APPENDIX A:

ECONOMIC MODEL OF MARKETS AFFECTED BY THE BOILERS AND PROCESS HEATERS MACT

The primary purpose of the EIA for the proposed rule is to describe and quantify the economic impacts associated with the rule. The Agency used a basic framework that is consistent with economic theory and the analyses performed for other rules to develop estimates of these impacts. This approach employs standard microeconomic concepts to model behavioral responses expected to occur with regulation. This appendix describes the spreadsheet model in more detail and discusses how the Agency

- collected the baseline data set from the Annual Energy Outlook 2002 (DOE, EIA, 2002), U.S. Census Bureau (U.S. Department of Commerce, 2001), and U.S. Department of Agriculture (USDA, 2002).
- characterized market supply and demand for each market and specified links between the energy and agricultural, manufacturing, mining, and commercial markets.
- introduced a policy "shock" into the model by using control cost-induced shifts in the supply functions, and
- used a solution algorithm to determine a new with-regulation equilibrium for each market.

A.1 Baseline Data Set

EPA collected the following data to characterize the baseline year, 2005:

- *Energy Market Data*—The Department of Energy's Supplemental Tables to the Annual Energy Outlook 2002 report forecasts of price, quantity, and fuel intensities used to calibrate the model.
- *Agriculture, Mining, Manufacturing, Commercial Sectors*—EPA obtained shipment data from the 1997 Economic Census and 1997 Agriculture Census. We then used annual growth rates reported by the Bureau of Economic Analysis (BEA, 1997) to estimate baseline shipment data for 2005. The Agency selected units for output such that the price in each market equals one. We computed energy demand using fuel intensity data reported in the AEO 2002.
- *Supply and Demand Elasticities*—The supply and demand elasticity values used in the market model are reported in Table 5-2 of this report. Given the uncertainties regarding these parameters, EPA also conducted several sensitivity analyses and report these results in Appendix B.

A.2 Multi-Market Model

The model includes four energy markets (coal, electricity, natural gas, and petroleum) and 24 goods and service markets. The following sections describe model equations the Agency developed to characterize these markets and estimate welfare changes resulting from the rule.

A.1.1 Supply Side Modeling

EPA estimated the change in quantity supplied as follows:

$$\Delta q^S = q_0^S \cdot \varepsilon^S \cdot \frac{\Delta p - \alpha - \sum_{j=1}^{n} \alpha_j \Delta p_j}{p_0} \quad \text{(A.1)}$$

where q_0^S is the baseline quantity, ε^S is the domestic supply elasticity, the term $\Delta p - \alpha - \sum_{j=1}^{n} \alpha_j \Delta p_j$ is the change in the producer's net price, and p_0 is the baseline price. The change in net price is composed of the change in baseline price resulting from the regulation, the direct shift in the supply function resulting from compliance costs, and the indirect shift in the supply function resulting from changes in input prices in energy market (j). The fuel share is allowed to vary using a fuel switching rule relying on cross-price elasticities of demand between energy sources.

A.1.1.2 Producer Welfare Measurement

EPA approximated the change in producer surplus with the following equation:

Increased control costs, higher energy input costs, and output declines have a negative effect

$$\Delta PS = q_1 \cdot (\Delta p - \alpha - \sum_{j=1}^{n} \alpha_j \Delta p_j) - 0.5 \cdot \Delta q \cdot (\Delta p - \alpha - \sum_{j=1}^{n} \alpha_j \Delta p_j) \quad \text{(A.2)}$$

on domestic producer surplus. However, these losses are mitigated to some degree as a result of higher market prices.

A.1.2 Energy Demand Side Modeling

Market demand in the energy markets is expressed as the sum of the energy, residential, agriculture, manufacturing, mining, commercial, and transportation sectors:

$$Q_{Dj} = \sum_{i=1}^{n} q_{Dji}, \quad \text{(A.3)}$$

where j indexes the energy market and i indexes the consuming sector. The change in residential quantity demanded of energy market j can be approximated as follows:

$$\Delta q^{Dj} = q_0^{Dj} \cdot \eta^{Dj} \cdot \frac{\Delta p_j}{p_{j0}} \quad \text{(A.4)}$$

where q_0^{Dj} is baseline consumption, η^{Dj} is the residential demand elasticity and (Δp) is the change in the market price.

In contrast, energy demand from energy, agricultural, manufacturing, mining, commercial, and transportation sectors is modeled as a derived demand resulting from the production and

consumption choices in these industries. Energy demand responds to changes in sector output and fuel switching that occurs in response to changes in relative energy prices. For each of these sectors, energy demand is expressed as follows:

$$BTU_{ij1} = \frac{BTU_{ij0}}{q_{i0}} \cdot FSW \cdot q_{i1} \qquad \text{(A.5)}$$

where BTU is demand for energy market j from sector i, q is sector i's output, and FSW is a factor generated by the fuel switching algorithm. The subscripts 0 and 1 represent baseline and with regulation conditions, respectively.

A.1.3 Agriculture, Manufacturing, Mining, Commercial, and Transportation Demand Side Modeling

The change in quantity demanded in these markets can be approximated as follows:

$$\Delta q^{D_i} = q_0^{D_i} \cdot \eta^{D_i} \cdot \frac{\Delta p_i}{p_{i0}} \qquad \text{(A.6)}$$

where $q_0^{D_i}$ is baseline output, η^D is the demand elasticity of the respective market (i) and (Δp_i) is the change in the market price.

The change in consumer surplus in markets is approximated as follows:

As shown, higher market prices and reduced consumption lead to welfare losses for consumers.

$$\Delta CS = - q_1 \cdot \Delta p + 0.5 \cdot \Delta q \cdot \Delta p \qquad \text{(A.7)}$$

A.2 With-Regulation Market Equilibrium Determination

Market adjustments can be conceptualized as an interactive feedback process. Supply segments face increased production costs as a result of the rule and are willing to supply smaller quantities at the baseline price. This reduction in market supply leads to an increase in the market price that all producers and consumers face, which leads to further responses by producers and consumers and thus new market prices. The new with-regulation equilibrium is the result of a series of iterations in which price is adjusted and producers and consumers respond, until a set of stable market prices arises where total market supply equals market demand (i.e., $Qs = Q_D$) in each market. Market price adjustment takes place based on a price revision rule that adjusts price upward (downward) by a given percentage in response to excess demand (excess supply).

The algorithm for determining with-regulation equilibria can be summarized by seven recursive steps:

1. Impose the control costs on affected supply segments, thereby affecting their supply decisions.

2. Recalculate the market supply in each market. Excess demand currently exists.

3. Determine the new prices via a price revision rule.

4. Recalculate market supply with new prices, accounting for fuel switching choices associated with new energy prices.

5. Compute market demand in each market.

6. Compare supply and demand in each markets. If equilibrium conditions are not satisfied, go to Step 3, resulting in a new set of market prices. Repeat until equilibrium conditions are satisfied (i.e., the ratio of supply to demand is arbitrarily close to one).

APPENDIX B

ASSUMPTIONS AND SENSITIVITY ANALYSIS

In developing the economic model to estimate the impacts of the industrial/ commercial/institutional boilers and process heaters NESHAP, several assumptions were necessary to make the model operational. This appendix lists and explains the major model assumptions and describes their potential impact on the analysis results. Sensitivity analyses are presented for numeric assumptions.

Assumption: The domestic markets for goods and services are all perfectly competitive.

Explanation*:* Assuming that these markets are perfectly competitive implies that the producers of these products are unable to unilaterally affect the prices they receive for their products. Because the industries used in this analysis are aggregated across a large number of individual producers, it is a reasonable assumption that the individual producers have a very small share of industry sales and cannot individually influence the price of output from that industry.

Possible Impact: If these product markets were in fact imperfectly competitive, implying that individual producers can exercise market power and thus affect the prices they receive for their products, then the economic model would understate possible increases in the price of final products due to the regulation as well as the social costs of the regulation. Under imperfect competition, producers would be able to pass along more of the costs of the regulation to consumers; thus, consumer surplus losses would be greater, and producer surplus losses would be smaller in the final product markets.

Assumption: Market Supply and Demand Elasticity Uncertainty

Explanation: The goods and service markets are modeled at the two or three-digit NAICS code level to operationalize the economic model. Because of the high level of aggregation, only limited data on elasticities of supply and demand estimates are available. However, these elasticities strongly influence the distribution of economic impacts between producers and consumers.

Sensitivity Analysis: Tables B-1a and Table B-1b show how the economic impact estimates vary as the supply and demand elasticities for goods and services change by 25 percent.

Table B-1a. Sensitivity Analysis: Supply and Demand Elasticities in the Goods and Services Markets

Change Supply Demand Constant	25% Decrease	Elasticities Reported in Section 6	25% Increase
Change in consumer surplus	–367.8	–414.3	–450.5
Change in producer surplus	–495.2	–448.7	–412.4
Change in social welfare	–862.9	–862.9	–862.9

Assumption: Cross-price elasticities of demand for fuels are based on 2015 NEMS projections.

Explanation: Cross- and own-price elasticities of demand from NEMS were used to capture fuel switching in the manufacturing sectors in the economic model. As shown in Table 5-2, allowing manufacturers to switch fuels in response to changes in relative energy prices decreases the change in social welfare by approximately 10 percent. However, the NEMS projection reflects aggregate behavioral responses in the year 2015. Because this is a longer window of analysis compared to the baseline year 2005, this analysis may overestimate firms' ability to switch fuels in the short run.

Table B-1b. Sensitivity Analysis: Supply and Demand Elasticities in the Goods and Services Markets

Supply Constant Demand Change	25% Decrease	Elasticities Reported in Section 6	25% Increase
Change in consumer surplus	–462.7	–414.3	–364.4
Change in producer surplus	–400.2	–448.7	–498.5
Change in social welfare	–862.9	–862.9	–862.9

Sensitivity Analysis: Table B-2 shows how the economic impact estimates vary as the own- and cross-price elasticities used in the EIA are reduced by 50 percent and 75 percent.

Table B-2. Sensitivity Analysis: Own- and Cross-Price Elasticities Used to Model Fuel Switching

	Fuel Price Elasticities Presented in Table 5-2	Reduced by 50 Percent	Reduced by 75 Percent
Change in consumer surplus	–414.3	–414.6	–414.9
Change in producer surplus	–448.7	–448.4	–448.0
Change in social welfare	–862.9	–862.9	–862.9

Assumption: The domestic markets for energy are perfectly competitive.

Explanation: Assuming that the markets for energy are perfectly competitive implies that individual producers are not capable of unilaterally affecting the prices they receive for their products. Under perfect competition, firms that raise their price above the competitive price are unable to sell at that higher price because they are a small share of the market and consumers can easily buy from one of a multitude of other firms that are selling at the competitive price level. Given the relatively homogeneous nature of individual energy products (petroleum, coal, natural gas, electricity), the assumption of perfect competition at the national level seems to be appropriate.

Possible Impact: If energy markets were in fact imperfectly competitive, implying that individual producers can exercise market power and thus affect the prices they receive for their products, then the economic model would understate possible increases in the price of energy due to the regulation as well as the social costs of the regulation. Under imperfect competition, energy producers would be able to pass along more of the costs of the regulation to consumers; thus, consumer surplus losses would be greater, and producer surplus losses would be smaller in the energy markets.

Assumption: The elasticity of supply in the electricity market for existing sources is approximately 0.75.

Explanation: The price elasticity of supply in the electricity markets represents the behavioral responses from existing sources to changes in the price of electricity. However, there is no consensus on estimates of the price elasticity of supply for electricity. This is in part because, under traditional regulation, the electric utility industry had a mandate to serve all its customers and utilities were compensated on a rate-based rate of return. As a result, the market concept of supply elasticity was not the driving force in utilities' capital investment decisions. This has changed under deregulation. The market price for electricity has become the determining factor in decisions to retire older units or to make higher cost units available to the market.

***Sensitivity Analysis*:** Table B-3 shows how the economic impact estimates vary as the elasticity of supply in the electricity markets varies.

Table B-3. Sensitivity Analysis: Elasticity of Supply in the Electricity Markets

	ES = 0.5	ES = 0.75	ES = 1.0
Change in consumer surplus	–405.0	–414.3	–419.6
Change in producer surplus	–457.9	–448.7	–443.4
Change in social welfare	–862.9	–862.9	–862.9

Appendix C

Air Quality Changes for the Above-the-Floor Option (Option 1A)

Table C-1 provides a summary of the predicted ambient PM_{10} and $PM_{2.5}$ concentrations from the S-R matrix for the 2005 baseline and changes associated with Option 1A, the above-the-MACT floor examined in this RIA. The results indicate that the predicted change in PM concentrations is composed almost entirely of reductions in fine particulates ($PM_{2.5}$) with little or no reduction in coarse particles (PM_{10} less $PM_{2.5}$). Therefore, the observed changes in PM_{10} are composed primarily of changes in $PM_{2.5}$. These results are quite similar to those for the proposed rule (MACT floor option). In addition to the standard frequency statistics (e.g., minimum, maximum, average, median), Table C-1 provides the population-weighted average which better reflects the baseline levels and predicted changes for more populated areas of the nation. This measure, therefore, will better reflect the potential benefits of these predicted changes through exposure changes to these populations. As shown, the average annual mean concentrations of $PM_{2.5}$ across all U.S. grid-cells declines by roughly 0.9 percent, or 0.10 $\mu g/m^3$. The population-weighted average mean concentration declined by 0.9 percent, or 0.12 $\mu g/m^3$, which is slightly larger in absolute terms than the spatial average. This indicates that the above-the-floor option generates slightly greater absolute air quality improvements in more populated, urban areas than in less populated, rural areas.

Table C-1.

Summary of 2005 Base Case PM Air Quality and Changes Due to MACT Above-the-Floor Option: Industrial Boiler/Process Heater Source Categories

Statistic	*2005 Baseline*	*Change*[a]	*Percent Change*
PM_{10}			
Minimum Annual Mean (µg/m^3) [b]	6.09	-0.08	-1.3%
Maximum Annual Mean (µg/m^3) [b]	69.30	-0.03	-0.1%
Average Annual Mean (µg/m^3)	22.68	-0.36	-1.6%
Median Annual Mean (µg/m^3)	21.84	-0.43	-1.9%
Population-Weighted Average Annual Mean (µg/m^3) [c]	28.79	-0.38	-1.3%
$PM_{2.5}$			
Minimum Annual Mean (µg/m^3) [b]	0.74	-0.01	0.0%
Maximum Annual Mean (µg/m^3) [b]	30.35	-0.77	-2.5%
Average Annual Mean (µg/m^3)	11.15	-0.10	-0.9%
Median Annual Mean (µg/m^3)	11.11	-0.13	-1.2%
Population-Weighted Average Annual Mean (µg/m^3) [c]	13.50	-0.12	-0.9%

[a]The change is defined as the control case value minus the baseline value.

[b] The baseline minimum (maximum) is the value for the populated county with the lowest (highest) annual average. The change relative to the baseline is the observed change for the populated county with the lowest (highest) annual average in the baseline.

[c] Calculated by summing the product of the projected 2005 county population and the estimated 2005 PM concentration for that county, and then dividing by the total population in the 48 contiguous States.

Table C-2 provides information on the 2005 populations that will experience improved PM air quality under the above-the-floor option. There are also fairly significant populations that live in areas with meaningful reductions in annual mean $PM_{2.5}$ concentrations resulting from the above-the-floor option, though the increment of reduction between the above-the-floor option and the MACT floor option is quite small. As shown, about 1 percent of the 2005 continental U.S. population are predicted to experience reductions of greater than 1 µg/m^3. Furthermore, about 4 percent of the 2005 U.S. population will benefit from reductions in annual mean $PM_{2.5}$ concentrations of greater than 0.5 µg/m^3 and about 38 percent will live in areas with reductions of greater than 0.1 µg/m^3.

Table C-2.

Distribution of PM2.5 Air Quality Improvements Over 2005 Population Due to MACT Above-

the-Floor Option: Industrial Boiler/Process Heater Source Categories

Change in Annual Mean $PM_{2.5}$ Concentrations ($\mu g/m^3$)	*2005 Population*	
	Number (millions)	*Percent (%)*
) $PM_{2.5}$ Conc = 0	34.3	12.1%
0 >) $PM_{2.5}$ Conc # 0.05	86.4	30.5%
0.05 >) $PM_{2.5}$ Conc # 0.1	56.5	19.9%
0.1 >) $PM_{2.5}$ Conc # 0.25	77.2	27.3%
0.25 >) $PM_{2.5}$ Conc # 0.5	18.1	6.4%
0.5 >) $PM_{2.5}$ Conc # 1.0	8.6	3.0%
1.0 >) $PM_{2.5}$ Conc # 2.0	2.0	0.7%
) $PM_{2.5}$ Conc > 2.0	0.2	0.1%

[a] The change is defined as the control case value minus the baseline value.

Table C-3.

Summary of Absolute and Relative Changes in PM Air Quality Due to MACT Above-the-Floor Option: Industrial Boiler/Process Heater Source Categories

Statistic	*PM_{10} Annual Mean*	*$PM_{2.5}$ Annual Mean*
Absolute Change from 2005 Baseline ($\mu g/m^3$)[a]		
Minimum	0.00	0.00
Maximum	-19.20	-6.09

Average	-0.36	-0.10
Median	-0.20	-0.07
Population-Weighted Average [c]	-0.38	-0.12
Relative Change from 2005 Baseline (%)[b]		
Minimum	0.00%	0.00%
Maximum	-58.34%	-38.47%
Average	-1.52%	-0.85%
Median	-0.94%	-0.65%
Population-Weighted Average [c]	-1.46%	-0.87%

[a] The absolute change is defined as the control case value minus the baseline value for each county.

[b] The relative change is defined as the absolute change divided by the baseline value, or the percentage change, for each county. The information reported in this section does not necessarily reflect the same county as is portrayed in the absolute change section.

[c] Calculated by summing the product of the projected 2005 county population and the estimated 2005 county PM absolute/relative measure of change, and then dividing by the total population in the 48 contiguous states.

Table ~~A~~C-3 provides additional insights on the changes in PM air quality resulting from the above-the-floor option. The information presented previously in Table 8-6 illustrated the absolute and relative changes for different points along the distribution of baseline 2005 PM concentration levels, e.g., the change reflects the lowering of the minimum predicted baseline concentration rather than the minimum predicted change for 2005. The latter is the focus of Table A-3 as it presents the distribution of predicted changes in both absolute terms (i.e., $\mu g/m^3$) and relative terms (i.e., percent) across individual grid-cells. Therefore, it provide more information on the range of predicted changes that as shown, the absolute reduction in annual mean PM_{10} concentration ranged from a low of 0.00 $\mu g/m^3$ to a high of 19.20 $\mu g/m^3$, while the relative reduction ranged from a low of 0.0 percent to a high of 58.5 percent. Alternatively, for mean $PM_{2.5}$, the absolute reduction ranged from 0.00 to 6.09 $\mu g/m^3$, while the relative reduction ranged from 0.0 to 38.5 percent.

Comparison of Air Quality Changes for the MACT Floor and Above The Floor Options

The increment in air quality improvements between the above the floor option and the MACT floor option (the proposed rule) in 2005 is quite small as seen in a comparison between the results for each option. There is only a 0.01 $\mu g/m^3$ decrease in nationwide average annual mean $PM_{2.5}$ concentration for the above-the-floor option compared to the MACT floor option, and a 0.04 $\mu g/m^3$ decrease in average annual mean PM_{10} concentration. In addition, the differences in the nationwide population-weighted average annual mean are 0.02 $\mu g/m^3$ for $PM_{2.5}$ and 0.05 $\mu g/m^3$ for PM_{10} concentrations. Hence, the difference in air quality improvement between the options is small. The improvements in air quality is one possible component of choosing between a MACT floor option and an above the floor option.

Visibility Improvements

Table ~~A~~C-4 provides the distribution of visibility improvements across the 2005 U.S. population resulting from the above-the-floor MACT option. The majority of the 2005 U.S. population live in areas with predicted improvement in annual average visibility of between 0 to 0.1 deciviews. As shown, 5 percent of the 2005 U.S. population are predicted to experience improved annual average visibility of greater than 0.25 deciviews. Furthermore, just over 80 percent of the 2005 U.S. population will benefit from an improvement in visibility, i.e., change in deciview greater than zero.

Table C-4.

Distribution of Populations Experiencing Visibility Improvements in 2005 Due to MACT Above-the-Floor Option: Industrial Boiler/Process Heater Source Categories

Improvements in Visibility [a] *(annual average deciviews)*	*2005 Population*	
	Number (millions)	*Percent (%)*
) Deciview = 0	50.2	17.7%
0 > *) Deciview* # 0.05	152.5	53.9%
0.05 > *) Deciview* # 0.1	55.8	19.7%
0.1 > *) Deciview* # 0.15	10.5	3.7%
0.15 > *) Deciview* # 0.25	10.2	3.6%
0.25 > *) Deciview* # 0.5	2.8	1.0%
) Deciview > 0.5	1.1	0.4%

[a]The change is defined as the MACT Above-the-Floor control case deciview level minus the base case deciview level.

Residential Visibility

For the above-the-floor option, the air quality modeling results predict slightly greater improvements in visibility through the country than for the MACT floor option. In Table ~~A~~C-5, we summarize residential visibility improvements across the Eastern and Western U.S. in 2005 that result

from the above-the-floor MACT option. The baseline annual average visibility for all U.S. counties in the contiguous 48 States is 14.8 deciviews. The mean improvement across these U.S. counties is 0.05 deciviews, or almost 0.2 percent. In urban areas with a population of 250,000 or more (i.e., 819 out of 3,080 counties), the mean improvement in annual visibility was 0.06 deciviews and ranged from 0.01 to 0.98 deciviews. In rural areas (i.e., 2,261 counties), the mean improvement in visibility was 0.05 deciviews in 2005 and ranged from 0.01 to 0.52 deciviews.

On average, the Eastern U.S. experienced larger absolute and relative improvements in visibility than the Western U.S. from the industrial boilers and process heaters reductions. In Eastern U.S., the mean improvement was 0.06 deciviews from an average baseline of 22 deciviews. Western counties experienced a mean improvement of 0.01 deciviews from an average baseline of 17.82 deciviews projected in 2005. Overall, the data suggest that the proposed rule provides slight improvements in visibility for 2005.

Table C-5.

Summary of 2005 Baseline Visibility and Changes by Region Due to MACT Above-the-Floor Option: Residential(Annual Average Deciviews)

Regions[a]	*2005 Baseline*	*Change*[b]	*Percent Change*
Eastern U.S.	22.00	-0.06	-0.2%
Urban	22.95	-0.07	-0.3%
Rural	21.62	-0.06	-0.2%
Western U.S.	17.82	-0.01	-0.1%
Urban	19.19	-0.01	-0.1%
Rural	17.55	-0.01	-0.1%
National, all counties	21.19	-0.05	-0.2%
Urban	22.49	-0.06	-0.3%
Rural	20.72	-0.04	-0.2%

[a] Eastern and Western regions are separated by 100 degrees West longitude. Background visibility conditions differ by region.

[b] An improvement in visibility is a decrease in deciview value. The change is defined as the MACT Above-the-Floor control case deciview level minus the baseline deciview level

Recreational Visibility

In Table C-6, we summarize recreational visibility improvements resulting from the Above-the-Floor MACT option in 2005 for Federal Class I areas by region. These recreational visibility regions are the same ones as those in Figure 8-1 in Chapter 8 of the RIA. As shown, the national improvement in visibility for these areas is 0.3 percent, or 0.05 deciviews. Predicted relative visibility improvements are the largest in the Southeast (0.3%) and Northeast/Midwest (0.2%). These improvements are only slightly greater than those estimated for the MACT floor option. California was predicted to have no visibility improvements in Class I areas within that state.

Table C-6.

Summary of 2005 Baseline Visibility and Changes by Region Due to MACT Above-the-Floor Option: Recreational (Annual Average Deciviews)

Class I Visibility Regions[a]	*2005 Baseline*	*Change*[b]	*Percent Change*
Southeast	21.49	-0.07	-0.3%
Southwest	17.18	-0.01	-0.1%
California	19.86	0.00	0.0%
Northeast/Midwest	20.64	-0.06	-0.2%
Rocky Mountain	17.29	-0.02	-0.1%
Northwest	20.62	-0.03	-0.1%
National Average (unweighted)	19.17	-0.05	-0.3%

[a] Regions are pictured in Figure 8-1 and are defined in the technical support document for the air quality analysis.

[b] An improvement in visibility is a decrease in deciview value. The change is defined as the MACT Above-the-Floor control case deciview level minus the baseline deciview level.

APPENDIX D:

Derivation of Quantified Benefits

As Chapter 10 of this RIA explains, the benefit analysis of the Industrial Boilers/Process Heaters NESHAP entails two phases of analysis. We have also used two approaches (Base and Alternative) to provide source benefit estimates from which the benefit transfer values are derived. These approaches differ in their treatment of estimation and valuation of mortality risk reductions and in the valuation of cases of chronic bronchitis. In addition, results reflect the use of two different discount rates to value reduced incidences of mortality; a 3% rate which is recommended by EPA's Guidelines for Preparing Economic Analyses (US EPA, 2000a), and 7% which is recommended by OMB Circular A-94 (OMB, 1992). In phase one, we modeled approximately 50 percent of the estimated emission reductions of SO2 and PM in an air quality model (the SR Matrix) and a benefit valuation model (the CAPMS model). This appendix provides tables that detail the steps necessary to derive the total benefits of the NESHAP.

Tables D-1 to D-4 show the benefits estimation for the MACT floor for the Base Estimate. Table D-1(a) shows the results of the phase one analysis when we modeled SO2 emission reductions alone. Given a total benefit estimate of $1.7 billion from the assessment of benefits for 85,542 tons of SO2 reduced out of a total estimated reduction of 112,936 tons, we then calculate a coefficient for each benefit endpoint to derive benefit transfer values for (1) incidence per ton reduced, and (2) benefit per ton reduced.

Table D-1(b) shows the results of phase two of the analysis associated with SO2 reductions. Using the benefit transfer values for incidence and value, we calculate the approximate benefits of the remaining 30,394 tons of SO2 out of the total 112,936 tons. Multiplying the total benefit per ton from Table D-1(a) of $20,028 to the 30,394 tons SO2 yields total benefits of the phase two analysis for SO2 of $609 million.

Tables D-2(a) and D-2(b) present results of the phase one and phase two analysis for the expected 562,110 tons of PM reduced due to the MACT Floor regulatory option of the NESHAP. The phase one analysis of PM reductions (Table D-2(a)) results in total benefits of $6.6 billion for 265,155 tons of PM10 and 75,095 tons of PM2.5. The resulting total benefit transfer value is $88,118 per ton of PM. Applying the benefit transfer values to the remaining 296,955 tons of PM results in total phase two benefits of approximately $7.4 billion.

Tables D-3(a) and D-3(b) show the summary of results of the phase one and phase two analysis for the combination of SO2 and PM reductions. Then Table D-4 aggregates the

results of the two phases for all pollutant reductions to provided an estimate of the total benefits of the Industrial Boilers/Process Heaters NESHAP under the MACT Floor regulatory option in 2005 equal to $16.3 billion.

Tables D-5 to D-8 show the Base Estimate of benefits for the above the MACT floor regulatory option. Table D-5(a) shows the results of the phase one analysis when we modeled SO2 emission reductions alone. Given a total benefit estimate of $$2.1 billion from the assessment of benefits of 95,361 tons of SO2 reduced out of a total estimated reduction of 136,733 tons, we then calculate a coefficient for each benefit endpoint to derive benefit transfer values for (1) incidence per ton reduced, and (2) benefit per ton reduced.

Table D-5(b) shows the results of phase two of the analysis associated with SO2 reductions. Using the benefit transfer values for incidence and value, we calculate the approximate benefits of the remaining 41,372 tons of SO2 out of the total 136,733 tons. Multiplying the total benefit per ton from Table D-5(a) of $22,071 to the 41,372 tons SO2 yields total benefits of the phase two analysis for SO2 of $913 million.

Tables D-6(a) and D-6(b) present results of the phase one and phase two analysis for the expected 569,229 tons of PM reduced due to the above the MACT floor regulatory option of the NESHAP. The phase one analysis of PM reductions (Table D-6(a)) results in total benefits of $7.9 billion for 313,947 tons of PM10 and 94,565 tons of PM2.5. The resulting total benefit transfer value is $83,647 per ton of PM. Applying the benefit transfer values to the remaining 255,282 tons of PM results in total phase two benefits of approximately $6.4 billion.

Tables D-7(a) and D-7(b) show the summary of results of the phase one and phase two analysis for the combination of SO2 and PM reductions. Then Table D-8 aggregates the results of the two phases for all pollutant reductions to provided an estimate of the total benefits of the Industrial Boilers/Process Heaters NESHAP under the above MACT floor regulatory option in 2005 equal to $17.2 billion.

Tables D-9 through D-16 show the Alternative Estimate of benefits for the MACT floor and the above the MACT floor options.

Table D-1(a). Base Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP
MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	241	$1,405	1.0805	$1,518	0.00292461	$18,385.89
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	241	$1,319	1.0805	$1,425	0.00292461	$17,269.44
CHRONIC ILLNESS							
Chronic Bronchitis	Schwartz, 1993	321	$106	1.0911	$115	0.00388893	$1,397.96
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	51	$1	1.0000	$1	0.00061787	$7.65
Pneumonia-Related	Samet et al. (2000)	62	$1	1.0000	$1	0.00075113	$11.04
Asthma-Related	Sheppard et al. (1999)	24	$0	1.0000	$0	0.00029076	$1.99
Cardiovascular-Related	Samet et al. (2000)	149	$3	1.0000	$3	0.00180514	$33.19
Asthma-Related ER Visits	Schwartz et al. (1993)	134	$0.0	1.0000	$0.0	0.00162342	$0.48
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	490	$0.0	1.0275	$0.0	0.00593637	$0.35
Upper Respiratory Symptoms	Pope et al. (1991)	12,976	$0.3	1.0275	$0.3	0.15720022	$3.91
Lower Respiratory Symptoms	Schwartz et al. (1994)	5,327	$0	1.0275	$0	0.06453591	$1.01
Asthma Attacks	Whittemore and Korn (1980)	11,120	B	1.0275	B	0.13471911	B
Work Loss Days	Ostro (1987)	42,611	$5	1.0000	$5	0.51623645	$54.72
MRAD - Adjusted	Ostro and Rothschild (1989)	214,592	$10	1.0275	$11	2.59979181	$129.42
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Base PM-Related Benefits, Discount Rate = 3%			**$1,530**		**$1,653**		$20,027.62
Total Base PM-Related Benefits, Discount Rate = 7%			**$1,445**		**$1,561**		$18,911.17

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

SO2 Emission Reductions modeled in SR Matrix & CAPMS	82542
Total SO2 Emission Reductions from all sources (MACT floor)	112936
SO2 reductions applied to benefit transfer values	30394

Table D-1(b). Base Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	89	$517	1.0805	$559
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	89	$486	1.0805	$525
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	118	$39	1.0911	$42
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	19	$0	1.0000	$0
Pneumonia-Related	Samet et al. (2000)	23	$0	1.0000	$0
Asthma-Related	Sheppard et al. (1999)	9	$0	1.0000	$0
Cardiovascular-Related	Samet et al. (2000)	55	$1	1.0000	$1
Asthma-Related ER Visits	Schwartz et al. (1993)	49	$0.0	1.0000	$0.0
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	180	$0.0	1.0275	$0.0
Upper Respiratory Symptoms	Pope et al. (1991)	4,778	$0.1	1.0275	$0.1
Lower Respiratory Symptoms	Schwartz et al. (1994)	1,962	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	4,095	B	1.0275	B
Work Loss Days	Ostro (1987)	15,690	$2	1.0000	$2
MRAD - Adjusted	Ostro and Rothschild (1989)	79,018	$4	1.0275	$4
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$563**		**$609**
Total Base PM-Related Benefits, Discount Rate = 7%			**$532**		**$575**

Table D-2(a). Base Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	903	$5,254	1.0805	$5,677	0.01202477	$75,594.95
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	903	$4,935	1.0805	$5,332	0.01202477	$71,004.58
CHRONIC ILLNESS							
Chronic Bronchitis	Schwartz, 1993	2,356	$776	1.0911	$847	0.00888537	$3,194.03
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	417	$5	1.0000	$5	0.00157267	$19.47
Pneumonia-Related	Samet et al. (2000)	509	$7	1.0000	$7	0.00191963	$28.21
Asthma-Related	Sheppard et al. (1999)	90	$1	1.0000	$1	0.00119848	$8.21
Cardiovascular-Related	Samet et al. (2000)	1,229	$23	1.0000	$23	0.00463502	$85.22
Asthma-Related ER Visits	Schwartz et al. (1993)	949	$0.3	1.0000	$0.3	0.00357904	$1.07
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	1,866	$0.1	1.0275	$0.1	0.02484853	$1.46
Upper Respiratory Symptoms	Pope et al. (1991)	91,618	$2.2	1.0275	$2.3	0.34552721	$8.60
Lower Respiratory Symptoms	Schwartz et al. (1994)	20,369	$0	1.0275	$0	0.27124181	$4.26
Asthma Attacks	Whittemore and Korn (1980)	80,696	B	1.0275	B	0.30433468	B
Work Loss Days	Ostro (1987)	158,563	$17	1.0000	$17	2.11150235	$223.82
MRAD - Adjusted	Ostro and Rothschild (1989)	760,866	$37	1.0275	$38	10.13204793	$504.40
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Base PM-Related Benefits, Discount Rate = 3%			**$6,123**		**$6,617**		$88,118.38
Total Base PM-Related Benefits, Discount Rate = 7%			**$5,803**		**$6,273**		$83,528.02

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

Industrial Boiler PM Reductions modeled in SR Matrix & CAPMS	265155
Process Heater PM Reductions modeled in SR Matrix & CAPMS	0
Total PM10 Reductions modeled in Phase One	**265155**
Total PM2.5 Reductions modeled in Phase One	**75095**
Total PM Reductions from All Sources (MACT floor)	562110
PM10 reductions applied to benefit transfer values	296955
Non-Inventory PM2.5 reductions applied to benefit transfer values	84101

Table D-2(b). Base Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP
MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	1,011	$5,884	1.0805	$6,358
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	1,011	$5,527	1.0805	$5,972
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	2,639	$869	1.0911	$948
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	467	$6	1.0000	$6
Pneumonia-Related	Samet et al. (2000)	570	$8	1.0000	$8
Asthma-Related	Sheppard et al. (1999)	101	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,376	$25	1.0000	$25
Asthma-Related ER Visits	Schwartz et al. (1993)	1,063	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,090	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	102,606	$2.5	1.0275	$2.6
Lower Respiratory Symptoms	Schwartz et al. (1994)	22,812	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	90,374	B	1.0275	B
Work Loss Days	Ostro (1987)	177,580	$19	1.0000	$19
MRAD - Adjusted	Ostro and Rothschild (1989)	852,117	$41	1.0275	$42
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$6,857**		**$7,411**
Total Base PM-Related Benefits, Discount Rate = 7%			**$6,499**		**$7,025**

Table D-3(a). Base Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP
MACT Floor in 2005 (PM and SO2 reductions modeled together)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	1,165	$6,778	1.0805	$7,324
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	1,165	$6,367	1.0805	$6,879
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	2,344	$772	1.0911	$843
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	415	$5	1.0000	$5
Pneumonia-Related	Samet et al. (2000)	507	$7	1.0000	$7
Asthma-Related	Sheppard et al. (1999)	117	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,225	$23	1.0000	$23
Asthma-Related ER Visits	Schwartz et al. (1993)	925	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,425	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	89,477	$2.2	1.0275	$2.2
Lower Respiratory Symptoms	Schwartz et al. (1994)	26,465	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	79,018	B	1.0275	B
Work Loss Days	Ostro (1987)	205,400	$22	1.0000	$22
MRAD - Adjusted	Ostro and Rothschild (1989)	1,011,204	$49	1.0275	$50
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$7,660**		**$8,278**
Total Base PM-Related Benefits, Discount Rate = 7%			**$7,249**		**$7,833**

Table D-3(b). Base Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP
MACT Floor in 2005 (PM and SO2 reductions)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	1,100	$6,401	1.0805	$6,916
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	1,100	$6,012	1.0805	$6,496
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	2,757	$908	1.0911	$991
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	486	$6	1.0000	$6
Pneumonia-Related	Samet et al. (2000)	593	$9	1.0000	$9
Asthma-Related	Sheppard et al. (1999)	110	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,431	$26	1.0000	$26
Asthma-Related ER Visits	Schwartz et al. (1993)	1,112	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,270	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	107,384	$2.6	1.0275	$2.7
Lower Respiratory Symptoms	Schwartz et al. (1994)	24,773	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	94,468	B	1.0275	B
Work Loss Days	Ostro (1987)	193,270	$20	1.0000	$20
MRAD - Adjusted	Ostro and Rothschild (1989)	931,135	$45	1.0275	$46
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$7,420**		**$8,020**
Total Base PM-Related Benefits, Discount Rate = 7%			**$7,032**		**$7,600**

NOTE: Results of this table are based on the addition of incidences and monetary values from Tables D-1(b) and D-2(b).

Table D-4. Base Estimate: Total Benefits of the Industrial Boilers/Process Heaters NESHAP - MACT Floor in 2005
(Combined Estimates of Reduced Incidences and Monetized Benefits from Phase One and Two Analyses)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	2,265	$13,179	1.0805	$14,240
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	2,265	$12,379	1.0805	$13,376
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	5,101	$1,680	1.0911	$1,834
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	901	$11	1.0000	$11
Pneumonia-Related	Samet et al. (2000)	1,100	$16	1.0000	$16
Asthma-Related	Sheppard et al. (1999)	227	$2	1.0000	$2
Cardiovascular-Related	Samet et al. (2000)	2,656	$49	1.0000	$49
Asthma-Related ER Visits	Schwartz et al. (1993)	2,037	$0.6	1.0000	$0.6
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	4,695	$0.3	1.0275	$0.3
Upper Respiratory Symptoms	Pope et al. (1991)	196,861	$4.8	1.0275	$4.9
Lower Respiratory Symptoms	Schwartz et al. (1994)	51,238	$1	1.0275	$1
Asthma Attacks	Whittemore and Korn (1980)	173,486	B	1.0275	B
Work Loss Days	Ostro (1987)	398,671	$42	1.0000	$42
MRAD - Adjusted	Ostro and Rothschild (1989)	1,942,339	$94	1.0275	$97
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$15,080**		**$16,297**
Total Base PM-Related Benefits, Discount Rate = 7%			**$14,280**		**$15,432**

NOTE: Results of this table are based on the addition of results from Tables D-3(a) and D-3(b).

Table D-5(a). Base Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	308	$1,792	1.0805	$1,936	0.00322983	$20,304.67
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	308	$1,683	1.0805	$1,819	0.00322983	$19,071.71
CHRONIC ILLNESS							
Chronic Bronchitis	Schwartz, 1993	398	$131	1.0911	$143	0.00417361	$1,500.29
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	58	$1	1.0000	$1	0.00060822	$7.53
Pneumonia-Related	Samet et al. (2000)	71	$1	1.0000	$1	0.00074454	$10.94
Asthma-Related	Sheppard et al. (1999)	31	$0	1.0000	$0	0.00032508	$2.23
Cardiovascular-Related	Samet et al. (2000)	170	$3	1.0000	$3	0.00178270	$32.78
Asthma-Related ER Visits	Schwartz et al. (1993)	147	$0.0	1.0000	$0.0	0.00154151	$0.46
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	657	$0.0	1.0275	$0.0	0.00688919	$0.41
Upper Respiratory Symptoms	Pope et al. (1991)	14,162	$0.3	1.0275	$0.4	0.14851322	$3.70
Lower Respiratory Symptoms	Schwartz et al. (1994)	7,174	$0	1.0275	$0	0.07523289	$1.18
Asthma Attacks	Whittemore and Korn (1980)	12,248	B	1.0275	B	0.12844191	B
Work Loss Days	Ostro (1987)	54,979	$6	1.0000	$6	0.57653799	$61.11
MRAD - Adjusted	Ostro and Rothschild (1989)	279,759	$14	1.0275	$14	2.93367993	$146.05
WELFARE EFFECTS							
Visibility							
Recreational	Direct Economic Valuation		$0	1.1908	$0		$0.00
Total Base PM-Related Benefits, Discount Rate = 3%			**$1,948**		**$2,105**		$22,071.34
Total Base PM-Related Benefits, Discount Rate = 7%			**$1,839**		**$1,987**		$20,838.38

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

SO2 Emission Reductions modeled in SR Matrix & CAPMS	95361
Total SO2 Reductions from all sources (Above MACT Floor)	136733.3
SO2 reductions applied to benefit transfer values	41372.3

Table D-5(b). Base Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	134	$777	1.0805	$840
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	134	$730	1.0805	$789
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	173	$57	1.0911	$62
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	25	$0	1.0000	$0
Pneumonia-Related	Samet et al. (2000)	31	$0	1.0000	$0
Asthma-Related	Sheppard et al. (1999)	13	$0	1.0000	$0
Cardiovascular-Related	Samet et al. (2000)	74	$1	1.0000	$1
Asthma-Related ER Visits	Schwartz et al. (1993)	64	$0.0	1.0000	$0.0
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	285	$0.0	1.0275	$0.0
Upper Respiratory Symptoms	Pope et al. (1991)	6,144	$0.1	1.0275	$0.2
Lower Respiratory Symptoms	Schwartz et al. (1994)	3,113	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	5,314	B	1.0275	B
Work Loss Days	Ostro (1987)	23,853	$3	1.0000	$3
MRAD - Adjusted	Ostro and Rothschild (1989)	121,373	$6	1.0275	$6
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$845**		**$913**
Total Base PM-Related Benefits, Discount Rate = 7%			**$798**		**$862**

Table D-6(a). Base Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	1,087	$6,327	1.0805	$6,836	0.01149862	$72,287.27
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	1,087	$5,942	1.0805	$6,421	0.01149862	$67,897.76
CHRONIC ILLNESS							
Chronic Bronchitis	Schwartz, 1993	2,683	$884	1.0911	$964	0.00854575	$3,071.95
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	470	$6	1.0000	$6	0.00149707	$18.53
Pneumonia-Related	Samet et al. (2000)	573	$8	1.0000	$8	0.00182515	$26.82
Asthma-Related	Sheppard et al. (1999)	109	$1	1.0000	$1	0.00115265	$7.89
Cardiovascular-Related	Samet et al. (2000)	1,385	$25	1.0000	$25	0.00441157	$81.12
Asthma-Related ER Visits	Schwartz et al. (1993)	1070	$0.3	1.0000	$0.3	0.00340822	$1.02
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	2,230	$0.1	1.0275	$0.1	0.02358633	$1.39
Upper Respiratory Symptoms	Pope et al. (1991)	103,400	$2.5	1.0275	$2.6	0.32935392	$8.20
Lower Respiratory Symptoms	Schwartz et al. (1994)	24,325	$0	1.0275	$0	0.25722847	$4.04
Asthma Attacks	Whittemore and Korn (1980)	90,940	B	1.0275	B	0.28966831	B
Work Loss Days	Ostro (1987)	190,370	$20	1.0000	$20	2.01311570	$213.39
MRAD - Adjusted	Ostro and Rothschild (1989)	918,645	$45	1.0275	$46	9.71442399	$483.61
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Base PM-Related Benefits, Discount Rate = 3%			**$7,319**		**$7,910**		$83,646.62
Total Base PM-Related Benefits, Discount Rate = 7%			**$6,935**		**$7,495**		$79,257.11

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

Industrial Boiler PM Reductions modeled in SR Matrix & CAPMS	295645
Process Heater PM Reductions modeled in SR Matrix & CAPMS	18302
Total PM10 Reductions modeled	**313947**
Total PM2.5 Reductions modeled	**94565**
Total PM Reductions from All Sources (Above MACT Floor)	569229.1
PM10 reductions applied to benefit transfer values	255282.1
PM2.5 reductions applied to benefit transfer values	76894

Table D-6(b). Base Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	884	$5,144	1.0805	$5,558
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	884	$4,832	1.0805	$5,221
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	2,182	$719	1.0911	$784
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	382	$5	1.0000	$5
Pneumonia-Related	Samet et al. (2000)	466	$7	1.0000	$7
Asthma-Related	Sheppard et al. (1999)	89	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,126	$21	1.0000	$21
Asthma-Related ER Visits	Schwartz et al. (1993)	870	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	1,814	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	84,078	$2.0	1.0275	$2.1
Lower Respiratory Symptoms	Schwartz et al. (1994)	19,779	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	73,947	B	1.0275	B
Work Loss Days	Ostro (1987)	154,797	$16	1.0000	$16
MRAD - Adjusted	Ostro and Rothschild (1989)	746,984	$36	1.0275	$37
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$5,951**		**$6,432**
Total Base PM-Related Benefits, Discount Rate = 7%			**$5,639**		**$6,094**

Table D-7(a). Base Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM and SO2 reductions modeled together)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	1,390	$8,086	1.0805	$8,737
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	1,390	$7,595	1.0805	$8,207
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	2,864	$944	1.0911	$1,029
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	502	$6	1.0000	$6
Pneumonia-Related	Samet et al. (2000)	613	$9	1.0000	$9
Asthma-Related	Sheppard et al. (1999)	139	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,480	$27	1.0000	$27
Asthma-Related ER Visits	Schwartz et al. (1993)	1142	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,869	$0.2	1.0275	$0.2
Upper Respiratory Symptoms	Pope et al. (1991)	110,367	$2.7	1.0275	$2.7
Lower Respiratory Symptoms	Schwartz et al. (1994)	31,293	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	97,058	$4	1.0275	$4
Work Loss Days	Ostro (1987)	243,866	$26	1.0000	$26
MRAD - Adjusted	Ostro and Rothschild (1989)	1,196,497	$58	1.0275	$60
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$9,165**		**$9,904**
Total Base PM-Related Benefits, Discount Rate = 7%			**$8,674**		**$9,373**

Table D-7(b). Base Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP
Above the MACT Floor in 2005 (PM and SO2 reductions)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	1,018	$5,922	1.0805	$6,399
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	1,018	$5,562	1.0805	$6,010
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	2,354	$776	1.0911	$846
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	407	$5	1.0000	$5
Pneumonia-Related	Samet et al. (2000)	497	$7	1.0000	$7
Asthma-Related	Sheppard et al. (1999)	102	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,200	$22	1.0000	$22
Asthma-Related ER Visits	Schwartz et al. (1993)	934	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,099	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	90,222	$2.2	1.0275	$2.2
Lower Respiratory Symptoms	Schwartz et al. (1994)	22,892	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	79,261	$3	1.0275	$3
Work Loss Days	Ostro (1987)	178,650	$19	1.0000	$19
MRAD - Adjusted	Ostro and Rothschild (1989)	868,357	$42	1.0275	$43
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$6,800**		**$7,348**
Total Base PM-Related Benefits, Discount Rate = 7%			**$6,440**		**$6,960**

NOTE: Results of this table are based on the addition of incidences and monetary values from Tables D-5(b) and D-6(b).

Table D-8. Base Estimate: Total Benefits of the Industrial Boilers/Process Heaters NESHAP - Above the MACT Floor in 2005
(Combined Estimates of Reduced Incidences and Monetized Benefits from Phase One and Two Analyses)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Ages 30+, Mean, Discount Rate = 3%	Krewski et al. (2000)	2,408	$14,008	1.0805	$15,136
Ages 30+, Mean, Discount Rate = 7%	Krewski et al. (2000)	2,408	$13,158	1.0805	$14,217
CHRONIC ILLNESS					
Chronic Bronchitis	Schwartz, 1993	5,218	$1,719	1.0911	$1,876
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	909	$11	1.0000	$11
Pneumonia-Related	Samet et al. (2000)	1,110	$16	1.0000	$16
Asthma-Related	Sheppard et al. (1999)	241	$2	1.0000	$2
Cardiovascular-Related	Samet et al. (2000)	2,680	$49	1.0000	$49
Asthma-Related ER Visits	Schwartz et al. (1993)	2,076	$0.6	1.0000	$0.6
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	4,968	$0.3	1.0275	$0.3
Upper Respiratory Symptoms	Pope et al. (1991)	200,589	$4.9	1.0275	$5.0
Lower Respiratory Symptoms	Schwartz et al. (1994)	54,185	$1	1.0275	$1
Asthma Attacks	Whittemore and Korn (1980)	82,130	B	1.0275	B
Work Loss Days	Ostro (1987)	275,708	$29	1.0000	$29
MRAD - Adjusted	Ostro and Rothschild (1989)	2,064,854	$100	1.0275	$103
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Base PM-Related Benefits, Discount Rate = 3%			**$15,942**		**$17,229**
Total Base PM-Related Benefits, Discount Rate = 7%			**$15,091**		**$16,310**

NOTE: Results of this table are based on the addition of results from Tables D-7(a) and D-7(b).

Table D-9(a). Alternative Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	160	$166	1.0805	$179	0.00193841	$2,172.99
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	160	$191	1.0805	$207	0.00193841	$2,505.48
CHRONIC ILLNESS							
Chronic Bronchitis (COI valuation)	Schwartz, 1993	321	$34	1.0911	$37	0.00388893	$454.02
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	51	$1	1.0000	$1	0.00061787	$7.65
Pneumonia-Related	Samet et al. (2000)	62	$1	1.0000	$1	0.00075113	$11.04
Asthma-Related	Sheppard et al. (1999)	24	$0	1.0000	$0	0.00029076	$1.99
Cardiovascular-Related	Samet et al. (2000)	149	$3	1.0000	$3	0.00180514	$33.19
Asthma-Related ER Visits	Schwartz et al. (1993)	134	$0.0	1.0000	$0.0	0.00162342	$0.48
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	490	$0.0	1.0275	$0.0	0.00593637	$0.35
Upper Respiratory Symptoms	Pope et al. (1991)	12,976	$0.3	1.0275	$0.3	0.15720022	$3.91
Lower Respiratory Symptoms	Schwartz et al. (1994)	5,327	$0	1.0275	$0	0.06453591	$1.01
Asthma Attacks	Whittemore and Korn (1980)	11,120	B	1.0275	B	0.13471911	B
Work Loss Days	Ostro (1987)	42,611	$5	1.0000	$5	0.51623645	$54.72
MRAD - Adjusted	Ostro and Rothschild (1989)	214,592	$10	1.0275	$11	2.59979181	$129.42
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Alternative Benefits Estimate, Discount Rate = 3%			**$220**		**$237**		$2,870.79
Total Alternative Benefits Estimate, Discount Rate = 7%			**$246**		**$264**		$3,203.28

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

SO2 Emission Reductions modeled in SR Matrix	82542
Total SO2 Emission Reductions from all sources (Inventory + non-inventory)	112936
Non-modeled SO2 reductions	30394

Table D-9(b). Alternative Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	59	$61	1.0805	$66
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	59	$70	1.0805	$76
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	118	$13	1.0911	$14
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	19	$0	1.0000	$0
Pneumonia-Related	Samet et al. (2000)	23	$0	1.0000	$0
Asthma-Related	Sheppard et al. (1999)	9	$0	1.0000	$0
Cardiovascular-Related	Samet et al. (2000)	55	$1	1.0000	$1
Asthma-Related ER Visits	Schwartz et al. (1993)	49	$0.0	1.0000	$0.0
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	180	$0.0	1.0275	$0.0
Upper Respiratory Symptoms	Pope et al. (1991)	4,778	$0.1	1.0275	$0.1
Lower Respiratory Symptoms	Schwartz et al. (1994)	1,962	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	4,095	B	1.0275	B
Work Loss Days	Ostro (1987)	15,690	$2	1.0000	$2
MRAD - Adjusted	Ostro and Rothschild (1989)	79,018	$4	1.0275	$4
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$81**		**$87**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$90**		**$97**

Table D-10(a). Alternative Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	546	$562	1.0805	$608	0.00727079	$8,092.06
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	546	$651	1.0805	$703	0.00727079	$9,366.88
CHRONIC ILLNESS							
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,356	$252	1.0911	$275	0.00888537	$1,037.35
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	417	$5	1.0000	$5	0.00157267	$19.47
Pneumonia-Related	Samet et al. (2000)	509	$7	1.0000	$7	0.00191963	$28.21
Asthma-Related	Sheppard et al. (1999)	90	$1	1.0000	$1	0.00119848	$8.21
Cardiovascular-Related	Samet et al. (2000)	1,229	$23	1.0000	$23	0.00463502	$85.22
Asthma-Related ER Visits	Schwartz et al. (1993)	949	$0.3	1.0000	$0.3	0.00357904	$1.07
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	1,866	$0.1	1.0275	$0.1	0.02484853	$1.46
Upper Respiratory Symptoms	Pope et al. (1991)	91,618	$2.2	1.0275	$2.3	0.34552721	$8.60
Lower Respiratory Symptoms	Schwartz et al. (1994)	20,369	$0	1.0275	$0	0.27124181	$4.26
Asthma Attacks	Whittemore and Korn (1980)	80,696	B	1.0275	B	0.30433468	B
Work Loss Days	Ostro (1987)	158,563	$17	1.0000	$17	2.11150235	$223.82
MRAD - Adjusted	Ostro and Rothschild (1989)	760,866	$37	1.0275	$38	10.13204793	$504.40
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Alternative Benefits Estimate, Discount Rate = 3%			**$907**		**$976**		$13,000.39
Total Alternative Benefits Estimate, Discount Rate = 7%			**$996**		**$1,072**		$14,275.21

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

Industrial Boiler PM Reductions modeled in SR Matrix	265155
Process Heater PM Reductions modeled in SR Matrix	0
Total PM10 Reductions	**265155**
Total PM2.5 Reductions	**75095**
Total PM Reductions from All Sources (MACT floor)	562110
Non-Inventory PM10 reductions	296955
Scaled Non-Inventory PM2.5 reductions	84101

Table D-10(b). Alternative Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	611	$630	1.0805	$681
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	611	$729	1.0805	$788
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,639	$282	1.0911	$308
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	467	$6	1.0000	$6
Pneumonia-Related	Samet et al. (2000)	570	$8	1.0000	$8
Asthma-Related	Sheppard et al. (1999)	101	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,376	$25	1.0000	$25
Asthma-Related ER Visits	Schwartz et al. (1993)	1,063	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,090	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	102,606	$2.5	1.0275	$2.6
Lower Respiratory Symptoms	Schwartz et al. (1994)	22,812	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	90,374	B	1.0275	B
Work Loss Days	Ostro (1987)	177,580	$19	1.0000	$19
MRAD - Adjusted	Ostro and Rothschild (1989)	852,117	$41	1.0275	$42
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$1,016**		**$1,093**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$1,115**		**$1,201**

Table D-11(a). Alternative Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP MACT Floor in 2005 (PM and SO2 reductions modeled together)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	702	$724	1.0805	$782
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	702	$836	1.0805	$903
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,344	$251	1.0911	$274
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	415	$5	1.0000	$5
Pneumonia-Related	Samet et al. (2000)	507	$7	1.0000	$7
Asthma-Related	Sheppard et al. (1999)	117	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,225	$23	1.0000	$23
Asthma-Related ER Visits	Schwartz et al. (1993)	925	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,425	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	89,477	$2.2	1.0275	$2.2
Lower Respiratory Symptoms	Schwartz et al. (1994)	26,465	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	79,018	B	1.0275	B
Work Loss Days	Ostro (1987)	205,400	$22	1.0000	$22
MRAD - Adjusted	Ostro and Rothschild (1989)	1,011,204	$49	1.0275	$50
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total of Alternative Benefits Estimate, Discount Rate = 3%			**$1,084**		**$1,167**
Total of Alternative Benefits Estimate, Discount Rate = 7%			**$1,196**		**$1,288**

Note: All benefits, except those valued at the cost of illness, reflect growth in real income to 2005.

Table D-11(b). Alternative Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP
MACT Floor in 2005 (PM and SO2 reductions)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	670	$691	1.0805	$747
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	670	$800	1.0805	$864
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,757	$295	1.0911	$322
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	486	$6	1.0000	$6
Pneumonia-Related	Samet et al. (2000)	593	$9	1.0000	$9
Asthma-Related	Sheppard et al. (1999)	110	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,431	$26	1.0000	$26
Asthma-Related ER Visits	Schwartz et al. (1993)	1,112	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,270	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	107,384	$2.6	1.0275	$2.7
Lower Respiratory Symptoms	Schwartz et al. (1994)	24,773	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	94,468	B	1.0275	B
Work Loss Days	Ostro (1987)	193,270	$20	1.0000	$20
MRAD - Adjusted	Ostro and Rothschild (1989)	931,135	$45	1.0275	$46
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$1,097**		**$1,181**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$1,205**		**$1,298**

NOTE: All benefits, except those valued at the cost of illness, reflect growth in real income to 2005.
Results of this table are based on the addition of incidences and monetary values from Tables D-9(b) and D-10(b).

Table D-12. Alternative Estimate: Total Benefits of the Industrial Boilers/Process Heaters NESHAP - MACT Floor in 2005
(Combined Estimates of Reduced Incidences and Monetized Benefits from Phase One and Two Analyses)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Monetary Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	1,372	$1,415	1.0805	$1,529
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	1,372	$1,636	1.0805	$1,767
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	5,101	$546	1.0911	$596
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	901	$11	1.0000	$11
Pneumonia-Related	Samet et al. (2000)	1,100	$16	1.0000	$16
Asthma-Related	Sheppard et al. (1999)	227	$2	1.0000	$2
Cardiovascular-Related	Samet et al. (2000)	2,656	$49	1.0000	$49
Asthma-Related ER Visits	Schwartz et al. (1993)	2,037	$0.6	1.0000	$1
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	4,695	$0.3	1.0275	$0
Upper Respiratory Symptoms	Pope et al. (1991)	196,861	$4.8	1.0275	$5
Lower Respiratory Symptoms	Schwartz et al. (1994)	51,238	$1	1.0275	$1
Asthma Attacks	Whittemore and Korn (1980)	173,486	B	1.0275	B
Work Loss Days	Ostro (1987)	398,671	$42	1.0000	$42
MRAD - Adjusted	Ostro and Rothschild (1989)	1,942,339	$94	1.0275	$97
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$2,181**		**$2,348**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$2,402**		**$2,586**

NOTE: All benefits, except those valued at the cost of illness, reflect growth in real income to 2005.
Results of this table are based on the addition of results from Tables D-11(a) and D-11(b).

Table D-13(a). Alternative Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	184	$190	1.0805	$205	0.00192951	$2,152.82
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	184	$218	1.0805	$236	0.00192951	$2,470.08
CHRONIC ILLNESS							
Chronic Bronchitis (COI valuation)	Schwartz, 1993	398	$43	1.0911	$46	0.00417361	$487.26
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	58	$1	1.0000	$1	0.00060822	$7.53
Pneumonia-Related	Samet et al. (2000)	71	$1	1.0000	$1	0.00074454	$10.94
Asthma-Related	Sheppard et al. (1999)	31	$0	1.0000	$0	0.00032508	$2.23
Cardiovascular-Related	Samet et al. (2000)	170	$3	1.0000	$3	0.00178270	$32.78
Asthma-Related ER Visits	Schwartz et al. (1993)	147	$0.0	1.0000	$0.0	0.00154151	$0.46
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	657	$0.0	1.0275	$0.0	0.00688919	$0.41
Upper Respiratory Symptoms	Pope et al. (1991)	14,162	$0.3	1.0275	$0.4	0.14851322	$3.70
Lower Respiratory Symptoms	Schwartz et al. (1994)	7,174	$0	1.0275	$0	0.07523289	$1.18
Asthma Attacks	Whittemore and Korn (1980)	12,248	B	1.0275	B	0.12844191	B
Work Loss Days	Ostro (1987)	54,979	$6	1.0000	$6	0.57653799	$61.11
MRAD - Adjusted	Ostro and Rothschild (1989)	279,759	$14	1.0275	$14	2.93367993	$146.05
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Alternative Benefits Estimate, Discount Rate = 3%			**$258**		**$277**		$2,906.46
Total Alternative Benefits Estimate, Discount Rate = 7%			**$286**		**$307**		$3,223.71

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

SO2 Emission Reductions modeled in SR Matrix & CAPMS	95361
Total SO2 Reductions from all sources (Above MACT Floor)	136733.3
SO2 reductions applied to benefit transfer values	41372.3

Table D-13(b). Alternative Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (SO2 reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	80	$82	1.0805	$89
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	80	$95	1.0805	$102
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	173	$18	1.0911	$20
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	25	$0	1.0000	$0
Pneumonia-Related	Samet et al. (2000)	31	$0	1.0000	$0
Asthma-Related	Sheppard et al. (1999)	13	$0	1.0000	$0
Cardiovascular-Related	Samet et al. (2000)	74	$1	1.0000	$1
Asthma-Related ER Visits	Schwartz et al. (1993)	64	$0.0	1.0000	$0.0
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	285	$0.0	1.0275	$0.0
Upper Respiratory Symptoms	Pope et al. (1991)	6,144	$0.1	1.0275	$0.2
Lower Respiratory Symptoms	Schwartz et al. (1994)	3,113	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	5,314	B	1.0275	B
Work Loss Days	Ostro (1987)	23,853	$3	1.0000	$3
MRAD - Adjusted	Ostro and Rothschild (1989)	121,373	$6	1.0275	$6
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$112**		**$120**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$124**		**$133**

Table D-14(a). Alternative Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits	National Benefit-Transfer Values: Incidence/ton	National Benefit-Transfer Values: $/ton (1999$)
MORTALITY							
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	676	$696	1.0805	$752	0.00714852	$7,952.50
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	676	$805	1.0805	$870	0.00714852	$9,197.93
CHRONIC ILLNESS							
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,683	$287	1.0911	$313	0.00854575	$997.70
HOSPITALIZATION							
COPD-Related	Samet et al. (2000)	470	$6	1.0000	$6	0.00149707	$18.53
Pneumonia-Related	Samet et al. (2000)	573	$8	1.0000	$8	0.00182515	$26.82
Asthma-Related	Sheppard et al. (1999)	109	$1	1.0000	$1	0.00115265	$7.89
Cardiovascular-Related	Samet et al. (2000)	1,385	$25	1.0000	$25	0.00441157	$81.12
Asthma-Related ER Visits	Schwartz et al. (1993)	1070	$0.3	1.0000	$0.3	0.00340822	$1.02
MINOR ILLNESS							
Acute Bronchitis	Dockery et al. (1996)	2,230	$0.1	1.0275	$0.1	0.02358633	$1.39
Upper Respiratory Symptoms	Pope et al. (1991)	103,400	$2.5	1.0275	$2.6	0.32935392	$8.20
Lower Respiratory Symptoms	Schwartz et al. (1994)	24,325	$0	1.0275	$0	0.25722847	$4.04
Asthma Attacks	Whittemore and Korn (1980)	90,940	B	1.0275	B	0.28966831	B
Work Loss Days	Ostro (1987)	190,370	$20	1.0000	$20	2.01311570	$213.39
MRAD - Adjusted	Ostro and Rothschild (1989)	918,645	$45	1.0275	$46	9.71442399	$483.61
WELFARE EFFECTS							
Visibility							
Recreational		Direct Economic Valuation	$0	1.1908	$0		$0.00
Total Alternative Benefits Estimate, Discount Rate = 3%			**$1,092**		**$1,175**		$12,425.53
Total Alternative Benefits Estimate, Discount Rate = 7%			**$1,201**		**$1,293**		$13,670.96

NOTE: Emission Reduction Summary (Converted from Mg to Tons)

Industrial Boiler PM Reductions modeled in SR Matrix	295645
Process Heater PM Reductions modeled in SR Matrix	18302
Total PM10 Reductions	**313947**
Total PM2.5 Reductions	**94565**
Total PM Reductions from All Sources (Inventory + non-Inventory)	569229.1
Non-Inventory PM10 reductions	255282.1
Scaled Non-Inventory PM2.5 reductions	76894

Table D-14(b). Alternative Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM reductions only)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	550	$566	1.0805	$612
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	550	$655	1.0805	$707
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,182	$233	1.0911	$255
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	382	$5	1.0000	$5
Pneumonia-Related	Samet et al. (2000)	466	$7	1.0000	$7
Asthma-Related	Sheppard et al. (1999)	89	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,126	$21	1.0000	$21
Asthma-Related ER Visits	Schwartz et al. (1993)	870	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	1,814	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	84,078	$2.0	1.0275	$2.1
Lower Respiratory Symptoms	Schwartz et al. (1994)	19,779	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	73,947	B	1.0275	B
Work Loss Days	Ostro (1987)	154,797	$16	1.0000	$16
MRAD - Adjusted	Ostro and Rothschild (1989)	746,984	$36	1.0275	$37
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$888**		**$955**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$976**		**$1,051**

Table D-15(a). Alternative Estimate: Results of Air Quality and Benefit Analyses for the Phase One Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM and SO2 reductions modeled together)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$) Simple Mean	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	857	$882	1.0805	$953
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	857	$1,019	1.0805	$1,101
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,864	$306	1.0911	$334
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	502	$6	1.0000	$6
Pneumonia-Related	Samet et al. (2000)	613	$9	1.0000	$9
Asthma-Related	Sheppard et al. (1999)	139	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,480	$27	1.0000	$27
Asthma-Related ER Visits	Schwartz et al. (1993)	1142	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,869	$0.2	1.0275	$0.2
Upper Respiratory Symptoms	Pope et al. (1991)	110,367	$2.7	1.0275	$2.7
Lower Respiratory Symptoms	Schwartz et al. (1994)	31,293	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	97,058	$4	1.0275	$4
Work Loss Days	Ostro (1987)	243,866	$26	1.0000	$26
MRAD - Adjusted	Ostro and Rothschild (1989)	1,196,497	$58	1.0275	$60
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$1,323**		**$1,424**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$1,460**		**$1,572**

Note: All benefits, except those valued at the cost of illness, reflect growth in real income to 2005.

Table D-15(b). Alternative Estimate: Results of Benefit Transfer Application for the Phase Two Analysis of the Industrial Boilers/Process Heaters NESHAP Above the MACT Floor in 2005 (PM and SO2 reductions)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Monetary Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	630	$537	1.0805	$580
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	630	$620	1.0805	$670
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	2,354	$252	1.0911	$275
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	407	$5	1.0000	$5
Pneumonia-Related	Samet et al. (2000)	497	$7	1.0000	$7
Asthma-Related	Sheppard et al. (1999)	102	$1	1.0000	$1
Cardiovascular-Related	Samet et al. (2000)	1,200	$22	1.0000	$22
Asthma-Related ER Visits	Schwartz et al. (1993)	934	$0.3	1.0000	$0.3
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	2,099	$0.1	1.0275	$0.1
Upper Respiratory Symptoms	Pope et al. (1991)	90,222	$2.2	1.0275	$2.2
Lower Respiratory Symptoms	Schwartz et al. (1994)	22,892	$0	1.0275	$0
Asthma Attacks	Whittemore and Korn (1980)	79,261	$3	1.0275	$3
Work Loss Days	Ostro (1987)	178,650	$19	1.0000	$19
MRAD - Adjusted	Ostro and Rothschild (1989)	868,357	$42	1.0275	$43
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$891**		**$958**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$974**		**$1,049**

NOTE: All benefits, except those valued at the cost of illness, reflect growth in real income to 2005.
Results of this table are based on the addition of incidences and monetary values from Tables D-13(b) and D-14(b).

Table D-16. Alternative Estimate: Total Benefits of the Industrial Boilers/Process Heaters NESHAP - Above the MACT Floor in 2005
(Combined Estimates of Reduced Incidences and Monetized Benefits from Phase One and Two Analyses)

Endpoint	Reference	Avoided Incidence (cases/year) Mean	Monetary Benefits (millions 1999$)	Income Adjustment Factor	Adjusted Benefits (millions 1999$)
MORTALITY					
Short-Term Exposure, Discount Rate = 3%	Schwartz et al., 1996	1,483	$1,419	1.0805	$1,533
Short-Term Exposure, Discount Rate = 7%	Schwartz et al., 1996	1,483	$1,639	1.0805	$1,771
CHRONIC ILLNESS					
Chronic Bronchitis (COI valuation)	Schwartz, 1993	5,218	$558	1.0911	$609
HOSPITALIZATION					
COPD-Related	Samet et al. (2000)	909	$11	1.0000	$11
Pneumonia-Related	Samet et al. (2000)	1,110	$16	1.0000	$16
Asthma-Related	Sheppard et al. (1999)	241	$2	1.0000	$2
Cardiovascular-Related	Samet et al. (2000)	2,680	$49	1.0000	$49
Asthma-Related ER Visits	Schwartz et al. (1993)	2,076	$0.6	1.0000	$1
MINOR ILLNESS					
Acute Bronchitis	Dockery et al. (1996)	4,968	$0.3	1.0275	$0
Upper Respiratory Symptoms	Pope et al. (1991)	200,589	$4.9	1.0275	$5
Lower Respiratory Symptoms	Schwartz et al. (1994)	54,185	$1	1.0275	$1
Asthma Attacks	Whittemore and Korn (1980)	82,130	B	1.0275	B
Work Loss Days	Ostro (1987)	275,708	$29	1.0000	$45
MRAD - Adjusted	Ostro and Rothschild (1989)	2,064,854	$100	1.0275	$103
WELFARE EFFECTS					
Visibility					
Recreational		Direct Economic Valuation	$0	1.1908	$0
Total Alternative Benefits Estimate, Discount Rate = 3%			**$2,191**		**$2,382**
Total Alternative Benefits Estimate, Discount Rate = 7%			**$2,412**		**$2,621**

NOTE: All benefits, except those valued at the cost of illness, reflect growth in real income to 2005.
Results of this table are based on the addition of results from Tables D-15(a) and D-15(b).