6.0 EMISSIONS, AIR QUALITY, AND COST IMPACTS OF $PM_{2.5}$ ALTERNATIVES

6.1 RESULTS IN BRIEF

Based on projected emission levels for the year 2010 this analysis estimates that 102 counties need additional reductions beyond those currently mandated in the Clean Air Act (CAA) and beyond those needed to partially attain the current ozone and coarse particulate matter (PM_{10}) standards to meet the selected fine particulate matter ($PM_{2.5}$ 15/65) national ambient air quality standard (NAAQS). The control cost associated with achieving full attainment in 72 of these counties and partial attainment in 30 counties is estimated to be $8.6 billion (1990 dollars). Due to overlap between projected $PM_{2.5}$ nonattainment counties and projected ozone nonattainment areas, some control measures may produce air quality benefits for both standards, and result in cost efficiencies.

The additional cost associated with control measures modeled to achieve partial attainment of the newly revised PM_{10} NAAQS is estimated to be $440 million (1990 dollars). This partial attainment control cost is less than half the partial attainment cost associated with the current PM_{10} standard, confirming that the newly revised PM_{10} standard is less stringent than the current PM_{10} standard.

6.2 INTRODUCTION

This chapter presents the methodology and results for the PM NAAQS alternatives emissions, air quality, and control cost impacts analysis. This analysis estimates the projected emission reductions and air quality improvements resulting from additional controls needed by the year 2010 to meet the alternative PM standards presented in Chapter 3. Emissions and air quality changes are inputs to the benefits analysis presented in Chapter 12. This analysis also estimates the projected costs (in 1990 dollars) of installing, operating, and maintaining additional controls. These control costs are inputs to the economic impact analysis presented in Chapter 11. Chapter 9 addresses the potential cost of full attainment, including the benefits of technological innovation and flexible implementation strategies. The administrative cost of the selected standard is addressed in Chapter 10. The following sections in this chapter cover:

- Methodology for estimating emissions, air quality, and cost impacts for PM alternatives;
- Emission reduction, air quality improvement, and control cost results for PM alternatives; and
- Analytical uncertainties, limitations, and potential biases.

6.3 EMISSIONS, AIR QUALITY, AND COST ANALYSIS METHODOLOGY

This analysis estimates the emission reductions and control costs for achieving air quality improvements to meet the newly revised PM_{10} NAAQS and alternative $PM_{2.5}$ NAAQS in projected nonattainment counties. The 2010 baseline air quality reflective of CAA-mandated controls is the primary input to the cost analysis. Chapter 4 explains the bases of, and assumptions pertaining to, the 2010 emissions and air quality projections. The cost and emission reductions for each $PM_{2.5}$ alternative are estimated from a “layered” control baseline that incorporates the 2010 baseline air quality *plus* partial attainment of the current ozone NAAQS *plus* partial attainment of the current PM_{10} NAAQS. From this baseline, three $PM_{2.5}$ annual average/daily average standards are examined: 16/65, 15/65, and 15/50. The new PM_{10} standard, which is a relaxation of the current PM_{10} standard is also examined. The baseline for the analysis of the new PM_{10} standard incorporates the baseline air quality *plus* partial attainment of the current ozone NAAQS.

Figure 6.1 shows the analysis steps that make up these baselines.

Figure 6.1 PM Analysis Baselines

$PM_{2.5}$ Analysis Baseline

2010 CAA Baseline ------------> Attain Current O_3 NAAQS --------------> Attain Current PM_{10} NAAQS

New PM_{10} Analysis Baseline

2010 CAA Baseline ------------> Attain Current O_3 NAAQS

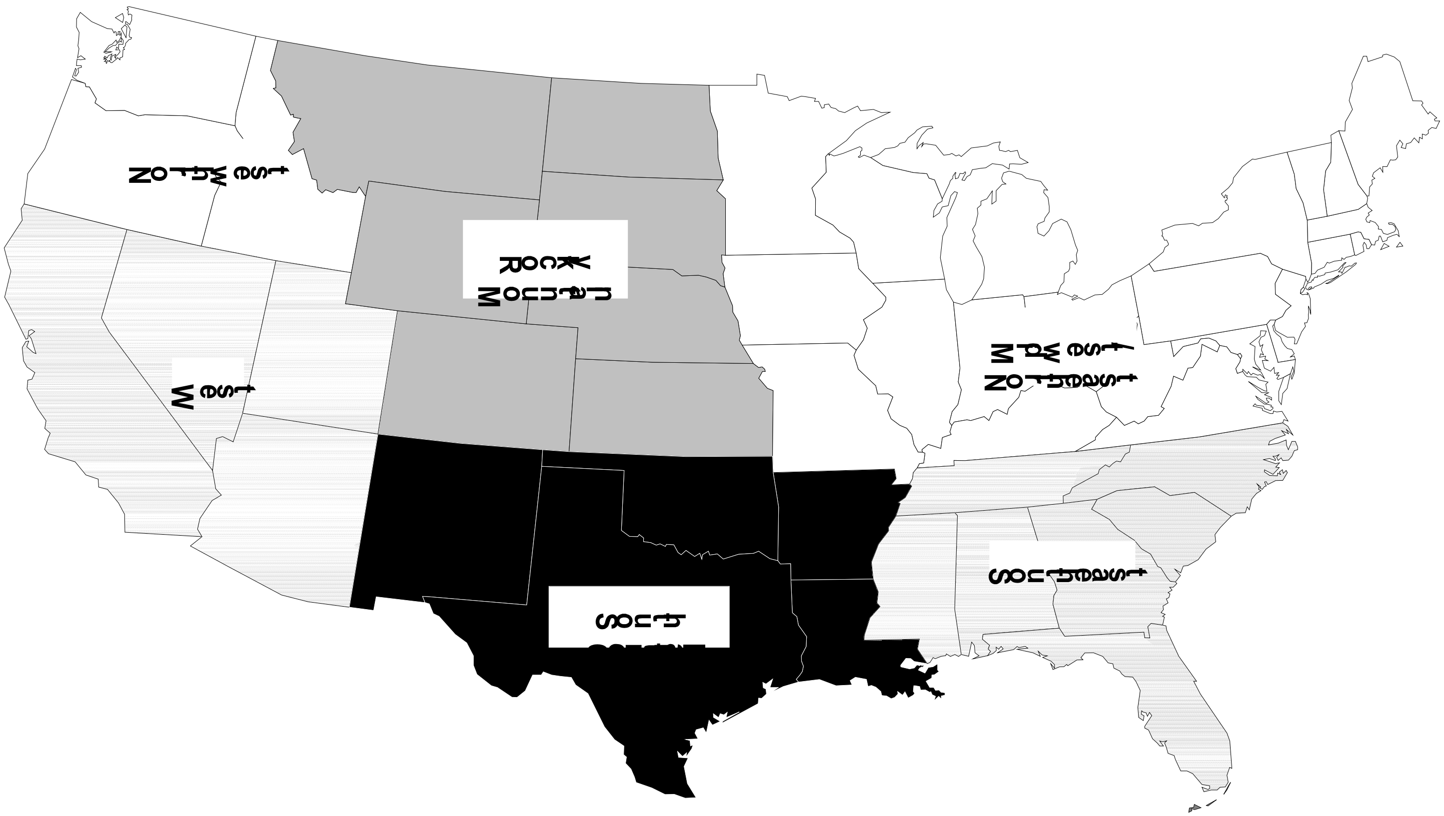
Since the 2010 CAA baseline projection indicates that 45 counties do not attain the current PM_{10} standard, control measures are first applied to address nonattainment of the current PM_{10} standard. In the analyses of both the current and new PM_{10} standards, control measures affecting only those PM_{10} emissions sources located inside the boundaries of each projected PM_{10} nonattainment county are evaluated. This *local* approach to control measure application is believed to be consistent with current implementation practices. The results of the current PM_{10} standard analysis are presented and discussed in Appendix C.

For achieving alternative $PM_{2.5}$ standards, control measure selection is modeled using a broader *regional* approach that is more appropriate for addressing air quality problems caused by trans-boundary pollution transport. The fine particle precursors that make up $PM_{2.5}$ can be transported over long distances by prevailing winds. Since sources outside of projected nonattainment counties may significantly contribute to elevated $PM_{2.5}$ concentrations in the nonattainment counties, controls may be imposed on sources outside the boundaries of counties projected to be out of attainment. Given the long-range transport of $PM_{2.5}$ precursors, air quality changes will be realized in nonattainment counties and counties outside nonattainment counties, some of which initially attain the standards. Ultimately, state and local air pollution control authorities, in cooperation with federal efforts, will devise implementation strategies that achieve air quality goals in a manner that minimizes negative impacts.

As discussed in Chapter 4, this analysis is confined to those projected nonattainment counties from a subset of 504 counties currently monitored for PM_{10} in the 48 contiguous States. The set of projected nonattainment counties is subdivided into six regions, the boundaries of which are depicted in Figure 6.2. The boundaries of these regions are delineated to reflect both the meteorological conditions that influence the long-range transport of $PM_{2.5}$ precursors and the locations of their major sources (e.g., electric utilities). The control regions in this analysis have been revised from the control regions used in the 1996 analysis of the proposed NAAQS. For this analysis, the former California Coastal and West regions have been merged to form a single West region. Therefore, in this analysis there are six rather than seven control regions. This consolidation is made recognizing that the major urban areas in the former California Coastal region have an effect on air quality in areas hundreds of miles eastward. Control measure selection is optimized within each control region to bring projected $PM_{2.5}$ nonattainment counties within each region into attainment at the lowest possible cost.

The costs in this analysis reflect *real, before-tax, 1990 dollars* and a *7 percent real interest (discount) rate*. "Real" dollars are those uninfluenced by inflation; in other words, a "1990 dollar" is assumed to be worth the same today as it was in 1990. "Before-tax" means that the cost analysis does not consider the effects of income taxes (State or federal). Because income taxes are merely transfer payments from one sector of society to another, their inclusion in this cost analysis would not affect total cost estimates. The year 1990 was selected as the cost reference date to be consistent with the analysis base year. Finally, to be consistent with the real-dollar analytical basis and in accordance with Office of Management and Budget guidance, a 7 percent real interest rate is used to annualize capital costs.

Figure 6-2


Northwest
Rocky Mountain
West
Midwest
Northeast
Southeast
South

6.3.1 Selecting $PM_{2.5}$ Control Measures Using the PM Optimization Model

This analysis uses two methods for selecting control measures that reduce emissions of $PM_{2.5}$ precursors; one method is used for the utility sector and another method is used for all other emissions sectors. This analysis assumes a National $PM_{2.5}$ Strategy for utilities that reduces the SO_2 emissions cap beyond Title IV Phase II levels. The allocation of SO_2 control responsibility and the control measures selected for sources in the utility sector are analyzed using the Integrated Planning Model (IPM) (U.S. EPA, 1996). Control measures for all other emissions sectors are selected using the PM optimization model. The types of control measures available to both utility and non-utility sources is discussed in Chapter 5 of this report.

The remainder of this section describes the optimization model used for selecting non-utility control measures in each of the $PM_{2.5}$ control regions. The optimization model uses several inputs to determine which control measures to apply to meet alternative $PM_{2.5}$ standards. These inputs are the: 1) Incremental Control Measure Data File, 2) Source-Receptor (S-R) Matrix, and 3) Receptor Input File. Each of these inputs will be described below, after which the optimization procedure will be discussed.

6.3.2 Incremental Control Measure Data File

This file contains the incremental precursor pollutant emission reductions and the total annual cost (in 1990 dollars) for each individual control measure-emission source combination. Each of the emission sources is given a "source number" that is indexed to the S-R matrix (described below). A significant number of control measures are either added or revised since the Regulatory Impact Analysis (RIA) for the proposed NAAQS was published. Chapter 5 presents and discusses the control measures used in this analysis.

The incremental control measure data file is created via optimization on *average annual incremental cost per ton.* For purposes of this analysis, average incremental cost per ton is defined as the *difference* in the annual cost of a control measure and the annual cost of the baseline control (if any), divided by the *difference* in the annual mass of pollutant emissions removed by the control measure and the emissions removed by the baseline control.

The average annual incremental cost per ton is calculated at the source or unit level for point source control measures and at the county level for area and mobile source control measures. For any individual source (e.g., boiler), only the control measures that are most cost-effective at reducing the $PM_{2.5}$ precursor emissions are included in the incremental control measure data base. This step eliminates inefficient solutions.

Consider, for example, a furnace that emits 1000 tons per year of primary $PM_{2.5}$. Suppose that this source could be controlled by one of three control devices: 1) high-energy scrubber; 2) fabric filter; or 3) electrostatic precipitator (ESP). Further suppose that the associated annual costs, emission reductions, and the average annual incremental cost per ton for these devices is shown in Table 6.1.

Table 6.1 Hypothetical Furnace Control Measures

Control Device	Annual Cost ($/year)	$PM_{2.5}$ Emission Reduction (tons/year)	Average Annual Incremental Cost per Ton ($/ton)
Scrubber	700,000	950	740
Electrostatic Precipitator	600,000	970	620
Fabric filter	800,000	990	810

In this illustration, the ESP would be the most cost-effective option ($620 per ton), as it provides the most emission reduction at the lowest annual cost. Because the scrubber provides the lowest emission reduction at a cost greater than that of the ESP, it would never be selected. The fabric filter provides the highest emission reduction (990 tons per year), but its annual cost is also the highest of the three options. Because it provides a higher emission reduction than the ESP, even at a higher cost, the fabric filter would be retained in the control measure data base.

6.3.3 Source-Receptor Matrix

The S-R matrix, which is discussed in more detail in Chapter 4, provides a link between emission reductions and resulting air quality concentrations. When a control measure from the incremental control measure data file is applied at a source, PM concentrations are reduced by some amount at *all* associated receptors (i.e., counties) regardless of their distance from the source.

The S-R matrix was developed from an air quality model that divides sources into two general categories: *elevated point sources* and *area/mobile sources*. In turn, the elevated point sources are aggregated into three categories: 1) sources with effective stack (release) heights less than 250 meters; 2) sources with heights between 250 and 500 meters; and 3) sources with heights above 500 meters. Except for the last category, all sources are assumed to be situated at the population centroid of the county in which they are located. The >500 meter sources are sited according to their individual longitude/latitude coordinates.

The S-R coefficients for a given source and all receptors determine the concentration reductions that occur in proportion to the emission reductions provided by a given control measure. The PM optimization model calculates the reduction in concentration for the least average annual incremental cost per ton measure for each unique source-pollutant combination. A comparison is then made between each of these unique source-pollutant combinations to determine the most cost-effective measure on the basis of cost per microgram per cubic meter $PM_{2.5}$ reduced. The most cost-effective measure is selected, concentration is reduced at each associated receptor, and the process is repeated until all receptors are in compliance or all remaining measures exceed a specified threshold expressed in terms of the *cost per microgram per cubic meter* $PM_{2.5}$ *reduced*.

For example, the order of selection on an average incremental cost per ton basis for controlling VOC emissions in a hypothetical county may be: 1) pressure/vacuum vents and vapor balancing for Stage I service station refueling, 2) VOC incineration for metal can coating operations, and 3) VOC content limits and improved transfer efficiency for autobody refinishing operations. However, each of these individual measures has the same S-R coefficient and source number, because all area sources in a county are assumed to release their emissions at the same height and location (the county centroid). Consequently, the cost per microgram per cubic meter reduced--which, within a given aggregation of sources, is directly proportional to the cost per ton reduced--will follow the same order of selection as the *average incremental cost per ton* of precursor reduced. Table 6.2 provides an indication of the magnitude of the S-R coefficients for a hypothetical receptor (Acme County).

Table 6.2 Simple Illustration of S-R Coefficients For The Hypothetical Acme County Receptor

Source (all in the county)	Primary $PM_{2.5}$ Coefficient	Nitrate Coefficient	Sulfate Coefficient	Ammonia (NH_3) Coefficient
Point (0-250m)	$0.154x10^{-7}$	$0.191x10^{-8}$	$0.392x10^{-9}$	$0.147x10^{-7}$
Point (250-500m)	$0.258x10^{-8}$	$0.243x10^{-9}$	$0.518x10^{-10}$	$0.277x10^{-8}$
Area Sources	$0.224x10^{-7}$	$0.267x10^{-8}$	$0.546x10^{-9}$	$0.215x10^{-7}$

The units of the coefficients are *seconds per cubic meter*. S-R matrix coefficients generally decrease with distance, dropping off rapidly beyond a one or two county layer from the receptor county. To illustrate how these coefficients are used to calculate changes in air quality, consider a 1000 ton per year reduction in primary $PM_{2.5}$ emissions from area sources in Acme County. The change in $PM_{2.5}$ concentration is calculated as follows:

$$\text{Reduction} = (1{,}000 \text{ tons/year})(0.224 \times 10^{-7} \text{ sec/m}^3)(28{,}767 \text{ micrograms-yr/ton-sec})$$

$$= 0.644 \text{ micrograms per cubic meter,}$$

where 28,767 is the micrograms-yr/ton-sec conversion factor.

6.3.4 Receptor Input File

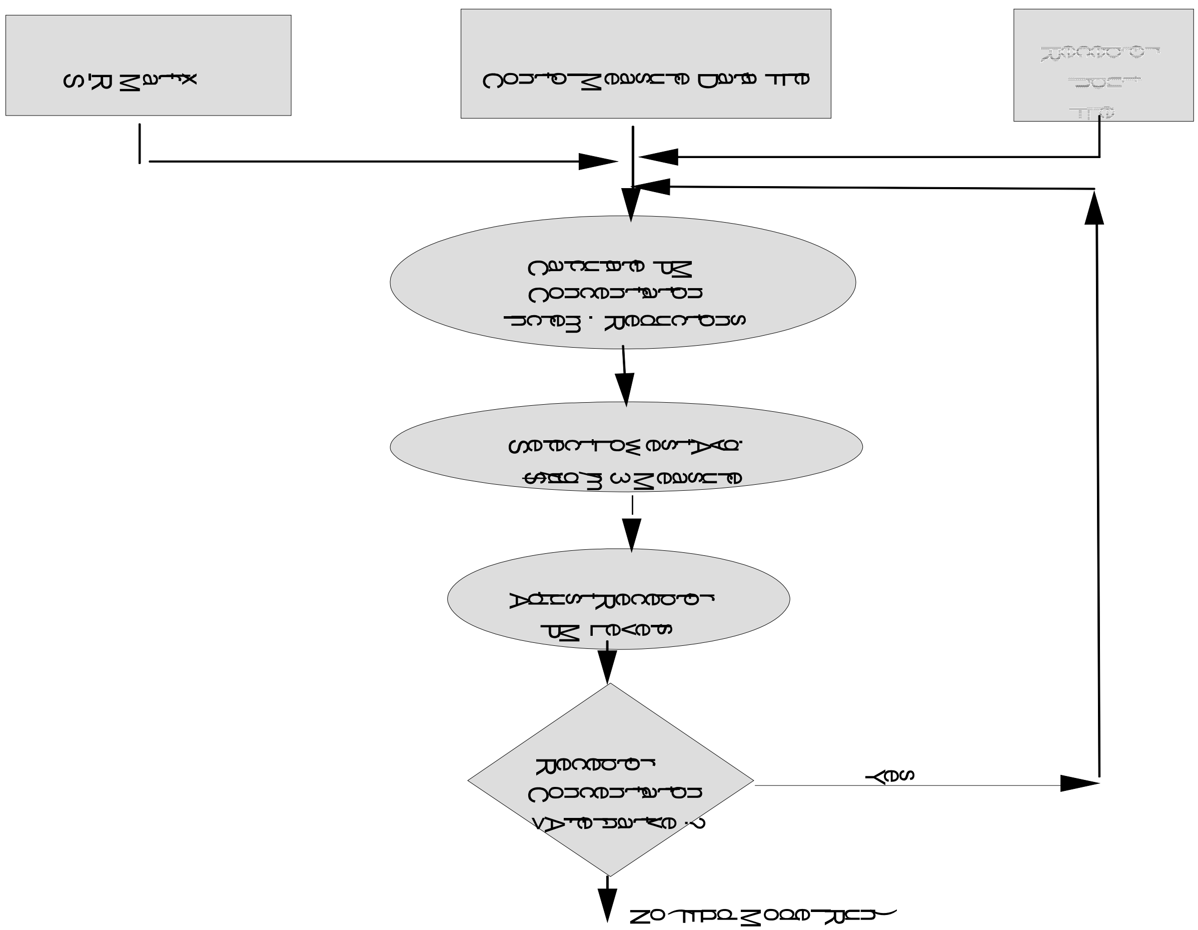
This file contains the starting total county-level normalized PM_{10} and $PM_{2.5}$ concentrations for the 2010 CAA baseline emissions scenario. The normalization procedure used to calibrate predicted concentrations to actual monitor data is described in Chapter 4.

6.3.5 Optimization Routine

The optimization routine developed for this analysis is illustrated in Figure 6.3, and employs the following steps:

<u>Step 1</u>. The incremental control measure data file is sorted by source number, precursor pollutant controlled, and increasing average incremental cost per ton of pollutant reduced.

<u>Step 2</u>. The *incremental* reduction in $PM_{2.5}$ concentration is calculated *for each associated receptor* for the least costly (on a cost per ton basis) control measure for each individual source-pollutant combination. As explained above, while control measure selection is made on a cost per microgram per cubic meter basis, for a given source-pollutant combination, the measure with the least cost per ton may also be least costly on a cost per microgram per cubic meter basis. The number of these selections equals the number of source-pollutant combinations analyzed. This number, in turn, varies based on the control region to which the optimization model is applied.



Step 3. The cost per *average* microgram per cubic meter reduced across *all receptors out of compliance with the standard* is calculated for each control measure. Thus, for a receptor already meeting the target alternative standard, the impact of a control measure on that receptor is *not* counted so that measures which impact receptors already in compliance are not selected. In addition, any reduction in excess of that needed to meet the standard is *not* counted in the calculation of the cost per average microgram reduced. This prevents application of measures that would give emission reductions in excess of those required to meet the standard when measures with lower overall cost and less over control are still available. However, these reductions *are* carried through in the final analysis of *all* receptor concentrations.

Step 4. The measure with the *lowest cost per average microgram per cubic meter reduced* is selected and the $PM_{2.5}$ concentration at each receptor is adjusted to reflect implementation of the selected measure.

Step 5. Steps 2 through 4 are repeated until all input receptors meet the target level *or* the minimum cost per microgram reduced threshold is exceeded by all remaining measures.

Step 6. Adjust final post-control air quality predictions in all regions to account for the trans-boundary effect of control measures selected outside each control region.

To illustrate steps 3 and 4, consider the example shown in Table 6.3. This table lists three control measures (A, B, and C) and four receptors (counties 1, 2, 3, and 4). The annual cost (in millions of 1990 dollars per year) is given for each control measure. Also listed for each measure is the reduction in $PM_{2.5}$ concentration at each receptor that result if that measure is applied. For control measure A, these reductions range from 0.1 to 0.3 micrograms per cubic meter, and average 0.23 micrograms per cubic meter (column 2). Listed below these reductions are the cost-per-microgram-per-cubic meter ratios for each of the four receptors. These ratios are obtained by dividing the annual cost for control measure A by each of the four $PM_{2.5}$ reductions. The last number in column 2 is the ratio of the annual cost for control measure A divided by the average microgram per cubic meter $PM_{2.5}$ reduction among the four receptors.

Similar calculations are made for control measures B and C, in turn.

Table 6.3 Simple Illustration of the Calculation of Cost per Average Microgram per Cubic Meter Reduced

		Control Measure A	Control Measure B	Control Measure C
Cost (million $/yr)		1.0	1.5	1.5
$PM_{2.5}$ Reduced ($\mu g/m^3$)				
	Receptor 1	0.20	0.30	0.80
	Receptor 2	0.30	0.40	0.10
	Receptor 3	0.10	0.50	0.10
	Receptor 4	0.30	0.40	0.25
	Average	0.23	0.40	0.25
Cost per microgram per cubic meter				
	Receptor 1	5.0	5.0	1.9
	Receptor 2	3.3	3.8	15.0
	Receptor 3	10.0	3.0	15.0
	Receptor 4	3.3	3.8	--
	Average	4.4	3.8	6.0

The control measure selected in this optimization scheme is the one that gives the lowest cost per average microgram per cubic meter reduction. Based on this decision criterion, control measure B is selected first, followed by measure A and measure C, as needed. But suppose, for instance, that the application of measure B brought receptors 2 through 4 into compliance with the NAAQS alternative of interest. If that is the case, the next iteration of the optimization model results in the selection of measure C, in preference to measure A. Why? Since control measure B brought receptors 2 through 4 into compliance, they are longer included in the calculation of the cost per average microgram reduced. This leaves only receptor 1 under consideration. And, as Table 6.3 shows, control measure C has the lowest annual cost per microgram per cubic meter reduction ratio for receptor 1. (Note: Because there is only one receptor, this ratio also equals the lowest annual cost per average microgram per cubic meter). Consequently, measure C is selected.

Because the optimization model only includes receptors out of compliance in the calculation of the cost per average microgram reduced, selection of measures that have little or no impact in reducing concentrations in non-complying areas is avoided. Finally, the reader should keep in mind that the scope of this example has been kept small for purposes of illustration. During each iteration of the PM optimization model, the control measure selections are made from literally thousands of measure-receptor combinations.

6.3.6 Dollar Per Microgram Per Cubic Meter Reduction Control Measure Selection Threshold

In this analysis, a maximum cost per microgram per cubic meter reduction threshold is used to eliminate control measures that either: 1) have little or no effect on air quality at a non-complying receptor; or 2) are extremely costly relative to the air quality benefit they achieve at a non-complying receptor. The minimum (or most cost-effective) cost per microgram is calculated as the *cost per microgram reduced for the receptor that achieves the most reduction from a control measure*. This analysis uses a threshold of $1 billion per microgram per cubic meter reduced. If the cost per microgram reduced exceeds this value for all associated receptors currently out of compliance, the measure is not selected. If all remaining measures exceed this value, the simulation ends.

The $1 billion per microgram per cubic meter reduced threshold is taken from the analysis performed for the 1996 RIA of the proposed $PM_{2.5}$ standard. In that analysis, a value above $1 billion was tested for the Midwest/Northeast control region, and the conclusion was that only a minor air quality improvement is achieved at a higher cut-off (Pechan, 1996). However, for the current analysis the effect of a $500 million and $2 billion per microgram per cubic meter control measure selection threshold is examined. The results of this sensitivity analysis are presented in Appendix D. These results indicate that the number of nonattainment counties, air quality results are not highly sensitive to the alternative cut-off levels that are evaluated. However, the nationwide incremental cost is somewhat sensitive to the threshold level. As the threshold level is doubled from $500 million to $1 billion, the incremental cost also nearly doubles. When the threshold is doubled again from $1 billion to $2 billion, the incremental control cost increases by only 16 percent.

6.3.7 Number of Monitored Counties

This analysis selects control measures with the goal of reducing $PM_{2.5}$ concentrations in projected nonattainment counties from a subset of counties currently monitored for PM_{10}. There are over 700 counties that currently contain monitors capable of measuring PM_{10} air quality, however, only 504 of these monitors meet what is referred to in this analysis as *Tier 1* criteria. Chapter 4 provides a more detailed discussion of the monitoring criteria used to establish tiers. It is possible that additional counties will contain monitors to measure $PM_{2.5}$ concentrations, and therefore the number of potential nonattainment counties could be greater than the number of counties included in this analysis. A sensitivity analysis on the number of monitored counties included in the analysis is presented in Appendix D.

6.4 EMISSION REDUCTION AND AIR QUALITY IMPACT RESULTS

This section presents the emission reduction and air quality impact results for the analysis of the newly revised PM_{10} standard and alternative $PM_{2.5}$ standards. The $PM_{2.5}$ results presented in this section are incremental to partial attainment of the current ozone and current PM_{10} standards. The results for the newly revised PM_{10} standard are incremental to partial attainment of the current ozone standard. This section includes estimates of the emission reductions and PM air quality improvements resulting from control measures selected in each control region, and estimates of the change in the attainment status for the initially projected PM nonattainment counties.

Table 6.5 presents the emission levels associated with the alternative standards. The emissions represent the level of emissions after modeled control measures are applied. The emission levels corresponding to the National $PM_{2.5}$ Strategy include reductions from measures modeled to meet the current ozone and PM_{10} standards, as well as reductions achieved by the National $PM_{2.5}$ Strategy. The emission levels do not account for potential increases in emissions due to the small additional energy requirements for producing, installing, and operating selected control devices.

Table 6.6a presents the projected number of initial and residual nonattainment counties for each $PM_{2.5}$ alternative. For the 16/65 and 15/65 standards, only a few counties (8) initially violate the 24-hour average concentration standard. The number of counties that initially violate the 24-hour average concentration standard increases to 47 when the 24-hour average concentration standard is tightened to 50 $\mu g/m^3$. For the 16/65 and 15/65 alternatives, the estimated residual nonattainment counties are driven by annual average rather than 24-hour average violations. For the 15/50 alternative, the number of counties violating the 24-hour average after control increases from 6 to 22.

Table 6.6b presents the projected number of initial and residual nonattainment counties for the new PM_{10} 50/150 (99th percentile) standard. The West control region contains the majority of projected initial and residual nonattainment counties.

Table 6.5 National Summary of Projected Emission Impacts for Alternative $PM_{2.5}$ Standards: Baseline and Post-Control Emission Levels

Pollutant	Region	Sector	2010 Baseline Emissions	National $PM_{2.5}$ Strategy	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
NOx	**Midwest/Northeast**	Area	982,080	975,588	921,777	912,513	909,455
		Mobile	2,539,129	2,529,735	2,488,984	2,470,900	2,448,567
		Nonroad	731,096	731,096	731,096	731,096	731,096
		Point	598,963	590,682	571,373	568,147	567,850
		Utility	1,961,858	1,853,260	1,853,260	1,853,260	1,853,260
		TOTAL	**6,813,127**	**6,680,361**	**6,566,490**	**6,535,917**	**6,510,229**
	Southeast	Area	390,015	389,888	384,946	383,027	383,027
		Mobile	1,208,578	1,208,578	1,208,578	1,201,445	1,201,445
		Nonroad	354,961	354,961	354,961	354,961	354,961
		Point	340,664	340,664	340,503	339,722	339,722
		Utility	749,463	662,790	662,790	662,790	662,790
		TOTAL	**3,043,681**	**2,956,881**	**2,951,778**	**2,941,946**	**2,941,946**
	South Central	Area	1,008,261	1,003,845	992,901	992,115	989,242
		Mobile	729,764	715,165	708,499	708,497	708,497
		Nonroad	387,424	387,424	387,424	387,424	387,424
		Point	597,899	590,695	559,362	557,623	557,580
		Utility	463,977	419,915	419,915	419,915	419,915
		TOTAL	**3,187,325**	**3,117,044**	**3,068,100**	**3,065,573**	**3,062,657**
	Rocky Mountain	Area	339,259	338,270	327,557	323,972	320,287
		Mobile	344,110	343,753	333,163	333,093	323,492
		Nonroad	166,444	166,444	166,444	166,444	166,444
		Point	146,006	131,758	101,370	93,799	89,829
		Utility	429,778	233,740	233,740	233,740	233,740
		TOTAL	**1,425,598**	**1,213,966**	**1,162,274**	**1,151,049**	**1,133,792**
	Northwest	Area	92,296	91,741	90,867	90,867	89,249
		Mobile	274,413	274,281	274,281	274,281	264,682
		Nonroad	84,343	84,343	84,343	84,343	84,343
		Point	93,831	88,027	88,027	88,027	72,953
		Utility	27,781	7,761	7,761	7,761	7,761
		TOTAL	**572,663**	**546,153**	**545,279**	**545,279**	**518,987**
	West	Area	208,701	193,310	185,400	185,214	184,862
		Mobile	478,403	469,834	462,766	460,448	460,416
		Nonroad	338,405	338,405	338,405	338,405	338,405
		Point	180,188	121,744	106,344	105,999	105,080
		Utility	122,236	32,476	32,177	32,177	32,177
		TOTAL	**1,327,934**	**1,155,770**	**1,125,093**	**1,122,243**	**1,120,940**

Table 6.5 National Summary of Projected Emission Impacts for Alternative $PM_{2.5}$ Standards: Baseline and Post-Control Emission Levels

Pollutant	Region	Sector	2010 Baseline Emissions	National $PM_{2.5}$ Strategy	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
PM_{10}	**Midwest/Northeast**	Area	14,943,811	14,885,028	13,664,341	13,243,888	13,209,030
		Mobile	90,992	90,967	90,785	90,700	90,678
		Nonroad	124,690	124,674	124,351	124,260	124,235
		Point	541,272	534,965	476,330	454,017	450,566
		Utility	111,048	88,803	88,803	88,803	88,803
		TOTAL	**15,811,814**	**15,724,436**	**14,444,610**	**14,001,667**	**13,963,312**
	Southeast	Area	7,830,399	7,825,067	7,805,131	7,689,958	7,689,958
		Mobile	39,480	39,480	39,480	39,457	39,457
		Nonroad	69,608	69,608	69,607	69,557	69,557
		Point	264,104	264,052	261,750	257,615	257,615
		Utility	96,748	47,752	47,752	47,752	47,752
		TOTAL	**8,300,340**	**8,245,959**	**8,223,720**	**8,104,338**	**8,104,338**
	South Central	Area	11,602,813	11,487,945	11,139,934	10,712,825	10,691,327
		Mobile	24,548	24,533	24,494	24,498	24,495
		Nonroad	80,443	80,437	80,303	80,286	80,274
		Point	225,738	218,377	184,396	180,201	180,142
		Utility	29,571	28,606	28,606	28,606	28,606
		TOTAL	**11,963,112**	**11,839,899**	**11,457,733**	**11,026,416**	**11,004,843**
	Rocky Mountain	Area	7,393,394	7,316,194	6,699,502	6,588,270	6,486,080
		Mobile	10,738	10,731	10,710	10,699	10,688
		Nonroad	26,596	26,586	26,553	26,539	26,502
		Point	34,200	32,316	28,634	27,977	27,466
		Utility	22,653	15,348	15,348	15,348	15,348
		TOTAL	**7,487,582**	**7,401,176**	**6,780,746**	**6,668,833**	**6,566,084**
	Northwest	Area	2,008,191	1,967,074	1,967,073	1,967,073	1,744,208
		Mobile	8,325	8,314	8,314	8,314	8,299
		Nonroad	16,108	16,100	16,100	16,100	16,066
		Point	63,546	58,110	58,110	58,110	34,267
		Utility	3,670	2,002	2,002	2,002	2,002
		TOTAL	**2,099,841**	**2,051,600**	**2,051,599**	**2,051,599**	**1,804,841**
	West	Area	2,686,636	2,638,386	2,400,241	2,396,093	2,360,974
		Mobile	29,486	29,321	29,194	29,175	29,103
		Nonroad	33,927	33,847	33,757	33,754	33,742
		Point	41,000	36,779	27,353	27,039	25,526
		Utility	12,979	6,744	6,744	6,744	6,744
		TOTAL	**2,804,029**	**2,745,076**	**2,497,289**	**2,492,804**	**2,456,088**

Table 6.5 National Summary of Projected Emission Impacts for Alternative $PM_{2.5}$ Standards: Baseline and Post-Control Emission Levels

Pollutant	Region	Sector	2010 Baseline Emissions	National $PM_{2.5}$ Strategy	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
$PM_{2.5}$	**Midwest/Northeast**	Area	1,108,152	1,105,657	994,215	967,697	964,434
		Mobile	62,934	62,917	62,770	62,706	62,689
		Nonroad	107,290	107,275	106,979	106,895	106,872
		Point	302,883	300,689	274,494	265,153	263,387
		Utility	43,050	39,775	39,775	39,775	39,775
		TOTAL	**1,624,310**	**1,616,313**	**1,478,233**	**1,442,225**	**1,437,157**
	Southeast	Area	751,982	751,650	748,252	733,567	733,567
		Mobile	27,541	27,541	27,541	27,523	27,523
		Nonroad	59,236	59,236	59,235	59,189	59,189
		Point	189,276	189,225	187,560	184,406	184,406
		Utility	32,497	23,870	23,870	23,870	23,870
		TOTAL	**1,060,533**	**1,051,521**	**1,046,457**	**1,028,554**	**1,028,554**
	South Central	Area	652,871	646,859	607,168	591,118	588,857
		Mobile	17,034	17,025	16,993	16,996	16,993
		Nonroad	68,230	68,224	68,101	68,085	68,074
		Point	156,143	150,221	124,594	121,823	121,811
		Utility	17,873	17,568	17,568	17,568	17,568
		TOTAL	**912,151**	**899,898**	**834,425**	**815,590**	**813,303**
	Rocky Mountain	Area	465,065	459,214	420,454	413,862	404,453
		Mobile	7,545	7,539	7,522	7,514	7,505
		Nonroad	21,762	21,754	21,723	21,710	21,676
		Point	22,334	21,632	18,679	18,210	17,885
		Utility	10,570	8,017	8,017	8,017	8,017
		TOTAL	**527,276**	**518,156**	**476,395**	**469,314**	**459,537**
	Northwest	Area	270,725	259,686	259,686	259,686	188,928
		Mobile	5,809	5,801	5,801	5,801	5,788
		Nonroad	12,426	12,418	12,418	12,418	12,387
		Point	48,611	43,452	43,452	43,452	23,423
		Utility	2,140	1,493	1,493	1,493	1,493
		TOTAL	**339,711**	**322,850**	**322,850**	**322,850**	**232,019**
	West	Area	246,787	239,924	207,058	206,847	202,979
		Mobile	19,987	19,874	19,777	19,762	19,702
		Nonroad	24,971	24,898	24,815	24,812	24,801
		Point	24,376	22,199	16,725	16,571	15,409
		Utility	5,238	4,064	4,064	4,064	4,064
		TOTAL	**321,359**	**310,959**	**272,439**	**272,055**	**266,955**

Table 6.5 National Summary of Projected Emission Impacts for Alternative $PM_{2.5}$ Standards: Baseline and Post-Control Emission Levels

Pollutant	Region	Sector	2010 Baseline Emissions	National $PM_{2.5}$ Strategy	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
SO_2	Midwest/Northeast	Area	767,035	767,035	767,035	767,035	767,035
		Mobile	183,136	183,092	183,036	182,968	182,960
		Nonroad	63,052	63,052	63,052	63,052	63,052
		Point	2,870,350	2,827,546	1,955,450	1,836,590	1,790,145
		Utility	5,570,030	2,781,020	2,781,020	2,781,020	2,781,020
		TOTAL	**9,453,603**	**6,621,745**	**5,749,593**	**5,630,666**	**5,584,212**
	Southeast	Area	293,314	293,314	293,314	293,314	293,314
		Mobile	78,096	78,096	78,096	78,084	78,084
		Nonroad	27,555	27,555	27,555	27,555	27,555
		Point	1,020,543	1,020,543	1,014,779	967,240	967,240
		Utility	2,253,170	962,810	962,810	962,810	962,810
		TOTAL	**3,672,679**	**2,382,319**	**2,376,554**	**2,329,003**	**2,329,003**
	South Central	Area	259,423	259,423	259,423	259,423	259,423
		Mobile	49,107	49,074	49,072	49,072	49,072
		Nonroad	64,117	64,117	64,117	64,117	64,117
		Point	1,335,048	1,315,486	1,252,721	1,225,970	1,225,970
		Utility	1,192,120	838,040	838,040	838,040	838,040
		TOTAL	**2,899,814**	**2,526,139**	**2,463,373**	**2,436,622**	**2,436,622**
	Rocky Mountain	Area	105,470	105,470	105,470	105,470	105,470
		Mobile	21,020	21,016	21,006	21,002	20,994
		Nonroad	10,307	10,307	10,307	10,307	10,307
		Point	306,995	297,775	244,919	230,623	205,326
		Utility	583,874	510,944	510,944	510,944	510,944
		TOTAL	**1,027,666**	**945,512**	**892,645**	**878,346**	**853,041**
	Northwest	Area	71,995	71,995	71,995	71,995	71,995
		Mobile	16,454	16,447	16,447	16,447	16,444
		Nonroad	14,663	14,663	14,663	14,663	14,663
		Point	140,764	138,432	138,432	138,432	132,874
		Utility	32,170	27,670	27,670	27,670	27,670
		TOTAL	**276,045**	**269,206**	**269,206**	**269,206**	**263,646**
	West	Area	22,163	22,163	22,163	22,163	22,163
		Mobile	61,419	61,165	61,080	61,071	61,065
		Nonroad	56,766	56,766	56,766	56,766	56,766
		Point	316,087	314,841	272,540	272,285	272,285
		Utility	114,290	114,300	114,300	114,300	114,300
		TOTAL	**570,726**	**569,235**	**526,849**	**526,586**	**526,580**

Table 6.5 National Summary of Projected Emission Impacts for Alternative $PM_{2.5}$ Standards: Baseline and Post-Control Emission Levels

Pollutant	Region	Sector	2010 Baseline Emissions	National $PM_{2.5}$ Strategy	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
VOC	**Midwest/Northeast**	Area	3,387,272	3,296,818	3,110,178	3,067,793	3,058,994
		Mobile	1,691,373	1,681,922	1,619,912	1,593,951	1,566,579
		Nonroad	759,617	759,616	759,616	759,616	759,616
		Point	1,101,612	1,098,967	1,097,996	1,097,996	1,097,996
		Utility	20,257	21,244	21,244	21,244	21,244
		TOTAL	**6,960,132**	**6,858,567**	**6,608,947**	**6,540,600**	**6,504,429**
	Southeast	Area	1,641,703	1,641,355	1,598,843	1,582,897	1,582,897
		Mobile	1,019,816	1,019,816	1,019,816	1,009,609	1,009,609
		Nonroad	359,685	359,685	359,685	359,685	359,685
		Point	428,138	428,138	427,976	427,976	427,976
		Utility	10,632	13,648	13,648	13,648	13,648
		TOTAL	**3,459,974**	**3,462,643**	**3,419,969**	**3,393,816**	**3,393,816**
	South Central	Area	1,059,321	1,040,429	986,916	985,038	981,813
		Mobile	568,203	550,930	540,687	540,685	540,685
		Nonroad	328,952	328,952	328,952	328,952	328,952
		Point	422,698	422,551	422,551	422,551	422,551
		Utility	10,317	10,565	10,565	10,565	10,565
		TOTAL	**2,389,491**	**2,353,426**	**2,289,671**	**2,287,791**	**2,284,566**
	Rocky Mountain	Area	550,376	546,095	507,600	501,216	493,682
		Mobile	255,614	255,233	238,916	238,838	227,175
		Nonroad	118,730	118,730	118,730	118,730	118,730
		Point	66,639	66,639	66,499	66,499	66,499
		Utility	4,129	4,223	4,223	4,223	4,223
		TOTAL	**995,487**	**990,920**	**935,967**	**929,505**	**910,308**
	Northwest	Area	373,140	365,636	360,593	360,593	321,672
		Mobile	195,725	195,597	195,597	195,597	185,187
		Nonroad	89,223	89,223	89,223	89,223	89,223
		Point	56,018	56,018	56,018	56,018	56,018
		Utility	1,296	1,287	1,287	1,287	1,287
		TOTAL	**715,402**	**707,762**	**702,718**	**702,718**	**653,388**
	West	Area	769,202	717,558	693,558	693,150	689,704
		Mobile	215,160	206,318	197,694	195,040	195,023
		Nonroad	231,545	231,545	231,545	231,545	231,545
		Point	89,364	86,908	86,894	86,894	86,867
		Utility	3,313	3,292	3,292	3,292	3,292
		TOTAL	**1,308,585**	**1,245,620**	**1,212,983**	**1,209,921**	**1,206,431**

Table 6.5 National Summary of Projected Emission Impacts for Alternative $PM_{2.5}$ Standards: Baseline and Post-Control Emission Levels

Pollutant	Region	Sector	2010 Baseline Emissions	National $PM_{2.5}$ Strategy	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
SOA	**Midwest/Northeast**	Area	33,153	32,324	26,857	26,117	25,975
		Mobile	11,342	11,284	10,906	10,748	10,581
		Nonroad	9,304	9,304	9,304	9,304	9,304
		Point	11,627	11,627	11,618	11,618	11,618
		Utility	262	245	245	245	245
		TOTAL	**65,688**	**64,784**	**58,930**	**58,031**	**57,723**
	Southeast	Area	15,050	15,044	13,556	13,038	13,038
		Mobile	6,686	6,686	6,686	6,624	6,624
		Nonroad	4,785	4,785	4,785	4,785	4,785
		Point	7,234	7,234	7,233	7,233	7,233
		Utility	95	84	84	84	84
		TOTAL	**33,851**	**33,833**	**32,344**	**31,764**	**31,764**
	South Central	Area	8,623	8,398	6,522	6,457	6,373
		Mobile	3,890	3,784	3,722	3,722	3,722
		Nonroad	4,436	4,436	4,436	4,436	4,436
		Point	3,734	3,732	3,732	3,732	3,732
		Utility	63	58	58	58	58
		TOTAL	**20,746**	**20,409**	**18,470**	**18,405**	**18,322**
	Rocky Mountain	Area	4,738	4,630	3,485	3,386	3,275
		Mobile	2,015	2,012	1,913	1,912	1,841
		Nonroad	1,594	1,594	1,594	1,594	1,594
		Point	738	738	737	737	737
		Utility	54	52	52	52	52
		TOTAL	**9,138**	**9,026**	**7,779**	**7,680**	**7,498**
	Northwest	Area	5,334	5,114	4,956	4,956	3,417
		Mobile	1,287	1,286	1,286	1,286	1,223
		Nonroad	1,145	1,145	1,145	1,145	1,145
		Point	979	979	979	979	979
		Utility	4	4	4	4	4
		TOTAL	**8,748**	**8,528**	**8,370**	**8,370**	**6,768**
	West	Area	5,945	5,350	4,652	4,648	4,607
		Mobile	1,699	1,645	1,592	1,576	1,576
		Nonroad	3,057	3,057	3,057	3,057	3,057
		Point	861	828	828	828	827
		Utility	14	14	14	14	14
		TOTAL	**11,576**	**10,894**	**10,143**	**10,123**	**10,081**

Table 6.6a Summary of Projected Initial and Residual $PM_{2.5}$ Nonattainment (Number of Tier 1 Monitored Counties)

Control Region	$PM_{2.5}$ 16/65					
	Initial Nonattainment			Residual Nonattainment		
	Total	Annual	24-Hour	Total	Annual	24-Hour
Midwest/Northeast	38	38	3	6	5	1
Southeast	8	8	0	0	0	0
South Central	5	5	0	2	2	0
Rocky Mountain	8	8	0	3	3	0
Northwest	0	0	0	0	0	0
West	11	10	5	8	7	5
Nation	70	69	8	19	17	6

Control Region	$PM_{2.5}$ 15/65					
	Initial Nonattainment			Residual Nonattainment		
	Total	Annual	24-Hour	Total	Annual	24-Hour
Midwest/Northeast	56	56	3	10	9	1
Southeast	16	16	0	1	1	0
South Central	7	7	0	2	2	0
Rocky Mountain	11	11	0	6	6	0
Northwest	0	0	0	0	0	0
West	12	11	5	11	10	5
Nation	102	101	8	30	28	6

Control Region	$PM_{2.5}$ 15/50					
	Initial Nonattainment			Residual Nonattainment		
	Total	Annual	24-Hour	Total	Annual	24-Hour
Midwest/Northeast	58	56	12	11	9	4
Southeast	16	16	0	1	1	0
South Central	8	7	3	2	2	0
Rocky Mountain	18	11	10	8	6	2
Northwest	6	0	6	4	0	4
West	16	11	16	15	10	12
Nation	122	101	47	41	28	22

Table 6.6b Summary of Projected Initial and Residual Nonattainment for the New PM_{10} 50/150 (99th percentile) Standard (Number of Tier 1 Monitored Counties)

Control Region	Initial Nonattainment			Residual Nonattainment		
	Total	Annual	24-Hour	Total	Annual	24-Hour
Midwest/Northeast	2	1	2	2	1	2
Southeast	0	0	0	0	0	0
South Central	1	1	0	1	1	0
Rocky Mountain	1	0	1	1	0	1
Northwest	1	0	1	1	0	1
West	6	4	3	4	2	3
Nation	11	6	7	9	4	7

Table 6.7a presents the average baseline and post-control $PM_{2.5}$ concentrations for the subset of counties in each control region that are projected to initially violate the $PM_{2.5}$ alternatives. Table 6.7b presents the same information for the new PM_{10} 50/150 (99th percentile) standard.

Table 6.8a presents the average baseline and post-control $PM_{2.5}$ concentrations for the subset of counties in each control region that are residual nonattainment for the $PM_{2.5}$ alternatives. Table 6.8b presents the same information for the new PM_{10} 50/150 (99th percentile) standard. The approximate average difference between the predicted post-control PM concentration and the attainment level in each control region can be calculated from this table. For instance, for the 15/65 alternative presented in table 6.8a, the South Central control region contains 2 residual nonattainment counties with an average post-control annual $PM_{2.5}$ concentration of 16.1 $\mu g/m^3$. This is roughly 1.1 $\mu g/m^3$ above the 15 $\mu g/m^3$ standard after accounting for the rounding convention (i.e., 15.05 $\mu g/m^3$ is considered nonattainment).

Table 6.7a Average Baseline and Post-Control $PM_{2.5}$ Concentrations for Projected Initial $PM_{2.5}$ Nonattainment Counties (μg/m³)

Region	No. of Counties	$PM_{2.5}$ 16/65			
		Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	38	18.0	48.7	15.1	40.9
Southeast	8	17.3	36.3	15.5	32.4
South Central	5	17.2	44.9	15.9	41.6
Rocky Mountain	8	18.4	48.1	16.3	42.9
Northwest	0	--	--	--	--
West	11	17.6	69.0	16.8	65.9
Nation	70	17.6	50.1	15.6	44.1

Region	No. of Counties	$PM_{2.5}$ 15/65			
		Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	56	17.2	45.0	14.1	36.9
Southeast	16	16.4	35.2	14.2	30.5
South Central	7	16.7	40.9	15.0	36.6
Rocky Mountain	11	17.5	43.4	15.5	38.5
Northwest	0	--	--	--	--
West	12	17.5	67.7	16.7	64.5
Nation	102	17.1	45.7	14.6	39.3

Region	No. of Counties	$PM_{2.5}$ 15/50			
		Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	58	17.1	45.3	13.9	37.0
Southeast	16	16.4	35.2	14.2	30.5
South Central	8	15.8	42.5	14.2	38.2
Rocky Mountain	18	14.7	47.6	13.1	42.9
Northwest	6	11.1	55.8	10.1	50.8
West	16	16.7	65.2	15.9	62.0
Nation	122	16.2	47.3	13.9	41.0

Table 6.7b Average Baseline and Post-Control PM_{10} Concentrations for Projected Initial PM_{10} Nonattainment Counties: New PM_{10} 50/150 (99th percentile) Standard ($\mu g/m^3$)

Control Region	No. of Counties	Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	2	49.9	356.7	41.8	276.9
Southeast	0	--	--	--	--
South Central	1	57.0	127.7	51.7	115.8
Rocky Mountain	1	15.8	235.8	15.2	227.1
Northwest	1	38.5	175.5	37.6	171.4
West	6	49.0	207.2	48.2	204.9
Nation	11	45.9	226.9	43.4	208.8

Table 6.8a Average Baseline and Post-Control $PM_{2.5}$ Concentrations for Projected Residual $PM_{2.5}$ Nonattainment Counties (μg/m³)

Region	No. of Counties	$PM_{2.5}$ 16/65			
		Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	6	20.4	79.0	17.5	68.0
Southeast	0	--	--	--	--
South Central	2	18.1	49.6	16.7	46.2
Rocky Mountain	3	20.9	50.8	18.1	44.3
Northwest	0	--	--	--	--
West	8	18.1	74.3	17.4	71.5
Nation	19	19.2	69.5	17.5	63.4

Region	No. of Counties	$PM_{2.5}$ 15/65			
		Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	10	19.7	68.0	16.6	57.6
Southeast	1	17.3	41.6	15.2	36.5
South Central	2	18.1	48.6	16.1	43.3
Rocky Mountain	6	18.9	49.2	16.7	43.6
Northwest	0	--	--	--	--
West	11	17.6	69.1	16.9	66.3
Nation	30	18.6	62.5	16.6	56.3

Region	No. of Counties	$PM_{2.5}$ 15/50			
		Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	11	19.3	67.9	16.2	56.9
Southeast	1	17.3	41.6	15.2	36.5
South Central	2	18.1	48.6	16.1	43.2
Rocky Mountain	8	17.1	51.5	15.1	45.8
Northwest	4	10.8	57.5	9.7	51.7
West	15	16.7	66.0	16.0	63.1
Nation	41	17.0	61.4	15.2	55.3

Table 6.8b Average Baseline and Post-Control PM_{10} Concentrations for Projected Residual PM_{10} Nonattainment Counties: New PM_{10} 50/150 (99th percentile) Standard (μg/m^3)

Control Region	No. of Counties	Baseline Concentration		Post-Control Concentration	
		Annual	24-Hour	Annual	24-Hour
Midwest/Northeast	2	49.9	356.7	41.8	276.9
Southeast	0	--	--	--	--
South Central	1	57.0	127.7	51.7	115.8
Rocky Mountain	1	15.8	235.8	15.2	227.1
Northwest	1	38.5	175.5	37.6	171.4
West	4	47.4	236.9	47.2	235.7
Nation[a]	9	44.6	244.4	41.9	223.4

a All 9 projected residual nonattainment counties are also projected to be residual nonattainment for the current PM_{10} standard.

For each alternative standard, Tables 6.7a and 6.8a indicate that the most persistent nonattainment problem occurs with counties in the West region, where less than a handful of the initial nonattainment counties are able to attain after control measures are applied. This apparent insensitivity to control can be explained in part by the high predicted background biogenic concentrations in this region. For the $PM_{2.5}$ 15/65 standard, the S-R matrix predicts that annual average biogenic organic concentrations for residual nonattainment counties in these regions ranges from 2.7 to 8.6 μg/m^3. However, the PM Staff Paper indicates the range of *total* background concentrations (i.e., organics, nitrates, sulfates, soil dust) in the western United States is 1 to 4 μg/m^3 (U.S. EPA, 1996, p. IV-13). The IMPROVE monitoring network's measurements of soil dust generally shows average concentrations less than 1 μg/m^3. Therefore, it is not unreasonable to expect biogenic concentrations in the western United States to generally be below 3 μg/m^3. If the biogenic component of the air quality in residual nonattainment counties located in the western United States (i.e., counties in the Rocky Mountain, Northwest, and West control regions) is capped at 3 μg/m^3 and total post-control $PM_{2.5}$ concentrations recalculated, the total number of residual nonattainment counties for the $PM_{2.5}$ 15/65 alternative declines to 18.

Some of the residual nonattainment counties also are predicted to have high 2010 CAA baseline and post-control levels of fugitive dust. Many of these counties contain large urban areas, where the fugitive dust fraction of total $PM_{2.5}$ mass is expected to be smaller than in rural areas. For a typical eastern urban area, recent speciated monitoring data indicate that the soil component is 5% of $PM_{2.5}$ mass. Primary $PM_{2.5}$ emissions from paved roads and construction sites account for this ambient contribution (U.S. EPA, 1997). In contrast, for the 4 eastern urban counties from the set of 30 residual nonattainment counties, the fugitive dust component of $PM_{2.5}$ averages 24%. This illustrates the propensity of the air quality model to over predict the impact of fugitive dust sources in some cases and suggests that the actual number of residual nonattainment counties may be lower. Chapter 4 discusses this aspect of the $PM_{2.5}$ air quality modeling and how it may affect the cost analyses.

6.5 COST IMPACT RESULTS

This section presents the incremental annual control cost associated with control measures modeled to meet alternative $PM_{2.5}$ standards. These results are incremental to partial attainment of the current ozone and PM_{10} standards. There are two components that make up the incremental cost results for the $PM_{2.5}$ alternatives. The first component is the cost associated with the National $PM_{2.5}$ Strategy. The second component is the cost associated with application of control measures in each of the six PM control regions. The costs reported in this analysis *do not* represent the present value of the annual cost of control measures applied on a year-by-year basis from 1997 through 2010. Rather, the costs are derived from a static framework that compares two “states”; the first state being the future year 2010 in the absence of a new $PM_{2.5}$ standard, and the second state being the year 2010 with actions taken to meet a new $PM_{2.5}$ standard. The costs reported in this analysis represent the difference in cost between these two states.

Table 6.9 presents the control cost associated with meeting alternative $PM_{2.5}$ standards, as well as the new PM_{10} standard. These costs represent partial attainment of the alternative standards, since not all projected $PM_{2.5}$ nonattainment counties are predicted to attain the alternative standards using the control measures available in the incremental control measure database. For all alternative standards, the greatest fraction of the national incremental cost for partial attainment is concentrated in the Midwest/Northeast control region.

Table 6.9 National Partial Attainment Cost for New PM_{10} and Alternative $PM_{2.5}$ Standards--Total Annual Cost[a] (Million 1990$)

Region	PM_{10} 50/150 (99th Percentile)	$PM_{2.5}$ 16/65	$PM_{2.5}$ 15/65	$PM_{2.5}$ 15/50
Midwest/Northeast	220	1,800	3,100	3,300
Southeast	--	14	130	130
South Central	170	340	1,800	1,800
Rocky Mountain	5	450	640	840
Northwest	20	0	0	340
West	27	280	310	380
National $PM_{2.5}$ Strategy	--	2,600	2,600	2,600
National Total[b]	440	5,500	8,600	9,400

a Costs for new PM_{10} standard are incremental to partial attainment of the current ozone standard. Costs for the alternative $PM_{2.5}$ standards are incremental to partial attainment of the current ozone and current PM_{10} standards.

b The national totals for $PM_{2.5}$ include the cost of the National $PM_{2.5}$ Strategy. However, the Integrated Planning Model (IPM) used to estimate utility sector impacts does not include the same control region definitions used in the PM Optimization Model, so the incremental $PM_{2.5}$ cost shown for each control region does not include the cost of the National $PM_{2.5}$ Strategy. All totals may not agree due to rounding.

6.6 ESTIMATING $PM_{2.5}$ IMPACTS AFTER ATTAINMENT OF AN ALTERNATIVE OZONE NAAQS

Many NOx and VOC control measures selected to reduce ozone concentrations also can affect concentrations of $PM_{2.5}$. Therefore, it is possible to reduce the overall cost of addressing the combination of ozone and $PM_{2.5}$ nonattainment if control strategies can be thoughtfully designed to reduce concentrations of both pollutants simultaneously. Table 6.10 indicates the potential for this type of cost savings by showing the projected number of initial ozone nonattainment areas and $PM_{2.5}$ nonattainment counties and the potential overlap. For the 0.08

5th Max. alternative, from 10 to 13 of the initial 15 ozone nonattainment areas contain at least one county projected to be nonattainment for the $PM_{2.5}$ alternatives listed. For the 0.08 3rd Max. alternative, from 15 to 20 of the initial 28 ozone nonattainment areas contain at least one county projected to be nonattainment for the $PM_{2.5}$ alternatives listed. Not shown in the table is the fact that several projected $PM_{2.5}$ nonattainment counties are located near (i.e., within a one or two county radius), but not in, projected ozone nonattainment areas. The NOx and VOC reductions occurring in ozone nonattainment areas that are near $PM_{2.5}$ nonattainment counties may also influence $PM_{2.5}$ air quality in the nearby $PM_{2.5}$ nonattainment counties.

Table 6.10 Projected $PM_{2.5}$ Nonattainment Counties Located in Projected Ozone Nonattainment Areas

Ozone-$PM_{2.5}$ Standard Combination		**Number of Initial Ozone Nonattainment Areas (Counties)[a]**	**Number of Initial $PM_{2.5}$ Nonattainment Counties[b]**	**Number of $PM_{2.5}$ Nonattainment Counties Located In Ozone Nonattainment Areas[c]**
0.08 5th Max.	**$PM_{2.5}$ 16/65**	15 (167)	70	20 (10)
	$PM_{2.5}$ 15/65	15 (167)	102	25 (11)
	$PM_{2.5}$ 15/50	15 (167)	122	28 (13)
0.08 3rd Max.	**$PM_{2.5}$ 16/65**	28 (278)	70	26 (15)
	$PM_{2.5}$ 15/65	28 (278)	102	35 (18)
	$PM_{2.5}$ 15/50	28 (278)	122	39 (20)

a Number of initial ozone nonattainment areas and counties incremental to the 2010 CAA Baseline.
b Number of initial $PM_{2.5}$ nonattainment counties incremental to partial attainment of the current PM_{10} standard; Tier 1 monitored counties only.
c There may be more than one $PM_{2.5}$ nonattainment county located in an ozone nonattainment area. The number in parentheses indicates the number of projected ozone nonattainment areas containing at least one projected $PM_{2.5}$ nonattainment county.

Appendix D of this report contains an analysis that estimates the potential effect that compliance with the 0.08 3rd Max. ozone alternative has on attaining the $PM_{2.5}$ 15/50 alternative. Following the selection of ozone control measures, the S-R matrix is used to assess the improvement in $PM_{2.5}$ air quality that is achieved by those measures. The control measures selected in the ozone analysis are not available for selection again in the PM optimization to eliminate double counting of the emission reductions and costs of a control measure. The analysis indicates that some cost savings is likely to accrue, but the level of estimated savings is small (roughly $100 million) due to projected residual nonattainment of the ozone standard. Full attainment of the 0.08 3rd Max. ozone standard is likely to further reduce the incremental cost of control for $PM_{2.5}$ alternatives.

6.7 ANALYTICAL UNCERTAINTIES, LIMITATIONS, AND POTENTIAL BIASES

Because a quantitative uncertainty cannot be assigned to every input, the total uncertainty in the emission reduction, air quality, and cost outputs cannot be estimated. Nonetheless, the individual uncertainties can be characterized qualitatively.

Air quality projections to 2010 embody several component uncertainties, such as uncertainties in emission data, emission growth rates, baseline air quality data, and air quality modeling. These uncertainties are addressed in Chapter 4. The application of control measures and their associated costs are affected by the propensity of either the emissions projection methodology or the air quality prediction methodology to overstate or understate initial nonattainment in specific areas.

As noted previously, the optimization model annual cost inputs are in the form of average incremental cost per ton reduced. Even if these cost per ton estimates are adjusted to account for source size differences (as is done for some point source controls), these adjustments do not account for other important cost-determining variables, such as source status (new versus retrofit), annual operating hours, equipment, materials of construction, and unit prices for utilities, materials, and labor.

Also, the optimization seeks least cost solutions for attainment of alternative $PM_{2.5}$ standards. Political, institutional, and social constraints may prevent the type of least cost strategies modeled in this analysis from being implemented in reality.

The least-cost optimization model also introduces a measure of uncertainty. For instance, when calculating the cost per average microgram per cubic meter reduced, the model does not count any emission reductions that are in excess of those needed to meet a specified standard. This assumption could cause the cost per average microgram per cubic meter—and, in turn, the final control costs—to be overstated or understated depending upon whether control of the precursor was beneficial.

6.8 REFERENCES

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