animal production (NAICS 111 and 112 with receipts less than $25,000 per year). These findings are similar to those for the final SI RICE rule promulgated in August 2010, though the impacts are lower due to the reduction in the cost estimates for these industries.

6.1 Small Entity Data Set

The industry sectors covered by the proposed rule were identified during the development of the cost analysis (EC/R, 2012). The Statistics of United States Business (SUSB) provides national information on the distribution of economic variables by industry and enterprise size (U.S. Census, 2012a, b).[1] The Census Bureau and the Office of Advocacy of the SBA supported and developed these files for use in a broad range of economic analyses.[2] Statistics include the total number of establishments and receipts for all entities in an industry; however, many of these entities may not necessarily be covered by the proposed rule. SUSB also provides statistics by enterprise employment and receipt size.

The Census Bureau's definitions used in the SUSB are as follows:

- *Establishmen*t: An establishment is a single physical location where business is conducted or where services or industrial operations are performed.

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[1] The SUSB data do not provide establishment information for the national security NAICS code (92811) or irrigated farms. Since most national security installations are owned by the federal government (e.g., military bases), EPA assumes these entities would not be considered small. For irrigated farms, we relied on receipt data provided in the 2008 Farm and Irrigation Survey (USDA, 2009).

[2] See http://www.census.gov/csd/susb/ and http://www.sba.gov/advo/research/data.html for additional details.

- *Receipts*: Receipts (net of taxes) are defined as the revenue for goods produced, distributed, or services provided, including revenue earned from premiums, commissions and fees, rents, interest, dividends, and royalties. Receipts exclude all revenue collected for local, state, and federal taxes.
- *Enterprise*: An enterprise is a business organization consisting of one or more domestic establishments that were specified under common ownership or control. The enterprise and the establishment are the same for single-establishment firms. Each multiestablishment company forms one enterprise—the enterprise employment and annual payroll are summed from the associated establishments. Enterprise size designations are determined by the summed employment of all associated establishments.

Because the SBA's business size definitions (SBA, 2010) apply to an establishment's "ultimate parent company," we assumed in this analysis that the "enterprise" definition above is consistent with the concept of ultimate parent company that is typically used for SBREFA screening analyses and the terms are used interchangeably.

6.2 Small Entity Economic Impact Measures

The analysis generated a set of establishment sales tests (represented as cost-to-receipt ratios)[3] for NAICS codes associated with sectors listed in Table 6-1. Although the appropriate SBA size definition should be applied at the parent company (enterprise) level, we can only compute and compare ratios for a model establishment owned by an enterprise within an SUSB size range (employment or receipts). Using the SUSB size range helps us account for receipt differences between establishments owned by large and small enterprises and also allows us to consider the variation in small business definitions across affected industries. Using establishment receipts is also a conservative approach, because an establishment's parent company (the "enterprise") may have other economic resources that could be used to cover the costs of the final rule.

6.2.1 Model Establishment Receipts and Annual Compliance Costs

The sales test compares a representative establishment's total annual engine costs to the average establishment receipts for enterprises in several size categories.[4] For industries with SBA

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[3] The following metrics for other small entity economic impact measures (if applicable) would potentially include

- small governments (if applicable): "revenue" test; annualized compliance cost as a percentage of annual government revenues and
- small nonprofits (if applicable): "expenditure" test; annualized compliance cost as a percentage of annual operating expenses,

[4] For the 1 to 20 employee category, we excluded SUSB data for enterprises with zero employees. These enterprises did not operate the entire year.

employment size standards, we calculated average establishment receipts for each enterprise employment range (Table 6-2).[5] For industries with SBA receipt size standards, we calculated average establishment receipts for each enterprise receipt range (Table 6-3). We included the utility sector in the second group, although the SBA size standard for this industry is defined in terms of physical units (megawatt hours) versus receipts. Crop and animal production (NAICS 111 and 112) also have an SBA receipt size standard that defines a small business as receiving $750,000 or less in receipts per year. However, SUSB data were not available for these industries. Therefore, we conducted the sales test using the following range of establishment receipts: farms with annual receipts of $25,000 or less, farms with annual receipts of $100,000 or

Table 6-1. SI NESHAP for Existing Stationary Reciprocating Internal Combustion Engines (RICE): Affected Sectors and SBA Small Business Size Standards

Industry Description	Corresponding NAICS	SBA Size Standard for Businesses (November 5nd, 2010)	Type of Small Entity
Electric Power Generation	2211	[a]	Business and government
Natural Gas Transmission	48621	$7.0 million in annual receipts	Business
Crude Petroleum & NG Production	211111	500 employees	Business
Natural Gas Liquid Producers	211112	500 employees	Business
National Security	92811	NA	Government
Hydro Power Units	See NAICS 2211	1,000 employees	Business and government
Irrigation Sets	Affects NAICS 111 and 112	Generally $750,000 or less in annual receipts	Business
Welders	Affects industries that use heavy equipment such as construction, mining, farming	Varies by 6-digit NAICS code; Example industry: NAICS 238 = $14 million in annual receipts	Business

[a] NAICS codes 221111, 221112, 221113, 221119, 221121, 221122: A firm is small if, including its affiliates, it is primarily engaged in the generation, transmission, and/or distribution of electric energy for sale and its total electric output for the preceding fiscal year did not exceed 4 million megawatt hours. Source: U.S. Small Business Administration (SBA). 2010. "Table of Small Business Size Standards Matched to North American Industry Classification System Codes." Effective November 5nd, 2010. Downloaded 2/16/12.

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[5] 2007 Economic Census data are at http://www.census.gov/econ/census07/.

less, farms with annual receipts of $500,000 or less, and farms with annual receipts of $750,000 or less.

Table 6-2. Average Receipts for Affected Industry by Enterprise: 2009 ($2009 Million/Establishment)

				Owned By Enterprises with Employee Range:			
NAICS	NAICS Description	SBA Size Standard for Businesses (effective November 5, 2010)	All Enterprises	1–20 Employees	20–99 Employees	100–499 Employees	500+ Employees
211111	Crude petroleum & natural gas extraction	500 employees	$30.22	$2.15	$33.02	$151,76	1,570
211112	Natural gas liquid extraction	500 employees	$172.81	$0.30	NA	$11.88	NA
335312	Motor & generator mfg	1,000 employees	$18.58	$1.37	$6.14	$15.96	$29.47
333992	Welding & soldering equipment mfg	500 employees	$18.51	$1.56	$6.60	$33.25	NA

Source: U.S. Census Bureau. 2012a. “Firm Size Data from the Statistics of U.S. Businesses: U.S. Detail Employment Sizes: 2009.” <http://www.census.gov/csd/susb/ Downloaded 2/22/12.

NA = Not available.

Table 6-3. Average Receipts for Affected Industry by Enterprise Receipt Range: 2007 ($2008 /establishment)

NAICS	NAICS Description	SBA Size Standard for Businesses (effective November 5, 2010)	All Enterprises	0–99K Receipts	100–499.9K Receipts	500–999.9K Receipts	1,000–4,999.9K Receipts	5,000,000–9,999,999K Receipts	<10,000K Receipts	10,000–49,999K Receipts	50,000–99,999K Receipts	100,000K+ Receipts
					Owned By Enterprises with Receipt Range:							
2211	Electric Power Generation	[a]	$261.0	$31.2	$272.5	$724.9	$2,399.5	$7,330.5	$2,617.7	$24,786.9	$67,706.8	$1,394,051.0
622110	Hospitals	$34.5 million in annual receipts	$202,058.7	NA	$23.82	NA	$3,255.0	$7,291.0	$4,692.1	$23,481.9	$67,545,6	$508,705.8
237310	Highway , street, and bride construction	$33.5 million in Annual Receipts	$7.74	$0.06	$0.32	$0.84	$2.74	$8.11	$2.00	$22.62	$56.48	$56.81
237110	Water and sewer line and related structures, construction	$33.5 million in Annual Receipts	$3.89	$0.06	$0.32	$0.85	$2.73	$8.17	$1.84	$20.62	$45.05	$47.27
237130	Power andcommunication line and related structures construction	$33.5 million in Annual Receipts	$3.39	$0.06	$0.31	$0.83	$2.52	$7.75	$1.32	$16.84	$34.50	$23.86
237990	zOther heavy and civil engineering construction	$33.5 million in Annual Receipts	$2.66	$0.06	$0.30	$0.83	$2.48	$7.76	$0.99	$18.72	$40.53	$42.35
92811	National Security	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: Note: Industries in green were included for consistency with the analysis done for finalrule. National Security is included in this table but does not have size standards.

[a] NAICS codes 221111, 221112, 221113, 221119, 221121, 221122: A firm in these industries is defined as small by SBA if, including its affiliates, it is primarily engaged in the generation, transmission, and/or distribution of electric energy for sale and its total electric output for the preceding fiscal year did not exceed 4 million megawatt hours.

NA = Not available. SUSB did not report this data for disclosure or other reasons.

Source: U.S. Census Bureau. 2009a. “Firm Size Data from the Statistics of U.S. Businesses: U.S. Detail Employment Sizes: 2009.” <http://www.census.gov/csd/susb/

Annual entity compliance costs vary depending on the size of the SI engines used at the affected establishment. Absent facility-specific information, we computed per-entity compliance costs based for three different cases based on representative establishments—Cases 1, 2, and 3 (see Table 6-4). Each representative establishment differs based on the size and number of SI engines being used. Compliance costs are calculated by summing the total annualized compliance costs for the relevant engine categories, dividing the sum by the total existing population of those engines, and multiplying the average engine cost by the number of engines assumed to be at the establishment. Since NAICS 2211 and 48621 are fundamentally different than other industries considered in this analysis due to the number of engines affected and amount of cost incurred resulting from this proposed rule, we used different assumptions about what constitutes the representative establishment and report these assumptions separately.

- Case 1: The representative establishment for all industries uses three 750+ hp engines with an average compliance cost of $680 to $730 per engine, resulting in a total annualized compliance cost of approximately $2,040 to $2,200 for this representative establishment.
- Case 2: The representative establishment in NACIS 2211 and 48621 uses two 25 to 750+ hp engines with an average compliance cost of $412 per engine, resulting in a total annualized compliance cost of $824 for this representative establishment. For all other industries, the representative establishment uses two 25 to 300 hp engines with an average compliance cost of $246 per engine, resulting in a total compliance cost of $492 for this representative establishment.
- Case 3: The representative establishment for all industries uses two 50 to 100 hp engines with an average compliance cost of $73 per engine, resulting in a total compliance cost of $145 for this representative establishment.

EPA believes that small entities are most likely to face costs similar to Case 2 (columns shaded in gray in Table 6-4) because most of the engines to be affected by this proposed rule in NAICS 335312, 333992, 211111, and 211112 are under 300 hp capacity, and most small entities in these industries will own engines of this size or smaller. This is corroborated by Figure 6-1 and 6-2 which shows the distribution of engine population and compliance costs by engine size for all industries. However, it is difficult to make a similar claim for NAICS 2211 and 48621 based on the existing distribution of engines in these industries.[6]

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[6] This claim also cannot be made for NAICS 92811: National Security. However, since most national security installations are owned by the federal government (e.g., military bases), EPA assumes these entities would not be considered small.

For the sales test, we divided the representative establishment compliance costs reported in Table 6-4 by the representative establishment receipts reported in Tables 6-2 and 6-3. This is known as the cost-to-receipt (i.e., sales) ratio, or the "sales test." The "sales test" is the impact

Table 6-4. Representative Establishment Costs Used for Small Entity Analysis ($2009)

	Case 1		**Case 2**		**Case 3**	
	NAICS 2211, 48621 (+750 hp only)	**All Other NAICS (+750 hp only)**	**NAICS 2211,48621 (25-750+ hp)**	**All Other NAICS (25–300 hp)**	**NAICS 2211, 48621 (25–100 hp only)**	**All Other NAICS (25–100 hp only)**
Total Annualized Costs ($)	$7,710,388	$586,434	$82,806,141	$28,057,798	$8,510,985	$6,174,805
Engine Population	10,548	863	200,974	114,517	117,040	84,913
Average Engine Cost ($/engine)	$731	$680	$412	$246	$73	$73
Assumed Engines Per Establishment	3	3	2	2	2	2
Total Annualized Costs per Establishment	$2,193	$2,040	$824	$492	$145	$145

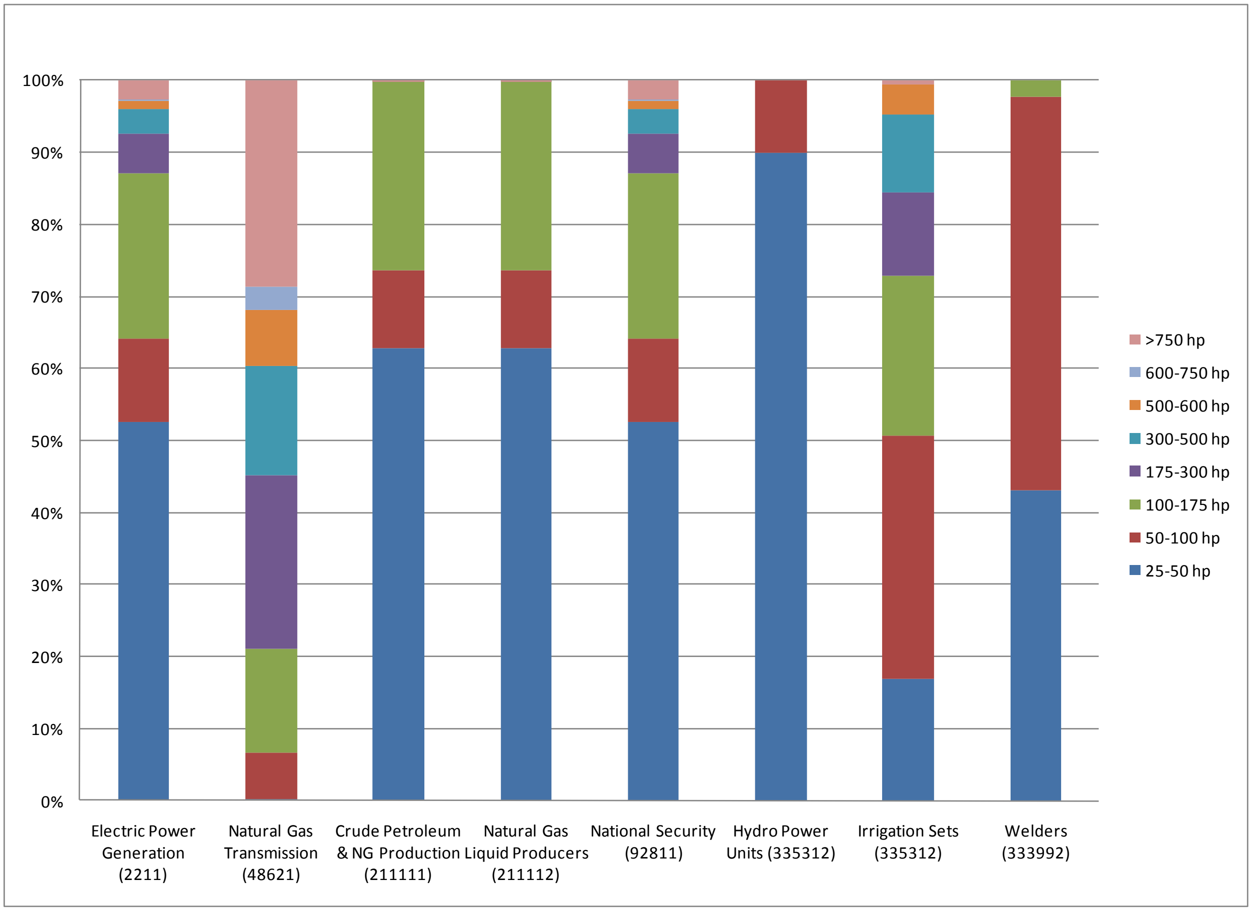

Figure 6-1. Distribution of Engine Population by Size for All Industries

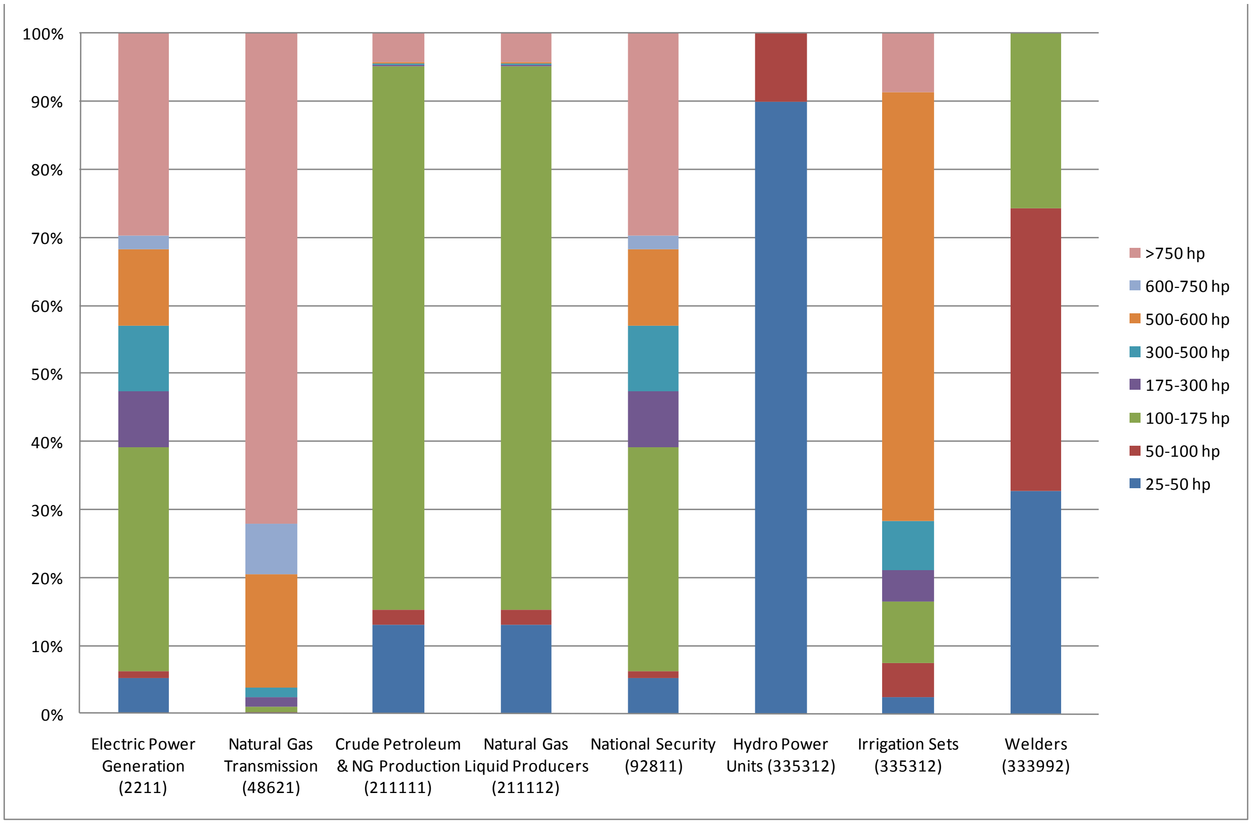

Figure 6-2. Distribution of Compliance Costs by Engine Size for All Industries

methodology EPA employs in analyzing small entity impacts as opposed to a "profits test," in which annualized compliance costs are calculated as a share of profits.

This is because revenues or sales data are commonly available data for entities normally impacted by EPA regulations and profits data normally made available are often not the true profit earned by firms because of accounting and tax considerations. Revenues as typically published are usually correct figures and are more reliably reported when compared to profit data. The use of a "sales test" for estimating small business impacts for a rulemaking such as this one is consistent with guidance offered by EPA on compliance with SBREFA[7] and is consistent with guidance published by the U.S. SBA's Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities in relation to increases on large entities.[8]

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[7] The SBREFA compliance guidance to EPA rulewriters regarding the types of small business analysis that should be considered can be found at http://www.epa.gov/sbrefa/documents/rfafinalguidance06.pdf, pp. 24-25.

[8] U.S. SBA, Office of Advocacy. A Guide for Government Agencies, How to Comply with the Regulatory Flexibility Act, Implementing the President's Small Business Agenda and Executive Order 13272, May 2003.

If the cost-to-receipt ratio is less than 1%, then we consider the proposed rule to not have a significant impact on the establishment company in question. We summarize the industries with cost-to-receipt ratios exceeding 1% below:

Primary Analysis:

- *Case 2*: NAICS 2211 with receipts less than $100,000 per year and NAICS 111 and 112 with receipts less than $25,000 per year
- *Case 3*: No industries

Sensitivity Analysis (unlikely):

- *Case 1*: NAICS 2211 with receipts less than $100,000 per year

In the Case 2 primary analysis, only establishments in NAICS 2211 with receipts less than $100,000 per year (less than 5 percent of the total), and establishments in NAICS 111 and 112 with receipts less than $25,000 per year (around 30 percent of the total) have cost-to-receipt ratios above 1%. However, establishments earning this level of receipts are likely to be using smaller engines than those assumed in Case 2, such as 25 to 300 hp engines. The results of our Case 3 analysis demonstrate that these establishments are not significantly impacted when taking this engine size into account.

After considering the economic impacts of this proposed rule on small entities, we certify that this action will not have a significant economic impact on a substantial number of small entities. This certification is based on the economic impact of this proposal action to all affected small entities across all industries affected. The percentage of small entities impacted by this proposal having annualized costs greater than 1 percent of sales is less than 2 percent according to this analysis. We thus conclude that there is no significant economic impact on a substantial number of small entities (SISNOSE) for this proposed rule.

Although the proposed rule would not have a significant economic impact on a substantial number of small entities, EPA nonetheless tried to reduce the impact of the rule on small entities. When developing the revised standards, EPA took special steps to ensure that the burdens imposed on small entities were minimal. EPA conducted several meetings with industry trade associations to discuss regulatory options and the corresponding burden on industry, such as recordkeeping and reporting. In addition, as mentioned earlier in this preamble, EPA proposes to reduce regulatory requirements for a variety of area sources affected under this RICE rule with amendments to the final RICE rules promulgated in 2010. We continue to be interested in the potential impacts of this proposed rule on small entities and welcome comments on issues related to such impacts.

6.3 Small Government Entities

The rule also covers sectors that include entities owned by small and large governments. However, given the uncertainty and data limitations associated with identifying and appropriately classifying these entities, we computed a “revenue” test for a model small government, where the annualized compliance cost is a percentage of annual government revenues (U.S. Census, 2005a, b). The use of a “revenue test” for estimating impacts to small governments for a rulemaking such as this one is consistent with guidance offered by EPA on compliance with SBREFA,[9] and is consistent with guidance published by the US SBA’s Office of Advocacy.[10] For example, from the 2007 Census (in 2008 dollars), the average revenue for small governments (counties and municipalities) with populations fewer than 10,000 is $4 million per entity, and the average revenue for local governments with populations fewer than 50,000 is $9 million per entity (U.S. Census Bureau, 2009a; U.S. Census Bureau, 2009b). For the smallest group of local governments (<10,000 people), the cost-to-revenue ratio would be 0.2% or less under each case. For the larger group of governments (<50,000 people), the cost-to-revenue ratio is 0.1% or less under all cases.

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[9] The SBREFA compliance guidance to EPA rule writers regarding the types of small business analysis that should be considered can be found at http://www.epa.gov/sbrefa/documents/rfafinalguidance06.pdf, pp. 24-25.

[10] U.S. SBA, Office of Advocacy. A Guide for Government Agencies, How to Comply with the Regulatory Flexibility Act, Implementing the President’s Small Business Agenda and Executive Order 13272, May 2003.

Section 7

HUMAN HEALTH BENEFITS OF EMISSIONS REDUCTIONS

Synopsis

Implementation of emissions controls required by the proposed SI RICE NESHAP reconsideration is expected to reduce emissions of hazardous air pollutants (HAP) and have ancillary co-benefits that would lower ambient concentrations of NO_2, $PM_{2.5}$ and ozone. In this section, we quantify the monetized co-benefits for this rule associated with reducing exposure to ambient fine particulate matter ($PM_{2.5}$) by reducing emissions of precursors. We estimate the total monetized co-benefits to be $62 million to $150 million at a 3% discount rate and $55 million to $140 million at a 7% discount rate in 2013. All estimates are in 2010$. These estimates reflect the monetized human health benefits of reducing cases of morbidity and premature mortality among populations exposed to $PM_{2.5}$ reduced by this rule. 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 7-2. Data, resource, and methodological limitations prevented EPA from monetizing the benefits from several important benefit categories, including benefits from reducing exposure to HAP, carbon monoxide, NO_2 and ozone, as well as ecosystem effects and visibility impairment. In addition to reducing emissions of PM precursors such as NOx, this rule would reduce 1,800 tons of HAP and 22,000 tons of carbon monoxide each year.

7.1 Calculation of $PM_{2.5}$-Related Human Health Co-Benefits

Assuming that our baseline does not include implementation of the 2010 final SI RICE rule, as we state earlier in this RIA, this proposed reconsideration NESHAP would reduce emissions of NO_X, and VOCs. Because these emissions are precursors to $PM_{2.5,}$ reducing these emissions would also reduce $PM_{2.5}$ formation, human exposure and the incidence of $PM_{2.5}$-related health effects. Due to analytical limitations, it was not possible to provide a comprehensive estimate of $PM_{2.5}$-related benefits or provide estimates of the health benefits associated with exposure to HAP, CO, NO_2 or ozone. 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 believes would provide 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, 2010).

The *Integrated Science Assessment* (ISA) *for Particulate Matter* (U.S. EPA, 2009b) identified the human health effects associated with ambient $PM_{2.5,}$ which include premature morality and a variety of morbidity effects associated with acute and chronic exposures. Table 7-1 shows the quantified and unquantified benefits captured in those benefit-per-ton estimates, but this table does not include entries for the unquantified health effects associated with exposure to ozone and NO_2 nor welfare effects such as ecosystem effects and visibility impairment that are described in section 7.2. It is important to emphasize that the list of unquantified benefit categories is not exhaustive, nor is quantification of each effect complete.

Table 7-1: Human Health 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 qualitatively 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 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 (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.

The effect coefficients are drawn from epidemiology studies examining two large population cohorts: the American Cancer Society cohort (Pope et al., 2002) and the Harvard Six Cities cohort (Laden et al., 2006).[1] These are logical choices for anchor points in our presentation because, while both studies are well designed and peer reviewed, there are strengths and weaknesses inherent in each, which we believe argues for using both studies to generate benefits estimates. Previously, EPA had calculated benefits based on these two empirical

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[1] These two studies specify multi-pollutant models that control for SO_2, among other co-pollutants.

studies, but derived the range of benefits, including the minimum and maximum results, from an expert elicitation of the relationship between exposure to $PM_{2.5}$ and premature mortality (Roman et al., 2008).[2] Within this assessment, we include the benefits estimates derived from the concentration-response function provided by each of the twelve experts to better characterize the uncertainty in the concentration-response function for mortality and the degree of variability in the expert responses. Because the experts used these cohort studies to inform their concentration-response functions, benefits estimates using these functions generally fall between results using these epidemiology studies (see Figure 7-2). In general, the expert elicitation results support the conclusion that the benefits of $PM_{2.5}$ control are very likely to be substantial.

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 $PM_{2.5}$ and its precursors from in the “Other Non-EGU Point” sector(U.S. EPA, 2012).[3] 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. The air quality modeling data used in this analysis use more narrow sectors. In addition, the updated air quality modeling data reflects more recent emissions data (2005 rather than 2001) and has a higher spatial resolution (12km rather than 36 km grid cells). The benefits methodology, such as health endpoints assessed, risk estimates applied, and valuation techniques applied did not change. As noted below in the characterization of uncertainty, these updated estimates still have similar limitations as all national-average benefit-per-ton estimates in that they reflect the geographic distribution of the modeled emissions, which may not exactly match the emission reductions in this rulemaking, and they may not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors for any specific location. In this analysis, we apply these national benefit-per-ton estimates calculated for this category for NOx and multiply them by the corresponding emission reductions.

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

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[2] Please see the Section 5.2 of the Portland Cement RIA in Appendix 5A for more information regarding the change in the presentation of benefits estimates.

[3] Stationary engines are included in the other non-EGU point source category. If the affected stationary engines are more rural than the average of the non-EGU sources modeled, then it is possible that the benefits may be somewhat less than we have estimated here. The TSD provides the geographic distribution of the air quality changes associated with this sector. It is important to emphasize that this modeling represents the best available information on the air quality impact on a per ton basis for these sources.

to allow differentiation of effects estimates by particle type. NOx is the primary $PM_{2.5}$ precursors affected by this rule. Even though we assume that all fine particles have equivalent health effects, the benefit-per-ton estimates vary between precursors depending on the location and magnitude of their impact on $PM_{2.5}$ levels, which drive population exposure. The sector-specific modeling does not provide estimates of the $PM_{2.5}$-related benefits associated with reducing VOC emissions, but these unquantified benefits are generally small compared to other $PM_{2.5}$ precursors (U.S. EPA, 2012).

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 (U.S. EPA, 2006). Specifically, this analysis uses the method first applied in the Portland Cement NESHAP RIA (U.S. EPA, 2009a), which applied the functions directly from the epidemiology studies without an adjustment for an assumed threshold. 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 Portland Cement proposal, and we now calculate incremental benefits down to the lowest modeled $PM_{2.5}$ air quality levels.[4]

Based on our review of the current body of scientific literature, EPA now estimates 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 recognizing potential uncertainty about the exact shape of the concentration-response function.

Consistent with this finding, we have conformed the previous threshold sensitivity analysis to the current state of the PM science by incorporating a "Lowest Measured Level" (LML) assessment, which is a method EPA has employed in several recent RIAs including the Cross-State Air Pollution Rule (U.S. EPA, 2011b). This information allows readers to determine the portion of population exposed to annual mean $PM_{2.5}$ levels at or above 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 major cohort studies that estimate PM-related mortality. While an LML assessment 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. It is important

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[4] Additional updates since the Cement RIA include a revised VSL and updated baseline incidence rates.

to emphasize that we have high confidence in $PM_{2.5}$-related effects down to the lowest LML of the major cohort studies, which is 5.8 µg/m^3. Just because we have greater confidence in the benefits above the LML, this does not mean that we have no confidence that benefits occur below the LML. For a summary of the scientific review statements regarding the lack of a threshold in the $PM_{2.5}$-mortality relationship, see the Technical Support Document (TSD) entitled *Summary of Expert Opinions on the Existence of a Threshold in the Concentration-Response Function for $PM_{2.5}$-related Mortality* (U.S. EPA, 2010b).

For this analysis, policy-specific air quality data is not available due to time or resource limitations. For these rules, 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 source apportionment modeling used to calculate the benefit-per-ton estimates for this sector. 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 rule-specific air quality modeling, is the shift in exposure associated with this specific rule. Therefore, caution is warranted when interpreting the LML assessment for this rule. The results of this analysis are provided in Section 7.3.

As is the nature of 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 $5.5 million (2000$)[5] 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

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[5] After adjusting the VSL for a different currency year (2010$) and to account for income growth to 2015 of the $5.5 million value, the VSL is $8.0 million.

official guidance on the use of VSL in rulemakings 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)[6] 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 1991. The mean VSL across these studies is $6.3 million (2000$).[7] 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

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[6] In revised Economic Guidelines (U.S. EPA, 2010c), 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.

[7] This value is $4.8 in 1990$. 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.

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 implementation rules are from a specific class of well-characterized sources. In general, EPA is more confident in the magnitude and location of the emission reductions for implementation rules rather than illustrative NAAQS analyses. 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, 2010a).

Figure 7.1 illustrates the relative breakdown of the monetized $PM_{2.5}$ health benefits.

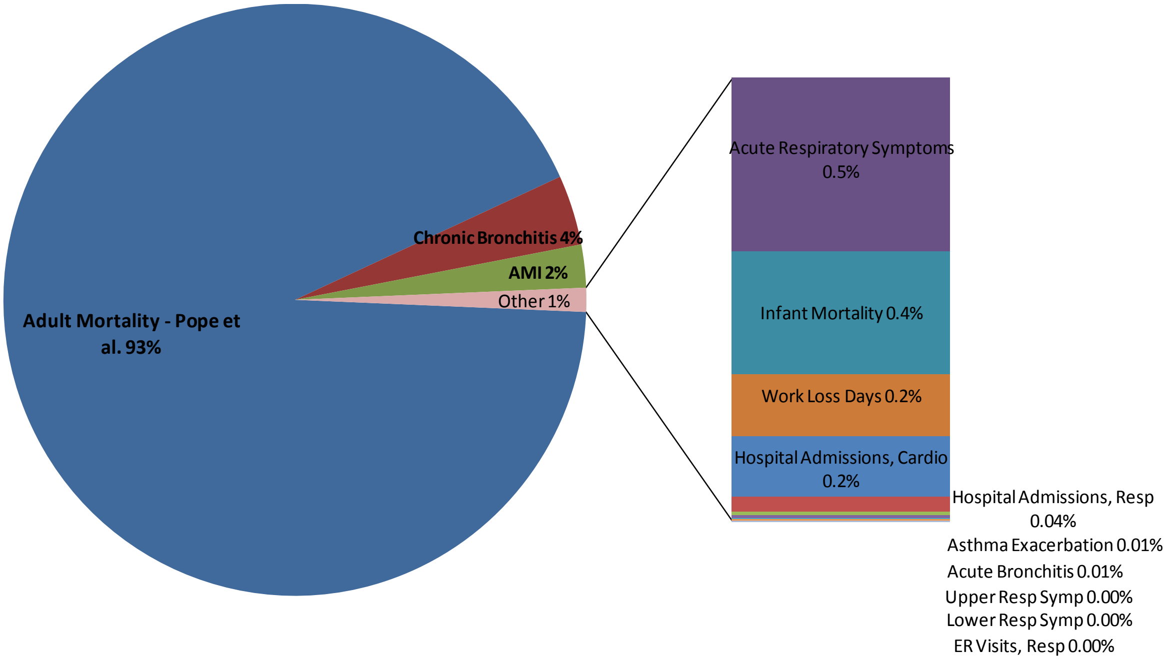

Figure 7-1: Breakdown of Monetized $PM_{2.5}$ Health Benefits using Mortality Function from Pope et al. (2002)*

*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 7-2 provides a general summary of the monetized PM-related health benefits by precursor, including the emission reductions and benefit-per-ton estimates at discount rates of 3% and 7%.[8] Table 7-3 provides a summary of the reductions in health incidences as a result of the pollution reductions. In Table 7-4, 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 7-2 provides a visual representation of the range of $PM_{2.5}$-related benefits estimates using

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[8] 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., 2013), 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.

concentration-response functions supplied by experts. Figure 7-3 shows a breakdown of monetized benefits by engine size.

The benefit-per-ton estimates shown in this RIA are different than the benefit-per-ton estimates cited in the 2010 final SI RICE RIA for two reasons. First, these estimates are based on updated air quality modeling, which results in slightly higher benefits per ton for other non-EGU point sources than the previous modeling. Second, these estimates have been inflated to 2010$. Third, the new air quality modeling did not provide estimates associated with reducing VOCs.

Table 7-2: General Summary of Monetized $PM_{2.5}$-Related Health Co-Benefits Estimates for the Proposed SI RICE NESHAP Reconsideration (millions of 2010$)*

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 of 2010$ at 3%)	Total Monetized Benefits (millions of 2010$ at 7%)
$PM_{2.5}$ Precursors							
NO_X	9,648	$6,400	$16,000	$5,700	$14,000	$62 to $150	$55 to $140
					Total	**$62 to $150**	**$55 to $140**

* All estimates are for the analysis year (2013), and are rounded to two significant figures so numbers may not sum across columns. It is important to note that the monetized benefits do not include reduced health effects from direct exposure to NO_2, ozone exposure, ecosystem effects, or visibility impairment. All fine particles are assumed to have equivalent health effects, but the benefit per ton estimates vary because each ton of precursor reduced has a different propensity to form $PM_{2.5}$. 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 7-3: Summary of Reductions in Health Incidences from $PM_{2.5}$-Related Co-Benefits for Proposed SI RICE NESHAP Reconsideration*

Avoided Premature Mortality	
Pope et al.	7
Laden et al.	18
Avoided Morbidity	
Chronic Bronchitis	5
Emergency Department Visits, Respiratory	5
Hospital Admissions, Respiratory	1
Hospital Admissions, Cardiovascular	3
Acute Bronchitis	11
Lower Respiratory	140
Upper Respiratory	110
Minor Restricted Activity Days	5,600
Work Loss Days	950
Asthma Exacerbation	230
Acute Myocardial Infarction	8

* All estimates are for the analysis year (2013) and are rounded to whole numbers with two significant figures. All fine particles are assumed to have equivalent health effects because the scientific evidence is not yet sufficient to allow differentiation of effects estimates by particle type. Confidence intervals are unavailable for this analysis because of the benefit-per-ton methodology.

Table 7-4: All $PM_{2.5}$ Co-Benefits Estimates for the Proposed SI RICE NESHAP Reconsideration at discount rates of 3% and 7% in 2013 (in millions of 2010$)*

	3%	7%
Benefit-per-ton Coefficients Derived from Epidemiology Literature		
Pope et al.	$62	$55
Laden et al.	$150	$140
Benefit-per-ton Coefficients Derived from Expert Elicitation		
Expert A	$160	$150
Expert B	$120	$110
Expert C	$120	$110
Expert D	$87	$78
Expert E	$200	$180
Expert F	$110	$100
Expert G	$74	$66
Expert H	$93	$83
Expert I	$120	$110
Expert J	$100	$89
Expert K	$24	$21
Expert L	$82	$73

[*] All estimates are rounded to two significant figures. 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

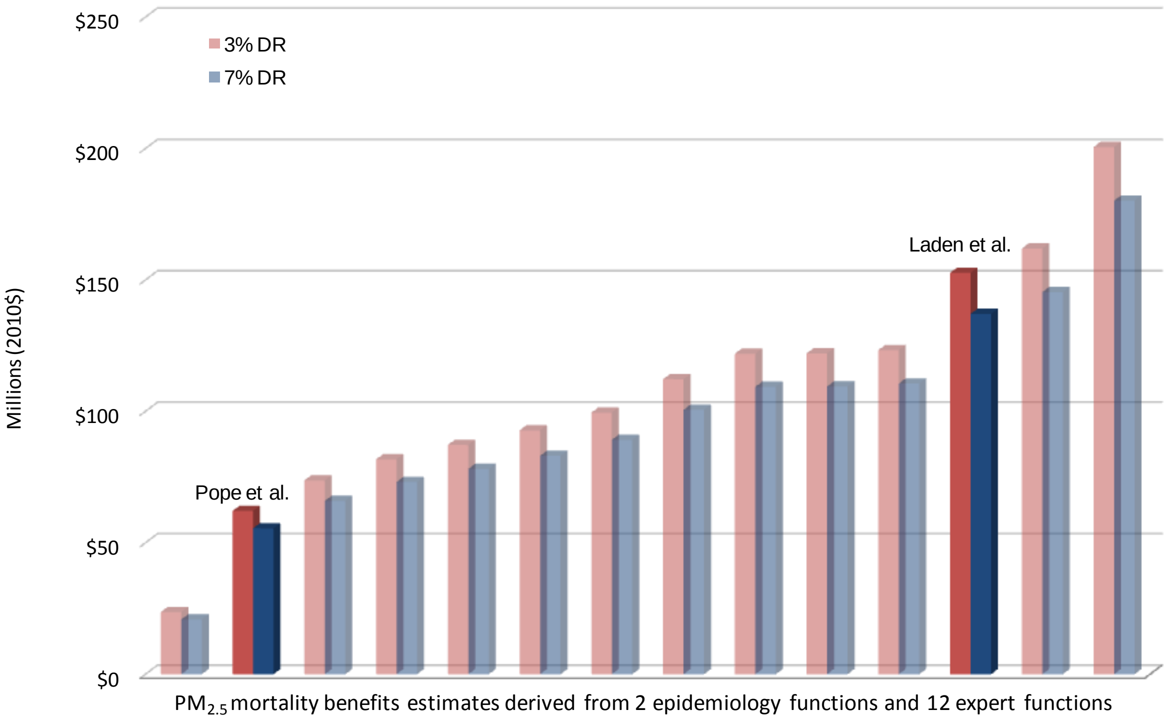

Figure 7-2: Total Monetized $PM_{2.5}$ Co-Benefits of Proposed SI RICE NESHAP Reconsideration in 2013

*This graph shows the estimated benefits at discount rates of 3% and 7% using effect coefficients derived from the Pope et al. study and the Laden et al 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.

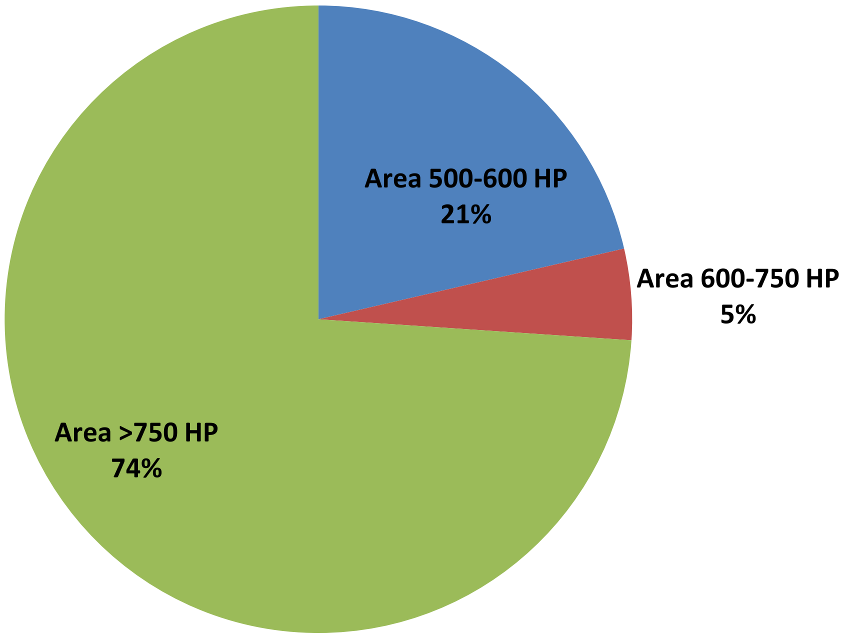

Figure 7-3: Breakdown of Total Monetized $PM_{2.5}$ Co-Benefits of Proposed SI RICE NESHAP Reconsideration by Engine Size

7.2 Unquantified Benefits

The monetized benefits estimated in this RIA only reflect a subset of benefits attributable to the health effect reductions associated with ambient fine particles. Data, time, and resource limitations prevented EPA from quantifying the impacts to, or monetizing the benefits from several important benefit categories, including benefits from reducing exposure to HAP, CO, NO_2, and ozone exposure, as well as ecosystem effects, and visibility impairment. This does not imply that there are no benefits associated with these emission reductions. These benefits are described qualitatively in this section.

7.2.1 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, 2011c).[9] 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

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

of greatest potential concern, U.S. EPA conducts the NATA.[10] 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.[11] 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,[12] subchronic,[13] or acute[14] inhalation exposures to air toxics, and include neurological, cardiovascular, liver, kidney, and respiratory 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.

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[10] 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.(2011). 2005 National-Scale Air Toxics Assessment. http://www.epa.gov/ttn/atw/nata2005/

[11] 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.

[12] 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).

[13] 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).

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

Figure 7-4 and Figure 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.

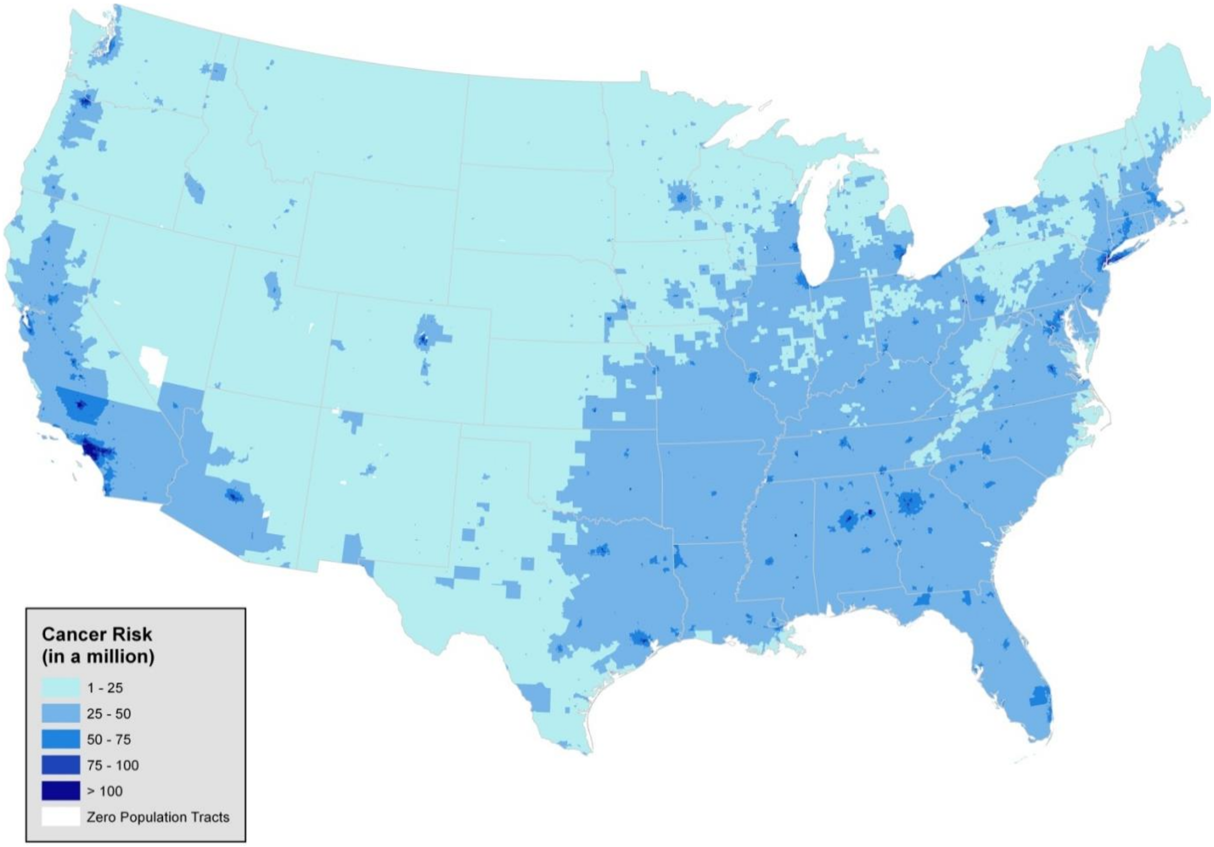

Figure 7-4 Estimated Chronic Census Tract Carcinogenic Risk from HAP exposure from outdoor sources (2005 NATA)

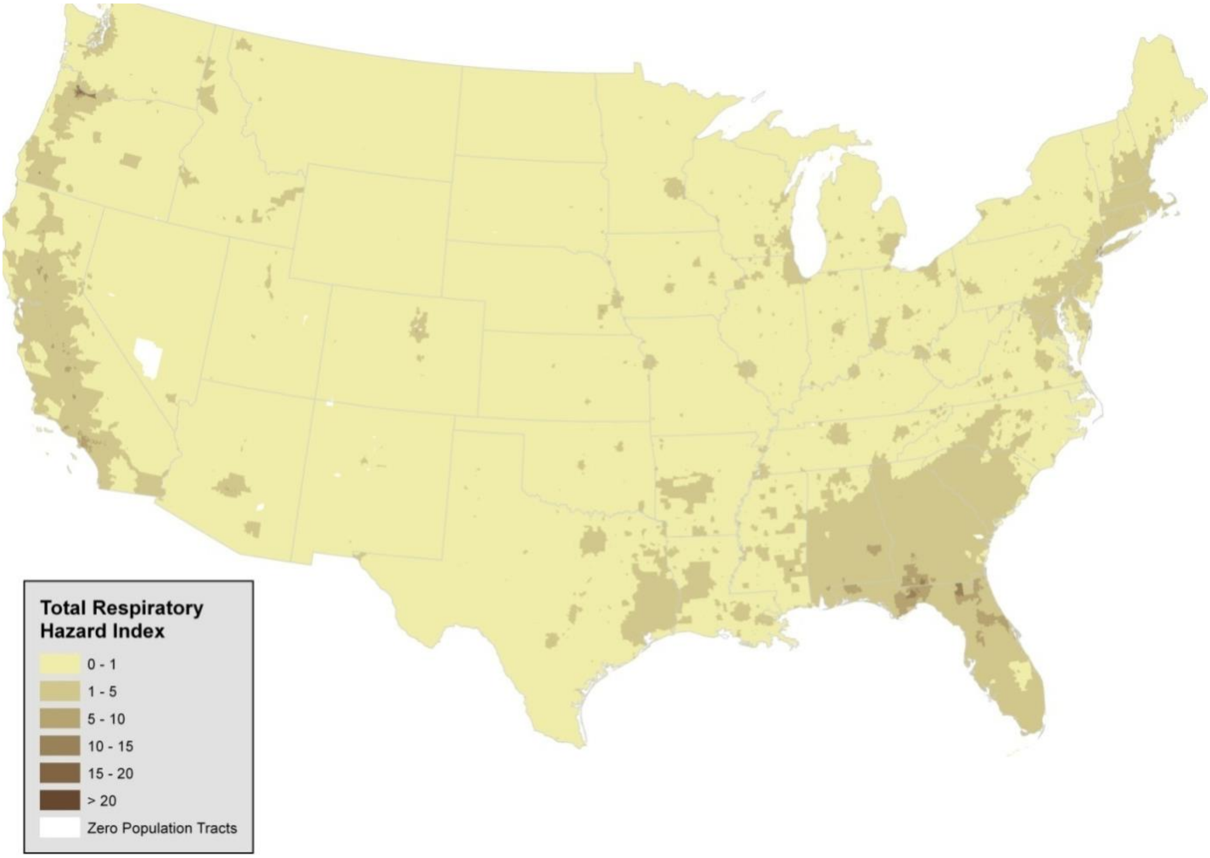

Figure 7-5 Estimated Chronic Census Tract Noncancer (Respiratory) Risk from HAP exposure from outdoor sources (2005 NATA)

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 HAP, 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.[15] 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 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

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[15] 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 $\mu g/m^3$ of a pollutant.

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 HAP.

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 HAP. 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 HAP, 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 HAP in this analysis. Instead, we provide a qualitative analysis of the health effects associated with the HAP anticipated to be reduced by these rules.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.

Although numerous HAPs may be emitted from SI RICE, a few HAPs account for over 90% of the total mass of HAPs emissions emitted. These HAPs are formaldehyde (72%), acetaldehyde (8%), acrolein (7%), methanol (3%), and benzene (3%). Although we do not have estimates of emission reductions for each HAP, this rule is anticipated to reduce 1,800 tons of HAPs each year. Below we describe the health effects associated with the top 5 HAPs by mass emitted from SI RICE.

Formaldehyde

Since 1987, EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[16] Substantial additional research since that time informs current scientific understanding of the health effects associated with exposure to formaldehyde. These include recently published research conducted by the National Cancer Institute (NCI) which found an increased risk of nasopharyngeal cancer and lymphohematopoietic malignancies such as leukemia among workers exposed to formaldehyde.[17,18] In an analysis of the lymphohematopoietic cancer mortality from an extended follow-up of these workers, NCI confirmed an association between lymphohematopoietic cancer risk and peak formaldehyde exposures.[19] A recent NIOSH study of garment workers also found increased risk of death due to leukemia among workers exposed to formaldehyde.[20] Extended follow-up of a cohort of British chemical workers did not find evidence of an increase in nasopharyngeal or lymphohematopoietic cancers, but a continuing statistically significant excess in lung cancers was reported.[21]

In the past 15 years there has been substantial research on the inhalation dosimetry for formaldehyde in rodents and primates by the Chemical Industry Institute of Toxicology (CIIT, now renamed the Hamner Institutes for Health Sciences), with a focus on use of rodent data for

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[16] U.S. EPA. 1987. Assessment of Health Risks to Garment Workers and Certain Home Residents from Exposure to Formaldehyde, Office of Pesticides and Toxic Substances, April 1987. Docket EPA-HQ-OAR-2010-0162.

[17] Hauptmann, M..; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2003. Mortality from lymphohematopoetic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95: 1615-1623. Docket EPA-HQ-OAR-2010-0162.

[18] Hauptmann, M..; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2004. Mortality from solid cancers among workers in formaldehyde industries. American Journal of Epidemiology 159: 1117-1130. Docket EPA-HQ-OAR-2010-0162.

[19] Beane Freeman, L. E.; Blair, A.; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Hoover, R. N.; Hauptmann, M. 2009. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute cohort. J. National Cancer Inst. 101: 751-761. Docket EPA-HQ-OAR-2010-0162.

[20] Pinkerton, L. E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193-200. Docket EPA-HQ-OAR-2010-0162.

[21] Coggon, D, EC Harris, J Poole, KT Palmer. 2003. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. J National Cancer Inst. 95:1608-1615. Docket EPA-HQ-OAR-2010-0162.

refinement of the quantitative cancer dose-response assessment.[22,23,24] CIIT's risk assessment of formaldehyde incorporated mechanistic and dosimetric information on formaldehyde. These data were modeled using a biologically-motivated two-stage clonal growth model for cancer and also a point of departure based on a Benchmark Dose approach. However, it should be noted that recent research published by EPA indicates that when two-stage modeling assumptions are varied, resulting dose-response estimates can vary by several orders of magnitude.[25,26,27,28] These findings are not supportive of interpreting the CIIT model results as providing a conservative (health protective) estimate of human risk.[29] EPA research also examined the contribution of the two-stage modeling for formaldehyde towards characterizing the relative weights of key events in the mode-of-action of a carcinogen. For example, the model-based inference in the published CIIT study that formaldehyde's direct mutagenic action is not relevant to the compound's tumorigenicity was found not to hold under variations of modeling assumptions.[30]

Based on the developments of the last decade, in 2004, the working group of the IARC concluded that formaldehyde is carcinogenic to humans (Group 1), on the basis of sufficient evidence in humans and sufficient evidence in experimental animals - a higher classification than previous IARC evaluations. After reviewing the currently available epidemiological evidence, the IARC (2006) characterized the human evidence for formaldehyde carcinogenicity as

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[22] Conolly, RB, JS Kimbell, D Janszen, PM Schlosser, D Kalisak, J Preston, and FJ Miller. 2003. Biologically motivated computational modeling of formaldehyde carcinogenicity in the F344 rat. Tox Sci 75: 432-447. Docket EPA-HQ-OAR-2010-0162.

[23] Conolly, RB, JS Kimbell, D Janszen, PM Schlosser, D Kalisak, J Preston, and FJ Miller. 2004. Human respiratory tract cancer risks of inhaled formaldehyde: Dose-response predictions derived from biologically-motivated computational modeling of a combined rodent and human dataset. Tox Sci 82: 279-296. Docket EPA-HQ-OAR-2010-0162.

[24] Chemical Industry Institute of Toxicology (CIIT).1999. Formaldehyde: Hazard characterization and dose-response assessment for carcinogenicity by the route of inhalation. CIIT, September 28, 1999. Research Triangle Park, NC. Docket EPA-HQ-OAR-2010-0162.

[25] U.S. EPA. Analysis of the Sensitivity and Uncertainty in 2-Stage Clonal Growth Models for Formaldehyde with Relevance to Other Biologically-Based Dose Response (BBDR) Models. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/R-08/103, 2008. Docket EPA-HQ-OAR-2010-0162.

[26] Subramaniam, R; Chen, C; Crump, K; .et .al. (2008) Uncertainties in biologically-based modeling of formaldehyde-induced cancer risk: identification of key issues. Risk Anal 28(4):907-923. Docket EPA-HQ-OAR-2010-0162.

[27] Subramaniam RP; Crump KS; Van Landingham C; et. al. (2007) Uncertainties in the CIIT model for formaldehyde-induced carcinogenicity in the rat: A limited sensitivity analysis–I. Risk Anal, 27: 1237–1254. Docket EPA-HQ-OAR-2010-0162.

[28] Crump, K; Chen, C; Fox, J; .et .al. (2008) Sensitivity analysis of biologically motivated model for formaldehyde-induced respiratory cancer in humans. Ann Occup Hyg 52:481-495. Docket EPA-HQ-OAR-2010-0162.

[29] Crump, K; Chen, C; Fox, J; .et .al. (2008) Sensitivity analysis of biologically motivated model for formaldehyde-induced respiratory cancer in humans. Ann Occup Hyg 52:481-495. Docket EPA-HQ-OAR-2010-0162.

[30] Subramaniam RP; Crump KS; Van Landingham C; et. al. (2007) Uncertainties in the CIIT model for formaldehyde-induced carcinogenicity in the rat: A limited sensitivity analysis–I. Risk Anal, 27: 1237–1254. Docket EPA-HQ-OAR-2010-0162.

"sufficient," based upon the data on nasopharyngeal cancers; the epidemiologic evidence on leukemia was characterized as "strong."[31]

Formaldehyde exposure also causes a range of noncancer health effects, including irritation of the eyes (burning and watering of the eyes), nose and throat. Effects from repeated exposure in humans include respiratory tract irritation, chronic bronchitis and nasal epithelial lesions such as metaplasia and loss of cilia. Animal studies suggest that formaldehyde may also cause airway inflammation – including eosinophil infiltration into the airways. There are several studies that suggest that formaldehyde may increase the risk of asthma – particularly in the young.[32,33]

The above-mentioned rodent and human studies, as well as mechanistic information and their analyses, were evaluated in EPA's recent Draft Toxicological Review of Formaldehyde – Inhalation Assessment through the Integrated Risk Information System (IRIS) program. This draft IRIS assessment was released in June 2010 for public review and comment and external peer review by the National Research Council (NRC). The NRC released their review report in April 2011 (http://www.nap.edu/catalog.php?record_id=13142). The EPA is currently revising the draft assessment in response to this review.

Acetaldehyde

Acetaldehyde is classified in EPA's IRIS database as a probable human carcinogen, based on nasal tumors in rats, and is considered toxic by the inhalation, oral, and intravenous routes.[34] Acetaldehyde is reasonably anticipated to be a human carcinogen by the U.S. Department of Health and Human Services (DHHS) in the 11th Report on Carcinogens and is classified as

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[31] International Agency for Research on Cancer (2006) Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol. Monographs Volume 88. World Health Organization, Lyon, France. Docket EPA-HQ-OAR-2010-0162.

[32] Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for Formaldehyde. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. http://www.atsdr.cdc.gov/toxprofiles/tp111.html. Docket EPA-HQ-OAR-2010-0162.

[33] WHO (2002) Concise International Chemical Assessment Document 40: Formaldehyde. Published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organization, and the World Health Organization, and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals. Geneva. Docket EPA-HQ-OAR-2010-0162.

[34] U.S. Environmental Protection Agency (U.S. EPA). 1991. Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at http://www.epa.gov/iris/subst/0290.htm.

possibly carcinogenic to humans (Group 2B) by the IARC.[35,36] The primary noncancer effects of exposure to acetaldehyde vapors include irritation of the eyes, skin, and respiratory tract.[37]

Acrolein

EPA determined in 2003 that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was available on the carcinogenic effects of acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[38] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[39]

Acrolein is extremely acrid and irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation, mucus hypersecretion and congestion. The intense irritancy of this carbonyl has been demonstrated during controlled tests in human subjects, who suffer intolerable eye and nasal mucosal sensory reactions within minutes of exposure.[40] These data and additional studies regarding acute effects of human exposure to acrolein are summarized in EPA's 2003 IRIS Human Health Assessment for acrolein.[41] Evidence available from studies in humans indicate that levels as low as 0.09 ppm (0.21 mg/m^3) for five minutes may elicit subjective complaints of eye irritation with increasing concentrations leading to more

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[35] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: http://ntp.niehs.nih.gov/go/16183.

[36] International Agency for Research on Cancer (IARC). 1999. Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemical to Humans, Vol 71. Lyon, France.

[37] U.S. Environmental Protection Agency (U.S. EPA). 1991. Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at http://www.epa.gov/iris/subst/0290.htm.

[38] U.S. Environmental Protection Agency (U.S. EPA). 2003. Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at http://www.epa.gov/iris/toxreviews/0364tr.pdf.

[39] International Agency for Research on Cancer (IARC). 1995. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 63, Dry cleaning, some chlorinated solvents and other industrial chemicals, World Health Organization, Lyon, France.

[40] U.S. Environmental Protection Agency (U.S. EPA). 2003. Integrated Risk Information System File of Acrolein. EPA/635/R-03/003. p. 10. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at http://www.epa.gov/iris/toxreviews/0364tr.pdf.

[41] U.S. Environmental Protection Agency (U.S. EPA). 2003. Integrated Risk Information System File of Acrolein. 2003. Research and Development, National Center for Environmental Assessment, Washington, DC. EPA/635/R-03/003. This material is available at http://www.epa.gov/iris/toxreviews/0364tr.pdf.

extensive eye, nose and respiratory symptoms.[42] Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein.[43] Acute exposure effects in animal studies report bronchial hyper-responsiveness.[44] In a recent study, the acute respiratory irritant effects of exposure to 1.1 ppm acrolein were more pronounced in mice with allergic airway disease by comparison to non-diseased mice which also showed decreases in respiratory rate.[45] Based on these animal data and demonstration of similar effects in humans (i.e., reduction in respiratory rate), individuals with compromised respiratory function (e.g., emphysema, asthma) are expected to be at increased risk of developing adverse responses to strong respiratory irritants such as acrolein.

Benzene

The EPA's IRIS database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure, and concludes that exposure is associated with additional health effects, including genetic changes in both humans and animals and increased proliferation of bone marrow cells in mice.[46,47,48] EPA states in its IRIS database that data indicate a causal relationship between benzene exposure and acute lymphocytic leukemia and suggest a relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia. The IARC has determined that benzene is a human carcinogen and the DHHS has characterized benzene as a

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[42] U.S. Environmental Protection Agency (U.S. EPA). 2003. Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. EPA/635/R-03/003. p. 11. This material is available at http://www.epa.gov/iris/toxreviews/0364tr.pdf.

[43] U.S. Environmental Protection Agency (U.S. EPA). 2003. Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. EPA/635/R-03/003. This material is available at http://www.epa.gov/iris/toxreviews/0364tr.pdf.

[44] U.S. Environmental Protection Agency (U.S. EPA). 2003. Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. EPA/635/R-03/003. This material is available at http://www.epa.gov/iris/toxreviews/0364tr.pdf.

[45] Morris JB, Symanowicz PT, Olsen JE, et al. 2003. Immediate sensory nerve-mediated respiratory responses to irritants in healthy and allergic airway-diseased mice. J Appl Physiol 94(4):1563-1571.

[46] U.S. Environmental Protection Agency (U.S. EPA). 2000. Integrated Risk Information System File for Benzene. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at: http://www.epa.gov/iris/subst/0276.htm.

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

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

known human carcinogen.[49,50] A number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene.[51,52]

Methanol

Exposure of humans to methanol by inhalation or ingestion may result in central nervous system depression and degenerative changes in the brain and visual systems. After inhaled or ingested, methanol is converted to formate, a highly toxic metabolite that within the course of a few hours can cause narcosis, metabolic acidosis, headaches, severe abdominal and leg pain and visual degeneration that can lead to blindness.[53]

Methanol has been demonstrated to cause developmental toxicity in rats and mice, and reproductive and developmental toxicity in monkeys. A number of studies have reported adverse effects in the offspring of rats and mice exposed to methanol by inhalation including reduced weight of brain pituitary gland, thymus, thyroid, reduced overall fetal body weight and increased incidence of extra ribs and cleft palate.[54,55,56] Methanol inhalation studies using rhesus monkeys

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[49] International Agency for Research on Cancer (IARC). 1987. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Supplement 7, Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France.

[50] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: http://ntp.niehs.nih.gov/go/16183.

[51] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193-197.

[52] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541-554.

[53] Rowe, VK and McCollister, SB. 1981. Alcohols. In: Patty's Industrial Hygiene and Toxicology, 3rd ed. Vol. 2C, GD Clayton, FE Clayton, Eds. John Wiley & Sons, New York, pp. 4528-4541.

[54] New Energy Development Organization (NEDO). 1987. Toxicological research of methanol as a fuel for power station: summary report on tests with monkeys, rats and mice. Tokyo, Japan.

[55] Nelson, BK; Brightwell, WS; MacKenzie, DR; Khan, A; Burg, JR; Weigel, WW; Goad, PT. 1985. Teratological assessment of methanol and ethanol at high inhalation levels in rats. Toxicol Sci, 5: 727-736.

[56] Rogers, JM; Barbee, BD; Rehnberg, BF. 1993. Critical periods of sensitivity for the developmental toxicity of inhaled methanol. Teratology, 47: 395.

have reported a decrease in the length of pregnancy, and limited evidence of impaired learning ability in offspring.[57,58,59,60] EPA has not classified methanol with respect to its carcinogenicity.

Other Air Toxics

In addition to the compounds described above, other toxic compounds might be affected by these rules. Information regarding the health effects of those compounds can be found in EPA's IRIS database.[61]

7.2.2 Additional NO_2 Co-Benefits

In addition to being a precursor to $PM_{2.5}$, NO_x emissions are also associated with a variety of respiratory health effects. Unfortunately, we were unable to estimate the health benefits associated with reduced NO_2 or ozone exposure in this analysis because we do not have air quality modeling data available. Therefore, this analysis only quantifies and monetizes the $PM_{2.5}$ benefits associated with the reductions in NO_2 emissions.

Following an extensive evaluation of health evidence from epidemiologic and laboratory studies, the Integrated Science Assessment (ISA) for Nitrogen Dioxide concluded that there is a likely causal relationship between respiratory health effects and short-term exposure to NO_2 (U.S. EPA, 2008c). Persons with preexisting respiratory disease, children, and older adults may be more susceptible to the effects of NO_2 exposure. Based on our review of this information, we identified four short-term morbidity endpoints that the NO_2 ISA identified as a "likely causal relationship": asthma exacerbation, respiratory-related emergency department visits, and respiratory-related hospitalizations. The differing evidence and associated strength of the evidence for these different effects is described in detail in the NO_2 ISA. The NO_2 ISA also concluded that the relationship between short-term NO_2 exposure and premature mortality was "suggestive but not sufficient to infer a causal relationship" because it is difficult to attribute the mortality risk effects to NO_2 alone. Although the NO_2 ISA stated that studies consistently

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[57] Burbacher, T; Grant, K; Shen, D; Damian, D; Ellis, S; Liberato, N. 1999. Reproductive and offspring developmental effects following maternal inhalation exposure to methanol in nonhuman primates Part II: developmental effects in infants exposed prenatally to methanol. Health Effects Institute. Cambridge, MA.

[58] Burbacher, T; Shen, D; Grant, K; Sheppard, L; Damian, D; Ellis, S; Liberato, N. 1999. Reproductive and offspring developmental effects following maternal inhalation exposure to methanol in nonhuman primates Part I: methanol disposition and reproductive toxicity in adult females. Health Effects Institute. Cambridge, MA.

[59] Burbacher, TM; Grant, KS; Shen, DD; Sheppard, L; Damian, D; Ellis, S; Liberato, N. 2004. Chronic maternal methanol inhalation in nonhuman primates (Macaca fascicularis): reproductive performance and birth outcome. Neurotoxicol Teratol, 26: 639-650.

[60] Burbacher, TM; Shen, DD; Lalovic, B; Grant, KS; Sheppard, L; Damian, D; Ellis, S; Liberato, N. 2004. Chronic maternal methanol inhalation in nonhuman primates (Macaca fascicularis): exposure and toxicokinetics prior to and during pregnancy. Neurotoxicol Teratol, 26: 201-221.

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

reported a relationship between NO_2 exposure and mortality, the effect was generally smaller than that for other pollutants such as PM.

NOx emissions also contribute to a variety of adverse welfare effects, including acidic deposition, visibility impairment, nutrient enrichment. Deposition of nitrogen causes acidification, which can cause a loss of biodiversity of fishes, zooplankton, and macro invertebrates in aquatic ecosystems, as well as a decline in sensitive tree species, such as red spruce (*Picea rubens*) and sugar maple (*Acer saccharum*) in terrestrial ecosystems. In the northeastern United States, the surface waters affected by acidification are a source of food for some recreational and subsistence fishermen and for other consumers and support several cultural services, including aesthetic and educational services and recreational fishing. Biological effects of acidification in terrestrial ecosystems are generally linked to aluminum toxicity, which can cause reduced root growth, which restricts the ability of the plant to take up water and nutrients. These direct effects can, in turn, increase the sensitivity of these plants to stresses, such as droughts, cold temperatures, insect pests, and disease leading to increased mortality of canopy trees. Terrestrial acidification affects several important ecological services, including declines in habitat for threatened and endangered species (cultural), declines in forest aesthetics (cultural), declines in forest productivity (provisioning), and increases in forest soil erosion and reductions in water retention (cultural and regulating). (U.S. EPA, 2008d)

Deposition of nitrogen is also associated with aquatic and terrestrial nutrient enrichment. In estuarine waters, excess nutrient enrichment can lead to eutrophication. Eutrophication of estuaries can disrupt an important source of food production, particularly fish and shellfish production, and a variety of cultural ecosystem services, including water-based recreational and aesthetic services. Terrestrial nutrient enrichment is associated with changes in the types and number of species and biodiversity in terrestrial systems. Excessive nitrogen deposition upsets the balance between native and nonnative plants, changing the ability of an area to support biodiversity. When the composition of species changes, then fire frequency and intensity can also change, as nonnative grasses fuel more frequent and more intense wildfires. (U.S. EPA, 2008d)

7.2.3 Ozone Co-Benefits

In the presence of sunlight, NOx and VOCs can undergo a chemical reaction in the atmosphere to form ozone. Reducing ambient ozone concentrations is associated with significant human health benefits, including mortality and respiratory morbidity (U.S. EPA, 2008a). Epidemiological researchers have associated ozone exposure with adverse health effects in numerous toxicological, clinical and epidemiological studies (U.S. EPA, 2006c). These health effects include respiratory morbidity such as fewer asthma attacks, hospital and ER visits, school loss days, as well as premature mortality.

7.2.4 Carbon Monoxide Co-Benefits

Carbon monoxide in ambient air is formed primarily by the incomplete combustion of carbon-containing fuels and photochemical reactions in the atmosphere. The amount of CO emitted from these reactions, relative to carbon dioxide (CO_2), is sensitive to conditions in the combustion zone, such as fuel oxygen content, burn temperature, or mixing time. Upon inhalation, CO diffuses through the respiratory system to the blood, which can cause hypoxia (reduced oxygen availability). Carbon monoxide can elicit a broad range of effects in multiple tissues and organ systems that are dependent upon concentration and duration of exposure. The Integrated Science Assessment for Carbon Monoxide (U.S. EPA, 2010a) concluded that short-term exposure to CO is "likely to have a causal relationship" with cardiovascular morbidity, particularly in individuals with coronary heart disease. Epidemiologic studies associate short-term CO exposure with increased risk of emergency department visits and hospital admissions. Coronary heart disease includes those who have angina pectoris (cardiac chest pain), as well as those who have experienced a heart attack. Other subpopulations potentially at risk include individuals with diseases such as chronic obstructive pulmonary disease (COPD), anemia, or diabetes, and individuals in very early or late life stages, such as older adults or the developing young. The evidence is suggestive of a causal relationship between short-term exposure to CO and respiratory morbidity and mortality. The evidence is also suggestive of a causal relationship for birth outcomes and developmental effects following long-term exposure to CO, and for central nervous system effects linked to short- and long-term exposure to CO.

7.2.5 Visibility Impairment Co-Benefits

Reducing secondary formation of $PM_{2.5}$ would improve visibility throughout the U.S. Fine particles with significant light-extinction efficiencies include sulfates, nitrates, organic carbon, elemental carbon, and soil (Sisler, 1996). Suspended particles and gases degrade visibility by scattering and absorbing light. Higher visibility impairment levels in the East are due to generally higher concentrations of fine particles, particularly sulfates, and higher average relative humidity levels. Visibility has direct significance to people's enjoyment of daily activities and their overall sense of wellbeing. Good visibility increases the quality of life where individuals live and work, and where they engage in recreational activities. Previous analyses (U.S. EPA, 2006; U.S. EPA, 2011a; U.S. EPA, 2011b) show that visibility benefits are a significant welfare benefit category. Without air quality modeling, we are unable to estimate visibility related benefits, nor are we able to determine whether VOC emission reductions would be likely to have a significant impact on visibility in urban areas or Class I areas.

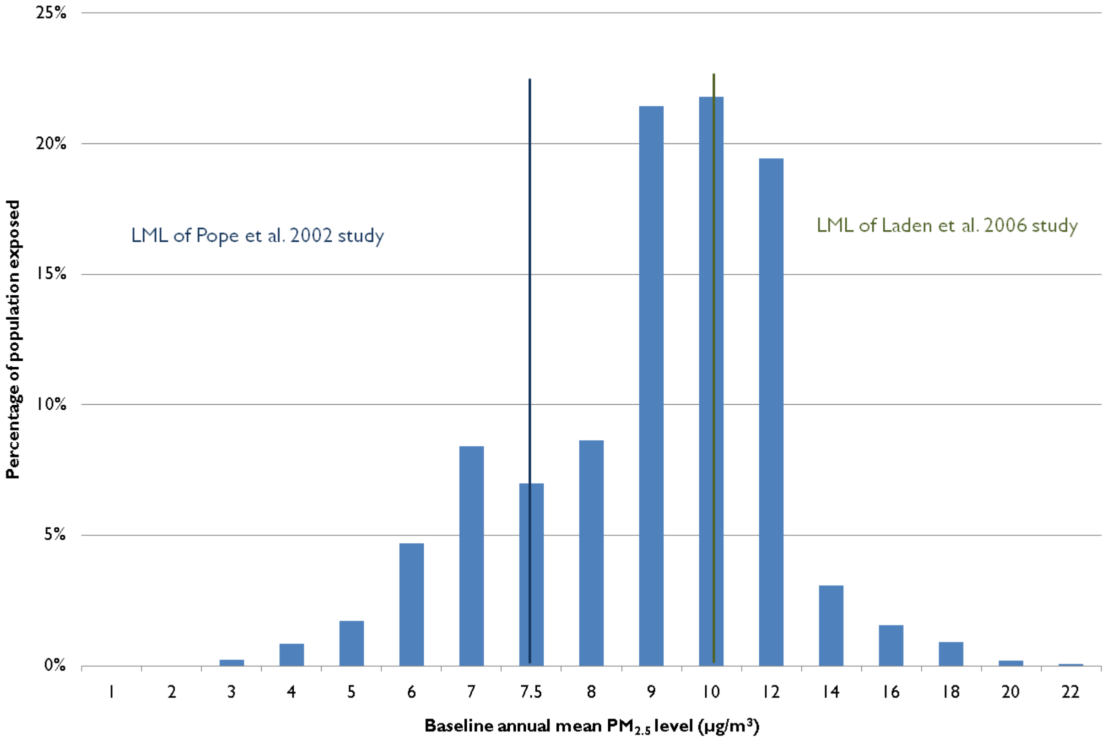
7.3 Characterization of Uncertainty in the Monetized Co-Benefits

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. As discussed in the $PM_{2.5}$ NAAQS RIA (Table 5.5) (U.S. EPA, 2006), 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. For example, these estimates do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors. Use of these $/ton values to estimate benefits 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 are all based on national or broad regional emission reduction programs and therefore represent average benefits-per-ton over the entire United States. The benefits-per-ton for emission reductions in specific locations may be very different than the estimates presented here. For more information, see the TSD describing the calculation of the new benefit-per-ton estimates (U.S. EPA, 2012).

$PM_{2.5}$ 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. For this analysis, policy-specific air quality data is not available due to time or resource limitations, thus we are unable to estimate the percentage of premature mortality associated with this specific rule’s emission reductions at each $PM_{2.5}$ level. As a surrogate measure of mortality impacts, we provide the percentage of the population exposed at each $PM_{2.5}$ level using the source apportionment modeling used to calculate the benefit-per-ton estimates for this sector. A very large proportion of the population is exposed at or above the lowest LML of the cohort studies (Figures 7-6 and 7-7), increasing our confidence in the PM mortality analysis. Figure 7-6 shows a bar chart of the percentage of the population exposed to various air quality levels in the pre- and post-policy policy. Figure 7-7 shows a cumulative distribution function of the same data. Both figures identify the LML for each of the major cohort studies. As the policy shifts the distribution of air quality levels, fewer people are exposed to $PM_{2.5}$ levels at or above the LML. Using the Pope et al. (2002) study, the 77% of the population is exposed to annual mean $PM_{2.5}$ levels at or above the LML of 7.5 µg/m^3. Using the Laden et al. (2006) study, 25% of the population is exposed above the LML of 10 µg/m^3. As we model avoided premature deaths among populations exposed to levels of $PM_{2.5}$, we have lower confidence in levels below the LML for each study. It is important to emphasize that we have high confidence in $PM_{2.5}$-related effects down to the lowest LML of the major cohort studies. Just because we have greater confidence in the benefits above the LML, this does not mean that we have no confidence that benefits occur below the LML.

A large fraction of the baseline exposure occurs below the level of the National Ambient Air Quality Standard (NAAQS) for annual $PM_{2.5}$ at 15 µg/m^3, which was set in 2006. It is important to emphasize that NAAQS are not set at a level of zero risk. Instead, the NAAQS reflect the level determined by the Administrator to be protective of public health within an adequate margin of safety, taking into consideration effects on susceptible populations. While benefits occurring below the standard may be less certain than those occurring above the standard, EPA considers them to be legitimate components of the total benefits estimate.

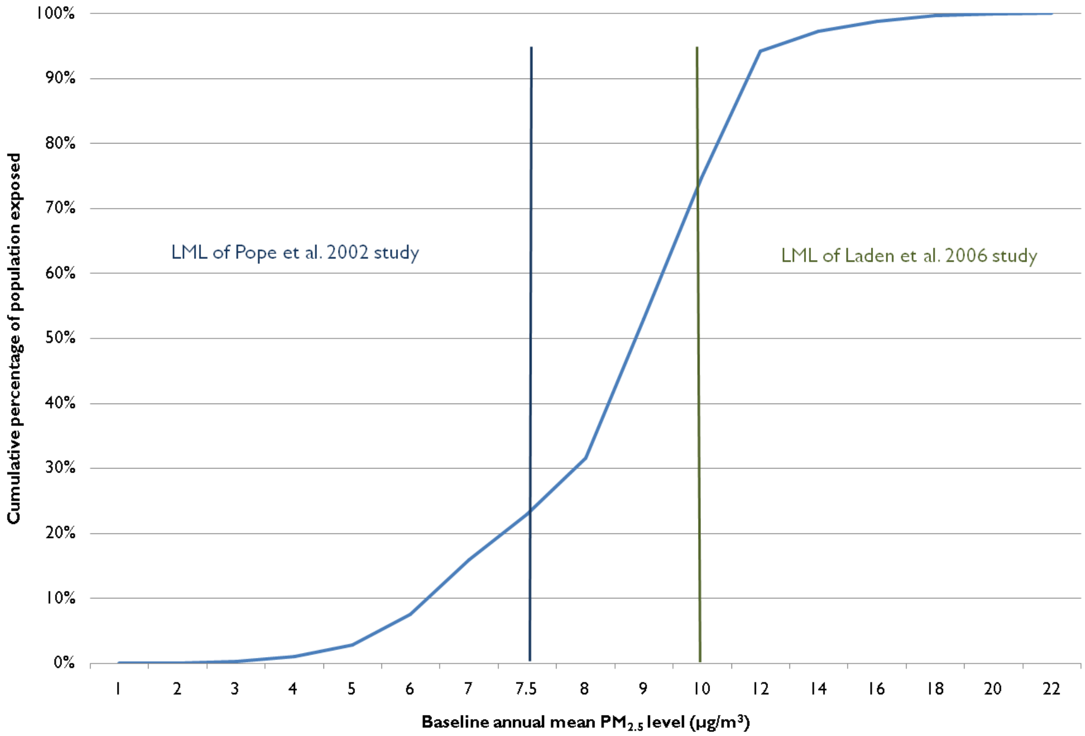


Among the populations exposed to $PM_{2.5}$ in the baseline:

77% are exposed to $PM_{2.5}$ levels at or above the LML of the Pope et al. (2002) study

25% are exposed to $PM_{2.5}$ levels at or above the LML of the Laden et al. (2006) study

Figure 7-6. Percentage of Adult Population by Annual Mean $PM_{2.5}$ Exposure in the Baseline



Among the populations exposed to $PM_{2.5}$ in the baseline:

77% are exposed to $PM_{2.5}$ levels at or above the LML of the Pope et al. (2002) study

25% are exposed to $PM_{2.5}$ levels at or above the LML of the Laden et al. (2006) study

Figure 7-7. Cumulative Distribution of Adult Population by Annual Mean $PM_{2.5}$ Exposure in the Baseline

Above we present the estimates of the total benefits, based on our interpretation of the best available scientific literature and methods and supported by the SAB-HES and the NAS (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 more than 90% of the total benefits, we were able to quantify include the following:

1. $PM_{2.5}$ benefits were derived through benefit per-ton estimates, which 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 PM precursors. We do not have data on the specific location of the air quality changes associated with this rulemaking; as such, it is not feasible to estimate the proportion of benefits occurring in different locations, such as designated nonattainment areas. In addition, the benefit-per-ton estimates are based on emissions from existing sources. To the extent that the geographic distribution of the emissions reductions for this rule are different than the

modeled emissions, the benefits may be underestimated or overestimated. In general, there is inherently more uncertainty for new sources, which may not be included in the emissions inventory, than existing sources.

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 no clear scientific grounds exist for supporting differential effects 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 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.

7.4 Comparison of Co-Benefits and Costs

Using a 3% discount rate, we estimate the total combined monetized co-benefits of the reconsidered SI RICE NESHAP proposal to be $62 million to $150 million in the implementation year (2013). Using a 7% discount rate, we estimate the total monetized co-benefits of the final rule to be $55 million to $140 million. The annualized social costs of the reconsidered SI RICE NESHAP proposal are $115 million at a 7% interest rate.[62] Thus, the net benefits are $-53 million to $35 million at a 3% discount rate and $-60 million to $ 25 million at a 7% discount rate. All estimates are in 2010$ for the year 2013.

Table 7-5 shows a summary of the monetized co-benefits, social costs, and net benefits for the reconsidered SI RICE NESHAP proposal, respectively. Figures 7-8 and 7-9 show the full range of net benefits estimates (i.e., annual co-benefits minus annualized costs) utilizing the 14 different $PM_{2.5}$ mortality functions at discount rates of 3% and 7%. In addition, the benefits from reducing 22,000 tons of carbon monoxide and 1,800 tons of HAPs each year from SI RICE have not been included in these estimates.

Table 7-5. Summary of the Monetized Benefits, Compliance Costs and Net benefits for the 2010 Rule with the Proposed Amendments to the Stationary SI Engine NESHAP in 2013 (millions of 2010 dollars)[a]

	3% Discount Rate			7% Discount Rate		
Total Monetized Benefits[2]	$62	to	$150	$55	to	$140
Total Compliance Costs[3]		$115			$115	
Net Benefits	$-53	to	$35	$-60	to	$25
Non-monetized Benefits	Health effects from HAP exposure Health effects from CO, NO_2, and ozone exposure Ecosystem effects Visibility impairment					

[1] All estimates are for the implementation year (2013), and are rounded to two significant figures.

[2] The total monetized benefits reflect the human health benefits associated with reducing exposure to $PM_{2.5}$ through reductions of $PM_{2.5}$ precursors such as NOx. Human health 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 effects estimates by particle type. Because these estimates were generated using benefit-per-ton estimates, we do not break down the total monetized benefits into specific components here. See Figure 7-1 for an illustration of the breakdown, or the RIA for the final Cross-States Air Pollution Rule (EPA, 2011) for more information.

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[62] For more information on the annualized social costs, please refer to Section 5 of this RIA.

[3] The annual compliance costs serve as a proxy for the annual social costs of this rule given the lack of difference between the two. The engineering compliance costs are annualized using a 7 percent discount rate.

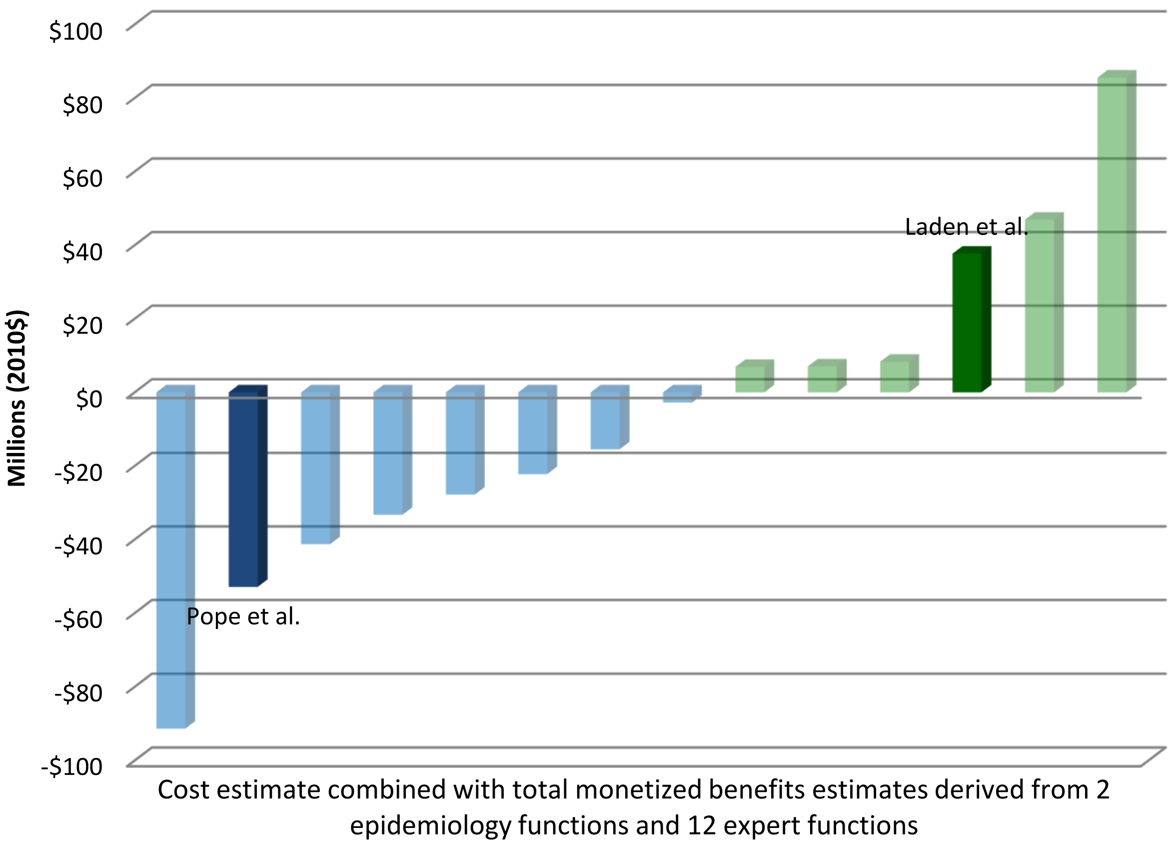

Figure 7-8. Net Benefits for Proposed SI RICE NESHAP Reconsideration at 3% discount rate*

*Net Benefits are quantified in terms of $PM_{2.5}$ at a 3% discount rate for 2013 and are in 2010$. This graph shows 14 benefits estimates combined with the cost estimate. All fine particles are assumed to have equivalent health effects. The monetized benefits incorporate the conversion from precursor emissions to ambient fine particles.

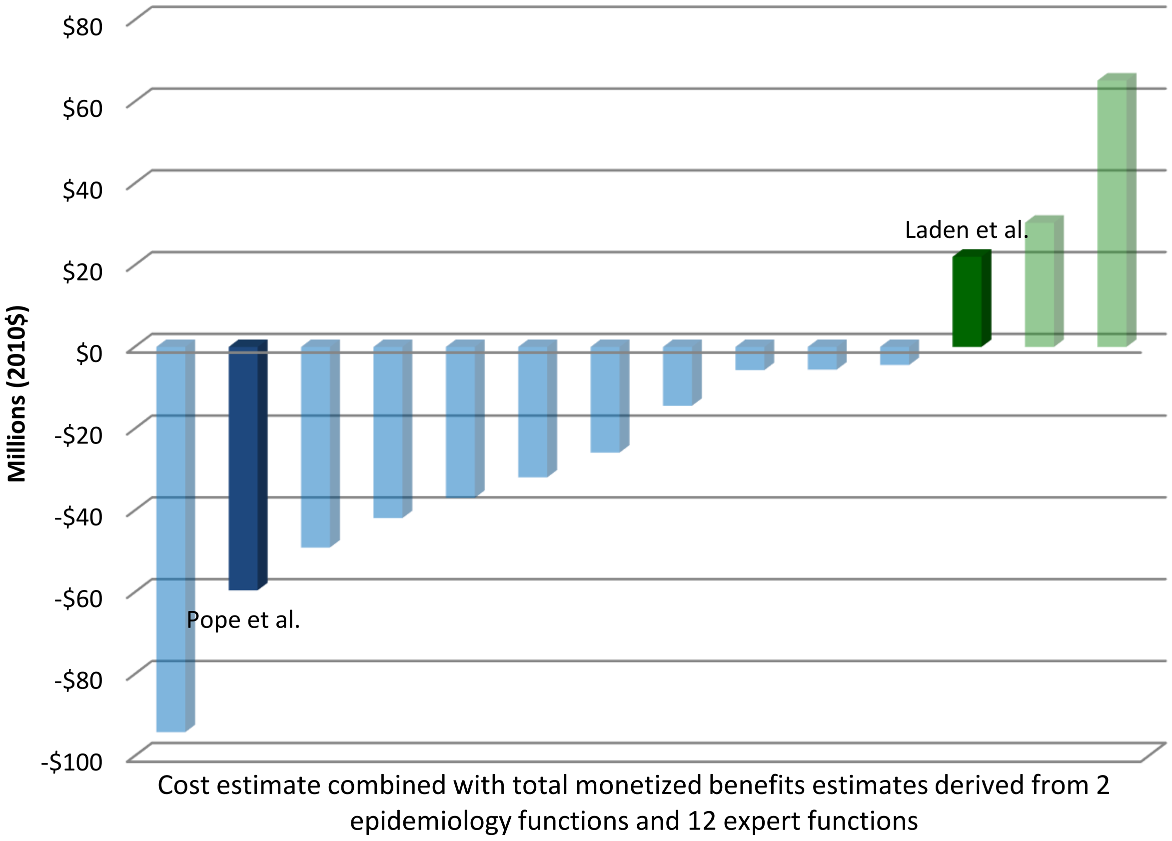

Figure 7-9. Net Benefits for Proposed SI RICE NESHAP Reconsideration at 7% discount rate*

*Net Benefits are quantified in terms of $PM_{2.5}$ benefits at a 7% discount rate at a 3% discount rate for 2013 and are in 2010$. This graph shows 14 benefits estimates combined with the cost estimate. The monetized benefits incorporate the conversion from precursor emissions to ambient fine particles.

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Section 8

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